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Effect of GA3 on Biochemical Attributes and Yield of Summer Tomato

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Abstract

An experiment was carried out in pots at Bangladesh Institute of Nuclear Agriculture, Bangladesh to evaluate influence of different concentrations of GA3 on biochemical parameters at different growth stages in order to maximize yield of summer tomato var. Binatomato-2. The concentrations of GA3 were 0, 25, 50, 75 and 100 ppm. They were applied at three stages, namely root soaking of seedlings before transplanting, vegetative and flowering stages. The experiment was laid out in a randomized complete block design with four replications. Results indicated that the highest chlorophyll and soluble protein contents were recorded when GA3 was applied through root soaking followed by vegetative stage and the lowest was found at the flowering stage. In contrast, the highest nitrate reductase activity was observed when GA3 was applied at the vegetative stage and the lowest activity was recorded at the flowering stage. The applications of 50-75 ppm GA3 had significantly encouraged the bio-chemical parameters studied at 50 DAT. The amount of GA3 applied at different stages had significant influence on the yield and yield attributes of summer tomato. The highest plant height was recorded when 50 ppm of GA3 was applied at the vegetative stage. While, the longest time to first fruit setting was required when the roots of the seedlings were soaked in 100 ppm GA3 solution. The application of 50 ppm GA3 by root soaking had significantly increased the number of flowers, fruits and fruit yield per plant but similar results were achieved when only 25 ppm GA3 was applied at the flowering stage. The fruit yield of tomato per plant increased linearly with the increased number of flowers and fruits per plant.

Keywords: *Summer Tomato, Gibberellic Acid, Chlorophyll, Soluble protein and Nitrate reductase activity*

I. Introduction

Tomato (*Lycopersicon esculentum)* is one of the most popular and nutritious vegetables of Bangladesh (Mondal *et al*., 2011). Tomato is cultivated all over the country due to its adaptability to a wide range of soil and climate. Normally tomato is grown in winter season due to its requirements for temperate climate. Hence, it is difficult to grow tomato in summer season due to adverse climatic conditions, such as high temperature, high rain fall, hailstorms, etc. Bangladesh Institute of Nuclear Agriculture (BINA) has developed some tomato varieties to cultivate in summer season. But the yield potential of these varieties cannot be achieved due to the above mentioned climatic conditions. In summer season, tomato can however be successfully grown under glasshouse conditions. But it is not possible for the poor farmers to go for large scale production in glasshouses because it is highly expensive and need technical skills. The other option is the use of plant growth regulators to minimize the effect of harsh environments in order to maximize the yield of summer tomato. The application of Gibberellic acid (GA_3) had significantly increased the number of fruits per plant than the untreated controls (Tomar and Ramgiry, 1997). Adlakha and Verma (1964) reported that the application of GA_3 on flower cluster resulted in an increase in fruit weight. To increase the yield as well as to avoid flower and fruit dropping, application of GA_3 at optimum concentration and at right time is important.

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Gibberellic acid has great effects on plant physiological systems including fruit setting, leaf expansion, germination, breaking dormancy, increasing fruit size, improving fruit quality and in many other aspects of plant growth and thereby on crop production. Keeping the above circumstances in view, the study was under taken to evaluate the performance of GA_3 on biochemical parameters (chlorophyll, soluble protein and nitrate reductase activity) growth and yield attributes; and to determine the optimum time and concentration of GA_3 application in order to maximize the yield of Binatomato-2.

II. Materials and Methods

A pot experiment was conducted with tomato var. Binatomato-2 at the experimental site of Crop Botany Department, Bangladesh Agricultural University, Mymensingh during March to July 2012. Five levels of GA_3 (Gibberellic Acid) *viz*. 0, 25, 50, 75 and 100 ppm were applied at (i) seedling stage by root soaking before transplanting (ii) vegetative stage [20 days after transplanting (DAT)] and (iii) flowering stage (40 DAT) by hand sprayer. The experiment was laid out in a randomized complete block design with four replications. Twelve kilograms of sun-dried sandy loam soil and cow dung, urea, TSP and MP @ 583.33, 2.9, 2.54 and 1.81 g/pot corresponding to 10 tons, 400, 350 and 250 kg/ha were applied in each pot (BARC, 2005). Before pot filling, full doses of TSP, MP and cow dung were thoroughly mixed with the soil. Half of the urea was applied during transplanting and the remaining half at vegetative stage. Intercultural operations were done as and when necessary. Data on yield and yield contributing characters were recorded at final harvest. Biochemical analyses *viz*. chlorophyll, soluble protein contents and nitrate reductase activities in leaves were estimated at 50 DAT following the methods of Arnon (1949), Lowry *et al.*, (1951) and Stewart and Orebamjo (1979). Data were analyzed to find out the level of significance using MSTAT-C package programme (Russell, 1986) and significant differences among the treatments were adjudged by Duncan`s New Multiple Range Test (DMRT) at 5% level of significance (Gomez and Gomez, 1984).

