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Influence of fertilizers and ways of processing on parameters of soil fertility at cultivation of soya

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The purpose. To study influence of fertilizers and ways of soil cultivation on maintenance of plants of soya with nutrients. **Methods.** Laboratory-analytical, statistical. **Results.** Results of researches on studying influence of fertilizers and ways of processing on nutritious mode of dark grey podzolized soil are presented at cultivation of soya. It is fixed that nitric fertilizers at different ways of entering raised the content of mineral nitrogen. Additional quantity of nitrogen on the phosphate-potash background during vegetation improved feed of plants by phosphorus and potassium. **Conclusions.** Nitric fertilizers on the phosphate-potash background created preconditions for increase of yield of soya concerning the control. In comparison with subsoiling the highest level of this parameter is gained at ploughing.

Key words: *soil cultivation, soya, nutritious mode, fertilizers.*

Crops growing technologies with tillage minimising technologies, which are based on the use of no-ploughing equipment, by reducing the intensity of mechanical impact on soil and increased revenues of stubble residues help to restore the reserves of humus and macro elements. Compared to technologies based on ploughing, no-ploughing techniques change the nature of the flow of organic matter, mostly confining it along with chemical fertilisers at the top of the soil [1, 2, 3, 4, 5].

By minimising soil cultivation, it was detected a shortage of soil nutrients in early years of growing, especially nitrogen. This was due to the high activity of micro-organisms that use this element for the optimisation of the C:N [6, 7]. However, scientists research established improvement of the nutrient regime in variants with tillage minimization. According to E. Scopel and others. [8], E. O. Adeleye and others. [9], M. L. Himmelbauer and others [10] Nitrogen nutrition were optimised and content of mobile Potassium and Phosphorus compounds increased. Given the diversity of generalisations, often opposite, very crucial issues concern studies of the effect of fertiliser on soil fertility under ploughing-less cultivation of dark gray-ashed soils. Because it directly determines the nature of the nutrient regime. These changes may affect the growth and development of soybean plants.

The purpose of the research was to examine the impact of fertilisers and tillage methods on soybean plants during the growing season.

Materials and methods of research. Studies of the impact of different methods of cultivation and fertiliser regulations on soil nutrient regime were carried out during the 2013–2015. A field experiment was performed in agricultural chemistry and quality department named after O. Dushechkin of the NULES of Ukraine (Boryspil district, Kyiv region). Area of the cultivated field was 100 m^2, accounting area – 54 m^2, with repetition of the experiment three times. The research was conducted with variety Merlin of the first reproduction (included in the State Register of varieties in 2008).

In the experiment, the effect of different Nitrogen fertilisers on Phosphorus-Potassium background with the application of ploughing, compacting, minimum tillage and direct seeding were studied. In control, the norm of $P_{60}K_{60}$ was used. The number of Nitrogen input in different variants increased from N_{20} to N_{80} with N_{20} intervals on the background of Phosphorus-Potassium fertiliser.

The traditional way of cultivation included the following technological operations: stubble peeling of the predecessor (10–12 cm), autumn ploughing (25–27 cm), pre-sowing cultivation (10–12 cm). Minimum tillage anticipated flaky stumbling (10-12 cm), pre-sowing cultivation (10–12 cm). In areas with direct sowing, only fertiliser was mixed with soil to the depth of 3–4 cm. In the variant with the compactor, peeling with stubble predecessor (10–12 cm), compacting (38–40 cm) and preplanting ploughing (10–12 cm) was done.

Fertilisers were applied in pre-sowing cultivation in all parts of the experiment.

Laboratory tests were carried out according to existing methods and standards.

The results of research and analysis. It was established that the method of cultivation affected the nutritional profile of dark gray-ashed soils on soybean during vegetation season (Table).

As it was expected, the least amount of mineral nitrogen was in control ($P_{60}K_{60}$) and was 12.3–14.0 mg/kg. The input of Nitrogen fertiliser on the background of Phosphorus-Potassium fertilisers increased the content of this element. The norm of $N_{80}P_{60}K_{60}$ provided the highest amount of Nitrogen in the soil. Depending on soil cultivation method, the concentration of mineral Nitrogen at the start of the growing season in the layer 0–25 cm was 28.4–31.7 mg/kg.

It was defined that content of mineral Nitrogen decreased up to the phase of technical maturity. The most intense change of this indicator was the phase from germination to the formation of beans, in its critical period in relation to this item. Nmin content in direct seeding variant and in minimum tillage variant did not change rapidly. Thus, the difference between the concentration of mineral Nitrogen content from the phase of plant shoots to the formation of beans was 5.39–9.22 mg/kg and 5.79–10.9 mg/kg, respectively. It should be noted that for the comparison were selected variants with Nitrogen fertiliser on the background of $P_{60}K_{60}$.

It was established that the input of the equal amount of Phosphorus fertilisers contributed to ensuring a higher content of this element in the soil for cultivation without ploughing compared to ploughing method. In the phase of shooting in traditional ploughing variant in the layer 0–25 cm concentration of mobile Phosphorus was 135 mg/kg, which was for 27.5–31.2% less than in non-ploughing cultivation variant. This difference between the level of this indicator can be explained by a change in biological activity due to the saturation of the upper 0–10 cm layer of plant residues.

It was defined that in branching phase concentration of mobile Phosphorus increased depending on the variant of fertilisers input and soil cultivation methods (Table.). Thus, this figure increased in the compacting variant to 45 mg/kg, in tillage and direct seeding variant – up to 40 mg/kg and for minimum tillage – 21 mg/kg. Given the fact that soybean is a crop that is able to absorb inaccessible Phosphorus from the soil, such increase could be due to the release of acidic roots materials and Carbon Dioxide. Also, the formation of Carbon Dioxide is possible due to the decomposition of plant residues.

