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RESEARCH ARTICLE

EFFECT OF ZINC ON GROWTH AND YIELD OF TOMATO (*LYCOPERSICON ESCULENTUM CV.PUSA RUBY)*

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ABSTRACT

The field experiment was carried out at Rabi 2016-17 and 2017-18 at Research farm of Central Agricultural University, Imphal, Manipur. The experiment was laid out with four replications and four treatment, considering four levels each of zinc (0, 2.5, 5.0, and 10.0 Zn kg/ha in form of ZnSO4.7H2O). The results of experiment indicated that, application of different dose of Zn significantly increased plant growth and yield of tomato. The maximum plant height (cm), number of branches per plant, number of leaves per plant, first day flowering 29.83 days (first year) and 29.57 (second year), number of fruits per plant 27.90 (first year) and 28.76 (second year), fruit weight per plant 1.37 kg (first year) and 1.39 kg (second year) and fruit yield 50.69 (first year) and 51.54 (second year) t/ha were obtained in both the years under 10 Zn kg/ha.

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INTRODUCTION

Tomato is one of the major vegetable crops predominantly grown in the valley areas of Manipur both under irrigated and rainfed condition. Tomato fruits are very popular because of its high nutritive value and diversified use. Its food value is very rich because of higher contents of A, B, C vitamins and calcium (Bose and Some, 2002). Zinc (Zn) is another important essential micronutrient which helps in the formation of tryptophan, a precursor of IAA responsible for growth stimulation (Mallick and Muthukrishnan, 1979) and plays a vital role in synthesis of carbonic anhydrase enzyme which helps in transport of CO_2 in photosynthesis (Alloway, 2008). Zinc deficiency causes shorter and thinner internodes, stunted growth, appearance of chlorotic flecks on the older leaves and twisting of leaf borders in upward direction and plant with abnormal features (Passam *et al*., 2007). The zinc deficiency may be due to soil deficient in Zn, competition with Ca, Mn, Fe, P, to some degree K, and soil properties that influence Zn availability (Srivastava and Singh, 2003).

MATERIALS AND METHODS

In the present investigation the effect of Zinc nutrition use in the growth and yield of tomato, the experiment was laid out in Factorial randomized block design in the *Rabi* Seasons of 2016-17 and 2017-18, with four numbers of treatments of Zinc. Zinc was applied 0, 2.5, 5.0, 10.0 kg/ha which is replicated in three numbers. The initial studies of the soil has shown high in organic carbon (2.3%), acidity in character with pH of 5.4, clayin texture, deficient in Zinc (0.5 mg/kg), medium in Nitrogen (325.2 kg/ha), Phosphorus (18.5 kg/ha) and Potash (291 kg/ha). Ten plants of each plot of the experimental field were selected randomly for each treatment and their height (cm), number of branches per plant, number of leaves, fruit weight, number of fruits per plant, fruit yield/plant and fruit yield tonnes per hectare were recorded.

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RESULT AND DISCUSSION

Effect of zinc on plant height: Plant height (cm) of tomato plant as influence by different zinc treatments is given in Table 1. Plant height was recorded at 20, 40, 60 days after transplanting and at final harvest. Its graphical presentation has been shown in Fig. 1. The plant height (cm) increased significantly with the increased crop growth period. At 20 days after transplanting, the maximum 23.13cm in first and 26.90 cm in second year plant height was recorded in T_{13} (Zn_{10} B_0 kg per ha). While, the minimum 16.33 cm in first year and 19.27 cm in second year plant height was observed in treatment T_1 (Z_0B_0 kg/ha). In case of 40 DAT, significantly maximum 42.82 cm in first year and 44.27 cm in second year plant height was registered under T_{13} ($Z_{10}B_0$ kg/ha).

Table 1. Effect of zinc on height (cm)

Year	2016-17				2017-18				Pooled			
$ZnSO_4$ (kg/ha)	20 DAT	40 DAT	60 DAT	Final	20 DAT	40 DAT	60 DAT	Final	20 DAT	40 DAT	60 DAT	Final
Z_0	16.33	35.60	56.91	86.94	19.27	37.37	58.84	84.97	17.80	36.48	57.88	85.96
$Z_{2.5}$	19.57	40.06	62.58	92.31	21.67	40.53	63.84	94.96	20.62	40.30	63.21	93.64
$Z_{5.0}$	19.80	41.89	63.24	93.17	23.60	42.07	66.80	97.55	21.70	41.98	65.02	95.36
Z_{10}	23.13	42.82	65.75	94.14	26.90	44.27	69.18	98.72	25.02	43.55	67.47	96.43
S.E(D)±	0.59	0.66	0.67	0.68	0.49	0.70	1.07	1.38	0.40	0.55	0.60	0.86
C D 5%	1.20	1.30	1.37	1.40	1.01	1.43	2.18	2.82	0.82	1.12	1.22	1.76

