



Effect of spacing, fertilizers and varieties on growth and yield parameters of okra (*Abelmoschus esculantus* (L.) Moench)

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Abstract: The experiment was conducted during spring summer seasons of 2013 and 2014 conducted at Research Farm of Vegetable Science, CCS HAU, in summer season. There were three spacing, three fertilizer levels and two varieties in split-split plot design with three replications. Growth parameters of okra crop were significantly affected by spacing, fertilizer and varieties. Highest plants were observed in wider spacing with fertilizer application of 187.5 kg N + 75 kg P₂O₅ + 60 kg K₂O per hectare in variety HBT-49-1. However, numbers of branches were highest in variety Hisar Unnat. Yield attributes like first fruiting node, intermodal length, fruit length and diameter etc. were highest in variety HBT-49-1 resulting in highest fruit yield (q/ha) in spacing 30 cm x 10 cm with the application of 187.5 kg N + 75 kg P₂O₅ + 60 kg K₂O per hectare. The seed yield attributes and yield was significantly affected by spacing, fertilizer and varieties. Finally, spacing 30 cm x 10 cm resulted in higher growth parameters, yield attributes and yield with the application of 187.5 kg N + 75 kg P₂O₅ + 60 K₂O in variety HBT-49-1 of okra.

Keywords: Fertilizer, Okra Spacing, Varieties, Yield

INTRODUCTION

Okra [*Abelmoschus esculantus* (L.) Moench] is one of the most important summer vegetable crop grown for its immature fruits, which are commonly used in culinary preparation. Its tender green fruits are also canned, dehydrated or frozen for off season consumption. The crop is grown in both spring-summer (February-May) and rainy seasons in tropical and subtropical regions of the country. In North India, spring-summer crop remains free from the infections of yellow vein mosaic virus disease and fetches better price in the market. In India, the second largest producer of okra after China, it occupies an area of 4.98 lakh hectares with average production and productivity of 57.48 lakh tonnes and 11.75 t/ha, respectively, and is 3.9% of total vegetable production (Vanitha *et al.*, 2013), while in Haryana, it occupies an area of 18,200 hectares with an average production and productivity of 1.45 lakh tonnes and 7.96 tonnes/ha, respectively (Anonymous, 2011).

The main okra growing areas of Haryana State are Sonapat, Karnal, Panipat and Hansi where the farmers grow okra on both sides of the ridges by dibbling 4 to 5 seed per hill at very close spacing using 50-60 kg seed compared to recommended rate of 20-25 kg/ha and 3-4 times higher amount of nitrogen against rec-

ommended dose of 100 kg /ha. Application of exceptionally high nitrogen dose in a number of split applications in the standing crop helps to extend the harvesting period and increase the fruit yield significantly. It has been recommended to grow spring-summer crop of okra at 30 x 20 cm spacing with nitrogen 100 kg and phosphorus 50 kg/ha in Haryana. Nath *et al.* (1987) have advocated 30 x 15 cm and 30 x 13 cm spacing, respectively for growing okra during summer season. A new promising advance line HBT-49-1 of okra found superior to check Hisar Unnat for yield in station trail of three years in spring-summer on recommended spacing and dose of fertilizers. It has been observed that each genotype has its own requirement of spacing and fertilizer for proper growth and development in a particular season since okra is a photosensitive crop. HBT-49-1 has different plant canopy (taller and stout) than earlier released varieties Hisar Unnat and Varsha Uphar. Hence, the present study has been planted to find out the effect of spacing and fertilizer on growth and yield of okra, *A. esculantus*.

MATERIALS AND METHODS

The present study was carried out at the Research Farm of the Department of Vegetable Science, CCS HAU, Hisar during spring-summer season, 2013 and 2014. Hisar is situated between 29° 10' N latitude and