For formation of vegetative and generative organs soybeans consume Phosphorus evenly throughout the growing season. However, during the phase of branching to the formation of beans, it uses the largest amount of Phosphorus. This explains the reduction of mobile Phosphorus in the phase of formation of beans. In the traditional tillage method, depending on the variant of fertilisation, its content was reduced to 15–46 mg/kg, in compacting variant up to 12–41 mg/kg, in the minimum cultivation method – to 10–19 mg/kg and for direct seeding – to 16–34 mg/kg. It is worth noting the fact that in areas where Nitrogen was contributed on Phosphorus-Potassium background, the concentration of Phosphorus decreased significantly compared to the control. This means that additional Nitrogen optimised growth processes of underground and up-ground parts of soybean plants.

Dynamics of main nutrients content in soil (0–25 cm) for the cultivation of soybeans, the average for 2013–2015.

Cultivation method	Experiment variant	N_{min}				P_2O_5				K_2O			
		Growth and development phase of plant											
		Shoots	branching	formation of beans	technical maturity	shoots	branching	formation of beans	Technical maturity	shoots	branching	Formation of beans	technical maturity
Ploughing (control)	$P_{60}K_{60}$	14,0	12,6	7,17	4,19	128	162	147	139	155	149	143	130
	$N_{20}P_{60}K_{60}$	17,4	15,1	9,37	4,93	133	174	151	142	149	153	145	132
	$N_{40}P_{60}K_{60}$	23,6	20,4	12,6	7,17	144	185	139	131	151	156	142	133
	$N_{60}P_{60}K_{60}$	28,0	23,8	15,1	9,49	135	179	163	149	152	152	134	125
	$N_{80}P_{60}K_{60}$	31,7	27,2	17,8	9,94	136	176	159	156	156	152	143	128
Compacting*	$P_{60}K_{60}$	12,3	10,7	7,03	5,09	169	209	198	193	161	178	154	146
	$N_{20}P_{60}K_{60}$	16,0	13,8	9,39	6,91	169	219	195	189	170	203	163	149
	$N_{40}P_{60}K_{60}$	20,3	17,0	10,5	7,57	182	235	194	188	176	198	157	144
	$N_{60}P_{60}K_{60}$	25,7	21,5	12,8	8,67	165	207	183	186	164	191	155	148
	$N_{80}P_{60}K_{60}$	30,5	28,4	16,9	10,3	188	230	207	205	183	196	155	155
[illegible]	$P_{60}K_{60}$	13,2	12,4	8,20	5,42	181	190	181	175	167	179	165	141

	$N_{20}P_{60}K_{60}$	16,6	15,6	10,8	6,44	174	204	185	178	160	175	155	143
	$N_{40}P_{60}K_{60}$	22,1	20,1	13,1	8,12	171	192	173	165	158	170	159	142
	$N_{60}P_{60}K_{60}$	26,0	24,3	15,5	9,22	175	190	176	169	168	169	149	143
	$N_{80}P_{60}K_{60}$	28,4	26,0	17,5	10,5	170	201	189	185	157	176	154	137
Direct seeding	$P_{60}K_{60}$	13,3	12,6	9,69	6,88	171	197	181	154	163	166	146	133
	$N_{20}P_{60}K_{60}$	16,5	15,2	11,2	7,45	170	216	182	171	173	176	147	132
	$N_{40}P_{60}K_{60}$	22,9	20,6	14,6	9,12	166	201	171	166	159	177	148	132
	$N_{60}P_{60}K_{60}$	25,9	24,8	17,9	10,9	170	217	184	179	161	171	145	129
	$N_{80}P_{60}K_{60}$	28,4	26,3	19,2	11,3	169	218	191	187	171	178	154	141
$LSD_{0.5}$, mg/kg		1,11	0,99	0,63	0,54	13,9	16,4	13,1	13,0	15,9	16,3	13,8	13,0
Sx, %		1,84	1,65	2,07	1,91	2,90	2,88	2,72	2,80	3,35	3,31	3,18	3,32

Note: compacting* – results for 2014–2015 pp.

We found that from the shooting phase to branching, by minimising tillage and fertilisation, the content of exchangeable Potassium increased. Most of its growth was in the layer 0–25 cm in the compacting variant. It should be noted that in the ploughing variant clear trend was not established.

During the period from the branching to the phase of technical maturity is a typical reduction of exchangeable Potassium, depending on the norms of fertilisers and methods of cultivation. The greatest decline was in the phase of beans formation. In ploughing variant Potassium level decreased for 6.00–18.3 mg/kg, in compacting variant – for 24.0–41.0 mg/kg, in minimum tillage variant – for 11.0–22.0 mg/kg and in direct sowing variant – for 20.3–28.0 mg/kg. This is due to the biological characteristics of soybeans on the intensive assimilation of a common element in this period.

With the application of non-ploughing methods of cultivation during the maximum consumption of macro elements, soybeans plants were facilitated with these elements on the medium and high level. However, the yield was lower as compared to ploughing variant. In ploughing variant, it was 3.81 t/ha, which was for 15.2 % more than in compacting method, for 9.37 % more than in minimum tillage variant and for 20.8 % – for direct sowing. This difference in soybeans productivity could be caused by a higher density of soil in non-ploughing variants. In this regard, soybean plants grew slower and formed smaller leaf surface area compared to ploughing variant.

Conclusions.

The content of Nmin in the layer of 0–25 cm depending on cultivation method correlated with the norms of fertilisers (r^2 = 0,98–0,99). An additional input of Nitrogen on the background of $P_{60}K_{60}$ with ploughing-less cultivation improved Phosphate and Potash regimes, but this did not indicate the increase of productivity. These trends have caused the deterioration of the physical parameters of the soil, including its density.

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