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Influence of foliar supplementation of zinc and manganese on yield and quality of potato, *Solanum tuberosum* L

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ABSTRACT

An investigation on influence of foliar supplementation of zinc and manganese on yield and quality of potato was carried out in factorial randomized block design with three replications during Rabi 2012 at SD Agricultural University, Sardarkrushinagar. Total sixteen treatments comprised foliar application of Zn (0, 5, 10 and 15 ppm) and Mn (0, 2, 4 and 6 ppm). Results of present investigation revealed that the main effect of Zn 15 ppm and Mn 6 ppm was significantly superior with respect to various yield and quality attributes. Significantly highest tuber yield per plant (610. 43 g), tuber yield per hectare (417.61 q) and quality parameters viz reducing sugar (3.53%), non-reducing sugar (4.33%), total sugars (7.86%) and protein (2.60%) were recorded under the supplementation of Zn 15 ppm and Mn 6 ppm (Z_3 M_3).

Keywords: Manganese; zinc; potato; quality; yield

INTRODUCTION

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

Indian agricultural production heavily depends on fertilizer application which results in greater rate of nutrient collapse and soil health problems. Regular depletion of nutrient resources from soils has led to emergence of several nutrient deficiencies. Most of the Indian soils are widely deficient in micronutrients especially Zn, Mn, B and Fe. In most of the productive bowls of the world the yield levels of different crops are showing declining trends in spite of addition of sufficient quantity of fertilizers carrying macro and micronutrients. The efficiency of applied inorganic micronutrients is rather low due to their fixation in the soil.

Zinc (Zn) and Manganese (Mn) are well known essential micronutrients which play important role in vegetative and

reproductive cycle of plants. 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). 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 reduced 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 cultivation in Gujarat. The present study was conducted to investigate the influence of foliar supplementation of zinc and manganese on yield and quality of the crop.

MATERIAL and METHODS

Plant material

Kufri Badshah variety of potato was tested in the field during Rabi season 2012 at the Horticulture Instructional Farm, SD Agricultural University, Sardarkrushinagar. The soil of experimental field was sandy loam textural class having pH and electrical conductivity of 7.8 and 0.18 ds/m respectively. The fertility status of the experimental field was found to be low in organic carbon (0.17%) and available nitrogen (149 kg/ha) whereas medium in available phosphorus (26 kg/ha) and potash (287 kg/ha).

The crop was grown in plots with row to row distance of 45 cm and plant to plant distance of 15 cm. FYM (25 tons/ ha), recommended dose of fertilizers (275:140:275 kg NPK per ha) and recommended package of practices were applied to raise the crop.

The experiment comprised Zn (0, 5, 10 and 15 ppm) and Mn (0, 2, 4 and 6 ppm). The treatments were supplemented with $ZnSO_4$ and $MnSO_4$ in three replications. Accordingly sixteen treatments were applied (Table 1). Spraying was done at 30 days after sowing.

The experiment was laid out in factorial randomized block design with three replications. The treatments were evaluated on the basis of yield attributes viz tuber yield per plant (g), tuber yield per ha (q) and quality parameters viz reducing sugar (%), non-reducing sugar (%), total sugars (%) and protein (%). Five plants from each net plot were tagged to record the data. Protein was analysed by Lowry et al (1951) method. The recorded data were subjected to statistical analysis using the analysis of variance technique (Gomez and Gomez 1984).

Table 1. Details of treatments applied in the experiment

Treatment	Notation	Treatment details
T_1	Z_0 M_0	Zinc 0 ppm + Manganese 0 ppm/ha
T_2	Z_0 M_1	Zinc 0 ppm + Manganese 2 ppm/ha
T_3	Z_0 M_2	Zinc 0 ppm + Manganese 4 ppm/ha
T_4	Z_0 M_3	Zinc 0 ppm + Manganese 6 ppm/ha
T_5	Z_1 M_0	Zinc 5 ppm + Manganese 0 ppm/ha
T_6	Z_1 M_1	Zinc 5 ppm + Manganese 2 ppm/ha
T_7	Z_1 M_2	Zinc 5 ppm + Manganese 4 ppm/ha
T_8	Z_1 M_3	Zinc 5 ppm + Manganese 6 ppm/ha
T_9	Z_2 M_0	Zinc 10 ppm + Manganese 0 ppm/ha
T_{10}	Z_2 M_1	Zinc 10 ppm + Manganese 2 ppm/ha
T_{11}	Z_2 M_2	Zinc 10 ppm + Manganese 4 ppm/ha
T_{12}	Z_2 M_3	Zinc 10 ppm + Manganese 6 ppm/ha
T_{13}	Z_3 M_0	Zinc 15 ppm + Manganese 0 ppm/ha
T_{14}	Z_3 M_1	Zinc 15 ppm + Manganese 2 ppm/ha
T_{15}	Z_3 M_2	Zinc 15 ppm + Manganese 4 ppm/ha
T_{16}	Z_3 M_3	Zinc 15 ppm + Manganese 6 ppm/ha

