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Original Research Article

Effect of Fertility Levels and Plant Spacing on Growth and Yield of Okra (*Abelmoschus esculentus* L.)

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A B S T R A C T

A field experiment was conducted at the AKS University Satna (M.P.) during summer season of 2016 to study the effect of fertility levels and fertility and plant spacing on Okra. The highest fertility (N_{120} P_{60} K_{60}) and widest plant spacing (30 x 55cm) increased the maximum plant height, branches, and leaves/plant, stem diameter, and plant spread, length, diameter and weight of pod, seeds/pod, seed yield/plant of okra var. VRO-6. The highest fertility and plant spacing resulted in maximum fruit yield upto 76.89 and 66.61q/ha with net income up to Rs. 107572 and Rs. 88882/ha, respectively. All these parameters were further augments synergistically due to combined input of highest fertility and widest spacing.

Keywords

Okra, plant spacing fertility levels and plant spacing

Introduction

Okra (*Abelmoschus esculentus* (L.) moench) belongs to the family malvaceae and well distributed through Indian subcontinent. It is cultivated in 5.33 lakh ha with annual production 63.46 thousand mt. in Madhya Pradesh, okra is grown in 26.51 thousand ha with the production of 305.91 mt (anonymous, 2014). Nitrogen, phosphorus and potassium in proper combination play an important role in fruit and seed yield and development of quality of okra. Similarly plant growth is considerably governed by suitable plant spacing under varied agro-climatic conditions. The competitiveness of the plant in a community varies greatly and depends upon plant stand per unit area.

Optimum plant spacing is responsible for higher production by efficient utilization of underground resources and also solar radiation and in turn better photosynthetic (Thavapra Kash *et al.*, 2005)

Available evidences reveal that in okra production both spacing and fertility levels play on important role together.

Interactive effect of both these inputs shows increasing trend of various parameters of okra crop due to linear increase in number of fruits per plant, diameter and weight of fruit etc. (Anonymous, 2012).

Although a lot of research work on these aspects has been done in the past, however the information is lacking profitable cultivation of okra is Satna region hence the present research was carried out.

Materials and Methods

A field experiment was conducted at the AKS University, Satna (M.P.) during summer season of 2016. The soil of the experimental field was silty clay loam having pH. 7.2, electrical conductivity 0.42 ds/m, organic carbon 047g/kg, available N, P_2O_5, $N_{40}P_{20}K_{20}$, $N_{80}P_{40}K_{40}$ and N_{120} P_{60} K_{60}) and three plant spacing (30 x 35, 30 x 45 and 30 x 55 cm). These were laid out in the factorial randomized block design with three replications. The okra var VRO-6 was sown on 1Feb. 2016 manually @ 15 kg seed/ha. The recommended package of practices were followed. The crop was harvested on 7 May, 2016, the periodical observation were recorded and the data are resented after statistical computation. The net income from the treatments was estimated based on market value of inputs and the produce obtained.

Results and Discussion

Growth Parameters

At the harvest stage, the highest fertility level (Ni23P6olCo) recorded maximum plant height (85.66 cm), primary branches (5.57/plant) number of leaves (32.03/plant), stem diameter (2.45cm) and plant spread (56.65 cm). The increase in all these growth parameters might be attributed to the improved nutritional environment or increased availability multi of nutrients for the plant growth and development, which favorably influenced the energy transformation activities of enzymes and chlorophyll synthesis and carbohydrate metabolism. According to Singh *et al.*, (2005), beneficial effect of N, P, K may be attributed to its important role in energy transformation and plant metabolism providing conductive conditions for the better utilization of photosynthetic which ultimately caused better vegetative growth, flowering, fruiting and yield. These findings are in agreement with those or. Chattopadhyay and Sahana (2000), Shanke of a/. (2003) Khan (2006), Rahman and Akter (2012).

The wider spacing between plants (30 x 55 cm) proved highly beneficial for all the growth parameters under study. At this widest plant spacing the maximum plant height was 84.72 cm primary branches 5.62/plant, leaves 31.74/plant stem diameter 2.48 cm and plant spread 55.68 cm at the, rest stage of crop. The increased growth parameters with the widest spacing between plants was due to the fact that wider spacing reduced the competition between plants for space, light moisture and nutrients for proper growth and development. According to Sarkar and Malik (2004). The wider spacing encouraged the fullest and efficient interception of solar radiation and utilization of soil nutrients, moisture and space the major growth resources. Such favorable conditions brought about increased photosynthetic activities better translocation utilization of photosynthetic which ultimately caused better vegetative growth. In fact crop production is the practical means of tapping solar energy and converting into food and other usable material through the production of leaves. The surface area of the leaves per plant is the important determinant in the production of photosynthates. The present findings corroborate with those of many researches Bajpai *et al.,* 2004, Singh at al. 2005 and Ram Harischand *et al.*, 2013)

Phenological parameters

Days to first flowering occurrence and days to first pod formation in okra were minutely observed against the applied fertility levels and plant spacing treatments.

