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Effects of foliar application of indol butyric acid(IBA), gibberellic acid(GA_3) and zinc(Zn) on growth and yield of tomato

Md. Shoriful Islam[1*], Mst. Sarmin Akter Ranu[1], Parvin Akter Bithy[1], Mohammad Jony[2], Shamim Ara Sumi[3], Md. Mofizur Rahman[4], Mohidul Islam Mia[1]

[1]*Department of Agricultural Botany, Sher-e-Bangla Agricultural University, Dhaka-1207, Bangladesh*

[2]*Department of Genetics and Plant Breeding, Sher-e-Bangla Agricultural University, Dhaka-1207, Bangladesh*

[3]*Department of Biotechnology, Sher-e-Bangla Agricultural University, Dhaka-1207, Bangladesh*

[4]*Department of Horticulture, Sher-e-Bangla Agricultural University, Dhaka-1207, Bangladesh*

Key words: Tomato, Growth hormones (IBA, GA_3), Zinc (Zn), Yield.

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Abstract

The growth and yield of tomato largely depend on soil and climatic conditions and also on variety. Proper application of plant growth regulators and Zn plays a vital role. The field experiment was conducted at Sher-e-Bangla Agricultural University Farm, Dhaka, Bangladesh during October 2017 to April, 2018 to evaluate the appropriate doses and combination of growth regulators and effect of foliar application of IBA, GA_3 and Zn on growth and yield of tomato. Single variety BARI Tomato-14, and foliar application of IBA 5ml/L, GA_3 5ml/l and Zn were used to conduct this experiment. The experiment was laid out in Randomized complete Block Design (RCBD) having three factors and replicated three times. Data were collected on plant height, number of leaves per plant, number of branches per plant, Leaf Area Index(LAI), chlorophyll content of leaf, number flowers cluster per pant, number of fruit per plant, weight of fruit, yield per hectare. A statistically significant variation was recorded in terms of all the characters related to growth and yield quality of tomato. The maximum plant height, number of branches per plant, length of branch was observed in treatment of T_7 (IBA+GA_3+Zn). The maximum number flowers cluster per plant and number of fruit per plant was produced by treatment of T_7 (IBA+GA_3+Zn). The maximum yield of fruits per hectare (100 tones) was obtained from treatment of T_7 (IBA+GA_3+Zn). The lowest yield of fruits per hectare (58 tones) was obtained from treatment of T_3 (Zn). In future need to conduct research to evaluate the appropriate doses and combination of growth regulators on tomato.

* **Corresponding Author:** Md. Shoriful Islam ✉ shorif@sau.edu.bd

Introduction

Tomato (*Solanum lycopersicum*) is a solanaceous self-pollinated vegetable crop. It's chromosome number 2n=24. It is one of the important, popular and nutritious vegetable grown in Bangladesh in both winter and summer season around all the parts of the country (Haque*et al.*, 1999). Now a day, it is also grown in summer season. The origin of tomato is South America (Salunkhe *et al.,* 1987). Tomato is one of the most popular, important and widely used vegetable crops ranked as second position vegetable of the world after potato (Dorais *et al.,* 2008; Olaniyi *et al.,* 2010. The leading tomato producing countries of the world are China, India, Egypt, Turkey, Iran, Mexico, Brazil and Indonesia (FAO, 1999).

Tomato is widely used as salad as well as for cooking purpose. It is well known for its nutritional importance as it is the rich source of nutrients Na, K, Fe, vitamin A and C and antioxidant especially lycopene and salicylate (Afzal *et al.,* 2013). Lycopene is an antioxidant which protect the cell from oxidative damage, so it decrease the risk of chronic diseases such as coronary heart diseases and cancer diseases (Giovannucci, 2002; Taber *et al*., 2008). The mode of action is tentative, but they are believed to reduce risk of cancer by successfully trapping oxygen and intermediate of free oxygen radical. Lycopene is soluble in fat and it is the precursor of β-carotene. It has two folds antioxidant capacity of β-carotene (Taber *et al*., 2008). Lycopene concentration in tomato fruit depends upon maturity, genetics, environmental conditions, cultivation techniques and production techniques. The environmental conditions like temperature, light, fertility and others affect fruit lycopene (Robertson, 1995).

In Bangladesh, it is cultivated as winter vegetable, which occupied on area of 59000 acres of land, and The total production of tomato were 255 thousands metric tons in Bangladesh in the year of 2011-2012 (BBS, 2014). Thus the Average yield of tomato is 14.35 tons/ha, while it was 41.81 t/ha in the world (FAO, 2007). Which is very low in compare with that of other countries, namely India (15.67 t/ha), Japan (52.82 t/ha) and USA (63.66 t/ha).The yield of tomato in our country is not satisfactory enough in compare to requirement (Aditya *et al.,* 1999).

