Effects of Cadmium in Different Peat Ratios on Plant Growth and Potassium Contents in Pepper Seedlings

Füsun GÜLSER **Ferit SÖNMEZ**

Yüzüncü Yıl University Faculty of Agriculture Soil Science Department 65080 Van, Türkiye

"Soil Management and Potash Fertilizer Uses in West Asia and North Africa Region"

22-25 November 2010
Lara, Antalya

Introduction

Heavy metals are hazardous group of soil pollutants.

The most common heavy metals in the environment are Cd, Cr, Hg, Pb and Zn.

Cadmium is particularly a hazardous pollutant due to its high toxicity and great solubility in water.

A variety of plant species including vegetable, crops and grasses accumulate or immobilize heavy metals (Pichtel et al., 2000; Datta and Sarkar, 2005; Mills et al., 2006; Tie et al., 2006).

The metals are responsible for many alterations of some physiologic functions such as photosynthesis, chlorophyll production, enzyme activity and pigment synthesis in the plant cell (Vaillant et al., 2005; Kanoun Boule et al., 2008).

The availability of heavy metals for uptake by plant roots may differ between metals bound in soluble organic complexes and free metals.

Organic matterials influence the binding of heavy metals in soil (Lo et al., 1992; Dell Castillho et al., 1993) and plant uptake (Haghiri 1974; Mc Bride et al., 1981).

The objectives of this study were

to determine effects of cadmium applications on plant growth and potassium contents of pepper seedlings in different mixtures of soil:peat ratios.

Materials and Methods

The soil used in the study had a sandy loamy texture, non saline, alkaline, moderate in lime and organic matter contents, insufficient in phosphorus and sufficient in potassium content.

The peat used in the study had non saline, slighltly alkaline, high in organic matter, phosphorus and potassium contents.

Table 1. Some properties of the growing media

	Texture	pH	Total Salinty (%)	Lime (%)	OM (%)	N (%)	P (ppm)	K (ppm)
Soil	Sandy Loam	8.66	0.013	14.8	2.40	0.192	4.56	176
Soil+10% Peat	-	8.54	0.022	9.38	27.9	0.210	5.67	184
Soil+20% Peat	-	8.37	0.026	8.38	30.2	0.215	6.78	287
Peat	-	7.76	0.030	-	69.8	0.311	25.67	495

This study was conducted with three different levels of Cd (0, 2.5, 5.0 mg/kg) and three different mixtures of soil:peat ratios (soil:no peat, soil:10% peat and soil:20% peat) as growing media in a factorial design with three replications.

As a basic fertilizer treatment, Triple Super Phosphate, K_2SO_4 and $(NH_4)_2SO_4$ were applied into each pot (90 mg P_2O_5 kg^{-1}, 180 mg K_2O kg^{-1} and 250 mg N kg^{-1} respectively).

Demre pepper variety was used as a plant material. Experiment was carried out in a plant growth room and ended 8 weeks after the sowing .

The levels of nutrients in plants were analysed according to the methods reported by Kacar and İnal (2008).

Variance analyses of the experimental data were done by TARIST statistic program and significantly different means numbered according to LSD test.

Results and Discussions

Shoot and root dry weights were significantly (P<0.01) influenced by the different ratios of peat treatment.

The root dry weight was also influenced by the cadmium application significantly (P<0.01).

Interactions of peat and cadmium significantly affected shoot and root dry weights (P<0.01).

Table 2. F values of the varience analyses for the seedling criterias.

	df	Shoot dry weight	Rhoot dry weight
Peat (Pt)	2	111.175**	44.696 **
Cadmium	2	0.78 ns	27.577 **
Pt x Cd	4	7.467 **	18.728 **

** significant at 0.01 level, *significant at 0.05 level, ns:non significant.

Application of 20% peat ratio significantly increased shoot dry weight compared to control and 10% peat ratio.

While the highest mean shoot dry weight (1,45 g) was obtained in the application of 20% peat ratio, the highest mean root dry weight (0.51 g) was determined in the growth media including no peat (0% peat ratio).

Mean root dry weights decreased with increasing Cd dose application.

Considering the interactions between soil:peat ratio and cadmium doses (Pt x Cd), the highest shoot (1.57 g) and root (0.64 g) dry weights were determined in $Pt_{20}Cd_0$ application.

Table 3. Effects of peat and cadmium applications on the pepper seedling criterias.

