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Effect of zinc and manganese through foliar enrichment on growth and yield of potato (*Solanum tuberosum* L.)

MEHUL PARMAR, B. M. NANDRE AND YOGESH PAWAR*

Department of Vegetable Science,
College of Horticulture, S. D. Agricultural University,
Sardarkrushinagar-385 506 (Gujarat) India.

** yogesh517.pawar@gmail.com*

ABSTRACT

An investigation on effect of zinc and manganese through foliar enrichment on growth and yield of potato was laid out in Factorial Randomised Block Design with three replications during *rabi* 2012 at S.D. Agricultural University, Sardarkrushinagar. Total sixteen treatments were comprised of foliar application of Zn (0, 5, 10, 15 ppm) & Mn (0, 2, 4, 6 ppm). Results of present investigation revealed that significantly maximum plant height at 60 days after sowing (46.33 cm), plant height at 90 days after sowing (59.66 cm), early maturity (93.67 days) and yield attributes *viz*., highest number of tubers per plant (7.80), average weight of tubers (135.77 g), yield of tubers per plant (610. 43 g) and yield of tubers per hectare (417.61 q) were reported under the supplementation of Zn 15 ppm and Mn 6 ppm (Z_3 M_3).

Kew words: Growth, manganese, potato, yield, zinc

INTRODUCTION

In the past, agricultural production has witnessed significant achievements due to fertilizer application that results in greater rate of nutrient exhaustion and soil health problems. Regular depletion of nutrient resources from soils has led to emergence of several nutrient deficiencies. Most of the light textured soils of arid and semi-arid tracts are widely deficient in micronutrients especially Zn, Mn, B and Fe.

Potato is a very popular vegetable grown all over the world and is an important food crop of more than 150 countries in world. Potato popularly known as 'The king of vegetables' has emerged as fourth most important food crop in India after rice, wheat and maize.

In most of the productive bowls of the world, the yield levels of different crops are showing declining trends inspite of addition of sufficient quantity of fertilizers carrying macro and micro-nutrients. The efficiency of applied inorganic micronutrient is rather low due to their fixation in the soil. Zinc and Manganese are well known essential micronutrients which play important role in vegetative and reproductive cycle of plants. Zinc (Zn) is known to have an important role either as a metal component of enzymes or as a functional, structural or regulatory cofactor of a large number of enzymes (Grotz and Guerinot, 2006). Manganese (Mn) in turn, is regarded as an activator of many different enzymatic reactions and takes part in photosynthesis. Manganese activates decarboxylase and dehydrogenase and is a constituent of complex PSII-protein, SOD and phosphatase. Deficiency of Mn induces inhibition of growth, chlorosis and

necrosis, early leaf fall and low reutilization (Kabata-Pendias and Pendias, 1999). Quick compensation of nutrient deficiency and application of lesser rates and thus, reducing toxicity arises from excessive accumulation of elements and preventing nutrients fixation in the soil (Malakouti and Tehrani, 1999).

Potato crop has got immense potentiality for the cultivation in Gujarat and it ranking top in productivity with 30 t ha^{-1}. So, the present investigation entitled "Effect of zinc and manganese through foliar enrichment on growth and yield of potato" was planned and executed at College of Horticulture, S. D. Agricultural University, Sardarkrushinagar.

MATERIALS AND METHODS

Plant material

Kufri Badshah variety of potato was used in the study. The crop was tested in the field during *rabi* season 2012 at Horticulture Instructional Farm, S. D. Agricultural University, Sardarkrushinagar (India). The soil of experimental field was sandy loam textural class having pH and electrical conductivity 7.8 and 0.18 dsm^{-1} respectively. The fertility status of the experimental field was found to be low in organic carbon (0.17 %), low in available nitrogen (149 kg ha^{-1}), medium in available phosphorus (26 kg ha^{-1}) and available potash (287 kg ha^{-1}).

Farm Yard Manure(FYM) 25 t ha^{-1}, Recommended Dose of Fertilizer: 275: 140: 275 kg NPK per ha. The crop was grown in different plots keeping 45 cm and 15 cm distance between rows and with in rows, respectively. Recommended package of practices were followed to raise the crop.

Experimental materials

The experiment was comprised of Zn (0, 5, 10, 15 ppm) and Mn (0, 2, 4, 6 ppm). The treatments were supplemented with $ZnSO_4$ and $MnSO_4$ in three replications. Accordingly sixteen treatments were applied (Table 1).

