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THE DYNAMICS OF TRACE ELEMENTS CONTENTS IN SOIL AND SUNFLOWER LEAVES DURING LONG-TERM FERTILIZATION

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The researches results of dynamics changes of trace elements (Mn, Zn, Cu, B) contents in soil and sunflower leaves during the vegetation period under different fertilization with organic and mineral fertilizers are showed. The investigations were conducted under conditions of stationary field experiment in the Southern Steppe zone, samples of soil and plants were taken simultaneously four times during the vegetation period according to the phases of plant development. It was found that long-term (four rotations) trace elements fertilization both individually and on a background of manure (8 t / ha and 15 t / ha) increases the trace elements contents in the leaves. From the beginning to the end of vegetation trace elements content decreases both in the soil and plants. The dynamics of changes for each of the studied trace elements is different.

***Key words**: trace elements, sunflower, Southern Steppe zone.*

Introduction. The role of trace elements in plant nutrition is multifaceted. In particular, Mn, Zn, Cu, B, and others increase the activity of many enzymes systems in the plant and improve other batteries from the soil [1]. The trace elements are actively involved in photosynthesis, respiration, carbohydrate and protein metabolism and affect the intensity of biochemical reactions [2, 3, 4]. The influence of organic and mineral fertilizers for the trace elements content in agricultural plants revealed in the scientific works of many authors [5, 6, 7]. The dynamics of the trace element content in sunflower plants during the growing season in the arid conditions of southern Ukraine is almost not investigated, that's why this also dedicated to our work.

Purpose – to **determine** the long-term **application** after-effect of organic and mineral fertilizers on the dynamics of trace elements content in soil and in the sunflower leaves of crops during the growing season.

The methods and conditions for investigations. The researches were conducted on the basis of stationary field experience the IAR NAAS Black Sea, which laid in 1972 on the chernozem southern heavy clay loam in the arid Steppe zone conditions.

The alternation of cultures in crop rotation: bare fallow, winter wheat (*Triticum aestivum L.*), maize (*Zea mays L.),* peas (*Pisum sativum*), winter wheat (*Triticum aestivum L.*), corn milky-wax ripeness (*Zea mays L.*), winter wheat (*Triticum aestivum L.*), and sunflower (*Helianthus annus L.*). Cultivated such sunflower hybrids: Meridian, Alliance, Altes, Serzhon, Khors.

During investigations it was of four crops rotation. The first rotation was 10-fields, following – 8- fields. The options for field experience trials - the total amount of applying fertilizers on 1 ha of crop rotation area for the four rotation cycles is represented in Table 1.

As mineral fertilizers applied ammonium nitrate (NH_4NO_3), granulated superphosphate ($Ca(H_2PO_4)_2•H_2O+H_3PO_4+2CaSO_4•2H_2O$) and potassium salt (KCl). Fertilizers were applied in the autumn under the plowing.

Experience options replications – 3-times. The size of the research area – 48 m^2.

To determine the content of Mn and Zn mobile forms in soil samples used acetate ammonium buffer solution with pH 4,8; to determine the content of Cu mobile

forms – solution 1N HCl [8, 9, 10], boron [11]. For the determination of the trace elements content in plants used standard methods [12, 13].

Soil samples were taken from the topsoil and preparing a mixed sample of each variant of the experiment in four-times. Sample the leaves of plants were collected in the amount of 10 reps with one variant of experience and prepared 4 mixed sample after drying plant material. Sampling of soil and plants was carried out simultaneously according to the phases of plant development.

1. The amount of fertilizer for four rotations

Variant [1)]	The total amount of fertilizer, t / ha			
	Manure	Mineral (active ingredient)		
		N	P_2O_5	K_2O
Control (without fertilizer)	0	0	0	0
Manure –8 t/ha + $N_{56.5}P_{47.8}K_{41.8}$	245	1,675	1,435	1,255
$N_{56.5}P_{47.8}K_{41.8}$	0	1,675	1,435	1,255
Manure – 15 t/ha + $N_{56.5}P_{47.8}K_{41.8}$	410	1,675	1,435	1,255
[1)] *average norms of crop rotation area for four crop rotation*				

Results. Determined that the content of trace elements in soil and plants change during the sunflower growing season. The manganese content in arable soil layer without fertilizers in phase 4-6 leaves was is 70.94 mg/kg, and the period of complete maturity decreased to 43.7 mg/kg (Table 2). The decrease in the content of manganese in the period of vegetation is observed in plants. The systematic application of fertilizers increased the manganese content in the soil and plants, but its pattern of decline during the growing season of plants remains.

