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RESPONSE OF BRINJAL (*Solanum melongena* L.) CULTIVARS TO ZINC LEVELS

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ABSTRACT

To assess the effect of different degrees of zinc to brinjal cultivars, an experiment was carried out at Horticulture Research Nursery, The University of Agriculture Peshawar during 2012. Two Factorial Randomized Complete Block Design (RCBD) was used in this experiment. Four levels of zinc (0, 0.1, 0.2, and 0.3%) were applied to three brinjal cultivars (Purple, Shimla, Shamli). Both cultivars and zinc levels proved significantly different among growth parameters. Plant height, number of leaves per plant, numbers of fruits per plant, fruit weight and total yield were significantly increased by zinc levels. Maximum plant height (131.89 cm), number of leaves per plant (437.78), number of fruits per plant (9.00), fruit weight (280.11 g) and total yield (15.33 t/ha) were recorded for plants treated with 0.2% zinc, while least number of leaves per plant (231.33), number of fruits per plant (5.33), fruit weight (143.89 g) and total yield (4.51 t/ha) were recorded in control treatments. Plant height, number of leaves per plant, number of fruits per plant, fruit weight and total yield was significantly different among cultivars. Maximum number of fruit per plant (7.42), fruit weight (210.583 g) and total yield (10.21 t/ha) were recorded for cultivar Purple. The growth and yield parameters indicates that cultivar Purple applied with 0.2% zinc showed best results and hence recommended for the brinjal growers in Peshawar valley.

Keywords: brinjal, zinc, plant height, yield.

1. INTRODUCTION

Brinjal or eggplant (*Solanum melongena* L.) belongs to family solanaceae and is mainly cultivated in sub-tropics and tropics. The major brinjal producing countries on the globe are India, Bangladesh, Pakistan, China, Cyprus, Egypt, Japan, Philippines, Syria and Western Europe (Anon., 2001a). Eggplant is a perennial but cultivated on commercial level as an annual crop. Plant is herbaceous, annual with erect or semi-spreading in nature. It is quite rich in terms of nutritional value. Plant nutrition plays a vital part for increasing yield and quality of brinjal. Eggplant yield can be booming on any good agricultural soil by using suitable management practices. A deep, fertile and well-drained sandy loam or silt loam soils, with a pH of 5.5 to 6.8, and rich with organic content are advantageous for eggplant cultivation (Kiran, 2006). The three primary nutrients (N, P, K) are of greater importance in plant growth and development. Nitrogen is responsible for various metabolic processes viz., cell division, photosynthesis, protein synthesis and expansion of shoot and root development in plants and also facilitate vegetative growth. Phosphorus is main constituent of nucleoproteins, concerned with high energy transfer compounds such as ATP and plays a vital role in energy transfer in the metabolic processes. Potassium is responsible for regulation and continuation of electrochemical equilibrium in cells and other parts and activation of enzymal activities (Kiran 2006). Besides the major nutrients, micronutrients also have a good role in plant growth. The most important sources of micronutrients are parent substances, sewage sludge, town refuse, fungicides (Nafees *et al*. 2009) and farmyard manure that are available in small amount in soil (Awad and Romheld, 1993). Micronutrients like iron, zinc and boron are necessary for plant development and metabolism. Plants take zinc in the ionic form (Zn^{++}) or in a complex type with a chelating substance e.g., EDTA. Salts or complexes of zinc can be simply absorbed straightly through leaves. Foliar spray of micronutrients facilitates efficient consumption of nutrients straightly through leaves, the effect of which can show its importance soon (Kiran, 2006). The principle role of zinc in plants is a metal activator of enzymes. The symptoms of zinc deficiency are visible generally in younger leaves, starting from inter-veinal chlorosis resulting to a decrease in shoot development and shortening of internodes, mottle leaf, little leaf etc (Kiran,2006). The varieties of *Solanum melongena* L. exhibits a great range of fruit shape and appearance from oval (egg shaped) to long club shaped. In terms of colour, from white, yellow, green, through degrees of purple pigmentation to black. Tropical Chinese and Indian types were established for commercially important varieties. The fruit production of brinjal per unit area is very less in Pakistan as compared to western countries. Studies have shown the beneficial effects of chemical fertilizers, bio fertilizers and micronutrients on growth, fruit yield, seed yield and quality in solanaceous crops. The concentrated crop cultivation needs the use of micronutrients application (Kiran, 2006). Keeping in view the importance of brinjal cultivars and zinc the present field trial was conducted at Horticulture Research Nursery,

the University of Agriculture Peshawar to achieve the subsequent aims.

a) To find out the optimum level of zinc for better growth and yield of brinjal.
b) To select the best cultivar of brinjal for Peshawar growers.