Salinity constitutes the most agricultural problem in many parts of the world (Ramage, 1980). In Bangladesh, the recent statistics shows that tomato was grown in 63000 acres of land and the total production was approximately 255000 metric tons during the year 2011-2012 and the average yield of tomato was 4035kg/acre (BBS, 2012*)*. Tomato is very rich in nutrients, especially potassium, folic acid, vitamin C and contains a mixture of different carotenoids, including vitamin A, effective β-carotene as well as lycopene (Wilcox *et al*., 2003). It contains Calories 97, Iron 2.7 mg, Protein 4.5 g, Riboflavin 0.15 mg, Calcium 50 mg, Niacin 3.2 mg, Phosphorus 123 mg and Ascorbic acid 102 mg per 1 pound edible portion (Lester, 2006). Tomato (*Solanum lycopersicum*) is a rich source of lycopene and vitamins. Lycopene may help counteract the harmful effects of substances called "free radicals". Lycopene one of nature most powerful antioxidant, is present in tomatoes and especially when tomatoes are cooked, had been found beneficial in preventing prostate cancer. The consumption of tomatoes rich in lycopene leads directly to a decreased incidence of cancer in mouth, pharynx, esophagus, stomach, large intestine and rectum (Franceschi *et al*., 1994). However, the yield of the crop is very low compared to those obtained in some advanced country (Sharfuddin and Siddique, 1985).

The growth promoting hormones (GPH) is used in commercial horticulture to improve plant growth and yield. Can used safely on fruits, vegetables and leafy crops. Products produce under hormonal treatment are safe to eat, like wise naturally organic product producer Indole 3-Butyric Acid is a plant bio-regulator belonging to the auxin group referred as organic compound either natural or synthetic that modifies or controls one or more specific physiological processes within a plant. IBA that regulate growth and influence various developmental process, including stem elongation, early root

formation, callus formation, enhance flowering, enzyme induction and leaf & fruits senescence. They can accelerate or retard the growth and maturation rate (Olaiya et al., 2009). Indole 3-Butyric Acid (IBA) is the leading plant hormone used to promote the formation of roots and to generate new roots in the cloning of tomato plants through cuttings (Rao *et al.*, 2005).

Adequate supply of micronutrients also plays an important role in tomato production. Among the micro elements, Zinc plays an important role directly and indirectly in improving the yield and quality of tomato in addition to checking various diseases and physiological disorders. It gives a rosette appearance and yellowing between veins of new growing leaves occur in plant (Marchner, 1995).

Zn is known to have an important role either as a metal component of enzymes or as a functional, structural or regulatory cofactor of a large number of enzymes (Grotz and Guerinot, 2006). Zinc deficiency is thought to restrict RNA synthesis, which in turn inhibits protein synthesis (Katyal and Randhawa, 1983). In the salt affected areas, zinc application could alleviate possible Na and Cl injury in plants. (Mehmet *et al.,* 1998) Currently, a large number of growth regulators are available in the market but basically they are two types i.e. growth promoters and growth inhibitors or retardants. The Gibberellic acid is one of the most important growth stimulating substances used in agriculture since long. It may promote cell elongation, cell division and thus helps in growth and development of tomato plant. Gibberellic acid when applied to flowers controlled fruit drop in tomato (Feofanova, 1960). Fruit set in tomato can be increased by applying plant growth regulators to compensate the deficiency of natural growth substances required for its development (Singh and Choudhury, 1966). The use of Growth regulators and micro elements improved the production of tomato including other vegetables respect of better growth and quality whichultimately lead general interest among scientist and farmers for commercial application of these substances. It is, therefore, highly desirable to explore possible ways and means to enhance the productivity of this important crop employing cost effective and easy to use techniques. In this regard, the effect of spray of gibberellic acid (GA_3) at very low concentrations could be exploited beneficially as its natural occurrence in plants in minute quantities is known to control their development. It is an established phytohormone used commercially for improving the productivity and quality of a number of crop plants. It is necessary to find out the effective dose of Zinc and Growth regulators (GA_3) in promoting.

Although, tomato is the second major crop of the world after potato, but there is lack of research, particularly under field conditions, to show interactive effects of zinc and Gibberellic acid on tomato. Keeping the above point of view, the present study was undertaken to evaluate the effect ofIBA (Indol butyric acid), GA3 (Gibberellic acid) and Zinc ongrowth and yield of tomato.

Materials and methods

Experimental site

The field experiment was conducted in the experimental farm of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, and Dhaka-1207 during the period from October, 2017 to March, 2018. The location of the experimental site was at $23^{o}74^{/}$ N latitude and $90^{o}35^{/}$ E longitude with an elevation of 8.45 meter from the sea level.

Varieties and treatment of the experiment

In the experiment, Tomato variety "BARI Tomato-14" was used. It was a high yielding, heat tolerant and indeterminate type variety. The seeds were collected from the Horticulture Research Centre, Bangladesh Agricultural Research Institute (BARI), Joydebpur,Gazipur. The experiment consisted of three factors as follows:-Factor A: IBA (Indol Butyric Acid), Doses of IBA 5 ppm, Factor B: GA_3 (Gibberellic Acid) Doses of GA_3 5 ppm, Factor C: Zinc level (1kg/ha). Total 8 treatments were as follow with symbolically: T_0= control, T1= IBA 5ppm, T2= GA_3 5ppm,T_3= Zn,T_4= IBA 5ppm+ GA_3 5ppm,T_5= IBA

5ppm+ Zn,T_6= GA_3 5ppm+ Zn,T_7= IBA 5ppm+ GA_3 5ppm+ Zn.

