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AGROBIOLOGICAL FEATURES OF INCREASING THE OAT AND SPRING BARLEY PRODUCTIVITY IN NORTHERN STEPPE OF UKRAINE

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The article reflects the results of researches to identifying the effective agrobiological methods of increasing the grain productivity in oat and spring barley plants. It is established, that spring small cereal crops, placed after recommended predecessors, much better reacts to increasing agrochemical background. Cultivation of oat and spring barley after predecessor winter wheat by application $N_{40}P_{40}K_{40}$ and subsequent feeding plants by nitrogen in the phase of tillering (N_{30}) and spraying micronutrients reakom provides the largest grain harvest – 3,96 and 3,32 t/ha, respectively, in of oat and barley plants, while reducing the pesticide load on agrocoenosis.

Keywords: *oats, spring barley, predecessors, mineral fertilizers, grain, crop yield.*

Formation the highly stable agrocenoses of cereals in general, and oats and spring barley in particular, is largely depends on the choice of the predecessor, which affects the agrochemical, agrophysical and biological properties of soil and also on the phytosanitary conditions, that defines a system of care for these crops sowings. It is well known, that spring oats and barley are less demanding crops to soil fertility than spring wheat. However, their crop yield increases sharply when placing after the best predecessors. Therefore, measures that provide optimal conditions for oats and spring barley with intensive growing technology, should stick to the basic requirements agrobiological – they should be sown on fertile, weed-free soil [1, 2].

Despite the important agronomic, biological and dietary value of oats and barley, grain yield and quality of these important, in feed and food regard, crops remains low, that can be a result of irregularities the technological discipline and environmental standards [3, 4].

The long and multifaceted search work toward the development of new and improvement of existing agrobiological methods of oats and barley growing, the results of which are reflected in the large number of scientific publications is not able to reduce the negative impact of the spring-summer droughts on the realization of genetically determined productivity potential of these crops. So, taking into consideration the lack of knowledge of the effects of current farming elements to growing modern varieties of oats and spring barley in dry conditions Steppe of Ukraine, it is feasible to develop the agrobiological farming techniques aimed at improving the efficiency and stabilization of environmentally sound grain products. In this regard, relevant, in our view, is to identify the most effective ways of acclimatization the oats and barley plants to drought conditions by optimizing the mineral nutrition under various predecessors as consistent with agrobiological requirements of crops.

The study was conducted at the Erastivka Experimental Station of the Institute of Agriculture of Steppe zone of NAAS during 2011–2013, according to generally known methods [5, 6]. Soil of experimental field – ordinary chernozem, low-humic, loamy. The humus content in arable soil layer (0–30 cm) – 4,0–4,5 %, total nitrogen – 0,23–0,26 %, phosphorus – 0,11–0,16 %, po-tassium – 2,0–2,5 %, pH of water extract – 6,5–7,0.

Field experiments were laid after 3 predecessors: winter wheat, corn for fodder and sunflower on a background of different rates of NPK. Seeding rate of barley and oat was 4,5, million of grains/ha. In experiments seeded varieties of oats (Busol) and spring barley (Ilot).

Soil preparation, sowing, care of crops and harvesting were carried out according to the zonal recommendations. Variants in a field experiment designed systematically, with three replications. Accounting plots area – 50 m^2.

Weather conditions during the investigation were different, which made it possible to fully assess its impact on grain productivity potential of spring small cereals. Thus, in 2011, during the growing season dropped 245,3 mm of rainfall, which is 25 mm more than the average long-term rate, the average temperature was 17,7 ºC, hydrothermic index (GTI) during the growing season was 1,33.

Extremely dry was 2012 (GTI = 0,61), which was characterized by higher temperatures (24,1 ºC, which is 9,1 ºC high than norm) and a deficit of rainfall (during the growing season dropped 172 mm of rainfall, 50 mm less the norm).

Weather conditions in 2013 and 2014 included both periods of drought and periods of abundant moisture (GTI = 0,77 and 1,18 respectively). The total depth of precipitation during the growing season in 2013 amounted to 141,2 mm and average atmospheric temperature 17,6 ºC and in 2014 – 188,3 mm and 16,8 ºC, respectively.

