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Yield response of Okra to different row spacings and fertilizer application methods under drip irrigation system

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ABSTRACT

An experiment was conducted to study the okra yield response (*Abelmoschus esculentus* L. Moench) to the different methods of fertilizer application (i.e through fertigation tank and by manual application) & row to row spacing during February-May 2017. Two row spacings of 40x60 cm and 50x60 cm were selected. Analysis of the data showed that the response of the okra crop was considered a better combination of 50 x 60 cm through fertigation method compared to manual application. Yield in plot III was observed to be 22% more compared to manual application under same row to row spacing. Yield attributes such as pod weight, pod length and pod perimeter was also observed to be best in spacing of 50 x 60 cm. Similarly plant characteristics namely plant height, root depth and lateral distribution of roots were also found to be highest in 50 x 60 cm by fertigation method.

Key words : *Yield, Row to row spacing, Fertigation, Pod perimeter*

Introduction

Water and land resources are the primary needs of agriculture and economic development in any country. The need for these resources will continue to grow due to the increasing population. The world population is growing rapidly than the food supply. India has only 2.4% of the world's landmass and 4% of its freshwater resources. However, it is necessary to support 17.31% of the country's population, which is growing at an startling rate of 2% per year since independence. Agriculture sector consumes around 70 to 80% of available water. Water is perceived as an essential resource for livelihoods, food security and environmental sustainability. If sufficient water resources are available, the intensity of cultivation can be increased to 300% and above, and large areas of fallow land can be brought under arable land,which will solve the problem of food insecurity for a growing population..

In the current context of limited availability of surface water and depletion of groundwater resources day by day the only alternative is to use pressurized irrigation systems, i.e. drip or sprinkler irrigation systems, to meet the food security of a growing population and increasing the arable land by utilizing the limited water resources judicially . In micro-irrigation system, water is injected directly into the root zone of the plant through a network of main lines, submains and lateral lines with emission

points along the entire length. Micro-irrigation system saves water, increases the productivity per unit of water. It ensures water savings of 30-70%, an increase in yield of 25-50% and a reduction in operating costs about 15-30%.

Okra (*Abelmoschus esculents*) belongs to Malvaceae family and is grown across the world for immature fruits used as vegetables. The okra grows well in almost all soils from sandy to clayey soils with a pH range of 5.8-8. The lady's finger is one of the important vegetables grown in all the tropics and subtropics. India is the highest country that produces 4.18 million tons of okra per year, which represents about 70% of world okra production, and the largest okra growing states of India are Uttar Pradesh , Bihar and West Bengal. It is available all year round with a maximum season in the summer months. The pods grow rapidly, are ready for harvest within 50 days of summer time, grown from seeds. There are many okra types that differ in time and form of fruit growth, leaf color and stem length. It plays an important role in human nutrition and is a good source of protein, carbohydrates, vitamins, calcium, potassium, enzymes and total minerals (Abd El-Kader *et al*., 2010) which are often lacking in the diets of developing countries and are also used as coffee substitutes, while ground okra seeds are used as substitutes for aluminum salt in water treatment.

The degree of nutritional value differs when using organic fertilizers, according to liquid seaweed, according to the carbohydrate composition 7.39% protein, 28.04% and fiber 35.55%. Okra has found medical use as a plasma substitute or blood volume expander, and responsible for removing toxic substances such as bad cholesterol, helps to restore psychological disorders as well as it reduce injuries,.

Currently, most horticultural crops grown in India, following traditional irrigation methods, planting seeds in a fixed row to row spacing as per agronomic standards and using fertilizer manually. Since the micro-irrigation system has been shown to be a water-saving system with higher productivity, it is considered necessary to use a drip irrigation system. With this concept in mind, an experiment has been planned to study the response of a drip irrigation system on the yield potential of okra (Bhendi) by planting with two different distances between the rows and two different fertilizer application methods, with the main objective to determine the response of spacing(i.e 40x50 and 40x60) and method of fertigation on the yield and quality characteristics of okra and study the vegetative growth characteristics under the variations of spacing and methods of fertigation.

