LIGNOHUMATE MAX on rice

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2. **Growth regulator presented for testing with rice**: Lignohumate potassium with microelements, liquid, Type MAX

3. **Test purpose**: arrangement of rice demonstration tests.

4. **Specimen** – rice of *Liman* Sort.

Liman is a variety of Italika Sort. Its origin is individual selection. It is included in the Selection Achievements State Register in 1986 in North Caucasian Region. The Sort is mid-season; its vegetative period is 105-110 days. Plant's height is 71-75 cm., it is lodged-stable and well-clustered. Its panicle is short (11-16 cm.), solid and slightly drooped. The number of spikelets in a panicle varies from 90 to 120. The caryopsis is rounded and its length/width ratio is 1.7-1.8. Its glassiness is 94-97%, its filminess is low and makes up 16-17%, the mass of 1000 grains is 27-30 gr. Cereals output is 71-72%, including the whole kernel – 69-82%, the cereals are white. Its crop capacity reaches 80-90 centners per hectare. Its sowing is carried out in a well-prepared soil. The seeding rate is 5-6 Mln. germinated seeds per hectare. The Sort reacts well on chemical fertilizers: nitrogen– 60-90 kg., phosphorus – 120 kg., potassium – 60 kg. per hectare. It bears flood well in the period of its bushing out and forming tubules. The Sort has increased stability to rice blast disease and nematode; it is easily thrashed and suitable for direct combining.

5. **Soil and climatic conditions**.

The Soil is meadow and black-earth; it is characterized with topsoil week compression. The topsoil volumetric weight is equal to 1.42 gr./cm^3, its value is increased with the depth (up to 1.51-1.56 gr./cm^3); The "A" horizon specific weight is equal to 2.75 gr./cm^3. The soil is characterized with humus high content in its plough-layer from 3.69 to 3.10 %; nitrogen gross content varies from 0.21 to 0.22 %, active phosphorus content is 3.12 – 3.40 mg/100 gr. of soil, active potassium 32.8 - 30 mg/100 gr. of soil. The plough-layer soil medium reaction is close to neutral (pH 6.46-7.76) being weakly alkaline.

The Climate. The Region for testing is in the 4th Zone with moderate humidity and 0.3 – 0.4 precipitation/evaporation ratio having 600-700 mm. precipitations annually. Winter is moderately mild with -3.5 – -1.5°C mean air temperature in January. Minimal temperatures can reach from -36 to -30 °C. Snow is unstable in 60-90%. Air temperature transfer over +5°C is registered in spring in the second half of March – at the beginning of April. Frost-free period in the most part of the territory is hot and the average monthly temperature in July is +22 - +24°C, and its maximum temperature can reach +38- +40°C. The precipitations are of short duration being mainly storm rain falls. There are 250-400 mm. precipitations falling during the active vegetation period. Soil moisture accumulation takes part mainly due to cold period precipitations. Warm period precipitations are spent mostly for evaporation.

Predominant winds are of eastern and western directions; the first have negative influence on the climate bringing cold air masses in winter and dry air masses in summer causing storms in separate years; the western winds soften the climate.

Weather conditions in the rice vegetation period (in 2010) were considerably different from the average long-term observation data.

Table 1 – Weather conditions during rice vegetation period (The Slavyanskiy Area)

Month	*Mean air temperature, °C*		*Precipitations, mm*		*Relative air humidity, %*	
	Average long-term	*Current year*	*Average long-term*	*Current year*	*Average long-term*	*Current year*
April	10.9	11.3	48	57.0	69	60
May	16.8	18.0	57	49.0	67	72
June	20.4	23.5	67	71.0	66	71
July	23.1	25.5	60	65.0	64	65
August	22.7	26.0	51	27.0	67	64
September	19.0	21	31	18.0	50	65

As it is seen (Table 1), the weather conditions during rice vegetation period were considerably different from the average long term conditions. In spite of the fact that its own microclimate is created in the rice system, high temperature at the blossoming period and later on in the ripening period (especially from the pollination moment to milky ripening) had a negative impact on transporting the assimilators to caryopsis (to filling capacities), thus increasing the percentage of sterile spikelets in panicles.

6. **Test plan and test procedure.**

Test plan:

– Control (basic technology);

– Lignohumate – seed processing (preparation consumption 1 l/t, working solution – 10 l/t) + plant processing (preparation consumption 0.8 l/hectare, working solution – 100 l/hectare).

The test was carried out in Anastasievskoye Joint Stock Company of the Slavyanskiy Area in its rice system. The tested area was as follows (two maps with 16 and 15 hectares, correspondingly, with Lignohumate and control variants).

The tested Object is the rice of *Liman* Sort.

Agricultural methods of rice cropping in the farm (basic technology) are as follows.

