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Zoning the sylvan habitats of the Roudbar's Siahroud protected zone with an emphasis on the elimination of residential complexes and non-sylvan applications using the GIS/RS technology

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ABSTRACT

The Siahroud protected zone lies 35 km to the northeast of Roudbar on 49° 32 27.1 - 49° 50 45.9 eastern longitude and 36° 44 11.4 - 36° 54 26.4 northern latitude. This region came under the supervision of the Department of Environment on January 5, 2000. In the present research, aerial and satellite images, direct observations, sample-collecting and territorial photographs of the general appearance of the region have been used. The main objective of the present research is the zoning of sylvan habitats of the Siahroud protected zone with an emphasis on eradicating its residential pattern and non-sylvan applications using the GIS and RS technologies. In the first step, the contour lines and height points of the 1:25000 maps of the cartographic center has been used in order to prepare the hypsometric maps and identify the slope and slope inclination of Siahroud protected zone. The results show that the minimum height of the zone is 176 meters and its maximum is 2714 meters above the sea level. The highest level of elevated stories belong to the 1200 – 1800 meters class which constituted 45.44 percent of the whole region. The most extensive area of the slope stories belongs to the 30 – 65 class which comprises some 47.34 percent of the whole region. The inclinations of the western and southern slopes are 29.2 and 26.89 percent respectively and have involved the highest amount of the slope inclination stories level. In the next step, the 2007 IRS satellite image of Roudbar's Siahroud zone has been selected in the ERDAS software. In introducing the classes (stories), satellite images, topographic data and Google Earth images were used in the scale of 1:25000. It is noteworthy that in introducing the classes which had unidentified or indistinct land uses, the longitude and latitude were specified, the land was examined through field search, the latitude and longitude were specified using GPS and its use was made out. The algorithm used in the observed classification was Maximum Likelihood Classification. The results produced showed that the total area of the forest in the region has been 13787.79 hectares which comprises 48.73 percent of the whole region. 195.25 hectares (0.69 percent) was dedicated to garden, 132.95 hectares (0.47 percent) to garden and agronomy, 2050.42 hectares (7.25 percent) to residential complexes, 1051.17 hectares (3.72 percent) to arid lands and 11072.16 hectares (39.14 percent) to pasturage. The residential area includes one city (Barehsar) and 54 villages which with an area of 2050.42 hectares comprise some 7.25 percent of the whole region.

Key words : *Protected zone, Roudbar's Siahroud ,Geographic Information System, Satellite images, Guilan*

Introduction

International Union for Conservation of Nature and Natural Resources has announced the destruction of the habitats as the main factor in the extinction of the species. The studies carried out show that since 1600

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years ago, human being has been the main contributor to the extinction of some 75% of the birds and mammals (Ardakani, 2002), specially given that in the recent years, the man has acquired the advanced high-speed, high-accuracy and comprehensive technologies (Makhdum, 2003). With an area of 13810 km^2 (0.86 percent of the country's total area), Guilan province has a population of 2636209 with a growth rate of 1.63 percent in the year 2006. Roudbar city lies on longitude 49° 11 - 50° 5 and latitude 36° 34 - 37° 8 and is consisted of 4 districts including central district, Rahmatabad and Bolukat district, Khourgam district and Amarlu district. It has an urban population of 64910 as of 2006 with a growth rate of 1.75 percent and a rural population of 61271 with a growth rate of 0.46 percent. Of the total lands of Roudbar city which is equal to 142630.4 hectares, 19875 hectares are dedicated to agronomic lands and gardens. 4582 households use the productions of the olive gardens and are active in olive cultivation. A total of 511984 saplings of olive trees exist in the city. The climate of the region is mild and in the vernal and autumnal equinox the temperature varies from hibernal 8.2°C to vernal 20.8°C and the average temperature of 25.6°C in summer reaches to 13.5°C in autumn, giving the city a thoroughly distinctive and different appearance. The number of frosty days in the researched area reaches to an average of 17.4 days per year of which 6.4 days belong to January, 6.4 days to February and 1 one day to March. This phenomenon sometimes takes place in December, as well. Overall, the climate of the region is very humid and mild. Sometimes when hot dusty winds blow, the aridity of the weather ascends and the relative humidity falls down to 42 percent; this status causes the most dangerous situation for the forests and the forests catch fire. The maximum average rainfall of Roudbar takes place in March (35 mm) and the minimum average rainfall takes place in July and August (4 mm). The average annual rainfall of Roudbar is about 348 mm. With the rising of temperature, the rainfall decreases in such a way that in the hottest months of the year, July and August, the rainfall is minimally 4 mm. The prevailing direction of the wind in the region is westward except for May and June in which the prevailing direction of the wind is northeastward, so the prevailing direction of the wind and its annual average is westward and its speed is 11.2 meters per second. Roudbar is the highest city of the Guilan province with 250 meters height above the sea level. Generally, the roughness of the Roudbar city can be divided in two types of "mountains" and "mountainside plains." The majority of the region's roughness is consisted of elevated peaks and high mountains. Most of the times in year, the peaks are covered with snow and deep valleys are situated between them. At the foothills, alluvium plains are shaped out of the sediments and in the southern part of the central district in the territory between Majil and Lowshan, there exist hills the extent of which is quite diminutive. Of the total water reservoirs of the Roudbar city accumulated through the storage of surface and underground waters, 64.4 million cubic meters is used for agriculture, industry and home usage. Of the total area of the Guilan province, 14.5 percent equivalent to 81497.07 hectares is considered to be under the management and supervision of the Environment Department. The Siahroud protected zone with an area of 28289.65 hectares, the Lilium ledebourii flower which grows in an area of 0.6 hectares and the Harzavil cypress tree which grows in an area of 0.6 hectares are situated in the Roudbar city. The Siahroud protected zone was announced as a sylvan protected area by the Iran's Official Newspaper in the volume 2094-12 dated April 16, 2001. The aforementioned zone contains thick and open forests, pasturage lands and extensive agricultural lands, deep and watery valleys, rocky regions, several springs and permanent rivers. Several villages are located in this territory, the Toutkabon – Damasch black-top road goes through it and the peak of Dorfak Mountain is situated in its northern region. According to the investigations carried out, some one third of the whole area is purely forest. This region has beautiful natural perspectives which can help attract more tourists. As to the situation of plant covering, according to the investigations carried out, some 3 to 4 thousands hectares of the natural lands of the region in the downstream of the mountains are covered with scattered Cupressus sempervirens trees. Around 5 to 6 thousands hectares of the whole region in the upstream of the northern and southern mountains are covered with scattered thick forests in which the major species of trees can be found including beech, hornbeam, oak, maple, tilia, *Parrotia persica, Taxus baccata*, Date plum, *Juglans regia*, *Prunus avium* and *hawthorn*. A considerable pat of the region is dedicated to pasturage and agronomic lands, situated at the southern part of the region in which *Lilium ledebourii* which was already registered as a National

heritage grows. These parts are the four zones under the management and supervision of the Department of Environment. Among the most important animal species in this region we can point to Caspian red deer, roe deer, leopard, bear, wild boar, *Felis chaus*, jackal, porcupine, least weasel and birds such as grey partridge, woodcock, woodpecker, lesser-spotted eagle, common kestrel and Peregrine Falcon.

The factors threatening this region include the presence of livestock and their grazing in it, the occupation of lands for agriculture, extravagant hunting, the existence of one city (Barehsar city with a population of 1508 and 446 households) and 54 villages with a population of 14034 in 3876 households as populous centers; therefore, organizing and managing the biological diversity which is accompanied with the preservation and expansion of wildlife habitats including herbal and animal and one of the most important ways of preserving the biological diversity is the preservation and supporting of 4 protected zones. By recognizing the potentials and values of each of the regions and introducing them in the scientific and public societies, one can prevent their destruction or the challenges facing them. In the present research, the investigation of sylvan coverage and residential areas and agricultural lands in the region has been carried out using satellite images.

Materials and Methods

The Digital Elevation Model is an elevation digital map which shows the relief of the land through a cellular network. Each cell or pixel of this network is specified with a digital code which is indicative of the actual height of that point. The DEM models are presented both in 2d and 3d modes in GIS environment. To do this, the digital elevation model is first provided using the contour lines and the height points of the 1:25000 maps of cartographic center using the 3d analyst function in the ArcGIS software and then the slope and direction of slope or the classification of the land processing of Dr. Makhdum was prepared using the DEM of hypsometric maps. Roudbar's Siahroud has been selected for classification and the method used for this purpose was observed classification. In introducing the classes (ranks) the satellite images, topographical data and Google Earth images were used in the 1:25000 scale. It's noteworthy that in introducing the classes which had unidentified or indistinct land uses, the latitude and longitude were specified, the land was examined through field search, the latitude and longitude were specified using GPS and its use was made out. The main classes for the classification of the forest use (thick and semi-thick), pasturage, arid land, residential areas, garden and agronomic fields were selected. The algorithm used in the observed classification was Maximum Likelihood Classification.

The minimum height of the region was 176 meters and its maximum was 2714 meters above the sea level. The highest level of elevated stories area belonged to the 1200-1800 meters class which comprised some 45.44 percent of the whole region. The most extensive area of the slope stories belonged to the 30-65% class which constituted around 47.34 percent of the whole region. The inclinations of the western and southern slopes were 29.2 and 26.89 percent of the whole region respectively which devoted the most extensive area of the slope stories' inclination to themselves.

Results

The followings are the results of slope stories and slope inclinations in Roudbar's Siahroud protected zone.

The results show that the minimum height of the zone is 176 meters and it's maximum is 2714 meters above the sea level. The highest level of elevated stories belongs to the 1200-1800 meters class which constituted 45.44 percent of the whole region. The most extensive area of the slope stories belongs to the 30-65 class which comprises some 43-34 percent of the whole region. The inclination of the western and southern slopes are 29.2 and 26.89 percent respectively and have involved the highest amount of the slope inclination stories level.After wards , the 2007 IRS satellite image of Roudbar's Siahroud zone has been selected in the ERDAS software and the relevant method was observed classification. In introducing the classes (stories), satellite images, Topographic data and Google Earth images were used in the scale of 1:25000. It's noteworthy that in introducing the classes which had unidentified or indistinct land uses, the longitude and latitude were specified, the land was examined through field search, the latitude and longitude were specified using GPS and its use was made out. The main classes were selected for classification the forest(thick forest and semi – thick forest), Pasturages, arid lands- the residential areas, garden and agronomic lands, the algorithm

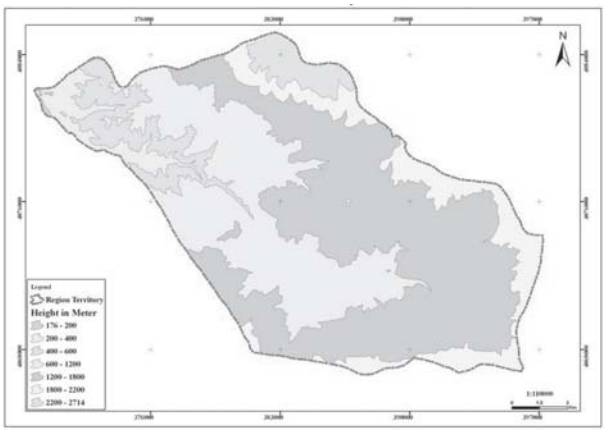

Fig. 1. The hypsometric map of Roudbar's siahroud protected zone

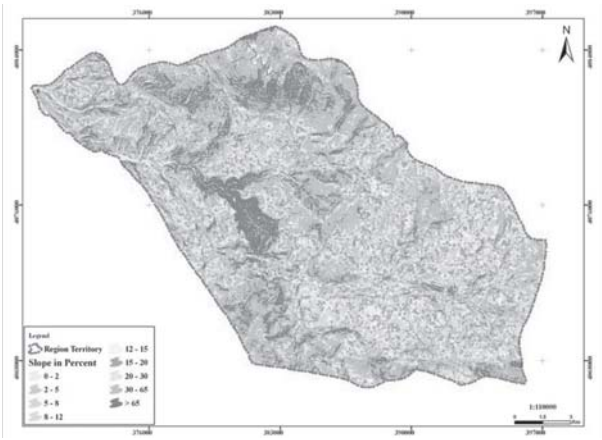

Fig. 2. The slope man of Roudbar's siahroud protected zone.

used in the do served classification was Maximum Likelihood Classification.

According to the graph, it can be said that: of the whole region, 0.69 percent was dedicated to garden, 30.84 percent to thick forest, 9.32 percent to open forest, 0.47 percent to garden and agronomic complexes, 3.72 percent to arid lands, 7.25 percent to residential areas, 39.14 percent to average pasturage, 8.56 percent to semi-thick forest and the total area of the forest in the region is 13787.79 hectares which comprises some 48.73 percent of the whole region. Given that the protected area of Roudbar's Siahrood is part of the 10 percent forest area, introducing a territory with such a forest covering might be questionable. Pasturages are divided into three branches of good, average and weak in terms of classification and in this region, it simply comprises 39.14 percent of the whole region. However, it's noteworthy that the land use of some parts of these pasturages have been altered by the indigenous inhabitants and the people have occupied the lands surrounding their residential buildings and carry out dry-land farming (wheat and barley). The arid lands are the very cliffs at the northern region which include the summit of Mount Dorfak and adjacent mountains. The residential areas include one city (Barehsar) and 59 villages which have comprised some 7.25 hectares of the whole region to with an area of 205.42 hectares.

Discussion and Conclusion

The optimal identification of a land and employing

Table 1. The area of elevated stories in Roudbar's siahroud protected zone.

Percent to the whole region	Area (hectares)	Stories elevated (meter)	Percent to the whole region	Area (hectares)	Elevated stories (meter)
45.44	12854.74	1200-1800	0.11	31.92	176-200
12.08	3416.1	1800-2200	3.63	1028.14	200-400
3.59	1016.26	2200-2714	6.63	1874.42	400-600
100	28289.65	total	28.52	8068.07	600-1200

Table 2. The area of slope stories in Roudbar's siahroud protected zone.

Percent to the whole region	Area (hectares)	Slope stories (percent)	Percent to the whole region	Area (hectares)	Slope stories (percent)
8.15	2306.7	15-20	7.48	2117.33	0-2
18.74	5301.93	20-30	0.39	110.18	2-5
47.34	13392.88	30-65	0.75	212.51	5-8
11.58	3274.81	›65	2.53	714.67	8-12
100	28289.65	Total	3.04	858.64	12-15

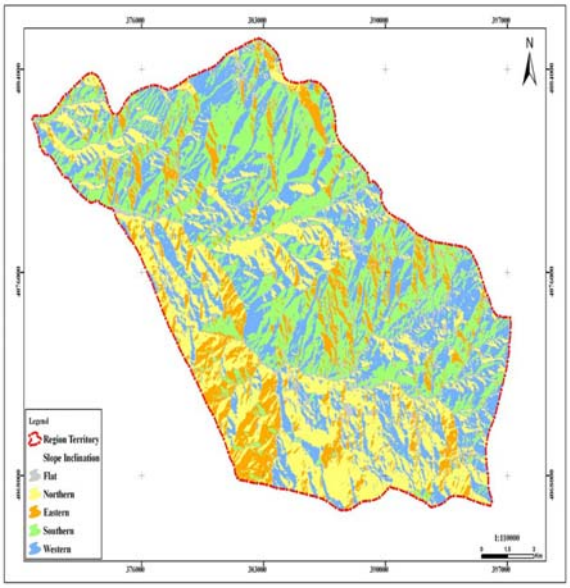

Fig. 3. The slope inclinations of Roudbar's Siahroud protected zone.

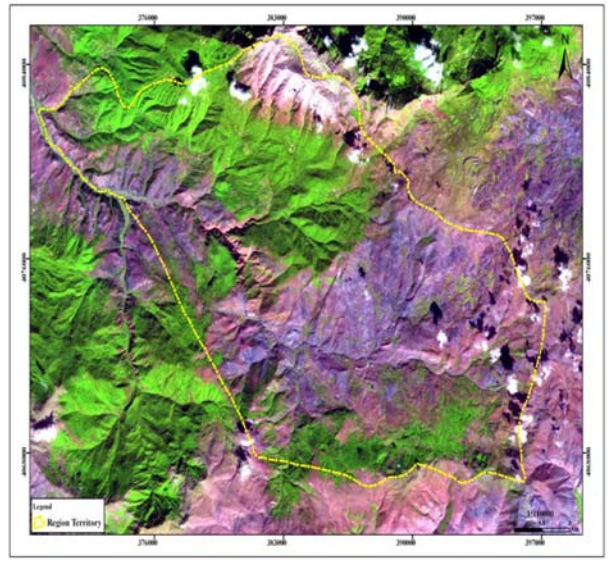

Fig. 4. The 2007 IRS satellite image map of Roudbar's Siahroud protected zone.

its natural blessings have been long of major importance and given the unmethodical growth of population in the recent years, the limitedness of the renewable resources and uncalculated employment of them have caused their destruction; therefore, the investigation and evaluation of the changes which have taken place in each of the four regions of Guilan's Department of Environment in a certain period of time using the satellite images with high resolutions and digital and print data is indispensable, so the zoning of the regions under the present circumstances can assist the managers with the improved preservation of the four regions. Raising the environmental awareness of the regional people by publishing brochures, producing movies, taking photographs, planning scientific tours and proposing environment managerial programs are effective in preserving the genetic resources and ecological values. At the current moment, one city and 54 villages are situated in the region and most of the villagers' domestic animals and cattle feed in the region. Due to the occupation of the region's lands by the inhabitants and the vulnerability of the region as a result of its geographical and mountainous situation, one should consider the modification of the

Table 3. The area of slope inclination in Roudbar's Siahroud protected zone.

Percent to the whole region	Area (hectares)	Slope inclination	Percent to the whole region	Area (hectares)	Slope inclination
26.89	7605.69	South	7.38	2088.49	Flat
29.2	8260.61	West	23.8	6734.29	North
100	28289.65	Total	12.73	3600.57	East

Table 4. The area of exited application in Roudbar's Siahroud protected zone.

Percent to the whole region	Area (hectares)	Application icon	Percent to the whole region	Area (hectares)	Application Icon
8.56	2421.71	Semi thick forest	0.69	195.16	Garden
39.17	11072.16	Average fasturages	30.84	8725.06	Thick forest
7.25	2050.42	Residential areas	9.33	2641.02	Open forest
100	28289.65	Total	0.47	132.95	Garden and agronomic complexes
			3.75	1051.17	Arid lands

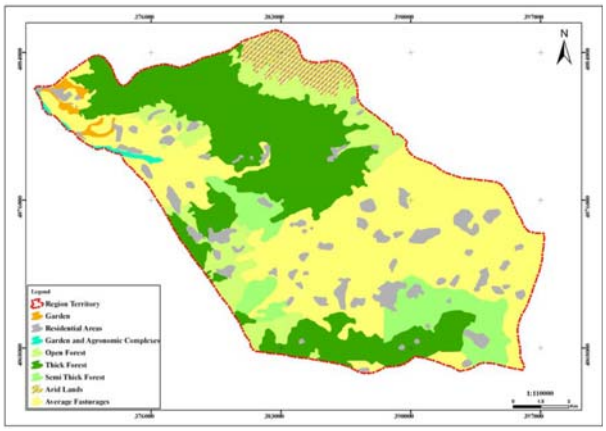

Fig. 5. The lands application map of Roudbar's Siahroud protected zone.

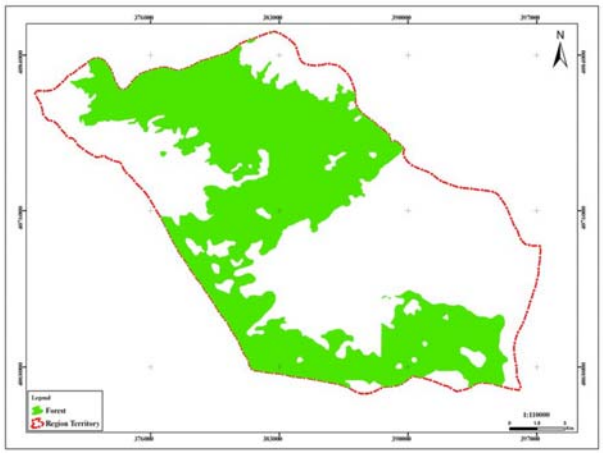

Fig. 6. The sylvan area map of Roudbar's Siahroud protected zone

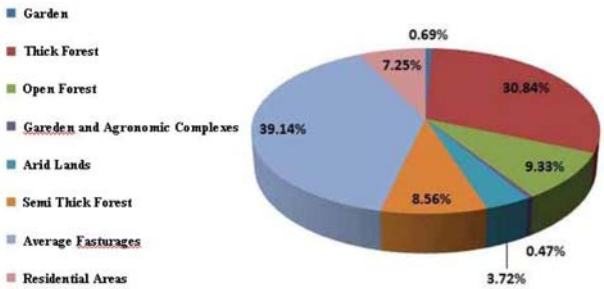

Fig. 7. The application percent of Roudbar's siahroud protected zone

boundaries of the region. The populous areas and their center of activities should be taken out of the region and an equivalent amount of jungles and forests which have biological value should be annexed to the region and the regular census of the wildlife in order to explore the population changes during several years should be brought on the agenda. Preparing the comprehensive plan of the Siahroud protected zone is vital to managing it We express our gratitude to all of the managers and experts of the Guilan's Department of Environment who supported us during the conduction of the present research. Tehran university have done the study of Lisar and Jokandan area ,Bojagh national park and Amirklayeh wildlife refuge which its final results was mentioned areas zoning according to the present usage.

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Considering the silviculture characteristics of man-made *Alnus subcordata* and *Acer velutinum* species in Iran's north forests

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ABSTRACT

In this study the manmade *Alnus subcordata* and *Acer velutinum* species that were available in parcelle 112 from Guilan province forest in North of Iran were studied from the view point of quantitative and qualitative characteristics. The inventory was done by the random – systematic method in 57 sample pieces with a 5 percent intensity. The obtained results showed that the minimum and maximum *Alnus subcordata* trees thickness growth of *Alnus subcordata* trees is 1.30 centimeter and that of the *Acer velutinum* trees is 0.98 centimeter. Also the maximum and minimum height of *Alnus subcordata* trees are 9 and 23 meters and in *Acer velutinum* species it is assigned as 9 and 18 meters. The height mean of the *Alnus subcordata* trees is 15.05 and the height mean of *Acer velutinum* trees is 14.11 meters, these trees annual height growth means are obtained in order for *Alnus subcordata* 0.75 meter and *Acer velutinum* 0.7 meter. These trees dimention means in order are calculater in *Alnus subcordata* 45.58 silve and for *Acer velutinum* 22.78 silve. As for the distribution models the number of trees in diameter classifications made clear that *Alnus subcordata* species didn't have a normal distribution but the number of distribution in diameter classifications in *Acer velutinum* species forms a normal distributions. The statistical tests show that the thickness, height and dimension of the studied trees with a 95 percent probability have a significant difference with each other. The study of the qualitative characteristics of the two *Alnus subcordata* and *Acer velutinum* species showed that only the trunk's intricacy character in the level of á = 7% and the crown's health character in the level of á= 5% are significant and the other studied qualitative characters didn't show a significant difference.

Key words : *Alnus subcordata, Acer velutinum, Silviculture, Iran's North forests*

Introduction

Afforestation means the formation of an artificial forest stand on non _ forest soils. In forest areas actually afforestation doesn't take place perhaps it is just a type of reforestation. But in the general expression we call both these methods that result in making artificial forest stands "afforestation" (Behboudiyan, 1987). By considering the growing process of natural resources demolition especially forests and the quick reduction of their areas the necessity of these resource's protection, restoration and development is strongly felt. A way of preventing the process of forest demolition and increasing the ability of their production is afforestation with local and fast growth species. Afforestation with the purpose of forest restoration doesn't have a long precedent in Iran and although the first afforestation activities began with planting the nonnative needle _ leaved trees in Guilan and Mazandaran, but these days afforestation with local species has had a great development (Bihamta and Chahooki, 2008). By studying and analyzing the geology and pedology , regional characteristics and the qualitative and quantitative parameters related to the trees trunk and crown we could take an action more certainly in a wider area about planting these species.The most important goals of this research are, studying the

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silviculture characteristics and considering the manmade *Alnus subcordata* and *Acer velutinum* stands qualitatively and quantitatively in Iran's North forests so that being successful or unsuccessful to afforestate with these species could be judged. Teleikani (2000) studied the *Alnus subcordata* manmade stands growth in two ecological fronts in Tonekabon forests. The obtained result showed that the diagonal growth of the trees in the two stands didn't have a significant difference with each other but the altitudinal growth of the eastern slope were a little more compared to the western slope (Lust, 1987). Sadighi (2002) studied the qualitative and quantitative characteristics of *Alnus glutinosa* manmade stands in Guilan's eastern forests and came to the result that this species regarded to its qualitative and quantitative characteristics has a desirable situation, the Alder afferestation has the capability to be expanded in Guilan province plain areas and this species could be used for afforestation in these areas. Of course the studied qualitative and quantitative characteristics shows the competitive capability of alder against other species in the same area (Mosadegh, 1999). Lust in 1987 studied the drainage structure and the preduction of 13 year olds *Alnus glutinosa* forests in Belgium (Mosadegh, 1996). Myastkovskii and his colleagues in 1988 studied the effect of soil drainage on the increase of Alder production in white Russia (Ukraine) (Myastkovskii *et al.,* 1988). Vaast and colleagues in 1996 studied Alder silviculturly in south east of France (Mohajer, 2005).

Materials and Methods

In the study area the first series Tootky is a part of low altitude forests and the intermediate altitude forests Shenroud's 25th district in North of Iran and it is located 25 kilometers away from Lahijan city (Fig. 1). Geographically it is located between 49° 53' 45", 49° 51' 30" longitude and 37° 5' 45" , 37′ 2' latitude. Its minimum height above the level of international waters is 100 meters and the maximum height is 950 meters and its general direction is east. Regarding the gradient these series belong to forests with slight or medium slopes so that 875 hectares have less than 30 percent slope and 5.787 hectares have 30 _ 60 percent slope and 11 hectares have 60 _ 80 percent slope and 5.2 hectares have more than 100 percent slope.

Paleontologically this series area is related to the second era, the Jurassic era and cretaceous and the lowest Jurassic sediments cover a main part of it. Also the upper cretaceous volcanic rocks which are mostly basalt have a remarkable expansion in the south series. Also the mother rock type are mostly made of hard and resistant limes and they have a appropriate penetrability.

A massed movement or soil sliding also have appropriate resistance but because of the volcanic substances exit among them the faults have been created which have decreased the resistence of these type of lands. The soil type is also red podzolic along with forest light brown color.

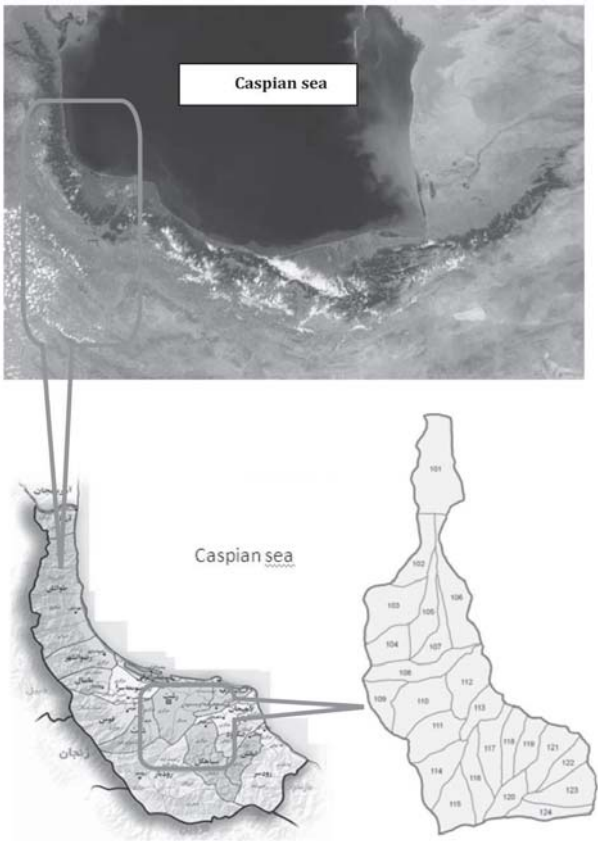

Fig. 1. The under study view map

Study method

In this study systematic random method was used for inventory in this way that the 150 ×100 meters dot grid was placed on the 1:1000 map by the use of ArcGis software and the peculiarities of each plot became distinct in the area. This dot grid was placed on the map in a way that 100 meter distances be in the direction of the plot's main slope (from north te

east). Then the plot's longitude and latitude date were give to Gps system. In this way the size of parcelle 112 (66 hectares) and the percent of the planted species *Acer velutinum* 37.9% and *Alnus subcordata* 30.3% and the total size of inventory (57 hectares) and 57 sample pieces with area of 500 square meters were estimated (8,9). Then all the trees were studied from the view point of qualitative and quantitative characteristics and their information were recorded in inventory forms. For statistical consideration and analysis spss software was used.

Results

The quantitative situation of the under study forest stand

Measuring the diameter breast height of the available trees in the sample pieces show that the most number of *Alnus subcordata* and *Acer velutinum* trees are distributed in 20 centimeter diameter class (Table 1). Also the average annual thickness growth in *Alnus subcordata* species is 1.30 centimeter and in *Acer velutinum* species is 0.98 centimeter.

Table 1. The average number in hectare according to diameter class in *Alnus subcordata* and *Acer velutinum* species.

Species type Diameter classes	*Alnus subcordata* Number in hectare	*Acer velutinum* Number in hectare
10 _ 15	33	44
20 _ 25	94	89.6
30 _ 35	54	6.4
40 _ 45	26	_

In this area the average height of *Alnus subcordata* trees is 15.05 meters and the average height of *Acer velutinum* trees is 14.11 meters. Also the average annual growth of *Alnus subcordata* species is 0.75 meters and that of *Acer velutinum* species is 0.70 meters.

In this area the average volume of *Alnus subcordata* trees is evaluated 45.58 silve and the average volume of *Acer velutinum* trees is evaluated 22.78 silve. As for the relation between the diameter breast height and total height by the use of parabolic model with the most correlation coefficient the following models were resulted that the correlation coefficient in both *Alnus subcordata* and *Acer velutinum* species at the level of 1 percent is significant. The linear regression equation between the total height and the diameter breast height in *Alnus subcordata* species is as H = 11.33 + 0.14*DBH and its correlation coefficient is 38 percent (Fig. 3).

The linear regression equation between the total height and the diameter breast height in *Acer velutinum* species is as H = 7.51 + 0.34*DBH and its correlation coefficient is 41 percent (Fig. 4).

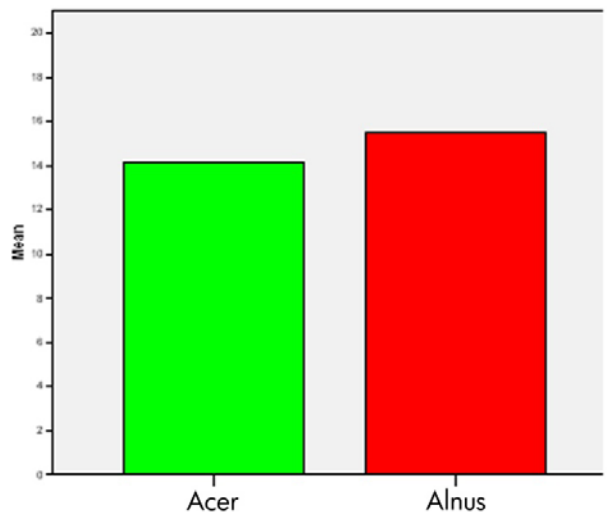

Fig 2. The average height of the two species *Alnus subcordata* and *Acer velutinum* in the under study area.

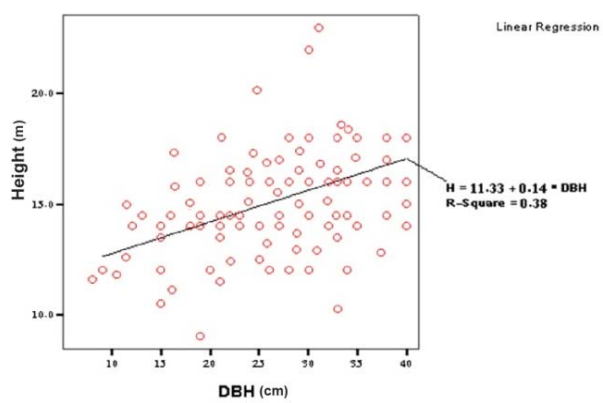

Fig. 3. The scatter diagram of the diameter breast height points and the total height in *Alnus subcordata* species.

As for the relation between the diameter breast height and volume, by the use of parabolic model with the most correlation coefficient, the following models were resulted in which the correlation coefficient in each species at the level of 1 percent is significant.The linear regression equation between the volume and diameter breast height in *Alnus*

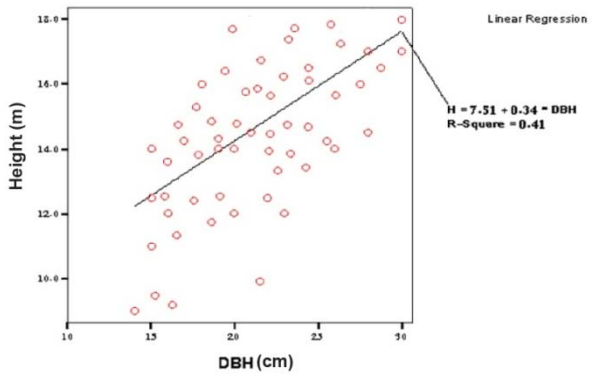

Fig. 4. The scatter diagram of the diameter breast height points and the total height in *Acer velutinum* species.

subcordata species is as V = -0.51 + 0.04*DBH and its correlation coefficient is 94 percent (Fig. 5).

The linear regression equation between the volume and the diameter breast height in *Acer velutinum* species is as V m^3 = -0.34 + 0.03*DBH and its correlation coefficient is 94 percent (Fig. 6).

The comparison of the trees quantitative characteristics by the use of χ^2 test.

About *Alnus subcordata* species, the amount of χ^2 of table (10) at a level of 5% and freedom degree of 6 from chi _ square table equals 12.592. Since the amount of the calculated χ^2 equals 35.94 and it exceeds the Table's, χ^2 with a 95 percent probability the zero assumption meaning the nonsignificant *Alnus subcordata* distribution difference is rejected. This means that the number of *Alnus subcordata* trees distribution in diameter classes in the under study area isn't a normal distribution (Table 2).

As for *Acer velutinum* species , the amount of the Table's 5 2 at a 5% level and a freedom degree of 3 from the table 5 χ^2 equals 7.815. Since the amount of the calculated 5 2 equals 6.38 and it is less than the Tables 5 2 with a 95 percent probability the number of *Acer velutinum* trees in diameter classes in the under study area has a normal distribution (Table 3).

The qualitative situation of the under study forest stand

As for the health of the trees crown and specifying the crown's type and situation and a qualitative inventory from , it was their settlement condition and situation in the area can appear in different forms (developed, weak, healthy, unhealthy). Table 4 shows the situation of the trees crown in *Alnus subcordata* and *Acer velutinum* species. As it is seen in the table, *Alnus subcordata* species with 82.10 perecent and *Acer velutinum* species with 82.90 percent from the view point of crown health, are healthy.

Table 5 also shows the quality of the trees trunks in *Acer velutinum* and *Alnus subcordata* species and

Table 2. The observed and expected frequencies of the number of *Alnus subcordata* trees in diameter classes.

$(B_i - E_i)^2/E_i$	The expected frequency (E_i)	The amount of extracted Y_i from the table	The amount of calculated (Z_i)	The observed frequency (B_i)	Diameter classes (cm)
4.16	7.64	0.0244	- 1.97	2	10
4.95	20.84	0.0885	- 1.35	31	15
3.07	38.17	0.2296	- 0.74	49	20
0.36	49.22	0.4522	- 0.12	45	25
6.73	44.26	0.6879	0.49	27	30
0.04	28.05	0.8643	1.10	27	35
16.63	11.92	0.9564	1.71	26	40

Table 3. The observed and expected frequencies of the number of *Acer velutinum* trees in diameter classes.

$(B_i - E_i)^2/E_i$	The expected frequency (E_i)	The amount of extracted Y_i from the table	The amount of calculated (Z_i)	The observed frequency (B_i)	Diameter classes (cm)
1.61	46.36	0.1292	- 1.13	55	15
0.09	80.36	0.5398	0.10	83	20
1.64	36.78	0.9082	1.33	29	25
3.04	4.36	0.9948	2.56	8	30
6.38				175	total

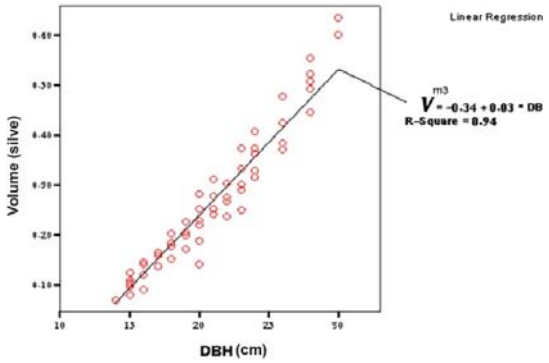

Fig. 5. The scatter diagram of the diameter breast height points and volume in *Alnus subcordata* species.

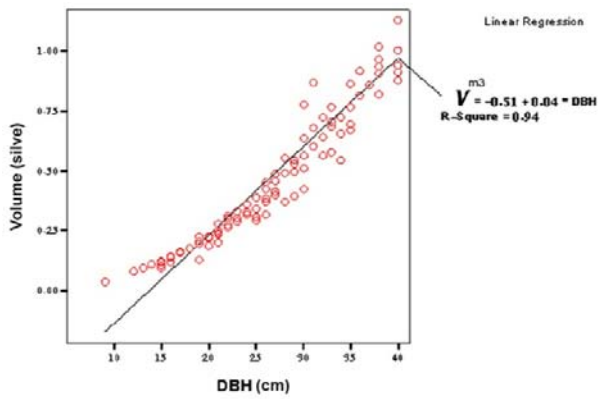

Fig. 6. The scatter diagram of the diameter breast height points and volume in *Acer velutinum* species.

according to that 84.5 percent from *Alnus subcordata* trees and 90.3 percent from *Acer velutinum* trees have healthy trunks.

Comparing the qualitative characteristics of *Alnus subcordata* and *Acer velutinum* species by the use of Kruskal – wallis test.

According to Table 6, the characteristics of the trunk's health, the trunk being cylindrical, the development of the crown and the health of the crown in *Alnus subcordata* and *Acer velutinum* species at the levels of 1 percent and 5 percent were tested and the obtained result showed that the characteristics of the trunks health and trunk being cylindrical and crown development at the level of one percent are significant and the crown's health character at the level of 5 percent has a significant difference (Telikani, 2000).

Discussion

In this study it was specified that the amount of average thickness in *Alnus subcordata* species is more than *Acer velutinum*. Also the average amount of annual diameter growth in *Alnus subcordata* is more that explains the fast growth of this species in the area. Telikani (2000) in a study that he had about the growth of *Alnus subcordata* manmade stands in

Table 4. The percent of the trees crown health in *Alnus subcordata* and *Acer velutinum* species.

The species Name / situation	developed	weak	healthy	unhealthy
Alnus subcordata	48.30	51.70	82.10	17.90
Acer velutinum	56.60	43.40	82.90	17.10

Table 5. The quality of the tree trunks in *Alnus subcordata* and *Acer velutinum* species.

The species Nam Thetrunk's quality	Healthy %	Unhealthy %	Cylindrical %	Non – cylindrical %
Alnus subcordata	84.50	15.50	68.10	31.90
Acer velutinum	90.30	9.70	60.60	39.40

Table 6. The comparison of the qualitative characters of *Alnus subcordata* and *Acer velutinum* species by the use of Kruskal – wallis test.

Character	*Alnus subcordata*	*Acer velutinum*	sig
Trunk's health	341.32	219.03	**
Trunk's being cylindrical	294.26	407.47	**
Crown's development	332.84	284.81	**
Crown's health	350.33	349.39	*

** significant at the level of 1 percent * significant at the level of 5 percent

Tonekabon area resulted that the average diameter and diameter growth of *Alnus subcordata* with a 95 percent probability has a significant different that agrees with the results obtained in this study (Lust, 1987). Sadighi chafjiri (2002) also in a silviculture study of *Alnus subcordata* manmade stands in Guilan's eastern forests came to similar results about this case. In this area the average diameter growth of *Alnus subcordata* has been 1.30 cm which amount has been more than the average diameter growth in natural stands of Shafaroud area (Marvi, 2005). The average annual altitude growth of *Alnus subcordata* species in this area has been 0.75 meters that exceeds Sadighi's research results in which Sadighi in her research (2002) obtained the average annual growth altitude in east of Guilan 0.69 meters. This case shows the better and appropriate growth of these manmade species in the study area. In a study by Sadighi (2002) the average dimension growth of *Alnus subcordata* species in east of Guilan was reported as 9.55 silve in hectare the amount which is more than the average dimension growth of *Alnus subcordata* in the under study area (9.5 silve in hectare). This is while the average dimension growth of *Alnus subcordata* in natural stands of Shafaroud district is 8.77 silve in hectare which is less than the amount in the study area.

As for the qualitative characters we could say that as the trees diameter increases and it becomes older the percent of rotten trees increases. So by considering the researches that have been done, more than 84% of both species trunks in the under study area have healthy trunks. (*Alnus subcordata* = 84.50%, *Acer velutinum* = 90.30%) this situation is because of the absence of domesticated animals and less human in terference in the mentioned areas and finally causing less damage. Unhealthy trunks in *Alnus subcordata* trees are observed more in this area. This may be because of the short period of physiologic long life of *Alnus subcordata* species that causes the appearance of pests, diseases and rottenness in the diameter in older ages (Zobeiri, 2000). In Tonekabon forests according to a research that was done by Telikani (2000) showed that the percent of healthy trunks are more than the results obtained in this research and it is about 95 percent. This amount in *Alnus subcordata* natural stand in Shafaroud district is more than 94 percent (Lust, 1987). The studies show that in the under study area cylindrical trunks are mostly related to *Alnus subcordata* species (68.10%). This is caused because of better natural pruning and consequently the production of more cylindrical trees. In the manmade *Acer velutinum* forests in Guilan, 97.4 percent of the trees were cylindrical (Zobeiri, 2000). In the *Alnus glutinosa* manmade stands in east of Guilan, more than 73 percent of trees were cylindrical (Marvi Mohajer, 2005). In natural pruning canopy, the form of the tree and the form of the trunk are very effective. Canopy is responsible for providing the energy and the food that is necessary for the tree through photosynthesis. The way that the canopy develops in the same direction is very effective on the tree's radial growth. As for the canopy development, approximately half of the *Alnus subcordata* trees have developed canopies and the other half have weak canopies. This is applied to *Acer velutinum* species but the percent of this species that have developed canopy is a little more (Zobeiri, 2000). As for the tree's canopy health, also, more than 82% of *Alnus subcordata* and *Acer velutinum* trees have healthy canopies.

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The application of the intersection of maps in the evaluation of ecological potential for the development of tourism (north of Iran)

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ABSTRACT

With an area of 5490.429 km2, Lahijan is the seventh city of Guilan province in terms of area. Lahijan city is comprised of two districts (central and Roudbaneh), 7 rural districts (Roudbaneh, Shir-jo-posht, Ahandan, Bazkia Gourab, Lafamjan, Lialestan and Lil) and 188 villages. The inhabitants of this city are of Guilaki origins and speak Guilaki language with Lahijani accent. In order to evaluate the ecological potential of the environmental effects of the tourism projects in the territory of the coastal lands of Hasan-bekandeh village of Lahijan city, the method of the intersection of maps using the automatic interpretation of the satellite images with the ArcGIS software has been used as follows. Firstly, the intended parameters (slope, height, geographical direction, application, geology, ecology and demography) were specified for the territory of the research according to the fitting model, then each of these parameters were supplied in the GIS system (ArcGIS software) and then using the intersection functions, all of the maps were intersected in the GIS system and finally the output map was produced which included all of the important environmental parameters in the tourism model and has the capability of power and suitable category for each of the usages existing in the researched territory.

Key words : *The evaluation of ecological potential, Tourism development, Maps intersection, Tourism*

Introduction

A general overview of the stages of the historical development of a number of cities in our country leads us to the fact that although the urban development has been accompanied by the superficial development of the cities and an increase in constructions along with the improvement of urban revenues from a quantitative point of view, this development has been subject to a number of challenges from the viewpoint of environmental quality. In order to better comprehend the issue, we'd better take a look at the problems such as water shortage, air pollution, lack of urban green space, unpleasant urban landscapes and the inefficiency of the transportation networks which are often considered as serious crises in the cities. Tourism in the today's modern world and especially in the knowledge-based economies has a significant and undeniable role in the economic growth and development. In its diverse and multifarious dimensions, tourism has so many important and considerable features of which one of the best ones is nature-based tourism which we hope to be taken seriously in our country.

Tourism has turned into a basis for theorization, entertainment and recreation, job-creation and entrepreneurship and in a more modern form has become an interconnected network of economic, social,

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constructional and cultural infrastructures which together function as an integrated objective and a package, contributing to the predetermined objectives of national development.

Evaluating the environmental effects and the process of investigating the impacts of the operation of a project on the environmental factors includes the physical, chemical, economic, social and cultural spaces in the construction and inauguration phases and its positive and negative consequences are explored on the basis of long-term, mid-term and short-term periods. In line with this objective and having the necessities examined above in mind, the evaluation of the environmental impacts of the recreational and touristic projects in the Hasan-bekandeh region located in the Roudbaneh's Pirashahr (Roudbaneh district) at the eastern coast of the Caspian Sea adjacent to the coastal Chaaf-Kiashahr black-top road has become the subject of the present research. With its capability in interconnecting the environmental characteristics with information technology, Geographical Information System (GIS) makes possible the precise evaluation of the ecological resources in great details with high volumes and extreme complicatedness and provides a remarkable capability in programming and evaluating with its power of combining different information and creating maps which indicate the intersection of some different conditions (Huigent, 2003).

Presuming that the Hasan-bekandeh does have remarkable potentials in terms of attracting tourists (adjacency to the coastline, adjacency to the Amirkalayeh wildlife refuge, access to road etc) and since the realization of this potential leads to development, we have carried out investigations and analysis. The purpose of environmental studies is the evaluation of power of the region's concentrated tourism and access to the programming systems for using the land and operating it in conformity with the region's capacities and the purpose of the application is the "application of the process of intersection of the maps in the evaluation of the ecological potential for the development of tourism.).

Materials and Method

Study Area

Hasan-bekandeh village is located in the Roudbaneh district of Lahijan city and the Shir-joposht rural district. The area of this village is 11430.67 hectares and lies on 50° 4 2 to 50° 13 22.6 eastern longitude and 37° 14 30.2 to 37° 23 40.5 northern latitude.

Table 1. The geographical territory of the researched area

Location	Longitude (E)	Latitude (E)
North	427508	4138943
East	431225	4131069
South	424256	4122485
West	417262	4124613

Geologically, the region is a young coastal deposit and lacks faults. The topographical situation of the region is plain and its height from the sea level is -27 meters. From the viewpoint of the land processing (Dr. Makhdum) and hypsometeric categorization, it's placed in the first class which is less than 100 meters and from the viewpoint of land processing categorization, the slope of the site is placed in the first rank. According to the ecological categorization of Amberger, the region's ecology is highly humid. The highest daily temperature of the region can be observed in May (28°c) and the lowest daily temperature can be observed in December (10.2°c). The highest amount of rainfall is observed in November (336 mm) while the lowest amount of rainfall is observed in August (21.2mm). The highest amount of relative humidity can be found in February (97%) while the lowest amount of relative humidity can be seen in January and March (91%).

The intersection method is one of the methods of evaluating the ecological potential of environment. In this method, the intended parameters are set for the territory of the research according to the fitting model, and then the maps of each of these parameters are provided for each using the GIS system (ArcGIS software). Using the intersection functions, we intersect all of the maps on each other in the GIS system. The output map is a map which contains all of the parameters and the suitable capability and category for each of the usages at the researched territory can be specified. It's noteworthy that the intersection method is more fitting in the regions which cover considerable area and have several usages.

The first stage for the implementation of the intersection method for the evaluation of the ecological potential of the researched territory is to specify the intended parameters. Firstly, the ecological models of tourism are explained, then the parameters are introduced and then the intersection method is run in the GIS system and finally the fitting ecology will be identified.

Results

The application of interaction method:

Providing the map of land shape

The first stage of intersection method is to prepare the maps of land shape. By using the interaction function of height ; slope and the direction of land shape's slope will be obtained . In categorization of the height's map , the slope and slope' direction , the land hypsometric categorization of (Makhdum, 1900) was used.

After preparing the map of slope case study territory , it was seen that this territory according to above categorization is consisted of three first class (0-2) , second class (2-5) and third class (5-8) in which the prevailing category is the first rank region The following is the slope direction map of case study territory

After intersecting the height 's maps ; slope and the direction of land shape 's slope will be obtained. Providing the maps of environmental units

Table 2. The Height categories (Dr. Makhdum)

Category number	Heights in Meters
1	0-100
2	100-200
3	200-400
4	400-600
5	600-1200
6	1200-1800
7	1800-2200
8	>2200

Table 3. The slope categories (Dr. Makhdum)

Category number	Slope in percentage
1	0-2
2	2-5
3	5-8
4	8-12
5	12-15
6	15-20
7	20-30
8	30-65
9	>65

The second stage of intersection method in the evaluation of ecological potential of the environment is to prepare the maps of the environmental units (environmental brigades) including the following steps:

1. The intersection of the map of the units of land shape and the map of the soil type and preparing the maps of environmental units of the first rank.
2. The intersection of the first rank unit map with the map of the societies or herbal types and preparing the map of the environmental units of the second rank
3. The intersection of the second unit map with the map of the plant cover and preparing the final map of the environmental units

Preparing the model of ecological potential and preparing the land potential map (the map of the categorization of lands and usages)

Given the parameters mentioned in the previous stages for the intended territory, one can decide that the fitting ecological model is the ecological model of concentrated tourism and can be placed in the first category

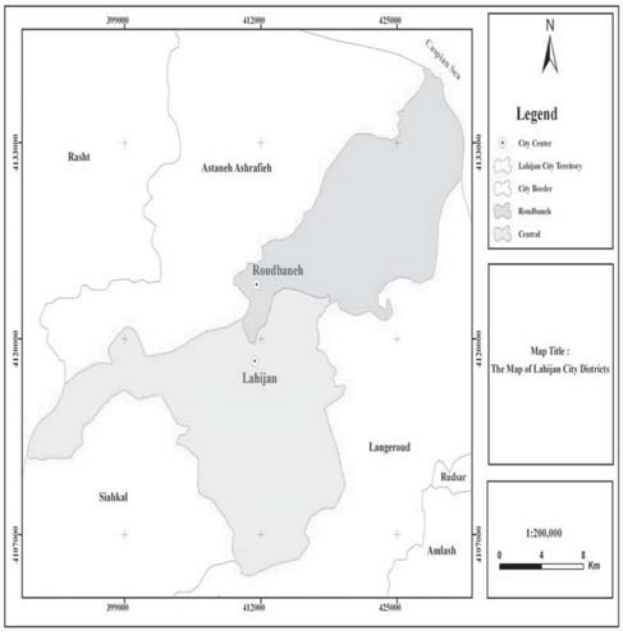

Fig. 1. The map of Lahijan City Distriets

Table 4. The slope direction categories (Dr. Makhdum)

Flat - North - East - South - West	Category 5
Flat - North - Northeast - East - Southeast - South - Southwest - West - Northwest	Category 9

After preparing the map of height categories of the case study territory, it was observed that according to the above categorization , this territory is consisted of first rank (29 - 100).

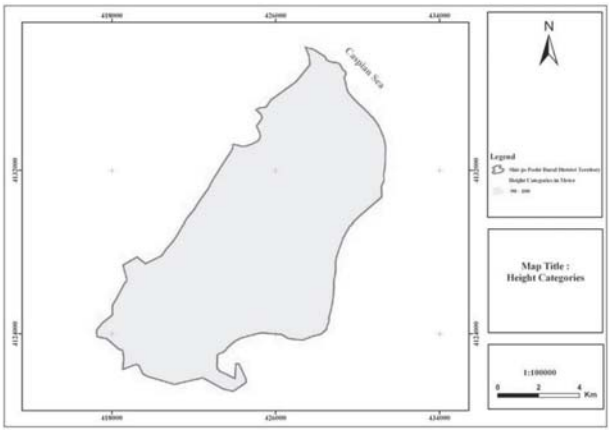

Fig. 2. Height categories Map of shir - jo - posht village

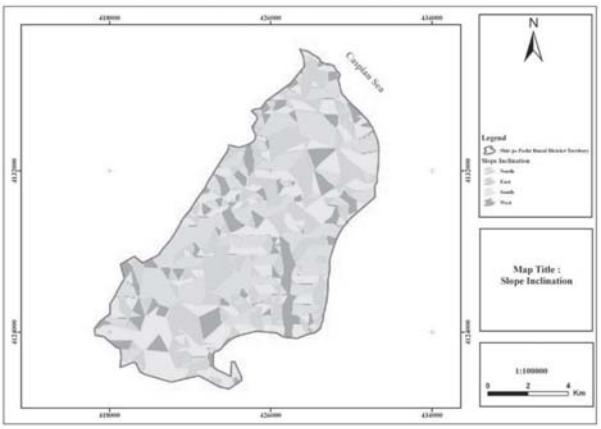

Fig. 4. The slope direction Map of shir - jo - posht village

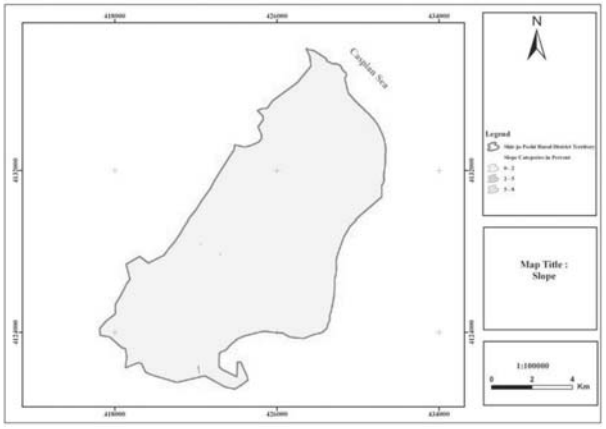

Fig. 3. The slope categories Map of shir - jo - posht village

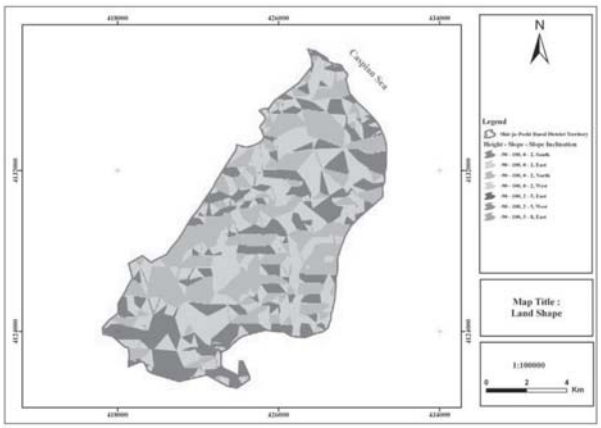

Fig. 5. The land shape map of shir - jo - posht village

Discussion and Conclusion

Given the diversity and numerousness of the properties which are effective in development, using the GIS paves the groundwork for the exploration and analysis of these data while the same job would be so difficult and time-consuming manually. The results of the evaluation of the ecological potential of the region using the method of intersection of maps for the development of the tourism of Lahijan's Hasan-bekandeh reveal that some 800.35 hectares of the whole region have the potency 2 of concentrated recreational areas and the extensiveness of the hectare is also unsuitable for tourism. Overall, the evaluation of the ecological potential of the region using the process of intersection of the maps for the development of the tourism of Lahijan's Hasan-bekandeh is a quite suitable method for evaluating the potential of tourism due to flexibility, inexpensiveness and swift access to the result.

1. Since the evaluation of ecological power is considered to be a requirement in land use planning, it's necessary that the evaluation of ecological power be carried out in every sensitive coastal region.
2. The evaluation of environmental impacts is one of the programs which can be taken into consideration as an impediment to the destruction of environment and a support for the preservation of the natural resources.
3. In addition to providing new occupational and economic opportunities to improve the economic power of the inhabitants of the region, the development of tourist regions can also help meet the recreational needs of the city and the province as a whole.sharan land use advising company used the same method for ecotourism carrying capacity (exclusive and non-exclusive recreation) for the studying of environmental

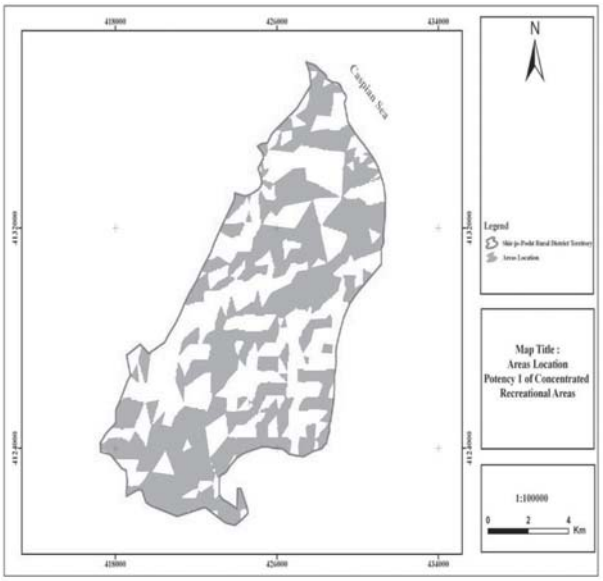

Fig. 6. The map of the position of the regions with the potency 1 of concentrated recreational areas in the Shir-jo-posht village

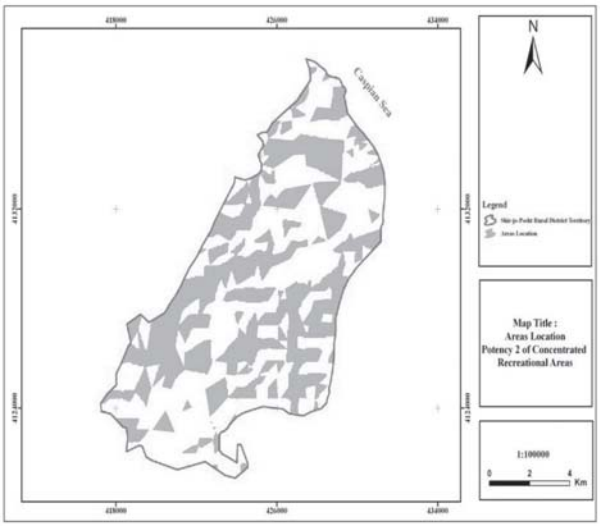

Fig. 7. The map of the position of the regions with the potency 2 of concentrated recreational areas in the Shir-jo-posht village

impact assessment in ghaleh roudkhan special ecotourism zone (region) in august 2009.

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The study of some statistical distributions in order to fit *Fagus orientalis* (Beech) trees diameter in Iran's north forests

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ABSTRACT

The distribution of the number of trees in different diameter classes is not only needed in the study of the quality of the forest stand progress but also they are used to assign the worth and the quality of production and standing stand supply. Thus recognizing and evaluating the quantitative characteristics of these stands is one of the primary need in forest programming. Nowadays, since probability distributions are very important in forest researches their application in forecasting the future of the stands can't be ignored. This study is done in order to present the most suitable diameter classes in number distribution model in a natural and uneven aged forest in which the least interference has taken place in. For this reason the number of 238 *Fagus orientalis* trees from 20, 10 R (1000 m^2) sample pieces with a network dimensions of 100×200 meters were random _systematically selected in Iran's north Siyahkal forests. I all sample pieces the trees diameter were more than 7.5 centimeters and they were full callipering and they were written down in the special forms. In order to fit the data the statistical models (distributions) normal, lognormal, weibull, beta, gamma and exponential were used. The results obtained from kolmogrof_smirnof test (k.s) showed that in the under study arena in order to fit the diameter classes in number distribution fit, normal distribution is suitable for this purpose. And the other distributions don't have the explaining ability and are not appropriate for this purpose.

Key words : *Fit, Probability, Fagus orientalis diameter classes, Iran's north forests, Siyahkal*

Introduction

The first and simplest quality that can be measured in forest stand trees is diameter breast height feature. Nowadays the number of trees distribution in diameter classes is used in different forestation and silviculture researches. For example, the forest export by the help of this curve uses the quality of operation progress in thinning and leading the forest towards regulation.

With the help of these curves which nowadays with the help of probability_ statistical distributions can be demonstrated easily, the quality of stand progress or the quality of the supply in different diameter classes in future can be predicted and it can be used in the programming (Cao, 2004). The first study that was done in Iran in this field refers to the study of the trees diameter distribution in Noshah's forests. In this study the 3 beta, weibull and negative binominal distributions were used, the results obtained from goodness fit, chi_square and kolmogrof_smirnof (k.s) tests showed that the two beta and weibull distributions don't have the ability to describe the trees diameter distribution (Bihamta and Chahouki, 2008). Nowadays frequency distributions and probability distributions have important

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roles in scientific forestation and actually in forest measurement and statistics and also forest production, frequency and statistical distributions and their application are very important (Fallah *et al.,* 2005).

Also the diameter distribution and the statistical model related to it can have an important role in some forest sciences discussions such as silviculture; for example, in some growing models it is necessary to make the diameter distribution function type and other parameters clear so that the desired model could be known (Mohammad *et al.,* 2009). In using the frequency distributions for presenting the distribution manner of the desired parameters a distribution should be used that calculates the best index composition of skew ness and kurtosis of the community distribution or in a more clear expression, the best distribution, is the distribution that evaluates the amounts of the mean, standard of deviation distribution extent in the most exact aspect (Mataji *et al.,* 2000).

in this direction a study was done to consider the trees diameter distribution in uneven aged stands in Gorazbon area Khairoud forest near Noshahr in Iran. In this study the 3 distribution beta, weibull and normal were fit to the related data ,the results obtained from chi_ square and kolomogrof_smirnof showed that the beta and weibull distributions have the ability to explain the distribution of the diameters data but the normal distribution doesn't have this ability.

In another research Fallah and his colleagues (2006) in order to study the Fagus orientalis trees diameter structure in uneven aged stands used a few regression models. In this study also the statistical models (distribution) beta, gamma, power, exponential, weibull, normal and log normal in order to consider the trees diameter data were used so that the power and agreement of these distribution could be revealed for diameter data fit (Namiriyan, 2006). During some studies shiver (1988) used the three maximum likelihood, modified moments, percentile methods to fit weibull distribution to pinus elioty diameter data (Namiriyan, 1993). Cao (2007) in another study that was done on pinus teada, the collected data from 200.6 hectare sample pieces was used. In this study the description of the trees diameter distribution was done by the distribution parameters the variables number in hectare, dominant altitude, stand 's age and relative distance of the trees were used (Namiriyan, 1993).

Materials and Methods

The study area

The study area is located in the western part of Siyahkal Shenroud forests in north of Iran and regarding to the geographical position it is located between 49º 47´ 50? geographical longitude and 36º 55´ 30? geographical latitude and minimum altitude from the sea level is 70 meters and its maximum altitude from the sea level equals 2100 meters and it's general slope is towards north. By considering that the mentioned area has 56 parcelles, a parcelle was chosen which reaching the area was easier as well as it had in tacted and uneven aged Fagus orientalis natural stands. Therefore after several sprayer forests the parcelle 751 with a measurement of 68 hectares which was located in the altitude area of 850-1000 meters was selected. Pedagogically the soil is acidic forest brown type with an average loam and argillaceous tissue and its ph is acidic. The area's average annual precipitation is 1266.5 mm and its average annual temperature is about 16 ºC. The area's climate type is humid and its relative annual humidity is 78 percent.

Study method

In order to study the quality of *Fagus orientalis* trees diameter distribution it was tried to select the areas with less interference and uneven aged forest stands. on this basis in the under study area the desired parcelle was selected and the number of 238 Fagus orientalis treed from 20 circle shape sample pieces that each of their measurement was 1000 square meters in an inventory network with the dimensions of 100×200 meters were measured. In these percales the diameter breast is recorded as 7.5 centimeters and for further calculation they were saved in mini tab and spss software's.

Statistical distributions

Beta distribution

$$f(x) = \frac{1}{B(\alpha_1, \alpha_2)} \frac{(x-a)^{\alpha_1 - 1}(b-x)^{\alpha_2 - 1}}{(b-a)^{\alpha_1 + \alpha_2 - 1}}$$

In this formula is the considered characteristic and α_1 and α_2 are distribution parameters.

Weibull distribution

$$f(x) = \frac{\alpha}{\beta}\left(\frac{x-y}{\beta}\right)^{\alpha-1} \exp\left(-\left(\frac{\chi-\gamma}{\beta}\right)^{\alpha}\right)$$

In this formula γ is the beginning point and β shows the degree of the curve and is the factor form curve.

