Studies on Optimum Spacing and Manuring for Okra (*Abelmoschus esculentus* (L) Moench)

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by

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Introduction: Okra (*Abelmoschus esculentus* (L) Moench) is one of the most important vegetable crops grown in India and the variety Pusa Sawani enjoys wide popularity on account of its high yield, better quality and tolerence to vein clearing disease. The production of this vegetable being simple, with short crop period of about 90 days and ease in cultivation, it is important to devise ways and means for increasing its production by judicious agronomic practices and proper plant protection measures. Accordingly, an experiment was conducted at the Vegetable Section, Agricultural College and Research Institute, Coimbatore to find out the optimum doses of major plant nutrients and economical spacing required for okra and the results are presented.

Materials and Methods: The effects of spacing, N, P and K on okra were studied at Coimbatore with the popular cultivated variety, Pusa Sawani. The experiment was conducted for three seasons adopting 3^4 confounded factorial design with the following three different spacings and three graded doses of N, P and K over a basal dose of 25 tonnes of farm yard manure/ha.

1) Spacing at 3 levels *viz.*, 60 cm × 20 cm, 60 cm × 30 cm and 60 cm × 40 cm
2) N at 3 levels *viz.*, 0, 40 and 80 kg/ha (in the form of Ammonium sulphate)
3) P_2O_5 at 3 levels *viz.*, 0, 50 and 100 kg/ha (in the form Super phosphate)
4) K_2O at 3 levels *viz.*, 0, 30 and 60 kg/ha (in the form of Muriate of potash)

The field was prepared well and 25 tonnes of farm yard manure/ha was applied before last ploughing. Ridges were formed at 60 cm apart and plots separated with guard rows. Half the dose of N and full doses of P and K were applied as basal dressing. Seeds of Pusa Sawani variety of *bhendi* were dibbled at specified spacing on one side of ridges. The remaining half the quantity of N was applied one month after sowing and earthed up. Other routine cultural operations were attended to regularly. Yield of Okra pods, in terms of number and weight, was recorded. The earliness of the crop was computed as suggested by Bartlette (1937). The data were subjected to statistical scrutiny. Economics of the various treatments were also computed.

Results: The effect of spacing, N, P and K and earliness are presented in Table 1. The economics of treatments are furnished in Table 2.

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TABLE 1. *Effect of Spacing and Fertilizers on the yield of Okra (Mean of three seasons)*

Particulars	Spacing (cm)			N (kg/ha			P (kg/ha)			K (kg/ha)		
	60×20	60×30	60×40	0	40	80	0	50	100	0	30	60
Yield per hectare												
(A) No. of fruits (00s)	4,823	4,019	3,250	3,876	4,085	4,136	4,141	3,951	4,000	4,018	4,183	3,891
As % on 60 cm × 40 cm spacing and '0' level of N, P and K	148.4	123.7	100	100	105.4	106.7	100	95.4	96.6	100	104.1	96.8
Whether significant by 'F' test		Yes			No			No			No	
S.E.		151			151			151			151	
C.D(P=0.05)		592			—			—			—	
Conclusion		S_0, S_1, S_2			—			—			—	
(B) Weight of fruits (kg/ha)	7,267	5,921	5,058	5,658	6,209	6,379	6,193	5,788	6,266	6,071	6,391	5,785
As % on 60 cm × 40 cm spacing and '0' level of N, P and K	143.7	117.1	100	100	109.7	112.7	100	93.5	101.2	100	105.3	95.3
Whether significant by 'F' test		Yes			No			No			No	
S.E.		157			157			157			157	
C.D (P=0.05)		616			—			—			—	
Conclusion		S_0, S_1, S_2			—			—			—	

TABLE 1. (Contd.)

