PHOSAGRO. ENERGIYA ZEMLI
ALPHABET OF FERTILITY FROM A TO Z
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NEW FERTILIZER NP(S) 14:40(7)+1Zn

INCREASES THE UTILIZATION OF NITROGEN, PHOSPHORUS, AND POTASSIUM FROM MINERAL FERTILIZERS BY PLANTS BY 11–80%

An extended study of the ratio of the required amount of nitrogen to phosphorus in fertilizers in stationary experiments has shown the importance of finding the optimal value of this ratio in practice. In a short-term experiment, six types of fertilizers with different ratios of nitrogen and phosphorus were tested. In addition to these, the fertilizers contained potassium, sulfur and zinc; pre-sowing application was considered. Approximating the pellets to the seeds allowed applying small doses of fertilizers with a better effect.

The experiment scheme included the study of different nitrogen and phosphorus, as well as sulfur and zinc ratios in order to select the most effective ratio of nutrients during spring pre-sowing fertilization of spring wheat.

Adding sulfur to nitrogen and phosphorus, as well as to NPK-compound gave an additional 0.7–1.2 centner/ha increase compared to ammophos and diammonium phosphate. Wheat responded positively to the inclusion of zinc in the fertilizer. This option showed the highest yield increase of 3.4 centner/ha compared to the option with ammophos and 2.2 centner/ha compared to the option with the inclusion of sulfur only.

The fertilizers of different composition and nutrient ratios had a minor effect on the content of crude gluten in the grain, as it was approximately the same in all options and amounted to 28.2–30.6%. The protein content in wheat grain also was almost identical in all the options and varied between 13.45 and 14.48%.

In all the experiment options, the content of N, P_2O_5, K_2O was defined to determine their yield from the soil by harvested plants. The total yield of N, P_2O_5, K_2O by wheat was high, especially the nitrogen yield, which is typical for a prior set-aside. The higher the wheat yield, the greater was nitrogen yield caused by the fertilizers. Among all nutrients, the yield was the most significant in the option with NP(S) 14:40(7) +1 Zn fertilizer (Table 2).

All fallow field preparation costs are attributed to the costs of growing the 1st crop after fallow. They were calculated according to the Kurgan Research and Development Institute's program for calculating economic efficiency in conventional technologies and total costs amounted to 10,164 rubles/ha compared to the option without fertilizer and 12,101 rubles/ha of the ammophos option.

Similar calculations for other complex fertilizers revealed that the largest profit was 10,178 rubles/ha in the zinc-sulfoammophos option, which also produced a higher profitability of 74%.

TABLE 1. THE FERTILIZING PLAN IN THE FIELD EXPERIMENT ON SPRING WHEAT AT URAL AGRO LLC

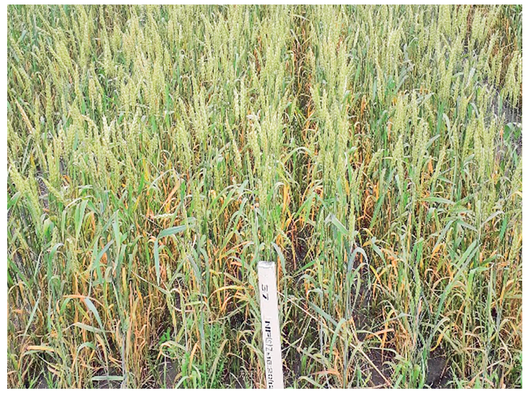
Option of the experiment	Fertilizers	Dose, kg/ha		Application Method
		Physical weight	Equiv. to primary nutrients	
1	Reference	-	$N_0P_0K_0$	When sowing
2	Ammophos NP 12:52	50	N_6P_{26}	When sowing
3	Diammonium phosphate NP 18:46	54	$N_{9.7}P_{25}$	When sowing
4	~~Sulfoammophos~~ NP(S) 20:20(14)	100	$N_{20}P_{20}S_{14}$	When sowing
5	NP(S) + Zn 14:40(7) + 1Zn	100	$N_{14}P_{40}S_7Zn_1$	When sowing

TABLE 2. NUTRIENT YIELD BY HARVESTED WHEAT, KG/HA

Option	N	P_2O_5	K_2O
Reference	81.1	11.9	21.2
N_6P_{26}	120.8	15.2	38.0
N_9P_{23}	117.6	26.1	45.5
$N_{20}P_{20}S_{14}$	122.2	27.4	42.8
$N_{14}P_{40}S_7 + Zn_1$	135.2	28.4	50.5

