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Effect of Different Plant Growth Regulators on Growth and Yield of Tomato

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Abstract: An experiment was conducted to find out the effect of different plant growth regulators on tomato at Horticulture Farm in Sher-e-Bangla Agricultural University, Dhaka-1207, Bangladesh, during September 8, 2008 to January 19, 2009. Four different plant growth regulators (Denoted as PGR) were used as treatments, viz. PGR_0 = Control (No application of plant growth regulator), PGR_1= NAA (Naphthalene acetic acid) @ 30 ppm, PGR_2= GA_3 (Gibberellic Acid) @ 30 ppm and PGR_3 = 2, 4-D (2, 4- Dichloro-phenoxy acetic acid) @ 30 ppm in the study. The growth and yield contributing characters were significantly differed due to different plant growth regulators on tomato. The maximum plant height at 15 DAT (33.41 cm), 30 DAT (59.07 cm) and 45 DAT (76.36 cm), number of leaves plant^{-1} at 15 DAT (15.08), 30 DAT (47.20) and 45 DAT (72.86), number of branches plant^{-1} at 15 DAT (8.06), 30 DAT (12.13) and 45 DAT (17.85), number of flowers cluster^{-1} (5.81), number of flower cluster plant^{-1} (8.83), number of flowers plant^{-1} (59.62), number of fruits cluster^{-1} (4.81), number of fruits plant^{-1} (42.66), average weight of individual fruit (92.06 g), yield plant^{-1} (2.49 kg) and yield hectare^{-1} (93.23 t/ha) were found in PGR_2 and the minimum for all the parameters were found in control (PGR_0) treatment.

Key words: Naphthalene acetic acid % Gibberellic Acid % 2 % 4- Dichloro-phenoxy acetic acid % Growth % Yield and tomato

INTRODUCTION

Tomato (*Lycopersicon esculentum* L.) belonging to Solanaceae and its origin is the Andean zone particularly Peru-Ecuador-Bolivian areas [1] but cultivated tomato originated in Mexico. Tomato is one of the most highly praised vegetables consumed widely and it is a major source of vitamins and minerals. It is one of the most popular salad vegetables and is taken with great relish. It is widely employed in cannery and made into soups, conserves, pickles, ketchup, sauces, juices etc. Tomato juice has become an exceedingly popular appetizer and beverage. The well ripe tomato (per 100 g of edible portion) contains water (94.1%), energy (23 calories), calcium (1.0 g), magnesium (7.0 mg), vitamin A (1000 IU), ascorbic acid (22 mg), thiamin (0.09 mg), riboflavin (0.03 mg) and niacin (0.8 mg) [2]. Plant growth substances are essential for growth and development of tomato plant. It plays an important role in flowering, fruit setting, ripening and physiochemical changes during storage of tomato. Application of IAA as foliar sprays or to the growing media of tomato plants had a stimulatory effect on plant growth and development [3]. On the other hand gibberelic acid (GA_3) plays role on controlling fruit setting, pre-harvest fruit drop, increasing fruit yield and extending self-life [4, 5]. Fruit set in tomato was successfully improved by application of NAA and IAA [6, 7]. In fact the use of growth regulators had improved the production of tomato including other vegetables in respect of better growth and quality, which ultimately led to generate interest between the scientists and farmers for commercial application of growth regulators. So the present investigation was undertaken to find out the effect of different plant growth regulators on growth and yield of tomato.

MATERIALS AND METHODS

The experiment was carried out at Horticultural Farm in Sher-e-Bangla Agricultural University, Dhaka-1207, Bangladesh during rabi season (September 8, 2008 to January 19, 2009.). The area had sub tropical climate characterized by high temperature (28°-32°C) accompanied by moderately high rainfall during Kharif (April-September) season and low temperature (15°-20°C) in the rabi (October-March) season. The soil belongs to

