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EFFECT OF SOIL TILLAGE AND SOWING SYSTEMS OF WINTER WHEAT ON AGROPHYSICAL PROPERTIES AND SOIL NUTRITIOUS REGIME

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Висвітлено результати виробничої перевірки та впровадження систем обробітку ґрунту і сівби пшениці озимої. З'ясовано особливості агрофізичних властивостей, динаміку вологозабезпеченості та поживного режиму ґрунту під впливом досліджуваних факторів.

Ключові слова: *пшениця озима, обробіток ґрунту, сівба, продуктивна волога, елементи живлення.*

In today's world the Ukraine’s grain market has all chances to take the leading position. However, the increase in gross grain harvest hampers insufficient and unstable for years crop yields level of grain crops, due to the complex meteorological, agro-technological and agrobiological factors. Productivity of winter wheat is largely determined by its biological characteristics. Among other winter crops has higher drought tolerance and can more productively spend moisture to create a unit of organic matter [1, 2].

Winter wheat has high requirements to soil structure and to predecessor. Growing it according to biological requirements always increases productivity. When implementing scientifically based soil tallage made the rotation factor as element of biological agriculture. It stabilizes productivity level even without fertilization [3].

Soil tillage and sowing systems of winter wheat has a positive effect on water and nutrient regimes of the soil, and in combination with fertilizers and other means of growing technology yields increased by 35–50% at stable indicators of soil fertility. In the current socio-economic farming conditions, aggravated by climate change, the development and implementation a varietal agro technology of most adapted grain crops in specific soil and climatic conditions and the development of resource-saving technology elements based on the fullest possible use of plants biological potential has a practical interest and is an actual problem for modern plant growing [4].

Production testing the feasibility of using surface and no tillage and sowing of winter wheat was carried out in SE EF "Dnipro" IGC NAAS Soloniansky district, Dnipropetrovs’k region (field № 7, division № 2) during 2008–2010 in crop rotation link: pea – winter wheat – sunflower.

In field experiment were studied the effectiveness of these technological schemes of winter wheat growing variety Kuial’nyk: 1 – no-tillage, seeding with sowing machine ATD-6,35; 2 – surface tillage, seeding with sowing machine ATD-6,35; 3 – surface tillage, seeding with SZ-3,6. In variant 1 after harvesting predecessor and regrowth of weeds (on August) used a herbicide mixture (vulkan – 4 l/ha + esteron – 1 l/ha). Technology of surface tillage (var. 2 and 3) included soil disking with BDT-7 at a depth of 8–10 cm, subsurface loosening with combined aggregate KR-4,5 at a depth of 10–12 cm, pre-sowing cultivation with KPS-4 at a depth of 6–8 cm. Other agrotechnical elements – were generally accepted for Steppe zone [5, 6].

Seeding of winter wheat variety Kuial’nyk at rate of 5 million pcs. of germinated seeds/ha held on October, 1. At the end of tillering phase of plants in spring the sowings were locally dressed by ammonium nitrate (N_{30}).

Weather conditions during 2008–2009 were favorable for winter wheat growing. Abundant rains in the second half of September have created good prerequisites for obtaining even sprouts and plant establishment. In October and November observed elevated air temperature conditions at ceasing of autumn vegetation (CAV) of winter wheat was marked only on December, 8. Wintering of crops was successful. Early spring was cool, April was dry, but due to rain fall in May, the winter wheat is well developed and has formed a relatively high grain yield.

The structural condition of ordinary chornozem, determined before winter wheat seeding and in spring during the phase of tillering plants characterized as excellent. It had slightly changed under the influence of various technological schemes of pre-sowing field preparation and seeding.

Number of agronomically valuable aggregates with size of 10,0–0,25 mm in the topsoil over experiment variants at that time amounted to 91–93 and 85–86 %, and the content of silty fractions (<0,25 mm) did not exceed 5 %. Analysis of samples taken before harvest, showed the presence in soil on zero agricultural background the large number (25,4 %) lumpy fractions with diameter of 10 mm, which resulted in reducing the content of agronomically useful particles with size of 10,0–0,25 mm (9,4–12,2 %) and structuring coefficient (1,4–2,0 times) compared with plots of surface tillage.

It was established that in the autumn before winter crops seeded the density of topsoil layer (0–10 cm) on uncultivated plots was higher, than on shallow loosened background, but does not extend beyond the optimum allowable values (1,30 g/cm³). Making three technological operations in the period in pre-sowing period in variants of surface tillage causes the formation of dense layer at a depth of 10–30 cm. At renewal of spring vegetation (RSV) there was observed a slight decrease of dry unit weight indicators of topsoil comparing to the first definition, but this specific pattern persisted. In the phase of full ripeness when topsoil dehydrated the soil was too compacted, especially on plots where direct seeding was carried out with ATD-6.35 (1,38 compared to 1,32–1,33 g/cm³ at surface tillage).

