Agronomical Field Testing of New Kinds of Multicomponent Mineral Fertilizers

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Abstract

Analysis of modern scientific literature and patents has shown the absence of acid-free production technology of a mechanically activated multicomponent mineral fertilizer containing water-holding substances. Experimental researches connecting with mechanochemical activation and physicochemical properties of Karatau phosphorites prove a possibility of development of a new multicomponent mineral fertilizer. Application of inorganic and organic activators considerably improves qualities of fertilizers because the developed fertilizer mixtures contain nitrogen, phosphorus, potassium, humate and microelements. The suggested technology intends to use wastes of coal mining that leads to presence of humates and microelements in the end product. It was determined, that content of total nitrogen, phosphorus and potassium depends on a form of nitrogen-phosphorus-potassium-containing substances. The given article contains data of researches connecting with use of multicomponent mineral fertilizers in field conditions for cotton cultivation on irrigated light sierozems consisting of soil-forming rocks of loess and loess-type clay loams. The research results show the increase of soil's fertility and cotton's productivity. Studying of agronomic efficiency of the new kinds of mechanically activated multicomponent mineral fertilizers at the cultivation of a bean-cereal mixture has been carried out in the Negorelsk experimental nursery-garden of the Belarus State Technical University on a sod-podzol sandy-loam soil and has shown the essential influence on productivity and quality of the bean-cereal mixture. The researches fulfilled on a sod-podzol sandy-loam soil have revealed the essential increase of key indicators of feed productivity. Application of the mineral fertilizers has promoted increase of nitrogen, phosphorus and potassium content in green plants. In so doing content of calcium and magnesium in green mass depends from quantity of the fertilizer used to a smaller extent. An essential difference of crop capacity and feed productivity indicators depending on forms of the applied mineral fertilizers has not been found.

Introduction

The modern agriculture solves the problem of increasing agrocenosis efficiency by the optimization of application of traditional and nonconventional kinds of organic and mineral fertilizers in a complex with other agrotechnical methods. The scientifically substantiated fertilizing system should provide a high productivity of agricultural crops with optimum indicators of a product quality, preservation or differentiated increasing fertility of soils at the conformity to specifications of ecological safety [1-2].

Mineral fertilizers contain nutrients as mineral salts, and depending on a content of nutrient elements they are subdivided on macro fertilizers and micro fertilizers. Nitric, phosphoric and potash fertilizers are the basic macro fertilizers, making the most essential impact on efficiency and quality of agricultural crops are [3-4].

A part of mineral fertilizers is made in the form of the complex compounds which structure includes several nutrient elements. These complex fertilizers provide the best availability of the nutrients to a root system. The complex fertilizer application allows not only to satisfy the requirement of plants for nutrients, but also provides economy on transport

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expenses, construction of warehouses, using mechanized equipment at loading, unloading and application of fertilizers.

Main tasks of the research

For the development of production technology of a multicomponent mineral fertilizer of the durable action containing nitrogen-phosphorus-potassium-humate-vermiculite and microelements, the chemical composition and physicochemical properties of the basic raw component – phosphorite at the mechanochemical activation were investigated.

Experimental

Production of the fertilizer pilot batch and its test on the cotton fields of Kazakhstan Research Institute of soil science and agrochemistry

On the basis of the analysis of literary and patent information concerning the production of mineral fertilizers containing phosphorus, nitrogen, potassium, humate and water-holding substances on the basis of vermiculite it was found, that the manufacture of multicomponent mineral fertilizers of the given type in the Republic of Kazakhstan and in the countries of near and far abroad is absent.

Preliminary researches of complex-mixed fertilizers produced from the burnt phosphorite and vermiculite have shown their positive influence on the quality and quantity of tomatoes and carrots [5-7].

The proposed production technology of multicomponent mineral fertilizers with specific features for sierozem soils provides for using the wastes of coal mining that leads to the presence of humates and microelements in the end product.

