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RESEARCH PAPER

Effect of Different Rates of Nitrogen and Phosphorus Application on the Growth and Yield of BARI Tomato-2 (Ratan) (*Solanum lycopersicum L.*)

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ABSTRACT

The experiment was conducted at the Research Farm of Sher-e-Bangla Agricultural University, Dhaka, to evaluate the effect of nitrogen (N) and phosphorous (P) on the growth and yield component of BARI tomato-2. The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications of each fertilizers treatment combination. The treatments used were: four levels of nitrogen as N_0: O kg N/ha, N_{100}: 100 kg N/ha, N_{150}: 150 kg N/ha and N_{200}: 200 kg N/ha and four levels of phosphorus as P_0: 0 kg P_2O_5/ha, P_{50}: 50 kg P_2O_5/ha, P_{100}: 100 kg P_2O_5/ha and p_{150}: 150 kg P_2O_5 /ha with 16 treatment combinations. Yield and yield contributing characters were recorded. Plant height , number of branches per plant, number of flowers per plant, number of fruits per plant, fruit weight per plant and fruit yield increased significantly with increasing N level up to 200 kg N/ha, whereas fruit size (length) increased significantly up to 150 kg N/ha. All these parameters also increased significantly with increasing the level of P up to 150 kg P_2O_5/ha. However, the treatment combination $N_{200}P_{150}$ showed the maximum plant height at harvest (93.62 cm). The treatment combination $N_{200}P_{100}$ produced the maximum number of flowers per plant (49.86), number of fruits per cluster (3.99), number of fruits per plant (38.30) and fruit yield (89.93 t/ha). So, it can conclude from this study that 200 kg N/ha and 150 kg P_2O_5/ha doses performed best in case of growth and yield of Tomato.

Key words: BARI tomato-2, Fruit size, Nitrogen, Phosphorus, Yield

Introduction

The edaphic and climatic conditions of winter seasons of Bangladesh are congenial for tomato cultivation. The lower yield of tomato in Bangladesh, however, 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 fertilizations in crops will act as an insurance against possible nutrient deficiencies that may be created by the respected use of a single nutrient (Manang et al., 1982).

Among different nutrients that were required for tomato cultivation nitrogen and phosphorus are the most important nutrients. On the other hand, soils of Bangladesh have been deficient in nitrogen and phosphorus fertilizer. So, it is necessary to apply these nutrient elements for satisfactory growth, development and also yield of tomato.

It is well documented that application of N promotes vegetative growth and fruit yield of tomato, and later application in the growing stages favours fruit development, thus nitrogen has a dramatic effect on tomato growth and development in soils with limited N supplies such as sandy soils (Hokam et al., 2011). It also promotes vegetative growth, flower and fruit setting of

tomato. Optimum nitrogen increases fruit quality, fruit size, color, taste and acidity. It significantly increases the growth and yield of tomato (Banerjee et al., 1997). Next to nitrogen fertilizer, phosphate fertilizers dwell is the second most important input for increasing crop production. Tomatoes have the greatest demand for phosphorus at the early stages of development (Csizinszky, 2005). Application of phosphorus is an important nutrient for tomato plant growth and development, a deficiency of P leads to reduced growth and reduced yields (Hochmuth et al., 2009).

The relationship between nitrogen and phosphorous to the tomato has received considerable attention and appears to have had a profound influence on horticultural practices. In Bangladesh, BARI (Bangladesh Agricultural Research Institute) has released at least ten HYVs (High yielding varieties) of tomato. The variety BARI Tomato-2 (Raton) is one of the high yielding varieties of indeterminate type. It may be cultivated throughout the year all over the country. Research in response of tomato to nitrogen, phosphorus, potassium and sulphur fertilization is very limited for tomato cultivation. Keeping all the above facts in view, the present experiment has been undertaken with following objectives: To find out the optimum doses of nitrogen and phosphorous for growth and yield of tomato and to find out the combined effect of nitrogen and phosphorous for attaining desirable tomato yield.

