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Alüminyum ve Kadmiyum Metallerinin Mısır ve Mercimek Tohumlarının Çimlenmesine Etkileri*

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Özet: Bu çalışmada; mısır (*Zea mays* L.) ve mercimek (*Lens culinaris* Medik cv. Kafkas) tohumlarının çimlenmesi üzerine çeşitli konsanstrasyonlardaki alüminyum [$(Al(NO_3)_3.9H_2O$] ve kadmiyumun [$Cd(NO_3)_2.4H_2O$] etkileri araştırılmıştır. Çimlenme deneyleri 7 gün boyunca, sabit bir sıcaklıkta (20°C), karanlıkta ve inkübatörde gerçekleştirilmiştir. Alüminyum ve kadmiyum, özellikle de kadmiyum, her iki türde de tohum çimlenmesini konsantrasyon artışına paralel olarak geciktirmiş ve engellemiştir. Mercimek tohumları metallere karşı mısırdan daha duyarlı davranmıştır. Mısırda radikula ve koleoptil çıkışları kıyaslandığında; radikulanın aluminyum ve kadmiyuma karşı daha duyarlı bulunmuştur. Mercimekte ise radikula ve hipokotil benzer oranlarda etkilenmiştir. Taze ağırlıklar da çimlenen tohumların fideciklerinde iki metalin etkisiyle azalmıştır.

Anahtar kelimeler: Metal stresi, alüminyum, kadmiyum, tohum çimlenmesi

The Effects of Aluminum and Cadmium Metals on Germination of Maize and Lentil Seeds

Abstract: In this study; the effects of various concentrations of aluminium [$(Al(NO_3)_3.9H_2O$] and cadmium [$Cd(NO_3)_2.4H_2O$] on the germination of maize (*Zea mays* L.) and lentil (*Lens culinaris* Medik cv. Kafkas) seeds were invastigated. Germination experiments were carried out at a constant temperature (20°C), in the dark and in an incubator for 7 days. When Aluminum and cadmium, particularly cadmiumwere increased in the seed concentration, seed germination was inhibited and delayed for both species. Lentil seeds were more sensitive to the metals than from maize. When radicle output compared with coleoptile output of mazie; radicle have been more sensitive to aluminum and cadmium. Radicle and hypocotyl of lentil are affected by the same rate. Fresh weights of the seedlings from the germinated seeds were also found to be decreased by two metals.

Key words: Metal stress, aluminum, cadmium, seed germination

* It is from Süleyman Demirel University PhD Thesis.

Introduction

One of the most important problems of nowadays is decrease of efficient cultivated area as against increase population of the world. The contaminants such as heavy metal, salt, acid, etc. adversely affect the cultivated areas (Munns and Tester, 2008). When the metals, that are one of these contaminants, are accumulated in the soil, they have important effects not only on the soil efficiency and ecosystem functions but also on animal and human health through the food chain (Gadd, 2000a). It is unavoidable that plants at the status of main step of food chain and biological cycle will be affected from this metal contamination. Tolerances of plants against heavy metal toxicity may vary depending on plant species, element type, exposure time to stress and structure of tissue organ exposed to the stress. Therefore, knowing type, amount and usefulness of the heavy metal and intensity and type of its damage as well as process of damage formation is very significant in terms of development and vitality of the plants (Öktüren and Sönmez, 2006).

In this study; morphological, physiological responses of maize and lentil seeds to aluminum and cadmium metal stress were investigated.

Materials and Methods

In the study; aluminum in the compound of [$Al(NO_3)_3.9H_2O$] (Merck) and cadmium salts in the compound of [$Cd(NO_3)_2.4H_2O$] were used as metal with maize (*Zea mays* L.) and lentil (*Lens culinaris* Medic. cv. Kafkas) seed.

