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Effects of nitrogen and phosphorous use efficiency on the growth and yield of tomato

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Abstract

The study was to evaluate the effect of nitrogen (N) and phosphorous (P) on the growth and yield component of tomato. The treatments were four levels of N (N_0: 0kg N/ha, N_{100}: 100kg N/ha, N_{150}: 150kg N/ha and N_{200}: 200kg N/ha) and four levels of P (P_0: 0kg P_2O_5/ha, P_{50}: 50kg P_2O_5/ha, P_{100}: 100kg P_2O_5/ha and p_{150}: 150kg P_2O_5/ha). The result of the study revealed that number of flowers per plant, number of fruits of plant and fruit weight per plant increased significantly with increasing N level up to 200kg N/ha, whereas fruit yield increased significantly up to 200kg N/ha. All these parameters also increased significantly with increasing the level of P up to 150kg P_2O_5 /ha. However, from this study it may be concluded that application of N_{200} and 150kg P_2O_5 per hectare maximize the higher yield of tomato.

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Introduction

Tomato (*Lycopersicon esculentum* Mill) is one of the most important vegetable crops in Bangladesh and it is one of the main major crops which have a significant contribution to national domestic consumption and food needs. Agriculture contributed 19.29 of total GDP (BBS, 2012) in Bangladesh and it also covering the 8.52 million hectares of cultivated land. These are the major important source of income to small and marginal farmers and contribute to the nutrition of the consumer (Begum *et al*., 2011). It is also important in terms of area, production, yield, and commercial use, placed sixth based on total annual world production (FAO, 2011). Nowadays land area under tomato cultivation has been expanded day by day due to increasing domestic consumption of demand. The main factors of production like, seeds, human labour, tillage, fertilizer, irrigation and insecticides were considered to estimate the impacts on tomato production. Amongst 3 farm size groups, small tomato farmers earned highest profit, followed by medium farmers. Gross returns per acre of small, medium and large farms were Tk. 104180, 95000 and 82600 and their corresponding net returns were Tk. 46978, 45356 and 5354, respectively and benefit cost ratio of was the highest for medium farmers (1.91), followed by small farmers (1.82), while it was the lowest (1.74) for large farmers (Samshunnahar *et al.,* 2016).

Tomato was produced 255000mt. tons in Bangladesh during the 2011-12 (BBS, 2012), while it was about 190213mt. tons from 23817 hectares of land in 2009-10 (BBS, 2010). In Bangladesh, tomato yield is lowest; is not an incidence of the low yield potentiality of this crop, but, the fact that the lower yield may be attributed to a number of reasons viz. unavailability of quality seeds of improved varieties, fertilizers management, disease infestation and improper moisture management. Among them fertilizer management is a vital factor that influence the growth and yield of tomato. Balance fertilization in crops will act as an insurance against possible nutrient deficiencies that may be created by the respected use of a single nutrient (Manange *et al.,* 1982). Among different fertilizers, N and phosphorous are two of the essential plant nutrient elements and each plays a significant role in tomato production and considered as prime nutrient for tomato production.

Currently, the soils of Bangladesh are facing the deficiency of N and phosphorous fertilizer. So, it is mandate to apply these nutrient elements for satisfactory level of growth and development and its ultimate effect fall on yield of tomato. Tomato required large quantity of readily available fertilizer nutrients (Gupta and Shukla, 1977).

In Bangladesh, fertilizer especially N is the most critical input for increasing production and had appropriately been recognized as the central element for agricultural development (Mukhopadhyay *et al.,* 1986). Optimum N increases fruit quality, fruit size, color, taste and acidity (Sharma and Mann, 1971). It significantly increases the growth and yield of tomato. Next to N fertilizer, phosphate fertilizers dwell is the second most important input for increasing crop production. High level of phosphorous throughout root zone is essential for rapid root development and for good utilization of water and other nutrients by the plant. Phosphorous has profound effect on number of flowers that progressively increases the yield (Razia and Islam, 1980) and marketable yield of tomato (Candilo, 1993). Keeping all the above facts in view, the present study has been undertaken to evaluate the response of tomato to N and phosphorous for maximizing the higher yield.

Materials and Methods

Plant materials and season

The experiment was conducted at the Research farm of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka, during November 2016 to March 2017. BARI Tomato-2 (Raton), a high yielding variety of tomato (*Lycopersicon esculentum* Mill.) was used in this experiment. The size of the seed bed was 3m × 3m, raised 10 to 12cm (approximately) above the ground level. The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications of each fertilizer treatment combinations. Fertilizer treatments consisting of 4 levels of N (N_0: 0kg N/ha, N_{100}: 100kg N/ha, N_{150}: 150kg N/ha and N_{200}: 200kg N/ha) and 4 levels of P (P_0: 0kg P_2O_5 /ha, P_{50}: 50kg P_2O_5 /ha, P_{100}: 100kg P_2O_5 /ha, P_{150}: 150kg P_2O_5 /ha).

Data collection

The field data were recorded considering the following traits such as plant height (PH), number of cluster per plant, number of flowers per cluster, number of flowers per plant, number of fruits per cluster, number of fruits per plant, weight of individual fruit (gm), fruit yield per plant (gm), and fruit yield per hectare.

