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Effect of gibberellic acid and boron on yield and biochemical parameters of tomato (*Lycopersicon esculentum*) fruits

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ABSTRACT

A green house experiment was conducted at St. John's College Agra (U.P.) to study the effect of gibberellic acid and boron on yield and biochemical parameters of tomato (Lycopersicon esculentum) fruits. The treatments consisted of four levels each of gibberellic acid (0, 25. 50 and 75 mg L^{-1}) and boron (0, 0.1, 0.2 and 0.3%) were evaluated in complete randomized design with three replications. The results revealed that the fruit size (4.88 cm) fresh fruit yield/plant (498.7 g), dry matter yield/plant (29.89 g) were highest with spraying of 50 mg/l GA. Boron spraying (0.3%) also improved these parameters over no boron spraying. The biochemical parameters, i.e. ascorbic acid, aciditylycopene, carotene and TSS were also improved with sprayings of GA, over control. Boron sprays also improved these biochemical parameters of tomato fruits significantly over no B spray, Boron spraying were more effective in enhancing the fruit yield and biochemical parameters than that of GA. . The contents of N, P and K in tomato fruits were higher under 75 mg/l solution of GA. Similarly boron concentrations also increased the N, P and K contents in tomato fruits over control. The concentration of B and Fe were remarkably higher in tomato fruits at 75 mg/l GA except that of zinc. The spraying of boron solution also improved the content of Zn, Fe and B in tomato fruits.

Keywords: Gibberellic acid, boron, biochemical parameters yield tomato

INTRODUCTION

Tomato (*Lycopersicon esculentum Mill.*) is one of the most popular and widely grown vegetables in the world ranking second in importance to potato in many countries. It belongs to the family of Solanaceae. The fruits of tomato are eaten raw or cooked. It is cooked alone or mixed with other vegetables to prepare a variety of luscious and delicious dishes. Large quantities of tomato are used to produce soup, juice, ketchup, puril paste and powder. Tomato is popular also because it supplies Vitamin C and adds variety of colours and flavours to the foods. Gibberellin plays an important role in the initiation of flowering. It plays an important role in the growth and development of plants exerting its effects on a variety of different processes but its surprising roles are regulation of sub apical meristem activity and the induction of flowering in certain plants.Boron is associated with meristematic activity, auxin, cell-well, protein and pectin metabolism, maintaining correct water relations within the plant, sugar translocation, fruiting processes and phenolase inhibitions. Boron is closely related to the functions that calcium performs in the plant. It has also been suggested that boron is necessary for the lignin polymerization process. Since, there is an association between flavonoids content and lignin production. Very meager information is available on the contribution of gibberellic acid and boron on growth, yield and quality of tomato in Agra region. Therefore, the present investigation was carried out in to study the effect of gibberllic acid and boron on yield and biochemical paeameters of tomato fruits.

MATERIAL AND METHODS

A green house experiment was carried out at St. John's College Agra. The experimental soil was sandy loam with pH 79, organic carbon 3.2 g kg^{-1}, available N 77 mg kg^{-1}, available P 5.0 mg kg^{-1}, available K 90 mg kg^{-1} and available boron 0.39 mg kg^{-1}. The experiment was laid out in complete randomized design with three replications. Treatments consisted four levels each of gibberellic acid (0, 25, 50 and 75 mg L^{-1}) and boron (0, 0.1, 0.2 and 0.3 per cent). Earthen pots of similar size and shape were filled with 10 kg of soil. The basal dose of N, P, K, S and Zn at the rate of 40, 50, 60, 10 and 5 mg kg^{-1}, respectively were applied through urea, diammonium phosphate, muriate of potash, elemental sulphur and zinc oxide solutions and the soil of each pot was mixed thoroughly. Three seedlings of 8-10 cm height were transplanted in each pot and watered with deionized water. After two days, the plants were thinned out to one in each pot. One third of recommended dose of N (30 mg kg^{-1}) was applied after three and six weeks of transplant. The gibberellic acid and boron solutions were sprayed on the plants 20 days after transplanting. The pots were irrigated with deionized water as and when required. The crop was grown up to stage of maturity. The fruits were collected in five pickings and summed up to work out the total fresh weight. The dry weight was recorded after crushing and drying the fruits in the sun and them in oven at constant temperature of 60^0 C. Nitrogen was determined by micro Kjeldall method. Phosphorus, K, Fe and Zn were determined in di-acid (HNO_3, $HClO_4$ 10:4) digest by vanadomolybdate yellow colour method, flamephotometer and atomic absorption spetrophotometer respectively. Boron in the acid digest was determind colorimetrically by carmine method (Hatcher and Wilcox 1950). Chlorophyll a and b and carotenoids were estimated by the method of Jayaraman (1981). The acid content, lycopene and ascorbic acid in fresh fruits was determined as per methods of Ranganna (1977).