2. MATERIAL AND METHODS

An experiment entitled "Response of brinjal (*Solanum melongena* L.) cultivars to zinc levels" was conducted at Horticultural Research Nursery, The Agricultural University Peshawar in summer 2012.

2.1 Nursery rising

Seeds of three brinjal cultivers (shimla, shamli, and purple) were sown in pots. Pots were irrigated and cultural practices were carried out.

2.2 Soil analysis

Soil samples were collected from the field chosen for the experiment, before plantation. The collected samples were analyzed to evaluate the fertility condition of field. The results of soil fertility status before plantation are as follows.

determination	**Zinc** (ppm)	**Lime** (%)	**pH**	**EC Dms^{-1}**	**Texture**
Quality	2.022	11.4	7.89	0.33	Silty loam

2.3 Land preparation

The field (61.74 m^2) selected for experiment was ploughed well before plantation with FYM @ 25 tones ha^{-1}. Phosphorus and potash @ 50 kg ha^{-1} were thoroughly mixed with soil after first ploughing and nitrogen @ 100 kg ha^{-1} with two split doses, half dose was applied basely and the reminder of nitrogen was top dressed after two weeks of transplantation. Ridges were made manually with a space of 70 cm and 35 cm between plants.

2.4 Transplantation

The transplants of equal height and vigor of each cultivar were transplanted on raised beds. Subsequent irrigation was done when required. During the growing season of the crop, normal agronomic practices i.e. hoeing, weeding etc. were carried out during the experiment.

2.5 Experimental design and treatments

The two factor Randomized Complete Block Design (RCBD) was used in the experiment. The two factors were zinc levels and cultivars. There were 12 treatments which were replicated three times.

FactorA:
Zinc levels (%)
Zn_0: 0% (control)
Zn_1: 0.1%
Zn_2: 0.2%
Zn_3: 0.3%
Factor B:
Brinjal cultivars:
C_1 :Purple
C_2 : Shimla
C_3:Shamli

The levels of zinc were applied as foliar spray after 40 days of transplantation.

Data was collected on the following parameters.

Survival percentage (%):

Survival percentage was calculated by following formula:

$$\text{Survival \% age} = \frac{\text{plants survived}}{\text{Total number of plants transplanted}} \times 100 \quad (1)$$

Plant height (cm) (2)
Number of leaves plant^{-1} (3)
Days to flowering (4)
Days to fruiting (5)
Number of fruit plant^{-1} (6)
Fruit weight (gm) (7)
Total yield (tons ha^{-1}):

The yield in tons / ha was calculated with the following formula

$$\text{Yield (tons ha}^{-1}) = \frac{\text{Yield plot-1(tones)} \times 10000\text{m}^2}{\text{Plot Area (m}^{2})} \quad (8)$$

3. RESULTS AND DISCUSSIONS

The information concerning plant growth and yield were statistically analyzed and presented in Tables 1 to 8.

3.1 Survival percentage

Survival percentage was not considerably influenced by different zinc levels, cultivars and their interaction as shown in Table-1. However, the mean values for different doses of zinc revealed that highest survival percentage (93.65%) was recorded for control, while application of 0.2% zinc solution produced lowest survival (84.12%). Comparing the mean values for different cultivars maximum survival percentage, (92.86%) was recorded for cultivar purple while cultivars shamli and shimla had the minimum survival percentages i.e. 89.28% and 88.09%, respectively. The mean values for interaction revealed that maximum survival percentage (95.24%) was recorded for cultivar purple and shamli in control, Purple in plots receiving 0.1 %and 0.3% zinc and shimla in plots receiving 0.2%, respectively, followed by 90.47% for shimla with control, (90.47%) for shamli with 0.3% zinc, while minimum survival percentage (80.75%) was recorded for cultivar shimla receiving 0.2% zinc. Data for survival percentage was affected non significantly by different cultivars and zinc doses. The non-significant effect of cultivars and zinc levels might be because of seedbed optimal top soil wetness, which was approximately homogeneous for the treatments, somewhat than the ease of use of nutrients from soil. These consequences are in accordance with kiran *et al*. (2006)

who accounted insignificant effect of nutrient management on survival percentage of eggplants seedlings.

Table-1. Effect of zinc levels on survival percentage (%) of brinjal cultivars.

