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# Gumiton - New Organo-Mineral Complex to Increase the Productivity of Agricultural Cultures

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***Abstract:*** ***Given the composition and properties of new organo-mineral complex based on peat GUMITON. The characteristics of peat required for the production GUMITON. Conducted production tests GUMITON in farms of different ownership forms, on different types of soils, crops and potatoes. It is shown that the use of GUMITON in the cultivation of grain crops increased the productivity of spring wheat – by 15-22%; winter wheat by 17-40%; barley – by 19.5-23%; triticale – by 13-14%. The protein content in grain of winter wheat in the processing GUMITON increased up to 2.1%; spring wheat – up to 2.1%, in triticale grain – up to 1.3% compared to untreated crops. Collection of triticale protein (centner/ha) increased by 21-27%. The use of GUMITON is a highly effective method of increasing potato yield in agricultural technologies. The use of GUMITON allowes to increase the yield by 12-36% and to obtain an additional crop of potato tubers on floodplain soil up to 5.7 t/ha, on soddy-podzolic soil - up to 9.8 t/ha; and on gray forest soil – up to 10.0 t/ha, depending on the variety.***

***Key words: peat, GUMITON, grain crops, potatoes, grain, productivity, protein content***

## I. INTRODUCTION

Improvement of technologies of cultivation of crops with the use of new drugs that improve the growth, development of plants and increase their productivity is one of the main directions of increasing the efficiency of crop production and fodder production. In Russian research Institute of radiology and Agroecology successfully conducts production tests on farms of various forms of ownership of the new organo-mineral complex based on peat GUMITON featuring high efficiency, both in terms of productivity and quality, and is environmentally safe agricultural products.

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## I. CHARACTERISTICS OF PEAT

Peat accumulates in waterlogged areas from the remains of dead plants that have undergone incomplete decomposition in conditions of high humidity and difficult air access.
In peat formation, the main role is played by anaerobic processes of biochemical humification, occurring with the participation of microorganisms, with the formation of a dark-colored amorphous substance - humus, the percentage of which determines the degree of decomposition of peat and, along with the floristic composition,
has an impact on all its important properties. Peat is characterized by the following indicators: the degree of decomposition, absorption capacity (1 kg of dry peat absorbs 8-15 liters of moisture), acidity (pH 2,6–7,2), ash content (2-15%), the content of organic compounds (at least 50%), nitrogen content(0,8–3,5%) [1]. The organic part consists of a water-soluble 1,4–4,1% and hydrolyzable 11-47% substances, humic acids 8-47%, fulvic acids 6-24%, hardly hydrolysable substances 3-26% (including pulp 2-16%), nonhydrolizable residue (lignin) 4-30%. The elemental composition of organic matter of peat: carbon – 48-60%, hydrogen 4.5–6.5%, nitrogen 0.5–3.8%, oxygen 31-42%, sulfur 0.02–1.5%. The use of peat in its pure form for convenience is permissible only in relation to high-ash lowland peat with a neutral reaction, near the places of its preparation, and peat rich in lime (peat) or phosphorus (vivianite peat) [2]. Lowland peat is formed when moistened with hard mineralized waters, which cause rich mineral nutrition and provide favorable conditions for the growth of demanding and diverse composition of auto-trophic vegetation (herbal and woody-herbal groups). They all haracterize high ash content (≥ 6-8%), neutral or weakly acid reaction (pH 4,8–6,0). The degree of saturation of the bases exceeds 50%. An important property of peat is the level of decomposition defines the content of the unstructured part including humic substances and small particles dehumidification residues. Lowland peat are often well decomposed, brown, black, spotting, they are difficult to distinguish races vegetative residues. They are divided according to the degree of decomposition into three classes: the first (up to 15%), the second (16-34%) and the third (>35%). Types of peat are divided into subtypes: forest, forest-swamp and swamp, and depending on the type of growth into 6 groups: wood, wood-grass, grass, wood-moss, grass-moss and moss. The value of peat also depends on the retention of non-combustible or ash components; often their amount reaches 50% of the dry matter. In the practical assessment of peat are included such factors as contamination by inclusions, humidity, metabolic and hydrolytic acidity, chemical composition of fly ash, the content of total nitrogen and sulfur, heavy metals
and radioactive elements.

According to the limit content of heavy metals and boron peat fertilizers are divided into four classes. Doses of first-class fertilizers are not limited, the second is limited; the use of peat of the third and fourth classes is not allowed. Below (table. 1) the structure of classification of peat for agricultural purposes, depending on the pH and content of humic acids and requirements for peat raw materials for fertilizer production. In many studies of Russian scientists it is shown that under the influence of physiologically active humus substances the resistance of plants to adverse environmental conditions of different nature increases [3].