Concentration values determined with prestudies for germination experiments. As a result of prestudies, the germination of maize and lentil seeds that is blocked in mild to moderate aluminum and cadmium levels were determined separately. The concentrations determined by prestudies are shown below;

Aluminum (mM)
Maize 0.0- 11- 13- 15- 17- 19- 21
Lentil 0.0- 2.5- 5.0- 7.5- 12.5- 17.5- 22.5- 27.5

Cadmium (mM)
Maize 0.0- 1.25- 1.50- 1.75- 2.0- 2.25- 2.50
Lentil 0.0- 0.10- 0.30- 0.50- 0.75- 1.0- 1.25

The seeds were subjected to surface sterilization before the cultivation (Baltepe and Mert, 1973). 25 seeds at plump appearance and almost similar bigness were placed on 15 cm diameter petri with two layers filter paper including 13 ml pure water (control group) or above mentioned Al and Cd solutions at various concentrations. Germination experiments were carried out at a constant temperature (20°C), in the dark in an incubator for 7 days. The coleoptile/hypocotyl percentages were detected with germination per 24 hours and the criteria of that radicula length was 10 mm for maize seeds and 5 mm for lentil seeds were taken as basis as germination criteria (Bozcuk, 1978). The germination criteria were reached after detection of germination and coleoptile/ hypocotyl percentages at the last day of the experiment, radicle and coleoptile/ hypocotyl lengths (cm) and fresh weights (mg/seedling) of the seedlings were detected.

The experiments were arranged with four repeats and statistical assessment regarding to all parameters were done by using SPSS 14.0 Duncan's of Multiple Range Test.

Results

Time dependent germination and some growth parameters were investigated at the seedlings, germinated at the metal mediums at various concentrations for a week.

Effects of Al and Cd on time-dependent germination experiment

Al generally delayed germination, parallel to concentration increase, at maize but did not make any inhibitive effect on these concentrations over final germination belonging to 7th day at the end of germination period and control values were reached (Table 1). Cd generally both delayed and inhibited germination of maize seeds in parallel to concentration increase (Table 2). When Cd and Al effects were compared, it may be said that Cd was a more effective stress compared to Al at maize germination. For example; while 2.5 mM Cd leaded to 50.6% germination, 96% final germination occurred at 21 mM Al.

Table 1. The effect of Al on time dependent germination percentage of maize seeds
Tablo 1. Mısır tohumlarının zamana bağlı çimlenme yüzdelerine Al etkisi

Al (mM)	Day *Gün*						
	1	2	3	4	5	6	7
0.0	0±0.0	0±0.0	93.3±2.3	96.0±4.0	97.3±2.3	97.3±2.3	98.6±2.3
11	0±0.0	0±0.0	85.3±2.3	93.3±2.3	96.0±4.0	96.0±4.0	96.0±4.0
13	0±0.0	0±0.0	86.6±2.3	93.3±2.3	94.6±4.6	94.6±4.6	97.3±2.3
15	0±0.0	0±0.0	76.0±4.0	92.0±4.0	97.3±2.3	97.3±2.3	97.3±2.3
17	0±0.0	0±0.0	66.6±2.3	82.6±12.2	85.3±10.0	92.0±4.0	92.0±2.3
19	0±0.0	0±0.0	62.6±2.3	93.3±2.3	96.0±0.0	98.6±2.3	98.6±2.3
21	0±0.0	0±0.0	54.6±2.3	86.6±2.3	94.6±2.3	94.6±2.3	96.0±0.0

Table 2. The effect of Cd on time dependent germination percentage of maize seeds
Tablo 2. Mısır tohumlarının zamana bağlı çimlenme yüzdelerine Cd etkisi

Cd (mM)	Day *Gün*						
	1	2	3	4	5	6	7
0.00	0±0.0	0±0.0	93.3±2.3	96.0±4.0	97.3±2.3	97.3±2.3	98.6±2.3
1.25	0±0.0	0±0.0	62.6±2.3	77.3±2.3	89.3±2.3	90.6±4.6	90.6±2.3
1.50	0±0.0	0±0.0	52.0±4.0	61.3±6.1	81.3±6.1	82.6±4.6	82.6±2.3
1.75	0±0.0	0±0.0	38.6±2.3	52.0±4.0	61.3±6.1	69.3±2.3	73.3±2.3
2.00	0±0.0	0±0.0	44.0±4.0	50.6±2.3	68.0±4.0	69.3±4.6	72.0±0.0
2.25	0±0.0	0±0.0	30.6±2.3	41.3±2.3	45.3±2.3	52.0±4.0	53.3±6.1
2.50	0±0.0	0±0.0	20.0±4.0	33.3±2.3	44.0±4.0	50.6±4.6	50.6±4.6

