RESPONSE OF ZINNIA TO FOLIAR APPLICATION OF BORON AND ZINC

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ABSTRACT: *A Study on "response of zinnia to foliar application of boron and zinc' was initiated. The experiment was laid out with randomized complete block design having three replications in Horticulture Research Farm of the University of Agriculture, Peshawar during 2014. Foliar application of zinc (0, 25, 50 and 75 kg ha-1) and foliar application boron (0, 5, 10 and 15 kg ha-1) were applied to each plot. Plot size was 2.4 m x 2 m (4.8 m2) having 3 rows with 60 cm row to row distance and 2 m row length. Nitrogen was applied and urea was used as a source. Phosphorus and potassium were kept constant as basal dose in all plots from the sources SSP and sulphate of potash. All the cultural practices were done as per need of crop. Leaf area, number of leaves plant-1, plant height, days to flowering, number of flower plant-1, flower size, flower shelf life, number of roots, root length and root thickness were studied and they were significantly affected by foliar applications of zinc and boron. The interaction between zinc and boron and flower stalk length was significant with zinc. Maximum leaf area (79.5 cm2) was observed with application of 5 kg B ha-1, highest number of leaves plant-1 (95.3), plant height (86.2 cm), number of flower plant-1 (16), flower shelf life (7.8 days), number of roots (35.5) and root length (22.7 cm) was observed with application of 15 kg B ha-1 whereas highest flower size (10.7 cm) and root thickness (2.4 cm) were noticed with application of 10 kg B ha-1. Delayed flowering was observed at control plots. Maximum leaf area (79.8 cm2), number of leaves plant-1 (99.8), plant height (86.3 cm), number of flowers plant-1 (15), flower stalk length (16.9 cm), flower size (10.7 cm), flower shelf life (7.8 days), number of roots (34.2), root length (24.5 cm) and root thickness (2.4 cm) were noticed with application of foliar zinc at the rate of 75 kg ha-1 whereas more days to flowering was observed with no application of zinc.*

Key Words: Boron (B), Zinc (Zn), Zinnia

1. INTRODUCATION

Zinnia Elegans belongs to Asteraceae family and it is the most popular annual summer flower used widely in the border, and the bed edges in most parts of the country have used planted zinnias for cut flowers to meet the foreign exchange requirements, at the present time Zinnia are the different types that have a lot of colors For example, rose pink, lavender cheery, purple red, orange and the thickness of the golden salmon, yellow, white or light green cream. Xenia has the ability to withstand a variety of environmental case and modify different from drought in the soil due to rise strongly in the hot season if irrigated properly [1]. Dry flowers of Zinnia are also used to arrange flowers [2]. Zinnia is a genus of 20 species of annual and perennial plants that they are native to the dry scrub and grassland in an area stretching southwest from the United States to South America, with a diversity center in Mexico. Members of the genus are notable for their solitary long-stemmed flowers that come in a variety of bright colors. Sex was named by the German botanist Johann Gottfried honors Zain (1727-1759) [3]. Micronutrients play an important role in plant growth, and take the micro flora of nutrients in a small amount. Boron and zinc are required for all plant growth. Sufficient boron and zinc nutrition is critical for high yield and quality of crops. Different lesson should the appropriate dose of micronutrients in the absorption of paper can increase vegetative plant height and flower size and yield of plants growth. Boron is one of the essential micronutrients for all vascular plants (Warrington 0.1923). It is absorbed from the soil by plants and borates. Since boron is not mobile in the plant, and a continuous supply of soil or planting media is required in all MERISTEMS factory. Deficiency or toxicity of boron causes a sharp drop in the crop, which is due to disturbance in the metabolism of events involving boron [4]. In addition, boron has a vital role in the formation of proteins, and metabolism of nitrogen, and cell division, and the integrity of the cell membrane, and the formation of the cell wall, and nucleic acids, and systems antioxidants [5], [6]. That plays a vital role in the process of transpiration potassium movement into the stomata of paper. Boron maintains a stable balance between sugars and starches, pollination and seed production [3]. Led zinc and boron levels increase in the development and fruition rise [7]. The introduction of micro-nutrients that are essential for plant growth, it became possible to get the best growth of plants [8]. Micronutrient greatly affected plant growth and development, including boron and zinc nutrients. Zinc plays a key role in plant physiology, where activates certain enzymes related to carbohydrate metabolism, and useful effect of zinc in many ornamental plants [9]. Foliar spray of zinc by 0.5% and was the most effective body station in influencing the vegetative growth and the size of the rise [10].

