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Growth and Yield of Tomato *(Lycopersicon esculentum* L.) as Influenced by Different Levels of Zinc and Boron as Foliar Application

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Abstract: An experiment was carried out at Agriculture Research Institute (ARI) Tarnab Peshawar, during 2012 to study the "Growth and yield of tomato *(Lycopersicon esculentum* L.) cv 'Rio Grand as influenced by different levels of zinc and boron as foliar application'. Four levels of zinc (0, 0.2, 0.4 and 0.6%) and four levels of boron (0, 0.05, 0.10 and 0.15%) were applied as foliar spray. Data was recorded on, number of flowers cluster plant^{-1}, number of flowers cluster^{-1}, number of fruits cluster^{-1}, number of branches plant^{-1} and yield (t ha^{-1}). Zinc, boron and their interaction significantly increased the growth and yield parameters. Among different levels of Zn 0.4% showed significant increased in number of flowers cluster plant^{-1} (27.45), number of flowers cluster^{-1}(5.66), number of fruits cluster^{-1}(4.57), number of branches plant^{-1} (7.36) and yield (tha^{-1}) (23.40). Boron also significantly affected growth and yield components. Among different levels of boron 0.15% showed significant increased in number of flowers cluster plant^{-1}(27.55), number of fruits cluster^{-1}(4.40) and yield (tha^{-1}) (23.33). Based on the above results it can be recommended that Zn @ 0.4% and B @ 0.15% should be combinely applied to tomato for better growth and yield under the agro climatic conditions of Peshawar.

Key words: Tomato · Zinc · Boron · Foliar application · Fruit yield

INTRODUCTION

Tomato (*Lycopersicon esculentum* L.) belonging to Solonicaeca family. It is a well known vegetable grown all over the world. It is second important vegetable after potato. South America is native origin of tomato and before Columbus its plants were brought to Europe by Red Indians and started cultivation. The plants of maximum size of tomato fruit have been taken from Peru to Italy, after that were taken to northern Europe and last to America in 1817 [1]. It was introduced in Subcontinent by the Europeans. Later on local people also started its consumption due to its popularity. It is now used every where in the country in so many forms [2]. Tomato is herbaceous plant with alternate leaves. The flowers are present in cluster on the stem between the nodes. Fruit of tomato is berry type, it has fleshy placenta and small kidney shaped seeds which are covered with short hairs. Fruit skin of different cultivars has deposition of cutin varying from cultivars to cultivars [3]. Tomato is a self pollinated crop. It is susceptible to high temperature, especially the large fruited fresh varieties. High night temperature may lead to lower fruit set of small and seedless fruit development. Most favorable temperature for fruit set is 25-30 °C [4].

All type of soil are suitable for tomato production including sandy and heavy clay with soil pH of 5.5 to 7.5 best one. However sandy loam soil is considered best for early crop. Highest yield can be obtained by growing tomato in loam, clay loam and silty loam having enough organic matter [5]. Fertilizer play important role in tomato yield and quality. Macro essential nutrient (N, P, K) and some micro nutrient such as (B, Cu and Zn) are very important for enzymatic reactions with in plant body such as the making of RNA and DNA, protein formation, synthesis of cell wall, occurrence of flowering and fruit formation, important part of growth hormone, while there deficiency affected the growth and quality of plants [6]. Boron is very essential for growth, yield and quality of tomato. It help in the development of cell wall, occurrence of cell division, formation of vascular bundle (phloem) and transport of CH_2O (sugar). Foliar application of B resulted increase in setting of fruit, yield of fruit in plant like plums, almond and grapes [7]. It plays an important role in N, P,

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fats, hormones metabolism, salt absorption and photosynthesis [8]. Plants with deficient of boron have leaves thickened, wilted and curled form, petioles thickened, cracked one with watery condition. Fruits, tuber, roots are discolored, cracked or rotted one [6]. Zinc is essential for carbohydrates, protein metabolism and sexual fertilization, while manganese is involved in photoproducation of oxygen in chloroplast [9]. Although a lot of research work has been done on the requirements of tomato for major nutrients, but insufficient data is available on micronutrients requirements. Keeping in view the importance of micronutrients, the present study was initiated to find out the combined effect of Zn and B as foliar on the growth and yield of tomato.

