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# Formation of humus state and nutritive regimen of soil for cultivation of corn for grain in crop rotation at irrigation

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**The purpose.** To determine directions of formation of humus state, nutritive regimen of dark-chestnut soil and productivity of corn for grain at use as fertilizer of collateral products of cultures of crop rotation on the background of different ways, depths of basic cultivation and doses of application of fertilizers in crop rotation at irrigation. **Methods.** Field, quantitatively-weight, visual, laboratory, calculative-comparative and mathematical-statistical with the use of conventional in Ukraine techniques and methodical recommendations. **Results.** It is established that after harvesting soya bean (predecessor of corn for grain) on not fertilized background (on alternatives of basic cultivation for soya bean) the mass of collateral products on surface of soil made 2.71 – 3.05 t/hectare. Calculated indexes of formation of humus testifies to negative balance of humus on not fertilized background in all alternatives of systems of basic soil cultivation with the highest index (– 0.58 t/ha) at one-deep-seated shallow subsoil cultivation. At use of fertilizers the negative balance of humus also is fixed. The maximum productivity of grain of corn (14.82 t/ha) is gained in alternative of shallow disk cultivation with slit planting on depth of 38 – 40 cm in system of differentiated-1 soil cultivation for crop rotation on the background of dose of fertilizers N180P60. On the average for 3 years on the background without importation of fertilizers the level of productivity on alternatives of ways and depths of basic cultivation oscillated from 3,05 t/ha at subsoil shallow disk cultivation on the background of its long use in crop rotation up to 4,46 t/ha at system of differentiated-1 soil cultivation with one slit planting on depth of 38 – 40 cm for crop rotation. **Conclusions.** At growing corn for grain in crop rotation at irrigation it is expedient to apply disk cultivation on depth of 8 – 10 cm in system of differentiated cultivation with one slit planting on depth of 38 – 40 cm during rotation, to use as fertilizer of cormophyte and rooted masses with importation of fertilizers at dose of N180P60.

***Key words:*** *corn, dose of fertilizers, postharvest residues, humus, system of basic soil cultivation, productivity.*

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**Entry.** Economy of resources and guard of environment during the production of agricultural goods on the reclamated lands are two associate directions, realization of which can be provided due to introduction of the scientifically reasonable systems of agriculture which answers the terms of the maximal use of self-potential most full. Therefore these questions are in the spotlight of agrarian science and have a decision value for maintenance and improvement of fertility of soils in crop rotations on the irrigated lands.

Basic treatment of soil in agrotechnologies is most energycapacious, on her stake is to 75% of general charges of energy, that is why there is possibility to reduce these charges at growing of agricultural cultures.

In connection with intensifying of ecological situation in the agroindustrial complex of Ukraine the necessity of decision of this problem is not subject to the doubt, and the scientifically reasonable systems of treatment of soil must provide maintenance of fertility of soils and defence of them from erosion at the complete use of bioclimatic potential of area, realization of potential possibilities of modern sorts and hybrids of cultures and economy charges of technogenic resources.

Under separate cultures must optimization of methods and depth of basic treatment of soil provide diminishing of charges of labour, slowing down of mineralization of organic matter, warning of degradation processes and maintenance and fertility-improving of soil [1].

In Ukraine, where soils test intensive influence of different types of erosion, development of the zonal systems goes with the use of receptions of nonmoldboard treatment of soil [2-4]. Kovalenko A. specifies that in the droughty terms of the Steppe area of Ukraine minimization of treatment of soil includes receptions, able to influence on aquatic and air modes. With reduction of amount and combination of a few technological operations and diminishing of depth of the processed layer the best accumulation and maintenance of moisture are arrived at from atmospheric fallouts, more even distribution her on an area and depth first. Due to it in good time appears shoots and good development of cultures is marked and firmness rises to the unfavorable terms of external environment in the further phases of development [5].