**Table 1. The structure of the classification of peat for agricultural purposes [4].**

| Class of peat | | | | |
|---|---|---|---|---|
| pH | Humic acid, % | | | |
| | Up to 15 | 15-25 | 25-35 | More than 35 |
| 2,6-3,2 | Strongly acid weakly humus | Strongly acid little humus | Strongly acid humus | Strongly acid high humus |
| 3,2-4,6 | Acid weakly humus | Acid little humus | Acid humus | Acid high humus |
| 4,6-5,8 | Weakly acid weakly humus | Weakly acid little humus | Weakly acid humus | Weakly acid high humus |
| 5,8-7,2 | Neutral weakly humus | Neutral little humus | Neutral humus | Neutral high humus |

Substances of humic nature enrich the soil with biologically available nitrogen, mobilize available phosphorus from its insoluble compounds. Under the influence of humic compounds the biochemical and microbiological properties of soils are improved, the processes of soil respiration, synthesis and destruction of complex substances are activated. Humic compounds in the form of drugs do not significantly affect soil fertility in terms of changes in the chemical and physical characteristics of the soil, since the concentration of humic preparations is extremely low compared to fertilizers based on humic substances [5]. The most common method of obtaining humic preparations is "leaching" of humic substances from fossil raw materials (brown coal, peat), which is based on the property of humic acids to form water-soluble salts of sodium, potassium, ammonium [6]. The use of peat and brown coal for the production of humic drugs is due to the presence of significant reserves, high content of humic acids, low cost of production of drugs, the possibility of organizing waste-free and environmentally safe production [7]. Along with growth-regulating properties, humic acids to a certain extent are characterized by the effects of recently discovered physiologically active compounds of new generation. Preparations of this class are characterized by acceleration of growth processes and increase of plant resistance to adverse physical, chemical and biological factors. The peculiarity of such environmentally safe regulators is non-specific activation of protective mechanisms of plants. However, their effective concentration is so small that they are named the signal molecules [8]. The drugs that increase the stability of plants to stress factors include humates and oxyhumates – compounds that contribute to the intensification of life processes in plants, increase the yield and immunity of plants to diseases and the effects of adverse environmental factors. Processing of seeds and plants with humic substances activates enzyme systems, redox reactions, processes of carbohydrate and protein metabolism, increases the intensity of photosynthesis. Humates increase immunity to phytopathogens and resistance to adverse factors such as drought and frost [9]. In recent years, a good responsiveness of vegetables and potatoes to the action of humic acids has been established. Under the influence of growth regulators, metabolism is activated in the plant body, breathing, synthetic processes and the flow of minerals are enhanced [10]. The prospect of using humates in technologies of cultivation of agricultural crops is associated with the possibility of regulating the assimilation of elements of mineral nutrition during the development of plants. Due to the rise in the cost of fertilizers and the increase in the cost of their transportation, the use of humic compounds is economically profitable and promising, including in technogenic contaminated areas [11].

## II. THE COMPOSITION AND PROPERTIES OF GUMITON

GUMITON is a comprehensive all-purpose liquid concentrate with content (%): N – 12,0; P2O5 – 23,0; K2O was 30.3. The content of organic matter is 20.1%, including potassium humates 12-14%. GUMITON harmless in use, it is soluble in water, compatible with most operation used mineral fertilizers and means of plant protection.

The main raw material for the production of GUMITON is peat. Production technology GUMITON include: alkaline hydrolysis of peat with the aim of increasing the yield of humates; neutralization of phosphoric acid and ammonification.

Organo-mineral complex GUMITON intended: a) for on top of a finite difference treatment of vegetating plants (by spraying); b) for processing of seed. At surface, sheet treatment of plants 1 litre of the preparation is dissolved in 200-300 liters of water per hectare. GUMITON treatment is carried out 1-2 times during the vegetation period, during main phases of plant development. For pre-sowing treatment of seed and planting material, the concentrate of GUMITON is diluted with water in a ratio of 1:40 at the rate of: 1 ton of seed is used 10 liters of working solution. Who-can be used in conjunction with drugs for treatment against pathogens..

The mechanism of action of GUMITON is based on activation of biochemical processes in plants under the action of biologically active substances contained in it. Application GUMITON improves plant immunity, increases the efficiency of root nutrition and productivity of agricultural crops [12].