Materials and Methods

Study area

The experiment was conducted at research farm of the Vijaya College of Engineering during the summer months. The geographical position is 17.2334° N latitude and 80.2394° E longitude with an altitude of 107 m. Khammam experiences typical Indian climatic conditions. The summer season (from March to the end of May) is hot and the temperature can rise sharply during the day, can reach between 40 °C and 42 °C.

Details of the experiment

An area of 400 m^2 has been chosen and is divided into four plots, each of 100 m^2. The seeds were sown at different row spacings in four plots, two of which are maintained at a distance of 50x60 cm, and the remaining two at a distance of 40x60 cm with an equal plant spacing of 60 cm in all fourplots (Table 1). Application of fertilizer is done through fertigation in two plots and remaining two plots by manual application. Before sowing the okra seeds were kept in warm water and left to soak for 12 - 24 hours. This will soften the seed coat and facilitate rapid germination. The seeds werehand dibbled 2-3 seeds per hole in the prepared plots according to the according to the treatment combination of inter- and intra-row spacing into a depth of 3-5 cm.

Table 1. Details of experiment under different row to row spacing and methods of fertilizer application

Plot. No	Area (m^2)	Spacing (cm x cm)	Method of fertilizer application
1	100	40 x 60	Fertigation
2	100	40 x 60	Manual application
3	100	50 x 60	Fertigation
4	100	50 x 60	Manual application

Field irrigation is carried out with an in-line drip system that saves water and fertilizer by allowing water to drip slowly through the valve network to the roots of various plants, either on the soil surface or directly in the area of the roots.

Ammonium Sulphate was applied in two stages namely development stage and fruit bearing stage at the rate of 2.5 kgs (the recommended dose of 104 kg/ha) applied to two plotsmanually and through fertigation tank, to the remaining plots. For enhancing the crop growth, 15-15-15 (N-P-K granules–water insoluble) fertilizer was manually applied at the stages of 25 days and 55 days after sowing at the rate of 2.5 kgs to two plots. The soluble fertilizer of 19-19-19 with same composition and ingredients was selected and applied to the remaining two plots.

The ammonium sulphate was applied in two phases, namely the development phase and the fruit bearing phase, at the rate of 2.5 kgs (the recommended dose of 104 kg/ha) applied to two plots manually and through fertigation tank, to the remaining plots. In order to increase yield, 15-15-15 (N-P-K granules - insoluble in water) were applied manually applied at the stages of 25 days and 55 days after sowing at the rate of 2.5 kgs to the all plots.

Crop water requirement

The water requirement of crop is based on the Evapo-transpiration of the crop. The Potential Evapo-Transpiration was estimated by using Modified Penman's method.

Water requirement of plant in lit/plant/day = ET_P × Crop factor × Gross area per plant.

Plant and Yield attribute's:

Plant attributes namely plant height, root depth and lateral distribution of roots etc. and yield attributes like number of green pods per plant, length of green pods, pod diameter, pod fresh weight, pod dry weight, root length were determined.

Results and Discussion

Effect of yield under spacing of 40 × 60 cm in combination with two different fertilizer application methods

The total yield obtained from plot I with a spacing of 40 × 60 cm was 26.24 kg with the effect of spacing and method of fertilizer application on yield response and vegetative growth characteristics through the method of fertigation and was 37.41 kg in plot II with equal spacing by manual application of fertilizer. It was observed that the yield in the plot-I was manually higher than 42% at a distance between the rows of 40 cm with respect to the yield obtained at the same spacing with fertigation. It may be attributed, to the field conditions where the application of farm yard manure might be more in this particular plot and also the status of fertility of that particular crop may be higher. Because of this fact, the effect of spacing and method of application could not be focused well.