The hardness of top soil in the date of seeding, tillering and harvesting of winter crops in all cases was higher than the conventional optimum 10 kg/cm² (at surface tillage in 1,3–2,0, at no-tillage – 1,7–2,1 times), but was below the critical limit of 25 kg/cm². Growing the soil resistance did not lead to inhibition of plants, due to possible negatives of this effect had leveled, in our view, by optimizing the structural state and moisture of chornozem.

The reserves of productive moisture in seed layer and topsoil layer on October, 1 at surface tillage amounted 9,9–10,2 and 36,4–37,5, as for no-tillage – 14,8 and 42,6 mm (Table 1).

So, uncultivated agricultural background better maintained precipitations in seed layer 0–10 cm, which is decisive in terms of obtaining even sprouts, establishment and development of winter wheat plants in the early growing season. In 0–100 cm soil layer the moisture content had slightly changed on experiment variants and reached 71–72 mm (about 60 % of long-term norm).

1. The reserves of productive moisture in soil under winter wheat depending on tilling and seeding methods, mm

Tilling and seeding methods	Soil layer, cm	Seeding	RSV	Harvesting
No-tillage (seeding ATD-6.35)	0–10	14,8	9,2	3,7
	0–30	42,6	34,1	-2,4
	0–50	56,9	61,3	-10,0
	50–100	13,8	57,8	-20,5
	0–100	70,7	119,1	-30,5
Surface tillage (seeding ATD-6.35)	0–10	10,2	9,0	4,5
	0–30	37,5	34,9	-0,2
	0–50	61,8	63,5	-7,5
	50–100	9,9	56,1	-17,9
	0–100	71,7	119,6	-25,4
Surface tillage (seeding SZ-3,6)	0–10	9,9	10,2	5,9
	0–30	36,4	36,5	1,3
	0–50	62,1	60,4	-4,3
	50–100	10,0	58,4	-17,8
	0–100	72,1	118,8	-22,1

During the cold period of year (CPY), regardless of the methods of soil preparation and seeding, had observed the restocking of productive moisture in 0–100 cm soil layer to level of 119–120 mm. Abundant rains in May, significantly improved the water regime of chornozem, so the crops were well supplied with water almost to the end of June. At the time of ripening the grain culture was fully used the available soil moisture, due to the formation of a large vegetative mass and relatively high grain yields.

Results of soil sample analyzes, taken before seeding of winter crops show a sufficient provision level by the main soil nutrients (Table 2).

2. Weighted average content of nutrition elements in the soil before seeding winter wheat, mg/kg

Soil layer, cm	$N\text{-}NO_3$			P_2O_5	K_2O
	without composting	after composting	nitrification energy	after Chirikov	
0–10	22,0	37,3	15,3	142	134
10–20	15,4	33,6	18,2	126	113
20–30	12,7	18,0	5,3	91	92
0–30	16,7	29,6	12,9	120	113

Background weighted average content of nitrate nitrogen in the arable soil layer was 16,7, mobile forms of phosphorus – 120, potassium – 113 mg/kg and characterized as intermediate and advanced. It should be noted also a higher values $N–NO_3$ and K_2O (22,0 and 134,0 mg/kg) in the seed layer (0–10 cm), according to which the level of provision by this elements is corresponds to higher and advanced. The soil has sufficient potential of replenishment the nitrogen available to plants through the process of nitrification, as evidenced by the indicators of its energy in the topsoil at 12,9 mg/kg. This will make possible under the favorable conditions to mobilize about 50 kg/ha of nitrogen.

In general, the calculations shows that existing stocks of nitrate nitrogen in 0–30 cm layer before seeding were at 62 kg/ha, and taking into account the layer 30–60 cm – reached 120 kg/ha. This element amounts in the soil is sufficient for plant growth and development during the autumn growing season. Precipitations in autumn-winter period caused a redistribution of the nitrate nitrogen content in the soil profile due to its migration with moisture. In spring on all variants of experiment in the area of active functioning the winter wheat root system (0–60 cm) nitrate content was low (6,3–8,3 mg/kg) (Table 3).

