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SEARCH FOR OPTIMAL CHAINS OF CROP ROTATIONS AND TYPES OF ORGANIC FERTILIZERS ALTERNATIVE TO MANURE

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Search for optimal crop rotation and for organic fertilizers, alternative to the manure. It is shown that the optimal sequence is the field crop rotation is from grain fallow under manure introduction that stipulates most collection of wheat winter grain and protein units feed that also provides the extended reproduction of southern chernozem fertility with humus, nitrogen, potassium and simple soil recreation by phosphorus content.

Keywords: *field crop rotation succession, grain productivity, protein grain of feed of units, restoring the southern chernozem fertility, humus and nutrients.*

Introduction: In South Steppes region the agricultural cultures harvest is formed mainly due to the soils natural (potential) fertility [1]. The topsoil content with humus in the years 1957-1961 was 3.84 % and in years 2001-2006 it was 3 % [2].The annual yield of nutrients with harvest for 2003-2013 periods averaged to 109.6 kg/h, and their return into soil with mineral fertilizers amounted to 34 kg/h. The humus reserve in soils annually diminished on the average of 0.04 - 0.4 t/h, and the manure return brought into in 2011-2013 was 0.07 t/h [3].Therefore the return into soil of the substances and energy taken away with a harvest experiences essential deficit, also observed in other regions of country [4].

An analysis of the basic grain-crops productivity by agroclimatic areas of the southern region allows concluding that the decline of their productivity in the last few years is explained also by violation of sowing areas previous structure and the winter crops repeated sowing expansion. That process has a completely spontaneous character and resulted in negative issues for agriculture in the whole [5-8].The one-in-two task that stands before farmers is to get stably high harvests of agriculture's and to save soil fertility this one being the main production tool that is why it is so important to conduct the search of crop rotation optimal sequences and for organic fertilizers alternative to the humus [9-14].

Research aim: To create an information analytical database and to work out tools for soils fertility restoring and providing for a permanent production of plant-grower goods.

Research methods: The field researches were conducted with stationary experimental areas in 2011-2014 years on southern chernozem.The experimental data are taken from four crop rotations (5-course rotation) that differ only with the first field (autumn fallow, green-manure fallow, seed fallow, peas on grain).The green-manure fallow was used to cultivate the winter vetch (Primorka kind), the seeded fallow served to cultivate the mixture of peas with mustard white.

In five crop rotations studied by the Agricultural Institute of the National Academy of Agriculture the 16 chain links are distinguished : a) fallow-land (lack, green and cropped fallow) winter-annual wheat; b) peas on grain - and the winter-annual wheat; c) fallow-land-winter-annual wheat - and further the winter-annual wheat; d) peas on grain - winter-annual wheat and further the winter-annual wheat; e) winter-annual wheat - oat - winter-annual wheat; f) oat - winter-annual wheat (table1).

The efficiency of changes in crop rotation was determined by indexes: a) total grain productivity from 1 hectare area of crop rotation; b) collection of winter wheat grain and feed-stuff crop; c) gain in grain and protein feed units from 1 hectare of plough-land; d) balance of humus and nutrients [15].

Results of researches: The experimental data do witness (table 1) that the greatest productivity of winter-annual wheat (4.10, 4.00, 4.13 and 3.91 t/ha), returns from the two courses cycle (fallow winter-annual wheat; peas-winter-annual wheat). At the three field change excluding fallow and peas fields (winter-annual wheat - oat - winter-annual wheat), the productivity, comparatively with the three-field change including fallow and peas, was more significant in grain cultures and protein feed units, but the yield in grain of winter-annual wheat was less, (3.71, 3.58, 3.58 and 3.36 t/h).

The less productivity is registered for the 2 changes grain-growing field (oat - winter-annual wheat).The productivity of winter-annual wheat after peas, as a predecessor, is 0.19 t/h - less, when compared to fallow-lend, or decreases for 4.64 % (3.91 t/h against 4.10). Taking into account the grain harvest of peas (1.52 t/ha) the yield in protein feed units and grain cultures increases in the crop rotation sequences including peas (instead of fallow field) comparatively to the fallow fields.

The cornmeal (oat) yield amounted (by crop rotation changes) to: for autumn fallow 0.42 t/h, green manure fallow 0.43 t/h, seeded fallow 0.41

t/h, by peas on grain 0.40 t/h. Productivity of winter-annual wheat: 3.50, 3.44, 3.45 and 3.25 t/h. Exit of protein feed units: 2.82, 2.79, 2.77 and 2.62 t/h. Collection of grain-growing cultures: 2.29, 2.37, 2.36 and 2.23 t/h.