Al both delayed and inhibited germination of lentil seeds in parallel to concentration increase especially as of 7.5 mM compared to the control group (Table 3). Cd made delayer and inhibitive effect on germination depending on the concentration increase especially as of 0.50 mM compared to control group (Table 4). Similar to the one in maize, it was seen that delayer and inhibitive effect of Cd on germination was much more than Al at lentil. For example; while 1.25 mM Cd leaded to 50.7% germination, 57.3% final germination occurred at 27.5 mM Al.

Table 3. The effect of Al on time dependent germination percentage of lentil seeds
Tablo 3. Mercimek tohumlarının zamana bağlı çimlenme yüzdelerine Al etkisi

Al (mM)	Day *Gün*						
	1	2	3	4	5	6	7
0.00	0±0.0	76.0±6.9	93.3±2.3	97.3±2.3	97.3±2.3	97.3±2.3	97.3±2.3
2.50	0±0.0	70.6±9.2	85.3±9.2	94.6±4.6	97.3±2.3	100.0±0.0	100.0±0.0
5.00	0±0.0	69.3±12.2	94.6±2.3	98.6±2.3	98.6±2.3	98.6±2.3	98.6±2.3
7.50	0±0.0	64.0±10.6	82.6±9.2	85.3±2.3	86.6±2.3	88.0±0.0	88.0±0.0
12.50	0±0.0	52.0±4.0	72.0±10.6	81.3±4.6	84.0±0.0	84.0±0.0	84.0±0.0
17.50	0±0.0	45.3±8.3	66.6±4.6	82.6±9.2	84.0±6.9	85.3±8.3	85.3±8.3
22.50	0±0.0	34.6±6.1	52.0±8.0	61.3±6.1	62.6±4.6	64.0±4.0	64.0±4.0
27.50	0±0.0	29.3±2.3	42.6±6.1	49.3±12.2	54.6±6.1	56.0±4.0	57.3±2.3

Table 4. The effect of Cd on time dependent germination percentage of lentil seeds
Tablo4. Mercimek tohumlarının zamana bağlı çimlenme yüzdelerine Cd etkisi

Cd (mM)	Day *Gün*						
	1	2	3	4	5	6	7
0.00	0±0.0	76.0±6.9	93.3±2.3	97.3±2.3	97.3±2.3	97.3±2.3	97.3±2.3
0.10	0±0.0	77.3±6.1	96.0±4.0	97.3±2.3	98.6±2.3	100.0±0.0	100.0±0.0
0.30	0±0.0	74.7±2.3	88.0±4.0	96.0±4.0	97.3±4.6	100.0±0.0	100.0±0.0
0.50	0±0.0	64.0±4.0	76.0±4.0	82.7±2.3	84.0±0.0	84.0±0.0	84.0±0.0
0.75	0±0.0	49.3±2.3	53.3±2.3	66.7±2.3	70.7±2.3	70.7±2.3	70.7±2.3
1.00	0±0.0	50.7±6.1	52.0±4.0	52.0±4.0	64.0±4.0	64.0±4.0	64.0±4.0
1.25	0±0.0	37.3±2.3	41.3±2.3	49.3±2.3	50.7±2.3	50.7±2.3	50.7±2.3

When Al and Cd were compared in terms of their time dependent germination, Cd was found much more effective on both maize and lentil. As seen above, Cd reached the inhibitive effect degrees with 22 times much more lower dose (1.25 mM) done by 27.5 mM Al on lentil germination. On the other side, when two species used in terms of sensitivity to these metals were compared, it was seen that lentil was much more sensitive to maize against metal.

