RESPONSE OF OKRA [*ABELMOSCHUS ESCULENTUS* (L.) MOENCH.] TO INTRA-ROW SPACING IN NORTHERN HILLS OF CHHATTISGARH

Amit Dixit* and Okesh Chandrakar

Department of Horticulture
Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.) 492012
Email: amitdixit1872@yahoo.in

Received-07.05.2015, Revised-16.05.2015

Abstract: Field experiments were conducted *Kharif* season, during the years 2010 and 2011 planting seasons at the northern hills of Ambikapur Chhattisgarh, to evaluate the response of 'Arka Anamika' variety of okra to different intra-row spacing and to determine the optimal intra-row spacing that would maximize yield under northern hills conditions. The treatments consisted of three intra-row spacing (35 cm, 30 cm and 25 cm), replicated four times in a randomized complete block design. Results of the study showed that while the tallest okra height was produced from the intra-row spacing of 30 cm, the number of branches per plant, leaf area, pod length, pod diameter, number of pods per plant, pod weight and yield decreased as intra-row spacing reduced. The greatest yield was obtained from the intra-row spacing of 35 cm. The yield produced from the intra-row spacing of 35 cm was significantly ($P<0.05$) greater by 6.00 and 6.12 tone/ha respectively, in the year 2010 and 2011 compared to that obtained from the intra-row spacing of 30 cm and by 5.00 and 5.10 tone/ha respectively, in the year 2010 and 2011 compared to that produced from the intra-row spacing of 25 cm. The implication of this study showed that to maximize okra yield for variety 'Arka Anamika' the optimal intra-row spacing was found to be 35 cm and could therefore, be recommended for northern hills region of, Ambikapur C.G.

Keywords: Okra, Spacing, Yield, Variety

INTRODUCTION

Okra (*Abelmoschus esculentus* L. Moench) is one of the most important vegetable crops in India covering an area of 3.58 lakh hectare with an annual production of about 35.25 lakh tones (FAO, 2013). In Chhattisgarh state, it is cultivated on an area of 2050 ha with an annual production of 28700 metric tons (Anonymous, 2013). In grown in tropical and subtropical parts of the world (Absar and Siddique, 1992). In India, it is among the foremost vegetable crops, in terms of consumption and production area (Iremiren and Okiy, 1999).

The immature pods are used as boiled vegetable while its dried form is used as soup thickner (Owonubi and Yayock, 1981). The green pods are rich sources of vitamins, calcium, potassium and other minerals (Lee *et al.*, 2000). It is popularly grown by farmers both for home use and source of income. There are several reasons for poor growth and yield of okra, among those, intra-row spacing play an important role (Yadev and Dhankhar, 2005).

The intra-row spacing for optimal okra seed yield as recommended by different authors ranged from 20 to 40 cm (Hossain *et al*., 2001 and Rastogi *et al*., 2001). Sing *et al*., (1996) reported a taller okra height when grown at a closer intra– row spacing of 30 cm than when grown at a wider intra–row spacing of 40 cm. Similarly, Ghanti *et al*., (1991) observed progressive yield decreases of up to 0.5 t/ha for each reduced intra–row spacing from 30 cm.

Yield decreases of 'Arka Anamika 'okra varieties attributable to reduced intra-row spacing have been reported by Iremiren and Okiy (1999). Similarly, Ezeakunne (2004) reported that the yield components of 'Arka Anamika'' okra variety, such as pod length, pod diameter, number of pods and pod weight were relatively higher in value at wider intra-row spacing of 35 and 30 cm than at reduced spacing. He attributed this to a greater assimilation of growth resources for the plants grown at the wider spacing.