Under-winter ploughing at 20-25 cm. depth is made in autumn after rice harvesting. Winter tillage at 14-16 cm. depth is carried out in early spring (in the first decade of April with 28-32% soil humidity). To splice the soil lumps after ploughing, the soil disking is carried out at 5-7 cm. depth. The planning is made for leveling the rice field microrelief, topsoil decomposing and compressing. The chemical fertilizers (70 kg/hectare physical weight ammophos doze) are inserted into the soil by shovels.

The rice treated seeds (Vincent, Rycat Start) are sown in optimal terms (from April 25 to May 15) with 1-2 cm. depth of seeding and the seeding rate 5-7 Mln. pcs./hectare (~ 250 kg/hectare). The initial flooding is carried out not later than 1 – 2 days after sowing. The first additional fertilizing (150 kg/hectare physical weight carbamide doze) is carried out after one regular rice leaf appears. The rice chemical weeding takes place in 7-10 days having wasted water from paddy fields (using the *Nominee* herbicide). The second additional rice fertilizing (150 kg/hectare physical weight carbamide doze) is made in two (2) days. The rice infected with rice blast (in any form) is treated chemically (using fundozol).

The beginning of rice harvesting is determined by grain ripeness in panicles (with 85-90% ripe spikelets in a panicle). Direct or separate combining is used for harvesting. At a separate combining the cutting height of straight-standing rice is 15-20 cm. and the lodged rice is 5-8 cm. The rice thrashing is started in 3-5 days after mowing the rice down (at 15-16% grain humidity). Rice harvesting period should not exceed more than 18-20 days.

During the experiment the following parameters are determined within the vegetation period: rice standing density (according to germination and after harvesting – according to rice stubble); rice growth rates; crop structural analysis is made, crop capacity is determined in accordance with rice gross output from the areas and rice quality (1000 seeds mass, filminess, glassiness, fissuring).

The data are processed using the Variance Analysis Method developed by B.A. Dospekhov (1985).

7. **Research results and discussion**

Formation of highly-productive cereal crop sowing (including rice) requires the regulation of numerous factors determining high biological and, especially, economic yield. It is determined by three main components, namely:

- A number of productive stems in one plant;
- A number of spikelets in a panicle;
- A mass of 1000 grains.

Rice stem density standing is inseparably linked with the shoot forming process and optimal spikelet number formation.

Table 2 – Lingnohumate preparation influence on Rice stem density standing

Variant	*Rice stem density standing, pcs./m²*		*Plant loss %*
	over germination	*over rice stubble*	
Control (basic process)	273	252	7.7
Lignohumate	283	269	4.9
HCP_{05}	12.3	11.6	

As it is seen (Table 2), the differences of the rice stem density standing values are not considerable between the sprouts of the control and experimental variants (273 and 283 pcs./m^2, HCP_{05} – 12,3 pcs.). Rice crop thinning grows up at the vegetation end. This fact is connected with negative influence of different stress factors on the plants (high air and water temperature in paddy fields, long drought, etc.). Lignohumate's additional application (on seeds and plants) on the basic technology background reduces to some extent the negative action of the aforementioned stresses and raises plants' vital capacity. The percentage of loosing plants in the control variant was 7.7%, as for the variant with Lignohumate's application – 4.9%.

Rice stem density standing exerts significant influence on plants' height growth, as well as their shoot – and leaf formation.

Table 3 – Rates of rice plant growth depending on Lignohumate's application in cultivation technology (in bushing out phase)

Variant	*Plants' height, cm*	*Overground organ mass, gr./ plant*		*Dry substance %*
		wet	*Dry*	
Control (basic technology)	48.5	13.95	2.57	18.4
Lignohumate	53.4	16.64	3.16	19.0
HCP_{05}	1.8	0.54	0.10	

The data (Table 3) indicate the fact that the following changes take place in the Variant with the seeds and rice plants processed by Lignohumate (on the basic technology background): the growth of rice plants in height is more intensive (53.4 cm., in Control – 48.5 cm., HCP_{05} – 1,8 cm), the biomass is increased (16.64 gr., in Control – 13.95, HCP_{05} – 0.54 gr.) and the dry mass (3.16 and 2.57 gr., correspondingly, HCP_{05} – 0.10 gr.) of the overground organs.

The accumulation of dry substance, which is a function of assimilation process, determines plant's productivity. Dry mass absolute growth is increased proportionally to the leaf surface area; as a result the plant's assimilation capability increases as well.

The results of many researches show that the main condition of high yield achievement is a quick formation of photosynthetic system. The size and dynamics of leaf surface development are influenced by numerous factors: Sort peculiarities, bushing out character, nutrition mode, especially nitric, etc.

The application of Lignohumate in rice cultivation technology improves the nutritional mode, hence stimulates the leaf-formation process and increases vital capacity of leaves.