III. Results and Discussion

There were significant differences among the treatments in respect of chlorophyll content, soluble protein content and nitrate reductase (NR) activities in tomato leaves at 50 DAT (Table 01). The highest chlorophyll content in leaves was obtained when the roots of seedlings were soaked in GA_3 solutions before transplanting, which was identical to the application of GA_3 at vegetative stage. The lowest chlorophyll content was found in plants when GA_3 was applied at the flowering stage. Chlorophyll content in leaves was influenced significantly due to the application of different concentrations of GA_3. The highest chlorophyll content was found from 100 ppm GA_3 followed by 75 ppm and the lowest was found from the control, which was identical to those obtained from the application of 25 and 50 ppm of GA_3. Chlorophyll content increased with increased concentrations of GA_3.

The application of GA_3 through root soaking of seedlings and at vegetative stages resulted in the highest but similar soluble protein contents in tomato leaves and the lowest was found when it was applied at the flowering stage. The soluble protein content in leaves was also significantly influenced by the application of variable levels of GA_3. The highest content was recorded with 50 ppm and the lowest content was recorded with 100 ppm GA_3 which indicated that soluble protein content in leaves increased significantly until the application of 50 ppm and thereafter decreased with further increase in GA_3 concentrations. Masroor *et al*., (2006) also reported that GA_3 had appreciably increased the protein synthesis in leaves.

The maximum nitrate reductase activity was recorded at vegetative stage. The lowest was observed in flowering stage and this was similar to the activity performed when GA_3 was applied through root soaking. Nitrate reductase activity was significantly influenced by the application of different

concentrations of GA_3. The maximum nitrate reductase activity was recorded with 75 ppm GA_3 and the minimum was found from the control. Spraying of 50 and 75 ppm GA_3 did not show any difference in NR activities at 40 days after planting (Table 01).

Table 01. Effect of GA3 application at different stages of plant growth on bio-chemical parameters of summer tomato var. Binatomato-2 at 40 DAT

Treatments	Chlorophyll content (mg/gfw)	Soluble protein content (mg/gfw)	NR activity (µ $moN0_2$/gfw/h)
GA_3 application			
Root soaking	0.70 a	2.33 a	13.20 a
Vegetative stage	0.64 a	2.32 a	14.19 a
Flowering stage	0.54 b	2.02 b	13.07 b
Level of significance	**	**	**
CV%	*7.22*	*8.27*	*4.31*
GA_3 concentrations (ppm)			
0	0.58 c	2.13 c	11.26 d
25	0.61 bc	2.42 b	13.28 c
50	0.62 bc	2.67 a	14.15 b
75	0.65 ab	2.10 c	14.86 a
100	0.67 a	1.78 d	13.90 b
Level of significance	*	**	**
CV%	*7.22*	*8.27*	*4.31*

In a column, figures having similar letter(s) do not differ significantly at 5% level of probability by DMRT

The applications of GA_3 at different stages of plant growth resulted in significant influence on yield and yield attributes of summer tomato (Table 02). The highest plant height was recorded when GA_3 was applied at the vegetative stage and the lowest height was recorded at the flowering stage. GA_3 had significant influence on plant height. It increased until the application of 50 ppm and declined remarkably with further increase in GA_3 concentrations. The interactions between stage and concentrations of GA_3 indicated that the application of 50 ppm of GA_3 at the vegetative stage encouraged vigorous plant growth and thereby resulted in the highest plant height.

There was no significant difference among the stages of hormone application in respect of time to first fruit setting. The maximum number of flowers, fruits and fruit weight per plant was produced when GA_3 was applied through root soaking followed by the vegetative stage (Table 02). All those parameters showed the lowest results when GA_3 was applied at flowering stage. Similar result was also reported by Kaushik *et al*., 1974. They applied GA_3 at vegetative stage and obtained increased fruit weight per plant. Sanyal *et al*., (1995) observed that foliar application was more effective than root soaking of seedlings. GA_3 concentrations had statistically significant effect on plant height, time to first fruit setting, number of flowers, fruits and fruit weight per plant. The highest plant height was found with the application of 50 ppm GA_3 which was identical to 25 ppm and the lowest was found from the control. The maximum time for first fruit setting was required when GA_3 was applied at 100 ppm and the lowest time was required with lower concentrations of GA_3. The maximum number of flowers, fruits and fruit weight per plant was produced with 50 ppm GA_3 application and the lowest was recorded with 100 ppm. Saleh and Abdul (1980) reported similar result from their experiment. They found that GA_3 at 50 ppm decreased the total number of flowers per plant but increased the total yield. Hossain (1974), Adlakha and Verma (1995) found that the application of 50 ppm GA_3 had increased the fruit setting, while Saleh and Abdul (1980) observed that GA_3 at 25 or 50 ppm had increased the total yield of tomato compared to the control. Sanyal *et al*., (1995) also found that 50 ppm of GA_3 had profound effect on the yield of tomato.

