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Effect of different levels of nitrogen and potassium on the growth and yield of okra

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ABSTRACT

Nitrogen and potassium levels influence the growth and yield of okra. The results of the experiment revealed that plant height, plant diameter, petiole length, leaves, breadth, number of leaves, number of branch and green pod length, pod diameter, number of green pod per plant, green pod yield per plant and green pod yield per hectare were significantly influenced by the different levels of nitrogen and potassium except plant diameter at 40 DAS (days after sowing). The height levels of Nitrogen (160 kg ha^{-1}) produced the height green pod yield (9.602 t ha^{-1}). The highest green pod yield (8.247 t ha^{-1}) was observed from 80 kg of K ha^{-1}. The combined effect of various levels of nitrogen and potassium levels as well as was also found significant except plant height and diameter at 20 DAS and leaf length and leaf breadths. The use of maximum nitrogen dose 160 kg N ha^{-1} and potassium 80 kg K_2O ha^{-1} produced the highest yield (9.99 t ha^{-1}) and the lowest (5.94 t ha^{-1}), respectively were recorded from the control treatments. The benefit-cost ratio (BCR) was maximum (2.02) in the treatment combination of (160 kg N ha^{-1} + 80 kg K_2O ha^{-1}) whereas the minimum (1.23) was recorded in the control treatment (0 kg N ha^{-1} + 0 kg K_2O ha^{-1}).

Introduction

Okra (*Abelmoschus esculentus* L. Moench) is a member under Malvaceae family and is also known as Lady's finger. It is an annual vegetable crop grown from seed in tropical and sub-tropical parts of the world (Hossain *et. al.*, 2010). It is well distributed throughout the Indian sub-continent and East Asia (Talukder *et. al.,* 2016). Okra is a nutritious and delicious vegetable, fairly rich in vitamins and minerals. Per 100 g of edible portion of pod have moderate levels of vitamin A (0.01 mg) and C (18 g), calcium (90 mg), phosphorus and potassium. The content of thiamine (0.07 mg), riboflavin (0.08 mg) and niacin (0.08 mg) per 100 g edible portion of pod is higher than that of many vegetables (Rashid, 1990). The pods also have some medicinal value and a mucilaginous preparation from the pod can be used as a plasma replacement or blood volume expander. Its production is mainly concentrated during summer. Total production of okra is about 19210 metric tons produced from 6210.53 hectare of land in the year 2003, and the average yield is about 3.093 t ha^{-1} (BBS, 2004). Use of proper doses of fertilizer is one of the most important way of quality green pod yield production of okra and nitrogenous, and potassic fertilizers have a great effect in this respect. Firoz (2010) reported that application of nitrogen and potassium generally increase yield of okra. Similar results were reported by Sharma and Shukla (1973).

Nitrogen plays an important role in building up of protoplasm and protein, which induce cell division and initiate meristematic activities when applied in optimum quantity. Moniruzzaman and Quamruzzaman (2009), reported that nitrogen application significantly increased pod weight, diameter, number of fruits per plant and number of seeds per pod in okra. Potassium also has an important role on balancing physiological activities. Different levels of potassium influence on the growth and yield of okra. Different K levels have no significant effect on yield in the absence of N (Mani & Ramanathan, 1990). Growth, and yield performance and seed production capability of okra at different fertilizer doses have been studied considerably in various parts of the world. Under the above circumstances, the present research was undertaken to study the effect of nitrogen, and potassium on the growth and yield of okra.

The present research was under taken with the mentioning objectives as to study the effect of combined and individual effect of nitrogen and potassium on growth and yield of okra and also to determine the optimum levels of nitrogen and potassium individual or in combination, which would be best for the growth of okra.

