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EFFECT OF INDOLE ACETIC ACID AND BORON ON THE YIELD OF SUMMER TOMATO CULTIVAR BINA TOMATO-3

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Abstract

A pot experiment was conducted at the net house of the Department of Agricultural Chemistry of Bangladesh Agricultural University, Mymensingh from March to August, 2010 to study the effect of Indole Acetic Acid (IAA) and Boron on the growth and yield of summer tomato CV. BINA Tomato-3. There were four levels of IAA viz. 0, 20, 40 and 60 ppm and B viz. 0, 1.5, 2.0 and 2.5 kg ha^{-1}. The experiment was laid out in a Completely Randomized Design (CRD) with 3 replications. The result revealed that parameters like plant height, number of leaves $plant^{-1}$, number of inflorescences $plant^{-1}$, number of fruits and yield $plant^{-1}$ were significantly influenced by the application of IAA and B. The highest plant height (90.33 cm), number of inflorescence $plant^{-1}$ (14.67), number of fruit (18.00) and yield (533.33 g) $plant^{-1}$ were obtained in 60 ppm IAA along with 2.0 kg B ha^{-1} and the lowest plant height (84.00 cm), number of inflorescence $plant^{-1}$ (10.33), number of fruit (9.33) and yield (249.71 g) $plant^{-1}$ were obtained in control treatment. The overall results suggest that treatment $IAA_{60}B_{2.0}$ was the best from other treatments.

Key words: Indole acetic acid, B, growth, yield, summer tomato

Introduction

Tomato (*Lycopersicon esculentum,* mill.), a member of solanaceae is the most nutritious vegetable in Bangladesh as well as in other parts of the world. It is one of the most palatable vegetables which usually occupies the maximum number of our daily dishes and also takes its possession in market. It was originated in tropical America (Solunkhe *et al.*1987). However, It is widely cultivated in tropical, sub-tropical and temperate climates and thus it ranks third in terms of world vegetable production (FAO, 2005). In the year 2008 about 130 million tons of tomatoes were produced in the world and China was the largest producer (33.8 million tons).

In Bangladesh, it is cultivated due to its adaptability to wide range of soil and climate (Ahmed, 1995). Soil and climatic conditions of all the districts of Bangladesh, especially Rajshahi, Natore, Chapainawabganj, Naogaon, Pabna, Bogra, Sirajgonj, Joypurhat, Rangpur and Gaibandha districts are very suitable for tomato cultivation. Tomato is a very nutritious vegetable crop containing considerable amounts of vitamins A, B and C and minerals (Bose and Some, 2002). It also possesses medicinal value. It is much popular as a fresh salad. It is also used as vegetables or as processed food items such as sauce, soup, juice, ketchup, pickles, paste, puree, powder, jam and jelly. Food value of tomato is greatly dependent on its chemical compositions such as dry titratable acidity, total sugar, total soluble solids, ascorbic acid etc. It is generally grown in the winter season and its production in summer is now at emerging stage in Bangladesh. Its cultivation in summer season is affected due to high temperature, rainfall, wind, storms etc. during monsoon season. Production of summer tomato is highly remunerative and need oriented. The Olericulture Division under Horticulture Research Center (HRC) in Bangladesh Agricultural Research Institute (BARI) has developed some heat tolerant tomato varieties like BARI Tomato-3, BARI Tomato-4, BARI Tomato-10 (Anupama), BARI Tomato-13 (Shrabony), etc. (Zaman *et al.*2006). Bangladesh Institute of Nuclear Agriculture (BINA) has also developed some heat tolerant tomato varieties like BINA Tomato-2, BINA Tomato-3 and BINA Tomato-5 (Begum *et al.*1998). There is still a long way to go for successful commercial production of the crop in summer in this country. The study on IAA for tomato production in Bangladesh is very rare and limited at the Research Institutes. This crop differs in their sensitivity to Boron deficiency and the adsorption of B varies with the types of soil. The reduced level of water in the soil also causes a proportionate decrease the rate of boron

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diffusion to root (Barber, 1995). Sinha *et al.* (2002) reported that visible symptoms of B deficiency (0.3 µm) initiated on young leaves as internal chlorosis later leading to necrosis. A positive correlation was observed between B and flower bud, number of flower and weight of fruit in tomato (Bose and Some, 2002). Keeping these points in view the experiment was undertaken to examine the effect of IAA and B on the growth and yield of BINA Tomato-3.

