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RESPONSE OF SOME VEGETATIVE GROWTH CHARACTERISTICS OF ORGANICALLY FERTILIZED POTATOES TO ZINC AND MANGANESE FOLIAR APPLICATION

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Abstract

A field experiment was conducted during spring season of 2012 in the field of horticulture and garden of engineering dept., college of agricultural engineering sciences, Baghdad University. To study effect of Response of some vegetative growth characteristics (Number of stems, Plant height and Dry weight of the vegetative total) of organically fertilized potatoes to zinc and manganese foliar application. The experiment was a factorial in randomized complete block design with three replication. Treatments were four foliar applications: Control T_0 (water), T_1 (60 mg L^{-1} Zn^{+2}), T_2 (30 mg L^{-1} Mn^{+2}) and mixture T_3 (60 mg L^{-1} Zn^{+2} + 30 mg L^{-1} Mn^{+2}) and their interactions with three stages of plant growth (vegetative growth stage, tuber initiation stage and tuber bulking stage). Results showed that Zn^{+2} and Mn^{+2} applications increased all plant parameters under study. The higher of valuable number of stems, plant height and dry weight of the vegetative total were 2.93 stalk plant^{-1}, 90.62 cm and 7.79 tan ha^{-1} respectively with Mixture solution application (Zn^{+2}+Mn^{+2}) compared to control and Zn^{+2} or Mn^{+2} applied. The interaction (foliar spraying Zn+Mn application date) was significant, foliar Spraying of Zn^{+2}+Mn^{+2} at vegetative growth stage increased mean weight of number of stems, plant height and dry weight of the vegetative total which were 3.03 stalk plant^{-1}, 90.83 cm and 8.87 tan ha^{-1} respectively, also its gave the highest mean of characteristics 3.06 stalk plant^{-1}, 100.89 cm and 9.68 tan ha^{-1}, respectively.

Key words: zinc, manganese, potato and foliar spraying.

Introduction

Potato is one of the foremost carbohydrate foods of human diet in the world. It is a good source of daily calorie needed for human because it provides many vital vitamins and nutrients including potassium, phosphorus, manganese, magnesium etc. (Moinuddin *et al*., 2017). Potato crop has important role in food security and must be increasing the attention for crop fertilization. In this target, the foliar application of fertilization has proven successful amend the needs nutrients to plant (Matloob *et al*., 2000). Iraq comes in the fourth place after Egypt, Algeria and Morocco in potatoes cultivation. Increased attention to cultivate potatoes during the last 2 decades and the cultivated area reached in 2009 to 33.000 ha and the production was 348.800 ton and at average of 10.6 ton ha^{-1} (Central Statistical Organization, 2009). Symptoms of micronutrient deficiencies clearly appear on cultivated plants in the Iraq soil because most of the macronutrient and micronutrients are failed in this soil. As micronutrients, boron (B), iron (Fe), zinc (Zn) and manganese (Mn) are concerned with nutrient management of potato (Moinuddin *et al*., 2017). Fertilizer application has important effects on the potato quality and yield (Westermann, 2005). Foliar fertilization has potential role in potato production (Jasim, 2013). Alloway (2008) pointed that the use of fertilizers containing zinc element lead to increase the quantity and improve the quality of potato tubers because the zinc activates enzymes and improve the carbohydrates and proteins manufacturing. Al-Fadhly (2016) has applied Zn+Mn spraying on potato plants and result significantly increasing in weight of tuber, mean tuber yield per plant and total tuber yield. Also, Al-Fadhly (2018) use Foliar application of Zn and Mn and the results indicates the highest rate of N and K concentration in

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potatoes tuber at vegetative stage and highest rate of K concentration at bulking stage. In this way, this study was planned to study the response of potato plants to foliar spraying with Zn and Mn at three stage of plant growth cultivated in soil fertilized with organic fertilizers.