Keeping in view the importance of the zinnia as bedding plant as well as cut flowers and respond to various micronutrients such as zinc and B, the current study was designed in Horticulture Department of the University of Agriculture Peshawar.

2. MATERIALS AND METHODS

A field experiment entitled "Response of zinnia to foliar application of boron and zinc" was conducted during spring 2014 at Horticulture Research Farm, The University of Agriculture Peshawar. A randomized complete block design (RCBD) was used. Nursery was raised of ornamental nursery and after 2-3 weeks when the size reached to 10 cm seedlings were transplanted to field. Plot size was kept 2.4 m by 2 m, with row to row and plant to plant distances 60 cm and 45 cm respectively. Foliar application of boron and zinc were applied after transplantation seedlings to the field. All other cultural practices were kept uniform for all treatments.

Spray the prepared solution

For this experiment, prepared solutions of commercial spray micronutrients available in the market.
The details of the factors and levels as follows:
Factor A: levels of zinc sulfate ($ZnSO_4.7H_2O$)
Zn1 = control
Zn2 = 25 kg ha-1
Zn3 = 50 kg ha-1
ZN4 = 75 kg ha-1
Factor B: levels of boric acid (H3BO3)
B1 = control
B2 = 5 g ha 1
B3 = 10 g ha 1
B4 = 15 g ha 1

3. RESULTS AND DISCUSSIONS

Leaf area (cm^{-2})

The data regarding to the leaf area is shown in the Table 1. The results showed that leaf area was significantly affected by boron and zinc application. The interaction between zinc and boron was also significant. Leaf area as influenced by various levels of zinc and boron are presented by Figure 1. The results indicated that boron levels significantly varied the leaf area of the zinnia. Mean values of the data showed that greater leaf area (79.3 and 78.4 cm^{-2}) was recorded with application of boron at the rate of 5 and 10 kg ha^{-1} respectively. The minimum leaf area (66.7 and 67.6 cm^{-2}) was noticed in the plots treated with 15 kg B ha^{-1} and control plots respectively.

The zinc levels also significantly affected the leaf area of zinnia. Higher value of leaf area (79.8 cm^{-2}) was obtained with application of zinc at the rate of 75 kg ha^{-1}, while statistically similar leaf area (77.5 cm^{-2}) was obtained with application of zinc at the rate of 50 kg ha^{-1}, while minimum leaf area (63.4 cm^{-2}) was recorded in control plots.

The interaction between zinc and boron revealed that increasing boron level up to 10 kg ha^{-1} increased leaf area with increase 90.3 kg ha^{-1} in zinc levels, while further increase in boron level decreased the leaf area with increasing or decreasing zinc level.

Boron significantly enhanced leaf area, plant height and number of leaves as well as flowers. These results are line with Sharma et al [11]. They reported that vegetative growth of gladiolus flower was significantly enhanced through foliar application of boron. Foliar zinc have significantly affected leaf area which might be due the fact that zinc activated different types of enzymes which ultimately increased leaf area of zinnia and additionally zinc also increased vegetative growth while improve flower. These results are line with Tariq et al [12]. The foliar application of zinc and boron were significantly increases vegetative growth and size of spike of gladiolus plant [10].