The research purpose included the carrying out of chemical analyses and laboratory tests of physicochemical properties of a multicomponent mineral fertilizer which structure contains (mass ratios):

1) ground phosphate rock: vermiculite: brown coal: potassium carbonate: ammonium sulphate –1:0,15:1:(0.3-0.8):(0.3-0.5);

2) phosphorite fines: vermiculite: brown coal: potassium chloride: ammophos – 1:0,15:1:(0.6-0.8):0.5;

3) ground phosphate rock: vermiculite: brown coal: carbamide: sunflower ash – 1:0,15:1:(0.3-0.5):0.5;

4) ground phosphate rock: vermiculite: brown coal: ammonia water: draft coal of the beat-sugar manufacture – 1:0,15:1:(0.02-0.03):0.3;

5) ammophos: vermiculite: brown coal: ammonia water: potassium carbonate: phosphorite fines: sulphur – (0.3-0.5):0.15:1:(0.02-0.03):(0.3-0.5):1:0.2;

6) phosphorite fines: ammoniac saltpeter: vermiculite: brown coal: draft coal: potassium carbonate: sulphur: coal – 1:0.3:0.15:1:0.2:(0.3-0.5):0.2:1.

According to the laboratory researches the highest content of the total carbon in the sample # 6 (phosphorite fines: saltpeter: vermiculite: brown coal: draft coal: potassium hydroxide: sulphur) is nearly 16.4%, the least carbon content in the sample # 1 (phosphorite fines: vermiculite: brown coal: potassium carbonate: ammonium sulphate) is 10.6%. Other the samples (2-5) contain the intermediate carbon content (from 12.3 to 14.6%).

The content of the total nitrogen in the samples of multicomponent fertilizers depends on the form of nitric fertilizers. So for example, the highest content of the total nitrogen is 5.516 % in the sample # 3 (ground phosphate rock: vermiculite: brown coal: carbamide: potassium carbonate). It is necessary to notice, that the carbamide (urea) contains 46.3% of nitrogen.

The sample # 1 and the sample # 6 contain rather less the total nitrogen – from 2.884 to 2.380%. The ammonium sulphate except nitrogen (21%) contains sulphur (24%).

In the samples 4-5 containing ammoniac saltpeter (34%), the total nitrogen content is less in comparison with the samples 5-6; it connects with the nitrogen fixation and volatilization.

The sample #2 containing ammophos (42-52% P_2O_5, 10-12% N) has the least total nitrogen content in comparison with other the fertilizer samples – 0.924%.

The total phosphorus content depends on the forms of applied phosphoric fertilizers and a ratio of nitrogen kinds and fluctuates from 4.8 to 8.0% in the samples 1-5. In the sample 6 containing only the phosphorite fines the total phosphorus content is less – only 2.8%.

The total potassium content in the samples is also different depending on a kind of the potash fertilizers. So, the total potassium content in the sample 2 containing potassium chloride (60% K_2O) is the greatest one – 11%. In other the samples containing potassium carbonate (14-20% K_2O) the total potassium content changes from 6 to 9%.

A content of phosphorus and potassium mobile forms depends on the components entering into the composition of fertilizers. So, the mobile P_2O_5 content in the samples 2 and 5 makes 25-30 g/kg, but the content of mobile potassium in the samples varies from 82 to 140 g/kg. In other the samples these values are considerably lower.

A medium reaction in the fertilizers is different. According to the analyses the sample 2 has an acidic environment, the sample # 6 is neutral, and other the samples are alkaline.

Research technique of the multicomponent fertilizers in the field

The field researches were carried out inthe fields of the cooperative society "Ketebay", settlement Ketebay,Maktaaral area, the Republic of Kazakhstan. The fields are located in the northwest part of the Hungry steppe. Soil – is an irrigated light sierozem, a crop – is cotton, a cultivar of the cotton – is Maktaaral 4007.

Soil-forming rocks are loess soils and loess-like loams characterizing light mechanical composition, high gypsum content on the most part of the territory and salinity by readily soluble salts in some cases. The vegetative cover is ephemeroid-ephemeral groupings.