Table 2. Effect of zinc on number of branches per plant

Year	2016-17			2017-18			Pooled		
$ZnSO_4$ (kg/ha)	20 DAT	40 DAT	60 DAT	20 DAT	40 DAT	60 DAT	20 DAT	40 DAT	60 DAT
Z_0	1.41	2.30	2.66	1.77	2.49	3.29	1.59	2.40	2.98
$Z_{2.5}$	1.48	3.67	3.34	1.97	3.24	3.74	1.72	3.45	3.54
$Z_{5.0}$	1.43	3.42	3.90	2.42	4.09	4.31	1.93	3.76	4.11
Z_{10}	2.38	3.84	4.33	2.63	4.43	4.50	2.50	4.14	4.41
S.E(D)±	0.14	0.12	0.13	0.11	0.15	0.14	0.10	0.12	0.10
C D 5%	0.28	0.24	0.26	0.23	0.31	0.29	0.19	0.24	0.20

Table 3. Effect of zinc on number of leaves per plants

Year	2016-17			2017-18			Pooled		
$ZnSO_4$ (kg/ha)	20 DAT	40 DAT	60 DAT	20 DAT	40 DAT	60 DAT	20 DAT	40 DAT	60 DAT
Z_0	13.99	24.42	32.38	15.93	24.13	32.38	14.96	24.28	32.22
$Z_{2.5}$	14.22	27.63	36.76	18.03	30.78	36.76	16.13	29.21	38.13
$Z_{5.0}$	18.56	30.39	40.31	18.33	35.25	40.31	18.45	32.82	42.46
Z_{10}	19.38	31.65	40.70	20.07	36.40	40.70	19.72	34.02	42.80
S.E(D)±	0.55	0.64	1.20	0.69	0.91	1.74	0.47	0.59	1.21
C D 5%	1.12	1.30	2.44	1.41	1.86	3.55	0.96	1.20	2.47

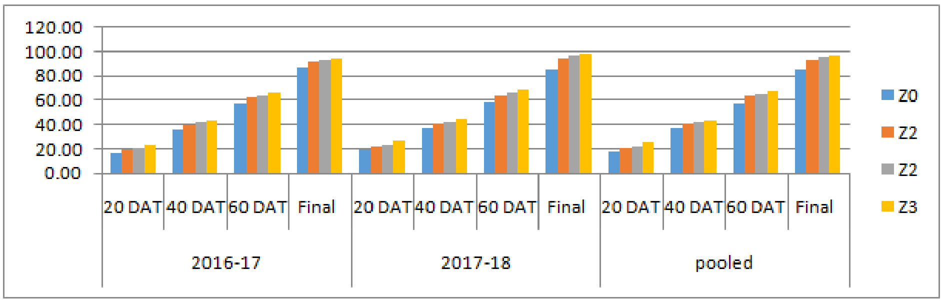

Fig.1. Effect of zinc on height (cm)