Materials and Methods

The experiment was carried out in the experimental field of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka. BARI Tomato-2(Raton), a high yielding variety of tomato (*Solanum lycopersicum* L) was used in this experiment .The selected land for nursery bed was well drained and sandy loam type soil. The size of the seed bed was 3m × 3m, raised 10 to 12 cm (approximately) above the ground level. The seed bed was prepared for raising the seedlings. Ten (10) grams of seeds were sown in the seed bed. After sowing, the seeds were covered with light soil. Complete germination of the seeds took place within 5 days of seed sowing. Necessary shading was made by bamboo mat (chatai) from scorching sunshine or rain. No chemical fertilizer was used in the seed bed.

Experimental design and treatment combination: The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications of each fertilizer treatment combinations. The study comprised the following treatments:

A. Four levels of nitrogen (N)

(i) N_0: 0 kg N/ha; (ii) N_{100}: 100 kg N/ha; (iii) N_{150}: 150 kg N/ha; (iv) N_{200}: 200 kg N/ha

B. Four levels of phosphorus (P_2O_5)

(i) P_0: 0 kg P_2O_5 /ha; (ii) P_{50}: 50 kg P_2O_5 /ha; (iii) P_{100}: 100 kg P_2O_5 /ha; (iv) P_{150}: 150 kg P_2O_5 /ha

The two factors experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. Each block was divided into 16 plots where 16 treatment combinations were allotted at random. There were 48 unit plots altogether in the experiment. Each of the plot area was 3.60 m^2 (2m × 1.8m) .The distances maintained between two blocks and two plots were kept 1.0 m and 0.5 m, respectively.

Application of manure and fertilizers: The sources of N, P_2O_5, K_2O, S as urea, triple super-phosphate (TSP), muriate of potash (MOP), and gypsum were applied, respectively. One third (1/3) of whole amount of urea, the entire amounts of TSP, MOP and gypsum were applied during the final land preparation. The remaining urea were top dressed in two equal installments at 20 days after transplanting (DAT) and 35 days after transplanting, respectively. Healthy and uniform sized 30 days old seedlings were uprooted from the seed bed and were transplanted in the experimental field. Fruits were harvested at 5 days intervals during maturity to ripening stage.

Collection of experimental data: Five (5) plants from each plot were selected randomly and were tagged for the data collection. Data were recorded on the following parameters namely Plant height, Number of leaves per plant at 30 DAS and 60 DAS, Number of branches per plant(Final harvest) and Number of cluster per plant , Number of flowers/plant, fruits/plant and flowers/cluster Number of fruits/cluster and Rate of fruit setting (%),Fruit size (length × breadth), Fruit yield/plant (gm), yield/plot (kg) and Fruit yield/hectare (ton).

Calculations followed: Number of fruits per cluster=Total number of flowers of sample plants/Total number of clusters of sample plants; Rate of fruit setting (%) = (Total number of fruits per plants/ Total number of flowers per plants)×100; Weight of individual fruit (gm)= Total weight of marketable fruits from10 harvested sample plants/ Total number of marketable fruits from 10 harvested of sample plant; Weight of fruits per plant (gm) = Total weight of fruits from10 samples/10. A pan scale balance was used to take the weight of fruits during the period from first to final harvest{yield/plot (kg)}; Fruit yield per hectare (ton) = {Fruit yield per plot (kg) × 10000}/ (Area of plot in square meter × 1000).

Statistical Analysis

The data obtained for different parameters were statistically analyzed to find out the significance difference of the different levels of nitrogen and phosphorous on yield and yield contributing characters of tomato. The mean values of all the characters were calculated and analysis of variance was performing by the 'F' (variance ratio) test. The significance of the difference among the treatment combinations means was estimated by the Duncan's Multiple Range Test (DMRT) at 5% level of probability.