The cotton cultivar Maktaaral 4007 is a medium fibrous, early ripening variety. A cotton bush has a cylindrical form; height is 125-127 cm. A body and fruit branches of the bushes have the first or one-and-a-half branching type.

Field experimental grounds are arranged under the following scheme:

1) the test area; 2) sample “A”; 3) sample “B”; 4) sample “C”; 5) humate; 6) Gulsu; 7) Edagum; 8) adaptogen preparation (PA-2).

The fertilizers Edagum (Russia) and PA-2 (Kazakhstan) include in the testing for comparison.

The registration plot area is 72 m^2 (7.2 m × 10 m). The experiments were repeated three times.

During the testing initial soil samples from the experimental field from the soil layers 0-20, 20-40 and 40-60 cm were selected. Before the cotton sowing the cotton seeds were processed by different preparations, and also the fertilizers of the samples “A”, “B”, “C” according to the variants (2-4) (Table 1) were applied. In the cotton sprouting and flowering period the phenological observations were spent and soil samples according to the experimental variants on height 0-20, 20-40 cm were selected.

In time of the cotton sprouting and budding, the plants were processed by different preparations (variants 5-8).

Table 1
Characteristic of the applied fertilizers

Fertilizer	Samples		
	"A"	"B"	"C"
Phosphorite, %	75	65	55
Vermiculite, %	10	10	10
Coal, %	10	20	30
Potassium hydroxide, %	5	5	5

The cotton was cultivated according to the technology developed by the scientists of Kazakhstan Research Institute of Chemistry. The field tests and chemical analyses of the soils were fulfilled according to the standard technique [8]. Analyses of the soil samples includes: electrometric definition of pH, humus – by Tyurin, hydrolyzable nitrogen – by Tyurin-Kononova, mobile phosphorus and exchange potassium – by Machigin, the total nitrogen – by Kjeldahl, the total phosphorus – by Ginzburg-Shcheglova, the total potassium – by Smith, CO_2 – by Golubev, granulometric composition – by Kachinsky, an aqueous extract in accordance with GOST, absorbed Ca, Mg, Na and K bases – in accordance with Shmukh.

Results and Discussions

The basic sources of accumulation of organic substances in a soil are residues of organisms of animals and plants and their waste products. Organic soil substances, especially humus, contain all ashy elements of the plants nutrition and nitrogen which promote the arrangement of favorable for plants water-air and thermal conditions of a soil, improve its structure and increase absorption capacity.

Results of early researches have shown, that the total humus content on a virgin land plot makes in layers: 0-10 cm – 2.55%, 10-20 cm – 0.84%, 20-30 cm – 0.77% and with depth it decreases up to 0.74%. The high content of the total humus in the layer 0-10 cm is connected with the presence of turf horizon [9].

Developing sierozems leads to the full mineralization of organic residues and decreasing humus content. The chemical composition of a light sierozem before the experiments is given in the Table 2.

The data (Table 2) analysis shows, that the total humus content in the layer 0-20 cm is low and makes 0.55 %; it reduces with increasing the depth.

Nitrogen – one of basic nutrients for plants – is a part of organic substances (5-10%). The total nitrogen content makes 0.040-0.056%.

Another important indicator of a soil’s fertility is a content of phosphorus and potassium total forms which are equal 0.13-0.17% and 2.00-2.19% accordingly. The hydrolysable nitrogen content in the sierozem top-soil is in limits of 25.2-30.8 mg/kg of the soil, the mobile phosphorus content – 18.6-22.0 mg/kg, the exchange potassium content – 280.0-310.0 mg/kg. The soils are carbonate, and the carbonate content makes 7.14-7.35%. The medium is alkaline, pH = 8.16-8.46.