		Pt 0	**Pt 10**	**Pt 20**	Mean
	Cd0 (0 mg/kg)	1.07 bc	0.60 d	**1.57 a**	1.08
Shoot Dry	**Cd1 (2.5 mg/kg)**	1.20 b	0.67 d	1.56 a	1.14
Weight, g	**Cd2 (5.0 mg/kg)**	1.24 b	0.83 cd	1.22 b	1.10
Mean		1.17 B	0.70 C	**1.45 A**	
LSD (Pt):0.147** LSD(PtxCd):0.255**					
	Cd0 (0 mg/kg)	0.57 ab	0.32 d	**0.64 a**	0.51 A
Root Dry	**Cd1 (2.5 mg/kg)**	0.52 b	0.35 d	0.52 b	0. 46 A
Weight, g	**Cd2 (5.0 mg/kg)**	0.45 bc	0.37 cd	0.29 d	0.37 B
Mean		**0.51 A**	0.35 B	0.48 A	
LSD (Pt, Cd):0.055** LSD(PtTxCd):0.094**					

**significant at 0.01, *significant at 0.05 level, Pt0: soil:0%peat; Pt10: soil:10%peat; Pt20: soil:20%peat.

The peat applications significantly affected K contents of shoots and roots (P<0.01) and Cd contents in shoots (P<0.01).

Cd contents in shoots and roots were also significantly influenced by the Cd application.

The interaction between peat ratio and cadmium doses significantly affected K (P<0.01) and Cd (P<0.05) contents of shoots.

Table 4. F values of the varience analyses for the cadmium and K contents.

		Shoot		**Root**	
	df	Cd	K	Cd	K
Peat (Pt)	2	9.68 **	98.54 **	1.74 ns	10.96 **
Cadmium	2	14.63 **	1.33 ns	13.20 **	0.46 ns
Pt x Cd	4	4.26 *	36.74 **	0.21 ns	2.49 ns

** significant at 0.01 level, *significant at 0.05 level, ns:non significant.

While the means of Cd contents in shoots were significantly increased by Cd application, they were significantly decreased by the peat treatments (Figure 1).