Table 1

The performance level of field crop rotations, t/ha (Average for 2011 -2014 years.)

change of crop rotation	All grain	Including grain		Yield of winter-annual wheat	Protein feed units	Grain-growing units
		winter-annual wheat	forage			
1-2	2.05	2.05	0.00	4.10	2.36	2.05
1-2-2	2.47	2.47	0.00	3.71	2.84	2.47
2-3-2	2.85	2.14	0.71	3.20	3.13	2.63
3-2	2.61	1.54	1.07	3.09	2.76	2.29
1-2-2-3-2	2.52	2.10	0.42	3.50	2.82	2.39
4-2	2.00	2.00	0.00	4.00	2.30	2.00
4-2-2	2.39	2.39	0.00	3.58	2.75	2.39
2-3-2	2.82	2.11	0.71	3.16	3.10	2.61
3-2	2.66	1.59	1.07	3.18	2.85	2.34
4-2-2-3-2	2.49	2.07	0.43	3.44	2.79	2.37
5-2	2.06	2.06	0.00	4.13	2.37	2.06
5-2-2	2.39	2.39	0.00	3.58	2.75	2.39
2-3-2	2.76	2.08	0.68	3.12	3.05	2.56
3-2	2.62	1.60	1.02	3.21	2.81	2.31
5-2-2-3-2	2.48	2.07	0.41	3.45	2.77	2.36
6-2	1.96**	1.96	0.00	3.91	2.25**	1.96
6-2-2	2.24**	2.24	0.00	3.36	2.58**	2.24
2-3-2	2.61	1.95	0.66	2.92	2.87	2.41
3-2	2.50	1.50	1.00	3.02	2.67	2.20
6-2-2-3-2	2.35**	1.95	0.40	3.25	2.62**	2.23

1-Autumn fallow; 2- Winter-annual wheat; 3- Oats; 4- Green-manure fallow; 5-Seeded fallow; 6- Peas for grain; Grain of peas not inclusive (1.52 t/h).

The specified data do evidence, that the fallow land after-action is observed during the crop rotation process. On the peas background the grain collected was 6.75 % less than, the yield after the autumn fallow (grain of peas not inclusive).The calculation of the crop rotation productivity shows that exit of grain five-crop rotation next to the fallow makes 2.52 t/h (100 %), to the fallow manure 2.49 t/h (98.8 % from autumn fallow), and to the seed fallow 2.48 t/h (98.4 %), therefore all fallows background produced almost identical amount of bread.

But the autumn fallow and peas on grain (instead of fallow) had a negative balance of humus and nitrogen (table 2, 3).

Table 2

Balance of humus in the soil of experimental crop rotation, kg/ha (2011-2014 years)

change of crop rotation		BCY *, t\h	Vegetable*, t/h				Humus*, t/h		
			SP	CB	SF	all	NH	MH	BH
Crop rotation №1	Autumn f.	0.00	0.00	0.00	0.00	0.00	0.00	2.0	-2.0
	wheat	4.1	5.41	3.91	2.66	11.98	2.40	1.25	1.15
	wheat	3.32	4.38	3.36	2.41	10.15	2.03	1.25	0.78
	oat	3.04	4.10	2.12	2.06	8.28	1.82	1.20	0.62
	wheat	3.09	4.08	3.19	2.34	9.61	1.92	1.25	0.67
	sum	13.6	18.0	12.6	9.47	40.02	8.17	6.95	1.22
Crop rotation №2	Green f.	-	31.2	16.9	-	48.1	5.08	1.10	3.98
	wheat	4.0	5.28	3.84	2.63	11.75	2.35	1.25	1.10
	wheat	3.15	4.16	3.24	2.36	9.76	1.95	1.25	0.7
	oat	3.05	4.12	2.12	2.06	8.3	1.83	1.20	0.63
	wheat	3.18	4.20	3.26	2.37	9.83	1.97	1.25	0.72
	sum	13.4	49.0	29.4	9.42	87.7	13.2	6.05	7.13
Crop rotation №3	Seeded f.	-	18.2	7.44	-	25.64	1.80	1.10	0.7
	wheat	4.13	5.45	3.93	2.67	12.05	2.41	1.25	1.16
	wheat	3.02	3.99	3.14	2.32	9.45	1.89	1.25	0.64
	oat	2.91	3.93	2.06	2.03	8.02	1.76	1.20	0.56
	wheat	3.21	4.24	3.28	2.38	9.90	1.98	1.25	0.73
	sum	13.3	35.9	19.9	9.4	65.1	9.84	6.05	3.79
Crop rotation №4	peas	1.5	2.22	1.43	0.77	4.42	1.02	1.5	-0.48
	wheat	3.91	5.16	3.78	2.60	11.54	2.31	1.25	1.06
	wheat	2.82	3.72	3.00	2.25	8.97	1.79	1.25	0.54
	oat	2.84	3.83	2.03	2.02	7.88	1.73	1.20	0.53
	wheat	3.02	3.99	3.14	2.32	9.45	1.89	1.25	0.64
	sum	14.1	19.0	13.4	9.96	42.3	8.74	6.45	2.29