Materials and Methods

The pot experiment was carried out with BINA Tomato-3 in the net house of the Department of Agricultural Chemistry, Bangladesh Agricultural University (BAU), Mymensingh. The research work was accomplished in earthen pot and the different nutrients of the fruit and plant samples were analyzed in the laboratory of the Department of Agricultural Chemistry, BAU, Mymensingh.

The climate of the experiment area was under the sub-tropical climatic zone, which is characterized by moderate to high temperature, heavy rainfall, high humidity and relatively long day during Kharif season (March to August). Before starting the experiment initial soil sample of the experimental plots was analyzed in the laboratory for determination of its physical and chemical properties. The treatments included in the experiment were as follows:

Factor A : Four levels of IAA viz.

1. No IAA (IAA_0)
2. 20 ppm IAA (IAA_{20})
3. 40 ppm IAA (IAA_{40})
4. 60 ppm IAA (IAA_{60})

Factor B: Four levels of Boron viz.

1. No B ($B_{0.0}$)
2. 1.5 kg B ha^{-1} ($B_{1.5}$)
3. 2.0 kg B ha^{-1} ($B_{2.0}$)
4. 2.5 kg B ha^{-1} ($B_{2.5}$)

The experiment was laid out in Completely Randomized Design (CRD) with three replications and thus total number of earthen pots was 48 having diameter of 25 cm and height of 23 cm each. The collected soils from 0-15 cm depth were pulverized and inert materials, visible insect pests and plant residues were removed. The soil was air dried and then mixed thoroughly and the processed soil samples were then placed in the pots at the rate of 8 kg pot^{-1}. The tomato cultivar BINA Tomato-3 was used as test crop in the study. Seedlings were collected from Genetics and Plant Breeding Division, BINA, Mymensingh. Healthy, vigorous, plumy 30 day-old seedlings were used for the study. Two seedlings were transplanted in each pots in the afternoon on 30 November 2011. Light irrigation was given immediately after transplanting using a watering cane.

Indole Acetic Acid was applied in two installments, one half at the first flowering stage and the rest after first fruiting stage of the crop plant. N, P, K, S were applied @ 304 kg urea ha^{-1}, 210 kg TSP ha^{-1}, 176 kg MOP ha^{-1}, 100 kg gypsum ha^{-1} and cowdung 12 t ha^{-1} (i.e. 1.2 g urea pot^{-1}, 0.8 g TSP pot^{-1}, 0.7 g MOP pot^{-1}, 0.4 g gypsum and 48 g dry cowdung pot^{-1}, respectively) following the Fertilizer Recommendation Guide (BARC, 2005). One third of urea and total of PKS fertilizers were mixed with soils at the time of pot preparation. Rest two third of urea was top dressed at 20 and 40 days after transplanting of seedling. Boron was applied @ 0.06, 0.08 and 0.10 g pot^{-1} according to the treatments of 1.5, 2.0, and 2.5 kg B ha^{-1}, respectively and no B was applied for the treatment 0.0 kg B ha^{-1}. Data were collected on plant height, number of leaves $plant^{-1}$, and number of inflorescence $plant^{-1}$ at every 10 day intervals starting from 20 days after planting (DAT) up to 70 DAT while data in terms of number of fruits $plant^{-1}$ were collected at every 10 day intervals starting from 40 DAT up to 70 DAT. Tomato fruits were started to harvest from 55 DAT and it was continued up to 85 DAT. Weight of harvested fruits from each pot at different dates were added together to attain the total yield $plant^{-1}$. Average yield of tomato fruits $plant^{-1}$ was calculated from dividing by 2 of the total yield obtained from two plants of each pot. Tomato fruits were harvested in the morning and kept in gunny bags. Proper care was taken during harvesting and handling the collected fruit samples to avoid any mechanical injury. The recorded data were subjected to statistical analysis. All the data were analyzed for ANOVA with the help of a computer package program of MSTAT-C developed by Russel (1986). Mean separation was done using Duncan's Multiple Range Test at 5% level of probability wherever F value was significant.