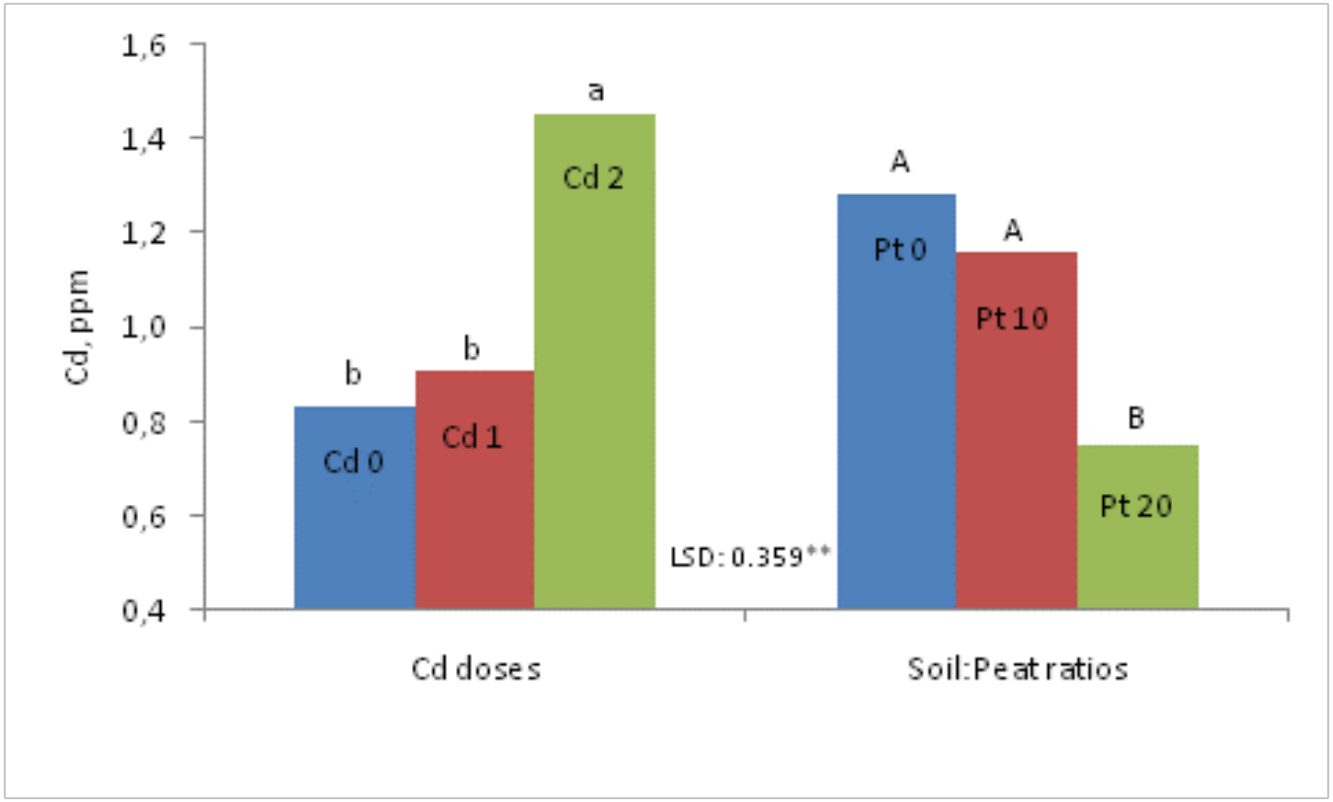

Figure 1. Cadmium contents in shoots of pepper seedlings.

When considering the interaction between Cd and peat ratio, the highest Cd content (2.06 ppm) was in Pt_0Cd_2 and the lowest Cd content (0.70 ppm) was in $Pt_{20}Cd_0$ application (Figure 2).

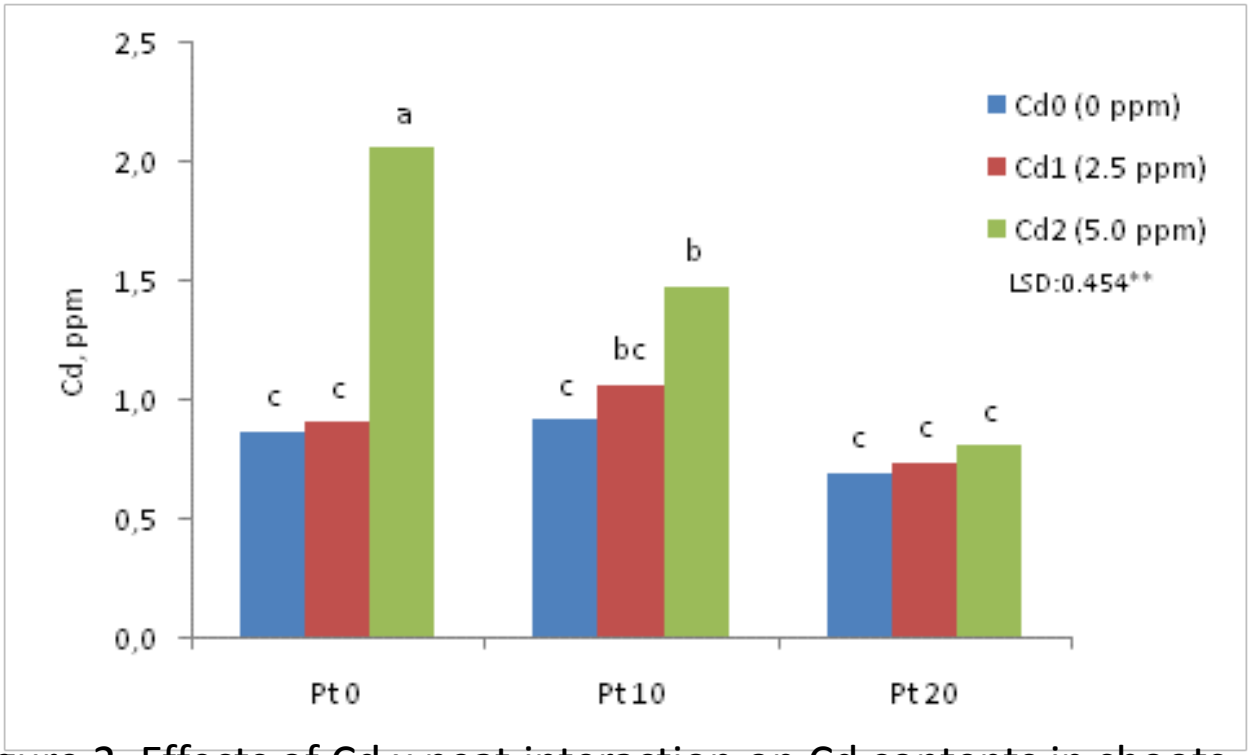

Figure 2. Effects of Cd x peat interaction on Cd contents in shoots.

