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EFFECT OF IRRIGATION SCHEDULES AND PLANTING METHODS ON YIELD AND WATER USE EFFICIENCY OF OKRA UNDER RICE-RAI-OKRA CROPPING SYSTEM

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ABSTRACT

An experiment was conducted during summer season 2011 at Agronomy Research Farm of Narendra Deva University of Agriculture and Technology, Kumarganj, Faizabad (U.P.) to evaluate the effect of Irrigation Schedules and Planting Methods on okra. The experiment was laid out in split-plot design with four replications, assigning 12 treatments consisting 4 irrigation schedules and 3planting methods. The results revealed that different irrigation schedules and planting methods significantly influenced the growth, yield and water use efficiency of okra. Irrigation schedule at five days interval recorded Thehighest plant height (80.20 cm),dry matter accumulation plant^{-1} (44.33g), No. of picking plant^{-1} (11.00), No. of fruits plant^{-1}(17.00), Total yield plant^{-1} (188.38), Yield ha^{-1} (9516 kg) and Water use efficiency (96.50 kg/ha/cm). In case of planting methods Raised bed sowing method significantly proved best than others with the maximum plant height (82.11 cm), dry matter accumulation plant^{-1} (42.98g), No. of picking plant^{-1}(11.00), No. of fruits plant^{-1}(17.25), Total yield plant^{-1} (192.73g), Yield ha^{-1} (9735kg) and Water use efficiency (95.46 kg/ha/cm). On the basis of the above summarized results okra growers can adopt the 5 day interval irrigation schedule and raised bed method of planting for higher yield of okra and efficient use of water.

INTRODUCTION

Okra [*Abelmoschus esculentus* (L.) Moench] belongs to the family malvaceae, it is also known as 'lady finger' in English, 'gumbo' in French, 'bhindi' in Hindi and 'bamiah' in Arabic. Okra is herbaceous annual plant bearing bisexual flower. Generally used in the fresh state, but canned and dehydrated forms of the fruits are also being used. Fruits at their edible stage are rich source of protein, carbohydrates, minerals and vitamins. Physiologically it is a day neutral plant. Hence it's cultivated in every season as possible. It is extensively cultivated throughout the India during summer and rainy season. A Suitable irrigation schedule may be an effective tool serving the purpose, as this system considerably saves water and increased yield of the crop. Irrigation schedules which maintain soil water near field capacity, found to significantly increase the yield of okra and other crops (Home *et al.,* 2002; Dadhich *et al*., 2014). Okra is medium to deep rooted crop and prefers soil moisture level at 40% available soil moisture. It generally required an inch of water at every 5-7 days intervals during summer season. The critical period of irrigation is during flowering stage.Proper soil moisture and planting method may greatly influence the yield as well as water use efficiency. Planting method is an important constituent of almost all which considerably increased the production of vegetable crops because ideal planting geometry is important for better aeration and efficient utilization of available plant nutrients in order to get optimum yield of crops over a unit of land (Kumar and Singh, 2014; Reddy *et al*., 2015). Little efforts have been done so for on this aspect, proper soil moisture and planting method may greatly influence the plant growth, nutrient availability as well as water use efficiency. As okra is the most important vegetable crop during spring summer season, such information is required for developing new strategies for intensive production of vegetables. Therefore, the present investigations were undertaken to study the effect of Irrigation Schedule and planting methods on growth, yield and water-use efficiency of okra.

MATERIALS AND METHODS

The field experiment was conducted during summer season of 2011 at Agronomy Research farm of Narendra Deva University of Agriculture and Technology, Narendra Nagar, Kumarganj, Faizabad (U.P.) during summer season of 2011. There were 12 treatment combinations comprised of four Irrigation schedules(3, 5, 7, 9 days intervals) and three planting methods (flat sowing, ridge sowing, and raised bed sowing) replicated four times and laid down in split plot design, irrigation schedules in main-plots and planting methods in sub-plots. The seeds of variety *Prabhanikranti* were sown in

rows at a spacing of 30 cm from row to row and 15 cm from plant to plant in plot of size 4.50 × 3.00 m^2 on 28-feb-2011. Two manual weeding were done with the help of Khurpi at 25 and 45 days after sowing. Irrigation was schedule as per the treatment Plucking of fruits was done carefully time to time when pod were in soft condition. Data were recorded on Initial plant population, Plant height (cm), Dry matter accumulation (g $plant^{-1}$), No. of picking $plant^{-1}$, No. of fruits $plant^{-1}$, fruit yield using standard methods. Plants were cut at soil surface and the dry weight of top growth (stem and leaves) was determined after complete drying at 60ºC. The water use efficiency was computed by dividing okra yield with total water applied (cm).