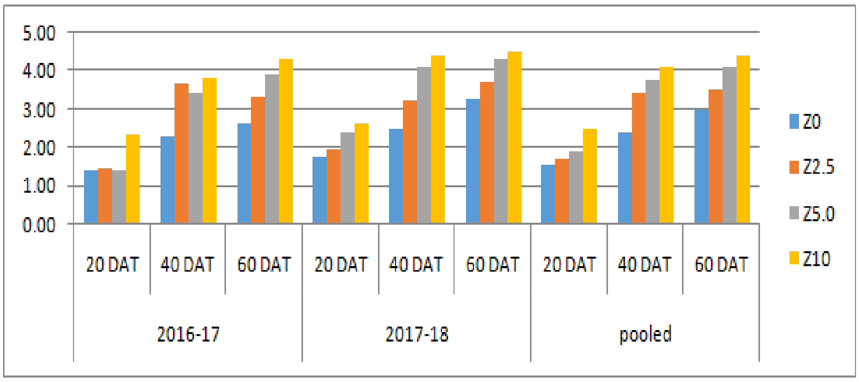

Fig.2. Effect of zinc on number of branches per plant

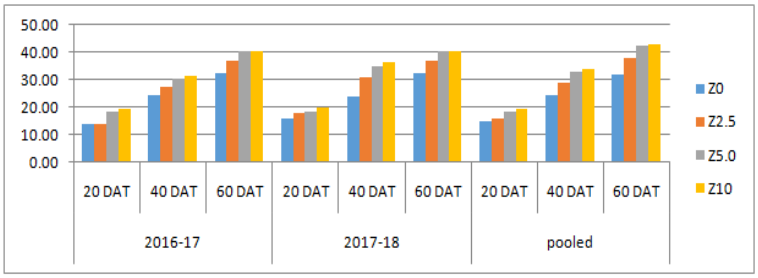

Fig. 3. Effect of zinc on number of leaves per plants

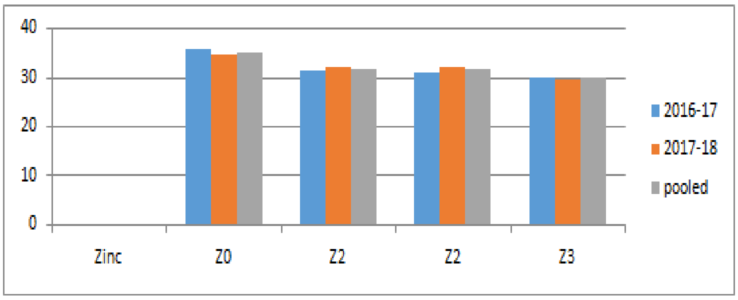

Fig. 4. Effect of zinc on first day flowering

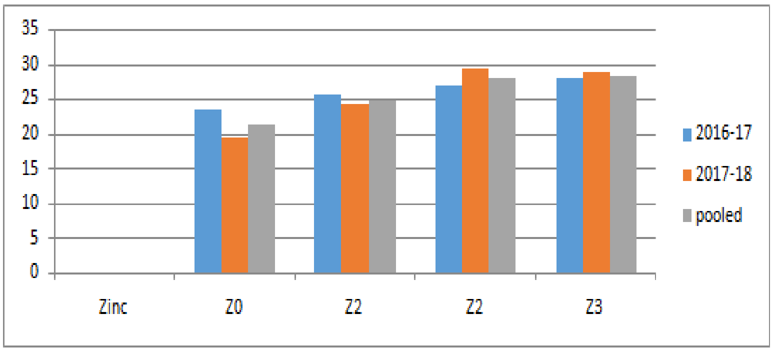

Fig. 5. Effect of zinc on number of fruits per plant

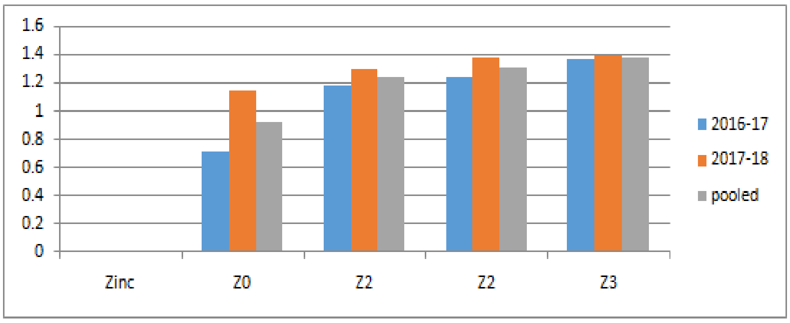

Fig. 6. Effect of zinc on weight of fruits per plants (kg)

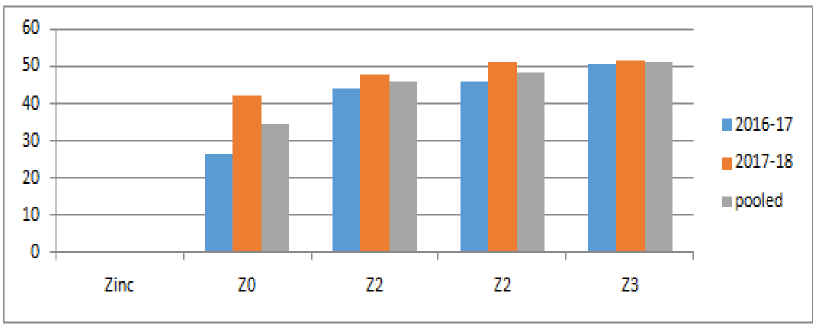

Fig.7. Effect of zinc on yield (t/ha)