Layout and land preparation of the experiment

The experiment was laid out in a Randomized Complete Block Design (RCBD) having three factors with three replications. The treatment combinations were accommodated randomly in the unit plots. An area of 19.5 m × 8 m was divided into three equal blocks. Each block consisted of 8 plots where 8 treatments were allotted randomly. There were 24 unit plots altogether in the experiment. The size of each plot was 2 m × 1.8 m. The distance between two blocks and two plots were 0.5m and 0.5 m respectively. Tomato seedlings were raised in the seedbed situated on a relatively high land at Farm of Sher-e-Bangla Agricultural University, Dhaka.

The size of the seedbed was 3 m × l m. The soil was well prepared with the help of spade and made into loose friable and dried mass to obtain fine tilth.

Seedlings emergence

All weeds and stubbles were removed and 5 kg well rotten cow dung was applied during seedbed preparation. The seeds were sown in the seedbed on 15 october, 2017 and after sowing, seeds were covered with light soil to a depth of about 0.6 cm. Heptachlor 40 WP was applied @ 4 kg/ha around each seedbed as precautionary measure against ants and worm.

The emergence of the seedlings took place within 5 to 6 days after sowing. Necessary shading by banana leaves was provided over the seedbed so that the young seedlings were safe from scorching sun or heavy rain. Weeding, mulching and irrigation were done from time to time as and when required and no chemical fertilizer was used in the seedbed.

Manure and fertilizer application

Manure and fertilizers such as cow dung, urea, triple super phosphate (TSP) and murate of potash (MOP) were applied in the experimental field as per recommendation of BARI (2005). The sources of N, P_2O_5, K_2O as urea, TSP and MP were applied, respectively. The entire amounts of TSP and MP were applied during the final land preparation. Urea was applied in three equal installments at 20, 30 and 40 days after seedling transplanting. Well-rotten cow dung 20 t/ha also applied during final land.

Application of IBA, GA3and Zn was done at 15, 30, 45 days after transplanting as per treatment.

Data collection

Randomly five plants were selected and uprooted carefully at the time of collecting data and mean data on the following parameters were recorded :Plant height, Number of leaves per plant, Number of branches per plant, Leaf Area index Chlorophyll content, Number of cluster per plant, Number of fruit per plant, Fruit weight per plant, Fruit yield (t/ha).

Statistical analysis

Data were statistically analyzed by a computer program MSTAT-C software and Duncan's multiple range tests was used to analyze the growth, yield and quality contributing characters of tomato to find out the statistical significance. The significance of the difference was evaluated by Duncan's Multiple Range Test (DMRT) according to Gomez and Gomez, (1984) for interpretation of the results at 5% level of probability.

Results and discussion

Growth characters

Plant height

Indol butyric acid (IBA), gibberellic acid (GA_3) and zinc (Zn) had significant influence on crop growth characters.Table 1 shows the effect of IBA, GA3 and Zn on plant height in tomato.

The interaction effect of IBA, GA_3 and Zn at all the successive growth stages, significantly influenced by the combined effect of treatments. The longest plant height was recorded under treatment T_7 (IBA 5ppm+ GA_3 5ppm+Zn) which was investigate among 30,45,60,75 and 90 DAT and the minimum under the treatment T_0 (control), respectively at all the successive growth stages.

Table 1. Effect of different plant growth regulators and Zn on plant height at different days after transplanting in tomato.

Treatments	Plant height (cm)				
	30 DAT	45 DAT	60 DAT	75DAT	90DAT
T_0	27.69d	36.00d	57.10c	75.70d	85.24f
T_1	31.33bc	44.93c	68.68b	86.60c	93.64cd
T_2	30.22cd	48.77bc	69.82b	84.70c	94.44c
T_3	27.89d	36.29d	56.01c	76.40d	87.30ef
T_4	33.22b	51.22ab	74.44a	90.35b	99.22b
T_5	32.67bc	50.21b	73.94a	86.69c	90.70de
T_6	33.00bc	50.71ab	68.63b	85.37c	90.86cde
T_7	37.55a	55.16a	76.37a	96.53a	103.03a
$LSD_{(0.05)}$	2.8189	4.6733	3.5438	3.6390	3.6820
CV (%)	5.08	5.72	2.97	2.44	2.26

T_0=control, T_1=IBA 5ppm, T_2= GA_3 5ppm T_3= Zn T_4= IBA 5ppm+ GA_3 5ppm T_5= IBA 5ppm+Zn,T_6= GA_3 5ppm+Zn,T_7= IBA 5ppm+ GA_3 5ppm+Zn.

Table 2. Effect of different plant growth regulators and Zn on no. of leaf of tomato plant at different days after transplanting in tomato.

