EFFICIENCY OF APPLICATION OF MINERAL AND ORGANIC FERTILIZERS UNDER THE CULTURE OFCROP ROTATION IN THE IRRIGATION CONDITIONS OF FOOTHILL ZONE OF ALMATY REGION

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ABSTRACT

The paper presents the results from studies carried out in the farming conditions.
It has been found that with the application of rational norms of mineral and organic fertilizers used for growing various crops (barley, rape, flax, soybean), soil fertility could be stabilized and their effectiveness enhanced.
The content of mineral nitrogen under rape crops was at the level of the control variant. Its content in the variant using liquid manure (biofertilizer) was somewhat lower than that of in the rotted manure - 29.3; 28.9; 29.2, and 31.2 mg/kg, respectively, under rotation crops. The least influence on the nitrogen content of the soil from among organic fertilizers was made by the straw incorporation (6t/ha). The amount of mineral nitrogen in the surface and subsurface soil decreased at the end of the growing season for the studied crops.
Fertilizers in varying degrees affected the value of this indicator.
The introduction of calculated rates of mineral fertilizers (NPK) increased the content of mobile phosphorus to 27.8-29.3 mg/kg, that is, by 6.6-6.8 mg/kg of soil compared with the control variant.
Organic fertilizers also contributed to an increase in the mobile phosphorus content in soil. Of these, the manure application had a greater impact (30t/ha). On average, over 3 years of direct action and 2 years of aftereffect, application of 30 t/ha of rotted manure increased the content of mobile phosphorus under rotation crops by 3.5-4.8 mg/kg of soil compared with the control variant.
The use of liquid manure had somewhat less effect on an increase in the mobile phosphorus content in soil. On average, over 3 years of action and aftereffect, it increased in the surface soil under rotation crops by 1.7-2.4 mg/kg compared with the control variant.
The straw incorporation had no significant effect on this indicator, and its value under the crops was at the control level.
The use of liquid manure also had a positive effect, when in the first year an appreciable increase in the grain yield of 0.70 t/ha was achieved, and in subsequent years the

aftereffect was insignificant; on the whole, 1.04 t/ha of additional yield was obtained over 3 years, which is about 15% of the value in the control variant. An even lower yield increase was achieved due to the straw incorporation (0.50 t/ha over 3 years). The same mode of action of mineral and organic fertilizers also differs in the flax and rape crops.

Keywords: fertilizers, yield, rotation crops, flax, rape, spring barley

INTRODUCTION

At present, application of expensive industrial fertilizers leads to a decrease of goods production profitability of plant cultivation. Therefore development of the system of the cultures' fertilizers, including biologization elements (use of the bean cultures in a crop rotation, accumulating biological nitrogen, leaving of straw and cultures' stalks of a crop rotation, an importation of different types of a manure, bio humus, etc.) notably will reduce a share of mineral fertilizers by optimization of a nutrition [1].
It is known that among organic fertilizers large specific gravity is given to animal manure, mainly to litter. Not in less degree uses near-by stock-raising farms and liquid manure, at the correct use of which there is enough perceptible efficiency on fertility of soil and productivity of agriculture's [2].
In recent years many farmers use a manure as an alternative energy source as raw materials for different types of biogas installations.
At the same time there is a question of wastes utilization of these biogas installations, about a possibility of their use also as fertilizers [3].
In this regard there was a necessity to study wastes of the biogas installation under cultures of crop rotation (spring barley, rape, flax, soya) in comparison with mineral fertilizers and a dung.
Field experiments laying educational-experimental station (EES) «Agro University» on the sprayed meadow-chestnut soil in the 4th field crop rotation, in unfolded space and in time: 1 spring barley, soya, olive flax, spring rape.
The content of humus in an arable layer of soil of 4.46-4.49%, in the sub arable of 4.46-4, 47%, the content of bulk nitrogen and phosphorus respectively 0,250 and 0,211%. Soil of the site is highly provided with available nitrogen and potassium, and low provided with the mobile phosphorus.
The following scheme of entering of fertilizers under cultures of a crop rotation was studied:
1. Control (without fertilizer);
2. Calculation norm of NPK (for RK soya);
3. A dung of 30 t/hectare – action and 2 years – a consequence;
4. Straw of 6, 0 t/hectare – action and 2 years – a consequence;
5. A fluid dung (bio fertilizer) of 30 t/hectare – action and 2 years – a consequence.

