Possibilities for using soils polluted with heavy metals for seedlings production of annual flowers

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Abstract

The experiment with Tagetes patula cv. "Roodkapje" and Ageratum houstonianum cv. "Delphy" grown on polluted soil with different levels of Pb, Zn, Cu and their combination was studied. Pot experiment in four replications was carried out. The morphological behavior in T. patula and A. houstonianum, stem and flowers were investigated.

The results show that the highest doses of pollution with Cu, Pb inhibit the stem laterals with 11.3% and 15.0% for T. patula and with 9.6% and 8.5% for A. houstonianum respectively. There is a tendency towards reduction of number of flowers with increasing of concentration in all treatments, and at highest doses the rates are reduced by 12.9% for Cu; 35.5% for Zn; and 38.7 % for Pb for T. patula and 4.8% for Cu, Zn, Pb for A. houstonianum. The changes in the phenologylal behavior of T. patula and A. houstonianum are insignificant.

Key words: Ageratum houstonianum, biometrical behavior, heavy metals, pollution, Tagetes patula

Introduction

The published data on the content of heavy metals in plants shows that it varies depending on the type of the crop, the soil conditions, the applied agricultural technology and the climate (Boyadjiev, 1980). Growing agricultural crops in the regions with heavy metals polluted soils brings the necessity of solving a lot of problems, concerned with influence on vegetative and decorative behavior of plants (Aleksiev, 1987). The known data from the scientific literature is incomplete and often contradictory. It was found that the heavy metals content in the soil influences germination in annual flowers, biometrical responses, vase life of some cut flowers (Ivanova, 2005), etc. The purpose of our research was to establish the influence on decorative and vegetative behavior of Tagetes patula and Ageratum houstonianum, as a result of heavy metals content in the soil.

Material and methods

It was carry out an model experiment on polluted with heavy metals (Cu, Zn, Pb and their combination) soil for estimating their influence in cultivation of test crops – Tagetes patula, cv. "Roodkapje" and Ageratum houstonianum, cv. "Delphy". The treatments were done with $CuSO_4.5H_2O$; $ZnSO_4.7.H_2O$ and $Pb(NO_3)_2$ with working solution 50 ml per plant in there consentrations, respectively for Pb – 500 mg; 125 mg and 31.25 mg; for Zn – 150 mg; 37.5 mg; 9.38 mg; for Cu – 150 mg; 40 mg and 10 mg. The plants were grown by the conventional technology for seedlings production of annual flowers. Indices, determining the ornamental qualities and morphologycal characteristics of plants were estimated. The variants analysis was made by Fisher`s method. For the similarity in the results averaged values are given.

Results and discussion

It can be observed from the data on the phenological observation (Table 1) that the soil pollution by heavy metals does not influence significantly the flowering phases in T. patula and A. houstonianum. Budding srarts from 26 (control) to 31 (Cu + Zn + Pb) days for T. patula and from 34 (Cu) to 37 (Cu + Zn + Pb) days

for A. houstonianum after sowing, as only under combined treatment plants initiate this phase later that the other variants. The differences are within the range of 3-5 days and they are not proved. A similar tendency is observed also at the onset of blooming – plants initiate onset of blooming later that the other variants only under combined treatment (Cu + Zn + Pb).

The results show that the highest doses of pollution by Cu, Zn, and Pb, inhibit the number of stem laterals (Table 2), respectively by 46.3 %; 38.8% and 62.5% for T. patula and 56.4%, 47.9% and 3.19% for A. houstonianum. The stem diameter has not been influenced significantly by heavy metal pollution – the values of this index in the different variants are close to the control value, as the differences vary from 0.5 cm less (in combination of Cu + Zn + Pb) for T. patula to 0.3 cm more (in Pb) for A. houstonianum. The number of leaves follows the tendency established in the of stem laterals – the plants grown on polluted soil treated by the lowest doses both of the separated metals – Cu; Zn; Pb and also by their combination have the greatest value. All these variants are less than the control number respectively by 6.8%; 6.8%; 29.9% and 28.7% for T. patula and 20.5%; 1.3%; 2.8% and 48.7% for A. hous tonianum. The results of volume of root system show that pollution with separate metals Cu, Zn, Pb has a slightly stimulating effect for root system of T. patula with exception of combinated treatments (Cu + Zn + Pb). The plants of A. houstonianum, grown on polluted soil, treated both of the separated metals Cu; Zn; Pb and also by their combination, have lower volume of root system in all variants that the control. The number of flowers (Table 3) in all variants of T. patula is lower that the control and it varies from 1.6 (Cu + Zn + Pb) to 3.2 (Pb). The drastically small number of flowers in the plants treated by the three high concentration of the combination of Cu + Zn + Pb is quite impressive – without flowers; 1.6 and 2.7 respectively, this being 100%, 48.4% and 12.9% smaller than the control variant. The same tendency is observed in A. houstonianum where the highest dose of Cu, Pb and combination (Cu + Zn + Pb) are without any flowers. In most variants the growing of T. patula and A. houstonianum on soils polluted by heavy metals, leads to the increasing of flower diameter, as the differences compared to the control, vary from 0.3 cm (Cu and Zn high dose) to 0.5 cm (Zn high dose). The exceptions in both species are the plants treated by the combination of the three metals. The number of buds follows the tendency established in the number of flowers.