Treatments	Leaf no.				
	30 DAT	45 DAT	60 DAT	75DAT	90DAT
T_0	24.50d	31.13e	37.83e	41.74ef	47.88f
T_1	30.53c	33.58de	40.70d	44.43de	51.66de
T_2	31.06c	36.84bc	42.63cd	45.45cd	52.85d
T_3	26.09d	31.04e	35.53e	41.00f	49.26ef
T_4	34.20ab	37.77ab	45.99ab	51.04b	61.70b
T_5	30.06c	36.63bc	43.29bcd	48.09bc	52.23de
T_6	31.32bc	34.74cd	43.99bc	46.62cd	57.64c
T_7	35.60a	39.43a	48.30a	54.06a	65.70a
$LSD_{(0.05)}$	2.9065	2.5714	2.8361	3.0015	3.2302
CV (%)	5.46	4.18	3.83	3.68	3.36

T_0=control, T_1=IBA 5ppm, T_2= GA_3 5ppm T_3= Zn T_4= IBA 5ppm+ GA_3 5ppm T_5= IBA 5ppm+Zn, T_6= GA_3 5ppm+Zn, T_7= IBA 5ppm+ GA_3 5ppm+Zn.

This agrees with the work of Olaiya et al. (2009b) examined that Bio-regulators affect fundamental processes of plant growth and development.

Indole-3-acetic acid (IAA), Indole-3-butyric acid (IBA) and Naphthalene acetic acid (NAA) are plant bio-regulators belonging to the auxin group.

Plant bio regulators are organic compounds that modify or controls one or more specific physiological processes within a plant. They can accelerate or retard the growth or maturation rate or otherwise alter the behaviour of plants or their products.

Number of leaves

Number of leaves of tomato varied significantly due to the application of IBA, GA3 and Zn at 30, 45, 60, 75 and 90 DAT.Combined effect of IBA, GA_3 and Zn showed statistically significant variation on number of leavescompare to others treatment.At 90 DAT, the maximum no. of leaves (65.70) was recorded from T_7 (IBA 5ppm+ GA_3 5ppm+Zn) and the minimum (47.88) was recorded from T_0 (control) (Table 2). This agrees with the work of Sheeja and Mandel (2004) found that GA_3 found to be the best among all treatments for producing calli with very good growth from leaf and stem explants of tomato cultivars.

Table 3. Effect of different plant growth regulators and Zn on branch number of tomato at different days after transplanting in tomato.

Treatments	Branch no.				
	30 DAT	45 DAT	60 DAT	75DAT	90DAT
T_0	1.22f	4.11e	6.22e	8.89e	10.33f
T_1	2.12d	5.07c	6.52de	9.34cde	11.47de
T_2	2.19d	5.08c	6.88cd	9.66cd	11.75cd
T_3	1.45e	4.67d	6.47e	9.13de	10.85ef
T_4	2.55b	5.56ab	7.33b	11.22a	12.48ab
T_5	2.45bc	5.37bc	7.15bc	10.37b	12.14cd
T_6	2.37c	5.44b	7.05bc	9.86bc	12.23bc
T_7	2.83a	5.78a	7.73a	11.83a	13.11a
$LSD_{(0.05)}$	0.1478	0.3188	0.3712	0.6502	0.6853
CV (%)	3.93	3.55	3.06	3.70	3.32

T_0=control, T_1=IBA 5ppm, T_2= GA_3 5ppm T_3= Zn T_4= IBA 5ppm+ GA_3 5ppm T_5= IBA 5ppm+Zn,T_6= GA_3 5ppm+Zn,T_7= IBA 5ppm+ GA_3 5ppm+Zn.

Number of branches per plant

Number of branches per plant of tomato varied significantly due to the application of IBA, GA3 and Znat 30, 45, 60, 75 and 90 DAT (Table 3)**.**Combined effect of IBA, GA_3 and Zn showed statistically significant variation on number of branches compare to others treatment.At 90 DAT, the highest no. of branches (13.11) was recorded from T_7 (IBA 5ppm+ GA_3 5ppm+ Zn) and the lowest (10.33) was recorded from T_0 (control).

Leaf area index (LAI) (cm²)

Leaf area index of tomato varied significantly due to the application of IBA, GA3 and Znat 60, 75 and 90 DAT (Fig.1).The interaction effect of IBA, GA_3 and Zn at all the successive growth stages, significantly influenced by the combined effect of treatments.

Table 4. Effect of different plant growth regulators and Zn on fruit weight of tomato at different harvest in tomato.

Treatments	Fruit weight (kg)		
	1st harvest	2nd harvest	3rd harvest
T_0	0.57f	2.02f	1.74f
T_1	1.51d	3.17d	2.36e
T_2	1.88c	3.55c	2.49de
T_3	1.37e	2.61e	1.77f
T_4	2.21b	4.61a	3.01b
T_5	1.90c	3.99b	2.57d
T_6	2.17b	3.94b	2.82c
T_7	2.36a	4.69a	3.24a
$LSD_{(0.05)}$	0.1292	0.2295	0.1542
CV (%)	4.23	3.67	3.52

T_0=control, T_1=IBA 5ppm, T_2= GA_3 5ppm T_3= Zn T4= IBA 5ppm+ GA_3 5ppm T5= IBA 5ppm+Zn, T6= GA_3 5ppm+Zn, T7= IBA 5ppm+ GA_3 5ppm+Zn.