Table.1 Growth and yield-attributing parameters of okra var. VRO-6 as influenced by fertility levels

Treatments	Plant height (cm)	Primary braches /plant	Leaves /plant	Plant spread (cm)	Stem diameter (cm)	Days to first flowering	Days to first pod formation	Length of pod (cm)	Diameter of pod (cm)
Fertility levels									
$N_0P_0K_0$	76.68	4.95	30.61	52.40	2.21	39.70	42.57	15.06	1.21
$N_{40}P_{20}K_{20}$	78.95	5.20	31.26	54.09	2.29	39.10	41.97	15.49	1.25
$N_{80}P_{40}K_{40}$	81.59	5.37	31.43	55.82	2.35	38.60	41.46	15.72	1.30
$N_{120}P_{60}K_{60}$	85.66	5.57	32.03	56.65	2.45	37.61	40.64	16.24	1.33
CD (P=0.05)	**2.03**	**0.04**	**0.31**	**0.662**	**0.039**	**0.44**	**0.30**	**0.27**	**0.061**

Table.2 Growth and yield-attributing parameters of okra var. VRO-6 as influenced by fertility levels and plant spacings

Treatments	Plant height (cm)	Primary braches /plant	Leaves /plant	Plant spread (cm)	Stem diameter (cm)	Days to first flowering	Days to first pod formation	Length of pod (cm)	Diameter of pod (cm)
Plant spacings									
30x35cm	77.06	4.94	30.67	53.78	2.15	39.45	42.17	14.43	1.23
30x45cm	80.38	5.25	31.37	54.76	2.34	38.82	41.88	15.81	1.27
30x55cm	84.72	5.62	31.74	55.68	2.48	37.98	40.93	16.63	1.32
CD (P=0.05)	**1.77**	**0.24**	**0.26**	**0.573**	**0.098**	**0.38**	**0.26**	**0.115**	**0.053**
Interaction	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

Table.3 Yield-attributes, yield and economics from okra var. VRO-6 as influenced by fertility levels

	Weight of pod (g)	Seeds /pod	Yield /plant (g)	Yield (q/ha)	Net income (Rs./ha)	B:C ratio
Fertility levels						
$N_0P_0K_0$	12.24	43.06	96.29	46.03	49611	2.18
$N_{40}P_{20}K_{20}$	13.50	43.60	112.51	54.49	65119	2.49
$N_{80}P_{40}K_{40}$	14.90	44.38	127.02	61.04	77045	2.71
$N_{120}P_{60}K_{60}$	16.89	45.03	160.90	76.89	107572	3.33
CD (P=0.05)	**0.43**	**0.70**	**2.67**	**1.22**	**-**	**-**

Table.4 Yield-attributes, yield and economics from okra var. VRO-6 as influenced by Plant spacings

Treatment	Weight of pod (g)	Seeds /pod	Yield /plant (g)	Yield (q/ha)	Net income (Rs./ha)	B:C ratio
Plant spacings						
30x35cm	13.20	42.46	90.12	54.17	63997	2.43
30x45cm	14.90	43.66	116.19	58.06	71631	2.61
30x55cm	14.98	45.93	166.22	66.61	88882	2.99
CD (P=0.05)	**0.37**	**0.61**	**2.32**	**1.06**	**-**	**-**
Interaction	**NS**	**NS**	**Sig.**	**Sig.**	**-**	**-**

Fig.1 Growth and yield-attributing parameters of okra var. VRO-6 as influenced by fertility levels