TABLE 3. ECONOMIC EFFICIENCY OF COMPLEX FERTILIZERS IN WHEAT SOWING

Option	Yield, centner/ha	Sales amount, rubles/ha	Total costs, rubles/ha	Including fertilizers, rubles/ha	Profit, rubles/ha
Reference	16.3	16,952	10,164	-	6,388
N_6P_{26}	19.7	20,488	12,101	1,342	8,387
N_9P_{23}	20.2	21,008	12,049	1,228	8,959
$N_{20}P_{20}S_{14}$	20.9	21,736	13,231	2,323	8,505
$N_{14}P_{40}S_7 + Zn_1$	23.1	24,024	13,846	2,662	10,178



Wheat in the milky stage, the option of complex fertilizer with zinc in a dose of 100 kg/ha

Complex fertilizer containing sulfur and zinc ensures higher utilization rates of mineral fertilizer nutrients. For example, when applying NP(S) +Zn 14:40(7)+1Zn, the phosphorus yield when harvesting is increased by 80%, potassium by 33%, and nitrogen by 11% compared to the ammophos option NP 12:52 without sulfur and zinc.

Seeding rate:
4.3 million germinating grains/ha
Predecessor: fallow
Sowing date: 06/03/2019
Plot area: 73.5 m2
Harvest date: 09/06/2019
Replication: 3 times

CONCLUSIONS

1. The maximum yield (23.1 centner/ha) was achieved in the option with NP(S) 14:40(7) +1Zn in a dose of 100 kg/ha, which significantly exceeds the yield on the reference plot, the yield obtained with the application of 50 kg/ha of ammophos and the yield from the application of 54 kg/ha of diammonium phosphate.
2. The greatest nitrogen and phosphorus yield by spring wheat plants was observed with NP (S) 14:40(7) + 1Zn, which indicates the highest utilization of nutrients from this fertilizer compared to the reference and ammophos.
3. The greatest economic effect was obtained in the option with NP(S) 14:40(7) + 1Zn, which secured a profit of 10,178 rubles/ha compared to the reference option.

Marketing and Development Directorate of PhosAgro PJSC:
marketing@phosagro.ru 8 (495) 231-45-13

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PhosAgro Presented the Eco-Label for Russian Mineral Fertilizers at Green Week in Berlin

PhosAgro took part in the 85th Green Week 2020 International Exhibition and Fair held in Berlin from January 17 to 26, and presented the participants and visitors an eco-label of Russian mineral fertilizers.

Eco-labeling is a Russian mark of conformity to national standards for mineral fertilizers with improved environmental performance. The eco-label is part of the Green Standard national brand, first introduced to the agricultural community as part of the Golden Fall 2019 exhibition.

At the end of last year, the Russian Association of Fertilizer Producers (RAPU) completed the state registration of the trademark for eco-labeling in Russia. In the future, the new mark of environmental conformity will be certified internationally.

The introduction of eco-labeling on the packages of domestic mineral fertilizers will also emphasize that Russian agricultural products are produced exclusively on environmentally friendly fertilizers, and will contribute to the promotion of Russian agro-industrial products in foreign markets and increasing agricultural exports to $45 billion by 2024.

New Russian eco-labels follow a worldwide tendency to toughen requirements to toxic elements content in mineral fertilizers, primarily, cadmium. After years of debate, in 2019, the European Union decided to ban the circulation of phosphorus fertilizers with a cadmium content higher than 60 mg/kg starting from 2022. At the same time, the new regulations stipulate that mineral fertilizers with cadmium content not exceeding 20 mg/kg may be labeled with a special environmental conformity mark.

The new Russian GOST for mineral fertilizers with enhanced environmental characteristics sets stricter requirements for mineral fertilizers than those adopted in the European Union. In particular, 20 mg/kg for cadmium. It is important that Russian methods for determining heavy metals in mineral fertilizers are harmonized with those currently adopted in the EU, so Russian producers can use environmental labeling for their products already today.

This Green Week, apart from new brands of NPK fertilizers and new approaches to crop management, PhosAgro introduced its new product concept to European consumers. Now, all PhosAgro product brands are grouped into 5 product categories depending on their shape, type, composition, and purpose.

Fertilizer packaging has a uniform design reflecting the idea of PhosAgro products sharing the values of Green Standard, the Russian national brand of environmentally friendly agricultural products, created on the initiative of Russian President Vladimir V. Putin. PhosAgro actively contributes to projects implemented in line with the President's instruction to develop the brand.