Humus is one of major component parts of soil. The losses of humus are so considerable, that negatively influence on agrophysical properties of soils, and the low level of intensification of agricultural production conduces to the further worsening of their agronomical-valuable properties. The loss of 1т humus answers the shortage of 6-8 c/ha of grain-crops [6, 7]

It is set researches of domestic scientists, that alternation of dump and nonmoldboard treatment with the use of the combined instruments with the use of the combined instruments with the working organs of subsurface, chisel and disk-type, improves fertility of soil, nourishing mode and phytosanitary state of sowing. Thus the requirements of intensification of agroindustrial production in all areas of Ukraine are completer than all answered by the differentiated system of basic treatment of soil in crop rotations both on a depth and on methods with the use of tillage tools of different type

By researches, conducted domestic and foreign researchers, it is already set that the differentiated system tillage of soil, combining in itself different methods and depth of processing according to the biological features of the grown cultures, in crop rotations on the irrigated lands not only most effective, but also ecologically safe.

Thus establishment of effective methods and depth of basic till of soil, optimal doses of bringing of mineral fertilizers with the use of side products of soy of crop rotation and their influence on fertility of darkly-chestnut medium loamy soils and productivity of corn on grain in the irrigated terms of south Steppe of Ukraine caused the necessity of realization of research on the central experimental base of Institute of the irrigated agriculture of NAAS of Ukraine in the area of action of Ingulets irrigation system

**The purpose of researches** consisted in establishment of directions of forming of the humus state and nourishing mode of livery soil and the productivity of corn at the use on the fertilizer of after harvesting bits and pieces soy on a background different methods and depth of basic treatment and doses of bringing of mineral fertilizers under sowing of corn in a crop rotation on irrigation.

**Materials and methods of researches.** Researches were conducted in stationary experience of Institute of the irrigated agriculture of NAAS in the 4-fields link of the cultivated crop rotation. A corn on grain was sown in a crop rotation after soy. The hybrid of Sov-329 SV, density of standing of plants – 80 thousand pieces on a hectare. In the field experience five systems of basic treatment were studied soils (Factor A) which differed in inter se methods and in depth loosening, and three systems of fertilizer with bringing of different doses of nitric-phosphoric fertilizers were tested on a background the use as a fertilizer of the yellowed bits and pieces of cultures of crop rotation (Factor B).

**Factor A (soil tillage):**

1. Moldboard plowing under a corn on a depth of 20-22 cm in the system of moldboard tillage in a crop rotation;
2. Chisel loosening under a corn on a depth of 20-22 cm in the system of subsoil tillage in a crop rotation;
3. Disk cultivation under a corn on a depth a 12-14 cm in the system of subsoil tillage in a crop rotation;
4. Disk cultivation under a corn on a depth a 8-10 cm in the system of the differentiated – 1 tillage with subsoiling on 38-40 cm;
5. Moldboard plowing under a corn on a depth of 18-20 cm after disk cultivation on the depth of 14-16 cm under the previous crop within the differentiated – 2 tillage.

**Factor B (mineral fertilizer in a crop rotation):**

1. System of fertilizer № 1. Without bringing of mineral fertilizers on a background the use on the fertilizer of all side products of agricultural cultures of crop rotation;
2. System of fertilizer № 2. Bringing under the corn of mineral fertilizers by the dose of $N_{120}P_{60}$ + side products of agricultural cultures of crop rotation.
3. System of fertilizer № 3. Bringing under the corn of mineral fertilizers by the dose of $N_{180}P_{60}$ + side products of agricultural cultures of crop rotation.

Calculating on a 1 hectare of area of crop rotation at the systems of fertilizer № 2 - $N_{82,5}P_{60}$ and № 3 - $N_{120}P_{60}$

Soil of the experienced field - livery is a middle loam with subzero material well-being by nitrates and middle by mobile phosphorus and exchange potassium, maintenance of humus in a layer a 0-40 cm presents 2.15%.

During an experiment used the field, in-gravimetric, visual, laboratory, calculation-comparative, mathematically-statistical methods with the use of confessedly in Ukraine methods and methodical recommendations.

