Bangladesh J. Environ. Sci., Vol. 46, 101-106, 2024 @ BAED ISSN 1561-9206

CONSEQUENCES OF FERTILIZER AND IRRIGATION ON THE GROWTH AND YIELD OF OKRA (*Abelmoschus esculentus* L.)

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ABSTRACT

Aim of this investigation was to determine the consequences of fertilizer and irrigation on the growth and yield of okra var. "BARI Dherosh- 1". The results of the showed that the combination of 150, 100, 150 kg/ha NPK and three times irrigation produced the maximum plant height, petiole length, leaf length, number of leaves per plant, number of branches per plant, number of flowers per plant, number of green pods per plant, green pod length, green pod diameter, individual green pod weight and green pod yield per hectare whereas their lowest values were obtained from the treatment combination of 100, 50, 100 kg/ha NPK and one time irrigation. In general, the present investigation showed that moderate doses of fertilizer and three times irrigation showed better performance in respect of growth and yield of okra.

Key words: Fertilizer, irrigation, growth, yield, okra.

Introduction

Okra (*Abelmoschus esculentus* L.) is particularly prized for its succulent, delectable edible pod, which are abundant in vitamins and minerals. The total amount of okra produced in Bangladesh is approximately 83861 metric tons, which was grown on 14652 hectares of land in the year of (BBS, 2004). The average yield is only 5.72 t/ha, which is extremely low when compared to other developed nations where the yield can reach up to 7.0-12.0 t/ha (Yamaguchi, 1998). Here the consequences of fertilizer and irrigation can play crucial role in increasing okra yield. Fertilizer (NPK) is one of the most important inputs contributing to crop production because it increases productivity and improves yield and quality (Shiyab *et al*., 2014). Use of proper doses of fertilizer is one of the most important way of quality green pod yield production of okra and phosphorus fertilizer have a great effect in this respect (Yogesh and Aora, 2001). Nitrogen, phosphorus and potassium fertilizer have been reported to yield and quality increase in okra (Babatola, 2006). 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. Plants exhibit numerous physiological and metabolic adaptations in response to seasonal variations in phosphorus content. Activities of both acid and alkaline phosphatases increased manifold in winter to cope up with low phosphorus content. On the other hand, potassium (K) plays a variety of significant roles in regulating physiological processes. Potassium has a special function in the regulation of osmotic pressure, opening and closing of stomata, and enhancement of fruit color, flavor, and size (Bhende *et al.*, 2015). Irrigation also plays an important role in energy transformation and metabolic process of plant and stimulates early root formation and growth, gives a rapid and vigorous growth to plants. The greatest percentage reduction in okra fresh fruit yield occurred when moisture stress was imposed at the flowering stage of Kano Dwarf and Awgu Early (Majanbu *et al*., 1986). In all cultivars, moisture stress at both in flowering and pod-filling stages resulted in a reduction of more than 70% in fruit yields, while the lowest reduction in fruit yield occurred with moisture stress during the vegetative stage. Ogunlela *et al.* (2005) indicated that, okra plant height was significantly reduced by water stress. Growth and yield performance of okra using fertilizer (NPK) at different doses have been studied considerably in various parts of the world. But combined effect of fertilizer and irrigation is not studied considerably. Additionally, many farmers do not know the optimum dose of fertilizer and irrigation

for okra cultivation. Given the aforementioned information and in light of earlier observations, the objective of the present investigation was to find out the optimum levels of NPK fertilizers, irrigation and suitable combination of NPK fertilizers and irrigation which would be best for the optimum growth and yield of okra.