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the "Modhupur Tract", AEZ-28, (FAO, 1988). Roma VF variety of tomato was used in the experiment. Four different plant growth regulators (Denoted as PGR) were used as treatments, viz. PGR_0 = Control (No application of plant growth regulator), PGR_1= NAA (Naphthalene acetic acid) @ 30 ppm, PGR_2= GA_3 (Gibberellic Acid) @ 30 ppm and PGR_3 = 2, 4-D (2, 4- Dichlorophenoxy acetic acid) @ 30 ppm in the study. The experiment was laid out in a Randomized Complete Block Design with six replications. Thirty days old and a height of 10 cm seedlings were collected from Horticulture farm, Sher-e-Bangla Agricultural University, Dhaka, Bangladesh and transplanted at the spacing of 60cm × 40cm in the experimental plot on October 20, 2008. Manures and chemical fertilizers were applied at the rate of cow dung 20 t/ha, Urea 250 kg/ha, Triple Super phosphate (TSP) 200 kg/ha and Muriate of Phosphate (MoP) 150 kg/ha as per recommendation. The size of the experimental plots was 4.0 m × 1.8 m. Data were collected from ten randomly selected plants for each plot; viz., plant height (cm), leaf length and number of branch plant-1 at different harvesting times, days to first flowering, flower cluster plantG^{1}, number of fruit clusterG^{1}, number of fruit plantG^{1}, average fruit weight (g), yield plantG^{1} and yield haG^{1}. The means were separated by Duncan's Multiple Range Test (DMRT) at 5% level of significance [8].

RESULTS AND DISCUSSION

Plant Height (cm): Plant height of tomato varied significantly at 15, 30 and 45 DAT due to application of plant growth regulators (Fig. 1). The maximum plant height at 15 DAT (33.41 cm), 30 DAT (59.07 cm) and 45 DAT (76.36 cm) was recorded from PGR_2 treatment (application of GA_3 @ 30 ppm), while the minimum plant height at 15 DAT (20.83 cm), 30 DAT (49.29 cm) and 45 DAT (63.90 cm) was recorded from control treatment (No PGR application) at 15 DAT (20.83 cm), 30 DAT (49.29 cm) and 45 DAT (63.90 cm). It was revealed that plant height of tomato increased with the application of plant growth regulators. This might be due to that the plant growth regulators enhanced cell division with considerable stem elongation and the ultimate result was the longest plant of tomato. Shittu and Adeleke [9] and Wu *et al*. [10] reported the same trend of the results on tomato. But Chhonkar and Ghufran [11] reported that plant height decreased with the increased concentration of NAA concentration which was not similar to that of the present study.

Number of leaves PlantG^{1}: Number of leaves plantG^{1} of tomato varied significantly at 15, 30 and 45 DAT due to application of plant growth regulators (Fig. 2). The maximum number of leaves plantG^{1} at 15 DAT (15.08), 30 DAT (47.20) and 45 DAT (72.86) was recorded from PGR_2 treatment (application of GA_3 @ 30 ppm), while the minimum number of leaves plantG^{1} was recorded from PGR_0 treatment (No PGR application) at 15 DAT (10.31), 30 DAT (32.86) and 45 DAT (59.28). It was revealed that number of leaves plantG^{1} of tomato increased with the application of plant growth regulators in tomato especially GA_3 at 15, 30 and 45 DAT. This might be due to that plant growth regulators enhanced cell division with considerable stem elongation. Gabal *et al*. [12] found same trend of result in tomato.

Number of branches PlantG^{1}: Number of branches plantG^{1} of tomato varied significantly at 15, 30 and 45 DAT due to application of plant growth regulators (Fig. 3). The maximum number of branches plantG^{1} at 15 DAT (8.06), 30 DAT (12.13) and 45 DAT (17.85) was recorded from PGR_2 treatment (application of GA_3 @ 30 ppm), while the minimum number of branches per plant was recorded from control treatment (No PGR application) at 15 DAT (3.32), 30 DAT (6.82) and 45 DAT (11.52). It was revealed that number of branches plantG^{1} of tomato increased with the application of plant growth regulators in tomato especially GA_3 at 15, 30 and 45 DAT. Similar trend of result was reported by other scientist like Singh and Singh [13].

Days to First Flowering: Plant growth regulators showed statistically significant variation on days to first flowering from the date of transplanting of tomato (Table 1). The maximum days (34.92) required to first flowering in PGR_0 treatment (No application of plant growth regulator) which was statistically similar to that of PGR_1 treatment (application of NAA), while the minimum days (31.73) required to first flowering in PGR_2 treatment (application of GA_3) which was statistically similar to that of PGR_3 treatment (application of 2,4-D). It was found that GA_3 showed a positive effect among different plant growth regulators. This might be due to that GA_3 induced flower initiation in tomato. Singh and Singh [13] reported that the initiation time of first flowering and first fruiting was significantly and highly increased by application of NAA which did not agree with the present result.