Technology of growing of corn in a crop rotation is generally accepted except factors which were investigated. Soil moisture during the vegetation of corn was kept up at the level of 70% of the soil water-holding capacity in the layer of 0-50 cm.

**Results of researches.** On the average for seven years of crop rotation (2011-2018) it is set on irrigation that maintenance of humus largely depended on the biological features of agricultural cultures, and also from influence of the investigated systems of basic treatment of soil and doses of bringing of mineral fertilizers. So, the results of agricultural chemistry analyses testify on determination of maintenance in soil of accessible ingredients of mineral feed, that the plants of corn at the beginning of vegetation are well provided with nutritives and their maintenance in a top-soil was sufficient for a height and development of plants both due to nutritives, brought in with mineral fertilizers and as a result of mineralization of organic matter of after harvesting bits (root and leaves and stems) and pieces.

A predecessor of corn in a crop rotation is soy which as well as all one-year leguminous, greater part of the mastered nitrogen is used on forming of seed and takes away approximately so much nitrogen with a harvest, how many of him link, i.e. soy does not enrich soil nitrogen, and only by a less measure, what other cultures, exhausts him. In addition, after harvesting leaves and stems mass of soy mineralized during the short interval of time and provides nutritives the next cultures of crop rotation. Due to such properties soy is a good predecessor for all cultures of crop rotations on the irrigated lands.

Methods and depth of basic treatment under a corn and doses of mineral fertilizers created different terms for decomposition of after harvesting bits and pieces. At the dose of fertilizers of $N_{30}P_{60}$ under soy on the variants of basic treatment it was backfilled in soil of 3.05-3.53 t/ha. At the further increase of dose of bringing of mineral fertilizers ($N_{60}P_{60}$) under soy, mass of after harvesting bits and pieces used on the fertilizer of corn grew in accordance with 3.31-3.90 t/ha, and on the unfertilized background after the variants of till on the surface of soil them there was from 2.71 to 3.05 t/ha or less than on the fertilized backgrounds on 11.1-21.8% (table. 1).

Calculation of indexes of formation of humus in accordance with mass of done up in soil after harvesting bits and pieces of soy testifies to negative balance of humus on the unfertilized background in all variants of the systems of basic treatment of soil with the greatest index (minus of 0.58 t/ha) at one deep shallow nonmoldboard treatment.

***1. Average annual calculation balance of humus in a top-soil at different methods and depth of treatment and fertilizer under a corn on grain after soy, t/ha***

| Method and depth of basic till of soil | Mass bits and pieces | Arrival of humus | Losses to the humus | Balance of humus | Pus for indemnification of losses |
|---|---|---|---|---|---|
| Without fertilizers | | | | | |
| Plowing on a 20-22 cm | 3,05 | 0,70 | 1,2 | -0,50 | 2,2 |
| Chisel loosening on 20-22cm | 2,84 | 0,65 | 1,2 | -0,55 | 2,4 |
| Disk loosening on a 12-14 cm | 2,71 | 0,62 | 1,2 | -0,58 | 2,5 |
| Disk loosening on a 8-10 cm | 3,04 | 0,70 | 1,2 | -0,50 | 2,2 |
| Plowing on a 18-20 cm | 2,90 | 0,67 | 1,2 | -0,53 | 2,3 |
| $N_{120}P_{60}$ | | | | | |
| Plowing on a 20-22 cm | 3,53 | 0,81 | 1,2 | -0,39 | 1,7 |
| Chisel loosening on 20-22cm | 3,31 | 0,76 | 1,2 | -0,44 | 1,9 |
| Disk loosening on a 12-14 cm | 3,05 | 0,70 | 1,2 | -0,50 | 2,2 |
| Disk loosening on a 8-10 cm | 3,53 | 0,81 | 1,2 | -0,39 | 1,7 |
| Plowing on a 18-20 cm | 3,14 | 0,72 | 1,2 | -0,48 | 2,1 |
| $N_{180}P_{60}$ | | | | | |
| Plowing on a 20-22 cm | 3,90 | 0,90 | 1,2 | -0,30 | 1,3 |
| Chisel loosening on 20-22cm | 3,68 | 0,85 | 1,2 | -0,35 | 1,5 |
| Disk loosening on a 12-14 cm | 3,10 | 0,76 | 1,2 | -0,44 | 1,9 |
| Disk loosening on a 8-10 cm | 3,65 | 0,84 | 1,2 | -0,36 | 1,6 |
| Plowing on a 18-20 cm | 3,42 | 0,79 | 1,2 | -0,41 | 1,8 |