** BCY- Basic culture yield; SP-Side products; CB-To cor-nubits and pieces; SF-Super facial bits and pieces; NH-New-born humus; MH-Mineralization; BH-Balance of humus.*

Such phenomenon is conditioned by that on autumn fallow an intensive mineralization of humus takes place, and the pea itself provides nitrogen, due to lactic-fermentation bacteria from atmospheric air, but almost does not leave that nitrogen in soil after itself. The negative soil balance in substances and energy taken away with a harvest implies the decrease in fertility of soil, especially when humus replenishment is practically absent, that is why it is necessary to conduct the search of alternative to the pus of organic fertilizers types.

In a crop rotation with autumn fallow the humus accumulation is small, or even its deficit takes place. On the field with black fallow there arises the mineralization of humus in an amount 2 t/h, and due to straw, root and superficial bits and pieces of winter wheat and oat the new-born humus accumulates in an amount of 8.17 t/h, but under the canopy of wheat and oat the 6.95 t/h of humus is mineralized, that is why it remains in soil only in the amount of 1.22 t/h (table 2).

When grain yield of winter wheat is less that 2 t/h the soil is deficient with humus. Regression analysis of the data obtained indicates the close relationship between the humus content and the amount of straw, which remains on the field after harvesting the grain. The winter-annual wheat productivity less than 30 t/h at the deficit of humus (amount of straw, that does not provide self-supporting balance of humus, diminishes) is marked.

The winter-annual vetch forms 31.2 t/h of biomass already in the end 2 ten-day periods of May. Transformation of vetch biomass allows accumulating 3.98 t/h to the humus. Mineralization of humus in soil under the canopy of above-ground mass of vetch presents 1.10 t/h, i.e. 0.90 t/h less than, than on a black fallow. A positive balance of humus on a green-manure fallow pair presents 2.88 t/h. Due to the straw, root and straw residues the winter-annual wheat and oat balance of humus in a crop rotation from green-manure fallow increases to 7.13 t/h. In a crop rotation with seeded fallow (by mixture of peas and mustard white on a green fertilizer) the humus balance is also positive, 3.79 t/h. A crop rotation with peas on grain (instead of autumn fallow) has a positive humus balance at the level of 2.29 t/h, but in soil after peas there is a deficit of humus (- 0.48 t/h).

The second criterion of soil fertility is the balance of nutrients. In crop rotation with autumn fallow and peas on grain there is negative balance of nitrogen accordingly minus 132.8 and 121.2 kg/h. In a crop rotation from green-manure fallow the balance of nitrogen is positive and presents 199.9 kg/h. In a crop rotation seeded fallow the balance of nitrogen is also positive due to the mixture of peas with mustard white 7.72 t/h (table 3).

In a crop rotation with peas on grain (instead of fallow) the nitrogen balance is less negative than in a crop rotation with autumn fallow. The peas itself provide nitrogen, but only a small nitrogen content in soil remains. By the amount of the accumulated nitrogen on the first place there is a crop rotation from green-manure fallow (a vetch-annual) and on the second place-seeded fallow (mixture of peas and mustard white).

Table 3

Balance of nitrogen in the soil of experimental crop rotation, kg/ha (2011 -2014 years)

Crop rotation tabl.2	Productivity of products, t/h		Receipt of nitrogen, kg/h				B_{ON}, kg/h	B_N, kg/h
	BP	SP	P_N	H_N	A_N	all		
first	13.55	17.97	92.06	15.4	34.8	142.26	275.01	-132.75
other	13.38	48.96	410.79	17.1	43.5	471.39	271.49	199.90
third	13.27	35.80	209.16	24.51	43.5	277.17	269.45	7.72
fourth	14.11	18.86	102.45	24.3	43.5	184.45*	305.60	-121.15

Note: *BP-Basic products; SP-Side products;* P_N*- Receipt of nitrogen with organic fertilizers(side plant-grower products);* H_N*- Is a receipt of nitrogen with sowing seed;* A_N*- Is a receipt of nitrogen with atmospheric precipitations;* ***-** *Is the symbiotic fixing of nitrogen by leguminous culture (14,2)kg/h;* B_N*- Balance of nitrogen;* B_{ON}*-Bearing-out of nitrogen basic products.*

The positive balance of phosphorus (P_2O_5) is provided not in all crop rotations, even when all straw used for an organic fertilizer. The mustard white accumulates the phosphorus in green mass more that the winter-annual vetch, but the productivity of mustard is lower and that is why the gross accumulation of phosphorus is less (table 4).