The maximum leaf area index was recorded under treatment T_7 (IBA 5ppm+ GA_3 5ppm+Zn) which was investigate among 60, 75 and 90 DAT and the minimum under the treatment T_0 (control), respectively at all the successive growth stages. This ahree with the work of Wu *et al.* (1983) sprayed one month old transplanted tomato plants with GA_3 at 1, 10 or 100 ppm. They noticed that GA_3 at 100 ppm increased plant height and leaf area.

Chlorophyll content of leaf

Chlorophyll content of leaf of tomato varied significantly due to the application of IBA which applied singly in treatment T_1 recorded (48.7%) that

may compare to treatment T_0 (Fig.2).Chlorophyll content of leaf of tomato varied significantly due to the application of GA_3 which applied singly in treatment T_2 recorded (48.9%) that may compare to treatment T_0. Chlorophyll content of leaf of tomato varied significantly due to the application of Zn which applied singly in treatment T_3 recorded (48.7%) that may compare to treatment T_0.Combination effect of IBA, GA_3 and Zn showed statistically significant variation on chlorophyll content of leaf. The highest chlorophyll content of leaf (59.32%) was found from T_7 (IBA 5ppm+ GA_3 5ppm+Zn) while the lowest chlorophyll content of leaf. (46.61%) was recorded from T_0 (control).

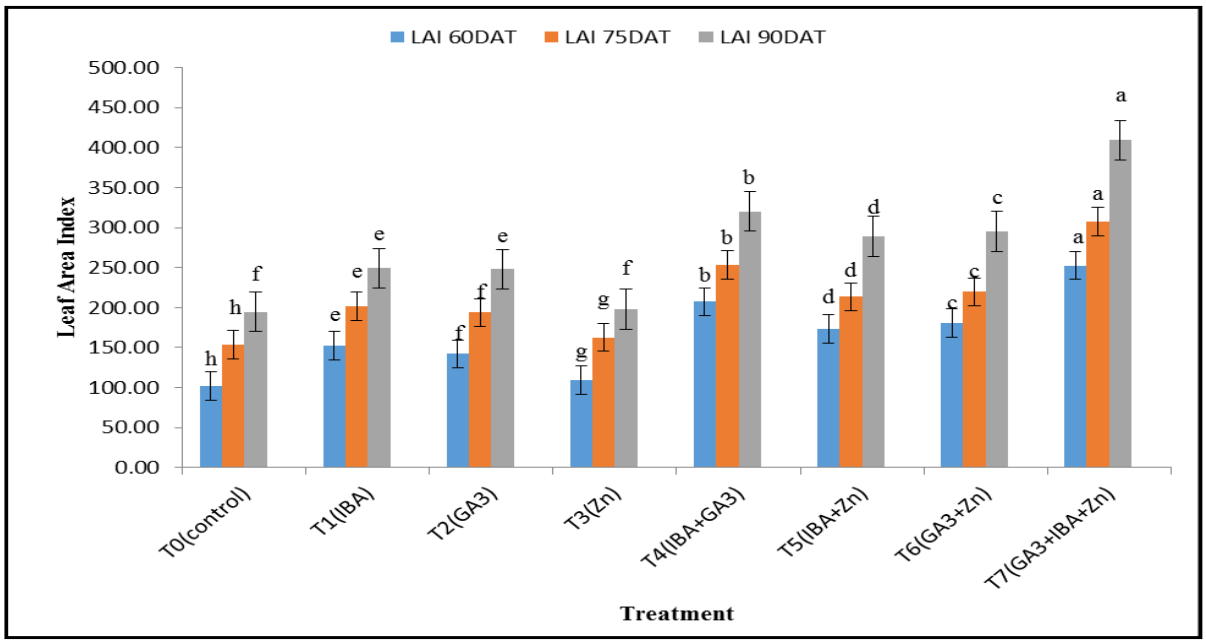

Fig. 1. Effect of different plant growth regulators and Zn on LAI of tomato at different DAT.

Yield characters

Number of flower clusters per plant

Number of flower clusters per plant of tomato varied significantly due to the application of IBA at 60, 75 and 90 DAT which applied in treatment T_1 that may compare to treatment T_0 (control) (Fig.3).Number of flower clusters per plantof tomato varied significantly due to the application of GA_3 at 60, 75 and 90 DAT which applied in treatment T_2 that may compare to treatment T_0 (control).

Number of flower clusters per plantof tomato varied significantly due to the application of Zn at 60, 75 and 90 DAT which applied in treatment T_3 that may compare to treatment T_0(control). There was statistically significant difference among the treatment combinations in respect of number of flower clusters per plant. It was evident that the treatment combination of T_7 (IBA 5ppm+ GA_3 5ppm+Zn) gave the maximum number of flower clusters per plant at 60 and 75 DAT and the minimum number of flower cluster per plant was recorded from the treatment combination of T_0 (control). But at 90 DAT the maximum number of flower clusters per plant was both T_7 and T_4 and the minimum number of cluster was recorded from treatment T_0 (Fig.3).This agree with the work of Olaiya et al. (2009a) found that IBA that regulate growth and influence various developmental process, including stem elongation, early root formation, callus formation, enhance flowering, enzyme induction and leaf & fruits senescence. They can accelerate or retard the growth and maturation rate.