Under cultures of a crop rotation the calculated norm of NPK made:
For spring barley – 2012г.- N_{70} P_{65} K_{10}
2013г.- N_{80} P_{50} K_0
2014г.- N_{67} P_{45} K_0
For spring rape – 2012г.- N_{75} P_{70} K_{20}
2013г.- N_{68} P_{75} K_{10}

2014г.- N_{60} P_{70} K_{20}

For flax – 2012г.- N_{83} P_{75} K_{15}
2013г.- N_{70} P_{70} K_{20}
2014г.- N_{80} P_{55} K_{20}

For soya – 2012г.- P_{80} K_{25}
2013г.- P_{75} K_{10}
2014г.- P_{70} K_{25}

The area of an experienced allotment is 54 m^2 (3,6x15), repeatability of experience is 3-fold. Crops of cultures with the optimum term of sowing, norm of seeding, depth of seeds sealing, the area of nutrition are placed according to the scheme of alternation.
As fertilizers were used: nitric–ammonium nitrate with the maintenance of 34% of N; phosphoric–ordinary superphosphate with the maintenance of 19% of P_2O_5 and potassium – potassium chloride with the maintenance of 50% of K_2O.
Organic fertilizer is semi-rotting manure, bio humus - a product of vermiculture, straw is grain crops. Liquid manure is a fertilizer, forming in the process of biogas installations using different wastes and finding recently broad application.
The calculation norms of mineral fertilizers were brought annually, and organic (manure, straw, liquid manure) one time, further within 2 years were studied their consequence.
Humidity of soil in experience at the level of 60-70% from NV was supported by conducting 1-4 watering with watering norm of 650-700 m3/hectare under cultures of a crop rotation taking into account the dropping-out rainfall and features of cultures.
Soya seeds before sowing were treated with nitrogen.
During the vegetation of cultures on the main growth phases and development were selected samples of plants and soil in layers of 0-20, 20-40 cm. Accounting of a biological crop is on portion.
In soil was determined- nitrate nitrogen ($N\text{-}NO_3$) by GrandvalLyazh, ammoniac nitrogen with the Nessler's reagent, mobile phosphorus in 1% carbonate ammoniac extraction on the method of Machigina B.A.
Formation and accumulation of mineral nitrogen is caused by a number of the complex processes – an ammonification, a nitrification, chemical and biological absorption, and washing away of nitrates from soil, non-exchange fixation of an ammonium, and also consumption by plants [4] .
The results of researches showed that in meadow-chestnut soil practically all cultures at the beginning of vegetation note the content of mineral nitrogen, relatively high for this soil (table 1).
From the table it is visible that the importation of calculated norms of mineral fertilizers, in particular nitric (except for soya) promoted in the increase of its size in relation to a control variant. So, under sowing of a spring barley content of mineral nitrogen increased to 34, 8 mg/kg in an arable layer at its size on control option of 24, 7 mg/kg of the dry soil. The same increase of amount of mineral nitrogen is noted under other cultures of a crop rotation. Thus it should be noted that in spite of the fact that under soya nitrogenous fertilizers were not included but only phosphorus-potassium, the content of mineral nitrogen was higher than on control (without fertilizers) option.

The amount of mineral nitrogen in soil was differently affected by an importation of organic fertilizers.

As be obvious from a table, at bringing of 30 t/hectare of manure on the average for 3 years, taking into account an action and 2 years of a consequence content of mineral nitrogen in the first term of determination was enough high in relation to a control variant and did not concede to an annual importation of mineral fertilizers (35,5 mg/kg under barley, 20,6 mg/kg under rice, 30,3 mg/kg under flax, 32,6 mg/kg under soya).

Under sowing of colza content of mineral nitrogen appeared at the level of control variant. It is slightly lower than contents of it than from the manure rotting was on option with use of a fluid manure (bio fertilizer) – 29,3; 28,9; 29,2 and 31,2 mg/kg relatively under cultures of a crop rotation. The least impact on the content of nitrogen in soil from organic fertilizers was exerted by a straw importation (6t/hectare). The amount of mineral nitrogen in arable and sub arable layers of soil decreases by the end of vegetation of the studied cultures.