Effect of yield under spacing of 50 × 60 cm in combination with two different fertilizer application method

The total yield obtained from plot III 50 x 60 cm was 38.16 kg and 31.29 kg in plot IV for the same spacing under fertigation and manual application of fertilizer respectively. The yield in plot III through a fertigationis higher than 22%. The reason for the higher yield could be due to a well-developed root system with strong plant growth over a wider distance of 50 x 60 cm.

Quality characteristics of okra yield

Pod weight (g)

The average pod weight of okra under different row to row spacing's and methods of fertilizer application are furnished in the Table 2.

The weight of the pod was observed to be higher in plot II was 11 g. Due to the higher weight of the pods, the yield was also recorded maximum. Overall,the weight of the pods in plot III was 10.83 g is almost equal to the mass of the pods obtained in plot II.

Pod length (cm)

Before the harvesting of crop length of pod was measured in all four plots, randomly six plants were selected in each plot its pod length was noted. The highest pod length was recorded in plot III i.e. 11.02 cm presented in Table 3, followed by plot II (manual application) was observed to be 10.20 cm.

Pod perimeter (mm)

The pod perimeter also measured in all four treatments. The highest pod perimeter was observed in plot II i.e 14.50 mm (Table 4) this is due to

fertigation, the nutrients are applied at correct doses and at appropriate stages of plant growth (Padmanabah *et al.*, 2018). In plot III through manual application method, pod perimeter was recorded as 14.25 cm.

Wetting Pattern

During the application of the water, the wetted perimeter of the surface and the depth of the water percolated were recorded in all four treatments. The water was applied according to cultivation needs for 4 hours in each application. The horizontal and vertical movement of the moisture front was recorded at 30 minute intervals to know the spreading pattern, represented in Fig. 2. The diameter of the wetted circle gradually increased from 27 cm after the application of the water in the first 30 minutes to 55 cm at the end of the irrigation, that is after 4 hours (Fig. 1). The percolation depth gradually increased from 23 cm after 1 hour to 70 cm after 4 hours.

Vegetative growth parameters of okra under different row spacing's and fertilizer application methods

Plant height

The height of okra plant was measured at 14 days

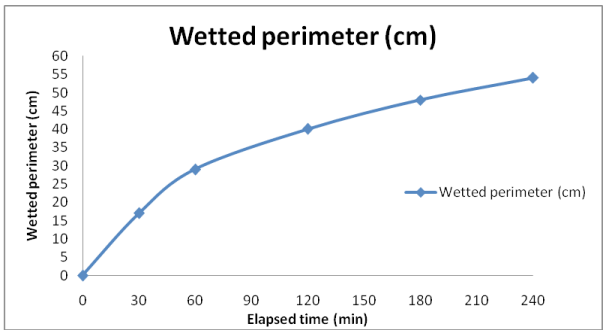

Fig. 1. Moisture front advance in horizontal direction under point source ofapplication

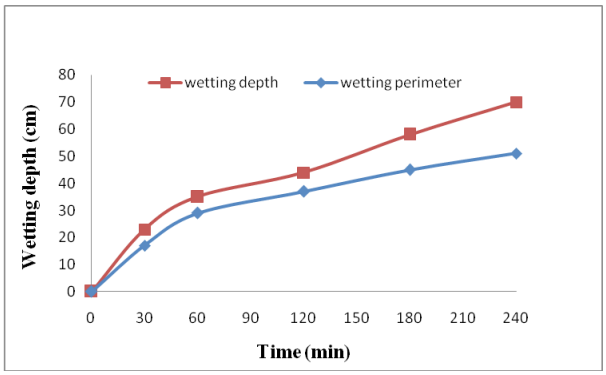

Fig. 2. Variation of wetting perimeter and depth with time

Table 2. Pod weight of okra in all treatment

Plot No.	Row Spacing(cm)	Method of fertilizer application	Pod weight of okra (g)
I	40 × 60	Fertigation	10.0
II	40 × 60	Manual application	11.0
III	50 × 60	Fertigation	10.83
IV	50 × 60	Manual application	10.41