Results and Discussion

Yield and yield contributing character of tomato

Plant height: Plant height varied significantly due to application of nitrogen in tomato under the present trial. At 30 days after transplanting (30 DAT) the maximum plant height (60.38 cm) was recorded from N_{200}

treatment which was statistically similar (58.76 cm) with N_{150} treatment and the minimum plant height (56.16 cm) was recorded from N_0 treatment that is in control treatment (Table 1). At 60 DAT, the highest plant height (78.31cm) was recorded from N_{200} treatment and the lowest plant height (70.78 cm) was recorded from N_0 treatment (Table 1). During the harvesting period, the maximum plant height (89.58 cm), was further recorded from N_{200} treatment and the minimum plant height (80.17cm) was recorded from N_0 treatment (Table 1). Present result revealed that highest dose of Nitrogen responsible for maximum plant height in all 30 DAT, 60DAT and harvesting period. Melton and Dufault (1991) found that plant height of tomato was increased as highest level of nitrogen. Similar result was also reported by Chung *et al*. (1992).

Different level of phosphorus showed statistically significant differences for plant height. At 30 DAT, the maximum plant height (59.43 cm), was recorded from P_{100} treatment which was statistically similar (59.15cm) with P_{150} treatment and (58.51cm) with P_{50}, the minimum plant height (55.46 cm) was recorded from P_0 treatment (Table 1). At 60 DAT, the maximum plant height (77.61 cm), was recorded from P_{150} , the minimum plant height (72.04 cm) was recorded from P_0 treatment (Table 1). During the harvesting period, the maximum plant height (88.93 cm), was recorded from P_{150} treatment which was statistically similar (88.08) with P_{100} treatment and the minimum plant height (80.64 cm) was recorded from N_0 treatment (Table 1).

Interaction effect was also found statistically significant. At 30 DAT the maximum plant height (61.74 cm), was recorded from N_{200} P_{150} treatment which was statistically similar with other treatments like N_{150} $P_{50,}$ N_{150} P_{100}. The minimum plant height (52.77 cm) was found at N_0 P_0 treatment (Table 2). At 60 DAT the maximum plant height (81.48 cm), was recorded from N_{200} P_{150} treatment which was statistically identical (79.99 cm) with $N_{200}P_{100}$ treatment. The minimum plant height (68.23 cm) was recorded from N_0P_0 treatment which was statistically similar (70.51 cm) followed by N_0P_{50} treatment (Table 2). During the harvesting period, the maximum plant height (93.62 cm), was recorded from N_{200} P_{150} treatment which was statistically similar (92.20 cm) with N_{200} P_{100}. The minimum plant height (75.44 cm) was recorded from control condition (Table 2).

Number of leaves per plant at 60 DAT: Number of leaves per plant varied significantly due to application of nitrogen in tomato under the present trial. At 60 DAT, significantly highest number of plant leaves (51.72), was recorded from N_{200} treatment and the lowest number plant leaves (39.72) was recorded from N_0 treatment (Table 1). Different level of phosphorus showed statistically significant differences for plant leaves. At 60 DAT, significant number plant leaves (48.49), was recorded from P_{150} which was statistically similar with P_{100} treatment (47.78) and the minimum number of plant leaves (40.10) was recorded from P_0 treatment (Table 1). The ranges of number of leaves per plant at 60 DAT incase of phosphorous application was 40.10 to 48.49.

Interaction effect found statistically significant. At 60 DAT, significantly maximum number of plant leaves (56.09) was recorded from N_{200} P_{150} treatment. The minimum number of plant leaves (35.87) was observed from N_0P_0 treatment which was statistically similar (39.52) with the N_0P_{50} and $N_{100}P_0$ treatments (Table 2).

Number of branches per plant at final harvest: At harvesting period, significantly highest number of branches per plant (11.26), was observed from N_{200} treatment and significantly lowest number of branche**s** per plant (9.668) was observed from N_0 treatment (Table 1). Different level of phosphorus showed statistically significant differences for branches per plant. At final harvesting period, the highest number of branches per plant (11.35), was recorded from P_{150} treatment and the minimum branches per plant (9.45) was recorded from P_0 treatment (Table 1).

Interaction effect found statistically significant. At harvesting period, the maximum number of branches per plant (12.19) was recorded fromN_{200} P_{150} treatment and minimum number of branches per plant (8.39) was recorded from N_0P_0 treatment which was statistically similar with N_0P_{50} treatment (Table 2).

