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Effect of planting geometry and nitrogen levels on crop growth, fruit yield and quality in okra grown during early winter in terai zone of West Bengal

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ABSTRACT

A field-experiment was conducted in early winter of 2006 and 2007 under sub-Himalayan terai agroclimatic region of West Bengal to evaluate comparative effect of planting geometry and nitrogen levels on growth, yield and fruit quality in okra variety Arka Anamika. The experiment was laid out in factorial randomized block design and replicated thrice, with four levels of nitrogen, viz., 50 kg, 100 kg, 150 kg and 200 kg ha^{-1} and four different spacings viz., 30 cm x 15 cm, 30 cm x 30 cm, 45 cm x 30 cm and 60 cm x 30 cm. Among different treatment combinations, application of 150 kg N ha^{-1} and 45 cm x 30 cm spacing recorded the highest number of fruits plant^{-1} (13.7), individual fruit weight (18.5 gm), fruit yield plant^{-1} (195.0 g), fruit yield ha^{-1} (12.2 t) and Vitamin C content in fruits (25.3 mg /100 g). Fertilization with 200 kg N ha^{-1} and 45 cm x 30 cm spacing recorded the highest value for nitrate content in fruits (658.1 mg kg^{-1}). The study amply revealed scope for growing okra crop profitably during early winter season of mild, cool-temperature by adopting nitrogen levels of 150 kg ha^{-1} with plant spacing of 45 cm x 30 cm in the terai agro-climatic region of West Bengal.

Key words: Okra, spacing, nitrogen levels, yield and quality

INTRODUCTION

Okra [*Abelmoschus esculentus* (L.) Moench; Malvaceae] is an important warm-season vegetable, widely cultivated for its tender, green fruits. India is the largest producer of okra in the world and exports considerable amount of fresh okra to the international market, after fulfilling domestic demand (Anon, 2005). In India, okra is mostly grown during pre-kharif (March to June) and kharif season (July to October). It is also grown during early winter season of mild cool temperatures when price remains very high and farmers earn handsome remuneration from such an okra crop. However, traditional cultivation practices promote use of excessive chemical fertilizers, particularly nitrogen, at irregular plant-spacing to obtain more branches and higher fruit-yield. As a result large amount of residual nitrogen remain in the soil after harvesting the crop, which affects ground-water quality, through leaching. Also, excess nitrogen encourages nitrate accumulation in fruits. Normally, higher amount of nitrogen fertilizer has a positive effect on fruit size, fruit weight and fruit yield. However, if the dose of nitrogen fertilizer crosses the limit, it increases nitrate accumulation in fruits, and may be toxic to human health (Sajjan *et al*, 2002). Adoption of optimum plant geometry facilitates efficient absorption of nutrients and adequate trapping of solar energy to have a positive effect on fruit yield. Several workers have standardized nitrogen levels and spacing in okra for pre-kharif and kharif seasons, but rarely for early-winter season. Therefore, an attempt was made to standardize nitrogen levels and plant geometry for growth, yield, quality and nitrate accumulation studies in okra during early-winter season of the terai region of West Bengal.

MATERIAL AND METHODS

A field study was conducted during early-winter season from September to December in 2005 and 2006 at the Instructional Farm, Uttar Banga Krishi Viswavidyalaya, Pundibari, Coochbehar, West Bengal (26^{o}192 862 2 N and 89^{o}232 532 2 E) at an elevation of 43m above MSL to arrive at suitable spacing and nitrogen levels for okra variety