RESULTS and DISCUSSION

Yield and quality parameters were significantly influenced by foliar spray of Zinc and Manganese (Table 2 and 3). The maximum yield attributes viz tuber yield per plant (564.57 g), tuber yield per hectare (389.84 q) and quality parameters viz reducing sugar (3.36%), non-reducing sugar (4.36%), total sugars (7.62%) and protein (2.57 %) 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 increases qualitative and quantitative performance of potato tubers. Due to shortage of Zn, performance and quality of potato decreases (Alloway 2004). Numerous studies have reported that utilization of micronutrients increases performance and quality of potato tubers (Mohamadi 2000, Mousavi et al 2007). Present results are in accordance with the findings of Jasim et al (2013) and Horvat et al (2014) in potato.

Under the influence of various Mn levels, foliar application of 6 ppm (M_3) gave maximum yield of tubers per plant (559.27 g) and per hectare (384.15 q) and best quality parameters viz reducing sugar (3.34%), non-reducing sugar (4.35%), total sugars (7.69%) and protein (2.53%). 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

Table 2. Influence of foliar supplementation of zinc and manganese on yield and quality of potato

Treatment	Tuber yield /plant (g)	Tuber yield /hectare (q)	Reducing sugar (%)	Non-reducing sugar (%)	Total sugars (%)	Protein (%)
Zinc (Zn)						
Z_0	532.63	359.96	3.23	4.24	7.47	2.44
Z_1	534.84	378.79	3.30	4.31	7.61	2.48
Z_2	546.70	383.96	3.17	4.32	7.49	2.47
Z_3	564.57	389.84	3.36	4.36	7.72	2.57
SEm±	8.575	3.175	0.031	0.034	0.042	0.079
$CD_{0.05}$	24.683	9.139	0.090	0.098	0.120	0.228
Manganese (Mn)						
M_0	530.10	373.49	3.21	4.28	7.49	2.41
M_1	541.57	374.13	3.22	4.35	7.57	2.51
M_2	547.79	380.78	3.29	4.24	7.53	2.51
M_3	559.27	384.15	3.34	4.35	7.69	2.53
SEm±	8.575	3.175	0.031	0.034	0.042	0.079
$CD_{0.05}$	24.683	9.139	0.090	0.098	0.120	0.228
Zn x Mn						
SEm±	17.15	6.34	0.06	0.067	0.083	0.15
$CD_{0.05}$	49.36	18.27	0.18	0.19	0.24	0.45

Table 3. Interaction effect of foliar supplementation of zinc and manganese on yield and quality of potato

Treatment	Tuber yield/ plant (g)	Tuber yield/ hectare (q)	Reducing sugar (%)	Non-reducing sugar (%)	Total sugars (%)	Protein (%)
Z_0 M_0	492.52	345.43	3.18	4.23	7.41	2.46
Z_0 M_1	484.61	373.37	3.33	4.22	7.55	2.45
Z_0 M_2	542.28	341.77	3.37	4.21	7.58	2.46
Z_0 M_3	545.04	379.27	3.32	4.28	7.60	2.47
Z_1 M_0	499.95	386.93	3.19	4.35	7.54	2.47
Z_1 M_1	574.38	362.79	3.04	4.43	7.47	2.47
Z_1 M_2	504.03	368.08	3.20	4.26	7.46	2.43
Z_1 M_3	544.38	368.76	3.25	4.38	7.63	2.53
Z_2 M_0	532.37	392.39	3.41	4.21	7.62	2.50
Z_2 M_1	550.66	379.11	3.38	4.34	7.62	2.53
Z_2 M_2	589.47	386.63	3.41	4.25	7.66	2.40
Z_2 M_3	565.00	394.30	3.24	4.42	7.66	2.33
Z_3 M_0	543.62	377.72	3.06	4.31	7.37	2.57
Z_3 M_1	536.76	378.71	3.13	4.41	7.54	2.43
Z_3 M_2	599.42	397.37	3.18	4.24	7.42	2.55
Z_3 M_3	610.43	417.61	3.53	4.33	7.86	2.60
SEm±	17.15	6.34	0.06	0.067	0.083	0.15
$CD_{0.05}$	49.36	18.27	0.18	0.19	0.24	0.45

micronutrients (Zn and Mn) application on yield and quantitative parameters of crops (Mousavi et al 2007) on potato. Among various interactions effect Zn 15 ppm and Mn 6 ppm (Z_3 M_3) resulted in the highest yield of tubers per plant (610.43 g), yield per hectare (417.61 q) and quality parameters viz reducing sugar (3.53%), non-reducing sugar (4.33%), total sugars (7.86%) and protein (2.60%). Zn and Mn have main role in synthesis of proteins, enzyme activation, oxidation, revival reactions and metabolism of carbohydrates. 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 as foliar application caused increase in efficiency and quality of potato crop.

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