Table 4

Balance of phosphorus (P_2O_5) in the soil of experimental crop rotation, kg/ha (2011 -2014 years)

Crop rotation tabl.2	Productivity of products, t/h		Receipt of phosphorus, kg/h				B_{OP}, kg/h	B_P, kg/h
	BP	SP	P_P	H_P	A_P	all		
first	13.55	17.97	33.67	5.83	0.60	40.1	103.0	-62.9
other	13.38	48.96	69.86	6.48	0.60	76.94	101.75	-24.81
third	13.27	35.80	62.87	8.07	0.60	71.04	100.81	-29.77
fourth	14.11	18.86	36.28	8.07	0.,60	44.96	108.29	-63.33

Note: *BP-basic products; SP-side products;* P_P*-is a receipt of phosphorus with the organic fertilizers (side plant-grower products);* H_P*- a receipt of phosphorus with sowing seed;* A_P*- is a receipt of phosphorus with atmospheric precipitations;* B_{OP}*- bearing-out of phosphorus basic products;* B_P*-balance of phosphorus.*

Balance of potassium (K_2O) is positive in all crop rotation (table 5).The greatest index from the accumulation of potassium in a crop rotation from a green-manure fallow is 174.52 kg/h, decreasing when a crop rotation with seeded fallow (by mixture of peas and mustard white) 368.65 kg/h, and crop rotation with peas on grain (instead of fallow) and with autumn fallow it has an almost identical amount of potassium 191.69 and 188.53 kg/h.

Table 5

Balance of potassium (K_2O) in the soil of experimental crop rotation, kg/ha (2011 -2014 years)

Crop rotation tabl.2	Productivity of products, t\h		Receipt of potassium, kg/h				B_{OK}, kg/h	B_K, kg/h
	BP	SP	O_K	B_K	S_K	all		
first	13.55	17.97	210.70	3.83	41.0	255.53	67.00	188.53
other	13.38	48.96	288.65	4.72	41.0	334.37	66.18	268.19
third	13.27	35.80	249.90	7.39	41.0	298.29	65.61	232.68
fourth	14.11	18.86	225.32	7.39	41.0	273.71	82.02	191.69

Note: *BP-Basic products; SP-Side products; O_K-Is a receipt of potassium with the organic fertilizers (side plant-grower products); B_K- A receipt of potassium with sowing seed; S_K- Is a receipt of potassium with atmospheric precipitations; B_{OK}- Bearing-out of potassium basic products; B_K-Balance of potassium.*

The negative role of green-manure fallow can reveal itself in that the vetch spends moisture on phytomass forming, as well as in the loss of moisture that takes place at land plowing for wrapping green mass into soil. For the terms of steppe we are working out the innovative technological variant of green manure fallow preparation. The above-ground mass of green manure culture is not ploughed into, as when classic procedure, but it is ground down by disk instruments and partly mixed with the superficial layer of soil. At such technology on the surface of the field a part of vegetable remainders not wrapped in soil remains that reliably protects the plough-land from deflation and partly protects it from physical evaporation of the moisture. Exactly this variant is approved and gave a positive result.

The winter-annual vetch, as a green-manure culture, accumulates the phytomass and nutrients more essentially than other plants that are grown on a green fertilizer under equal biotic conditions [16].The rooting of vetch is proportional to its above-ground mass. Here is the first positive side of winter-annual vetch: the developed and ramified roots pierce soil on a depth above 1 meter, increasing porosity of soil and this culture supplies the organic mass that contains nitrogen fixed from atmospheric air due to the symbiosis with lactic - fermentation bacteria. Transformation and mineralization of biomass of rootage is less intensive comparatively with superficially wrapped aboveground biomass.

The second positive side is that after disking of vetch in May there are 4 months to sowing of winter wheat (25 September - 5 October), that allows to conduct a careful supervision after seeded-manure fallow (1-2 disking for growing of biomass and mixing with soil ,3-5 cultivating).

