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OPTIMIZATION OF AGRICULTURAL NUTRITION FOR PHYSICO-CHEMICAL DEGRADATION OF ACID SOILS

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Goal. Investigate and identify the features of the formation of physico-chemical degradation of gray forest soil under different anthropogenic load in grain crop rotation. **Methods.** Field, laboratory, computational, mathematical and statistical. **Results.** Against the background of a decrease in the aftereffects of radical chemical reclamation by 10–13 years, the application of an annual dose of alkaline earth elements taking into account the physiological characteristics of the crop (average 11,4 kg/ha and 4,6 kg/ha of calcium and magnesium, respectively), provides for 10–12 years close to neutral, and for 13 years of action weakly acid reaction of soil solution. In addition, there is a slight increase in the content of metabolic Ca and Mg in soil absorption complex, their content increases to 6,71–7,00 mg-eq/100 g of soil. The results of research on the impact of different agrochemical loads on gray forest soil with increasing doses of fertilizers, both in combination with and without radical chemical reclamation measures, obtained during 2016–2019, are presented. It is established that the use of intensive fertilizer systems without radical chemical reclamation leads to the deterioration of the physicochemical properties of gray forest soil. **Conclusions.** The use of a dose of mineral fertilizers on gray forest soil, calculated according to the species genotypic ratio of the content of elements in the biomass of the crop against the background of lime application, provides: optimization of crop nutrition, reduction of phosphorus and potassium, optimization of physicochemical, soil toxicity and soil properties H^+ and Al^{3+}. The optimal combination of N, P, K, Ca and Mg (216 k/ha in the ratio 1:0,4:0,5:0,3:0,1) in combination with seed inoculation with nitrogen-fixing and phosphorus-mobilizing bacteria, provides an increase in the level of productivity of the grain crop rotation to 5,45 t/ha of grain units and the payback of 1 kg of active substance of fertilizers to 15,6 kg of grain units. Physico-chemical degradation on acid soils with the application of high doses of nitrogen fertilizers can be partially prevented by saturating the soil absorption complex with exchange cations of alkaline earth metals, supplementing the fertilization system by applying small doses of Ca and Mg calculated on the basis of species content based on the recommended dose of nitrogen, an element that is limited to acidic soils.

***Key words:** liming, soil acidity, gray forest soil, system of fertilization, doses of fertilizers, payback of fertilizers, productivity of crop rotation.*
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The present stage of land development slavery is becoming an increasingly important issue stability and efficiency of application mineral fertilizers and microbial preparations those. Low payback of the recommended doses mineral and organic fertilizers, which depending on the type of soil and culture is 5,0–2,0 kg of grain per 1 kg of NPK, compared to succulent countries in which the return 1 kg NPK – 20–36 kg of grain, requires search new approaches to determining the optimal their doses. This is a very important issue low soil acidity and increasing their level of fertility consequence of the limited use of alkaline earth elements (Ca, Mg) and organic fertilizers [1]. Prevention of physico-chemical soil gradation, achieving optimal acid-base balance and preservation soil fertility is possible with optimization fertilizer systems for crops and properties soil through the introduction of measures to rhino chemical reclamation 1 time in several years. Against the background of the aftereffect of chemical reclamation annually in the system of crop fertilization biogenic (P, K) and alkaline ground (Ca, Mg) elements, doses of which should be calculated by species genotype ratio (SGR) of the content of elements in crop biomass.

Due to intensive use agricultural land is observed their depletion and increasing load on the environment [2, 3]. In Ukraine the area of acid soils is 10,3 million ha is 26,3% of the total area, every 4th hectare of land is acidic, in zones Forest-Steppe and Polissya – almost every 2nd (49,7 and 47,4%). Deficiency of organic fertilizers (0,5 t/ha) and intensive removal organic matter is caused annually loss of humus is about 1,0 t/ha, and for the last in 130 years they make up 30% [4]. By such circumstances are extremely important reducing the environmental burden on soil.

A feature of gray forest soils is violation of the physiological balance of the solution in the soil environment in the direction of increase acidity [1, 3, 4], low absorption capacity weak buffering, resulting in deteriorating physical and chemical properties [1, 5], the activity of soil microorganisms and increasing the intensity of microbiological processes [6]. There is a decrease fertility, contaminated crop production products and deteriorating environmental new [7, 8]. Decreased acidity soils involved in intensive agricultural economic production, possible in this case radical improvement of soil properties environment and neutralization of excessive acidity, as well as liming, which held once every few years, or annual contribution of insignificant (maintenance – 350–500 kg of $CaCO_3$) dose of ameliorant [1, 5].