The aim of investigation was to identify effective agrobiological measures of increasing the grain productivity of small cereal crops (oat, variety Busol and spring barley, variety Ilot) in Northern Steppe of Ukraine by choosing the best predecessor and integrated use of mineral fertilizers and micronutrients.

1. Formation the structure elements of oat crop yield depending on the predecessor and background of mineral nutrition (means for 2011–2014)

Predecessor (A)	Background of mineral nutrition (B)	Panicle length, cm	Index of productive tillers	Grain weight, per plant, g	Grain weight, per panicle, g
winter wheat	control	13,78	1,31	1,43	1,09
	$N_{20}P_{20}K_{20}$	13,78	1,33	1,61	1,21
	$N_{20}P_{20}K_{20}$ + N_{30}	14,14	1,32	1,63	1,24
	$N_{20}P_{20}K_{20}$ + N_{30} + reakom	14,36	1,36	1,65	1,21
	$N_{40}P_{40}K_{40}$ + N_{30} + reakom	14,55	1,38	1,67	1,21
corn for fodder	control	13,73	1,13	1,15	1,02
	$N_{20}P_{20}K_{20}$	14,23	1,21	1,46	1,21
	$N_{20}P_{20}K_{20}$ + N_{30}	14,88	1,30	1,52	1,16
	$N_{20}P_{20}K_{20}$ + N_{30} + reakom	15,08	1,34	1,58	1,18
	$N_{40}P_{40}K_{40}$ + N_{30} + reakom	14,70	1,47	1,66	1,14
sunflower	control	13,29	1,17	1,38	1,18
	$N_{20}P_{20}K_{20}$	13,60	1,22	1,40	1,15
	$N_{20}P_{20}K_{20}$ + N_{30}	13,78	1,29	1,41	1,10
	$N_{20}P_{20}K_{20}$ + N_{30} + reakom	13,95	1,34	1,50	1,11
	$N_{40}P_{40}K_{40}$ + N_{30} + reakom	14,05	1,41	1,55	1,10
LSD_{05} for: factor A		0,29	0,10	0,15	0,10
factor B		0,37	0,08	0,11	0,08
interaction AB		0,46	0,13	0,20	0,13

It is commonly known that, the highest crop yields formed with optimal correlation structure elements of crop yields. Thus, in the studies found that the maximum panicle length (15,08 cm) in oats plants was in variant of the application $N_{20}P_{20}K_{20}$ and subsequent feeding by nitrogen in the phase of tillering (N_{30}) and spraying micronutrients reakom after predecessor corn for fodder, and the smallest (13,29 cm) – the plant in control after predecessor sunflower (watch the table 1).

The longest ear of barley plants was after predecessor winter wheat (7,11 cm) and corn for fodder (7,10 cm) in a variant of application $N_{40}P_{40}K_{40}$ and subsequent feeding by nitrogen in the phase of tillering (N_{30}) and spraying micronutrients reakom. In a similar option after predecessor sunflower the ear length was 2 % lower than after winter wheat and corn for fodder (Table 2).

Studies indicates that by proper choice of predecessor and application of science-based system of mineral nutrition may create the conditions for optimum density productive tillers. Thus, the average for 2011–2014 in variant of application $N_{40}P_{40}K_{40}$ and subsequent feeding by nitrogen in the phase of tillering (N_{30}) and spraying micronutrients reakom formed the largest density of productive oat stems and consequently the most productive tillering rate, which reached after predecessor sunflower – 1,41; winter wheat – 1,38 and after corn for fodder – 1,47.

A similar pattern is noted in barley crops.

2. Formation the structure elements of spring barley crop yield depending on the predecessor and background of mineral nutrition (means for 2011–2014)