RESULTS AND DISCUSSION

Effect of irrigation scheduling

The data against different growth and yield parameters of okra presented in table-1 and it is quite clear from data that initial plant population of okra was not significantly affected by different irrigation schedules since there was enough and uniform moisture at the time of sowing which led for proper germination. The plant height of okra was recorded significantly higher at 30 and 60 DAS (20.07cm and 80.20cm respectively) with irrigation at 5th day's interval. The increase in plant height under 5 days interval might be due to continuous water supply and maintenance of soil moisture nearby field capacity. Panigrahi and Sahu (2007) and Anant Bahadur *et al.*,(2013) also reported similar results in okra and Sharangi and Roychowdhury (2014) in coriander.Dry matter production is a result of various growth parameters, like plant height and number of branches. Irrigation schedules significantly increased dry matter accumulation the highest dry matter accumulation was recorded in irrigation 5th day's interval at 30, 60 and 90 DAS (6.44 g, 39.98 g and 44.33g respectively) however, irrigation schedule at 9th days interval reduced the dry matter accumulation per plant at all the stages i.e. 30, 60 and 90 DAS (4.74g, 26.57g and 29.47g respectively). This is might be due to shorter plant height, number of branches and number of leaves which ultimately decreased the dry matter accumulation. Under adequate supply of moisture, the proper functioning of stomata might increase the photosynthetic efficiency as well as translocation of photosynthates from sources leaves to sink.In okra yield is proportionally related to the number of nodes, as number of nodes increases, the number of pods also increased and vice-versa. Almost all nodes, except few lower bears single pod in their leaf axial. Maximum number of pickings and pods per plant (11.0 and 17.0 respectively)recorded with the irrigation applied at 5 days interval was significantly highest over the rest of treatments and lowest (9.0 and 15.33 respectively) in irrigation applied at 9 days interval. Yield of okra pod g/plant and kg/ha was received highest (188.38g and 9516 kg respectively) with the irrigation applied at 5 days intervals and lowest (138.73g and 7007kg respectively) in irrigation applied at 9 days interval. It is attributed due to the higher plant height and number of pods per plant. Soil moisture condition is observed congenial for physiological and metabolic activities of plant. All these

Table 1: Effect of Irrigation Schedule and Planting Method on growth, yield and water use efficiency of okra

Treatments	Initial plant population at 20 days	Plant height (cm)		Dry matter accumulation (g $plant^{-1}$)			No. of picking $plant^{-1}$	No. of fruits $plant^{-1}$	Total yield $plant^{-1}$	Yield (kg ha^{-1})	Water use efficiency (kg/ha/cm)
		30 DAS	60 DAS	30 DAS	60 DAS	90 DAS					
I_1	219.25	16.80	67.20	5.20	32.23	35.73	10.00	15.00	151.90	7671	50.10
I_2	219.58	20.07	80.20	6.44	39.98	44.33	11.00	17.00	188.38	9516	96.50
I_3	219.33	18.91	75.77	6.05	37.57	41.67	10.33	16.67	177.00	8942	84.20
I_4	218.67	18.85	75.40	4.74	26.57	29.47	9.00	15.33	138.73	7007	95.58
SEm±	1.114	0.498	1.960	0.154	1.679	1.900	0.20	0.297	4.667	22.7	2.235
CD at 5%	NS	1.594	6.271	0.491	5.370	6.078	0.90	0.949	14.929	72.6	7.150
M_1	219.50	16.51	65.73	4.54	28.18	31.23	9.00	14.75	132.73	6703	66.10
M_2	219.44	19.10	76.09	5.70	35.35	39.20	10.25	16.00	166.56	8413	83.23
M_3	218.69	20.36	82.11	6.58	38.74	42.98	11.00	17.25	192.73	9735	95.46
SEm±	1.122	0.365	1.429	0.114	1.377	1.502	0.15	0.270	3.254	16.8	1.519
CD at 5 %	NS	1.064	4.171	0.332	4.020	4.383	0.82	0.788	9.497	49.1	4.434

Table 2: Economics of different treatment combinations

Treatments	Cost of cultivation(Rs. ha^{-1})	Gross Return(Rs. ha^{-1})	Net Return(Rs. ha^{-1})	B: CRatio
I_1M_1	18592	62074	43481	2.34
I_1M_2	20103	77908	57805	2.87
I_1M_3	20903	90149	69245	3.31
I_2M_1	16006	77012	61005	3.81
I_2M_2	17196	96655	79459	4.62
I_2M_3	17996	111841	93844	5.21
I_3M_1	15267	72361	57093	3.34
I_3M_2	16365	90818	74453	4.54
I_3M_3	17165	105087	87921	5.12
I_4M_1	14529	56708	42178	2.90
I_4M_2	15534	71172	55638	3.58
I_4M_3	16334	82355	66020	4.04