Table 02. Effect of GA3 application at different stages of plant growth on yield and yield components of summer tomato var. Binatomato-2

Treatments	Plant height (cm)	Time to first fruit setting (DAT)	No. of flowers/plant	No. of fruits/plant	Fruit wt./ plant (g)
GA_3 application					
Root soaking	94.20b	40.70	22.80a	16.25a	376.04a
Vegetative stage	104.03a	39.90	22.25a	15.90a	372.68a
Flowering stage	91.*98b	41.45	17.85b	13.20b	306.57b
Level of significance	**	*ns*	**	**	**
CV %	*7.75*	*6.50*	*10.37*	*9.05*	*8.73*
GA_3 concentrations (ppm)					
0	80.88d	39.50bc	18.92bc	13.92c	321.48c
25	107.21a	38.92c	23.42a	16.59b	382.00b
50	109.08a	39.25c	24.58a	18.25a	427.37a
75	98.67d	41.92ab	20.25b	14.58c	343.47c
100	87.83c	43.83a	17.67c	12.25d	284.51d
Level of significance	**	**	**	**	**
CV %	*7.75*	*6.50*	*10.37*	*9.05*	*8.73*
Interaction					
Root x 0	85.25efg	40.50bcvd	19.00def	14.00de	321.80ef
Root x 25	105.88bc	36.50d	23.00a-d	14.75d	338.75de
Root x 50	103.50bc	39.50bcd	27.25a	20.75a	468.60a
Root x 75	99.50cd	40.50bcd	24.00abc	16.25cd	397.49bc
Root x 100	76.87g	46.50a	20.75cde	15.50d	353.57cde
Vegetative x 0	81.87fg	37.50cd	20.75cde	15.25d	353.25cde
Vegetative x 25	103.25bc	39.75bcd	21.50b-e	16.00cd	368.15cde
Vegetative x 50	127.25a	36.50d	24.50abc	18.00bc	438.42ab
Vegetative x 75	107.00bc	42.50abc	20.75cde	15.50d	362.25cde
Vegetative x 100	100.75bcd	43.25ab	23.75abc	14.75d	341.32de
Flowering x 0	75.50g	40.50bcd	17.00ef	12.50e	289.37fg
Flowering x 25	112.50b	40.50bcd	25.75ab	19.00ab	439.10ab
Flowering x 50	96.50cde	41.75abc	22.00bcd	16.00cd	375.07cd
Flowering x 75	89.50def	42.75ab	16.00f	12.00e	270.67g
Flowering x 100	85.87efg	41.75abc	8.50g	6.50f	158.62h
Level of significance	**	*	**	**	**
CV %	*7.75*	*6.50*	*10.37*	*9.05*	*8.73*

In a column, figures having similar letter(s) do not differ significantly at 5% level of probability by DMRT. Significant at 5% level, ** Significant at 1% level

The interaction between GA_3 concentrations and stages of application indicated that the highest number of flowers, fruits and fruit weight per plant were produced when GA_3 was applied through root soaking of seedlings at 50 ppm which was identical to the application of 50 ppm at vegetative stage or 25 ppm at flowering stage. A positive and linear relationship was found between the number of flowers per plant and fruit weight per plant (r = 0.96**) (Figure 01), number of fruits per plant and fruit weight per plant (r = 0.99**) (Figure 02) which indicated that the fruit yield of tomato is highly influenced by the production of flowers and the retention of fruits per plant irrespective of the stage and amount of GA_3 applied in tomato plants.