Table 3. Length of pod in all treatments

Plot No.	Row Spacing (cm)	Method of fertilizer application	Length of Pod (cm)						
			S_1	S_2	S_3	S_4	S_5	S_6	Average
I	40×60	Fertigation	12.43	10.43	10.14	9.27	8.35	6.67	9.548
II	40×60	Manual application	13.00	10.75	10.90	10.50	9.02	7.73	10.20
III	50×60	Fertigation	15.58	12.40	12.57	10.62	9.69	7.24	11.02
IV	50×60	Manual application	12.14	10.91	10.60	8.66	8.02	6.65	9.496

Table 4. Pod perimeter of okra under different row to row spacing

Plot No.	Row Spacing(cm)	Method of fertilizer application	Pod Perimeter (mm)
I	40 × 60	Fertigation	12.90
II	40 × 60	Manual application	14.09
III	50 × 60	Fertigation	14.50
IV	50 × 60	Manual application	14.25

Table 5. Root depth and lateral distribution of roots under different treatments

Plot No.	Row Spacing (cm)	Method of fertilizer application	Avg. root depth(cm)	Mean of maximum lateral length(cm)
I	40 × 60	Fertigation	14.46	12.32
II	40 × 60	Manual application	15.13	14.54
III	50 × 60	Fertigation	18.14	19.27
IV	50 ×40	Manual application	15.11	15.24

interval in all four plots. While recording the height of the plants, three laterals were randomly selected from each plot at an interval of 5 m. It can be concluded that the plant height of 39.16 cm pertains to plot III with 50 × 60 cm row spacing and fertigation was observed to be higher than the other treatments presented in Fig 3. It also confirms to the higher yield as indicated earlier.

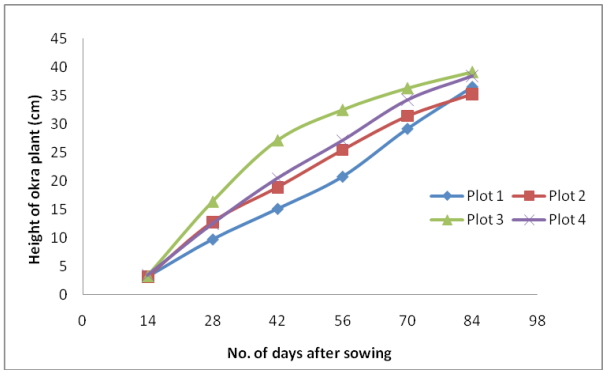

Fig. 3. Height of the plant in different treatments

Root depth and Root distribution

The root development and root distribution, initially the soil was kept wet for about an hour and dug until the tip of the root exposed as well as horizontally in order to know the distribution of roots, results were tabulated in Table 5.

Below table represents the data on mean of maximum root depth and lateral length of roots obtained in different row to row spacing's and fertilizer application methods. The values of maximum depth and lateral lengths of root are found to be 15.33, 14.66; 14.66, 20; 18, 19; and 14.33, 12.33 cm for plots I, II, III and IV.

From the Table 5 can be concluded that the maximum root depth and lateral length of 18.14, 19.27 cm pertains to plot III with 50 × 60 cm row spacing and fertigation was observed to be higher than the other treatments. Similar results were reported by Hari and Ramesh, 2017.

Conclusion

It was concluded that plot which was cultivated at a spacing of 50x60cm under fertigation showed higher yields and the water application through drip have reduced the evaporation losses. The total yield of okra in 50 × 60cm spacing of plot III through fertigation is higher by 22%. The reason attributed for higher yield, may be due to well-developed root system with vigorous growth of plant in wider spacing of 50 × 60 cm. Similarly pod weight, pod length and pod perimeter were also observed to be best under the spacing of 50 x 60 cm. Similarly plant characteristics namely plant height, root depth and lateral distribution of roots were also found to be highest in 50 x 60 cm by fertigation method.

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