## III. APPLICATION GUMITON IN TECHNOLOGIES OF CULTIVATION OF GRAIN CROPS

**Winter crops.** Tests GUMITON impact on the productivity of winter wheat variety Moskovskaya 56 in field experiments on grey forest medium loamy soil on the basis of the **State scientific research Institute of agriculture of Kaluga**. Winter wheat was cultivated by zonal technology. Grey forest soil had the following characteristics: $pH_{KCl}$ 6.1; humus – 2.9%; the content of $P_2O_5$ – 200; $K_2O$ – 150 mg/kg of soil, respectively. Scheme experience: 1. $N_{90}P_{120}K_{140}$ – technology management (without treatment); 2) $N_{90}P_{120}K_{140}$ + 1 processing GUMITON (0.5 l/ha) in the phase of stem elongation; 3. $N_{90}P_{120}K_{140}$ + 1 GUMITON treatment (total dose 1 l/ha) in phase of the tube; 4. $N_{90}P_{120}K_{140}$ + 1 processing Gamitana (0.5 l/ha) in the phase of stem elongation + 2 treatment (0.5 l/ha) at the beginning of earing. Single treatment of winter wheat with GUMITON 0.5 l/ha in phase of elongation enhanced the grain yield by 20% in comparison with technology without treatment. Double treatment with GUMITON 0.5 l/ha in the phase of stem elongation and earing increased the grain yield by 30%. Maximum effect increase the yield by 40%, gave a single of spraying of wheat GUMITON 1 l/ha (tab. 2).

Application GUMITON effect on sowing qualities of grain: weight of 1000 grains was up 6.8% higher than in the variant without treatment (tab. 3). The content of crude protein in the processing GUMITON increased from 0.5 to 2.1%. Collect the maximum crude protein obtained by a single treatment crop GUMITON (1 l/ha) – 6,5 t/ha, which is 63% higher than the control. Processing wheat GUMITON in the phase of stem elongation and early heading at 0.5 l/ha in each operation increased the collection of protein is 57.5%.

**Table 2. GUMITON impact on the productivity of winter wheat variety Moskovskaya 56 on gray forest soil, Scientific research Institute of agriculture of Kaluga**

| Variant | Yield of grain, centner/ha | Yield increase, % over control |
|---|---|---|
| $N_{90}P_{120}K_{140}$ – farm technology | 40.0 | – |
| Farm technology + 1 treatment GUMITON (0,5 l/ha) | 48.0 | 20.0 |
| Farm technology (NPK) + 1 treatment GUMITON (1 l/ha) | 56.0 | 40.0 |
| Farm technology (NPK) + 2 treatments GUMITON (0,5 l/ha per each treatment) | 52.0 | 30.0 |
| $LSD_{05}$ | 4.8 | |

**Table 3. GUMITON influence on grain quality of winter wheat**

| Variant of treatment | Grain content, % | | | | | Weight of 1000 grains, g |
|---|---|---|---|---|---|---|
| | Dry matter | Ash | Protein | Fat | Fiber | |
| $N_{90}P_{120}K_{140}$ – farm technology | 89.6 | 1.85 | 9.94 | 1.51 | 3.15 | 43.8 |
| Farm technology + 1 treatment GUMITON (0,5 l/ha) in phase of the tube | 89.7 | 1.93 | 10.48 | 1.52 | 3.53 | 44.4 |
| Farm technology + 1 treatment GUMITON (1 l/ha) in phase of the tube | 89.5 | 1.78 | 11.11 | 1.51 | 3.95 | 46.8 |
| Farm technology + 2 treatments GUMITON: in phase of the tube (0,5 l/ha) and at the beginning of earing (0,5 l/ha) | 89.6 | 1.95 | 12.05 | 1.64 | 3.55 | 46.8 |
| $LSD_{05}$ | 0.0 | 0.07 | 0.45 | 0.10 | 0.35 | – |

On the basis of **farm 'Petuhov' (Babyninsky district of Kaluga region**) on soddy-podzolic medium-loamy soil tests to assess the effectiveness of GUMITON on winter wheat crops variety Moscovskaya 39 showed that one treatment with GUMITON in the phase of tillering led to an increase in grain yield by 19%.

On the basis of the **farm "Brothers Fetisov" (Duminichsky district of Kaluga region**) tests to evaluate the effectiveness GUMITON carried out on soddy-podzolic light loamy soil, on crops of winter wheat variety Moskovskaya 39. Agrochemical parameters of soil: $pH_{KCl}$ 7.0 and a humus content of 1.99%, $P_2O_5$ – 167, $K_2O$ – 71 mg/kg soil. One treatment of wheat plants in the exit phase of the tube led to an increase in the grain yield by 17%, and the processing of wheat varieties Suita – by 19% compared with the control (tab. 4).

**Table 4. GUMITON influence on the yield of winter wheat on soddy-podzolic light-loamy soil. Farm "Brothers Fetisov"», Duminichsky district**

| Variant of treatment | Variety Moscovskaya 39 | | Variety Suita | |
|---|---|---|---|---|
| | Yield of grain, centner/ha | Yield increase, % over control | Yield of grain, centner/ha | Yield increase, % over control |
| Farm technology – control | 30.1 | – | 57.0 | |
| Control + 1 treatment GUMITON in phase of the tube | 35.2 | 16.9 | 68.0 | 19.3 |
| $LSD_{05}$ | 3.5 | | 6.9 | |

Production tests on the effect of GUMITON on the productivity and quality of triticale grain were carried out at the **collective farm "Mayak" in the Peremyshl district of Kaluga region** on gray forest soil: $pH_{KCl}$ 5.1; humus content – 2.3%; $P_2O_5$ – 88-148 mg/kg; $K_2O$ – 71-116 mg/kg of soil. Test GUMITON in the triticale variety Nemchinovsky 56 was carried out with soil application of mineral fertilizers – $N_{90}P_{90}K_{120}$.