Arka Anamika for better productivity and profitability. The soil was sandy-loam, with high organic carbon (0.96%) and available nitrogen (214.25 kg ha^{-1}), low phosphorus (29.17 kg ha^{-1}) and available potassium (58.56 kg ha^{-1}) with pH 5.13. Average monthly rainfall of 131 mm during September and October and no rainfall during the rest of the crop period were recorded. Maximum and minimum temperatures during crop period varied between 34.5 to 25.5ºC and 20.5 to 9.9ºC, respectively. The experiment was laid out in factorial randomized block design, with combination of four levels of nitrogen (50 kg (N_{50}), 100 kg (N_{100}), 150 kg (N_{150}) and 200 kg (N_{200}) and four different spacings (30 cm x 15 cm (S_{30x15}), 30 cm x 30 cm (S_{30x30}), 45 cm x 30 cm (S_{45x30}) and 60 cm x 30 cm (S_{60x30}). Total number of treatment combinations was 16, which was replicated thrice in plots of 3m x 3m size. An additional dose of 80 kg phosphorus and 80 kg potash ha^{-1} was applied. Inorganic fertilizers N, P and K were applied in the form of urea (46% N), single super phosphate (16% P_2O_5) and muriate of potash (60% K_2O), respectively. Farm Yard Manure (FYM) was applied during land-preparation and the total phosphorus, potash and ¼ of total nitrogen were applied at sowing. Remaining ¾ of total nitrogen was top-dressed in three equal splits at 21, 42 and 63 days after sowing. The crop was raised using standard cultural practices. Plots were irrigated as and when required. Weeding, hoeing and shallow earthing-up were done after each top-dressing of nitrogenous fertilizer. Plant protection measures were imposed at regular intervals to ensure optimal harvest.

Growth and yield attributes, namely, plant height, number of leaves per plant, leaf chlorophyll content, number of branches per plant, days to first fruit-picking, number of fruits per plant, individual fruit weight, fruit yield, Vitamin C and nitrate content of fruits were recorded and economics of cultivation worked out. Chlorophyll content in leaves was measured by a portable chlorophyll meter (SPAD 502; Minolta, Japan). Vitamin C content in the fruit was estimated by colorimetric estimation (Ranganna, 1986). Nitrate content of fruits was estimated by the method of Woolley *et al* (1960). Data were statistically analyzed by INDOSTAT statistical package.

RESULTS AND DISCUSSION

Results revealed that different doses of nitrogen, various spacings and their interaction significantly influenced important growth and yield parameters. There was a significant difference in plant height, number of leaves per plant, chlorophyll content of leaves (Table1), number of fruits per plant, individual fruit weight, fruit yield, Vitamin C and nitrate content of fruits (Table 2) for different spacings and levels of nitrogen. Soil application of nitrogen at 150 kg ha^{-1} recorded maximum number of fruits $plant^{-1}$ (12.0), individual fruit weight (16.8g), fruit yield ha^{-1} (11.2 t) and Vitamin C content of fruits (23.2 mg/100g), whereas, 200 kg N ha^{-1} gave highest plant height (108.7 cm), number of branches/plant (5.4) and nitrate content in fruits (582.3 mg kg^{-1}). Increase in plant height was greater with higher levels of nitrogen fertilizer application and closer spacing. This may be due to increased availability of nitrogen and close competition for sunlight. Shanke *et al* (2003) also recorded similar findings with tallest plants (68.9 cm) at 125 kg N ha^{-1} and shortest plants of (54.9 cm) with no application of nitrogen in okra variety Parbhani Kranti. Increase in yield

Table 1. Effect of plant-spacing and N level on growth attributes in okra (pooled data of two years)

Treatment	Plant height (cm)	Number of leaves/ plant	Chlorophyll content of leaves (SPAD-502 value)	Number of branches/ plant	Days to first fruit picking
S_{30x15}	100.5	24.6	45.3	2.9	44.4
S_{30x30}	94.1	26.1	46.9	3.3	46.4
S_{45x30}	91.0	27.5	48.2	3.9	47.2
S_{60x30}	87.3	30.1	49.2	5.1	50.3
S Em (±)	0.3	0.3	0.2	0.2	0.4
CD(*P=0.05*)	0.6	0.5	0.4	0.3	0.8
N_{50}	75.2	23.5	44.8	2.3	44.6
N_{100}	85.9	26.4	47.1	3.1	46.6
N_{150}	103.1	28.5	49.6	4.4	47.8
N_{200}	108.7	29.9	48.2	5.4	49.3
S Em (±)	0.3	0.3	0.2	0.2	0.4
CD (*P=0.05*)	0.6	0.5	0.4	0.3	0.8
S_{30x15} N_{50}	78.9	20.5	42.7	1.5	41.8
S_{30x30} N_{50}	76.1	22.8	43.5	1.7	44.3
S_{45x30} N_{50}	74.6	24.6	45.6	2.2	44.7
S_{60x30} N_{50}	71.3	26.1	47.5	3.8	47.7
S_{30x15} N_{100}	89.7	23.6	44.4	2.1	43.5
S_{30x30} N_{100}	86.5	26.1	46.3	2.3	46.5
S_{45x30} N_{100}	85.3	26.3	48.3	3.5	46.7
S_{60x30} N_{100}	82.2	29.4	49.2	4.4	49.7
S_{30x15} N_{150}	114.5	27.0	47.6	3.6	45.3
S_{30x30} N_{150}	105.4	26.8	49.4	4.3	47.2
S_{45x30} N_{150}	97.6	28.8	50.2	4.7	47.4
S_{60x30} N_{150}	94.9	31.4	51.0	5.1	51.0
S_{30x15} N_{200}	119.1	27.2	46.5	4.3	47.1
S_{30x30} N_{200}	108.6	28.7	48.5	4.8	47.5
S_{45x30} N_{200}	106.5	30.4	48.9	5.4	50.1
S_{60x30} N_{200}	100.6	33.4	49.0	6.9	52.7
S Em (±)	0.63	0.52	0.36	--	--
CD (*P=0.05*)	1.29	1.07	0.73	NS	NS