MATERIALS AND METHODS

The experiment entitled "Growth and yield of tomato (*Lycopersicon esculentum* L.) as influenced by different levels of zinc and boron as foliar application" was conducted during summer 2012, at Agricultural Research Institute Tarnab Peshawar. The experiment was laid out in Randomized Complete Block Design (RCBD), with two factors i.e. Zn and B levels. There were 3 replications and 16 treatments. There were forty eight plots and the area of each was $2.4m^2$. Plant to plant distance was kept 30 cm and row to row distance 100 cm. Planting was done on raised beds of about 45 cm high using transplanting of the available tomato cultivar Rio Grand. The basal dozes of N @ 150 kg ha^{-1}, P @ 100 kg ha^{-1} and K 60 kg ha^{-1} were applied by using urea, Triple Super Phosphate (TSP) and potassium sulphate sources. P, K and half N was mixed with soil before transplantation, while the remaining N was applied after two weeks of transplantation. During the research all other cultural activities like weeding, hoeing, irrigation were carried out at proper time. Before foliar application water was spray on the plant to know the exact amount of water for foliar application. After that solution of zinc and boron were prepared for each treatments and replication. The solutions were applied to the plant with help of pump. The zinc and boron were applied as a foliar application twice i.e. before flowering and at fruit setting. Sources used were zinc sulphate and borax for zinc and boron respectively. Data regarding days to flowering was recorded by counting number of days of randomly selected plants form transplanting to first flowering opening and their average was calculated. Numbers of flower clusters $plant^{-1}$, flowers $cluster^{-1}$, fruits $cluster^{-1,}$ branches $plant^{-1}$of selected 5 plants were counted and then calculated their mean. Plant height was measured from selected 5 plants in each treatment after first picking. For which with the help of measuring tap plant height from the soil line to the top was measured and average was taken to represent the corresponding treatments. Final yield was calculated by weighting the fruits picked in each plot and converted the weight to yield ha^{-1}.

Statistical Analysis: The software was used statistics 8.1.Getting the significant variation, the mean was further assessed for differences through least significant difference (LSD) test at (0.05) probability level.

RESULTS AND DISCUSSION

Number of Flowers Cluster $Plant^{-1}$: Number of flowers cluster $plant^{-1}$ significantly increased with the foliar application of Zn, B either alone or in combination. Number of flowers cluster $plant^{-1}$ was increased from 18.66 in control to a maximum 27.45 with application Zn @ 0.4% followed by (24.96) with 0.6% Zn. The highest number of flowers cluster $plant^{-1}$ (27.55) was noted in plants with 0.15% boron, followed by (24.80) and (21.81) in plants of 0.1% and 0.05% B, respectively. Where as, the lowest number of flower cluster $plant^{-1}$(19.08) was recorded in control. Number of flowers cluster $plant^{-1}$ was increased upto 32.90 with applying of 0.4% Zn and 0.15% B from 15.50 in control treatment (Table 1). Boron has an important role in water regulatation and. Also helps in carbohydrate metabolism [10]. Thus, it is likely that the higher number of flowers per cluster could be due to sufficient levels of carbohydrates available for flower formation and fruit set in tomato [11].

Number of Flowers $Cluster^{-1}$: Number of flowers $cluster^{-1}$ was significantly affected by applying of Zn and B^{-1}, while their interaction has no significant effect.Number of flowers $cluster^{-1}$ was increased from 4.79 in control to 5.66 with applying of 0.4% Zn followed by 5.26 and 4.97 with 0.6% and 0.2% Zn. Boron application also significantly affected number of flowers $cluster^{-1}$. The maximum number of flower $cluster^{-1}$ 5.59 and 5.36 was recorded in plants sprayed with B @ 0.1% and 0.15%, whereas the least number of flowers $cluster^{-1}$(4.63) was recorded in control plants (Table 1). Haque *et al.* [10] reported that boron nutrition regulates water absorption and carbohydrate metabolism. While, Desouky *et al.* [12] and Smit and Combrink [11] found that application of boron and zinc enhances fruit set by delaying abscission of flowers.Thus, it is likely that the higher number of flowers per cluster could be due to sufficient levels of carbohydrates available for flower formation and fruit set in tomato [11].

Table 1: Effect of different levels of foliar application of zinc and boron on growth and yield of tomato

Treatments	Number of flowers cluster plant^{-1}	Number of flowers cluster^{-1}	Number of fruits cluster^{-1}	Number of branches plant^{-1}	Yield (tha^{-1})	Days to flowering
Zinc levels						
Zn1	18.66 d	4.79 c	3.37 c	5.82 c	19.12 d	33.64
Zn2	22.17 c	4.97 bc	3.62 b	6.28 bc	19.83 c	33.28
Zn3	27.45 a	5.66 a	4.57 a	7.36 a	23.40 a	32.29
Zn3	24.96 b	5.26 b	3.75 b	6.61 b	22.15 b	33.14
LSD ($P \leq 0.05$)	0.98	0.33	0.21	0.67	0.29	NS
Boron levels						
B1	19.08 d	4.63 c	3.29 d	5.71 c	18.54 d	34.20
B2	21.81 c	5.11 b	3.62 c	6.34 bc	20.51 c	33.08
B3	24.80 b	5.59 a	4.02 b	7.14 a	22.12 b	32.91
B4	27.55 a	5.36 ab	4.40 a	6.88 ab	23.33 a	32.17
LSD ($P \leq 0.05$)	0.98	0.33	0.21	0.67	0.29	NS
Zinc ×Boron						
Zn1×B1	15.50	4.13	2.83	5.12	17.50	36.57
Zn1×B2	17.33	4.93	3.22	5.83	18.45	31.73
Zn1×B3	19.83	5.10	3.53	6.13	19.77	32.43
Zn1×B4	21.97	5.01	3.90	6.20	20.75	33.83
Zn2×B1	17.52	4.55	3.12	5.53	18.01	33.08
Zn2×B2	21.85	4.97	3.55	6.07	19.10	33.63
Zn2×B3	23.58	5.17	3.71	6.80	20.51	33.30
Zn2×B4	25.72	5.20	4.12	6.73	21.69	33.12
Zn3×B1	23.64	5.10	3.77	6.53	20.56	33.50
Zn3×B2	24.55	5.50	4.08	7.00	22.80	33.27
Zn3×B3	28.71	6.31	5.07	8.43	24.50	32.32
Zn3×B4	32.90	5.74	5.38	7.47	25.73	30.07
Zn4×B1	19.65	4.74	3.43	5.63	18.08	33.63
Zn4×B2	23.50	5.04	3.62	6.47	21.69	33.67
Zn4×B3	27.05	5.78	3.78	7.20	23.68	33.60
Zn4×B4	29.62	5.48	4.18	7.13	25.16	31.67
LSD ($P \leq 0.05$)	1.96	NS	0.42	NS	0.59	NS