The intensity of assimilation of animal elements crops is a fairly dynamic process and depends from hydrothermal conditions of vegetation periods, phenological phase of plant development, reactions of soil solution, varietal features and the length of the growing season cultures, norms, plowing depths [16] and localization of batteries in the profile soil [8, 9, 12, 14, 15]. Accordingly, the dynasty mica assimilation of elements by the plant will be quite different and will vary depending from the action of certain factors [9, 10, 13].

The ratio of batteries in agricultural plants did not depend on the dose of fertilizer, geographical or soil-climatic conditions, agrotechnical measures [1, 3, 9, 15–18]. It is possible argue that the ratio of these is a consequential (genetic) trait and can be taken as a genotypic species ratio and belong to only one biological species, or, as in our variety, variety or hybrid of agricultural culture. Having identified by species genotype ratio culture, say the content of N:P:K:Ca:Mg in the main and by-products, can be carefully learn and clarify various factors of influence and significantly reduce the number of research options du when developing the scheme.

Goal. Investigate and identify the features of the formation of physico-chemical degradation of gray forest soil under different anthropogenic load in grain crop rotation.

Materials and methods of research. Research features of nutrition optimization crops for different physico-chemical degradation of the soil was carried out during 2016–2019 in the long-term national experiment of the Department of Agricultural Soil Science and soil microbiology of NSC «Institute Agriculture NAAS». The soil of the research – gray forest coarse-grained co-loam on carbonate forest-deep loam. By particle size distribution composition of the soil of the experimental site – large- dusty-loamy cancellation: content physical clay – 20,51%, silt – 12,85 fraction of medium and fine sand – 6,51, dust fraction – 79,5, including large dust – 52,4%.

The scheme of the experiment contains a combination of different doses of nutrients and alkaline earth elements with the use of chemical reclamation of lime and without fertilizers. Researched fertilizer doses were calculated according to the wild recommendations [19-20], the basis which is the optimization of agricultural fertilizers gift cultures. Calculation of application doses nutrients and alkaline earth elements for by species genotype ratio (SGR) their content in the biomass of the culture carried out-shafts, based on the dose of nitrogen, which in deficit on acid soils. Researched options: without fertilizers (control); $N_{45}P_{33}K_{51}$; $N45P_{16,6}K_{30,4}Ca_{11,4}Mg_{4,6}$; $N_{45}P_{33}K_{51}$ + $CaCO_3$ (1,0 Hg); $N_{45}P_{16,6}K_{30,4}Ca_{11,4}Mg_{4,6}$ + $CaCO_3$ (1,0 Hg); $N_{67,5}P_{24,9}K_{45,6}Ca_{17,0}Mg_{6,9}$ + $CaCO_3$ (1,0 Hg); $N_{90}P_{33,1}K_{46,0}Ca_{22,7}Mg_{9,2}$ + $CaCO_3$ (1,0 Hg); $N_{45}P_{16,6}K_{30,4}Ca_{11,4}Mg_{4,6}$ + $CaCO_3$ (1,0 Hg) + by-products and green manure; $N_{90}P_{33,1}K_{46,0}Ca_{22,7}Mg_{9,2}$ + $CaCO_3$ (1,0 Hg) + side products and green manure. The scheme of the experiment the use of polyfunctional action for cereals Phospho-agrobacterin, legumes – Phosphonitragin. Alkaline earth elements you made in granular form Omya Calciprill (CaO – 52% + MgO – 0,5%) and Omya Magprill (CaO – 36% + MgO – 15%).

In order to determine the changes in physico-chemical properties of the soil layer 0–20 cm brano and prepared (ISO 11464:1994, IDT) soil samples. Analytical work was performed by the following methods: pH_{KCl} potentiometric method according to DSTU ISO 10390–2001; hydrolytic soil acidity to DSTU 7537:2014; exchange-well – according to DSTU 7910:2015, the contents of the mobile aluminum – according to GOST 26485–85; exchangeable calcium and magnesium – atomic sorption method on a spectrophotometer AAS–3 DSTU 3866–99 and DSTU 7945:2015. Nitrogen content in the main and by-products determined by the method according to DSTU ISO 5983:1997, phosphorus – spectrometric method according to DSTU ISO 6491:1998, potassium – using flame emission spectrometry according to DSTU ISO 7485:2000. Accounting harvest and indicators of its structure drove in accordance with the «Methodology of the state variety testing of agricultural cultures» (2001). The area of the experimental plot – 30 m^2, accounting – 24 m^2. Repetition experiment – 4 times.