Application of 20% soil:peat ratio (Pt_{20}) significantly incresaed mean K (5.96%) content of shoots when compared with the mixtures of no peat and 10% soil:peat ratios (Figure 3).

Mean K contents in shoots were not significantly influenced by the Cd application.

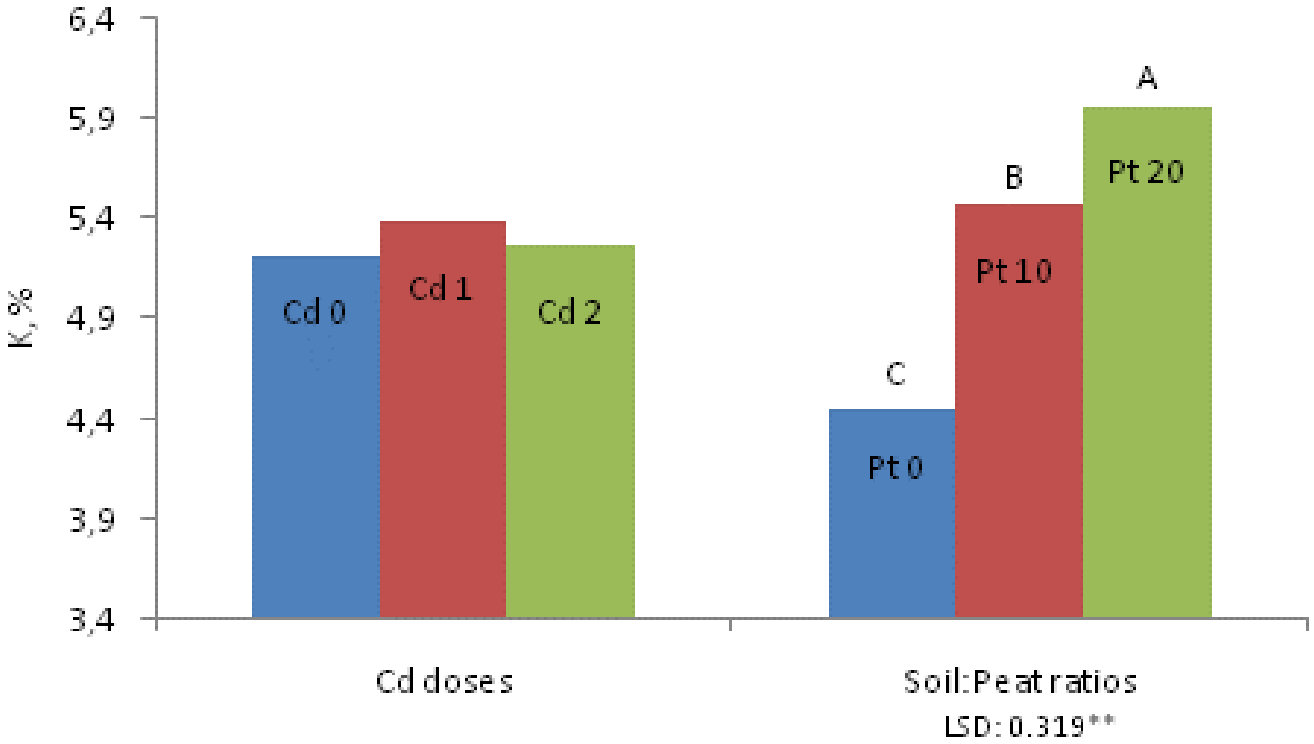

Figure 3. Potassium contents in shoots of pepper seedlings.

When considering the interaction between Cd and peat ratio, the highest K content (7.00 %) was in $Pt_{20}Cd_2$ and the lowest K content (4.10%) was in Pt_0Cd_2 application (Figure 4).

While the K content was generally decreased in Pt_0 and Pt_{10} ratios with Cd application, it was increased in Pt_{20} ratio with increasing Cd doses.