15° 46'E longitude at mean elevation of 215.2 meter above mean sea level, has a semi arid, sub-tropical climate, hot and dry winds during summer and dry severe cold in the winter are the common features of this region. The mean maximum and minimum temperature of 42^o to 46^oC is quite common during summer months (May-June). The rainfall is restricted mainly to the monsoon months from July to September, but sometime pre-monsoon showers occur in June also. The soil of this area is derived from Indo-Gangentic alluvium, which is very deep and sandy loam in texture. The pH of the soil varies from 7.8 to 8.9 since these soil are poor in organic carbon, available nitrogen, medium in phosphorus and rich in potash content. The experimental material for the present investigation was comprised of two varieties, three spacing and three fertilizer levels. The experiment with two varieties (Hisar Unnat and HBT-49-1), three spacing (30 x 5 cm, 30 x 10 cm and 30 x 15 cm) and three fertilizers levels (150 kg N + 60 kg P₂O₅, 187.5 kg N + 75 kg P₂O₅ + 60 kg K₂O and 225 kg N + 90 kg P₂O₅ + 60 kg K₂O) in okra was laid out in split-split block design with three replications. In each replication, there were 18 plots and each plot was of 3.6 m x 3 m size accommodating three rows. 2-3 seeds per hill were sown and later thinned to one plant per hill. Recommended package of practices for other operations were followed to raise a healthy crop. Composite soil sample were taken from four different place of experimental field from a depth of 0-15 cm during season. The samples were analyzed to determine mechanical and chemical and composition of the soil. The soil was sandy loam with sand (55%), silt (34%) and clay (11%). The chemical properties like electrical conductivity was 0.30 (dS/m at 25^oC), pH (1:2.5: water) 8 (alkaline), and organic carbon (0.6%). The available nitrogen was 320 kg/ha (low), phosphorus (17kg/ha) (medium) and potassium was 307 kg/ha (rich).

RESULTS AND DISCUSSION

Growth studies in okra

Effect of spacing: Spacing 30 x 15 cm and 30 x 10 cm significantly produced taller plants at 45, 60 and 75 days after sowing and at harvest as compared to spacing 30 x 15 cm, but on par with each other. Spacing 30 x 15 cm significantly resulted into higher number of branches (2.31) in okra as compared to 2.20 and 1.84 in 30 x 10 and 30 x 5 cm spacing, respectively (Table 1). It might be due to more competition for light, space between the crop plants and okra height when grown at closer intra- row spacing of 30 cm than when grown at a wider intra-row spacing of 40 cm. Hossain *et al.*, (2001) also reported greater plant height from closer intra-row spacing than from wider intra-row spacing. Similar results were obtained by Gorachand *et al.*, (1990) and Randhawa and Pannum (2000). As per the observation made by Ekwu and

Nwokwu (2012), plant height increased as the plant spacing increased from 50 cm x 25 cm to 50 cm x 50 cm beyond which there was decrease in plant height, confirmed the results. The maximum number of branches (2.31) was obtained with 30 cm row to row spacing at 15 cm. The reduced competition for light and other resources as well as reduced overlapping from adjacent okra plants within the population could have enabled the plants to utilize its energy for maximum branching. This result was similar to the findings of Saha *et al.*, (2005), Ijoyah *et al.* (2010) and Maurya (2013) who reported a greater branch number at wider intra- row spacing of 40 cm compared to that produced from a reduced intra-row spacing of 20 cm. Moreover, the vegetative growth characteristics results obtained may be attributed to the varying levels of intra-specific competition caused by the three plant spacing utilized in the experiment. In nature the competition effect may be completely absent until population density reaches some threshold at which resources become limited (Talukder *et al.*, 2003 and Makinde and Macarthy; 2006).

Effect of fertilizer levels: Plant height of okra at different time intervals i.e. 37.16 cm at 45, 69.55 cm at 60, 110.35 cm at 75 days after sowing and 134.41 cm at final harvest was found maximum with fertilizer application of 187.5 kg N + 75kg P₂O₅ + 60 kg K₂O as compared to all other treatments. Plant height is a vegetative trait and height responds well to N availability. The basic function of nitrogen in plant is increased vegetative growth through cell elongation and cell enlargement. Nitrogen increased the growth photosynthetic activity of plant by stimulating its vegetative growth (Banger *et al.*, 2000; Kushwaha, 1989; Chaurasia *et al.* 2001; Misra and Singh, 2005 and Kumar *et al.*, 2013). Higher availability of nitrogen induced higher plant height in okra up to 25% higher recommended dose of N and P + 50kg potash but beyond this, the threshold limit may arise which failed to respond to 50% higher recommended dose of N and P + 50kg potash (F₃: 225 kg N + 90kg P₂O₅ + 60 kg K₂O). The number of branches per plant was maximum in 50% higher recommended dose of N and P + 50kg potash (F₃: 225 kg N + 90kg P₂O₅ + 60 kg K₂O) (Table 1). This may be explained that partitioning of the nitrogen and phosphorus in to different components of the plant resulted into higher demand of nutrients and established a source and sink relationship. Application of higher doses of P increased the number of branches. The results are in conformity with Prasad and Naik (2013) conducted an experiment having different treatments resulted in significant effect on number of branches per plant. The maximum number of branches (3.97) was obtained by the application of biofertilizer (*Azotobacter* + *Azospirillum* + PSB) + FYM (15 t/ha) + RDF (50%) NPK/ha followed by (3.47) respectively with application of RDF + FYM (15t/ha) and bio-fertilizer (*Azotobacter*) + FYM (15t/ha). Among the different treat-

Table 1. Effect of spacing, fertilizer and varieties on plant height at 45, 60, 75 days after sowing and at final harvest and number of branches of okra.

