Effect of Spacing and Levels of Nitrogen on Growth and Seed Yield of Okra (*Abelmoschus esculentus* L. Moench) During *Kharif* Season

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A field experiment was conducted at College Agronomy Farm, Anand Agricultural University, Anand, Gujarat to study the effect of spacing and levels of nitrogen on growth and seed yield of okra (*Abelmoschus esculentus* L. Moench) during *kharif* season of the year 2013. Result revealed that wider spacing (75×20 cm) significantly increased growth attributes i.e. plant height and number of branches plant^{-1} except days to 50% flowering that remained non significant and yield attributes i.e. number of pods plant^{-1}, pod length, pod girth, number of seeds pod^{-1} and test weight while the highest seed yield (1503 kg ha^{-1}) was obtained from the closest spacing (45×20 cm). Nitrogen influenced all growth, yield attributes and seed yield (1699 kg N ha^{-1}) significantly and it increased gradually with increasing levels of nitrogen upto 150 kg N ha^{-1}. The interaction effect between spacing and nitrogen levels was found significant with respect to seed yield.

Keywords: Spacing, Nitrogen levels, Okra and Yield.

Okra (*Abelmoschus esculentus* L. Moench) is an important vegetable crop belonging to the family Malvaceae and grown throughout the tropical and subtropical regions of the world. In world, India ranks second in production of vegetables, next to China with 573.93 million tonnes from 24.56 million hectares of land (Anon, 2013).

Production of the vegetable okra often suffers a setback due to unavailability of high yielding good quality seeds in the market. Seed is very important input on which the ultimate yield of the crop depends. Further, to obtain maximum seed yield with better seed quality, the proper growth of the plant and its fruits are desired. This can be achieved to great extend by the use of optimum plant spacing and nitrogen levels.

Nutrient supply in the soil is another principal factor that determines the crop growth and yield. Among the nutrient, nitrogen is the main limiting factor in most of the soils and the need for its application in one form or in another form has been well recognized in vegetable and other farm crops for increasing the yield as it exhibits a high positive response in okra. It plays an important role in chlorophyll, protein, nucleic acid, hormone and vitamin synthesis and also helps in cell division, cell elongation. Application of judicious nitrogen is the reliable way of increasing the seed yield of okra.

Farmers in India generally do not use any special technique for quality okra production. Among the culture practices, the spacing allowed to individual plant is one of the most important factor which control their development and yield. Appropriate plant spacing can lead to optimum fruit and seed yield whereas too high or low plant spacing could result in relatively low yields (Amjad *et al*., 2002). The literature on seed production of okra crop is meager. Keeping this in view, the present study was made to assess the effect of

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spacing and levels of nitrogen on seed yield of okra (*Abelmoschus esculentus* L. Moench).

MATERIALS AND METHODS

An experiment was carried out in loamy sand soil, low in organic carbon (0.49%) and high in available phosphorus (42.70 kg ha^{-1}) and available potassium (230.30 kg ha^{-1}) at 0-15 cm soil depth during *kharif* season of the year 2013 at College Agronomy Farm, Anand Agricultural University, Anand. The treatment comprised of three levels of spacing (45×20, 60×20 and 75×20 cm) and four nitrogen levels (75, 100, 125 and 150 kg N ha^{-1}). The experiment was laid out in randomized block design with factorial concept in four replications. The size of the unit plot were 3.6m x 6.0m, 3.6m x 6.0m and 3.75m x 6.0m and each accommodate 8, 6 and 5 rows of plant, respectively. Entire quantity of phosphorus (50 kg ha^{-1}) and potash (50 kg ha^{-1}) were applied as a common basal dose in furrow to all the plots in form of single super phosphate and muriate of potash, respectively. One half quantity of nitrogen was given as a basal dose at the time of preparation of land and remaining quantities was applied as top dressing at around 30 and 45 days after sowing. The crop was harvested during second week of October. Need based plant protection measures were given whenever required. Economics was calculated based on the input and output prices.

RESULTS AND DISCUSSION

Growth parameters

The data on growth parameters, (Table 1) indicated that the growth parameters of the crop were significantly higher with wider spacing. Wider spacing (S_3) 75×20 cm and S_2 (60×20 cm) recorded higher values of plant height (121cm) at harvest as compared to narrow spacing of (S_1) 45×20cm. This might be due to population pressurize planting distance markedly affected the individual plant performance as plant population per unit area increase a point is reached at which plant beings to compete for certain essential growth factors *i.e.* mineral nutrients, sun light, air and water contrary to it if the plant population is below the optimum, there will be inefficient uses of the growth factor. The results are in agreement with those reported by Singh *et al.* (2002). The most profusely branched plants were obtained at the widest plant spacing of 75×20 cm (S_3), while the least was at 45×20 cm (S_1). The reduced competition for light and reduced overlapping from adjacent okra plants within the ridge could have enabled the plants grown at the wider spacing to utilize its energy for maximum branching. This result was similar to the findings of Ijoyah *et al*. (2010). The differences in days to 50% flowering were not changed significantly due to different spacing.

In present investigation, application of 150 kg N ha^{-1} produced significantly the tallest plant at harvest as compared to 75 and 100 kg N ha^{-1} (Table 1). However it was at par with 125 kg N ha^{-1}. The higher plant height under higher levels of nitrogen might be attributed to increased availability of nitrogen which structural component of protein molecules and protoplasm which might have increased synthesis of protein and carbohydrates in favour of increasing cell division and elongation under sufficient nitrogen supply. These results are in conformity with the findings of Ambare *et al.* (2005) and Firoz (2009). The highest number of branches plant^{-1} (4.61) was observed under the application of 150 kg N ha^{-1} (N_4). The higher number of branches plant^{-1} under higher levels of nitrogen might be due to higher nitrogen stimulated the assimilation of carbohydrates and proteins which in turn enhanced cell division and formation of more tissues resulting in luxuriant vegetative growth and more number of branches plant^{-1}. The results confirm the findings of Mani Ram *et al.* (1999), Paliwal *et al.* (1999). Significantly days to 50% flowering delayed under the treatment N_4 (150 kg ha^{-1}) than treatment N_1 (75 kg ha^{-1}) except treatment N_2 (100 kg ha^{-1}) and N_3 (125 kg ha^{-1}) which was on par. These observations are in confirmation with the findings of Singh *et al.* (2012) and Pandey *et al.* (2012).