	Cultivars			
Level (%)	**purple**	**shimla**	**shamli**	**Mean**
0.0	95.24	90.47	95.24	93.65
0.1	95.24	95.24	85.71	92.06
0.2	85.71	80.95	85.71	84.12
0.3	95.24	85.71	90.47	90.47
Mean	92.86	88.09	89.28	

3.2 Plant height (cm)

The records concerning to plant height (cm) of brinjal cultivars are demonstrated in Table-2. The data statistical analysis revealed that different cultivars, zinc level and interaction had significant effects on plant height. The mean values of different doses of zinc showed that maximum plant height (131.89 cm) was recorded for plants treated with 0.2 % zinc, followed by (113.29cm) receiving 0.1% zinc whereas minimum plant height (102.02 cm) was counted in treatment having 0.3% zinc. Maximum plant height (133.73 cm) was recorded for cultivar shimla followed by (112.02 cm) for shamli while minimum plant height (94.26 cm) was recorded for cultivar purple. The interaction effects were also found significant. Highest plant height was recorded for cultivar shimla (145.87 cm) treated with 0.2 % zinc, whereas lowest plant height (74.85 cm) was recorded for cultivar purple in control treatment. Plant tallness is a role of the mutual effect of environmental influences, genetic makeup and nutritional condition of the soil. Information on the subject of plant tallness was appreciably influenced by cultivars and zinc levels. Plant height at maximum was noted for cultivar shimla while the lowest for purple. These variations in plant height among cultivars can be due to environmental influences or genetic makeup. Moreover, the tallest plant was observed with the application of 0.2 % zinc while shortest plant height was recorded from zinc level 4 (0.3 %) . the probable reason might be that zinc is involved in chlorophyll formation which might have favoured cell division, meristematic growth in apical tissue, enlargement of cell and synthesis of new cell wall (singh *et al*, 1989). These consequences are in line with the discoveries of Ingel *et al*. (2003), who accounted that tallest plant was observed with increase level of zinc.

Table-2. Effect of zinc levels on Plant height (cm) of brinjal cultivars.

	Cultivars			
Level (%)	**purple**	**shimla**	**shamli**	**Mean**
0.0	74.85	143.33	92.26	104.82
0.1	91.28	125.93	122.65	113.29
0.2	116.11	145.87	133.67	131.89
0.3	94.79	115.80	95.47	102.02
Mean	94.26	132.73	112.02	

3.3 Number of leaves plant^{-1}

The records concerning number of leaves per plant of brinjal cultivar are demonstrated in Table-3. The statistical analysis of the data revealed that different cultivars, zinc levels and interaction had significant effect on number of leaves plant^{-1}. The mean values of different doses of zinc confirmed that greatest number of leaves plant^{-1} (437.78) was proofed with 0.2% zinc, at the same time minimum number of leaves plant^{-1} (231.33) was evidenced from control treatment. The mean values intended for number of leaves plant^{-1} cleared that the highest number of leaves plant^{-1} (375.75) was counted for cultivar shamli where least number (273.42) was recorded for cultivar purple. The interaction effects were also found significant. The cultivar shamli at zinc level 3 (0.2%) produced highest number of leaves (538.33), where as lowest (107.33) number of leaves plant^{-1} were produced by cultivar purple with control treatment. Leaves are very important in plants due to its food manufacturing role in the presence of sunlight, which is necessary for plant growth and other metabolic activities. Information documented on number of leaves plant^{-1} was appreciably affected by different cultivars and levels of zinc. Upper most leaves plant^{-1} were found for cultivar shmali whereas minimum number of leaves plant^{-1} were documented for cultivar purple. This disparity possibly might be because of the varietal characteristics and environmental conditions. Highest numbers of leaves plant^{-1} were noted

at 0.2 % zinc while bare lowest number of leaves plant^{-1} were proved in control. The increase in number of leaves plant^{-1} might be because of the reality that zinc is involved in chlorophyll formation which might have favoured cell division, meristematic growth in apical tissue, enlargement of cell and synthesis of new cell wall (singh *et al;* 1989). These consequences are in concurrence with the discovery of J. Kiran *et al.* (2005- 06) who reported more number of leaves plant^{-1} with high dose of zinc.

Table-3. Effect of zinc levels on number of leaves plant^{-1} of brinjal cultivars.