On the fertilized backgrounds with bringing under soy of $N_{30}P_{60}$ and $N_{60}P_{60}$ negative balance of humus is also marked. In accordance with the doses of bringing of mineral fertilizers he laid down minus 0.50 and 0.44 t/ha, that below on 13.4 and 24.1%, as compared to the unfertilized background.

It is related to that in crop rotations on the irrigated lands at bringing of mineral fertilizers the processes of decomposition of leaves and stems mass of agricultural cultures activate and terms are created for the greater accumulation of humus in an arable layer, as compared to the unfertilized background. At the same time negative balance of humus remains at all methods basic treatment and doses of fertilizers. The coefficient of humification of leaves and stems mass of soy presents 0.23.

Realization of calculations on determination of arrival in soil of ingredients of mineral feed with after harvesting leaves and stems mass and roots of soy at the different methods and depth of basic treatment and fertilizer testifies that the increase of nitrogen in an arable layer grew within the limits of 13.5-19.6 kg, phosphorus are 6.9-9.8 kg and potassium are 20.2-23.5 kg operating matter (table. 2).

***2. Average annual entering soil of NPK with after harvesting bits and pieces of soy at the different methods of basic treatment and fertilizer under a corn, kg/ha***

| System of basic treatment of soil | Method and depth of treatment | mass of bits and pieces т/ha | N | $P_2O_5$ | $K_2O$ |
|---|---|---|---|---|---|
| Without fertilizers | | | | | |
| Moldboard soil tillage with different depth | 20-22 (о) | 3,05 | 15,2 | 7,6 | 18,2 |
| Nonmouldboard soil tillage with different depth | 20-22 (ч) | 2,84 | 14,2 | 7.1 | 17,0 |
| Nonmouldboard soil tillage with one deep | 12-14 (д) | 2,71 | 13,5 | 6,8 | 16,2 |
| Differentiated- 1 | 8-10 (д) | 3,04 | 15,2 | 7,6 | 18,2 |
| Differentiated - 2 | 18-20 (о) | 2,9 | 14,6 | 7,3 | 17,5 |
| $N_{120}P_{60}$ | | | | | |
| Moldboard soil tillage with different depth | 20-22 (о) | 3,53 | 17,6 | 8,8 | 21,1 |
| Nonmouldboard soil tillage with different depth | 20-22 (ч) | 3,31 | 16,5 | 8,3 | 19,8 |
| Nonmouldboard soil tillage with one deep | 12-14 (д) | 3,05 | 15,2 | 7,6 | 18,2 |
| Differentiated- 1 | 8-10 (д) | 3,53 | 17,6 | 8,8 | 21,1 |
| Differentiated - 2 | 18-20 (о) | 3,14 | 15,7 | 7,8 | 18,8 |
| $N_{180}P_{60}$ | | | | | |
| Moldboard soil tillage with different depth | 20-22 (о) | 3,90 | 19,6 | 9,8 | 23,5 |
| Nonmouldboard soil tillage with different depth | 20-22 (ч) | 3,68 | 18,5 | 9,3 | 22,2 |
| Nonmouldboard soil tillage with one deep | 12-14 (д) | 3,1 | 16,9 | 8,4 | 20,2 |
| Differentiated- 1 | 8-10 (д) | 3,65 | 18,3 | 9,1 | 21,9 |
| Differentiated - 2 | 18-20 (о) | 3,42 | 17,2 | 8,6 | 20,6 |

At determination of maintenance of ingredients of mineral feed at the beginning of vegetation of corn, that most nitrates in the layer of soil a 0-40 cm appeared on the system of different depth treatment with the turn of layer and plowing on a depth a 20-22 cm under a corn. Them there were 39.2 mg/kg on the unfertilized background, at $N_{120}P_{60}$ – 69.0, and at bringing of $N_{180}P_{60}$ are 87.3 mg/kg of soil.