Table 1. Effect of nitrogen and phosphorous on plant height, number of leaves per plant and branches per plant of tomato.

Treatments	Plant height (cm)			No. of leaves/plant at 60 DAT	No. of branches/plant at harvesting period
	30 DAT	60 DAT	Harvesting period		
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
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

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

Table 2. Interaction effect of nitrogen and phosphorus on plant height, number of leaves per plant and branches per plant of tomato.

Treatments (N×P)	Plant height (cm)			No. of leaves/plant at 60 DAT	No. of branches / plant (harvesting period)
	30 DAT	60 DAT	Harvesting period		
N_0 P_0	52.77d	68.23h	75.44i	35.87e	8.39h
N_0 P_{50}	56.50bc	70.51gh	79.50h	39.52de	9.40g
N_0 P_{100}	58.55ab	72.85efg	82.80gh	41.50cd	10.32def
N_0 P_{150}	56.82bc	71.51fgh	82.95fgh	42.01cd	10.56def
N_{100} P_0	54.43cd	72.38fg	80.40h	39.53de	9.69fg
N_{100} P_{50}	58.15ab	75.35cdef	84.30efg	43.38cd	10.32def
N_{100} P_{100}	58.25ab	77.38bcd	87.51cde	44.42c	10.77cde
N_{100} P_{150}	58.17ab	77.97abcd	87.98cde	45.00c	10.99bcd
N_{150} P_0	56.71bc	73.23efg	82.20gh	41.67cd	9.82fg
N_{150} P_{50}	58.46ab	76.72bcde	86.71def	45.31c	10.57def
N_{150} P_{100}	60.03ab	78.76abc	89.82bcd	49.84b	11.57abc
N_{150} P_{150}	59.86ab	79.49ab	91.15abc	50.87b	11.66ab
N_{200} P_0	57.92abc	74.34defg	84.52efg	43.31cd	9.93efg
N_{200} P_{50}	60.94a	77.43bcd	88.00cde	52.10ab	10.87bcd
N_{200} P_{100}	60.91a	79.99ab	92.20ab	55.36a	12.05a
N_{200} P_{150}	61.74a	81.84a	93.62a	56.09a	12.19a
CV (%)	3.37	2.80	2.45	5.48	4.50

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

Number of flower clusters per plant: The significantly highest number of flower clusters per plant (8.800), was found from N_{200} treatment and on the other hand significantly lowest number of flower clusters per plant (6.350) was recorded from N_0 treatment (Table 3).The maximum number of flower clusters per plant (8.580) was found from P_{150} treatment which was statistically similar (8.530) with P_{100} whereas the minimum number of flower clusters per plant (6.365) was recorded from P_0 treatment under the present trial. With increasing level of phosphorous, plant growth increases and the number of flower clusters per plant also increases (Table 3). Interaction effect found statistically significant. The maximum flower clusters per plant (9.60) was recorded from N_{200} P_{100} treatment which was statistically similar(9.580) with $N_{200}P_{150}$, (9.540) with $N_{150}P_{100}$ and (9.440) with $N_{150}P_{150}$ treatment. The minimum flower clusters per plant (5.01) was recorded from N_0P_0 treatment (Table 4).

Number of flowers per cluster: The significantly highest number of flowers per cluster (4.943) was observed from N_{200}, which was statistically similar with N_{150} treatment (4.932), the lowest number of flowers per cluster (4.520) was found from N_0 treatment (Table 3). The maximum number of flowers per clusters (5.003) was recorded from P_{150} treatment and the minimum number of flowers per cluster (4.452) was recorded from P_0 treatment (Table 3). Grela *et al*. (1988) put forward almost similar opinion with the result of number of flower cluster/plant of this study. Interaction effect found statistically significant. The maximum number of flowers per cluster (5.140) was found from $N_{100}P_{150}$ treatment which was statistically similar with both $N_{150}P_{100}$ and $N_{150}P_{150}$ treatment (5.100) and also (5.09) with $N_{200}P_{100}$treatment. The minimum number of flowers per cluster (4.1) was recorded from N_0P_0 treatment which was statistically identical with the treatment $N_{100}P_0$ (4.42) (Table 4).