Normal distribution

$$f(x)=\frac{\exp\left(-\frac{1}{2}\left(\frac{\chi-\mu}{\sigma}\right)^2\right)}{\sigma\sqrt{2\pi}} \quad \delta>0, \qquad \mu \varepsilon R, \quad \infty- < x <+\infty$$

Log normal distribution

$$f(x)=\frac{\exp\left(-\frac{1}{2}\left(\frac{\ln(x-\gamma)-\mu}{\sigma}\right)^2\right)}{(\chi-\gamma)\sigma\sqrt{2\pi}} \quad \delta>0, \quad \mu>0, \quad 0< x <+\infty$$

Gamma distribution

$$f(x)=\frac{(x-\gamma)^{\alpha-1}}{\beta^{\alpha}\Gamma(\alpha)}\exp(-(\chi-\gamma)/\beta) \quad \alpha,\beta>0, \qquad 0< x <+\infty$$

Γ, the symbol of gamma

Exponential distribution

$f(x) = \lambda \exp(-\lambda(x-\gamma)) \qquad y>0, \qquad 0<x<+\infty$

Considering the goodness fit

In this study the non_ parametric kolmogrof_ smirnof test was used in order to select the best fit (9).

Results

As seen in figure 1 the distribution diagram of *Fagus orientalis* trees diagram in number has a decrescent form but it's decreasing process isn't fast.

Also wide extents of trees are seen in different diameter classes that demonstrates its uneven aged structure. The existence of thick trees and extended distribution in diameter classes can be a reason for the naturalist for the above stand. In the distribution curve in diameter classes the numbers of trees with inadequate diameter are a lot and while the diameter increases the number of them decreases.

Table 1 also shows the results of the distribution calculation of 238 *Fagus orientalis* trees in 5 centimeters diameter classes that are measured in the present study stand along with the obtained evaluations from beta, weibull, exponential, gamma, lognormal evaluations from beta, weibull, exponential, gamma, lognormal and normal probable distributions.

In figure 2 the curves related to the observed frequencies of *Fagus orientalis* trees diameter in the study area and the evaluated frequencies from gamma, lognormal, normal, beta, weibull and exponential statistical distributions are shown.

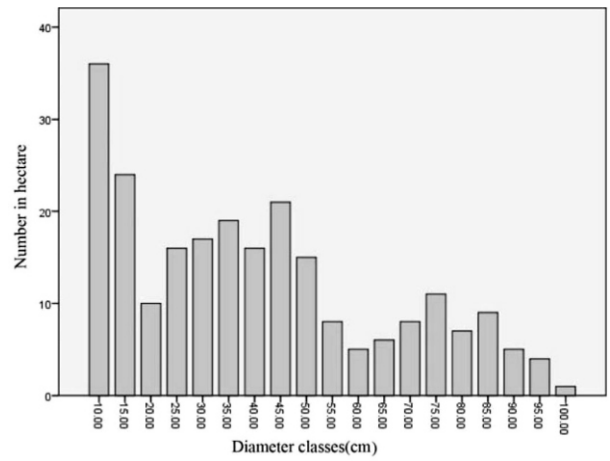

Fig 1. The diameter classes in hectare distribution of Fagus orientalis in the under study area.

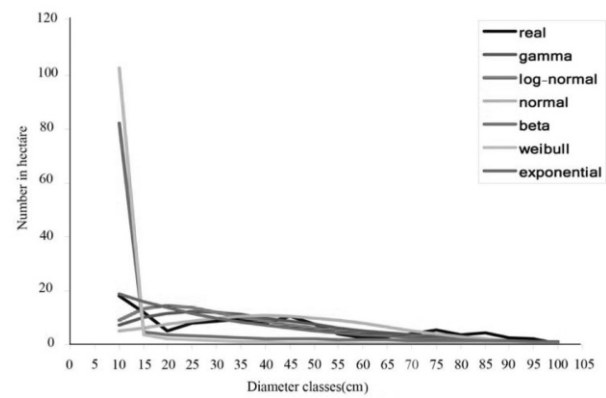

Fig 2. The comparison of the observed frequencies and the evaluated frequencies from probable distributions in the under study area.

According to the obtained results from kolmogrof_smirnof test the zero assumption from beta, weibull, exponential, gamma and log normal distributions are rejected with a 95% probability. And the only zero assumption is accepted for normal distribution (Table 2). Thus according to what has been said the normal distribution can be selected as a model with a better fit for *Fagus orientalis* trees in the study area.

Discussion

The consideration of the under study forest diam-

Table 1. The observed distribution of diameter classes in number and their evaluation with probable distributions

Diameter level	Observed quantity	Evaluated With gamma	Evaluated With log-normal	Evaluated With normal	Evaluated With beta	Evaluated With weibull	Evaluated With exponential
10	36	7.107	9.017	5.005	82.110	102.67	18.906
15	24	10.047	13.287	6.289	4.626	3.494	16.033
20	10	11.667	14.311	7.586	3.605	2.290	13.597
25	16	12.164	13.514	8.781	3.091	1.716	11.531
30	17	11.846	11.971	9.757	2.755	1.364	9.779
35	19	11.006	10.255	10.405	2.506	1.122	8.293
40	16	9.880	8.628	10.650	2.308	0.944	7.033
45	21	8.638	7.191	10.462	2.142	0.808	5.964
50	15	7.398	5.967	9.865	1.999	0.700	5.058
55	8	6.230	4.944	8.928	1.870	0.612	4.289
60	5	5.174	4.098	7.755	1.753	0.540	3.638
65	6	4.248	3.402	6.465	1.644	0.479	3.085
70	8	3.453	2.830	5.173	1.540	0.428	2.616
75	11	2.783	2.361	3.973	1.439	0.384	2.219
80	7	2.226	1.976	2.929	1.339	0.346	1.881
85	9	1.769	1.659	2.072	1.237	0.313	1.595
90	5	1.393	1.397	1.407	1.131	0.284	1.353
95	4	1.099	1.180	0.917	1.015	0.259	1.147
100	1	0.859	1.001	0.5773	0.879	0.236	0.973

Table 2. The results obtained from kolmogrof_smirnof test for the used statistical distributions

The distribution name	statistic	P-value
Beta	0.12126 n.s	0.72239
Exponential	0.15126 n.s	0.72232
Gamma	0.26695 n.s	0.10997
Log-normal	0.11729 n.s	0.9293
Normal	0.10955 **	0.95766
Weibull	0.16939 n.s	0.58858

** Significant in 5%level n.s = non _significant

eter classes in number distribution diagram shows that the stand has a kind of uneven agedness. By considering the diameter classes wide slope and its decrescent from it can be said that studied stand is irregularly uneven aged. The present study shows that in order to fit the diameter data among beta normal, lognormal, weibull, exponential and gamma distributions only normal distribution is selected as a model with a better fit for Fagus orientalis stand in the under study area. Mataji and colleagues (2000) studies show that beta, weibull, normal probability distributions have more ability in order to explain the trees diameter distribution. Namiriyan (1990) after inventory from Garazban forests in north of Iran which is an uneven aged high forest seeding crop, accomplishing the statistical tests for determing the best probability distribution from the view point of its fitness in representing the trees number distribution method in different diameter classes, it became clear that the two distributions weibull and beta have high accuracy by considering kolmogrof_smirnof test's value, beta distribution showed that in has more fitness compared to weibull distribution. Also in Nord_larson and Cao studies in 2006 weibull distribution model was used for *Fagus orientalis* trees diameter distribution (Shiver, 1988). These studies express the power of statistical distributions in describing the important distribution variables especially diameter variable which the present study also proves this claim. For this it is suggested to repeat these type of researches several times so that a deeper knowledge could be gained about forest stands and this knowledge could be used for a better and more accurate programming. It is necessary to mention that the results obtained from this study is only true for the present study area and necessarily in other studies different results would be obtained.

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Evaluation of the microbial contamination rate at swimming zones in Guilan Caspian sea South coast

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ABSTRACT

Caspian sea is the biggest brine lake in the world. And because of its rich and special geographical, ecological and biological environment that is provided a very suitable living condition for any sort of aquatic organisms. Unfortunately the entry of untreated industrial and urban sewages in rivers and also the urban solid waste and their extracts have been poured to sea by native coastal citizens that brought up many concerns about sea water's microbial quality for fisheries and entertaining usage and eventually all this will contaminate the sea. Therefore, using these natural swimming zones with having various contamination such as microorganisims are very dangerous for people and swimmers. The aim of this research is to evaluate the microbial contamination at swimming zone and its comparison with WHO standards. Three swimming zones (Anzali, Langroud, and Astara) were evaluating for total and feacal coliform counts. Also streptococcal contaminations were checked. The results demonstrated that the average of total and feacal coliform count in these areas were higher than WHO standersbut streptococcal counts averages were lower than WHO standards.

Key words : *Caspian sea, Total coliform, Streptococcus, Guillan, Swimming zones*

INTRODUCTION

The world's increasing development of industrial activities simultaneously with rapid population growth forced Man (human being) to use marine resources for their needs and survival more than ever in this context, many marine activities have done, for example: exploration, digging, construction and developing of port facilities, these activities have been caused many contaminations that were poured in to the seas. Unfortunately Caspian sea also is one of the examples. It is facing the problem of industerial, rural, urban and agricultural wastes, on one hand and lowering of salinity on the other hand. In these conditions the sea can not do self – purification and pathogenic. And entricmicroorganisms contamination will be going up. also for the reason that the level of underground water is higher than normal and it's mixture with waste and polluted materials and sewage, the Northern region have more microbial contaminations, coliforms bacteria and virus that all indicate the water infections. Presence of these contaminations in water are very dangerous and it may lead to intoxication and gastrointestinal diseases. They are divided in two categories; feacal and Non feacal coliforms. Feacal coliforms are present only in human intestine but non feacal can live in soil or on the plants. *Escherichia coli* is one of coliforms that lives in human intestine. Presence of *E. coli* in drinking water and food indi-

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cate that they are injected by faeces. If the coasts were infected by feacas and wastes, can infect aquatic organisms, coastal precipitants, see water and finally the swimmers. Recreational waters include many pathogemic and non pathogenic micro-organisms that the can induce many infections in intestine respiratory tracts. eyes, ears and skin. The aim of this study is to evaluate of microbial contamination rates of swimming zone and its comparison with WHO standards in Guilan province.

Geographical location at province and case study region

Guilan province is located between (36degree, 34 Minute to 38 degree and 27 Minute North latitude) and (48 degree, 53 Minute to 50 degree and 34 Minutes East) length from prime meridian. The length of province from western north to eastern south (* Chaboksar to Astara) is 270 kilometers, and its width is 105 km. The distance of mountain and sea in its lowest level is Gasemabad. According to the latest administrative divisions (end af September 2006) this province has 16 town 49 cities, 43 districts, 109 rural districts and 2927 rural communities. Based on the last census in 2005, the total population of Guilan is 2404861 and the population density is 171 km.

Table 1. The Geogtaphical location of case study's swimming zones

Row	The sampling name station	North latitude	East length
1	Astara	4245505	314182
2	Anzali	4152044	355088
3	Langroud	4119935	435026

Fig. 1. The Map of sampling stations location in Guilan province

Case study regions are the coastal parts at Langroud, Anzali and Astaraprovinces.

Materials and Methods

Three stations were selected from swimming zones in Caspian sea's coasts, and based on WHO standards (WHO/EEC 1996) quantity and quality of microbial contaminations were evaluated every 2 weeks and then every month. The samples were obtained in swimming and non swimming seasons. The samples were taken from one meter depth and used in 250-500 mL pre bottles. The place and date were published on bottles, then they put in under zero's flasks and transfered to Guilan's environmental laboratory for examinations. The MPN (most probable number) method was used for samples, then the results were confirmed. In this research total coliforms,feacal coliforms and feacal streptococcus as indictors were evaluated.

1. Probable Examination

This method was used from lactose broth or MacconckeyBroth with Durham tubes. Three dilutionsof samples (10^{-1}, 10^{-2}, 10^{-3}) were prepared by using these medias. Then they were put in 35 -$^{+}$ 0.5^{0} C incubator for 24 hours.

The turbidity is not seen, the culture was continued for another 24 hours. The positive samples were collected by producing gass and turbidity in cultures.

Comfirmatory examination

The positive samples were cultured in Brilliant Green lactose broth (BGLB) with durham tube. The media is selective for coliform bacteria and other microorganism can not growth in these medium. After incubation a loopfulof this medium was cultured on PSE agar, and incubated at 35-$^{+}$0.5^{0}C for 24 hours. Presence of brownish – black colonies with brownish zone indicated the positive reaction.

A-MPN for feacal streptococcus

It was performed in the same way as coliform for finding these bacteria, three dilution of samples were used but in Azid dextrose broth and the samples were incubated at 41.5^{0}C for 24 hours. If turbidity is not seen. The cultures were continued for another 24 hours. The positive samples were collected by producing turbidity in culture.

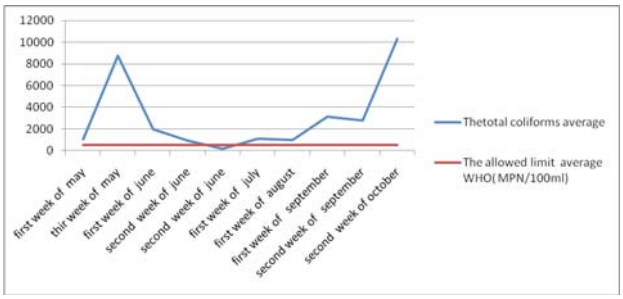

Fig. 2. The amount of Total coliforms in sea water's coast of Anzali (Coastal project of Sefidkenar) .

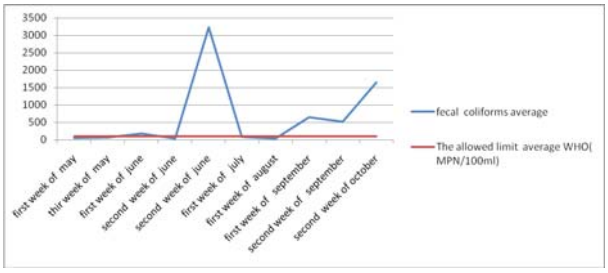

Fig. 3. The feacal coliforms average in sea water's sample of coast of Anzali(Coastal project of Sefidkenar)

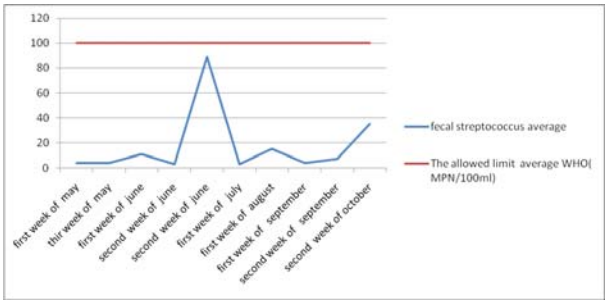

Fig. 4. The feacal streptococcus average in sea water's sample of coast of anzali (coastal project of Sefidkenar) .

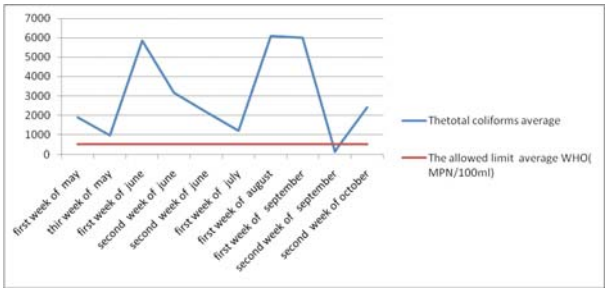

Fig. 5. The total coliform average in sea water's sample of Astara coast (Coastal project of sadaf)

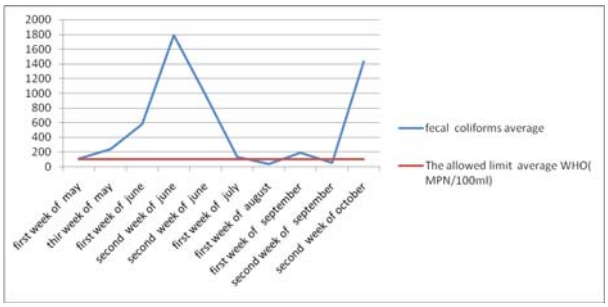

Fig. 6. The feacal coliform average in sea water's sample of Astara coast (coastal project of sadaf)

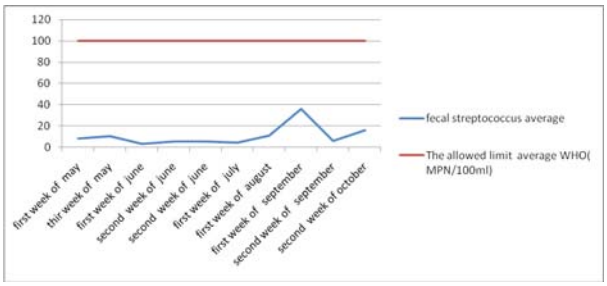

Fig. 7. The feacal streptococcus average in sea water's sample of Astara coast (coastal project of sadaf)

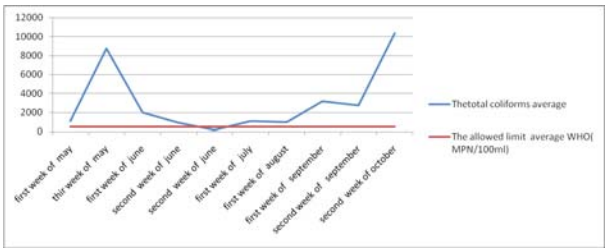

Fig. 8. The total coliform average in sea water's sample of Langroud's coast

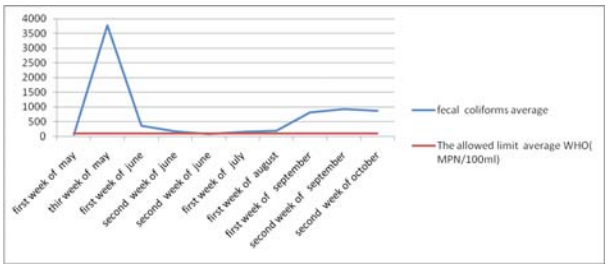

Fig. 9. The feacal coliform average in sea water's sample of Langroud's coast

Table 2. The provisions of Microbial quality of swimming zone's water

The minimum sampling frequency	Compulsory	recommended	Type indicator	Row
Fort nightly	10000	500	The total coliform (Number in 100 mL)	1
Fort nightly	2000	100	E .coli (Number in 100 mL)	2
Fort nightly	400	100	Fecal streptococci (Number in 100 mL)	3
In necessary condition	6-9	7/2-8	PH	4

Confirmation

A loopful media from positive sample media was cultured in PSE agar and it was incubated at 35 °C 0.5 for 24 hours. Presence of brown-black colonies with brownish zone indicated the positive reaction. Then, the contamination rate was determined by using Table.

Results

The comparative the total coliform average results between Anzali's swimming zone and WHO standards.

The comparative analysis results of microbial experiments in the sea water of Astara's swimming zones (confidence % 95)

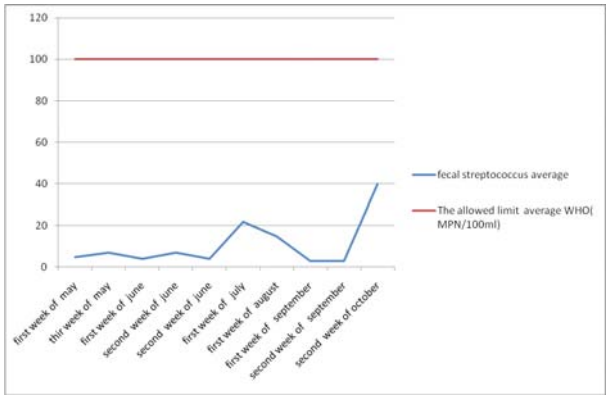

Fig. 10. The feacal streptococcus average in sea water's sample of Langroud's coast

Table 3. Bacteriological features of swimming pools (Institute of standards and industrial research of Iran)

The allowed limit number in 100 mL	Type indicator	Row
460	Total coliforms (Number in 100 mL)	1
100	E.coli (Number in 100 mL)	2
100	Fecal streptococci (Number in 100 mL)	3
7/2-8	PH	4

The comparative analysis results of microbial experiments in the sea water of Langroud's swimming zone (confidence %95) with WHO.

Discussion

A. Astara's swimming zone

Total coliform's average in spring. Summer and autumn were increasing. So that their counts were incredibly high. The highest total coliform count was 24000 MPN /100mL in Astara's swimming zone on November. The total coliform count average was higher than WHO standards in all months Feacal coliform count average was lower than WHO standards with the exception on July (1119 MPN / 100mL) and November (1437/100mL). Feacal streptococcal count,was always lower than WHO standards.

b. Anzali's swimming zone

total coliform's averages were increasing between June until November, with the exception at August. The highest rate was counted on November (24000 organism /100 mL) feacal coliform's averages were lower than WHO standards, with the exception. July (1148 organism/100 mL). October (585 organism/ 100 mL) and November (164 organism/100 mL), feacal streptococcal counts were lower than WHO standad.

C. Langroud's swimming zone

Total coliform's average was high in June but gradually it decreased in July, August and September. Then, it increased in October and November. As the highest feacal coliform count was measured in November (10333 organism/100) feacal coliform's average was very high in June (1918), and, it decreased in summer, then. it was increased in winter thefeacalstreptoccal count was lower than WHO standard. Total coliform's averages were higher than Who standard s in all averages were higher

than who standards in all evaluated months. This averages on June, October and November were higher than summer feacal coli form averages were higher than WHO standards in June. October and November and theychanges as the same as total coliform averages

Acknowladgement

My final thanks are due to all my colleagues from Guilan's Environmental laboratory who helped me a lot to brought this research into its present existence.

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The study of *Quercus castaneifolia* (Oak) trees diameter frequency fit by applying some probability distributions in Iran's North forests

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ABSTRACT

In order to study the Oak tees diameter breast height 367 trees from Oak un-even aged forest were selected randomly from Iran's north forests and their diameter breast heights were measured .The under study area's Land measurement was 60 hectares and in order to determine the best inventory network ,the random systematic inventory method with the inventory network of 200×100 meters was used. The inventory intensity was 5% and the sample pieces were considered 10R (1000 m^2) circle shape. All trees from 7.5 cm diameter above were measured and then the data-was analysis with Mini tab, spss soft ware. After the primary studies beta, weibull, exponential, gamma, log-normal and distributions were used for data fit and the obtained results showed that the data in the under study area have more agreement with gamma distribution and the other distributions don't have much ability to fit the collected data.

Key words : *Fit, Statistical distributions, Tree's diameter, Oak, Iran's north forests.*

Introduction

Iran's north forests not only in comparison with other four growing areas have monopolistic character but also in the world it is considered as an exception for its oldness and actually it is one of the world's natural inheritences. Besides these forests by having various tree, shrub and vegetation species are economically, socially and environmentally very important. In this direction the north Oak forests are considered one of the most valuable forest types. The reduction of these forests areas for different reasons, causes the necessity of performing the research programs more quickly about these valuable species. So fundamental steps should be taken for recognizing forest stands and it should be tried to increase the qualitative and quantitative efficiency of these species. This study is in the direction of recognizing Oak trees forest stands in the under study area. One of the most important characteristics for forest trees external measurements, is the diameter breast height variable. The tree's diameter can be studied from different aspects as an example the diameter distribution for a forest or stand trees can be determined and studied and this itself shows the forest or stand diameter structure. In the meanwhile the diameter distribution and its related statistical model can have an important role in silviculture and forest management. The diameter distribution function type and its parameters should be clear so that the considered model could be made. For this reason since the past the silviculturists have tried to consider the trees distribution in diameter classes with the help of statistical and mathematical methods (Namiranian, 1991).

In a study that Nord–Larson and Cao (2006) has done for presenting a model for *Fagus orientalis* trees even aged diameter distribution in Denmark, he studied weibull distribution and he considered the application of this distribution an appropriate distri-

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bution. The model was made on the basis of the distribution function parameters and by the use of non–linear least squares. The applied data in this study were collected from stable sample pieces and he suggested that about young stands (below 40 year) the distribution application should be used more accurately (Nord-Larson and Cao, 2006). Cao (2004) in another study that was done on *Pinus teada*, used the collected data from 20, 0.6 ha sample pieces. The description of the trees diameter distribution was done with the help of three parameter weibull distribution. And for predicting the distribution parameters he used the number in hectare, dominant altitude, the stands age and the trees relative distance variables. Nanang (1998) in a study on *Azadirachta indica* species in Ghana considered the three normal, lognormal, weibull distributions. The weibull distribution parameters were evaluated with the three maximum likelihood, moment, percentile methods, and among these three methods the maximum likelihood and moment had better predictions in comparison with the observed quantity. The result obtained from kolmogrof-smirnof test showed that the evaluation that was done indifferent age groups, log-normal distribution has an appropriate fit. In case it is mixed in all age groups weibull distribution with moment method can have a good evaluation but normal distribution can't have a correct description of the data (Nanang, 1998). Mataj and Namiranian, (2002) also did a study for considering the trees diameter distribution in un–even aged stands in Khairoud Kenar Gorazbon forest of Normal distributions were fit with the related data. The result obtained from chi–square and kolmogrof–smirnof tests showed that the two beta and weibull distributions have the power to explain the diameter data distribution, but normal distribution doesn't have such power (Mataj and Namiranian, 2002). Namiranian (1993) also in order to study the trees diameter breast height distribution quality in un–even aged stands and their fit by the means of statistical distribution did a study in Iran's north forests and after the primary considerations the three exponential, gamma and log-normal distributions were used to fit the data . The tests results showed that exponential distribution doesn't have the ability to explain the trees diameter distribution and among the two other distributions, gamma distribution is more appropriate for this purpose (Namiranian, 1993).

Materials and Methods

The study area with 60 hectare land measurement is located in Shanderman Siyahkesh area and it is in Masal town zone in north of Iran. The mentioned district is in the geographical area between 49 degree and 30 minutes northern latitude 37 degree and 30 minutes. The studied pieces are located on 100 to 250 meters above the sea level, the area's direction is eastern and its average slope is between 0 to 30 percent. Pedologically the soil type is light brown. The soil tissue is sandy loam to clayish and its structure is heavy with weak penetrability and good stability. The average annual precipitation of the study area is 1003 mm and the average annual temperature is 15.89 degrees. The climate type according to Emberge's method is considered to be very humid.

Study Method

Since the purpose of this research is the study of Oak species diameter frequency fit by the use of some probability distributions, in the first step it was tried to choose the Oak's natural stands in which no interference has taken place or those with the least interference, so at the beginning of the study 1:25000 map was provided and after sprayer forest in the area, Siyahkesh 12 series witness district was chosen that is Oak species seed extraction area. In order to determine the best inventory network, the random systematic inventory method with 100*200 meters inventory network was used . The inventory intensity was 5% and the sample pieces were considered 10R (1000 m^2) circle shape. All trees from 7.5 centimeters above were measured. In order to do the desert inventory at the beginning according to the need a form was prepared and after the inventory and collecting the data, the obtained data were exactly saved in Excel software and by the use of spss and Minitab soft wares. The measurements related to the trees diameter was done by caliper to diameter breast hight with centimeter accuracy and in order to case the analysis the obtained diameters were classified in 5 centimeter classes and diameter classes in number distribution curve was drawn. Then normal, gamma, log normal, beta, exponential, weibull distributions were calculated and they were compared together, for selecting and presenting an appropriate model among the mentioned distributions for the study area, the mentioned distributions were studied and evaluated by the observed measured sample pieces and finally a model or distribu-

tion was selected as the appropriate model that presents the best and most fit through the observed studies.

Statistical distribution

In this study normal, gamma, lognormal, beta, exponential, weibull statistical models (distributions) were used which their density function is as follows.

Normal distribution

$$f(x)=\frac{\exp\left(-\frac{1}{2}(\frac{x-\mu}{\sigma})^2\right)}{\sigma\sqrt{2\pi}} \quad \delta>0, \quad \mu\in R, \quad \infty-<x<+\infty$$

Gamma distribution

$$f(x)=\frac{x^{\alpha-1}}{\beta^{\alpha}\Gamma(\alpha)}\exp(-x/\beta)$$

Γ is the symbol of gamma function, $0<x<+\infty$ and α, β>0

Log-normal distribution

$$f(x)=\frac{\exp\left(-\frac{1}{2}\left(\frac{1nx-\mu}{\sigma}\right)^2\right)}{x\sigma\sqrt{2\pi}} \quad \delta>0, \quad \mu>0, \quad 0<x<+\infty$$

Beta distribution

$$f(x)=\frac{1}{\beta(\alpha_1\alpha_2)}\frac{(x-a)^{\alpha_1-1}(b-x)^{\alpha_2-1}}{(b-a)^{\alpha_1+\alpha_2-1}}$$

X is the desired character and α and β are the distribution parameters.

Exponential distribution

$$f(x)=\lambda\exp(-\lambda(x-y)) \quad y>0, \quad 0<x<+\infty$$

Weibull distribution

$$f(x)=\frac{\alpha}{\beta}\left(\frac{x-y}{\beta}\right)^{\alpha-1}\exp(-(\frac{x-y}{\beta})^{\alpha})$$

Y is the beginning port and β shows the amount of the curve and á the curves factor form

Studeying the goodness Fit

To use the statistical distribution, it should be determined at the beginning which statistical distributions are better and actually it should become clear that the observed data have a better fit with which distribution, for this the goodness fit test is used that has different methods. One of these methods is to draw all the probability distribution curves and selecting the probability distribution which points, have the most proximity with the observed distribution curve (which in this method distinguishing among them is very difficult). Another method is using the classic tests such as chi-square and kolmogorov-smirnov that in this study kolmogorov-smirnov was used for the best statistical distribution fit.

Results

According to the 5% inventery by the random systematic method 367 Oak trees were recognized and the results are presented in Table 1.

Table 1. The Oak trees diameter classes in number frequency in the under study area

Diameter class	Number	Percent	Number in class
15	66	18	22
20	55	15	18.33
25	49	13.4	16.33
30	39	10.6	13
35	30	8.2	10
40	26	7.1	8.67
45	21	5.7	7
50	14	3.8	4.67
55	10	2.7	3.33
60	16	4.4	5.33
65	21	5.7	7
70	11	3	3.67
75	8	2.2	2.67
85	1	0.3	0.33
Total	367	100	122.33

Figure 1. Also shows the Oak trees diameter classes in number distribution diagram in the under study area. As observed the number of trees in the lower diameter classes are more and it shows an un-even aged Oak forest.

Table 2 also shows the distribution calculation results of 367 Oak trees in 5 centimeter diameter classes along with the obtained evaluations from normal, gamma, lognormal, beta, exponential, weibull probability distributions.

Table 2. The observed diameter classes in number distribution and their evaluation with probability distribution

Diameter class	Frequency	Evaluated with gamma	Evaluated with log-normal	Evaluated with normal	Evaluated with beta	Evaluated with weibull	Evaluated with exponential
15	66	12.392	13. 073	8.951	85.927	120.158	28.853
20	55	15.984	18.53	11.294	6.969	0.665	22.237
25	49	17.172	19.347	13.68	5.072	0.346	17.138
30	39	16.434	17.292	15.267	4.126	0.233	13.208
35	30	14.521	14.18	15.698	33.505	0.175	10.18
40	26	12.103	11.059	14.871	0.041	0.14	8.845
45	21	9.648	8.373	12.979	2.668	0.116	6.046
50	14	7.424	6.228	10.437	2.352	0.099	4.66
55	10	5.553	4.587	7.732	2.074	0.086	3.591
60	16	4.057	3.361	5.278	1.822	0.076	2.768
65	21	2.906	2.459	3.319	1.587	0.068	2.133
70	11	2.047	1.799	1.923	1.363	0.061	1.644
75	8	1.421	1.319	1.026	1.142	0.055	1.267
85	1	0.66	0.715	0.228	0.676	0.047	0.752

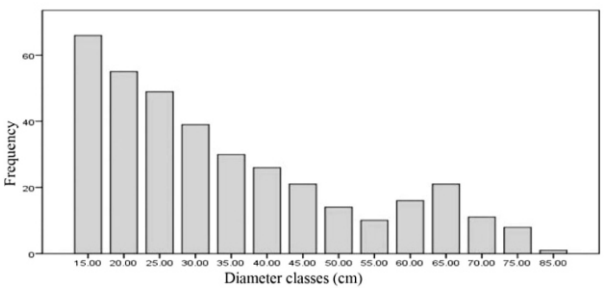

Fig. 1. The Oak species diameter classes distribution in the study area.

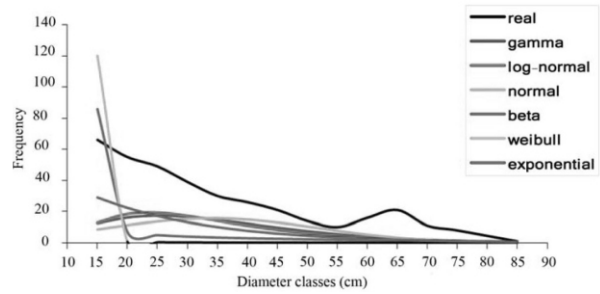

Fig. 2. The comparison of the observed frequencies and evaluated frequencies from Oak species diameter probability distributions in the study area.

Figure 2. Shows the curves related to the observed Oak trees diameter in the study area and the evaluated frequencies from gamma, lognormal, normal, beta, weibull and exponential statistical distributions.

Table 3 shows the kolmogorov-smirnov test for the probable distributions in the under study area for the Oak species

According to the obtained amounts from this test (Table 3) it is determined that gamma distribution with the least statistic and the most p value has shown a significant difference whit the observed frequencies in the study area. Actually the observed distribution in the study area is a random sample from the society which its characteristics are explained by gamma probability theory. Thus, gamma model with a better fit can be selected for describing the study area forests.

Table 3. The studied probability distribution in Oak trees diameter breast height by the use of K.S test.

Row	Distribution type	Statistic	P- value
1	Gamma	0.1214**	0.97
2	Log-normal	0.1236 n.s	0.96
3	Normal	0.1643 n.s	0.78
4	Weibull	0.1798 n.s	0.6915
5	Exponential	0.1798 n.s	0.6915
6	Beta	0.3274 n.s	0.077

n.s= non significant ** = significant in %5 level

About the other probability distributions it has been determined that the differences among exponential, beta, normal, lognormal and weibull distributions with real amounts have significant differences and this means that these distributions don't have high accuracy to present different diameters in trees distribution method.

Discussion

This study showed that the study stand are un-even aged and this un-even agedness by considering that

this study occurred in the witness piece has occurred naturally, and that is because there has been no type of interference in these stands. For this reason by evaluating the under study stand diameter classes in number distribution method it can be used as a method for directing the other forest stands of these areas as un-even aged seeding crop method (Fallah *et al.,* 2005). As Nanang has mentioned (1998) the application of appropriate probability theories for predicting the distribution situation of the number of trees in a forest stand not only is important for the production type in different ages but also it will guarantee optimum economical production and the stands resistance (Nanang, 1998). In this research the statistic consideration shows that the under study natural stands in Guilan Siyahkesh district in Caspian site totally from the view point of diameter classes in number distribution agrees with gamma model and it doesn't have a significant difference with the cloud of points and for this reason the provided gamma model by having the least amount of statistic, presents the best situation. Mataj (1998) also in diameter classes in number distribution in natural forests in Iran Noshar Gorazbon series mentioned hat beta distribution can be used for predicting the stands situation. Using appropriate probability distributions for predicting the distribution situation in a forest stand would be very effective in research operation programming, deterring evolution phases, yield tables and assigning the forest structure. At the end it is necessary to mention that results obtained from this study are affected by data of this study and necessarily they won't be repeated in other studies. Finally, it is suggested that this kind of study to be done in other Oak sits in north of Iran separately so that different models related to each district would be determind.

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Growth responses in common carp *Cyprinus carpio* (L.) fed with experimental diet of night soil

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ABSTRACT

Utility of night soil, a major urban waste, has been assessed as an additive to the conventional supplementary feed for the common carp (*Cyprinus carpio* Communis). Out of 3 levels of night soil offered to fish in the form of dried cake (50, 75, and 100%). The dose of 100% depicted the highest growth increment of 128.23% in the experimental fish reared for a period of 60 days in plastic pools. The proximate composition of common carp fed with night soil supplemented diet revealed appreciable increase in protein and fat contents in the fish as compared to the control fish. The Bacteriological screening of night soil supplemented diet fed fish for total & faecal coliforms, *E. coli* and faecal streptococci exhibited satisfactory low values in fish muscles. In the skin the values of total coliforms, faecal coliforms, *E. coli* and faecal streptococci were 2.5-5: 0-3.0 and 0-1 MPN/g respectively. These values were well within the safe levels prescribed for human consumption.

Key words : *Cyprinus carpio*, Night soil, Fish farming

Introduction

Freshwater fish production has a substantial contribution to human nutrition and well being over the years. Its role in future will be even more vital in supplying protein to the increasing human pollution. Further, people in some of the developing countries are mainly dependent on freshwater fish. Despite growing need of fish, the world catch of fish which was increasing until recent past, has shown no appreciable increase due to lack of proper culture technique and over exploitation of marine fisheries resources. Supplementary feeding has a special significance to boost up the fish production in culture waters. Mitra and Das (1965) found the superiority of supplementary feed in securing higher survival and yield. Heckling (1962) stated "while hunger dictates what the fish will eat?, when a wide variety of food is offered, the fish seems to adopt itself to the nutritional quality of the food, eating less rich food".

For any rearing system diet is an important item both in terms of its quality and capital inputs. When the fish is raised on costly diets, cost of fish production becomes too high. Under such conditions even the peasant families may not afford to eat fish or fish products due to economic constraints. In many countries formulated fish and prawn feeds are produced commercially for use in aquaculture. In India little attention has been paid so far on developing formulated fish feeds. But even if formulated feed is developed to meet the nutritional requirements of carps, this would be a costly affair. In case formulated feeds are imported from other countries, it involves foreign currency thereby further discouraging the farmer engaged in this enterprise. In view of this, it is right time that researches are conducted to develop cheap and yet nutritionally rich locally available feeds. Therefore, the present research was conducted in order to find out feasibility of using night soil as supplementary feed for the common carp (*Cyprinus carpio* Communis). This organic waste was offered in the form of oven dried cake to the experimental fish.

Materials and Methods

The present experiment was conducted in four sets

of circular containers of 65 liters capacity, each set consisted of 3 containeres. All the sets were filled with well water having desirable water quality(pH 8.16 ± 0.22, Dissolved oxygen 9.20 ± 1.92 - NO_3^-N ± 0.04 ppm, orthophosphate 0.16 ± 0.03 ppm and alkalinity 89 ± 1.23 ppm) for experimental fish rearing. For preparing night soil based diet, night soil was dried in an oven (600C.). Thus, the dried night soil, was mixed with ground nut oil cake + rice bran (1:1). The proximate composition of different formulated diets and their ingredients referred above was assessed and the results are given in Table 1.

Test fish *Cyprinus carpio* communis was collected from the departmental pond and transferred to the laboratory where these were acclimatized for 7 days and provided with supplementary diet (rice bran + oil cake 1:1) @ 3% of fish body weight per day during this period.

After taking initial weight of fish each container was stocked with 10 fishes (average weight 4.9 g). the levels of night soil based feed were used @ 3% of fish body weight per day as given in the Table 1. The feeding was done twice a day in the morning and evening. The fish weight was measured at an interval of 20 days for assessing increment in their growth.

To evaluate the impact of supplementary feeding in the biochemical configuration of fish, initial and final samples of whole fish were processed for the analysis of protein, fat, ash and moisture contents (AOAC, 1970). The samples of fish skin and muscles were analyzed for assessing the bacterial load, i.e. total coliforms, faecal coliforms, *E. coli* and streptococci population. Water samples for temperature, pH, CO_2, total alkalinity and dissolved oxygen were analyzed on initial day and than subsequently on 20th, 40th and 60th day of study period following APHA (1989).

The data observed from the present experience for fish growth were analyzed statistically for the analyses of variance. Moreover, Duncan's new multiple range test was employed to assess the significance of different treatments (Steel and Torrie, 1982) of the present experiment.

Results

The results of the present investigation pertaining to water quality, growth of fish, proximate composition and bacterial load of fish skin and muscles are presented in Tables 2-6.

Fish growth and survival: Growth data of fish *Cyprinus carpio* are presented in Table 3. The highest (128.23%) fish weight increase was noticed in N_1 followed by N_2 (78.74%) and N_0 (65.90%). While the lowest (68.6%) increase was observed in N_3. Data on the net weight gains are summarized in Table 3 which depicts the lowest net weight gain (3.08 g) in N_0 and the highest (6.04 g) in N_1. The survival of common carp was 100% in all the treatments (Table 3).

From Table 4, it would be seen that mean fish weight gain was statistically significant ($P<0.01$). Furthermore, Duncan's new multiple range test showed that mean weight was significantly different ($P<0.05$) in all the treatments.

Bacteriological Status of Fish: It would be seen from Table 5 that the highest (5 MPN/g) load of total coliforms was in fish skin from N_2 treatment while lowest (2.5 MPN/g) was noticed from fish skin of N_0 treatment. Further, the highest (3 MPN/g) faecal coliforms in fish skin were observed in the treatment N_2, whereas, the nil values were recorded in treatments N_3 and N_0, Intrestingly, *E. coli* and faecal streptococci were observed absent in fish skin of all the treatments. However, in N_2 treatment 1 MPN/g value of faecal streptococci was observed in fish skin. On the contrary, total coliforms, *E. coli* and faecal streptococcal were absent in fish muscles.

Proximate composition of fish carcass : Table 6 shows the results of proximate composition (wet Weight basis) of experimental fish Cyprinus carpio.

Table 1. Different treatments and proximate composition of formulated diets (on dry weight basis).

Treatments	Diets	Moisture %	Dry Matter %	Ash %	Protein %	Fat %
NO (Control)	100%					
RBO	12	88	14.80	17.20	5.40	
N1	100% NS	14	86	17.64	14.90	3.01
N2	25% RBO + 75% NS	15	85	16.59	15.17	3.56
N3	50% RBO + 50% NS	15	85	15.83	16.64	4.18

RBO = Rice Bran + Ground nut oil cake (1:1), NS = Night Soil.

Table 2. Physico-chemical water quality of experimental waters.

Treatments	Days of Observation	Parameters				
		Temp (^{0}C)	pH	Dissolved oxygen (mg dm^{-2})	Carbon Di-Oxide (mg dm^{-2})	Total Alkalinity (mg dm^{-2})
N_3	0	21.2	8.7	9.84	0.0	252.5
	20	16.5	8.6	10.20	0.0	224.0
	40	19.3	8.5	7.90	0.0	236.0
	60	18.0	8.6	9.40	0.0	201.6
N_2	0	21.4	8.6	9.50	0.0	240.0
	20	16.7	8.5	9.64	0.0	208.0
	40	19.5	8.6	8.20	0.0	258.0
	60	18.1	8.7	9.25	0.0	236.0
N_1	0	21.3	8.6	10.04	0.0	201.0
	20	16.6	8.5	9.50	0.0	217.0
	40	19.2	8.3	8.20	0.0	234.0
	60	18.0	8.5	9.40	0.0	239.0
N_0	0	21.2	8.6	9.43	0.0	240.0
	20	16.7	8.5	9.85	0.0	220.0
	40	18.8	8.6	8.50	0.0	264.0
	60	18.0	8.8	10.80	0.0	258.0

Table 3. Summary of growth data for *Cyprinus cairpio* fed with dried night Soil.

Treatments	Fish Weight (g)				Survival Percentage
	Initial	Final	Net Gain	Percentage increase	
N_3	5.28	9.40	4.12	65.60	100
N_2	5.42	10.45	5.03	78.74	100
N_1	4.71	10.45	6.04	128.23	100
N_0	4.47	7.55	3.08	68.9	100

Table 4. Summary of Statistical analysis of weight gain in *Cyprinus carpio* Fed with dried night-soil diet.
(I) ANOVA

Source of Variation	d.f.	SS	MSS	F
Treatment	3	14.66	4.88	
Error	8	0.027	0.003	1403.02*
Total	11			

*Highly significant at 1% level of significance ($p<0.01$)

(II) Duncan's New multiple range test (Steel & torrie,1982)

P	2	3	4	
q?4,8	3.26	3.39	3.47	
Rp	0.12	0.13	0.13	
Treatments	N_0	N_3	N_2	N_1
Mean Wt. gain(g)*	3.08^a	4.12^b	5.03^c	6.04^d

* The mean values super scribed with different letters are significantly different ($p<0.05$).

It is evident that lowest (79.88%) and highest values (80.04%) of moisture were in N_1 and N_0 respectively. The lowest (2.57%) amount of ash was observed in N_1, while highest (2.70%) was recorded in N_3. Whereas, treatment N_1 showed the highest (9.18%) protein, the lowest (8.93%) was observed in N_3. The lowest (4.73%) fat values were in N_3 while it was highest (5.71%) in N_0.

Table 5. Bacteriological status of experimental fish (*Cyprinus Carpio*) fed with dried night soil diet.

Treatments	Samples	Bacterial Population (MPN/g)			
		Total Coliforms	Faecal Coliforms	*E. Coli*	Faecal Streptococci
N_0	Skin	2.5	0	0	0
	Muscle	0	0	0	0
N_1	Skin	4.5	1	0	0
	Muscle	0	0	0	0
N_2	Skin	5.0	3	0	1
	Muscle	0	0	0	0
N_3	Skin	4.5	0	0	0
	Muscle	0	0	0	0

Table 6. Proximate composition of experimental fish (Cyprinus Carpio) fed with night soil.

Parameters	Initial	Treatments			
		N_0	N_1	N_2	N_3
Moisture %	80.10	80.04	79.88	80.00	79.92
Ash %	2.72	2.69	2.57	2.62	2.70
Protein %	8.62	9.06	9.18	9.00	8.93
Fat %	4.39	5.71	4.78	4.79	4.73
Others %	4.17	2.60	3.59	3.53	3.72

Discussion

Use of human excreta for aquaculture as an organic fertilizer is in vogue particularly in certain parts of Asia (Prowe, 1967 and Allen, 1972). Naturally, for a widespread use of excreta there are inherent constraints. Excreta may be used indirectly for producing feed for fishes or live stock (Edwards, 1990). However, reuse of excreta directly for aquaculture is presently practiced only in certain countries viz. China (Hora and Pillay, 1962). Obviously there are social problems due to high risk of disease outbreak as well as fear psychosis in the consumers. In the present study therefore, a modified methodology for the use of human excreta in aquaculture has been tried with fairly good success. Here instead of raw human excreta, night soil in dried form has been supplemented as feed with conventional feeds.

The impact of night soil as feed on the growth of common carp in the static waters is well evident from Table 3. The ready acceptability of such night soil formulated feed was also reflected in the water quality parameters of different treatments wherein the differences were negligible.

As for the growth and wellbeing of the test fish, dissolved oxygen levels were well above 5 ppm and interestingly no sign of distress or mortality was seen in the test fish. Moreover, the other water quality parameters measured in the experimental waters indicated more or less congenial environmental conditions for aquaculture (Schroeder *et al.,* 1976).

Another interesting aspect of night soil formulated feeding to common carp was a visible increase in the fish growth with higher quantity of night soil in the feed. Treatment N_1 (100% night soil) gave the highest weight gain. In terms of percentage weight gain (as compared to control) following raking order was evident for different treatments:

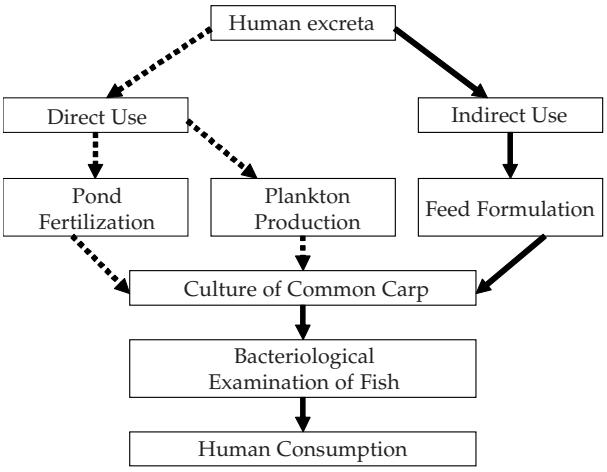
N_1 (49.05%)>N_3 (25.24%)> N_2 (24.45%)

This high fish growth exhibited in treatment N_1 is an exciting outcome of this study. It seems that despite low energy contents, night soil being a partially degraded organic matter very well match to the nutritional aspects profile and digestive abilities of fish. In view of low protein content of night soil the growth depicted could be explained for efficient utilization of food resources by the fish. Degani et al. (1982) have reported lower growth with the use of high protein (5% of body weight) food comparatively lower growth in treatments N_2 and N_3 therefore may be assigned to surplus amount of protein which common carp could not use effectively for their growth. The efficacy of night soil may also be viewed from the assumed growth increments of common carp under natural habitats with live fish food and conventional feeds. The fish is known to grow (1.6 to 11.0 g/day) under Indian conditions.

Human excreta in any form is subjected to high

risk of bacterial contamination. One gram of human faecal matter has been reported to contain 1 million bacteria of dreaded disease (Hutton, 1981). In the present case, however, use of oven dried night soil as fish diet greatly negotiated this problem. Even in the oven dried night soil possibilities of bacteria or their spores can not be ruled out. In such a case the ability of fish digestive system seems commendable screening out these pathogenic organisms. This may be vividly seen from the bacteriological examination of test fish which was found nutritionally fit for human consumption (Table 5). The muscle and skin of test fish indicated a scanty number (<5 MPN/g) of total coliforms which is well below the safe levels prescribed by WHO (1989).

In view of above discussion and results obtained, the usefulness of night soil in aquaculture of common carp is well justified and stresses the need for undertaking extensive field trails under varied agro climatic conditions. The results of present research further depicts that this omnivore common carp fed with night soil not only gave satisfactory growth and proximate composition at the same time it was bacteriologicallly safe. Use of this organic waste has therefore good prospects in view of growing problem of urban waste handling and disposal. The increasing cost of feed in aquaculture is also a matter of great concern for evolving low cost feeds for promoting aquaculture. From this point of view the organic waste feed attempted here could be prepared at a substantially low cost. This will also ensure proper disposal of urban waste through recycling in aquaculture systems.



A schematic presentation is presented below to indicate various pathways for the use of human excreta including the present attempt (indicated in boldliness).

Thus, considering different merits of night soil as alternative feed, it can be adopted as non-conventional feed for the common carp culture. There is also scope for undertaking further elaborative research efforts on this aspect by attempting formulated night soil feeding to other culturable fishes under varied environmental conditions.

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Geospatial characterisation of land use/ land cover in Pamba range of Periyar Tiger Reserve

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ABSTRACT

Periyar Tiger Reserve (PTR), the largest protected area in the state of Kerala with an area of 925 sq. km. is under severe anthropogenic pressure due to the annual pilgrimage to the Sastha temple (Lord Ayyappa temple), located at Sabarimala, in the south-western Pamba range of the reserve. The present study was conducted in this background to analyse the land use/ land cover change in Sabarimala and Karimala sections of the Pamba range of PTR. The forest cover was decreased during the period 1967- 2004, whereas other geographical elements such as open forest and grassland showed significant increase in the area. 44.16% of forest area has been reduced during the period, where 30% of the forest area was converted to other land use. Grassland showed sharp increase of 34.17% area between 1967- 2004 and open forest showed 7% increase during the period. 4% of the total forest area was converted to barren area and settlements during the period. The increasing number of pilgrims with improper and unplanned infrastructural facilities with less concern of waste management are causing pressure on the biodiversity and thus resulted in drastic change in land cover of this key protected area in the central Kerala. The pilgrimage activities inside the PTR have to be scientifically managed for preventing the further change in land cover pattern of the protected area.

Key words : *Sabarimala pilgrimage, Land use/ Land cover, Periyar Tiger Reserve, GIS, Remote Sensing*

Introduction

The indiscriminate anthropological activities result in devastating impact on forests, especially in hotspots of biodiversity (Roberts *et al.*, 1998). Various levels of applications of Geoinformatics on biodiversity conservation and management are reported from all over the world (Riitters *et al.*, 1997). Periyar Tiger Reserve (PTR) is the largest protected area in the state of Kerala with an area of 925 km^2. Sabarimala, Sastha temple a famous pilgrimage centre, is situated in the deep dense forests in south-east portion of Pamba range coming under Periyar Tiger Reserve, at an elevation of 461 m above mean sea level and recorded an inflow of more than fifty lakhs pilgrims every year (KFD, 1999). The Pamba range of PTR was composed of forest types including tropical evergreen, semi evergreen, moist deciduous and grassland and the area was supporting a rich biodiversity including a large number of endemics (KFD, 2007). The temple and the major trekking paths are coming under this range. There are only few studies reported on the pilgrimage activity in relation to land use/ land cover changes in PTR. The present study was conducted in this background to analyse the land use/ land cover change in Sabarimala and Karimala sections of the Pamba range of PTR.

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Materials and Methods

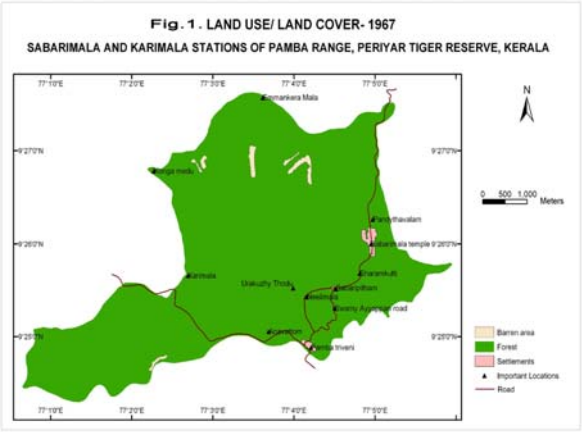
The impact of Sabarimala pilgrimage on land use/ land cover was estimated through remote sensing assisted GIS analysis coupled with ground truthing. Study area covers 28 km^2 of the reserved forest area, coming under Pamba range covering Karimala and Sabarimala sections located between 77^0 10′- 77^0 50′ E and 9^0 24′- 9^{0}28′ N. The study area is coming under the Survey of India toposheet 58 G/3 (1:50000 scale) of 1967 and is used as the basemap to create various thematic layers of the study area. For change detection two satellite imageries (Table 1) were used.

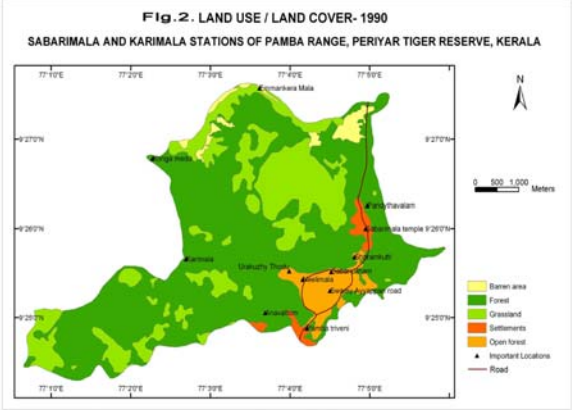
Arc GIS 9.3 version and ERDAS (Earth Resource Data Analysis system) Imagine 8.5 version, software packages were used to perform analysis. The land use/ land cover maps of the years 1967, 1990 and 2004 were prepared and overlay analysis was performed to detect the changes over these years and are statistically calculated.

Results and Discussion

The land use/ land cover map of Pamba range (Sabarimala and Karimala sections) of PTR are given in Fig.1, Fig.2 and Fig.3 respectively. The data on land use/ land cover pattern in the year 1967, 1990 and 2004 is given in Table 2. The land use/Land cover change map based on overlay analysis from 1967- 2004 is shown in Fig.4 and the related data on the change in land use/ land cover is given in Table 3.

It is found that forest cover was decreased during the period whereas other geographical elements such as open forest and grassland showed significant increase in the area. 44.16% of forest area has





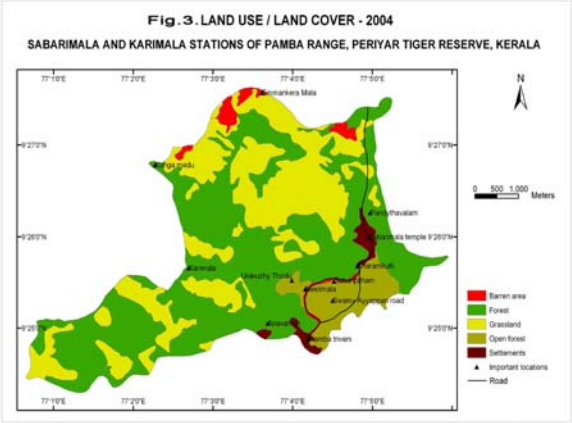


Table 2. Change in Land use\Land cover pattern of various years in Pamba range (Sabarimala-Karimala stations) in PTR, Kerala

Land use/Land cover type	CHANGE(Km^2)		
	1967- 1990	1990- 2004	1967- 2004
Forest	-8.88	-3.06	-11.94
Open forest	1.41	0.60	2.01
Grassland	6.73	2.51	9.24
Barren area	0.46	-0.06	0.40
Settlements	0.28	0.01	0.29

Table 1. Satellite data used for the study

Satellites	Date of acquisition	Path/Row	Band combination (RGB)
LANDSAT V (TM)	1990, 24th January	144/53	432
IRS P6 (LISS III)	2004, 19th February	100/67	432

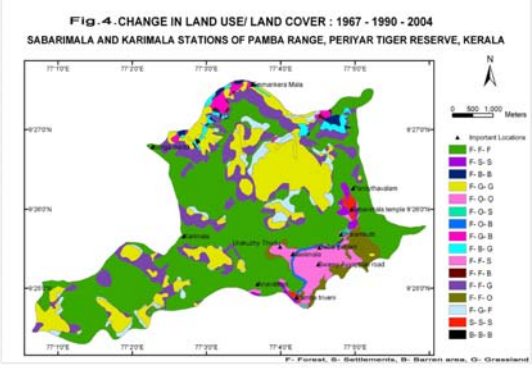


Table 3. Land use\Land cover pattern in Pamba range (Sabarimala-Karimala stations) in PTR, Kerala during 1967, 1990 and 2004.

Land use/Land cover type	AREA(Km^2)		
	1967	1990	2004
Forest	26.66	17.78	14.72
Open forest	0	1.41	2.01
Grassland	0	6.73	9.24
Barren area	0.24	0.70	0.64
Settlements	0.15	0.43	0.44
Total	27.045	27.045	27.045

been reduced during the period 1967- 2004; where 30 % of the forest converted to other land use between 1967- 1990. While, grassland showed sharp increase of 34.17 % area between 1967- 2004 and open forest showed 7% increase during the period. The drastic decrease in forest cover during this period is due to the increase in the number of pilgrims who visited the temple. Moreover the less attention of Kerala Forest Department during early periods of development of Sabarimala pilgrimage centre also contributed to the encroachment to further areas. Indiscriminate pollution including dumping of huge quantity of plastics may resulted in land degradation and which in turn affected the vegetation cover of the area. Mohanachandran (1988) reported the conversion of dense evergreen forest areas into highly degraded grassland as a result of intense pilgrims pressure on forest cover in sabarimala. Sasidharan (1999) reported that 27.78 gm of per capita fuel wood consumption was occurred during every pilgrimage season and that may be the reason for the spreading of open forest area around Sabarimala temple.

The barren area and the area occupied by settlements found to be increased during the period. 4 % of the total forest area was converted to any one of the either category during 1967- 2004 period. The forest area is converted for various pilgrimage related trade and infrastructure development in the area during this period. Mainly the buildings of Travancore Devasom board offices, Guest houses and forest section offices, Inspection bungalow, newly concreted road, Queue complex (*Nadapandal*), cardiology centre, waste treatment plants, KWA pump houses and water tanks, KSEB offices, permanent hotels and other trade buildings are emerged in the temple area (Pilgrimage management zone) of PTR. All these have led to fragmentation of forest ecosystem in Sabarimala region.

Strict measures should be implemented to confine the pilgrimage activity within the currently disturbed areas of the Pamba range. This will help to cease further degradation of the forest cover. Hence the Sabarimala pilgrimage programme inside the PTR should be scientifically managed, considering the importance of the rich natural biodiversity of the area.

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Experimental evaluation of two chemical fertilizers in relation to water quality and plankton production

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ABSTRACT

Water quality and plankton production was studied in cement cisterns, treated with SSP (Single Super Phosphate) and urea. Two doses of each fertilizers, i.e. 12 and 25 mg/L SSP and 4 and 8 mg/L Urea were used. Weekly estimation of phyto and zooplankton population indicated highly significant effects of both the fertilizers as compared to control. The average population of zooplankton in low doses of SSP and urea were 1076 and 1089 Nos/L respectively. While in higher doses the respective population was 1198 and 1158 Nos./L in SSP and Urea. Whereas in control zooplankton population was only 679 Nos./L. Further, the higher average population of phytoplankton from SSP and Urea was 590 cell/mL (25 mg/L SSP) and 580 cell/mL (8 mg/L Urea) respectively. However, water quality parameters were not significantly affected by fertilization. Statistically analysis of phyto and zooplankton production showed the result as highly significant at 1% level of probability. Moreover, Duncan's new multiple range test showed that all the treatments are significantly different from each other ($P<0.05$).

Introduction

Pond fertilization is gaining importance in the face of increasing demand for animal protein for human masses. Modern variations of the ancient practice of fertilizing pond to increase the yield of fish ponds have been considered by Schroeder (1974). There is general agreement in the work that a significant portion of increased fish yield following the successful use of fertilizers is due to the growth of plankton and the transformation of plankton to fish flesh through food webs of pond ecosystem.

Importance of inorganic fertilizers in increasing the production of fish has been emphasized by Schroeder (1974); Saha (1969); Sharma(1985) and Saini (1990). Hitherto, fertilization of fish pond has primarily been in concern with its impact on live fish food organisms. The present investigation was therefore undertaken with a view to collect detailed information regarding the changes in water quality and its influence on the production of live fish food organisms.

Material and Methods

This experiment was conducted in ten cement cistern of 84.5 × 44.50 × 60 cm. size at Fisheries College, Udaipur. Each cistern was filled with filtered well water and inoculated with 10 mL plankton concentrate collected from a seasonal earthen pond. After collecting the initial day water samples for analysis two doses of each fertilizers i.e. 12 mg/Ll (T1) and 25 mg/L (T2) of SSP and 4 mg/L (T3) and 8 mg/L (T4) of urea were applied in different sets of cement cisterns. Their control represented by T5 also runs simultaneously. The experiment was conducted in duplicate over a period of 21 days.

Water quality parameters, viz. water temperature. pH, dissolved oxygen, total alkalinity, No_3-N and orthophosphate were monitored at weekly intervals following the standard methods of APHA (1989). Plankton (Phyto and Zoo) were also sampled weekly from 7th day onwards and analysed quantitatively following the work of Pinnak (1984) and APHA (1989). The experimental results were statis-

tically analysed for analysis of variance test as per the methods of Steel and Torrie (1982).

Results

The impact of chemical fertilization in relation to physicochemical characteristics of experimental water is shown in Table 1. It would be seen from this Table that water temperature ranges from 19.0 to 21.9^{0}C. The highest (20.9^{0}C) and lowest (20.4^{0}C) average values were noticed in T_5 and T_4 respectively.

The oscillations in pH values were 8.0 to 8.9 with highest and lowest both in control (T_5). Alterations in pH were not great in any case to adversely affect the production of plankton. Thus, experimental water remained alkaline throughout the study period and total alkalinity ranged from 101.0 to 300 ppm. The lowest (101 ppm) was observed in T_3, while highest (300 ppm) being in all the treatments on initial "0" day. Further, the average values of total alkalinity ranged between 173.5 (T_3) to 203.5 ppm (T_2).

Dissolved oxygen (DO) fluctuations were between 6.8 to 12.8 ppm. The low (8.12 ppm) and high (10.52 ppm) mean values of DO were recorded in T_5 and T_4 respectively.

In general, the levels of nitrate-nitrogen were initially high in all the treatments including control. The values of NO_3-N ranged from 0.01 to 0.35 ppm. Whereas, the high (0.302 ppm) and low (0.10 ppm) average values were recorded in T_5 and T_3 respectively. It would be seen from Table 1 that the high (0.09 ppm) value of orthophosphate was in T_5. Whereas, it was nil in all the treatments on initial day, which were found to increase with increased experimental duration (in first phase i.e. 7 to 15 day) and subsequently decreased in all the treatments in the last phase of experimental (i.e. after 15th day). Thus, the higher (0.06 ppm) average value was calculated from T_2 and lowest (0.05 ppm) in both T_4 and T_5.

Data on the production of phytoplankton are summarized in Table 2. Table 2 depicts the highest 880 cell/mL and lowest 120 cell/mL in T_2 and T_1 respectively. Whereas, the respective maximum and minimum average populations of phytoplankton were noted in T_2 (590 cells/mL) and T_4 (580 cell/mL). It is evident from Table 2 that lowest population of cladocerans (60 No/L), copepods (90 No/L), rotifers (70 No/L) and nauplii (50 No/L) were in T_3, T_5, T_5 and T_1 respectively. However, the highest population of cladoceran (720 No/L) was in T_4, T_2, T_1 and T_2 respectively. Further, the respective highest (1198 No/L) and lowest (671 No/L) total population was observed in T_2 and T_5 respectively. Total zooplankton population was highly significant at 1% level of probability.

Discussion

The results of the present investigation have clearly revealed high prospects for mass production of zooplankton through chemical fertilization. The impact of single super phosphate (SSP) and Urea on water quality parameters and live fish food organisms production has been found significantly different (Tables 1 and 2) in both the fertilization programs.

