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Growth and Yield of Summer Tomato as Influenced by Plant Growth Regulators

S. Choudhury, N. Islam, M.D. Sarkar and M.A. Ali

Department of Horticulture, Sher-e-Bangla Agricultural University, Dhaka-1207, Bangladesh

Abstract: A field experiment was carried out at Horticulture Farm of Sher-e-Bangla Agricultural University, Dhaka-1207, Bangladesh, to assess the effect of different plant growth regulators on tomato during summer season 2011. Different plant growth regulators (PGR) viz. PGR_0 = Control, PGR_1 = 4-CPA (4-chloro phenoxy acetic acid) @ 20 ppm, $PGR_2 = GA_3$ (Gibberellic Acid) @ 20 ppm and PGR_3 = 4-CPA + GA3 @ 20 ppm of each were used in the study. The growth and yield contributing characters were significantly differed due to different plant growth regulators. The maximum plant height at 60 DAT (86.01cm), number of flowers cluster per plant (10.60), number of flowers per plant (39.69), number of fruits per plant (36.54), single fruit weight (74.01 g) and yield (28.40 t ha^{-1}) were found in PGR_3 and the minimum for all the parameters were found in control (PGR_0) treatment.

Key words: 4-Chlorophenoxy acetic acid · Gibberellic acid · Growth, Yield · Tomato

INTRODUCTION

Tomato is one of the most popular vegetable crops all over the world. Tomato has a significant role in human nutrition because of its rich source of lycopene, minerals and vitamins such as ascorbic acid and ß-carotene which are anti-oxidants and promote good health [1]. High temperature was reported as limiting fruit set due to an impaired complex of physiological process in the pistil, which results in floral or fruit abscission [2]. Plant growth regulators (PGRs) are essential for growth and development of plants and play an important role in flowering, fruit setting, changes ripening and physiochemical during storage. Several synthetic plant growth regulators were tested to determine whether they could be use in solving this problem of high temperature for tomato production. Growers in some countries are also commercially producing tomatoes at higher temperature through exogenous application of synthetic PGRs. Gemici *et al*. [3] reported that application of synthetic auxin and gibberellins (GAs) are effective in increasing both yield and quality of tomato. Application of certain PGRs like auxin and gibberellic acid (GA3) that bring the possibility of tomato production under adverse environmental conditions. Those PGRs are used extensively in tomato to enhance yield by improving fruit set, size and number [4, 5] and could have practical application for tomato growers. Tomato fruit setting was promoted by GA3 at low concentration [6,7]. Synthetic auxin 4-CPA (4-chloro phenoxy acetic acid) reduced pre-harvest fruit drop with increased number of fruits per plant and yield [6]. Application of 4-CPA is more effective during anthesis period than one week after anthesis [8]. 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. Tomato production in Bangladesh is largely affected due to adverse environmental conditions during summer season. However, information regarding the practical use of 4-CPA and GA3 and their combined application in crop production in general and tomato in particular is lacking. So the present study was therefore undertaken to investigate the effect of different PGRs on the growth and yield of tomato during summer.

MATERIALS AND METHODS

The experiment was carried out at Horticultural Farm of Sher-e-Bangla Agricultural University, Dhaka-1207, Bangladesh during summer season (May 2011 to September 2011). Different plant growth regulators viz.

Corresponding Author: S. Choudhury, Department of Horticulture,
Sher-e-Bangla Agricultural University, Dhaka-1207, Bangladesh.

PGR0 = Control (No application of plant growth regulator), PGR1 = 4-CPA (4-chloro phenoxy acetic acid) @ 30 ppm, PGR2 = GA3 (Gibberellic Acid) @ 30 ppm and PGR3 = 4-CPA + GA3 @ 30 ppm were used as treatments in this study. The experiment was laid out in a Randomized Complete Block Design with six replications. Thirty days old seedlings were transplanted at the spacing of 60cm × 40cm in the experimental plot on June 10, 2011. 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^{-1} and Murate of Phosphate (MP) 150 kg ha^{-1}. Later the stock solution was diluted in distilled water (dH_2O) to prepare the working solutions, just before application. Tween-20 at the rate of 0.05% (v/v) was added before spray and mixed well to act as cohesive agent. GA3 was applied in the form of foliar sprays at 21 days after transplanting and 4-CPA was sprayed on plants at anthesis stage. Spraying was performed early in the morning to avoid rapid drying of the spray solution, due to transpiration. Data were collected from ten randomly selected plants from each plot; viz., plant height (cm), number of flower cluster $plant^{-1}$, number of flower $plant^{-1}$, number of fruits $plant^{-1}$, fruit length and diameter, average fruit weight (g) and yield ha^{-1}. The means were separated by Duncan's Multiple Range Test (DMRT) at 5% level of significance [9].