NS = Non-significant

Table 2. Effect of plant-spacing and N level on yield attributes and quality in okra (pooled data of two years)

Treatments	Number of fruits/ plant	Individual fruit weight (g)	Fruit yield/per plant (g)	Fruit yield/ha (t)	Vitamin C content in fruit (mg/100g)	Nitrate content in fruit (mg/100 g fresh weight)
S_{30x15}	9.5	13.3	131.6	8.4	18.0	275.3
S_{30x30}	10.7	14.7	143.0	9.6	20.5	301.7
S_{45x30}	12.4	16.4	161.3	10.6	22.1	357.1
S_{60x30}	11.8	15.8	156.5	9.6	22.1	317.7
S Em (±)	0.2	0.2	0.4	0.2	0.3	3.2
CD(*P=0.05*)	0.4	0.5	0.9	0.3	0.5	6.5
N_{50}	9.5	13.0	88.3	7.6	16.3	123.7
N_{100}	11.1	14.4	147.5	9.1	20.8	242.3
N_{150}	12.0	16.8	177.5	11.2	23.2	374.4
N_{200}	12.0	16.1	173.3	10.2	22.5	582.3
S Em (±)	0.2	0.2	0.5	0.2	0.3	3.2
CD(*P=0.05*)	0.4	0.5	0.9	0.3	0.5	6.5
S_{30x15} N_{50}	8.6	11.2	81.0	6.0	14.2	97.9
S_{30x30} N_{50}	8.8	12.9	85.0	7.8	16.3	122.9
S_{45x30} N_{50}	10.5	14.1	93.7	9.0	16.5	141.8
S_{60x30} N_{50}	10.1	13.9	93.5	7.8	18.0	132.2
S_{30x15} N_{100}	9.3	12.7	133.0	8.0	18.2	139.1
S_{30x30} N_{100}	10.1	13.8	145.1	9.5	20.6	145.0
S_{45x30} N_{100}	12.6	15.6	158.4	9.8	22.2	232.1
S_{60x30} N_{100}	12.4	15.5	153.4	9.1	22.2	169.0
S_{30x15} N_{150}	9.6	14.2	152.9	10.2	20.3	332.7
S_{30x30} N_{150}	11.3	16.8	168.1	10.9	22.6	380.5
S_{45x30} N_{150}	13.7	18.5	195.0	12.2	25.3	396.2
S_{60x30} N_{150}	13.3	17.7	192.9	11.4	24.8	388.1
S_{30x15} N_{200}	11.0	15.2	159.3	9.5	19.5	531.3
S_{30x30} N_{200}	12.7	15.3	173.8	10.2	22.5	558.5
S_{45x30} N_{200}	12.7	17.6	197.9	11.2	24.6	658.1
S_{60x30} N_{200}	11.4	16.3	186.4	10.0	23.3	581.3
S Em (±)	0.38	0.46	0.91	0.30	0.53	6.37
CD (*P=0.05*)	0.78	0.93	1.85	0.60	1.09	12.98

per unit area with increase in levels of nitrogen was also reported by Ambare *et al* (2005).