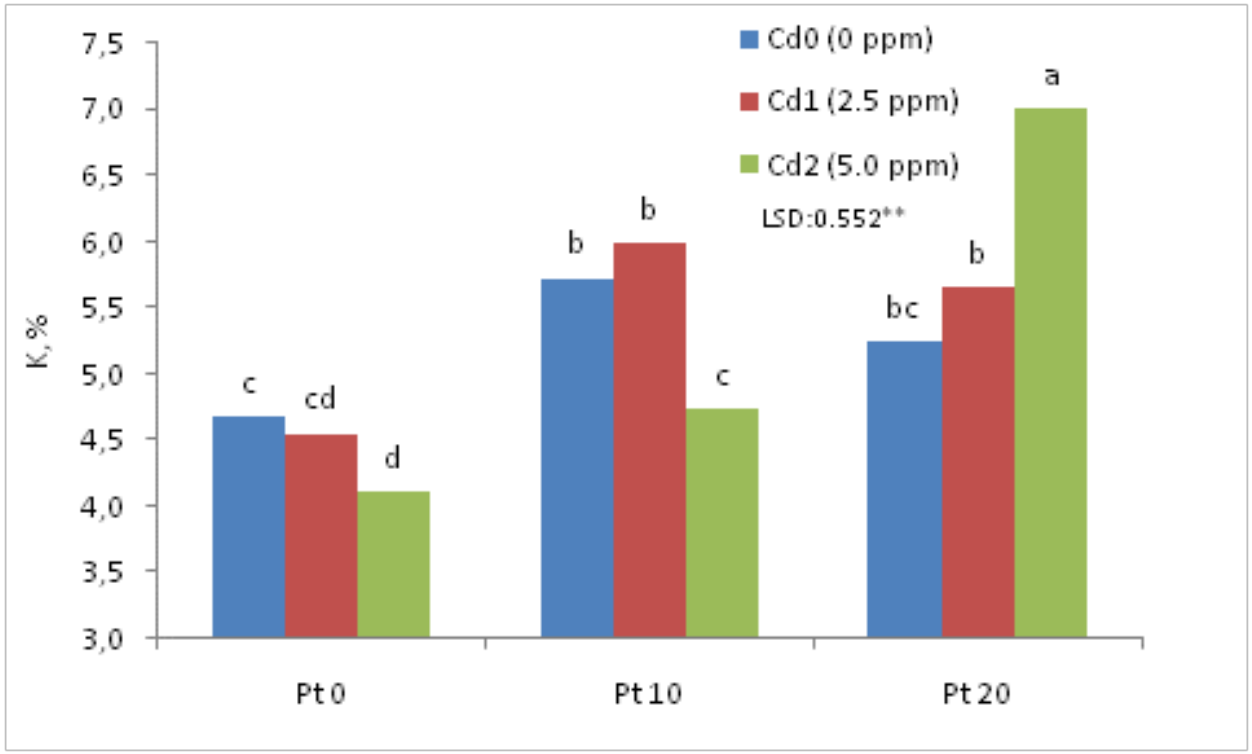

Figure 4. Effects of Cd x peat interactions on K contents in shoots.

While the means of Cd contents in roots were significantly increased by Cd application, they were decreased by the increasing soil:peat ratios (Figure 5).