Materials and Methods

The experiment was conducted at the research field of Department of Crop Science and Technology, University of Rajshahi, Rajshahi during the period from April to July, 2021 with Okra var. "BARI Dherosh-1". The site is 24. 370° N and 88.637° E latitude and 200 cm from the sea level. The experimental area was belonging to the Agro Ecological Zone (AEZ-11) "High Ganges River Floodplain". The experiment was designed with two factors Randomized Complete Block Design (RCBD) with three replicates viz., each of three levels of fertilizer (F_1: 100, 50, 100 kg/ha (NPK), F_2: 150, 100, 150 kg/ha (NPK), F_3: 200, 150, 200 kg/ha (NPK) and Irrigation (I_1: 1 time (20 DAS), I_2: 2 times (20, 40 DAS), I_3: 3 times (20, 40, 60 DAS). The unit plot size was 2.7 m² (2.25m×1.2m). Plant to plant and row to row distance was 45 cm and 60 cm. Fertilizers were applied as per recommendation of Rashid (1990). Intercultural operations were done, when it was necessary. Data were recorded for desired parameters from the sample plants at 60 days after sowing (DAS) and at harvest. Ten (10) plants were randomly selected from each unit plot for the collection of 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. The findings obtained from the experiment were analyzed statistically following MSTAT-C package program. The mean values recorded against all the treatments were compared by Duncun's Multiple Range Test (DMRT) and also with the help of LSD values following Gomez and Gomez (1984).

Results and Discussion

Plant height: Combined effect of NPK fertilizer and irrigation showed highly significant effect for this character. There was an increasing tendency of plant height as the level of NPK and irrigation was increased. The maximum plant height (79.78 cm) was measured from the treatment F_2I_3 (150, 100, 150 kg/ha NPK with three times irrigation) which was significantly different from all other treatments except F_3I_3 whereas the minimum (65.22 cm) was found in F_1I_1 (100, 50, 100 kg/ha NPK with one time irrigation) which was statistically different from all other treatments (Table 1). Many workers also found similar results from NPK fertilizer and irrigation application in okra. The results resemble with that of Gondane and Bhatia (1995) who reported that NPK fertilizer significantly increased plant height of okra. Evidently maximum plant height was measured from the treatment combination of NPK (200, 100, 200 kg/ha) + three times irrigation (20, 40, 60 DAS). Minimum plant height was found in F_3I_3 combination due to its poor nutritional status which resulted in retarded growth and reduced plant height. Majanbu *et al.* (1986) had shown that NPK and proper doses of irrigation are the most important nutrient that okra required for proper growth and pod production and their findings supports the present result.

Petiole length: Table 1 showed that the longest petiole (29.89cm) was produced by treatment F_2I_3 which was statistically different from all other treatments. On the other hand the lowest petiole length (18.33cm) was obtained from F_1I_1 which was also statistically different from all other treatments. This result indicated that N PK fertilizer and irrigation should be applied at early growth stage to get the desirable results. This findings was in agreement with Naik and Srinivas (1992), who reported that petiole length was highest with the highest rate of fertilizer application which was 200 kg N/ha and 120kg K_2O/ha in okra.

Leaf length: The present investigation showed that various levels of fertilizer and irrigation had highly significant effect on leaf lengths (Table 1). That is plants grew more vigorously where NPK fertilizer and irrigation were applied. However, the maximum leaf length (25.84cm) was measured from the treatment combination of F_3I_3 (200, 150, 200 kg/ha NPK with three times irrigation) which was statistically similar

with F_3I_2, F_3I_1, F_2I_3, F_2I_2 and F_2I_1 whereas the lowest leaf length (17.52 cm) was recorded from treatment F_1I_1 (100, 50, 100 kg/ha NPK with one time irrigation) which was statistically identical with treatment F_1I_2 and F_1I_3. Result revealed that application of F_3I_3 doses increase the leaf length at 60 DAS. This could be the fact that applied NPK take apart in photosynthesis reaction, starch formation, translocation of sugars and improvement of the utilization of nitrogen (Shongwe, 1989 and Masarirambi *et al*., 2013). Humayan *et al.* (2015) reported also similar results in okra.