Table 2
Chemical composition of a light sierozem before the experiments

A soil layer, cm	Humus, %	Total forms, %			Mobile forms, mg/kg			CO_2, %	pH
		N	P	K	N hydrolyzable	P_2O_5	K_2O		
0-20	0.55	0.056	0.16	2.19	30.8	22.0	310.0	7.14	8.46
20-40	0.48	0.042	0.17	2.09	28.0	20.8	290.0	7.35	8.41
40-60	0.40	0.040	0.13	2.00	25.2	18.6	280.0	7.20	8.16

Loamy sierozem soils contain in their absorbing complex the following cations: Ca^{2+}, Mg^{2+}, K^{+}, Na^{+}, which exert a big impact on properties of soils and conditions of agricultural plants growth. Bivalent cations Ca^{2+} and Mg^{2+} transform soil colloids from a sol into a gel, preserving thereby an active part of a soil and promoting the structure formation. Monovalent cations K^{+} and N^{+} destroy a soil structure. The saturated with calcium and magnesium ions soil medium is usually neutral, therefore favorable conditions for activity of microorganisms are created in the soil. Sodium and potassium cations cause an alkaline medium, depressing a microflora.

It was found that during the testing the sum of absorbed bases in the layer 0-20 cm has made 15,04 mg-equivalent on 100 g of soil, the content of calcium cations is 64% from the sum of the bases, the magnesium cations content – up to 30% from the sum of the bases, and the content of sodium and potassium ions – only 6%. The same regularity persists in the layer 20-40 cm.

According to the mechanical structure the studied soils are medium loamy: the sand content is to 47% (fraction 0.05-1.0 mm), dust (class 0.001-0.05 mm) – to 41% and silt – to 10-12%.

The carried out researches have shown that negative properties of the soils are a high water-lifting ability (2.5-3.5), a weak water yield (2-4% at humidity of 40-50%), a relatively low filtration coefficient (on the average 0.003 mm/sec). It explains a fast lifting of subsoil waters at watering and their slow decrease at the watering termination.

Usually secondary saline lands are the result of secondary soil salinization in the conditions of a powerful lifting of subsoil waters at irrigation, and saline lands contain mainly cations Na^{+}, Mg^{2+}, Ca^{2+} and anions Cl^{-}, SO_4^{2-}, CO_3^{2-}. Depending on a salinization type and the salts structure saline lands are divided on carbonate, soda, chloride, chloride-sulphate and sulphate.

It was found that a salinization type of the irrigated light sierozems is sulphate. The soil washing has allowed considerably lowering a content of the most harmful readily soluble salts – chlorides in the soil. Changing of the sulphate content from 0.079 to 0.361 in a root-inhabited layer doesn't influence on the sprouting of the cotton.

For studying of intensity of the cotton's growth and development phonological observations were spent.

The first phenological observation was fulfilled in June, 1st for the registration of the plants height and a quantity of leaves (Table 3).

Table 3
Biometric observations for the cotton crops

Variants	7 May		1 June			3 July		
	Germination on 1 m^2	Quantity of leaves	Quantity		Height, cm	Quantity		Height, cm
			plants, piece/m^2	leaves at the average		leaves at the average	buds	
1.Control	10	2.0	12	4.0	15	12	3-4	30-34
2.Sample "A"	15	2-3	17	4.2	20	19	4-5	45-48
3.Sample "B"	15	2-3	18	4.4	22	18	3-4	50-52
4.Sample "C"	16	3.0	20	4.1	20	17	3-5	50-55
5.Humate	17	3.0	21	4.3	22	21	4-6	56-59
6.Gulsu	15	2-3	19	4.4	22	20	4-5	55-60
7.Edagum	15	3.0	19	4.4	23	19	4-5	60-62
8.PA-2	14	3-4	18	4.3	22	19	3-5	54-57

Table 4
Biological accounting of the raw cotton harvest

Variants	Raw cotton harvest, metric centner/hectare				Harvest addition	
	I	II	III	Average value	metric centner/hectare	%
The test area	17.5	16.8	17.9	17.4	-	-
Sample "A"	22.4	21.6	22.8	22.2	4.8	27.5
Sample "B"	24.2	25.0	24.0	24.4	7.0	40.2
Sample "C"	25.4	25.3	25.5	25.4	8.0	46.0
"Edagum"	25.5	24.7	24.9	25.0	7.6	43.7
"PA-2"	21.7	22.2	22.1	22.0	4.6	26.4

The results obtained have shown that the plants quantity and the cotton bolls weight on the experimental plots "A", "B", and "C" in comparison with the test area is more on 15-16 %, thus the analogous parameters on the plots "Edagum" and "PA-2" are almost identical.