Number of flowers per plant: Significantly maximum number of flowers per plant (44.63) was recorded from N_{200} treatment, and significantly minimum number of flowers per plant (30.41) was recorded from N_0 treatment (Table 3). The highest number of flowers per plant (44.02), was observed from P_{150} treatment which was statistically similar with P_{100} treatment (43.38) and the lowest number of flowers per plant was recorded from P_0 treatment (30.01) (Table 3). Interaction effect found statistically significant. The maximum number of flowers per plant (49.86) was recorded from $N_{200}P_{100}$ The minimum number of flowers per plant were recorded from N_0P_0 (23.52) treatment (Table 4).

Number of fruits per cluster: First it is important to mention that the number of fruits per cluster increased with increasing level of N. Significantly highest number of fruits per cluster (3.828) was recorded from N_{200} treatment, the lowest number of fruits no cluster (3.325) was recorded from N_0 treatment (Table 3). Nassar (1988) also found that increased nitrogen level was tended to increase average number of fruits cluster per plant.

The maximum number of fruits per clusters (3.787), was recorded from P_{100} treatment which was statistically similar with P_{150} treatment (3.727) and with P_{50} treatment (3.630).The minimum numbers of fruits per cluster (3.525) were recorded from P_0 treatment (Table 3). The ranges of number of fruits per cluster incase of

phosphorous application was 3.525 to 3.787. Interaction effect found statistically significant .The maximum number of fruits per clusters (3.990), was recorded from $N_{200}P_{100}$ treatment The minimum numbers of fruits per cluster were recorded from N_0P_0 treatment (3.21) (Table 4).

Number of fruits per plant: Significantly highest amount of fruits per plant (33.77) was recorded from N_{200} treatment and lowest amount of fruits per plant was recorded from N_0 treatment (21.75) (Table 3).The maximum fruits number per plant (32.75) was recorded from P_{150} treatment and the minimum fruits number per plant was recorded from P_0 treatment (22.59) (Table 3). Similar statement was made by Fandi et al (2010), who stated that the highest number of fruits per plant was recorded at high phosphorus concentration level.

Interaction effect found statistically significant .The maximum number of fruits per plant was recorded from $N_{200}P_{100}$ treatment (38.30), The minimum numbers of fruits per plant (16.08) were recorded from N_0P_0 treatment (Table 4).

Table 3. Effect of nitrogen and phosphorous on number of cluster / plant, number of flowers/ cluster, number of flowers/ plant, number of fruits/ cluster and number of fruits/ plant of tomato

Treatments	Number of flower cluster / plant	Number of flowers/ cluster	Number of flowers/ plant	Number of fruits/ cluster	Number of fruits/ plant
Nitrogen					
N_0	6.35d	4.520b	30.41c	3.325b	21.75c
N_{100}	7.537c	4.813a	37.46b	3.697a	27.86b
N_{150}	8.432b	4.932a	42.41a	3.820a	32.33a
N_{200}	8.800a	4.943a	44.63a	3.828a	33.77a
Phosphorous					
P_0	6.365c	4.452c4.	30.01c	2.525b	22.59c
P_{50}	7.645b	4.805b	37.88b	3.630ab	27.89b
P_{100}	8.530a	4.947ab	43.38a	3.787a	32.49a
P_{150}	8.580a	5.003a	44.02a	3.727ab	32.75a

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

Table 4. Interaction effect of nitrogen and phosphorous on number of flower cluster/plant, number of flowers/cluster, number of flowers/plant, number of fruits/cluster and number of fruits/plant of tomato