Treatments Spacing	Plant height (cm)				
	45 DAS	60 DAS	75 DAS	At final harvest	No. of branches
S ₁ : 30 cm x 5 cm	37.45	69.60	110.94	134.50	1.84
S ₂ : 30 cm x 10 cm	36.50	68.51	109.50	133.63	2.20
S ₃ : 30 cm x 15 cm	30.70	63.73	105.38	129.30	2.31
SEm±	0.51	0.29	0.51	0.38	0.02
CD at 5%	2.00	1.11	2.00	1.50	0.07
Fertilizer					
F ₁ : 150 kg N + 60 kg P ₂ O ₅ (RD)	32.09	64.73	106.78	130.30	1.86
F ₂ : 187.5 kg N + 75 kg P ₂ O ₅ + 60 kg K ₂ O	37.16	69.55	110.35	134.35	2.24
F ₃ : 225 kg N + 90 kg P ₂ O ₅ + 60 kg K ₂ O	35.41	67.56	108.67	132.31	2.26
SEm±	0.74	0.32	0.52	0.39	0.06
CD at 5%	2.23	0.99	1.61	1.20	0.18
Varieties					
V ₁ : Hisar Unnat	33.13	65.31	105.41	128.81	2.16
V ₂ : HBT-49-1	36.64	69.25	111.79	136.52	2.07
SEm±	0.93	0.33	0.76	0.43	0.03
CD at 5%	2.77	0.99	2.27	1.28	0.08

Table 2. Effect of spacing, fertilizer levels and varieties on yield attributes and yield of okra.

Treatments	First fruiting node	Internodal length (cm)	Fruit length (cm)	Fruit diameter (cm)	Fruit weight (g)	No. of fruits per plant	Fruit yield (q/ha)
Spacing							
S ₁ : 30 cm x 5 cm	6.15	5.15	8.61	1.40	7.31	29.69	124.20
S ₂ : 30 cm x 10 cm	5.42	4.81	8.72	1.44	7.73	35.27	126.51
S ₃ : 30 cm x 15 cm	5.61	4.65	8.64	1.45	7.96	31.20	114.79
SEm±	0.09	0.10	0.13	0.01	0.06	1.01	0.113
CD at 5%	0.36	0.37	NS	0.04	0.22	3.94	0.441
Fertilizer							
F ₁ : 150 kg N + 60 kg P ₂ O ₅	5.33	4.18	8.34	1.39	7.46	31.07	113.55
F ₂ : 187.5 kg N + 75 kg P ₂ O ₅ + 60 kg K ₂ O	5.40	5.17	9.01	1.46	7.86	33.30	126.70
F ₃ : 225 kg N + 90 kg P ₂ O ₅ + 60 kg K ₂ O	6.46	5.26	8.63	1.44	7.68	31.79	125.25
SEm±	0.08	0.08	0.11	0.02	0.10	0.47	0.287
CD at 5%	0.25	0.24	0.33	0.06	0.31	1.46	0.884
Varieties							
V ₁ : Hisar Unnat	5.36	5.05	8.43	1.41	7.33	30.50	118.63
V ₂ : HBT-49-1	6.11	4.70	8.89	1.45	8.00	33.61	125.03
SEm±	0.05	0.05	0.07	0.01	0.06	0.36	0.236
CD at 5%	0.14	0.15	0.21	0.02	0.19	1.08	0.702

ments, biofertilizer (PSB) + FYM (15t/ha) produced minimum number of branches (2.89/plant).

Effect of varieties: It was observed that plant height at different intervals (45, 60, 75 DAS and at final harvest) was significantly higher in variety HBT-49-1 but another character *i.e.* number of branches per plant were significantly higher in variety Hisar Unnat (2.16) as compared to 2.07 in HBT-49-1. The reason for higher plant height in HBT-49-1 is its genetic constitution which contributed in the higher plant height. The number of branches per plant was also at trait which is higher in case of Hisar Unnat (a selection of Sel 2-2 x Parbhani Kranthi) (Table 1). Likewise, days to 50 per cent flowering with plant height at genotypic level; plant height with number of branches per plant,

This indicates the inter dependency of the various characters on each other. Jayapandi and Balkrishnan (1992) and Chitra (1999) reported similar results.