Particulars	Spacing (cm)			N (Kg/ha)			P (kg/ha)			K (kg/ha)		
	60×20	60×30	60×40	0	40	80	0	50	100	0	30	60
Yield per plant												
(A) No. of fruits	9.8	11.7	12.4	10.4	11.5	11.9	10.4	11.8	11.3	10.99	12.0	11.1
As % on 60 cm × 20 cm spacing and '0' level of N, P and K	100	119.5	126.6	100	110.5	114.6	100	113.5	109.1	100	109.5	101.2
Whether significant by 'F' test		Yes			Yes			No			No	
S.E.		0.383			0.383			0.383			0.383	
C.D (P=0.05)		1.501			1.501			—			—	
Conclusion		$\overline{S_2, S_1}$. S_0			$\overline{N_2, N_1}$, N_0			—			—	
(B) Weight of fruits (g/plant)	137	177	186	159	175	179	171	171	170	167	180	167
As % on 60 cm × 20 cm spacing and '0' level of N, P and K	100	121.9	137.8	100	110.1	112.5	100	100	99.4	100	107.8	100
Whether significant by 'F' test		Yes			No			No			No	
S.E.		0.0038			0.0038			0.0038			0.0038	
C.D (P=0.05)		0.015			—			—			—	
Conclusion		$\overline{S_2, S_1}$, S_0			—			—			—	
Bartlett's Index of earliness	0.6062	0.5776	0.5637	0.5914	0.5882	0.5812	0.5824	0.5859	0.5959	0.5924	0.5837	0.5860

TABLE 2. *Economics of Fertilizer Treatments*

Nutrient	(kg/ha) Levels	Mean yield (kg/ha)	Extra produce (kg/ha)	Value (at 30 P/kg) (Rs./kg)	Cost of fertilizers (Rs./ha)	Profit or loss (Rs./ha)
Nitrogen	0	5,666	—	—	—	—
	40	6,207	+541	162.30	105 30	+57
	80	6,298	+632	189.60	210.60	+21
Phosphorus	0	6,193	—	—	—	—
	50	5,788	−405	121.50	100.08	−221.58
	100	6,266	+73	21.90	200.16	−178.26
Potash	0	6,071	—	—	—	—
	30	6,391	+320	96.00	17.50	+78.50
	60	5,785	−286	85.80	35.00	−120.80

(i) *Spacing:* In all the three seasons of trial, closer spacing of 60 cm × 20 cm has significantly and consistently recorded highest yields per hectare both in terms of number and weight. In the pooled analysis also, closer spacing of 60 cm × 20 cm recorded higher yields, the increase being 48.4% and 22.7% over 60 cm × 40 cm spacing and 60 cm × 30 cm spacing respectively, in terms of number of fruits per hectare. Regarding weight of fruits, the increase was respectively 43·7% and 26.6% over the spacings, 60 cm × 40 cm and 60 cm × 30 cm. But the yield per plant was more in wider spacing. The spacing of 60 cm × 40 cm recorded higher yields of 26.6% over 60 cm × 20 cm spacing and 7.1% over 60 cm × 30 cm spacing in terms of number of fruits. The same trend was observed in terms of weight of fruits also. In both the cases, the two wider spacings were on a par. The yield per plant was low with a mean of 9.8 fruits weighing 137 g in closer spacing of 60 cm × 20 cm compared to 12.4 fruits weighing 186 g in wider spacing of 60 cm × 40 cm.

Closer spacing of 60 cm × 20 cm produced earlier crop as evidenced by higher Bartlett's earliness index of 0.6062 and was followed by 60 cm × 30 cm spacing (0.5776) and 60 cm × 40 cm spacing (0.5637).

(ii) *Nitrogen:* The yield differences in terms of number and weight of fruits were significant during the monsoon season of 1966. The doses of 80 kg N and 40 kg N/ha recorded increased yields of 22.06% and 16.02% respectively over no N plots in terms of number of fruits; while in terms of weight of fruits, the increases were 16.97% and 18.23% over no N plots. The two doses of 80 kg N and 40 kg N/ha were on a par. In other seasons and in the pooled analysis, the treatment differences were not significant.

In terms of number of fruits per plant also, 40 kg N and 80 kg N/ha recorded significant higher yields than no N plots, the increases being 10.5% and 14.6% over no N plots. The same trend was observed in the weight of fruits per plant; but the yield differences were not significant.

Regarding earliness, application of N delayed maturity as seen by low Bartlett's earliness index of 0.5882 and 0.5812 recorded by 40 kg N and 80 kg N/ha, respectively when compared to 0.5914 in no N plots.