Table 4. Effect of zinc on first day flowering

Zinc	2016-17	2017-18	Pooled
Z0	35.67	34.45	35.06
Z2	31.33	31.94	31.64
Z2	30.83	32.14	31.49
Z3	29.83	29.57	29.70
S.E(D)±	0.78	0.75	0.57
C D 5%	1.59	1.54	1.16

Table 5. Effect of zinc on number of fruits per plant

Zinc	2016-17	2017-18	Pooled
Z0	23.30	19.27	21.28
Z2	25.45	24.31	24.88
Z2	26.84	29.35	28.10
Z3	27.90	28.76	28.33
S.E(D)±	0.26	0.53	0.25
C D 5%	0.53	1.08	0.51

Table 6. Effect of zinc on weight of fruits per plants (kg)

Zinc	2016-17	2017-18	Pooled
Z0	0.71	1.14	0.93
Z2	1.18	1.30	1.24
Z2	1.23	1.37	1.30
Z3	1.37	1.39	1.38
S.E(D)±	0.04	0.04	0.03
C D 5%	0.08	0.08	0.06

Table 6. Effect of zinc on yield (t/ha)

Zinc	2016-17	2017-18	Pooled
Z0	26.39	42.18	34.29
Z2	43.78	47.94	45.86
Z2	45.63	50.79	48.21
Z3	50.69	51.54	51.12
S.E(D)±	1.43	1.53	0.97
C D 5%	2.93	3.12	1.99

However, minimum 35.60 cm in first year and 37.37 cm in second year plant height was observed in treatment T_1 (Z_0B_0kg/ha). As regards to 60 DAT, the treatments T_{13} ($Z_{10}B_0$ kg/ha) exhibited maximum plant height 65.75 cm and 69.18 cm respectively in both the years, as compared to other treatment. While, treatment T_1 (Z_0B_0 kg/ha) as control was recorded minimum 56.71 cm in first year and 58.84cm in second year. At final harvest, significantly maximum 94.14 cm and 98.72 cm plant height was registered in both the years with application of T_{13} ($Z_{10}B_0$ kg/ha). However, minimum 86.94 cm and 84.97 cm plant height was observed in both the years under treatment T_1 as control. The increase in plant height and number of leaves could be attributed to inter nodel elongation by cell division and synthesis of high photosynthesis due to recommended dose of NPK and micronutrients cations with the exception of zinc and there are capable of actions as 'electron carrier' in the oxidation-reduction in plant. The results uphold the finding of earlier studies made by makhansingh *et al*. (2003). On comparing the data of the two years, better performance was observed in the second year.

Effect of zinc on number of branches per plant: The number of branches per plant of different zinc treatments is given in Table 2. Number of branches per plant was recorded at 20, 40, 60 days after transplanting and at final harvest. Its graphical presentation has been shown in Fig. 2. The number of branches per plant of tomato increased significantly with the increased crop growth period. The treatments T_{13} ($Z_{10}B_0$ kg/ha) was recorded maximum 2.30 in first year and 2.63 in second year number of branches per plant as compared to other treatments. However, minimum 1.41 and 1.77 number of branches per plant was observed in both the year under treatment T_1 (Z_0B_0 kg/ha) as control at 20 DAT. In case of 40 DAT, significantly maximum 3.84 and 4.43 branches per plant was registered in both the years with application of T_{13} ($Z_{10}B_0$ kg/ha). While, it was minimum 2.30 and 2.49 branches per plant observed in both the years treatment T_1 (Z_0B_0 kg/ha) as control. The treatments T_{13} ($Z_{10}B_0$ kg/ha) was recorded maximum 4.33 in first year and 4.50 in second year number of branches per plant as compared to other treatments. However, minimum 2.66 and 3.29 number of branches per plant was observed in both the year under treatment T_1 (Z_0B_0 kg/ha) as control at 60 DAT.Zinc is essential for auxin and protein synthesis, Seed production and proper maturity of fruits. Increased vegetative growth might be due to residual effect of higher concentration of auxins in plant which produced high leaf, branches to fruit ratio ultimate cause of higher amount of photosynthates. These results are in contrary with that obtained by Balakrishnan (2000).