Treatment of plants with GUMITON was carried out in the phase of the tube and provided a reliable increase in grain yield from 32.3 to 36.7 centner/ha, i.e. the increase was 4.4 c/ha. Treatment of vegetative plants with GUMITON had a positive influence on sowing qualities of triticale: the weight of 1000 grains was 8.5% higher than in the control. During the processing of a sowing GUMITON the protein content in grain increased by 1.3% in comparison with the technology of agriculture, and the collection of protein by 27.3% (table. 5).

**Table 5. GUMITON influence on yield and quality of triticale variety Nemchinovsky 56 on the gray forest soil. Collective farm "Mayak", Peremyshl district.**

| Variant of treatment | Yield of grain, centner/ha | Yield increase, % over control | Protein content, % | Collecting protein, c/ha |
|---|---|---|---|---|
| $N_{90}P_{90}K_{120}$ – farm technology | 32.3 | – | 10.9 | 3.52 |
| Farm technology + treatment GUMITON | 36.7 | 13.9 | 12.2 | 4.48 |
| $LSD_{05}$ | 3.0 | | 1.2 | |

The results of the tests GUMITON in the triticale variety Nina showed that the grain yield in the field, processed GUMITON, was 13% above, than without treatment. The weight of 1000 grains increased by 4.7%, and the protein content in the grain – by 0.9%. Application GUMITON in the zonal technology of cultivation triticale contributed to the additional yield of grain and 5.8 t/ha, and increase the collection of protein from 1 hectare of 20.8% compared to control. The economic efficiency of GUMITON on crops triticale was (in 2013 prices) 5.25 thousand rubles/ha [13].

**Spring crops.** Tests on the effect of GUMITON a on yield and quality of grain of spring wheat variety Lyubava conducted in the field experiment on gray forest medium loamy soil on the basis of **State scientific research Institute of agriculture of Kaluga**. Scheme of experience: 1. $N_{91}P_{96}K_{144}$ control (no treatment); 2) $N_{91}P_{96}K_{144}$ + 1 processing GUMITON (0.5 l/ha), in phase of the tube; 3. $N_{91}P_{96}K_{144}$ + 1 GUMITON treatment (total dose 1 l/ha) in phase of the tube; 4. $N_{91}P_{96}K_{144}$ + 1 processing GUMITON (0.5 l/ha) in the phase of stem elongation + 2 processing GUMITON (0.5 l/ha) at the beginning of earing. Single treatment of wheat with GUMITON (0.5 l/ha) in phase of the tube has not led to higher grain yield compared to control. Double treatment with GUMITON: 1 (0.5 l/ha) in the phase of booting, and the 2nd (0.5 l/ha) at the earing phase in dose, increased the grain yield from 20.2 to 23.3 kg/ha, or 15% (tab. 6). The maximum effect was given by a single scouring of crops with GUMITON (1 l/ha) in phase of the tube: an increase in the yield of spring wheat by 22% compared to the control. Double treatment of crops with GUMITON (0.5 l/ha) significantly increased the 1000 grains weight of 8.3% compared to the control. The crude protein content in the grain by a single treatment with GUMITON (1 l/ha) in the phase of stem elongation of wheat dose was 2.1% higher than in the control variant without the use of the drug (tab. 6).

**Table 6. GUMITON impact on the productivity and quality of grain of spring wheat variety Lyubava on gray forest soil. Scientific research Institute of agriculture of Kaluga**

| Variant | Yield of grain, centner/ha | Weight of 1000 grains, g | Grain content, % | | | |
|---|---|---|---|---|---|---|
| | | | Dry matter | Ash | Crude protein | Fiber |
| $N_{60}P_{60}K_{60}$ – control | 20.2 | 36.0 | 89.80 | 1.98 | 9.54 | 3.48 |
| Control + 1 treatment GUMITON (0,5 l/ha) | 20.5 | 39.0 | 89.48 | 1.78 | 10.10 | 2.83 |
| Control + 1 treatment GUMITON (1 l/ha) | 24.6 | 37.0 | 89.43 | 1.79 | 11.61 | 2.85 |
| Control + 2 treatments GUMITON (0,5 l/ha per each treatment) | 23.3 | 39.0 | 89.22 | 1.63 | 10.67 | 2.28 |
| $LSD_{05}$ | 2.5 | – | 8.5 | 0.20 | 1.17 | 0.35 |