Materials and method

Experimental location and soil condition

An experiment was conducted at the central farm of Sher-e-Bangla Agricultural University Dhaka to study the effect of different levels of nitrogen and potassium on the growth and yield of okra. The experiment was conducted at the Central Farm of the Sher-e-Bangla Agricultural University, Dhaka. The site is 90.2 ^{O} N and 23.5 ^{0} E Latitude and at an altitude of 8.2 m from the sea level (Anon, 1993).

The soil of the experiment was carried out in a high land belonging to the Modhupur Tract (UNDP, 1998). The soil texture was silty loam with a pH 6.7. The experimental site was a medium high land. The morphological characters of soil of the experimental plots are AEZ No. 28, soil series- Tejgaon General soil- Non- calcareous, dark gray. The average maximum temperature during the period of experiment was 31.82 ˚C and the average minimum temperature was 28.14 ˚C. The okra variety used in the experiment was “BARI Dherosh-1”. This is a high yielding variety and the seeds were collected from the Horticulture Research Center, Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur.

Experimental treatments and design

Experiment consisted of two factors where the factor-A was 4 levels of nitrogen such as N_0: 0 kg N ha^{-1} (0 kg Urea ha^{-1}), N_1: 70 kg N ha^{-1} (152.17 kg Urea ha^{-1}), N_2: 110 kg N ha^{-1} (239.13 kg Urea ha^{-1}) and N_3: 160 kg N ha^{-1} (347.68 kg Urea ha^{-1}) and another factor-B was 4 levels of potassium as K_0: 0 kg K_2O ha^{-1}, (0 kg MP ha^{-1}), K_1: 40 kg K_2O ha^{-1} (66.64 kg MP ha^{-1}), K_2: 80 kg K_2O ha^{-1} (133.28 kg MP ha^{-1}) and K_3: 120 kg K_2O ha^{-1}, (199.92 kg MP ha^{-1}). The treatment combination was as 1st row (N_0K_0, N_1K_0, N_2K_0 and N_3K_0), 2nd row (N_0K_1, N_1K_1, N_2K_1 and N_3K_1); 3rd row (N_0K_2, N_1K_2, N_2K_2 and N_3K_2) and 4th row (N_0K_3, N_1K_3, N_2K_3 and N_3K_3). The Each experiment consisting of treatment combination was laid out in RCBD with three replications. The whole field was divided into three blocks and each block consisted of 16 plots. Altogether there were 48 unit plots in each experiment and required 351 m² lands. Each unit, bed was 2.4 m² (1.2 m × 2 m) in size. The replications were separated from one another by 1 m. The distance between plots was 0.75 m. The treatment was randomly assigned to each of the block. Each unit plot had 2 rows and each with 5 plants. So there were 10 plants per unit plot. The plants of one row (5 plants) in each unit plot were considered for growth of okra and other one row were considered for yield of okra. Plant to plant distance was 45 cm and raw to raw distance was 60 cm.

Land preparations

The land which was selected to conduct for the experiments was opened by disc plough. After opening the land with a tractor it was ploughed and cross-ploughed six times with a power tiller and each ploughing was followed by laddering to break up the soil clods to obtain unit good tilth and to level the land. After final land preparation the experimental plot was laid out, and the edge around each unit plot was raised to check run out of the nutrients.

Maturing and fertilizer application

The entire quantity of cow dung (10 t ha^{-1}) was applied just after opening the land (Roy *et. al.,* 2012). Urea, TSP and MP were applied as the source of nitrogen, phosphorus and potassium, respectively as per treatment in each experiment. In nitrogen and potassium was applied as per treatment and TSP was applied at the rate of 100 kg ha^{-1} (Rashid, 1990). The entire amount of TSP in both the experiments was applied at the time of final land preparation. Urea and MP were applied in two equal installments as top dressing. Urea and MP were applied as top dressing around the plant and incorporate with soil at 3rd and 5th week after seedling emergence.

Sowing of seeds

The okra seeds of cv. BARI Dherosh 1 were sown in rows of raised beds. Row-to-row and plant-to-plant spacing were maintained 60 cm and 45 cm, respectively. There seeds were sown in each location. Then the seeds were covered with fine soil by hand.