In the end of the testing the biological accounting of the raw cotton harvest was spent. These results are shown in Table 4.

The data (Table 4) analysis shows that the application of the multicomponent fertilizers positively influences on the cotton productivity. So, if the raw cotton yield on the test area has made 17.4 metric centner/hectare, then using the multicomponent fertilizers allows to increase the productivity to 22.2-25.4 metric centner/hectare and to provide the yield increase 4.8-8.0 metric centner/hectare. The application of “Edagum” preparation provides the harvest increase in 7.6 metric centner/hectare, and the “PA-2” using – 4.6 metric centner/hectare.

Field testing of the multicomponent mineral fertilizer at the cultivation of a fabaceous-cereal mixture on a sod-podzol sabulous soil

Annual fabaceous-cereal mixtures are widely used for the production of green mass, ensilage, haylage and grains which have a good balance of digestible protein and nutrients. Though annual fabaceous-cereal mixed grass crops are less productive than clover, clover-cereal grasses or lucerne, at the cultivation with winter-crops and intermediate cultures efficiency of a feeding field considerably increases, reaches a level of permanent grasses and even surpasses them. Besides, such mixes enrich soils by symbiotic nitrogen, carry out a phytosanitory role in crop rotations and are one of the best predecessors for grain crops. It is found that the receiving a rich harvest of annual fabaceous-cereal mixes is possible only at the sufficient level of fertilizers application [10, 11].

Researches of agronomical efficiency of new kinds of multicomponent mineral fertilizers at the cultivation of a fabaceous-cereal mixture (spring wheat of the grade Toma (*Tritucum aestivum* L.), sowing pea of the grade Eiffel (*Pisum sativum* L.) have been fulfilled in 2013 in the Negorelsk educational-experimental nursery of the Belarus State Technical University. Lands of the nursery are situated in the Dzerzhinsk area, Belarus; a type of the soil is sod-podzol sabulous.

The agrochemical characteristic of a plough-layer of the investigated soil has the following parameters: pHKCl – 5.8-6.2, P_2O_5 content (0.2 M HCl) – 105-115 mg/kg, K_2O (0.2 M HCl) – 125-135 mg/kg, humus – 2.2-2.4%.

Standard forms of mineral fertilizers (carbamide, ammophos, potassium chloride) were used as a background variant. Doses of new multicomponent mineral fertilizers were counted on nitrogen (N_{60}).

Variants of compositions of the multicomponent mineral fertilizers:

1. Composition "A": activated phosphorite fines of the Chulaktau deposit: vermiculite: brown coal: potassium carbonate: ammonium sulphate – 1:0.15:1:0.5:0.45 (N:P:K = 2.9:1.6:10.8);
2. Composition #4: activated phosphorite fines of the Chulaktau deposit: ammonium nitrate: potassium chloride – 1:0.3:0.27 (N:P:K = 7.2:4:10.6);
3. Composition # 5: activated phosphorite fines of the Chulaktau deposit: ammonium sulphate: potassium chloride – 1:0.6:0.28 (N:P:K = 6.6:3.3:9.4);
4. Composition #6 – a three-component mixture (phosphorite fines of the Zhanatas deposit – 80% + overburden of the Lenger deposit – 10% + vermiculite – 10%) calcined at 800 ºC: ammonium sulphate: potassium chloride – 1:0.6:0.28 (N:P:K = 6.6:3.1:9.4);
5. Composition #7 – a three-component mixture (phosphorite fines of the Zhanatas deposit – 80% + overburden of the Lenger deposit – 10% + vermiculite – 10%) calcined at 800 ºC: brown coal: ammoni-

um sulphate: potassium chloride – 1:0.97:0.53:0.28 (N:P:K = 4:2.7:6.3);