In a production environment on the basis of **limited liability company 'Rodina' Maloyaroslavezky district** GUMITON has been tested on soddy-podzolic medium loamy soil ($pH_{KCl}$ 5.7; humus – 1.77%, $P_2O_5$ – 192 mg/kg, $K_2O$ – 136 mg/kg) in crops of spring wheat variety Lyubava and spring barley variety Nur on the background of $N_{60}P_{60}K_{60}$. Treatment of growing plants was carried out in the tillering phase and the phase of the beginning of the tube with the drug (1 l/ha). The use of GUMITON on spring wheat crops provided an increase in grain yield of 4.0 t/ha or 17% compared to the non-processed version.

Treatment of spring barley solution GUMITON a increased the grain yield by 15% compared to the farm technology.

Tests on the effect of GUMITON on the yield of barley variety Vladimir carried out in field experiments on gray forest medium loamy soil in the **Kaluga research Institute of agriculture**. Agrochemical parameters of soil: $pH_{KCl}$ 5.7; humus – 2.6-2.7%; content of $P_2O_5$ – 220-250 mg/kg, $K_2O$ – 160-170 mg/kg of soil. Barley is cultivated at the zonal technology – has introduced nitrophoska ($N_{60}P_{60}K_{60}$). Scheme of the experiment: 1. $N_{60}P_{60}K_{60}$ control (no treatment); 2) Control + 1 treatment GUMITON (0.5 l/ha) at tillering; 3. Control + 1 treatment GUMITON (1 l/ha) at tillering; 4. Control + 1 processing GUMITON (0.5 l/ha) at tillering + 2 processing GUMITON (0.5 l/ha) in the phase of elongation.

A single treatment of crops with GUMITON (0.5 l/ha) in the phase of the tabernacles-tion has caused the increase of grain yield by 19.5% compared with control. Double treatment of plants with the drug (0.5 l/ha) in the tillering phase and in phase of the tube increased the grain yield from 43.9 to 53.0 c/ha, or 21%. The weight of 1000 grains increased by 5.7%. The maximum effect in increasing the yield of barley (by 22.5%) was given by a single spraying of crops with GUMITON (1 l/ha) (tab. 7).

**Table 7. GUMITON influence on the yield of barley variety Vladimir on gray forest medium loamy soil, Scientific research Institute of agriculture of Kaluga.**

| Variant of treatment | Yield of grain, centner/ha | Yield increase, % over control |
|---|---|---|
| Control – $N_{60}P_{60}K_{60}$ | 43,9 | – |
| Control + 1 treatment GUMITON (0,5 l/ha) | 52,5 | 19,5 |
| Control + 1 treatment GUMITON (1 l/ha) | 53,8 | 22,5 |
| Control + 2 treatments GUMITON (0,5 l/ha per each treatment) | 53,0 | 20,7 |
| $LSD_{05}$ | 5,5 | |

The effect of GUMITON on the formation of productivity can be explained by potassium humates and nitrogen contained in it, accelerating the biochemistry processes in plants, increasing the flow of nutrients to the apical point of growth [12, 14], as well as improving the conditions of mineral nutrition of plants, due to the phosphorus and potassium contained therein in an in an easily accessible form [14, 15]. The application of organo-mineral complex GUMITON for the treatment of winter crops and spring crops can be used as a factor of optimization of plant nutrition. This technological operation allows to manage the production process more effectively, increases the plants ' resistance to biotic stresses, ensures the formation of better conditions for their growth and development and has a significant impact on the yield. The use of a new organo-mineral complex GUMITON in the cultivation of grain crops on the background of activities carried out in farms increases productivity: spring wheat – by 15-22%; barley – by 19.5–23%; winter wheat by 17-40%, triticale – by 13-14%. The protein content in triticale grain during cultivation with the use of GUMITON is 0.9–1.3%, and the protein collection (c/ha) is 21-27% higher than in the fields without processing. The protein content in winter wheat grain increased by 0.5–2.1%; spring wheat – by 2.1%.