MATERIAL AND METHOD

The experiment was conducted *Kharif* season, during the years 2010 and 2011 planting seasons, at the Research station RMDCARS Ambikapur (C.G.) to evaluate the response of 'Arka Anamika' variety of okra to different intra-row spacing. The 'Arka Anamika', an improved okra variety in terms of yield, shows wide adaptation to different growing environment (Usman, 2001). The experimental area (84.0 m²) which consisted of sandy–loam soil was cleared, ploughed, harrowed, ridged and divided into twelve plots. Each plot had an area of 7.0 m². The plot consisted of four ridges spaced 90 cm apart. The treatments constituted the three intra-row spacing (35 cm, 30 cm and 25 cm) respectively, for the 'Arka Anamika' okra variety. The treatments were arranged in a randomized complete block design (RCBD) and replicated four times. Okra seeds were sown in a hole to a depth of 2 cm, on top of the ridges using the intra–row spacing specified for each plot. Three seeds were sown per hole and later thinned to one plant at 2 weeks after planting (WAP). The plots were manually weeded as the need arose. Mixed fertilizer NPK 200,100,100 kg ha^{-1}. Was applied as described by Ekpete (2000), using the side placement method of fertilizer application. The fertilizer was applied as a split application to the trial at 3 and 6 WAP.

*Corresponding Author

Harvesting was done in late September when the tip of pod was observed to break easily when pressed with the finger tip (Usman, 2001).

Data taken included plant height at 50 % flowering, number of branches per plant, leaf area, pod length, pod diameter, number of pods per plant, pod weight and yield (t/ha). The data were subjected to Analysis of Variance (ANOVA) while the Least Significant Difference (LSD) was used to separate treatment means following the procedure of Steel and Torrie (1980) number of rainy days (Table 1). The average monthly temperature for the two years ranged from 25.1 °C to 33.2 °C, while the average relative humidity ranged from 78.0 % to 80.0 % for the two years (Table 1). The average monthly temperature and relative humidity range were considered optimal for the growth and development of okra. Katung (2007) reported optimum growth and development for okra at temperature of 32 °C while Ezeakunne (2004) observed an improvement in the performance of okra with the relative humidity range of 75 to 85 %. Similar results were reported by Yamaguchi (1983).

RESULT AND DISCUSSION

Rainfall occurred from the months of July to September for the two years of study. The month of July recorded the highest amount of rainfall and highest number of rainy days (Table 1). The average monthly temperature for the two years ranged from 30.72°C to 31.20°C, while the average relative humidity ranged from 78.0% to 82.0% for the two years (Table 1). The average monthly temperature and relative humidity range were considered optimal for the growth and development of okra. Katung (2007) reported optimum growth and development for okra at temperature of 32 °C while Ezeakunne (2004) observed an improvement in the performance of okra with the relative humidity range of 70 to 85 %. Similar results were reported by Yamaguchi (1983)

Table 1. Meteorological information for Ambikapur, CG. (July– September) 2010 and 2011.

Months	Average monthly rainfall (mm)	Average monthly temperature (^{0}C)		Average relative humidity (%)
2011		Maximum	Minimum	
July	208	30.72	30.72	78.0
August	160	30.80	30.82	80.0
September	177	28.32	28.30	80.0
2012				
July	226	32.22	32.20	73.0
August	170	29.40	29.4 0	77.0
September	180	31.20	31.20	79.0

The Physico–chemical property of the soil of the experimental site in the year 2010 and 2011 is given in Table 2. Total nitrogen value in the soil over the two years was low (2.58 %% and 2.60 %). Similarly, the soil had a medium level of phosphorus (5.2 ppm and 5.6 ppm) with a corresponding low level of potassium (0.22 % and 0.32 %) respectively, for the year 2010 and 2011. Relatively moderate amounts of exchangeable bases (Ca g) were present in all the soil units. Over the years, organic matter was low (2.50% and 2.60 %), while the pH in water was near neutral (Table 2). The growth and yield components of 'Arka Anamika' variety of okra as influenced by different intra-row spacing in Research station RMDCARS Ambikapur, in years 2010 and 2011 is presented in Table 3.

Table 2. Physico-chemical properties of the soil of the experimental site in the year 2010 and 2011.