Effect of zinc on number of leaves per plant: The number of leaves per plant of different treatments of zinc is. As regards to 20 DAT, the treatment T_{13} ($Z_{10}B_0$ kg/ha) was recorded maximum 19.38 and 20.07 number of leaves per plant in both the years, minimum 13.99 and 15.93 number of leaves per plant was observed in both the years under treatment T_1 (Z_0B_0 kg/ha) as control. In case of 40 DAT given in Table 3. Number of leaves per plant was recorded at 30, 60, 90, 120 days after transplanting and at final harvest. Its graphical presentation has been shown in Fig. 3. The number of leaves per plant of tomato increased significantly with the increased crop growth period. Significantly maximum 31.65 in first year and 36.40 second year number of leaves per plant was registered in T_{13} ($Z_{10}B_0$ kg/ha). However, minimum 24.42 and 24.13 number of leaves per plant was observed in the both year under T_1 (Z_0B_0 kg/ha) as control. In case of 60 DAT, significantly maximum 40.70 and 44.89 number of leaves per plant was registered in both the years T_{13} ($Z_{10}B_0$ kg/ha). However, minimum 32.38 and 29.46 number of leaves per plant was observed in treatment T_1 (Z_0B_0 kg/ha) in both the years respectively. Increase in number of leaves per plant 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. These results are in harmony with the finding by singh*et al*. (1989).

Effect of zinc on first day flowering: The days to first flower initiation was recorded and have been presented in Table 4 and Fig. (4). The days to first flower initiation was significantly influenced due to various zinc doses. The earliest first flowering in 29.83 days (first year) and 29.57 (second year) was observed under treatment T_{13} ($Z_{10}B_0$ kg/ha), while, the late flowering 35.67 (first year) and 34.45 (second year) days was noted in treatment T_1 (Z_0B_0 kg/ha)as control. The following consequences are in accordance with the results of Bangali*et al*. (1993) who counted insignificant results of zinc on days to flowering.

Effect of zinc on number of fruits per plant: The number of fruits per plant was recorded treatment wise and the mean value are depicted in Table 5 and diagrammatically exhibited in Fig. 5. Data clearly indicated that (Table 4.8) the treatment T_{13} ($Z_{10}B_0$ kg/ha) was recorded the maximum 27.90 (first year) and 28.76 (second year) fruits per plant and was superior over other treatments, whereas the minimum 23.30 (first year) and 19.27 (second year) number of fruits per plant was found under treatment T_1 (Z_0B_0 kg/ha).Since, zinc is regulating the semi permeability of cell walls, thus mobilizes more water and metabolites into fruit which in turn has increased the yield. Similar observations were made by Prabu and Singaram (2001) in Muscat grapes.

Effect of zinc on fruits weight per plant (kg): The weight of fruit increased significant by the different treatments of zinc. The data on weight of fruit in different treatments is given in Table 6. Its graphical presentation has been shown in Fig. 6.
Significantly highest weight of fruit 1.37 kg (first year) and 1.39 kg (second year) was recorded in treatment T_{13} ($Z_{10}B_0$ kg/ha) as compared to other treatment. However, the lowest 0.71 kg in first year and 1.14 kg in second year was observed under the treatment T_1 (Z_0B_0 kg/ha) as control. This may be attributed to greater photosynthetic activity, resulting the increased production and accumulation of carbohydrates and favourable effect on vegetative growth and increased number and weight of fruits (sukanta *et al*., 2004).

Effect of zinc on yield per hectare: The data for the fruit yield per hectare. The fruit yield hectare^{-1} as affected by different treatment is presented in Table 7 and Fig. 7. Significantly maximum 50.69 (first year) and 51.54 (second year) t ha^{-1} fruit yield were recorded under the treatment T_{13} ($Z_{10}B_0$ kg/ha). While the lowest 26.39 and 42.18 t ha^{-1} fruit yield was obtained in the both the years under treatment T_1 (Z_0B_0 kg/ha) as control. This may be attributed to greater photosynthetic activity, resulting the increased production and accumulation of carbohydrates and favourable effect on vegetative growth and increased number and weight of fruits (sukanta *et al*., 2004).

Conclusion

Based on the findings of the investigation, it may be concluded that to improve tomato Growth and yield. Maximum plant height (cm), number of branches per plant, number of leaves per plant, first day flowering, number of fruits per plant, fruit weight per plant and fruit yield (t/ha) were obtained in both the years by the application of Zinc 10 kg/ha and RDF with vermicompost were congenial for clay soil of Manipur.

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