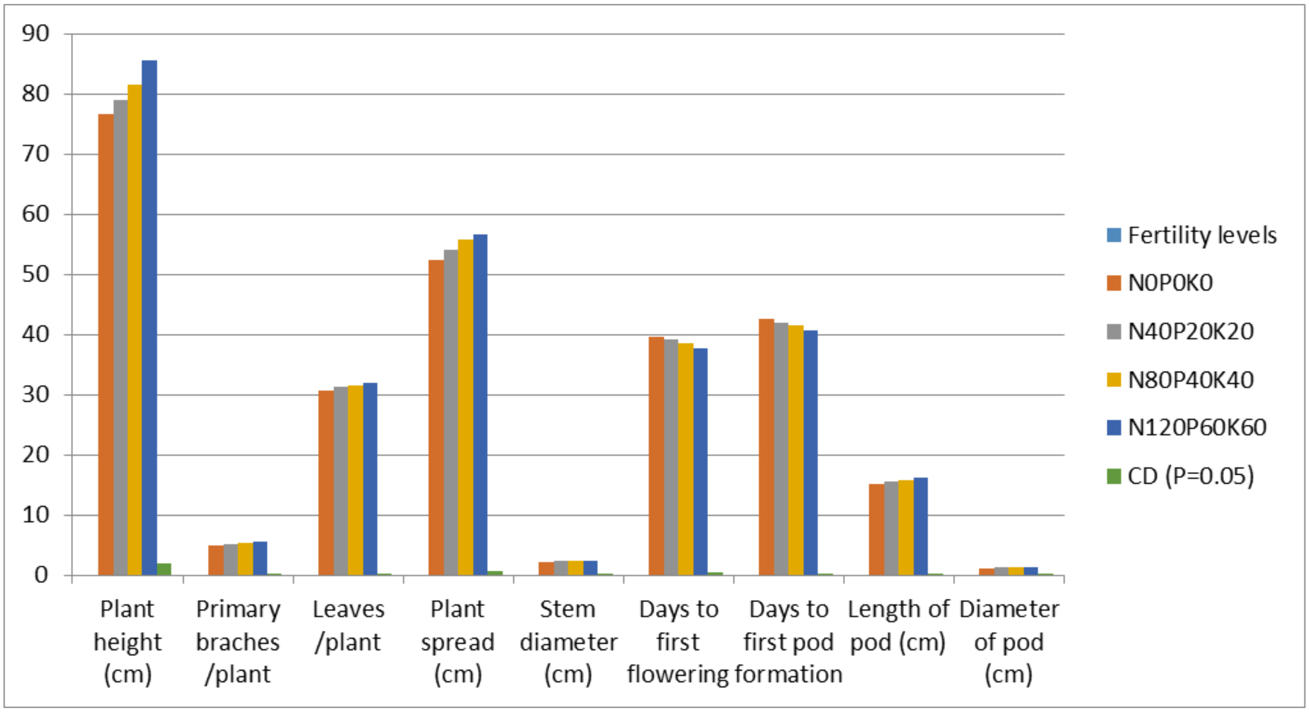


Fig.2 Growth and yield-attributing parameters of okra var. VRO-6 as influenced by plant, spacings