RESULTS AND DISSCUSION

Yield

The fruit size progressively increased over untreated plants with the rising GA and B levels. The highest fruit size of tomato was recorded where 0.3 percent of B and 75 mg/l GA were sprayed through the foliar application (Table 1). This increase in size may be attributed to the direct enhancement of growth as promoted by GA at higher levels. Gupta *et al.* (2003) also reported similar results. The spraying of 0.3% boron and 75 mg/l GA gave better size of tomato fruits. The fruit size of tomato tremendously improved at higher concentration of B and GA, which may be due to their beneficial effects on increasing fruits size of the tomato. The similar results were also reported by Bokade *et al.* (2006) and Manna and Maity (2016). The tomato yield was not affected adversely at higher concentration because of delay in appearance of toxicity symptoms. Since by that time plants would have completed most of the growth activities with increased B through foliar application. The tomato fruit yield significantly increased over control with the rising of B and GA level. At 75 mg/l solution of GA, the tomato yield was reduced indicating an adverse effect of higher concentration of GA on tomato fruits. Almost similar trend was observed with increasing B concentration along with GA. Similar observations were made by Gupta *et al.* (2003) and Kumar and Singh (2008). Maximum fruit yield was observed with the application of 0.3% boron solution spray (Table 1). The plants sprayed with boron had early flowering, greater vegetative growth, more number of fruits/plant and hence increased yields. The maximum yield with boron may be due to balanced nutrition of the crop from early stage of vegetative growth, which ensured healthy plants, more tolerant to the attack of various diseases, pests and bearing of more fruits. The results are in accordance with Naresh Babu (2002) and Solanki *et al.* (2018) in tomato. The dry mater yield significantly increased over control with the rising in B and GA level upto 0.3 percent B and 50 mg/l GA.

Table 1: Effect of GA and B concentration on yield and biochemical composition of tomato

Treatments	Fruit size (cm)	Fresh fruit yield/plant (g)	Dry matter yield/plant (g)	Ascorbic acid (mg/100g)	Acidity (%)	Lycopene (mg/100g)	Carotene (mg/100g)	TSS (%)
Gibberillic acid (mg/l)								
0	4.32	409.3	24.48	23.20	0.44	24.17	10.22	4.02
25	4.76	466.5	27.95	24.70	0.63	29.56	13.60	4.48
50	4.88	498.7	29.89	29.87	0.57	39.60	16.55	5.04
75	2.98	356.9	21.39	24.45	0.44	14.82	7.18	3.96
CD (P=0.05)	0.12	20.74	3.61	1.94	0.10	4.30	2.49	0.12
Boron concentration (%)								
0	3.62	419.8	25.16	22.23	0.56	24.95	9.75	4.12
0.1	4.22	424.3	25.43	23.62	0.54	25.90	11.47	4.30
0.2	4.55	439.4	26.32	25.95	0.50	28.03	12.80	4.44
0.3	4.56	448.0	26.80	30.42	0.48	29.27	13.66	4.64
CD (P=0.05)	0.12	20.74	3.61	1.94	0.10	4.30	2.49	0.12

Beyond 50 mg/l of GA the dry matter production reduced as compared to the control. The increase in dry matter content in tomato fruits with B was found to be significant. These results also confirm the findings of Ramana *et al.* (2016), Kumar and Singh (2006), Bhatt and Srivastava (2006) Ali (2017).