Predecessor (A)	Background of mineral nutrition (B)	Ear length, cm	Index of productive tillers	Grain weight, per plant, g	Grain weight, per ear, g
winter wheat	control	6,65	1,54	0,99	0,64
	$N_{20}P_{20}K_{20}$	6,74	1,54	1,04	0,67
	$N_{20}P_{20}K_{20}$ + N_{30}	7,05	1,55	1,07	0,69
	$N_{20}P_{20}K_{20}$ + N_{30} + reakom	7,05	1,62	1,10	0,68
	$N_{40}P_{40}K_{40}$ + N_{30} + reakom	7,11	1,64	1,14	0,70
corn for fodder	control	6,23	1,25	0,82	0,66
	$N_{20}P_{20}K_{20}$	6,33	1,39	0,88	0,63
	$N_{20}P_{20}K_{20}$ + N_{30}	6,95	1,46	1,12	0,76
	$N_{20}P_{20}K_{20}$ + N_{30} + reakom	7,00	1,51	1,12	0,74
	$N_{40}P_{40}K_{40}$ + N_{30} + reakom	7,10	1,67	1,06	0,64
sunflower	control	6,59	1,27	0,88	0,69
	$N_{20}P_{20}K_{20}$	6,48	1,39	0,90	0,65
	$N_{20}P_{20}K_{20}$ + N_{30}	6,78	1,45	0,98	0,68
	$N_{20}P_{20}K_{20}$ + N_{30} + reakom	6,89	1,42	1,11	0,78
	$N_{40}P_{40}K_{40}$ + N_{30} + reakom	6,96	1,42	1,11	0,78
LSD_{05} for: factor A		0,24	0,13	0,10	0,08
factor B		0,18	0,10	0,08	0,06
interaction AB		0,28	0,19	0,13	0,10

Revealed, that the greatest productivity indicators of panicle (in oats) and ear (in barley) and density of productive stems on average in 2011–2014 formed in crops after predecessors – winter wheat and corn for fodder. To achieve an appropriate level of plant growth, even in the control va-riant (without fertilizers) after winter wheat and maize in variants after predecessor sunflower had to make, at least, $N_{20}P_{20}K_{20}$ at pre-sowing cultivation and subsequent feeding by nitrogen in the phase of tillering (N_{30}).

Though, despite the high economic effect, enriching the soil by nutrients must be substan-tiated, as much as fertilizers have some ballast. Especially, dangerous in this regard is the remains of heavy metals and radionuclides. Concentrating in the soil, they may inhibit plants, accumulates in concentrations that often exceed the maximum permissible limits, degrade soil status, inhibit microflora.

Research has established that the phytosanitary status in crops of oat and spring barley de-pended on the choice of predecessor and nutrition regimen. So, by the time of the study it was ob-served, that in spring small cereal crops sowings after predecessors – winter wheat and corn for fodder, development and spread of harmful organisms was not exceed the economic injury level (EIL).

Available in experiments weeds were represented by the following species: ragweed, field bindweed, field thistle, redroot pigweed, green foxtail, Canadian horseweed, field penny-cress and lamb's quarters. However, in the spring small cereal sowings after predecessor sunflower in favorable for water provision investigation years, it was noted the presence of drops previous culture, and higher doses of mineral fertilizers, especially nitrogen, resulted in an increase in natural infestation of plant diseases, which required the use of recommended herbicides and fungicides, increasing the pesticide load on agrocenosis (Table 3).

3. Phytosanitary status in crops of oat and spring barley after various precursors (means for 2011–2014)

Title	Oat	Spring barley

	Predecessors					
	winter wheat	corn for fodder	sunflower	winter wheat	corn for fodder	sunflower
Weeds, pcs./m^2						
annuals (incl. drop)	1,2	1,6	2,9	1,7	1,8	3,1
perennials	0,4	0,4	0,5	0,5	0,6	0,6
Development of plant diseases, %						
root rot	0,0	0,2	0,2	1,7	1,0	0,9
brown rust	0,1	0,0	0,0	0,0	0,0	0,0
Septoria leaf blotch	0,2	0,4	0,1	1,5	1,7	1,3
Pests, specimens/m^2						
corn-flies	10,1	8,0	8,2	11,2	9,1	8,2
aphids	3,3	3,1	3,2	3,5	3,5	3,3
cereal leaf beetles	3,7	3,4	3,5	3,0	3,1	3,1

The best conditions for growth and development of oat plants and respectively for obtaining the largest crop yield were in variants after predecessor winter wheat. The level of productivity, depending on the system of fertilization, reached 3,33–3,96 t/ha, while after predecessors – corn for fodder and sunflower it was 2,93–3,21 and 2,67–2,98 t/ha, respectively. The greatest response to fertilizer application was observed in plants after predecessor winter wheat (Fig. 1).