Zn1= 0 %, Zn2= 0.2 %, Zn3= 0.4%, Zn4=0.6%

B1=0 %, B2=0.05 %, B3= 0.10%, B4=0.15 %

Different letters within columns indicate statistical significance ($P < 0.05$).

Number of Fruits Cluster^{-1}: Number of fruits cluster^{-1}was significantly affected by Zn, B and their interaction has significant effect on fruit cluster^{-1}. The maximum number of fruits cluster^{-1} (4.57) was noted in plants with 0.4% Zn followed by (3.75) with applying of Zn @ 0.6% where the least number of fruits cluster^{-1} (3.37) was recorded in control plants. It is obvious that form Table 1 the maximum fruits cluster^{-1} (4.40) was recorded in plants sprayed with B @ 0.15% followed by (4.02) and (3.62) at 0.1% and 0.05% B, while the minimum fruits cluster^{-1} (3.29) was recorded In control treatment. The combination of 0.4% Zn and 0.15% resulted in maximum number of fruits cluster^{-1} (5.38),while minimum number of fruits cluster^{-1} (2.83) was noted in control plants (Table 1). Boron nutrition regulates water absorption and carbohydrate metabolism [10]. The application of boron and zinc enhances fruit set (8) by delaying abscission of flowers [11]. Thus, it is likely that the higher number of flowers per cluster could be due to sufficient levels of carbohydrates available for flower formation and fruit set in tomato [11].

Number of Branches Plant^{-1}: Number of branches per plant was significantly affected by Zn and B, while there interaction was non-significant. The maximum number of branches plant^{-1} 7.36 was recorded in plants received 0.4% Zn followed by 6.61 with 0.6% Zn, while the least number of branches plant^{-1} 5.82 was noted in control. Regarding B, the highest number of branches plant^{-1}7.14, (6.88) and 6.34 was recorded in plants sprayed with B @ 0.1%, 0.15% and 0.05%, respectively, while the least number of branches plant^{-1}5.71 was recorded in control plants (Table 1). Both zinc and boron are required for the growth and development of plants [13]. Boron increased plant height and number of branches of tomato plant by promoting root growth, which enhances nutrient absorption. Plant with maximum height produced more branches. Application of Zn and B increase number of branches palnt^{-1} in tomato cv Pusa Ruby [13].

Yield (tha^{-1}): The application of Zn, B and their interaction significantly affected yield (tha^{-1}). The yield was increased from 19.12 in control treatment to 23.40 t ha^{-1} in 0.4% Zn followed by 22.15 t ha^{-1} in treatment received 0.6% Zn. (Table 1). Application of 0.15% B resulted in increase yield to 23.33 tha^{-1} followed by 22.12 tha^{-1} in the plants received 0.1% B, while minimum (18.54 tha^{-1}) was recorded in control plants. In response to the interaction of Zn and B maximum yield (25.73 tha^{-1}) was noted in Zn @ 0.4% and B @ 0.15%, while minimum yield (17.50 tha^{-1}) was noted in control treatment (Table 2). The yield of tomato was increased significantly with applying Zn and B. Final yield depend on the continued supply of food material and water [14]. Since boron helps in the absorption of water and carbohydrate metabolism [10], its deficiency may cause sterility, small fruit size and poor yield (7). Zinc is an essential component of various enzyme systems for energy production, protein synthesis and growth regulation and helps in photosynthesis by maintain full complement of chloroplast [7]. Foliar application of B @ 4 ppm considerable increased the number of fruits 11] and fruits yield plant^{-1}(1039.4 g) as compared to control (10.5 and 990.1 g, respectively [15].

CONCLUSION

It can be concluded that from the study that the combine application of Zn @ 0.4% and B @ 0.15% to tomato will result in better growth and yield under the agro climatic conditions of Peshawar.

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