The effect of various doses of Cd on productive features and quality of wheat

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Background

Similarly to the other heavy metals, cadmium (Cd) is in higher concentrations toxic to all living organisms, including plants. The main path by which Cd enters food chain is by the food of plant origin. Therefore, we set experiments to examine to which extent Cd to which wheet grain was exposed during imbibition before sowing, can affect later plant growth and Cd content in harvested grain.

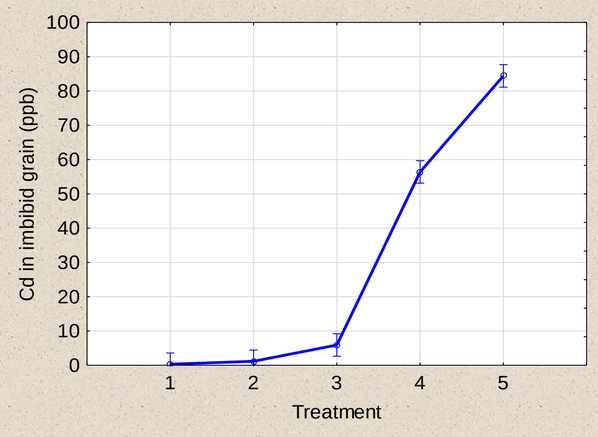
Materials and methods

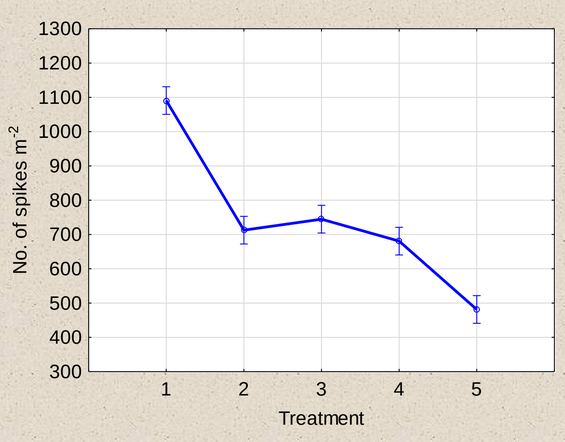
Winter wheat grains, cultivar Pobeda, were soaked in the following concentrations of $CdCl_2$, dissolved in deionized water (marked as Treatments from 0 to 5 in the figures, respectively): 0 (control), 10^{-5}, 10^{-4}, 10^{-3} and 10^{-2} M Cd, for 24 h. Thereafter, grains were breefly rinsed with deionized water and the excess of water removed by filter paper. One portion of seeds was used to assess concentration of Cd. The other portion of imbibid grains were sown in the field on soil classified as a calcareous, gleyic chernozem in which concentration of Cd in the soil was significantly lower than the maximally allowed (2 mg kg^{-1}). The plants were grown to maturity, in 4 replications, on 2 m^2 plots, and analysed at harvest. Analysis of variance, post-hoc LSD tests and correlation coefficients were calculated using STATISTICA 13.3 (StatSoft, University Licence, University of Novi Sad, 2018).

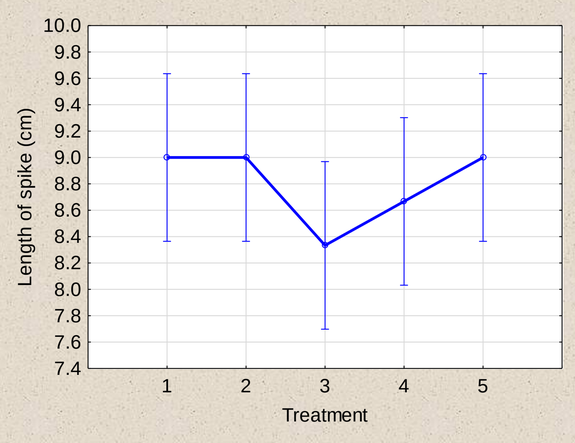
Results

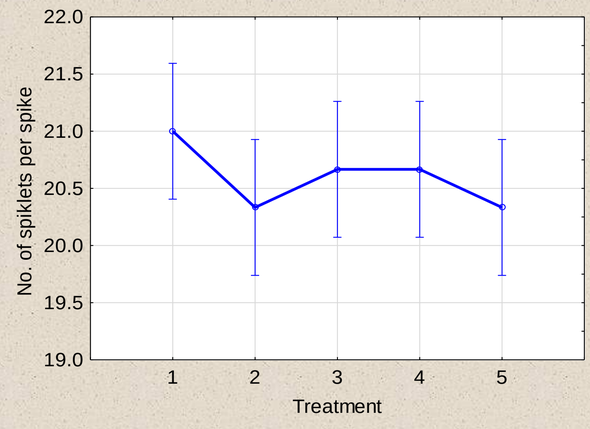
Increase in Cd concentration in the imbibition solution resulted in significant increase in Cd concentration in wheat grains. Plant height, number of spikes per m^2 and grain yield significantly declined with the increase in Cd concentration in the solution in which grains were imbibid prior to sowing. Concentration of Cd in harvested grains increased up to 40% with regard to the control. Concomitantly, length of spikes, number of spiklets per spike, harvest index and mass of 1000 grains changed to a much lesser extent. Grain weight per spike increased, which may be explained by much lower no. of spikes per m^2.