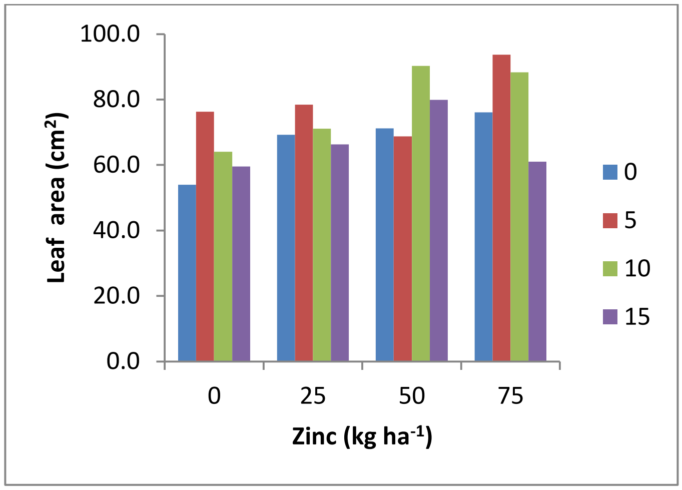

Fig. 1: Leaf area of zinnia as affected by zinc and boron

Number of leaves plant^{-1}

Number of leaves plant^{-1} as influenced by various levels of zinc and boron are presented in Table 1. Statistical analysis of the data showed that boron significantly affected the number of leaves plant^{-1}. Mean values of the data showed that more number of leaves plant^{-1} (95.3) were produced with application of 15 kg B ha^{-1}, which was statistically similar to the number of leaves plant^{-1} (94.8 and 93.3) recorded with application of 5 and 10 kg B ha^{-1} respectively. The minimum number of leaves was (85.6) were found in the plots where no boron was applied.

The number of leaves plant^{-1}was also significantly affected by different levels of zinc. The results indicated that maximum no of leaves plant^{-1} (99.8) were recorded with the addition of zinc at the rate of 75 kg ha^{-1}, while minimum number of leaves (80.2) were recorded in the control plots.

The interaction between zinc and boron was also significant for number of leaves plant^{-1}, which indicated that increasing boron level increased the number of leaves plant^{-1} with the application of zinc at high levels while there was more increase in the number of leaves with higher zinc levels 99.8 kg ha^{-1}.

Boron significantly enhanced leaf area, plant height and number of leaves and increases vegetative growth. These results are line with Sharma et al [11] who reported that vegetative growth of gladiolus flower was significantly enhanced with foliar application of boron. Foliar zinc application significantly affected number of leaves. Zinc might be activated different types of enzymes which increased the number of leaves and leaf area of zinnia flower and zinc also increased vegetative growth of flower. These results are line with Tariq et al [12]. The foliar application of zinc and boron were significantly increases vegetative growth and size of spike of gladiolus plant [10].