Effects of Al and Cd on some growth parameters of seeds germinations

Al almost did not any effect on the final germination percentages on maize at the end of 7th day (Table 5). With the concentration increase, in general no decrease was seen at the germination percentages and up and down fluctuations occurred. There was a small decrease at the ratio of 7% on the Al levels that seemed statistically significant at 17 mM compared to the control. When coleoptile percentages are reviewed, it is seen that Al levels not distinctly affecting the germination percentages significantly inhibited the coleoptile output. Along with that there were fluctuations locally, coleoptile output were significantly inhibited at all concentrations compared to control group.

Even at 11 mM Al level that was the lowest concentration, dramatic decreases occurred at fresh weights of seedlings with radicle and coleoptile lengths.

Table 5. Al effect on some morphological parameters at the end of maize germination
Tablo 5. Mısır çimlenmesi sonundaki bazı morfolojik parametrelere Al etkisi

Al (mM)	Growth Parameters *Büyüme Parametreleri*				
	Germination (%) *Çimlenme (%)*	Coleoptile (%) *Koleoptil (%)*	Radicle length (cm) *Radikula uzunluğu (cm)*	Coleoptile length (cm) *Koleoptil uzunluğu (cm)*	Fresh weight (mg/seedling) *Taze Ağırlık (mg/fidecik)*
0.00	*98.6 ± 2.3 ^{a}	64.0 ± 4.0 ^{a}	11.1 ± 2.1^{a}	2.6 ± 0.6^{a}	776.8 ± 21 ^{a}
11	96.0 ± 4.0 ^{ab}	43.0 ± 9.2 ^{bc}	2.4 ±0.6^{b}	1.8 ± 0.2^{b}	663.3 ± 43.1 ^{b}
13	97.3 ± 2.3 ^{a}	51.0 ± 2.3 ^{b}	2.5 ± 0.5^{b}	1.7 ± 0.3^{b}	616.5 ± 29.7 ^{b}
15	97.3 ± 2.3 ^{a}	44.0 ± 4 ^{bc}	2.2 ±0.5^{b}	1.8 ± 0.2^{b}	663.7 ± 9.2 ^{b}
17	92.0 ± 4.0 ^{b}	41.0 ± 2.3 ^{c}	2.3 ± 0.5^{b}	1. 7 ± 0.2^{b}	631.3 ± 48.9 ^{b}
19	98.6 ± 2.3 ^{a}	37.0 ± 6.1 ^{c}	2.2 ± 0.5^{b}	1.7 ± 0.2^{b}	625.4 ± 14.4 ^{b}
21	96.0 ± 0.0 ^{ab}	37.0 ± 2.3 ^{c}	2.0 ± 0.5^{b}	1.7 ± 0.2^{b}	636.7 ± 28.2 ^{b}

*The difference between values with the same letter in each column is not significant at 0.05 (± SD).
**Her bir parametre sütununda aynı harfle gösterilen değerler arasındaki fark (p<0.05) düzeyinde önemsizdir.*

Cd distinctly made inhibited effect on final germination and coleoptile percentages at the end of 7th day in parallel to concentration increase (Table 6). Lowest germination and coleoptile percentages were detected at 2.5 mM Cd that was the highest concentration. Cd leaded to a significant decrease on radicula and coleoptile lengths. While radicula length was 11 cm at the control group, this value showed a sharp decrease such as 2 cm on 1.25 mM that was the lowest concentration (a decrease at the ratio of 82%). Coleoptile extension distinctly inhibited as of 1.25 mM. Fresh weight showed decrease fluctuation at all concentrations compared to control group.

Table 6. Cd effect on some morphological parameters at the end of maize germination
Tablo 6. Mısır çimlenmesi sonundaki bazı morfolojik parametrelere Cd etkisi