Table 1. Effect of fertilizer and irrigation on vegetative growth of okra

Treatments	Plant height (cm)	Petiole length (cm)	Leaf length (cm)	Number of leaves per plant	Number of branches per plant
F_1I_1	65.22e	18.33e	17.52d	22.11e	3.89e
F_1I_2	72.22cd	22.44d	20.36cd	23.67e	5.00d
F_1I_3	74.11bc	24.78c	20.89bcd	25.56d	5.44d
F_2I_1	70.56d	24.67c	24.22ab	26.00cd	5.56cd
F_2I_2	74.78bc	27.44b	23.89abc	27.56bc	5.78bcd
F_2I_3	79.78a	29.89a	24.00abc	30.00a	8.33a
F_3I_1	72.78cd	26.33bc	24.56ab	27.11bcd	6.33bc
F_3I_2	77.11ab	27.00b	25.11a	27.67bc	6.56b
F_3I_3	78.56a	28.00b	25.84a	28.44ab	8.33a
CV (%)	4.25	1.87	1.59	2.98	0.73
LSD (5%)	2.89	1.62	3.45	1.58	1.41

Means followed by the same letter(s) do not statistically differ at 5% level tested by DMRT

Number of leaves per plant: Data of the present investigation showed that various levels of NPK fertilizer and irrigation had highly significant on number of leaves per plant. The use of NPK fertilizer and irrigation in the production of okra proved greatly to increase number of leaves per plant. It was noted that 150, 100, 150 kg/ha NPK + three times irrigation combination produce the highest number of leaves per plant (30.00) which was statistically identical with F_3I_3 whereas the treatment of 100, 50, 100 kg/ha NPK + one time irrigation produced the lowest (22.11) number of leaves per plant which was statistically similar with F_1I_2 (Table 1). Arora *et al.* (1991) irrigation with proper drainage and NPK application increased leaf number.

Number of branches per plant: Similar to number of leaves per plant the present investigation showed that various levels of NPK fertilizer and irrigation had highly significant on number of branches per plant (Table 1). Treatment F_2I_3 and F_3I_3produced the highest number of branches per plant (8.33) and the lowest number of branches per plant (3.89) was obtained from F_1I_1 which were statistically different from all other treatments. This might have caused by the application of N and P fertilizer which plays a major role in photosynthetic reactions, starch formation, translocation of sugars and improved utilization of nitrogen (Shongwe, 1989). Ogunlela *et al.* (2005) reported that nitrogen (N) promotes branching and leaf growth and forms proteins and chlorophyll, whilst phosphorus (K) contributes to stern and root growth as well as their development and the synthesis of proteins in okra.

Number of flowers per plant: The number of flowers per plant was highly significant as influenced by the interaction of fertilizer and irrigation. The result reveled that number of flowers per plant was gradually increased with the increased of combined effect of NPK fertilizer and irrigation. However, the maximum number of flowers per plant (46.78) was found from treatment F_2I_3 and the lowest (29.33) was obtained from F_1I_1 which were significantly different from all other treatments (Table 2). Jana *et al.* (2010) reported that 150 kg N ha^{-1} produced the highest number of flowers/plant (13.7) in okra.

Table 2. Effect of fertilizer and irrigation on yield attributing characters and yield of okra

Treatments	Number of flowers per plant	Number of green pods per plant	Green pod length (cm)	Green pod diameter (cm)	Individual green pod weight (g)	Green pod yield (t/ha)
F_1I_1	29.33g	22.33d	7.44f	1.16f	8.00f	4.78g
F_1I_2	33.44f	26.33cd	8.22ef	1.33e	8.67ef	5.78f
F_1I_3	35.78de	28.11bc	8.89de	1.49d	10.44d	8.89d
F_2I_1	34.67ef	26.78cd	9.11de	1.38e	9.22e	7.44e
F_2I_2	38.67c	31.00bc	11.33c	1.68bc	11.44c	9.78c
F_2I_3	46.78a	40.33a	14.44a	1.97a	13.33a	13.11a
F_3I_1	36.67d	29.33bc	8.67de	1.36e	10.00d	8.44d
F_3I_2	39.67c	32.56b	9.44d	1.66c	12.00bc	9.67c
F_3I_3	43.78b	37.78a	12.33b	1.78b	12.67ab	11.67b
CV (%)	2.88	2.15	1.41	0.20	1.87	2.10
LSD (5%)	1.23	4.50	1.95	1.89	1.56	1.85