Research results. Application in the power supply system of nutrients on acidic (pH_{CKl} 4,1–5,5) not limed soils leads to deterioration of physical and properties, especially the observed roared against the background of the application of $N_{45}P_{33}K_{51}$ without carrying out measures of radical chemical melioration. Use on gray forest soil, a characteristic feature of which is acidic reaction of the soil environment, in the system fertilizers of physiologically acidic nitrogen fertilizers and nutrients without chemical reclamation causes deterioration of physical and chemical strong soil properties, growth maximum permissible value of acids-soil content (Ng – 2,81–3,09 mg eq./100 g soil). With application annually in gray-change of fertilizer dose 129 kg/ha active substance ($N_{45}P_{33}K_{51}$) metabolic and hydrolytic acidity increases at 0,062 mg eq./100 g of soil (Table 1). On soils with this level of hydrolytic acid capacity ($Ng \geq 3,0$ mg eq./100 g of soil) should to carry out radical chemical reclamation and apply not less than 4,50 t/ha active substance $CaCO_3$. To reduce the cost structure that regulate the cost of chemical reclamation lime, can be applied annually since autumn maintenance doses of $CaCO_3$ 500 kg/ha active substance complex with phosphorus and potassium fertilizers. Which will allow to reduce you for the autumn-winter period acidity soil, the proportion of physiologically acidic nitrogen fertilizers applied in the spring and optimal physical and chemical parameters of the soil.

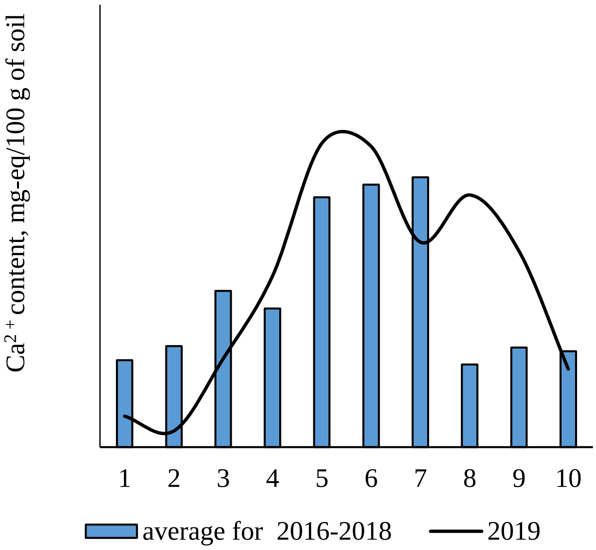
The according to research, comprehensive the effect of chemical reclamation of $CaCO_3$ (1,0 Hg), plowing of by-products of crops changes, which averages 5,69 t/ha crop rotation area, seed inoculation (for of cereal grains Phosphoagrobakterrine, legumes Phosphonitragin), application of doses of calcium-magnesium fertilizers, calculated for species genotype ratio (SGR) with their share in the ratio of the power system Ca – 5,0–15,3 and Mg – 2,3–6,4%, provides close to neutral the action of the soil environment pH_{CKl} 5,8 (average for 2016–2018 – 6,05) and Hg – 2,64 mg eq./100 g of soil (average for 2016–2018 – 1,95). Against the background of the action of chemical reclamation f or 10–13 years, applying annually dose of alkaline earth elements taking into account physiological features of culture (on average 11,4 and 4,6 kg/ha) content exchange of calcium and magnesium increases to average level of security and by 25–27% according to the indicators of the natural background, where organic and mineral were not used fertilizers (Figure).