Cd (mM)	Growth Parameters *Büyüme Parametreleri* Germination (%) *Çimlenme (%)*	Coleoptile (%) *Koleoptil (%)*	Radicle length (cm) *Radikula uzunluğu (cm)*	Coleoptile length (cm) *Koleoptil uzunluğu (cm)*	Fresh weight (mg/seedling) *Taze Ağırlık (mg/fidecik)*
0.00	*98.6 ± 2.3 a	64.0 ± 4.0 a	11.1 ± 2.1a	2.6 ± 0.6a	776.8 ± 21a
1.25	90.6 ± 2.3 b	61.0 ± 2.3 ab	2.0 ± 0.5b	1.8 ± 0.2b	653.8 ± 23.2b
1.50	82.6 ± 2.3 c	57.0 ± 2.3 b	1.9 ± 0.5b	1.8 ± 0.3b	650.2 ± 45.8b
1.75	73.3 ± 2.3 d	52.0 ± 0.0 c	1.6 ± 0.3b	1.6 ± 0.2bc	630.1 ± 29.3bc
2.00	72.0 ± 0.0 d	48.0 ± 0.0 c	1.6 ± 0.4b	1.5 ± 0.3cd	628.3 ± 16.5bc
2.25	53.3 ± 6.1 e	40.0 ± 4.0 d	1.4 ± 0.3b	1.3 ± 0.2d	619.1 ± 3.3bc
2.50	50.6 ± 4.6 e	40.0 ± 4.0 d	1.3 ± 0.3b	1.4 ± 0.2cd	599.1 ± 7.7c

*The difference between values with the same letter in each column is not significant at 0.05 (± SD).
**Her bir parametre sütununda aynı harfle gösterilen değerler arasındaki fark (p<0.05) düzeyinde önemsizdir.*

Al leaded to decrease at germination and hypocotyls percentages at lentil as of 7.5 mM in parallel to concentration increase. The germination and hypocotyls percentage, that was 97% at the control group, decreased at 27.5 mM (to 57%) which was the highest Al level (Table 7). Radicula and hypocotyls lengths showed reduction at al Al levels starting from 2.5 mM that was the most diluted concentration compared to the control group. This inhibition was much more remarkable on radicula extension compared to hypocotyls extension. The radicula length that was 7.3 cm at the control group inhibited at 2.5 mM and sharply decreased to 3.2 cm. Al pressure on radicula extension get severe in parallel to concentration increase and showed the most distinct effect with 0.6 cm radicula length at 27.5 mM which was the highest dosage. But along with that hypocotyls extension showed a decrease at all Al concentrations compared to control group, this effect occurred much more slightly compared to Al effect. For example; while 27.5 mM that is the highest Al level made 92% pressure on radicula extension compared to control, it showed 30% effectiveness on hypocotyls extension. In other words, hypocotyls extension did not show sharp decreases like radicula extension and it showed gradual reduction with increase at Al levels. Even if there were fluctuations at fresh weight compared to control group, a decrease was seen at all concentrations.

Table 7. Al effect on some morphological parameters at the end of lentil germination
Tablo 7. Mercimek çimlenmesi sonundaki bazı morfolojik parametrelere Al etkisi

Al (mM)	Growth Parameters *Büyüme Parametreleri* Germination (%) *Çimlenme (%)*	Hypocotyl (%) *Hipokotil (%)*	Radicle length (cm) *Radikula uzunluğu (cm)*	Hypocotyl length (cm) *Hipokotil uzunluğu (cm)*	Fresh weight (mg/seedling) *Taze ağırlık (mg/fidecik)*
0.00	*97.3 ± 2.3 a	97.0 ± 2.3 a	7.3 ± 1.1a	6.2 ± 0.7a	190.7 ± 3.8 a
2.50	100.0 ± 0.0 a	100.0 ± 0.0 a	3.2 ± 0.5b	5.1 ± 1.2bc	149.1 ± 3.9 b
5.00	98.6 ± 2.3 a	99.0 ± 2.3 a	1.7 ± 0.5c	5.2 ± 0.8bc	142.7 ± 1.1 bc
7.50	88.0 ± 0.0 b	88.0 ± 0.0 b	1.1 ±0.3cd	5.4 ± 0.5b	139.7 ± 7.6 bc
12.50	84.0 ± 0.0 b	84.0 ± 0.0 b	0.8 ± 0.1d	5.4 ± 0.6b	135.8 ± 1.9 bc
17.50	85.3 ± 8.3 b	85.0 ± 8.3 b	0.7 ± 0.1d	5.2 ± 0.7bc	131.1 ± 3.9 c
22.50	64.0 ± 4.0 c	64.0 ± 4.0 c	0.8 ± 0.2d	4.8 ± 0.9bc	142.2 ± 22.8 bc
27.50	57.3 ± 2.3 d	57.0 ± 2.3 d	0.6 ± 0.1d	4.4 ± 1.0c	125.8 ± 2.8 c

