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Weather based Agro indices and yield of direct seeded rice (*Oryza sativa*) as influenced by different dates of sowing and varieties in Union Territory of J&K, India

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ABSTRACT

Field experiments were conducted for three consecutive years from *kharif* 2018-20 at research field of Agro meteorology Section, Division of Agronomy, Skuast Jammu, to evaluate the effect of different sowing dates and Varieties of rice under direct sowing. The experiment was conducted in randomized block design with three dates of sowing '1st June', '16th June' and '30th June' and three rice varieties 'Pusa 1121', 'Basmati-370' and 'SRJ -129' during all the three *kharif* seasons. The pooled results of three year study revealed that amongst the different sowing dates, significantly highest plant height, grain and straw yield of rice were recorded with '1st June' sowing date and highest heat units, *i.e* accumulated GDD, Heliothermal units and photo thermal units to complete different phenophases were recorded with early sowing '1st June' date followed by timely sowing '16th June' and late sowing '30th June' where as among the different varieties significantly highest plant height, grain and straw yield of rice were recorded with 'Basmati-370' where as significantly lowest growth and yield parameters were recorded with variety 'Pusa 1121'. 'SRJ -129' was significantly different from other two varieties and highest heat units, i.e accumulated GDD, Heliothermal units and photo thermal units to complete different phenophases were recorded with Variety 'Basmati-370' followed by Pusa-1121 and SRJ-129 under different irrigated conditions of Union territory of Jammu and Kashmir .

Key words: *Growing degree days, Helio thermal Units, Photo thermal Units, Varieties, Yield*

Introduction

Rice is one of the major staple food crops of more than half of the global population and plays a very important role in food security. About 509.87 million metric tons of rice was consumed worldwide and India contributes 21.6 % of rice production in the world. In India, rice is grown in an area of 45.07 million hectare with production and productivity of 122.27 million and 27.13kg per hectare (Anonymous 2020-21a). In Union territory of Jammu and Kashmir, rice was grown on area of 267.58 thousand hectare with production and productivity of 5816 thousand quintals and 21.74 quintals per hectare, respectively (Anonymous 2020-21b). Planting time is one of the main factors that regulate the productivity of rice. Optimum planting time for a crop is location specific. Earliest planting of rice is preferable because of utilization of the entire growing season and thereby allowing greater profit margin. The most common method of planting rice in Jammu and Kashmir UT is through transplanting nursery which is more time consuming, laborious and is costly. Therefore, this method can be replaced by direct seeding. Direct seeding of rice is a method in which rice seeds are directly sown in the experimental field instead of transplanting seedlings from the nursery. In direct seeding of rice (DSR) rice was sown in unpuddled conditions in well pulverized soil which is the most reliable option to the farmers for efficient water saving and is cost and labor effective. Growth and development of crops are known to be influenced by multiple factors and amongst them selection of cultivars for a given set of environments is one of the major aspects besides soil fertility, temperature regimes, solar radiations, irrigation etc. and play a very important role in exploiting good crop growth and development. Several varieties of different yield potentials, quality and of varying maturity groups of different crops developed and released on the basis of different agro climatic conditions are tested for cultivation to assess their performance under varied environmental situations (Banotra *et al.,* 2021). Growing degree days is the most common temperature index used to estimate plant development (Qadir *et al.*, 2006). GDD can also be used to assess the suitability of a region for production of particular crop, also estimates the growth stages and heat stress on the crop. The Phenology development and crop yield are influenced by both temperature and photoperiod. Therefore, it is better to calculate Photo thermal unit (PTU) and Helio thermal unit HTU in addition to GDD. Prevailing weather and climatic conditions greatly influence the agricultural productivity of the crop. Crop yield of a particular area depends on its climatic conditions, temperature, sunshine hours, light intensity and radiation. Rice development depends on temperature and light and it requires a specific amount of heat to switch over from one growth stage in their lifecycle to another, such as from seeding to the harvest stage. Temperature plays a very important role for the biological processes and hence the growth and development of plants. Various forms of temperature summations, commonly referred to as thermal units or growing degree days, have been utilized to predict phenological events for different crops.

