The Application Effect of GA_3 on Plant Growth, Yield and Quality Attributes of Tomato (*Lycopersicom esculentum* Mill.)

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Abstract

This study was conducted at the 'Integrated Farm' of the International Anjel Association, Voluntary Organization of Japan, Konabari, Gazipure during the period of 10 November-30 January 2018, Bangladesh to find out the better performance of GA_3 treatments doses on tomato variety Ratan. Data were collected on plant height, leaves number, fruits number per plant, fruit weight per plant, ascorbic acid and total soluble solids (Brix) regarding five levels of gibberellic acid viz. 20 ppm (T_1), 40 ppm (T_2), 60 ppm (T_3), 80 ppm (T_4) and 100 ppm (T_5) beside T_0 which represents the control. The experiment was arranged in a randomized complete block design with three replications. Application of GA_3 at 100 ppm caused an increase in plant height (50.30 cm), leaves number (50), fruits number (29.50 per/plant), fruit weight (1.52 kg/plant), ascorbic acid (1.80 mg/100gm) and total soluble solids (4.10 Brix) among the different treatments of GA_3.

Keywords: Gibberellic acid (GA_3), Tomato, Yield, Quality, Bangladesh.

Introduction:

Tomato (*Lycopersicom esculentum* Mill.) is an important fruit in Bangladesh and it belongs to family Solanaceae having chromosome number (2n=24) (Haque, 2009). It is a self-pollinated crop and the Peru-Ecuador region is considered to be the center of origin (Kannan *et al*., 2009). Tomato was introduced by the Portuguese and cultivated in tropics and subtropics of the world. Tomato farming is gaining popularity in all the 16 districts under the Rajshahi division particularly in the vast tract of Barind area and expected to earn at least Taka 35 crore from the production during the current season (Haque, 2009). Tomato is one of the most highly praised vegetables consumed widely and it is a major source of vitamins and minerals (Khan *et al*., 2006). It is one of the most popular salad vegetables and

is taken with great relish. 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 by Sittu; and Adelekha, (1999).

Plant growth regulators (PGRs) are extensively used in horticultural crops to enhance plant growth and improve yield by increasing fruit number, fruit set, and size. Plant growth regulators like promoters, inhibitors or retardants play a key role in controlling internal mechanisms of plant growth by interacting with key metabolic processes such as nucleic acid metabolism and protein synthesis (Khan *et al*., 2006). The use of plant growth regulators (PGR's) might be a useful alternative to increase crop production by Quzounidou *et al*., (2010). Recently, there has been a global realization of the important role of PGR's in increasing crop yield (Uddain *et al*., 2009). GAs constitute a group of plant hormones that control developmental processes such as germination, shoot elongation, tuber form action, flowering and fruit set and growth in diverse species (Chaudhary *et al*., 2006).

The most widely available plant growth regulator is GA_3 or gibberellic acid, which induces stem and internodes elongation, seed germination, enzyme production during germination and fruit setting and growth (Davies *et al*., 1995). Gibberellic acid is an important growth regulator that may have many uses to modify the growth, yield and yield contributing characters of the plant (Rafeeker *et al.*, 2002). Regarding this, the present investigations are carried out to find out the effect of gibberellic acid (GA_3) on growth, quality, and yield of tomato. According to the review study the experiment was carried out to find out the proper doses of GA_3 application to increase tomato yield, and to idetify ß-carotene and ascorbic acids for the treatment of GA_3.

Materials and Methods:

Location of the experimental area (Konabari) in Gazipur district

Konabari Union in Gazipur Sadar Upazila, located in between 24°02' and 24°16' north latitudes and in between 90°30' and 90°42' east longitudes. It is bounded by Shreepure in the north, Tangil in the west, Joydevpure in east and Tungi in the south. Gazipur Sadar Upazila of Gazipur district, and this Sadar Upazila consists of 8 unions. The unions were Baria, Basan, Gachha, Kashimpur, Kayaltia, Konabari, Mirzapur, Pubail. Annual average temperature maximum 36°C and minimum 12.7°C; annual rainfall 2376 mm. The altitude of the experimental location was 8.4 meter from sea level (Anon, 1995).