Table 1. Details of different treatment of experiment; spraying at 30 days after sowing

Treat No.	Notation	Treatment details
T_1	$Z_0 M_0$	Zinc 0 ppm + Manganese 0 ppm ha^{-1}
T_2	$Z_0 M_1$	Zinc 0 ppm + Manganese 2 ppm ha^{-1}
T_3	$Z_0 M_2$	Zinc 0 ppm + Manganese 4 ppm ha^{-1}
T_4	$Z_0 M_3$	Zinc 0 ppm + Manganese 6 ppm ha^{-1}
T_5	$Z_1 M_0$	Zinc 5 ppm + Manganese 0 ppm ha^{-1}
T_6	$Z_1 M_1$	Zinc 5 ppm + Manganese 2 ppm ha^{-1}
T_7	$Z_1 M_2$	Zinc 5 ppm + Manganese 4 ppm ha^{-1}
T_8	$Z_1 M_3$	Zinc 5 ppm + Manganese 6 ppm ha^{-1}
T_9	$Z_2 M_0$	Zinc 10 ppm + Manganese 0 ppm ha^{-1}
T_{10}	$Z_2 M_1$	Zinc 10 ppm + Manganese 2 ppm ha^{-1}
T_{11}	$Z_2 M_2$	Zinc 10 ppm + Manganese 4 ppm ha^{-1}
T_{12}	$Z_2 M_3$	Zinc 10 ppm + Manganese 6 ppm ha^{-1}
T_{13}	$Z_3 M_0$	Zinc 15 ppm + Manganese 0 ppm ha^{-1}
T_{14}	$Z_3 M_1$	Zinc 15 ppm + Manganese 2 ppm ha^{-1}
T_{15}	$Z_3 M_2$	Zinc 15 ppm + Manganese 4 ppm ha^{-1}
T_{16}	$Z_3 M_3$	Zinc 15 ppm + Manganese 6 ppm ha^{-1}

The experiment was laid out in factorial randomized block design with three replications. The treatments were evaluated on the basis of growth characters like plant height, leaf area per plant at 60 days after sowing; yield attributes *viz.* days taken for maturity, number of tubers per plants, average weight of tuber (g), volume of tuber (c^3), yield of tuber per plant (g), yield of tuber per ha (q). Five plants from each net plot were tagged to record the data. The recorded data were subjected to statistical analysis using the analysis of variance technique (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

Growth and yield parameters

Growth and yield parameters were significantly influenced by foliar spray of Zinc and Manganese (Table 1 and 2). The maximum growth parameters *viz.* plant height at 60 DAS (43.50 cm), plant height at 90 DAS (57.40 cm), early maturity (95.08 days) and yield attributes *viz*., highest number of tubers per plant (7.08), average weight of tubers (133.50 g), yield of tubers per plant (564.57 g) and yield of tubers per hectare (389.84 q) were recorded in plants sprayed with Zinc 15 ppm (Z_3).

Due to metabolic role of Zn in synthesis of proteins, enzyme activation and metabolism of carbohydrate, utilization of fertilizers containing this element increase qualitative and quantitative performance of potato tubers. Due to shortage of Zn, performance and quality of potato would be decreased (Alloway, 2004). Numerous studies have reported that utilization of micronutrients is increasing performance and quality of potato tubers (Ranjbar and Malakoty, 2000; Mohamadi, 2000; Mousavi *et al*., 2007). Present results are in accordance with Jasim *et al.,* (2013), Horvat *et al.,* (2014) in potato.

Under the influence of various manganese levels, foliar application of Mn 6 ppm (M_3) produced maximum plant height at 60 DAS (43.20 cm), plant height at 90 DAS (56.75 cm), early maturity (96.00 days) and yield attributes *viz*.,

Table 2. Effect of zinc and manganese through foliar enrichment on growth and yield of potato