Although 40 g N and 80 kg N/ha have increased yields, the dose of 40 kg N/ha was better, yielding an additional monetary return of Rs. 57/ha over no nitrogen plots while 80 kg N/ha gave only Rs. 27/ha. Further increase in the dose of N from 40 kg N to 80 kg N/ha did not compensate the net return.

(iii) *Phosphorus:* There was significant difference between treatments with P in the monsoon season of 1966. Plots with no P recorded higher yields than 50 kg P and 100 kg P/ha, the latter two doses being on a par. No P registered an increased yield of 13.24% and 17.34% over 50 kg P and 100 kg P/ha, respectively, in terms of number of fruits. The increases in the weight of fruits were respectively 14.47% and 19.03%. Though okra responded to P in the other two seasons, the yield differences were not significant. Taking into consideration the mean of three seasons, the treatment differences were not significant. There was a slight increase in yield of 1.2% due to the application of 100 kg P/ha over no P. Also the differences in per plant yield due to P application were not significant.

Regarding the economics of treatments also, application of either dose of 40 kg P or 100 kg P/ha did not bring out any extra monetary return. Only loss was observed to an extent of Rs. 222/ha and Rs. 178/ha due to 50 kg P and 100 kg P/ha.

P induced earliness. The mean Bartlett's index of earliness was higher (0.5959) in 100 kg P/ha and next came 50 kg P/ha (0.5859) and no P (0.5824).

(iv) *Potash:* Application of potash did not have significant influence on okra. The yield differences in all the three years and in pooled analysis were not signifiant. Yet, K at 30 kg/ha registered numerical higher yields ranging from 1.0 to 9.53% over no K during 1965 monsoon and 1966 monsoon seasons in terms of number of fruits. But, the increase in the weight of fruits due to 30 kg N/ha was more than no K in these two seasons ranging from 12.98% to 29.91%. Thus application of K at 30 kg/ha increased the weight of fruits per hectare. Further increase of K to 60 kg/ha did not bring out any increased yields in okra. The same trend was noticed with the number and weight of fruits per plant also, wherein 30 kg K/ha increased the production of fruits per plant.

Regarding the economics of treatments, application of K at 30 kg/ha gave a net profit of Rs. 78/ha over no K. Further increase of K to 60 kg/ha resulted in loss on account of low yield.

Application of K did not have any appreciable effect on earliness of the crop as adjudged by Bartlett's index of earliness.

(v) *Interactions:* The interaction differences between the treatments were not significant. Closer spacing of 60 cm × 20 cm registered higher yields in all the combinations of N, P and K.

(vi) *Seasons:* There was significant differences between seasons as seen in Table 3. The summer season was significantly superior to monsoon season in increasing the yield by both number and weight of pods. The later two were on a par. But, the monsoon crop was earlier as evidenced by higher value of Bartlett's indices of earliness *viz.*, 0.6483 in 1965 monsoon and 0.5986 in 1966 monsoon compared to 0.5116 in the intervening summer crop.

TABLE 3. *Seasonal Influence on the Yield of Fruits*

Particulars	Seasons			Significance by 'F' test	S.E.	(P=0.05) C.D.	Conclusion
	Monsoon 1965	Summer 1966	Monsoon 1966				
Mean number of fruits/ha (in 00s)	2,988	5,937	3,167	Yes	151	592	S_{66}, M_{66}, M_{65}
Mean weight of fruits (kg/ha)	4,808	8,811	4,627	Yes	157	616	S_{66}, M_{65}, M_{66}
Bartlett's index of earliness	0.6483	0.5116	0.5986				