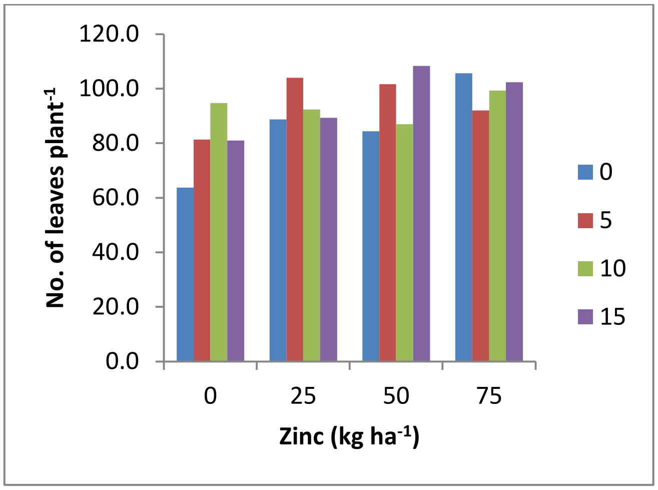

Fig: 2: Number of leaves of zinnia as affected by zinc and boron

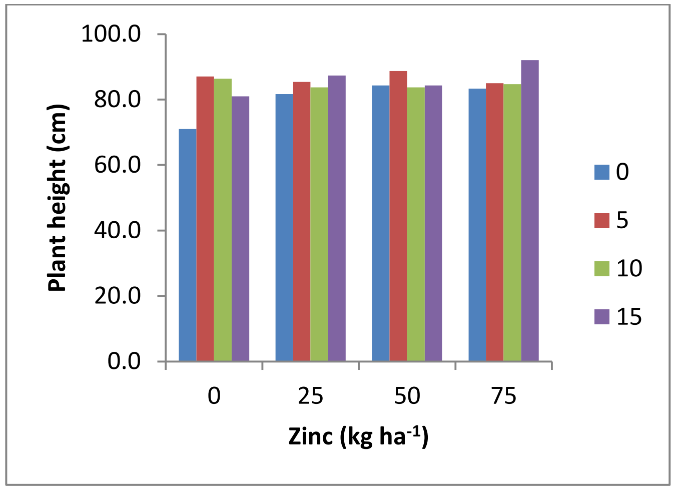

Fig. 3: Plant height of zinnia as affected by zinc and boron

Plant height (cm)

Analysis of the data showed that boron levels significantly affected plant height of the zinnia. Mean values of the data showed that taller plants (86.5 cm) were observed with application of 5 kg B ha^{-1}, which was statistically at par with plant who received 15 and10 kg B ha^{-1} respectively (86.2 and 84.6 cm) recorded with application of 15 and 10 respectively. The plant height was short (80.1cm) in control plots where no boron was applied (Table 1).

The plant height was also significantly affected by different levels of zinc. The results indicated that plants increase more high (86.3 cm) with the application of zinc 75 kg ha^{-1}, which was statistically at par with plant height (85.3 and 84.5 cm)obtained with 50 and 25 kg Zn ha^{-1}, while short plants (81.3 cm) were observed in plants with no zinc application (Table 1).

The interactive effect of zinc and boron was significant for plant height. The interaction effect indicated that increasing boron level increased the plant height (85.3 kg ha^{-1}) with increase in zinc level up to 50 kg ha^{-1} while further increase in zinc level did not increase the plant height (Fig. 3).

Boron significantly enhanced leaf area, plant height and number of leaves and increases vegetative growth. These results are line with Sharma et al [11] who reported that vegetative growth of gladiolus flower was significantly enhanced foliar application of boron. Zinc activated different types of enzymes which increased plant height of zinnia flower these results are line with Ambreen et al [13] who reported that zinc application significantly increased plant height of gladiolus flower. The foliar application of zinc and boron were significantly increases vegetative growth and size of spike of gladiolus plant [10].

Days to flowering

Analysis of the data showed that boron levels significantly affected plant height of the zinnia. Mean values of the data showed that control plots took more days (35.4 days) to flowering, while lesser days (32.2 days) to flowering were taken with application of boron at 5 kg ha^{-1} (Table 1).

Similarly the zinc levels also significantly affected the days to flowering as an early flowering (32.7 and 32.8 days) was observed with the application of the zinc at the rate of 75 and 50 kg ha^{-1} respectively, while more days (35.7 days) to flowering were taken by the control plots (Table 1).

The interaction of zinc between boron indicated that increasing boron levels delayed the flowering without application of zinc but the flowering was enhanced with increase in the levels of both zinc and boron. More days to flowering were taken with 75 kg Zn ha^{-1} and 15 kg B (fig 4).

Its might be due to boron and zinc application which delayed flowering with increasing boron and zinc rates activated enzymes and constantly increases vegetative growth, and delayed flowering with increasing levels of zinc and boron. These results are similar with Jat et al [14] who reported that zinc and boron significantly delayed flowering.