New design of ~~promotional~~ packaging

"In every country where intensive crop production is developing and where farmers care about natural resources and the purity of their products, mineral fertilizers from Russia will now stand out not only for their efficiency but also for their labeling that indicates their Russian origin and, consequently, their high environmental properties," **said PhosAgro Deputy General Director for Sales and Marketing and RAPU Board Member Sergey Pronin.** "Promotion of a special group of mineral fertilizers with proven environmental properties in Western markets will help strengthen Russia's reputation in the international arena as a producer and exporter of environmentally safe products."

Working ~~issues~~ at the Green Week exhibition

"The European Union, which takes a progressive approach to observing the environmental safety of agricultural products, is steadily increasing its consumption of Russian phosphorus-containing fertilizers. The PhosAgro share in the market of phosphorus-containing fertilizers imported to Europe is at least 15%, in the Russian market—about 20%. Even though the EU still imposes a discriminatory customs rate of 6.5% on Russian manufacturers. In fact, the European market has been closed to environmentally safe Russian fertilizers for many years. The recently adopted regulations may contribute to the revision of European import duties depending on the purity of products, which in the future will make an additional contribution to the increase in Russian non-resource non-energy exports," **emphasized Sergey Pronin.**

PhosAgro booth at the Green Week exhibition in Berlin

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PhosAgro Technologies for Producing High-Quality and Healthy Vegetables in the Open Field

WHITE CABBAGE

Vegetables are a valuable special purpose foodstuff, the main source of carbohydrates, vitamins, mineral salts, phytoncides, essential oils and dietary fibers necessary for normal functioning of the human body.

According to the Institute of Nutrition of the Academy of Medical Sciences of the Russian Federation, the daily human need for protein is 80–100 g, carbohydrates—400–500 g, fats—8–100 g, organic acids—2–3 mg, minerals—from 0.1 to 7,000 mg, vitamins—0.2 to 100 mg. Vegetables and potatoes can satisfy 20–25% of the daily need for protein, 70–80% for carbohydrates, 80–90% for mineral salts and vitamins.

To provide the population of Russia with fresh vegetables meeting the standards established by the Institute of Nutrition of the Academy of Medical Sciences of the Russian Federation, it is necessary to supply 17.9 million tons of vegetables, including 1.7 million tons from greenhouses.

According to Rosstat, in 2019, only 14.2 million tons of vegetables were grown. In 2014, only 14.7 million tons were grown. The difference between the demand and the actual harvest is compensated by imported products from near and far abroad countries. The volume of imported vegetable products grows annually and amounts to 20-30%, which is equivalent to more than 4.2 million tons annually. Imported vegetable products frequently have an attractive appearance but are not always of high quality.

Vegetables with healthy substances (vitamins, antioxidants, organic acids, carbohydrates, organic substances) are often contained in their natural, raw form. People today are increasingly striving for a healthy lifestyle and, as a result, consume more fresh vegetables.

Raw vegetables, in addition to supplying nutrients, are also the main source of nitrates for humans: up to 80–90% of all food nitrates are vegetable nitrates. The remaining 10–20% are nitrates contained in fruits, meat products, and water. The nitrates themselves are not harmful to our health. However, nitrites, a breakdown product of nitrates is hazardous. Children under 3 months are at risk of accumulating high concentrations of nitrates in the stomach, which, due to colonization of the stomach by bacteria, can redox into nitrites. Such conditions foster the formation of methemoglobin, which rapidly accumulates as young children do not have an enzyme that converts methemoglobin to hemoglobin.

Onset of cabbage-head formation by options

Planting cabbage

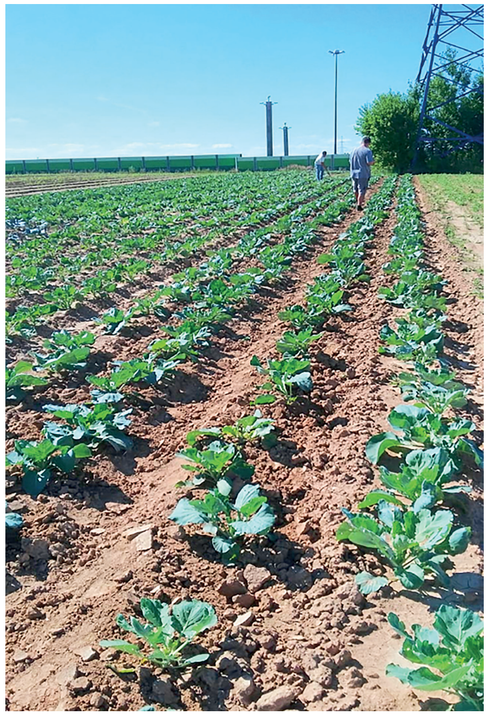
For plants, nitrates are the most important nutrient necessary for synthesizing amino acids, proteins, and other nitrogen-containing compounds that are necessary for humans. The plants would simply not grow without nitrates.