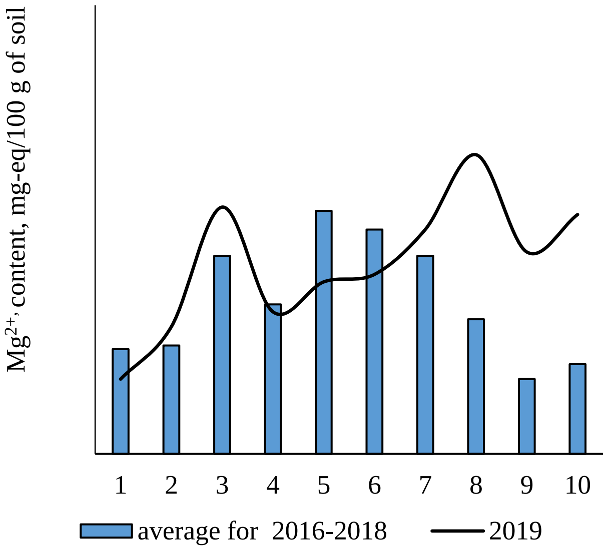
The use of high doses of physiological naturally acidic nitrogen fertilizers N_{67} and N_{90} less effective on acidic soils with low saturation of the bases, and in some cases it is the increasing doses of these fertilizers, on the contrary, worsen the physico-chemical parameters layer of soil. Actually created conditions soil reactions are unfavorable to realize the potential of cultural and effective assimilation of elements nutrition. Hydrolytic acidity increased for fertilizer application – $N_{45}P_{33}K_{51}$ and $N_{45}P_{16,6}K_{30,4}Ca_{11,4}Mg_4$ at 0,57 and 0,89 mg eq./100 g of soil, or 21,6 and 33,7% respectively compared to the fertilizer system which involved conducting a chemical

reclamation of $CaCO_3$ (1,0 Hg) 1 time in 14 years, application of biogenic and alkaline earth metals, doses of which were calculated for species genotype ratio (SGR) cultures of $N_{45}P_{16,6}K_{30,4}Ca_{11,4}Mg_{4,6}$ + $CaCO_3$ (1,0 Hg). This indicates a complex action agrotechnical measures, high efficiency the principle of calculation and applicability doses of calcium and magnesium in the last 10–13 years after the chemical reclamation of $CaCO_3$ (1,0 Hg).

1. The inflow of the zasosuvannya of small doses kindly to the physical and chemical power of the gray fox ground (ball ground 0–20 cm)

Fertilizer system	Actual acidity (pH_{KCl})		Al^{3+}, mg/100 g of soil		Metabolic acidity (mh-ekv/100 g soil)		Potential acidity (Hg) (mh-ekv/100 g soil)	
	average for 2016-2018	2019	average for 2016-2018	2019	average for 2016-2018	2019	average for 2016-2018	2019
Without fertilizers (control)	4,65	4,60	0,221	0,350	0,078	0,056	2,81	3,09
$N_{45}P_{33}K_{51}$	5,00	4,10	0,307	0,280	0,039	0,062	1,91	3,46
$N_{45}P_{16,6}K_{30,4}Ca_{11,4}Mg_{4,6}$	5,25	4,50	0,219	0,204	0,034	0,054	1,87	3,14
$N_{45}P_{33}K_{51}$ + $CaCO_3$ (1,0 Hg)	5,45	5,10	0,215	0,200	0,030	0,037	1,74	3,04
$N_{45}P_{16,6}K_{30,4}Ca_{11,4}Mg_{4,6}$ + $CaCO_3$ (1,0 Hg)	5,50	5,30	0,178	0,187	0,027	0,030	1,50	2,57
$N_{67}P_{24,9}K_{45,6}Ca_{17,0}Mg_{6,9}$ + $CaCO_3$ (1,0 Hg)*	5,55	5,50	0,148	0,308	0,034	0,049	1,83	2,86
$N_{90}P_{33,1}K_{46,8}Ca_{22,7}Mg_{9,2}$ + $CaCO_3$ (1,0 Hg)	5,55	5,00	0,145	0,449	0,056	0,065	1,96	2,99
$N_{45}P_{16,6}K_{30,4}Ca_{11,4}Mg_{4,6}$ + $CaCO_3$ (1,0 Hg)*	6,05	5,80	0,163	0,225	0,038	0,067	1,95	2,64
$N_{67}P_{24,9}K_{45,6}Ca_{17,0}Mg_{6,9}$ + $CaCO_3$ (1,0 Hg)*	5,70	5,50	0,340	0,328	0,043	0,035	1,99	2,57
$N_{90}P_{33,1}K_{46,8}Ca_{22,7}Mg_{9,2}$ + $CaCO_3$ (1,0 Hg)*	5,50	5,30	0,355	0,450	0,059	0,045	1,76	2,68
*In 2005, liming was carried out with the introduction of defects containing 52% $CaCO_3$ (for Tables 1, 2).								





