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Features of the Formation of Morphological Structures and Production of *Typha angustifolia* under Load on Lead

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Typha angustifolia L. is one of the most important helophyte. The aim of this study was to identify morphological and production reactions _Typha angustifolia_ under the action of different concentrations of lead. It was found that lead concentrations of 0.25; 2.5 and 10 mg / l stimulated the growth and production processes in the cattail, but at higher concentrations effect of stimulation was decreased. The highest lead concentration (10.0 mg / l) caused a decrease in the average leaf area. Stimulation of growth and production indicators of cattail plants can be considered as an adaptive response to pollution.

Key words: *Typha angustifolia,* lead, pollution, morphology, plants, biomass.

Typha angustifolia L. is one of the most important helophyte. On the Kuibyshev reservoir it takes 65% of the entire area (which is about 8 th. hectares) of littorals, overgrown with macrophytes[1]; it is an essential edificator of littoral zone and swamped-plots of watershed. This high level of overgrowing allows this kind the pioneering new settlement over-heating area[2], to has the advantage where another plants can not exist[3]. Furthermore, it is namely *Typha angustifolia* is more suited to inconstancy of the water level, which is characteristic of the Kuibyshev water-storage than *Typha latifolia* and other species of macrophytes.

Among toxicants, a serious environmental problem is the lead belongs to the group of the most dangerous metal fishing-toxicants for human and animal health[4]. Because of the lack of biodegradation properties of its accumulation in the environment, it is a serious environmental problem. Susceptible to lead contamination are both terrestrial and aquatic ecosystems experiencing effects of the toxicant, it is also another living organisms of different levels of organization[5], including higher aquatic plants. One of the criteria for evaluating the adaptive capacity of plants in a changing environment are morphological and production characteristics[6]. The latter are the results of labile processes allowing to quickly rebuild direction of metabolism in a changing environment, in particular human made load[7,8]. This ability can be used in determining the ecological plasticity of plants under load of toxicants with different mechanisms of action.

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The aim of this study was to identify morphological and production reactions *Typha angustifolia* under the action of different concentrations of lead.

MATERIALS AND METHODS

In the experiments, we used one of the most common plants in reservoirs of central Russia - *Typha angustifolia* L. This is a representative of a transitional form from terrestrial plants to water (helophyte). For its root system, it is characterized by a number of morphological and anatomical features of the structure present in typical aquatic plants - the presence of thick and thin rhizomes of adventitious roots - water and soil, a well-developed pneumatic tissue - aerenchyma that permeates all the organs of plants and provides a better gas exchange[9].

Research was conducted under the conditions of the experimental ponds including natural water with volume of 30 liters with concomitant hydrobiont, soil clumps, representative higher aquatic plants - *Typha angustifolia*, imported from Middle Lake Kaban. It is located in the city of Kazan, Republic of Tatarstan of the Russian Federation. When selecting the volume of experimental ponds was guided by methodical data Tsirtsisa[10.11]. These investigators noted that the volume of 30 liters produces satisfactory reproducibility and good agreement experimental-mental results with calculations on the model[10]. We simulated two types of habitats - overgrown (with *Typha angustifolia*) and open ones (without it). The prepared waters were stored at special areas of our Research Institute.

As the contaminant we used in the lead acetate salt $Pb(CH_3COO)_2$ in concentrations of 0.25; 2.5 and 10 mg / l. In the experimental ponds lead acetate was added once in two weeks after the post-design of experiments, when the system is stabilized, and the plants have taken root (beginning of June).

In the experiments, we considered the following averages parameters for plants of each variant and the controls: the length of the aerial parts of the plant, amount of shoots per 1 m^2, the maximum width of the leaves, the total biomass of plants, masses of elevated and underground parts and their relationship. Measurements were made in the seasonal dynamics. Determination of aboveground biomass and ground-term parts of *Typha angustifolia* was performed by the standard technique, it was expressede in grams of dry matter per 1 m^2 [12].

RESULTS AND DISCUSSION

We revealed the specificity of the morphological and production indicators of control and experimental variants in relation to the growing season and concentrations of the toxicant.

Morphological parameters after acclimatization of plants to a change of habitat conditions (transplantation from natural reservoirs) were increased in the seasonal dynamics of reaching certain thresholds. The maximum number of shoots was noted in experimental variants (compared to control). So, in the middle of August at a concentration of lead of 0.25 mg / l we detected 22 new formations (Table 1); at concentration of 2.5 mg / l during this period 19 shoots were detected (Table 2). This suggests that a higher concentration of lead (2.5 mg / l) decelerates the formation of new shoots in comparison with the lower (0.25 mg / l), and in relation to control it remained stimulating. With increasing concentrations of lead and 10 mg / l (Table 3), the number of shoots in the experimental version is even lower than at the low concentrations, but remained above the control, so it was maintained the stimulatory effect of lead. The average area of the sheet - for this indicator lead concentration of 0.25 mg / l was slightly stimulating (Table 1); 2.5 mg / l - in the beginning of the experiment stimulating, and from August - inhibitory (Table 2); 10.0 mg / l – it was exclusively inhibitory (Table 3).