The level of accumulated nitrates in vegetables depends on many factors, including the technology of mineral fertilizer application. Currently, the shortage of vegetables on the Russian market and often insufficient observance of the fertilizer technology leads to a greater spread of nutrition options with high doses of nitrogen fertilizers and insufficient use of phosphate and potassium fertilizers. Such technology produces high biomass and significantly increases the nitrate content in the final product. The lack of phosphorus and potassium in the plants prevents them from converting into beneficial substances for humans, i.e. amino acids and proteins.

Vegetables with short vegetation period and early ripening varieties contain more nitrates. The nitrates level is 2–4 times higher in young carrots and beetroots than during harvesting at the end of the vegetation period. Leafy vegetables (cabbage, lettuce, spinach, beets, chervil, arugula) have relatively high nitrate concentrations (more than 2500 mg/kg wet weight), and plants with spare organs (potatoes, carrots, beans, peas) have relatively low ones (less than 500 mg/kg wet weight). The nitrate level varies in different parts of the plant and decreases in the following sequence: petioles > leaves > stem > root > inflorescence > tuber > bulb > fruit > seeds.

In 2019, PhosAgro's Agricultural Service, together with the Federal Research Center for Vegetable Growing (FRCVG), launched the project "Creation of technology for safe open-field vegetable production on the basis of FSBSI FRCVG" and plans to introduce it into production.

The first stage of the work includes experiments with different feeding systems for white cabbage. In the course of vegetation, observations were made, the characteristics of vegetable development were assessed with different feeding systems.



Plant development by experiment options

TABLE 1. GIFT 2500 WHITE CABBAGE FERTILIZATION TECHNOLOGY

Option No.	Content of nutrients by option	At spring replowing of the fall-plowed land	When planting	4-5 leaves	Rosette phase prior to the cabbage head forming	Head growth phase	Head ripening phase
			gross weight, kg				
Cabbage: white cabbage, plan 1, gen. S 320 m² Planned yield 50 t/ha							
Option 1	Reference	No fertilizers	-	-	-	-	-
Option 2	$N_{127}P_{101}K_{69}(S_2)$	$N_8P_{20}K_{30}(S_2)$ - 230 kg	-	LCF (11:37) - 50 kg	LCF (11:37) - 40 kg N_{46} - 100 kg	LCF (11:37) - 40 kg N_{46} - 100 kg	LCF (11:37) - 20 kg
Option 3 (conventional fertilizer system)	$N_{110}P_{48}K_{69}(S_2)$	$N_8P_{20}K_{30}$(S2) - 230 kg	-	-	N_{46} - 100 kg	N_{46} - 100 kg	-
Option 4	$N_{76}P_{93}K_{69}(S_{20})$ 28Ca0	$N_{15}P_{15}K_{30}(S_2)$ + 7CaO - 400 kg	-	LCF (11:37) - 30 kg	LCF (11:37) - 20 kg N_{46} - 50 kg	LCF (11:37) - 20 kg N_{46} - 50 kg	LCF (11:37) - 20 kg

The feeding system for each crop included the options presented in Table 1.

The standard fertilization technology for white cabbage is presented in option 3 and includes pre-sowing application of complex fertilizers like diammonium phosphate and urea or ammonium nitrate. We suggested using NPK(S) fertilizer 8:20:30(2) with higher potassium and lower nitrogen as a reference for the experiment. Given the unbalanced utilization of nutrients by plants, as well as in order to reduce nitrate content in cabbage plants and to support the processes of high nitrogen fertilizer uptake, fractional application of LCF was proposed while maintaining the standard dosage of urea application.

TABLE 2. YIELD OF GIFT 2500 WHITE CABBAGE, 2019 T/HA

Options of the experiment	Average weight of the head, kg	Yield, t/ha			Marketability, %	The cost of fertilizers, rubles/ha	Additional income, rubles/ha
		marketable	not marketable	total			
Option 1 (reference)	3.4	54.4	3.2	57.6	94.4	0	0
Option 2	3.5	66.9	1.9	68.8	97.2	14,594	235,406
Option 3 (conventional)	3.4	64.0	2.6	66.6	96.1	10,034	181,966
Option 4	3.5	66.5	1.6	68.1	97.6	14,226	227,774

In Option 4, it was suggested to apply the NPK(S)+Ca 5:15:30(5) + 7CaO fertilizer in a dose of 400 kg/ha and to halve the nitrogen component—urea. To improve product quality, 20 kg of LCF 11:37 brand were added fractionally in a total dose of 80 kg/ha.