On the basis of Kaluga Branch of Moscow Agricultural Academy named by K. A. Timiryazev in a two-year field experiment on soddy-podzolic sandy soil studied the effect of GUMITON on the admission of heavy metals (HM) in barley grain variety Nur and oats variety Privet. Agrochemical characteristic of the soil: $pH_{KCl}$ 6.0, humus – 1.22%, hydrolytic acidity – 0.48 mg·eq./100 g of soil, content of $P_2O_5$ – 144 mg/kg, $K_2O$ – 112 mg/kg of soil. The treatment of crops of barley and oats with GUMITON was carried out twice: the first – at tillering, the second - in the phase of tube in the background $N_{96}P_{96}K_{140}$. Double treatment of plants with GUMITON against the background of $N_{96}P_{96}K_{140}$ increased barley yield by 19%. Maximum fee of crude protein (kg/ha) - in the variants with the treatment the plants of GUMITON at the tillering stage of barley and the phase of the tube – 2.42 t/ha. Application GUMITON on the background of mineral fertilizers promoted the increase of a collection of crude protein 15.8%, compared to the variant without processing the sowing of barley. Double treatment of vegetating plants of oats GUMITON on the background $N_{96}P_{96}K_{140}$ increased the grain yield by 12%. Spraying GUMITON reduced the flow of HM from the soil into the plant from 1.3 to 1.9 times compared to the technology without treatment. Treatment GUMITON contributed to the decrease in the content of HM in barley grain: Cd – 1.6 times, Pb – 1.3 times; and in grain of oats: Cd – 1.9, Pb – 1.4, Ni 1.3 times, due to the dilution effect with a significant increase of the vegetative mass.

## IV. APPLICATION GUMITON IN TECHNOLOGY OF POTATO CULTIVATION

Potatoes are demanding to soil fertility, responsive to the application of organic and mineral fertilizers. The use of zoned varieties and the proper preparation of seed material are important for producing high yields. Absorption of nutrients from the soil occurs most actively in the phase of mass germination and budding. On the basis of **Kaluga Scientific-research Institute of agriculture in Peremyshl district, Kaluga region**, on the gray forest soil tested GUMITON with the aim of improving the productivity of potatoes sort of Udacha. Soil – gray forest medium-loamy: $pH_{KCl}$ 5,4–6,2; hydrolytic acidity – 0,66–1,55 mg-eq./100 g of soil, humus – 2,37–3,69%, content of $P_2O_5$ – 175-384 and $K_2O$ – 131-219 mg/kg of soil, respectively. Test GUMITON in the technology of cultivation of potato was conducted during the pre-sowing treatment of tubers and the double treatment of vegetating plants: 1- at a height of 10-15 cm, 2 - in the budding phase. The results of the tests showed that the treatment of tubers before planting with GUMITON contributed to an increase in yield in an average of 3 years by 2.9 t/ha or 12% compared to the control (tab. 8). During the processing of tubers GUMITON when the additive of the crop was 2.4–3.5 t/ha, the highest increase in yield of tubers obtained in 2010, potato yield with twice the processing GUMITON increased by 16.5% on average over 3 years. Application GUMITON at double spraying of vegetating plants allows to obtain an additional 4.1 tons/ha of potato tubers. The average yield of potatoes without crop preparation was 24.9 t/ha, and when using GUMITON – 29.0 t/ha (tab. 8). GUMITON efficacy in raising the crop capacity of potatoes depended on the climatic conditions of the growing season as during the processing of tubers before planting, and vegetative plants. Potato yield in the processing plant drug GUMITON ranged from 23,9 t/ha to 32.9 t/ha. The highest increase in yield of tubers from relatively control (4.5 t/ha) was obtained in 2011.

**Table 8. GUMITON impact on the productivity of the potato variety Udacha on the gray forest soil in Peremyshl district of Kaluga region (average for 2010-2012)**

| Variant | Yield of tubers, t/ha | Yield increase, % over control | Starch content, % |
|---|---|---|---|
| $N_{90}P_{90}K_{140}$ – control | 24,9 | – | 14,4 |
| $N_{90}P_{90}K_{140}$ + GUMITON (processing tubers before planting) | 27,8 | 11,6 | 15,2 |
| $N_{90}P_{90}K_{140}$ + GUMITON (treatment of vegetating plants) | 29,0 | 16,5 | 15,6 |

Use GUMITON as in the preplant treatment of tubers and spraying of vegetating plants, positive impact on commercial productivity and increase the number laid down under a bush of tubers. The positive influence of GUMITON on the quality of potato tubers. The starch content as in the treatment of tubers with GUMITON before planting and in the treatment of vegetating plants increased from 14.4 to 15.2-15.6% or 0.8-1.2% compared with the control (tab. 8).

In **Babyninsky district of Kaluga region**, tests were conducted on the effect of GUMITON on potato productivity of Udacha variety on soddy-podzolic medium-loamy soil: $pH_{KCl}$ 4,5–4,7, hydrolytic acidity – 3,33–4,23 mg-eg./100 g of soil, humus – 1,82–2,24%, content of $P_2O_5$ – 175 and $K_2O$ – 136 mg/kg of soil, respectively. Twice treatment of vegetating plants was carried out: 1st - at the height of plants 10-15 cm, 2-nd – in the budding phase. The use of GUMITON in the technology of cultivation of potato on soddy-podzolic soil increased the yield of tubers on average for 2009-2011 years by 23% (tab. 9). The processing of potato by GUMITON to yield an additional crop of 3.8–to 9.8 t/ha of tubers. The potato crop in the most favorable weather conditions in 2009 use GUMITON was of 49.0 t/ha, and no crop processing drug – 39,2 t/ha. In 2010 GUMITON increased the potato yield by 15% compared to control. Growing conditions in 2011 in the processing plant GUMITON potato yield increased by 27%.