RESULTS AND DISCUSSION

Plant Height (Cm): different plant growth regulators showed a statistically significant variation on the plant height at 20, 40 and 60 days after transplanting (DAT). The tallest plant was recorded at 60 DAT from PGR_3 (Combined application of GA_3 and 4-CPA) which was statistically similar to PGR_2. On the other hand the shortest tomato plant was recorded in control condition (Fig. 1). Gibberellins are key regulator of shoot growth in plants and this might be reason to have longer shoots with GA treatments. The results are in agreement with the finding of Nibhavanti *et al*. [10].

Number of Flower Cluster per Plant: Number of flower cluster per plant significantly varied due to application of different plant growth regulators in tomato (Table 1). The highest number of flower cluster per plant (10.6) was recorded at PGR_3 treatment (application of 4-CPA and GA_3) which was statistically similar to PGR_2 (10.26), while the lowest number of flower cluster per plant (6.1) was recorded at PGR_0 treatment. Flower primodia was promoted by GA_3 with increase number of flower cluster per plant. The result of the present study is in agreement with the result of Onofeghara [11].

Number of Flower per Plant: Number of flower per plant significantly varied due to application of different plant growth regulators (Table 1). The maximum number of flowers per plant (39.69) was recorded from PGR_3 treatment which was statistically similar to PGR_2 (38.12), while the minimum number of flowers per plant (18.16) was recorded from PGR_0 treatment. Application of GA_3 had increased the number of flower buds and open flowers [12]. Superior result in respect to number of flower per plant was found in GA_3 application. GA3 increased

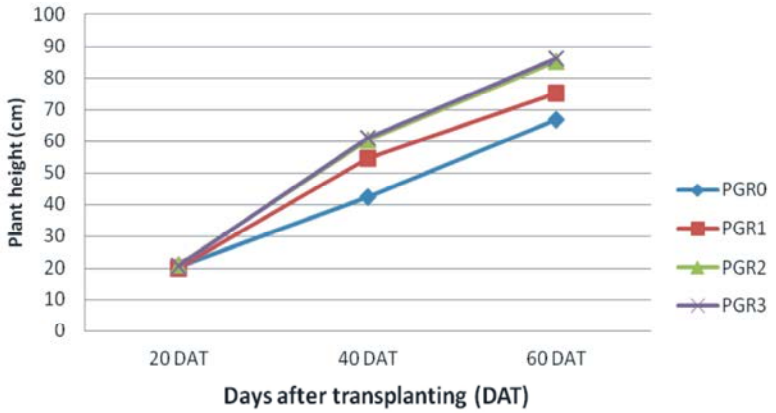

Fig. 1: Effect of different plant growth regulators on plant height of tomato at different days after transplanting. (PGR_0 = Control, PGR_1 = 4-CPA (4-chloro phenoxy acetic acid) @ 20 ppm, PGR_2 = GA_3 (Gibberellic Acid) @ 20 ppm and PGR_3 = 4-CPA + GA3 @ 20 ppm of each.)

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

Plant growth regulators	No. of flower cluster/plant	No. of flower/plant	No. of fruit/plant	Fruit length (cm)	Fruit diameter (cm)	Single fruit weight (g)
PGR_O	6.10 c	18.16 c	14.55 d	3.69 d	4.75 d	55.84 d
PGR_1	8.38 b	30.14 b	25.54 c	3.85 c	4.84 c	62.15 c
PGR_2	10.26 a	39.12 a	32.43 b	4.03 b	4.93 b	70.08 b
PGR_3	10.60 a	39.69 a	36.54 a	4.38 a	5.04 a	74.01 a
CV (%)	5.28	7.22	9.42	2.32	1.79	7.11