Soil analytical data			
Parameters'	**2010**	**2011**	**Method of analysis**
Organic matter	2.5 %	2 .6%	Walkley-Black method
Nitrogen	2.58 %	2.60 %	Alkaline Permanganate Method (Subbiah and Asija, 1956)
P_2O_5	5.2 ppm	5.6 ppm	Olsen's Method (Olsen, 1954)
K	0.22%	0.32 %	Flame Photometric Method (Jackson, 1967)
Ca	2.98meq/100g	4.66meq/100g	A. A. S
pH (H_2O)	6.8	6.4	pH meter
pH ($Cacl_2$)	5.9	5.4	pH meter

ppm: parts per million

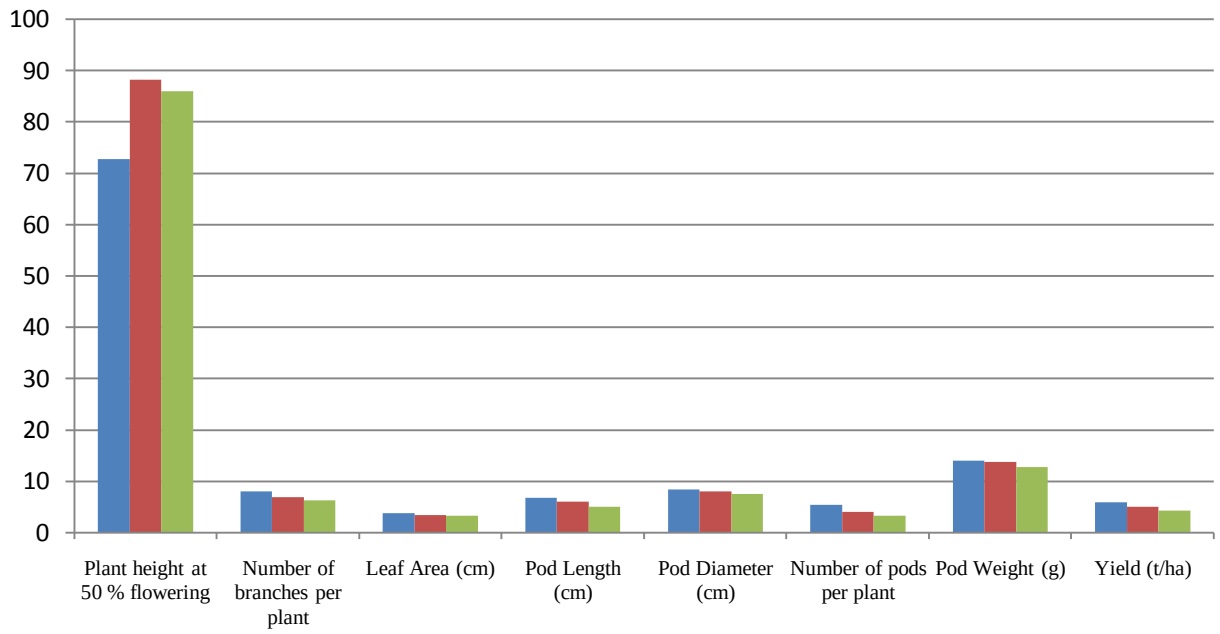
A.A.S.: Atomic Absorption Spectrophotometer

Table 3. Growth and yield components of 'Arka Anamika' variety of okra as influenced by different intra–row spacing in RMDCARS Ambikapur, in years 2010 and 2011.

	Plant height at 50 % flowering (cm)		Number of branches per plant		Leaf Area (cm)		Pod Length (cm)		Pod Diameter (cm)		Number of pods per plant		Pod Weight (g)		Yield (t/ha)	
Intra-row spacing	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011
35 cm	86.22	72.85	8.96	8.10	406.10	388.12	8.55	6.90	8.10	8.50	7.10	5.50	15.10	14.10	6.10	6.00
30 cm	92.12	88.33	7.66	6.94	388.14	350.55	8.10	6.12	7.80	8.10	6.50	4.10	13.36	13.90	5.00	5.10
25 cm	91.55	85.98	6.98	6.35	365.98	338.98	6.92	5.10	7.20	7.60	5.60	3.38	12.90	12.90	4.50	4.40
mean	89.96	82.38	7.86	7.13	386.72	359.21	7.85	6.04	7.70	8.06	6.40	4.46	13.78	13.46	5.20	5.16
LSD	4.46	5.52	0.62	66.35	16.30	11.70	5.72	4.12	3.92	3.98	2.98	2.90	1.12	0.22	1.00	0.28
(P=0.05) CV (%)	13.12	9.98	19.12	713.32	7.80	8.62	10.80	19.10	6.56	5.72	11.12	15.56	15.20	16.20	5.20	6.72