Dandroff and Dean (1967) have suggested a minimum level of 5 ppm for dissolved oxygen for good warm water aquaculture. In the present case the average values of dissolved oxygen were above this level in both the sets (i.e. with urea and SSP), which could be considered favourable for the growth of live fish food organisms (Table 1). Further, the dissolved oxygen levels were higher in the treated water as compared to control. Comparatively lower values of dissolved oxygen in the control (T_5) could be assigned to lower population of phytoplankton than treated waters. It is needless to mention that the lower population of phytoplankton resulted in lower rate of photosynthesis as compared to treated waters in which higher phytoplankton population caused the higher photosynthesis activity.

The fluctuations in pH were narrow and experimental waters remained alkaline throughout the study period (Table 1). pH vales of the experimental waters were found to be increased after fertilization as compared to control. Sharma et al. (1984) suggested that inorganic fertilization in general shift the pH towards little alkaline side. Thus the finding of these authors are in agreement with the results of present investigation. Further the importance of slightly alkaline pH in increasing productions has been emphasized by Nees (1949). Thus, the prevailing alkaline pH (Table 1) of experimental water might have favored a higher crop of zooplankton especially in T_2, i.e. 25 mg/L SSP (Table 1 and 2).

The significant impact of inorganic fertilization was seen on orthophosphate and NO_3 – N levels of experimental waters. The respective higher concentrations of orthophosphate and NO_3 – N were obtained with SSP and urea treated waters just after

Table 1. Range and Average (in parenthesis) values of water Quality parameter in various treatments

Sr. No.	Parameter	T_1	T_2	T_3	T_4	T_5
1.	Water Tem. (°C)	19.0-21.9 (20.75)	19.0-21.9 (20.75)	19.0-21.5 (20.60)	19.0-21.4 (20.40)	19.0-21.8 (20.92)
2.	pH	8.5-8.7 (8.57)	8.5-8.7 (8.64)	8.5-8.7 (8.60)	8.5-8.7 (8.68)	8.0-8.9 (8.44)
3.	Dissolved Oxygen (ppm)	8.1-8.90 (8.50)	7.6-9.60 (8.42)	8.2-12.00 (10.10)	8.1-12.80 (10.52)	6.8-9.60 (8.12)
4.	Total Alkalinity (ppm)	117-300.0 (180.0)	153-300.0 (203.5)	101-300.0 (173.5)	121-300.0 (184.0)	113-300.0 (180.5)
5.	Nitrate- Nitrogen (ppm)	0.250-0.0340 (0.301)	0.210-0.0340 (0.215)	0.010-0.0350 (0.100)	0.030-0.0360 (0.154)	0.280-0.0340 (0.302)
6.	Orthophosphate (ppm)	0.0-0.031 (0.22)	0.0-0.099 (0.068)	0.0-0.002 (0.002)	0.0-0.009 (0.005)	0.0-0.009 (0.005)

Table 2. Range and Average (in parenthesis) Plankton (Phyto and zooplankton) production in different treatments

Treatment	Phytoplankton cell/mL	Zooplankton (No./L)				
		Cladocerans	Copepods	Rotifer	Nauplii	Total Mean*
T_1	120-700 (450)	80-590 (313)	110-550 (323)	70-320 (220)	50-310 (220)	1076
T_2	280-880 (590)	90-640 (370)	200-680 (406)	120-260 (156)	110-400 (266)	1198
T_3	200-720 (480)	60-680 (340)	140-580 (353)	40-280 (193)	80-290 (203)	1089
T_4	260-861 (580)	80-720 (406)	180-660 (400)	100-160 (126)	120-280 (226)	1158
T_5	160-610 (433)	130-350 (266)	90-220 (156)	20-210 (116)	100-160 (133)	671

fertilization (i.e. on 7th day). Naturally, the chemical composition of these inorganic fertilizers might have caused the higher levels of orthophosphate and nitrate-nitrogen. However, the levels of these parameters drastically decreased in all the treated waters with increased phyto and zooplankton population. Sharma (1984) and Boyd (1981) have also reported the reduced levels of NO_3 – N and orthophosphate in fertilized ponds due to higher biological productivity. In addition, the lower levels of NO_3 – N in treated waters on 15th day onwards could be explained on the basis of observation made by Hepher (1967) who suggested that in alkaline waters NO_3 is leached away in the form of gaseous ammonia. As depicted in the results (Table 2) the analysis of variance for phyto and total zooplankton population has also justified significantly higher population in treated waters as compared to control. Still. Higher average total zooplankton population was with the use of SSP especially in T2 (i.e. @25 mg/Ll).

In view of the above discussion it is clearly evident; that inorganic fertilization has no adverse effects on water quality especially dissolved oxygen and pH of experimental waters. However, the production of phyto and zooplankton was maximum in higher doses than control and lower doses of fertilizers,. In conclusion, it could be suggested that SSP @ 25 mg/L should be preferred as fertilizer as compared to 12 mg/l SSP dose and urea. However, it would be advisable to perform further trials with the higher doses alone and in combination of both (urea and SSP) the fertilizers to find out the best fertilization programme.

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Effect of organic manures on SCMR, protein content and quality in Maize

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ABSTRACT

An experiment was conducted with organic sources like Enriched Microbial Compost (EMC), Poultry manure (PM), FYM to study the changes in total protein content, quality and seed yield of Maize. Addition of organic manures improved the SPAD chlorophyll content of the leaves. EMC followed by PM treatments increased the protein content. Protein characterization with SDS PAGE with EMC 3 t ha^{-1} revealed new bands of 43 and 66 kDa. Application of EMC @ 1 t ha^{-1} recorded maximum yields over PM and FYM. Higher doses of EMC @ 5 t ha^{-1} proved detrimental to crop yields.

Key words : *Enriched Microbial Compost, SPAD chlorophyll meter readings, protein content*

Introduction

Nutrients can be supplied from organic sources and can substitute chemical fertilizers. Enriched Microbial Compost (EMC) a secondary sludge obtained from Jeedimetla Industrial Effluent Treatment Limited (JETL), Hyderabad, contains organic and inorganic nutrients. JETL generates 3 tonnes of secondary sludge per day. EMC has the potential to be utilized as an organic source of nutrients. In the present investigation, EMC was incorporated @ 1,3,5 t ha^{-1} and compared with the addition of FYM @ 5 t ha^{-1} and Poultry Manure (PM) @ 5 t ha^{-1}, to study the effect on changes in total protein content, quality and seed yield of Maize.

Materials and Methods

Maize variety BH – 40625 was sown in college farm, ANGRAU, Rajendranagar during Rabi, 2009 in a Randomized block design with six treatments and four replications. Maize was sown with a spacing of 60 x 20 cm in plot size of 4 x 5 m. Nitrogen. Phosphorous and Potassium were added at 60 – 40 – 40 kg ha^{-1}. Treatments included T1= Soil alone, T2, T3, T4= EMC 1, 3, 5 t ha^{-1}, T5= FYM 5 t ha^{-1} and T6= Poultry manure 3 t ha^{-1}. Leaves were collected and utilized for estimation of total protein content (Lowry *et al*. 1951). Protein concentration was measured at 600 nm using spectrophotometer and expressed as mg g^{-1}. Protein was characterized on SDS polyacrylamide gel electrophoresis (Singh, 2001). Chlorophyll content of the leaves were measured by Minolta (model SPAD – 502) chlorophyll meter. Seed yield from various treatments laid out in Com-

Table. Effect of organic manures chlorophyll, protein content and seed yield in maize

Treatment	SPAD chlorophyll content	Protein content mg g^{-1}	Seed yield q ac^{-1}
EMC 1 t ha^{-1}	41.8a	1.86a	5.18b
EMC 3 t ha^{-1}	41.3a	1.35e	5.59a
EMC 5 t ha^{-1}	43.8a	1.41d	5.97a
FYM 5 t ha^{-1}	42.5a	1.21f	6.20a
PM 3 t ha^{-1}	44.2a	1.61b	5.97a
Control	39.1b	1.57c	3.04c
P=0.05	1.83	0.02	0.67

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pletely Randomized Block Design was collected and analyzed.

Results and Discussion

Leaf chlorophyll content has been shown to have correlation with leaf nitrogen content because much of the leaf nitrogen is contained in chlorophyll. SPAD provides a measure of the relative greenness of living leaves at a specific point in time (Bullock and Anderson, 1998). Iradiance during measurement also needs to be considered when using chlorophyll meter for the estimation of crop N-status. The lowest SPAD-values were measured at high irradiance. During a natural night-day-night cycle, SPAD values for winter wheat were lowest in the middle of the day, highest at low irradiance at dusk and dawn and intermediate in darkness before dawn and after dusk. (Hoel and Asbjorn, 1998). Addition of organic manures improved the chlorophyll content (Table). EMC 1, 3, 5 t ha^{-1}, FYM 5 t ha^{-1} and PM 3 t ha-1 addition recorded superior SPAD values which ranged from 41.3 to 44.2 over control which recorded 39.1 SPAD units.

Application of EMC 1 t ha^{-1} followed by PM 3 t ha^{-1} resulted in high protein content of 1.86 and 1.61 mg g^{-1}tissue. Alcohol-soluble prolamin and storage proteins called zeins were predominantly observed (>50% of total seed proteins). These account for >50% of total seed proteins but are deficient in several essential amino acids notably lysine, tryptophan, and methionine, without which corn grain has been considered to be nutritionally poor for monogastric animals. Corn mutants with reduced levels of zeins, such as opaque-2 (o2), have been demonstrated to possess grain with improved nutritional quality characteristics (Huang *et al.,* 2004).

Protein characterization with SDS PAGE in treatments with EMC 3 t ha^{-1} revealed new bands of 43 kDa and 66 kDa corresponding to the size of Ovalbumin and BSA respectively. Targeted reduction of the 19-kDa á-zeins, have been engineered through transgenics (Huang *et al.,* 2004).

Conclusions

Application of EMC @ 1 t ha^{-1} recorded maximum yield over PM and FYM (Table). Higher doses of EMC @ 5 t ha^{-1} proved detrimental to crop yields.

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A comprehensive study of aerosols around Visakhapatnam, a coastal region, India

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ABSTRACT

Aerosols play an important role in cloud formation and subsequent precipitation. In the long run from climatological point of view, the gradual increase in aerosol content leads to a change in earth atmosphere, heat balance and radiation balance leading to global warming and subsequent climate change. In the present article the aerosol concentrations in the urban atmosphere is measured and reported. The rain water analysis was also made to find out the chemical nature of aerosols that are washed down due to precipitation in the monsoon season. It is interesting to note that the aerosols play crucial role not only in the formation of cloud clusters but also the subsequent precipitation, the precipitation washes down the pollutant aerosols and the aerosol concentration goes down, in that way it is a cyclic process: the aerosols help in cloud formation and precipitation, where as precipitation washes down the aerosols in the atmosphere, there is an optimum concentration of aerosols which will promote precipitation either less aerosols or excess of aerosols hamper the growth of clouds and the subsequent precipitation will be less or nil, thus the aerosols are important component in cloud physics and precipitation chemistry, the aerosols also absorb effectively the insulation or net radiation, many of the urban aerosols have strong absorption bands in the infrared region, so they will allow insulation to reach the earth surface but will strongly absorb the outgoing long wave radiation from the earth surface, so part of the radiation is trapped and re-radiated back leading to global warming. Such aerosols are known as green house aerosols.

Key words : *Aerosols, Air pollution, Visakhapatnam*

Introduction

Aerosols are tiny solid or liquid particles in the atmosphere. There are both manmade and natural sources of aerosols. Aerosols are well known for their role in atmospheric heat and radiation balance equation. Aerosol effectively scattered radiation either by Raleigh scattering or Mie scattering depending on the size of the Aerosol. The dimming of the atmosphere due to increasing concentration of aerosol in the atmosphere attracting the attention of atmospheric scientists. The optical depth of an aerosol is a measure of its intensity. The aerosols also act as condensation nuclei and thus play an important role in cloud physics and cloud formation. The optimum density of aerosol is conducive to cloud formation particle growth and subsequent precipitation. If there are no sufficient aerosols the cloud formation becomes difficult. On the contrary excessive aerosol concentration leads to evaporation and cloud dissipation. Some of the weather modifications experiments are based on these principles (Aerosols or condensation nuclei are effectively supplied). Aerosols are also having strong absorption bands for earth and solar radiation and thus alter the radiation balance. For example aerosols with greenhouse property. Aerosols when increased can absorb the earth radiation and thus reflects back part of the long wave radiation and lead to global warming and sub sequent climate change so a study on urban

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aerosols is very much essential. In the present article aerosols concentration over the urban area of Visakhapatnam measured and presented.

The wash out of urban aerosols due to south westerly monsoon rain was also studied and collecting the precipitation samples at various locations, the aerosol concentration and their wash out in the urban area was also presented, the sulphate, chloride, potassium, calcium and sodium were measured. The ionic ratios like Sulphate to chloride, sodium to potassium and chloride to sodium were also presented. The average and range of the chemical composition at other Indian cities and northern Europe and Australia were also presented in a table. The important conclusion is that the aerosol concentrations are on the increase in the urban area of Visakhapatnam. The analysis of rain water not only gives an important insight into the different types of aerosols present in the urban area and the impact of urbanization and air pollution on aerosol concentrations.

Climate

Visakhapatnam enjoys characteristic tropical maritime climate and sea arid. All the elements of climate temperature pressure wind rainfall relative humidity and other weather phenomena hardly exhibit a well marked seasonal variation like that of other stations located inside the country .

(a) Temperature

average annual temperature varying between 24-35°C Annual ranges of temperature is very low, does not exceed 6°C. From November to February the main monthly temperature varies between 24°-26°C and from March onwards a gradual increase is noticed till it reaches maximum in May (36-38°C) average maximum temperature is 40°C. From November to February both the day and night temperatures are moderate and consequently this period remains pleasant. From March to June the day temperature becomes troublesome but the sea breeze reduces it to some extent.

(b) Rainfall

Visakhapatnam receives an average annual rainfall of 98cm of which 50% fall during the period October to November due to the retreating south-west monsoon. 30% falls during the south west monsoon period. The gradual rise of rainfall starts from April and reaches its maximum in October. From November the decrease is rapid as the south west monsoon completes its retreat by this month. The period from the middle of June to the first week of November is marked as rainy season at Visakhapatnam.

(c) Winds

The direction of the winds are south westerly in summer and north easterly in winter are the prevailing winds at this place. The south west monsoon prevails over a large period from April to October. The north east wind is less frequented at this place. The sea breeze is more prominent than land breeze. The average speed of wind varies between 7-15 knots. During south west monsoon periods wind speed varies between 15-20 knots.

(d) Relative Humidity

The humidity Visakhapatnam exhibits 70-80% through the year. The hih percentage (80%) is recorded in September (during monsoon period) and the lowest at the December (64%). due to the marine influence even during the day period the relative humidity at Visakhapatnam remains at a higher level. The diurnal variation of relative humidity is very low.

(e) Comfort season

the bitterness of summer temperature is modified by the influence of the sea breeze. The rainy season is not very damp. Freshness is the atmosphere is experienced even during the rainy days. The period from November to February (winter) shows fine weather.

Industries in Visakhapatnam

The present industrial land scale of Visakhapatnam has been shaped only during the last 40 yrs and that is genuinely the outcome of modern harbor. The post war period proved to be more favorable because all the large scale and many of the small scale industries have been established here during this period. Since independence the government policy has become more favorable industrialization.

Hindustan shipyard, Hindustan petroleum corporation, Indian oxygen plant, naval armament depot, coramandel fertilizers, Bharat heavy plates and vessels limited, Hindustan polymers, zinc smelter, Andhra steel corporation and Andhra Pradesh electrical equipment corporation are said to be large industries in the city.

Hindustan Petroleum Corporation is the second biggest industry at Visakhapatnam, designed by the

American technicians. The average daily production of the refinery is 27000 barrels which consists of motor gasoline, jet fuel, two grades of kerosene, oil and several grades of diesel and fuel oils. One of the byproducts is naptha.The total reduction consists 10-14% of naphtha.

Coramandel is said to be India s largest fertilizer plant. The plant cost rupees 48.4 cores with a capacity of 80000 tones of nitrate and 73000 tones of phosphate peranum. The production is started in 1969.the principle product is high analysis complex fertilizers at an annual rate of 260000 tones in addition about 16.5 thousand tons of urea is also produced every year.

With this background one can easily realize the importance of this coastal city which is surrounded by hill ranges. The peculiar geographical setting, though of great strategic importance is laden with some metrological problems that are were formerly not of much concern but assumed special significance since industrialization started in the early 50 s and continued to progress at a rapid space. The trend towards organization and greater industrial concentrations' as resulted in severe and wide spread environmental contaminations, especially pollution of the atmosphere the aero gel concentration as the suspended justification matter has also increases.

Suspended particular matter and trace element concentrations' over Visakhapatnam city

Suspended particulate matter in air may be defined as any dispersive matter either solid or liquid, in which the individual aggregates are larger than single molecules (about 0.002µ) but smaller than 500µ.aersols sources can be classified as primary and secondary. Primary aerosols are those which are emitted in particulate from directly from the sources and secondary aerosols refer to particles produced in the atmosphere the principle sources for the particulate matter are combustion sources, are wind borne dust,smelters,metal refinishing, stone cutting and grinding industries. Natural sourced includes the sea spray, spores, pollen etc. In a typical urban atmosphere the particulates change in their size, number and chemicals composition due to several mechanisms. They are ultimately removed by some natural process like gravitational settling or washout by rain. Particulate matter requires a care full definition since it effects on determined not only by their concentration but also by the chemical composition and physical form. Both of these properties are important in determining the effect of aerosols in atmospheric properties and human health. Environmental production agency of USA as given the primary and secondary standards for 24 hrs concentrations' of particulates as 260 and 150 micro grams per ccm respectively primary standards are designed to protect the human health and secondary standards are designed to protect against effects on soil, water, vegetation, minerals and visibility and personal comfort. Increasing industrial activity and obvious increase in fuel combustion will accelerate the day to day injection of pollutants into the atmosphere the Arial deposits of trace metals are terrestrial and aquatic ecosystem is receiving Increasing attention man made sources of these metals and upon combustion those metals are not retained in the ash, but will be released into the atmosphere along with the fly ash it is known the trace elements in the atmosphere are transported by wind and to long distances also washed out by precipitation.

From the health point of view particles below 5µ are more dangerous as they are respirable. The United States autonomic energy commission defined respirable dust as the fraction of inhaled in soluble dust is penetrates to the sections of the lungs. various types of disease like conjectivities, pneumoconiosis, emphysema and carcinoma can be caused due to in alation of particles and vapors' depending on their physical and chemical nature the site of deposition and pathological condition of the lung none of the countries have adopted ambient air standards for fine particles less than 3.5µm.however Germany has set ambient values for non hazardous dust smaller than 10µm.the ambient concentration should not exceed 0.1 mg/m^3 for long term averaging and it should not exceed 0.2mg/m^3 for short term averaging.

Referring to metallic contamination and particulate pollution in Visakhapatnam, out of all the sources mentioned earlier the main sources are iron ore carrying conveyor belt and Hindustan zinc limited. The ore handling plant was built with Japanese collaboration for shipping iron ore. This plant consists of belt conveyor which runs in west east north south and west east directions from stock pile to ore berth. This iron ore in raw stage (with density 2.56$gm/m^{3)}$) from kirundul and byladilla (Madhya Pradesh) is brought to Visakhapatnam by train. If the ship is rapidly available the ore is directly stripped from the trains. If not the ore is stored in

stock pail area the capacity is of the stock pail area is 6 lakh tons. The ore is shipped through a belt conveyor whose maximum loading capacity is 4000 tons per hour the belt conveyor is not continuous and there are 8 discrete belt conveyors running in different directions with 8 transfer point. So that the ore can be transported continuously the conveyor runs at speed f 160 m/sec while receiving the ore and at a speed of 210 m/sec while shipping. The total length of the conveyor belt is 5.876 kms. This conveyor belt is running at a height of 5 feet from the ground through some dense populated residential areas of the Visakhapatnam city. Where thick population, offices and high schools are concentrated out of the total length 0.325 kms of the conveyor belts is covered to prevent the raising of dust the ore is wetted with water and transported however the dust do raise along the conveyor belt, more at the transfer points than the ore handling plant is major contribution for particulate pollution in the city the particulate concentration in the city are ore are less regulated by the conveyor belt which is not a continues sources. Hindustan zinc is also a major pollution source for the trace element concentrations in the city which manufacture zinc 220MT/month, lead, 800MT/month and cadmium 8MT/month.

Methodology

To know the chemical nature of the total suspended particulate matter in the ambient air and for source deduction random samples are collected throughout the city on different dates in different months covering industrial (Mulagada and Gajuwaka) commercial (St. joseph's college, port hospital) and residential (Dabagardens, Akkaypalem, Judgecourt) and some traffic corners (Jagadamba, Asilmetta, Chavulamadum). Grab samples are collected on a dedicated and preweighed Whitman number 41 fitters using staplex high volume air sampler. The high volume air sampler consists o (a) filter holder,(b) pump and motor and (c) a device for reading temperature of flow of air. The 4 filter holder is of missioner aluminum in two parts and has been made to accommodate both pleated and flat papers. When using the flat filer paper a removable cross grid is inserted behind the paper to prevent rupture in service. The sampler can be used for indoor and outdoor sampling the sampling time was adjusted with previous knowledge so as to get the minimum required amount of sample for analysis. After appropriate sampling period the filters are again weighed nearest to 0.01 mg and the particulate concentrations reported in $\mu g/m^3$ of air, keeping all the sources in view and assuming the presence of different elements in the Visakhapatnam city,air,selected samples were analyzed for trace elements like Iron(Fe), Lead (Pb, Zinc (Zn), Manganese (Mn), Cadmium (Cd) and Nickel(Ni) using techtror variant atomic absorption spectra photometer with acetylene flame after digestion of the sample is HNo_3 and the results were tabulated the details of digestions of samples are given below the analysis was carried out partly at analytical chemistry division,BARC,Bombay and partly at geochemistry division, NGRI, Hyderabad.

Digestion of Sample

Transfer the filter paper into a 50mL beaker add 5ml of NO_3 and 0.5 mL of H_2SO_4 (electronic grade or spectral grade). Carefully stir the solution to disintegrate the filter paper and place tie breaker (covered with a watch glass) on a hot plate away from the burner. Allow the reaction to proceed very quietly. Heat the solution till H_2SO_4 starts fuming. If the solution is black or dark brown in color cool the beaker and add 2-3mL HNO_3 and continue heating on the hot plate till H_2SO_4fumes stocks. Repeat this processes till the pale yellow solution is obtained and add 2mL of HCL, 1mL of 20mgk/mL and few mL of water boil and cool. Transfer the solution into 10mL of volumetric flask and make up to volume.

NOTE: All glass apparatus must be soaked at least 25mg HNO_3 over high and deionizer water should be used in all operations particulate pollution due to iron ore carrying conveyor belt was quantitvely ensured and tabulated. For ensuring size spectrum of dust from the transfer point as it disperse throughout the city 2 samples were collected near two transfer points, situated in dense populated areas. The samples were analyzed in SF India, calculating using particle classifier where it classifying the dust according to sieving principle. The results are tabulated.

24hrs sample (monthly once)were collected at two locations Dab gardens centrally located residential sector in the city (2) university campus Meteorology Department. Dab gardens located in the heart of the city on which industrial impact is comparatively high .the impact of conveyor belt is also high as it is quite near the transfer point T_7.the uni-

versity campus is relatively free from pollution. The samplers were placed approximately 12ft from the ground so that there will be no windborne dust effect (ground effect).

The samples were collected on a desiccated reweighed what man 42 filter papers using the suction pump(70LPM and 50LPM).2 diameter filter is loaded in a brass filter holder and it is connected to the inlet pump through a plastic tube. A flow meter is connected in between these two to record the flow rate and to check any drop in flow rate after deposition of some matter on the filter. Filters have been changed for every one hour and after appropriate sampling period the filters were again weighed nearest to 0.001mg and the day time and the night time mean concentrations were reported in $\mu g/m^3$ of air sampled.

Results and Discussions

The total suspended particulate matter on with trace elements which were regular monitored are presented in table1 the sampling points in the city can be divided into three categories industrial, commercial and residential the Table 1 the sampling points old Gajuwaka, Mulagada are industrial area points which show relatively higher concentration air port NSTL, Chinawaltair and Ramnagar are residential area points they recorded relatively TSP (total suspended particulate) values rest of the sampling points commercial in nature and show concentrations between residential and industrial values in other words they not as high as industrial values but definitely higher than residential values however the concentration of trace elements depends on the proximity to the source for example the Iron particle concentration in NSTL which is a commercial area but nearer to the conveyor belt and in the direction of the wind so the concentration is more than the concentration of Lead is highest at Mulagada (2.189 $\mu g/m^3$)

The data regarding the chemical composition of rain water for different places in Visakhapatnam at given the table. It is inferred that the interval between two showers determine a large except the pollution wash out. For example in the showers were on two days that is on 18, 19 July in 1982, the pollutant wash out on was very much less than 18th July.

From Table 2 it is observed that the mean pH value of rain water is less at mulagada then at remaining places, the pH value in industrial areas is much less than both commercial and residential areas. The concentration of sulphate is also greater at

Table 1. Trace element concentrations in Visakhapatnam city air ($\mu g/m^3$)

Sampling point	TSP conc.2hr	FE	PB	MN	CD	ZN
Air port	126.50	0.683	0.507	0.034	0.005	0.097
Syndia	169.21	0.395	0.037	0.019	–	0.190
NSTL	172.20	1.298	0.0	0.022	–	0.025
Akkayapalem	245.63	0.635	0.489	–	–	0.019
Chinnawaltair	129.92	0.429	nil	Nil	nil	0.019
Port hospital	315.12	0.639	0.224	0.117	–	0.045
Dabagardens	309.60	0.803	0.86	0.018	0.005	0.201
Ramnagar	162.50	1.972	0.029	0.005	–	0.050
Old gajuwaka	365.09	0.790	0.011	0.014	–	0.023
Mulagada	215.67	1.60	2.189	0.060	0.012	0.602

Table 2. Mean and range of chemical composition of rain water

Sampling point	pH	So_4 (mg/L)	Cl (mg/L)	Na (ppm)	K (ppm)
Mulagada	6.38(5.8-7.08)	41.46(11.6-98.0)	13.02(4.19-34.67)	3.98(0.5-11.5)	2.89(0.8-10.01)
Jagadamba	6.74(6.17-7.18)	14.89(3.6-52.8)	6.4(2.29-11.05)	2.02(0.1-7.0)	0.82(0.15-3.25)
Old post office	6.69(6.03-7.17)	11.28(4-30.4)	7.5(3.81-13.36)	1.92(0.2-5)	0.52(0.1-0.15)
N.S.T.L	6.86(6.1-7.58)	8.84(0.8-29.2)	7.42(3.61-18.29)	2.54(0.3-7)	1.21(0.25-2.9)
Akkayapalem	6.81(6.31-7.85)	10.31(1.2-29.2)	6.86(2.2-11.05)	2.09(0.2-6)	0.57(0.15-1.7)
Chinnawaltair	6.93(6.15-7.71)	8.48(TRACE-18.80)	6.56(2.29-12.19)	1.58(0.2-4.9)	0.52(0.05-1.55)
Andhra university	6.85(6.34-7.4)	9.43(3.2-20.4)	10.58(4.57-24.38)	2.69(trace-9)	0.51(trace-2.05)

industrial areas than commercial areas. The highest value of sulphate in industrial areas due to fact that large amount of pollutants emitted from industrial chimneys. In commercial areas the concentration of sulphate is mainly due to traffic emissions and also commercial areas are nearer to industrial areas. The sodium and chlorine concentration at jagadamba, old post office, Chinna waltair, Andhra university are higher than the concentrations at Mulagada, NSTL,and Akkayyapalem. This is obviously due to the fact that these sampling points are imitate vicinity of the coast, whereas Mulagada, Akkayyapalem

Table 3 represents the mean and range of ionic ratios of the rain water it is observed that so_4/cl is very high at Mulagada an industrial area however Cl/Na ratio is high at places near to the sea

Table 4 represents the wash out factor. This depends of concentration of so_2 in air to so_4 in water that is $W=C_a/C_w$

Here C_a is concentration of So_2 in air and c_w is concentration of sulphate in the rain water

In Table 5 gives the chemical composition of rain water in some Indian cities.

Conclusions

Even though it is difficult to draw definite conclusions in view of the number of factors involved and the complexity of the problem, the following tentive conclusions can be drawn

1. Aerosol concentrations are high in Visakhapatnam and show maritime nature the so_2 concentrations are relatively high in industrial and traffic junctions and low in the residential areas
2. The humidity oxidizes so_2 to so_3 and so much to so so_2 concentrations are high
3. Wind speed plays a very important role in dilution or built of so_2 concentrations.
4. The particulate pollution (TSP) is high in industrial area compared to commercial and residential areas
5. The Iron concentration is high trough out the city because of impact of Iron ore conveyer belt
6. Lead and Cadmium are found near t he Zinc

Table 3. Mean and range of the ionic ratios of the rain water

Sampling point	So_4/cl	Na/k	Cl/na
Mulagada	4.78 (0.97-12.12)	1.51 (0.29-3.83)	4.57 (2.12-9.8)
Jagadamba	2.41 (0.52-7.69)	2.43 (0.67-0.6)	7.48 (0.98-25.4)
Old post office	1.5 (0.57-3.62)	3.35 (0.71-8.4)	7.14 (2.39-24.75)
N.S.T.L	1.2 (0.32-2.75)	2.14 (0.82-5.39)	5.15 (1.29-22.87)
Akkayapalem	1.49 (0.39-3.33)	3.25 (0.67-6)	7.43 (1.37-20.33)
China waltair	1.34 (0.0-3.67)	2.92 (0.43-5.47)	8.0 (1.56-22.87)
Andhra university	0.94 (0.31-2.23)	6.01 (1.33-18)	6.32 (1.85-25.4)

Table 4. Aaverage concentration of sulphate in air and water and wash out factor

Sampling point	So_4 in air µg/kg	Sulphate in water µg/kg	Washout factor
1. Mulagada	75.56	41460	548.5
2. Jagadamba	55.02	14890	270.62
3. Old post office	54.41	11280	207.3
4. N.S.T.L	44.34	8840	199.4
5. Akkayapalem	43.32	10310	243.6
6. Chinna waltair	40.31	8480	210.3
7. Andhra university	30.23	9430	311.9

Table 5. Average and Range of Chemical composition of rain water over Some Indian cities

Constituents	Visakhapatnam	Ahmadabad	Culcutta
pH	6.243(3.50-8.80)	7.84(6.90-9.10)	6.63(5.50-6.80)
Na (ppm)	7.622(3.0-23.0)	7.57(0.10-38.5)	1.17(0.3-3.26)
K (ppm)	4.129(2.0-8.0)	1.79(0.25-10.8)	0.43(Trc-1.96)
So_4	21.926(0-132)µg/ltr	1.39(0.38-7.87)µg/ltr	3.73(0.73-7.72)ppm
Cl	7.321(0.88-60.2) µg/ltr	2.51(Trc-8.48)ppm	2.87(0.52-10.92)ppm

smelter plant which clearly shows the that source of these trace elements is Hindustan Zinc Industry

7. The concentration of chemical constituents like so_4/Cl is higher in industrial area. However Cl/Na is high at stations near to sea.
8. The wash out factor varies from 199.4 to 548.5.The highest value is at Mulagada, an industrial area the chemical composition when compared with other urban centers show that the pollution is high at Visakhapatnam the ph value is least(acidic in nature). The sulphate concentration is very high in visakhapatnam then other cities Culcutta and Ahmadabad.

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Probability analysis of rainfall for crop planning in Dakshin Dinajpur, West Bengal, India

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ABSTRACT

Probability analysis of rainfall of a region provides a reliable prediction of minimum assured rainfall which help in crop planning and construction of hydrological structures. In the present study, gamma distribution is used to estimate the minimum assured rainfall at different probability of excedence in all the months and years. The study reveals that at 10% probability of excedence, the minimum assured rainfall is highest and at 50%, it matches with the annual average rainfall of the region. Production of early variety of paddy is desirable in order to use the rainfall received in October for establishment of rabi crop.

Key words : *Rainfall, Crop planning, Probability distribution, Gamma distribution.*

Introduction

The erratic trend, uneven distribution and uncertainty of rainfall in Dakshin Dinajpur district of West Bengal are responsible for creating moisture stress and crop failure. It is essential to consider crop planning by making best use of rainfall availability of an area. Since rainfall is spatially varied over time, space and quantity, the probability analysis of rainfall offer a better scope for predicting minimum assured rainfall. In India, the possible irrigation water potential has been developed but the demand for water for different purposes has been growing continuously (Govt. of India, 1999). It is of much importance to plan agriculture by making best use of rainfall potential of an area. Rainfall pattern of locality dictates decision and selection of enterprise, planning, investment and the care and management of crop and animal. Different weather parameters regulate the nature and extent of infestation of pest including weeds, pathogens, parasites, predicators and population and foraging of pollinating agents and thus productivity of crops and animals according to De and De (2003).

Several researchers have analyzed weekly, monthly and annual rainfall by using incomplete gamma distribution and have made use of the rainfall distribution for various purposes such as irrigation and crop planning (David and Hiller, 1970; Mooley, 1973; Tiwari *et al*., 1992; Singh, 1991). The gamma function has been used extensively to fit rainfall data on fairly large space and time scales, ranging from individual storms up to monthly and yearly distributions (Thorn, 1958; 1968).

In India, many research works have been conducted on rainfall analysis for crop planning in a particular region (Pimpale *et al.*,2003; Mishra, 1995; Jat *et al.*, 2006). Since pattern of rainfall is quietly location specific, a study of annual rainfall data is necessary for Dakshin Dinajpur District, West Bengal. No work has been carried out in Dakshin Dinajpur District on probability studies of monthly or annual rainfall particularly for crop planning and in-situ rain water management. During recent decades, use of probability distribution functions in analyzing monthly and annual rainfall has received much at-

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tention. In this study, the potential of two-parameter Gamma distribution to predict minimum assured monthly and annual rainfall at different probabilities of excedence have been explored.

Materials And Methods

The State of West Bengal has been broadly delineated into six agro-climatic zone based on rainfall, temperature, soil types and topography of land. The zones are Hill Zone, Terai Zone, Old Alluvial Zone, New Alluvial Zone, Red Laterite Zone and Coastal Saline Zone. The experimental site falls under Old Alluvial Zone. The Old Alluvial Zone consists of 81 Blocks which fall under several districts and covers the entire district of Dakshin Dinajpur and lying between $21^0 48'$ to $25^0 30'$ North latitude and $87^0 9'$ to 89^0 East longitudes. This zone is primarily agrarian in nature with about 71% of its total geographical area under cultivation and more than 60% of its total working force engaged in agriculture directly or indirectly. This zone consists of flat and slightly undulating alluvial plains with locations about 3 to 50 m above mean sea level. (Annual Report, RRS, 1995). It is observed that in the region, in Kharif (monsoon) season, the major crops grown in the area under study are jute, mesta, pre Kharif paddy, aman (kharif) paddy and few vegetables crops like chilli, brinjal, stripped pear guard (palwal) etc. But in low land, aman paddy (grown during monsoon) is the only crop grown in the area. The choices of the crops are made by the farmers according to the need of the family, marketing facility, land type and remunerative prices of the cultivated crop etc. Normally late varieties of paddy are grown in kharif season which results in delayed sowing of rabi crops and thereby facing the moisture stress. Knowledge of the probable availability of weekly rainfall could alleviate the problem if early variety of paddy is cultivated and moisture availability in October could be utilized.

For better crop planning under rainfed condition detailed analysis of rainfall data is vital. Analysis of rainfall data on weekly basis gives more information for rainfed crop planning. The 26 years (1980-2005) daily rainfall data were collected from the office of Deputy Director of Agriculture (Admn.), Department of Agriculture, Govt. of West Bengal, Dakshin Dinajpur District. Daily data were converted into the monthly and annual data. The whole year was divided into three seasons i.e. monsoon season (June-September), post monsoon season (October - January) and pre-monsoon season (February - May). Mean seasonal variation of rainfall of the study area are presented in Fig.1 (a). whereas Fig.1(b) represents the mean monthly variation of rainfall during monsoon season. The procedure of fitting data to Gamma Distribution is explained below:

The probability density function of two parameter gamma distribution is given by

$$f(x) = \frac{x^{\gamma-1} e^{\frac{x}{\beta}}}{\beta^{\gamma} \Gamma\gamma}, \quad \text{for } x>0; \qquad \text{... (1)}$$

$$= 0, \quad \text{for } x<0'$$

where,

$\tilde{a}$ = shape parameter

$\hat{a}$ = scale parameter

$\Gamma\gamma$ = gamma function of $\tilde{a}$

when $\gamma \to \infty$, distribution approaches normal distribution and when $\tilde{a}$ is large, distribution is Gaussion.

$$\gamma = \frac{1}{4A}\left[1+\left\{1+\frac{4A}{3}\right\}^{1/2}\right] \qquad \text{...(2)}$$

$$A = Ln\bar{x} - \sum Ln\frac{\bar{x}}{n},$$

$$B = \frac{\bar{x}}{\gamma}$$

$$\bar{x} = Arithmetic mean(A.M)$$

$$Ln = Natural \log arithms$$

The probability g(x) of non zero rain less than or equal to x is given by

$$g(x) = \int_0^x \frac{x^{\gamma-1} e^{-x/\beta}}{\beta\gamma\Gamma\gamma} dx \qquad \text{... (3)}$$

The probability p_1, of rain less than x can be given by

$$p_1 = p' + (1+p')g(x) \qquad \text{... (4)}$$

where p' is the probability of zero rain obtained from rainfall data. If there are m values of zero rains in a series of N data

$$p' = \frac{m}{N} \qquad \text{... (5)}$$

Probability p_2 rain equal or exceeding x is given by

$$p_2 = 1 - p_1$$

$$p_2 = 1 - p' - (1 + p')g(x)$$

If q' shows the probability of rainfall values more than zero

$$q' = 1 - p'$$

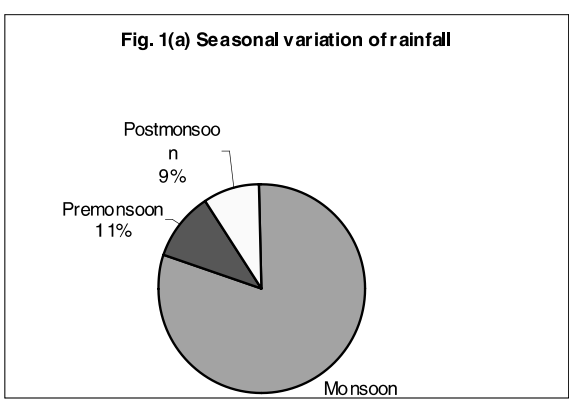
$$thus, p_2 = q' - q'g(x)$$

Using the above procedure, the minimum assured rainfall amount equally or exceeding a value x was determined for different probability levels using a computer program based on the mentioned procedure.

Results and Discussion

Analysis of 26 years rainfall data (1980-2005) shows that annual rainfall of the district Dakshin Dinajpur varies from 808.4 mm (2000) to 2537 mm (1991) with average of 1492.6 mm and coefficient of variation of 0.23 (Fig. 2). Out of 26 years, 70% received normal rainfall while 20% experienced excess rainfall and 10% years were deficit in rainfall causing slight to severe drought situation. Of the total annual rainfall, 71% is contributed by monsoon season (June-September), whereas15% and 14% are contributed by post monsoon (October – January) and pre monsoon season (February – May) respectively (Fig. 1 a). Out of total average monsoon rainfall, the September month contributed maximum rainfall with 30% followed by August with 27% (Fig. 1 b). The coefficient of variation was found between 11.7 to 18.1% during the monsoon season and had lesser variation as compared to the values in post and pre monsoon months (Table 1). The higher values of coefficient of variation in post monsoon months suggest rainfall more erratic in distribution.

The precipitation for different probabilities of excedence is shown in Table 2. It is observed that at 90% probability of excedence, the minimum assured rainfall was found to be 1222.7. The minimum assured rainfall was highest in case of 10% probability



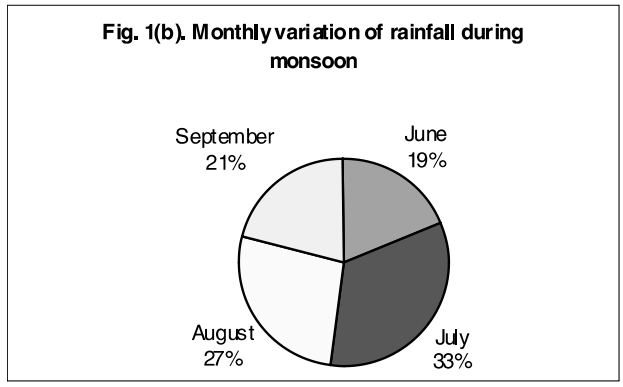


Table 1. Analysis of monthly rainfall

Months	Mean (mm)	Standard deviation	Coefficient of variation
January	10.2	19.0	1.870
February	7.6	9.1	1.201
March	15.8	24.3	1.540
April	64.5	53.5	0.830
May	189.4	119.2	0.629
June	232.7	109.5	0.471
July	357.4	151.9	0.425
August	297.5	172.8	0.581
September	357.3	175.5	0.491
October	151.8	165.2	1.088
November	8.0	14.7	1.833
December	12.1	31.6	2.624

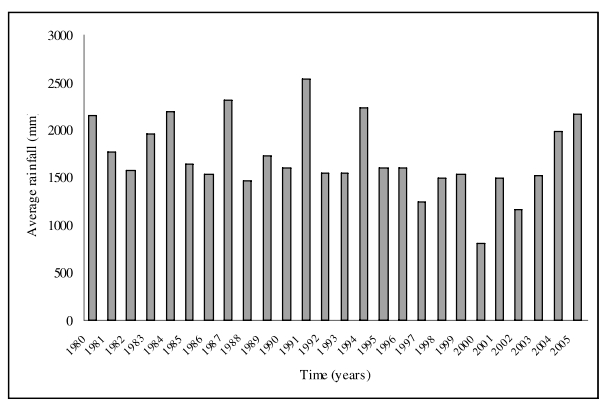


Fig. 2. Annual average rainfall of Dakshin Dinajpur district, West Bengal

Table 2. Minimum assured rainfall at different probabilities for Dakshin Dinajpur District

Months	Precipitation (mm) for the probabilities					Mean
	90%	75%	50%	25%	10%	(mm)
1	0.3	1.6	5.9	15.1	29.1	10.2
2	0.6	2.0	5.5	11.9	20.7	7.6
3	0.4	2.2	8.5	22.7	44.2	15.8
4	11.3	24.7	50.4	90.0	139.6	64.5
5	44.6	85.3	155.9	258.4	381.6	189.4
6	93.3	159.8	232.7	307.5	374.0	232.7
7	163.7	255.9	357.4	460.9	553.1	357.4
8	77.1	182.0	297.5	415.1	520.0	297.5
9	172.7	240.1	334.2	450.3	575.0	357.3
10	8.8	31.6	92.9	210.8	376.7	151.8
11	0.2	1.1	4.5	12.2	23.9	8.0
12	0.1	1.0	5.3	16.9	36.1	12.1
Annual	1222.7	1424.9	1674.8	1952.5	2226.9	1704.2

of excedence. The rainfall of all the months at different probabilities of excedence is shown in Table 3. Rainfall at 50% probability of excedence matches almost with the annual average rainfall of the district.

Conclusion

The study reveals that a good monsoon rainfall starts in June. However it has been found that there is enough scope for in-situ moisture conservation and run off collection in ponds for supplemental irrigation. Rabi crop is found to be under moisture stress under rain fed condition and pre-sowing irrigation is essential for good crop establishment. However if short duration paddy variety is chosen, the rainfall during October may be used for sowing Rabi crop. Minimum assured rainfall of 1674.8 mm has been found at 50% probability of exceedance which matches almost with the annual average rainfall of the district.

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Nitrate and Phosphate uptake by immobilized cells of *Synechocystis salina* Wislouch

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ABSTRACT

Eutrophication of water bodies is a major cause of pollution world wide. Algae are well known for their ability to absorb nutrients from wastewater. The growth rate and Nitrate and Phosphate uptake ability of free and immobilized cells of saline tolerant, non nitrogen fixing cyanobacterium *Synechocystis salina* were studied. Immobilization of cells was carried out in calcium alginate matrix. The immobilized cells were found to be highly effective in the removal of nutrients. 80% of nitrate and 74% of phosphate were absorbed by immobilized cells within 30 hours. The results suggest that *S. salina* is a promising biological agent for nutrient removal from wastewater. Bioreactors with immobilized cells of this alga could be developed for the removal of nutrients from aquatic system.

Key words : *Calcium alginate, Immobilization, Microalgae, Nutrient removal,* Synechocystis Salina.

Introduction

In recent years, pollution of water has become one of the most significant environmental problems in the world. The causes of water pollution are many, but industrialization and urbanization are prominent among them. Eutrophication of waterbodies is the major cause of pollution worldwide. Nitrate and Phosphate through agricultural effluents and industrial outpours are the chief cause of eutrophication (Thakur and Kumar, 1999). Pollution even affects the ground water resources. Nitrate concentration in ground water has increased globally (Kapoor and Viraraghavan, 1997).

Ground water in many locations are used as supply for drinking water; high nitrate and phosphate content in drinking water present a potential risk of public health (Gangolli *et al.,* 1994). Although nitrate itself is not toxic, its conversion to nitrite is a potential public health hazard in water consumed by infants (Sedlack, 1991).

The use of algae to treat wastewater has been under investigation for decades. In comparison to the entirely heterotrophic systems like activated sludge plants, the primary attraction of algae ponds lie in the low grade technology and in saving of energy, since photosynthetic oxygen production can replace mechanical aeration (Nirupama Mallick, 2002). Algae also perform a number of secondary functions in wastewater treatment, which include disinfection of the effluent. They increase the water temperature by converting light energy to heat, thus increasing the death rate of enteric bacteria (Pharhad, 1970) and metabolize bicarbonate, increasing the pH; thereby induce flocculation effectively increasing the sedimentation rate of the effluent being treated.

Sewage effluents supply algae with necessary inorganic compounds, especially nitrogen and phosphorous (Oswald and Golueke, 1960; Stewart *et al.,*1975). The pH of the sewage effluents between 7.5 and 8.5 is suitable for the growth of cyanobacterium (Fogg *et al.,* 1973). However, major drawback of algal ponds is the difficulty and associated cost of har-

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vesting microalgae (Huntley *et al.,* 1989). Recently research efforts have increasingly focused on the use of nonsuspended algae, either attached or immobilized as a valid method that avoids harvesting problem (Gonzalez *et al.,* 2000).

Alginate is the most frequently used polymer for algal immobilization. Alginate as a matrix seemed to be effective as the algae remained metabolically active longer in immobilized system (Brouers *et al.,* 1989). Studies have adequately verified cell viability in alginate matrix (Hertzberg and Jensen, 1989; Vilchez et al., 2001) and the effectiveness of nutrient removal by immobilized algae (Kaya *et al.,* 1996; Yan *et al.,*1996).

The present study aims to investigate the growth characteristics and nitrate and phosphate uptake by immobilized cells of *S.salina*.

Materials and Methods

Organism and Culture Conditions

Synechocystis salina culture maintained in the Department of Marine Biology, Microbiology and Biochemistry, School of Marine Sciences, Cochin University of Science and Technology, Cochin, India, was used for the study. Stock cultures of *S. salina* were raised in 1000mL Erlenmeyer flasks, containing 500mL Allen and Nelson Medium (Allen and Nelson, 1910). Illumination was provided by cold white fluorescent light of 2000 lux for a light/ dark period 12:12. The room temperature was maintained at 25± 1°C.

Immobilization

Algal culture in logarithmic phase of growth was used for immobilization. 100 mL of the culture was centrifuged at 3000 rpm for 10 minutes, the supernatant was discarded and the cells were resuspended in 100 mL autoclaved distilled water. Into that algal suspension 4% (W/V) sodium alginate was added with continuous manual shaking for 20 min and sieved with two layered cheesecloth. Beads of 4 mm diameter were obtained by dropping the alginate algal mixture into 100 mL 2.5% $CaCl_2$ solution in distilled water, at room temperature in sterile condition. The beads were washed several times in autoclaved distilled water to remove any remains of calcium chloride. The beads were stored at 4°C in autoclaved distilled water. Calcium alginate beads without *S. salina* are also produced using the same procedure, but without incorporating the alga.

Growth analysis

Growth was measured by estimating the concentration of chlorophyll *a* in the culture. One milliliter of algal culture was taken at regular intervals from free cell cultures and fourteen (approximately equal to 1 mL of free cell culture) beads were taken regularly from immobilized cell cultures. Both the samples were suspended in 10 mL of 0.1 'M' Trisoidium citrate separately. The cells were released from the beads after 15 minutes, and then the samples were filtered through GF/C filter. The filter was socked in 10 ml of 90% acetone and incubated for 24 hours in dark. After incubation the samples were centrifuged at 5000 rpm for 10 min, absorbance of the supernatant was noted using 90% acetone as blank at 750, 665, 645 and 630 nm in Hitachi U 2001 spectrophotometer and Chl *a* concentration was calculated (Strickland and Parsons, 1972).

Nutrient analysis

200 mL of *S. salina* culture was taken, from that 100 mL of the culture was immobilized as stated previously and the rest 100 mL was centrifuged at 3000 rpm for 10 minutes and the cells were isolated. The immobilized algae, algae free calcium alginate beads and free cells were introduced separately into 100 ml modified Allen and Nelson medium containing 100 mg/L nitrate and phosphate, in 250 mL conical flasks in triplicate. The cultures were incubated at 25±1^{0}C. Illumination was provided continuously by cold white fluorescent light of 2000 lux. Samples were collected from the cultures at 6 hours interval from each flask and filtered using GF/C filter. The filtrate was collected and used for the estimation of nitrate and phosphate. Nitrate was estimated photo metrically by Brucine Sulphuric acid method (Nicholas and Nason, 1957) and Phosphate using Stannous Chloride method (APHA, 1985).

Statistical Analysis

Statistical Analysis was done with SPSS Version 11. One way analysis of variance (ANOVA) was done and means compared using Tukeys test ($p<0.05$)

Results

Growth was measured in terms of Chl *a* concentration. There was a slight variation in concentration of Chl *a* in free and immobilized cells of *S. salina*. Chl *a*

values of free and immobilized cells were similar up to 6th day. But from the 6th day onwards the immobilized cells produced more chl *a* than its free living counterpart. On 15th day the total chl *a* value reached upto 4.93 µg/mL in immobilized cells and in free cells the value was 4.19 µg/mL (Fig. 1).

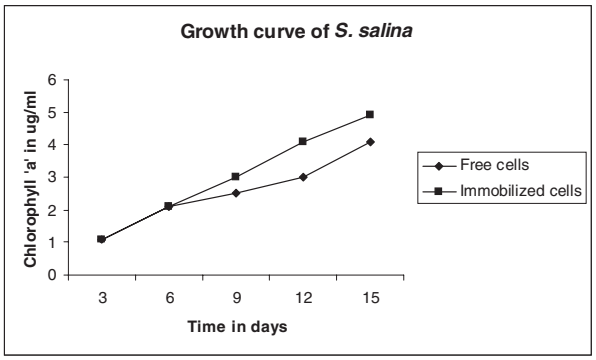

Fig. 1. Growth curve of *S. salina* in free and immobilized condition

Microscopic studies of sliced gel beads revealed that cells were randomly distributed throughout the gel beads immediately after immobilization. After an incubation period of 9-12 days in growth medium beads showed dense green colour and thick cell layer near their surface. The size of the cells was comparatively small in immobilized beads with that of free living cells. But the number of cells in immobilized beads was high, producing small colonies in the matrix. In the present study, microscopic observation of the culture medium indicated the absence of Cell leakage.

Immobilized cells were more effective in nitrate uptake than free cells. Upto 24 hours there was a decrease in nitrate concentration in the culture medium inoculated with *S. salina* free cells, but after that there was a rise in nitrate level in the medium due to the release of absorbed nitrate from the cell. Nitrate was absorbed more efficiently by *S. salina* beads up to 30th hour and the nitrate level was reduced to 20.16 milligram per litre. Whereas the nitrate concentration in the medium inoculated with *S. salina* free cells at 30th hour was 78.78 mg/L. The immobilized cells of *S. salina* could reduce the nitrate level by 80%. The algae free beads absorbed upto 53.94 mg/L nitrate by 24th hour. But it was gradually released to the medium and at 30th hour the nitrate in the medium was 78.18 mg/L (Fig.2).

In the case of phosphate uptake not much differences in uptake was noticed between free beads and

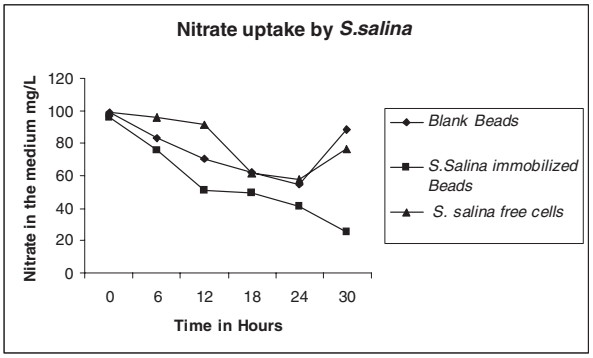

Fig. 2. Nitrate uptake by free and immobilized cells of *S. salina*

algae immobilized beads. *S. salina* free cells absorbed maximum phosphate within 24 hours (67%). But a gradual release of phosphate to the medium was observed after that. Free beads and *S .salina* beads could reduce the phosphate level by 74% at 30th hour. There was no phosphate release by the beads into the medium at any time (Fig. 3).

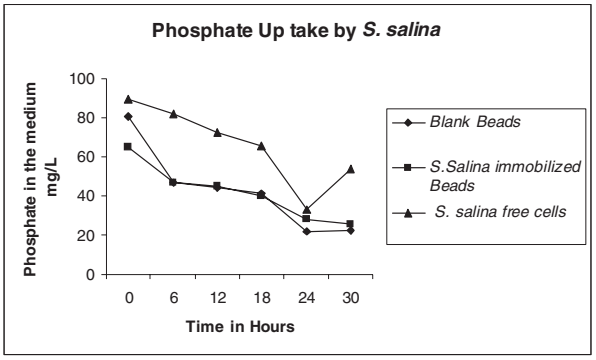

Fig. 3. Phosphate uptake by free and immobilized cells of *S .salina*

Discussion

Immobilization of cells can affect the growth of organisms. The growth rate of immobilized cells was generally found to be lower than that of the corresponding free cell cultures (Bailliez *et al*., 1985; Robinson *et al.,* 1985). Mitsui et al., (1985) reported the possibility to achieve high cell density with cultures grown in immobilized cell system than in free cell suspension. However the present study higher growth rate and increased amount of Chl *a* was observed in immobilized cells compared to its free living counterpart. Similar observations were made by Chevalier and de la Noue (1985) and Rai and Mallick (1992).

In the present study, microscopic investigation of beads revealed a high cell number and colony formation of the cells in the bead matrix after incubation. Thakur & Kumar (1999) reported immobilized cells of *D. salina* after 25 days of incubation showed 75% increase in growth rate than its free cells. Kuhn et al., (1991) and Jimenez *et al.,* (2004) who studied sliced gel beads entrapping algal cells also observed similar results. Immobilization can affect the morphology of cells also in calcium alginate matrix. Ca-alginate entrapped *Chlorella*; usually a unicellular organism tends to form small colonies (8-30cells) when released from the immobilized cells (Trevan and Mak, 1988). However, Musgrave *et al*., (1983) observed that immobilization has little effect on morphology of algal cells.

The rate of absorption of nutrients also varies in free and immobilized cells. Nitrate was absorbed more effectively by *S. salina* beads than free cells and blank beads. Our results agree with the findings of Megharaj *et al*., (1992) who reported that alginate immobilized *Chlorella vulgaris* was more efficient in removing both the nutrients (N and P) from wastewater. Rai and Mallick (1992) demonstrated a high uptake rate for both N and P by immobilized cells of Chlorella and Anabaena than their free living counterparts. Similar results were also observed in case of immobilized *Spirulina maxima* grown in Swine waste. Mallick and Rai (1993,1994) also observed that immobilized algae were most efficient for nutrient removal in the pH range 6-8. Vilchez Vega (1994) reported that alginate entrapped *Chlamydomonas reinhardtii* cells provide a stable and functional system for removing nitrogenous contaminants from wastewater. However, Faafeng *et al.*, (1994) and Lau (1997) observed that, immobilization carries a disadvantage of restricted nutrient diffusion.

In the case of phosphate uptake, the blank beads also absorbed maximum phosphate with in 30th hour. In our experiments the phosphate accumulated by the beads without algae could explain the difference between free and immobilized cultures. A high rate of phosphate absorption by blank beads may be due to the Phosphate precipitation by Ca-alginate matrix (Jimenez *et al.,* 2004).

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Physicochemical studies of ground water in the village Pavnar situated on the bank of river Dham in Wardha Distract (Maharashtra), India

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ABSTRACT

The present investigation deal with the determination of quality of well, tube well and river waters taken from different wells and tube wells situated at a distance of ½ km from one another in Pavnar village in Wardha distract of Maharashtra. The investigations were made in pre-monsoon, monsoon and post monsoon seasons of 2010-11 to evaluate the suitability of water for domestic and agriculture purpose. Twenty ground water samples including open wells and bore wells and river were analyzed for pH, EC, Total NH_3, Total hardness, TDS, Chlorine, Na, K, Total phosphate, sulphate, DO and COD. The variations in the values of these parameters are not significant in different seasons. Some deterioration in quality of water in some wells very near to river were observed from the result. In general water of all the wells can be safely used for drinking and irrigation purposes. Care must be taken to use this water for drinking purpose in pre-monsoon season. The attempts were also made to find out reason for degradation of water quality in some of the wells.

Key words : *Ground water, Water quality parameters, Maharashtra*

Introduction

Nature has given many gifts to mankind. Water is among the most precious gift of nature given to mankind. Whenever we think about the sources of water, we have to keep in mind that both the quality as well as quantity of water is equally important for domestic as well as agriculture and industrial purpose. India is the vast country but fortunate enough to have numerous rivers big and small which traverse the land in practically every direction carrying the much needed water through dry and thirsty lands. Some years back our major water sources were relatively free from pollution but at present marked deterioration in water quality has come to notice in a number of locations.

Drinking water has to meet certain fairly stringent quality standards and water quality is also important for agriculture and industrial uses. In recent time, on account of increase in population, urbanization and industrialization, there is an ever increasing threat to the quality of water in rivers, lakes and ground water. Due to industrialization day by day more and more industrial waste and effluent enters in to earth which pollute river as well as well water. Some times water becomes so polluted that its use becomes harmful even crops. It thus becomes necessary to test the quality of well water in the region where it is used for drinking and irrigation purposes. It was decided to test the well and river water in the locality and farms situated on the bank of river Dham in Pavnar village in Wardha district.

Pavnar(Pravarpur) was the capital of Vakataka dynastry during the reign of king Pravarsena. Pavnar is five miles away from wardha on Wardha –Nagpur Bus route .

Paramdham Ashram was established by Acharaya Vinoba Bhave in 1934 on the Bank of river

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Dham in pavnar village. Pavnar village is situated on the bank of Dham river. Main business here is agriculture, cultivation of cotton, sugarcane, Jawar and pluses.

Materials and Methods

20 wells and tube wells were selected in Pavnar village from which water is in use for irrigation and drinking purpose. These wells are kept under observation for one year. Water samples of all these 20 sources including running water from Dham river at pavnar were collected. For collecting running water from Dham river four different places where people perform their daily work of washing cloths and animal etc. were selected. The well water was collected from the wells which are at a distance of 0.5 km from one another. The collection were carried out in pre-monsoon season (April-May2010), during monsoon season (July-August2010) and in post monsoon season (Nov-Jan2010-11) in the year 20010-11. The bottles used for collection of water samples were made up of Pyrex glass and were cleaned by boiling them in dilute HNO_3 followed by distilled water (Brown *et al*. 1974).The characteristics like colour, temperature, pH, conductivity and dissolved oxygen etc. were measured as early as possible after sampling.

pH of the samples were determined by Equip-Tronics digital pH-Meter model EQ-610 using glass electrode. Specific conductance was measured by Equip-Tronics digital Conductivity Meter model No.EQ-660A which is first calibrated by using standard KCl solution. Suspended solids and total dissolved solids were determined by standard methods cited in the literature (AWWA 1976). Total hardness ($Ca^{++} + Mg^{++}$) in the water samples was determined by titration with standard EDTA (Jeffery *et al* .1978). Chloride and sulphate content were estimated by standard methods (Jeffery *et al*.1978).Sodium and Potassium were estimated by Systronics Flame Photometer model-128. Amount of phosphate content of samples was determined by treating the samples with ammonium molybdate and measuring the coloured compound with Spectrophotometer-169 at 460nm.The amount of Fe was estimated by testing water sample with ammonium thiocyanate and HNO_3 and measuring the absorbance at 540nm by spectrophotometer. The dissolved oxygen in water samples were estimated by standard method cited by Winkler (Winkler 1988). Marr's method (Marr *et al*.1983) was used to calculate Chemical oxygen demand of water samples

Results and Discussion

The data of various parameters of water calculated in pre-monsoon, monsoon and post-monsoon season are presented in Table 1, 2, and 3 respectively.

pH : pH of water is an indicative of its quality and its usability for drinking purpose. Its variation depends upon the equilibrium

$$CO_2 \rightleftharpoons CO_3^{--} \rightleftharpoons HCO_3^{-}.$$

From Table 1, 2, and 3 it is observed that no significant changes in pH are observed in pre-monsoon, monsoon and post-monsoon season. The values are within the permitted limit for use of water for domestic purposes as recommended by ICMR(1975) except Sample No. 17,18,19 and 20 (these are the places near river beach where people perform their usual work including bathing washing of cloths and animals etc.). The decrease in pH from pre-monsoon to post-monsoon season observed in all the places may be due to dilution of salts due to rains.

Electrical Conductivity (EC)

The electrical conductivity is an useful parameter of water quality for indicating salinity hazards. In the samples of water investigation, EC values vary widely from 2850 to 215 µs in pre-monsoon, 2380 to 190 µs in monsoon and 2610 to 200 µs in the post monsoon season respectively. It is a general observation that waters of high EC values are predominant with sodium and chloride ions. The alkalinity of natural waters is mainly due to soluble carbonates, bicarbonates and hydroxides. Generally bicarbonates are added in to water by the action of carbonates on the basic material present in soil. The decrease in conductivity values in the rainy season are mainly due to dilution of soluble salts due to rains. Due to percolation of water in the soil in rainy season water level rises and dilution occurs. The values of EC in the pre-monsoon season are more as compared to those in monsoon and post monsoon. This may be due to fact that in pre-monsoon season the ground water level is lowered due to excessive lifting of water for cultivation. These facts are in agreement with the observations of Yaduvanshi (1995). In sample No 11, 12 and 13 exceptionally high EC values are observed. It is a usual observa-

Table 1. Hydrochemical characteristics of ground water samples.
Parameters determined in pre-monsoon season(i.e. April – June 2010)

Sample No.	pH	EC	T_{NH3}	T_H	TDS	Cl	SO_4	PO_4	Na	K	DO	COD
1	7.59	800	0.56	230	365	580	370	0.83	120	39	9.22	73.62
2	7.54	770	0.61	224	350	470	270	1.59	176	22	5.57	53.34
3	7.39	540	0.57	425	235	590	350	2.00	48	28	4.13	41.32
4	8.10	345	0.52	215	216	440	270	1.38	270	41	4.82	48.28
5	6.79	240	0.55	136	115	490	310	2.24	103	44	7.61	40.63
6	7.37	687	0.63	275	308	499	352	1.24	124	37.6	6.34	45.94
7	7.61	840	0.54	225	405	590	300	0.91	113	34	4.35	21.18
8	6.67	250	0.58	156	128	270	308	0.20	38	28	3.20	21.80
9	7.42	675	0.51	255	240	530	360	1.67	88	29	3.86	61.92
10	7.67	640	0.57	365	296	490	370	2.70	185	33	6.32	46.80
11	7.01	2280	0.52	315	458	590	370	1.78	203	31	4.85	49.22
12	7.90	2600	0.65	1575	232	445	415	0.81	215	24	7.95	40.34
13	7.80	2850	0.64	1705	1716	666	405	0.62	290	54	6.38	63.62
14	7.76	450	0.54	189	205	580	300	0.74	123	33	8.86	58.51
15	7.62	565	0.57	365	243	610	370	0.24	91	55	5.82	50.82
16	7.16	390	0.51	196	185	590	355	3.20	135	57	8.12	58.24
17	8.40	215	0.89	128	138	277	210	3.20	69	74	8.26	58.62
18	8.70	280	0.62	275	187	600	400	0.94	155	68	7.52	48.52
19	9.10	1050	0.56	625	637	244	310	0.73	220	84	7.83	58.50
20	9.70	355	0.69	295	220	372	210	0.64	200	76	7.83	53.80
Average	7.76	841	0.576	408.7	344	496	330	1.383	170.7	44.6	6.76	49.80
Highest	9.70	2850	0.69	1705	1716	666	415	3.20	290	84.0	8.86	73.62
Lowest	6.70	215	0.51	128	115	244	210	0.20	38	22	3.20	21.18

Table 2. Hydrochemical characteristics of ground water samples.
Parameters determined during monsoon season(i.e. July -Sept 2010)

Sample No.	pH	EC	T_{NH3}	T_H	TDS	Cl	SO_4	PO_4	Na	K	DO	COD
1	7.42	675	0.53	215	347	570	360	0.79	116	35	10.23	75.91
2	7.48	650	0.58	208	342	465	255	1.50	171	19	5.53	57.34
3	7.32	460	0.54	390	227	575	335	1.84	45	26	4.55	46.52
4	8.00	290	0.50	207	210	440	260	1.32	260	35	5.56	52.25
5	6.74	210	0.52	130	108	480	300	2.20	98	41	8.12	40.12
6	7.31	575	0.60	260	295	460	340	1.21	120	35	6.75	48.12
7	7.38	710	0.51	213	392	555	290	0.87	109	30	4.68	24.40
8	6.61	210	0.54	148	124	270	325	0.18	35	24	3.55	24.90
9	7.36	565	0.48	240	228	515	345	1.62	83	24	4.35	67.00
10	7.61	545	0.55	347	287	480	350	2.65	183	30	6.67	50.80
11	6.92	1910	0.49	302	437	570	380	1.72	194	27	5.35	53.75
12	7.45	2185	0.61	1490	223	440	400	0.78	190	20	8.45	45.35
13	7.68	2380	0.61	1635	1630	642	385	0,58	265	50	6.88	68.35
14	7.68	375	0.52	174	196	552	280	0.72	116	28	9.45	62.75
15	7.54	475	0.53	343	235	592	350	0.22	77	48	5.75	55.35
16	7.07	320	0.48	188	176	570	335	3.00	124	47	8.64	62.50
17	8.28	190	0.55	120	130	270	205	2.95	64	70	9.05	60.32
18	8.52	230	0,57	260	178	610	385	0.91	149	63	7.84	52.35
19	8.95	885	0.55	590	602	220	330	0.71	205	76	7.98	63.05
20	9.52	300	0.64	280	212	360	215	0.61	191	72	8.45	56.50
Average	7.64	707	0.545	387	329	482	321	1.32	144.6	40	6.89	53.40
Highest	9.52	2380	0.640	1635	1630	642	400	3.00	265	76	9.45	75.91
lowest	6.61	190	0.480	120	108	220	205	0.18	35	19	3.55	24.40

Note : values in mg/L, (EC in µs), except pH, TH = Total hardness

tion that water containing high electrical conductance are predominant in sodium and chlorine but in the present study it can not be generalized.