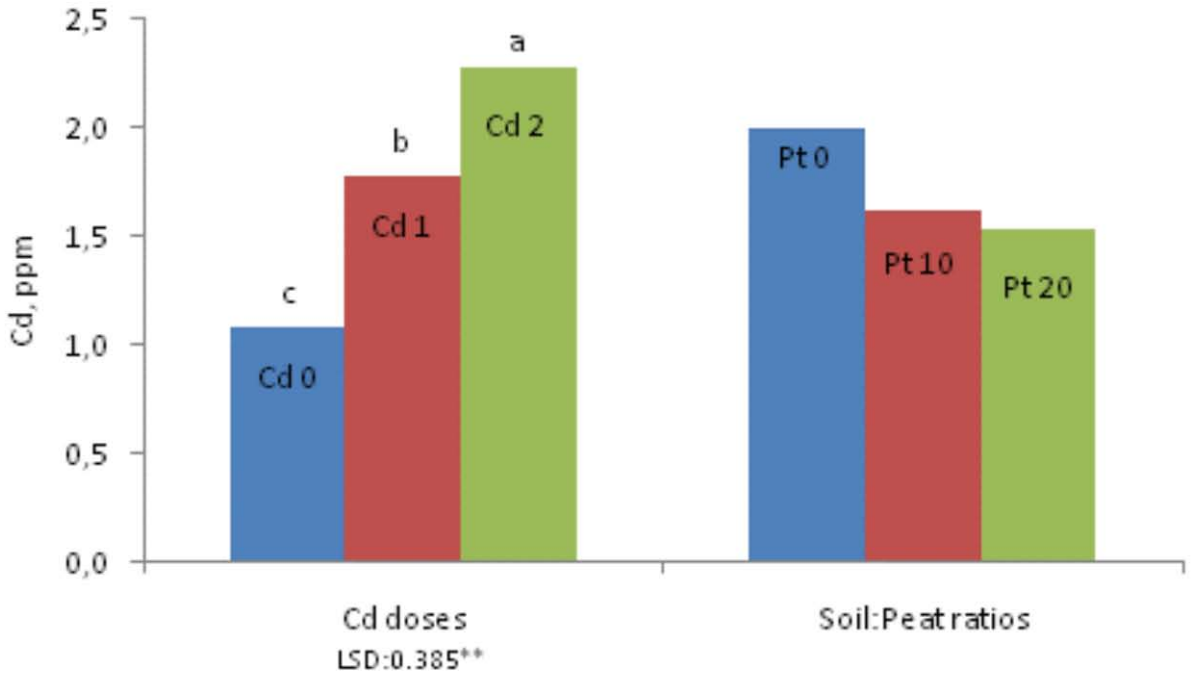

Figure 5. Cadmium contents in roots of pepper seedlings.

When considering the interaction between Cd and peat ratio, the highest Cd content (2.40 ppm) was in Pt_0Cd_2 and the lowest Cd content (0.96 ppm) was in $Pt_{20}Cd_0$ application (Figure 6).

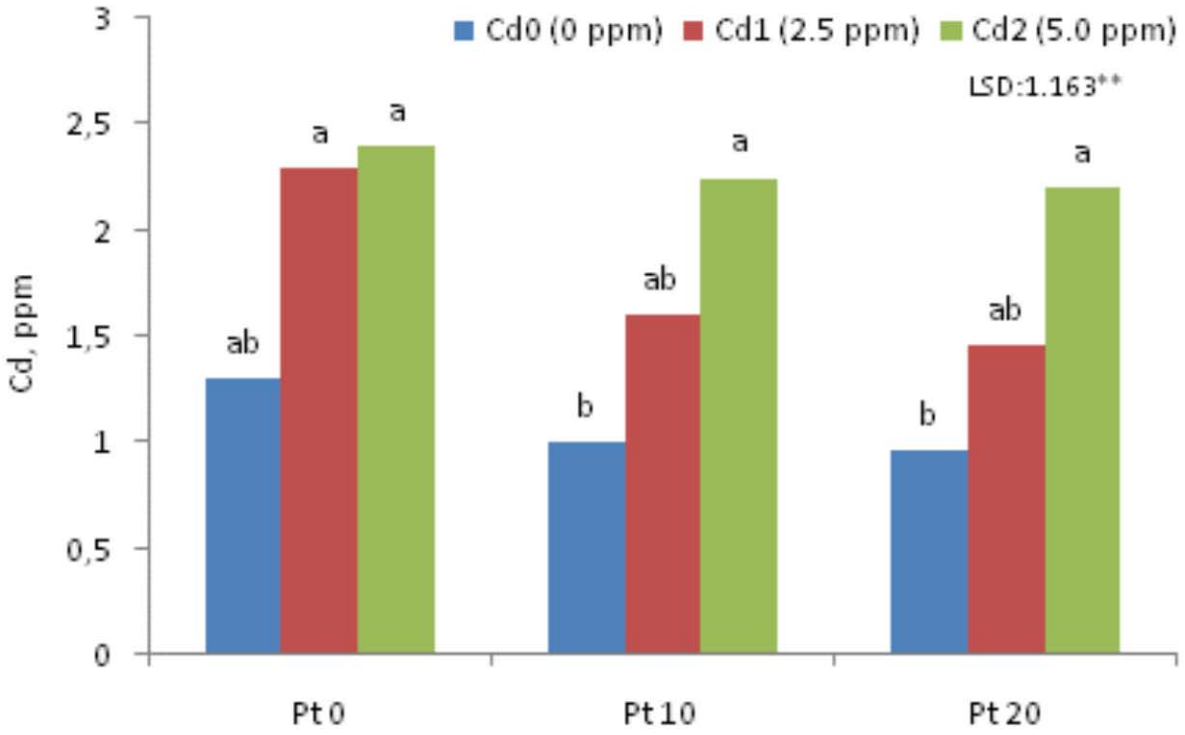

Figure 6. Effects of Cd x peat interactions on Cd contents in roots.