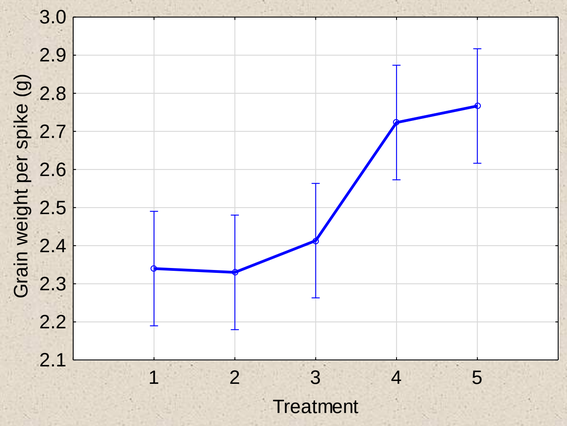
In the figures, Treatments represent the following concentration of $CdCl_2$ dissolved in deionized water in which wheat grains were imbibid prior to sowing in the field:
1 – 0 M $CdCl_2$ (Control)
2 – 10^{-5} M $CdCl_2$
3 – 10^{-4} M $CdCl_2$
4 – 10^{-3} M $CdCl_2$
5 – 10^{-2} M $CdCl_2$

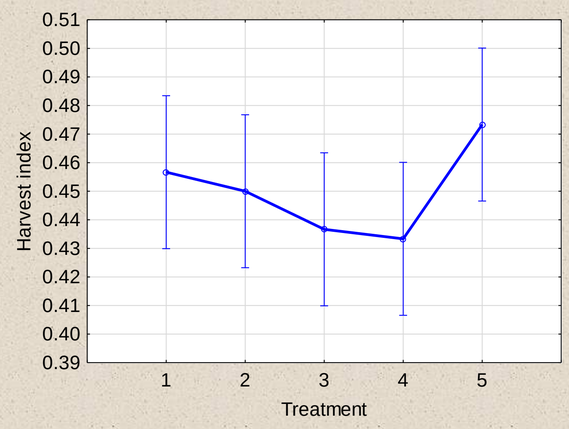


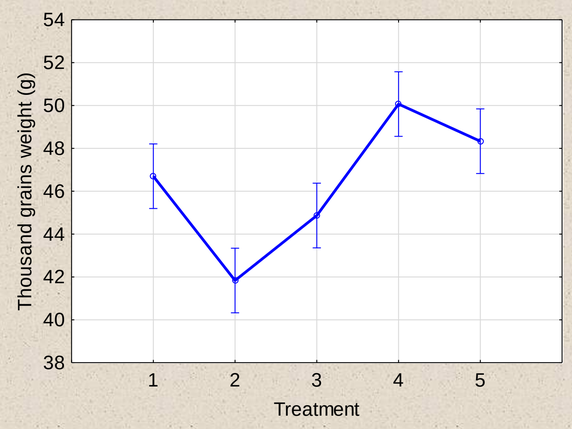












Concentration of Cd (mg kg^{-1}) **in the soil on which wheat was grown**

Soil Horizon	Depth (cm)	Extraction solution HCl	EDTA	HNO_3
Ap	0-20	0.64	0.206	0.703
A	20-35	0.64	0.208	0.753
AC	35-117	1.15	0.088	0.793
CG	117-195	1.05	0.084	0.777

Correlations between concentration of Cd in imbibid grain and parameters measured on plants after harvest.
Marked correlations are significant at $p < .05000$

Cd in harvested grain	0.542
Plant height	-0.626
No. of spikes m^{-2}	-0.735
Grain weight per spike	0.821
Thousand grain weight	0.673
Grain yield	-0.232
Spike length	0.082
Harvest index	0.199

Conclusion

Imbibition of wheat grains in the solution containing Cd prior to sowing resulted in the increased concentration of Cd in plants grown on the soil unpolluted with Cd and in the changes in their growth, especially at higher concentrations of applied Cd (10^{-3} and 10^{-2} M). Even in the harvested grains concentration of Cd was significantly higher, suggesting that Cd was transfered readilly to the next generation of seeds. Striking changes were recorded in no. of spikes per m^2 and in yield of all plants deriving from seeds treated with Cd, even at 10^{-5} M Cd.

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