Studies on yield attributes and yield of okra

Effect of spacing: Data pertaining to seven yield attributes *i.e.*, first fruiting node, internodal length, fruit length, diameter and weight, number of fruits per plant and fruit yield were presented in Spacing 30 × 10 cm significantly affected the yield attributes like first fruiting node and number of fruits per plant. First fruiting node was significantly earlier in 30 × 10 cm spacing but significant reduction in internodal length was observed in spacing 30 × 15 cm. Fruit length was not affected by any spacing. Fruit diameter (1.45 cm) and fruit weight (7.96 g) were significantly higher in spac-

ing 30 × 15 cm over 30 × 5 cm but on par with 30 × 10 cm. Significantly higher number of fruits and fruit yield (126.51 q/ha) were observed in spacing 30 × 10 cm over all the spacing (Table 2). Narrow spacing will result in higher plant population, higher competition for all the resource factors but in wider spacing, this competition will be less which imparts healthier plants and timely availability of all factors meant for higher yield (Saha *et al.*, 2005). The yield is a factor of plant population. Higher the plant population per unit area, higher will be yield in terms quintal per hectare. This explains the higher yield in spacing 30 cm × 10 cm as compared to 30 cm × 15 cm. (Gorachand *et al.*, (1990) where maximum okra yield was obtained from closer intra-row spacing of 25 cm. The conflicting results might also be due to the variation in the environment and differences in the genetic potential of the varieties used.

Effect of fertilizer levels: Recommended dose of nitrogen and phosphorus fertilizer resulted in earliness in first fruiting node. It also resulted in largest fruit diameter over all other fertilizer levels. But inter-nodal length of okra was significantly reduced (4.18 cm) by recommended dose of nitrogen and phosphorus as compared to 25 and 50% higher recommended dose of nitrogen and phosphorus. In contrast, application of 25% higher recommended dose of nitrogen and phosphorus plus 50 kg potash resulted in maximum fruit length, fruit weight, number of fruits per plant and higher fruit yield 126.70 q/ha. Higher fertilizer levels of nitrogen and phosphorus resulted in higher growth and development of the growth parameters which in turn provide more photosynthetic area for the accumulation and translocation of photosynthesis to the sink *i.e.* fruit (Table 2). Similar results were also reported by Pandey *et al.*, (1976). The maximum weight per fruit (8.82 g) were recorded 85 kg N/ha followed by 60 kg N/ha (7.32 g) and 35 kg N/ha (5.92) respectively. Wider spacing 60x30 cm recorded maximum weight per fruit (7.46 g) and superior to 45x30 cm (7.41 g) and 30 × 30 cm (7.13g) respectively. The quoted results are of present study not of Banger *et al.*

Effect of varieties : Earliness in first fruit node was seen in Hisar Unnat (5.36) as compared to HBT-49-1 (6.11). The intermodal length was higher in Hisar Unnat (5.05 cm) followed by 4.70 cm in HBT-49-1. Fruit length was higher in HBT-49-1 (8.89 cm) than 8.43 cm in Hisar Unnat variety of okra. Fruit diameter is higher in HBT-49-1 (1.45 cm) than Hisar Unnat (1.41 cm). Higher fruit weight (8.00 g), number of fruits per plant (33.61) and fruit yield (125.03 q/ha) was recorded in HBT-49-1 which are significantly higher than Hisar Unnat. Higher number of yield attributes resulted in higher yield in terms of quintals per hectare in HBT-49-1. The per cent increase in yield over Hisar Unnat is 5.39 in HBT-49-1. Fruit length showed highly significant and positive correlation with number of fruits per plant and internodal length (Table 2). Similar results were

also reported by Sood *et al.* (1993).

Conclusion

Spacing 30 cm x 10 cm resulted in higher growth parameters and yield attributes with the application of 187.5 kg N + 75 kg P₂O₅ + 60 K₂O in variety HBT-49-1 of okra. Growth parameters of okra crop were significantly affected by spacing, fertilizer and varieties. Highest plants were observed in wider spacing with fertilizer application of 187.5 kg N + 75kg P₂O₅ + 60 kg K₂O per hectare in variety HBT-49-1. However, numbers of branches were highest in variety Hisar Unnat. Yield attributes like first fruiting node, intermodal length, fruit length and diameter etc. were highest in variety HBT-49-1 resulting in highest fruit yield (q/ha) in spacing 30 cm × 10 cm with the application of 187.5 kg N + 75 kg P₂O₅ + 60 kg K₂O per hectare. The seed yield attributes and yield was significantly affected by spacing, fertilizer and varieties. Finally, spacing 30 cm × 10 cm resulted in higher growth parameters, yield attributes and yield with the application of 187.5 kg N + 75 kg P₂O₅ + 60 K₂O in variety HBT-49-1 of okra.

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