	Cultivars			
Level (%)	**purple**	**shimla**	**shamli**	**Mean**
0.0	107.33	363.00	223.67	231.33
0.1	335.33	305.33	409.33	350.00
0.2	376.7	398.33	538.33	437.78
0.3	274.33	272.67	331.66	292.89
Mean	273.41	334.83	375.75	

3.4 Days to flowering

The statistical analysis exposed that cultivars, zinc levels and the interaction was non-significant as publicized in Table-4. However it is obvious from the mean value of different doses of zinc that maximum number of days to flowering (52.22) was recorded for plants treated with control treatment, followed by (51.67) receiving 0.1% zinc, while minimum number of days to flowering (51.33) was recorded for plants treated with 0.2% zinc. Comparing the mean values of different cultivars it is clear that maximum days to flowering (52.42)was recorded for cultivar shimla followed by (51.42) for purple while minimum days to flowering (51.25) was recorded for cultivar shamli. The interaction effect was found non-significant; however application of 0.1% zinc to cultivar shimla took highest number of days to flower (53.33). And also for cultivar shamli at control treatment. At the same time the smallest amount of days to flowering (50.00) was counted for cultivar shamli at 0.3% zinc. Data regarding days to flowering was found insignificant for zinc levels and cultivars. However, shimla took more days to flowering though least days were taken by purple and shamli which may be attributed to the varietal characteristic of these cultivars. Upper most amounts of days to flowering were recorded with control treatment while minimum with 0.2% zinc. The following consequences are in accordance with the results of Kiran (2006) who counted insignificant results of zinc on days to flowering.

Table-4. Effect of zinc levels on days to flowering of brinjal cultivars.

	Cultivars			
Level (%)	**purple**	**shimla**	**shamli**	**Mean**
0.0	52.00	51.33	53.33	52.22
0.1	51.00	53.33	50.67	51.67
0.2	50.67	52.33	51.00	51.33
0.3	52.00	52.67	50.00	52.56
Mean	51.42	52.42	51.25	

3.5 Days to fruiting

The statistical analysis exposed that cultivars, zinc levels and the interaction was non-significant as publicized in Table-5. However it is obvious from the mean values of different doses of zinc that maximum number of days to fruiting (62.22) was recorded for plants treated with 0.3% zinc, followed by (62.00) receiving control treatment, while minimum number of days to fruiting (60.33) was recorded for plants treated with 0.2% zinc. Maximum number of fruiting (62.50) was recorded for cultivar shimla followed by (61.17) for shamli while minimum days to fruiting (60.83) was recorded for cultivar purple. The interaction effect was found non-significant; however application of 0.3% zinc to cultivar shimla took highest number of days to fruiting (64.67). At the same time the smallest amount of days to fruiting (58.67) was counted for cultivar purple at 0.2% zinc. Data regarding days to fruiting was found insignificant for zinc levels and cultivars. However, shimla took more days to fruiting, followed by shamli though least days were taken by purple which may be attributed to the varietal characteristic of these cultivars. Upper most amounts of days to fruiting were recorded with 0.3% zinc while minimum with 0.2% zinc. The following consequences are not in accordance with the results of Kiran *et al* (2006)

which might be because of the difference in experimental methods and environmental conditions.

Table-5. Effect of zinc levels on days to fruiting of brinjal cultivars.

	Cultivars			
Level (%)	**purple**	**shimla**	**shamli**	**Mean**
0.0	61.67	60.33	64.00	62.00
0.1	61.33	63.00	60.00	61.44
0.2	58.67	62.00	60.33	60.33
0.3	61.67	64.66	60.33	62.22
Mean	60.83	62.50	61.17	

3.6 Number of fruits plant^{-1}

Table-6 is with reference to information on number of fruits plant^{-1}. Table-6 exposed that different zinc levels and cultivars and interaction produced significant influences on number of fruits plant^{-1}. Comparing the mean values for different doses of zinc showed that highest number of fruits plant^{-1} (9.00) was recorded for 0.2% zinc even as bare minimum number of fruits plant^{-1} (5.33) were counted in control treatment. Maximum number of fruits plant^{-1} (7.42) were recorded for cultivar purple followed by (6.5) for shimla and (6.25) were recorded for cultivar shamli. The interaction showed significant effect too .The cultivar purple produced upper most number of fruits plant^{-1} (10.67) at 0.2% zinc while minimum number of fruits plant^{-1} (4.67) were evidenced for shamli treated with control treatment. Data on the subject of fruits plant^{-1} was considerably affected by zinc levels and cultivars. Purple resulted in maximum number of fruits plant^{-1}, while shamli and shimla resulted in minimum, which might be because of the genetic makeup of these cultivars. Zinc at 0.2% recorded maximum fruits plant^{-1} at the same time as lowest amounts of fruits plant^{-1} were calculated in control plots. Comparable consequences were accounted by Sharma *et al.* (2008) and Ravichandran *et al*. (1995) who conducted experiments on brinjal supplied various zinc levels.

Table-6. Effect of zinc levels on number of fruits plant^{-1} of brinjal cultivars.

