Foliar Selenate and Zinc Oxide Separately Applied to Two Pea Varieties: Effects on Growth Parameters and Accumulation of Macronutrients and Minerals in Seeds under Field Conditions

Maksymilian Malka[1], Gijs Du Laing[1], Alžbeta Hegedűsová[2], Torsten Bohn[3]

[1]Ghent University, Faculty of Bioscience Engineering, Department of Green Chemistry and Technology, Laboratory of Analytical Chemistry and Applied Ecochemistry, Coupure links 653, B-9000 Gent, Belgium

[2]Institute of Horticulture, Faculty of Horticulture and Landscape Engineering, Slovak University of Agriculture in Nitra, Tr. A. Hlinku 2, 94976 Nitra, Slovakia

[3]Luxembourg Institute of Health, Department of Precision Health, Nutrition and Health Research Group, 1 A-B, Rue Thomas Edison, L-1445 Strassen, Luxembourg

maksymilian.malka@ugent.be, gijs.dulaing@ugent.be, alzbeta.hegedusova@uniag.sk, torsten.bohn@lih.lu

Background

- The deficiency of selenium (Se) and zinc (Zn), two essential nutrients for human health[1-4], affects up to 15% and 17% of the global population, respectively[5,6].
- Foliar Se/Zn application (agronomic biofortification) is a highly effective method of plant biofortification[7,8].
- Pea (*Pisum sativum* L.) is an important legume and staple crop grown globally and employed for animal and human consumption due to its high protein and micronutrient concentrations[9-12].

Objectives and Methods

A field experiment (2014) was conducted in Nitra (Slovakia) to examine effects of foliar-applied sodium selenate (0/50/100 g Se/ha) and zinc oxide (0/375/750 g Zn/ha) at the flowering stage on two pea varieties (Ambassador, Premium). Parameters of growth and concentrations of soluble solids, protein, Se, Zn, Fe, Cu, Mn, Mo, Ca, Mg, K, and Na were assessed in seeds.

Seed analyses

- Concentration of soluble solids: handheld digital refractometer[13]
- Protein concentration: Dumas method[13]
- Concentrations of Se, Zn, Fe, Cu, Mn, Mo, Ca, Mg, K and Na: ICP-MS[13]

Statistical analysis: linear mixed models (SPSS, vs. 19)

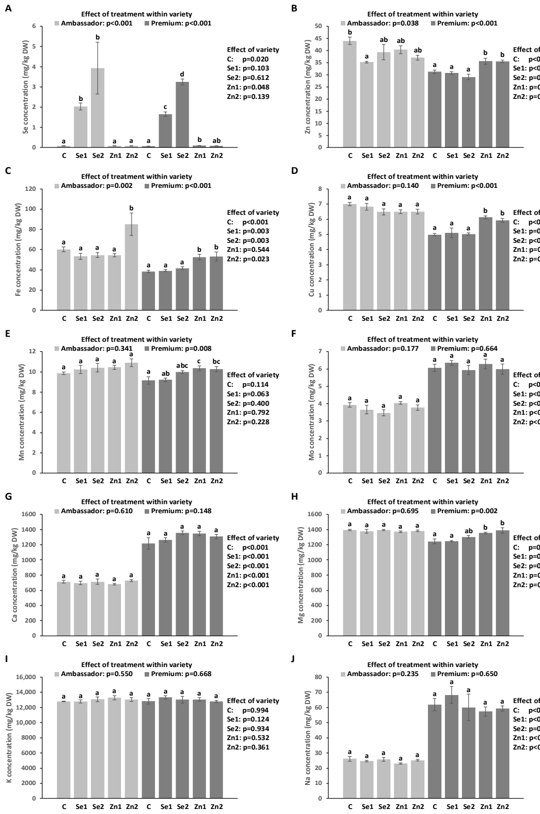

Figure 1. Foliar-applied Se and Zn and variety affect the concentration of Se (A), Zn (B), Fe (C), Cu (D), Mn (E), Mo (F), Ca (G), Mg (H), K (I), and Na (J) in seeds. C (control): without Se and Zn; Se1: 50 g; Se2: 100 g; Zn1: 375 g; Zn2: 750 g; all per ha; mean SD; n = 4. Bars that do not share an identical lower letter differ significantly within variety. p-values on the right part of the graph display the impact of treatment across varieties (Ambassador compared to Premium).

Results

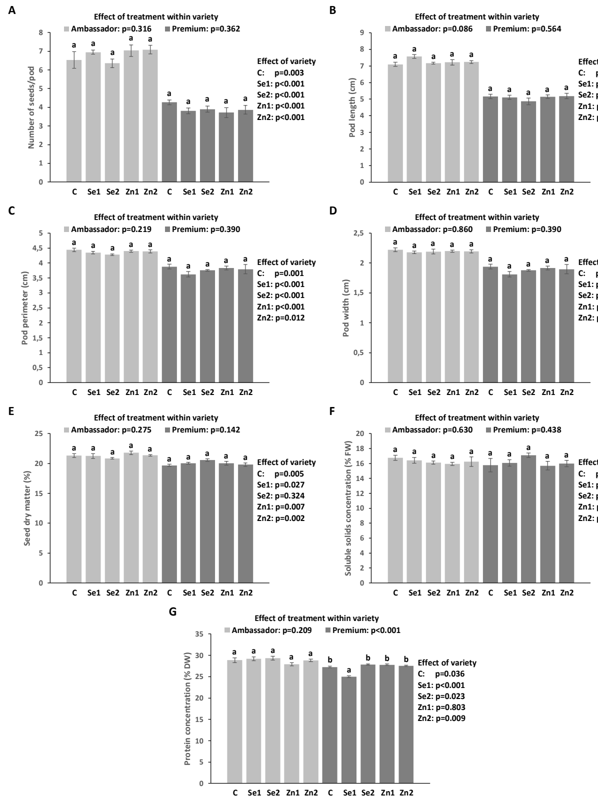

Figure 2. Impact of foliar Se and Zn treatments and variety on the number of seeds/pod (A), pod length (B), pod perimeter (C), pod width (D), seed dry matter (E), and concentrations of soluble solids (F) and protein (G) in seeds. C (control): no applied Se and Zn; Se1: 50 g; Se2: 100 g; Zn1: 375 g; Zn2: 750 g; all per ha; mean SD; n = 4 replicates. Bars without identical lower letters differed significantly within variety. p-values given on the right part of the graph indicate the impact of treatment across varieties (Ambassador compared to Premium).

Figure 3. Field experiment with peas conducted in Nitra (Slovakia).

Conclusions

- Selenate enhanced the accumulation of Se in the two seed varieties dose dependently. Selenium concentration was highest in seeds of Ambassador exposed to 100 g of Se/ha (3.93 mg/kg DW compared to the control (0.08 mg/kg DW), $p < 0.001$).
- 375 g of Zn/ha (35.7 mg/kg DW) and 750 g of Zn/ha (35.5 mg/kg DW) significantly and similarly enhanced Zn concentrations vs. the control (31.3 mg/kg DW) in Premium seeds, $p < 0.001$.
- Zinc oxide also improved accumulations of Fe, Cu, Mn, and Mg in Premium seeds.
- Se/Zn treatments did not significantly affect growth parameters and accumulations of soluble solids and protein in seeds.
- Consuming 33 g/d of pea biofortified with Se at 50 g/ha and 266 g/d of pea biofortified with 375 g of Zn/ha could provide 100% of the RDA for Se (55 µg) and Zn (9.5 mg) in adults, respectively.

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