According to the results of the harvesting of September 25, 2019, the indices of yields and marketability of cabbage heads were estimated. Options 2 and 4 with optimized fertilizer systems were marked with the highest marketability indices of 97.2 and 97.6 respectively, and the average head weight was 3.5 kg. The maximum increase in marketable yield relative to the reference was obtained in option 2 and amounted to 12.5 tons of cabbage. Option 3, with the standard fertilizer technology, produced an increase of 9.6 t/ha, while option 4, with a dose of nitrogen fertilizer reduced by 51 kg of nitrogen in equivalent to primary nutrient, saw an increase of 12.5 t/ha. Option 4, which featured fertilizers with calcium and high sulfur content, saw the smallest non-marketable part of the crop—1.6 t/ha, which was only 2.4% (compared to 3.2 t/ha in the reference system and 2.6 t/ha in the conventional fertilizer system).

For biochemical analysis, 5 cabbage heads were selected from each option of the three non-contiguous replications. The results of the biochemical analysis are given in Tables 3.1 and 3.2. The highest nitrogen content was marked in the reference option, the lowest—in option 4 (N5P15K30(S5) +Ca 400 kg). The highest dry matter content was marked in option 3. The fat content in all option was about the same.

The accumulation of nitrate nitrogen in vegetables of all options does not exceed MAC (Table 3.2). It should be noted that in the reference option, its amount was 2.5–3 times higher than in the option with the applied test fertilizer. Option 3 showed the highest concentration of sugars compared to all other feeding systems, while option 4 showed the highest vitamin C accumulation.

TABLE 3.1. BIOCHEMICAL COMPOSITION OF GIFT 2500 WHITE CABBAGE, %, 2019

Option	Nitrogen	Dry matter	Protein	Dry fat
B1	1.58 + 0.12	8.32 + 0.45	9.84 + 0.48	1.03 + 0.05
B2	1.36 + 0.10	8.04 + 0.09	8.53 + 0.32	1.02 + 0.05
B3	1.30 + 0.12NP	9.40 + 0.00	8.09 + 0.29	0.99 + 0.04
B4	1.26 + 0.12	7.84 + 0.12	7.88 + 0.32	1.01 + 0.04
HCP_{05}	0.18	0.45	0.65	Fф<P05

TABLE 3.2. BIOCHEMICAL COMPOSITION OF GIFT 2500 WHITE CABBAGE, 2019 (CONTINUED TAB. 3.1)

Option	Fiber	Crude ash	Sugars	Nitrates	Vitamin C
	% of crude substance	%		mg/kg	mg/100g
No fertilizers	0.79+0.12	5.97+0.24	3.41+0.12	110.0+35.0	11.7+1.4
$N_8P_{20}K_{30}(S_2)$ 230 kg + LCF	0.61+0.08	6.57+0.71	3.43+0.18	38.0+13.0	16.8+1.9
$N_8P_{20}K_{30}(S_2)$ 230 kg	0.66+0.09	5.74+0.48	4.17+0.42	38.0+13.0	14.2+1.5
$N_8P_{20}K_{30}(S_2)$ +Ca 400 kg + LCF	0.60+0.08	5.52+0.43	3.36+0.38	44.0+16.0	20.7 +2.1
HCP_{05}	0.07	0.48	0.29	18	2.1

Harvesting cabbage at the FRCVG's experimental station in Odintsovo

CONCLUSIONS

Thus, the beneficial properties in the white cabbage were most pronounced in the options with liquid compound fertilizers, that is, complex fertilizers, and fertilizers with calcium, proved to be the best. This experiment shows: in order to obtain high yields and improve product quality, it is necessary to fertilize white cabbage in a balanced manner with a ratio of doses of nitrogen fertilizers of not more than 80–90 kg/ha equiv. to primary nutrients, phosphorus fertilizers—in a dose of not less than 90 kg/ha of P_2O_5 and 70– 75 kg/ha K_2O. Subsequently, we can get a yield of 2.5 tons/ha higher than when using higher doses of nitrogen (over 100–110 kg/ha N), lower doses of phosphorus at a dose of 40–50 kg/ha P_2O_5 and potassium at a dose of 70–75 kg/ha K_2O.