Biochemical composition of tomato fruits

The B at the level of 0.3 percent and GA @ 50 mg/l brought about significant improvement in the ascorbic acid content (Table 1) but the ascorbic acid content decreased with the rise in GA levels. The 0.2 percent B and 50 mg/l GA were found to be more appropriate and effective levels amongst all. These results are in conformity with the findings of Ahiya and Shakila (2006), Kumar and Singh (2008) Paithankar and Sadawarte (2004).The percent acidity in tomato fruits increased with increasing levels of GA up to 25 mg/l. But it is simultaneously reduced over control with the higher concentration of B applied through foliar spraying (Table 1). It is quite obvious from the observations that the higher concentration of GA did not reflect its superiority and antagonistic effect over B levels and this may be due to the interactive and antagonistic effect of B over GA. The 0.1 percent B solution spraying with lower levels of GA progressively increased the percent acidity in tomato fruits. Similar observations were recorded by Sinha *et al.* (2006). The percent acidity in tomato fruit juice was higher in second year in comparison of first year at all the levels. The boron and GA brought about progressive significant improvement in TSS content in tomato fruits upto the level of 0.3% B and 50 mg/l GA (Table 1). At higher GA concentration, the TSS content narrowed down. Manna and Maity (2006) also reported that an application of boric acid on mango crop was found to be more significant on vegetative growth and TSS content over control. Bhattl and Srivastava (2006) also observed that the application of 0.2 percent B with 5 percent of urea markedly increased the reducing sugar, total sugar and TSS content in grapes. The increasing levels of B and GA brought about significant improvement in lycopene and carotene content in tomato fruits over untreated plants. The spraying of GA at higher concentration (75 mg/l) tended to reduce the lycopene and carotene contents (Table 1). The increased lycopene and carotene in tomato fruit may be due to the biosynthesis of chlorophyll in to lycopene, which is affected by varying intensities of light and temperatures. These results are in accordance with the findings of Ahiya and Shakila (2006) Sokade *et al.* (2006).

Table 2: Effect of GA and B concentration on chemical composition of fruits

Treatments	Nitrogen (%)	Phosphorus (%)	Potassium (%)	Zinc (mg kg^{-1})	Boron (mg kg^{-1})	Iron (mg kg^{-1})
Gibberellic acid (mg/l)						
0	2.83	0.25	1.79	21.4	26.3	63.4
25	2.90	0.28	1.88	21.6	28.3	63.7
50	2.92	0.31	1.92	21.8	30.8	64.2
75	2.92	0.31	1.93	22.1	34.0	64.3
CD (P=0.05)	0.06	0.02	0.08	0.26	1.94	NS
Boron (%)						
0	2.83	0.25	1.83	21.6	23.6	63.6
0.1	2.87	0.28	1.86	21.6	28.0	63.8
0.2	2.92	0.30	1.90	21.7	31.9	64.0
0.3	2.95	0.32	1.93	21.9	36.0	64.1
CD (P=.0.05)	0.06	0.02	0.08	0.26	1.94	NS

Elemental composition of tomato fruits

Nitrogen, P and K contents in tomato fruits increased significantly with increasing concentration of GA and B solutions over control (Table 2). The maximum values of N, P and K content in tomato fruits were noted under 0.3% B and 75mg/l GA solution. The trend of results obtained in this study suggest a favorable influence of B spraying on the nutrition these elements in tomato crop, possibly these elements were not metabolized properly in thepresence of higher amount of boron concentration in the tissues, Solanki *et al.* (2018) also reported similar results. Zinc content in tomato fruit improved significantly with spraying of GA and boron solutions in both crop seasons (Table 2). The increase in Zn content with boron may be due to reduced plant growth in the presence of higher concentration of boron solution. Boron content in tomato fruits improved significantly with spraying of GA and B solutions over control and maximum values were noted under 0.3% B and 75 mg/l GA in both crop seasons. The increase in B content was associated with foliar sprayings on the plants with increasing concentrations of boron solution. Ramana *et al.*(2016) and Rai *et al.* (2018) also reported similar results.

Boron content in tomato fruits was also significantly affected with their (B x GA) interaction in both crop seasons. Iron content in tomato fruits was not affected significantly with GA and B solutions. However, a slight increase in iron content was noted with increasing concentration of GA and boron. Rai *et al.* (2018) also reported similar results.

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