Results and Discussion

Plant height

Plant height is an important parameter which is positively correlated with the yield of tomato. The interaction effect among the different levels of IAA and B showed significant variations in respect of plant height at 50 days after transplanting (DAT) and 60 DAT (Table 1). The plant height varied from 84.00 to 90.33 cm at the harvesting stage *i.e*. 70 DAT where the tallest plant (90.33cm) was observed in $IAA_{60}B_{2.0}$ treatment while the shortest plant (84.00cm) was found in $IAA_0B_{0.0}$ (control) treatment. The highest plant height 19.00, 38.00, 65.67, 84.67 and 89.00 cm was observed at 20, 30, 40, 50 and 60 DAT, respectively with the application of 60 ppm IAA along with 2.0 kg B $ha^{-1.}$ The result have the agreement with Hossain (2008).

Number of leaves

Effect of interaction on number of leaves $plant^{-1}$ of BINA Tomato-3 is presented in Table 2. At 20 DAT the maximum number of leaves $plant^{-1}$ (8.00) was found with the combinations of $IAA_{40}B_{0.0}$ and $IAA_{60}B_{1.5}$. It was the lowest (6.00) in the combinations of $IAA_0B_{0.0}$, $IAA_{20}B_{2.0}$ and IAA_{60} $B_{2.5}$. At 30 DAT, the maximum number of leaves $plant^{-1}$ (13.67) was found with $IAA_{40}B_{0.0}$ treatment and the lowest number (10.67) was found with $IAA_0B_{0.0}$ (control). At 40 DAT, the maximum number of leaves $plant^{-1}$ (23.67) was found with $IAA_{60}B_{2.5}$ treatment and the lowest number (18.00) was found with $IAA_0B_{1.5}$ and $IAA_{20}B_{0.0}$ treatments. At 50 DAT, the combination of $IAA_{60}B_{2.5}$ gave the maximum number of leaves $plant^{-1}$ (29.33) and the combination of $IAA_{20}B_{0.0}$ gave the lowest number (21.00). At 60 DAT, the maximum number of leaves $plant^{-1}$ (33.33) was found with $IAA_{60}B_{2.5}$ treatment and the lowest number (24.67) was with the combination of $IAA_0B_{1.5}$. At 70 DAT, the maximum number of leaves $plant^{-1}$ (33.67) was found with both the combinations of $IAA_{40}B_{2.5}$ and $IAA_{60}B_{2.5}$ and the lowest number (25.67) was found with $IAA_0B_{0.0}$. It is clear from Table 2 that number of leaves $plant^{-1}$ of tomato was significantly influenced by the application of both IAA and B and it was related with the levels employed, when the levels of either of IAA or B was increased the number of leaves was also increased. A parallel result was reported by Hossain (2008).

Number of Inflorescences

Interaction effects of different treatments on the number of inflorescence $plant^{-1}$ were not statistically significant at 20, 30, 40, 50 and 60 DAT but significant at 70 DAT (Table 3). Number of inflorescence $plant^{-1}$ ranged from 10.33 to 14.67 at 70 DAT. The highest number of inflorescence $plant^{-1}$ was observed in $IAA_{60}B_{2.0}$ treatment and the lowest number of inflorescence $plant^{-1}$ was recorded in control treatment ($IAA_0B_{0.0}$). Hossain (2008) reported similar result.

Number of fruits

Interaction effects of different levels of IAA and B on the number of fruit $plant^{-1}$ was not statistically significant at 40 and 50 DAT but significant at 60 and 70 DAT (Table 4). Number of fruit $plant^{-1}$ ranged from 2.00 to 5.00, 5.00 to 8.33, 8.00 to 16.67 and 9.33 to 18.00 at 40, 50, 60 and 70 DAT, respectively. The highest number of fruit $plant^{-1}$ was observed in the combination of $IAA_{60}B_{2.0}$ and the lowest number of fruit $plant^{-1}$ was recorded in control treatment ($IAA_0B_{0.0}$). The result was in agreement with Yadav *et al*. (2006).