fig 1: Growth and yield components of 'Arka Anamika' variety of okra as influenced by different intra–row spacing in RMDCARS Ambikapur, in years 2010

fig 2: Growth and yield components of 'Arka Anamika' variety of okra as influenced by different intra–row spacing in RMDCARS Ambikapur, in years 2011



The tallest okra height was produced from the intra-row spacing of 30 cm, which was significantly ($P<0.05$) greater than that produced from the wider intra-row spacing of 35 cm. However, plant height obtained from the intra-row spacing of 30 cm and that recorded for 25 cm showed no significant difference (Table 3). The taller plants obtained from the intra-row spacing of 30 cm and 25 cm over the years might be attributed to the competition for light and other growth resources among the crops that were crowded at the closer intra-row spacing, thereby resulting in the production of taller plants. This result supports Sing *et al*., (1996) who reported a greater 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).

The number of branches per plant and leaf area decreased as intra-row spacing reduced. Over the years, the greatest branch number and largest leaf area were obtained from the intra-row spacing of 35 cm, which were significantly ($P<0.05$) greater than those produced at reduced intra-row spacing of 30 cm and 25 cm respectively. The reduced competition for light and reduced overlapping from adjacent okra plants within the ridge could have enabled the plants grown at the intra-row spacing of 35 cm to utilize its energy for maximum branching and subsequently, the production of a larger leaf area. This result was similar to the findings of Saha *et al*., (2005) 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 25 cm.

The pod length and pod diameter of okra were not significantly affected by the three intra-row spacing employed. This result contradicted those of Moniruzzaman *et al*., (2007) where pod length and pod diameter significantly reduced at closer intra-row spacing. These conflicting results might be due to the difference in the environmental pattern of the study locations and to the variation in the genetic potential of the variety used.

The number of pods per plant decreased as intra-row spacing reduced. The intra-row spacing of 30 cm produced the greatest number of pods per plant. The number of pods produced from the intra-row spacing of 35 cm was significantly ($P<0.05$) greater by 7.10 and 5.50 plant^{-1} respectively, in 2010 and 2011compared to that obtained from the intra-row spacing of 30 cm and by 6.50 and 4.10 plant^{-1} respectively, in 2010 and 2011compared to that obtained from the intra-row spacing of 25 cm. The greatest number of branches per plant obtained from the intra-row spacing of 30 cm might have also contributed to its greatest number of pods produced.

The greatest pod weight and yield were obtained from the intra-row spacing of 30 cm. Plants grown at the wider intra-row spacing might have received more nutrition and light for optimal growth and development, thereby producing the greatest pod weight and yield. Similarly, the largest leaf area

produced from the intra-row spacing of 35 cm might have also accounted for its greatest pod weight and yield. The yield produced from the intra-row spacing of 35 cm was significantly ($P<0.05$) greater by 15.10 and 14.10 gm respectively, in 2010 and 2011compared to that obtained from the intra-row spacing of 30 cm and by 13.36 and 13.90 gm respectively, in 2010 and 2011compared to that produced from the intra-row spacing of 25 cm. This result was similar to the findings of Hossain *et al*., (2001), but contradicted those of Gorachand *et al*., (1990) and Ghanti *et al*., (1991) 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.

CONCLUSION

From the results obtained, it can be concluded that in RMDCARS Ambikapur, in years 2010 and 2011which, the optimal intra-row spacing for 'Arka Anamika 'okra variety was found to be 35 cm. This is associated with a greater number of branches per plant, leaf area, pod length, pod diameter, number of pods per plant, pod weight and yield respectively. It is however, recommended that further investigation of study be evaluated across a wider combination of okra varieties and across different locations within the northern hills of Chhattisgarh.

REFERENCES

Absar, N. and Siddique, M.A. (1992). Influence of plant density on the yield of three varieties of okra *Bangladesh Journal of Agriculture*, 7 (3-4): 15–21.