Table 1 – Dynamics of mineral nitrogen in soil depending on use of fertilizers under sowing of cultures of a crop rotation, mg/kg of the dry soil (an average for 2012-2014)

Variants of fertilizers	Bopsoil, cm	Barley		Colza		Flax		Soy *	
		the I time	the II time	the I time	the II time	the I time	the II time	the I time	the II time
Control (without fertilizer)	0-20	24,7	17,8	20,8	13,1	23,0	15,0	24,6	15,6
	20-40	24,2	18,0	19,4	17,2	21,2	14,3	20,9	17,8
NPK Calculation norm									
Manure 30 t/hectare	0-20	34,8	22,9	32,4	18,3	37,3	24,9	29,1	18,0
Straw of 6, 0 t/hectare	20-40	22,9	24,6	28,6	25,9	33,7	20,2	24,8	21,2
Fluid manure	0-20	35,5	23,8	20,6	20,7	30,3	22,1	32,6	19,7
Control (without fertilizer)	20-40	27,3	23,5	25,4	19,7	26,3	16,5	25,2	22,1
NPK Calculation norm	0-20	27,8	18,9	22,9	15,0	25,7	18,2	25,6	14,9
Manure 30 t/hectare	20-40	22,8	17,4	17,8	14,1	20,4	16,0	21,3	18,0
Straw of 6, 0 t/hectare	0-20	29,3	20,4	28,9	20,9	29,2	22,3	31,2	19,4
	20-40	25,0	23,0	27,7	19,2	27,2	21,3	26,8	21,6

Note-* for soya - calculation norm of RK

The meadow-chestnut soil, on which researches were conducted, is noted by quite high content of bulk phosphorus (0,211%). However, as we know, security of agricultural plants is defined not by total quantity of phosphorus in soil, and the content of its available form which size is low in this soil.

So, from table 2 it is visible that under all cultures of a crop rotation the content of the mobile phosphorus is low and hesitates on average for 3 years within the limits of 21,2-22,5 mg/kg of soil in arable and 17,8-18,5 mg/kg in a sub arable layer of soil.

Fertilizers in a different degree influenced on the size of this index.
So, bringing of calculation norms of mineral fertilizers (NPK) increases the content of mobile phosphorus to 27, 8-29, 3 mg/kg, that on 6, 6-6, 8 mgs/kg of soil in relation to a control variant.
Organic fertilizers also promoted increase of the relative frame phosphorus in soil. From them the greater influence was exerted by a manure importation (30t/hectare). On average for 3 years taking into account a direct action and 2 years an after-action importation of 30 t/hectare of the manure rotting increased the content of the mobile phosphorus under cultures of a crop rotation on 3,5 - 4,8 mg/kg of soil in relation to a control variant.
A few less influence on the increase of mobile phosphorus in soil was exerted by use of liquid manure. On the average for 3 years of action and consequence it rose in an arable layer under the cultures of crop rotation on 1, 7-2, 4 mg/kg in relation to a control variant.
The importation of straw did not exert noticeable impact on this indicator and its size under cultures was at the level of control.

Table 2 – Dynamic of mobile phosphorus in soil depending on application of fertilizers under sowing of cultures of crop rotation, mg/kg of dry soil

Variants of fertilizers	Topsoil, cm	Barley		Colza		Flax		Soy *	
		the I time	the II time	the I time	the II time	the I time	the II time	the I time	the II time
Control (without fertilizer)	0-20	22,3	18,6	22,1	17,5	22,5	17,3	21,2	18,0
	20-40	18,3	15,4	17,8	15,2	18,5	16,5	18,4	15,1
NPK Calculation norm									
Manure 30 t/hectare	0-20	28,2	21,3	27,8	21,6	28,3	22,1	29,3	22,9
Straw of 6, 0 t/hectare	20-40	21,1	16,8	20,9	17,0	21,4	17,3	18,8	16,0
Fluid manure	0-20	26,4	21,1	26,9	20,8	26,0	20,9	25,9	22,3
Control (without fertilizer)	20-40	18,9	16,8	19,9	19,8	20,1	17,6	18,0	15,4
NPK Calculation norm	0-20	22,4	19,6	22,8	19,7	23,1	19,1	22,3	18,7
Manure 30 t/hectare	20-40	17,4	16,0	18,3	16,1	18,8	17,4	18,5	14,1
Straw of 6, 0 t/hectare	0-20	24,4	19,2	23,9	19,8	24,2	19,2	23,6	21,0
	20-40	20,0	17,3	20,3	16,9	19,1	15,3	19,8	13,9