Yield $plant^{-1}$

The results presented in Fig. 1 revealed that the four levels of IAA *i.e*. IAA_0 (no IAA), IAA_{20} (20 ppm IAA), IAA_{40} (40 ppm IAA) and IAA_{60} (60 ppm IAA) showed a significant effect on fruit yield. IAA_{60} was found superior over all other levels, as it yielded highest (480.76 g $plant^{-1}$). The results presented in Fig. 2 revealed that the four levels of B i.e. $B_{0.0}$ (no B), $B_{1.5}$ (1.5 kg B ha^{-1}), $B_{2.0}$ (2.0 kg B ha^{-1}) and $B_{2.5}$ (2.5 kg B ha^{-1}) showed a significant effect on fruit yield. The highest yield (433.73 g $plant^{-1}$) was found in $B_{2.0}$ treatment.

The different treatment combinations of IAA and B fertilizers showed a significant interaction effect on fruit yield. The yield varied from 249.71 to 533.33 g $plant^{-1}$ in different treatment combinations (Fig. 3). The results indicated that the treatment combination of $IAA_{60}B_{2.0}$ had the best effect on yield of tomato. The combination gave the highest fruit yield of 533.33 g $plant^{-1}$ while the lowest yield (249.71 g $plant^{-1}$) was observed in control ($IAA_0B_{0.0}$) treatment.

Table 1. Interaction effects of IAA and B on the plant height of BINA Tomato-3 at different days after transplanting (DAT)

Treatments	Plant height (cm)					
	20 DAT	**30 DAT**	**40 DAT**	**50 DAT**	**60 DAT**	**70 DAT**
$IAA_0B_{0.0}$	15.00	30.00	56.33	66.33e	78.00c	84.00
$IAA_0B_{1.5}$	16.33	31.67	59.33	68.67ef	79.67bc	85.00
$IAA_0 B_{2.0}$	17.67	36.33	60.00	73.00de	84.00ab	87.00
$IAA_0 B_{2.5}$	17.67	34.67	59.67	71.00def	84.67ab	86.00
$IAA_{20} B_{0.0}$	16.67	33.33	59.00	68.67ef	79.67bc	85.00
$IAA_{20} B_{1.5}$	16.67	34.67	59.00	73.33cde	83.00abc	87.00
$IAA_{20} B_{2.0}$	17.00	36.00	60.33	76.33bcd	84.67ab	87.67
$IAA_{20} B_{2.5}$	18.00	36.33	62.67	77.33bcd	84.67ab	87.33
$IAA_{40} B_{0.0}$	16.33	32.33	59.00	76.33bcd	83.00abc	86.33
$IAA_{40} B_{1.5}$	16.00	31.67	60.00	76.67bcd	84.00ab	86.00
$IAA_{40} B_{2.0}$	17.33	33.33	60.00	77.33bcd	84.00ab	86.00
$IAA_{40} B_{2.5}$	17.00	33.67	63.33	77.33bcd	84.67ab	87.00
$IAA_{60} B_{0.0}$	17.33	33.33	62.67	79.67abc	84.67ab	87.33
$IAA_{60} B_{1.5}$	18.00	34.67	63.33	82.00ab	85.00ab	88.00
$IAA_{60} B_{2.0}$	19.00	38.00	65.67	84.67a	89.00a	90.33
$IAA_{60} B_{2.5}$	17.00	36.00	62.67	77.33bcd	84.33ab	87.67
Level of significance	NS	NS	NS	**	**	NS
$LSD_{0.05}$	2.32	4.72	4.17	3.28	3.08	2.56
CV (%)	1.86	1.93	1.01	1.07	0.63	0.44

*NS = Not significant, **indicates significant at 1% level of probability. Figures in a column having same or no letter(s) do not differ significantly.*

Table 2. Interaction effects of IAA and B on the number of leaves plant^{-1} of BINA Tomato-3 at different days after transplanting (DAT)