Materials and Methods

Preparation of soil samples and experiment design

The current study was conducted in horticulture and garden of engineering department, college of agricultural engineering sciences, Baghdad University, Abu-Ghraib, Iraq at spring season 2017 under clay loam soil. The soil samples were taken from depth of roots and it analyzed before transaction as represented in table 1. The experiment was laid out in Randomized Complete Block with three replications. The treatments comprised of F_1 vegetative growth stage, F_2 tuber initiation stage and F_3 tuber bulking stage, with interactions four foliar application treatments: T_0 control spraying water only (without Zn or Mn), T_1 foliar application of 60 mg Zn L^{-1}, T_2 foliar application of 30 mg Mn L^{-1} and T_3 foliar application of (60+30 mg) Zn+Mn L^{-1}. The field was divided into three blocks, each block was divided to 12 experimental plots. The area of each experimental plot was 6.75 m^2 left a distance 1m between experimental plots and between blocks.

The compost mixture was composed from equal amount of waste cow, sheep and poultry with 50 ton (Al-Fadlly, 2011) and the mixture was added to all experimental units. The specifications of the produced compost were set out in table 2. Compost was added to each ridge after making slit in the top of ridges with 30 cm depth and 20 cm width then covered with soil.

Table 1: Some physical and chemical properties of soil sample for field experiment.

Property		Value	Unit
Soluble cation	Ca^{++}	8.40	C mol Kg^{-1}soil
	Mg^{++}	5.13	
	K^{+}	0.55	
	Na^{+}	3.93	
Available Nutrient Element	N	36.00	mg Kg^{-1}soil
	K	161.64	
	P	11.35	
	Mn	2.19	
	Zn	1.73	
CEC		26.80	C mol Kg^{-1}soil
SOM		18.20	g kg^{-1}soil
Carbonate minerals		182.50	
Gypsum		5.24	
EC		3.15	dS m^{-1}
pH		7.59	
Partialsize	Sand	171.50	g kg^{-1}soil
	Silt	512.64	
	Clay	315.86	
Texture		Silt clay loam	
Bulk density		1.36	g cm^{-1}

Table 2: Chemical analyses of organic manures used for compost production.

Property	Value	Unit
Ca	22.00	meq L^{-1}
Mg	11.00	
Mn	174.34	ppm
Zn	220.16	
Organic Matter	50.32	%
Organic C	325.00	g kg^{-1}
Organic N	19.90	
Organic P	11.99	
Organic K	17.46	
Humic	1.43	%
Volvic	0.19	
Human source	6.98	
C:N ratio	16.33	
pH (1:5)	6.30	
EC (1:5)	30.37	dS m^{-1}

Tubers barren class, in 18 January 2017, were sown in top of rides deeply at 10-12 cm depth, the distance between tubers was 25 cm. Sources of Zn and Mn were $ZnSO_4$, $7H_2O$ and $MnSO_4$, respectively. Treatment of S_1 sprayed in 9 April 2017, S_2 sprayed in 20 April and the S_3 sprayed in 1 May 2017. Irrigation of all experimental units was done as the standard recommendations. After maturation of the crop, weeds were cut. Tubers were harvested on 26 May 2017. Five plants from each experimental unit were obtained to calculate. Number of stems (stalk $plant^{-1}$), Plant height (cm) and dry weight of the vegetative parts (tan ha^{-1}).

Experimental Analyses

The properties of soil and compost were determined as recorded in the standard methods, soluble cations, available nutrient element and SOM were measured by Page *et al.*, (1982). Exchangeable cations of soil and carbonate minerals were measured (FAO, 1970). Bulk density and partial size of soil were measured by Black (1965), while pH, EC and gypsum were measured by Richards (1954).

Statistical analyses

All data were recorded as minimum 3 replicates and analyzed statistically through the analysis of variance (ANOVA) using SAS system (SAS, 2001) and comparison among the average was calculated using the LSD test at significance level of 0.05.

Results and Discussion

Data presented in table 3, showed that mean of number of plant stems was significantly increased as a result of plant spraying with mixture (60 mg L^{-1} Zn + 30 mg L^{-1} Mn) compared with the control treatment. It gave the highest value, 3.02 stalk $plant^{-1}$, in an increase of 10.62, 15.27 and 24.80% as compared to other treatments T_0, T_1 and T_2, respectively. Also, the results showed that mean of F_1 treatment gave the highest value of 2.93 stalk $plant^{-1}$ in an increase of 16.73 and 10.57% as compared to F_2 and F_3, respectively. The difference between spray applications was non-significant at F_2 and F_3 treatment. Effect of interactions between type of foliar and time of application were significantly in T_3 F_1 that gave the highest value 3.06 stalk $plant^{-1}$ in an increase of 35.40% compared with T_0 F_2 treatment (control without adding in tuber initiation stage) 2.26 stalk $plant^{-1}$.