**Table 9. GUMITON influence on yield of potato cultivar Udacha on soddy-podzolic soil, (Babyninskaya district, Kaluga region)**

| Variant | Yield of tubers, t/ha | | | Average for 2009-2011 yy., t/ha |
|---|---|---|---|---|
| | 2009 y. | 2010 y. | 2011 y. | |
| Control – without treatment GUMITON | 39,2 | 25,0 | 30,0 | 31,4 |
| Control + 2 treatments GUMITON | 49,0 | 28,8 | 38,0 | 38,7 |
| $LSD_{05}$ | 2,8 | 3,4 | 3,2 | – |

Treatment GUMITON (at plant height of 10-15 cm and after the closing of plants in rows) increased productivity of potatoes of different varieties by 15-17% in comparison with the farm technology (tab. 10). Under the same conditions of cultivation of potatoes on soddy-podzolic soil, the use of GUMITON provided an increase in the yield of tubers Nevsky variety from 34.0 t/ha to 39.0 t/ha, and varieties Bryansky delicates – from 35.0 t/ha to 41.0 t/ha.

**Table 10. Influence of GUMITON on potato yield of different varieties on soddy - podzolic soil Babyninsky district of Kaluga region [12]**

| Variant | Yield of tubers, t/ha | |
|---|---|---|
| | Variety Nevsky | Variety Bryansky delicates |
| Control – farm technology | 34.0 | 35.0 |
| Control + 2 treatments GUMITON | 39.0 | 41.0 |
| $LSD_{05}$ | 3.4 | 3.5 |

In **Maloyaroslavetsky district of Kaluga region** were tested for GUMITON impact on the productivity of potato. Soil – soddy-podzolic medium-loamy: $pH_{KCl}$ 4.9; hydrolytic acidity – 2.62 mg-eq./100 g of soil; humus – 1.73%; content of $P_2O_5$ – 152 and $K_2O$ – 121 mg/kg of soil, respectively. Use GUMITON when growing potatoes variety Briz – one treatment at a plant height of 10-15 cm increased the yield by 16-19%. After the couple was obtained tuber yield of 15.7 t/ha, and the application GUMITON and 18.2 t/ha. In the processing of landings with GUMITON (predecessor – potatoes) yield increased by 19% in comparison with farm technology.

In the **farm "Mayak", Peremyshl district, Kaluga region** in two years tests were conducted on the effect of GUMITON on the yield of potatoes of different varieties in the floodplain medium loamy soil ($pH_{KCl}$ 6.3; humus – 2.96%; $P_2O_5$ and K2O 230 – 113 mg/kg soil, respectively). The yield of potatoes (a mixture of varieties: Zhukovsky – 33%, St – 34%, Ro-the mule – 33%), in 2011, when two-time processing of landings with Gamitana (1 at plant height 10 – 15 cm, 2nd- in the phase of Bud formation) was 23% higher than in the cultivation for zonal technology. Application Gamitana in the cultivation of potato varieties success in 2012 allowed us to obtain additional tuber yield of 5.7 t/ha. the Yield of potatoes at processing plants in the budding stage increased from 15.8 t/ha to 21.5 t/ha, or 36%, compared to the technology without the treatment.

In **farm "Brothers Fetisov" Duminichsky district** on soddy-podzolic soil during 3 years were carried out industrial tests on GUMITON impact on yield depending on the varietal characteristics of potatoes. The soil had the following agrochemical parameters: humus content – 2.15%; $pH_{KCl}$ 5.3; hydrolytic acidity – 1.98 mg-eq./100 g of soil; content of $P_2O_5$ – 183, $K_2O$ – 84 mg/kg of soil, respectively. Under identical agronomic conditions of cultivation of potatoes of different varieties of double treatment of vegetating plants with GUMITON in the dry conditions of 2010 led to the growth of tubers harvest in 14-21% in comparison with the farm technology (table. 11).

Application GUMITON increase potato yield varieties of Scarb and Wynetta by 4.0 t/ha, and the variety of Udacha – by 6.0 t/ha. Starch content in tubers during the processing of potatoes GUMITON increased from 17.5% to 19.1%, the nitrate content decreased.