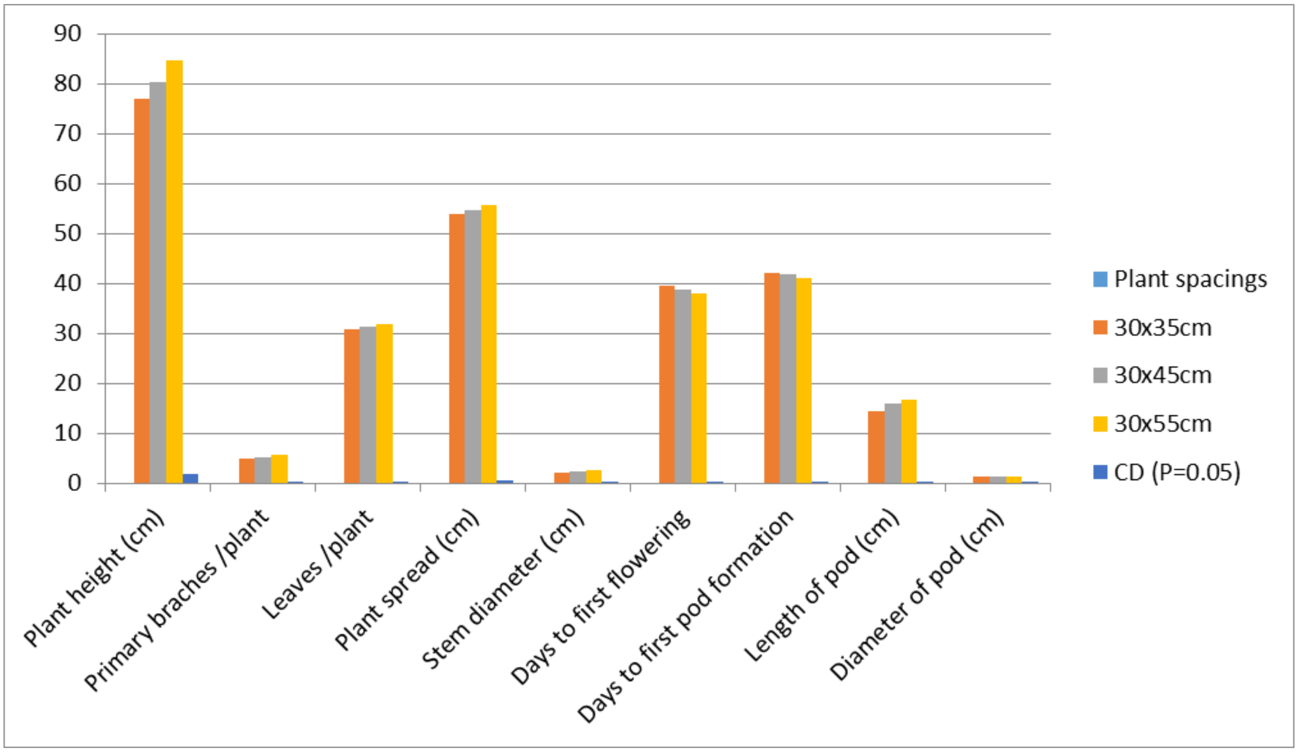
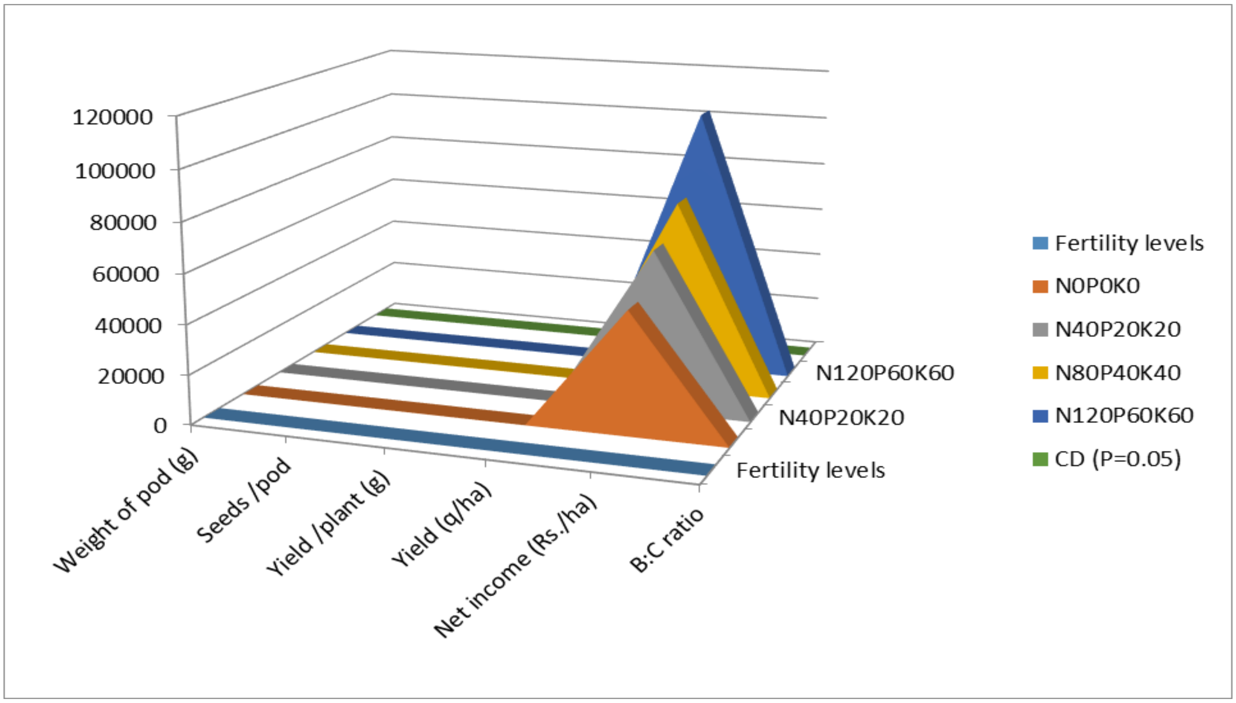


Fig.3 Yield-attributes, yield and economics from okra var. VRO-6 as influenced by fertility levels