Number of fruits per plant

Number of fruits per plant of tomato varied significantly due to the application of IBA at 60, 75 and 90 DAT which applied in treatment T_1 that may compare to treatment T_0(control)(Fig. 4). Number of fruits per plant of tomato varied significantly due to

the application of GA_3 at 60, 75 and 90 DAT which applied in treatment T_2 that may compare to treatment T_0(control). Number of fruits per plant of tomato varied significantly due to the application of Zn at 60, 75 and 90 DAT which applied in treatment T_3 that may compare to treatment T_0(control).Combined effect IBA, GA_3 and Zn on number of of fruit per plant were found to be significant.

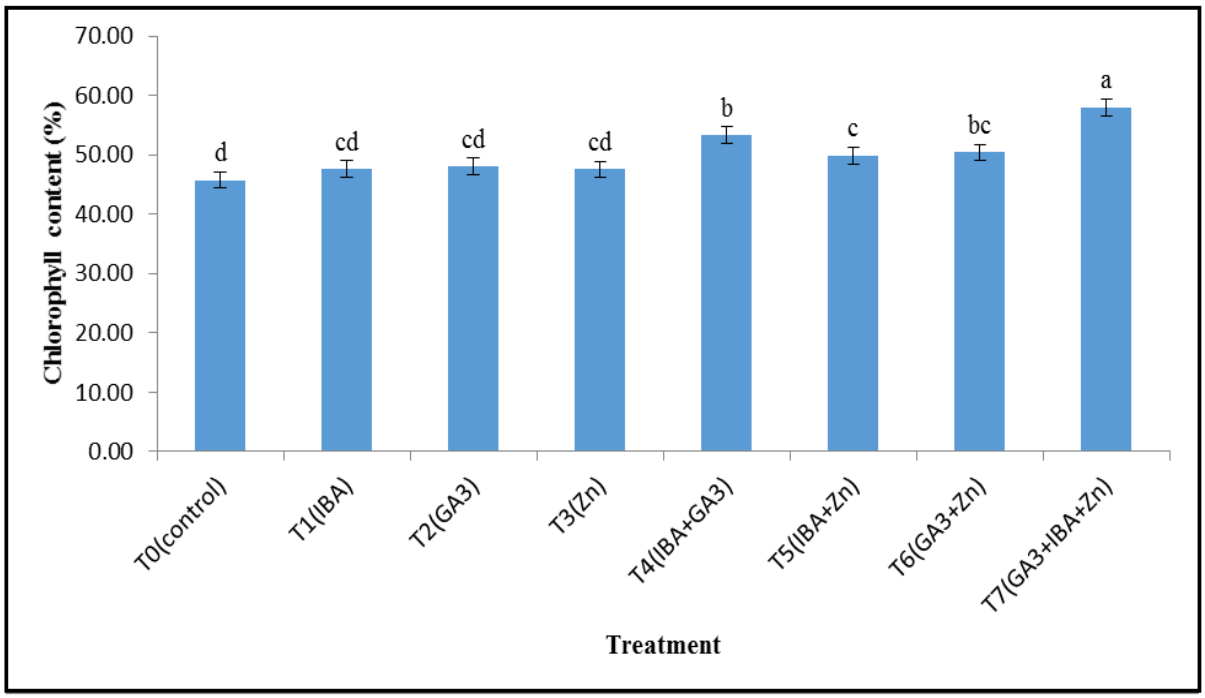

Fig. 2. Effect of different plant growth regulators and Zn on Chlorophyll content of tomato.