Statistical analysis

The collected data were statistically analyzed to find out the significance difference of the different levels of N and phosphorous on yield and yield contributing characters of tomato. The significance of the difference among the treatment combinations means were estimated by the Duncan's Multiple Range Test (DMRT) at 5% level of probability (Gomez and Gomez, 1984).

Result and discussion

Application of N and P in tomato under this trial was found statistically significant in respect of number of flower clusters per plant (Table 1). The highest number flower clusters per plant (8.800) was found in N_{200} and the lowest number of flower clusters per plant (6.350) was recorded from control. Grela *et al.* (1988) found the similar trend of finding in number of flower cluster per plant. On the other hand, the maximum number of flower clusters per plant (8.580) was found in P_{150} which was statistically similar to that of P_{100} whereas the minimum number of flower clusters per plant (6.365) was recorded from the control. With increasing level of phosphorous, plant growth increases and the number of flower clusters per plant also increases.

Plant height

PH is an important trait to assess and can be even judged by visual observation using normal scale. It's height significantly varied due to the application of different doses N in tomato under the present trial. The minimum PH (56.16cm) was recorded from N_0 treatment where no N was added to the soil. During the harvesting, the maximum PH (89.58cm), was recorded from N_{200} treatment consisting of 200kg N/ha and the minimum PH (56.16cm) was recorded from N_0 treatment which was closely (80.17cm) followed by N_0 treatment (Table 1). 200kg of N/ha ensured the favorable condition for growth of the plant and ultimate result is plant height and other performance related to better yield. As above N level, hinder the plant growth and height. Melton and Dufault (1991) found that PH of tomato was increased as highest level of N. Similar result was reported by Chung *et al.* (1992), Grela *et al.* (1988), Sharma and Mann (1971). In a column means having common letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability. N_0: 0kg N/ha, N_{100}: 100kg N/ha, N_{150}: 150kg N/ha, N_{200}: 200kg N/ha, P_0: 0kg P_2O_5 /ha, P_{50}: 50kg P_2O_5 /ha, P_{100}: 100kg P_2O_5 /ha, P_{150}: 150kg P_2O_5 /ha.

Table 1. Effect of nitrogen and phosphorous on plant height at 30 DAT, 60 DAT and at final harvest, number of leaves per plant at 60 DAT and number of branches per plant at harvesting period of tomato.

Treatments		Plant height (cm)			No. of leaves / plant	No. of branches / plant
		30 DAT	60 DAT	Harvest	60 DAT	Harvest
Nitrogen	N_0	56.16c	70.78c	80.17d	39.72d	9.668c
	N_{100}	57.25bc	75.77b	85.05c	43.08c	10.44b
	N_{150}	58.76ab	77.05ab	87.47b	46.92b	10.90a
	N_{200}	60.38a	78.31a	89.58a	51.72a	11.26a
	$LSD_{(0.05)}$	1.636	1.765	1.747	2.073	0.3964
Phosphorous	P_0	55.46b	72.04c	80.64c	40.10c	9.458c
	P_{50}	58.51a	75.00b	84.63b	45.08b	10.29b
	P_{100}	59.43a	77.24a	88.08a	47.78a	11.18a
	P_{150}	59.15a	77.61a	88.93a	48.49a	11.35a
	$LSD_{(0.05)}$	1.889	2.038	2.017	2.393	0.4577

Number of branches

The number of branches per plant has significant effect on yield production. In the present study, it varied significantly due to application of N. At final harvesting period, the highest number of branches per plant (11.26) was observed from N_{200} treatment consisting of 200kg N/ha and which was statistically identical (10.90) with N_{150} treatment as 150kg N/ha and the lowest number of branches per plant (9.67) was observed from N_0 treatment (Table 1).

Number of flowers per cluster varied significantly due to application of N and P in tomato (Table 1). The maximum number of flowers per cluster (4.94) was observed in N_{200}, which was statistically similar with N_{150} (4.9) and N_{100} (4.8) but the lowest number of flowers per cluster (4.52) was recorded in the control.

Meanwhile, the maximum number of flowers per clusters (5) was recorded from P_{150}, which was statistically similar with P_{100} and the minimum number of flowers per cluster (4.45) was recorded from the control.

Application of different doses of N and P varied significantly in number of flowers per plant of tomato (Table 2). The ranges of number of flowers per plant in case of N application were 30.41 to 44.63. The maximum number of flowers per plant (44.6) was recorded from N_{200}, which was statistically similar (42.8) to N_{150}, and the minimum (30.4) was recorded from the control. The ranges of number of flowers per plant in case of phosphorous application were 30 to 44. The highest number of flowers per plant (44.02) was observed from P_{150} which was statistically similar with P_{100} and the lowest number of flowers per plant was recorded from the control.