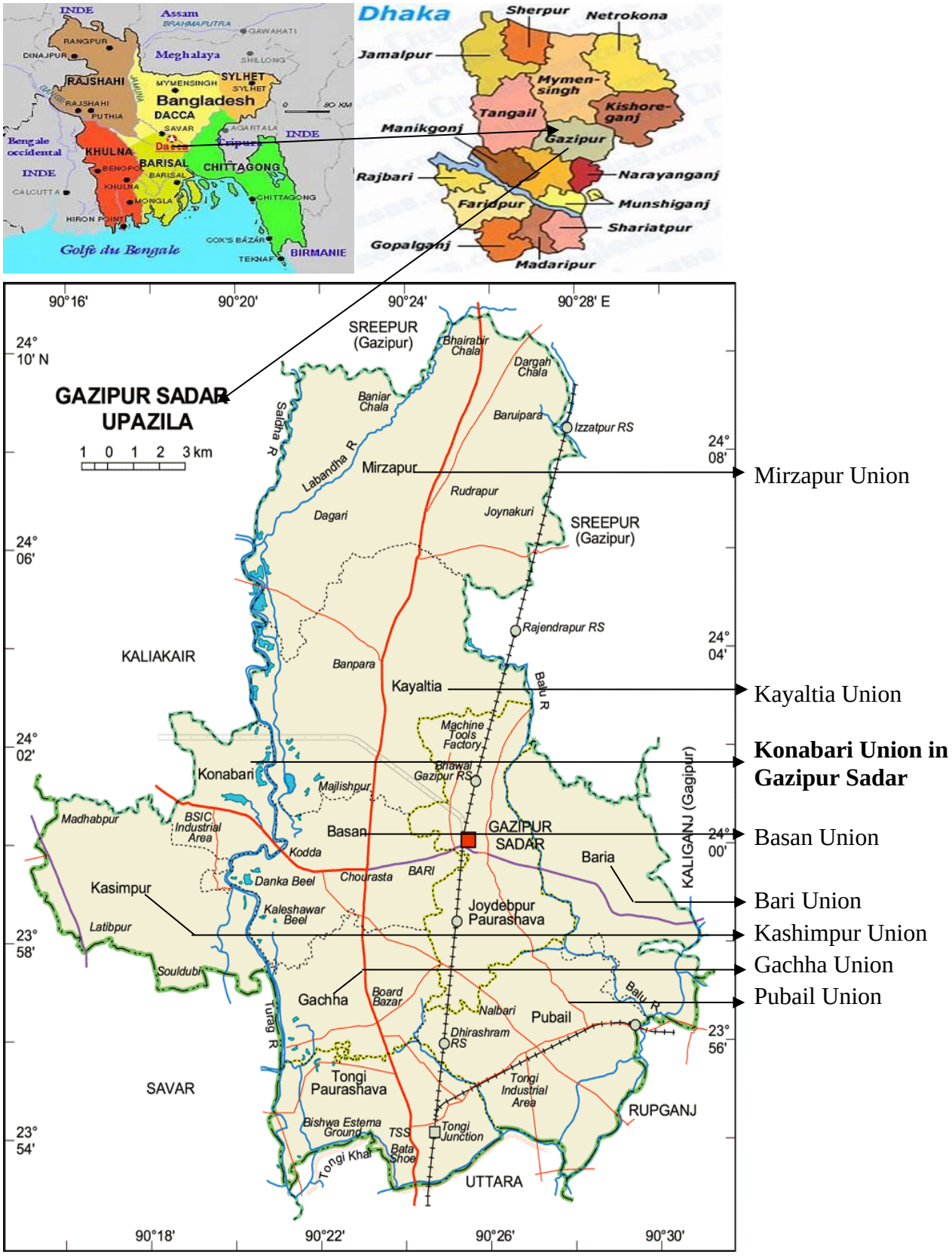

Fig 1. Location of the experimental area at Konabari in Gazipur Sadar district.