The highest number of fruits/plant (12.4), individual fruit weight (16.4g), fruit yield (161.3g plant^{-1}; and 10.5t ha^{-1}), nitrate content of fruits (357.0 mg kg^{-1}) and Vitamin C content of fruits (22.1 mg/100g) were recorded in 45 cm x 30 cm spacing. However, the maximum plant height (100.5 cm) was attained by plants spaced at 30 cm x 15 cm. Maximum number of leaves plant^{-1} (30.1), number of branches plant^{-1} (5.1), days to first fruit-picking (50.3) and chlorophyll content in leaves (49.2 SPAD value) were recorded in 60 cm x 30 cm spacing.

With reference to interaction effect, highest plant height (119.1 cm) was recorded by the treatment combination of 200kg N ha^{-1} and 30cm x 15cm spacing, whereas, the treatment combination of 200kg N ha^{-1} and 60cm x 30cm spacing recorded highest number of leaves plant^{-1} (33.4). The treatment combination of 150 kg N ha^{-1} and 45cm x 30cm spacing recorded the highest number of fruits plant^{-1} (13.7), individual fruit weight (18.5 g), fruit yield (195g plant^{-1} and 12.2t ha^{-1}) and Vitamin C content in fruits (25.3 mg/100g). The treatment combination of 200kg N ha^{-1} and 45cm x 30cm spacing recorded the highest value for nitrate content in fruits (658.1mg kg^{-1}), whereas, the treatment combination of 150 kg N ha^{-1} and 60cm x 30cm spacing recorded highest chlorophyll content in leaves (51.0 SPAD value). The reason for better growth may be stimulation of plant growth due to greater absorption and translocation of nutrients due to optimal plant density which might have enhanced fruit weight, fruit number and, subsequently, fruit yield. According to Soni *et al* (2006), a linear vegetative growth contributing character like plant height in okra variety Akola Bahar recorded maximum value under a closer spacing of 45cm x 15cm, when fed with a higher dose of nitrogen (150 kg ha^{-1}). Similar observation was also reported by Singh *et al* (2005). Interaction effect of nitrogen and spacing did not influence branch number per plant or days to first fruit-picking.

The benefit:cost ratio increased gradually with increase in nitrogen level and wider spacing independently, to a level of 150 kg N ha^{-1} and 45cm x 30cm spacing, and decreased thereafter. Highest benefit:cost ratio of 2.6 was observed in the treatment combination of 150 kg N ha^{-1} and 45cm x 30cm spacing.

From these results, it can be concluded that the treatment combination of 150kg N ha^{1} and 45 cm x 30 cm spacing resulted in maximum yield and quality parameters like number of fruits $plant^{-1}$, individual fruit weight, fruit yield and Vitamin C content in fruits. The same is recommended to farmers for higher production of quality okra fruits during early-winter season under the terai agro-climatic region of West Bengal.

REFERENCES

Ambare, T,P., Gonge, V.S., Rewatkar, S.S., Mohariya, A. and Shelke, T.S. 2005. Influence of nitrogen levels and varieties on yield and quality of okra. *Crop Res.,* **30**:80-82

Anonymous. 2005. Indian Horticulture Database-2005. National Horticulture Board, Government of India, Gurgaon

Ranganna, S. 1986. Analysis and quality control for fruits and vegetable product. 2nd edition. Tata McGraw-Hill Publishing Company Ltd., New Delhi, India

Sajjan, A.S., Shekhargouda, M. and Badanur, V.P. 2002. Influence of date of sowing, spacing and levels of nitrogen on yield attributes and seed yield in okra. *Karnataka J. Agril. Sci*., **15**:267-274

Shanke, B.R., Jadao, B.J., Ghawade, S.M. and Mahorkar, V.K. 2003. Effect of different levels of N and P on growth and seed yield of okra (var. Parbhani Kranti), under Akola condition. *Orissa J. Hort*., **31**:123-124

Singh Avtar, Ramphal and Yadav, A.C. 2005. Comparative performance of new okra variety HRB-108-2 with standard variety Varsha Uphar under different levels of nitrogen and plant spacing. *Haryana J. Hortl. Sci.,* **34**:387-388

Soni, N., Bharad, S.G., Gonge, V.S., Nandre, D.R. and Ghawade, S.M. 2006. Effect of spacing and nitrogen levels on growth and seed yield of okra. *Int'l. J. Agril. Sci.,* **2**:444-446

Woolley, J.T., Hicks, G.P. and Hageman, R.H. 1960. Plant analyses for rapid determination of nitrate and nitrite in plant material. *J. Agril. and Food Chem.,* **8**: 481-483

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