The number of fruits per cluster varied significantly due to application different doses of N and P in tomato (Table 2). The ranges of number of fruits per cluster in case of N application was 3.33 to 3.83. The highest number of fruits per cluster (3.83) was recorded from N_{200}, which was statistically identical with N_{150} and the lowest (3.33) was recorded from the control. The ranges of number of fruits per cluster in case of phosphorous application was 3.53 to 3.79. The maximum number of fruits per clusters (3.79) from P_{100} and the minimum was (3.53) recorded from the control.

Number of fruits per plant varied significantly due to application of N and P in tomato (Table 2). The highest number of fruits per plant (33.8) was recorded from N_{200} and the lowest (21.8) was recorded from the control. Nassar (1988) found that increased N level was tended to increase average number of fruits cluster per plant. Whereas the maximum fruits number per plant (32.75) was recorded from P_{150} and the minimum was recorded from the control due to application of P. With increasing levels of phosphorous, plant growth increases and which ensure maximum number of flowers and fruits per cluster as well as the number of fruits per plant.

Table 2. Effects of N and P on yield contributing characters of tomato cv. Roton.

	Treatments	No. flower clusters / plant	No. flowers / cluster	No. flowers / plant	No. fruits/ cluster	No. fruits / plant
Nitrogen	N_0	6.4d	4.5b	30.4c	3.33b	21.8c
	N_{100}	7.5c	4.8a	37.5b	3.70a	27.9b
	N_{150}	8.4b	4.9a	42.4a	3.82a	32.3a
	N_{200}	8.8a	4.9a	44.6a	3.83a	33.8a
Phosphorus	P_0	6.4c	4.5c	30.0c	3.53b	22.6c
	P_{50}	7.6b	4.8b	37.9b	3.63ab	27.9b
	P_{100}	8.5a	4.9ab	43.4a	3.79a	32.5a
	P_{150}	8.6a	5.0a	44.0a	3.73ab	32.8a

*In a column means having common letter(s) are statistically identical, and those having dissimilar letter(s) differ significantly at 0.05 level of probability. N0: 0kg N/ha, N100: 100kg N/ha, N150: 150kg N/ha, N200: 200kg N/ha, P0: 0kg P2O5 /ha, P50: 50kg P2O5 /ha, P100: 100kg P2O5 /ha, P150: 150kg P2O5 /ha.

Table 3. Effects of N and P on size of fruit and yield of tomato cv. Roton.

	Treatment	Wt. individual fruit (g)	Fruit weight /plant (kg)	Yield (t/ha)
Nitrogen	N_0	66.2c*	1.09d	39.0d
	N_{100}	80.4b	1.69c	60.9c
	N_{150}	83.8a	2.05b	73.8b
	N_{200}	83.3a	2.13a	76.5a
Phosphorus	P_0	71.5b	1.23c	44.1c
	P_{50}	79.5a	1.69b	60.6b
	P_{100}	81.0a	2.01a	72.2a
	P_{150}	81.7a	2.03a	73.3a

*In a column means having common letter(s) are statistically identical and those having dissimilar letter(s) differ significantly at 0.05 level of probability. N_0: 0kg N/ha, N_{100}: 100kg N/ha, N_{150}: 150kg N/ha, N_{200}: 200kg N/ha, P_0: 0kg P_2O_5 /ha, P_{50}: 50kg P_2O_5 /ha, P_{100}: 100kg P_2O_5 /ha, P_{150}: 150kg P_2O_5 /ha.

The maximum weight of individual fruit (83.8g) was recorded from N_{150} and the minimum was recorded from the control (Table 2). In case of N the maximum fruit weight (79.25g) was found at 200kg N/ha. Whereas, the maximum weight of individual fruit (81.7g), was recorded from P_{150} and the minimum (71.5g) was recorded from the control.

The maximum weight fruit per plant (2.13kg) was recorded from N_{200}, while the minimum (1.09kg) was observed from the control (Table 2). Chung *et al.* (1992) reported that increasing levels of N increased the fresh weight of tomato fruit.

Similarly, the maximum weight of fruit per plant (2.033kg) was recorded from P_{150} and the minimum (1.23kg) was recorded from the control (Table 2). The maximum fruit yield (76.72ton/ha) was recorded from N_{200} and the minimum fruit yield (39.00ton/ha) was recorded from the control (Table 3). Chung *et al.* (1992) reported that increasing levels of N increased the fresh weight of tomato fruit as well as fruit yield.

Conclusion

Tomato (*Lycopersicon esculentum*) is one of the most important winter vegetables in Bangladesh. Now-a-days, it is not consumed throughout the years due to its importance of nutrition. In the present study, the maximum flower clusters per plant, number of flowers per cluster, flowers per plant, number of fruits per cluster, number of fruits per plant, weight of individual fruit, weight of fruits per plant and fruit yield (76.72ton/ha) was recorded from N_{200} and the lowest for the parameters were found in the control. In case of P_{150} all the parameters were the highest and the minimum in the control. It is clearly mention that P_{150} and N_{200} is the best for tomato production and best yield is found in previous recommended yield performance. For this purpose, we should take initiatives to make our farmers more knowledgeable and expert to grow more food from our limited lands. In addition, we should encourage the farmers and other NGOs to grow more and more vegetable like tomato. The government should take the steps to establish tomato processing plant because of our huge production in all the year.

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