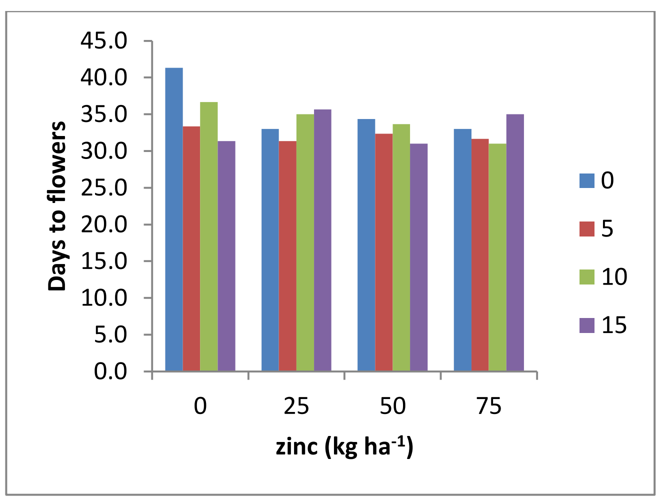

Fig. 4: Days to flowering of zinnia as affected by zinc and boron

Number of flowers plant^{-1}

Mean values of the data showed that more number of flowers plant^{-1} (16) was produced with application of 15 kg B ha^{-1}, which was statistically similar to the number of flowers plant^{-1} (14.8) recorded with application of 10 kg B ha^{-1}. The number of flowers was minimum (12.8) in the plots where no boron was applied (Table 1).

The number of flowers plant^{-1} was also significantly affected by different levels of zinc. The results indicated that maximum no of flowers plant^{-1} (15.2) were recorded with the addition of zinc at the rate of 25 and 50 kg ha^{-1} both, which was statistically similar with number of flowers (15) recorded with application of 75 kg Zn ha^{-1}, while minimum number of flowers (12.8) were recorded in the control plots (Table 1).

The interaction of zinc and boron was significant for number of flowers plant^{-1}. The interaction effect indicated that increasing boron level enhanced the number of flowers plant^{-1} with slight increase in zinc levels but increasing zinc level did not increase the number of flowers with increased boron levels (Fig. 5).

Its might be due to boron and zinc application increases number of flowers with increasing boron and zinc rates which activated enzymes and increases vegetative growth and number of branches so therefore more flowers were produced with increasing levels of zinc and boron these results are similar with Jat et al [14] who report that zinc and boron was significantly increases number of flowers.

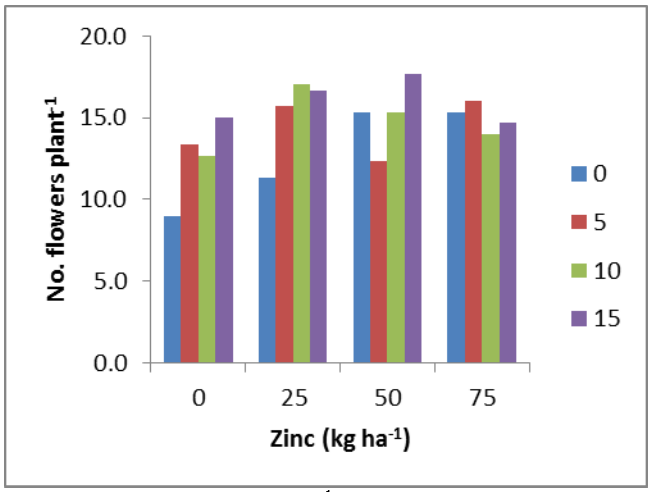

Fig. 5: Number of flower plant^{-1} of zinnia as affected by zinc and boron

Flower stalk length (cm)

Analysis of the data showed that the stalk length was significantly affected by different levels of zinc. The results indicated that longer stalk length (16.9 cm) was recorded with the application of zinc at the rate of 75 kg ha^{-1}, which was statistically at par with stalk length (16.4 and 16.1 cm) obtained with 50 and 25 kg Zn ha^{-1}, while stalk length was lower (13.3 cm) with no zinc application (Table 1).

The interaction between zinc and boron was significant for flower stalk length. The interaction effect indicated that increasing boron level beyond 5 kg ha^{-1} decreased the stalk length with increase in zinc level while the stalk length increase with application of 5 kg B ha^{-1} with lower level of zinc (Fig 6).

Flower stalk length was significantly enhanced by foliar boron and zinc. Number of flowers and flower stalk length increased with increasing boron and zinc levels which activated enzymes and increased vegetative growth and number of branches so therefore more flower stalk length was produced with increasing levels of zinc and boron. These results are similar with Jat et al [14] and Khalifa et al [15] who reported that zinc and boron was significantly increased flower stalk length.