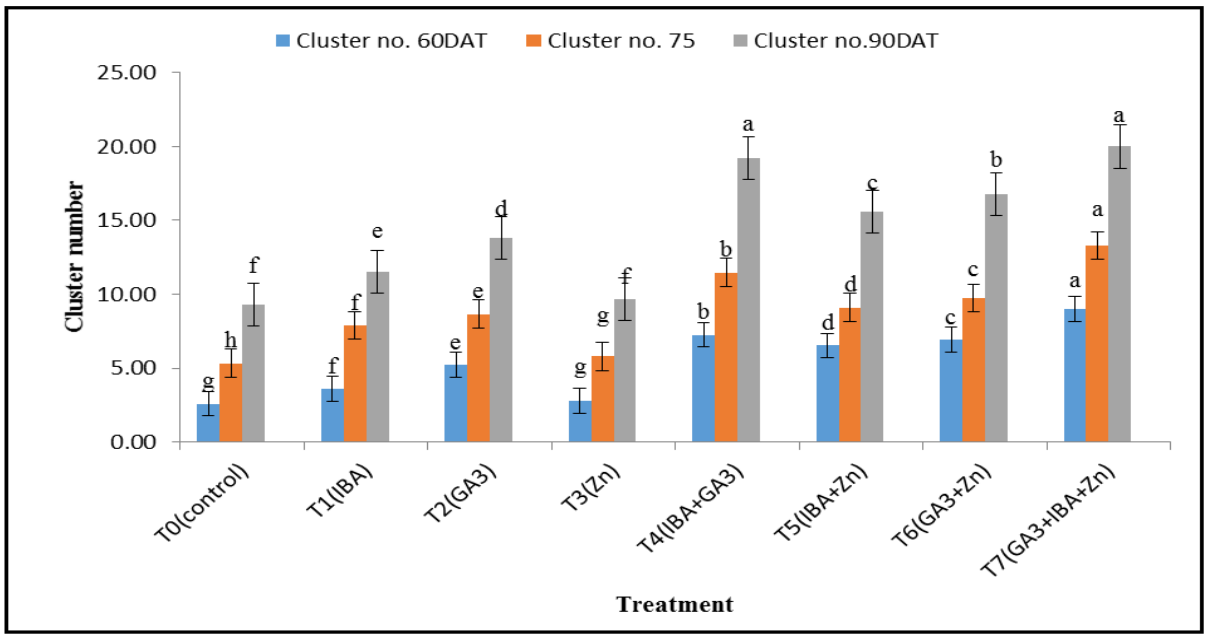

Fig. 3. Effect of different plant growth regulators and Zn on cluster no. of tomato at different DAT.

The maximum number of fruit per plant was observed in the treatment combination of at T_7 (IBA 5ppm+ GA_3 5ppm+Zn) the count from 60, 75 and 90 DAT and the minimum was T_0 (control).This agree with Gustafson (1960) worked with different concentration of GA_3 and found that when 35 and 70 ppm GA_3 were

sprayed to the flowers and floral buds of the first three clusters, percentage of fruits set increased but there was a decrease in the total weight. When only the first cluster was sprayed, the number of fruit set and the total weight per cluster was increased, but this response did not occur in subsequent clusters.

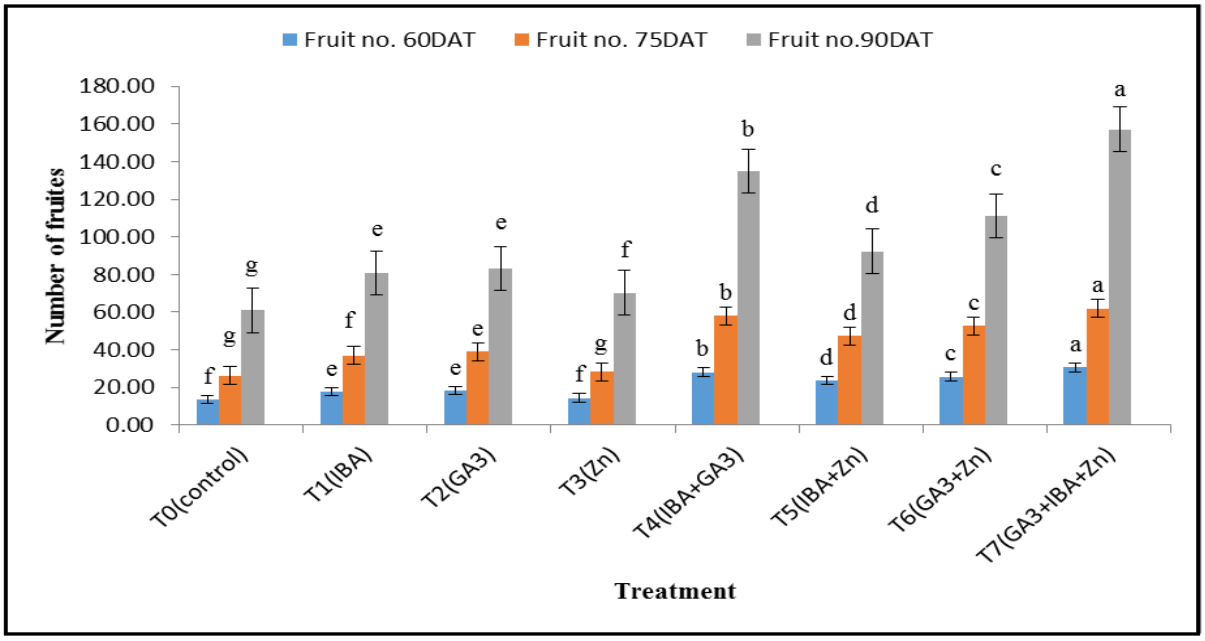

Fig. 4. Effect of different plant growth regulators and Zn on no. of fruits of tomato at different DAT.

Weight of fruits per plant

Weight of fruits per plant when harvest 1st,2nd and 3rd of tomato varied significantly due to the application of IBA which applied in treatment T_1 that may compare to treatment T_0(control)(Table 4)**.**

Weight of fruits per plant when harvest 1st,2nd and 3rd of tomato varied significantly due to the application of GA_3 which applied in treatment T_2 that may compare to treatment T_0(control). Weight of fruits per plant when harvest 1st,2nd and 3rd of tomato varied significantly due to the application of Zn which applied in treatment T_3 that may compare to treatment T_0(control). There was significant combined effect of IBA, GA_3 and Zn on the weight of fruits per plant.