	Cultivars			
Level (%)	**purple**	**shimla**	**shamli**	**Mean**
0.0	6.00	4.67	5.33	5.33
0.1	7.67	5.33	5.67	6.22
0.2	10.67	8.00	8.33	9.00
0.3	6.00	6.67	6.33	6.33
Mean	7.42	6.50	6.25	

3.7 Fruit weight (g)

The records concerning the fruit weight of brinjal cultivars are demonstrated in Table-7. The statistical analysis of the records revealed that different cultivars, zinc levels and their interaction had significant effects on the fruit weight. The mean values of different doses of zinc showed that maximum fruit weight (280.11g) was documented for 0.2% zinc, at the same time as lowest (143.89g) was counted in control treatments. The greatest fruit weight (210.58g) was calculated for cultivar purple followed by (193.83g) for shamli while minimum fruit weight (180.42g) was recorded for cultivar shimla. The interaction was also found significant. The application of 0.2% zinc to cultivar purple produced the highest fruit weight that is (301.67g) although smallest fruit weight (130.33g) and (129.00) was counted for cultivar shimla with control and 0.1% zinc. Data on fruit weight was drastically influenced by cultivars and zinc doses. Greatest fruit weight was noted for purple whereas least fruit weight was noted for shimla. Highest fruit weight was calculated with the use of 0.2% zinc, even as least fruit weight from control treatments. These findings are in concord with Mallick and Muthukrishnan (1980) and Raj *et al*. (2001) who stated larger fruit weight with increasing zinc levels.

Table-7. Effect of zinc levels on fruit weight (g) of brinjal cultivars.

	Cultivars			
Level (%)	**purple**	**shimla**	**shamli**	**Mean**
0.0	150.67	130.33	150.67	143.89
0.1	215.00	129.00	148.00	164.00
0.2	301.67	263.00	275.67	280.11
0.3	175.00	199.33	201.00	191.78
Mean	210.58	180.42	193.83	

3.8 Total yield hectare^{-1}

Table-8 is with reference to information on yield hectare^{-1}. Table-8 exposed that different zinc levels, cultivars and their interaction significantly influenced the yield hectare^{-1}. Comparing the mean values of different zinc levels showed that maximum yield (15.33 t ha^{-1}) was recorded for plants treated with 0.2% zinc. At the same time as smallest amount of yield (4.51 t ha^{-1}) was recorded for plants in control treatment. Maximum yield (10.21 t ha$^{-1)}$ was recorded for cultivar purple followed by (8.33 t ha^{-1}) for cultivar shamli while minimum yield (7.73 t ha^{-1}) was recorded for cultivar shimla. The interaction effect was significant; the application of 0.2% zinc to cultivar purple (20.08 t ha^{-1}) produced the highest yield. While minimum yield (4.18 t ha^{-1}) was recorded for cultivar shamli treated with control treatment. Fruit yield is very important and its improvement through varietal or agronomic practices needs to be explored for the success of any crop. Highest yield was proved with zinc at 0.2% even as least amount was traced in control plots. In fact the augmentation in fruit yield was predicted for the reason that of the positive involvement of zinc in the direction of the number of yields contributing components such as number of leaves plant^{-1}, plant height, fruit weight and by producing more vigorous growth. These consequences are in concord with the discoveries of Kiran (2006) and Ravichandran *et al* (1995) who found higher fruit yield with zinc application.

Table-8. Effect of zinc levels on total yield ha^{-1} of brinjal cultivars.

	Cultivars			
Level (%)	**purple**	**shimla**	**shamli**	**Mean**
0.0	4.72	4.46	4.18	4.51
0.1	9.75	4.07	7.93	7.25
0.2	20.08	12.38	13.54	15.33
0.3	6.27	7.79	7.66	7.24
Mean	10.21	7.73	8.33	

4. CONCLUSION AND RECOMMENDATIONS

4.1 Conclusions

It is clear from the data that both zinc levels and cultivars were significantly different among growth parameters except survival percentage (%) days to flowering and days to fruiting. The results recorded showed that among zinc levels 0.2% zinc was competent in increasing growth and yield while in brinjal cultivars the performance of purple was found efficient as compared to the other cultivars used.

4.2 RECOMMENDATIONS

Following recommendations are made in the light of results obtained from the experiment.

For better growth and highest yield brinjal should be supplied with 0.2% zinc along with basic NPK dose (100, 50, 50 kg ha^{-1}).

On the basis of overall performance, the cultivar purple is recommended for the growers of Peshawar.

For general and validated zinc recommendations for brinjal a long term project using different cultivars and soil types should be made the first move.

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