Treatments (N×P)	Number of flower cluster / plant	Number of flowers/ cluster	Number of flowers/ plant	Number of fruits/ cluster	Number of fruits/ plant
N_0 P_0	5.01g	4.10e	23.52h	3.21d	16.08f
N_0 P_{50}	6.41f	4.52d	29.97fg	3.33bcd	21.35e
N_0 P_{100}	6.98def	4.69bcd	33.74def	3.52abcd	24.57de
N_0 P_{150}	7.00def	4.77abcd	34.39de	3.24cd	24.99de
N_{100} P_0	6.32f	4.42de	28.89g	3.52abcd	22.21e
N_{100} P_{50}	7.53cd	4.78abcd	36.99cd	3.68abc	27.71cd
N_{100} P_{100}	8.00bc	4.91abc	40.28bc	3.75ab	30.00bc
N_{100} P_{150}	8.30b	5.14a	43.66b	3.84a	31.54b
N_{150} P_0	6.75ef	4.62cd	32.19efg	3.67abcd	24.77de
N_{150} P_{50}	8.00bc	4.91abc	40.28bc	3.77ab	30.16bc
N_{150} P_{100}	9.54a	5.10a	49.65a	3.89a	37.11a
N_{150} P_{150}	9.44a	5.10a	49.14a	3.95a	37.29a
N_{200} P_0	7.38cde	4.67bcd	35.46de	3.70abc	27.31cd
N_{200} P_{50}	8.64b	5.01ab	44.29b	3.74ab	32.32b
N_{200} P_{100}	9.60a	5.09a	49.86a	3.99a	38.30a
N_{200} P_{150}	9.58a	5.0ab	48.90a	3.88a	37.17a
CV (%)	4.84	4.08	6.15	6.74	7.00

Weight of individual fruit: Significantly maximum weight of individual fruit per plant (83.77 gm) was recorded from N_{200}, which was statistically similar (83.27 gm) with N_{150} treatment, and on the other hand the minimum weight of individual fruit per plant (66.22 gm) was recorded from N_0 treatment that is zero level of nitrogen (Table 5). Incase of N the maximum fruit weight was found at 200 kg N/ha, similar findings was showed by Ahmed and Choudhury (1990). The maximum weight of individual fruit per plant (81.67 gm), was recorded from P_{150} treatment and the minimum weight of individual fruit per plant (71.54) was recorded from P_0 treatment (Table 5).

Interaction effect found statistically significant. The maximum weight of individual fruit per plant (87.59 gm) was recorded from $N_{150}P_{100}$ treatment and the minimum weight of individual fruit per plant (63.85 gm) was recorded fromN_0P_0 treatment (Table 6).

Fruit size (Fruit length): Significantly highest fruit length (5.320 cm) was recorded from N_{150} treatment, which was statistically similar with N_{200} treatment, and with N_{100} treatment, significantly minimum fruit length (4.605 cm) was recorded from N_0 treatment that zero level of nitrogen (Table 5). Significantly maximum fruit length (5.262 cm) was recorded from P_{150} treatment and the minimum fruit length (4.960 cm) was recorded from P_0 (Table 5). Interaction effect found statistically significant. The maximum fruit length (5.610 cm) was recorded from a, and the minimum fruit length per plant (4.52 cm) was recorded from N_0P_0 treatment (Table 6) and founds with N_0P_{150}, N_0P_{100} and N_0P_{150} treatments.

Fruit size (Fruit breadth): Significantly highest fruit breadth (5.88 cm) was found from N_{200} treatment consisting of 200 kg N/ha, and the significantly lowest fruit breadth (4.283 cm) was recorded from N_0 treatment (Table 5). Islam *et al*. (1997) in his experiment made similar observation that the length and breadth of individual fruit increased with increasing of nitrogen level. The maximum fruit breadth (4.6 cm) was observed from P_{150} treatment which was statistically identical (4.568 cm) with P_{100} treatment while (4.505 cm) with P_{50} treatment and the minimum fruit breadth (4.358 cm) was recorded from P_0 treatment (Table 5). Interaction effect found statistically significant The maximum fruit breadth per plant (4.700cm) was recorded from both $N_{100}P_{100}$ and $N_{150}P_{100}$ treatment and on the other hand the minimum fruit breadth (4.11cm) was recorded from N_0P_0 treatment (Table 6).