Conclusions

The grown of Tagetes patula and Ageratum houstonianum on soils polluted by heavy metals. does not influence significantly the budding and the onset blooming of the plants. It has been established that the increase of the concentration of the heavy metals in the soil leads to reducing of the stem laterals. number of leaves and buds. No significant influence on the stem diameter has been observed. A clearly manifested stimulating effect on the diameter of the inflorescences has been observed – the bigger the concentration of the heavy metals. the larger the sizes of the inflorescences. The greatest is the number of inflorescences in the presence of the low doses of pollution caused both by the separate metals. and also by their combination.

It has been established that T. patula and A. houstonianum can be used for gardening in places polluted with heavy metals.

References

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Table 1. Phenological indices

Variant		Tagetes patula				Ageratum houstonianum			
		Budding		Onset of blooming		Budding		Onset of blooming	
		data	days from setting	data	days from setting	data	days from setting	data	days from setting
K		27.03	26	4.04	35	3.04	34	16.04	47
Cu	1	30.03	29	4.04	35	4.04	35	15.04	46
	2	29.03	28	3.04	34	3.04	34	16.04	47
	3	29.03	28	3.04	34	3.04	34	16.04	47
Zn	1	29.03	28	5.04	36	4.04	35	17.04	48
	2	28.03	27	4.04	35	4.04	35	16.04	47
	3	29.03	28	4.04	35	4.04	35	17.04	48
Pb	1	30.03	29	6.04	37	5.04	36	16.04	47
	2	30.03	29	6.04	37	4.04	35	16.04	47
	3	29.03	28	6.04	37	4.04	35	16.04	47
Cu+Zn+Pb	1	31.03	30	8.04	39	5.04	36	18.04	49
	2	1.04	31	6.04	37	6.04	37	17.04	48
	3	31.04	30	6.04	37	6.04	37	17.04	48

Table 2. Vegetative behaviors

Variant		Tagetes patula				Ageratum houstonianum			
		Stem laterals	Stem diameter	Number of leaves	Volume of root system	Stem laterals	Stem diameter	Number of leaves	Volume of root system
K		8.0	0.8	7.3	3.8	9.4	0.6	7.8	5.6
Cu	1	4.3	0.5	3.9	4.1	4.1	0.4	3.4	4.9
	2	5.6	0.6	5.0	5.1	5.2	0.4	4.8	4.9
	3	7.1	0.6	6.8	6.3	8.5	0.6	6.2	6.1
Zn	1	4.9	0.5	4.3	4.3	4.9	0.4	4.0	4.8
	2	4.8	0.5	4.5	4.3	6.7	0.5	5.9	4.2
	3	6.8	0.6	6.8	4.8	8.6	0.7	7.9	4.0
Pb	1	4.3	0.5	4.0	4.3	5.3	0.5	5.0	5.1
	2	4.1	0.5	4.0	4.2	5.9	0.6	5.0	4.3
	3	7.5	0.7	5.7	4.8	9.1	0.9	7.2	4.0
Cu+Zn+Pb	1	1.6	0.3	1.0	3.0	3.3	0.3	3.0	2.8
	2	4.0	0.4	4.3	2.9	4.1	0.4	4.0	2.8
	3	5.8	0.4	5.2	3.6	4.4	0.4	4.0	3.4
GD	5%	3.41	0.15	3.66	2.88	4.18	0.21	3.84	3.91
	1%	4.60	0.28	4.94	3.91	5.66	0.34	4.52	4.48
	0.1%	6.18	0.34	6.84	4.52	7.11	0.45	6.88	5.67

Table 3. Reproductive behavior

Variant		Tagetes patula						Ageratum houstonianum					
		Flowers		Diameter		Buds		Flowers		Diameter		Buds	
		number	%	cm	%	number	%	number	%	cm	%	number	%
K		3.1	100	1.5	100	5.2	100	2.1	100	0.5	100	7.3	100
Cu	1	2.7	87.1	1.8	120.0	2.0	38.4	-	-	-	-	4.1	50.1
	2	2.9	93.5	1.9	126.6	3.1	59.6	1.3	61.9	0.8	160.0	4.0	54.7
	3	3.0	96.7	2.0	133.3	4.1	78.8	2.0	95.2	0.9	180.0	6.5	89.0
Zn	1	2.0	64.5	1.8	120.0	2.9	55.7	0.8	38.1	1.0	200.0	4.1	56.1
	2	2.1	67.7	1.7	113.3	2.8	53.8	1.0	47.6	0.8	160.0	5.7	78.1
	3	2.8	90.3	2.3	153.3	4.0	76.9	2.0	95.2	0.8	160.0	6.6	90.0
Pb	1	1.9	61.3	1.9	126.6	2.4	46.2	-	-	-	-	5.3	72.6
	2	1.7	54.8	2.1	140.0	2.4	46.2	0.9	42.9	0.9	180.0	5.0	68.4
	3	3.2	103.2	2.2	146.6	4.4	84.6	2.0	95.2	0.9	180.0	7.0	95.8
Cu+Zn+Pb	1	-	-	-	-	1.7	32.7	-	-	-	-	3.3	45.2
	2	1.6	51.6	1.0	33.3	2.4	46.2	1.1	52.4	0.3	60.0	3.0	41.0
	3	2.7	87.1	0.8	46.6	3.1	59.6	1.1	52.4	0.3	60.0	3.3	45.2
GD	5%	1.54		2.31		3.42		1.57		1.34		4.57	
	1%	2.31		4.58		4.54		2.68		2.41		5.63	
	0.1%	4.48		4.98		6.88		3.34		4.51		6.41	