Results in table 4, shows significant increments in mean of plant height, T_3 treatment was gave the highest value 90.83 cm compared with T_0, T_1 and T_2 treatments which has 89.54, 87.11 and 84.00 cm in an increase of 1.44, 4.27 and 8.13%, respectively. While, mean of plant height between T_2 and T_3 treatments were not significant. F_1 treatment gave the highest value of plant heights, it had 90.62 cm in an increase of 9.26% compared with F_2 treatment (82.94 cm), but, the mean of plant height between F_1 and F_3 treatments were not significantly, T_3 F_1 treatment was gave higher interactions values 100.89 cm in an increase of 26% compared with lowest interaction values T_0 F_2 was 80.07 cm.

Table 3: Effect of foliar application Zn, Mn and (Zn and Mn) gmL^{-1} on number of stems (stalk $plant^{-1}$).

Type of foliar / Time of APP.	T_0	T_1	T_2	T_3	mean
F_1	2.60	3.00	3.06	3.06	2.93
F_2	2.26	2.33	2.53	2.93	2.51
F_3	2.40	2.53	2.60	3.06	2.65
mean	2.42	2.62	2.13	3.02	
LSD. F= 0.23LSD.	T= 0.26		LSD. F×T= 0.46		

Table 4: Effect of Foliar Application Zn, Mn and (Zn and Mn) gmL^{-1} onplant height (cm).

Type of foliar / Time of APP.	T_0	T_1	T_2	T_3	mean
F_1	84.60	92.53	84.47	100.89	90.62
F_2	80.07	80.07	94.67	76.93	42.94
F_3	87.33	88.73	89.47	94.67	90.05
mean	84.00	87.11	89.54	90.83	
LSD. F= 1.64	LSD. T= 1.90		LSD. F×T= 3.28		

Table 5: Effect of foliar application Zn, Mn and (Zn and Mn) g L^{-1} on dry weight of the vegetative total (tan ha^{-1}).

Type of foliar / Time of APP.	T_0	T_1	T_2	T_3	mean
F_1	6.15	7.96	7.37	9.68	7.79
F_2	5.98	6.67	7.96	7.78	7.07
F_3	6.43	6.87	7.73	9.25	7.57
mean	6.17	7.17	7.69	8.87	
LSD. F= 0.60	LSD. T= 0.70		LSD. F×T= 1.21		

Data in table 5, shows the effect of zinc, manganese spraying separately and mixed, time of application, on dry weight of the total vegetative properties, T_3 treatment was given higher mean values 8.87 tan ha^{-1}, it was significant compared to other treatments. It increased by 43.76, 23.71 and 15.34% compared with T_0, T_1 and T_2, respectively. Also, data noted in table 5, the results of F_1 treatment statistical analysis showed that it was given higher significant values 7.79 tan ha^{-1} by increasing of 9.24 and 2.82% compared to F_2 and F_3 treatments, respectively. In case of dry weight of the vegetative properties between F_2 and F_3 treatments, it wasn't significant. Effect of interactions between type of foliar and time of application were significantly in T_3 F_1 that gave the highest value 9.68 tan ha^{-1} in an increase of 61.87% compared with T_0 F_2 treatment (control without adding in tuber initiation stage) 5.98 tan ha^{-1}.

These results are agreed to those recorded by previous authors (Henricksen and Molgaard, 2005, Jasim, 2013). Due to metabolic role of Zn in synthesis of proteins, enzyme activation and metabolism, zinc deficiency reduces the quality and performance of potatoes (Alloway, 2008). In other way, manganese has an important metabolic role in nitrate-reducing enzyme activity and activation of enzyme involved in carbohydrate metabolism thus its deficiencies decrease photosynthesis and thereby reducing crops yield and quality (Malakouti and Tehrani, 1999, Diedrick, 2010). The use of elements Zn and Mn together from its sulfate source increased efficiently and quality of potato crop (Kelling and Speth, 2001). The potato plants foliar with fertilizer contain high potash, caused improving in growth and tubers yield per unit area (Jasim, 2013).