The content of exchange cations in the gray forest soil under different fertilizer systems, mg eq./100 g of soil: 1 – without fertilizers (control); 2 – $N_{45}P_{33}K_{51}$; 3 – $N_{45}P_{16,6}K_{30,4}Ca_{11,4}Mg_{4,6}$; 4 – $N_{45}P_{33}K_{51}$ + $CaCO_3$ (1,0 Hg); 5 – $N_{45}P_{16,6}K_{30,4}Ca_{11,4}Mg_{4,6}$ + $CaCO_3$ (1,0 Hg); 6 – $N_{67}P_{24,}K_{45,6}Ca_{17,0}$ $Mg_{6,9}$ + $CaCO_3$ (1,0 Hg); 7 – $N_{90}P_{33,1}K_{46,8}Ca_{22,7}Mg_{9,2}$ + $CaCO_3$ (1,0 Hg); 8 – $N_{45}P_{16,6}K_{30,4}$ $a_{11,4}Mg_{4,6}$ + $CaCO_3$ (1,0 Hg) + by-products + green manure; 9 - $N_{67}P_{24,9}K_{45,6}Ca_{17,0}Mg_{6,9}$ + $CaCO_3$ (1,0 Hg) by-products + green manure; 10 – $N_{90}P_{33,1}K_{46,8}Ca_{22,7}Mg_{9,2}$ + $CaCO_3$ (1,0 Hg) + by-products + green manure

Addition of organic and mineral fertilization systems, nagging unmarketable parts I grow crops of harvest (5,0–5,5 t/ha) that rose hunok dozi mineral good for by species genotype ratio (SGR) the growth of biogenic and rain-earth elements in biomass crops $N_{90}P_{33,1}K_{46,8}Ca_{22,7}Mg_{9,2}$ + $CaCO_3$ (1,0 Hg) level of productivity – 5,45 t/ha of grain units, by 16,7 and 33,2%, according to the zasosuvannya doses of mineral good, yak 0,5 and 1,0 times smaller. Introduced 129 kg/ha of mineral goodness in spivdnoshennyakh NPK – 1:0,7:1,1 without carrying out cheesy melioratsii made it impossible to pay off Mineral goodness on a level of 10,2 kg of grain units (Table 2).

2. Productivity of grain crop rotation and efficiency of application of different doses of fertilizers on gray forest soil

Fertilizer system	Productivity, t/ha of grain units	± to control		± species genotype ratio (SGR) cultures		Fertilizer application rate kg/ha	Payback of 1 kg of mineral fertilizers by grain
		t/ha	%	t/ha	%		
Without fertilizers (control)	2,07	-	-	-	-	-	-
$N_{45}P_{33}K_{51}$	3,39	1,32	63,5	-	-	129	10,2
$N_{45}P_{16,6}K_{30,4}Ca_{11,4}Mg_{4,6}$ (control species genotype ratio (SGR) cultures)	3,62	1,54	74,4	-	-	108	14,3
$N_{45}P_{33}K_{51}$ + $CaCO_3$ (1,0 Hg)	3,97	1,90	91,5	0,36	9,8	129	14,7
$N_{45}P_{16,6}K_{30,4}Ca_{11,4}Mg_{4,6}$ + $CaCO_3$ (1,0 Hg)	4,20	2,13	103	0,58	16,2	108	19,7
$N_{67,5}P_{24,9}K_{45,6}Ca_{17,0}Mg_{6,9}$ + $CaCO_3$ (1,0 Hg)	4,49	2,42	116	0,87	24,1	162	14,9
$N_{90}P_{33,1}K_{46,8}Ca_{22,7}Mg_{9,2}$ + $CaCO_3$ (1,0 Hg)	4,81	2,74	132	1,20	33,1	216	12,7
$N_{45}P_{16,6}K_{30,4}Ca_{11,4}Mg_{4,6}$ + $CaCO_3$ (1,0 Hg)*	3,64	1,57	75,6	0,03	0,7	108	14,5
$N_{67,5}P_{24,9}K_{45,6}Ca_{17,0}Mg_{6,9}$ + $CaCO_3$ (1,0 Hr)*	4,54	2,47	119	0,92	25,5	162	15,2
$N_{90}P_{33,1}K_{46,8}Ca_{22,7}Mg_{9,2}$ + $CaCO_3$ (1,0 Hg)*	5,45	3,38	163	1,84	50,8	216	15,6
Sx,%	2,05	-	-	-	-	-	-
$LSD_{0,05}$	0,26	-	-	-	-	-	-