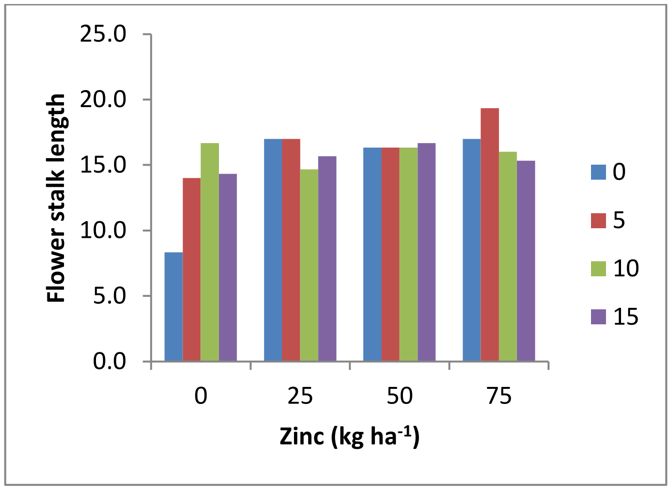

Fig 6: Flower stalk length of zinnia as affected by zinc and boron

Table 1: Leaf area, number of leaves plant^{-1}, plant height, days to flowering, number of flowers plant^{-1} and flower stalk length of Zinnia as affected by foliar application of boron and zinc

Boron (kg ha^{-1})	Leaf area (cm^2)	Number of leaves plant^{-1}	Plant height (cm)	Days to flowering	Number of flowers plant^{-1}	Flower stalk length
0	67.6 b	85.6 b	80.1 b	35.4 a	12.8 b	14.7 b
5	79.3 a	94.8 a	86.5 a	32.2 b	14.3 ab	16.7 a
10	78.4 a	93.3 a	84.6 a	34.1 ab	14.8 a	15.9 a
15	66.7 b	95.3 a	86.2 a	33.3 b	16.0 a	15.5 ab
LSD α 0.05	3.4	3.6	3.1	2.1	1.9	1.7
Zinc (kg ha^{-1})						
0	63.4 c	80.2 c	81.3 b	35.7 a	12.5 b	13.3 b
25	71.3 b	93.6 b	84.5 ab	33.8 a	15.2 a	16.1 a
50	77.5 a	95.3 b	85.3 a	32.8 b	15.2 a	16.4 a
75	79.8 a	99.8 a	86.3 a	32.7 b	15.0 a	16.9 a
LSD α 0.05	3.4	3.6	3.1	2.1	1.9	1.7

Flower size (cm)

The data regarding to the flower size in the Table 2 showed that flower size was significantly affected by boron and zinc application. The interaction between zinc and boron was non-significant. Flower size as influenced by various levels of zinc and boron are presented in Table 7. The data showed significant results regarding different boron levels. Mean values of the data indicated that boron applied at the rate of 10 kg ha^{-1} produced larger flowers (10.7 cm), which was statistically at par with the flower size (10.3 cm) obtained with 5 kg B ha^{-1} the smaller flowers (9.00 cm) were produced in control treatment.

Different zinc levels also considerably varied the flower size of zinnia. Larger flowers (10.7 cm) were produced in the plots treated with 75 kg Zn which was statistically similar with flower size (10.3 cm) observed with the application of

50 kg Zn ha^{-1}, while smaller flowers (9.00 cm) were observed in the control plots.

Flower size was significantly enhanced by foliar application of boron and zinc this may be due to boron and zinc which activated enzymes and increases flower size and reproductive growth so therefore higher flower size were produced more with zinc and boron these results are similar with Jat et al [14] who reported that zinc and boron significantly increases flower size.

Flower shelf life

The data showed that flower shelf life was significantly affected by boron and zinc application. The interaction between zinc and boron was also significant. Flower shelf life as influenced by various levels of zinc and boron are presented in Table 8. The results indicated that the effect of boron was significant on shelf life of flowers. Mean values showed that boron applied at the rate of 15 kg ha^{-1} have higher flower shelf life (7.8 days) while control plots have minimum shelf life (5.7 days).