Treatments	Plant height at 60 DAS (cm)	Plant height at 90 DAS (cm)	Days to maturity	Number of tubers per plant	Average weight of tubers (g)	Yield of tubers per plant (g)	Yield of tubers per hectare (q)
Zinc (Zn)							
Z_0	40.99	55.00	97.75	5.82	130.50	532.63	359.96
Z_1	43.04	53.86	96.75	5.98	125.92	534.84	378.79
Z_2	41.29	55.64	97.08	6.30	133.17	546.70	383.96
Z_3	43.50	57.40	95.08	7.08	133.50	564.57	389.84
S.E.m±	2.093	0.529	0.294	0.067	1.905	8.575	3.175
C.D. at 5%	6.025	1.523	0.846	0.191	5.484	24.683	9.139
Manganese (Mn)							
M_0	40.82	53.68	97.92	6.13	127.17	530.10	373.49
M_1	42.36	54.88	96.50	6.18	129.08	541.57	374.13
M_2	42.44	56.58	96.25	6.29	130.17	547.79	380.78
M_3	43.20	56.75	96.00	6.58	136.67	559.27	384.15
S.E.m±	2.093	0.529	0.294	0.067	1.905	8.575	3.175
C.D. at 5%	6.025	1.523	0.846	0.191	5.484	24.683	9.139
S.E.m±	4.18	1.05	0.58	0.13	3.81	17.15	6.34
C.D. at 5%	12.05	3.04	1.69	0.38	10.96	49.36	18.27

highest number of tubers per plant (6.58), average weight of tubers (136.67 g), yield of tubers per plant (559.27 g) and yield of tubers per hectare (384.15 q). Deficiency of Mn induces inhibition of growth, chlorosis and necrosis, early leaf fall and low reutilization (Kabata-Pendias and Pendias, 1999). Several researches indicated a positive influence of micronutrient (Zn, Mn) application in increase of yield and quantitative parameters of crops (Mosavi *et al.,* 2007) on potato (Table 3)

Among various interactions effect Zn 15 ppm and Mn 6 ppm (Z_3 M_3) were reported better results with respect to growth and yield parameters. The maximum growth parameters *viz.* plant height at 60 DAS (46.33 cm), plant height at 90 DAS (59.66 cm), early maturity (93.67 days) and yield attributes *viz*., highest number of tubers per plant (7.80), average weight of tubers (135.77 g), yield of tubers per plant (610. 43 g) and yield of tubers per hectare (417.61 q).

Table 3 . Interaction effects of zinc and manganese through foliar enrichment on growth and yield of potato

Treatments	Plant height at 60 DAS (cm)	Plant height at 90 DAS (cm)	Days to maturity	Number of tubers per plant	Average weight of tubers (g)	Yield of tubers per plant (g)	Yield of tubers per hactare (q)
Z_0 M_0	40.12	53.83	100.67	5.77	119.67	492.52	345.43
Z_0 M_1	40.17	55.49	94.67	5.67	128.33	484.61	373.37
Z_0 M_2	42.35	55.95	95.33	5.80	127.00	542.28	341.77
Z_0 M_3	41.31	54.73	96.67	6.03	133.00	545.04	379.27
Z_1 M_0	43.80	52.13	96.33	6.00	133.67	499.95	386.93
Z_1 M_1	43.38	50.86	96.00	6.00	122.33	574.38	362.79
Z_1 M_2	41.50	55.58	97.00	5.97	130.67	504.03	368.08
Z_1 M_3	43.47	56.84	97.67	5.93	131.00	544.38	368.76
Z_2 M_0	41.63	52.75	98.33	6.17	136.33	532.37	392.39
Z_2 M_1	42.16	56.81	97.00	6.17	122.33	550.66	379.11
Z_2 M_2	43.87	57.91	96.33	6.30	128.33	589.47	386.63
Z_2 M_3	42.17	55.11	96.67	6.57	147.00	565.00	394.30
Z_3 M_0	43.89	56.01	95.67	6.57	126.67	543.62	377.72
Z_3 M_1	44.03	56.36	98.33	6.87	134.67	536.76	378.71
Z_3 M_2	45.07	57.57	96.33	7.10	135.67	599.42	397.37
Z_3 M_3	46.33	59.66	93.67	7.80	135.77	610. 43	417.61
S.E.m±	4.18	1.05	0.58	0.13	3.81	17.15	6.34
C.D. at 5%	12.05	3.04	1.69	0.38	10.96	49.36	18.27

Zn and Mn elements have significant role in synthesis of proteins, enzyme activation, oxidation and revival reactions and metabolism of carbohydrates. By utilizing of fertilizers contain above elements, performance on quality of crops is increasing and with shortage of this elements due to decline in plant photosynthesis and destroy RNA, amount of solution carbohydrates and synthesis of

protein decreased and then performance and quality of crop would decrease. Kelling and Speth (2001) reported that utilization of elements like Zn and Mn together from resource sulfate Zn and Mn increased efficiency and quality of potato crop. Mohamadi (2000) found that application of Zn along with Mn to from foliar application caused increase in efficiency and quality of potato crop.

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