For a comprehensive day of visits to the melioration that fertilizer in general will take care of payback rate of 1 kg mineral fertilizers for 4,5 kg grain units (14,7 kg of cereal units for 1 kg of every kind of speech of mineral good). Decrease the dose of phosphorus and high-grade good by 49,7 i 40,4%, about to become approximately 16,6 ta 30,4 kg/ha, i additional fertilization with small doses 11, and 4,6 kg/ha Ca and Mg, for a certain period of time, will provide a payback on the basis of 14,3 kg of grain units for 1 kg after adding for the system and fertilization $N_{45}P_{16,6}K_{30,4}Ca_{11,4}Mg_{4,6}$ – 1:0,4:0,7:0,3:0,1.

The highest payback of 1 kg of introduced nutrients and the efficiency of different doses of mineral fertilizers reflected precisely at the level of productivity crops and harvesting of grain units from 1 ha of crop rotation area was obtained at a ratio of 108 kg/ha mineral to the eyebrows, where the calculation of dose and ratio the particles between the elements were based on the new physiological features of the cultures and their for species genotype ratio (SGR) cultures elements in the constituent biomass $N_{45}P_{16,6}K_{30,4}Ca_{11,4}Mg_{4,6}$ + $CaCO_3$ (1,0 Hg). Water doses of 162 and 216 kg/ha of fertilizers were increased respectively $N_{67,5}P_{24,9}K_{45,6}Ca_{17,0}Mg_{6,9}$ and $N_{90}P_{33,1}K_{46,8}Ca_{22,7}Mg_{9,2}$ + $CaCO_3$ (1,0 Hg) noprovide a significant increase in crop productivity and mineral payback fertilizers. The effectiveness of mineral fertilizers, especially high doses 162 and 216 kg/ha, it grows on a limed background ($CaCO_3$ 1,0 Hg). With regard to the application in the complex of support doses of calcium (11,4 kg/ha) and magnesium (4,6 kg/ha) fertilizers in recent years chemical reclamation, the minimum dose of nitrogen (45 kg/ha) and reduced doses of phosphorus (16,6 kg/ha) and potassium (30,4 kg/ha) 2 and 1,6 times less fertilizer is provided the highest payback of mineral fertilizers and optimization of physicochemical properties soil.

Annual accumulation of phosphorus and potassium in the soil occurs due to the use of excessive doses of fertilizers, their low assimilation by crops, low level of absorption by the root system of nutrients, fixation in soil absorbing complex of phosphorus. The incorrectly selected forms of mineral fertilizers without taking into account soil properties (inconsistency of the chemical composition of the drug). The reduced activity soil microflora order to regulate phosphorus nutrition and availability for assimilation by plants on acidic soils it is necessary to optimize the physico-chemical properties of the soil environment, increasing the pH_{CKI} level to 6,0–7,0. It occurs after chemical reclamation or the use of trisubstituted calcium phosphates and provides prolonged reclamation action. Assimilation by plants can in the first year to be 52–100% of the application dose.

Application of a dose of mineral fertilizers on gray forest soil, which is calculated by species genotype ratio (SGR) content of elements in the biomass of the culture against the background of the aftereffect of application lime provides food optimization crops, optimization of physico-chemical soil properties, dose reduction phosphorus and potassium and reduce toxicity actions of H^+ and Al_3^+. The optimal combination of N, P, K, Ca and Mg (216 kg/ha in the ratio 1:0,4:0,5:0,3:0,1) in a complex with inoculation of seeds with nitrogen-fixing and phosphorus-mobilizing bacteria for increases productivity units of grain crop rotation up to 5,45 t/ha with from and payback of 1 kg of fertilizer applied drugs up to 15,6 kg with. Physico-chemical degradation on acid soils by application of increased doses of nitrogen fertilizers saturation can be partially prevented soil absorbing complex exchange cations of alkaline earth metals, supplementing the fertilization system with low doses of Ca and Mg, which are calculated species genotype ratio content of elements in the biomass of the culture, based on the recommended dose of nitrogen limited to acidic soils.

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