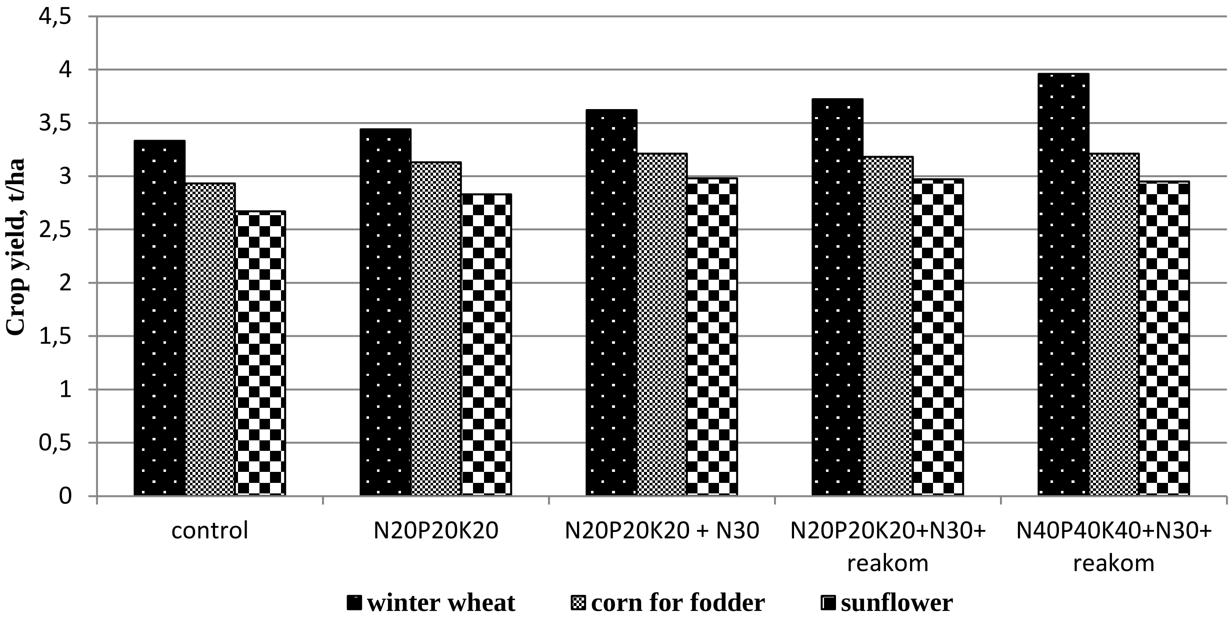

Fig. 1. Effect of predecessor and background of mineral nutrition on oats crop yield (means for 2011–2014) (LSD_{05} = 0,21 t/ha).

Compared with the control by application $N_{40}P_{40}K_{40}$ and subsequent feeding plants by nitrogen in the phase of tillering (N_{30}) and spraying micronutrients reakom in sowings after predecessor winter wheat obtained the increase of oats grain yield 0,63 t/ha (18,9 %), while after predecessor sunflower in similar variant received an increase of 0,28 t/ha (10,5 %), and after corn for fodder – 0,28 t/ha (9,6 %).

It should be also noted a positive effect of foliar fertilizing with nitrogen and spraying micronutrients reakom on increasing the environmental plasticity and implementation potential of oats crop yield. So, after predecessor winter wheat, feeding plants by nitrogen in the phase of tillering (N_{30}) the crop yield increased to 3,62 t/ha versus 3,44 t/ha – in the variant without fertilization. As a result of combination the feeding plants by nitrogen in the phase of tillering with spraying plants by micronutrients reakom the crop yield reached 3,72 t/ha. A similar situation is observed after other predecessors.

Effect of predecessors on realization the potential of barley crop yield was significant in all variants of the experiment. On average for 2011–2014 in variants after predecessor winter wheat formed the highest yield – 2,70–3,32 t/ha against 2,09–2,70 t/ha – after corn for fodder and 1,96– 2,73 t/ha – after sunflower (depending on the system of fertilization) (Fig. 2).