The highest mean K (3.11%) content of roots was in the mixture of 0% soil:peat ratio (Figure 7).

Mean K contents in roots decreased when adding the peat into soil and not significantly influenced by the Cd application.

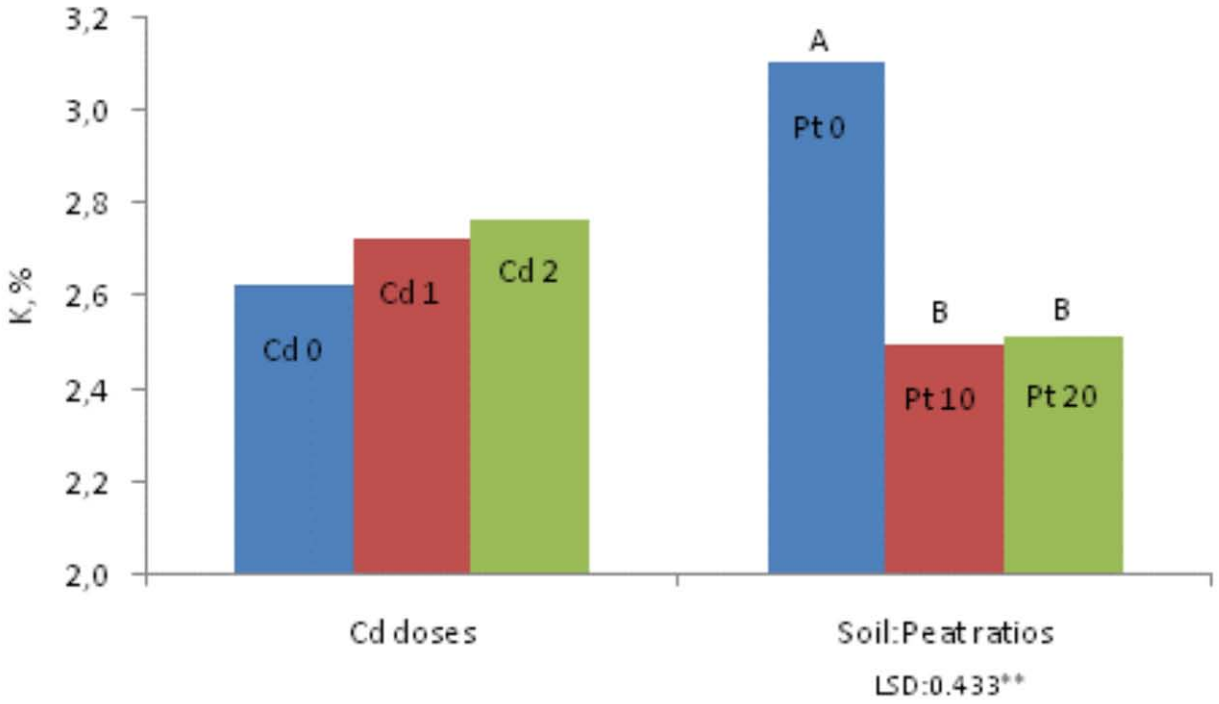

Figure 7. Potassium contents in roots of pepper seedlings.

When considering the interaction between Cd and peat ratio, the highest K content (3.27%) was in Pt_0Cd_2 and the lowest K content (2.12%) was in $Pt_{20}Cd_0$ application (Figure 8).

While the K content was generally decreased in Pt_{10} ratio with Cd application, it was increased in Pt_0 and Pt_{20} ratios with increasing Cd doses.