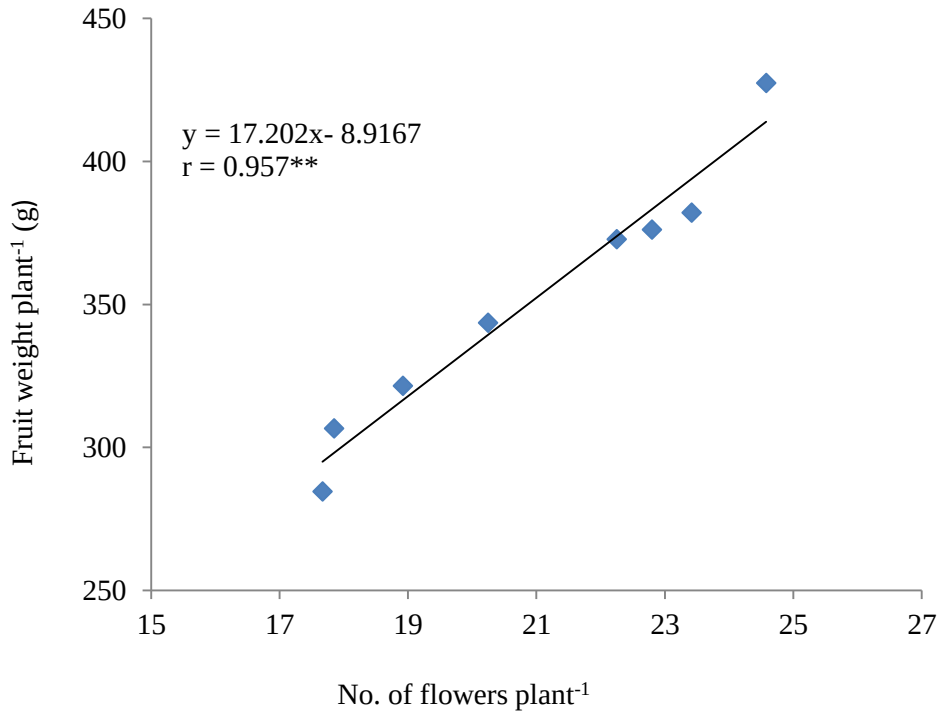

Figure 01. Relationship between the number of flowers plant^{-1} and fruit weight plant^{-1}of summer tomato var. Binatomato-2

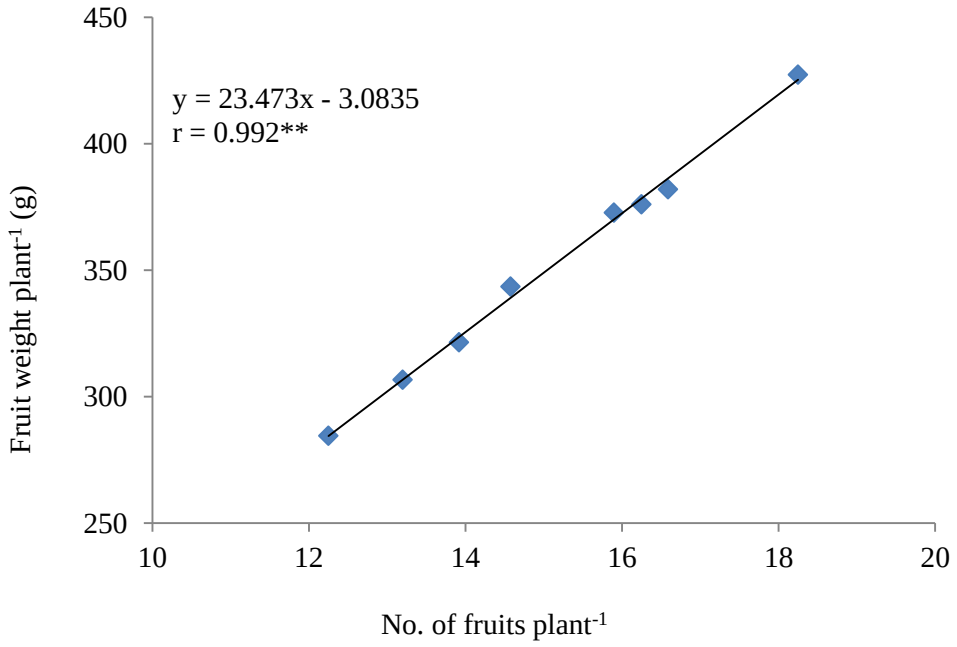

Figure 02. Relationship between the number of fruits plant^{-1} and fruit weight plant^{-1} of summer tomato var. Binatomato-2

IV. Conclusion

Application of GA3 at the rate of 50-75 ppm by root soaking and at vegetative stage increased biochemical parameters (chlorophyll, soluble protein and nitrate reductase activity) as well as increase the number of flowers, fruits and fruit yield per plant of Binatomato-2. It can be concluded that foliar application of 50 ppm Gibberelic acid on Binatomato-2 variety provide the best result in terms of biochemical attributes and yield.

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