Materials and Methods

The field experiment was conducted for consecutive three years from *kharif* 2018-2020 at Research field of Agrometerology section of Skuast-Jammu to evaluate the effect of different planting dates and varieties on growth and yield of rice (*Oryza Sativa*) in irrigated Subtropical conditions of J&K. The soil of the experimental field was sandy clay loam in texture, with low in organic C and available nitrogen but medium in available phosphorus and available potassium with pH 7.31.The experiment was conducted in randomized block design with three replications. The treatments comprised of three planting dates (1^{st} June, 16^{th} June and 1^{st} July) and three rice varieties 'Pusa 1121', 'Basmati-370' and 'SRJ -129'. All the three varieties were sown by direct seeding on 1^{st} June, 16^{th} June and 1^{st} July during *kharif* 2018, *kharif* 2019 and *kharif* 2020. Rice varieties were sown at specified row to row distance of 20 cm and plant to plant distance of 10 cm**.** The plot size remains same 4.0 m ×3.6 m for all the three years. The recommended dose of nitrogen (45 kg/ha), phosphorus (30 kg/ha), potassium (15 kg/ha) were applied for variety 'Pusa 1121' where as for variety 'Basmati-370' and 'SRJ -129' the recommended dose of nitrogen (30 kg/ha), phosphorus (20 kg/ha), potassium (10 kg/ha) in the form of Urea, Diammounium phosphate and murate of potash. Full dose of Phosphorus and potassium were applied as basal in all the treatments .Half dose of nitrogen was applied as basal dose at the time of sowing whereas remaining half nitrogen was applied in two equal splits at 45 DAS and panicle initiation stage . The plant height, grain yield and straw yield were calculated by using standard formula during three years. The data on crop Phenology was taken by visual observations and the crop yield was recorded at maturity. Growing degree days (GDD) were determined as per the formula given below:

$$\mathbf{GDD = T_{mean} - T_{base}}$$

Where,

$\mathbf{T_{mean}}$ = Mean of maximum and maximum temperature (^{0}C) during a day.

$\mathbf{T_{base}}$ = Base temperature (10^{0}C).

The Photo thermal unit (PTU) was computed by taking the product of GDD and day length. The Helio thermal (HTU) were computed by taking the product of GDD and corresponding actual sunshine hours for that day. The data recorded for various characters were subjected to statistical analysis according to procedure outlined by Cochran and Cox (1963). All the comparisons were worked out at 5 per cent level of significance during three years.

Results and Discussion

Growth and Yield : Result of pooled data of plant height (cm) of rice presented in Table 1 revealed that plant height at harvest of rice was significantly influenced by different sowing dates and different varieties of rice during all the three growing season by direct seeding. Among the three planting dates, significantly highest plant height at harvest (136.45 cm) was recorded with (early sown) 1st June sowing date whereas significantly lowest plant height at harvest was recorded with (late sown) 1st July sowing dates. 16th June (Mid sown) sowing date was found significantly different from 1st June and 1st July sowing date in plant height (126.91 cm) during all the three crop growing season. It was might be due to the reason that late sowing (1st July) had shorter growing period due to photoperiodic response whereas (1st June sowing date had longer growing season which produced taller plants and had lesser dry matter accumulation as compared to other planting dates. Similar, results were also reported by Bashir *et al.*, (2010). Among the different rice varieties significantly highest pooled plant height of rice (158.48 cm) at harvest was recorded with variety 'Basmati-370' whereas significantly minimum plant height at harvest was recorded with variety 'SRJ -129' whereas variety 'Pusa-1121' was found significantly different from other two varieties in plant height . This was might be due to reason of different genotypes of rice varieties which may be responsible for the difference in growth characters. These results were in line with the findings of Thomas and Lal (2012). Grain yield is the function of integrated effect of all individual yield components and interaction between the genetic makeup and plant environment during the growing period (Banotra *et al.*, 2021). Yield parameters viz. grain yield and straw yield of rice were significantly influenced by different planting dates and rice varieties. Among the different planting dates significantly highest grain yield (28.42 qha^{-1}) and straw yield (76.56 qha^{-1}) of rice was recorded with 1st June sowing date whereas significantly lowest grain yield (21.82 qha^{-1}) and straw yield (65.89 qha^{-1}) of rice was recorded with 1st July sowing date. Among the different rice varieties, significantly highest grain yield (29.72 qha^{-1}) and lowest straw yield and of rice was recorded with variety 'SRJ-129' whereas significantly lowest grain yield (21.08 qha^{-1}) and highest straw yield of rice were recorded with variety basmati-370. Variety Pusa-1121 was found significantly different from other two varieties in yield during three years.