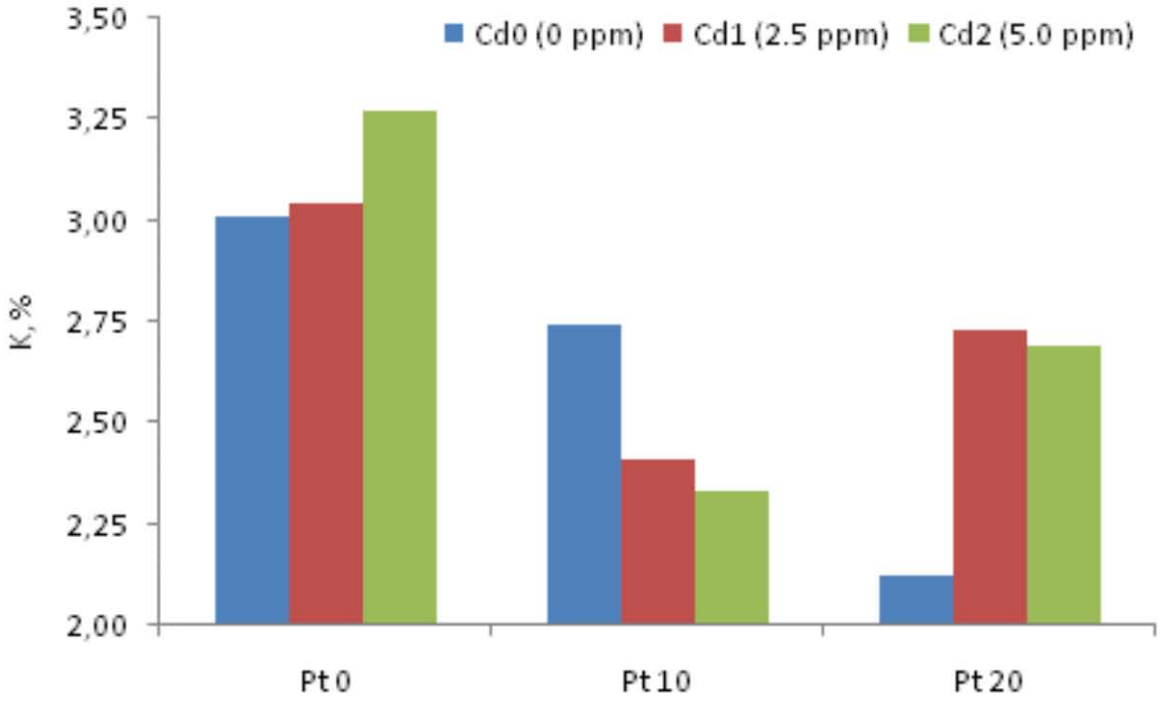

Figure 8. Effects of Cd x peat interactions on K contents in roots.

Increasing peat concentrations in mixtures of soil:peat ratio had positive effects on shoot dry weight. Ameliorative effects of peat on seedling criteria were reported by the most researchers (Gülser et al. 1998; Özman and Ocak, 2002; Çinkılıç, 2008).

Root dry weight significantly decreased by the cadmium application. Torun et al. (2009) also determined that amount of dry matter in cherry plants decreased depending of application of Cd at increasing rates.

Increasing cadmium doses increased cadmium contents in both shoots and roots. Cadmium was concentrated mainly in the roots, and its small amount was transferred to the shoots. The results of the present investigation are similar to the previous studies (Kumar et al., 1995; Jiang et al., 2001; Liu et al., 2006; and Wang et al., 2007).

Cadmium contents in shoots and roots were decreased by the increasing rates of soil:peat mixtures.

Krogstad (1983) reported that organic matter makes strong complexes with heavy metals.

Soil organic matter may retain metals in the solid phase of the soil, on the contrary dissolved organic matter may increase mobility of the metals (Japenga et al., 1992; Lo et al., 1992).

The decrease in the cadmium contents with peat application is similar to the results reported by the other researchers (Eriksson, 1988; He and Singh, 1993; Arnesen and Singh, 1998).

Mean Cd contents in shoots were decreased with increasing K contents in shoots and growing media from soil:no peat (176 ppm K) to 20% soil:peat ratio (287 ppm K). While there was a significant positive correlation ($r= -0.577$, $P<0.05$) between Cd and K contents in shoots, there was a positive but insignificant correlation between Cd and K contents in roots.

Chen et al. (2007) similarly reported that the application of K_2SO_4 significantly reduced the uptake of Cd in different parts of wheat.

As a result;

while increasing peat mixture ratio into soil increased K uptake and seedling growth, they decreased Cd uptake by the plants.

Thanks for your attention