When the lead concentration was 0.25 mg / l, the total biomass plants in the experimental variant exceeded that of controls by 1.9 times, aboveground - 3.3 times, underground - 1.2 times (Table 4); at 2.5 mg / l, respectively, 1.6; 1.2 and 1.6-fold (Table 5); at 10.0 mg / l - 1.5; 1.3 and 1.5 (Table 6).

The obtained results allow to conclude that the studied concentration of lead stimulated growth and production processes in the plant, but the effect of stimulation was reduced at higher concentrations. At that, there was not significant differences between the concentrations of 2.5 and

10.0 mg / l. However, as for the average area of leaf, the concentration of lead (10.0 mg / l) showed a clear inhibitory effect. The obtained results are consistent with the opinion of a number of authors, according to which heavy metals in low concentrations can have stimulating effect on

Table 1. Growth characteristics for *Typha angustifolia* under lead load (0.25 mg / l) (l – a length of ground part, cm, a – maximal width of a leaf, cm, n - number of bines, S- average area of leaves, cm^2)

Date of	Control				Lead (experimental variant)			
observation	l	a	n	S	l	a	n	S
30.05.	110,5	0,7		77,4	120,0	0,7		84,0
19.06.	143,0	0,7		100,1	140,0	0,7		98
28.06.	151,0	0,8		120,8	157,0	0,8		125,6
17.08.	140,0	0,8	14	112,0	164,0	0,8	22	131,2

Table 2. Growth characteristics for *Typha angustifolia* under lead load (2.5 mg / l) (l – a length of ground part, cm, a – maximal width of a leaf, cm, n - number of bines, S- average area of leaves, cm^2)

Date of	Control				Lead (experimental variant)			
observation	l	a	n	S	l	a	n	S
8.07.	140	0,7	12	84	160	0,6	14	96
18.08.	185	0,8	13	148	180	0,7	19	126
20.09.	170	0,8		136	180	0,7		126

Table 3. Growth characteristics for *Typha angustifolia* under lead load (10mg / l) (l – a length of ground part, cm, a – maximal width of a leaf, cm, n - number of bines, S- average area of leaves, cm^2)

Date of	Control				Lead (experimental variant)			
observation	l	a	n	S	l	a	n	S
10.06.	115	0,6	11	69	115	0,5	14	57,5
15.07.	125	0,6	11	75	120	0,5	14	60
16.08.	125	0,6	13	75	125	0,5	16	62,5
18.09.	135		17		135		18	

Table 4. Biomass of *Typha angustifolia* under lead load (0.25 mg / l)

Variant	Total	Ground biomass		Underground biomass	
	biomass, g	g of dried substance	% of total	g of dried substance	% of total
Control	246,4	79,8	32,4	166,6	67,6
Lead (experimental variant)	468,6	264,0	56,3	204,6	43,7

Table 5. Biomass of *Typha angustifolia* under lead load (2.5 mg / l)

Variant	Total	Ground biomass		Underground biomass	
	biomass, g	g of dried substance	% of total	g of dried substance	%of total
Control	1548,8	98,8	6,4	1450	93,6
Lead (experimental variant)	2438,8	118,8	4,9	2320	95,1

growth processes. For example, cadmium ions rose the percentage of germinated seeds in pea plants[13]. In the presence of lead increased plant height, number of lateral shoots and the length of the spike in wheat plants[14], number of leaves and the height of pea plants[15], above-ground biomass in rape plants (http://yadyra.ru/attachments/hm-rape.pdf). In papers of some authors, it was demonstrated the stimulatory effect of heavy metals (cadmium, zinc, and lead) on the growth of roots[16-18]. Lead in concentration of 200 mg / kg of the substrate has a positive effect on plant height of *Setaria viridis* and over-ground biomass[19]. A similar effect of low concentrations of the metals can be associated with the activation of cell division, as well as with increased size of cells[20]. In general, such a stimulation can be considered as an adaptive response of plants to abiotic stress.

Table 6. Biomass of *Typha angustifolia* under lead load (10mg / l)

Variant	Total biomass, g	Ground biomass		Underground biomass	
		g of dried substance	% of total	g of dried substance	%of total
Control	1882,3	82,3	4,4	1800	95,6
Lead (experimental variant)	2825,8	105,8	3,7	2720	96,3

Findings

1. Lead concentrations of 0.25; 2.5 and 10 mg / l stimulated the growth and production processes in the cattail, but at higher concentrations effect of stimulation was decreased.
2. The highest lead concentration (10.0 mg / l) caused a decrease in the average leaf area.
3. Stimulation of growth and production indicators of cattail plants can be considered as an adaptive response to pollution.

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