Intercultural operations

Necessary intercultural operations were done through the cropping season for proper growth and development of the plant. Five to six days after germination only one healthy seedling was kept to grow in each location and other seedling were removed. Three weeding were done to keep the plots free from weeds. Stagnant water was effectively drained out at the time of heavy rain. No irrigation was applied.

Gap filing

Dead, injured and weak seedlings were replaced by new vigor seedling from the stock kept on the border line of the experiment.

Irrigation

Light irrigation was given just after sowing the seed. A week after sowing the requirement of irrigation was envisaged through visual estimation. Wherever the plants of a plot had shown the symptoms of wilting the plots were irrigated on the same day with a hosepipe until the entire plot was properly wet.

Plant protection measure

For controlling shoot and pod borer Diazinon 60 EC @ 3.5 ml L^{-1} in water was sprayed at an interval of 10 days started soon after the appearance of infestation. After fruit setting No-gos @ 0.02% was sprayed at an interval of 7 days for controlling Jassid.

Harvesting

Green pods were harvested at 1 day interval when they attained edible stage (i.e. the tender young pods of 8-13 cm long). Green pod harvesting was started from 4, June and was continued up to 20 July.

Collection of data

Data were recorded on the following parameters from the sample plants during experiment. Ten (10) plants were randomly selected from each unit plot for the collection of per plant data. The plants in the outer rows were selected for data collection of growth of okra and the other rows were selected for data collection of yield of okra. Such as the data Plant height, plant diameter, petiole length, leaves length, leaves breadth, number of leaves per plant, number of leaves per plant, number of branches per plant, green pod length, green pod diameter, number of green pods per plant, green pod yield per plot, green pod yield per hectare.

Statistical analysis

The collected data on various parameters were statically analyzed using MSTATC package program. The mean for all the treatment was calculated and analyses of variances of all the characters were performed by F-variance test. The significant of difference between the pairs of treatment means was evaluated by the least significant difference (LSD) test at 5% and at 1% levels of probability (Gomez & Gomez, 1984).

Results and discussion

Effect of nitrogen on green pod length

There was highly significant effect on the green pod length due to the application of different level of nitrogen and potassium (Table 1). The nitrogen levels of 160 kg and 0 kg ha^{-1} gave the longest (13.987 cm) and the shortest (11.250 cm) green pod length, respectively (Table 1). The results revealed that green pod length was gradually increased with the increasing in nitrogen levels (Singh, 1995) reported that application of nitrogen at 90-160 kg ha^{-1} gave the highest pod length (16.7-17.6 cm). Karun *et. al.* (1997) also observed that N rates up to 100 kg ha^{-1} could increases the fruits length. N_0 = Nitrogen 0 kg ha^{-1} (Control), K_0 = Potassium 0 kg ha^{-1} (control), N_1 = Nitrogen 70 kg ha^{-1}, K_1 = Potassium 40 kg ha^{-1}, N_2 = Nitrogen 110 kg ha^{-1}, K_2 = Potassium 80 kg ha^{-1}, N_3 = Nitrogen 160 kg ha^{-1}, K_3 = Potassium 120 kg ha^{-1}. The green pod length was recorded at different stages of plucking of okra. The green pod length varied significantly due to the application of different levels of potassium. The result revealed that green pod length was gradually increased with the increase in potassium dose. The different treatments of potassium had highly significant effect on the green pod length. The highest green pod length (13.200 cm) was obtained from at 80 kg K_2O ha^{-1} whereas, the lowest (12.088 cm) at 0 kg K_2O ha^{-1}.