Table 4 – Influence of Lignohumate on assimilation capability (Bushing out phase)

Variant	*Number of leaves, pcs.*	*Length of leaves, cm*	*Width of leaves, cm*	*Surface area of leaves, cm^2/plant*
Control (basic technology)	6,3	23,8	0,7	77,1
Lignohumate	6,4	25,4	0,8	98,8
HCP_{05}	0,2	0,9	0,03	3,1

As it is seen from the data (Table 4), the action of the tested preparation becomes apparent to a greater extent in the leaf size. Average data of the leaf length and width in the experimental variant are 25.4 and 0.8 cm. and in the control one – 23.8 and 0.7 cm, correspondingly. Despite of the fact that no difference is registered in the number of the formed leaves (6.4 and 6.3 pcs., HCP_{05} – 0.2 cm.) at the sampling moment, there is a considerable difference in the leaf surface area values (98.8 cm^2 in the experimental variant and 77.1 cm^2 – in the control one, HCP_{05} – 3.1 cm^2).

Photosynthetic activity of the sown plants is the main factor determining crop formation. That is why it is very important to obtain in the crops not only an optimal leaf surface area, but also to have their optimal working productivity.

Table 5 – Influence of Lignohumate on photosynthetic activity of rice plants (Bushing out phase)

Variant	*Leaf working efficiency, gr./dc^2*	*Pigmentation, mg./gr. of raw substance*	
		chlorophylla + b	*carotene*
Control (basic technology)	3.3	2.78	0.86
Lignohumate	3.2	3.04	1.01

As the data show (Table 5), the photosynthetic processes go more actively in the Lignohumate variant, pigment content in the rice leaves is increased (chlorophyll a + b – 3.04 mg/gr. raw material, carotene – 1.01 mg; in the control variant – 2.78 and 0.86 mg/gr raw material, correspondingly). Some reduction of leaf working productivity (3.2 gr/dm^2 compared with 3.3 gr/dm^2 in the control variant) is connected with advanced tempos of leaf surface area growth over the mass growth tempos.

Crop formation is interconnected with the productivity processes and economic crop element formation, which separated elements are developed gradually in the ontogenesis process. The main elements of rice crop structure are bushiness, seed quantity and seed mass in a rice plant.

Table 6 – Lignohumate influence on forming rice crop structure elements

Variant	Plant height, cm.	Bushiness, pcs. stems/plants		Panicle average length, cm.	Seed quantity, pcs./plant		Mass, gr./plant		Ratio $M_з/M_c$
		General	Incl. productive		General	Incl. sterile spikelets	Seeds	Straw	
Control (basic technology)	92.5	3.2	3.0	14.7	323.3	49.2	7.82	9.00	0.87
Lignohumate	102.6	3.4	3.3	15.4	356.3	58.8	8.57	9.48	0.90
HCP_{05}	3.4	0.1	0.1	0.5	11.9	1.9	0.29	0.32	

Food mode improvement in the process of applying Lignohumate results not only in strengthening growth, but also forming processes. The data (Table 6) indicate the fact that the experimental variant values have overcome all the values under consideration of the control variant. Formation of bigger panicles, number of seeds and mass led to rice yield increase.

Table 7 – Lignohumate influence on rice yield

Variant	*Yield, centner/hectare*	*Increase in Control Variant*	
		centner/hectare	*%*
Control (basic technology)	76.7	-	-
Lignohumate	82.0	5.3	6.9
HCP_{05}	3.9		

As it is seen from the data (Table 7), the yield increase is up to 5.3 centner/hectare (crop capacity 82.0 centner/hectare, in control variant – 76.7 centner/hectare, HCP_{05} – 3.9 centner/hectare), when the Lignohumate preparation is applied with the seeds and plants (at the moment of chemical weeding – together with a herbicide).

One of the main tasks set before the scientists and practicing rice-growers is to increase the raw rice quality.

Table 8 – Raw rice quality depending on Lignohumate application

Variant	*Mass of 1000 seeds, gr.*	*Filminess , %*	*Glassiness, %*	*Fissuring, %*
Control (basic technology)	28.2	16.2	95.0	5.8
Lignohumate	28.8	16.0	96.0	5.5
HCP_{05}	1.0			

Technological parameters of the raw rice quality are as follows: mass of 1000 seeds, filminess, glassiness, fissuring. Rice cereal output depends considerably on the values of those parameters. As a rule, the bigger the seeds are (mass of 1000 seeds), the lower is the filminess percentage and the bigger the rice cereal output is. The rice seed kernels having fissured nuclei reduce the outcome of the whole rice seeds kernels and it depends considerably on seed consistency (glassiness)

The data (Table 8) indicate that the good quality seeds were obtained both in the control variant (basic technology) and in the Lignohumate variant.

8. Conclusion

– Application of the Lignohumate preparation in rice cultivation technology (with seeds and plants) raises the plant survival percentage.

– Processing rice grains and plants with the Lignohumate preparation intensifies growth and formation processes.

– when the Lignohumate preparation is applied, it increases panicle grain quantity and rice grain mass of a plant allowing to obtain higher rice crops with good quality (increase by 5.3 centner/hectare)