Total Ammonia content (NH_3)

The variation in total ammonia content found in this investigation is from 0.69 to 0.51 mg/L in pre-monsoon season, from 0.64 to 0.48 mg/L in monsoon and from 0.61 to 0.45 ppm in post monsoon season. These values are found higher than the standard values recorded in Official Journal of European Committees(1980). The reason is attributed to the fact that most of these wells are in the fields of farmers where cultivations are continuously carried out for decades. Similarly the fields are very near to river also. Due to lack of scientific knowledge farmers use the excessive amount of fertilizers and insecticides containing ammonia, ammonium salts or nitrogen.

Total Hardness

The total hardness variation during this investigation is found as 1705 to 128 ppm in pre-monsoon, 1635 to 120 mg/L in monsoon and 1614 to 115 mg/L in post monsoon season. The values are found maximum in pre-monsoon and minimum in post-monsoon season. This may again be due to decrease in water content in wells and river in pre-monsoon season. In these investigations though separate calcium and magnesium content has not been recorded, still it is seen that concentration of magnesium is usually less than that of calcium. Dissolution of Mg rich minerals is time taking process than that of Ca and calcium minerals are plenty in this area. These observations are some what similar to those recorded by Pujari and Sinha(1999).

Total dissolved solids(TDS)

The TDS values vary from 115 to 1716 mg/L. in pre-monsoon, 108 to 1630 mg/L in monsoon and 112 to 1670 mg/L. in post-monsoon season. The higher TDS values are observed in pre-monsoon season. The TDS values are related to electrical conductance. In pre-monsoon season EC is higher because TDS is also more as compared to that in post monsoon season. The higher values of TDS in pre-monsoon samples may be due to lifting of excessive water in pre-monsoon season for cultivation. These observations are in accordance with those reported by Paka and Rao (1997).

Table 3. Hydrochemical characteristics of ground water samples.
Parameters determined in post-monsoon season (i.e., Nov 2010-Jan 2011)

Sample No.	pH	EC	T_{NH3}	T_H	TDS	Cl	SO_4	PO_4	Na	K	DO	COD
1	7.22	740	0.51	207	354	545	355	0.77	111	32	11.18	78.56
2	7.26	705	0.56	198	347	448	245	1.45	166	17	6.15	60.24
3	7.07	510	0.52	378	230	545	325	1.80	40	24	5.00	48.23
4	7.84	310	0.48	200	213	430	255	1.28	250	32	6.20	54.42
5	6.51	230	0.49	115	112	455	295	2.10	95	38	9.62	44.46
6	7.05	630	0.57	252	300	440	335	1.15	116	32	7.22	52.23
7	7.06	790	0.49	206	397	525	285	0.85	104	32	5.58	28.35
8	6.38	220	0.52	142	124	260	320	0.16	30	22	4.32	28.35
9	7.11	600	0.45	233	234	490	335	1.54	80	22	5.12	70.86
10	7.33	590	0.53	241	292	455	340	2.60	180	28	7.35	53.60
11	6.71	2140	0.47	294	442	540	370	1.69	175	25	5.98	55.40
12	7.15	2390	0.58	1460	227	425	395	0.75	178	18	9.48	47.78
13	7.35	2610	0.58	1614	1670	607	380	0 .56	253	47	8.02	72.84
14	7.43	410	0.49	166	200	520	275	0.68	110	25	9.96	64.57
15	7.40	510	0.51	334	239	562	340	0.20	70	43	5.96	57.26
16	6.90	360	0.45	182	181	528	325	2.80	128	44	9.66	64.70
17	8.05	200	0.52	192	133	255	200	2.85	60	68	10.10	64.57
18	8.15	265	0.54	252	182	585	375	0.89	143	60	8.25	55.52
19	8.60	970	0.52	578	623	210	320	0.69	190	72	9.04	48.55
20	9.14	320	0.61	271	216	345	210	0.58	185	68	9.64	58.20
Average	7.39	775	0.52	376.2	335.8	458.5	314	1.27	160.3	37.45	7.69	55.43
Highest	9.14	2610	0.61	1614	1670	607	395	2.85	253	72	11.18	78.56
Lowest	6.38	200	0.45	124	112	210	200	0.16	30	17	4.32	28.35

Note : values in mg/L, (EC in µs), except pH, TH = Total hardness

Chlorine (Cl)

The chloride content of wells and river water is generally due to presence of soluble chloride materials on the surface as well as in the rocks. In the present work about chloride content, it is observed that it goes on decreasing from pre-monsoon to most monsoon season slowly. In the present study the chloride content vary from 244 to 666 mg/L in pre-monsoon, 220 mg/L to 642 mg/L in monsoon and 210 mg/L to 607 mg/L in post monsoon season. In 90% of the samples the values are within standard limit of 250 mg/L to 600 mg/L of ISI and in slightly above UPSH standard (European Committees, 1980). Chlorine is a broadly spread up element in most of the salts in one or the other form. It has more affinity for sodium so its concentration is more in ground water. It also depends upon quality of soil, its porosity and permeability. All these factors must be taken into consideration. The decrease in chloride concentration in monsoon and post monsoon may be again due to dilution effect of rain in rainy season as explained by Mitra (1982).

Sulphates (SO_4)

The sulphate content of water samples under consideration is found to decrease from 415 mg/L to 210 mg/L in pre-monsoon, 400 mg/L to 205 mg/L in monsoon and 395 mg/L to 200 mg/L in post monsoon season. According to WHO the maximum permissible sulphate concentration is 400mg/L. (WHO, 1984 AWWA, 1976). Sample No 12 & 13 have crossed this limit in pre-monsoon season. A high concentration of sulphate may some times be due to bacterial oxidation of sulphides to sulphate. Over all values are within the safe limit for household and agriculture uses.

Phosphates (PO_4)

The phosphate content in water is due to contribution by sewage and run off land water. This may be due to prolong use of phosphatic fertilizers during cultivation of variety of crops for decade together. The values of phosphate content in these water samples are ranging from 3.20 to 0.20 mg/L in the pre-monsoon season, 3.0 to 0.18 mg/L in monsoon and 1.27 to 0.16 mg/L in post monsoon season. These values are high as compared to those recommended by ICMR(1975). These values are high but not harmful for use of water as household, drinking and agriculture purposes. The presence of PO_4 leads to eutrophicaction of water.

Sodium and Potassium (Na & K)

The values of sodium and potassium content found in the present study are :
Sodium 290 mg/L to 48 mg/L in the pre-monsoon season, 265 mg/L to 35 mg/L in monsoon and 253 mg/L to 30 mg/L in post monsoon season.

Potassium 84 mg/L to 22 mg/L in the pre-monsoon, 70 to 19 in monsoon and 72 to 17 in post-monsoon season. The values of Na and K are found to decrease from pre-monsoon to post-monsoon season. The values of Na and K are found to be higher than the normal values (Health 2000). The less values during monsoon and post monsoon season may be due to dilution effect of rains. The concentration of sodium is very important in classifying water for irrigation. High sodium concentration leads to the formation of an alkali soil. By base exchange process sodium may replace calcium from soil because of which permeability of soil to water may be reduced. If this is continued for long time then it has an adversed effect on growth of plant.

Dissolved Oxygen (DO)

The dissolved oxygen observed in this investigations is 8.86 mg/L. maximum and 3.20 mg/L. minimum in pre-monsoon and 11.18 mg/L to 4.32 mg/L in post monsoon period. The dissolved oxygen level for good quality water samples should be above 4 mg/L as described in manual of standard of quality for drinking water (ICMR 1975). In the present study two water samples (No.8 & 9) show values less than 4.0 mg/L in pre-monsoon season and one sample (No.8) shows value less than 4.0 mg/L during monsoon season. However, the D.O. content of these samples is improved in post monsoon season. High values of D.O. do not support the values in ICMR(1975) but are in good agreement with what is given by Masood and Krishnamurty (1990)

Chemical Oxygen Demand (COD)

Chemical oxygen demand is a quantity which is a measure of organic compounds and other oxidisable elements present in water. It is directly related to extent of oxidisable matters present in water which correlates the water quality by aesthetic view and amount of various pollutant present in water (Rudd, 1979). In the present study the values of COD recorded are pre-monsoon 73.62 mg/L maximum and 21.18 mg/L minimum, Post-monsoon 78.56 mg/L maximum and 28.35 mg/L minimum. The

values recorded in this study shows that the values increase from pre-monsoon to post monsoon which is reasonable because during monsoon the addition of unfiltered biomass and organic material take place.

Conclusion

In physicochemical parameters of under ground water and river water studied from 20 different sources in Pavnar village near Dham river it is observed that these parameters have higher values in pre-monsoon season and lower values in post-monsoon season. This is definitely due to excessive lifting of under ground water for cultivation by farmers since most of these wells are in their farms and are mainly used for agriculture purpose. The increase of COD values in tube well water may be due to improper sanitation and unhygienic use. However the values of parameters like pH, EC, Total NH_3 Total hardness, TDS, Cl, Na. K, PO_4, SO_4, DO, COD are within the permissible limit for drinking and agriculture purposes.

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Studies on inter-relationship between protein content, grain yield and its component traits in lentil under different growth environments

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ABSTRACT

Sixteen diverse genotypes of lentil were evaluated for character association analyses under four different environments created by different planting dates and fertilizer doses during *rabi* 2007-08 and 2008-09 at Punjab Agricultural University, Ludhiana. The data were recorded on days to 50% flowering (DF), days to maturity (DM), plant height (PH), number of fruiting branches per plant NFBPP), number of pods per plant (NPPP), number of seeds per pod (NSPP), biological yield per ha (BY), grain yield per ha (GY), harvest index % (HI), 100-seed weight (SW) and grain protein content (GPC). The correlation study showed that under timely sown normal fertilizer conditions, DM, BY, HI, SW and GPC were positively associated to grain yield. While under timely sown high fertilizer level conditions, grain yield was positively correlated to DF, DM, BY and HI. The positive correlation of grain yield with PH, BY and SW was observed under late sown normal fertilizer level conditions. Whereas, grain yield exhibited positive association with BY and HI under late sown high fertilizer level conditions.

Key words *: Lentil, Character association, Growth environments, Yield components*

Introduction

Lentil (*Lens culinaris* Medikus) is considered to be the oldest and widely adapted pulse crop all over the world. As a food crop, its provides a valuable protein source which coupled with its ability to thrive well on relatively poor soils and under adverse environmental conditions has ensured its survival as a crop species to the present day. It is the second most important *rabi* pulse crops next to chickpea. In Punjab lentil occupied an area of 1.1 thousand hectares with a production of 0.7 thousand tonnes during 2008-09 (Anonymous 2010). A breeders objective is to develop cultivars with high and stable yield along with good quality traits, particularly protein content which is an important aspect of pulse crops. It is important to understand the effect of different environments on protein content and to identify suitable genotypes which can give optimum yield and protein content under different growth environments. Through understanding of yield contributing characters and interrelationship among themselves and with yield is necessary for effective selection for higher grain yield. Direct selection for protein content is difficult under field conditions, hence information on association with some morphological traits can help for indirect selection for its improvement keeping above in view, sixteen promising genotypes of lentil were evaluated for their yield potential and protein content under different growth environments.

Material and Methods

The experimental material comprised of 16 genetically diverse lentil genotypes. Of these, seven geno-

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types namely LL 1020, LL 1023, LL 1024, LL 699 , LL 147, PL 4 and L 4147 were small seeded (100-seed weight ≤ 2.5 g) and nine genotypes namely LL 986, LL 991, LL 992, LL 999, LL 931, LL 932, LL 1036, LL 1049 and LL 1031 were bold seeded (100-seed weight ≥ 2.5 g). The experiments were conducted in the experimental area of Punjab Agricultural University, Ludhiana during *rabi* 2007-08 and 2008-09. Sixteen genotypes were planted in factorial experiment in split plot design with three replications taking date of sowing (timely sown –D_1, late sown –D_2) and level of nitrogen and phosphorus (normal fertility –N_1, high fertility – N_2) as main plots and genotypes as sub-plots. Each genotype was accommodated in a plot of four rows of three meter length, keeping row to row spacing of 22.5 cm. One set was planted during first week of November and other set during first week of December. One set in each planting date was given recommended dose of nitrogen and phosphorus viz., 12.5 kg/ha and 20 kg/ha, respectively. While the other set in each planting date was given 33% more nitrogen and phosphorus dose viz., 16.6 kg/ha and 26.6 kg/ha, respectively. The recommended packages of practices were followed to raise a good corp. In this way, eight different environments were created during the two years at one location. These environments were classified as D_1N_1- E_1, D_1N_2- E_2, D_2N_1- E_3 and D_2N_2- E_4 in the first year; D_1N_1- E_5, D_1N_2- E_6, D_2N_1- E_7 and D_2N_2- E_8 in the second year. The analysis of covariance was carried out for all possible combinations of characters and phenotypic correlation coefficients were worked out according to the method given by Al-Jibouri *et al.* (1958) in different growth environments.

Results and Discussiuon

Breeding for high yielding varieties of crops require information on association of component characters with yield and among themselves. This knowledge helps in designing suitable criteria for selection of genotypes having high yield potential. Correlation coefficients were worked out to determine the relationship between different characters especially with grain yield. The data of two years were pooled according to dates of sowing land levels of fertilizer and finally the correlation coefficients were obtained for four sets at Ludhiana location namely D_1N_1 , D_1N_2, D_2N_1 and D_2N_2. The results are presented environment wise as follows:

Timely sown normal fertility level (D_1N_1)

Under timely sown normal fertility level conditions grain yield exhibited significant positive correlation with days to maturity, biological yield, harvest index, 100-seed weight and grain protein content (Table 1). Positive association of grain yield with harvest index and biological yield under timely sown normal fertility level conditions was also reported earlier by Solanki (2006). Days to 50% flowering and plant height showed significant negative correlation with grain yeild. Similar results were reported by Kakde *et al.* (2006). Whereas, Aich *et al.* (2007) reported significant positive association between grain yield and plant height and Kumar *et al.* (2002) observed negative association between grain yield and grain protein content. These results indicated that under timely sown normal fertility conditions the yield potential of genotypes could be improved by direct selection for early flowering late maturity, higher biological yield, harvest index and 100-seed weight.

Days to flowering was found to significantly negatively correlated with plant height and biological yield whereas, days to maturity exhibited significant positive association with plant height, biologi-

Table 1. Phenotypic correlations among different characters in lentil under timely sown normal fertility conditions, Ludhiana (D1N1)

	DM	PH	NFBPP	NPPP	NSPP	BY	GY	HI	SW	GPC
DF	-0.129	-0.622**	0.077	0.018	-0.209	-0.508**	-0.371*	0.192	0.095	-0.002
DM		0.371*	-0.019	0.027	-0.126	0.306*	0.328*	0.237	0.378*	0.233
PH			-0.051	0.056	-0.175	0.639**	-0.349*	0.237	0.226	0.327*
NFBPP				0.329*	-0.256	0.028	0.066	0.012	-0.114	0.321*
NPPP					-0.134	0.155	0.181	0.145	-0.031	0.286
NSPP						0.019	-0.027	0.017	0.014	0.144
BY							0.926**	0.244	0.291*	0.641**
GY								0.525**	0.289*	0.549**
HI									0.138	-0.045

cal yield and 100-seed weight. These results indicated that delayed maturity would increase 100-seed weight which in turn would increase grain yield. Therefore, late maturing genotypes would be desirable under timely sown normal fertility conditions as it will increases the grain filling period. Plant height showed significant positive correlation with grain protein content and biological yield which in turn was positively correlated to 100-seed weight. Number of fruiting branches were significantly positively correlated to number of pods per plant and grain protein content and 100-seed weight also exhibited significant positive association with grain protein content. The positive correlation of grain protein content with plant height fruiting branches, biological yield, grain yield land 100-seed weight suggested that indirect selection for these characters can improve grain protein content for which direct selection is not possible in the field.

Timely sown high fertility level (D_1N_2)

Under timely sown high fertility level conditions, grain yield exhibited significantly positive correlation with days to flowering, days to maturity, biological yield and harvest index (Table 2). Kakde *et al.* (2006) reported that grain yield was positively correlated to seeds per pod, 100-seed weight, biological yield and harvest index at higher fertility level. Days to flowering showed significant positive association with days to maturity, number of pods per plant and significant negative association with plant height.

Days to maturity exhibited significant positive association with number of pods per plant and biological yield which are important components contributing towards grain yield. So more number of days to maturity would be desirable to improve the yield potential of genotypes. Joshi *et al.* (2005) reported positive association between days to flower-

Table 2. Phenotypic correlations among different characters in lentil under timely sown high fertility conditions, Ludhiana (D1N2)

	DM	PH	NFBPP	NPPP	NSPP	BY	GY	HI	SW	GPC
DF	0.433*	-0.319*	0.116	0.321*	-0.033	0.276	0.327*	0.146	0.008	-0.085
DM		-0.084	0.045	0.303*	0.159	0.415**	0.448**	0.155	0.168	0.065
PH			-0.131	-0.321*	-0.156	0.053	0.141	0.157	0.113	-0.11
NFBPP				0.438**	0.057	-0.056	0.096	0.264	-0.247	-0.333*
NPPP					0.291*	0.064	0.222	0.32	-0.16	-0.081
NSPP						0.11	0.088	-0.004	0.009	-0.066
BY							0.826**	-0.147	0.165	-0.006
GY								0.433**	0.019	-0.181
HI									-0.233	-0.317*
SW										0.075

*,**- significant at 5% and 1% level respectively
DF: Days to 50% flowering; DM: Days to maturity; PH: Plant height; NFBPP: Number of fruiting branches per plant; NPPP: Number of pods per plant; NSPP: Number of seeds per pod; BY: Biological yield; GY: Grain yield; HI: Harvest index; SW: 100-seed weight; GPC: grain protein content

Table 3. Phenotypic correlations among different characters in lentil under late sown normal fertility conditions, Ludhiana (D_2N_1)

	DM	PH	NFBPP	NPPP	NSPP	BY	GY	HI	SW	GPC
DF	0.084	-0.233	-0.037	0.073	0.04	0.139	0.051	-0.147	0.296*	0.373*
DM		0.238	0.109	-0.01	-0.032	0.248	0.173	-0.154	0.586**	-0.1
PH			-0.232	-0.196	0.014	0.183	0.305*	0.233	0.133	-0.196
NFBPP				0.213	-0.001	0.189	0.169	-0.049	0.124	0.171
NPPP					0.003	0.142	0.168	0.081	-0.036	0.059
NSPP						-0.151	-0.125	0.058	-0.095	-0.163
BY							0.692**	-0.428*	0.319*	0.077
GY								0.106	0.319*	0.039
HI									0.003	-0.072
SW										-0.064

ing and days to maturity. Plant height showed significant negative correlation with number of pods per plant which in turn was significantly positively correlated to number of fruiting branches per plant. Similar results have also been reported by Begum *et al.* (1999). Protein content exhibited significant negative association with number of fruiting branches per plant and harvest index. These results indicated that under timely sown high fertility conditions, the yield potential of genotypes could be improved by direct selection for days to flowering, days to maturity, number of fruiting branches per plant, number of pods per plant, biological yield and harvest index.

Late sown normal fertility level (D_2N_1)

Under late sown normal fertility level conditions, grain yield showed significant positive correlation with plant height, biological yield and 100-seed weight (Table 3). Significant positive association of grain yield with pods per plant, biological yield and harvest index was also observed by Kumar *et al.* (2002). Solanki *et al.* (2006) reported non-significant effect of planting dates on most of the associations and observed significant positive association of grain yield with biological yield. Similar association of grain yield with biological yield and harvest index under double dose of NPK was reported earlier by Yadav *etal*.(2005). Significant positive correlation of grain yield with number of seeds per pod has been reported earlier by Aich *et al.* (2007). Days to flowering, maturity and biological yield showed significant positive association with 100-seed weight which is an important yield contributing trait. Grain protein content was also positively correlated to days to 50% flowering. These results indicated that under late sown normal fertility conditions, the yield potential and protein content of genotypes could be improved by direct selection for early flowering, days to maturity, biological yield land 100-seed weight.

Late sown high fertility level (D_2N_2)

Under late sown high fertility level conditions, grain yield exhibited significant positive correlation with biological yield, harvest index and significant negative association with days to flowering (Table 4). Joshi *et al.* (2005) also reported significant negative association between grain yield and days to flowering, whereas, significant positive association of grain yield with biological yield and harvest index has been reported by Yadav *et al.* (2005). Significant positive association of grain yield with number of pods per plant and number of seeds per pod was reported by Chakraborty and Haque (2000). Days to flowering was positively associated to days to maturity and number of pods per plant, but exhibited negative association with biological yield. Days to maturity showed positive correlation with plant height, number of pods per plant. Significant positive correlation between days to flowering and days to maturity and between days to maturity and plant height has been reported by Joshi *et al.* (2005). Harvest index was found to be significantly negatively correlated with number of fruiting branches per plant which in turn showed significant positive association with 100-seed weight. These results indi-

Table 4. Phenotypic correlations among different characters in lentil under late sown high fertility conditions, Ludhiana (D2N2)

	DM	PH	NFBPP	NPPP	NSPP	BY	GY	HI	SW	GPC
DF	0.633**	0.098	-0.049	0.541**	0.121	-0.356*	-0.306*	0.077	0.056	-0.148
DM		0.329*	-0.001	0.734**	0.031	-0.102	-0.075	0.088	0.018	-0.239
PH			-0.125	0.174	-0.076	-0.025	-0.027	0.01	-0.123	-0.181
NFBPP				0.232	-0.014	0.078	-0.258	-0.496**	0.367*	0.211
NPPP					0.062	-0.243	0.251	0.009	-0.224	-0.268
NSPP						-0.084	0.053	0.219	0.135	0.194
BY							0.405**	-0.217	0.059	-0.164
GY								0.443**	0.036	-0.137
HI									-0.031	0.002
SW										0.087

*,**- significant at 5% and 1% level respectively

DF: Days to 50% flowering; DM: Days to maturity; PH: Plant height; NFBPP: Number of fruiting branches per plant; NPPP: Number of pods per plant; NSPP: Number of seeds per pod; BY: Biological yield; GY: Grain yield; HI: Harvest index; SW: 100-seed weight; GPC: grain protein content

cated that under late sown high fertility level conditions, the yield potential of early flowering genotypes could be improved by direct selection for high biological yield.

Conclusion

In the present study, biological yield and harvest index were identified as important yield contributing traits which could be directly exploited to improve the yield potential of lentil genotypes under different sowing dates and fertilizer levels.

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Adopt adaptation to changing climate: realizing the need of the hour

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ABSTRACT

The world's climate is changing and will continue to change in the coming century at rates projected to be unprecedented in recent human history. The risks associated with these changes are real but highly uncertain. Adequate attention must be given to respond to the impacts of climate change that are already occurring, while at the same time preparing for future impacts. It is important to understand the nature of those risks, where natural and human systems are likely to be most vulnerable, and what may be achieved by adaptive responses. It is most urgent to ensure adequate and rapid support to the most vulnerable countries and communities. Adaptation is one such significant measure that reduces vulnerability to actual or expected climate change effects. There is an urgent need for adaptation assessment in the short-term, as witnessed by the increasingly high costs of extreme weather events, compounded by rising population densities, eroding natural protection systems and aging infrastructure. In this context, the review and theoretical perspective of this study provides an insight of broad patterns in defining adaptation, need for adaptation, strategies of adaptation, types and challenges of adaptation. The issues raised in this note present some real reasons for concern and urge the significant facets of adaptation in mainstream discourses on climate change.

Key words *: Adaptation, Climate Change, Impacts, Risks, Vulnerability.*

Introduction

Climate change is one of humanity's greatest challenges, affecting both current and future generations. Without urgent and concerted action, it will damage fragile ecosystems, impede development efforts, increase risks to public health, frustrate poverty alleviation programs, and force large-scale migration from water or food-scarce regions. The two fundamental societal response options for reducing these risks are mitigation of climate change and adaptation to climate change. In the climate change context, mitigation means limiting global climate change by reducing the emissions of greenhouse gases or enhancing their sinks. Adaptation means actions targeted at the vulnerable system in response to actual or expected climate stimuli with the objective of moderating harm from climate change or exploiting opportunities (IPCC, 2001a). Thus, it is persuasive to state that one of the effective ways to address climate change is creating adaptation mechanisms to boost resilience and the ability to cope with anticipated impacts (Nicol and Kaur, 2008).

Despite the urgent need for mitigation there is also convincing arguments for increasing consideration of adaptation. First of all, anthropogenic greenhouse gas and aerosol emissions are already affecting average climate conditions and climate extremes. For example, eleven of the twelve warmest years globally occurred between 1995 and 2006. Even the relatively small magnitude of climate

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change observed so far had substantial impact on many natural and social systems. Second, climate will continue to change for the foreseeable future. As a result of accumulation of greenhouse gases emitted in the past and the inertia of the climate system, the rate of global warming in the next few decades is projected to be substantially faster than in the last few decades, largely irrespective of the emission scenario. Third, the effect of emissions reduction takes at least several decades to become fully apparent whereas most adaptation measures have a much shorter lead time. Fourth, adaptation can be implemented on a local or regional scale, and its efficacy is less dependent on the actions of others. Finally, many measures undertaken to adapt to climate change have important ancillary benefits, for example reducing current climate-sensitive risks. On the other hand increasing interest in adaptation to climate change is reflected in the development of the theory and practice of climate change assessments, and in increasing consideration by political organizations and funding bodies (Fussel, 2007).

From the above observation it has been understood that, adaptation to climate is not a new phenomenon. Climate varies much more over space than over time, and the widespread distribution of human populations attests to a largely successful history of adaptation (Burton *et al.* 2006). Indeed, throughout human history, societies have adapted to natural climate variability by altering settlement and agricultural patterns and other facets of their economies and lifestyles. Human-induced climate change lends a complex new dimension to this age-old challenge. Viewed over the long span of human history and pre-history, adaptation to climate has been remarkably successful. Biologists, anthropologists and archaeologists often characterize humans as the most adaptable of animal species. The record of collapsed societies shows that coping with climate has not always been easy or successful, and there are limits to adaptation. Yet societies have been able to thrive in all but the most extreme climate zones. Over time, often by trial and error, and by the adroit use of technology, human beings have adapted to cold sub-arctic, hot semi-desert, and tropical rainforest environments, as well as to temperate grasslands, mountains, coasts and small islands. Even though the environmental, economic, and social costs of inaction will far exceed the cost of taking immediate steps to address climate change (Lagos *et al.* 2009), sensitivity to the issue of adaptation has grown over the last couple of years, particularly after the IPCC (Intergovernmental Panel on Climate Change) TAR (Third Assessment Report). And now adaptation has emerged as an urgent policy priority, prompting action both within and outside the climate change negotiations (Parry *et al*. 2005).

Need for adaptation

Climate change creates both risks and opportunities worldwide. By understanding, planning for and adapting to a changing climate, individuals and societies can take advantage of opportunities and reduce risks. The need for adaptation in the short-term is being driven by the increasingly high costs of extreme weather events that are being further compounded by rising population density, eroding natural protection systems and aging infrastructure. In the longer term, adaptation to climate change will be necessary to minimize the impacts of rising sea levels on societies and ecosystems and to protect quality of life (WBCSD, 2008). In recent years, adaptation to climate change impacts has slowly established itself as an important and complementary response to greenhouse gas (GHG) mitigation. However, it is still regarded as a priority primarily for developing countries. This is on account of two reasons: developing countries have a relatively larger proportion of their population dependent on climate sensitive natural resources and they typically have significantly lower adaptive capacity, thereby making them much more vulnerable to the potential impacts of climate change (IPCC, 2007). Considerably less attention has been paid thus far to the experiences of developed countries in planning and implementing adaptation measures.

There is a significant research gap that deserves greater attention for two main reasons. First, many of the observed and projected climatic changes are considerably greater in temperate latitudes where many developed countries are located (IPCC, 2001b). Therefore, the need to adapt to these changes might be quite significant. Second, developed countries have access to considerably greater technical and financial resources and often have a stronger institutional base, both of which provide a better enabling environment for adaptation planning (Lebrun and Agrawala, 2006). Thus, it is no longer possible to ignore climate change adaptation as an element in development work as there are serious dangers of climate change which will under-

mine development interventions, millennium development goals and increase poverty (Schipper and Pelling, 2006). Moreover, identifying the need of appropriate adaptation responses to climate change should be a key element of the sustainable development Strategies (GTZ, 2009).

Defining adaptation

Adaptation to climate change is defined as the adjustment of practices, processes and structures to reduce the negative effects and take advantage of any opportunities associated with climate change. According to Smithers and Smith (1997) adaptation is described as "Changes in a system in response to some force or perturbation, in this case related to climate". Whereas, Pielke (1998) defines adaptation as an "...adjustment in individual, group and institutional behavior in order to reduce society's vulnerabilities to climate". It is also defined as an adjustment in ecological, social or economic systems in response to actual or expected stimuli and their effects or impacts. This term refers to changes in processes, practices and structures to moderate potential damages or to benefit from opportunities associated with climate change. Adaptation hence involves adjustments to decrease the vulnerability of communities, regions, and nations to climate variability and change and in promoting sustainable development (IPCC, 2001a). UNDP (2006) states that adaptation is a process by which strategies to moderate, cope with and take advantage of the consequences of climatic events are enhanced, developed, and implemented. UK Climate impact Programme -UKCIP (2004) explains adaptation as, the process or outcome of a process that leads to a reduction in harm or risk of harm, or realization of benefits associated with climate variability and climate change. Thus, from above mentioned definitions, it has been understood that, adaptation needsvary across geographical scales (local, national, regional, global), temporal scales (coping with current impacts versus preparing for long-term change), and must be addressed within complex and uncertain conditions. To respond to this process, call for an interdisciplinary and multiple expertises, a coalescing of researchers and practitioners in climatology, ecology, economics, management of natural resources, public health, disaster risk reduction, and community development (Teri, 2001) are highly required.

Adaptation concepts and strategies

To understand the potential for adaptation to ameliorate adverse impacts of climate change or the need to anticipate the impacts of changes in climate, it is necessary to understand the terms resilience, vulnerability and adaptive capacity (Fig. 1). Resilience provides the capacity to absorb shocks while maintaining function. When change occurs, resilience provides the components for renewal and reorganization (Gunderson and Holling, 2002; Berkes *et al*. 2002). The Resilience Alliance defines resilience

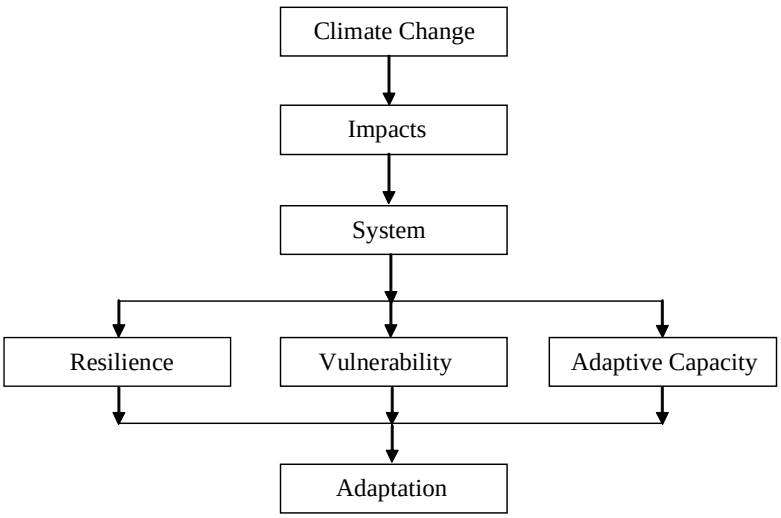

Fig. 1. Concept and strategies framework of adaptation

as applied to integrated systems of people and nature as (a) the amount of disturbance a system can absorb and still remain within the same state or domain of attraction (b) the degree to which the system is capable of self-organization (versus lack of organization, or organization forced by external factors) and c) the degree to which the system can build and increase the capacity for learning and adaptation (Carpenter *et al*. 2001).

Vulnerability is the flip side of resilience: when a social or ecological system loses resilience it becomes vulnerable to change that previously could be absorbed (Kasperson and Kasperson, 2001). In a resilient system, change has the potential to create opportunity for development, novelty and innovation. Whereas, in a vulnerable system even small changes may be devastating. Thus, vulnerability may also refer to the propensity of social and ecological system to suffer harm from exposure to external stresses and shocks. It involves exposure to events and stresses, sensitivity to such exposures (which may result in adverse effects and consequences), and resilience owing to adaptive measures to anticipate and reduce future harm (Kasperson *et al.* 1995). IPCC, in its Second Assessment Report, defines vulnerability as "the extent to which climate change may damage or harm a system." It adds that vulnerability "depends not only on a system's sensitivity, but also on its ability to adapt to new climatic conditions" (Watson *et al.* 1996). The IPCC report further argues that the vulnerability of a region depends to a great extent on its wealth, and that poverty limits adaptive capabilities (Watson *et al.* 1998). According to the Second Assessment Report, vulnerability depends on the level of economic development and institutions. The report justifies that socio-economic systems "typically are more vulnerable in developing countries where economic and institutional circumstances are less favorable". The report continues that vulnerability is highest where there is "the greatest sensitivity to climate change and the least adaptability." According to Easterling *et al.* (2004) vulnerability can also be defined as a measure of system's sustainability to climate change which is a function of the system's exposure, sensitivity and adaptive capacity. It has become common knowledge that the poor are likely to be hit hardest by climate change, and that capacity to respond to climate change is lowest in developing countries and among the poorest people in those countries. It seems clear that vulnerability to climate change is closely related to poverty, as the poor are least able to respond to climatic stimuli. Furthermore, certain regions of the world are more severely affected by the effects of climate change than others. In general vulnerability and adaptation to climate change are urgent issues among many developing countries. For this reason, there exist provisions in the United Nations Framework Convention on Climate Change (UNFCCC) to assist those countries that are thought to be most vulnerable and least able to adapt (Olmos, 2001).

Adaptive capacity is the ability of a social-ecological system to cope with novel situations without losing options for the future, and resilience is key to enhancing adaptive capacity (Folke *et al.* 2002). Klein (2002) describes it as, "the ability of a system to adjust to climate change (including climate variability and extremes) to moderate potential damages, to take advantage of opportunities or to cope with the consequences". It is closely related to a range of terms including: coping ability, stability, robustness, flexibility and resilience. Adaptive capacity has a particularly strong connection to resilience. Tompkins *et al.* (2005) states that "adaptive, capacity, which is often used to refer to the set of preconditions that enables individuals or groups to respond to climate change, is a synonym for many characteristics of resilience". In terms of human social systems Smit and Wandel (2006) identifies that at the local level adaptive capacity is determined by factors such as managerial ability, access to financial, technological and information resources, infrastructure, the institutional environment, political influence and kinship networks. It has also been stated that one of the key ways this adaptive capacity has been examined has been through the concepts of thresholds and coping ranges. These terms are defined by the "conditions that a system can deal with, accommodate, adapt to and recover from". The Inter-governmental Panel on Climate Change states that adaptive capacity is the degree to which individuals or groups can adapt to risk at any given time. It is therefore suggested that a multi-faceted approach be taken to build the capacities of communities and regions for adapting to impacts associated with global climate change (Budreau and McBean, 2007)

Types of adaptation

The IPCC (2001b) distinguishes several types of adaptation (Fig. 2) as a) Anticipatory Adaptation: Ad-

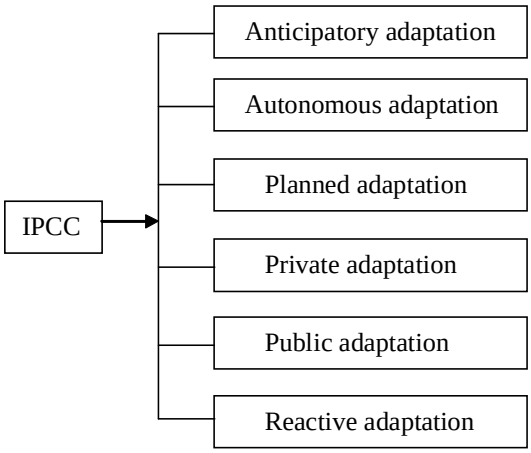

Fig. 2. Types of adaptation

aptation that takes place before impacts of climate change are observed and it is also referred to as proactive adaptation. b) Autonomous Adaptation: Adaptation that does not constitute a conscious response to climatic stimuli but is triggered by ecological changes in natural systems and by market or welfare changes in human systems are also referred as spontaneous adaptation. c) Planned Adaptation: Adaptation that is the result of a deliberate policy decision, based on an awareness that conditions have changed or are about to change and that action is required to return to, maintain, or achieve a desired state. d) Private Adaptation: Adaptation that is initiated and implemented by individuals, households or private companies and it is usually in the actor's rational self-interest. e) Public Adaptation: Adaptation that is initiated and implemented by governments at all levels. Public adaptation is usually directed at collective needs. f) Reactive Adaptation: Adaptation that takes place after impacts of climate change has been observed. From the above mentioned types it may conclusive to state that, adaptation can be spontaneous or planned and can involve enhancing the feasibility of social and economic activities to make them less vulnerable to climate. Spontaneous adaptations are considered to be those that take place as a reactive response to climate stimuli. Planned adaptations can either be reactive or anticipatory, i.e. undertaken before the impacts are apparent.

A portfolio of adaptation measures can diminish the risks associated with climate change and so adaptation activities can be categorized as: Relocation: shifting current activities or structures to another location. Accept Loss: do not implement vulnerability measures and bear the burden of loss. Prevention of loss: reduce vulnerability to climate change by engineering or other measures. Activity Changes: replace current activities with more sustainable activities. Spread losses: distribute the burden of losses through property insurance, government relief and other measure. Research and monitoring: to inform the adaptation process, improve knowledge of processes by using data and information and observe trends. Public awareness and education: sensitize and increase the population's awareness, including selected target audiences, to obtain their support or change their behavior (UNEP, 2008).

Challenges of adaptation

Adaptation to the adverse effects of climate change is vital in order to reduce the impacts of climate change that are happening now and increase resilience to future impacts. Scientific research shows that climate change exacerbates many existing strains and stresses on natural resource systems and built infrastructure. The critical and overarching challenge of climate change is how and when to act in face of scientific evidence. First, ecosystems and social-ecological systems can absorb significant perturbations if they are resilient. When thresholds are breached, they often undergo significant regime shifts into alternate states that may be equally resilient, yet are often undesirable from human perspective. Second, the impacts and consequences of climate change can be valued according to different metrics, but are certainly not limited to economic measures. Third, the implementation of adaptation is essentially a governance issue. On the other hand, adaptation involves deliberate action or inaction taken by individuals and through collective action The scale of adaptation action required is enormous, yet at the same time the geopolitical systems that are in thrall creates massive inertia. Under these circumstances, in reality, the governance of adaptation is likely to be complex, a legacy of past modes of operating combined with the persistence of outdated paradigms that make it difficult to enact effective adaptations to an issue as complex and multifaceted as climate change (Adger *et al.* 2009).

Funding adaptation

Adaptation needs sufficient and sustained funding so that countries can plan for and implement adaptation plans and projects. Funding is required for all

developing countries to develop national adaptation plans and for these to exist at all levels: local, sub-national and national. Without sustained funding, adaptation responses are likely to be limited to reactive action, such as short-term emergency relief or humanitarian aid. Furthermore, humanity will face increased costs and greater risks in the future, including: large-scale population movements, with the number of environmentally displaced persons outgrowing the number of traditional refugees, conflict due to competition over scarcer resources such as water, food and energy (UNFCCC, 2009). Adaptation to climate change will mean additional costs for the public and private sectors. However, assessing the costs and, especially, the benefits of adaptation is more complicated than for mitigation. The performance of adaptation options cannot be measured in a single indicator making it difficult for decision-makers to compare alternative adaptation options. Adaptation is expected to be increasingly important in future climate policies, but explicit funding possibilities for adaptation activities are limited. At the same time, the demand for adaptation is still unclear. The total costs of adaptation are very difficult to estimate, due to the dependency of vulnerability on local characteristics and changes in vulnerability over time (Bouwer and Aerts, 2006). The Global Environment Facility (GEF) operates the UNFCCC's financial mechanism, which channels funds to developing countries on a grant or loan basis, including funds received from Annex II Parties (Tematea 2007). The GEF currently manages four funds that support climate change adaptation on behalf of the UNFCCC. Those include the Strategic Priority on Adaptation (SPA), the Least Developed Countries Fund (LDCF), the Special Climate Change Fund (SCCF) and the Adaptation Fund (AF). Recent calculations show that costs of adaptation and corresponding needs for financial support are high and it is an inevitable challenge, especially in developing countries. The international community therefore has to face urgent questions on how to meet these financial needs on the one hand and how to channel available funds to respective developing countries and vulnerable communities on the other. In bi- and multilateral development cooperation, there is a strong trend towards programme-based approaches for financing multi-sectoral poverty reduction strategies. These instruments can also be relevant for funding adaptation measures as a means of supporting a country-driven integration of adaptation into national policies. In order to use programme-based approaches for adaptation funding, the following issues need to be addressed: (i) ensure a country-driven integration of adaptation policies into poverty reduction strategies and development planning, (ii) take a participatory approach to the policy dialogue and (iii) develop an assessment framework for monitoring and evaluation (Horstmann, 2009).

Conclusion

Adaptation is a social process with implications for ecosystem services, economic, social, political stability and culture. Yet the science of adaptation has not yet progressed to the point where we have a solid understanding of what is actually involved in adapting to dramatic changes and uncertainties that are both predicted and increasingly observed (Adger *et al.* 2009). The content of this review and theoretical study debated the importance of understanding and defining adaptation, and highlights the need and challenges of adaptation. There is a need to develop, disseminate and implement the knowledge, tools and technologies required to effectively engage in an integrated approach. There are several assessment frameworks in place that can potentially help reduce vulnerability to climate change. At the same time, new tools are needed to address lacunae that have been identified, such as tools for screening projects for their exposure to climate risks (Agarwala, 2004) and economic valuation of climate change impacts (OECD, 2005). Financing adaptation activities and costs associated with the impacts of climate change is a key concern for developing countries together with long-term, firm and regular support is indispensable. Particular attention needs to be paid to the issues of adaptation in any future international climate regime, as a cross-cutting theme that is fully integrated into UNFCCC actions related to future research, commitments, capacity building, and also into decision making and management practices at various scales (Teri, 2001). Thus, Successful adaptation not only depends on governments but also on the active and sustained engagement of stakeholders, including national, regional, multilateral and international organizations, the public and private sectors, civil society and other relevant stakeholders.

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Effect of organic manures and biofertilizers on the yield parameters of gladiolus (*Gladiouls* sp.) cv. 'White Prosperity'

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ABSTRACT

A field experiment was conducted at Horticulture Farm of Rajasthan College of Agriculture, Udaipur taking gladiolus (*Gladiouls* sp.) cv. 'White Prosperity' as a test crop to find out the effect of organic manures and biofertilizers on yield parameters. The number of spikes, corms, cormlets, weight of corms and cormlets per plant increased significantly with the application of organic manures. Among the organic manures, vermicompost was found significantly superior over control with respect to yield parameters. The application of biofertilizers showed a perceptible improvement in yield attributing parameters of gladiolus. The highest number of spikes and corms per plant was observed with PSB (phosphorus solubilizing bacteria) followed by VAM (vesicular arbuscular mycorrhiza) and *Azotobacter*. A significant improvement was recorded in the weight of corms per plant with the application of biofertilizers and the highest weight was found with VAM. Interactive effect of organic manures and biofertilizers also found significant in case of number of spike, corms and cormlets per plant and highest values were recorded under PSB and vermicompost (T_{10}).

***Key word** : Organic manure, Biofertilizer, Gladiolus*

Introduction

Gladiolus is the queen of bulbous ornamentals, is one of the most popular cut flower of the world, especially used for decoration purpose. It belongs to family Iridaceae and it is one of the native of Africa and Asia Minor. Gladiolus is very much liked for its majestic spikes which contain attractive, elegant and delicate florets. Today nearly 89,600 ha area is under flower crops out of which about 3500 ha area is under bulbous ornamentals with maximum area being under gladiolus i.e., 1200 ha (Desh Raj, 2004).

Several factors are responsible for low productivity of gladiolus i.e. climate, cultivar, nutrition management, diseases and pest, amongst them nutrition management is considered to be most important. The chemical fertilizers increased the cost of cultivation and use of chemical fertilizer on the other hand is detrimental to soils and environment especially under faulty management leading to pollution of soil, water and atmosphere. Integrated use of various nutrient resources *viz*., organic manures and biofertilizers may help in increasing the productivity of gladiolus. Organic manures provide not only major nutrients but also micronutrients. They increase the organic matter content and serve as energy source for soil micro-organisms which helps in transformation of unavailable plant nutrients into available forms. Biofertilizers are biologically active product containing selective strains of microorganisms which can contribute nutrients to the plants through microbial activity. These are supplements of

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chemical fertilizers as they contribute plant nutrients through biological nitrogen fixation and solubilization of immobile phosphorus (Sivakumar *et al*., 2002). Besides other crops biofertilizers have also been found beneficial in flower crops like gladiolus, tuberose, dahlia, rose, chrysanthemum and marigold etc. (Maurya and Beniwal, 2003). However, very little or infect no research work has been conducted on this aspect under Udaipur agro-climatic conditions. Therefore, keeping above points in view, this study was carried out to evaluate the effect of organic manures and biofertilizer on the yield parameters of gladiolus (*Gladiolus* sp.) var. "White Prosperity".

Materials and Methods

The field experiment was conducted at Horticulture Farm, Rajasthan College of Agriculture, Udaipur during *rabi* season (from October, 2005 to April, 2006). The experiment was comprised of 12 treatment combinations having three types of organic manures i.e. control, vermicompost and FYM and four types of biofertilizers i.e. control, *Azotobacter*, *VAM* and *PSB.* The experiment was laid out in factorial randomized block design with three replications. After field preparation half of the recommended doses of nitrogen, phosphorus and potassium i.e., 150, 100 and 100 kg/ha, respectively were applied through urea, single super phosphate and muriate of potash. Out of which one half nitrogen and full dose of phosphorus and potassium was given at three leaf stage as soil application and remaining half quantity of nitrogen was given at six leaf stage through broadcasting of urea. Also half dose of FYM 2 kg/m^2 applied one month before planting of corms. Before plating, corms were dipped in Bavistin (0.2%) solution for 30 minutes to treat the corms against pathogens. During planting biofertilizers each @ 2 g/corm was applied below corm and corm were placed upon them followed by a cover of one handful sand for proper aeration. Planting was done at 30 cm x 20 cm spacing at 8-10 cm depth in a plot of size 1.5 m x 0.8 m. Various parameters were recorded at various stages after planting. The number of spikes and corms produced per hectare was worked out with the help of following formula and the data were used for statistical analysis.

$$\text{Spikes or corms yield/ha} = \frac{\text{Number of spikes/corms}}{\text{Net experimental field}} \times 10{,}000$$

Results and Discussion

Effect of organic manures

The data in Table 1 revealed that organic manures significantly improved the number of spikes, corms, cormlets, weight of corms and cormlets per plant. The highest number of spikes per plant (1.53), number of corms per plant (1.81), number of cormlets per plant (20.62), weight of corms per plant (55.72 g) and weight of cormlets per plant (2.48 g) was recorded with the application of vermicompost followed by FYM. It may be due to the fact that vermicompost provided better nutrition as it contains all major nutrients besides micronutrients and it also favours the beneficial activity of microorganisms. Similar findings were observed by Asrey *et al*. (2002) in gladiolus.

Effect of biofertilizers

In case of biofertilizers, *PSB* showed significantly higher number of spikes (1.57) as compared to *Azotobacter* (1.46) and control (1.28) but it was found at par with *VAM* (1.49). Significantly higher number of corms per plant (2.10) was recorded with *PSB* while, minimum number of corms per plant (1.36) was observed under control. Similar findings were observed by Swaminathan *et al*. (1999) in tuberose. Improvement in these parameters was due to enhanced availability of phosphorus because of the increased presence of *PSB* in *rhizosphere*, which stimulates of certain growth promoting compounds. Meanwhile, *Azotobacter* treatment gave the significantly highest number of cormlets per plant (21.60) followed by VAM (20.98) whereas lowest number of cormlets per plant (15.66) was found under control. Improvement in this character could be ascribed to the proper availability of nitrogen fixed by *Azotobacter* as non-symbiotic bacteria in the rhizosphere of inoculated corms. Misra (1998) also observed the maximum number of cormlets per plant with *Azotobacter* application in gladiolus. VAM significantly gave maximum weight of corms per plant (58.41 g) which was found at par with PSB (57.20 g) while minimum weight of corms per plant (43.87 g) was recorded under control. Significantly higher weight of cormlets (2.65 g) was observed in PSB which was found at par with VAM (2.59 g) whereas; minimum weight of cormlets (1.90 g) was noted under control. It might be due to the fact that VAM making the nutrients available for diffusion of phosphatic ions and increasing the surface area for absorption of

other nutrients such as N, K, Mg and Zn. Similar results has also been reported by Kathiresan *et al*. (2002) in gladiolus.

Interactive effect of organic manures and biofertilizers

Significantly the higher number of spikes per plant (1.67) was recorded with T_{10} treatment (PSB and vermicompost) but it was found at par with T_7 (VAM and vermicompost) and T_{11} (PSB and FYM) while; minimum (1.00) was recorded under control (T_0). The number of corms per plant under treatment T_{10} (2.20) was found significantly superior over rest of the treatment combinations except T_9 (PSB only) and T_{11} while minimum number of corms per plant (1.07) was recorded in control. It was because of complimentary effect of both PSB and vermicompost. The obtained results are in close conformity with the results reported by Karuppaiah (2005) in French marigold. Significantly maximum number of cormlets per plant (23.37) was found in treatment T_4 (vermicompost and *Azotobacter*) and it was found at with T_{10} (22.00) and T9 (21.00) while minimum number of cormlets (14.27) was recorded under control. It may be due to the complimentary effect of both vermicompost and *Azotobacter*. Similar results were reported by Mogal *et al*. (2006) in China aster. The combined effect of organic manures and biofertilizers was found to be non-significant on weight of corms per plant and weight cormlets per plant.

Thus in general, the application of organic manures and biofertilizers brought perceptible improvement in yield parameters of gladiolus as compared to control and the combined use (interactive effect) of vermicompost and phosphate solubilizing

Table 1. Effect of organic manures, biofertilizers and their interaction on the yield parameters of gladiolus cv. 'White Prosperity'

Treatment	Number of spikes per plant	Number of corms per plant	Number of cormlets per plant (g)	Weight of corms per plant (g)	Weight of cormlets per
Organic manures					
Control (O_0)	1.33	1.64	18.13	49.76	2.22
Vermicompost (O_1)	1.53	1.81	20.62	55.72	2.48
FYM (O_2)	1.48	1.73	20.27	54.61	2.43
SEm ±	0.027	0.033	0.344	1.114	0.052
CD at 5 %	0.080	0.097	1.009	3.269	0.151
Biofertilizers					
Control (B_0)	1.28	1.36	15.66	43.87	1.90
Azotobacter (B_1)	1.46	1.68	21.60	53.98	2.36
VAM (B_2)	1.49	1.77	20.98	58.41	2.59
PSB (B_3)	1.57	2.10	20.46	57.20	2.65
SEm ±	0.031	0.038	0.397	1.287	0.594
CD at 5 %	0.093	0.111	1.165	3.774	0.174
Interactive effect of organic manures x Biofertilizers					
B_0O_0 (T_0)	1.00	1.07	14.27	37.67	1.58
B_0O_1 (T_1)	1.43	1.57	15.90	48.42	2.11
B_0O_2 (T_2)	1.40	1.43	16.80	45.52	2.02
B_1O_0 (T_3)	1.40	1.67	20.17	51.75	2.21
B_1O_1 (T_4)	1.50	1.70	23.37	54.83	2.48
B_1O_2 (T_5)	1.47	1.67	21.27	55.35	2.40
B_2O_0 (T_6)	1.43	1.77	20.63	58.37	2.53
B_2O_1 (T_7)	1.53	1.77	21.20	58.89	2.60
B_2O_2 (T_8)	1.50	1.77	21.10	57.98	2.63
B_3O_0 (T_9)	1.50	2.07	17.47	51.26	2.57
B_3O_1 (T_{10})	1.67	2.20	22.00	60.74	2.72
B_3O_2 (T_{11})	1.53	2.03	21.90	59.59	2.66
SEm ±	0.055	0.066	0.688	2.223	0.103
CD at 5 %	0.160	0.193	2.018	NS	NS

NS = Non-significant

bacteria have the substantial enhancement in yield attributing characters of gladiolus.

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Effect of cyclic use of sewage water on growth, yield and heavy metal accumulation in cabbage

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ABSTRACT

A field experiment was conducted during *rabi* season of the year 2005-06 taking cabbage as a test crop on sandy clay loam soil for evaluating the effect of cyclic use of sewage water on growth, yield and heavy metal accumulation. The maximum size of head, weight per head and highest crop yield was recorded under alternate irrigation with groundwater and sewage water. The concentration of nitrogen, phosphorus, potassium, zinc, copper, iron, manganese, lead, cadmium and nickel in heads and roots of cabbage increased significantly due to application of sewage water irrigation. Under groundwater irrigation the contents of lead, cadmium and nickel were not detectable in heads and roots of cabbage but under totally sewage water irrigation the contents of lead, cadmium and nickel was observed 1.560, 0.052 and 0.925 ppm in heads and 0.581, 0.230 and 0.297 ppm in roots of cabbage.

Key words : Cabbage, Heavy metal accumulation, Sewage water.

INTRODUCTION

Water and nutrient are the major input for crop production. It is predicted that most Asian countries will face severe problem related to water availability by 2025 (Singh, 1999) due to rapid industrialization, increasing population and greater urbanization. Of the total available water on the globe, the average water use during last two decades for agricultural, industrial and domestic purposes accounted for 69, 23 and 8 per cent, respectively. In addition, demand of the scarce water resources for industrial and domestic use is increasing day by day and thereby the quantum of water available for agriculture is dwindling. Rapid industrialization and urbanization have created enormous problems of environmental pollution in terms of the variable quantity and quality. Untreated and contaminated sewage and industrial effluent increase the concentration of Cd, Pb, Zn, Cu, Mn, Fe, and Ni in surface layer of irrigated soil (Sakal *et al*., 1992; Adhikari *et al*., 1993) and long term use of the metal rich sewage water for irrigation purpose has a potential of causing accumulation of metals in soil and plants grown there on (Baddesha *et al*., 1997). Crops grown on toxic metals contaminated soils accumulate heavy metals in quantities excursive enough to cause clinical problems. In India, the existing waste water disposal farms receive about 75 % untreated waste water and the remaining as primary and/or secondary treated waste water. Cabbage is an important vegetable of cole group. It is a rich source of vitamin A, B, C and contains minerals, especially iron. Cabbage covers about 4 per cent of total area under vegetables in India. India comes next to China in cabbage production. Cabbage is a winter season crop that thrives best in climate of Udaipur. It can withstand extreme cold and frost relatively better than cauliflower. It loses its flavor in dry and warm weather. It can be grown on all types of soils. How-

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ever in clay loam or silt, higher yield may be obtained. It does not grow well on highly acidic soils and it is best grown in soils with pH ranging between 6.5 and 7.5. The leaves accumulate more heavy metals and nutrients as compared to flowers and fruits of a plant. The edible portion in cabbage is head or modified leaves. Being a leafy vegetable, cabbage highly responds to sewage water irrigation. Long term and indiscriminate use of raw sewage water for irrigating the crops may cause metal accumulation in soil to such an extent that it may lead to cause phyto-toxicity, which in turn may cause clinical problem in human and animals. A regular monitoring and evaluation of sewage irrigated areas based on scientific approach with reference to environment, health and crops is a vital need. This helps in developing long time water reuse strategies. Keeping the above facts in view the present investigation was undertaken to evaluate the effect of cyclic use of sewage water for irrigation on growth, yield and accumulation of heavy metals in cabbage.

Materials and Methods

A field experiment was conducted at Horticulture Farm (Tekri Farm), Rajasthan College of Agriculture, Udaipur during *rabi* season of the year 2005-06 to find out effect of cyclic use of sewage water and groundwater on growth, yield and heavy metal accumulation in cabbage crop. Udaipur is situated at the step foot of Aravali hills at 24º35ì N latitude and 73º42ì E longitude with an altitude of 582.17 m above mean sea level. This region falls under agro-climatic zone IV-a, "sub-humid southern plain and Aravali Hills" of Rajasthan. It has a typical sub-humid climatic conditions characterized by mild winters and moderate summers with high relative humidity during the months of July to September. The average annual rainfall of Udaipur is 637 mm, most of which is received during the last week of June to September contributed by south-west monsoon. A representative soil sample was taken from the experimental field prior to incorporation of fertilizers and subjected to mechanical and chemical analyses to assess the physio-chemical status of soil (Table 1). The source of sewage water is the main *nala* emerging from the centre of Udaipur city and laying parallel to the road from Surajpole to Pratapnagar. Samples of sewage water were collected in plastic bottles at the time of irrigations. A part of each collected sample was acidified by adding nitric acid at the rate of 5 ml L^{-1} and kept for analysis of metallic cations. The remaining samples were subjected to analysis for other constituents immediately after sampling. The sewage water and groundwater samples collected at the time of each irrigation for the experimental use were analyzed for assessing TSS (Total Suspended Solids) pH, EC, soluble cations (Na and K) and soluble anions (CO_3, HCO_3, Cl, NO_3) in addition to metallic cations (Zn, Cu, Fe, Mn, Pb, Cd, Ni) using standard methods of analyses. Based on analytical data the quality of sewage water and groundwater (Table 2) was assessed to find out their suitability for crop production (Ayers and Westcot, 1985; ISI Standards, 1982 and Pratt, 1972). The experiment was conducted in Randomized Block Design with four replications taking cabbage cv. Golden acre as test crop. The treatments were T_1 = All irrigations with groundwater, T_2 = one irrigation with groundwater followed by one irrigation with sewage water, T_3 = one irrigation with groundwater followed by two irrigation with sewage water, T_4 = one irrigation with groundwater followed by three irrigation with sewage water, T_5 = one irrigation with groundwater followed by four irrigation with sewage water and T_6 = all irrigation with sewage water. Six weeks old seedlings of cabbage were

Table 1. Physico-chemical properties of the experimental soil

Parameters	Value
Sand (%)	48.30
Silt (%)	19.42
Clay (%)	32.20
Texture class	Sandy Clay Loam
Bulk density (Mg m^{-3})	1.46
Porosity (%)	41.68
Water Holding Capacity (%)	40.12
pH	8.28
Electrical conductivity (dS m^{-1})	0.84
Organic carbon (g kg^{-1})	7.75
Available nitrogen (kg ha^{-1})	260.56
Available phosphorous (kg ha^{-1})	23.25
Available Potassium (kg ha^{-1})	368.20
Metallic cation (mg kg^{-1})	
Zinc	2.10
Copper	0.62
Iron	3.11
Manganese	5.01
Lead	ND
Cadmium	ND
Nickel	ND

ND = Not detectable

transplanted in experimental field at a row spacing of 60 cm and plant spacing of 45 cm. Flood method of irrigation was used and irrigations were given as per standard package of practices. The harvesting of cabbage was done manually by cutting the vegetative portion (head) from their base with blade and harvested green matter was weighed for recording yield and sampling was done. The roots were uprooted gently to avoid any breakage and washing with tap water and subjected to chemical analyses. The plant samples were washed in fresh water and finally in distilled water. The dried plant samples were finally grinded. The grinded plant materials were subject to chemical analysis for N, P, K and metallic cations (Zn, Cu, Fe, Mn, Pb, Cd, Ni) using standard method of analysis. The various assessed soil and plant parameters of the experiment were subjected to statistical anlaysis and their significance were judged using analysis of variance technique (Fisher, 1950).

Table 2. Quality of groundwater and sewage water used for irrigation

Characteristics	Groundwater	Sewage water
pH	8.18	7.72
EC (dS m^{-1})	1.60	2.32
TSS (mgL^{-1})	12.0	161
Na (meL^{-1})	12.01	13.79
K (meL^{-1})	0.23	0.28
CO_3 (meL^{-1})	0.63	0.00
HCO_3 (meL^{-1})	2.00	3.8
Cl (meL^{-1})	11.98	4.74
NO_3 (meL^{-1})	0.82	7.92
PO_4 (meL^{-1})	0.09	9.03
Zn (μgL^{-1})	8.00	234.2
Cu (μgL^{-1})	4.50	219
Fe (μgL^{-1})	ND	101.2
Mn (μgL^{-1})	26.00	282
Pb (μgL^{-1})	ND	70.8
Cd (μgL^{-1})	ND	122.8
Ni (μgL^{-1})	ND	107.8

ND = Not detectable

Results and Discussion

The data in Table 3 showed that the maximum size of head, weight per head and highest crop yield was obtained under treatment T_2 followed by T_3 and T_4. The size of head, weight per head and crop yield was observed 28.09, 28.6 and 28.6 per cent more as compared to T_1 (All irrigations with groundwater). Except alternate irrigations with groundwater and sewage water, further increase in number of sewage water irrigation tended to decrease or decreased significantly the size of head, weight per head and crop yield. The minimum size of head, weigh per head and crop yield was recorded under treatment T_6 when crop was irrigated with sewage water only. The improvement in size of head, weight per head and crop yield under treatment T_2 might be the result of additional supply of nutrients through sewage water (Table 2) and it favoured greater availability of macro and micronutrients and their steady supply throughout growth for optimum development. These results are in conformity with those of Zebarth *et al.* (1991); Wange *et al.* (1996) who have reported increase in plant growth and weight per head of cabbage due to sewage water irrigation. Further increase in number of irrigations with sewage water decreased the growth and yield due to higher supply of macro-nutrients and heavy metals which crossed their safe limits and caused toxicity. EI-Beheidi and EI-Mansi (1973) reported the decrease in weight of head and number of outer leaves due to nitrogen toxicity through sewage irrigation.