6. Composition #8 – activated phosphorite fines of the Chulaktau deposit: brown coal: ammonium nitrate: potassium chloride – 1:1:0.34:0.26 N:P:K = 4.5:3.1:6.3);

7. Compositions of the samples 7-12 are given in Table 5.

The compositions 1-6 were prepared on the basis of mechanically activated ground phosphorite rock obtained from phosphorite fines of the Zhanatas and Chulaktau deposits. The samples (50 g) were subjected to mechanical activation in a ball mill-activator at the following parameter – 100 rotation/min; 30 minutes; loading of balls – 15: 1; ø of grinding bodies – 5 mm. Results of the chemical analysis of some compositions, carried out on an x-ray spectrometer PANalytical Axios^{mAX}, are presented.

Judging by the research results, the application of multicomponent mineral fertilizers has made essential impact on the fabaceous-cereal mix productivity and quality.

The received data analysis shows, that the separate application of standard forms of mineral fertilizers (background) $N_{60}P_{40}K_{80}$ has increased the productivity of green mass on 89 metric centner/hectare. The general productivity in the investigated variant is 342 metric centner/hectare and the payback of 1 kg of NPK makes 49.4 kg of the green mass (humidity of the samples is 80%).

In the variants (1-11) at the application of new forms of multicomponent mineral fertilizers the addition of the green mass harvest has made 85-98 metric centner/hectare at the general productivity 338-351 metric centner/hectare and a payback of 1 kg of NPK is 30.9-54.5 kg of the green mass.

Table 5
Fertilizer compositions for agrochemical tests

# of a sample	Composition of samples				
	Ground phosphate rock, g	Vermiculite, g	Brown coal, g	KOH, g	Ammoniac saltpeter, g
7 (# 1.2)	39.75	5	5	1.5	3.75
8 (# 1.3)	36.75	5	5	0.75	2.5
9 (# 2.3)	34.2	5	5	0.75	5
10 (# 5.1)	36.3	5	2.5	2.5	3.75
11 (# 5.2)	37.2	5	2.5	1.5	3.75
12 (# 6.1)	41.45	5	1.25	2.5	-

It is necessary to note, that the essential distinction in the green mass productivity among the variants with the using the fertilizers is absent. It should be noted a tendency to increase or decrease in the green mass productivity in the variants where the total content of phosphorus and potassium slightly differ from the total content of phosphorus and potassium in the background variant.

The composition # 8 contains a small amount of potassium in comparison with nitrogen and phosphorus that has caused a need of additional application of potash fertilizers (K_{60} as potassium chloride). The composition # 11 contains only phosphorus and potassium therefore carbamide was additionally used.

Quality of a fodder is estimated according to various indicators; first of all there are fodder units and fodder-protein units [12, 13].

A fodder unit is the general nutritiousness of a fodder in comparison with 1 kg of oats of an average quality (1 kg of oats = 1 fodder unit), and a fodder-protein unit takes into account a content of fodder units and digestible protein simultaneously.

For calculation of fodder-protein units the following formula is used:

$$KPE\frac{(KE+12P\rho)}{2} \quad (1)$$

where: KE – a content of fodder units in 1 kg of a fodder, 12 – a coefficient taking into account a ratio of fodder units quantity and digestible protein in an oat grain of an average quality; $P\rho$ – a content of digestible protein in 1 kg of a fodder, kg.

It was found, that at the carrying out of experimental researches on a sod-podzol sabulous soil the application of the fertilizers has essentially increased the basic parameters of fodder productivity. Especially it is necessary to note a high balance of the green mass of the wheat-pea mixture concerning digestible protein content. In the investigated variants provision of 1 fodder unit by digestible protein makes 134-138 g. For example, for cattle the provision of 1 fodder unit is 107 g, for pigs – 110 g, for poultry – 135 g of digestible protein.

In addition, as shown the results of the experiments, the mineral fertilizers application has promoted the increase of nitrogen, phosphorus and potassium content in the green mass.