The maximum fruit weight per plant was obtained from the treatment combination of T_7 (IBA 5ppm+ GA_3 5ppm+Zn) at 1st and 2nd harvested but at 2nd harvest the maximum fruit weight per plant was recorded the treatment T_7 (IBA 5ppm+ GA_3 5ppm+Zn) and T_4. The lowest in this respect was found from the treatment combination T_0. This result similer with Adlakha and Verma (1965) noticed that when the first four clusters of tomato plants were sprayed three times at unspecified intervals with GA_3 at 50 and 100 ppm, the fruit setting, fruit weight and total yield increased by 5, 35 and 23%, respectively with the higher concentration than the lower.

Fruit yield per hectare

Fruits yield per hectare of tomato varied significantly due to the application of IBA that is 71.27 which applied in treatment T_1 that may compare to treatment T_0(control) that is 39.75(Fig. 5). Fruits yield per hectare of tomato varied significantly due to the application of GA_3 that is 80.00 which applied in treatment T_2 that may compare to treatment T_0(control) that is 39.75.

Fruits yield per hectare of tomato varied significantly due to the application of Zn that is 61.63 which applied in treatment T_1 that may compare to treatment T_0(control) that is 39.75. The interaction effect of IBA, GA_3 and Zn at all the successive growth stages, significantly influenced by the combined effect of treatments.

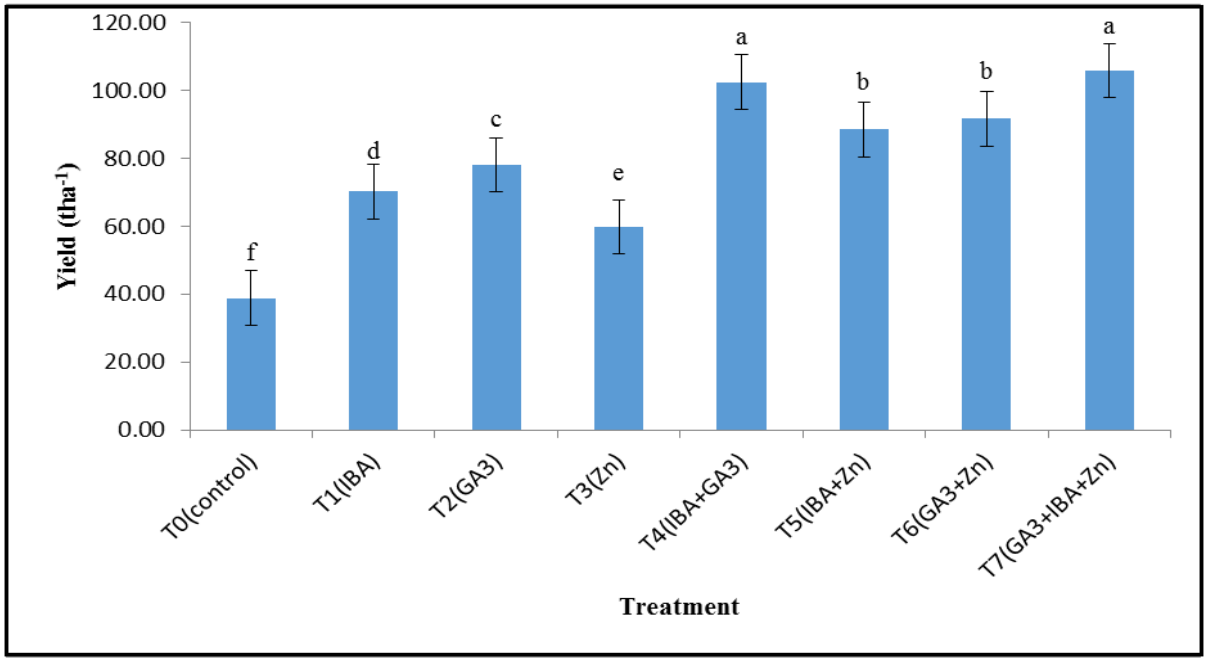

Fig. 5. Effect of different plant growth regulators and Zn on yield of tomato.

The treatment combination of T_7 (IBA 5ppm+ GA_3 5ppm+Zn) and T_4(IBA 5ppm+ GA_3 5ppm) gave the maximum yield (100.00 t/ha) and the minimum yield (39.75 t/ha) was found from the treatment combination on T_o(control) his similer with Hossain (1974) examined the effect of gibberellic acid along with parachlorophenoxy acetic acid on the production of tomato. He found that GA_3 applied at 50, 100 and 200 ppm produced an increased fruit set. However, GA_3 treatment induced a small size fruit production. A gradual increase in the yield per plant was obtained with higher concentration of GA_3.

Conclusion

On the basis of the present research,it can be concluded that BARI Tomato-14 with combination of IBA (5ppm), GA_3 (5ppm) and Zn performed better all studied parameter.

The maximum fruit weight per plant was obtained from the treatment combination of T_7 at 1st and 2nd harvested but at 2nd harvest the maximum fruit weight per plant was recorded the treatment T_7 and T_4. The lowest in this respect was found from the treatment combination T_o. T_7 and T_4 gave the maximum yield (100.00 t/ha) and the minimum yield (39.75 t/ha) was found from the treatment combination on T_o. The conclusion from above fact that, the treatment T_7 that conducted IBA 5mg/L, GA_3 5mg/L and Zn is suitable combination for the tomato production. Further investigation may be done to observe in different agro-ecological zones before more conformation of the results.

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