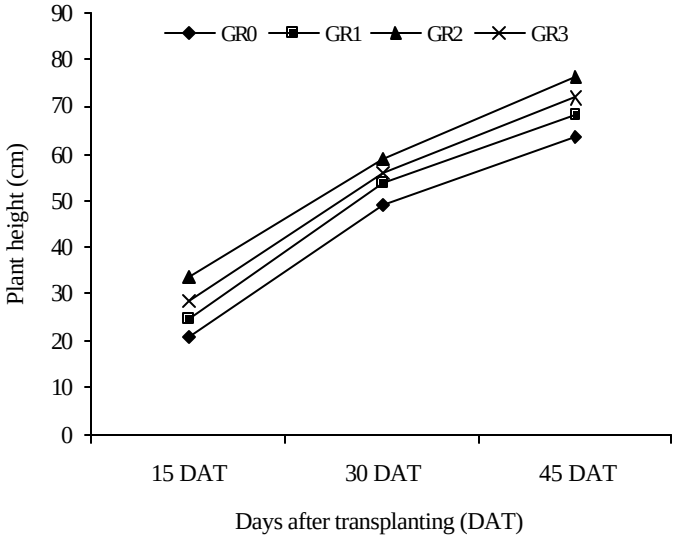

Fig. 1: Effect of plant growth regulators on plant height at different DAT in tomato

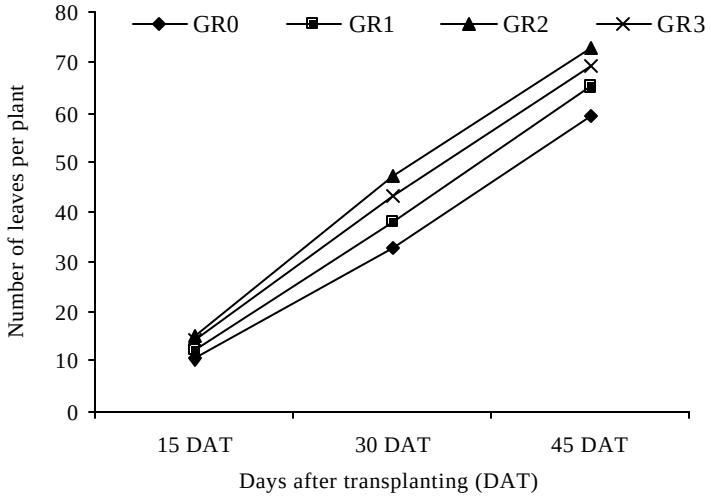

Fig. 2: Effect of plant growth regulators on number of leaves plant^{-1} in tomato at different DAT

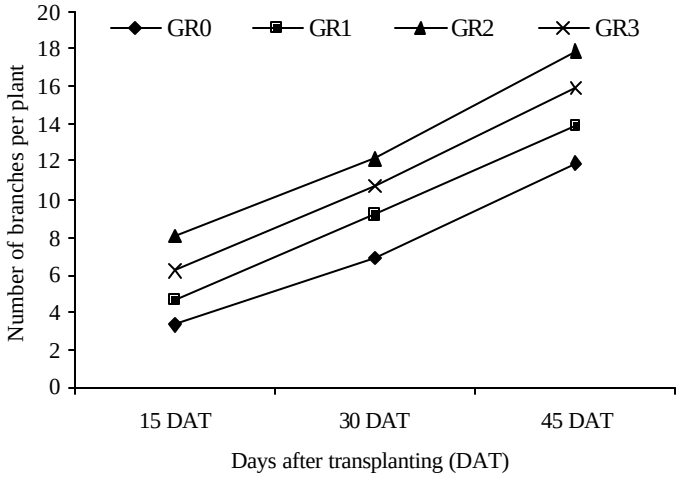

Fig. 3: Effect of plant growth regulators on number of branches plant^{-1} in tomato at different days after transplanting

Table 1: Effect of plant growth regulators on yield contributing characters in tomato