Treatments	Number of leaves plant^{-1}					
	20 DAT	**30 DAT**	**40 DAT**	**50 DAT**	**60 DAT**	**70 DAT**
$IAA_0B_{0.0}$	6.00	10.67	18.33d	23.67	25.00ef	27.33
$IAA_0B_{1.5}$	7.33	12.00	18.00d	22.00	24.67f	25.67
$IAA_0 B_{2.0}$	7.33	12.67	19.67a-d	25.00	28.00b-e	28.67
$IAA_0 B_{2.5}$	7.00	12.67	18.33d	23.67	26.33def	27.00
$IAA_{20} B_{0.0}$	6.67	12.33	18.00d	21.00	25.67ef	26.67
$IAA_{20} B_{1.5}$	6.33	11.33	18.67cd	26.67	31.33a-d	32.00
$IAA_{20} B_{2.0}$	6.00	13.00	19.00 bcd	24.33	29.33a-f	29.67
$IAA_{20} B_{2.5}$	7.67	13.00	19.67 a-d	24.00	28.67a-f	29.00

Treatments	Number of leaves plant^{-1}					
	20 DAT	**30 DAT**	**40 DAT**	**50 DAT**	**60 DAT**	**70 DAT**
IAA_{40} $B_{0.0}$	8.00	13.67	22.33 a-d	26.00	30.00a-e	30.00
IAA_{40} $B_{1.5}$	7.33	12.67	21.33 a-d	24.67	27.33b-f	28.33
IAA_{40} $B_{2.0}$	6.33	11.67	21.00a-d	24.67	28.67a-f	30.33
IAA_{40} $B_{2.5}$	7.00	11.00	23.67ab	28.33	32.33abc	33.67
IAA_{60} $B_{0.0}$	7.67	13.00	22.67ab	28.00	30.00a-e	31.00
IAA_{60} $B_{1.5}$	8.00	13.33	23.33abc	27.33	31.00a-d	32.33
IAA_{60} $B_{2.0}$	6.33	13.33	23.67ab	29.00	32.67ab	33.33
IAA_{60} $B_{2.5}$	6.00	12.00	24.33a	29.33	33.33a	33.67
Level of significance	NS	NS	**	NS	**	NS
$LSD_{0.05}$	1.49	1.59	2.32	2.96	2.58	2.14
CV (%)	3.05	1.89	2.10	1.98	1.73	1.51

*NS = Not significant, **indicates significant at 1% level of probability. Figures in a column having same or no letter(s) do not differ significantly.*

Table 3. Interaction effects of IAA and B on the number of inflorescence plant^{-1} of BINA Tomato-3 at different days after transplanting (DAT)

Treatments	Number of inflorescence plant^{-1}					
	20 DAT	**30 DAT**	**40 DAT**	**50 DAT**	**60 DAT**	**70 DAT**
$IAA_0B_{0.0}$	1.00	2.00	4.33	7.00	9.00	10.33d
$IAA_0B_{1.5}$	1.33	2.33	4.67	7.67	9.33	10.67cd
IAA_0 $B_{2.0}$	1.67	3.00	6.00	8.67	10.00	11.00cd
IAA_0 $B_{2.5}$	1.33	2.33	6.00	8.33	10.00	11.00cd
IAA_{20} $B_{0.0}$	1.00	2.00	5.33	8.33	9.67	10.67cd
IAA_{20} $B_{1.5}$	1.67	2.67	6.67	8.67	10.33	11.33bcd
IAA_{20} $B_{2.0}$	2.00	2.67	6.33	9.00	11.33	12.00bcd
IAA_{20} $B_{2.5}$	1.33	2.33	6.33	9.00	11.00	11.67bcd
IAA_{40} $B_{0.0}$	1.00	2.00	5.00	8.00	10.00	11.00cd
IAA_{40} $B_{1.5}$	1.33	2.33	5.67	8.00	10.67	11.33bcd
IAA_{40} $B_{2.0}$	2.33	3.67	6.33	8.33	11.00	12.00abc
IAA_{40} $B_{2.5}$	1.67	3.33	6.00	8.67	9.67	10.67cd
IAA_{60} $B_{0.0}$	1.33	2.33	5.00	8.67	10.00	12.67a-d
IAA_{60} $B_{1.5}$	1.67	3.33	6.67	10.00	12.00	13.33abc
IAA_{60} $B_{2.0}$	2.00	4.00	7.00	10.33	14.00	14.67a
IAA_{60} $B_{2.5}$	1.67	3.00	5.67	11.00	13.00	13.67ab
Level of significance	NS	NS	NS	NS	NS	*
$LSD_{0.05}$	0.85	0.90	1.46	1.59	1.66	1.30
CV (%)	7.83	5.27	3.65	2.79	2.63	2.04