Table 1. Growth and yield of rice in direct seeded rice as influenced by different dates of sowing and varieties (Pooled data of 3 years)

Treatments	Plant height (cm)	Grain yield (q ha^{-1})	Straw yield (qha^{-1})
Sowing dates			
D_1 - 1st June	136.45	28.42	76.56
D_2 –16th June	126.91	25.13	71.89
D_3 -1st July	116.62	21.82	65.89
CD (5%)	1.93	1.40	5.13
Varieties			
V_1 - Pusa-1121	116.15	24.57	72.22
V_2 - Basmati-370	158.48	21.08	80.63
V_3 - SRJ-129	105.15	29.72	61.45
CD (5%)	1.93	1.40	5.13

Weather based Agro indices

Accumulated Growing degree days: The accumulated growing degree days or heat unit concept or thermal unit concept was developed assuming that there is a direct and linear relationship between crop growth and temperature. The GDD accumulated by different rice varieties sown under different planting dates under direct seeded rice were calculated and presented in Table 2. The pooled results of three year study revealed that highest accumulated GDD (2679^{0}C) by rice crop were recorded by early sown direct seeded rice (1st June) where as lowest accumulated GDD (2293^{0}C) were observed in late sown direct seeded rice (30th June) where as 2468^{0}C accumulated GDD were recorded in (16th June) sowing date while attaining physiological maturity. The early direct sown rice crop (D_1) accumulated more thermal time to attain different phenological stages *viz.*, germination, tillering, jointing, panicle emergence, flowering, milking, hard dough and physiological maturity in comparison to 16th June (D_2) and 30th June (D_3) sown crop. The accumulated growing degree days (GDD) by D_2 and D_3 were 7.87 percent and 14.40 percent lower than that of accumulated GDD by D_1 for attaining physiological maturity. In different rice varieties, highest number of accumulated growing degree days (2577^{0}C) were recorded with Variety "Basmati-370" followed by variety "Pusa-1121" with accumulated growing degree days (2530⁰C) whereas lowest number of accumulated growing degree days (2441⁰C) were recorded with rice variety "SRJ-129". The difference between maximum and minimum accumulated growing degree days values were 89⁰C. Basmati rice accumulated 1.82 percent and 5.28 percent more growing degree days than variety "Pusa-1121" and "SRJ-129".

Accumulated Heliothermal Units: Rice crop needs a certain amount of thermal time to enter its next crop stage and this explains the direct impact of temperature on crop growth. In order to find out the effect of day length and bright sunshine hours on growth of different rice varieties under different sowing dates were computed were expressed as accumulated Heliothermal units and are presented in Table 2. Among the different sowing dates in rice, highest accumulated Heliothermal units (17363 ⁰C days hours) from sowing to physiological maturity were recorded with early 1st June sowing date under direct sown method where as lowest (14066⁰C days hours) accumulated Heliothermal units were recorded with 30th June sowing date. 16th June sowing dates with accumulated Heliothermal units (15531⁰C days hours) was found intermediate between other two dates to complete the life cycle.

Table 2. Weather based Agro indices in direct seeded rice as influenced by different dates of sowing and varieties (Pooled data of 3 years)

Phenology Treatments		Germination P_1	Tillering P_2	Jointing P_3	Panicle Emergence P_4	Flowering P_5	Milking P_6	Hard dough P_7	Physiological Maturity P_8
Accumulated Growing degree days									
Sowing dates									
D_1	(1st June)	154	755	1372	2083	2213	2360	2518	2679
D_2	(16th June)	145	622	1203	1907	2037	2184	2319	2468
D_3	(30th June)	125	569	1174	1756	1894	2036	2174	2293
	Mean	141	649	1249	1915	2048	2193	2337	2480
Varieties									
V_1	(Pusa- 1121)	142	645	1258	2020	2139	2281	2411	2530
V_2	(Basmati 370)	151	651	1254	2036	2169	2306	2444	2577
V_3	(SJR129)	143	601	1166	1589	1738	1893	2048	2217
	Mean	146	632	1226	1881	2015	2160	2301	2441
Accumulated Helio thermal heat units									
Sowing dates									
D_1	(1st June)	1127	5174	8565	12683	13958	15059	16199	17363
D_2	(16th June)	898	3894	6953	11571	12469	13571	14632	15531
D_3	(30th June)	902	3162	6425	10362	11411	12417	13392	14066
	Mean	976	4076	7315	11538	12613	13682	14741	15653
Varieties									
V_1	(Pusa- 1121)	954	4150	7453	12152	13420	14519	15533	16336
V_2	(Basmati 370)	1009	4165	7578	12707	13638	14716	15825	16576
V_3	(SJR129)	954	3914	6913	9756	10781	11811	12865	14048
	Mean	973	4076	7315	11539	12613	13682	14741	15653
Accumulated Photo thermal heat Units									
Sowing dates									
D_1	(1st June)	2141	10639	19154	28304	29867	31647	33493	35311
D_2	(16th June)	1935	8370	16421	25056	27303	28398	29967	31490
D_3	(30th June)	2049	7624	15280	22310	23966	25492	26893	28211
	Mean	2041	8877	16952	25223	27045	28513	30117	31671
Varieties									
V_1	(Pusa- 1121)	1998	9060	17375	26921	28312	29936	31374	32662
V_2	(Basmati 370)	2128	9128	17317	27121	28651	30216	31746	33158
V_3	(SJR-129)	1998	8444	16163	21628	24173	25384	27232	29194
	Mean	2041	8877	16952	25223	27045	28512	30117	31671