Discussion: The present study has shown that yields of okra per unit area can be increased by 44% by spacing the plants closer at 60 cm × 20 cm compared to wider spacing of 60 cm × 40 cm. This is because okra (variety Pusa Sawani) occupies less space on account of its compact body facilitating closer spacing. The advantages of closer spacing are in agreement with that of Thompson and Kelly (1957), Yawalker (1969), McFerran *et al* (1963) and Spivey *et al* (1957). On contrary, the per plant yield increased with wider spacings and the fruits also were heavier. Spacing plants at 60 cm × 40 cm and 60 cm × 30 cm produced respectively, 27% and 20% more number of fruits weighing 38% and 22% more than when plants were spaced closely at 60 cm × 20 cm. The reduction in per plant yield in closely spaced plants was due to decrease in the number of lateral branches as suggested by McFerran *et al.* (1963). But the low per plant yield in closer spacing of 60 cm × 20 cm was compensated by a large number of population of 83,330 plants per hectare as

compared to 55,550 plants per hectare in 60 cm × 30 cm and 41,660 plants per hectare in 60 cm × 40 cm spacing. Larger the population, higher was the yield and correspondingly the net profit was also higher. In addition, closer spacing produced an early crop as adjudged by Bartlett's index of earliness which is an advantage.

According to Yawalker (1969) Okra does not require heavy fertilizer application as the per acre yield is only about 6,000 lbs. Further, okra responds to a lesser degree than other fruit vegetables like tomato and brinjal. The response of okra to N, P and K was not much in the present study also. In only one season N at 40 kg and 80 kg/ha gave increased yields, in terms of both number and weight. But, the trend was linear as reported by Sundaram *et al* (1969), Sutton (1963 and 1966), Yawalker (1969) and Spivey *et al* (1957). Considering the economics of the doses of N, 40 kg N/ha only gave more monetary return. The higher yields obtained by further increase of N did not compensate the cost of fertilizers and the margin profit got reduced even leading to loss. This is in agreement with the findings of Khalil and Hamdi (1964). Application of N increased the yield per plant, but not to a significant level as observed by McFerran *et al* (1963). The response of okra in the other two seasons and in the pooled analysis was not significant. Nitrogen delayed maturity as seen by the low Bartlett's index of earliness. This finding is in agreement with Thompson and Kelly (1957) and Yawalker (1969).

P did not have any influence on okra. Plots without P registered significant higher yields in one season. In other two seasons, 100 kg P increased the yields upto an extent of 1.2% over no P ; but the differences were not significant. There was also no response in per plant yield due to application of P. Negative response of okra to P has been recorded by Sundaram *et al.* (1969) and Singh *et al.* (1967). Application of P did not bring about any additional monetary return (vide Table 2). But it induced earliness in okra as recorded by Yawalker (1969), Thompson and Kelly (1957).

Like P, application of K did not affect the yields and other characters of okra during all the three years of the trial. This is in conformity with the findings of Sutton (1963) and Singh *et al* (1967). But K at 30 kg/ha had produced numerical increase in yields with more effect towards increasing the weight of fruits upto 29.91%, but not appreciably to realise significantly higher yield. Further increase to 60 kg/ha did not alter the yields fovourably. The same trend was observed in the per plant yield also. This numerical increae in yield by 30 kg K/ha gave a net return of Rs. 78/ha. Application of K did not influence earliness of the crop.

of fertilizers. Among the seasons, summer season registered significantly higher yield (both by number and weight) than both the monsoon seasons of trial which were on a par. The monsoon crops produced earlier crops as evidenced by higher rate of Bartlett's index of earliness.

Summary and Conclusion: An experiment was conducted at Coimbatore for three consecutive seasons to find out the effects of spacing, N, P and K on okra (variety Pusa Sawani). The results have indicated that (i) closer spacing of 60 cm × 20 cm increases the yield per hectare compared to wider spacing; (ii) But, wider spacing produces more yield per plant; (iii) N has a linear response, but 40 kg N/ha is found to be an economic dose; (iv) P has no effect on okra, (v) K at 30 kg/ha enhances the yield and further increase to 60 kg/ha decreases the yield; (vi) N delays maturity, while P induces earliness whereas K has no effect; (vii) the low per plant yield in closer spacing is compensated by more number of plants per unit area; (viii) there is no interaction difference between N, P and K; but at all combinations of N, P and K, closer spacing of 60 cm × 20 cm gives high yield; (ix) summer crop yields higher than monsoon crop and (x) monsoon crop is earlier than summer crop.

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