Perusal of data in Table 3 revealed that the concentration of nitrogen, phosphorus and potassium in heads and roots of cabbage increased with increase in number of sewage irrigations. Concentration of nitrogen content in heads under irrigation with sewage water ranged between 2.54 and 2.65 per cent and under groundwater irrigation the nitrogen content was 2.21 per cent. Maximum concentration of nitrogen was recorded in heads irrigated with sewage water only. Further, results presented in Table 3 reveal that concentration of nitrogen in roots irrigated with sewage water ranged between 0.951 to 1.189 per cent whereas 0.820 per cent nitrogen concentration was recorded in roots under irrigation with groundwater. Concentration of phosphorus content in heads under irrigation with sewage water ranged between 0.270 and 0.346 per cent whereas 0.251 per cent phosphorus was observed in heads under irrigation with groundwater. Similar to nitrogen, the maximum concentration of phosphorus was obtained in heads with sewage water irrigation. The concentration of phosphorus in roots irrigated with sewage water ranged between 0.220 and 0.262 per cent whereas 0.190 per cent phosphorus concentration was found in roots irrigated with groundwater. The concentration of potassium content in heads irrigated with sewage water ranged between 2.620 and 2.731 per cent while 2.170 per cent potassium

Table 3. Effect of sewage irrigation on growth, yield and N, P and K content of cabbage

Treatment	Size of Head (diameter) (cm)	Weight per head (gm)	Yield (qha^{-1})	% Nutrient content in head			% Nutrient content in roots		
				Nitrogen	Phosphorus	Potassium	Nitrogen	Phosphorus	Potassium
T_1	10.04	759	234.20	2.210	0.251	2.170	0.820	0.190	0.869
T_2	12.86	976	301.20	2.540	0.276	2.620	0.951	0.220	1.042
T_3	12.24	928	285.80	2.600	0.291	2.660	0.984	0.231	1.103
T_4	11.33	859	264.60	2.610	0.293	2.670	0.992	0.233	1.112
T_5	9.52	717	221.60	2.620	0.296	2.671	1.000	0.237	1.121
T_6	7.86	589	181.80	2.650	0.346	2.731	1.189	0.262	1.233
SEm±	0.53	28.17	10.52	0.070	0.0067	0.055	0.020	0.007	0.024
CD (P=0.05)	1.60	84.90	31.72	0.210	0.020	0.167	0.060	0.020	0.073

Table 4. Effect of sewage irrigation on heavy metal accumulation in cabbage head and roots

Treatment	Heavy metal concentration in head (ppm)							Heavy metal concentration in roots (ppm)						
	Zn	Cu	Fe	Mn	Pb	Cd	Ni	Zn	Cu	Fe	Mn	Pb	Cd	Ni
T_1	20.37	3.27	20.72	60.49	ND	ND	ND	5.46	0.740	12.96	21.66	ND	ND	ND
T_2	38.29	7.32	36.67	67.74	0.806	0.020	0.442	23.91	1.287	21.12	28.37	0.330	0.013	0.142
T_3	42.96	8.20	43.71	71.98	1.216	0.028	0.546	27.90	1.487	24.62	29.67	0.461	0.163	0.219
T_4	42.99	8.24	43.92	72.58	1.231	0.031	0.549	28.11	1.494	25.27	29.99	0.466	0.169	0.223
T_5	43.01	8.26	44.13	73.18	1.247	0.035	0.551	28.28	1.520	25.91	30.27	0.469	0.170	0.226
T_6	48.48	10.39	51.80	83.47	1.560	0.052	0.925	37.81	1.853	31.62	33.35	0.581	0.230	0.297
SEm±	0.736	0.156	0.822	1.245	0.026	0.001	0.009	.535	0.025	0.469	0.639	0.006	0.002	0.005
CD (P=0.05)	2.219	0.471	2.478	3.754	0.078	0.002	0.029	1.611	0.074	1.413	1.927	0.020	0.005	0.017

ND = Not detectable

was observed in heads irrigated with groundwater solely. Maximum concentration of potassium was recorded in heads irrigated with sewage water. Furthermore, the concentration of potassium in roots irrigated with sewage water ranged between 1.042 and 1.233 per cent and 0.869 per cent potassium concentration was recorded in roots irrigated with groundwater. It was observed that when the crop was grown with totally sewage water irrigation the N, P and K content in heads and roots of crop were significantly higher than those grown with groundwater irrigation. The higher status of available N, P and K in sewage water might have contributed to a higher concentration of these nutrients in the heads and roots of crop. The findings of the present investigation are found well in agreement with the findings of Kumar (2005) and Malla and Totawat (2006).

The results related to metallic cation contents in heads and roots of cabbage plants are presented in Table 4. The results revealed that the concentration of zinc, copper, iron, manganese, lead, cadmium and nickel in heads and roots of cabbage increased significantly due to application of sewage water as irrigation. Zinc, copper, iron and manganese content in heads of cabbage due to sewage water irrigation (T_6) were found to be 2.38, 3.18, 2.50 and 1.38 times higher respectively, as compared to control (T_1). The highest content of zinc, copper, iron and manganese in roots of cabbage were also observed under exclusively sewage water irrigation and it was higher by 6.92, 2.50, 2.44 and 1.54 times respectively, as compared to groundwater irrigated roots of cabbage. The lead, cadmium and nickel content in heads and roots of cabbage increased significantly with increasing application of sewage water. With groundwater irrigation the contents of lead, cadmium and nickel were not detectable by atomic absorption spectrophotometer in heads and roots of cabbage. However, with entirely sewage water irrigation the contents of lead, cadmium and nickel were observed as 1.560, 0.052 and 0.925 ppm in heads and 0.581, 0.230 and 0.297 ppm in roots respectively. The content of metallic cations (Zn, Cu, Fe, Mn, Pb, Cd and Ni) in the heads and roots of the crop increased successively with an increase in the proportion of sewage water for irrigation, which may be due to higher level of these metallic cations in the sewage water. These results are quite compatible with the findings of Kumar (2005) and Malla and Totawat (2006), who reported an elevated content of various metallic cations in plants with increasing proportion of sewage sludge or effluents (sewage water) to the soil.

Conclusions

On the basis of above findings, it can be concluded that the alternate irrigation with sewage water and groundwater, in general, brings about an improvement in crop growth and yield, however it results in several folds build up of the metallic cations in the heads and roots of the crop. Zinc, Copper and iron content in the heads and roots of crop irrigated with only sewage water crossed the prescribed safe limits. Hence, the findings of the present study emphasize the need for proper treatment of sewage water before its use for irrigation.

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Effect of integrated nitrogen management on available N, P and CO_2 evolution at different intervals under wheat (*Triticum aestivum*) cultivation

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ABSTRACT

A field experiment was conducted at Agronomy Farm, Rajasthan College of Agriculture, Udaipur (Rajasthan) during rabi season of 2005-06 to evaluate the effect of integrated nitrogen management on available N, P and CO_2 evolution at different intervals under wheat cultivation. The results indicated that application of nitrogen through organic manure or in integration with chemical fertilizer significantly improved the available N, P and CO_2 evolution at 7, 15, 30 and 45 days after sowing and organic carbon at harvest.

Key words : *Integrated nitrogen management, Wheat.*

Introduction

In Rajasthan state, wheat occupies an area of 2.1 m ha with the production of 5.8 m tonnes with an average yield of 2.54 m tonnes which is at par with the nation's acreage but compared with realizable yield limit, it is far below. This suggests a great scope to further elevate the productivity in the state. It is generally recognized that the gap between actual and potential yield is primarily due to lack of sufficient and effective nutrient management. It is an established fact since long that amongst the nutrients, nitrogen plays an important role in the growth and development of crop plants. Nitrogen is indispensable for increasing crop production and productivity. Maintenance of crop production requires judicious use of nitrogen through fertilizer and manure in an integrated manner. Increase in productivity of soil, without deteriorating soil and environment has drawn attention of scientists working on natural resources. These resources need to be managed in a way that enhance biological activity, maintain biodiversity and productivity of soil for long term in a sustainable way. There is need to explore the additional untapped organic sources. Mushroom cultivation is based on compost or crop residues and harvest of a crop results in disposable organic waste. Mushroom waste is partly or fully decomposed organic matter with narrow C: N ratio and may serve as a source of nutrients as well as a source of inoculum for decomposition of soil organic residues. Therefore, this study is an attempt to study the comparative efficiency of FYM, button, and oyster spent mushroom compost in integration with inorganic source of nitrogen taking wheat as a test crop to study the effect of spent mushroom compost, farm yard manure and fertilizer on CO_2 evolution and available nutrient status of rhizosphere soil.

Material and Methods

A field experiment was conducted at Rajasthan College of Agriculture, MPUAT, Udaipur (Raj.) during *rabi* season 2005-06. The soil of experimental field

was clay loam texture, slightly alkaline in reaction (pH 8.2, EC 0.86 dSm^{-1}) and calcareous in nature. The soil was medium in available nitrogen (292.15 kg ha^{-1}), available phosphorus (22.5 kg ha^{-1}) and available potassium (360.15 kg ha^{-1}) and well supplied with micronutrients copper (1.94 mg kg^{-1}), iron (6.84 mg kg^{-1}), manganese (9.30 mg kg^{-1}) and zinc (3.14 mg kg^{-1}). The experiment consisted of 14 treatments replicated 3 times in a randomized block design. The soil samples were collected at 7, 15, 30 and 45 days after sowing and at the harvest of the crop and analyzed for available nitrogen, phosphorus, CO_2 evolution and organic carbon content following standard procedures. The experimental data were statistically analyzed for analysis of variance and test of significance through the procedure appropriate to the randomized block design. The critical differences were calculated whereas 'F' test was found significant at 5 per cent level of significance. The treatment details were as:

Results and Discussion

Nutrient availability

The data in Table 1 revealed that the application of nitrogen through different sources significantly increased the available nitrogen, phosphorus and CO_2 evolution in soil at different days interval 7, 15, 30 and 45 days after sowing (DAS). The available nitrogen was highest at initial stage (7 DAS) in treatment T_1 (100% N through inorganic source), but on later stages (at 15 DAS, 30 DAS and 45 DAS) N availability was maximum under treatment T_4 (75% nitrogen through urea + 25% nitrogen through button SMC followed by T_2 (75% nitrogen through urea + 25% nitrogen through FYM). Among organic manures the button SMC was superior over the FYM and oyster SMC because button SMC have lower C: N ratio than the oyster SMC and FYM. Dose of nutrient, mineralization rate and uptake of nutrients directly govern availability of nutrients in rhizosphere. The organic manures along with fertilizer influence the availability of nutrients in soil by mineralization process (Surendra Rao and Sitaramayya, 1997). The similar results were also reported by Ramanathan and Krishanmurthy (1973).

The available phosphorus content in rhizosphere soil at all stages (7, 15, 30 and 45 DAS) was significantly increased with application of nitrogen through different sources. The maximum available phosphorus was recorded under treatment receiving 25% nitrogen through urea + 75% nitrogen through button SMC followed by treatment receiving 25% nitrogen through urea + 75% nitrogen through FYM. The availability of phosphorus increased with increasing organic acids, which were released during decomposition of organic matter. These organic acids helped in the solubility of native phosphates. Further, the organic matter reduces fixation capacity of soil and increases the availability. Results of the present study are in close agreement with those of Bhardwaj and Omanwar (1994).

CO_2 evolution

CO_2 evolution is directly related to microbial activity. CO_2 evolution was also increased with increasing organic matter content. The maximum CO_2 evolution was obtained in treatment receiving 100% ni-

Treatment No.	Treatment Combinations
T_o	Control
T_1	100% N through inorganic source
T_2	75% N through inorganic source + 25% through FYM
T_3	75% N through inorganic source + 25% N through oyster SMC
T_4	75% N through inorganic source + 25% N through button SMC
T_5	50% N through inorganic source + 50% N through FYM
T_6	50% N through inorganic source + 50% N through oyster SMC
T_7	50% N through inorganic source + 50% N through button SMC
T_8	25% N through inorganic source + 75% N through FYM
T_9	25% N through inorganic source + 75% N through oyster SMC
T_{10}	25% N through inorganic source + 75% N through button SMC
T_{11}	100% N through FYM
T_{12}	100% N through oyster SMC
T_{13}	100% N through button SMC

SMC = Spent Mushroom Compost

Table 1. Effect of Integrated nitrogen management on available N, P (kg ha^{-1}) & CO_2 evolution (mg 100 g^{-1} soil) at different intervals and organic carbon (%)

Treatments	7 days after sowing			15 days after sowing			30 days after sowing			45 days after sowing			At harvest
	Available N	Available P_2O_5	CO_2 evolution	Available N	Available P_2O_5	CO_2 evolution	Available N	Available P_2O_5	CO_2 evolution	Available N	Available P_2O_5	CO_2 evolution	Organic carbon
T_0	285.32	20.16	9.42	280.42	19.41	11.42	275.00	18.32	14.98	274.33	17.21	13.64	0.61
T_1	342.13	23.42	12.56	344.11	24.18	13.62	345.14	25.12	15.26	346.26	25.48	14.78	0.66
T_2	338.21	26.32	14.72	342.23	27.27	15.27	346.78	28.18	17.78	347.14	28.72	16.23	0.74
T_3	335.12	25.70	13.48	340.56	26.16	14.32	344.26	27.12	16.92	345.21	27.78	15.43	0.73
T_4	340.16	27.34	15.32	344.85	28.43	16.38	347.38	29.16	18.71	349.36	29.72	17.39	0.75
T_5	335.27	27.43	15.46	338.12	28.56	17.52	340.31	29.37	19.43	341.33	29.94	18.31	0.76
T_6	330.42	26.34	14.26	334.23	27.54	15.39	336.16	28.43	17.58	338.11	28.84	16.72	0.74
T_7	338.52	28.26	16.73	340.26	29.74	18.56	341.19	30.58	20.32	343.39	31.03	19.13	0.78
T_8	331.38	29.72	17.23	336.37	30.47	19.71	338.21	31.67	22.46	340.52	32.16	21.27	0.80
T_9	327.17	28.62	16.37	332.62	29.54	18.31	334.28	30.47	21.57	336.68	30.84	19.78	0.79
T_{10}	334.19	30.12	18.29	338.51	31.17	21.58	339.14	32.17	23.73	341.74	32.94	22.37	0.82
T_{11}	326.26	25.13	18.56	330.62	26.56	21.63	335.52	27.34	24.53	338.51	28.31	23.12	0.83
T_{12}	322.24	24.72	17.62	328.26	25.38	20.12	331.47	26.56	22.43	334.36	27.13	21.53	0.80
T_{13}	328.28	26.16	19.23	334.39	27.14	23.14	337.38	28.39	26.19	340.18	29.12	24.62	0.85
SEm±	8.16	0.57	0.30	8.54	0.581	0.34	7.78	0.632	0.41	8.36	0.68	0.38	0.015
CD (P=0.05)	23.73	1.67	0.88	24.82	1.69	1.00	22.64	1.839	1.19	24.30	1.98	1.10	0.046

trogen through button SMC followed by FYM and oyster SMC. Application of fertilizer also increased CO_2 evolution but rate was slower than the plot receiving organic manures. It may be due to the fact that larger the level of soil organic carbon source larger will be survival of diversified microbial population and higher will be microbial activity. CO_2 evolutions in incubation of soil at different days were also influenced by decomposition of organic material, which is directly correlated to microbial activity. Table 1 clearly showed that increase in dose of organic matter content, the CO_2 evolution rate also increased till 30 days and at later stage it declined because mineralization and decomposition rate slower down than earlier stages. The results are in agreement to findings of earlier workers i.e., Sharma *et al.* (1983); Gregorich and Druury (1996); Maheswarappa *et al*. (1999); Chen *et al*. (2002) and Urmila (2005).

Organic carbon at harvest

Results pertaining to the organic carbon status of post-harvest soil presented in Table 1. A critical examination of data revealed that soil organic carbon status ranged between 0.61 to 0.85 % under various treatments. The highest organic carbon content was observed in treatment T_{13} (100% nitrogen through button SMC) followed by treatment T_{11} (100% nitrogen through FYM) and minimum value (0.61%) of organic carbon was observed in control. The soil organic carbon also increased with the use of different source of nitrogen irrespective whether in sole application or along with fertilizers indicating recycling of organic matter in the form of organic manures on continuous basis results in cumulative buildup depending upon the weather, temperature and other agronomic practices i.e. 100% N through organic sources (button SMC, FYM and oyster SMC) with a build up to extent of 0.85, 0.83 and 0.80 g kg^{-1} organic carbon (Table 1). Use of inorganic nutrients also resulted in comparatively better level of soil organic carbon, which could be attributed to enhanced root growth that remained in soil at harvest. The results are in agreement to earlier findings of Mathur (1997); Sharma and Gupta (1998); Yadav *et al*. (2000),

Parmar and Sharma (2002); Ranganathan and Selvaseelan (1997).

Thus, organic manure alone though improve chemical and biological properties of soil considerably but could not sustain high crop yield due to slow release of plant nutrients. The study revealed that integrated use of chemical fertilizer and organic manure is an imperative in intensive cropping system, which maintained soil fertility status and soil health.

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Influence of forest litter on soil enzyme activities

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ABSTRACT

Effect of forest litter on soil physico-chemical, biological properties and enzyme activities was assessed. Except pH improved physico-chemical properties were noticed in forest soil accumulated with litter than control soil (without litter) which includes pH 4.8 – 5.1, WHC 0.30 – 0.33 ml/gram of soil, EC 0.09 – 0.10 µ Mhos/cm, Phosphorus 2– 9kg/h, Potassium 103 – 108 Kg/h. The biological properties such as bacterial and fungal population was enumerated and expressed in terms of CFU/g of soil. Two fold higher bacterial and four fold higher fungal population was found in litter soil than control soil. The enzyme activities such as cellulase, protease and dehydrogenase were measured with/without supplementation of substrates (1% CMC, 1% Casein and 0.18 mM TTC respectively). With increase in soil incubation days enzyme activities increased up to 14th day interval and there after declined at 21st day interval. Forest soil accumulated with litter exhibited higher enzyme activities than control soil at all incubation days.

Key words : *Forest litter, Physico-chemical properties, Enzyme activities*

Introduction

Vegetation plays an important role in soil formation (Chapman and Reiss, 1992). Forest ecosystem contributes a lot of organic matter in the form of leaves, twigs, branches, reproductive parts, fruits etc., which after decomposition results in the formation of organic matter and release of nutrients (Tandel *et al.,* 2009). Forest trees help improving soil fertility through biological nitrogen fixation, phosphorus solubilization and decomposition of organic matter in their rhizosphere and non rhizosphere zone. These processes play an important role in plant nutrition and maintaining soil fertility (Prasad and Mertia, 2005). The fertility of soil improves *under* the tree cover which checks soil erosion, adds soil organic matter, available nutrients and replenishes the nutrients through effective recycling mechanisms (Tripathi *et al.,* 2009). Decomposition of leaf litter includes leaching, breakup by soil fauna, and transformation of organic matter by micro organisms and transfer of organic and mineral compounds. Decomposition of plant residues is influenced by substrate quality, decomposer community and environmental factors (Swift *et al.,* 1979; Coleman and Crossley, 1996; Smith and Bradford, 2003). Plant tissues are the main sources of organic matter which influences physico-chemical characteristics of soil such as pH, WHC, texture and nutrient availability (Johnston, 1989). Physico-chemical characteristics of forest soils vary in space and time due to variations in topography, climate, physical weathering, processes, vegetation cover, microbial activities and several other biotic and abiotic variables. (Shishir poudel and Jay sah, 2003).

Various soils exhibits enzyme activities but differ based on the respective crops and are related to microbial biomass, therefore changes in enzymes and microbial activities could alter the availability of nutrients for plants uptake (Dick *et al.,* 1988 a) and these changes are potential sensitive indicators of soil quality. The term "soil microbial activity" implies to the overall metabolic activity of all microorganisms inhabiting soil including bacteria, fungi,

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actinomycetes, protozoa, algae and micro fauna (Nannipieri, 1990). The microbial activity plays a vital role in soil productivity, sustainability as it underpins a number of fundamental soil properties such as fertility and structure. The diversity and population of soil microorganisms and the enzymes produced will depend mainly on the chemical composition of plant residues. The soil enzymes are sensors for soil degradation and microbial status (Wick *et al.*, 1998; Aon and Colaneri, 2001; Baum *et al.*, 2003).

The objective of the present investigation is to determine influence of available nutrients (litter) on soil physico-chemical, biological properties and soil enzyme activities which in turn represents soil quality.

Materials and Methods

Collection of soil samples

Soil sample composed with litter was collected from Seshachala forest, Tirupati. A.P. India. The soil sample collected from adjacent site served as control. It was air dried and mixed thoroughly to increase homogeneity and shifted to < 2mm. sieves for determination of soil texture.

Analytical methods for physico-chemical characterization of soil samples

Mineral matter of soil samples such as sand, silt, clay contents were analyzed with the use of different sizes of sieves by following method of Alexander (1961). Cent percent water holding capacity of soil samples were measured by the method of Johnson and Ulrich (1960). Soil pH was measured in ELICO digital pH meter with Calomel glass electrode assembly. Electrical conductivity of soil samples were determined by the conductivity bridge quantified by the method of Chapman and Pretty (1961). Soluble phosphorus and potassium contents were determined by the method of Kuprevich and Shcherbakova (1972). The microbial populations such as bacteria and fungi in both the soil samples were enumerated by serial dilution technique.

Enzyme activities in soils samples with/without litter

Five g of soil samples were transferred to test tubes. Samples were maintained at 60% water holding capacity at room temperature in the laboratory (28±4°C). Duplicate soil samples (with/without substrate) of test and control were withdrawn at periodic intervals (0, 7, 14 and 21 days) to determine the cellulase, protease and dehydrogenase activity followed by the method of Pancholy and Rice (1973), Cole (1977) and Chandrayan *et al.*, (1980) and Casida *et al.*, (1964). The soil samples were transferred to 250 mL Erlenmeyer flasks and 1 mL of toluene was added. After 15 min, 6 mL of 0.2 M acetate buffer (pH 5.9) containing 1% carboxymethyl cellulose, 1% casein was added to the soil samples and flasks were plugged with cotton and incubated at 30 min, at room temperature. After desired incubation, soil extracts were passed through what man filter paper and cellulase and protease activities in the filtrate was measured by the method of Nelson-Somogyi (1944) and Folin-Lowry (1951) respectively. Dehydrogenase activity was determined by treating soils samples with 0.1 g calcium carbonate and 1 mL of 0.18 mM TTC incubated at 30°C for 24 hours. The triphenyl formazan formed was extracted with methanol from the reaction mixture and assayed at 485 nm in spectrophotometer (ELICO, SL 171).

Results and Discussion

Physico-chemical characteristics of soil samples with/without litter

Soil fertility mediated by microorganisms is dependent on maintenance of physico-chemical properties of soil. Therefore the soil samples were analyzed for physico-chemical characteristics and results were represented in Table 1. Analysis of soil samples revealed that forest litter soil (test) underwent changes in all the measured parameters in comparison to

Table 1. Physico-chemical characteristics of soil samples with/without litter

Properties	Test (litter) soil	Control soil
Color	Reddish brown	Grey
Odor	Light pungent	Normal
pH	4.8	5.1
Water Holding Capacity (mL/g of soil)	0.33	0.30
Electrical conductivity (μMhos/cm)	0.10	0.09
Texture		
Sand (%)	80.11	85.70
Silt (%)	14.60	9.92
Clay (%)	4.94	3.90
Phosphorous (kg/h)	9	2
Potassium (kg/h)	108	103

control. Soil composed with forest waste (litter) exhibited texture different from that of corresponding control. Soil texture in terms of percentage of sand, silt and clay were 80.11, 14.60 and 4.94 in the test; 85.70, 9.92 and 3.90 in control soils (Table 1). The above results indicated that test sample had lower sand and higher silt and clay content in comparison to the control. The results of the present study seem to be in agreement with an earlier study, Oseni *et al.,* (2007) reported that natural forest and aged plantation soils show similar particle size characteristics of sand, clay and silt.

Soil pH is one of the most indicative measurements of soil because it is an important factor for the survival of microorganisms (Evans *et al.,* 1984). In the present study, the pH of litter sample was decreased to 4.8 from 5.1. This change in pH may be due to the deposition of plant residues in the soil. Similar reports were made by Oseni *et al.,* (2007) that pH of the natural forest soil was acidic, as acidity was observed to increase with increase in soil depth. The pH of soil ranged about 4.03 to 4.24 in *Pinus densiflora* forest soils and 4.38 to 4.65 in *Quercus mongolica* forest soils (Lee *et al.,* 1998). An acidic pH of 5.25and 5.35 was recorded in oak and pine oriented forests (Prashant, 2010). Water holding capacity (WHC) and electrical conductivity (EC) of 0.33 ml/g and 0.10 µMhos/Cm was recorded in test soil where as 0.30 ml/g and 0.09 µ Mhos/Cm was recorded in control. This improvement in EC and WHC in the test soil may be due to the long term deposition of organic manure in the form of plant residues. Phosphorous and potassium content in the test soil is 9 kg/h and 108 kg/h as against control 2 kg/h and 103 kg/h respectively (Table 1). Similar results were reported by Cavero *et al.,* (1997), Clark *et al.,* (1998), Poudel *et al.,* (2002). Higher levels of total organic carbon, total nitrogen and soluble phosphorous were found in organic soils. High content of available phosphorous (11.2 mg/kg) was observed in pine oriented than oak oriented forest areas (6.3 mg/kg), (Prashant, 2010). Concentrations of C, N and potassium increased significantly with increasing application rates of organic amendments (Supradip Saha *et al.,* 2008). Amendment of sewage sludge to the soil improved total N and P contents (Subbaiah and Sreeramulu, 1979).

Enumeration of microflora in soil samples with/without litter

Microorganisms are widely distributed in different types of environments like soil, water and air. In soil these organisms play an important role in maintaining soil fertility by recycling of nutrients through their biochemical processes. Amendment of sewage sludge (litter) to the soil generally raises microbial activity by increasing the soil organic matter. Because of importance of soil microbial biomass in breakdown of organic matter in soil and decomposition in soil by proteolytic fungi and bacteria, micro flora of both soil samples were enumerated. Higher bacterial and fungal populations were observed in the test soil than the control (Table 2). The fungal populations were relatively higher in litter decomposed soil by nearly 3 folds than in control soil. For instance the fungal population in the test soil was $14x10^4$ CFU/g of soil where as $3x10^4$ CFU/g of soil in control (Table 2). Two folds higher bacterial population with $384x10^4$ CFU/g in test soil was recorded than in control soil with $158x10^4$ CFU/g. Increase in size of fungal and bacterial population observed in the litter soil may be attributed to deposition of organic manure (mostly lignocellulosic wastes) and lower pH favorable for fungal organisms. These findings corroborate with observation of Oseni *et al.,* (2007). The natural forest at 0-10Cm depth has the greatest number of both fungi and bacteria count. Similarly, Narasimha *et al.,* (1999) and Nagaraj *et al*., (2009), reported that organic waste released from agro -based industries improved the microbial populations. Higher microbial activity (Mader *et al.,* 2002) and microbial biomass (Mader *et al.,* 2002; Mulder *et al.,* 2003) were found in organic soils. The higher microbial activities in rhizosphere soil in oak oriented forest soil might be due to increased supply of carbon and nutrients from dead root cells and rhizodeposition (Huxley, 1999; Kang *et al.,* 2009) and less forest floor removal (Xiao *et al.,* 2008).

Enzyme activities in soil samples with/without litter

Cellulase activity

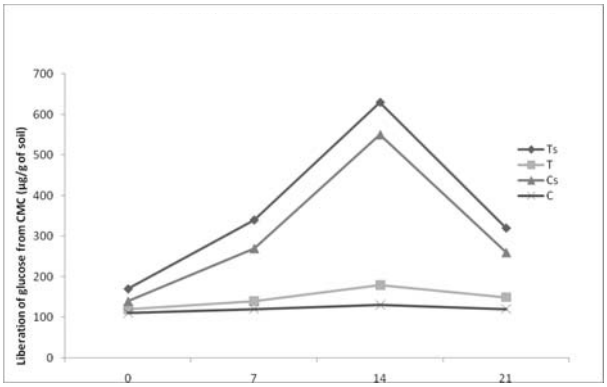
Soil cellulase activity was measured by disappear-

Table 2. Microbial populations* in soil samples with/without litter

Parameter	Test (litter) soil	Control soil
Bacteria	384×10^4	158×10^4
Fungi	14×10^4	3×10^4

*Microbial populations in terms of colony forming units (CFU/g soil)

ance of substrates like cellulose powder, carboxymethyl cellulose and appearance of reducing sugars quantitatively measured by spectrophotometer (Levinson and Reese *et al.,* 1950). Disturbance of micro flora in soil system due to pollution such as discharge of industrial effluents or accumulation of vegetative waste (litter) may adversely affect recycling of nutrients. Therefore cellulase activity was measured with or without addition of substrate (CMC) and represented in Fig. 1. Cellulase activity was enhanced in soils with/without litter composition upon inclusion of substrate in the assay systems (Fig. 1). The enzyme activity was measured in terms of liberation of µg of glucose from CMC/g of soil. With increase in soil incubation period cellulase activity was improved by one fold up to 14th day and declined at further intervals in both soil samples. For instance, the enzyme activity in test soil (litter) at 0 day interval was 170µg of glucose liberated /g of soil where as 630µg of glucose/g at 14th day interval and decreased to 320µg/g. Higher levels of enzyme activity were observed in the test soil than control at all incubations. For instance the cellulase activity was 170µg/g in test soil were as 140µg/g in control soil at initial day. Similar pattern was noticed at remaining intervals. A slight variation in the cellulase activity was observed at all incubation days in the absence of substrate (CMC) in both soils. For instance, the cellulase activity was 120µg of glucose/g of soil at 0 day where as 180 µg/g at 14th day interval and reduced to 150µg/g in the test sample. Same trend was observed in control soil(Fig.1). Higher cellulase activity was observed in test soil than the control at all incubations. For instance the enzyme activity was 120µg/g in test against 110µg/g in control sample. Analogous trend was observed at remaining soil incubation days. Higher cellulase activity was observed in the litter soil in the present study could be attributed to the presence of high organic content and microbial population.(Table 2)



Incubation period (in days)

Ts – Test soil with substrate
T – Test soil without substrate
Cs –Control soil with substrate
C – Control soil without substrate
*Activity measured in terms of liberation of µg of glucose from CMC/gram of soil.
*Values represented in the figure are average mean of duplicates.

Fig. 5. Cellulase activity in forest litter and control soils (with/without substrate)

According to Joshi *et al.,* (1995) cellulase activity was greatly increased in soils treated with cellulose as a substrate. Narasimha *et al.,* (1999) made similar observations in soils discharged with effluents of cotton ginning industry stimulated the soil cellulase activity. In contrast, cellulase activity was greater in mineral fertilized soil than in organically amended soil (Supradip Saha *et al.,* 2008).

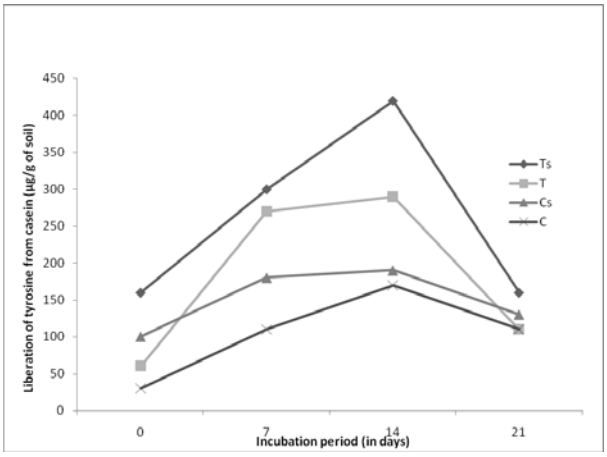
Protease activity

Protease enzymes are widely distributed among the soils exhibiting a wide range of activities and properties (Ladd and Butler, 1972). These enzymes are involved in the initial hydrolysis of protein compounds of organic nitrogen to simple amino acids. Protease can hydrolyze not only added proteins but also native soil proteins and peptides. Soil samples with/without litter composition were incubated with 60% water holding capacity at room temperature. After incubation two soil samples were supplemented with/without 1% sodium caseinate in order to determine enzyme activity in litter/control soils. Protease activity was determined in terms of tyrosine equivalents formed in trichloro acetic acid soluble fraction during 6 hours at 30°C. Protease activity in terms of formation of tyrosine from casein remained steady over a period of first 14 days and then onwards slightly declined in further intervals of measurement made in the present study (Fig. 2). At initial day the enzyme activity was 160µg of tyrosine/g in test soil; it was increased to 420µg/g at 14th day of incubation and reduced to 160µg/g at 21st day. Similar trend was observed in control soil. Higher protease activity was recorded in test sample than control at all incubations. For instance at initial day the test sample exhibited 160µg/g against 100µg/g in control soil. Same trend was continued at the rest of incubation days.

The protease activity in both soil samples without supplementation of substrate also shows analogous

trend. With increase in incubation days the enzyme activity increased up to 14th day and declined at further incubation. For instance, at 0 day interval the protease activity was 60µg/g in the test, it was increased to 290µg/g at 14th day and declined to 110µg/g at 21st day of incubation. Similar trend was observed in control soil. Increase in the protease activity was recorded in test soil compared to control at all incubation days (Fig.2). For instance, at initial day incubation, the casein hydrolyzing enzyme activity was 60µg/g in test soil where as 30µg/g in control soil. Identical trend was noticed at remaining days.

Increased proteolytic activity in litter soil may be due to availability of suitable substrates (Casein), decrease in soil pH and increased proteolytic microorganisms in soil. Soil protease activity was correlated with number of micro flora as reported earlier by Narasimha *et al.,* (1999). Similarly, soils treated with tomato processing waste (Sarade and Joseph Richard, 1994), effluents of cotton ginning mills (Narasimha, 1997) paper mill (Chinnaiah *et al.,* 2002), improved soil protease activity than control. The rates of protease activity were higher with the organic amendments than in mineral fertilizer amended and unamended soils (Supradip saha *et al.,* 2008). In contrast, soil polluted with organic matter (Ladd and Butler, 1969), cement dust from cement industries (Shanthi, 1993), waste water treatment plant discharge (Montuelle and Volat, 1998; Zdenek Filip *et al.,* 2000), herbicides (Pahwa and Bajaj, 1999), insecticides (Omar and Abd-Alla, 2000) ceased the soil protease activity.

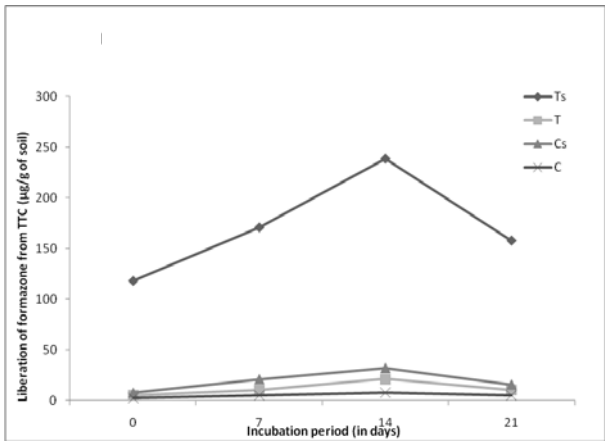


Ts-Test soil with substrate
T – Test soil without substrate
Cs – Control soil with substrate
C – Control soil without substrate
*Activity measured in terms of liberation of µg of tyrosine from casein/gram of soil.
*Values represented in the figure are average mean of duplicates.

Fig. 2. Protease activity in forest litter and control soils (with/without substrate)

Dehydrogenase activity

Soil dehydrogenase activity measured in terms of formation of formazan from triphenyl tetrazolium chloride was also chosen as good index of microbial activity in soil. The soil dehydrogenase system is due to rather wide group of soil enzymes which transfer electrons to available acceptors. Its activity appears to be more dependent on metabolic state of microbial population of the soil rather than activity of specific free enzymes. The dehydrogenase activity was maximum at 14th day interval and there onwards decline in both samples with/without substrate. For instance at 0 day incubation, the dehydrogenase activity was 118µgof formazan /g of soil, it was increased to 239µg/g at 14th day and later declined to 158µg/g at 21st day. The control soil also exhibited same trend. Higher dehydrogenase activity was recorded in test sample in comparison to control. For instance, at initial day of incubation, the enzyme activity was 118 µg/g in test sample where as 8.05 µg/g was recorded in control. Similar trend was followed at remaining incubation days (Fig. 3).



Ts – Test soil with substrate
T – Test soil without substrate
Cs – Control soil with substrate
C – Control soil without substrate
*Activity measured in terms of liberation of µg of formazan from TTC/gram of soil.
*Values represented in the figure are average mean of duplicates

Fig. 7. Protease activity in forest litter and control soils (with/without substrate)

The dehydrogenase activity was maximum at 14th day interval in the absence of substrate in both the soil samples. For instance, the enzyme activity was noted as 5.3µg/g at 0 day in the test soil against 2.68µg/g control soil. Soil samples with litter always recorded significantly higher dehydrogenase activity than control soil samples. But no regular pattern of increments in dehydrogenase activity in test sample over control soil was observed. Similarly, addition of organic materials, composts and low metal sludges has been found to increase soil dehydrogenase activity (Chander and Brookes, 1991 b; Giusquiani *et al.,* 1994). The enzyme activity was higher in the rhizosphere soils than in non-rhizosphere sludge amended soils. However, the addition of sludges or composts at the higher rates reversed this effect causing a decrease in dehydrogenase activity (Reddy *et al.,* 1987). Dehydrogenase enzyme is high in soils polluted with pulp and paper mill effluents (McCarthy *et al.,* 1994) but low in soils polluted with flyash (Pitchel and Hayes, 1990). Moreno *et al.,* (1999) and Masciandaro *et al.,* (2000) studied dehydrogenase activity under the influence of organic matter and reported an increase following the organic matter amendement. Amendment of *sesbania* straw to the soil improved dehydrogenase activity than wheat straw, maize straw amended soils and unamended soil (Sajjad *et al.,* 2002). The dehydrogenase activity had ranges of 170.67 to 221.66 µg TPF/g in pinus densiflora and Quercus mongolica forest soils that showed lower values than in Kawngneung site (Lee *et al.,* 1998). Higher dehydrogenase activity of 106.28 nmol/g/2hr was recorded in oak oriented forest area where as less (66.37 nmol/g/2hr) in pine oriented forest area (prashant, 2010).

Soils discharged with effluent waste water from pulp and paper mills exhibited relatively higher dehydrogenase activity than soil without corresponding irrigation (Kannan and Oblisami, 1990). Increase in soil dehydrogenase activity was attributed to low pH and high organic content in the effluents. Reddy and Faza (1989) compared dehydrogenase activity in soil amended with/without industrial sludge. The activity was more in soils without sludge than in soils amended with sludge.

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The effect of water flow rate on the dissolution of gypsum and anhydrite layers in hydraulic structures foundation

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ABSTRACT

The existence of gypsum and anhydrite in materials which are located in places, in which high water flow rate and permeability are significant, is worrisome. Experiences and researches show in regions with low flow rate the probability of dissolution is lower and if the water flow has been saturated before contacting with gypsum in this case the solubility decreases too, so evaluating the behavior of these materials against these factors seems to be necessary. In this research, by performing tests on materials with gypsum the solubility rate of gypsum in two kinds of distilled water and distilled water with one percent sodium chloride is measured and the amounts of dissolution coefficient by using circulation tests in front of the above solutions have been measured and calculated in different speeds.

Keywords *: Gypsum materials, Dissolution coefficient, Permeability, Hydraulic gradient, Circulation test.*

Introduction

The soluble minerals which exist in the dam structures, cause cracks and gaps, an increase in permeability of foundation and bases, destruction of injection curtains and some problems in the stability of the dam. These problems which can cause a non uniform settlement in the foundation can also destroy a hydraulic structure but it should be noted that some hydraulic structures which are bases on soluble stones, are safe against the dissolution phenomena because the underground water has been saturated before reaching these stones.

Experiments show that despite the solubility potential of gypsum and anhydrite, the existence of another factor is necessary to make the dissolution become real and that is water flow between layers of gypsum with sufficient speed. During this process, the soluble minerals are displaced by water as a soluble load and instead of those, empty places are remained in the rock which this phenomena in dams foundations can cause problem in the dam stability. Preventing the solubility of gypsum and anhydrite layers located in the hydraulic structures foundation against the water flow is very essential in supplying the stability of bases and foundations in dams and hydraulic structures.

According to grand's theory, the underground water flow in soluble stones is different with the water flow in insoluble fields. This subject shows the solubility feature of the soluble grounds. Approximately all of the underground and surface phenomena which exist in soluble regions are related with the water flow. According to this reason, accurate evaluation and complete studies on all types of water and the long term persistence of these flows in soluble regions, is useful and necessary. Of course due to the geology conditions, it is hard to recognize evaluate accurately the water stop in soluble areas which cause water saturation with water flow in these areas. Of course the experiments obtained from Catzer and Sivich are really helpful. (Bazargan and Moazami, 2010; Ghobadi, 2008).

The solubility of carbonate rocks has been studied

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in 1978 by White and he has presented regulation 1 for calculating the solubility coefficient (solubility speed coefficient): (James and Kirkpatrick, 1980).

$$\frac{V}{A}\cdot\frac{dc}{dt} = K(C_s - C)^n \qquad (1)$$

Which in this regulation:

V: water flow volume

dc/dt: Changes in calcium concentration over time

n: reaction degree

In 1980, James and Kerk Patrick presented an article about the design of foundations on soluble stones, and in addition to gypsum and anhydrite they evaluated the Calcite and Halides minerals too. (James, and Lupton, 1985).

Research Method

In this research, the circulation test has been performed on gypsum materials in different speeds which are mentioned below:

In the circulation test for a cubic sample, 1 litre distilled water and for a cylinder sample 0.5 litre water from Marash dam was used. After measuring 1 L water with a graduated cylinder, it was poured into a container with a pump inside it, and by turning on the pump, the water started to move inside the sample. The discharge of this current was measured by a pinhole test tube. The water flow which had passed the sample, was returned back to the pump container and with a conductivity meter, the concentration of the calcium ion in the water in different times was measured. The pump discharge was about 52cm^3/s. The Calcium ion concentration in the circular solution was considered as a criterion of calcium sulfate amount (gypsum) in the water.

The circulation flow lasted for 23 hours and in all this time the electrical conductivity changes were measured by a conductivity meter. At the beginning of the test electrical conductivity changes of the soluble were high but as time passed it started reducing. When the electrical conductivity becomes constant, it shows that the soluble is saturated.

Fig. 1. Tools and the circulation test for a cubic sample

The circulation test for a cylinder sample with Marash dam well water and the water pumping system is shown below.

For evaluating this subject, some gypsum and anhydrite samples which were the same in length, hole diameter, water circulation volume, temperature and test time and only different in their flow rate were examined in a circulation test. For measuring the discharge rate a volume meter was used. So that in each test cycle, the filling time was measured and the water volume rate in time unit or the flow discharge, in each cycle was obtained. By having the flow discharge and the pipe section, the flow rate amount in each level was calculated. (Ranjbar, 1999)

Fig. 2. Pumping system and Marash dam water sample in the circulation test for a cylinder

Fig. 3. Circulation test and measuring the calcium ion concentration in a cylinder sample

This test has been performed in 4 different speed rates with Marash dam water which the volume of circulating water was 0.5 L. In each of the above con-

ditions the electrical conductivity amount and the time to reach saturation and stabilizing the electrical conductivity was measured and recorded.[2]

The results of this test are shown in figure 4.

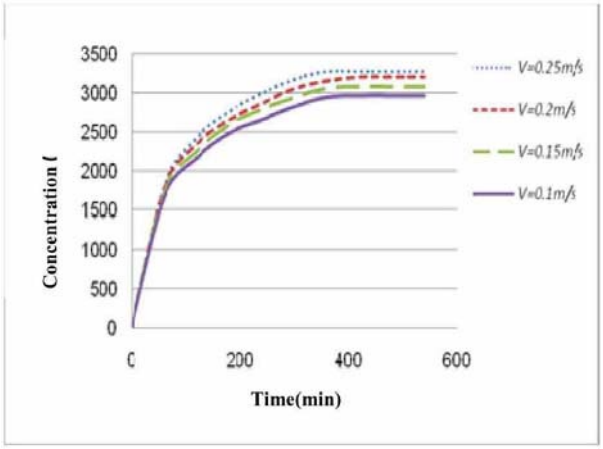

Fig. 4. Flow rate effect on the soluble coefficient rate

Flow rate 0.15m/s

According to the standard diagram (diagrams for defining the maximum amount of gypsum in a solution) which is same as Marash dam water's standard and the electrical conductivity changes toward time diagrams, which are obtained from the circulation test, we can calculate the calcium ion concentration rate changes in a soluble towards time.

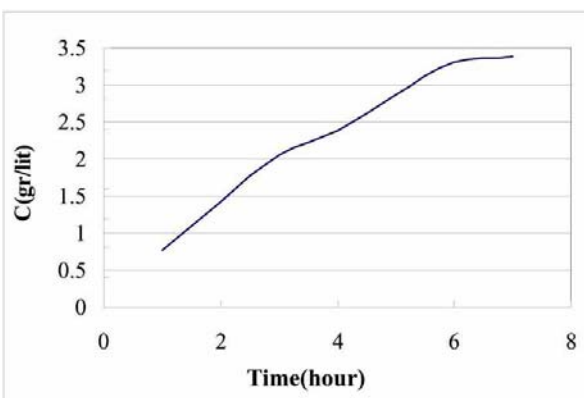

Fig. 5. Calcium ion concentration rate changes in a soluble towards time. (v=0.15m/s)

Table 1. Soluble coefficient amounts (k) and n for Marash water with a 0.15 m/s rate.

K (m/s)×10^{-5})	n	Cs (g/L)
1.25	1.57	3.5

According to the above diagram and regulation 1, k and n parameters can be calculated.

These amounts for Marash water with a 0.15m/s rate is as the following:

For the above amounts, the error rate for the test results is shown below.

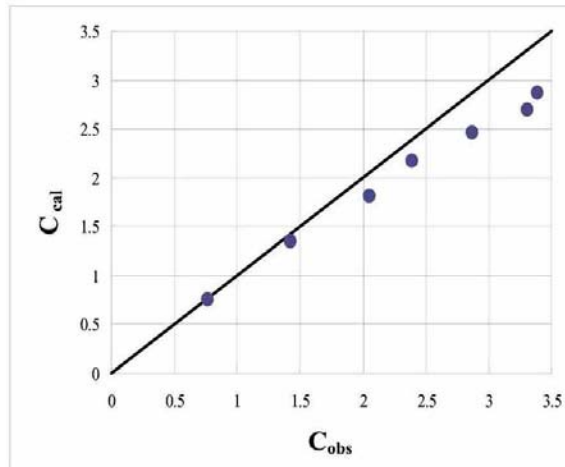

Fig. 6. Correlation between the Computational and observational values of the concentration of calcium ions (v=0.15 m/s)

Flow rate 0.20 m/s

According to the standard diagram (diagrams for defining the maximum amount of gypsum in a solution) which is same as Marash dam water's standard and the electrical conductivity changes toward time diagrams, which are obtained from the circulation test, we can calculate the calcium ion concentration rate changes in a soluble towards time.

According to the above diagram and regulation 1, k and n parameters can be calculated.

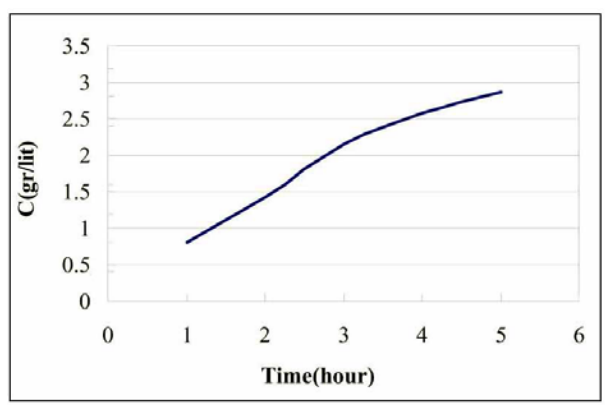

Fig. 7. Calcium ion concentration rate changes in a soluble towards time. (v=0.20m/s)

These amounts for Marash water with a 0.20m/s rate is as the following:

Table 2. Soluble coefficient amounts (k) and n for Marash water with a 0.20m/s rate.

K (m/s)×10^{-5})	n	Cs (g/L)
1.76	1.93	3.5

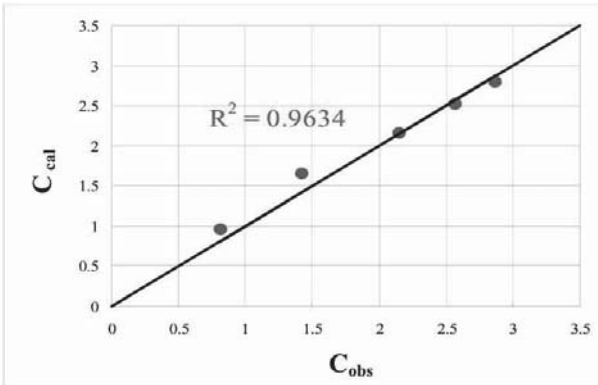

Fig. 8. Correlation between the Computational and observational values of the concentration of calcium ions (v=0.20 m/s)

For the above amounts, the error rate for the test results is shown below:

Flow rate 0.25 m/s

According to the standard diagram (diagrams for defining the maximum amount of gypsum in a solution) which is same as Marash dam water's standard and the electrical conductivity changes toward time diagrams, which are obtained from the circulation test, we can calculate the calcium ion concentration rate changes in a soluble towards time.

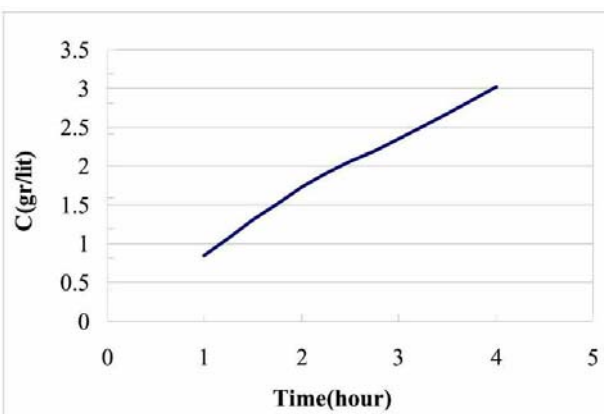

Fig. 9. Calcium ion concentration rate changes in a soluble towards time. (v=0.25m/s)

According to the above diagram and regulation 1, k and n parameters can be calculated.

These amounts for Marash water with a 0.25m/s rate is as the following.

Table 3. Soluble coefficient amounts (k) and n for Marash water with a 0.25m/s rate.

K (m/s)×10-5)	n	Cs (g/L)
1.76	1.93	3.5

For the above amounts, the error rate for the test results is shown below:

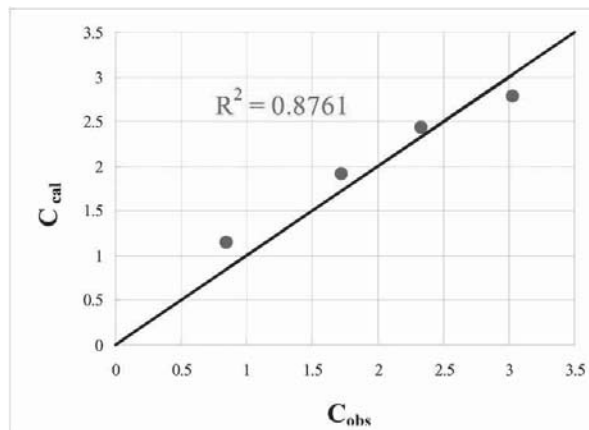

Fig. 10. Correlation between the Computational and observational values of the concentration of calcium ions (v=0.25 m/s)

Soluble coefficient rate changes towards different speeds in circulation test, for Marash water has been mentioned in Table 4.

Table 4. Soluble coefficient amount(k) and n for Marash dam water.

K((m/s)×10^{-5})	n	V(m/s)
1.02	1.5	0.1
1.25	1.57	0.15
1.42	1.89	0.2
1.72	1.93	0.25

The above table shows that, by increasing the circulation test rate, the concentration amount (k) and soluble coefficient (n) increase.

From The results obtained from fig.4, we can say that for a constant electrical conductivity coefficient, by increasing the flow rate, the time for reaching to saturation in both conditions, reduces. If we assume

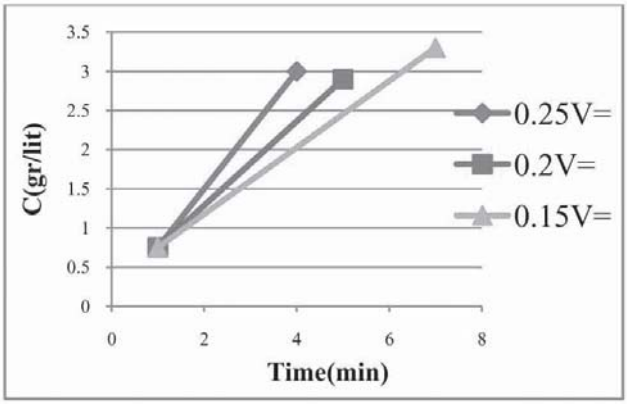

Fig. 11. Calcium concentration changes against time for different speeds.

that diagrams 5,7 and 9 are linear and put them in a different diagram, diagram 11 will be obtained.

By comparing diagrams 5, 7 and 9 and according to the results shown in fig.11 we can conclude that for different flow rates, calcium concentration rates is approximately constant, but since with flow rate increasing, the time to reach to maximum calcium concentration or saturation decreases, so The slope of the concentration-time diagram or dc/dt increases which due to regulation 1, the soluble coefficient rate increases too.

More we will evaluate the flow rate effect on the soluble coefficient and n coefficient in more details. Flow rate changes towards soluble coefficient and n coefficient are shown in the diagrams below:

Fig. 12 shows the soluble coefficient and n coefficient changes in regulation 1 against the flow rate through the pore, created in the circulation test. In general with flow rate increasing, the calcium concentration rate dissolved in water, increases.

The main point in Fig. 12 is that the flow rate increasing effect is different for the soluble coefficient and the n coefficient. For more analysis the above changes have been evaluated in three levels:

1. Flow rate between 0.1 to 0.15 m/s: in this range the soluble coefficient changes is rather constant but the n coefficient changes towards the flow rate is increasing.
2. Flow rate between 0.15 to 0.20 m/s: in this range the soluble coefficient changes is rather constant but with a lower slope to the previous level but the n coefficient changes towards the flow rate have a higher increasing slope comparing with the previous level.
3. Flow rate between 0.20 to 0.25 m/s: in this range the soluble coefficient changes is rather constant but with a higher slope than the previous level but the n coefficient changes towards the flow rate have a lower increasing slope comparing with the previous level.

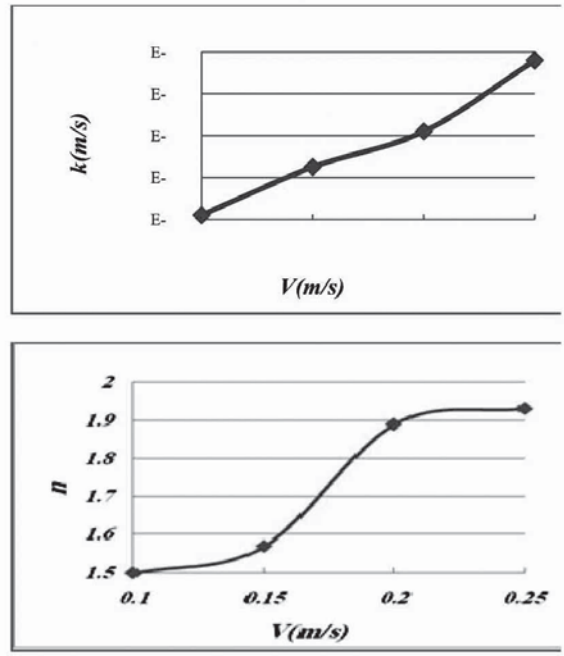

Fig. 12. Soluble coefficient and n coefficient changes against the flow rate passing through the gypsum layer.

Results

The results obtained from the soluble tests and the analysis made on the soluble regulations show:

1. Due to fig.4 for a constant time period, the electrical conductivity rate increases with the increase of the flow rate.
2. The studies done in this research show that by increasing the circulation speed, the concentration coefficient (n) and the soluble coefficient, increase.
3. By increasing the flow rate, the concentration-time diagram slope (dc/dt) increases so the soluble coefficient increases too.
4. In general, the soluble constant coefficient changes against the flow rate is linear but the n coefficient changes against the flow rate is non-linear which shows that in low rates the changes are low and in high rates the changes are constant. But the main changes observed are in average rate which this can be because of two reasons:

(a) In low rates or primary rates gypsum solvability is done very slowly and because n is the power in regulation 1 and a small change in this coefficient may cause a lot of change in solvability, for this reason, in low rates the change of n is too low.

(b) In higher rates also the changes are rather constant because the maximum amount of n for materials with gypsum and anhydrite is 2, so the increasing of this coefficient with the rate increase is only allowed until this limit. So it is completely logical that in average rates which we have the highest solvability n changes have an increase. It is to be mentioned that regulation 1 and its coefficients are different for different materials, and the results obtained in this research can only be justified for the mentioned materials. But in general we can say that for any kind of soluble material, the soluble coefficient increases with the increasing in rate, because the solved calcium rate in the passing flow towards time increases.

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Land use planning for ecotourism potential

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ABSTRACT

This article presents collaborative tools based upon lessons learned from the model sites and from ecotourism cases around the world—for example, how the Small Tourism Enterprises Program (STEP) approach might be utilized for: (a) a brands and standards system; (b) coaching and technical assistance; (c) walk-in centers to support product development and marketing; (c) operating guidelines for small hotels; (d)an environmental management program (e) financing assistance and an investment fund; (f) volunteer programs and partnerships; and (g) regional marketing system based upon an "experience" approach. Recent academic research from the disciplines of tourism, environmental management, economics, and sociology, among others, has focused on different aspects of the relation between tourism and protected natural areas.

Keywords : *Land use, Planning, Ecotourism*

Protected Area Ecotourism Competitive Cluster Approach

There has always been strength in numbers. Tourism development is no different. In order to be competitive, all destination players must work together by identifying the elements that make up the destination, beginning with the reasons tourists will travel to the area, the services available to them and the activities that support the tourist services.

Figure 1 presents a graphic representation of this concept. The focus is on meeting three concurrent goals which must be addressed using sustainable principles and practices: (1) biodiversity conservation: protecting natural and cultural resources; (2) poverty reduction through SME development, job creation, and social equity measures; and (3) business viability through access to capital, return on investment and profitability.

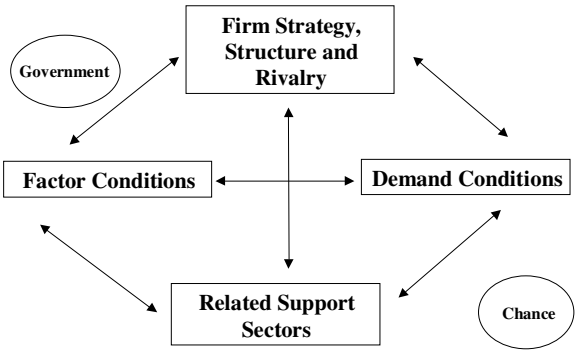
The Competitive Cluster Approach

The "competitive cluster" concept is a strategic set of activities and services organized as an effective ecotourism supply chain. The core of the "cluster" is the comparative advantage represented by a protected area's natural attractions and biodiversity. The competitive cluster is used to examine and support a set of strategic relationships between donors, the private sector and government in a specific program of support to ecotourism development linked to improved management of a country's protected areas. This concept may have merit as a key element of national tourism development as well as an essential element of formulating a National Ecotourism Strategy, as a means of promoting biodiversity conservation and local enterprise development.

A tourism assessment was conducted in Bulgaria as part of a Competitiveness Initiative undertaken by J. E. Austin Associates, sponsored by the Bulgarian tourism industry and supported by the U.S. Agency for international Development from June 2000 to April 2001. This initiative:

- Explains the basic concept of competitiveness
- Introduces an approach to improving competitiveness
- Assists business to recognize strategic gaps and opportunities for improved strategies

Determinants of Competitive Advantage



Source: Michael E. Porter; The Competitive Advantage of Nations

- Assists business to begin to discuss competitiveness together, identifying common interests
- Focuses is on what business can do as an industry group or cluster
- Provides a first step in an ongoing approach to improve strategies

The strategic issues of cost leadership, differentiation, and focus emerged from the initial discussions on areas of common concern and the prospects for collaborative action. Porter's Diamond Model was used to develop an outline of possible strategies. Porter affirms that the competitive advantage of a firm or a group of firms is determined by four fundamental elements, which when combined form the four points of the "Competitive Diamond". These elements and their interaction with one another explain how an industry remains innovative and competitive within a localized area. These factors are (1) factor conditions; (2) demand conditions; (3) related support sectors; (4) strategy, structure and rivalry among firms. In addition to the four principal elements, government and chance or unplanned factors also play a large role as described in the following figure:

Factor Conditions. Classic economic theory suggests that an area's basic resources, which include land, human resources and capital, determine competitive advantage. However, this does not explain why any one area would lead the world in a particular industry. Instead, it is specialized factors, which are not inherited but created by each destination, such as educational systems, technological "know-how", specialized infrastructure, and other capabilities, which respond to the specific needs of an industry. Within tourism, basic elements such as natural, cultural and archeological resources would allow for product development almost anywhere on earth. However, specialized factors such as trained tourism professionals, infrastructure that allow access to natural resources, availability of long-term capital, personal security, and sufficient public services are what allow one destination to surpass others with similar basic resources.

Demand Conditions

It would appear as globalization advances that local demand would become insignificant. However, research has shown exactly the opposite. High expectations by local consumers seem to drive firms to a more competitive and innovative position. In the case of tourism, demand can be from either regional/national tourists or foreign tourists that visit the region. In this industry, instead of exporting products, the consumers travel to the attraction. In order to analyze demand, attention should be paid to the volume and growth of demand, source and caliber of markets, as well as tourist behavior and level of sophistication.

Related Support Sectors

The existence of specialized and efficient support industries helps foster competition with a destination by allowing the "cluster" to have lower costs, superior quality and rapid product turn-over rates. In order for a tourism "cluster" to be competitive it is vital that there be an innovative, dynamic support system. This includes high quality hotel, transportation and food service suppliers and professional personnel not only within the operation of a tourism product but also in its design and engineering.

Firm Strategy, Structure and Rivalry

Competition is dependent upon an environment that promotes innovation and efficiency. An effective cluster forces firms to reduce costs, improve quality, and develop new markets. Within tourism, competition should be analyzed both from a local and an international focus. On a local level, firms compete within each area of the industry, such as automobile rental, hotel availability, tour operation, etc. On the international level, rivalry is between destinations that position themselves with similar tourism products.

Additional Factors

More important than each individual sector or element of the diamond is the interaction of each linked together. This creates a complex system where imitation is virtually impossible. Government and chance are also factors included within Porter's diamond. These play a significant role in cluster development. Chance is nothing more than unplanned events that influence product development. These could include technological advances, market changes, political decisions, terrorist attacks, natural or mad-made disasters, among others. Strong firms should incorporate contingency plans for the unexpected. Of course, government regulation and attitude will influence competitive advantage regardless of the industry. At the same time, government may, in turn, be influenced by the factors in the diamond, as well.

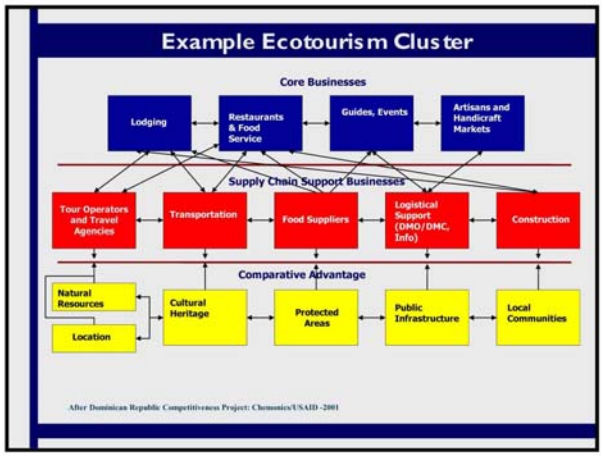
The competitive cluster approach is now being employed in developing and transitional countries. "A cluster is a geographically proximate group of companies and associated institutions in a particular field, linked by commonalities and complementarities." Industries tend to cluster. It may seem a paradox but global competition can be fostered with local elements of competitive advantage. A cluster allows SME's to compete globally thanks to a better access to information and specialized resources, flexibility and rapid adoption of innovations. The key for competitive success is strategy.

"Competitive strategy is about being different. It means deliberately choosing a different set of activities to deliver a unique mix of value"[2]

The competitive cluster is used to examine and support a set of strategic relationships between the private sector, NGOs and government in a specific program of support to ecotourism development linked to improved management of protected areas. The following figure describes these relationships:

The "competitive cluster" concept is a strategic set of activities and services organized as an effective ecotourism supply chain. The core of the "protected area ecotourism cluster" is the comparative advantage represented by the protected area's natural attractions and biodiversity.

The identification and pursuit of those ecotourism niches can be most successful is essential. The market niches described in the following diagram can be reached through marketing strategies using catalytic events, tour operators and destination promotion.



In the cluster development process, it is essential to define niche ecotourism market segments through market research and then to provide services resulting in high levels of customer satisfaction. The focus of market research and analysis should be on all phases of the travel experience that are relevant to forming the cluster, as described in the diagram which follows.

The supply and demand elements resulting from these analyses and cluster development activities need to be harmonized as described in the following diagram:

Sustainable Tourism Stakeholder Management Model

Some destinations now acknowledge that operating in a sustainable manner can minimize costs and protect the surrounding environment, which in many cases, is the basis for the appeal of their destination to tourists. According to Simpson, "recent attitudes to the sustainability of tourism development have tended to move away from an initial approach which classified all forms of activity as sustainable ('good' tourism) alongside another style simultaneously condemning unsustainable ('bad' tourism)" (Simpson, 2001). Simpson then explains that the importance of sustainable tourism is to set a "global target to which all forms of tourism must necessarily aspire."