Fruit weight per plant: Significantly highest fruit weight per plant (2.13 kg) was recorded from N_{200} treatment, while Significantly lowest fruit weight per plant (1.085kg) was observed from N_0 treatment (Table 5). Fruit weight per plant due to different levels of N application ranged from 1.085 to 2.125 kg. The maximum weight of fruit per plant (2.033 kg) was recorded from P_{150} treatment which was statistically similar (2.007 kg) with P_{100} treatment and whereas the minimum weight of fruits per plant (1.225 kg) was recorded from P_0 treatment (Table 5). Interaction effect found statistically significant The highest weight of fruits per plant (2.5 kg) was recorded from $N_{200}P_{100}$ treatment while the lowest weight of fruits per plant (0.770 kg) was recorded fromN_0P_0 treatment (Table 6).

Fruit yield: The maximum fruit yield (76.72 ton/ha) (Figure 1) was recorded from N_{200} treatment, and the minimum fruit yield (39.0 ton/ha) was recorded from N_0 treatment (Table 5). Regarding phosphorus, the maximum fruit yield (73.26 ton/ha) was found from P_{150} treatment which was statistically similar (72.24 ton/ha) (Figure 2) with P_{100} treatment and while the minimum fruit yield (44.11 ton/ha) was recorded from P_0 treatment (Table 5). Similar observation was made by Fandi et al (2010), he stated that the highest yield was recorded at high phosphorus concentration level.

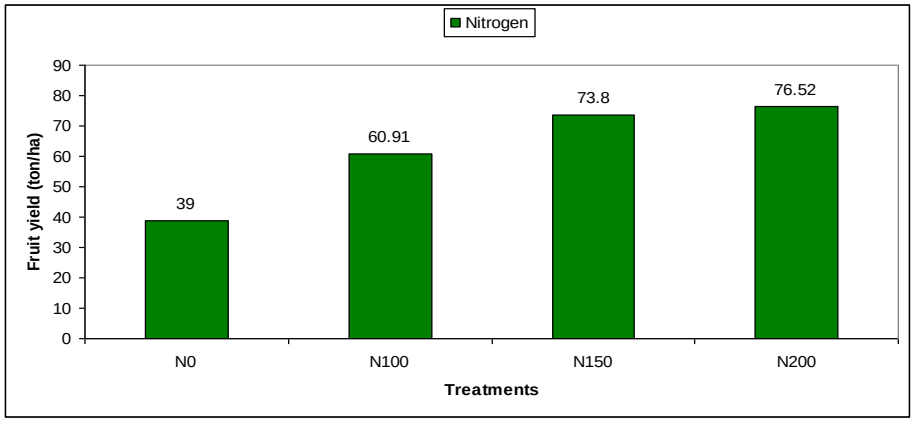

Figure 1. Effect of nitrogen on the yield (ton/ha) of tomato

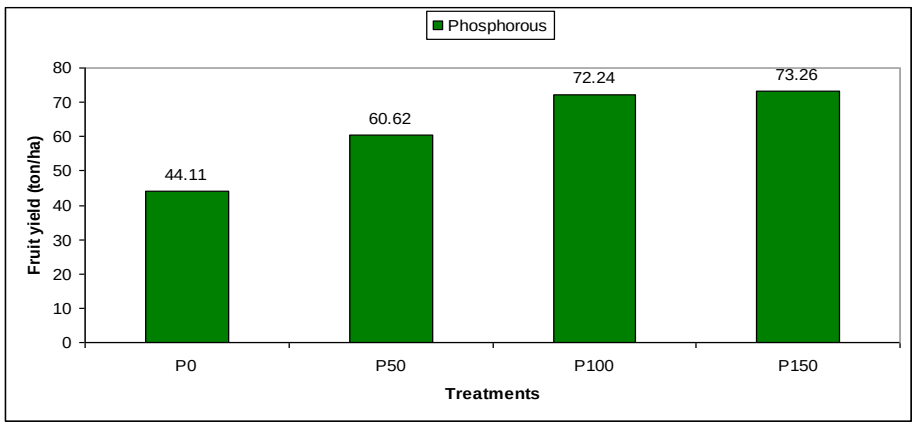

Figure 2. Effect of phosphorous on the yield (ton/ha) of tomato

Table 5. Effect of nitrogen and phosphorous on fruit size, weight of individual fruit, fruit weight/plant and fruit yield of tomato

