

Effects of Zinc and Phosphorus Levels on Yield, Nutrients Uptake and Zinc Recovery and Agronomic Efficiency in Potato

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Introduction: Potato production has fourth rank in the world after rice, wheat, and maize with the production of 321 million tons from 19.6 million hectares. In Iran this important crop has third rank after wheat and tomatoes with the production of 4.6 million tons. Potato is a temperate crop, growing and yielding well in cool and humid climates or seasons, but it is also cultivated in tropical to sub-polar climatic regions, and represents a major food crop in many countries. Potato is sensitive to nutrients deficiency especially phosphorus and zinc. At least one-third of the cultivated soils globally are estimated to contain too low amounts of bioavailable zinc for optimal crop production. In Iran more than 70 percent of irrigated soils suffer from zinc deficiency. Many reasons have role in mentioned deficiency such as calcareous and alkaline soils, lower organic carbon and higher application of phosphorus fertilizer. So, evaluation of zinc fertilizers efficiency is essential under different soil phosphorus conditions.

Materials and Methods: This project was carried out in order to investigate the effect of zinc sulfate levels on yield, nutrients concentration and zinc recovery and agronomic efficiency under different phosphorus conditions in potato (*Solanum tuberosum* L.) in Hamedan province (Tajarak station). The current research was done as a randomized complete block design with 9 treatments, three replications and three locations (with different soil phosphorus levels). The phosphorus locations were involved two locations with 10-15 mg available P per kg of soil (without or with phosphorus application) and a locations with 20-25 mg available P per kg of soil. Zinc treatments were consisted of soil application of 0, 20, 40, 60, 80, 100 and 120 kg of zinc sulfate ($ZnSO_4 \cdot 7H_2O$) per hectare and foliar spray of zinc sulfate at the rate of 5 grams per liter at one week before and one week after flowering. After harvesting, the tuber and shoot yield, tubers and shoot zinc uptake, nutrients concentration were measured in different parts of potato plant, and recovery and agronomic efficiency of applied zinc fertilizer were calculated.

Results and Discussion: The results showed that the zinc treatments significantly affected the tuber yield of potato. The application of 40 kg.ha⁻¹ zinc sulfate and foliar spray of Zn one week after flowering evidenced the highest and the lowest yield, respectively and the difference between these treatments were 17 percent. The differences between without Zn application and foliar spray of Zn one week after flowering were not significant on yield which showed that the time of fertilizer foliar application is very important and by delaying of foliar spray the yield could not increase. The zinc treatments affected significantly tuber zinc uptake and the foliar spray of Zn one week after flowering by 80 percent increase comparing with control, had the highest tubers zinc uptake. The tuber and shoot zinc concentration were significantly affected by the zinc sulfate levels. The highest and lowest concentration of zinc in shoot and tubers were observed in the foliar spray of Zn one week after flowering and control. This treatment caused 160 and 24 percent increasing in shoot and tubers zinc concentration in comparison with control. In spite of considered increase in zinc content by foliar application of zinc one week after flowering, the potato yield did not increase considerably. The tuber and shoot yield were affected significantly by different phosphorus locations ($p < 0.01$). Application of phosphorus or higher concentration of it's in soil increased tuber and shoot yield and decreased the most of measured nutrients concentration. So the interaction between phosphorus and most of measured nutrients were negative. Increasing of soil zinc fertilizer application decreased agronomic efficiency of it. The highest zinc agronomic efficiency was obtained in the foliar spray of zinc sulfate treatments (at the rate of 5 grams per liter) especially one week before flowering (6 times higher than the soil application of zinc treatments). Zinc recovery was lower than 2 percent for all soil applied zinc levels that increased up to 20 percent in the foliar spray of Zn levels. These results showed that most of applied zinc remained in soil and could be used by the next season's crops.

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Conclusion: To achieve the maximum yield of potato in similar soils and conditions, application of 40 kg zinc sulfate per hectare would be recommended. Under Application of phosphorus or higher concentration of it's in soil this recommendation must be increased.

Keywords: Foliar spray, Nutrients concentration, Potato tubers, Soil application

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