Sunflower refers to the cultures of the increased removal of trace elements [14]. In all phases of plant development is well provided manganese, due to its high content in the soil.

2. *Dynamics of trace elements content in soil and sunflower plants on the phases of plant growth during the growing season (average of the hybrids, 2006-2008)*

Variant	Object	The content of microelements in soil and plants on phases of plant development (mg/kg of soil, mg/kg of dry substance)			
		4–6 leaves	budding	flowering	full ripeness
Manganese					
Control (without fertilizer)	soil	70,94	54,20	55,20	43,70
	leaves of plants	93,60	68,10	57,90	24,80
Manure –8 t/ha + $N_{56.5}P_{47.8}K_{41.8}$	soil	78,22	59,90	60,90	51,34
	leaves of plants	102,80	75,30	66,60	28,80
$N_{56.5}P_{47.8}K_{41.8}$	soil	76,94	57,94	59,96	51,08
	leaves of plants	102,10	78,10	62,50	30,40
Manure – 15 t/ha + $N_{56.5}P_{47.8}K_{41.8}$	soil	81,78	60,92	62,44	54,38
	leaves of plants	106,3	73,5	62,6	30,2
Zinc					
Control (without fertilizer)	soil	1,05	0,56	0,51	0,41
	leaves of plants	23,70	21,10	19,10	12,40
Manure –8 t/ha + $N_{56.5}P_{47.8}K_{41.8}$	soil	1,20	0,75	0,55	0,49
	leaves of plants	26,30	22,00	19,60	13,70
$N_{56.5}P_{47.8}K_{41.8}$	soil	1,15	0,61	0,56	0,49
	leaves of plants	28,80	25,40	21,90	14,20

Manure – 15 t/ha + $N_{56.5}P_{47.8}K_{41.8}$	soil leaves of plants	1,39 29,20	0,73 26,00	0,64 23,50	0,57 15,30
Copper					
Control (without fertilizer)	soil leaves of plants	10,92 12,10	10, 52 11,80	9,98 9,80	9,62 7,88
Manure –8 t/ha + $N_{56.5}P_{47.8}K_{41.8}$	soil leaves of plants	11,56 11,00	10,86 10,90	10,34 8,40	9,82 5,53
$N_{56.5}P_{47.8}K_{41.8}$	soil leaves of plants	12,28 12,50	11,68 11,40	10,58 8,80	9,84 6,02
Manure – 15 t/ha + $N_{56.5}P_{47.8}K_{41.8}$	soil leaves of plants	13,08 12,90	12,02 13,00	11,14 7,80	10,62 5,06
Boron					
Control (without fertilizer)	soil leaves of plants	1,22 35,60	1,10 26,70	0,96 21,40	0,75 18,2
Manure –8 t/ha + $N_{56.5}P_{47.8}K_{41.8}$	soil leaves of plants	1,56 37,00	1,36 28,30	1,18 23,40	1,00 19,60
$N_{56.5}P_{47.8}K_{41.8}$	soil leaves of plants	1,44 37,40	1,20 28,30	1,04 22,70	0,86 19,20
Manure – 15 t/ha + $N_{56.5}P_{47.8}K_{41.8}$	soil leaves of plants	1,66 41,50	1,42 31,90	1,26 25,2	1,08 20,60

The content of zinc in the soil decreased during growth of sunflower on control plots from 1.05 to 0.41 mg/kg of soil, or 39 %. Decreasing the amount of zinc content in plants occurs in 52%. For the systematic application of fertilizers, the content of zinc significantly increased, but remains at low levels as in soil and plants. Low zinc content in soil indicates the need for complex or zinc micronutrient fertilizers containing zinc.

The content of copper mobile form in soil and plants remains the most stable during the whole sunflower vegetation period, and the degree of this trace element is assessed as high. But the application of fertilizers increases its content though to a small extent.

Boron for sunflower is necessary during the entire of vegetation period. The content of boron in the soil decreased during growth of sunflower on control plots from 1.22 to 0.75 mg/ kg, or 62%. There is also a reduction of boron content in the leaves by 51%. However, with regular fertilizer, boron content in the soil increased and the availability of plant it is optimal. Under the influence of boron increases the content of phosphorus in the upper young leaves, and at the bottom, on the contrary, decreases.

Conclusions

1. The positive effect of long-term fertilization on the content of manganese, zinc, copper, and boron in soil and sunflower plants in dynamics during the vegetation period is determined. The most deficient micronutrient in chernozem southern is zinc.

2. Established certain dynamics of trace elements (Mn, Zn, Cu, and B) content in the leaves of sunflower with the phases of development (4–6 leaves, budding, flowering, full ripeness).

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