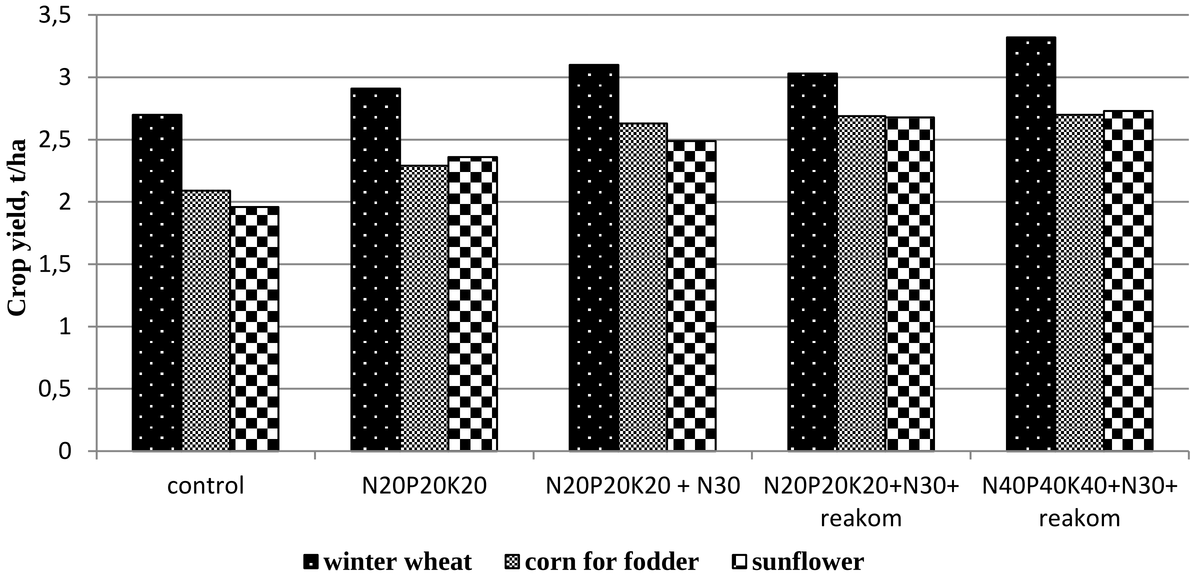

Fig. 2. Effect of predecessor and background of mineral nutrition on spring barley crop yield (means for 2011–2014) (LSD_{05} = 0,20 t/ha).

Compared with the control by application $N_{40}P_{40}K_{40}$ and subsequent feeding plants by nitrogen in the phase of tillering (N_{30}) and spraying micronutrients reakom in sowings after predeces-sor sunflower was obtained additional grain yield – 0,77 t/ha (39,3 %), while after winter wheat in the same variant received an increase of crop yield 0,62 t/ha (23,0 %), and after corn for fodder – 0,61 t/ha (29,2 %).

It is revealed the positive effect of foliar fertilizing with nitrogen and spraying plants by micronutrients reakom on increasing the crop yield of barley. So, after predecessor winter wheat by fertilizing plants by nitrogen in the phase of tillering (N_{30}) the grain yield increased to 3,10 t/ha versus 2,91 t/ha – in the variant without fertilization. A similar situation was observed after other predecessors.

Conclusions. Analyzing the experimental data, we can conclude that in drought conditions the effective agrobiological measure to improve grain productivity is predecessor, the correct selection of which significantly affects the increase of ecological plasticity and crop yields of oats and spring barley. Revealed that more adapted to the arid Steppe conditions are oats that during the years of the experiment provided by 0,72 t/ha (30,9 %) higher crop yield compared to barley. Research has established that spring small cereal crops planted after winter wheat and corn for fodder significantly better respond to increasing agricultural chemistry background. Revealed that cultivation of oat and barley after predecessor winter wheat by application $N_{40}P_{40}K_{40}$ and subsequent feeding plants by nitrogen in the phase of tillering (N_{30}) and spraying micronutrients reakom provides the greatest grain yield – 3,96 and 3,32 t/ha, respectively. Growing these crops after sunflower provided significantly lower crop yield and require the need to use high doses of mineral fertilizers and pesticide treatments to protect crops from weeds and diseases, leading to increased pesticide load on agrocenosis.

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