*The difference between values with the same letter in each column is not significant at 0.05 (± SD).
**Her bir parametre sütununda aynı harfle gösterilen değerler arasındaki fark (p<0.05) düzeyinde önemsizdir.*

Cd did not lead to any inhibition on germination and hypocotyls percentages at the concentrations up to 0.50 mM. It leaded to gradual decreases on germination and coleoptile percentages in parallel to concentration increase as of 0.50 mM. While radicula extension showed a sharp decrease as of 0.1 mM, it leaded to gradual decreases on germination and coleoptile percentages as of 0.50 mM in parallel to concentration increase. While radicula extension showed to a sharp decrease as of 0.1 mM, hypocotyls extension showed gradually increasing but progressive decreases with Cd increases (Table 8).

Table 8. Cd effect on some morphological parameters at the end of lentil germination
Tablo 8. Mercimek çimlenmesi sonundaki bazı morfolojik parametrelere Cd etkisi

Cd (mM)	Growth Parameters *Büyüme Parametreleri*				
	Germination (%) *Çimlenme (%)*	Hypocotyl (%) *Hipokotil (%)*	Radicle length (cm) *Radikula uzunluğu (cm)*	Hypocotyl length (cm) *Hipokotil uzunluğu (cm)*	Fresh weight (mg/seedling) *Taze ağırlık (mg/fidecik)*
0.00	*97.3 ± 2.3 [a]	97.0 ± 2.3 [a]	7.3 ± 1.1[a]	6.2 ± 0.7[a]	190.7 ± 3.8 [a]
0.10	100.0 ± 0.0 [a]	100.0 ± 0.0 [a]	1.8 ± 0.4[b]	6.6 ± 1.1[a]	158.8 ± 5.4 [b]
0.30	100.0 ± 0.0 [a]	100.0 ± 0.0 [a]	0.9 ± 0.2[c]	4.3 ± 0.9[b]	133.7 ± 1.9 [c]
0.50	84.0 ± 0.0 [b]	84.0 ± 0.0 [b]	0.7 ± 0.1[c]	3.4 ± 0.6[c]	130.3 ± 4.0 [c]
0.75	71.0 ± 2.3 [c]	71.0 ± 2.3 [c]	0.6 ± 0.1[c]	2.6 ± 0.4[d]	122.8 ± 11.5 [cd]
1.00	64.0 ± 4.0 [d]	64.0 ± 4.0 [d]	0.5 ± 0.0[c]	2.6 ± 0.4[d]	124.9 ±8.3 [cd]
1.25	51.0 ± 2.3 [e]	51.0 ± 2.3 [e]	0.5 ± 0.0[c]	2.3 ± 0.2[d]	116.6 ± 3.2 [d]

*The difference between values with the same letter in each column is not significant at 0.05 (± SD).
**Her bir parametre sütununda aynı harfle gösterilen değerler arasındaki fark (p<0.05) düzeyinde önemsizdir.*

Similar to Al stress, radicula extension was much more affected at the Cd existence compared to hypocotyls. While radicula length (that was 7.3 cm) sharply decreased (to 1.8 cm) at 0.10 mM (the lowest concentration), hypocotyls extension was not adversely affected at the same Cd level. Hypocotyls extension inhibition as of 0.3 mM was not observed but occurred slowly rather than dramatically like radicula inhibition. Fresh weight values showed a decreasing progression in parallel to concentration increase at both Al and Cd status compared to control group.

Discussion

Al and Cd (especially Cd) both delayed and inhibited germination of each both species. Also so many researchers notified the similar effects (Polar and Küçükcezzar, 1986; Ayaz and Kadıoğlu, 1997; Iqbal and Shafiq, 2003; Alamgir and Akhter, 2009). These effects were found much more repressive at lentil. In other words, lentil seeds behaved much more sensitive against Al and Cd compared to maize.