**Table 11. GUMITON influence on the yield of potatoes of different varieties on soddy - podzolic soil (Duminichi district, Kaluga region), 2010**

| Variant of treatment | Variety Udacha | | Variety Winetta | | Variety Scarb | |
|---|---|---|---|---|---|---|
| | Yield of tubers, t/ha | Yield increase, t/ha | Yield of tubers, t/ha | Yield increase, t/ha | Yield of tubers, t/ha | Yield increase, t/ha |
| Control – farm technology | 28.0 | – | 29.0 | – | 21.0 | – |
| Control + 2 treatments GUMITON | 34.0 | +6.0 | 33.0 | +4.0 | 25.0 | +4.0 |
| $LSD_{05}$ | 2.9 | – | 3.2 | – | 3.9 | – |

Use GUMITON in the cultivation of potatoes on soddy-podzolic soil in 2011 allowed to get additional harvest of tubers up to 7.5 t/ha. GUMITON increased the yield of potato varieties: Coletta – 13% Wynetta – 18%, Gelly – 19.5%, respectively, compared with technology without treatment [15]. The yield of potato tubers, variety Bellaroza, and in 2012 when using GUMITON 17% higher than without treatment. Potato productivity, Gelly variety, increased by 26%.

The use of a new organo-mineral complex GUMITON is a highly effective method of increasing the yield of potatoes in the zonal technologies of cultivation on different soil types. The economic efficiency of GUMITON on the potatoes sort Udacha were calculated profit from sales of products obtained by the technology management and technology management with the use of GUMITON. Profit in the cultivation of potatoes in the technology sector was in 2013 prices 5 624 000 rubles/ha, and in the processing GUMITON – 23 360 000. The economic efficiency of GUMITON made 17 736 000 rubles/ha [13].

In fig. is given the efficacy of GUMITON in different crops in terms of yield increase and reduction of heavy metal content in agricultural products.

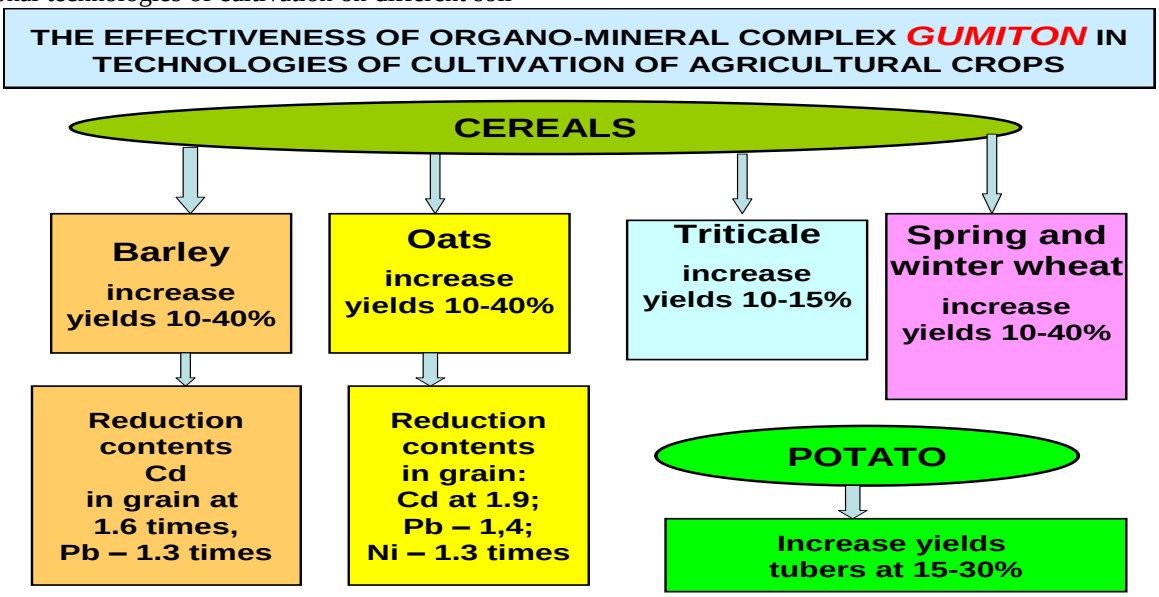


**Fig. Efficiency of application of organo-mineral complex GUMITON in technologies of cultivation of grain crops and potatoes**

## V. CONCLUSION

The use of a new organo-mineral complex GUMITON in the production of grain crops on the background of activities carried out on farms, increases the productivity of spring wheat – by 15-22%, winter wheat – by 17-40%, barley – by 19.5–23%, triticale – by 13-14%. The protein content in the grain of winter wheat when processing GUMITON increased on 0.5–2.1%; spring wheat – 2.1%, grain triticale - 0.9 to 1.3% compared to untreated crops. Collection of triticale protein (centner/ha) increased by 21-27%.

Use GUMITON is a highly efficient method of increase of productivity of potatoes in the zonal technologies of cultivation. It allows to increase the yield by 12-36% and to obtain an additional yield of potato tubers on floodplain soil – 5.7 t/ha, on soddy-podzolic soil – 2.5–9.8 t/ha; and on gray forest soil – from 3.7–10.0 t/ha, depending on the variety.

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