Means followed by the same letter(s) do not statistically differ at 5% level tested by DMRT

Number of green pods per plant: The effect of NPK fertilizer and irrigation were found to be highly significant in case of number of green pods per plant in okra. The combined effect of 150, 100, 150 kg NPK/ha + three times irrigation produce maximum number of green pods per plant (40.33) which was statistically identical with F_3I_3 whereas the treatment combination of 100, 50, 100 kg NPK/ha + one time irrigation produced minimum number of green pods per plant (22.33) which was statistically similar with F_1I_2 and F_2I_1 (Table 2). Singh *et al.* (1998) reported that increase in green pod number of okra due to the application of NPK and they stated that it plays an important role in promoting vegetative growth by enhancing cell division, cell elongation and protein synthesis.

Green pod length: Pod length is a tone character for economic yield which depends upon various factors such as genetic makeup of the cultivars and their response to prevailing environmental conditions. The maximum (14.44 cm) green pod length was measured from the treatment combination of F_2I_3 which was significantly different from all other treatments. The minimum green pod length (7.44cm) was observed from F_1I_1 which was statistically similar with treatment F_1I_2 (Table 2). This outcome reflects that more the fertilizer dose better will be the green pod length. The results found resembles to those of Arora *et al.* (1991) who reported that green pod length in okra was significantly improved by application of N, P and K.

Green pod diameter: A significant variation was observed on the green pod diameter due to the application of different levels of NPK fertilizer and irrigation (Table 2). The widest diameter of pod (1.97 cm) was measured from the treatment of F_2I_3 and the minimum diameter of green pod (1.16 cm) was found from the treatment combination of F_1I_1 which were statistically different from all other treatments. Green Pod diameter was increased due to application of N and P which may be causing that the mobility of photosynthetates from the source to sink (Ananthi *et al*., 2004). Similar observations were made by Singh *et al.* (1998) in okra.

Individual green pod weight: The effect of NPK fertilizer and irrigation in the respects of individual green pod weight was found to be significant (Table 2). The maximum individual green pod weight (13.33g) was measured from the combined treatment of F_2I_3 which was statistically similar with F_3I_3. On the other hand, the minimum individual green pod weight (8.00 g) was found from the treatment combination of F_1I_1 which was statistically similar with F_1I_2. Tomar and Chauhan (1982) observed that the green pod yield per plot was highest with respect to 75kg N/ha. They reported that NPK fertilizer and

irrigation combining application increased the number of green pod per plant and green pod weight. These findings are supported the present results.

Green pod yield: A highly significant difference was found between different levels of NPK fertilizer and irrigation in respect of green pod yield per hectare **(**Table 2). The maximum green pod yield (13.11t/ha) was measured from the combined treatment of F_2I_3 (150, 100, 150 kg NPK/ha + three times irrigation) which was statistically different from all other treatments. On the other hand, the minimum green pod yield (4.78 t/ha) was found from the treatment combination of F_1I_1 (100, 50, 100 kg NPK/ha + one time irrigation) which was also significantly different from all other treatments. Application of NPK fertilizer with irrigation results in increasing green pod yields per hectare. This may be due to nitrogen is a part of the chlorophyll molecule, which gives plants their green color and it involved in creating food for the plant through photosynthesis. Sultana (2002) mentioned highest yield from N 100 kg/ha in cv. BARI Dherosh-1. This is in agreement with paliwal *et al.* (1999) and Rahman *et al.* (1992). From the above discussion it may be concluded that the treatment combination NPK fertilizer and irrigation gave the highest yield in most of the parameter including yield. So this dose combination could be efficiently use in okra cultivation on field condition.

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