The perusal of data indicated that increasing the fertility levels and plant spacing tended to decrease the period of the first flowering and consequently the first pod formation. Application of highest fertility level (N12oP601<so) resulted in first flowering in 37.61 days and first pod formation in 40.63 days. Whereas N0P0Ki, resulted in first flowering in 39.70 days and first pod formation in 42.57 days. That means, highest fertility reduced the vegetative period thereby first flowering and first pod formation occurred by about two days earlier Similar was the case with wider spacing between the plants where vegetative period reduced thereby first flowering and first pod formation occurred earlier by one day. The higher level of gibberellins has been reported to promote early flowering in crop plant. These findings were also supported by > Sere at al. (2011). Maximum days to first picking (57.33 days) was 174t recorded in Narita and Minimum (50.67 days) in Sonal (Tiwari and Singli 2003).

Yield attributing parameters

The yield attributes are directly responsible for ultimate okra production which were augmented significantly due to increasing levels of fertilizers and plant spacing. Therefore the highest fertility level (N120 P601(60 recorded significantly higher pod length (16.24 cm), pod diameter (1.33 cm) weight of pod (15.89 g), number of seeds (45.03 seeds/pod) and yield (118.68 g/plant). The highest yield attributes from highest fertility level may be owing to maximum increase in growth parameters (height, branches, leaves. stem diameter plant spread). The improvement in yield components due to fertility levels might have resulted from their favorable influence on growth and yield attributes as well as dry matter accumulation, an efficient and greater partitioning of metabolites, adequate photosynthates and nutrients to the developing reproductive structure. Singh *et al.*, (2005) mentioned that the improvement in the yield and yield attributor traits may be ascribed to the improved vegetative growth due to NPK fertilization facilitating photosynthesis thereby increasing translocation of organic food materials in the fruits from stem and leaves which accelerated the formation and development of fruits exhibiting greater size and weight thus increasing the yield. These findings corroborate with those of many researchers Shanke *et al.,* 2003; Khan, 2006; and Rahman *et al.,* 2012.The yield attributing parameters were enhanced significantly with the increase in the spacing between the pants. Thus the widest spacing (30 x 55 cm) resulted in maximum pod length (16.63 cm), pod diameter (1.32 cm), weight of pod (14.98 g) number of seeds (45.93/pod) and yield (110.65 g/pod). The maximum yield attributes under widest spacing may be owing to maximum increase in the growth parameters (height, branches, leaves, stem diameter and plant spread) which means adequate photosynthates production and greater partitioning of metabolites and nutrients towards the reproductive organs. This was eventually happened as a result of reduced competition between widely spaced plants for space, light, nutrients and moisture. These favorable conditions increased the growth parameters upto maximum extents. These results are in close agreement with those Bajpai *et al.,* 2004; Singh *et al.,* 2005 and Ram Harischand, 2013).

Productivity and economics

The application of highest fertility level (N120 P601<60) brought about the significantly higher okra yield (76.89 q/ha0 over the lower fertility levels. ConsequentiV the net income was also obtained highest (Rs. 107572/ha) with B: C ratio 3.33. This net income was higher by Rs. 57961/ha over NoPoKo. The increased productivity fruit yield was due to increased yield — attributes under highest fertility level which fetched maximum price from the market sale of the produce. Similar findings have also been reported by. Shanke *et al.,* (2003), Singh *et al.,* (2005), Khan (2006) and Rahamat *et al.,* (2012).The widely placed plants provided increased fruit yield as well as economical gain from okra cv. VRO-6. The widest plant spacing upto 30 x 55 cm resulted in significantly higher okra yield (66.61 q/ha) over the closer spacing. Accordingly the maximum net income was obtained up to Rs. 88882/ha with B: C as compared to the closest spacing (30 x 35 cm).It is evident from these findings that the widely spaced plants (means loser plant population per unit area) might have encouraged the fullest and efficient interception of solar radiation and utilization of soil nutrients moisture and space. This situation consequently resulted in increased yield attributes and yield. Therefore wider spacing most have compensated the loss in yield due to lower plant population. On the other hand, closer spacing (30 x 35 cm and 30 x 45 cm) resulted in greater competition amongst the growing plants for space, light, moisture and nutrients leading to lowered yield attributes and yield okra. The highest yield and income from widest spacing was owing to the highest yield attributes obtained under this spacing. These results confirm the findings of Bajpai *et al.,* (2004) Singh *et al.,* (2005), Maurya and Pal (2002) and Ram Harischand (2013).

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