Under early sowing date '1st June' the accumulated Heliothermal units under different phenophases, i.e. from sowing to germination were (1127⁰C days hours), sowing to tillering (5174⁰C days hours), sowing to jointing (8565⁰C days hours), sowing to panicle emergence (12683⁰C days hours), sowing to flowering (13958⁰C days hours), sowing to milking (15059⁰C days hours), sowing to hard dough (16199⁰C days hours) and sowing to physiological maturity (17363⁰C days hours). '16th June' sowing date in rice accumulated (898⁰C days hours), (3894⁰C days hours), (6953⁰C days hours), (11571⁰C days hours), (12469⁰C days hours), (13571⁰C days hours), (14632⁰C days hours) and (15531⁰C days hours) Heliothermal units under different phenophases from sowing to germination, tillering, jointing, panicle emergence, flowering, milking, hard dough and physiological maturity respectively. In late sowing of rice (902⁰C days hours), (3162⁰C days hours), (6425⁰C days hours), (10362⁰C days hours), (11411⁰C days hours), (12417⁰C days hours), (13392⁰C days hours) and (14066⁰C days hours) accumulated Heliothermal units were recorded while attaining different phenophases from sowing to germination, tillering, jointing, panicle emergence, flowering, milking, hard dough and physiological maturity respectively. Among the different rice varieties, highest accumulated Heliothermal units (16576 ⁰C days hours) were recorded with variety 'Basmati-370' followed by (16336 ⁰C days hours) accumulated Heliothermal units with variety 'Pusa-1121' and (14048⁰C days hours) accumulated Heliothermal units with variety 'SRJ-129'.

Accumulated Photo thermal Units: Photo thermal unit is the product of growing degree days and day length indicating that higher day length leads to more accumulated PTU. The pooled data of accumulated photo thermal unit required for various phenophases of rice crop under direct sowing were presented in Table 2 revealed that the highest accumulated photo thermal units 35311 ⁰C days hours were required from phenophases from sowing to physiological maturity were recorded in '1st June' early sowing of rice as compared to 31490°C days hours accumulated photo thermal units recorded with '16th June' sowing date and 28211°C days hours accumulated photo thermal units recorded with 30th June sown basmati rice crop from phenophases sowing to harvest. The accumulation of photo thermal units decreased with the delay in date of sowing. Among the different varieties, 'Basmati 370' took maximum accumulated photo thermal unit 33158 ⁰C days hours to reach the physiological maturity from sowing followed by (32662 ⁰C days hours) accumulated photo thermal unit for variety 'Pusa 1121' and (29149 ⁰C days hours) accumulated photo thermal unit for variety 'SJR-129' from sowing to physiological maturity during the crop season in rice crop under irrigated subtropical conditions of J&K.

Conclusion

Based on three year study, rice variety when sown on SRJ-129 when sown on 1st June sowing date with direct sowing can perform better than other planting dates and varieties in irrigated Subtropical conditions in Union Territory of J&K.

References

Anonymous, 2020-21a.Economic Survey. 2022-23. Government of India Ministry of Finance Department of Economic Affairs.

Anonymous 2020-21b. Digest of Statistics. 2020-21. Government of Jammu and Kashmir Planning Development and Monitoring Department Directorate of Economics and Statistics, J&K. 46th Edition. Pp:99-107.

Bashir, M.S., Akbar, N., Iqbal, A. and Zaman, H. 2010. Effect of different sowing Dates on yield and yield components of direct seeded coarse rice (*Oryza sativa*). *Pakistan Journal of Agricultural Sciences*. **47**(4): 361-365.

Banotra, M., Sharma, B.C., Samanta, A., Gupta, L. and R. Kumar. 2021. Production and economics of irrigated transplanted basmati rice (*Oryza sativa*) as influenced by substitution of nutrients through organics in Jammu region of India. **66**(3): 295-299.

Cocharn, G. and Cox, G.M. 1963. Experimental design. Asia Publishing House, Bombay, India.

Thomas, N. and Lal, G ML. 2012. Genetic divergence in rice genotypes under irrigated conditions. *Annals of Plant and Soil Research*. 14 (1): 109-112.

Qadir, G., Ahmad, S., Hassan, F.U. and Chemma, 2006. Oil and Fatty acid accumulation in sunflower as influenced by temperature variations. *Pakistan Journal of Botany*. 38: 1137-1147.