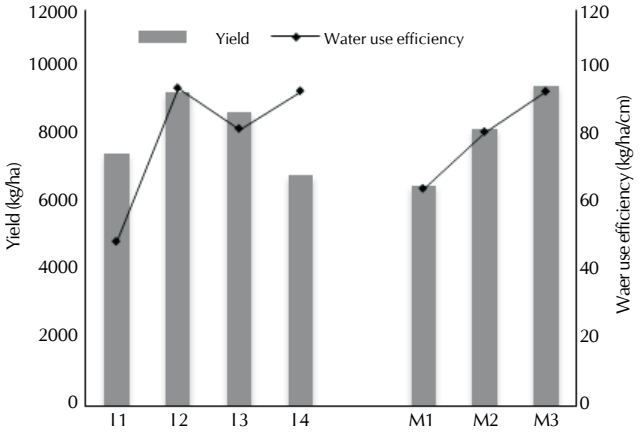

Figure 1: Effect of Irrigation Schedule and Planting Method on yield and water use efficiency of okra

condition favored the proper vegetative growth which ultimately reflected higher pod yield. In contrary to above, at 60% PE, the plants always remains in moisture stress condition resulted in low CO_2 intake due to stomata closure, poor water supply and nutrient uptake, loss of turgidity etc which might have contributed for lower yield under the said treatment. The similar findings were also reported by Home *et al*. (2002), Shinde *et al*. (2002) and Anant Bahadur *et al*. (2013) in okra. The maximum water use efficiency (96.50kg/ha/cm) was recorded with irrigation scheduling at 5 days interval whereas, lowest water use efficiency (50.10kg/ha/cm) was observed in irrigation scheduling at 3 days interval. The present study of okra are in close conformity with finding of Panchal *et al*. (2000), Rana (2007) and Anant Bahadur *et al*. (2009) and Morteza *et al*. (2014) in okra.

Effect of planting method

It is quite clear from data (Table 1) that all the parameters of okra significantly affected by the planting methods except initial plant population which was non-significant. Highest plant height at 30 and 60 DAS (20.36cm and 82.11cm, respectively) was recorded in raised bed planting method and lowest (16.51cm and 65.73cm, respectively) in flat bed planting. Dry matter accumulation per plant at different stages *i.e.* 30, 60 and 90 DAS were maximum (6.58g, 38.74g and 42.98g, respectively) under raised bed planting and minimum (4.54g, 28.18g and 31.23g, respectively) in flat bed planting method. The increase in growth characters like plant height, and dry matter accumulation method might be due to better aeration which reflected because of higher absorption of available growth resources. The findings are in close proximity to those of Rathore *et al*. (2006).The yield component viz. number of pickings, pods plant^{-1} and pods yield plant^{-1}were recorded significantly highest (11.00, 17.25 and 192.73g, respectively) in raised bed planting method than others and lowest was recorded in flat bed planting. Raised bed method of planting had significantly higher dry matter accumulation in assimilating organs which in turn brought significantly increase of yield attributes. The results are close conformity with those of Kumar and Singh (2014) in French bean; and Singh *et al*. (2008) in sugarcane Alizai *et al*. (2005) in okra. Yield is the result of co-ordinate inters play of growth characters and yield attributes. Highest yield of okra green pods (9735 kg ha^{-1}) was recorded under the raised bed planting method followed by ridge method of planting (8413kg ha^{-1}) and lowest (6703 kg ha^{-1}) in flat bed planting method. In raised bed method of planting plants were able to absorb a larger quantity of plant nutrients and water Kumar and Singh (2014). Yield increased with raised bed of planting method may be due to increase in dry matter production and yield attributes characters as the result of better aeration required for plant growth. The results obtained are in accordance to Kumar and Singh (2014), Rathore *et al*., (2006) and Tripathi and Singh, (2007).The water use efficiency was recorded higher (95.46 kg/ha/cm) in raised bed planting method and lower (66.10 kg/ha/cm) in flat bed planting method. This might be due to congenial growth of plants as the result of better metabolic activity of plants consumed more amount of water for the metabolic processes and transpiration which ultimately turned into higher yield properties to per unit of water used. The increase in water use efficiency under raised bed method was might be due to proportionately higher increase in yield than water used. Similar results were also reported by Kumar and Singh (2014) in French bean, Home *et al*. (2002) and Morteza *et al*. (2014) in okra.

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