Treatment(s)	Days to 1st flowering from transplanting	Number of flowers per cluster	Number of flower cluster per plant	Number of flowers per plant	Number of fruits per cluster	Number of fruits per plant	Average weight of individual fruit (g)
PGR_0	34.92 a	4.50 d	6.03 c	41.55 d	3.66 d	21.45 d	82.37 c
PGR_1	33.94 a	5.09 c	7.78 b	46.72 c	4.09 c	31.75 c	85.01 bc
PGR_2	31.73 b	5.81 a	8.83 a	59.62 a	4.81 a	42.66 a	92.06 a
PGR_3	33.13 ab	5.52 b	8.18 b	52.86 b	4.52 b	36.90 b	87.57 b
$LSD_{(0.05)}$	1.728	0.247	0.545	2.305	0.251	2.576	3.112
CV (%)	6.20	5.66	8.48	5.51	7.00	9.30	4.30

In a column means having similar letter (s) are statistically similar and those having dissimilar letter (s) differ significantly at 5% level of probability

PGR_0: Control (No application of plant growth regulators; PGR_1: NAA (Naphthalene acetic acid); PGR_2: GA_3 (Gibberellic Acid); PGR_3: 2,4-D (2,4-Dichlorophenoxy acetic acid)

Number of Flowers per Cluster: Number of flowers clusterG^{-1} in tomato plant showed statistically significant variation due to the application of plant growth regulators (Table 1). The maximum number of flowers clusterG^{-1} (5.81) was recorded from PGR_2 treatment (application of GA_3), while the minimum number of flowers clusterG^{-1} (4.50) was recorded from PGR_0 treatment (no application of plant growth regulator). It was revealed that GA_3 gave the higher number of flowers clusterG^{-1}. This caused that GA_3 promoted flower primodia production. Similar trend of the result was found by Onofeghara [14] and Leonard *et al*. [15].

Number of Flower Cluster per Plant: There had remarkable variation in number of flower cluster plantG^{-1} in tomato due to application of different plant growth regulators (Table 1). The maximum number of flower cluster plantG^{-1} (8.83) was recorded from PGR_2 treatment (application of GA_3) while the minimum number of flower cluster plantG^{-1} (6.03) was recorded from PGR_0 treatment (no application of plant growth regulators). The result revealed that GA_3 increased the number of flower cluster plantG^{-1}. Flower primodia was promoted by GA_3 carrying number of flower cluster plantG^{-1}. The result of the present study divulged with the result of Onofeghara [14].

Number of Flowers per Plant: Number of flowers plantG^{-1} of tomato showed statistically significant variation among different plant growth regulators (Table 1). The maximum number of flowers plantG^{-1} (59.62) was recorded from PGR_2 treatment (application of GA_3), while the minimum number of flowers plantG^{-1} (41.55) was recorded from PGR_0 treatment (no application of plant growth regulators). Superior result in respect of number of flower plantG^{-1} was found in GA_3 application. This might be caused that GA_3 promoted flower primodia production in tomato plant. This result disagreed with the result of Onofeghara [14] and Saleh and Abdul [16]. This might be due to the application of different concentration of GA_3.

Number of Fruits per Cluster: Number of fruits clusterG^{-1} of tomato plant performed statistically significant variations due to application of plant growth regulators (Table 1). The maximum number of fruits clusterG^{-1} (4.81) was recorded from PGR_2 (application of GA_3) which was closely followed by PGR_3 (application of 2, 4-D), while the minimum number of fruits clusterG^{-1} (3.66) was recorded from PGR_0 (no application of plant growth regulators). Gibberelic acid (GA_3) played role on controlling fruit setting. Similar trend of result was divulged by Adlakha and Verma [17].

Number of Fruits per Plant: Statistically significant variation found in the number of fruits plant$G^{-1}$of tomato due to application of plant growth regulators (Table 1). The maximum number of fruits plantG^{-1} (42.66) was recorded from PGR_2 treatment (application of GA_3), while the minimum number of fruits plantG^{-1} (21.45) was recorded from PGR_0 treatment (no application of plant growth regulators). It was found that GA_3 produced higher number of fruits plantG^{-1} over other plant growth regulators. It might be due to that Gibberelic acid (GA_3) enhanced fruit setting in tomato. Adlakha and Verma [17], Hossain [18] and Mehta and Mathi [5] supported this finding. But Jenson [19] also mentioned that increasing concentration of GA_3 reduced the number of fruits plantG^{-1} which disagreed with the present study.