Note-* for soya - calculation norm of RK

Fertilizers, the best nourishing mode of soil, rendered positive influence on increase of one of the important indexes of their efficiency is a size of harvest.
So, from table 3 it is visible that the annual importation of calculation norms of NPK provides a grain yield of spring barley on average for 3 years – 3,92 t/hectare at productivity on control of 2,82 t/hectare, the increase makes - 1,10 t/hectare or 40% from its size on not fertilized option.
Organic fertilizers, brought in one time for 3 years, influenced differently on the size of harvest of the studied cultures.

So, the semi-rotting manure norm of 30 t/hectare taking into account action and an after-action provided in the sum for 3 years 2,31 t/hectare of a padding increase of a harvest that makes nearly 30% size of not fertilized option.
Positive impact was exerted and also use of a fluid manure where the perceptible increase of harvest of grain is got in the first year – 0, 70 t/hectare, and in the next years the after-action was insignificant and in a sum for 3 years it was got 1, 04 t/hectare of additional harvest, that makes an about 15% size of control variant. Also more low increase of harvest is got from importation of straw (0, 50 t/hectare for 3 years).
The same regularity of action of mineral and organic fertilizers differs on cultures of flax and colza.
However, it should be noted higher responsiveness on application of fertilizers of flax and colza in comparison with spring barley.
Thus, the increase of productivity of flax seeds at an importation of various norms of fertilizers on average for 3 years was 0,86 t/hectare at size on control of 1,49 t/hectare that is 58% (table 3).

Table 3 – Productivity of cultures of a crop rotation depending on use of fertilizers, t/hectare (an average for 2012-2014)

Variants of fertilizers	Barley			Colza			Flax			Soy *		
	Harvest, t/hectare	Increase of a harvest, t/hectare		Harvest, t/hectare	Increase of a harvest, t/hectare		Harvest, t/hectare	Increase of a harvest, t/hectare		Harvest, t/hectare	Increase of a harvest, t/hectare	
		in a sum for 3 years	on the average for 3 years		in a sum for 3 years	on the average for 3 years		in a sum for 3 years	on the average for 3 years		in a sum for 3 years	on the average for 3 years
Control (without fertilizer)	2,82	-	-	1,33	-	-	1,49	-	-	2,77	-	-
NPK Calculation norm	3,92	3,27	1,09	20,5	2,15	0,72	2,36	2,58	0,86	3,38	1,82	0,61
Manure 30 t/hectare	3,59	2,31	0,77	1,81	1,44	0,48	2,09	1,78	0,59	3,26	1,46	0,49
Straw of 6, 0 t/hectare	2,99	0,50	0,16	1,52	0,57	0,19	1,83	1,02	0,34	2,89	0,37	0,12
Fluid manure	3,17	1,04	0,35	1,56	0,67	0,22	1,85	1,13	0,38	2,97	0,61	0,20
HCP 005т/га	0,12-0,17			0,13-0,45			0,11-0,28			0,13-0,25		

Note-* for soya - calculation norm of RK

Responsiveness of flax is also high on bringing of organic fertilizers.
From the table it is visible that from an importation of 30 t/hectare of a manure, taking into account its action and 2 years of an after-action got in a sum the increase of seed of 1,78 t/ga, that is almost 40% from the sum of harvests on control.