Yield parameters and yield

Yield attributes and yield of okra were significantly affected by spacing and nitrogen levels. The widest spacing (75×20 cm) gave the highest number of pods plant^{-1} (14.59), pod length (17.18), pod girth (5.06), number of seeds pod^{-1} (44.24) and test weight (6.69). The increase in number of pods plant^{-1}, pod length and pod girth of okra due to wider spacing has been also reported by Paththinige *et al.* (2008) and Ekwu and

Table 1. Effect of spacing and nitrogen levels on growth attributes, yield attributes and seed yield of okra

Treatment	Plant height (cm)	Days to 50% flowering	No. of branches plant^{-1}	No. of pods plant^{-1}	Pod length (cm)	Pod girth (cm)	No. of seeds pod^{-1}	Test weight (g)	Seed yield (kg ha^{-1})
Spacings (cm)									
S_1 : 45×20	111.01	45.55	2.81	8.03	15.99	4.89	39.41	6.15	1503
S_2 : 60×20	115.11	45.02	3.34	13.41	16.54	4.98	40.95	6.41	1431
S_3 : 75×20	120.60	44.71	3.59	14.59	17.18	5.06	44.24	6.69	1347
S.Em.±	2.15	0.58	0.09	0.30	0.33	0.09	0.89	0.13	38.14
C.D. (P=0.05)	6.19	NS	0.25	0.87	0.94	NS	2.55	0.37	110
Nitrogen levels (kg ha-^{1})									
N_1 = 75	90.89	43.90	1.78	9.75	14.90	4.52	38.80	6.10	1035
N_2 = 100	106.57	44.29	2.80	11.29	16.47	4.90	39.55	6.32	1320
N_3 = 125	128.96	46.03	3.80	13.48	17.08	5.22	43.25	6.50	1654
N_4 = 150	135.87	46.15	4.61	13.52	17.84	5.27	44.53	6.76	1699
S.Em.±	2.48	0.67	0.10	0.35	0.38	0.10	1.02	0.15	44.04
C.D. (P=0.05)	7.15	1.94	0.29	1.00	1.09	0.30	2.94	0.43	127
(S×N)	NS	NS	NS	Sig.	NS	NS	Sig.	NS	Sig.

Table 2. Seeds yield as influenced by SxN interaction

Spacing (cm)	Seed yield (kg ha^{-1}) Nitrogen levels (kg ha^{-1})			
	N_1	N_2	N_3	N_4
S_1	1023	1309	1888	1791
S_2	1041	1326	1574	1784
S_3	1041	1324	1499	1523
S.Em.±	76.27			
C.D. (P=0.05)	219			

Nwokwu (2012). The highest seed yield (1503 kg ha^{-1}) was obtained from the closest spacing (45×20 cm) and the lowest was obtained from the widest spacing (75×20 cm). It was clearly evident from the result that the seed yield of okra was decreased with increasing plant spacing. Maximum seed yield at closest spacing might have been contributed by higher plant population per unit area. The finding on higher seed yields due to closer spacing are in agreement with Uddin, *et al.* (2006) and Moniruzzaman, *et al*. (2007).

The values of all the yield parameters gradually increased with gradual increase of nitrogen levels. Application of nitrogen at various levels had noticeable effect on the yield contributing characters i.e. number of pods plant^{-1}, pod length, pod girth, number of seeds pod^{-1} and test weight. Higher number of pods plant^{-1} were recorded under application of 125 and 150 kg N ha^{-1} as compared to lower levels of nitrogen (75 and 100 kg N ha^{-1}). Per cent increase in number of pods plant^{-1} under treatment N_4 and N_3 was 38.66 and 38.25 respectively, as compared to N_1 treatment. The higher number of pods plant^{-1} under increased level of nitrogen may be higher vigour of the plant and utilization of proteineous metabolites for build up of new tissues. These results are in agreement with those reported by Paliwal *et al.* (1999) Ambare *et al*. (2005). The significantly the higher pod length (17.18 cm), pod girth (5.06 cm), number of seeds pod^{-1} (44.53) and test weight (6.69 g) were observed under application of higher dose (150 kg N ha^{-1}) of nitrogen. Nitrogen application @ 150 kg ha^{-1} produced significantly the highest seed yield. The lowest seed yield was recorded under application of 75 kg N ha^{-1}. The increase in seed yield (1699 kg ha^{-1}) was recorded under treatment 150 kg ha^{-1} was 64.15 per cent over treatment 75 kg ha^{-1}. Significantly higher seed yield was recorded under treatment combination S_1N_3 (1888 kg ha^{-1}) as compared to rest of the treatment combinations but it was at par with treatment combination S_1N_4 (1791 kg ha^{-1}) and S_2N_4 (1784 kg ha^{-1}) (Table 2). This is might be due to more number of plants per unit area and there is least leaching losses of nitrogen in closest spacing and helps in availability of nutrients in adequate amount to increase growth and yield attributing characters. Spacing coupled with nitrogenous fertilizers increased the pod yields in okra were also reported by Amjad *et al*. (2002), Lal (2004) and Sajjan (2004).

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