On the average on a 1 hectare of winter-annual vetch sowing there accumulates the biomass in an amount at 31.2 t/h, root remainders 16.9 t/h, nitrogen 330 kg/h, P_2O_5 37.27 kg/h, K_2O 89 kg/h; on one hectare of peas and mustard white mixture there are observed: biomass 18.2 t/h, root remainders 7. 44 t/h, nitrogen 136.81 kg/h, P_2O_5 31.86 kg/h, K_2O 56 kg/h.

Intensity of balance in nitrogen (% return receipt to the grain yield) 173.63 % (a crop rotation with winter-annual vetch) 102.86 % (with mixture of peas and mustard white); in phosphorus 75.62 % (a crop rotation with vetch), 70.47 % (with mixture). Intensity of balance in humus (% accrued to mineralized) 217.85 % (a crop rotation with winter-annual vetch), 138.90 % (with mixture of peas and mustard white), 135.5 % (with peas on grain 117.55 % with autumn fallow).

Conclusions: The optimal change of the field crop rotation is three-field from seeded-manure fallow, that stipulates most collection of winter-annual wheat grain and of protein feed, also providing the extended recreation of southern black earth fertility by humus, nitrogen, potassium and simple reproduction of phosphorus. In protogynous to the crop rotation from seeded-mounted fallow (sowing of winter-annual vetch), a return from phosphorus folds only 76 %.

Straw of winter-annual wheat and oat, if remained on the field after grain harvesting, does compensate the nutrients bearing-out from soil with the harvest of grain by nitrogen on 51.7 %, by phosphorus on 38.9 %, and by potassium on 38.1 %, and also stipulates the self-supporting balance of humus.

Green manure from the peas and mustard white mixture green mass in a complex with straw does form a positive balance of humus, nitrogen, potassium and phosphorus compensating the bearing-out on 70.5 %.The crop rotation with autumn fallow (without pus) and peas on grain (instead of fallow) produces a negative balance of nitrogen and phosphorus, but a positive balance of potassium (due to the straw of winter-annual wheat and oat). The seeded manure fallow is the basic element of crop rotation for providing of the extended reproduction of soil fertility and a permanent production of plant-grower goods.

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Анотація

Друз'як В.Г., Юркевич Е.О.,Безедк Н.Г. ,Аль-джанабі К.Т. ***Пошук оптимальних ланок сівозмін і альтернативних гною видів органічних добрив.*** *Показано, що оптимальною ланкою польової сівозміни є трипільна з паром сидеральним ,яка обумовлює найбільший збір зерна пшениці озимої і кормопротеїнових одиниць, а також забезпечує розширене відтворення родючості чорнозему південного за вмістом гумусу, азоту і калію та просте відтворення щодо фосфору.*

Клочові слова: *ланки польових сівозмін, урожайність зерна ,вихід кормопротеїнових одиниць, відтворення родючості чорнозему південного .гумус і поживні речовини.*

Summary

Druzyak V.G. Yurkiewicz E.A. Bezede N.G., Q.T. Al-janabi ***Search for optimal chains of crop rotations and types of organic fertilizers alternative to manure****.*

It is shown that the chains of crop rotation sidereal with steam is optimal, as the greatest causes of winter wheat grain yield and protein fodder units, as well as providing expanded reproduction of fertility of chernozem southern humus content, nitrogen, potassium and phosphorus simple reproduction.

Keywords:*field crop rotation succession, grain productivity, protein grain of feed of units, restoring the southern chernozem fertility, humus and nutrients.*

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ГЕНЕТИЧНИЙ АНАЛІЗ ОЗНАКИ ОПУШЕННЯ СТЕБЛА ПІД КОЛОСОМ ОЗИМОЇ ТРВЕРДОЇ ПШЕНИЦІ

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«Опушення стебла під колосом» у рослин різновидів озимої твердої пшениці має гомогенну природу та домінантний характер успадкування. Її можливо використовувати, як домінантну маркерну ознаку в генетичних дослідженнях та селекційній роботі. Ця ознака впливає на збільшення довжини колоса та збільшення кількості продуктивних колосків, в тому числі у рослин нового різновиду твердої пшениці var. filatenkoae Zor. at Piln .

Ключові слова:*опушення стебла під колосом, генетика, тверда пшениця, нові різновиди*

Вступ. Вільне вітрозапилення призводить з селекційної точки зору до біологічного засмічення особливо інтродукційних зразків, або насіння яких сформовані в нетипових умовах середовища. Але за рахунок спонтанної гібридизації у твердої озимої пшениці [1] в колекційних та селекційних розсадниках і сьогодні продовжується формоутворюючий процес, в результаті якого можлива поява нових форм з новим співвідношенням ознак. З таких форм нам вдалося