According to Simpson, sustainable tourism development should be:

- Comprehensive – including social, cultural, environmental, economical and political implica-

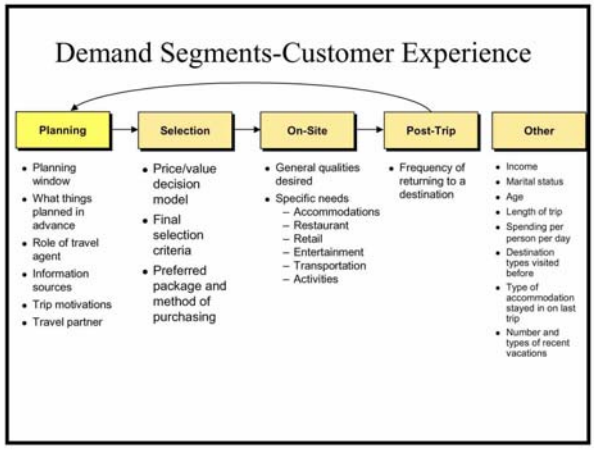
tions
- Iterative and dynamic – readily responding to environmental and political changes
- Integrative – functioning within wider approaches to community development
- Community oriented – all stakeholder needs addressed through community involvement
- Renewable – incorporating principles which take into account the needs of future generations
- Goal oriented – a portfolio of realistic targets results in equitable distribution of benefits

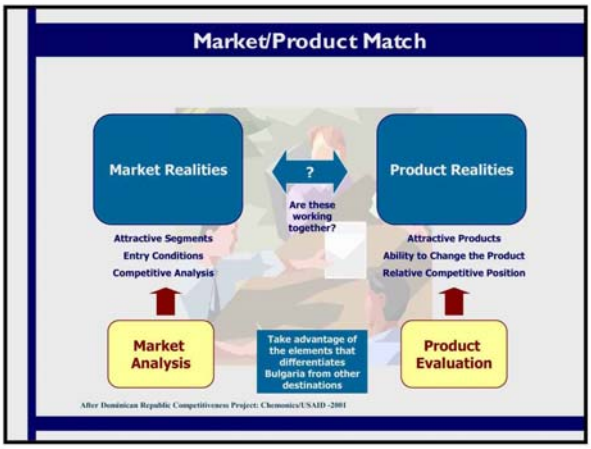
As the principles above indicate, every tourism destination is made up of any number of interested parties that are directly or indirectly affected by tourists visiting their location. Stakeholders range from private sector participants such as hotels, restaurants, transportation companies, and related businesses to public sector including local and regional governments. Stakeholders also include non-governmental organizations, private-public partnership entities and product suppliers, among others. There are those that argue that even the natural environment constitutes a stakeholder. Finally, the stakeholder group most directly affected by tourism development is most often the local community.

General management literature has evolved to include an array of stakeholder and participatory theories, including stakeholder theory, organization theory, strategic alliance and network theory, all focused on the basic notion that the "the whole is greater then the sum of its parts." In 1984, Freeman first presented the notion of stakeholders, explaining that a "stakeholder in an organization is (by definition) any group or individual who can affect or is affected by the achievement of the organization's objectives" (Freeman, 1984). While Freeman intended stakeholder theory to focus on a firm or company, the underlying premise is very much applicable to tourism destinations. In most cases where tourism occurs, there are groups of stakeholders directly affected. How tourism develops and its subsequent impact on the social and natural environment of a destination is very much determined by the stakeholders that lead the development, implementation or management processes. Although each destination may have a similar group of stakeholders, it is the party that leads or "pushes" tourism development that will determine to what degree the needs of each stakeholder, including the natural environment, are protected. These development "pushers" or "tourism entry points" range from tour operators, resort developers, non-governmental organizations, local/national governments and local communities pushing for tourism development. Additionally, specific situations such as the need to protect a National Park or to manage a coastal area or recover from a catastrophic event such as a natural disaster, war or terrorist attack may serve as a tourism entry point.

Conclusion

As in most cases, a middle path is the most creative way to maximize the sustainable economic potential of tourism, while at the same time minimizing the negative social influence and threats to the environment. Only ecotourism where the tourism, the service providers, the host community and authorities are well informed and prepared to homes tourism as an engine of growth can yield sustainable results.





Ecotourism, in partnership with research, has the potential to significantly affect nature conservation in many positive ways. The question of sustainability remains unanswered because many sites with nature-based tourism are relatively new and the long-term impacts have yet to be measured. The challenges of removing trash from remote wilderness lodges, of bringing in electricity with low-impact electric wires, or of minimizing the introduction of exotic species require the test of time to determine their success.

In the not-too-distant future, our wilderness areas will be small islands of biodiversity amidst seas of domesticated landscape. As the planet's sustainable natural, relatively unaltered ecosystems become increasingly rare, ecotourism allows more people to see isolated populations of wildlife, while benefiting local economies. Ecotourism has an impact on natural ecosystems, but more importantly it offers a way to promote conservation in ecologically fragile regions.

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The role of environmental development for sustainable ecotourism

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ABSTRACT

There are many differences between the developing world and the developed world when it comes to issues of sustainability and sustainable community development. The physical environment, economy, and social make up of these two regions of the world are very different and therefore are subject to different problems, requiring individual methods of approach and research Ecotourism creates an impact on natural ecosystems but more importantly, it offers a way to promote conservation in ecologically fragile regions; benefit the economies of local communities; provide the public with a nature-based education experience.

Key words : *Environment, Sustainable Eco-Tourism, Development*

Introduction

Sustainable eco-tourism planning is to help the preserves to survive without altering eco-tourists basic mission and unique status in the global environmental scheme.

In a true ecotourism project, a nature reserve allows a small number of tourists to visit its rare animals and uses the money that is generated to continue with important conservation work. The local people have jobs in the nature reserve as guides and wardens, but also have a voice in how the project develops. Tourists stay in local houses with local people, not in specially built hotels. So they experience the local culture and do not take precious energy and water away from the local population. They travel on foot, by boat, bicycle or elephant so that there is no pollution. And they have a special experience that they will remember all of their lives. Here is another definition of ecotourism:

"A form of tourism inspired primarily by the natural history of an area, including its indigenous cultures.

The ecotourist visits relatively undeveloped areas in the spirit of appreciation, participation and sensitivity.

The ecotourist practices a non-consumptive use of wildlife and natural resources and contributes to the visited area through labour or financial means aimed at directly benefiting the conservation of the site and the economic well-being of the local residents.

The visit should strengthen the ecotourist's appreciation and dedication to conservation issues in general, and to the specific needs of the locale.

Ecotourism also implies a managed approach by the host country or region which commits itself to establishing and maintaining the sites with the participation of local residents, marketing them appropriately, enforcing regulations, and using the proceeds of the enterprise to fund the area's land management as well as community development (Ziffer, 1989).

This type of tourism can only involve small numbers of people so it can be expensive. But we can apply the principles of ecotourism wherever we go for holiday. Following basic rules are to be observed.

- Be prepared. Learn about the place that you're going to visit. Find out about its culture and history. Learn a little of the native language, at

least basics like 'Please', 'Thank you', and 'Good Morning'. Think of your holiday as an opportunity to learn something.

- Have respect for local culture. Wear clothes that will not offend people. Always ask permission before you take a photograph. Remember that you are a visitor.
- Don't waste resources. If the area doesn't have much water, don't take two showers every day.
- Remember the phrase "Leave nothing behind you except footprints and take nothing away except photographs." Take as much care of the places that you visit as you take of your own home. · Don't buy souvenirs made from endangered animals or plants.
- Walk or use other non-polluting forms of transport whenever you can.
- Be flexible and keep a sense of humour when things go wrong.
- Stay in local hotels and eat in local restaurants. Buy local products whenever possible and pay a fair price for what you buy.

There are lots of names for these new forms of tourism: responsible tourism, alternative tourism, sustainable tourism, nature tourism, adventure tourism, educational tourism and more. Ecotourism probably involves a little of all of them. Ecotourism, which encompasses a range of activities including scientific tours, student internships, trips for nature lovers, bird-watching trips, and filming expeditions, is a relatively new phenomenon. Everyone has a different definition but most people agree that ecotourism must:

(a) conserve the wildlife and culture of the area.

(b) benefit the local people and involve the local community

(c) be sustainable, that is make a profit without destroying natural resources

(d) provide an experience that tourists want to pay for.

Choose our holiday carefully. Don't be afraid to ask the holiday company about what they do that is 'eco'. Remember that 'eco' is very fashionable today and a lot of holidays that are advertised as ecotourism are not much better than traditional tourism.

The Challenges of Successful Ecotourism

As mentioned, the benefits of ecotourism are becoming increasingly attractive. However, planners and managers must also face the problems that may arise. These issues tend to be complex. Ecotourism, by its very nature, builds up expectations and raises the risk of hit-and-run tourism; this is described as an influx of nature-lovers and culture-addicts to the latest wild spot, followed by its abandonment once discovered and degraded. Moreover, ecotourism attractions can be located in the most remote and rural areas. Therefore, ancient cultures and economies may be harmed or disrupted. These challenges, among others, need to be met. Planners and managers must be prepared and educated on the impacts of tourism. Their optimal strategy must involve minimizing these costs while maximizing the many benefits.

Ecotourism encompasses many aspects and faces many challenges. It is not only about safeguarding the environment, but employing and informing the locals, as well as educating the tourist. Ecotourism is a softer, more gentle version than the tourism we have come to know. It might not bring in as many people as other forms of tourism, but the true recipients of the benefits of ecotourism are the traveler, the host population, the tourism industry and, of course, the environment.

Many elements are involved when designing an optimal ecotourism strategy. Sustainable development is an important aspect of ecotourism development that involves harvesting our natural resources without depleting or permanently harming them. A niche market must also be determined in order to effectively match people and their interests with the ecotourism attractions at each particular site. However, with the existence of such tourists, each site must, to some degree, restore itself by natural means with or without the assistance of human management. This idea is discussed when looking at the ecological carrying capacity. The final important element of ecotourism development is known as site design, which takes all elements discussed thus far into consideration when designing satisfactory ecotourism facilities with as little ecological impact as possible.

Sustainable Development

Sustainable development is an emerging doctrine that demands a long-term view of economic activity. The concept has evolved within the past few years and has rapidly become a way of paying for natural conservation and increasing the value of the natural land that is left. Sustainable development not only ensures that consumption of tourism does not ex-

ceed the agility of the host destination to prosper, but also provides for the freedom, education and welfare of the host community. It has become common knowledge that it is unethical to save nature at the expense of the local people. The host community should be given the opportunity to act as partner in the sustainable development of its land, not as enemy of it.

Niche Market

When planning, implementing and marketing an sustainable ecotourism destination, it is important to look at the demographics and psychographics of the target market, so that the programs can be effectively matched with the people who enjoy such activities. Looking at the demographics of the ecotourists who most frequently participate in ecotourism is an important first step when designing an eco-tourism program.

Carrying Capacities

Sustainable carrying capacity can be defined in several different ways. Ecologists often define it as "the maximal population size of a given species that an area can support without reducing its ability to support the same species in the future. It is a `measure' of the amount of renewable resources in the environment in units of the number of organisms these resources can support." In sustainable ecotourism, carrying capacity could be the "measure of what is actually happening to a park's resources or the visitor's experience."

Large-scale tourist developments produce considerable pressures on the environment and on the local population. These include destruction of the traditional landscape; congestion in the transport system; and air, land and water pollution. In dealing with carrying capacities, we need to consider more than just the number of people an area can hold, but also the effect it has on local populations, their infrastructure, and the environment. It's difficult to put limits on every natural area's attendance, but through proper ecotourism ethics, we can regulate the impacts. It is essential we recognize the amount of stress that each environment can handle then act accordingly to preserve it for future sustainable use and enjoyment.

Ecotourism Site Design

The site design of any ecotourism area will include many different elements. These elements have to do with creating ways to prevent any environmental problems with the ecosystem and to keep visitors traveling to a certain ecotourist spot. It requires holistic, ecologically based strategies to create projects that do not alter or injure, but instead help repair and restore existing site systems, such as plans end animal communities, soils and waters.

The basic objective of sustainable ecotourism is to help visitors appreciate the natural and cultural uniqueness of a site by bringing them closer to it. In order to achieve this, the site design must be human-scaled and intimate, so that sensory features—such as sights, smells, and sounds—are appreciated and preserved.

Key factors required for successful sustainable ecotourism

a. Forging strong inter ministerial co-operation between the ministries of planning and investment, science technology and environment, tourism, education and training, agriculture and rural development, and

b. Being committed to management that facilitates and ensures input from all stakeholders: tour operators, protected area managers, government, NGOs, local communities etc;

- Establish a national Sustainable (Eco) Tourism Task force to develop a National Ecotourism or Nature Tourism Strategy;
- Create an environment conducive to the establishment of a private sector Ecotourism Association, independent Ecotourism Commission and Community Ecotourism Association;
- Intervene in the market eg: fees to protected areas, limits on numbers, regulations and Codes of Conduct for the industry (developed with the industry);
- Consider each natural area individually (eco and env impacts of tourism, what the area has to offer, local community needs and interaction with the environment, local infrastructure etc);
- Focus on the local and regional level - it is easier for nature tourism/ecotourism to be developed successfully at these levels;
- Start small and go slow;
- Believe that small is beautiful and quality is paramount;
- Invest in awareness raising, education and training for tourists, tour operators, local guides, protected area managers, local communities, local authorities;

- Aim to maximise local benefits for conservation and economic development;
- Aim to maximise local participation and involvement at all levels;
- Aim to maximise use of local products, materials;
- Aim to focus on recycling, waste management, alternative technologies and fuels. Manuals have been produced that provide practical information on such topics, we have a few and will be getting more;
- Constantly monitor and evaluate and develop a feedback mechanism for modifying growth and minimising impacts and setting limits.

Thus following suggestion can help us for sustainable ecotourism

(a) Enhance international cooperation, foreign direct investment and partnerships with both private and public sectors, at all levels;

(b) Develop programmes, including education and training programmes, that encourage people to participate in eco-tourism, enable indigenous and local communities to develope and benefit from ecotourism, and enhance stakeholder cooperation in tourism development and heritage preservation, in order to improve the protection of the environment, natural resources and cultural heritage;

(c) Provide technical assistance to developing countries and countries with economies in transition to support sustainable tourism business development and investment and tourism awareness programmes, to improve domestic tourism, and to stimulate entrepreneurial development;

(d) Assist host communities in managing visits to their tourism attractions for their maximum benefit, while ensuring the least negative impacts on and risks for their traditions, culture and environment, with the support of the World Tourism Organization and other relevant organizations;

(e) Promote the diversification of economic activities, including through the facilitation of access to markets and commercial information, and participation of emerging local enterprises, especially small and medium-sized enterprises.

Support efforts to attain sustainable tourism that contributes to social, economic and infrastructure development through the following measures:

(a) Implementing projects at the local, national and sub regional levels, with specific emphasis on marketing tourism products, such as adventure tourism, eco-tourism and cultural tourism;

(b) Establishing and supporting national and cross-border conservation areas to promote ecosystem conservation according to the ecosystem approach, and to promote sustainable tourism;

(c) Respecting local traditions and cultures and promoting the use of indigenous knowledge in natural resource management and eco-tourism;

(d) Assisting host communities in managing their tourism projects for maximum benefit, while limiting negative impact on their traditions, culture and environment;

(e) Support the conservation of biological diversity, the sustainable use of its components and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources, in accordance with commitments that countries have under biodiversity-related agreements to which they are parties, including such agreements as the Convention on Biological Diversity and the Convention on International Trade in Endangered Species of Wild Fauna and Flora, as well as regional biodiversity agreements.

Conclusion

Tourism has proved to be an engine of growth in many economies in the word. It provides for the generation of income, wealth and employment, and helps in the sustainable development of remote areas. Although beginning to be understood for its potentials to provide for development in the world, tourism still remains a sector that needs serious attention.

Tourism has proved to have negative impacts as well as the positive ones .It is criticized for contamination indigenous culture. This takes the form of changing values resulting in social maladies like drug addiction, child prostitution, etc. A far more widespread negative impact is caused by mass tourism in environmentally fragile areas like mountains, hills, deserts and coastal regions. Due to heavy tourist traffic in some area, the cultural and environmental assets of the community are under threat. Although this phenomenon is not widespread, there is a need to take note of the possible negative influences of tourism so that timely preservation action can be taken and irreparable loss avoided. The movement towards sustainable ecotourism is at once a threat and an opportunity to create more sustainable tourism: by diverting tourist traffic to ensure the carrying capacity of any destination is not

exceeded:; by planning for regeneration of natural resources; and by generating awareness in the host community whereby they are prepared and formed to deal with the negative impact of mass tourism.

As in most cases, a middle path is the most creative way to maximize the sustainable economic potential of tourism, while at the same time minimizing the negative social influence and threats to the environment. Only ecotourism where the tourism, the service providers, the host community and authorities are well informed and prepared to homes tourism as an engine of growth can yield sustainable results.

Ecotourism, in partnership with research, has the potential to significantly affect nature conservation in many positive ways. The question of sustainability remains unanswered because many sites with nature-based tourism are relatively new and the long-term impacts have yet to be measured. The challenges of removing trash from remote wilderness lodges, of bringing in electricity with low-impact electric wires, or of minimizing the introduction of exotic species require the test of time to determine their success.

In the not-too-distant future, our wilderness areas will be small islands of biodiversity amidst seas of domesticated landscape. As the planet's sustainable natural, relatively unaltered ecosystems become increasingly rare, ecotourism allows more people to see isolated populations of wildlife, while benefiting local economies. Ecotourism has an impact on natural ecosystems, but more importantly, it offers a way to promote conservation in ecologically fragile regions.

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Assessment of ecotourism potential modellling

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ABSTRACT

This article argues that before an eco-tourism strategy is devised four fundamental concerns to be tackled are: lack of clarity of definition, a lack of specific management structures, the nature of the industry and a lack of co-ordination. This article examines how the Green Tourism can develop the concept of urban green tourism Applying the practices of ecotourism to an urban environment is a relatively new concept but a concept that merits development in multiple cities, a concept that promotes environmental responsibility, local economic vitality, cultural diversity and experiential richness. The development and launch of the map is discussed and some of the problems encountered are examined. Key strategies for launching green tourism products are presented in the recommendations. This research seeks to outline how urban green tourism can be an effective approach to addressing the issues of Ecotourism in cities growth, waste management, etc., and demonstrates how sustainable tourism options can capitalize on the existing features of a city.

Key words : *Strategic, Planning, Ecocity, Promoting, Urban, Environment*

Introduction

The Eco-tourism is variously named :
environment friendly tourism , nature tourism, green tourism, scientific tourism, cottage tourism, wildlife tourism, wilderness tourism, safari tourism, designer tourism, hard tourism, risk tourism, adventure tourism etc.

In 1987, Ceballos-Lascurain defined the ecotourism as ecological tourism or ecotourism involving traveling to relatively undisturbed or uncontaminated natural areas, with the specific aims of studying, admiring and enjoying the scenery and its wild plants and animals, as well as any existing cultural aspects found in these areas. In fact, train journeys to the first North American national parks in the late nineteenth century were called as ecotourism (National Audubon Society, 1991). Johnson (1967) reported heavy over-use of the North American national parks, with traffic congestion and the resulting impacts was erosion and the loss of wilderness.

In recent years Blamey (1997); Fennell (1998); Fennell and Eagles (1989); Orams (1995); Swarbrooke and Horner (1999) and Valentine (1993) have modified, extended and developed many new definitions of ecotourism. The definitions of ecotourism are broad in scope. Ecotourism includes conservation, education, local ownership, and economic benefit for local communities, the relevance of cultural resources, minimum impacts and sustainability. The ecotourism must determine a visitor's status as an ecotourist and encompass the social motive.

Assessment of Ecotourism Potential in Model

The environmental assessment for ecotourism potential its sustainable development, management and strategies for future planning are the crucial factors in ecotourism development. There are many parameters for assaying the environmental impact of ecotourism development e.g., frequency and attendance, location, distance etc. The assessment of ecotourism potential in Pune district was done with

seven different parameters of ecotourism potential. The formal and informal assessment and standard tests were used for identifying the ecotourism potential of Pune district.

Environmental assessment, in any form, is a necessary component of effective ecotourism development. This assessment should be manageable and used as a guide for instructions, planning and development of ecotourism sites. The assessments should also provide data to measure environmental performance and the effectiveness of planning. Both daily formal and informal assessment and standardized tests must correlate with the standards of development and ecotourism potential.

Hence in this research, six ecotourism sites were surveyed in detail. These sites were located different directions e.g. west and south of Pune city. Most of the ecotourism potential in Pune district is in west and south of Pune which have the best attractions as the green area, hills and rivers are located to these sites.

Mulshi lake, Bhugaon lake, Bhushi lake and Valvan lake are in west direction of Pune and Katraj lake and Khadakwasala lake are in south direction of Pune district. The six different ecotourism sites (lakes) were assessed and compared on the basis of different parameters for finding their potential for ecotourism.

The best ecotourism potential of these six lakes were investigated through sample based survey and by using questionnaire and different statistical tests and methods for their development were also suggested.

Criteria and Data Analysis

The ecotourism impact criteria represent seven important factors that may be affected by the tourism in all ecotourism sites. Each of the seven criteria used in the present study was objectively scored after revision of the entire study sites. These seven criteria were subsequently numerically coded for the analysis. This table lists the properties of each criterion with its coding scheme and number of studies ,which fall into each category. Detailed information on each criterion and relevant references are given below.

Ecotourism Attractions, (Criteria A)
Environmental Quality, (Criterion B)
Amazing Area and Views, (Criterion C)
Frequency and Attendance Alternation, (Criterion D)
Compression on Places, (Criterion E)
Native Economic, (Criterion F)
Flora and Fauna, (Criterion G)

This criterion analyzes the effects that have arisen specifically because of ecotourism. For example, an area disturbed by traveling frequency or parking region would still be considered pristine by this rating scale, unless the effect was because of tourism (directly or indirectly).

Criterion G contains five categories like perfect protection, slight or infrequent intrusion, frequent intrusion, blatant abuse, no protection.

To carry out Environmental Impact Assessment (EIA) these were reduced into three category, consisting of: Positive, Ambivalant and negative. The characters of six selected lake and third column gave 95% confidence internal for each proportion.

Ecotourism Potential of Selected Lakes

The various lakes of Pune district have a great potential of ecotourism. If this potential is developed and managed efficiently these lakes will become very soon the best ecotourism sites in Pune district. This development will bring socioeconomic transformation in people of the nearby villages. With this view about six different lakes were surveyed and assessed with different analysis to find out their ecotourism potential.

Importance of Sample for Strategic Planning

During the survey of six different lakes around Pune city, it was noted that Bhugaon lake was the best ecotourism site for development of ecotourism because of its two highly positive factors.

1. Distance to travel for the visitors to visit Bhugaon lake, (68% of tourists come there from less than 10 kilometers around)
2. Frequency and attendance alternations of visitors. More than 61% of the visitors are visiting Bhugaon lake weekly.

Frequency of Visitors to Bhugaon Lake

The data collected indicate that about 200 ecotourists visit Bhugaon lake regularly per day. The number of visitors and their frequency was depending on the holidays, particular auspicious days, temperature, season, rain fall and many other factors.

Road to Bhugaon Lake

The nine km road to Bhugaon lake is a narrow road with uneven surface and has at least five sharp turns at a steep gradient. These locations are potentially accident-prone and require adequate warnings, signage, and retaining walls for erosion control, protective walls and ideally manned check posts.

The approach road faces unsafe conditions from its both sides. On the mountain side there is cracking rock and fast eroding soil, and on the valley side there are no protective walls. The road width is too narrow, occasionally quickly causing traffic jams at the peak holiday times.

Mode of Transport to Bhugaon Lake

At present mainly private cars,two wheelers and hired tourist vehicles are the only modes of transport for the tourists to visit Bhugaon lake. The charges per person from Pune to Bhugaon lake are approximately Rs. 50/- for a round trip . These vehicles do not operate unless they run full and therefore the travel time is uncertain. There are no buses or mini –buses following an organized schedule. There is no suitable public transport at present for visiting this lake.

In addition to the road, there exist alternative hilly routes for visiting the Bhugaon lake. But these are popular only among the hikers and fitness enthusiasts; these roads also lack adequate signage.

Parking Facility

The present parking facility is not enough to accommodate sufficient number of vehicles on a holiday or in the peak season of visitors. As a result, parking and pulling out of vehicles becomes are clumsy function, causing delays, noise and air pollution. On holidays due to inadequate parking space, vehicles are parked far away from entrance on the approach road. This blocks the road and causes bottlenecks. The entrance and exit to the parking area are informal. There is also no any type of controlling for parking of vehicles.

Guideline to Visitors

There is a lack of directional, informative and instructional signage at Bhugaon lake, there is no guiding map to guide the visitors, about the places of interest and places of visits to Bhugaon lake. As a result of this visitors are not able to enjoy all the sites of Bhugaon lake.

The internal paths are not of good quality, they are very narrow and do not necessarily lead to all the important locations. The road surfaces are worn out and uneven, thereby presenting risks of falls and slippages of pedestrians. This condition becomes very serious in monsoon, when the visitor number actually tends to be high, for experiencing the beautiful fogs torrential rains and greenery on hills. The road linkages to each other and to different points need to be identified by a distinctly visible location map. Certain important areas such as the south of lake have no access presently. If it is made accessible visitors can enjoy this beautiful site of the lake.

View Points

Several viewpoints require prominent directional and informative signs. Some of the viewpoints exist at the tip of cliff and are potentially adventurous thrilling as well as risky spots. They need large warning signs, manned check posts as well as very sturdy and safety railings.

The view points need facility to sit and walk around them. The visitors should enjoy the beauty of nature from these view points.

The viewpoints should have same specific features e.g. facility to watch sunrise or sunset, birds, lake view, clear sky etc.

Night Time Visitors

Because of the specific altitude and the geographic location of Bhugaon lake, fog prevails during rainy and winter months of the year. The visitors come to enjoy the fog during night time. But at present there are no adequate streetlights and path lights. Lighting at the viewing spots during night-time is not made available. As a result of this the place is virtually impossible to visit and use for night walk. The visitors are therefore limited to daytime only.

In fact the nature is more enjoyable during night e.g. movement of wild animals, night hunting, fighting of animals for food etc. could be seen during night time. But presently it is completely impossible for the visitors

Existing Vegetation

The existing vegetation as well as plant biodiversity is very rich around the lake and on the surrounding the hills. Tree species are highly dominant, which will attract the ecotourists because of their beautiful flowers, green foliage shade hugeness fruits, etc. Deforestation has caused soil erosion, and hence

there is heavy silting in lake every year during rainy season. These hills require thick plantation to protect soil erosion. The catchments area, the bunds and surrounding sides of the lake require systematic tree plantation. In future the dark green thick forest will attract the visitors, nature walking persons, as well as many birds, wild animals, reptiles, tigers and deer's.

Existing tree and shrubs species include Jambhool, Hirda , Fig, Rameta , Gela , Karanj, Silver oak, Palas, Mango, Gulmohar, Suru, Nirgudi and Karwand. All the trees are in healthy condition.

Sanitary and Waste Management Facility

Lots of wastes and garbage is generally collected, which is not properly disposed. Proper drainage and garbage disposal systems are totally absent. The visitors throw the empty drinking water bottles, plastic bags and generate plastic. The waste products created by visitors are up to 50 g. per day per person. Presently this lake is under major threat of noise air and plastic pollution.

The environmental degradation rate at Bhugaon lake is very high. The village women are washing the clothes and utensils directly in the lake as well as the milkmen was their daily animals like buffalos and cows in the lake water directly.

Management and Revenues

This lake is managed by forest department, government of Maharashtra. At present the maintenance is totally dependent on the financial support of forest department which is very inadequate. Due to lack of financial support there is no maintance of the lake. The present staff to look after the activities of lake is also very insufficient. The staff includes one forest officer ranger, one forest guard and sixteen labors .It is beyond their reach to maintain the lakes at satisfactory level. Hence many unlawful activities are going at the lake site. Encroachment on government-land by the local people is most important threat to this ecotourism site. Many illegal constructions are coming up at the lake site.

Socio-economic Activities

At present approximately 57 persons are making their living through self-employment at the lake site. Additionally, there are approximately 150 indirect employments supported by the Bhugaon lake ecotourism activities.

Majority of these are in the food vending area. Almost all the above persons live in the villages. The present average earning is approximately Rs.4, 000/- per month.

Conclusion

In this research Bhugaon lake has the best ecotourism potential for development and management amongst the six sites investigated.

The three approaches that will enhance the restoring of Bhugaon lake will be:

1- Planning for Eco-tourism.

2- Orienting the site to receive out of state and international tourists.

3-Launching a new well planed strategy for the management and revenue collection.

Successful ecotourism projects must:

- Effectively promote the preservation of entire local ecosystems, not just individual species, visits or sites;
- Be sustainable and economically viable in order to attract financing:
- Be well planned, financed, managed and marketed in order to meet the stringent environmental and recreational demands of true ecotourism.

In an era of heightened environmental consciousness and accessibility to exotic locales, countries are busy promoting their natural resources to lure tourists. The strategy of ecotourism is to preserve the natural resources while also promoting and accommodating volumes of tourists. However, most of the popular eco-travel destinations have fragile eco-systems and hence it is important to maintain a careful balance between preservation and promotion — "sustainable development" — in order to ensure the long-term health of both the eco-systems and the tourism economies.

The Long term environmental strategic management in this research consists of increasing recreational places for ecotourists, increasing the environmental viewpoints and amazing areas, planning of environmental long term strategies with attention towards occupation of local people, and increasing their life standards.

For development of ecotourism in Pune district following main recommendations are given: protection and conservation of native flora preparation of jogging tracks, children parks, yoga and meditation centre, cultural and traditional centers, amusement parks.

To develop ecotourism potential of Bhugaon lakes following ecotourism activities are recommended:

- Management of ecotourism area, proper disposal and reduction of wastes,
- Hosting –serving –cultural and coastal establishment,
- Green space and natural exhibition,
- Concentrated promenade-ecotourism projects,
- Estimation of expenditure promenade projects and ecotourism developments,

Similarly following main plans and models are suggested to develop ecotourism activities at Bhugaon lake.

- Creation of forest parks and zoos,
- Protection of native plant species,
- Conservation of natural sites,
- Management of environmental activities,
- Water park and boating,
- Jogging track and walking roads on hills at south east of Bhugaon lake,
- Yoga and meditation centre,
- Children parks,
- Amusement and children ecopark,
- Water park,
- Ecotourists camp, service centers and ecotourism facilities,
- Establishment of restaurants and residences for ecotourists.

All these developments will be undertaken by involving local people. In almost all the projects proposed for development of Bhugaon lake high priority will be given for the jobs and employment of local people. The suggested proposals and plannings will not disturb the nature and interfere the life of villagers in the vicinity of lake.Highest priority will be given to improve the economics and social standard of villagers. Where ever possible women self-help groups will be involved to empower the village women.

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The essential oil response of rosemary (*Rosmarinus officinalis* L.) by using Fe, Zn and growing media in Bam Iran

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ABSTRACT

An experiment was conducted under greenhouse condition at Bam region in 2010. The experiment design was factorial arranged in RCBD with four replications. Fertilizer factor(A) has four levels: control (without use microelements), application of Fe sulfate, application of Zn sulfate and application of Fe sulfate+ Zn sulfate and growing media factor (B) has four levels : cultural soil (sandy roses texture), combination of washed grand and cultural soil in 40 to 60., combination of pittmos (40%) + perlite (20%) + cocopitt (40%) and combination of pittmos +washed grand in 60 to 40. Fertilizers was used in 0.35 doses and with application of microelement fertilizers, net water was used in control. Microelements was used in four stages in all growing media (except control). Results showed that growing media and application of micro-elements had significant effect on measured traits. The highest length of roots, fresh and dry weight of roots, fresh and dry weight of shoots, the number of leaf in plant, leaf area and essential oil percentage, obtained from application of Fe sulfate + Znsulfate and combination of pittmos+ washed grand in 60 to 40 and the lowest of this traits, obtained from control and culture soil.

Key words : *Rosemary, Growing media, Fe and Zn sulfate, Essential oil percentage.*

Introduction

Labitea family is one of the most important botanical families that has great variation in Mediterranean . this family is important in terms of application in Food medical and cosmetic industries (Zargari, 1989). Rosemary (*Rosmarinus Officinalis* L.) is perennial and evergreen that originated from Mediterranean region and belongs to Labiatea family (Pintore, *et al.,* 2002). Its narrow leaves are as cross in stem. This plant has flower in bluish-violet. The characteristics odor of this plant is that it known as an aromatic plant and this plant has the potential for pesticide(Miresmaeili, 2005). Rosemary has medicinal properties and is listed in many pharmacopoeias as a drag. Essential oil of this plant has antibacterial properties and it is used in cosmetics and food industries (Omidbeighi, 1997).

Several factors affect on physichochemical properties of essential oil including the plant varieties, growing regions, planting date, method of oil extraction and maintenance of the essential oils of rosemary. The leaves of this plant contain essential oils, tannins, flavonoids, saponins and Rosemarysin. Despite the wide spread use of this plant, Little information has been published about how to plant and research about determining of cultural needs. Although Zinc and iron is a micro element , due to the extensive role that the plant has a large impact on the performance of plants(Malakooti, 2000). Zinc deficiency exists in calcareous soils of Iran and therefore the use of Zinc fertilizers is essential for rising of quantity and quality of products. Nateghi *et al.* (2009) reported that the highest biomass and grain yield of anise achieved from 6 ppm Fe and 4 ppm Zn. And the lowest biomass and grain yield

Table 1. Analysis of variance of oil percentage of rosemary

Leaf number	Height (cm)	Oil percentage	Degree of freedom	S.V.
3.31*	1.02ns	1.07ns	3	rep
18.84**	2.03*	5.56**	3	micronutrients
6.88**	8.39**	0.89ns	3	media
0.22ns	0.47ns	0.043ns	9	intraction
0.19	0.66	0.75	45	error
14.77	13.10	23.30		cv

ns : non significant *: significant in 5% and **: significant in 1 % level

obtained from non-application of Fe and Zn. Also the highest index harvest achieved from application of Fe in 4 ppm and Zn in 0 ppm. We examined the effects of different levels of iron and Zinc on morphological traits of anise and reported that the highest and lowest diameter of umbrella achieved from 6 ppm of Zinc and control respectively. Miguel *et al* (2007) examined the effect of cultural media on chemical composition of essential oil of rosemary and showed that the amount of camphor (4.4–8.5%) in sandy soils more than 1.8 sinoel (8.8–11.8 %). Vestervelt (2003) by consumption of 3 levels of nitrogen in rosemary showed that the highest root and shoot achieved from the lowest concentration of nitrogen.

Materials and Methods

This experiment carried out as factorial arranged in RCBD with four replications. Fertilizer factor(A) has four levels: a1:control (without use microelements), a2:application of Fe sulfate, a3:application of Zn sulfate and a4:application of Fe sulfate+ Zn sulfate and growing media factor (B) has four levels : b1:cultural soil (sandy roses texture), b2:combination of washed grand and cultural soil in 40 to 60, b3:combination of pittmass (40%) + perlite (20%) + cocopitt (40%) and b4:combination of pittmas +washed grand in 60 to 40. Fertilizers was used in 0.35% and with application of microelement fertilizers, net water was used in control. Microelements was used in four stages in all growing media (except control). First cuttings of rosemary was rooted in a bed-sand out of greenhouse and then rooted cuttings of rosemary were transferred in a pot with 17 cm diameter. Pots were filled with the material tested(b factor). After planting, according to the map, pots were kept in a greenhouse with 20 – 25 c. two weeks after planting, fertilizers treatments started and this operation repeated every week. The amount of irrigation in each pot was considered as fixed based on crop water requirements during the growth period. At the end of fourteenth week, the pots were harvested carefully and after removing the plant from the soil, roots were separated from shoots. To measure the oil of the leaves, 10 leaves were weighted from each pot and in order to faster and better extraction the oil, 100cc of distilled water was mixed with oil and extraction operation did by Clevenger and water distillation method and then amount of oil expressed as percentage. The data from experiment was analyzed using analysis variance and comparing of means. MSTAT-C software was used for this purpose.

Results and discussion

Micronutrient consumption increased oil percentage and highest oil percentage was found in iron and zinc sulfate by 3.25%. And the lowest of oil percentage was found in control (Fig. 1). The culture media of the plant had a significant effect on the amount of essential oil. Medium containing of pit, increased the amount of oil had significant differences with cultural soil and combination of soil and grand (figure 2). Interaction results suggested that the greatest amount of essential oil was viewed in iron and zinc consumption and media containing pitmos and washed grand in 60 to 40 ratio. And the lowest essential oil percentage belongs to control treatment (non-application of micronutrients and media containing of cultural soil) (Fig. 3). Azizi and Kahrizi (2008) stated that the essential oil of peppermint increased with nitrogen application up to 6 gr per square meter and oil percentage decreased with higher levels of nitrogen application. They also stated that climate and weather condition has a significant effect on the percentage of oil. Hashemi et al

(2007) showed that the percentage of essential oil of cumin increased by 60 kg/ha nitrogen and decreased by application of higher levels of nitrogen. Deficiency of manganese, boron, molybdenum and cobalt has a significant impact on yield and essential oil of peppermint(Omidbeigi, 1997). Glain (2002) has shown that different levels of micronutrients affect on essential oil of tarragon. In this experiment they found that micronutrients have most impact on oil quality.

b1: cultural soil (sandy roses texture)

b2: combination of washed grand and cultural soil in 40 to 60

b3: combination of pittmos (40%) + perlite (20%) + cocopitt (40%)

b4: combination of pittmos +washed grand in 60 to 40

Results showed that micronutrient application and media has significant effect on height of rose-

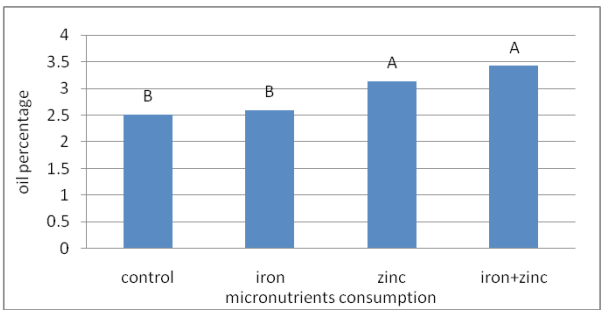

Fig. 1. The effect of micronutrients consumption on essential oil of rosemary

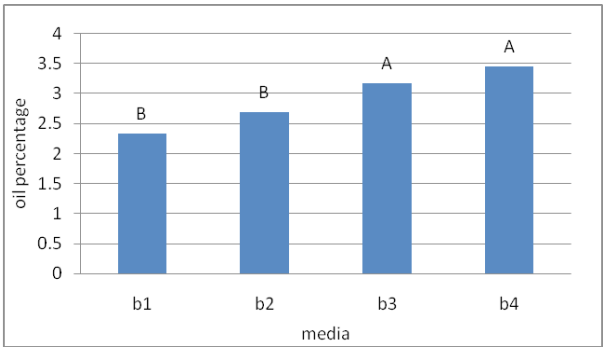

Fig. 2. The effect of media on essential oil of rosemary

mary (Table 1). Application of Fe and Zn sulfate caused increase in height of rosemary. Also combination of pittmos + washed grand in 60 to 40 was caused increase of height of rosemary. The highest height of rosemary 21.5 cm achieved from Fe and Zn sulfate application and media including pittmos +washed grand in 60 to 40 and the lowest height of rosemary (13.8 cm) achieved from non application of Fe and Zn sulfate and cultural soil (sandy roses texture) (Fig. 4). Boyle *et al* (1991) by comparison planting of rosemary in media including soil and without soil showed that height of rosemary increased in media without soil. Causes of more growing of plants in different media is relation to more cation exchange capacity and water keep capacity of different media (Westervelt, 2000). Media and micronutrient had significant effect on leaf number per plant so that using media including pit increased leaf number per plant. Interaction between media and micronutrient use showed that the highest number of leaf per plant belonged to Fe and Zn sulfate application and media including pittmos +washed grand in 60 to 40 by 17.88 and the lowest number of leaf per plant belonged to non application of Fe and Zn sulfate and cultural soil (sandy roses texture) by 10.32. Kafi *et al* (2002) reported that number of leaf per plant in rosemary has changed by change in cultural management such as planting date, number of irrigation, fertilizer management, culture media, salinity and drought stress and etc.

b1: cultural soil (sandy roses texture)

b2: combination of washed grand and cultural soil in 40 to 60

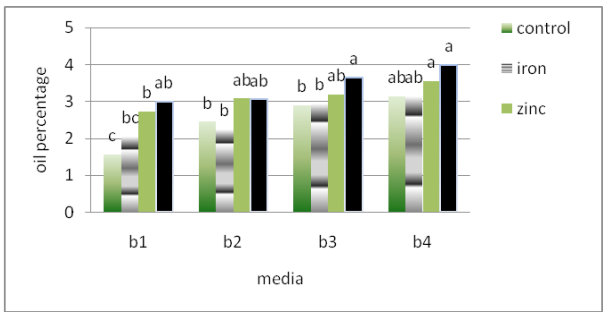

Fig. 3. Interaction between micronutrients and media on essential oil of rosemary

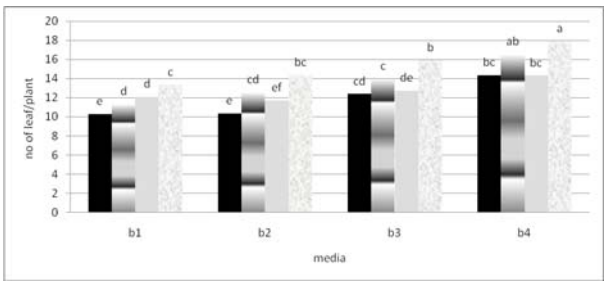

Fig. 4. Interaction between micronutrients and media on height of rosemary

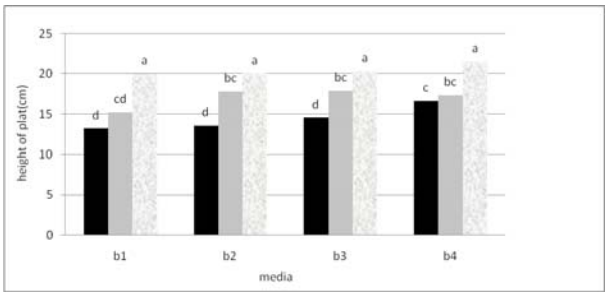

Fig. 5. Interaction between micronutrients and media on leaf number of rosemary

b3: combination of pittmos (40%) + perlite (20%) + cocopitt (40%)

b4: combination of pittmos + washed grand in 60 to 40

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An extension research for selection of best adoptive weed control methods to promote wheat cultivation in Chatra district of Jharkhand, India

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ABSTRACT

The present on Farm Trial is conducted in randomized block design with ten replications and three treatments to compare the performance of different weeding methods in wheat cultivation. The three treatment designed to be compared are, hand weeding by local *Khurpi* at 35 days after sowing (DAS), one weeding with Kriset hoe at 35 DAS and application of herbicide Isoprotiron 75 % dust @ 2.0 Kg/ha at 35 DAS in wheat var. H.U.W.9107 during Rabi 2007-08 and 2008-09. The results indicated that weeding with Kriset hoe recorded maximum grain yield (33.6q/ha), straw yield (44.7 q/ha), number of tillers per hill (6.25), weeding efficiency (77.4 %), gross income per hectare (Rs. 49260/-), net income per hectare (Rs. 27920/-) and benefit cost ratio (2.30) and has been found as the best treatment among the three. In spite of low cost of cultivation in treatment included chemical/weedicides i.e. Isoproturon, farmers reaction was negative due to unavailability of specified herbicides in local markets. Residual effect in soil and low weed control efficiency of chemical resulting in comparatively lower yield of wheat also discouraged the farmers interest in this treatment. Therefore, Kriset hoe was found to be suitable for weed management in wheat under the prevailing bio-physical and socio economic condition of Chatra district in Jharkhand.

Key words : *Kriset hoe, Isoproturon, Wheat H.U.W. 9107, Weed control, Weeding efficiency.*

Introduction

Wheat (*Triticum spp.*) is one of the most important cereal crops in the world. Importance of wheat world wide as main food can be understood by use of stylized wheat spike as a symbol of FAO. "*Give us this day our daily bread*" is an eternal prayer. Bread made from wheat has, from ancient times, been referred to as the stuff of life. It continues to be, the most important food grain of the world. It is grown across a wide range of environments around the world and has the highest adaptation among all the crop species. Worldwide more land is devoted to the production of wheat than any other crop. It is the main staple food of nearly 35 per cent of the world population than any other food source (Singh, 1998). It is the only crop so for reported to produce more than 500 million tonnes of yield in a single year. Wheat is rich source of protein, minerals and vitamins amongst all the cereals. It contributes about 60 per cent of daily protein requirement and more calories to world human diet than any other food crops (Mattern *et al.*, 1970). The acreage under wheat crop in the world is 211.06 million hectares with a production of 566.84 million tonnes, average productivity being 2686 kg/ha (Anon, 2001).

According to the well known studies of Vavilov, the North Western parts of the Indian Sub-continent together with contiguous region of Afganistan were the centre of origin of bread wheat. Archaeological investigations at Mohenjo-daro have shown that wheat was being grown in that region about 5000

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years ago. In fact, wheat was grown in India from pre-historic times. The wheat belongs to the Genus *Triticum* of family Graminae. The wheat is having different names in regional languages viz., Gehun, Kanak, Gandham in Hindi, Gehun, Gahang in Marathi, Godhumalu in Telugu, Godhi in Kannad, Godumai, Godumbairisi in Tamil, Gendhkum, Godamba in Malayalam. Although, as many as 25 species of wheat have been recognized in the world, only three species of wheat namely; T-aestivum / vulgare Linn **(Bread wheat),** T.durum **(Macaroni wheat)** and T.dicoccum **(Emmer wheat)** are commercially grown in India. In India wheat is the second most important food crop next to rice and it contributes nearly 35 per cent to the national food basket. Among winter crops, it contributes about 49 per cent of the food grains. During the crop year 2003-04 the area under wheat was 26.58 million hectares with a production of 72.10 million tonnes, average productivity being 2710 kg/ha (Anon, 2005).

Among all cereals, wheat is the most preferred food for human being. Wheat is planted to a limited extent as a forage crop for livestock and the straw can be used as fodder for livestock or as a construction material for roofing thatch (Palmer and John, 2001). Globally, it is the most important food grain and ranks second in total production as a cereal crop behind maize; the third being rice. It is reported that per 100 g of wheat grain contains 326-335 calories, 11.57-14.0 g water, 9.4-14.0 g protein, 1.2-2.5 g fat, 69.1-75.4 g total carbohydrate, 1.8-2.3 fiber, 1.7 g ash, 36-46 mg calcium, 354-400 mgphosphorus, 3.0-4.3 mg iron, 370-435 mg potassium, 0.43-0.66 mg thiamine, 0.11-0.12 mg riboflavin and 4.3-5.3 mg niacin (Ken, 2004).

The yield per unit area obtained in our country is far less than the yield of developed countries of the world. In Fig.1 the map shows the major wheat growing area in India and reveals the importance of on farm researches and trials required to raise the productivity potential of the country. Besides varied causes of this low grain yield per unit area, presence of weeds has also been become a key factor is reduction of yields. Weeds are seriously managed in crop production they not only reduced crop yield but in many cases the quality of farm is also affected. They compete with crop mainly for light, nutrient, water and carbon dioxide. Rao (2000) reported that reduction in crop yield has a direct correlation with weed competition, while Friesen *et al.* (2000) mentioned that herbicides would continue to be a key component in most weed management systems in wheat. Moreover, they observed that weeds consume three to four times more nitrogen, potassium and magnesium than weed free crop. Olea *et al.* (2003) reported that *Avena* spp., *Bromus* spp, *Promus* spp, *Parietaria debilies, Bowlesia incana, Hybanthus parviflorus* species of weeds in wheat resulted considerable losses on its yield. Wierrma *et al.* (2003) tested a number of herbicides to control weeds in wheat and found that tank mixing defenzoquat with imazamethabenz reduced weeds infestation, while Shao Xiaoming and Wu Wenliang (2003) applied Tribenuron and hand weeding and reported economic thresholds as 20 and 70 plant m^{-2}, respectively. In consideration with the growth dynamics of this weed community, the test weed density to use tribenuron in autumn was determined as 12 plant m^{-2}. An ocular estimate method was recommended for deciding the weeds density in wheat field. Kassai *et al.* (2002) tested a number of wheat varieties for their tolerance against weeds and observed 4 to 18 percent reduction in grain yield.

Fig. 1.

Integrated weed management (IWM) means the careful consideration of all available weed control techniques and subsequent integration of appropri-

ate measures that discourage the development of weeds and keep herbicides and other interventions to levels that are economically justified and reduce or minimized risks to human health and the environment (Ferrell *et al.*, 2001). Integrated weed management emphasizes the growth of a healthy crop with the least possible disruption to agro-ecosystems and encourages natural pest control mechanisms. Integrated weed management task into account all relevant control tactics and methods available locally, evaluating their potential cost effectiveness. It does not, however, consists of any absolute or rigid criteria. Implementation of IWM lies with farmers, who adopted those elements of IWM, which are seen to be practical and added value to their activities (Dumka *et al.*, 2004).

Similar to above discussion Wheat (*Triticum aestvum* L.) is an important crop of Chatra district of Jharkhand too. It covers an extensive area (20% of total cultivated area) during *Rabi*. A participatory survey report revealed that this crop has quite low average productivity i.e. 20q/ha in district due to mainly heavy weed infestation along with poor crop, nutrient as well as pest management practices. There is need of an effective weed control method in this crop which is convenient, feasible and economically viable for resource poor farmers of this area. The farmers generally practice manual weeding which is a costly and painstaking job. Mechanical and chemical weeding methods are the ways to minimize cost of cultivation. Chemical weed control method has its inherent limitations as chemical herbicides are generally unavailable in local markets well in time and are beyond the approach of resource poor farmers. Other drawback in application of chemical weedicides is accumulation of residual toxicity in soil spoiling the edaphic ecosystem (Kathiresan, 2001). Therefore, mechanical weeding with suitable implements becomes imperative for increasing production and productivity in wheat. With this view, this experiment has been designed with farmer's participatory mode for Judging the efficacy and economically viability of different weeding methods in the bio-physical and socio economic conditions of farmers of Chatra district of Jharkhand.

Materials and Methods

An On-Farm-Trial needs to be designed according to the thrust area in the region. Thrust area of the selected region always based on Primary data i.e. first hand information needs the support of Secondary data. Thus, in this trial also the Primary data and the Secondary data related to the experiment has been collected and concluded accordingly. Through the PRA study in the selected area its has been concluded that the region is trailing its productivity potential in case of wheat due to unawareness about the appropriate weeding method in wheat cultivation. As discussed earlier that the weeds have great influence on yield and region has been reported as full of weed in wheat cultivation and observed as well.

About Study area

Jharkhand is the 28th state of the Indian Union was brought into existence by the Bihar reorganization Act on November 15, 2000- the birth anniversary of the legendary Bhagwan Birsa Munda. Jharkhand is famous for its rich mineral resources like Uranium, Mica, Bauxite, Granite, Gold, Silver, Graphite, Magnetite, Dolomite, Fireclay, Quartz, Fieldspar, Coal (32% of India), Iron, Copper (25%of India) etc. Forests and woodlands occupy more than 29% of the state which is amongst the highest in India. Chatra district is located in the Hazaribag plateau of Jharkhand state. It is bounded by the district of Gaya of Bihar state in the north, Palamu district in the west and Latehar in the South and Koderma and Hazaribag district in the East. It has an area of 3706 sq. km and population of 7,90,680 persons (Census of India, 2001). The district comprises one subdivision and ten development blocks viz. Chatra, Simaria, Patrappur, Huntergunj, Itkhori, Tandwa, Kunda, Lawalong, Giddhor and Pratapgarha (Anonymous, 2006). Fig. 2 and 3 shows the location of Jharkhand state in India, Chatra district in

Fig. 2. Location of Jharkhand in India

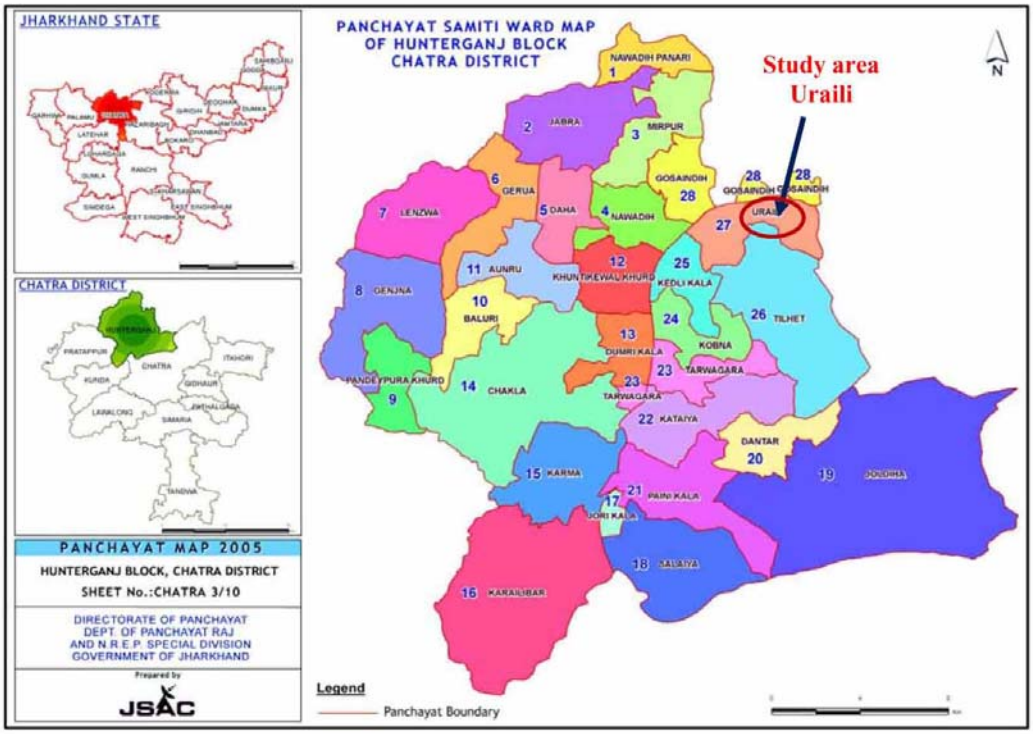

Fig. 3. Panchayatwise Map of Block Huntergunj and its location in Chatra District

Jharkhand, Hunterganj block in Chatra district and the selected panchayat Uraili as well. Uraili village of Uraili panchayat has been selected for the trial.

Physiography, Geology and Drainage of the study area

Since the district consists of part of Upper Hazaribag plateau and Lower Hazaribag plateau and northen scarp, it presents diverse physiographic features. It has an elevation of about 450 m. Kalua hill and Lahabar hill forms the higher elevations of the district. Due to scarp landforms some waterfalls are observed in the district. The general slope of the district is from north to south. Geologically the area is comprised with Archean granites and gneisses. In southern part Gondwana rock formation occur in patches. Major rivers flowing in the district are Yamuna, Barki, Chako, Damodar and Garhi (Anonymous, 2006).

Climate of the study area

The district receives an annual rainfall of 1250 mm. and most of the rainfall occurs during the rainy season. During winter season the area receives 1 to 2 mm rainfall. The mean annual temperature remains about 25^{0}C but in summer season it reaches upto 46^{0}C and in winter season it comes down to 2 to 3^{0}C (Anonymous, 2006).

Agriculture and Land Use of the study area

The major portion of the district is covered by forest (60.4 % of TGA) and has scattered settlement pattern. The forest is full of variety of medicinal plants, kendu leaves, bamboo, sal, teak and other timber species. The district has considerable flat land, which provide suitable site for agricultural use. The hilly areas are mostly under forest with patches of cultivation on scarp areas. Major crops grown in the district are rice, wheat and pulses. Only 12.21 percent area of agricultural use are net irrigated and major source of irrigations are well and tubewells (Anonymous, 2006).

Soils of the study area

The soils occurring in different landforms have been characterised during soil resource mapping of the state on 1:250,000 scale (Haldar *et al.* 1996) and three soil orders namely Entisols, Inceptisols and Alfisols were observed in Chatra district (Anonymous, 2006). Alfisols were the dominant soils covering 52.2 percent of TGA followed by Entisols (33.9 %) and Inceptisols (13.0) (Fig. 4).

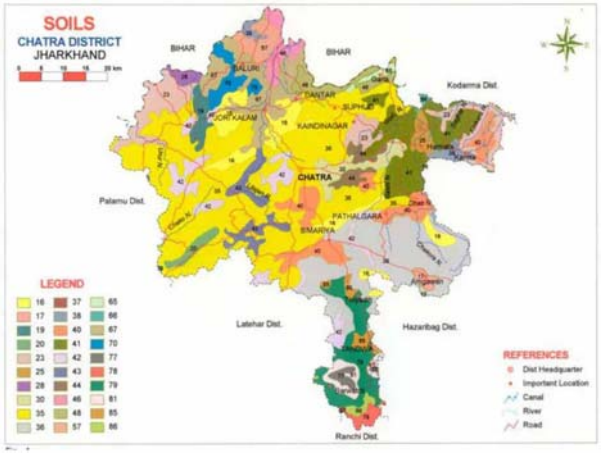

Fig. 4. Soil Map of Chatra district

The soil pH ranges from 4.7 to 8.1. The soil reaction classes with area are given in figure 5. The map reveals that majority of the area is acidic (66.2 % of TGA), in which 27.4 percent area is moderately acidic, 19.0 percent slightly acidic, 15.8 percent strongly acidic and 4.0 percent very strongly acidic in reaction. Soils of 17.6 percent area of the district are neutral whereas 15.3 percent area is alkaline in reaction (Fig. 5) (Anonymous, 2006).

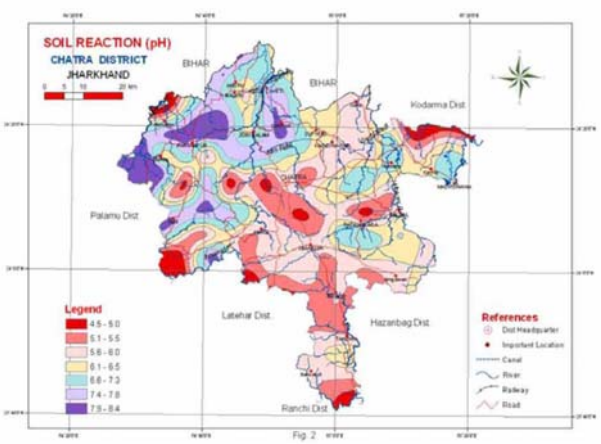

Fig. 5. Map showing the pH status in the Chatra district

The organic carbon content in the district ranges from 0.10 to 1.74 %. They are mapped into three classes i.e., low (below 0.5 %), medium (0.5-0.75 %) and high (above 0.75 %). It is seen that 26.2 percent area of the district shows low organic carbon content (Fig. 6). Medium and high organic carbon content constitutes 35.8 and 37.1 percent area respectively (Anonymous, 2006).

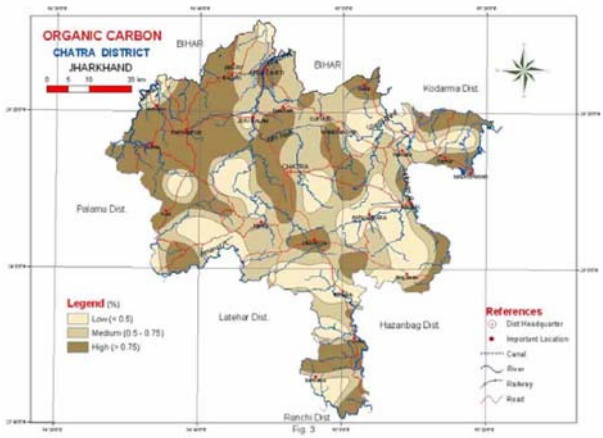

Fig. 6. Map showing the Organic carbon status in Chatra district

Nutrients like nitrogen (N), phosphorus (P) and potassium (K) are considered as primary nutrients and sulphur (S) as secondary nutrient. These nutrients help in proper growth, development and yield differentiation of plants and are generally required by plants in large quantity (Anonymous, 2006).

Available nitrogen content in the surface soils of the district ranges between 183 and 693 kg/ha (Fig. 7). Majority soils (63.1 % of TGA) of the district have medium status of available nitrogen (280-560 kg ha^{-1}) and soils of 20.7 percent area have low available nitrogen content (<280 kg ha^{-1}) (Anonymous, 2006).

Available phosphorus content in these soils ranges between 1.0 and 29.3 kg/ha and their distribution (Fig. 8). Map reveals that majority of the soils are low (78.3 % of TGA) followed by medium (20.5 % of TGA) and high (0.3 % of TGA) content of avail-

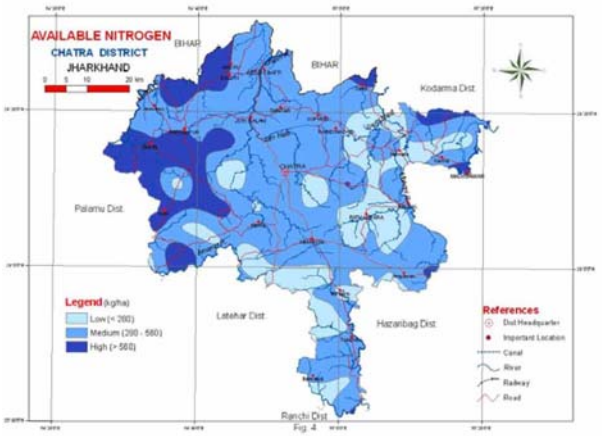

Fig. 7. Map showing the Nitrogen distribution in the Chatra district

able phosphorous (Anonymous, 2006).

Available potassium content in these soils ranges between 67 and 862 kg/ha and details about area and distribution is given in figure 9. The Map (Fig. 9) reveals that most of the soils (49.6 % of TGA) have medium available potassium content (108-280 kg ha^{-1}). Soils of 42.2 percent area are high (above 280 kg ha^{-1}) and 7.3 percent area are low (below 108) in available potassium content (Anonymous, 2006).

The available Sulphur content in the soils ranges from 0.36 to 47.38 mg kg^{-1} and details about area and distribution is shown in figure 10. Soils of 28.1 percent of the area are low (<10 mg kg^{-1}) whereas soils of 38.3 and 32.7 percent area are medium (10-20 mg kg^{-1}) and high (>20 mg kg^{-1}) in available sulphur content respectively (Anonymous, 2006).

The available iron content in the surface soils ranges between 9.6 and 83.2 mg kg^{-1}. As per the critical limit of available iron (> 4.5 mg kg^{-1}), all the soils are sufficient in available iron. They are grouped and mapped into four classes. Majority of the soils (52.3 % of TGA) have available iron content between the ranges of 25 to 50 mg kg^{-1}. The details of area and distributions are presented in Fig. 11(Anonymous, 2006).

The available manganese content in surface soils ranges between 7.6 and 64.7 mg kg^{-1}. As per the critical limit of available manganese (> 2 mg kg^{-1}), all the soils are sufficient in available manganese. They are grouped and mapped into four classes. Soils of 76.1 % area of district have available Mn content between 25 and 50 mg kg^{-1}. The details of area and distribution are presented in Fig. 12(Anonymous, 2006).