The account of the productivity of grain of corn testifies that on the average on a factor And, substituting of plowing by a 20-22 cm by chisel treatment with the same depth of loosening and disk treatment on a 12-14 cm in the system of nonmouldboard shallow one deep treatment of soil in a crop rotation (variant 2, 3) resulted in the decline of level of harvest on 0.62 and 2.94 t/ha accordingly. Application of disk till on a 8-10 cm in the system of differentiated – 1 till of soil with subsoiling on a 38-40 cm with bringing of mineral fertilizers assisted forming of the greatest productivity the dose of $N_{180}P_{60}$ – 14.82 t/ha (table. 3).

On the average on a factor B the increase of dose of fertilizers with $N_{120}P_{60}$ to $N_{180}P_{60}$, provided the height of the productivity of grain of corn on 2.70 t/ha. At the system of fertilizer, that was based on the use only of after harvesting bits and pieces of agricultural cultures of crop rotation without bringing of

mineral fertilizers the level of the productivity on the variants of methods and depth of basic treatment hesitated from 3.05 t/ha at the disk loosening on a depth a 12-14 cm on a background protracted his use in a crop rotation to 4,46 t/ha of the system differentiated – 1 treatment of soil with one subsoiling on a 38-40 cm for the crop rotation.

***3. Productivity of grain of corn at the different doses of fertilizers, methods and depth of basic treatment of soil in a crop rotation on irrigation, average 2016-2018, t/ha***

| System of basic treatment of soil (factor A) | Method and depth, cm | Doses of fertilizers (factor B) | | | AV on a factor A |
|---|---|---|---|---|---|
| | | without fertilizers | $N_{120}P_{60}$ | $N_{180}P_{60}$ | |
| Moldboard soil tillage with different depth | 20-22 (о) | 4,26 | 11,43 | 14,44 | 10,04 |
| Nonmouldboard soil tillage with different depth | 20-22 (ч) | 3,81 | 10,81 | 13,64 | 9,42 |
| Nonmouldboard soil tillage with one deep | 12-14 (д) | 3,05 | 8,16 | 10,08 | 7,10 |
| Differentiated- 1 | 8-10 (д) | 4,46 | 11,81 | 14,82 | 10,36 |
| Differentiated - 2 | 18-20 (о) | 3,86 | 10,28 | 13,01 | 9,05 |
| AV on a factor B | | 3,85 | 10,50 | 13,20 | |

LSD at p 0,05, is t/ha: A - 0,42, B - 1,41

Consequently systems of different depth basic treatment of soil with a turn and without the turn of layer and differentiated 2 provided the indexes of the productivity on 3.09-9.10 % below, than at differentiated 1 system of basic treatment of soil. The permanent use during the crop rotation of the shallow (12-14 cm) without the turn of layer loosening resulted in the substantial decline of the productivity of corn as compared to the system of different depth basic treatment with the turn of layer.

Realization of calculations of receipt of humus in soil from done up after harvesting bits and pieces of soy at the different systems of basic treatment and background of feed under a corn testifies that regardless of dose of fertilizer negative balance of humus is formed at all systems of treatment, at the same time the greatest indexes were at nonmoldboard one deep shallow is minus of 0.58 т/ha, and the least is minus of 0.30 t/ha at the protracted dump different depth treatment of soil.

**Conclusions**

*At growing of corn on grain in a crop rotation on irrigation after soy it is expedient to apply the disk loosening on a 8-10 cm in the system of differentiated – 1 treatment with subsoiling for a rotation, to use on a fertilizer leaves and stems mass of soy and to bring in mineral fertilizers the dose of $N_{180}P_{60}$.*

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