*NS = Not significant, **indicates significant at 1% level of probability. Figures in a column having same or no letter(s) do not differ significantly.*

Table 4. Interaction effects of IAA and B on the number of fruits plant^{-1} of BINA Tomato-3 at different days after transplanting (DAT)

Treatments	Number of fruits plant^{-1}			
	40 DAT	50 DAT	60 DAT	70 DAT
$IAA_0B_{0.0}$	2.00	5.00	8.00e	9.33e
$IAA_0B_{1.5}$	2.67	5.33	9.67cde	11.00de
$IAA_0 B_{2.0}$	3.00	6.33	10.00b-e	11.33cde
$IAA_0 B_{2.5}$	3.33	5.33	8.33de	9.67e
$IAA_{20} B_{0.0}$	3.00	6.67	9.67cde	10.67de
$IAA_{20} B_{1.5}$	3.67	8.00	9.67cde	11.00de
$IAA_{20} B_{2.0}$	3.67	6.67	10.67b-e	11.33cde
$IAA_{20} B_{2.5}$	4.00	6.33	8.67cde	9.67e
$IAA_{40} B_{0.0}$	3.00	5.67	10.67b-e	11.33cde
$IAA_{40} B_{1.5}$	3.33	7.67	9.67cde	11.00de
$IAA_{40} B_{2.0}$	4.00	6.67	11.67bc	13.33bcd
$IAA_{40} B_{2.5}$	3.67	6.67	11.33bcd	12.00cde
$IAA_{60} B_{0.0}$	3.00	6.33	10.67	12.67bcd
$IAA_{60} B_{1.5}$	4.00	8.00	13.00b	15.00b
$IAA_{60} B_{2.0}$	5.00	8.33	16.67a	18.00a
$IAA_{60} B_{2.5}$	3.33	6.33	11.67bc	14.00ab
Level of significance	NS	NS	**	**
$LSD_{0.05}$	1.30	1.36	1.59	1.46
CV (%)	5.50	3.35	3.33	3.05

*NS = Not significant, **indicates significant at 1% level of probability. Figures in a column having same or no letter(s) do not differ significantly.*

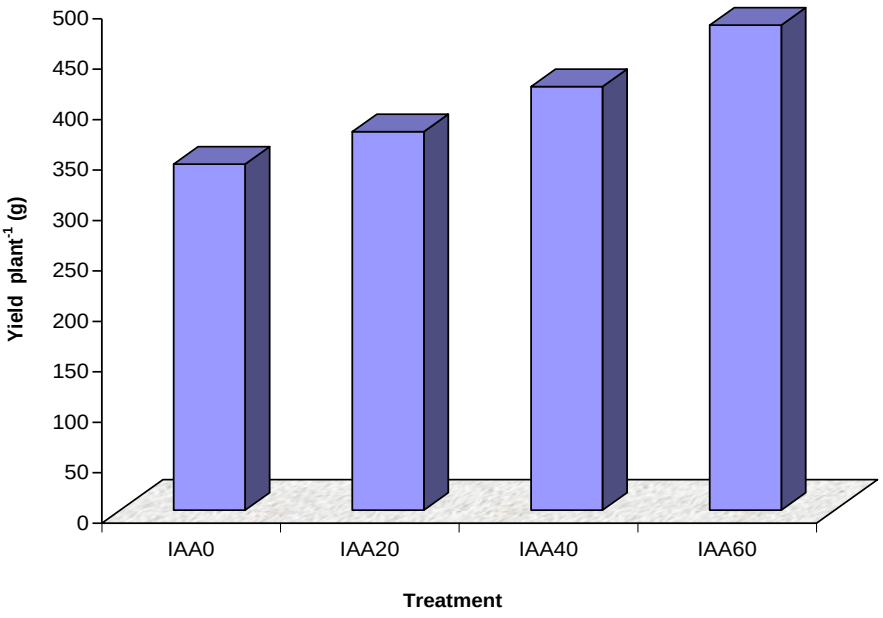

Fig. 1. The effect of different levels of IAA on the yield plant^{-1} of BINA Tomato-3 at different treatments