The available zinc in surface soils ranges between 0.42 and 4.48 mg kg^{-1}. They are grouped and mapped into five classes. Soils of majority area (91.9 % of TGA) are sufficient (>0.5 mg kg^{-1}) whereas soils

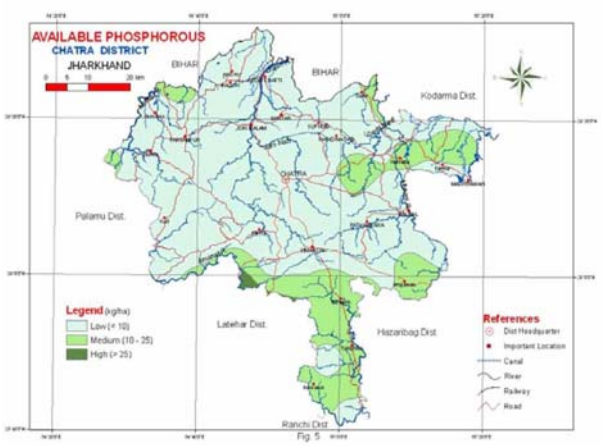

Fig. 8. Map showing the Phosphorous distribution in Chatra district

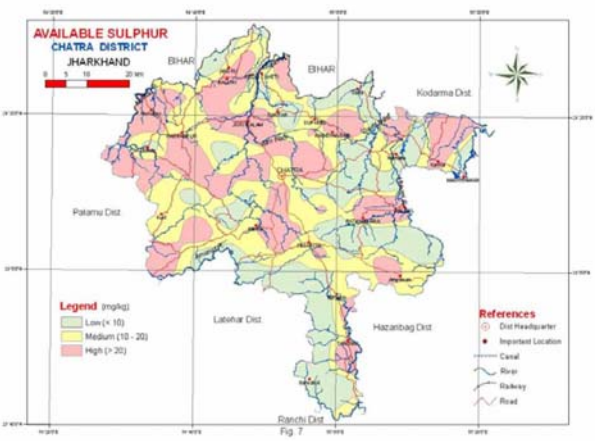

Fig. 10. Map showing distribution of Sulphur in Chatra district

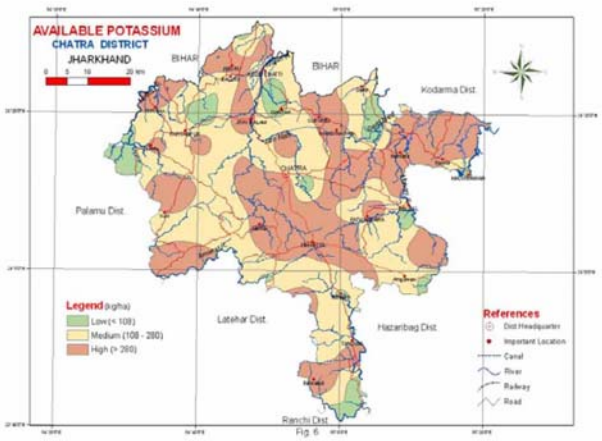

Fig. 9. Map showing distribution of Potassium in Chatra District

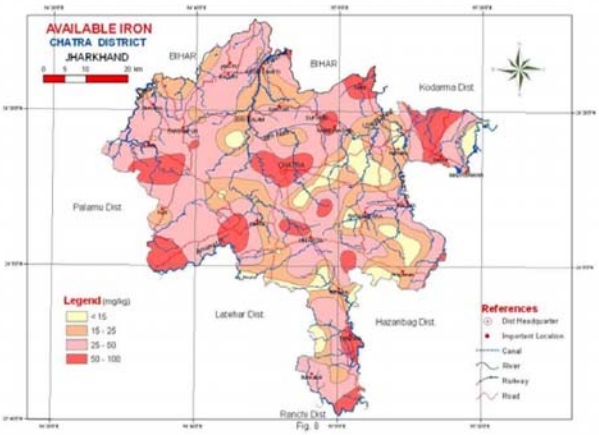

Fig. 11. Map showing distribution of Sulphur in Chatra district

of 7.2 percent area are deficient (<0.5 mg kg^{-1}) in available zinc. The details of area and distribution are presented in figure 13(Anonymous, 2006).

The available copper status in surface soils ranges between 0.18 and 4.38 mg kg^{-1}. They are grouped and mapped into six classes. Majority of soils (97.6 % of TGA) have sufficient amount of available copper (>0.2 mg kg^{-1}) and soils of 1.5 % area are deficient in available copper (<0.2 mg kg^{-1}). The details of area and distribution are presented in fig.14 (Anonymous, 2006).

The available boron content in the soils ranges from 0.07 to 4.48 mgkg^{-1} and details about area and distribution is given in figure 15. The critical limit for deficiency of the available boron is <0.5. Soils of 35.4 percent area of district are deficient (<0.50 mgkg^{-1}) whereas 63.7 percent area are sufficient (>0.50 mgkg^{-1}) in available boron content (Anonymous, 2006).

Beside the soil characteristics of the study area, the soils of the particular plots in which experiment conducted, has been analyzed and the basic soil properties of the soils are shown in the Table 1. (Farmer's name has been mentioned in place of plot no.). Soil characteristics plays very important role to establish any criteria to be adopted in any particular region and to recommend for the similar region.

The weekly rainfall data of the crop period of the years 2007-08 and 2008-09 have been collected and average has been taken to develop a rainfall pattern for graphical presentation (Table 2 and Fig.16). Rainfall also plays an important role to study any technology to be tested at farmer's field. This data also helps in making the recommendation stronger and more adoptive as well, especially the studies related to weed control.

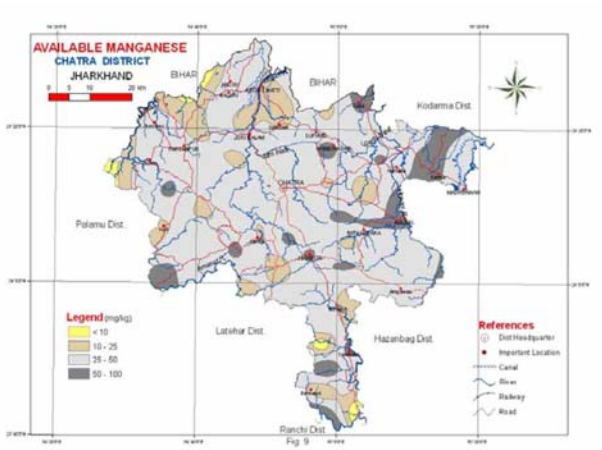

Fig. 12. Map showing distribution of Mangnese in Chatra district

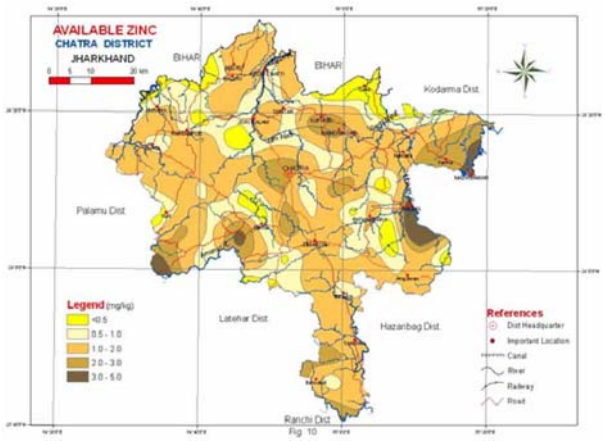

Fig. 13. Map showing distribution of Zinc in Chatra district

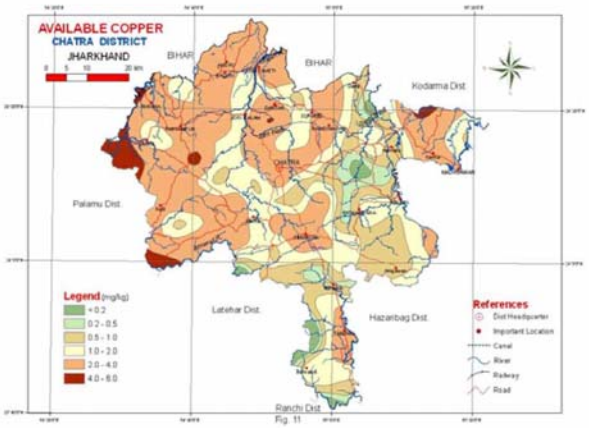

Fig. 14. Map showing distribution of Copper in Chatra district

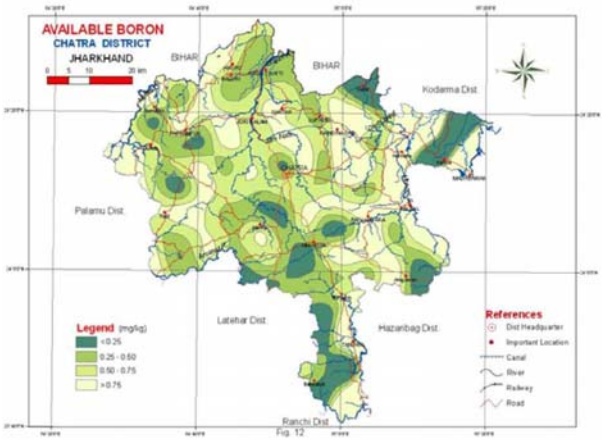

Fig. 15. Map showing distribution of Boron in Chatra district

Table 1. Basic Soil properties of the soils of the selectected farmers field

S. No.	Farmers Name	pH	OC	N	P_2O_5	K_2O
1	Shri Vishnudev Mahto	5.3	0.562	352	11.2	185
2	Shri Janki Mishra	4.8	0.51	310	11.2	174
3	Shri Nathuni Mahto	6.2	0.783	490	12.3	205
4	Shri Amarnath Singh	5	0.53	340	10.4	181
5	Shri Bhola Singh	5.8	0.665	385	12.1	200
6	Shri Vinod Kumar	4.6	0.49	290	9.7	167
7	Shri Gopal Singh	6	0.621	361	12	196
8	Shri Pramod Kumar	4.1	0.433	265	8.1	152
9	Shri Arjun Prasad	4.5	0.47	282	8.4	163
10	Shri Shri Mahto	4.9	0.5	300	9.1	160

Table 2. Average of Weekly Rainfall data Years 2007-08 and 2008-09 of the Crop Period

Week Nos	Week duration	Average Rainfall
1.	1st Nov. to 7th Nov.	6.2
2.	8th Nov. to 14th Nov.	2.1
3.	15th Nov. to 21st Nov.	0
4.	22nd Nov. to 28th Nov.	0
5.	29th Nov. to 4th Dec.	3.9
6.	5th Dec. to 11th Dec.	0
7.	12th Dec. to 18th Dec.	0
8.	19th Dec. to 25th Dec.	0
9.	26th Dec. to 2nd Jan.	0
10.	3rd Jan. to 9th Jan.	11.2
11.	10th Jan to 16th Jan	6.3
12.	17th Jan to 23rd Jan	0
13.	24th Jan to 31st Jan	4.1
14.	1st Feb. to 7th Feb.	8.2
15.	8th Feb. to 14th Feb.	7.1
16.	15th Feb. to 21st Feb.	0
17.	22 Feb. to 28th Feb.	0
18.	29th Feb. to 6th March	3.2
19.	7th March to 13th March	5.4
20.	14th March to 20th March	0
21.	21st March to 27th March	0
22.	28th March to 3rd April	0
23.	4th April to 10th April	0
24.	11th April to 17th April	7.1
25.	18th April to 24th April	0
26.	24th April to 1st May	0

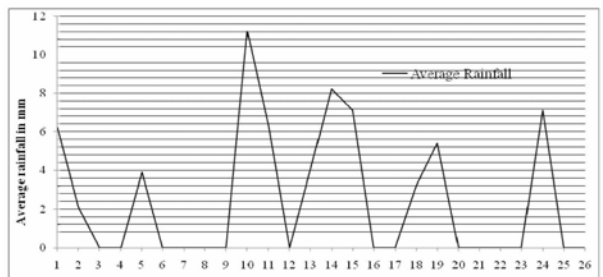

Fig. 16 Average of Weekly Rainfall data Years 2007-08 and 2008-09 of the Crop Period

Design of the experiment

The experiments was laid out in randomized block design with ten replications in Uraili villages of Hunterganj block of Chatra district in upland Tar II and Tar III during *Rabi* season of 2007 and 2008 in participatory mode.

The treatments included, Farmers practices i.e. hand weeding by local special *Khurpi* at 35 days after sowing (DAS), and one weeding with Kriset hoe at 35 DAS and application of herbicide Isoprotiron 75 % dust @ 2.0 Kg /ha at 35 DAS. The plots selected for experiments were earlier noted for heavy weed infestation. The crops of wheat var. HUW-9107 under experiment were raised by application of recommended doses of NPK i.e. 120, 60 and 50 Kg/ha, in the form of urea, SSP and MoP, respectively. Data were recorded on weed population before and after weeding, man days required for weeding, number of tillers per hill, parameters of economics of weeding, grain and straw yield (q/ha). Numbers of weeds per square meter were counted and weeding efficiency was calculated by using the following formula.

$$\text{Weeding efficiency } (\%) = \frac{\text{Nos of weeds before weeding-Nos of weeds after weeding}}{\text{Nos of weeds before weeding}} x100$$

Results and Discussion

The results of present trial is presented in Table 3 & 4 and concluded as follows.

1. Effect on weed population and weeding efficiency

Pooled data of the two years have been processed and given in table 3 and regarding weed population, weeding efficiency and man days required are ex-

plained graphically through Fig. 17, 18 & 19. The result reveals that hand weeding with Khurpi i.e farmer's practice and weeding with Kriset hoe resulted at par in control of weeds (11.3 and 13.6 weeds/m^2 area) as compared to chemical control (22.8 weeds/sq-m) (Fig. 17). The weeding efficiency of different practices ranged from 63.04 to 81.01%. The highest weeding efficiency was noted under farmer practices followed by Kriset hoe. This was evident that manual weeding was effective in controlling weeds but consumed more time and cost, keeping in view, to reduce time and cost was the thrust area of the present trial. The lowest weeding

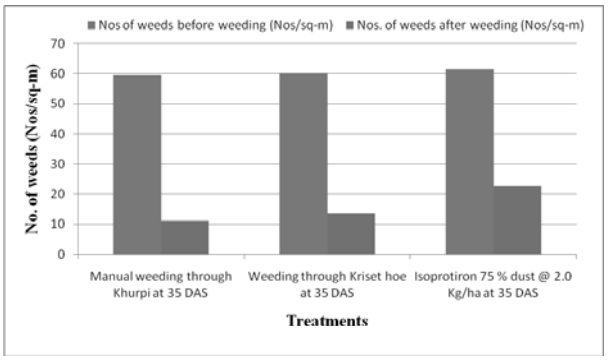

Fig. 17. Effect of different treatment on weed control

efficiency was recorded under chemical weed control. Higher weeding efficiency with Farm Implements like Weeders, Khurpi, Kriset hoe etc. as compared with weed control through chemical/herbicides has also been observed earlier (Anonymous, 1987 & 1988).

Focusing on the farmers concern with the weeding and their socio-economic status i.e. cost included in weeding along with weeding efficiency under wheat cultivation, which is discouraging wheat production in the selected study area as well, the Kriset hoe has shown its superiority and has been found most farmers friendly. Unavailability of herbicide/chemical in the local market, lowest weeding efficiency (63.04%), and least impact on weed control (22.8 weeds/m^2) concludes that chemical weed control cannot be recommended at all (Fig. 18).

2. Effect on performance of crop

The data in table 4 indicated that maximum number of effective tillers per hill (6.25), grain yield (33.6 q/ha) and straw yield (44.70 q/ha) was recorded from plots weeded with Kriset hoe. Manipulation of soil creates good aeration and loosening of soil around the Rhizosphere leading to proper root development

Table 3. Effect of different weed control methods on weed population, weeding efficiency, mandays required and cost of weeding

Treatments	Nos of weeds before weeding (Nos/sq-m)	Nos. of weeds after weeding (Nos/sq-m)	Weeding efficiency (%)	Mandays requirement for weeding (Nos/ha)	Cost of Weeding (Rs/ha)
Manual weeding through Khurpi at 35 DAS	59.6	11.3	81.01	58.6	5860
Weeding through Kriset hoe at 35 DAS	60.3	13.6	77.4	20.8	2080
Isoprotiron 75 % dust @ 2.0 Kg/ha at 35 DAS	61.7	22.8	63.04	2.13	1216
SEM		1.08		2.98	
CD at 5 %		2.18		6.02	

Table 4. Effect of different weed control method on Nos of Effective tillers, Grain yield, Straw yield, Cost of cultivation, Gross income, Net income and Benefit Cost ratio

Treatments	Nos of effective tillers/hill	Grain yield (q/ha)	Straw yield (q/ha)	Cost of cultivation (Rs/ha)	Gross income (Rs/ha)	Net income (Rs/ha)	Benefit-cost ratio
Manual weeding through Khurpi at 35 DAS	4.32	29.7	40.3	24120	43700	19580	1:1.81
Weeding through Kriset hoe at 35 DAS	6.25	33.6	44.7	21340	49260	27920	1:2.30
Isoprotiron 75 % dust @ 2.0 Kg/ha at 35 DAS	3.95	24.4	34.6	19200	36200	1700	1:1.88
SEM	0.98	1.21					
CD at 5 %	1.98	2.44					

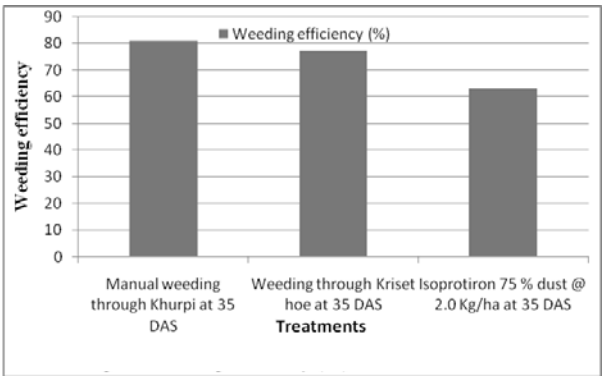

Fig. 18. Weeding efficiency (%) in different treatment

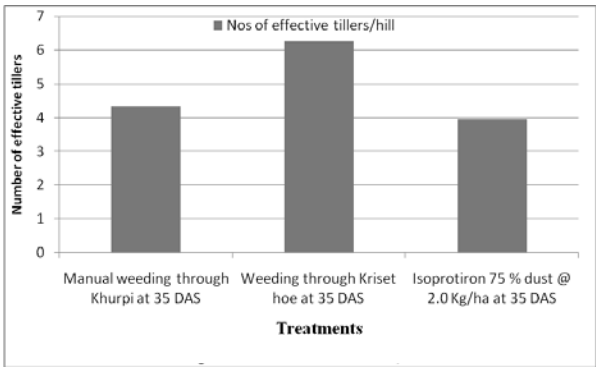

Fig. 19. Nos of effective tillers/hill

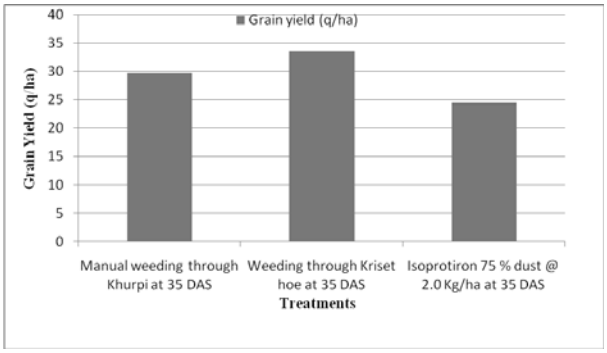

Fig. 20. Grain yield (q/ha) in different treatments

and penetration, results in emergence of more number of tillers (Singhal, 1997; Srivastava, 1996). Furthermore, decrease in crop weed competition during the critical crop growth stages might be promoting the nutritional supply to plants and thus increases number of tillers. In contrary, minimum number of effective tillers per hill (3.95), grain yield (24.4 q/ha) and straw yield (34.60 q/ha) was recorded from the plots under chemical control method, was probably due to no aeration and no tilth of soil and comparatively more competition with weeds, as Isoproturon is a selective herbicide for weeds of Graminae family which renders no control on many of broad leaved weeds.

Numbers of tillers being one of the important yield contributing characters lead to higher grain yield and straw yield in treatment, weeding with Kriset hoe (Srivastava, 1996). Since, most of herbicides have shocking effect on physiological activities of targeted as well as non-targeted plants; therefore, sudden slowing down of growth and development of crop plants might also be reason of lower yield. Hand weeding has show little bit better effect on effective tillers per hill (4.32), grain yield (29.7 q/ha) and straw yield (40.3 q/ha) but could not reach at par with the plot treated with Kriset hoe. The results are very well explained through Fig. 19, 20 and 21 regarding impact of different treatments on effective tillers per hill, grain yield, and straw yield respectively.

3. Effect on Economics of crop

Observing the data presented in table 3 and graphically through Fig. 19, regarding man days required for weeding in all the three treatments, the chemical control method has proved its superiority, scoring minimum (2.13 No. of man days required per hectare), similarly in Table 4 regarding cost of weeding (Rs. 1216/-) and cost of cultivation (Rs. 19200/-) as well. Highest cost of weeding, cost of cultivation and mandays required per hectare were recorded in farmers practice i.e. manual weeding with *Khurpi* (Rs 5860/-, Rs. 24120/- and 58.6, respectively). The observations are clearly compared through fig. 22, 23 and 24.

The treatment weeding through Kriset hoe performed, in between manual weeding through Khurpi and chemical weed control in mandays requirement, cost of weeding and cost of cultivation but proved to the best by observing the overall economics of the treatments i.e., gross income (Rs. 49260/-), net income (Rs. 27920/-) and the benefit cost ratio (1:2.3) (Table 4). The superiority of weeding through Kriset hoe is clearly focused through fig. 25 and 26.

Conclusion and Recommendation

The result and discussion clearly proves the treatment weeding through Kriset hoe as the best and can be recommended for weeding in wheat during

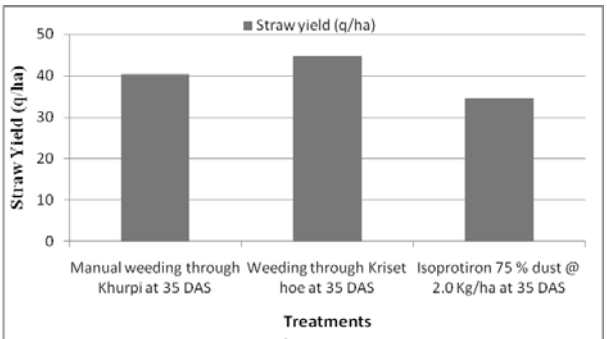

Fig. 21 Straw yield (q/ha) in different treatments

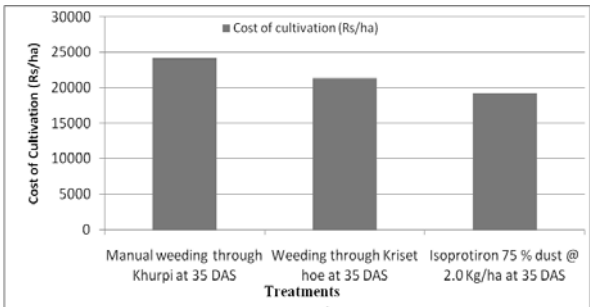

Fig. 24 Cost of cultivation (Rs/ha) in different treatments

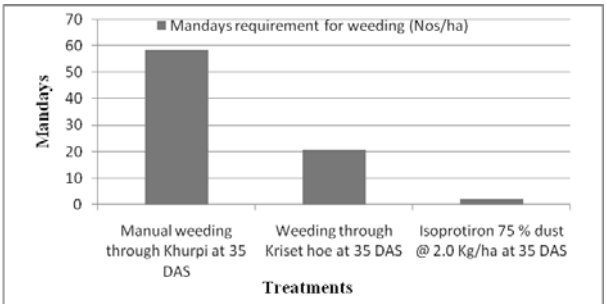

Fig. 22 Mandays requirement for weeding (Nos/ha) in different treatments

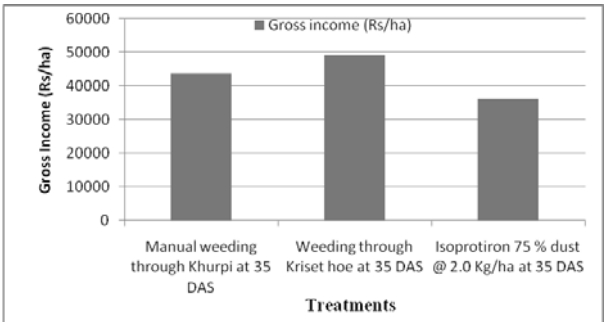

Fig. 25 Gross income (Rs/ha) in different treatments

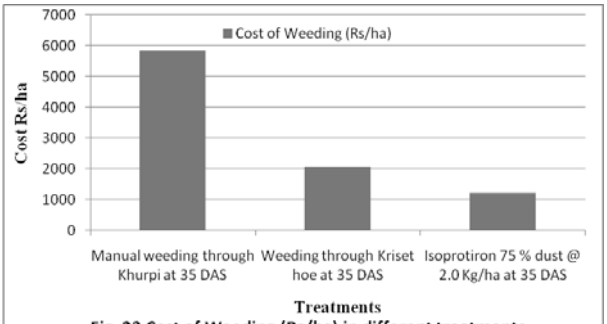

Fig. 23 Cost of Weeding (Rs/ha) in different treatments

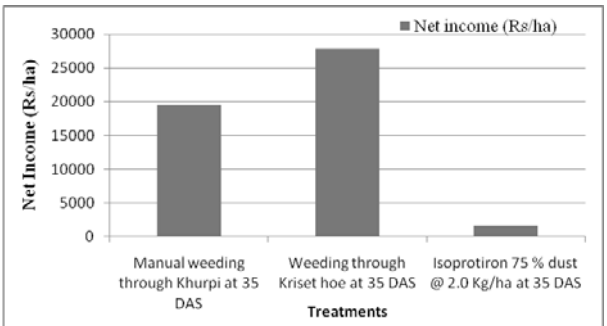

Fig. 26 Net income (Rs/ha) in different treatments

Rabi season in the study area.

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The study on heavy metal contamination and its impact on Machna river, Betul (Madhya Pradesh), India

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ABSTRACT

River water is not safe due to the high levels of toxic metals at some sampling points. However it has been found within the limit The traces of toxic metals in River water indicates contamination in water body, however the impact is not well defined. The water supply for domestic as well as irrigational purposes from the Machna River should be treated for toxic metal ions, and immediate action should be taken to control the quality of the river water. The water quality of the Machna River at Betul (M.P.) has been studied with reference to toxic metals during pre, monsoon and post-monsoon seasons. The metals analyzed include cadmium,chromium, copper, iron, manganese, lead and zinc. The quality of river water has deteriorated due to the continuous discharge of municipal and industrial, household effluents from various drains. The metal load discharged by various drains is quite high. The results show that the maximum load of metal ions was transported from Idol immersion point near Badora under Bridge and Most of the metal ions show higher concentrations in the post-monsoon season. The main sources of metal pollution in the Machna River include municipal, industrial effluents and hospital waste. The water quality should be treated for the toxic metals before the supply for drinking as well as irrigational purposes.

Key words *: Heavy metals, Toxic metals, Contamination, Municipal effluents*

Introduction

The toxic heavy metals entering the ecosystem may lead to geoaccumulation, bioaccumulation and biomagnifications. Heavy metals like Fe, Cu, Zn, Ni and other trace elements are important for proper functioning of biological systems and their deficiency or excess could lead to a number of disorders. Food chain contamination by heavy metals has become a burning issue in recent years because of their potential accumulation in biosystems through contaminated water, soil and air. Therefore, a better understanding of heavy metal sources, their accumulation in the soil and the effect of their presence in water, soil and on plant systems seem to be particularly important issues of present day research on risk assessment. The main sources of heavy metals to vegetable crops are their growth media (soil, air, nutrient solutions) from which these are taken up by the roots or foliage. The importance of environmental quality in India, generally, and in and around rivers, in particular has recently attracted a great deal of interest. Industrial units located in and at the outskirts of the city, intensive agricultural practices along the riversides and indiscriminate disposal of domestic and municipal wastes are the main sources of Machna river water pollution. Exposure to these wastes, which contain toxic components such as heavy metal ions, is of great concern, as it poses not only health risks to humans but also potentially unacceptable ecological risks to plants, animals and microorganisms.One surprising aspect of these catchments is communities use the polluted river

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water for irrigation. Some studies indicated that most of the vegetable supplied to Betul city come from the suburban directly irrigated by these water or fields flushed from waste water during the heavy rainy season or during the dry season. The presence of heavy metals such as Pb, Ni, Cd, Hg and Cr in Machna river water have the potential to contaminate crops especially vegetables growing under such irrigation. However, they contain both essential and toxic elements over a wide range of concentrations. Metal accumulation in vegetables may pose a direct threat to human health. Cadmium accumulation may cause bone deformation, kidney damage, anemia,injury of central nervous system and liver and itai itai disease. Copper toxicity may induce hypertension, coma and sporadic fever. Zinc accumulation causes vomiting and renal damage, whereas hexavalent chromium may induce gastrointestinal ulceration and cancer. Comprehensive studies related to the analyses of water, soil and vegetables around the particular river are only a few in the country. Therefore, the present study has been undertaken to assess the extent of heavy metal contamination in water.

Betul District extends between 21-22 and 22-24 degrees North Latitude and between 77-10 and 78-33 degrees East Longitude and forms a compact shape, almost a square with slight projection on the East and the West. According to the 2011 census Betul District has a population of 1,582,793 roughly equal to the nation of Gabon or the US state of Idaho. This gives it a ranking of 314th in India (out of a total of 640). The area is characterised by relatively hilly to undulating slopes with a combination of flatlands. The area receives large amount of rainfall during rainy season.

Materials and Methods

Sampling

Four water samples were taken from different locations in Machna river. All samples were collected same day and kept in two litres rubber bottles, which have been previously washed with 10% HNO_3 and 1:1 HCl for 48 h. The rubber bottles were labelled and immediately few drops of HNO_3 were added in order to prevent loss of metals, bacterial and fungal growth. Temperature and pH of water samples were also measured at the time of collection. The reagents used were of analytical grade, while water was deionized in a Milli Q-RG (Millipore, France) and had a resistivity of >18MΩ. The standard solutions were made from commercially available standards for AAS analysis (Merck, India). A solution of HCl made by Merck (Merck, India) by dissolving the acid of a density d=1.19 g mL^{-1} with deionized water at a ratio of 1:4 (3 M HCl). All the analysis were carried out as per APHA, (1999).

Sample analysis

Heavy metals were determined in water samples using a Perkin Elmer model 100 Atomic Absorption spectrophotometer.

Results and Discussion

The five heavy metals (Cd, Zn, Pb, Ni, Cr) were selected for the study and quarterly analysis was done for the two years 2009 and 2010.

The Cd limit given by WHO water quality guidelines is 0.005 mg/L. The Cd concentration ranged from 0.0001 to 0.004 mg/L. The values shown by Cd are well within the guidelines of WHO and this comparison is important since the river is used daily by the locals for domestic purposes without further treatment. The same results were obtained by the numerous studies of the heavy-metal water quality of the Mississippi River that have been conducted over the last several decades have emphasized mostly the water quality in specific regions of either the lower reaches of the river (Everett 1971; Hartung, 1974, Newchurch and Kahwa, 1984 and or the upper reaches of the river (Eisenreich and others, 1980; Water Quality Work Group of the Great River Environmental Action Team, 1980, 1980; Bailey and Rada, 1984. Heavy metals are transported as (1) dissolved species in the water, (2) suspended insoluble chemical solids, or (3) components of the suspended natural sediments. Metals dissolved in the water can exist as hydrated metal ions or as aqueous metal complexes with other organic or inorganic constituents. Water-insoluble inorganic (non-carbon-containing, except for carbonates) chemical solids such as metal hydroxides may be formed, as may organic (carbon-containing) chemical solids.

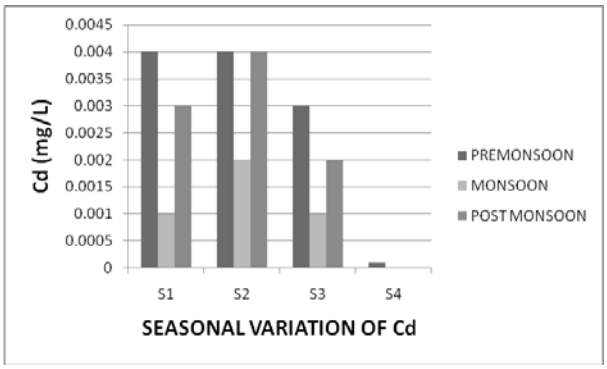
Millions of tons of fertilizers and pesticides are applied to croplands every year. Cultivated soils can become enriched with toxic metals associated with these applications. Although the concentrations may vary between specific formulations, many of these

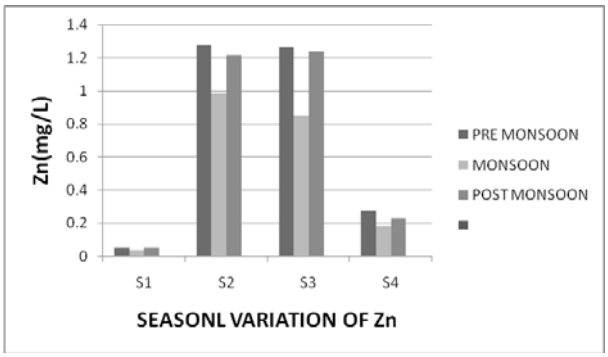
fertilizers contain chromium, copper, iron, manganese, nickel, and zinc. Selected pesticides use heavy metals such as mercury as an integral component. During the late spring and early summer, after fertilizers and pesticides have been applied, the runoff from rain flushes these contaminants into the Machna river. Zn levels were found to range between 0.035 and 1.275 mg/L. Maximum permissible limit for the Zn is 0.10 mg/L W.H.O (1991). The excess of Zn is reported which is hazardous for the aquatic living organism as well as human beings. Lead ranged from 0.0001 mg/L to 0.0045 mg/L. These values are with in limit. The permissible limit for the Lead is 0.05 mg/L W.H.O (1991). The Nickel ranged from B.D.L to 0.126 mg/L. The maximum value reported at S_1 sampling station that is Hathi Nalah. Permissible limit for the Ni is 0.05 mg/L W.H.O (1991).

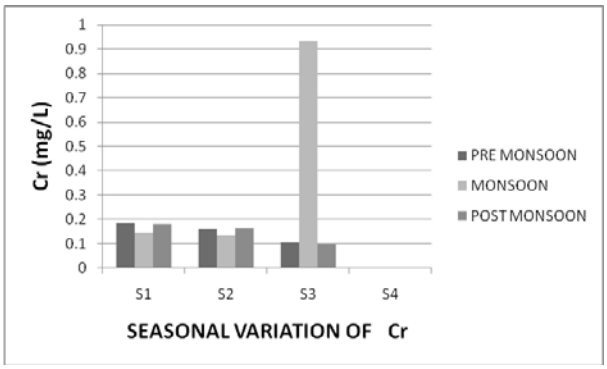
The solubility of trace metals in surface water is predominately controlled by the water pH (Osmond *et al.,* 1995), water temperature (Iwashita and Shimamura, 2003), the river flow Iwashita and Shimamura, 2003; Olías *et al.,* 2004) and the redox environment of the river system (Osmond *et al.,* 1995; Iwashita and Shimamura, 2003). A lower pH increases the competition between metal and hydrogen ions for binding sites. A decrease in pH may also dissolve metal-carbonate complexes, releasing free metal ions into the water column (Osmond *et al.,* 1995). The seasonal variation of the water temperature in the Machna River may influence the variability of the studied metals indirectly via biological activity (decay of phytoplankton) or due to possible decrease of dissolved oxygen which related to redox potential decrease. Fergusson (1990) also found the same result and studied the impact of heavy metals on the health and Environment. Brozska *et al.,* (2001) studied the Cadmium and Zinc metals. In wet period the intense rains cause an increase in the river flow, producing a dilution of the contaminants. During the mixing of large volumes of non contaminated runoff water, the pH increases and the sulphate and metal content decrease. When the river flow decreases during the warm period, the concentrations of contaminants begin to recover, reaching maxima in the summer due to sulphide-oxidising bacterial activity increasing with the temperature, and simultaneously, a concentrating effect of the dissolved pollutants occurs in the water due to water evaporation (Olías *et al.,* 2004). There are no river flow data for all the studied sampling sites of the Machna river.

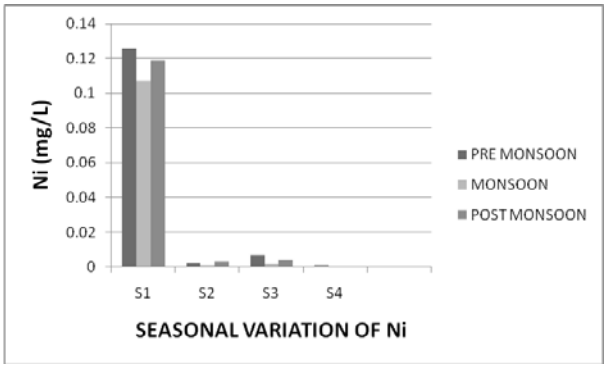
Chromium ranged from B.D.L to 0.185 mg/L at S_1 (Hathi Nalah). These values show that the data are well with in permissible limit.

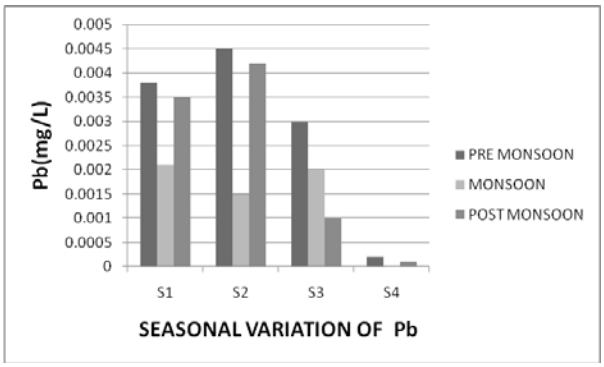
Overall, the data show that in the this analysis are within permissible limit so the water of Machna











river is safe for drinking as well as other purposes.The hospital waste released into the Karbala Nalah is great threat to the water quality of this river because the water of this river is used for the irrigation also and some fields are very close to the mentioned sampling point so it will be impossible for us to provide safe and pure water for the irrigational purposes.

Conclusion

Seasonal variations in the concentrations of selected heavy metals in Machna River water were investigated. The major sources of pollution are the urban and agricultural runoff. The heavy metal pollution status of Machna River was not published before other information was only available in rare cases.These water sources result with allowed heavy metal levels within WHO norms. The concentrations of heavy metals in different points of the river are different. The analysis shows the critical points of the river and also shows the points that continuous control should be done. The latter method of releasing heavy metals into the river is important especially where the river is a source for drinking water. A comparison with earlier investigations and as a result of the increased economic growth, population and living

standards suggest that the concentrations of important water quality constituents are not rising. As a general conclusion, some important contaminated areas were identified in the Machna river, Average heavy metals changes in different stations and different seasons will show that Zn concentration was higher than EC and W.H.O standards.

Acknowledgement

We are very much thankful to Dr Subhas Lawale, Principal, J.H. Govt. P.G. College, Betul (M.P.) for his constant support and valuable suggestions in this research work.We also express our gratitude towards Dr Abha Verma, H.O.D(Chemistry) for providing all research facilities in the Post Graduate Department of Chemistry.We are thankful municipality of Betul for their support.

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The effect of bed load on maximum scour depth at river confluence

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ABSTRACT

Local scour at river confluence is an important feature with a complex three-dimensional (3D) flow pattern. At this place, scour and sedimentation occur which can damage the surrounding area, change river morphology and can be harmful to navigation. In the past the effect of many variables which can affect the sedimentation pattern at river confluence has been studied. The main goal of this study is to experimentally investigate the effect of coming sediment from main channel on scour depth. To do so first a general non dimensional relation was developed, and then a sediment feeder was designed and calibrated. Afterwards, series of experimental tests were conducted in various hydraulic conditions and sediment discharge. The results indicate that increasing the amount of bed load, reducing the maximum scour depth ratio up to 35 percent. Also it was observed that bed scour and sedimentation patterns differs from the case of clear water. Finally, an equation was developed to predict the scour depth in terms of live bed. The accuracy of the new relation is within 90 percent. The sensitivity analysis of this equation shows that it is more sensitive to dens metric Froude number.

Key words *: Bed load, River confluence, Sediment feeder, Maximum scour depth.*

Introduction

River confluence is an important element of river system. Due to three dimensional flow structure at this place, especially due to the downstream mixing of flow, a deep scour hole is developed. The scour hole can cause change in river morphology which accelerate the rate of bank erosion. According to Best (1987) Six different zones exist at river confluence, including stagnation zone, flow deflection, separation, maximum velocity, flow recovery and shear layers between combining flows (Fig. 1). Flow separation at the left river bank just downstream of the river confluence, is the main cause for creation of horizontal vortex in this zone. Sediment can accumulate in the center of this zone and create a point bar. By increasing the flow velocity in zone 4, bank failure will accelerate at the right river bank and a meander is developed. The flow vortex and high flow velocity in this zone can also create problems for navigation. Because of this, the study of flow pattern, scour and sedimentation at river confluence has attracted the attention of many researchers.

Investigations were carried out to study the complicated junction flow characteristics, while only few works are available on river confluence scour. Few studies have been conducted the flow characteristics at river confluence such as Webber and Greated

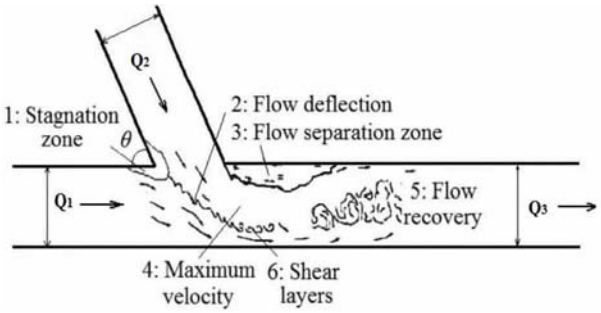

Fig. 1. Flow characteristics in river confluence (Best 1987)

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(1966); Modi *et al*. (1981); Best and Reid (1984); Ramamurthy *et al.* (1988); Gurram *et al*. (1997) and Weber *et al.* (2001). Also few studies have been conducted on the three dimensional mathematical models for simulating the flow at river confluence such as Bradbrook *et al.* (2001) and Huang *et al.* (2002).

Despite the extensive studies that have been done on the flow characteristics at river confluence; few studies have been conducted on sediment transport and scour at river confluence these are: Mosley (1976) conducted experimental tests for Y-shape river confluence in a small flume. His results showed that the scour hole increase very fast as river confluence angle increases from 15 to 75 degree then the rate of scour hole decreases. Roy and Roy (1988) conducted field measurement on 30 river confluences in a watershed basin. They found that in all these locations usually the flow area cross section downstream of river confluence decreases and the flow velocity increases. They found that the flow velocity in the scour hole can reach 1.6 times greater than the upstream flow velocity. Biron *et al*. (1993, 1996, 2002) studied the bed morphology of river confluence of unequal depth. During their study, they found that river bed morphology is changed even the scour hole dimensions remain constant. They found that river morphology in unequal channel depth is different than in river confluence of equal channel depth. Borghei and Nazari (2004) demonstrated with a 90° junction model that the scour depth increases with the discharge ratio of the tributary to the main branch and decreases with the sediment size and the tributary channel width. Ghobadian and Shafai Bejestan (2007) demonstrated the ratio of lateral flow discharge to the downstream main channel discharge is the most important parameter in river confluence studies which must be considered. Also they found that as the discharge ratio, densimetric Froude number and the confluence angle increases, the scour depth increases. They developed relation for predicting scour depth at river confluence. Shafai Bejestan and Hemmati (2008) demonstrated that bed discordance can reduce the scour as compared to the case of equal river bed level junction.

Despite the number of existing studies concerning the flow patterns and the morphology of river confluences at the clear water, additional knowledge is required on local scour under live bed conditions. Therefore it is the main purpose of this study to conduct experimental tests and to determine the effects of discharge ratio, dens metric Froude number and load sediment (live bed discharge) on the maximum scour depth at river confluence.

Materials and Methods

Dimensional analysis

In river confluence, many variables can affect the scour hole dimensions. To developed general relation for predicting these dimensions, the dimensional analysis was done. In the case of scour hole at river confluence it can be shown that the scour depth (D_s), depends on the total flow discharge (Q_3), the flow discharge in the main (Q_1) and in the lateral (Q_2) channel, the width of main and lateral channel (B_1 and B_2 respectively), the width of downstream confluence (B_3), the angle of river confluence (θ), the bed slop (S_o), the flow velocity and flow depth downstream of confluence (V_3 and Y_3 respectively), the bed material size (d_{50}), the bed elevation difference (ΔZ) and the load sediment or live bed discharge (Q_b) , one may consider the equation 1:

$$f\,(D_S, d_{50}, \rho_s, Q_b, Q_1, Q_2, Q_3, y_3, B_1, B_2, B_3, S_o, \theta, \sigma, \mu, g, \Delta Z) = 0 \quad (1)$$

In which ρ and μ are the flow density and viscosity respectively, σ is the surface tension force and g is the acceleration of gravity. Equation 1 can be written in the following non dimensional from using the Buckingham theory:

$$\frac{D_s}{B_3} = f\,(\frac{Q_2}{Q_3}, \frac{Q_b}{Q_1}, \frac{B_1}{B_2}, \frac{B_3}{d_{50}}, \frac{y_3}{d_{50}}, \theta, S_o, \frac{\rho_s}{\rho}, W_{e3}, \frac{\Delta Z}{B_2}, F_{g3}) \quad (2)$$

Study of Gurram *et al.* (1997) showed that bed slope has no significant effect on flow pattern under subcritical condition. For high Reynolds number and rough boundaries, Reynolds number also has no effect on the flow pattern. In this study B_1, B_2 and B_3 were kept constant, ΔZ and θ also were kept constant during this study equal to zero and 60° respectively. Therefore Eq. 2 is reduced to the following equation:

$$\frac{D_s}{B_3} = f_2(\frac{Q_2}{Q_3}, \frac{Q_b}{Q_1}, F_g) \quad (3)$$

Experimental setup

The experimental setup consist of a main flume (9 m

length, 25 cm width and 60 cm depth), a lateral flume (3m length, 25 cm width and 60 cm depth). At the upstream end of each flume a stilling box has been installed to reduce the kinetic energy of the entrance flow. Discharge was measured by the electronic flow meter with an accuracy of 0.01 L/s. a slide gate at the downstream of confluence controls the water surface in the main flume. Figure 2 shows the plan view of experimental setup.

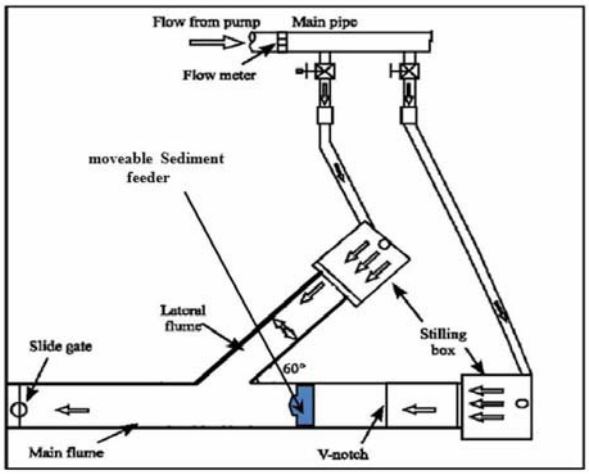

Fig. 2. Plan view of the experimental setup

Figure 3 shows the designed sediment feeder that consists of three general parts such as reservoir, base and valves. For increasing the accuracy and uniformity of sediment transportation the following actions was applied:

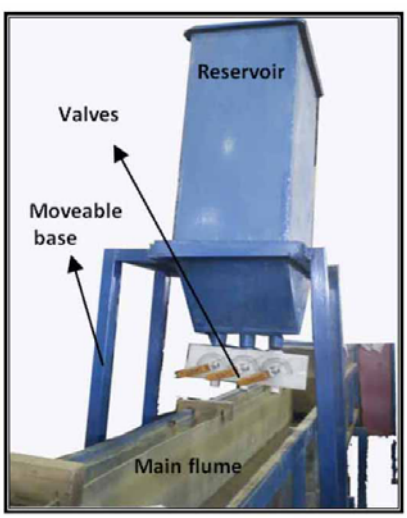

Fig. 3 Designed sediment feeder on the main flume

1. One of the problem associated with sediment feeder is the accumulation of some of the feeder sediment within the flume if its location has been selected reasonably. In order to minimize such sedimentation many trial tests were conducted for different hydraulic conditions and the place of sediment feeder upstream.

2. The height of sediment in the reservoir was kept constant during the tests in order to have constant sediment rate.

3. Before the experimental tests the sediment feeder was calibrated. This was done by gradually opening of the valves. Then the amount of sediment released was weighted for a period of time and the amount of sediment was plotted versus valve opening.

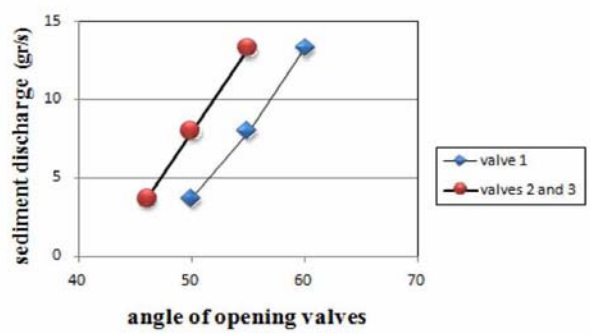

Fig. 4. Calibration curve.

Experimental procedure

In this study the size of sediment which was placed at the flume bed and sediment within the reservoir were selected in such a way as to ensure live bed condition during all tests. For this reason fine sand sediment with d_{50}=0.6 mm was used. Before the test began, the flume bed was covered with sediment then the pump was started and flow allowed entering the flume very slowly. During the filling of the flumes the slide gate was kept closed. When the flow depth in both flumes were high enough to assure that sediment will not move, the flow discharge gradually was increased in both flumes till it reached the desired flow discharge. At the same time the slide gate was opened gradually to reduce the tail water depth until it reaches to the desired flow depth. This situation was kept constant for almost one hour. After this time the pump was shut down and flumes were drained then the bed topography was measured by the laser meter with accuracy of 0.1 mm. in current study total of 54 tests

were conducted. The ranges of variables are shown in Table 1. As it was stated the main purpose of this study was to conduct experimental tests on live bed conditions. For this reason the downstream flow depth was lowered in such a case that the downstream densimetric Froude number was in the range of 5.04 to 8.22. This parameter in previous studies was lower than 5 because in those studies the clear water conditions exist.

Table 1. Range of variables in current study

Parameters	Variation
Discharge ratio (Q_r)	0.1, 0.2, 0.3
Load sediment ratio (Q_b/Q_1)	0 to 0.00065
Densimetric Froude number (F_g)	5.04, 5.78, 6.79, 8.22

Results and Disccusion

Variation of maximum scour depth with time

The results for 2 tests under clear water (Q_b/Q_1=0) and live bed conditions with constants Q_r=0.2 and F_g=8.22 are shown in Figure 5, indicating that the maximum scour depth generally increasing for both conditions with extension of time till the equilibrium time. However, after the equilibrium time the trend shows changes. Maximum scour depth after the equilibrium time under clear water condition is stable and under live bed condition shows a systematic fluctuation.

Scouring at live bed condition occurred when the load sediment coming from upstream. In this condition, bed shear stress should be larger than critical bed shear stress and the ratio of flow velocity to the incipient motion velocity should be larger than one.

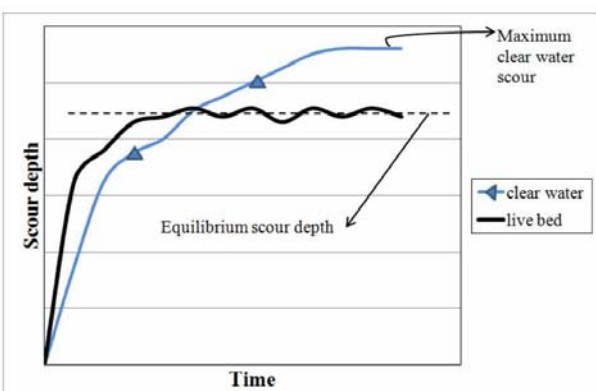

Fig. 5. Variation of maximum scour depth with time for clear water and live bed conditions

The maximum scour depth occurred when the flow velocity is equal to the incipient motion velocity. It is interesting to see that the equilibrium scour depth in live bed conditions can occur in much shorter time than in case of clear water. Usually in the clear water, the maximum scour depth can occur in longer period of time. In live bed, once the scour depth start to increase, the incoming sediment is trapped within the hole and settled for short time. Then the sediment will be washed away. These conditions can last for a long time without any significant changes in scour depth. Therefore for the case of live bed, some of the kinetic energy of flow is consumed to transport the trapped sediment out of the hole. In case of clear water all kinetic energy is consumed for transporting the initial bed sediment. This is why the scour depth in clear water is larger that in live bed condition.

The effect of discharge ratio (Q_r)

As it was found, the ratio of Q_2/Q_3 or Q_r has a significant affect on maximum scour depth. In the present study three different discharge ratios were studied. Figures 6 (a and b) shows variation of relative maximum scour depth (D_s/B_3) versus discharge ratio for two load sediment ratio such as Q_b/Q_1=0 and $0<Q_b/Q_1\leq 0.00017$. As it can be seen from these figures, as Q_r increases, the ratio of Ds/B_3 increases. This is because as Q_2 increase the separation zone dimensions increases pushing the main flow to the right bank, therefore the flow area in the main channel decreases and both flow velocity and bed shear stress increases. The trends had been illustrated above, holds true for all load sediment ratio such as $0.00017<Q_b/Q_1 \leq 0.0003$ and $Q_b/Q_1>0.0003$.

The effect of downstream densimetric Froude number (F_g)

Effect of densimetric Froude number of downstream on Ds/B_3 for two load sediment ratio such as Q_b/Q_1=0 and $0<Q_b/Q_1 \leq 0.00017$ are shown in figures 7(a and b). As it can be seen from these figures, as F_g increases, the ration of Ds/B_3 increases. This is because as F_g increases, the flow potential for transporting sediment and maximum velocity increases. The trends had been describe above, holds true for all load sediment ratio such as $0.00017<Q_b/Q_1\leq 0.0003$ and $Q_b/Q_1>0.0003$.

The effect of bed load ratio (Q_b/Q_1)

Figure 8(a, b and c) shows variation of relative maxi-

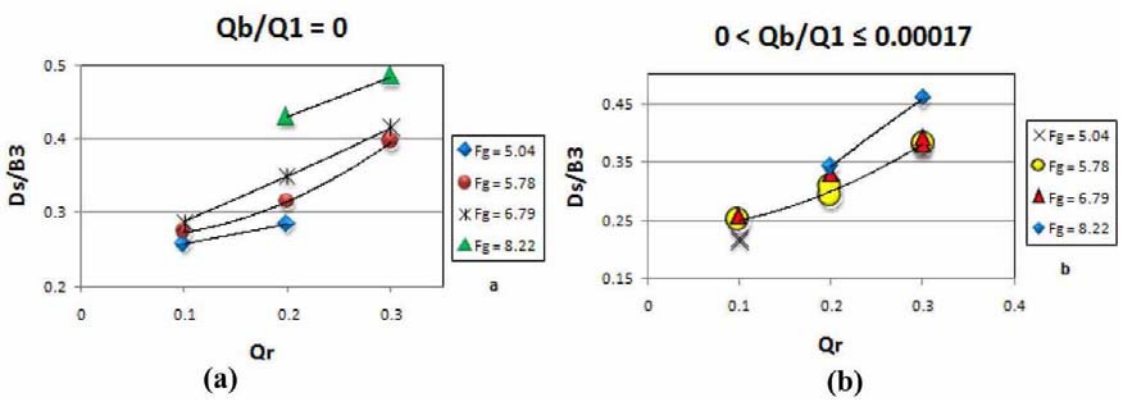

Fig. 6. Variation of relative maximum scour depth versus discharge ratio for a) $Q_b/Q_1=0$ b) $0<Q_b/Q_1\leq 0.00017$

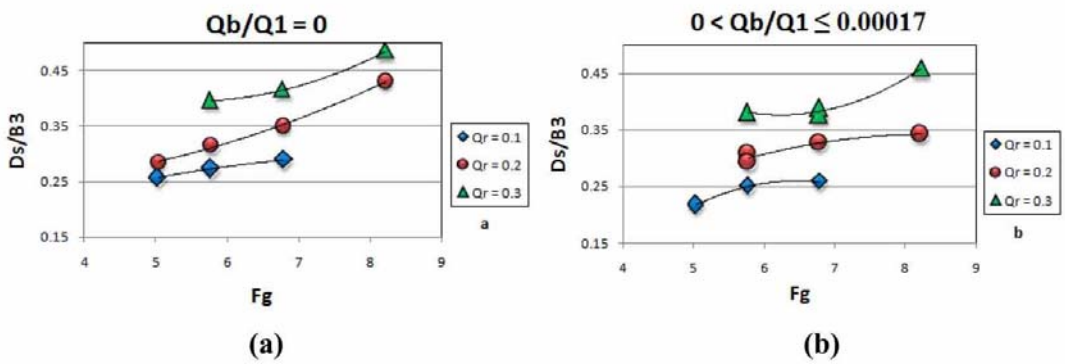

Fig. 7 variation of relative maximum scour depth versus densimetric Froude number for a) $Q_b/Q_1=0$ b) $0<Q_b/Q_1\leq 0.00017$

mum scour depth (D_s/B_3) versus bed load sediment ratio (Q_b/Q_1) for different densimetric Froude number and discharge ratio. The results indicating that the maximum scour depth generally decreases, as Q_b/Q_1 increases. Moreover the approximate maximum load sediment increases as Q_r decreases or F_g increases. This can be exemplified by constant Q_r=0.2 for densimetric Froude numbers such as 5.78, 6.79 and 8.22 which the approximate maximum load sediment is 0.00012, 0.00045 and 0.00053 respectively. Increasing the densimetric Froude numbers causes increasing the flow velocity and bed shear stress. So flow capacity of sediment transport is increases and it causes increasing the approximate maximum load sediment.

Table 2 shows the percentages of reduction in maximum scour depth ratio with and without bed load sediment for several densimetric Froude number such as 5.78, 6.79, 8.22 and constant Q_r=0.2. According to the above mentioned table the percentage of maximum scour depth decreased with increasing in load sediment as compare to the condition without load sediment. For instance, the value of D_s/B_3 for F_g=5.78 without load sediment equal to 0.315 and under load sediment condition by $Q_b/Q_1=7.4*10^{-5}$ equal to 0.308. It can be thus concluded that 2.4% reduction occurs in maximum scour depth ratio.

Accurate estimates of maximum flow capacity of sediment transport is not possible, but the attempt has been made the last injection is close to the maximum flow capacity of sediment transport. So regarding to the percentage reduction of maximum scour depth ratio at Table 2, this reduction shows the approximate range between zero to 35 percent. In other words, under the maximum load sediment condition that comes from upstream of main channel of river confluence, the maximum scour depth ratio reduces approximately to 35%.

Table 2. Comparison of maximum scour depth ratio with and without sediment load

F_g	$(Q_b/Q_1)*10^5$	D_s/B_3 Without transfusion	D_s/B_3 With transfusion	percentage reduction of maximum scour depth ratio
5.78	7.4	0.315	0.308	2.4
	12.1		0.292	7.3
6.79	9.4		0.327	6.6
	18.3	0.35	0.258	26.4
	29.4		0.242	30.8
	44.4		0.231	34.1
8.22	15		0.342	20.5
	22.5	0.431	0.335	22.3
	33.9		0.323	25
	53		0.308	28.6

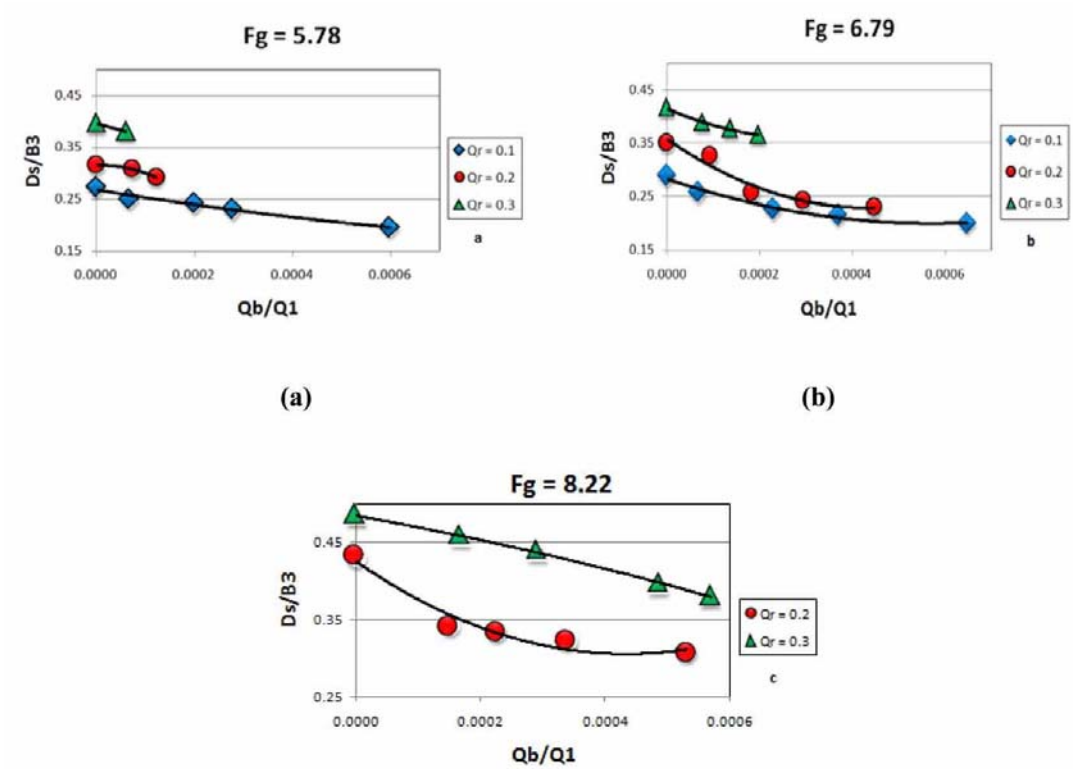

Fig. 8. Variation of relative maximum scour depth versus bed load ratio for a) Fg=5.78 b) Fg=6.79 c) Fg=8.22

Point bar height

The results and observation from the tests conducted in this study, indicate that point bar at the downstream of scour is not formed. This is in contrast with the conclusion has been stated by other investigators such as Ghobadian and Shafai Bejestan (2007). This can be attributing to the live bed condition which bed shear stress is larger than critical bed shear stress and the ratio of flow velocity to incipient motion velocity is also larger than one, which in this conditions the scoured material is transported by the flow and the washed sediment from the hole can not deposited just downstream of the hole to form a point bar. Therefore this is very important for navi-

gation and structures nearby river confluence that considering the live bed conditions and shows the importance of present study.

Maximum scour depth prediction

To develop a relation for predicting the maximum scour depth, the experimental data were applied. By analyzing these data by SPSS 18 software, the following equation is developed:

$$\frac{D_s}{B_3} = 0.06\left(\frac{Q_b}{Q_1}\right)^{-0.113}(F_g)^{0.696}(Q_r)^{0.413} \quad (4)$$

$$r^2 = 0.9$$

In which all variables have been defined previously. To investigate the accuracy of Eq. 4, measured values of relative scouring depth have drawn versus the predicted values and the results are presented in Fig. 9. As it can be seen from this figure, all of data are between the 90% confidence bands which mean that Eq. 4 can be applied for prediction of relative

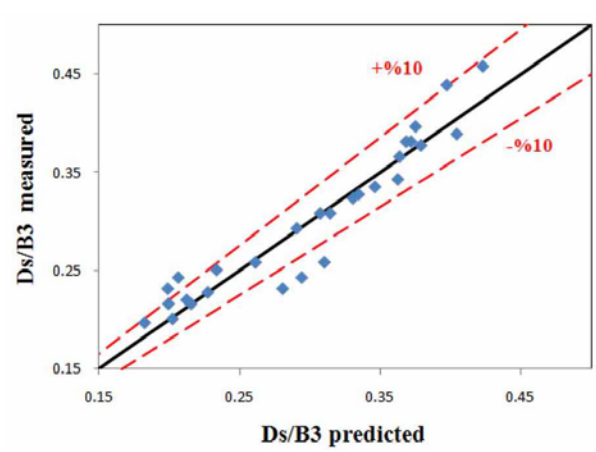

Fig. 9. Measured values of scouring versus predict values by Eq. 4

scouring depth in river confluence. The sensitive analysis of Eq. 4 shows that it is more sensitive to Densimetric Froude number.

Comparison the results to other investigators

Since we did not find any comprehensive study under live bed condition for the case of river confluence; the data for the case of clear water were compared with Ghobadian and Shafai Bejestan (2007). For this reason Figure 10 was plotted. Figure 10 shows variation of D_s/B_3 versus F_g (the most sensitive parameter). The sediment size and the

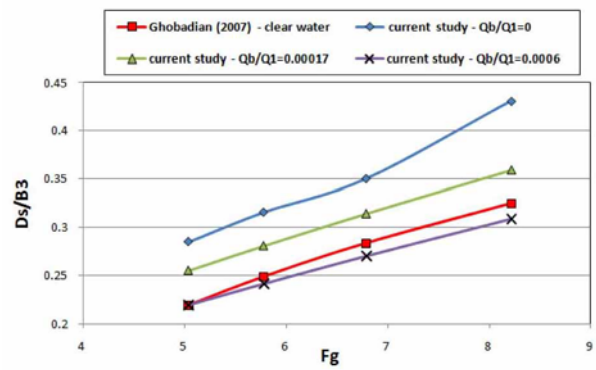

Fig. 10. Compare the results of this study with Ghobadian and Shafai Bejestan (2007)

confluence angle in Ghobadian and Shafai Bejestan (2007) were equal to d_{50}=1.05 mm and 90° respectively. The present data which were used for comparison were from those tests with d_{50}=0.6 mm for Q_b/Q_1 equal to 0, 0.00017 and 0.0006. Because of live bed condition in this study, in Q_b/Q_1=0 the maximum scour depth is higher. However, by increasing the value of Q_b/Q_1 in present study, the maximum scour depth is gradually decreases; the reason was explained earlier.

Conclusion

In this study, the important non dimensional variables are considered for local scour under live bed condition at river confluence such as discharge ratio, densimetric Froude number and bed load ratio. The analysis of experimental data shows that maximum scour depth has a direct proportional with discharge ratio and densimetric Froude number. However, it has an inversely proportional relationship with bed load ratio. The maximum scour depth under live bed conditions was found to be less than the scour depth at clear water conditions. For live bed conditions and no sediment coming from upstream, the scour depth is larger than the scour depth with bed load sediment. This is because in live bed conditions the point bar downstream of scour hole is not formed and sediment can easily escape from the scour hole. The results and observation from the tests show that as the amount of bed load increases, the maximum scour depth ratio is decreases up to 35 percent. Moreover, an equation is presented to predict the scour depth within 95% confidence and the sensitivity analysis of this equation shows that it is more sensitive to densimetric Froude number.