Characteristics of soil: The experiment was set up on a high land having a texture of sandy loam with P^H 6.5. The soil samples were taken before the setup of the experiment in the field to examine some

important physicochemical properties including their nutrient status. The soil nutrients were measured 1.75% N by Page *et al*., (1982) method, 1.42% P by Olsen *et al*., (1954) method, 1.92% K by Black, (1995) method and 0.15% S by Page *et al*., (1982) method.

Soil sample collection: For laboratory analysis, initial soil samples were collected from 10 randomly selected spots of the experimental field before final land preparation at plough depth (0-10 cm) level. Post-harvest soil sampling was done plot-wise accordingly. The samples were air-dried, ground to pass through 2 mm (10 meshes) sieve and stored in polyethylene bags for subsequent analysis that was done according to Soil Research Development Institute (SRDI) method, Farm-gate, Dhaka.

Soil analysis: Soil samples were analyzed for physical and chemical properties in the laboratory of the department of soil science, Soil Research Development Institute (SRDI), Farm-gate, Dhaka. (i). Particle size analysis: This analysis of soil was done by the hydrometer method as described by Black (1995) **(ii).** Particle density: The particle density of the soil samples were determined by the volumetric flask method as described by Black (1995) (iii). Bulk density was determined using the paraffined cold method as described by Black (1995) and (iv). Soil P^H: The soil P^H was measured with help of an electrode P^H meter using as described by Jackson (1962).

This study was conducted at the 'Integrated Farm' of the International Anjel Association, Voluntary Organization of Japan, Konabari Union, Gazipure during the period of 10 November to 30 January 2018, Bangladesh. The experiment was carried out on tomato variety-Ratan with five levels of gibberellic acid (GA_3-20 ppm, 40 ppm, 60 ppm, 80 ppm, and 100 ppm) arranged in randomized block design with three replications and six treatments (T_0-Control, T_1-20 ppm GA_3, T_2-40 ppm GA_3, T_3-60 ppm GA_3, T_4-80 ppm GA_3, T_5-100 ppm GA_3). The required weight of the plant growth regulators (PGRs) was taken using an electronic sensitive balance (ESB) and the solution was prepared by dissolving in 1 mg L^{-1} at the university laboratory. The solution was poured into the hand-held sprayer and was directly sprayed on the plants three times at 20, 40 and 60 days after transplanting (DAT). Spraying was performed early in the morning to avoid rapid drying of the spray solution, due to transpiration. All the recommended cultural practices were followed during the conduction of the experiment. Data were collected from selected plants in the rows. The collected data includes average plant height (cm), the average number of leaves per plant, the average number of fruits per plant, average fresh fruit weight (kg/plant), ascorbic acid (mg/100g) and total soluble solids (Brix). The data were analyzed statistically and using analysis of variance (ANOVA) and the means were compared by Duncan's Multiple Range Test (DMRT) according to Gomez and Gomez, (1994) for better interpretation of the results at 5% level of significance with the help of MSTATC computer program as well as mean separation was carried out at 5% probability level.

Results and discussion:

Plant height (cm):

Maximum plant height was found in T_5 (31.0 cm) at 20 days after transplanting (DAT) and the minimum was found in T_0 (15.5 cm), at 40 DAT maximum was found in T_5 (46.3 cm) and the minimum was found in T_0 (31.4 cm). At 60 DAT maximum plant height was found in T_5 (50.3 cm) and the minimum was found in T_0 (36.0 cm). The highest plant height recorded due to the influence of GA3. As a result, developed the highest number of plant cells, tissues, and organs that were occurred due to the highest nitrate reductase activity by the function of GA_3. It has been mentioned that an almost similar result was observed by Sittu and Adelekha (1999); Wu *et al.*, (1987); and Khan *et al.*,

(2006) in tomato.