Treatment	Fruit size		Weight of individual fruit (gm)	Fruit weight /plant (kg)	Fruit yield (ton/ha)
	Length (cm)	Breadth (cm)			
Nitrogen					
N_0	4.605b	4.289b	66.22c	1.085d	39.00d
N_{100}	5.225a	4.580a	80.40b	1.690c	60.91c
N_{150}	5.320a	4.580a	83.77a	2.050b	73.80b
N_{200}	5.278a	4.588a	83.27a	2.125a	76.52a
Phosphorous					
P_0	4.960c	4.358b	71.54b	1.225c	44.11c
P_{50}	5.080bc	4.505a	79.49a	1.685b	60.62b
P_{100}	5.125b	4.568a	80.96a	2.007a	72.24a
P_{150}	5.262a	4.600a	81.67a	2.033a	73.26a

Table 6. Interaction effect of nitrogen and phosphorous on fruit size, weight of individual fruit, fruit weight/plant and fruit yield of tomato

Treatments (N×P)	Fruit size		Weight of individual fruit (gm)	Fruit weight /plant (kg)	Fruit yield (ton/ha)
	Length (cm)	Breadth (cm)			
N_0 P_0	4.520e	4.110f	63.85d	0.7700i	27.72j
N_0 P_{50}	4.600e	4.300e	67.37d	1.080h	38.83i
N_0 P_{100}	4.650e	4.320de	65.99d	1.220g	43.78h
N_0 P_{150}	4.650e	4.400de	67.68d	1.270g	45.67h
N_{100} P_0	4.900d	4.420cde	73.03c	1.220g	43.79h
N_{100} P_{50}	5.200c	4.500abcd	80.86b	1.680d	60.50e
N_{100} P_{100}	5.300bc	4.700a	83.31ab	1.870c	67.48d
N_{100} P_{150}	5.500ab	4.700a	84.41ab	1.990bc	71.88bc
N_{150} P_0	5.200c	4.450bcde	74.87c	1.390f	50.07g
N_{150} P_{50}	5.220c	4.620ab	85.32ab	1.930bc	69.48cd
N_{150} P_{100}	5.250bc	4.600abc	87.59a	2.440a	87.76a
N_{150} P_{150}	5.610a	4.650ab	87.29a	2.440a	87.89a
N_{200} P_0	5.220c	4.450bcde	74.41c	1.520e	54.87f
N_{200} P_{50}	5.300bc	4.600abc	84.42ab	2.050b	73.67b
N_{200} P_{100}	5.300bc	4.650ab	86.97a	2.500a	89.93a
N_{200} P_{150}	5.290bc	4.650ab	87.29a	2.430a	87.60a
CV(%)	2.67	2.36	3.24	3.98	3.68

Interaction effect showed significant variation. The maximum fruit yield (89.93 ton/ha) was recorded from $N_{200}P_{100}$ treatment which was statistically similar with $N_{150}P_{150}$, $N_{150}P_{100,}$ and $N_{200}P_{150}$ treatment. The minimum fruit yield (27.72 ton/ha) was recorded from N_0P_0 treatment (Table 6).

Conclusion

Plant nutritional status affects yield and fruit quality. Hence it is essential to have a good knowledge of the plant's mineral requirements to ensure better growth and good yield and to avoid nutrient wastage, which will decrease production costs. This study revealed that 200 kg N/ha and 150 kg P_2O_5/ha performed best in terms of growth and as well as highest yield and control treatment performed lowest over all the treatments used in this study. So, from this study we may conclude that increasing the level of Nitrogen (up to 200kg N /ha) and phosphorus (up to150 kg P_2O_5 /ha) doses, increasing the growth and yield of tomato plant.

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