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Effect of gibberelhic acid and boron on growth and biochemical composition of tomato (*Lycopersicon esculentum*) plants

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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 growth and biochemical composition of tomato (Lycopersicon esculentum) plants. 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 plant height (63.0 cm), branches/plant (7.1) were highest with spraying of 75 mg/l GA. Boron spraying (0.3%) also improved these parameters over no boron spraying. The biochemical parameters, i.e. chlorophyll 'a' and 'b', total phinol, carotene and reducing and non-reducing sugars were also improved with sprayings of GA over control. Boron sprays also improved these biochemical parameters of tomato plants significantly over no B spray, Boron sprayings were more effective in enhancing the growth and biochemical parameters than that of GA.. The contents of N, P and K in tomato plants were higher under 75 mg/l solution of GA. Similarly boron concentrations also increased the N, P and K contents in tomato plants over control. The concentration of B, Zn and Fe were remarkably higher in tomato plants at 75 mg/l GA. The spraying of boron solution also improved the content of Zn, Fe and B in tomato plants.

Keywords: Gibberellic acid, boron, biochemical parameters growth 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. 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 growth and biochemical parameters of tomato plants.

MATERIALS 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 flowering stage. The dry weight was recorded after crushing and drying the plants in the sun and then 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 carotene were estimated by the method of Jayaraman (1981). The total phenol and reducing and non-reducing sugars were determined, by Jayaraman (1981).

RESULTS AND DISSCUSION

Growth

The plant height progressively increased over untreated plants with the rising GA and B levels. The highest value of plant height of tomato was recorded where 0.3 per cent of B and 75 mg/l GA were sprayed through the foliar application (Table 1). This increase in plant height may be attributed to the direct enhancement of growth as promoted by GA at higher levels. Bisaria and Bhatnagar (1978) also reported similar results. The plant height of tomato tremendously improved at higher concentration of B and GA, which may be due to their beneficial effects on increasing plant height of the tomato. The similar results were also reported by Kumar and Sharma (2006). The maximum number of branches were noted with increasing levels of GA and B over untreated plants. This increase was found to be highly significant over control. Probably this was also due to the enhancement of the cell division and growth, which was caused by GA and B by foliar application. This is in conformity with the findings of Bisaria and Bhatnagar (1978).

Table 1: Effect of B and GA on growth and biochemical composition of tomato plants

Treatments	Plant height (cm)	Branches /plant (g)	Chlorophyll "a"	Chlorophyll "b"	Total phenol (mg/100g)	Carotene (mg/l)	Reducing Sugar (mg/100g)	Non-Reducing Sugar (mg/ 100g)
Gibberillic acid (mg/l)								
0	57.8	5.3	27.5	39.5	481	145.8	27.7	244
25	59.7	5.9	41.4	51.4	618	158.5	43.4	258
50	61.2	6.4	47.6	58.8	660	188.4	61.1	285.
75	63.0	7.1	55.1	65.6	631	171.8	25.4	234
SEm±	0.81	0.43	1.78	1.50	18.1	4.60	1.91	7.1
CD (P=0.05)	1.63	0.88	3.60	3.02	37.1	9.38	3.89	14.5
Boron concentration (%)								
0	57.9	6.0	42.6	49.4	557	102.6	33.7	247
0.1	63.5	6.3	47.3	55.7	583	136.1	37.1	253
0.2	71.3	7.4	50.2	60.0	615	191.4	41.1	258
0.3	48.9	5.1	31.6	50.1	622	234.3	45.6	263
SEm±	0.81	0.43	1.78	1.50	18.1	4.60	1.91	7.1
CD (P=0.05)	1.63	0.88	3.60	3.02	37.1	9.38	3.89	14.5

Biochemical composition of tomato plant

Chlorophyll 'a' content in tomato leaves significantly increased up to 0.2% B and 50 mg/l GA level over untreated plants (Table 1). This increase in chlorophyll 'a' content may be due to synthesis of chlorophyll. Foliar application of solution containing B stimulated leaf chloroplast synthesis. These results are in conformity with the findings of Mohan and Sinha (1988). The higher concentration of GA exhibited promotory effect on biosynthesis of chlorophyll (Singhvi 1991). The spraying of GA at the rate of 75 mg/l and 0.2% B through foliar application had a dominating effect over their respective controls. Beyond these levels chlorophyll ‘b’ content decreased with the increase in B level. The amount of total phenol was significantly higher at 50 mg/l GA and 0.3% B (Table 1). The combination of 50 mg/l GA and 0.3% B through foliar application was found to be more superior over other treatment. The interaction (B X GA) had significantly beneficial effect on total phenol content (Table 3). Similar results were reported by Sinha *et al.* (2006). Carotene content increased significantly with the increasing levels GA and B over their respective untreated plants (Table 1). Spraying of 50 mg/l GA and 0.3% B were found to be more superior over other treatments. The interaction effect between B and GA was found to have significantly beneficial effect on carotene content (Table 3) and maximum concentration of carotene (283.1 mg/l) was noted with 50 ml/l GA and 0.3% boron treatment. The reducing and non-reducing sugar contents of tomato plants significantly increased up to 50 mg/l GA and 0.3% of B over control. After these levels, the sugar content in plants tremendously reduced over untreated plants. These findings are in conformity with those of Sinha *et al.* (2006).

Table 2: Effect of GA and B on chemical composition of tomato plants

Treatments	Nitrogen (%)	Phosphorus (%)	Potassium (%)	Zinc (mg kg^{-1})	Boron (mg kg $^{-1}$)	Iron (mg kg^{-1})
Gibberellic acid (mg/l)						
0	2.05	0.17	1.18	19.6	26.9	79.9
25	2.08	0.19	1.23	19.9	27.8	80.4
50	2.10	0.21	1.24	20.2	30.3	80.7
75	2.11	0.18	1.26	20.5	33.5	81.2
SEm±	0.02	0.21	0.03	0.05	0.76	0.53
CD (P=0.05)	0.04	0.02	0.06	0.10	1.56	NS
Boron (%)						
0	2.05	0.17	1.21	19.8	24.0	80.1
0.1	2.07	0.18	1.22	20.0	27.5	80.6
0.2	2.10	0.19	1.24	20.1	31.4	80.8
0.3	2.11	0.21	1.24	20.3	35.6	80.7
SEm±	0.02	0.01	0.03	0.05	0.76	0.53
CD (P=0.05)	0.04	0.02	0.06	0.10	1.56	NS

Elemental composition of tomato plants

Nitrogen, P and K contents in tomato plants 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 plants 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 the presence of higher amount of boron concentration in the tissues, Solanki *et al.* (2018) also reported similar results. Zinc content in tomato plants improved significantly with spraying of GA and boron solutions in both crop seasons (Table 2).

Table 3: Interactive effect of GA and boron on total phenol and carotene content in tomato plants

Boron (%)	Gibberillic acid (mg/l)							
	0	25	50	75	0	25	50	75
	Total phenol (mg/100g)				Carotene (mg/l)			
0.0	429	570	628	580	55.8	110.7	123.5	120.7
0.1	460	597	651	615	124.1	131.3	143.6	145.3
0.2	485	625	667	642	189.4	167.8	203.5	205.3
0.3	515	612	692	658	214.0	224.1	283.1	216.0
SEm±			36.3				9.2	
CD (P=0.05)			74.2				18.7	

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 plants 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. 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 plants was also significantly affected with their (B x GA) interaction. Iron content in tomato plants 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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