The nitrogen content in the green mass of the fabaceous-cereal mix makes 2.58-2.64%, phosphorus – 0.75-0.80%, potassium – 2.78-3.54%, calcium – 0.64-0.67%, magnesium – 0.25-0.28%.

High doses of phosphorus and potassium in the multicomponent mixes promoted the accumulation of phosphorus and potassium in the green mass of the wheat-pea mix. It is necessary to note the variant 1 in which the application of the mix A, evened with the background variant on nitrogen (N_{60}) and close to it on phosphorus (P_{33}), because of a superfluous potassium dose (K_{224}) has led to the considerable accumulation of potassium in the product (3.54%). This value exceeds the indicators recommended for fodder. At the application of the given multicomponent mix the fertilizer dose should be levelled on potassium, and a deficient quantity of nitrogen and phosphorus to add as simple forms of mineral fertilizers.

A total (economic) and specific (normative) carry-over of nutrients (nitrogen, phosphorus, potassium, calcium, and magnesium) is an important indicator at the estimation of fertilizer efficiency.

A total carry-over indicator is used for the calculation of a nutrient balance, a specific carry-over indicator – for the calculation of a balance of nutrients and humus, and also doses of mineral fertilizers in the agricultural production [1-2, 14-15].

A total carry-over of nutrients (V_x, kg/hectares) is calculated under the formula:

$$V_x = U_{co}C_o + U_{sp}C_p \quad (2)$$

where: U_{co} and U_{sp} – a harvest of a dry substance of basic and sideline products, metric centner/hectare; C_o and C_p – a nutrient content in a dry substance of basic and sideline products, %.

For the calculation of a specific carry-over (V_N, kg with 1 t of basic products and corresponding quantity of sideline products) use the formula:

$$V_n = \frac{v_x 10}{U_{ost}} \quad (3)$$

where: U_{ost} – a harvest of basic products at a standard humidity, metric centner/hectares.

In our researches a total carry-over of nitrogen has made 104-185 kg/hectares, phosphorus – 37-55, potassium – 107-249, calcium – 31-46, magnesium – 13-19 kg/hectares. On the average the total carry-over of nitrogen has made 180 kg/hectares, phosphorus – 53, potassium – 201, calcium – 45, magnesium – 18 kg/hectares. It is necessary to take into account that a part of the nutrients at the cultivation of annual fabaceous-cereal mixes comes back in a soil with root and stubble residues. For example, if the green mass productivity is 350 metric centner/hectares, an average quantity of root and stubble residues makes about 50 metric centner/hectares. Annual fabaceous-cereal mixes can accumulate nitrogen owing to symbiotic nitrogen fixation (on the average 0.20 kg of nitrogen on 1 metric centner of the green mass).

An average specific carry-over of nitrogen with 1 t of the green mass in investigated variants makes 5.2 kg, phosphorus – 1.6, potassium – 5.8, calcium – 1.3, magnesium – 0.5 kg.

Conclusions

1. At the carrying out of the experiments it was found that the multicomponent fertilizers' application essentially influences on the cotton growth and development in comparison with the control variant. By-turn the good cotton growth and development has considerable impact on the cotton efficiency.

2. The multicomponent fertilizer composition exerts the important impact on the cotton productivity. Using the composition "A" which contains 10% of brown coal has provided the harvest addition to 4.8 metric centner/hectares. Application of the composition "B" (20% of coal) and the composition "C" (30% of coal) increases the addition of the cotton harvest to 7.0-8.0 metric centner/hectares.

3. At the cotton cultivation on secondary saline light sierozems with a low humus content it is necessary to apply fertilizers with a high content of humic substances.

4. The application of new multicomponent mineral fertilizers on the sod-podzol sabulous soil has provided high indicators of agronomical efficiency at the cultivation of the wheat-pea mix.

5. The addition of the green mass harvest at the new fertilizers using makes 85-98 metric centner/hectares at the general productivity 338-351 metric centner/hectares.

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