

# Effect of Zinc on the Reduction of Cadmium Uptake in Onion with Different P-fertilizer Rates

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## INTRODUCTION

Cadmium is a bio-toxic metal regarded as contaminant in agricultural soils because of the adverse effects it may pose to soil health, food quality and the environment. Cadmium and Zn are chemically similar, Cd can substitute Zn and metabolically function as Zn in plants (Cherati and Malakouti 2006). McLaughlin et al. (1994) found that adding zinc sulphate up to 100 kg ha<sup>-1</sup> before planting potatoes reduces Cd concentrations in tubers in South Australia. Other studies also demonstrated that adding Zn decreases Cd concentrations in edible parts (Chaudhary et al. 1994, Abdel-Sobour 1998, Malakouti et al. 2000). The aim of this study was to investigate the effects of Zn applications on Cd contamination in onion bulbs that is caused by P-fertilization.

## METHODS

To evaluate the effects of different levels of P and Zn fertilizers on yield and Cd concentrations of two onion cultivars (Red Ray and White Qom), a randomized complete block factorial experiment was carried out in Khosroshahr Research Station, East Azarbyjan province with 32 treatments and 3 replications, in 2004. Factor A was P rates (0, 100, 200 and 300 kg ha<sup>-1</sup> P<sub>2</sub>O<sub>5</sub> as triple super phosphate (TSP) with 32 mg ha<sup>-1</sup> Cd), and factor B was Zn rates (0, 5, 10 and 15 kg ha<sup>-1</sup> Zn using ZnSO<sub>4</sub>.5H<sub>2</sub>O). One third of the N-fertilizer and all other fertilizers were applied to the soil before planting according to soil tests. The remaining N-fertilizer was used in three split application at the 4, 6 and 8 leaves stages. Soil analysis results are shown in Table 1.

**Table 1. Chemical and physical characteristics of soils used to cultivate two onion varieties.**

Depth	pH	EC	TNV	OC	Clay	P	K	Fe	Zn	Cu	Mn	B
cm		dS/m	%	%	%				mg kg <sup>-1</sup>			
0-30	8.1	2.6	12	0.66	29	10	250	4.5	0.48	1.5	7.0	1.80
31-60	8.2	3.4	18	0.35	32	7	200	4.0	0.30	1.2	5.0	1.86

## RESULTS AND DISCUSSION

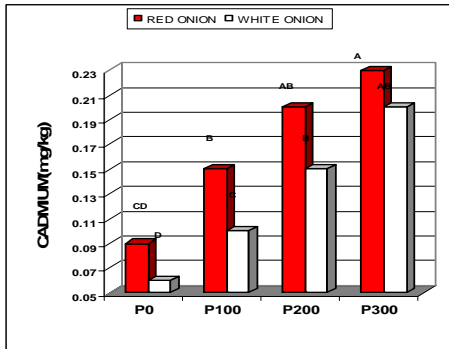
The results revealed that increasing the rate of P-fertilizer significantly increased onion yield and Cd concentrations. While onion yield and Cd concentration at P<sub>0</sub> were 40 t ha<sup>-1</sup> and 0.10 mg/kg<sup>-1</sup>, respectively, yield increased to 44.8 t ha<sup>-1</sup> and Cd increased to 0.23 mg kg<sup>-1</sup> at P<sub>300</sub>. This increase was mainly due to Cd content of TSP (Table 2). Results of the variation analysis for Zn applications showed that the effects of different Zn levels, namely increasing yield and reducing Cd concentrations in both onion varieties, were significant at the 1% probability level. While onion yield and Cd-bulb concentration at Zn<sub>0</sub> were 38 t ha<sup>-1</sup> and 0.36 mg kg<sup>-1</sup>, respectively, yield increased to 45 t ha<sup>-1</sup> and Cd-bulb concentration decreased to 0.23 mg kg<sup>-1</sup> at Zn<sub>15</sub> (Table 3). Altogether, increasing P concentrations led to an increase in Cd levels in onion bulbs of both varieties (Fig. 1). The highest concentration of Cd in bulbs was observed at the application of 300 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup>. On the contrary, Cd concentrations decreased and Zn content increased with increasing Zn-fertilizer rates (Fig. 2).

**Table 2. Effect of P-fertilizer on yield and Cd concentrations of onion bulbs.**

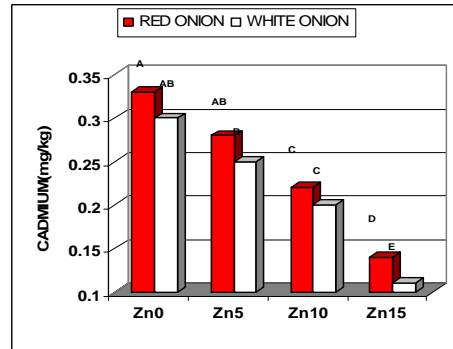
Applied P	Yield	Cd
kg ha <sup>-1</sup>	t ha <sup>-1</sup>	mg kg <sup>-1</sup> DW
0	40.0(c)	0.10(b)
100	42.0(b)	0.18(ab)
200	43.5(ab)	0.22(a)
300	44.8(a)	0.23(a)

**Table 3. Effect of Zn on yield and Cd concentrations of onion bulbs.**

Applied Zn	Yield	Cadmium
kg ha <sup>-1</sup>	t ha <sup>-1</sup>	mg kg <sup>-1</sup> DW
0	38(c)	0.36(a)
5	40(b)	0.28(b)
10	42(ab)	0.23(bc)
15	45(a)	0.20(c)



**Fig. 1. Effect of P-fertilizer rates on Cd concentration in two onion varieties**



**Fig. 2. Effect of Zn-fertilizer rates on Cd concentration in two onion varieties**

## CONCLUSIONS

Cadmium contamination in onion due to P-fertilizers may cause adverse health effects in humans. In the past five decades, Cd accumulation has increased in some soils and plants of Iran due to the use of Cd-contaminated P-fertilizers. In this study, applications of TSP with a high Cd content led to an increase of Cd concentrations in onion bulbs above a permissible level (0.20 mg kg<sup>-1</sup> DW). An increase of Zn concentrations in plant tissues, growth and development of plant cells may counteract Cd accumulation since Cd and P concentration in Zn-used treatments decreased possibly due to dilution. According to our results, it seems that an application of 50 kg ha<sup>-1</sup> P<sub>2</sub>O<sub>5</sub> with 15 kg ha<sup>-1</sup> Zn is suitable to have a favorable yield and low Cd contents. It is suggested to i) apply P-fertilizers based on soil test analyses with deep banding, ii) avoid P-fertilizers with higher Cd contents, and iii) practice a balanced fertilization including Zn applications especially in calcareous soils.

## REFERENCES

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