In order to compare maize and lentil, germination criteria are to be same. But 10 mm radicula length for maize and 5 mm radicula length for lentil were taken as basis. Although this criteria difference is a status in benefit for lentil, lentil reacted much more sensitively against two metals. There is no consensus concerning to radicula length as germination criteria in the seed germination researches. Various lengths as of 1 mm are taken as criteria by various researchers. Even crack of testa may be taken as a germination criterion. On the other side, plant biochemistries may take catabolic events at the store tissues and in pursuit of that anabolic and catabolic events starting at the embryo as germination criterion (Sharples, 1973; Ungar, 1974; Jann and Amen, 1977; Bewley and Black, 1982)

Al and Cd that are available at the nature densely are both of them a stress factor at the cultivation (Sheoran et al., 1990; Foy et al., 1993) and adversely affect growth and development events and therefore efficiency at the plants. Al and Cd may inhibit germination in various ways. Inhibition of root growth is the main symptom of toxic effects of both metals (Bayçu and Önal, 1992; Delhaize and Ryan, 1995). Root toxicity is an important problem for cultivation plants (Jones and Kochian, 1995). Root extension for either maize or lentil both at germination and growth stages after germination was inhibited by significantly affected from both two metals. Inhibition of root extension may be an important cause of Al/Cd inhibitive effect in from of the seed germination. Radicula output and root extension inhibition may occur by the way that these metals prevent cell division (Vazquez et al., 1992b) and DNA synthesis necessary for cell division (Matsumoto and Morimura, 1980) or increase of internal amount of abcycici acid (ABA) available at the seed (Abdalla, 2008). This hormone showing an increase at the various stress existence at the plant (Zeewart and Creelman, 1988; Jia et al., 2002; Gonia et al., 2004) leads to decrease at so many growth and development parameters such as mainly germination and root and body extension, fresh weight, dry weight and water content of the plant (Bray, 1988; Kabar, 1997). Al and Cd leaded to decrease at fresh weights of the seedlings from the germinated seeds. This situation indicates that blowing up the seeds by taking water as a precondition for the germination is inhibited by both of the metals. Türkay (2011) working with Al and Poschenrieder et. al. (1989) working with Cd received the same findings. As known, the events series that will start the germination such a hydrolytic activity only occur by the way that seed takes water and blow up. The inhibition deficiency may verify hydraulic activity deficiency. On the other side, these metals may prevent embryo transfer of the reserves at the seed by preventing synthesis and/or activity of the hydrolyses such as α-amylase (Wang and Kao, 2005). It is once more observed in this study that seed germination is the most sensitive phase at the life cycle of the plant (Bozcuk, 1978). On the condition that seed achieves germination at the existence of metal stress, it may be luckier in terms of maintaining the life process despite the stress existence at the growth period after the germination. The metal pressure seen on especially on the radicle extension on of these plant species at the germination period may be resulted from Ca^{2+} deficiency led by Al (Kruger and Sucoff, 1989; Huang and Bachelard, 1993) or prevention of cell division resulted from especially Cd based DNAaz avtivty increase (Lee et al., 1976). In the literature, mostly the generalizations such as metal stress and prevention are done relevant to effects of various growth parameters such as root growth, stem and leaf growth to metal pollution (Baker and Walker, 1989). But the studies in the literature concerning to different effects of different metals are both very few and they are studies specific to the specie. On the other side, both it is not possible that all plants give the same reaction(s) to a stress factor and this means neglecting the fact that the species may have different hardware.

Similar to our results in the study of cotton, rice and two barley cultivars; cadmium and aluminum stress may cause serious physiological, ultramorphological, biochemical anomalies on growth, root morphology, photosynthetic parameters and transpiration (Ali et al. 2011; Daud et al., 2013; He et al., 2014).

There should be alternative different ways and mechanisms in terms of coping with stress as well as the similar reactions. Both of these situations are seen in this study. As at all livings, there is also environment – structure – function coordination at the plants. As well as that there may be similarities on so many plant species at this coordination, there may be different coordination from other species that may service to the plant life at the variety level and make contribution to coping with stress.

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