Even, when using straw (6 t/hectare) and a fluid manure of an increase of a harvest of flax seeds in the sum for 3 years make 24-25% of a harvest on control option.
The same high responsiveness on change of the nutritious mode of the soil is noted on an oil-bearing crop - colza (table 3).
From the table it is visible that at productivity of colza seeds on control option (without fertilizers) on average for 3 years – 1,33 t/hectare its size on options with fertilizer hesitated within 1,52-2,05 t/hectare.
The increase of productivity hesitated at the same time from 0, 72 t/hectare at an annual importation of calculation norms (NPK) of mineral fertilizers to 0, 19÷0,48 t/hectare from organic fertilizers taking into account their action and an after-action.
It should be noted that at the sum of increases of harvest for 3 years from importation of 30 t/hectare manure of equal 1,44 t/hectare, in the first year the size of increase of harvest made 0,60 t/hectare in the subsequent years of consequence according to 0,45; 0,39 t/hectare.
Unlike a fluid manure (bio fertilizer) at an importation of which colza harvest increases by years were the following - 1 year of action – 0,29 t/hectare, the subsequent – 0,20; 0,20 t/hectare, when using straw on the contrary, in the first year the increase of a harvest was within an experience error – 0,11 t/hectare, whereas in the next years the noticeable after-action – 0,20-0,25Ô/hectare was noted.
Under crops of soya on option with calculation norms of mineral fertilizers, nitrogenous fertilizers were not introduced at all and only phosphorus-potassium were used. But at high-quality processing of seeds before crops nitragin, proper for soy culture, on roots in good time plenty of tubers and plant appeared on a phosphoric-potassium background did not test the lack of nitrogen that is confirmed by high productivity, and also the stable content of mineral nitrogen in soil during all vegetation of soya.
From a table evidently shown, that the calculation norm of phosphoric-potassium fertilizers provides the productivity of 3, 38 t/hectare on the average for 3 years at a size on control equal 2, 77 t/hectare, that, providing an increase in a sum for 3 years of 1, 82 t/hectare, and on the average 0, 6 t/hectare.
Positive influence on the productivity of soya exerted importation of 30t/hectare manure, providing the additional increase of harvest in a sum for 3 years of 1,46 t/hectare grain, and on years from first-year of action – 0,70 t/hectare, second year of after-action – 0,43 t/hectare, third - 0,33 t/hectare.
The importation of a fluid manure (30 t/hectare) provided in the sum for 3 years 0,6 t/hectare, and from a straw importation only of 0,37 t/hectare.
Thus, results of researches showed that all types of fertilizers exert positive impact on change of the nutritious mode of soil and on productivity of a crop rotation cultures on the meadow-chestnut soil in the conditions of irrigation.

CONCLUSIONS

It was revealed that almost all crops on the meadow-chestnut soils show signs of a relatively high content of mineral nitrogen for this soil at the beginning of the vegetation period.

It was established that the content of mobile phosphorus under all rotation crops was low and within 3 years varied on average from 21.2 to 22.5 mg/kg in the soil arable layer and from 17.8 to18.5 mg/kg in the subsoil layer.

It was established that all types of fertilizers had a positive impact on the change in the soil nutrient regime and on the productivity of rotation crops on the meadow chestnut soils under irrigation conditions.

It was found that the introduction of calculated rates of mineral fertilizers (NPK) increased the content of mobile phosphorus to 27.8-29.3 mg / kg, that is, 6.6-6.8 mg / kg relative to the control variant.

It was found that the introduction of straw had no significant effect on this indicator and its value under the crops was at the control level.

It was revealed that in the first year the amount of the crop increment was 0.60 t/hectare, in the following years of after activation, respectively, 0.45, with the addition of 30 t / ha manure equal to 1.44 t/hectare, 0.39 t/hectare.

The positive effect on soybean yield was made by 30 t/hectare of manure, which provided an additional yield increase of 1.46 t/hectare for 3 years, and 0.70 t/hectare for the first year of operation, 0 for the second year of aftereffect, 43 t/hectare of the third - 0.33 t/hectare.

It has been established that all types of fertilizers have a positive effect on the change in the nutrient regime of the soil and on the productivity of crop rotation crops on meadow chestnut soil under irrigation conditions.

It was using straw (6 t/hectare) and liquid manure, the increase in the yield of flax seed in the amount of 3 years in total is 24-25% of the crop in the control variant.

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