Average Individual Fruit Weight (g): Average individual fruit weight of tomato revealed statistically significant variation due to application of plant growth regulators (Table 1). The maximum average weight of individual fruit (92.06 g) was recorded from PGR_2 treatment (application of GA_3), while the minimum average weight of individual fruit (82.37 g) was recorded from PGR_0 treatment (no application of plant growth regulators). Application of GA_3 at vegetative stage increased fruit size which increased individual fruit weight. Kaushik *et al*. [20] supported this argument. But Sanyal *et al*. [21] found that foliar application was more effective than root soaking of seedlings on tomato.

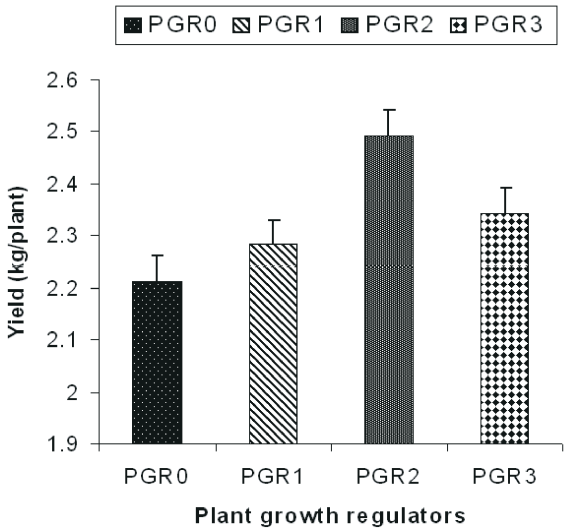

Fig. 4: Effect of plant growth regulators on yield plantG^1 in tomato

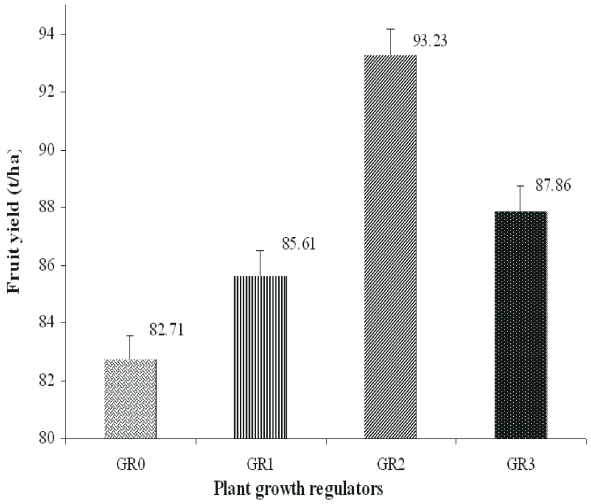

Fig. 5: Effect of plant growth regulators on the yield per hectare of tomato

Yield per Plant: Yield plant$G^1$of tomato showed statistically significant variation due to application of plant growth regulators (Figure 4). The maximum yield plantG^1(2.49 kg) was recorded from PGR_2 treatment (application of GA_3), while the minimum yield plantG^1 (2.21 kg) was recorded from PGR_0 treatment (no application of plant growth regulators). Similar trend of the result in tomato was found by Saleh and Abdul [16].

Yield per Hectare: Statistically significant variation found due to application of plant growth regulators in respect of yield hectareG^1 of tomato (Figure 5). The maximum yield hectareG^1 (93.23 t/ha) was recorded from PGR_2 treatment (application of GA_3), while the minimum yield hectareG^1 (82.71 t/ha) was recorded from PGR_0 treatment (no application of plant growth regulators). GA_3 increased the number and weight of fruits plantG^1 and thus increased in yield of tomato. These findings were supported by the results of Kaushik *et al*. [20] and Saleh and Abdul [16].

CONCLUSION

Plant growth regulators had significant influence on growth and yield of tomato and GA_3 gave the highest yield all days after transplanting (DAT) than other plant growth regulators. So, GA_3 gave the best response for tomato production. The present study was conducted in an individual soil type and further regional trials should be needed for plant growth regulators recommendation of tomato cultivation.

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