Number of leaves per plant:

The maximum number of leaves was found in T_5 (29.0) at 20 DAT and the minimum was found in T_0 (18.0), at 40 DAT maximum number of leaves was found in T_5 (50.0) and the minimum was found in T_0 (33). At 60 DAT maximum number of leaves was found in T_5 (52) and the minimum was found in T_0 (38). The highest plant height recorded due to the influence of GA3 that was developed due to the highest number of plant cells, tissues, and organs. The highest number of leaves developed caused by the highest plant height. It has been mentioned that a similar result was observed by Gabal *et al*., (1999) in tomato; and Kannan *et al.*, (2009) in paprika.

Table 1. Growth characters of tomato variety Ratan

Treatments	Plant Height (cm)			Number of Leaves		
	20 DAT	40 DAF	60 DAT	20 DAF	40 DAF	60 DAF
T_0	15.5a	31.40a	36.00a	18.00a	33.00a	38.00a
T_1	18.3a	34.00a	40.20a	22.00a	35.00a	42.00a
T_2	21.2a	35.30a	41.20a	24.00a	37.00a	43.00a
T_3	25.0a	40.20b	45.20ab	25.00a	44.00ab	45.00ab
T_4	27.2b	42.00b	47.20ab	27.00ab	45.00ab	47.00ab
T_5	31.0b	46.30b	50.30b	29.00b	50.00b	52.00b
CV%	**8.25**	**9.14**	**8.14**	**9.12**	**7.95**	**8.62**

Based on data recorded in a column, figures followed by common letters do not differ significantly by DMRT at 5% level of probability; CV: Coefficient of Variation.

Number of fruits per plant:

The maximum number of fruits was found in T_6 (29.5) and the minimum was found in T_0 (12.2). It reported that a similar result was found by Uddain *et al.* (2009). The highest nitrate reductase activity was observed when GA_3 was applied at the vegetative stage and was produced more flowers. As a result, produced more fruits per plant. The amount of GA_3 applied at different stages had a significant influence on the yield per plant. It has been reported that a similar result was found by Adlakha and Verma (1994); Uddain *et al.*, (2009); Mehta and Mathi (1995).

Table 2. Yield characters of the tomato variety Ratan

Treatments	Number of fruits/plant	Fresh fruit weight (kg/plant)
T_0	12.20a	0.90a
T_1	15.30a	1.25a
T_2	24.00ab	1.36a
T_3	28.60b	1.40a
T_4	27.20b	1.45ab
T_5	29.50b	1.52ab
CV%	**7.51**	**8.12**

Based on data recorded in a column, figures followed by common letters do not differ significantly by DMRT at 5% level of probability; CV: Coefficient of Variation.

Fresh fruit weight per plant (kg/plant):

Maximum fresh fruit weight (kg/plant) was found in T_5 (1.52 kg) and minimum fresh fruit weight was found in T_0 (0.90 kg). The highest nitrate reductase activity was observed when GA3 was applied at the vegetative stage and 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 a 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. In contrast, the highest nitrate reductase activity was observed when GA_3 was applied at the flowering and fruits setting stage. The applications of maximum GA_3 had significantly encouraged to fruit setting those were contributed to fruit weight and fruit weight per plant. Kaushik *et al.,* (1994); and Uddain *et al.,* (2009) have been mentioned that almost similar results were found in tomato.

Table 3.Quality characters treatments of the tomato variety Ratan

Treatments	Ascorbic acid (mg/100gm)	Total Soluble Solid (Brix)
T_0	1.05a	3.30a
T_1	1.23a	3.75a
T_2	1.40a	3.82a
T_3	1.53ab	3.87ab
T_4	1.70b	3.80ab
T_5	1.80b	4.10b
CV%	**9.01**	**8.21**

Based on data recorded in a column, figures followed by common letters do not differ significantly by DMRT at 5% level of probability; CV: Coefficient of Variation.