Effect of nitrogen and potassium on green pod diameter

A significant variation was observed on the green pod diameter due to use of different nitrogen and potassium levels (Table 2). The withiest diameter of green pod (1.59 cm) was obtained from the highest dose of nitrogen 160 kg ha^{-1} whereas, the smallest diameter of green pod (1.36 cm) was recorded from the control treatment. The nitrogen levels of 160 kg ha^{-1} and 110 kg ha^{-1} produced statistically identical result interims of green pod diameter. The result of present finding is supported by the previous research findings (Majanbu *et. al.*, 1995; Rahman & Akhter, 2012). They observed that nitrogen application increased the pod diameter (Table 2). Application of different levels of potassium increased the green pod diameter. The effect of different potassium levels of green pod diameter was significant (Table 2). The interaction effect of nitrogen and potassium in these respects was found to be highly significant, but the combined effect was insignificant. The effect of different potassium levels on diameter of green pod was significant. The maximum (1.55 cm) and the minimum (1.40 cm) diameter of pod were produced by the plants receiving K_2O ha^{-1} at the rates of 80 kg K_2O ha^{-1} and 0 kg K_2O ha^{-1}, respectively. Similar findings were obtained in sunflower by Sezek *et. al.*, (2018).

There was a significant interaction effect between nitrogen and potassium on the green pod diameter but the combined effect was insignificant (Table 2). The effect of nitrogen and potassium in this respect was found to be non-significant. The withiest diameter of pod (1.48 cm) was measured from the combined treatment of 160 kg N ha^{-1} + 80 kg K_2O ha^{-1}. However the minimum diameter of pod (1.29 cm) was found from the combination of 0 kg N and 0 kg K_2O ha^{-1} (Table 2). The interaction effect of nitrogen and potassium in this respect was found to be significant, but the combined effect was insignificant (Table 3). This result is conflicting with the finding of Majanbu *et. al.*, (1995). They reported that nitrogen and potassium combining application increase the number of green pod per plant. The effect of nitrogen and potassium was insignificant (Table 3). The effect of 160 kg N ha^{-1} and 80 kg K_2O ha^{-1} produced maximum number of green pod per plant (42.00) and the plant in control plot produced minimum number of green pod (27.00). Siddiqui *et. al.*, (2013) reported that N at 80 kg ha^{-1} and K at 40 kgha^{-1} significantly increased the number of green pod $plant^{-1}$.

Table 1. Effects of nitrogen and potassium on the pod length of okra

Treatment combination	N_0K_0	N_0K_1	N_0K_2	N_0K_3	N_1K_0	N_1K_1	N_1K_2	N_1K_3	N_2K_0	N_2K_1	N_2K_2	N_2K_3	N_3K_3	N_3K_1	N_3K_2	N_3K_3	LSD (0.05)	LSD (0.0 1)	Sig.
Pod length (cm)	10.50	10.90	12.0	11.60	11.75	12.75	13.0	12.90	12.35	13.18	13.50	13.35	13.75	13.90	14.30	14.0	0.459	0.62	*

*Significant at 5% level, **Significant at 1% level and NS = Non-Significant. N_0 = Nitrogen 0 kg ha^{-1} (Control), K_0 = Potassium 0 kg ha^{-1} (control), N_1 = Nitrogen 70 kg ha^{-1}, K_1 = Potassium 40 kg ha^{-1}, N_2 = Nitrogen 110 kg ha^{-1}, K_3 = Potassium 120 kg ha^{-1}, N_3 = Nitrogen 160 kg ha^{-1} and K_2 = Potassium 80 kg ha^{-1}.

Table 2. Effects of nitrogen and potassium on pod diameter of Okra

Treatment combination	N_0K_0	N_0K_1	N_0K_2	N_0K_3	N_1K_0	N_1K_1	N_1K_2	N_1K_3	N_2K_0	N_2K_1	N_2K_2	N_2K_3	N_3K_3	N_3K_1	N_3K_2	N_3K_3	LSD (0.05)	LSD (0.01)	Sig.
Pod Diameter (cm)	1.29	1.31	1.50	1.35	1.33	1.48	1.58	1.50	1.62	1.49	1.64	1.61	1.37	1.39	1.48	1.40	1.89	2.55	NS

NS = Non-Significant. N_0 = Nitrogen 0 kg ha^{-1} (Control), K_0 = Potassium 0 kg ha^{-1} (control), N_1 = Nitrogen 70 kg ha^{-1}, K_1 = Potassium 40 kg ha^{-1}, N_2 = Nitrogen 110 kg ha^{-1}, K_3 = Potassium 120 kg ha^{-1}, N_3 = Nitrogen 160 kg ha^{-1} and K_2 = Potassium 80 kg ha^{-1}.