3. Distribution of nitrate nitrogen content in soil profile under winter wheat crops in spring

Soil layer, cm	No-tillage (seeding ATD-6.35)		Surface tillage (seeding ATD-6.35)		Surface tillage (seeding СЗ-3,6)	
	mg/kg	kg/ha	mg/kg	kg/ha	mg/kg	kg/ha
0–20	8,2	20	8,0	19	8,3	20
20–40	7,8	20	7,0	18	8,0	20
40–60	7,3	18	6,3	16	7,3	18
60–80	8,9	24	9,2	25	10,0	27
80–100	12,3	34	11,0	30	13,2	37
0–60	-	58	-	53	-	58
60–100	-	58	-	55	-	64
0–100	-	116	-	108	-	122

Start with the layer of 60–80 cm has observed the tendency of increasing their content and, in 80–100 cm layer number of nitrates increased to 11,0–13,2 mg/kg, which corresponds to an average provision level. Obviously, nitrates were percolated below the 100 cm. Their stocks in 0–60 cm soil layer totaled 53–58 kg/ha, 60–100 cm – 55–64 kg/ha, or respectively 48–50 and 50–52 % relatively to 0–100 cm soil layer.

Investigation the soil nutrient regime during the spring-summer growing season of winter crop allow to determine some it changes, that are more associated with both features of nutrition a culture and the need in one element or another in a particular phase of development, and so far with the specifics of their behavior in the soil. However, significant differences between the variants of soil tillage were not recorded and marked trends manifested almost equally.

Monitoring the nitrogen regime shows that the least amount of $N\text{-}NO_3$ was recorded in the phase of stem elongation, which accounts the peak of element consumption. Nitrogen content in the topsoil was 7,7–8,1 mg/kg and was classified as low (Table 4).

4. Dynamics of main nutrients content in soil during the growing season of winter wheat mg/kg

Variant	Soil layer, cm	Stage of development		
		stem elongation	heading	full ripeness
Nitrate nitrogen				
1	2	3	4	5
No-tillage (seeding ATD-6.35)	0–10	8,6	9,3	11,2
	10–20	7,8	8,7	9,3
	20–30	8,0	8,3	9,0
	0–30	8,1	8,8	9,8
Surface tillage (seeding ATD-6.35)	0–10	7,8	8,4	11,3
	10–20	8,2	8,2	9,3
	20–30	7,1	8,0	9,1
	0–30	7,7	8,2	9,9
Surface tillage (seeding СЗ-3,6)	0–10	8,7	8,5	12,5
	10–20	7,9	7,9	8,7
	20–30	7,6	8,0	7,4
	0–30	8,1	8,1	9,5
Labile phosphorus				
No-tillage (seeding ATD-6.35)	0–10	143	131	116
	10–20	120	121	114
	20–30	110	107	114
	0–30	124	120	115
Surface tillage (seeding ATD-6.35)	0–10	133	127	122
	10–20	126	116	119
	20–30	120	108	110
	0–30	126	117	120

продовження таблиці 4

1	2	3	4	5
Surface tillage (seeding СЗ-3,6)	0–10	130	126	121
	10–20	118	111	117
	20–30	108	111	111
	0–30	119	116	116
Exchange potassium				
No-tillage (seeding ATD-6.35)	0–10	131	131	116
	10–20	125	116	97
	20–30	110	100	91
	0–30	125	117	101
Surface tillage (seeding ATD-6.35)	0–10	122	122	112
	10–20	122	109	100
	20–30	106	94	91
	0–30	120	108	101
Surface tillage (seeding СЗ-3,6)	0–10	125	122	118
	10–20	112	106	97
	20–30	106	91	85
	0–30	114	106	100

Already in the phase of heading observed a slight increasing a nitrate nitrogen content in the soil to 8,1–8,8 mg/kg, and a phase of full ripeness – to 9,5–9,9 mg/kg. It should be noted that the depth of 0–10 cm its indicators were at level of 11,2–12,5 mg/kg and corresponded to average provision.

During the growing season of winter wheat also taken place the changes of phosphate and potash soil regimes.

Expressed a downward trend in mobile forms of phosphorus and potassium, but within a particular gradation of it is topsoil provision. Thus, the content of available to plants P_2O_5 and K_2O decreased respectively from 119–124 and 114–125 mg/kg in the stem elongation phase up to 115–120 and 100–101 mg/kg in the phase of full ripeness. Such dynamics of these elements in the soil can be explained as its active consumption by plants and so far as partial transition into fixed and non-exchanged forms with the shortage of moisture.

Conclusions. Under the experiment conditions, the winter wheat formed the grain yield at level of 5,46–5,62 t/ha. Accordingly to this amount of grain the removal of nitrogen reached 164–169, of phosphorus – 66–67, and of potassium – 153–157 kg/ha.

Thus, accordingly to results of research, the significant changes between the variants of the experiment on studying the influence of tillage technologies or systems on effective soil fertility and the chemical composition of plants were not established. Some trends that had been fixed are fall under the category of a general character.

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