Ascorbic acid (mg/100gm):

Maximum ascorbic acid (mg/100gm) was found in T_5 (1.80 mg/100gm) and minimum ascorbic acid was found in T_0 (1.05 mg/100gm). Fine and fresh fruits were produced due to the application of the maximum dose of GA_3. So, fine and fresh fruits always would also be contained the highest vitamins (ascorbic acid), minerals and other ingredients. It has been mentioned that almost similar results were found by Chaudhary *et al.,* (2006); and Quzounidou *et al.,* (2010).

Total Soluble Solid (TSS):

Maximum TSS (Brix) was found in T_5 (4.10) and minimum TSS was found in T_0 (3.30). It was recorded that fine and fresh fruits were produced when applied maximum dose of GA_3 those fruits which obtained the highest Total Soluble Solid (TSS). It could be mentioned that close upon similar results was found by Gelmesa *et al.,* (2012); Graham and Ballesteros (2006) in tomato.

Conclusions:

Based on the experiment, it is concluded that gibberellic acid (GA_3) had a significant influence on growth, quality, and yield of tomato variety (Ratan), particularly the treatment with the application of GA_3 at 100 ppm. Application of GA_3 at 100 ppm showed an increase in plant height, number of leaves, number of fruits, fruit weight, ascorbic acid, and total soluble solids. So the application of GA_3 had been found positively contribution to yield and yield contributes to the tomato plant.

Recommendations:

The findings of the results were observed that the better performance shown due to the application of GA_3 treatments on tomato variety Ratan where the application of GA_3 in maximum dose (100 ppm) contributed to the yield attribute characters, Ascorbic acid and total soluble solids (TSS). Application of GA_3 at 100 ppm where increase in plant height (50.30 cm), leaves number (50), fruits number (29.50) per plant, fruits weight (1.52 kg/plant), ascorbic acid (1.80 mg/100gm) and total soluble solids (4.10 Brix) among the different treatments of GA_3. Finally, the findings of this study suggest that **(i)** the next trial could be given more highest treatment followed by maximum dose T_5 (100 ppm). (ii) trial of different doses could be applied to other varieties of tomato. (iii) training should be arranged of field technical persons whom are associated with local cultivars level. (iv) awareness of GA_3 application could be developed at cultivars level and used of GA_3 with a low cost or easily available.

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تأثير إضافة حمض الجبريليك GA3 في صفات النمو والصفات الإنتاجية والنوعية *lycopersicom esculentum* Mill.

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الملخص

نفذ البحث في المزرعة المتكاملة لمؤسسة انجل الدولية، وهي منظمة يابانية تطوعية، في مدينتي كوناباري وغازي بور ببنغلادش، وذلك في الفترة ما بين 10 تشرين الثاني/نوفمبر و30 كانون الثاني من عام 2018، بهدف دراسة تحديد التركيز الأمثل من حمض الجبريليك GA_3 لإضافته على نبات البندورة (صنف راتان). أخذت كل من القراءات: طول النبات، عدد الأوراق وعدد الثمار على النبات الواحد، وزن الثمار للنبات، حمض الأسكوربيك والمواد الصلبة الذائبة، وذلك باستخدام خمسة مستويات من حمض الجبريليك وهي: 20 (T1)، و40 (T2)، و60 (T3)، و80 (T4) و100 (T5) جزء بالمليون، بالإضافة للشاهد. نفذت التجربة وفق تصميم القطاعات الكاملة العشوائية بثلاثة مكررات. حقق التركيز 100 جزء بالمليون من حمض الجبريليك ارتفاعاً في طول النبات (50.30 سم)، وعدد الأوراق (50)، وعدد الثمار (29.50 ثمرة/نبات)، ووزن الثمار (1.52 كغ/نبات)، والأسكوربيك أسيد (1.80 مع/100غ)، والمواد الصلبة الذائبة الكلية (4.10 %) مقارنةً مع التراكيز الأخرى المدروسة من GA_3.

الكلمات المفتاحية : حمض الجبريليك (GA_3)، البندورة، الإنتاجية، النوعية، بنغلادش.