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Control of sediment entry to intake on a trapezoidal channel by submerged vane

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ABSTRACT

Construction of the intake structures to divert some portion of flow from a main channel causes variations of flow conditions at the intake entrance. Due such conditions the sediment can enter the intake. An effective measure to control the entry sediment is the use of submerged vanes. Most of previous studies in this regards have been conducted in a rectangular flume cross section. Since most of the main channels are in trapezoidal cross section and the effect of channel cross section on submerged vane criteria are not known, this study was conducted. In this study, four difference longitudinal distances equal to 4H, 6H, 8H and 10H between vanes were tested under four different flow conditions (Froude number equal to 0.45, 0.55, and 0.60 and 0.66). In all tests the flow discharge ratio was kept constant equal to 7.5 percent. The results of the study shows that submerged vanes can modify the flow patterns in front of intake in such a matter that entry sediment decreases up to 31%. Analyses of data also show that the entry sediment is minimum when the distance between vanes is equal to 8H.

Key words : *Lateral Intake, Trapezoidal Channel, Submerged Vanes, Intake ratio, Froude number.*

Introduction

Construction of the lateral intakes, for various applications, is one of the most primitive and inexpensive water diversion methods from rivers. The pattern of diverted flow is in a way that it causes sediment transport from rivers to the irrigation systems or power-generation installations. Neary and Odgaard (1993) have shown that in the vicinity of intake a three dimensional flow pattern as shown in Fig. 1 can be developed. All the water and sediment within the dividing-stream surface, which is shown in this figure, enters the intake. The width of the zone between the main channel bank and the dividing stream surface named "stream tube," increases from water surface to bottom. For this reason, a large portion of flow from the near-bed with more sediment concentration enters into the intake.

One of the sediment control measures at intakes is the use of the submerged vanes. The vanes' performance depends on many factors such as the ratio of the vane height to flow depth, longitudinal distances between vanes, vane angle to direction flow

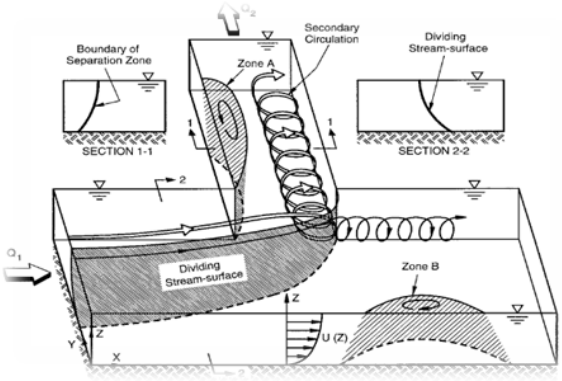

Fig. 1. Flow pattern in lateral intake [1]

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and distance from the first row of vanes to the bank.

During the several past decades, many researchers studied the different aspects of vanes' design for sediment control at intake e.g., Nakato *et al.*, 1984), Odgaard (2009), Wang *et al.*, (1996), Barkdoll *et al.*, (1995) Younesi *et al.*, (2003) Ho and With (2004), Tan *et al.*, (2005); and Karami Moghadam and Keshavarzi (2009).

The application of submerged vanes at intake was first reported by Nakato (1984) for shoaling control at Iowa generation Council Bluffs unit 3. The purpose of the vane installation for the above station was production a scour trench in front of the intake. Odgaard and Wang (1991), proposed the technology of submerged vanes with an angle 15-30° to flow direction and with a vanes' height above bed surface of 0.2-0.5 of flow depth. The distance between vanes and bank of the main channel was selected less than four times the vanes' height. Also the length of vanes was selected two to three times a vanes' height. Barkdoll (1999) investigated the limits and enhancements to vane use for sediment control at intake. The finding of experiments has shown that the sediment control performance of the vanes reduced when the ratio of unit discharge in the intake to the main channel, q_r, is about 0.2. The sediment entry was reduced about 40% by alone vanes for values of $q_r > 0.2$. Whereas the use of the vanes and skimming wall for $q_r > 0.3$ reduced the sediment entry by 60%. Karami Moghadam (2009) used a group of submerged vanes for sediment control at a rounded edge angle 55° intake with parallel and zigzag arrangements. The vanes' angle to flow direction was selected 10, 20, 30 and 40°. According to finding of experiments, the optimum vanes' angle to flow direction was found 30°, also the parallel arrangement was found as the best vane arrangements for the above intake. Most of the previous studies in this regard have been conducted in rectangular main channel cross sections whereas most of the main channel sections are in the shape of trapezoidal.

Therefore, this study was conducted in a trapezoidal flume. It was assumed that the flow pattern changes because the bank slope may affect the design dimensions of the vanes such as longitudinal distances as compared with the rectangular main channels.

Experimental

Flume: The experiments were conducted in the hydraulic laboratory of ShahidChamranUniversity, Ahwaz, Iran in a recirculation flume. The flume consisted of an 8.2 m long, as the semi trapezoidal main channel, with a 2.6 m long, 0.3 m high, as 60° intake channel located 4.13 m from the main channel inlet (Fig.2). The main Channel with a 0.2 m bottom wide consisted of two walls: the right wall with a 1 m high and sloping wall as the intake bank with a 1V:1.5H slope. The main and intake channels were made of Plexiglas. The main and intake channels were provided by one pump and withdrawn in two separate lines downstream from them. The flow rates were controlled with two sluice gates and measured by means of triangular weirs with vertex angles 53° and 90° located downstream from the end of main and intake channels, respectively.

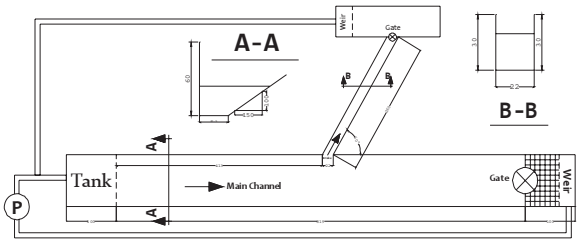

Fig. 2. Main channel and intake layout

Sediment: The bed of the main channel, 3.5m upstream to 1m downstream of the intake entrance was filled with a 0.1m deep layer of uniform sediment with a median grain size D_{50}= 1.59 mm. By paying attention to that grain size, the flow conditions must be determined based on two notions: simulation of rough bed conditions for eliminating viscosity effect and sediment movement just as bed load. For comparing with laboratory conditions, we conducted preliminary tests and it was observed that general movement of sediment, passing the intake entrance, occurred at the flow rate of the main channel equal to 0.0241 m^3/s. The mean velocity of flow in the main channel was 1.3 times that of required for incipient motion of sediment, estimated by Shafai Bejestan's equation. The time of each test, a 1 hour, was determined based on the time required for passing the first bed form the intake face at discharge of 0.0241 m^3/s. For all of the tests, the flow depth in the main channel, d, and the ratio of intake to main channel discharge, q_r, were kept constant of 0.12m and 7.5%, respectively. Also, the Froude number, Fr, in the main channel ranged from 0.45 to 0.66.

Vanes: The vanes for this study were made from galvanized steel. Six vanes were installed in one row at the in front of intake entrance. The vanes dimensions were calculated according the criteria provided by Odgaard and are equal to; 7cm height (3cm above the bed surface), 6cm long, 1mm thick, and aligned with $\alpha = 20°$ angle to flow direction. The specifications of the vanes, kept constant for all tests are summarized in Table 1. In this table H/d is the ratio of vane height above bed surface to flow depth, L is the vane length, and δ_b is the distance from the bank to vane.

Table 1. Vanes' specifications used in this study

Parameter	H/d	L	δ_b	α
Size	0.25	2H	1.5H	20°

δ_b in this study was determined. According to Odggard (2009)'s recommendation. This criterion reveals that the vanes should be installed at the boundary of dividing-stream surface. Which means δ_b should be equal to B_s in which Bs is the average width of stream tube formed between dividing stream surface and bank. For the case of main channel with rectangular section, Odgaard (2009) has provided the follow equation [11]:

$$\frac{Bs}{Tb} = qr(1)$$

Where T_b is the bottom width of the main channel and is equal to the width of the sediment surface. For the case of main channel with trapezoidal section, as in our study, in this paper, Karami Moghadam (2010) has developed the following equations for flow depth of 0.1 and 0.2 meter in his experimental tests:

$$\frac{Tb}{Tb} = \begin{cases} 1.26\ qr,\ d = 0.01m \\ 1.17\ qr,\ d = 0.2\ m \end{cases} \quad (2)$$

By interpolating the above equations for d= 0.12m and performing some initial tests, δ_b was obtained equal to 4.5cm (which is equal to1.5H). The longitudinal distances between vanes, δ_s, ranged from 4H to 10H.

A thin Plexiglas sheet, used as a supporter for vanes, was placed 4 cm below the bed surface at the intake face. The grooves with a 20° angle were created on a sheet to identify the vanes' placement for each longitudinal arrangement, (4-10) H. The vanes were pushed in the grooves and glued so they could not move in any direction or lifted due to drag forces exerted on them by the flowing water during the test.

Test procedures: Each test began by leveling the bed surface, closing up gates to avoid sediment movement before reaching the desired flow conditions by gradually opening the gate of the main channel. Then, the gate of intake was opened in a way that the flow depth, d, and discharge ratio, q_r, was simultaneously adjusted. After one hour, the flume was drained of water. Then, the accumulated sediment in the intake, g_i, and the sediment in the basket at the end of main channel, g_m, were collected, left to become dry and weighed for measuring the ratio of intake to flume transported sediment, g_r. The basket, trap, comprised a strainer mesh with hole of 1mm, smaller than D_{50}, to keep sediment and to pass water. The ratios of g_r computed by the following equation:

$$g_r = 100\left(\frac{g_i}{g_i + g_m}\right) \quad (2)$$

The results of these tests were evaluated based on the relationship between g_r and Fr, with and without vane presence. This study was conducted for four δs,equal to 4H, 6H, 8H, and 10H. Each distance was tested under four different Frs, equal to 0.45, 0.55, 0.60, and 0.66.

Results and discussion

Without vanes experiments: These experiments were carried out to evaluate the vanes'performance with different distances as compared with no vanes condition. Investigation of the Froude number effect from 0.45 to 0.66 on the ratio of g_r in the trapezoidal main channel was the other purpose of these experiments. The relationship between Fr and g_r is shown in Fig.3. It was observed that with increasing Fr from 0.45 to 0.55, the ratio of g_r increases, too. However, from 0.55 to 0.66, the ratio of g_r decreases.

Vane effect on sediment control: The concept behind vanes is that they generate vortex because of vertical pressure gradients on two vane sides. Combination of the vane induced circulation and flow velocity produce a helical motion or vortex downstream from the vanes [3], [12]. The vortex produces the transverse shear stresses at the bed river which makes sediment picked up from the vane suction

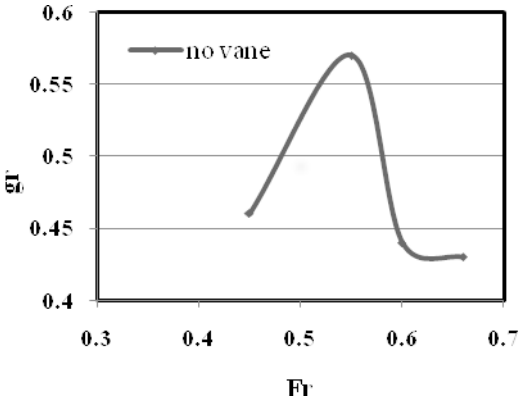

Fig. 3. Variation of gr with Fr for no vane conditions

side and deposited on the pressure side, forming a thalweg between vanes and bank consequently (Fig.4). The thalweg transports sediment to downstream from the intake entrance and decreases the ratio of g_r.

In this paper, the vane performance with different distances was consecutively evaluated based on the observation of the thalweg's changes, charge and discharge during the test. By charging the thalweg, sediment entry into the intake increases again.

Fig. 4. Vanes' function to form thalweg

Vanes' function with different distances: The specifications of transported sediment bed forms such as height and time migration, from downstream of the main channel to the vicinity of vanes or thalweg, dependon flow conditions. At the beginning of the experiment, the bed form moved with small height and low velocity. After a while, a bed form called "indicator bed form" here, approached the thalweg with higher velocity and height than previous bed forms. The importance of this bed form and the next ones were for their effects on the thalweg the. It was gradually filled by some of these bed forms. So, the rate of sediment entry into the intake intensified immediately. The time needed for the indicator to approach the thalweg at Froude number of 0.45, 0.55, 0.60, and 0.66 was 40, 25, 15, and 12 minutes, respectively.

Against, the vanes' function led to the thalweg restoration and sediment control at the intake. The time required that the thalweg was again formed by vanes, after each filling, for a Froude number and a distance between vanes differed from another. In other words, the thalweg changes during the experiment were the interaction of Froude number and vanes' function. It determined the trend of variation the ratio of g_r with Fr, for each distance, as compared with no vane tests. For example, in δ_s= 4H and δ_s= 6H, the required time at Fr=0.60 was longer than Fr=0.55. This matter is shown in Fig.5. The observation indicated that the thalweg of δs= 4H and δ_s= 6H were filled more times than δ_s= 8H, and formed again in the longer run. It may be due to the size of distance between vanes. In short distances, by overlapping the induced circulations, the vanes' performance for generating the induced shear stresses reduced and the ratio of g_r increased subsequently.

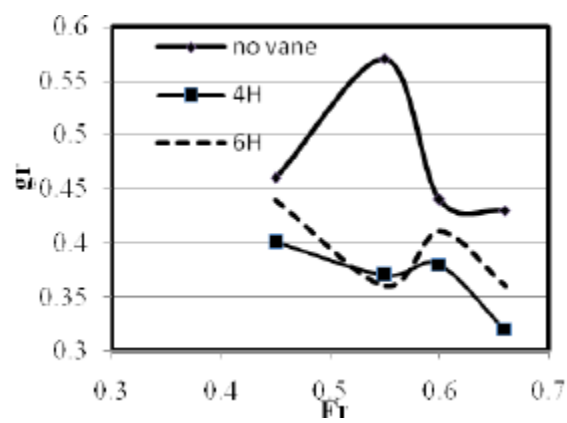

Fig. 5. Variation of growth Fr or δb = 4h, 6H

Also, based on the observations, least changes of thalweg during the test were occurred in δ_s= 8H (Fig.6). And, about δs= 10H, the thalweg had much lower depth than the thalweg formed in other distances. It entered more sediment into the intake for escaping sediment from the crest height of bed forms (Fig.6). The vanes' function in δs= 10H may be for weaker induced shear stresses because of longer distance.

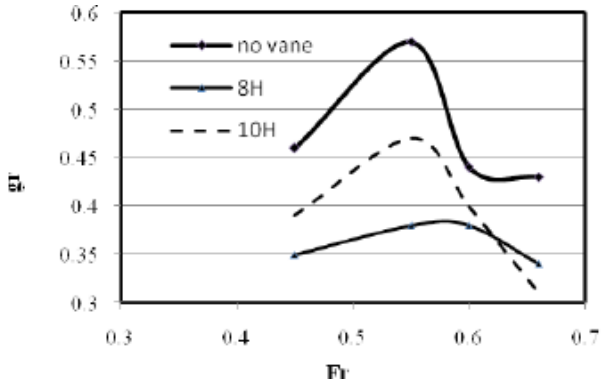

Fig. 6. Variation of growth Fr or δ_s= 8H, 10H

Comparison with an early study: The finding of a study conducted by Younesi (2003) have shown that in a rectangular main channel with a 60° intake, H=2.5cm, and Fr=0.7, the longitudinal distance of 4H results in the best performance in changing the thalweg [6]. But, according to the findings of the present study, δs= 8H was a suitable distance between vanes. This difference is due to the trapezoidal shape of the main channel.

Conclusion

In this study, experimental tests were conducted to investigate the vanes' performance with four distances for decreasing sediment entry into the intake. This paper presents observations and experimental results of the vanes' performance for different flow conditions in the trapezoidal main channel with a 60° intake.

By increasing the Froude number of 0.45-0.55 and 0.55-0.66, the ratio of g_r increased and decreased, respectively.

The vanes' presence with longitudinal distances equal to 4H, 6H, 8H, and 10H decreased g_r ,on the average 20%, 16%, 23%, and 17% ,respectively.

In similar flow conditions, the performance of vanes with äs= 8H in the trapezoidal channel with a 1:1.5 slop, is a suitable and economical distance.

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Experimental investigation of the effect of chute roughness height on energy dissipation

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ABSTRACT

In this study the effect of bed chute roughness height on energy dissipation has been investigated. To do so first general non dimensional relation was developed, then a series of experimental tests were conducted in a physical model using three different bed slopes (15, 22.5 and 30 degree) and three different uniform roughness heights (1.1, 1.43 and 2.1cm). Total of 48 tests were conducted with flow discharges ranged between 15 and 45 L/sec. The results show that in comparison with the smooth bed, nearly 12 to 48 percent of the energy is dissipated on roughened bed chute. The results prove that the maximum energy dissipation occurs for slope of 22.5 degree and the minimum energy is dissipated on 30 degree chute.

Key word *: Bed roughness, Chute, Energy dissipation, Hydraulic structures, Physical model*

Introduction

Control of energy in high-velocity flows is one of the challenges in the design of hydraulic structures. Such high speed flows occur, for example, at the spillway structures of dams, in the drainage systems of urban areas, and in steep mountain rivers. The excessive energy of these flows can cause serious damage to the surface of the structure itself and at the downstream end by scouring. Energy dissipaters for dam spillways include the conventional stilling basins and flip buckets. Another solution to dissipate energy as much as possible is to use stepped spillway chutes. The main features of a stepped spillway are its ease in construction and effective energy dissipation along the dam body. The number of these constructions has increased because of the recent development of Roller Compacted Concrete (RCC) dams. Many researchers in the field of energy dissipation in stepped spillway have been conducted (Horner and Esry, 1969; Sorensen, 1985; Rajaratnam, 1990; Peyras, *et al.*, 1992; Christodoulou, 1993; Chanson, 1994; Pegram *et al.*, 1999; Pagliara and Peruginelli, 2000; Yasuda, 2004 and Chinnarasri and Wongwises, 2006).

Another measure that can be applied for energy dissipation is placing obstacles (blocks) or roughness on the bed of chutes. Using the large dimensional blocks causes detachment of the water jets on the chute and turbulent flow, and then kinematic energy is decreased. The problem associated with the use blocks are cost construction and risk of cavitations. The use of continuously bed roughness on the Chute is another technique which might be more applicable in some cases. Chutes made of gabions are an example of roughened bed chutes which have been used. Therefore recently, these structures are considered because of the simplicity execution; economic and most important of all is that they are environmentally friendly. Previous studies on such structures have been more focused on the stability of the bed roughness. Therefore, few studies have been in relationship with the energy dissipation on such structures. Recently, many experimental investigations have been implemented on the stability bed materials and energy dissipation (Shafai-Bejestan

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and Kazemi, 2011). According to experimental studies conducted on the block ramps with different slopes (between 1V:4H and 1V:12H) and different bed materials (ranging from very coarse sand to small cobbles), the amount of energy loss of such structures was found to be a function of the relative submergence, the slope, and the ratio between the critical water depth and the length of the ramp. Furthermore, the result showed that the energy dissipation decreases with the slope of the ramp and from small scale roughness to large scale roughness. In order to evaluate the scale effects, runs were carried out in three different flumes: the first 0.25 m wide, the second 0.35 m, and the last one 0.8 m. They found that the relative energy dissipation $\theta E_1/E_0$ is a function of (k/d_{50}), (k/H) and the chute slope(S) and proposed the following relation:

$$\Delta E_{r1} = \frac{\Delta E_1}{E_0} = A + (1 - A)\exp(B_1 + C.S)\frac{k}{H} \quad (1)$$

Where θEr_1 is the relative energy loss between the beginning and the end of the ramp or $\theta E_1/E_0$ in which $\theta E_1 = E_0 - E_1$. The energy loss, E_0=1.5k+H is the total upstream specific energy, in which k=[(Q/b)2/g]0.33 is the critical depth, Q is the discharge and b is the ramp width, and H is the ramp height, $E_1 = h_1 + U_1 2/(2g)$ the specific energy at the ramp toe in which h_1 is the water depth at the ramp toe and U_1 is the approaching flow velocity, A, B_1, C are parameters depending on the scale roughness conditions of the ramp, S the ramp slope, and d_{50} is the average ramp material diameter[14].

This paper reports the results of an experimental study on the dissipation of energy due to the presence of roughness on the bed of chute.

Materials and Methods

Dimensional Analysis

The first step to develop a general relation is to select variables that have an influence on the energy loss of flow. These parameters are focused on the input parameters to keep the relation simple. The energy loss of flow on a roughness bed chute, ΔE, depends on the discharge per unit width of chute, q, the upstream flow head E_o, representative diameter of the material constituting the Chute, D_{50}, water dynamic viscosity, μ, , water density, ρ, the gravitational acceleration, g, and bed chute angle θ. These variables can be functionally expressed as;

$$f(q, \Delta E, E_0, D_{50}, \mu, \rho, g, \theta) = 0 \quad (2)$$

As the critical flow depth y_c in a rectangular channel can be expressed as $(q^2/g)^{1/3}$, using the Buckingham Pi theorem, the variables in Eq. (2) can be expressed in a non dimensional form as;

$$\Delta E_r = \frac{\Delta E}{E_0} = f(\frac{y_c}{D_{50}}, \text{Re}, \theta) \quad (3)$$

Where, The dimensionless term $\Delta E/E_0$=relative energy loss, y_c/D_{50}=relative critical flow depth, Re=Reynolds number, θ = bed slope angle. The Reynolds number in our study was much higher than 2000, thus the effect of the fluid viscosity is not important and therefore the Reynolds number can be deleted from the above equation. Therefore the relative energy dissipation ΔE_r can be expressed using the following explicit functional relationship:

$$\Delta E_r = \frac{\Delta E}{E_0} = f(\frac{y_c}{D_{50}}, \theta) \quad (4)$$

Experimental Details

The experimental tests were conducted at the hydraulic laboratory of Shahid Chamran University of Ahvaz. Runs were carried out for roughness bed chute with bed angle of 15, 22.5 and 30 degree using three different uniform roughness height 1.1, 1.43 and 2.1 cm (Fig. 1). The experimental flume is shown in Fig. 2, in which all dimensions are given in centimeters.

The Chute spillway was made of Plexiglas with

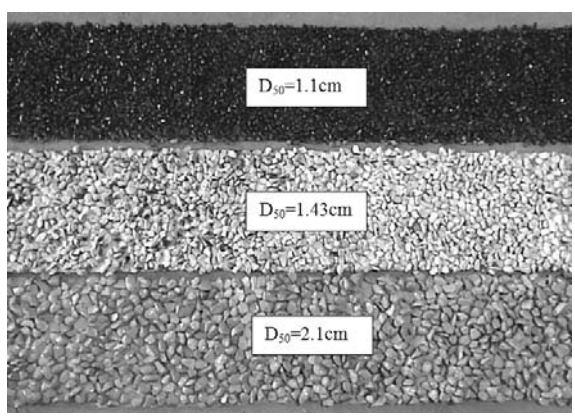

Fig. 1. Different sizes of bed Roughness

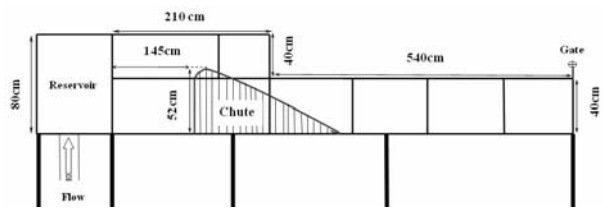

Fig. 2. Section view of the experimental flume

thickness 10 mm and then use of the angle bar and glue to avoid warping, over which the granular material was fixed. It was placed in a laboratory flume 7.5 m long and 0.3 m wide, and the height of the flume was 0.8 m for first section (2.1m) and 0.4m for second section (5.4m), which was connected upstream to a supply reservoir. The primary section of chute was connected to the spillway of the type of standard ogee. Glass walls on the two sides of the flume allow the flow conditions to be visible. According to Figure 3, to prevent the effect initial and terminal of roughness cover on the flow condition, the roughness cover continues of before ogee spillway to approximately 10 cm within the basin.

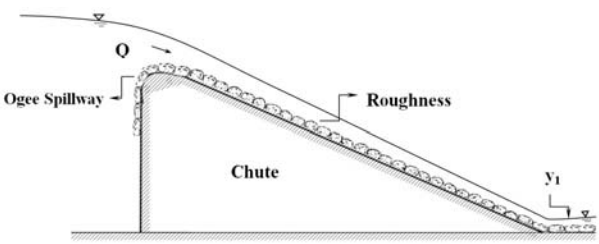

Fig. 3. Section view of the Chute

Beyond the toe of the Chute spillway, the flume had a bottom slope of zero, and there was no downstream control, so that supercritical flow was maintained without formation of a hydraulic jump. Total numbers of 48 tests were carried out, with discharges ranging between 15 L/s and 45 L/s. The measurement of discharge Q was performed by means of an electronic flow meter installed on the main supply line of the laboratory. In each run, the vertical water depth was measured at the upstream and downstream (toe of Chute)by means of a point gage mounted on an Iron frame so that it could be moved longitudinally and transversely over any point on the chute spillway. The gage was equipped with a vernire, readable to within 0.1 mm. However, minor irregularities of the water surface, due primarily to the influence of the side walls; render an overall accuracy on the order of 0.1 cm. The depth was recorded at three points across each flume (at W/4, W/2, 3W/4, where W is the flume width), and the arithmetic mean of the three values was considered as the vertical depth for the each point. The upstream water level was measured on the flume axis 0.6 m upstream of the crest. Based on the preceding

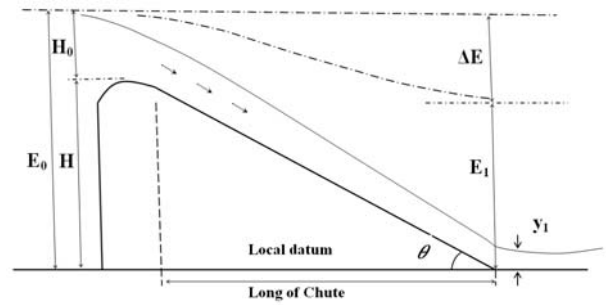

Fig. 4. Notation Sketch

measurements, the head loss was calculated as discussed in the following section. Referring to the notation shown in Fig. 4, the total head loss roughness bed Chute is expressed by:

$$\Delta E = E_0 - E_1 \quad (5)$$

Where E1 = $y_1 + (V_1^2/2g)$ = head on the downstream Chute spillway, $E_0 = y + (V^2/2g)$ = head upstream of the Chute spillway relative to the same datum, $V_1 = Q/(wy_1)$ = downstream velocity, and $V_0 = Q/(wy)$ = approach velocity. The velocity at the any section is calculated according to the continuity equation.

In this study tests were Conducted by fixing bed material Chute, Therefore the significant parameters of the tests carried out for roughness bed Chute are listed in Table 1.

Table 1. Range of Application of Experimental Tests

Range	Q(L/S)	D_{50} (cm)	θ (degree)	y_c/D_{50}	Re
Minimum	15	1.1	15	3	9804
Maximum	45	2.1	30	12	27305

Results and Discussion

To predict the head loss of the roughness bed Chute, experimental program was conducted. One type of Chute spillway with three slopes, were tested under

Tabel 2. Summary of the result (Chute with slope 15 degree)

θ=15	Q(L/S)	15	25	35	45
Roughness sizes	smooth	0.52	0.36	0.30	0.23
	1.1 cm	0.61	0.52	0.44	0.39
	1.43 cm	0.72	0.58	0.50	0.45
	2.1 cm	0.80	0.66	0.53	0.48

Tabel 3. Summary of the result (Chute with slope 22.5 degree)

θ=22.5	Q(L/S)	15	25	35	45
Roughness sizes	smooth	0.34	0.23	0.18	0.16
	1.1 cm	0.77	0.68	0.55	0.49
	1.43 cm	0.78	0.67	0.57	0.50
	2.1cm	0.82	0.69	0.59	0.53

Tabel 4. Summary of the result (Chute with slope 30 degree)

θ=30	Q(L/S)	15	25	45	35
	smooth	0.55	0.44	0.20	0.18
Roughness sizes	1.1 cm	0.70	0.56	0.55	0.45
	1.43 cm	0.72	0.58	0.58	0.48
	2.1 cm	0.80	0.59	0.59	0.49

different flow conditions and three uniform bed material sizes. Table 2 to 4 summarize the present experimental results for the slope 15, 22.5 and 30 degrees, respectively. According to Tables 2 to 4 differences energy dissipation between roughness and smooth bed Chute are evident for all slopes which have been investigated. The results obtained from these tests reveal that kinetic energy in smooth bed chute is generally larger than the other three types of roughened bed chutes.

As previously described, the amount of relative energy dissipation depends only on the parameter y_c / D_{50} and the slope S. Thus, in this section, the effects of these parameters on the energy loss have

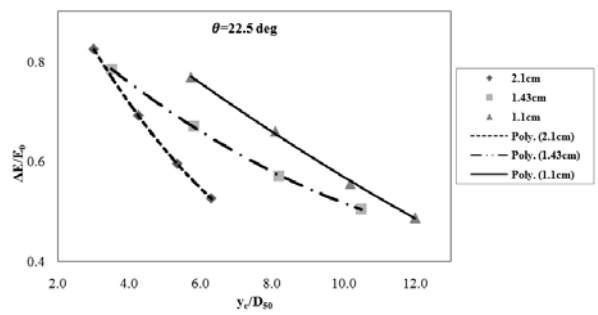

Fig. 6. Relative energy dissipation versus y_c / D_{50} for different scale roughness and Chute with slope 22.5 degree

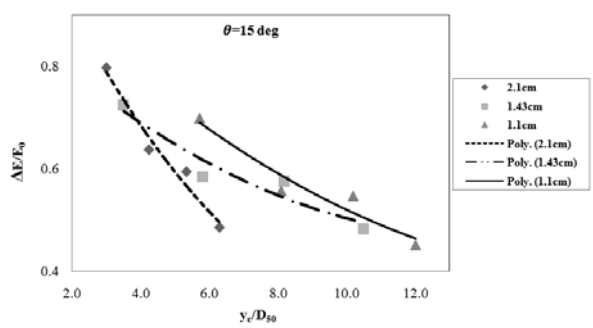

Fig. 5. Relative energy dissipation versus y_c / D_{50} for different scale roughness and Chute with slope 15 degree

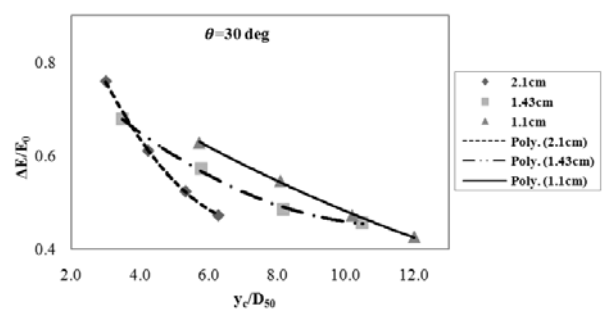

Fig. 7. Relative energy dissipation versus y_c / D_{50} for different scale roughness and Chute with slope 30 degree

been investigated. Figure 5 to 7 illustrate the dependence of $\Delta E/E_0$ on the parameter y_c/D_{50}. There is high energy dissipation for small y_c/D_{50}, due to the more pronounced effect of the small water depths relative to the roughness size. Clearly, a roughness bed Chute is most effective for energy dissipation when y_c/D_{50} is small or when the discharge is small. This means that at the same discharge values, the dissipation is directly proportional to the height of the roughness.

Figure 8 to 11 illustrates the dependence of $\Delta E/E_0$ on the parameter S (tangent of the bed slope angle). According to figure 8 the effect of the slope Chute in the control model (smooth bed Chute) is evident, since at any specific Q approximately the maximum relative energy dissipation occurs for slope of 15 degree and the minimum energy is dissipated on 22.5 degree chute. Furthermore, for a certain slope, the relative energy dissipation decreases with increasing discharge.

As shown in figure 9 to 11 the relative energy dissipation of the roughness bed Chute reduction with the increasing of the discharge. Furthermore, the effect of the slope Chute is evident, since at any specific discharge, the maximum relative energy dissipation occurs for slope of 22.5 degree and the minimum energy is dissipated on 30 degree Chute.

Conclusion

The present study aims to determine the energy dissipation caused by the presence of a roughness bed Chute. Tests were conducted on Chute with different bed slopes with 15, 22.5 and 30 degree and with different uniform bed materials with 1.1, 1.43 and 2.1cm. The effect due to the presence of roughness bed Chute has been compared with the smooth bed Chute. The results show that in comparison with the smooth bed, nearly 12 to 48 percent of the flow energy is dissipated on roughened bed chute. This is happened, because the energy dissipation is directly proportional to the height of bed roughness Chute. The relative energy dissipation increases with the reduction of the parameter y_c/D_{50}. Furthermore, experimental result indicated that the maximum energy dissipation occurs for slope of 22.5 degree (S=0.41) and the minimum energy is dissipated on 30 degree (S=0.58) chute.

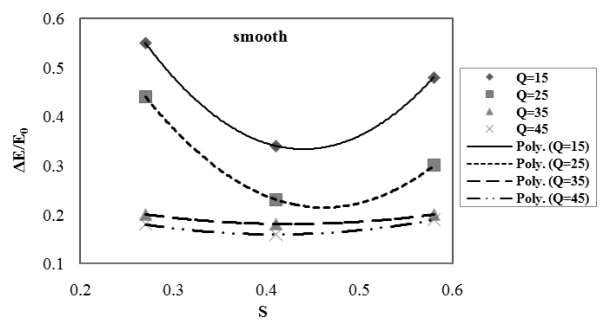

Fig. 8. Relative energy dissipation versus S (tangent of the bed slope angle) and smooth bed Chute

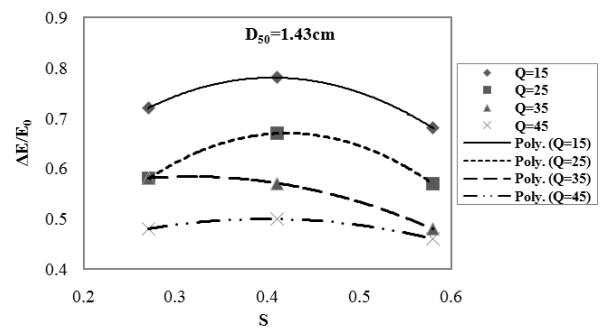

Fig. 10. Relative energy dissipation versus S (tangent of the bed slope angle) and roughness 1.43 cm

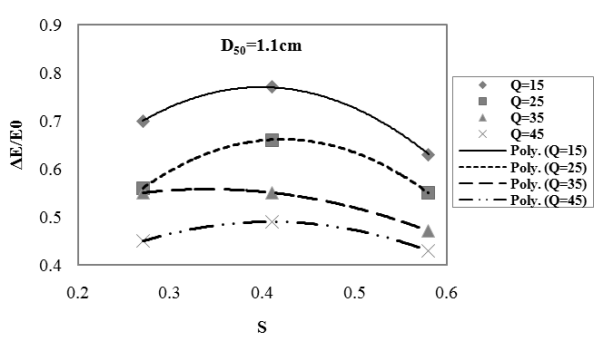

Fig. 9. Relative energy dissipation versus S (tangent of the bed slope angle) and roughness 1.1cm

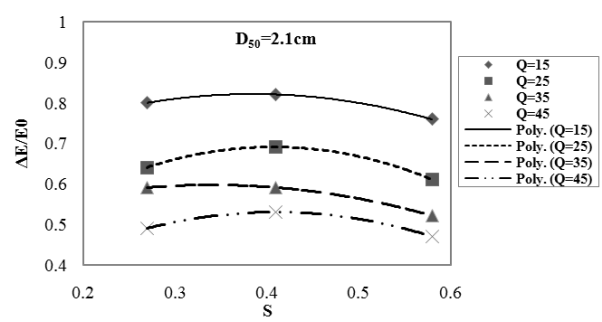

Fig. 11. Relative energy dissipation versus S (tangent of the bed slope angle) and roughness 2.1cm

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A countermeasure for scour reduction at bridge abutments

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ABSTRACT

During past few decades the cause of many bridge failures reported to be abutment scour. A great number of researches have been conducted to developed countermeasures for safety of the existing bridges. Submerged vane is a new technique which has been used for many practical river engineering works and in this paper the results of primary tests for the case of abutments are presented. Several tests were conducted with and without vane. Different location, number of vanes and vane angles were examined. The conclusion was that vane can effectively force the flow to separate from the abutment causing reduction of scour depth at the toe of abutment.

Key words : *Abutment, Scour, Vane, Bridge, River*

Introduction

Bridge abutments redirect the incoming flow and make disturbance in the river flow patterns. Such condition can cause erosion of bed material at the base of bridge abutments which can lead formation of scour hole and eventually failure of the bridge structure. During the past decades many studies have been conducted to understand the mechanism of this phenomenon and to find out the important hydraulic phenomenon associated with the scour (Laursen,1960; Gill,1972; Tey,1981; Frohlich,1989; Sturm and Janijua,1994; Melville, 1997; Melville and Coleman, 2000; Barbhuiya and Dey, 2004).

Developing techniques against scour at bridges has been the focus of few researches in the past decade. In general there are two methods of controlling scour in river engineering practice: (1) armor the river bed material around abutments to withstand shear stresses during high ?ow events; and (2) modify the approaching ?ow patterns to break up vortices and reduce velocities in the vicinity of the abutments. Design criteria for many of these techniques can be found in Hydraulic Engineering Circular (HEC)-23 (Lagasse et al. 1997).

Another technique is to have the main approaching streamlines away from the bridge abutments is the use of vanes. Vanes have been used for many years to control bank erosion. Submerged vanes are designed in order to modify the near-bed flow pattern and bed-sediment motion in transverse direction in the rivers. The vanes are installed vertically on the channel bed, at an angle of attack ?with the approaching flow (Odgaard and Mosconi, 1987). Rectangular plates are the most applied shape of the flow-training vanes because of their easy construction and field installation. Dimensions of the vanes (i.e. height and length) are determined based on water depth at design stage. The vanes initial height (Ho) is 0.2 - 0.4 times the flow depth. Their length (L) is 2.0 - 3.3 times the vanes initial height (Odgaard and Mosconi 1987), although the longer vanes are not economical. For the case of bridge abutment Johnson *et al.* (2001) conducted a series of experiments to investigate the effect of location, number and vane angle in reduction of scour at bridge abut-

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ment. The experiment was conducted in a compound channel. The abutment located at the flood plain and the vanes were tested installed in the main channel. Their conclusion was that the vane can effectively force the streamlines to separate from the channel bank at the vane, causing reduced velocities and shear stresses at the bank and increased velocities in the center of the channel. Thereby the abutment scour is moved away from the bank and abutment toward the center of the channel.

Since most of bridges are built in small and medium rivers with no flood plain and the abutments alter the main channel flow and yet no studies have been conducted to investigate the location and the number of vane in these cases, this study has been conducted.

Experimental set-up

In the present research, a laboratory recirculation flume has been used, 9.0 m in length, 1.0 m width, 0.6 m height, and constant slope of 0.0003, with side walls of transparent Plexiglas. The vanes were made of galvanizes sheets with thickness of 1 mm. A 2.0-m-long reach of the flume bottom was covered with sand of relative density 2.65 having median grain size D50 of 0.5 mm. The depth of the sediment bed layer of the test reach was fixed at 30 cm. Fig. 1 shows the plan view of the flume and the test section.

A centrifugal pump discharges 40 L/sec water from the ground reservoir into the stilling tank at the entrance of the flume. A tail gate is used to adjust the flow depth (Y) of water in the flume. The flow discharge is measured and adjusted by using a standard 53° triangular weir which was installed at the outlet system of flume. In this paper the results of ten experimental tests, one test without vane lasted for 12 hours to reach almost the equilibrium scour depth, and nine tests were conducted with vane in different locations and are presented. In these tests each experiment was run for 2 h. Although this length of time does not yield the maximum scour depth, it does provide approximately 83% of the maximum (see Fig.2). Because the main goal of the study was to determine any change in the scour pattern with different vane layout rather than the determination of the maximum scour depth, the 2-h time interval was chosen to be adequate time period. After the experiment was over, the scour and sedimentation pattern was measured in 2×2 mesh grids with the help of a laser distance meter that could be moved along rails fitted at the top of the flume.

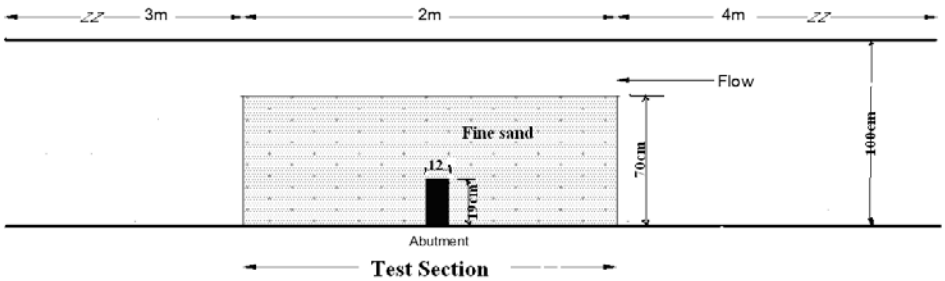


Fig. 1. Plan view of the experimental flume

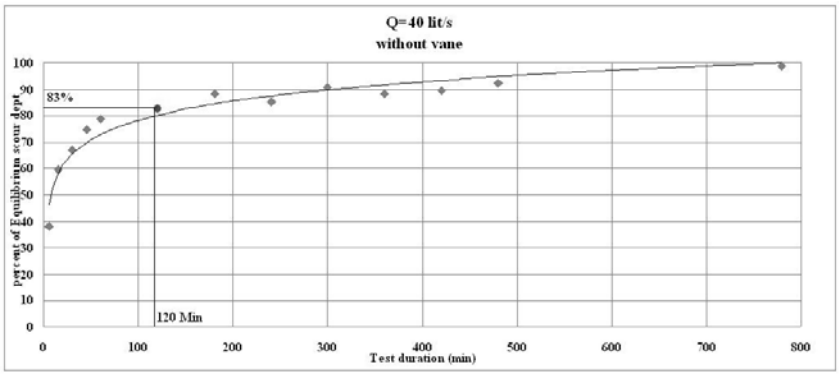
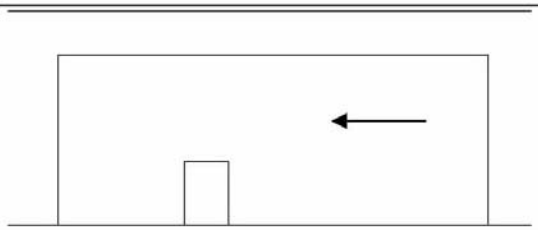
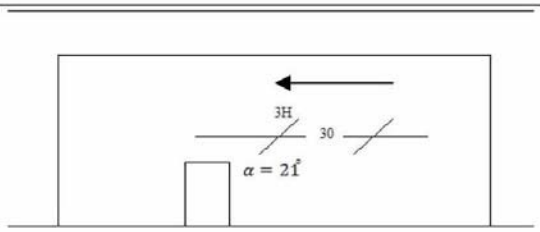
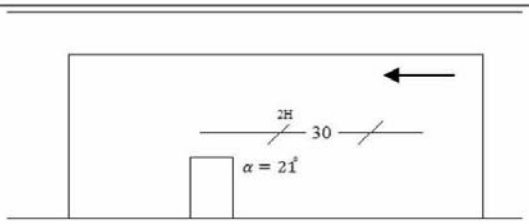
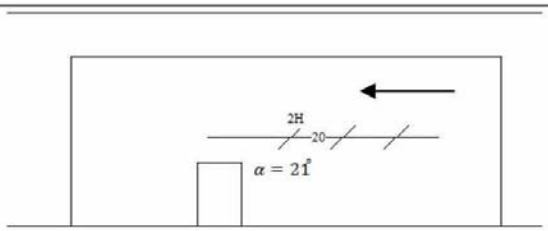
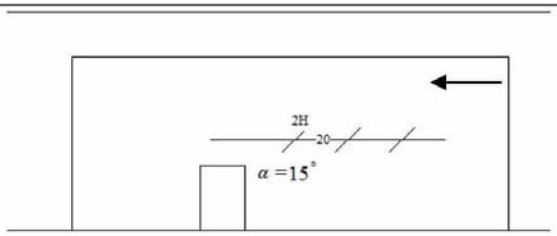


Fig. 2. Variation of scour depth versus time without vane

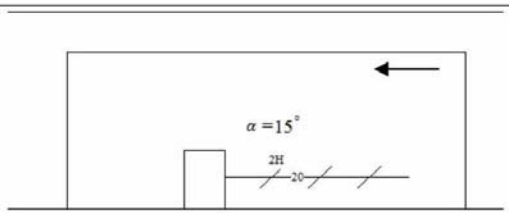
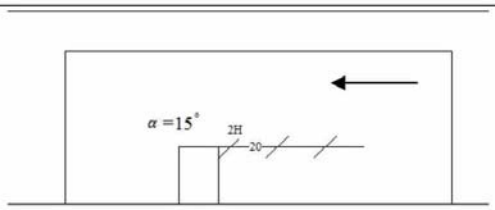
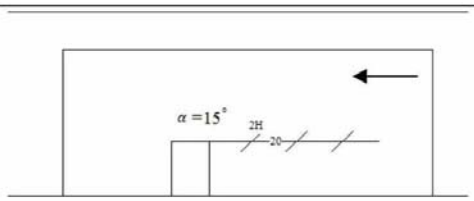
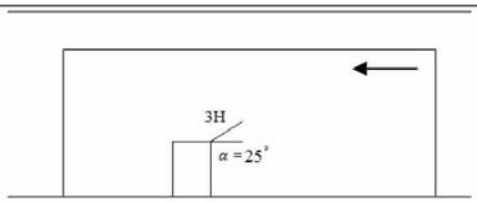
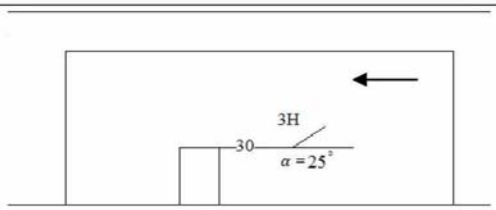
Table 1. Different location alternatives of vane installation

Test No.	Layout	Test Description	Results
1		Q=40 lit/sec Y=15 cm Fr=0.22 (Test without vane)	ds= 154.4 mm in 720 minutes ds =128.2mm in 120minutes
2		Q=40lit/sec Y=15cm Fr=0.22 N=2 H=5cm, L=15cm, Lb=30cm, Ls=30cm, Lf=10cm, =21degree	ds=113.2mm in 120minutes Pr=12%
3		Q=40lit/sec Y=15cm Fr=0.22 N=2 H=5cm, L=10cm, Lb=30cm, Ls=30cm, Lf=10cm, α=21degree	ds=113.8mm in 120minutes Pr=11%
4		Q=40lit/sec Y=15cm Fr=0.22 N=3 H=5cm, L=10cm, Lb=30cm, Ls=30cm, Lf=10cm, α=21degree	ds=114.6mm in 120minutes Pr=11%
5		Q=40lit/sec Y=15cm Fr=0.22 N=3 H=5cm, L=10cm, Lb=30cm, Ls=30cm, Lf=10cm,α=15degree	ds=109.5mm in 120minutes Pr=14%

Results

As was mentioned earlier, to reach the goal of this study and to find the performance of the vanes on controlling scour at abutment, a test conducted without vane for long duration of 12 hours when change in scour depth versus time was almost constant, see Fig. 2. To see the best location of vane, 9 other tests with different layout of vane installations was conducted. The flow conditions, geometric dimensions of vane, vane location, distance between vanes and angle of vanes are presented in Table (1).

In Table (1) Q=flow discharge, Y=flow depth, Fr=Froude number, N=number of vanes, H, L are the height and length of vane, Lb=distance from river bank, Ls=distance between vanes, Lf=distance

6		Q=40lit/sec Y=15cm Fr=0.22 N=3 H=5cm, L=10cm, Lb=10cm, Ls=30cm, Lf=10cm, α=15degree	ds=103.1mm in 120minutes Pr=20%
7		Q=40lit/sec Y=15cm Fr=0.22 N=3 H=5cm, L=10cm, Lb=30cm, Ls=30cm, Lf=0cm, α=15degree	ds=72.1mm in 120minutes Pr=44%
8		Q=40lit/sec Y=15cm Fr=0.22 N=3 H=5cm, L=10cm, Lb=19cm, Ls=30cm, Lf=10cm, α =21degree	ds=109.3mm in 120min Pr=15%
9		Q=40lit/sec Y=15cm Fr=0.22 N=1 H=5cm, L=15cm, Lb=30cm, Ls=0cm, Lf=0cm,α=25degree	ds=68.7mm in 120minutes Pr=46%
10		Q=40lit/sec Y=15cm Fr=0.22 N=2 H=5cm, L=15cm, Lb=25cm, Ls=30cm, Lf=0cm, α=25degree	ds=110.4mm in 120minutes Pr=14%

of the first vane from the abutment, ?=the vane angle (with river bank). ds=is the maximum scour depth at each test. Pr= is the percent reduction of scour depth compared to no vane test which was calculated from the following equation:

$$P_r = \frac{d_s(with..vane)}{d_s(without..vane)} \times 100$$

As it can be seen from the results, number of vanes has no effect on scour reduction. However the location and the angle play a significant role in reduction of scour hole. Maximum reduction occurs for test No.9 when the vane is installed at an angle of 25 degree attached to the upstream corner of abutment. In comparison with no vane test, for the same flow conditions, scour depth reduced about 46%. These results confirm that vane can shift away the main channel flow from the abutment and reduce the strength of vortices near the bed of abutment. It should be emphasized that by the use of vane the location of maximum scour depth is shifted away from the abutment. Fig.(3a)and Fig.(3b) show bed topography for the case of no-vane and test 0.9 with vane.

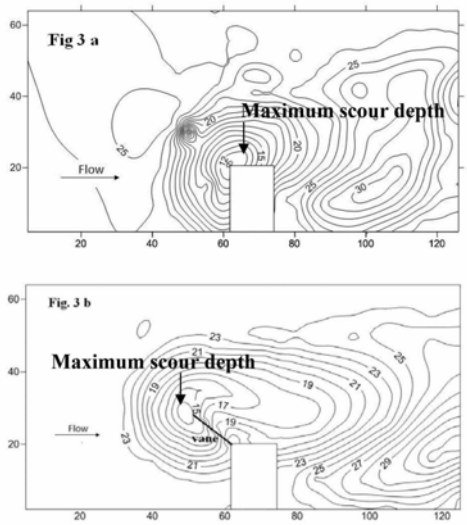


Fig. 3. Bed topography for (a)Without vane (b) With vane (test No.9)

Conclusion

This paper presents the results of tests conducted on vane as a countermeasure for reducing the abutment scour. In this paper several location and vane angle was tested and the scour depth compared with the case of no vane. The results indicate that vane can effectively force the flow to separate from the abutment causing reduction scour at abutment. It was found that vane number has no effect rather the vane location and its angle of attack play significant role. More tests should be conducted to clearly determine the optimum layout of the vane.

Acknowledgements

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Bed upward seepage effects on scour dimensions downstream of free falling jets

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ABSTRACT

Free falling jets occur in many river and dam site. Scour downstream of this structure can lead to failure of the structures. Over the past decades the effect of different variables on these phenomena has been studied, however the effect of upward seepage is not well known. In this paper the result of an experimental investigation on the characteristics of the scour hole downstream of a free falling jet with presence of upward seepage through the bed is presented. Experiments were run over beds of sediments (median sizes = 1.5, 2.4 and3.15 mm) under different flow discharge. The characteristic lengths of the scour hole determined from the scour profiles are: The horizontal distance of the location of maximum scour depth from the lower wall of weir XS, the point bar height h_d, and the horizontal distance of the point bar crest from the lower wall of weir XD.

Key words: *Scour, Free falling jets; Sediment transport, Hydraulics.*

Introduction

Free falling jet are a common hydraulic phenomenon in dam engineering to dissipate kinetic energy and in many river engineering practice such as river bed stabilization structures. Due to jet falling from above the river water surface, the kinetic energy of falling jet increases and penetrated into the downstream water; if the water depth is not enough, the high jet velocity reaches the bed material and causes erosion of this material. The removal of alluvial bed just downstream of the structure can lead the failure of the structure (Fig.1). Because of this local scour downstream of free falling jets, has attracted the attention of many researchers. A literature review and data analysis was carried out by Mason and Arumugam (1985) on the scour due to free falling jet and tested some formulae of scours using their experimental model and prototype data. Yuen (1987) proposed a relation for prediction of scour depth.

D' Agostino and Ferro (2004) applied the incomplete self-similarity (ISS) theory, proposed by Ferro (1997) and some available scour data downstream of free falling jets of Bormann and Julien (1991), Shafai Bajestan and Albertson (1991), D'Agostino (1994), and Mossa (1998) developed series of non-dimensional relationships describing the geometrical pattern of the scour profile including maximum scour depth, horizontal distance between the weir crest and the section of maximum scour depth, horizontal distance between the weir crest and the dune crest. For the maximum scour depth Guven and Gunal (2008) used neural networks for prediction of scour downstream of free falling jets. They concluded, performance of this method was superior to other regression- based equations. Scurtock et al. (2011) based upon laboratory data studied equilibrium scour downstream of three dimensional free falling jets. They compared their results with the well known relationship found within the literature and found that their expressions predict the scour dimensions more accurate.

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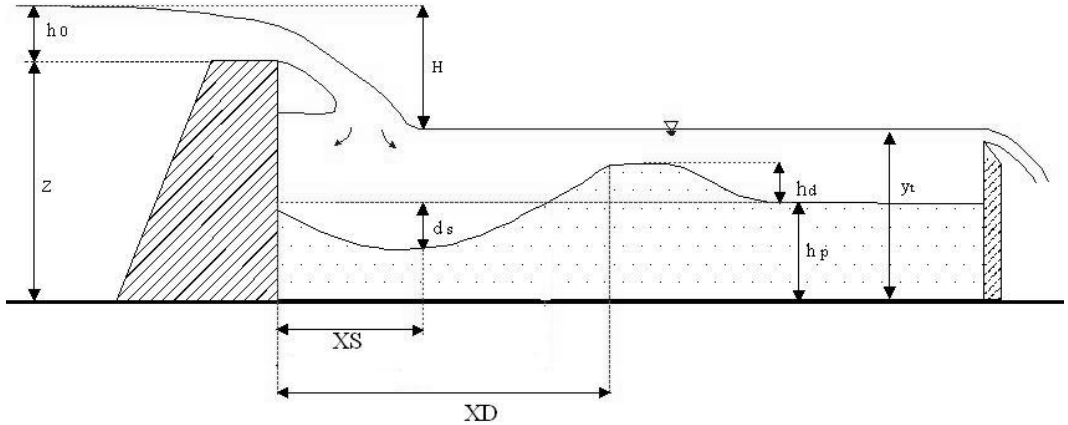

Fig. 1. Sketch of the scour of an alluvial bed downstream of a free falling jet

The effect of upward seepage which can exist on alluvial bed river because of difference between ground water table within the banks and river water surface has been subject of recent researchers. Sarker and Dey (2006) experimentally studied effect of upward seepage on the scour downstream of a horizontal apron due to submerged jets and showed that the characteristic lengths of the scour depth, such as maximum equilibrium scour depth, horizontal distance of maximum scour depth from the sluice gate, horizontal extension of scour hole from the sluice gate, dune height and horizontal distance of dune crest from the sluice, decrease with increase in seepage velocity. However in a recent study reported by Dey and Sarkar (2007) they found that all characteristic lengths of scour due to submerged jet increase when it is subjected to and upward seepage.

As has been mentioned over the past years, different studies have been conducted to investigate the effect of variables on scour hole dimensions downstream of free falling jets, however the effect of upward seepage, which is usually developed due to water surface difference between upstream and downstream of the structures or due to difference between banks water table and river water surface, has not been studied.

Experimental Set-up

Experiments were performed in a flume 0.88m wide, 0.80 m deep, 8.5 m long at the Hydraulic Department of Iranian Water Research Institute. The bed sediment in the sediment recess was 0.26m deep and 2m long. An arrangement was made to apply upward seepages from the bottom of the sediment recess through the sediment bed. The height of jet above the bed material was kept constant during the experimental tests. The rate of seepage flow was measured and controlled by a rectangular sharp weir and a valve, respectively. The valve remained closed in case of tests without seepage. The advantage of using this arrangement was that it provided a uniform distribution of the upward seepage flow.

Three uniformly graded sediments ($\sigma = \sqrt{\frac{d_{84}}{d_{16}}} \leq 1.3$) and median diameters d50 = 1.5, 2.4, 3.15 millimeters were used in the experiments (see Table 1).The flume side walls were made of glass to have visual access of the flow and sediment movement. The surface of weir and sidewalls were covered by plexi glass. The tail water depth yt was controlled by an adjustable tailgate at the downstream end of the flume. Water was fed to flume from a constant tank and pumped flow. In order to minimize undesirable water drops the weir without adequate tail water depth, the flume was first filled with water at a slow rate. Once the water level reached the desired depth, the experiments were started by adjusting the inflow to the required rate. The water surface profile was measured by two point gauge with a precision of 0.1 mm. The scour profiles were traced at regular time intervals. The time period to obtain equilibrium scour holes was about 6hr., when the scour profiles observed unchanged over a period of time.

Results and Discussion

The characteristic lengths of the scour hole are: The horizontal distance of the location of maximum

scour depth from the weir (XS); the horizontal distance of point bar crest from the weir (XD); the point bar height above the bed surface (hd) shown schematically in Fig. 1. In order to show the effect of upward seepage a new non-dimensional term (QQs) which is the ratio of upward seepage discharge (Qs) to the jet flow discharge (Q) is introduced in this paper. For the tests without upward seepage discharge, this term is zero. Few tests were conducted for upward seepage equal to jet flow discharge. Also to present the results of this study effectively all the characteristics length of scour hole obtained from series of tests with presence of upward seepage, were divided by the same characteristic length of the scour obtained from the tests without upward seepage. In this regard three non-dimensional parameter are defined which are: XXS= non-dimensional horizontal distance of the location of maximum scour depth from the weir; XXD= non-dimensional horizontal distance of point bar from the weir; and hhd= non-dimensional height of point bar above the bed. Fig. 2(a) presents the variation of non-dimensional distance of the location of maximum equilibrium scour length from the weir (XXS) versus QQS. As it can be seen the parameter XXS increase linearly as QQS increases.

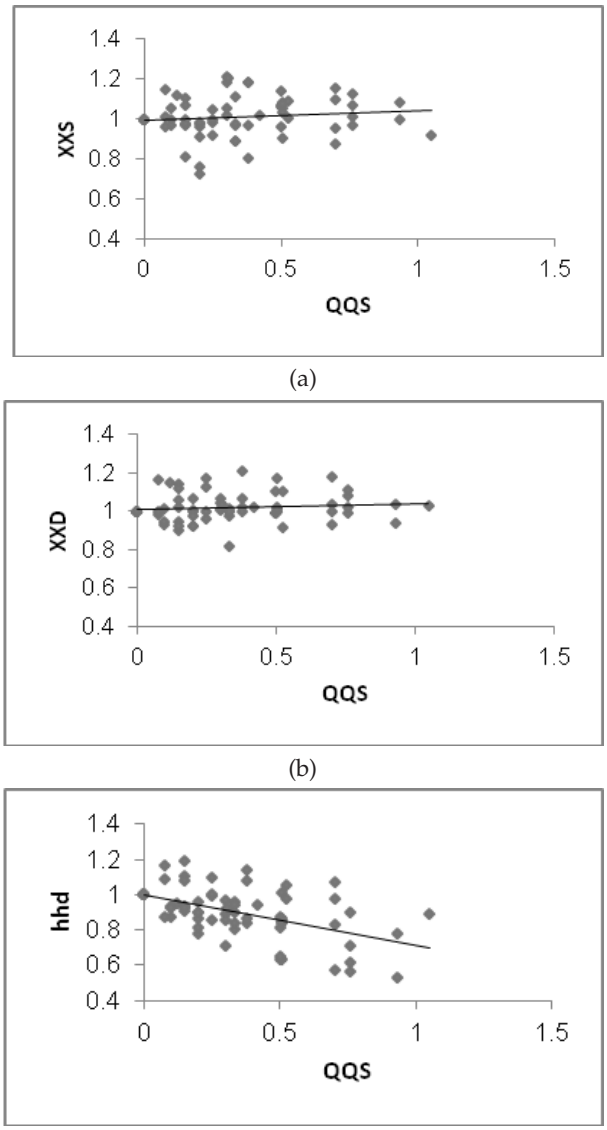

Fig. 2(a). Variation of XXS with QQS;(b) variation of XXD with QQS;(c) variation of hhd with QQS

A plot of the non-dimensional horizontal distance of the crest of the point bar form the weir(XXD) and plot of nondimensional dune height (hhd) versus the ratio of seepage discharge to jet flow discharge(QQS) are also plotted and are shown in Figs. 2 (b and c) respectively. As it can be seen from this figure XXD increases slightly with an increase in seepage discharge. On the other hand the height of point bar (hhd) decreases as the upward seepage increases. This is due to less bed material is washed away from the scour hole due to presence of upward seepage. One explanation for reduction of scour depth is reduction of the incoming jet flow velocity due to different direction of the upward seepage velocity and downward submerged velocity. This will cause a reduction of effective forces that acts on sediment particle and then necessary force for overcoming shear stress (for the initial movement of sediment particle) decrease in accordance with the magnitude of upward seepage velocity. Consequently, the submerged jet can remove less sediment particle from the scour hole in the presence of upward seepage. The presence of upward seepage in other location rather than the impinging point of jet will create upward seepage velocity which can reduce the incipient velocity of sediment. Thereby, sediment particle in a longer distance will be entrained by horizontal component of flow velocity of the flume. Consequently the horizontal dimensions of scour hole (XS and XD) increases with the presence of upward seepage.

Conclusion

Physical modeling of the local scour phenomena downstream of free falling jet was performed to explore the effected of upward seepage on scour di-

mensions in a large scale flume. The analysis and the comparison of experimental data have shown that upward seepage can effectively influence the scour dimensions and the effect of this parameter should be considered. The analysis of results show an increase in scour hole dimensions and slight decrease in point bar height.

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New species of microfungi from Vengalammacheruvu forest area of Puttaparthy Mandal, Anantapur District, A.P., India

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ABSTRACT

One new species of microfungi belonging to family Lasiophaeriaceae, Order-Sordariales namely *Tripterospora puttaparthii* sp. nov, from the Vengalammacheruvu forest area of Puttaparthy mandal, Anantapur District A.P. from South India is described.

The Genus *Tripterospora* was established by Cain (1956). Tripterospora has till date 12 species, namely *T. brevicaudata* Cain, *T. butleri* Pavigi and Ramadevi, *T. erostrata* (Griffths) cain, T. *indica* Pavigi and Ramadevi, *T. inermis* Cailleux, *T. latipes* N. Lundq, *T. leucotricha* (speg) N. Lundq, *T. longicaudata* (Cain) Arx, *T. spinosa* (cailleux), T. tetraspora Rai, Mukerji and Tewari, *T. utima* Cailleux, *T. verruculosa* Cailleux, T. tetraspora was described from India Rai, Mukerji, and Tewari (1963), Garg described *T. tetraspora* from marine saline soil.

During the course of studies on mycoflora of forest soils one new species of *Tripterospora* was isolated. The fungus occurs as a saprophyte in soils and the characteristic ascocarp cleistothecium is in clusters, the mycelium is superficial, hyaline to sub hyaline, composed of septate branched hyphae. The ascomatous of the present species differs distinctly from other species of *Tripterospora* in all the characters such as, the cleistothecium is 80-90 um in diameter, asci scattered numbering 18-21, it is 40-65 x 30-45 um in size, ascospore number is 6-9, 8 microns in length, ovoid to subglobose. Hence the species is described as a new species and is called as *Tripterospora puttaparthii* sp. nov. as it has not been recorded till date. The fungus identification was carried out using Nagamani *et al* (2006). The authors

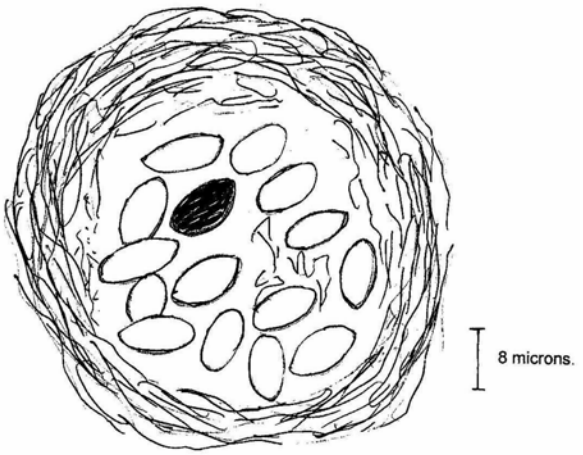

Fig. 1. Cleistothecium of *Tripterospora puttaparthii*. sp. nov.

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