Table 3. Effect of nitrogen and potassium on yield of okra

Treatment combination	N_0K_0	N_0K_1	N_0K_2	N_0K_3	N_1K_0	N_1K_1	N_1K_2	N_1K_3	N_2K0	N_2K_1	N_2K_2	N_2K_3	N_3K_3	N_3K_1	N_3K_2	N_3K_3	LSD (0.05)	LSD (0.0 1)	Sig.
Pod yield (ton/ha)	5.94	6.09	6.66	6.42	6.36	7.03	7.65	7.35	6.89	8.22	8.69	8.49	9.22	9.58	9.99	9.62	0.5	0.56	**

**Significant at 1% level, N_0 = Nitrogen 0 kg ha^{-1} (Control), K_0 = Potassium 0 kg ha^{-1} (control), N_1 = Nitrogen 70 kg ha^{-1}, K_1 = Potassium 40 kg ha^{-1}, N_2 = Nitrogen 110 kg ha^{-1}, K_3 = Potassium 120 kg ha^{-1}, N_3 = Nitrogen 160 kg ha^{-1} and K_2 = Potassium 80 kg ha^{-1}.

Effect of nitrogen and potassium on green pod yield

There was no significant interaction effect of N and K on the green pod yield per plot but the combined effect was highly significant effect (Table 3). The present study was revealed that there was a highly significant effect of nitrogen and potassium on green pod yield per hectare. The highest (9.602 t ha^{-1}) and the lowest (6.278 t ha^{-1}) pod yields per hectare were recorded from 160 kg N ha^{-1} and 0 kg N ha^{-1}, respectively. Majanbu *et. al.,* (1995) and Somkuwar *et. al.*, (1997) found that nitrogen application significantly increase green pod yield. Singh (1995) reported that nitrogen application improved the productivity of okra plants up to 200 kg ha^{-1}. Kurupet *et. al.*, (1997) and Sultana *et. al.*, (2013) also stated that N rates up to 100 kg ha^{-1} could increase the total green pod yield of okra cv. Kiran and Mungbean. Different level of potassium fertilization exhibited highly significant effect on the green pod yield per hectare. Application of K_2O at the rate of 80 kg ha^{-1}, gave the maximum green pod yield per hectare (8.242 t ha^{-1}), whereas the minimum green pod yield per hectare (6.980 t ha^{-1}) was obtained from the 0 kg K_2O ha^{-1}. Mani and Ramanathan (1990) reported that different K level had no significant effect in the absence of N. There was no significant interaction effect between the effect of nitrogen and potassium on the green pod yield per hectare but the combined effect of treatments was highly significant. However, the maximum green pod yield per hectare (9.990 t ha^{-1}) was obtained with the treatment combination of 160 kg N ha^{-1} + 80 kg K_2O ha^{-1} and the minimum (5.940 t ha^{-1}) with the control treatment (Table 3). Mohammed and Miko, (2009) reported that combined application of 80 kg N ha^{-1} with either 30 kg or 60 kg K_2O ha^{-1} produced the highest yields 17272 and 17526 kg ha^{-1}, respectively and different K level had no significant effect on yield in the absence of nitrogen.

Conclusions

Considering the results and discussion, it may be suggested that nitrogen level at 160 kg N ha^{-1} and potassium levels at 80 kg K_2O ha^{-1} can be used successfully for commercial okra production.

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