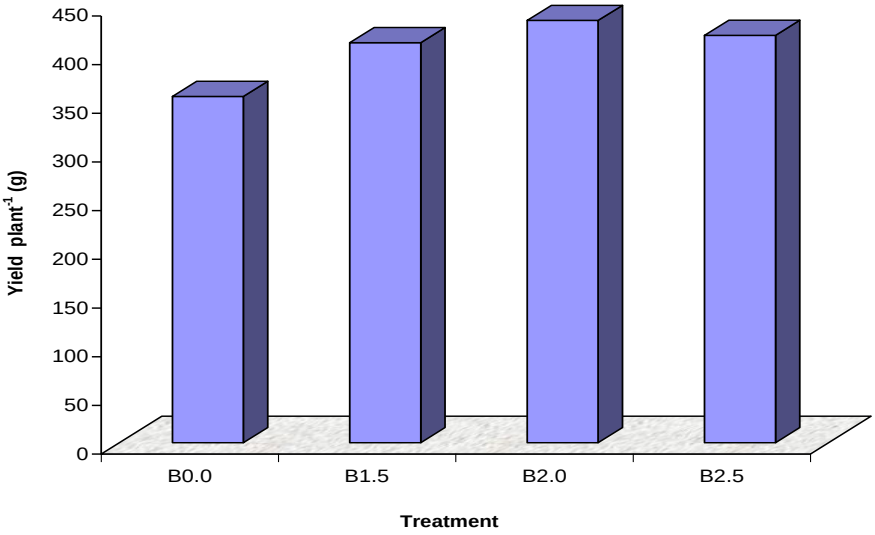

Fig. 2. The effect of different levels of B on the yield plant^{-1} of BINA Tomato-3 at different treatments

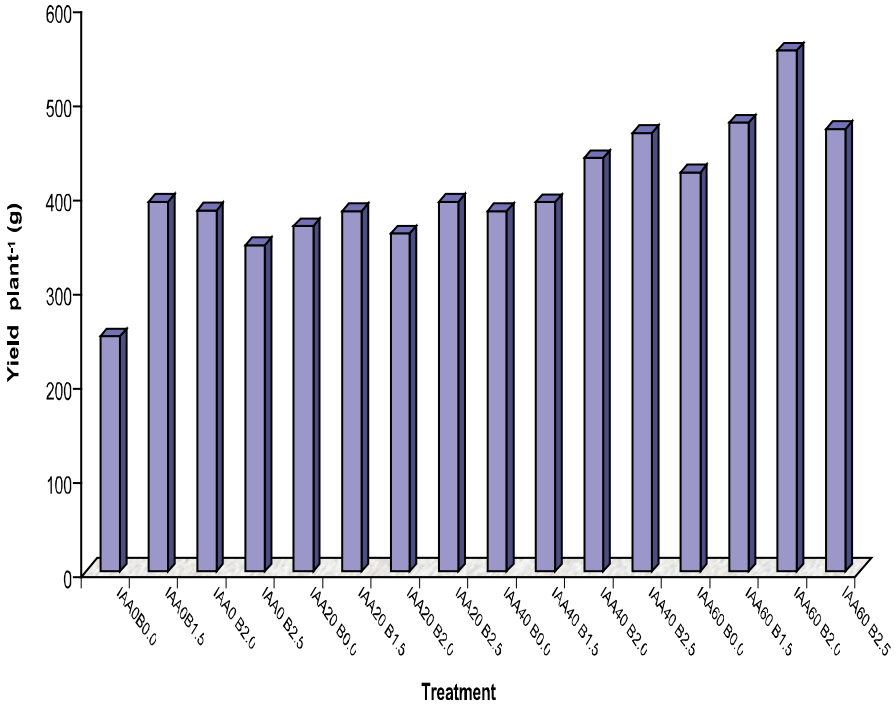

Fig. 3. Interaction effect of different levels of IAA and B on the yield plant^{-1} of BINA Tomato-3 at different treatments

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