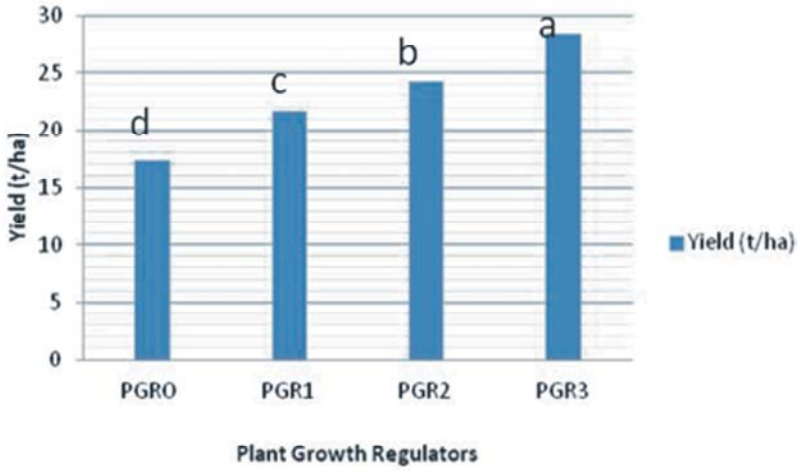

Fig. 2: Effect of different plant growth regulators on yield of tomato. (PGR_0 = Control, PGR_1 = 4-CPA (4-chloro phenoxy acetic acid) @ 20 ppm, PGR_2 = GA_3 (Gibberellic Acid) @ 20 ppm and PGR_3 = 4-CPA + GA3 @ 20 ppm of each.)

the number of the flowers per plant and this may be due the increase of the number of flower cluster per plant. This result agreed with the result of Onofeghara [11].

Number of Fruits per Plant: Tomato plants exposed to high temperature reduce fruit set. Spraying with plant growth regulators increased the number of fruits per plants. The highest number (36.54) was recorded from PGR_3 followed by PGR_2 and PGR_1. Lowest (14.55) was r ecorded in PGR_0 (Table 1). Results of the study showed that under high temperature the combination of 4-CPA and GA_3 induced higher number of fruit set to some extent. High temperature treatment decreases the levels of auxin and gibberellin's like substances, especially in floral buds and developing fruits of tomato [13]. Therefore, shortage of auxin and gibberellins could cause the reduction of fruit set under high temperature. Then it assumed that the treatments of the combinations of 4-CPA and GA_3 reduced the affect of high temperature [6]. Thus, application of GAs under high temperature would have a role in fruit set of tomatoes and might be combined effects with 4-CPA. Synthesized auxin and gibberellins are often used for promotion of fruit set in some fruit vegetable production including tomatoes.

Fruit Length and Diameter: Application of plant growth regulators significantly increased fruit length compared to control. Maximum fruit length (4.38 cm) was recorded with the treatment of PGR_3 while the lowest (3.69 cm) was recorded from the control treatment (Table 1). Hence, the PGR_3 indicated the possibility of increasing tomato fruit length with a combined application of the two PGRs (4-CPA and GA_3) that increase the length of fruit than when each of them was applied independently. In addition to fruit length, fruit diameter was also significantly affected. The combined effect of PGRs showed an increase in fruit diameter. Similarly, PGR_3 applications (5.04 cm) showed increasing trend in fruit diameter than PGR_0 (4.75 cm). However, the report by Khan *et al*. [7] indicated the significant role of GA_3 in tomato plant to increase fruit set that leads to larger number of fruits per plant and increased fruit size.

Fruit Weight: Fruit weight significantly varied due to application of different plant growth regulators (Table 1). The maximum fruit weight (74.01 g) was recorded from PGR_3 treatment while the minimum fruit weight (55.84 g) was recorded from PGR_0 treatment. Length and diameter of fruits is increased with the combined effect of 4-CPA and GA_3 and it might be the reason that increased fruit weight of tomato.

Yield per Hectare: Statistically significant variation found due to application of plant growth regulators in respect of yield per hectare. The maximum yield (28.4 t/ha) was recorded from PGR_3 treatment, while the minimum yield (17.35 t/ha) was recorded from PGR_0. Application of GA increases cell growth and elongation and leads to bigger plants with longer shoots and leaves in many plants with higher crop yields. Combined application of GA_3 and 4-CPA increased the number of fruits per plant, single fruit weight and thus increased in yield of tomato (Fig. 2).

CONCLUSION

Plant growth regulators had significant influence on growth and yield of summer tomato, especially the treatment with the combined application of 4-CPA and GA_3. Among the different treatments of plant growth regulators-plants treated with the combined application of 4-CPA and GA_3 showed an increased fruit set, fruit diameter, single fruit weight, number of fruits and yield as compared to the plants treated with 4-CPA and GA_3 alone.

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