Conclusion

From this research, we found the best spray solution on the vegetative total of the potato was the mixture of zinc with manganese (60 mg L^{-1} Zn^{+2} + 30 mg L^{-1} Mn^{+2}), and the best time to apply spraying in the stage of vegetative growth, although there is no significant difference compared to the stage of increasing the size of tubers.

References

AL-Fadlly, J.T.M. (2011). Effect of Organic and Mineral fertilizer on growth and yield of potato plants. Ph.D. Dissertation, Collage of Agric, Univ. of Baghdad.1-175.

Al-Fadhly, J.T.M. (2016). Response of Potato (*Solanum Tuberosum*) to Foliar Application of Zinc And Manganese Which Fertilized by Organic Fertilizer. *Journal of Agriculture and Veterinary Science*., **9(4) I:** 87-91.

Al-Fadhly, J.T.M. (2018). Concentration of N, P and K in potato tubers organically fertilized which sprinkled with Zn, Mn at different stage growth. R.J.P.B.C.S., **9(2):** 468-473.

Alloway, B.J. (2008). Zinc in soil and crop nutrition. International Zinc Association (IZA). Second edition, published by IZA and IFA Brussels, Belgium and Paris, France.1-135.

Black, C.A. (ed). (1965). Methods of Soil Analysis Agron. *J. Publisher Madison*., Wisconsin., USA. part I. 1572.

Central Bureau of Statistics (2009). The annual Statistical Symposium, Ministry of Planning, Republic of Iraq.1-117.

Diedrick, K. (2010). Manganese fertility in soybean production. *Pioneer Hi-Bred agronomy sciences.,* **20(14)**.

FAO (1970). Physical and chemical methods of soil and water analysis. Soils Bull. No. 10. *Food and Agriculture Organization.*, Rome, Italy.

Henricksen, C.B. and J.P. Molgaard (2005). The effect of timing of ridging on soil nitrogen and potato tuber yield quality. *Potato Res*., **32:** 81-89.

Jasim, A.H. (2013). Effect Of Foliar Fertilizer On Growth And Yield Of Seven Potato Cultivars (*Solanum Tuberosom* L.). Scientific Papers. *Series B, Horticulture*., **LVII:** 77-80.

Kelling, K.A. and P.E. Speth (2001). Effect of micronutrient on potato tuber and quality at Spooner. University of Wisconsin-Madis. www. Soils. Wisc. edu/ extension/ teachingmaterials/Micronutrient Defficiencies 2001/2001 micronutrientdef.ppt.

Matloob, A. al-Nasser, T.A.S. Mohammed and M.B.S. Salim (2002). Effect of potassium fertilization and spraying with boron on the vegetative growth and the amount of yield and quality potato class Desree. *J. of IPA of Ag. Sci*., **12(2):** 15-28.

Malakouti, M.J. and M.H. Tehrani (1999). Effect of micronutrient on the yieldand quality ofagricultural products: micro-nutrients with macro-effects. Tarbiat Modares University publication, Iran. *African Journal of Agricultural Research.,* **7(3):** 482-486.

Moinuddin, S.J., A.Sarkar and S. Dasgupta (2017). Response of potato (*Solanum tuberosum* L.) to foliar application of macro and micronutrients in the Red and Lateritic Zone of West Bengal. *Journal of Crop and Weed*., **13(1):** 185-188.

Page, A.L., R.H. Miller and D.R. Keeney (1982). Methods of soil analysis, 2. Chemical and microbiological properties, 2. Aufl. 1184 S., *American Soc. of Agronomy (Publ.)*, Madison, Wisconsin, USA.,733.

Richards, A. (1954). Diagnosis and Improvement of Saline and Alkali Soils. Agriculture handbook No. 60.USDA Washington. 841.

SAS (2001). User guide ststistic (Version 6-12). SAS Inst. Cary, N.C. USD.

Westermann, D.T. (2005). Nutritional requirements of potatoes. *Amer. J. Potato Res*., **82:** 301-307.