Similarly the zinc levels significantly affect the flower shelf life. Shelf life was maximum (7.8 days) with application of 75 kg Zn ha^{-1} while shelf life was minimum (6.3 days) in control treatments.

The interaction of zinc and boron was significant. The interaction effect showed that increasing boron levels increased the flower shelf life with the increase in zinc level and vice versa (fig 7). Flower shelf life was significantly enhanced by foliar boron and zinc this may be due to boron and zinc rates which activated enzymes and increases flower shelf life and reproductive growth so therefore more flower shelf life were produced more with zinc and boron these results are similar with Jat et al [14] who reported that zinc and boron was significantly increases flower shelf life.

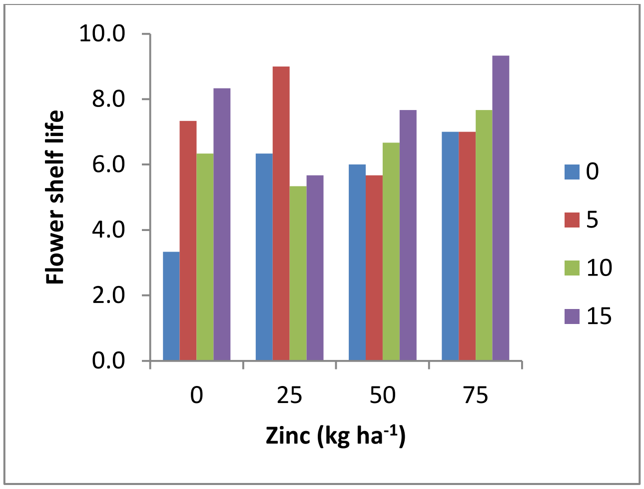

Fig. 7: Flower shelf life of zinnia as affected by zinc and boron

Number of root plant^{-1}

The data showed that number of roots plant^{-1} was significantly affected by boron and zinc application. The interaction between zinc and boron was non-significant. Number of roots plant^{-1} as influenced by various levels of zinc and boron are presented in Table 9. Statistical analysis of the data showed that boron levels significantly affected the number of root plant^{-1}. Mean values of the data showed that more number of root plant^{-1} (35.2) were produced with application of 15 kg B ha^{-1}, while the number of root was minimum (25.4) in the plots where no boron was applied.

The number of root plant^{-1}was also significantly affected by different levels of zinc. The results indicated that maximum no of root plant^{-1} (34.8) were recorded with the addition of zinc at the rate of 75 kg ha^{-1}, while minimum number of root (30.1) were recorded in the control plots and 25 kg Zn ha^{-1}. The interaction of zinc and boron was found non-significant for number of root plant^{-1}.

Zinc and boron have positive impact on number of roots, root length and root thickness due to enzymatic and significantly increases root length, thickness and number of roots with increasing zinc and boron levels these results are line with Ambreen et al [13] and Sharma et al [11].

Root length (cm)

The data showed that root length (cm) was significantly affected by boron and zinc application. The interaction between zinc and boron was non-significant. Root length (cm) as influenced by various levels of zinc and boron are presented in Table 10. The results indicated significant effect of boron on root length. Longer roots (23.5 cm) were formed with the application of baron at the rate of 10 kg ha^{-1}, while shorter roots (21.3 cm) were produced by control plots.

Similarly zinc levels significantly affect the root length of zinnia. Root length was higher (24.5 and 23.3 cm) with application of 75 and 50 kg ha^{-1} respectively, and shorter roots (20.5 cm) were formed in the control plots.

The interaction between zinc and boron was not significantly affected the root length of zinnia flower. Zinc and boron have positive impact on number of roots, root length and root thickness due to enzymatic and significantly increases root length, thickness and number of roots with increasing zinc and boron levels these results are line with Ambreen et al [13] and Sharma et al [11].