Anonymous, (2013). India Horticulture Database. National Horticulture Board.

Anonymous (2013). Area, production and Productivity. Directorate Horticulture, Ministry of Agriculture, Government of Chhattisgarh, Raipur (C.G.)

Ekpete, D.M. (2000). Analysis of responses to fertilizer by intercrops. *Nigerian Agricultural Journal*, 13: 96-102.

Ezeakunne, C. O. (2004). Large scale fruit and vegetable production in Nigeria. Extension Bulletin, Ahmadu Bello University, Zaira, 8pp.

Ghanti, P., Sounda, E and Verma, P. K. (1991). Effect of plant spacing on growth and yield of different bhindi varieties. *Environment and Ecology Journal*, 9: 176-179.

Gorachand, M., Malik, O. and Mondal, G. (1990). Growth and yield of bhindi (*Abelmoschus esculentus* L. Moench) as influenced by time of sowing and plant density, *Orissa Journal of Horticulture*, 18: 26–31.

Hossain, M. D., Rahman, M. A., Hoque, M. M. and Salem, M. A. (2001). Year round okra production and economic return as influenced by spacing in Barisal region. *Bangladesh Journal of Agricultural Research*, 25: 319–328.

Iremiren, G. O. and Okiy, D. A. (1999). Effect of spacing on the growth, yield and quality of okra in Southern Nigeria. *Journal of Agricultural Science*, U. K. 106 (1): 12–26.

Jackson, M.L. (1967). *Soil Chemical Analysis*, Prentice Hall of India Pvt. Ltd., New Delhi, pp. 205.

Katung, M. D. (2007). Productivity of okra varieties as influenced by seasonal changes in Northern Nigeria. *Agrobot*. 35 (1): 65–71.

Lee, K. H., Cho, C. Y., Yoon, S. T. and Park, S. K. (2000). The effect of nitrogen fertilizer, plant density and sowing date on the yield of okra. *Korean Journal of Crop Science*. 35(8): 179–183.

Moniruzzaman, M., Uddin, M. Z. and Choudhury, A. K. (2007) Response of okra seed crop to sowing time and plant spacing in South Eastern hilly region of Bangladesh. *Bangladesh Journal of Agricultural Research*, 32(3):393–402.

Owonubi, J. J and Yayock, J. Y. (1981). Climatic limitations to crop production in the savanna region of Nigeria. 1st National Seminar on Green Revolution in Nigeria. Technical and Environmental Perspective Session, 21st September, 1980, 81pp.

Randhawa, G. S. and Pannum, M. S. (2000). The effects of rospacing on the growth and yield of okra. *Punjab Agric University Research Journal*, 6: 320–324.

Rastogi, K. B., Shamma, P. P., Sing, N. P. and Karla, B.N. (2001). Effects of different levels of nitrogen and plant spacing on seed yield of okra. *Vegetable Science*, 14(2): 120-123

Saha, P. K., Aditya, D. K. and Sharfuddin, A. F. M. (2005). Effects of plant spacing and picking interval on the growth and yield of okra cv. Pusa sawani. *Bangladesh Horticulture*, 17: 10–14.).

Sing, K. P., Malik, Y. S., Lal, S. and Pandistha, M. L. (1996). Effects of planting dates and spacing on seed production of okra (*Abelmoschus esculentus* (L) Moench). *Haryana Journal of Horticultural Science*, 15(3-4):267–271.

Steel, R. G. D. and Torrie, J. H. (1980). Principles and Procedures of Statistics, Mc Graw–Hill, New York.

Usman, S. D. (2001). Seed Production and quality of okra as affected by sowing time. *Seed Research*, 29 (1): 47–51.

Yadev, S. K. and Dhankhar, B,. S. (2005). Performance of Varsha Uphar cultivar of okra as affected by plant spacing. *Vegetable Science*, 26(3): 180–182.

Yamaguchi, M. (1983). World Vegetables. Principles and Nutritive Values. Avi Publishing Company Inc. West Port, Connecticut, pp. 368- 37.