Root thickness (cm)

The data regarding to the root thickness (cm) is shown in the Table 2.The data showed that root thickness (cm) was significantly affected by boron and zinc application. The interaction between zinc and boron was also significant. Root thickness (cm) as influenced by various levels of zinc and boron are presented in Table11. Statistical analysis of the data showed that boron levels significantly affected the root thickness of zinnia. Mean values of the data revealed that roots were thicker (2.35 cm) with the application of boron at the rate of 10 kg ha^{-1} while minimum root thickness (2.12 cm) was recorded in the control plots.

Similarly the different levels of zinc significantly affect the root thickness of zinnia plant. Maximum root thickness (2.36 cm) was noticed in the plots treated with 75 kg Zn ha^{-1} while root thickness was lower (2.13 cm) in the control plots.

The interaction of zinc and boron significantly affect the root thickness and indicated that increasing boron level up to 10 kg ha^{-1} increased the root thickness with increase in zinc level while further increase in boron level decreased the root thickness with increasing zinc levels (fig 8).

Zinc and boron have positive impact on number of roots, root length and root thickness due to enzymatic and significantly increases root length, thickness and number of roots with increasing zinc and boron levels these results are line with Ambreen et al [13] and Sharma et al [11].

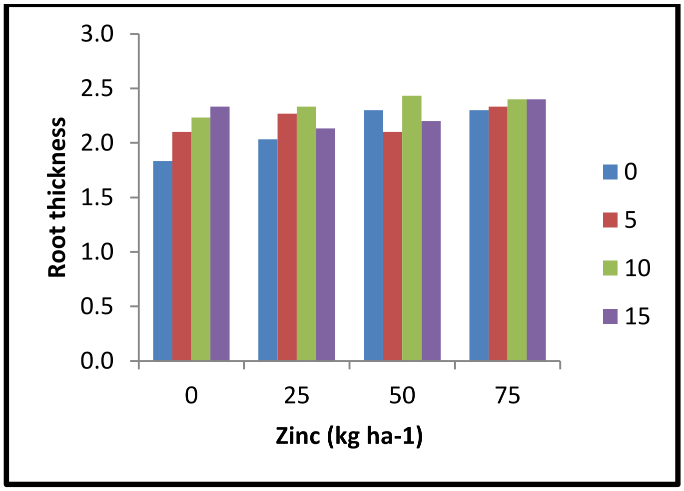

Fig. 8: Root thickness of zinnia as affected by zinc and boron

Table 2: Flower size, flower shelf life, number of roots plant^{-1}, root length and root thickness of Zinnia as affected by foliar application of boron and zinc

Boron (kg ha^{-1})	Flower size (cm)	Flower shelf life (Days)	Number of roots plant^{-1}	Root length (cm)	Root thickness (cm^2)
0	9.0 b	5.7 b	28.6 c	21.3 b	2.1 d
5	10.3 a	7.3 a	32.6 b	22.2 ab	2.2 c
10	10.7 a	6.5 b	33.0 a	23.5 a	2.4 a
15	9.9 ab	7.8 a	35.5 a	22.7 a	2.3 b
LSD α 0.05	1.15	1.05	2.6	1.5	1
Zinc (kg ha^{-1})					
0	9.0 b	6.3 b	31.8 b	20.5 b	2.1 d
25	9.9 ab	6.6 b	30.3 b	21.3 b	2.2 c
50	10.3 a	6.5 b	33.4 a	23.3 a	2.3 b
75	10.7 a	7.8 a	34.2 a	24.5 a	2.4 a
LSD α 0.05	1.15	1.05	2.6	1.5	1

CONCLUSION

Based on the experimental results the following conclusions were obtained;

Leaf area, number of leaves, plant height, flower size, flower shelf life and root observations performed better with foliar application of 15 kg B ha^{-1}. Leaf area, number of leaves, plant height, flower size, flower shelf life and root observations performed better with foliar application of 75 kg Zn ha^{-1}. Leaf area, number of leaves, plant height, flower size, flower shelf life and root observations performed better with foliar application of 15 kg B ha^{-1} with 75 kg Zn ha^{-1}.

On the basis of conclusion and experimental results, it is recommended that 15 kg B ha^{-1} and 75 kg Zn ha^{-1} was better for growth and development of Zinnia in Peshawar valley.

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