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Efficiency of Application of Liquid Fertilizer Gumavit When Sprouting Seeds

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Abstract

The object of this study was Gumavit, a liquid humic fertilizer based on peat. This fertilizer is obtained by cavitation dispergation of peat in a shock pulse generator and subsequent alkaline extraction from a water-peat mixture of humic acids. This study examined the effect of Gumavit on the germination energy and germination capacity of barley seeds, wheat and tomatoes, as well as its effect on plant growth and development. It was found that Gumavit did not adversely affect the germination energy and germination capacity of seeds of grain crops and tomatoes. The use of a 0.2% (of humic acids - HA) Gumavit solution had a positive effect on the sowing quality of the studied cultures' seeds. The use of a 0.01% (of HA) solution of Gumavit to moisten sand and germinate seeds after 14 days had a positive effect on the length and mass of Favorit wheat grain sprouts; as well as a positive effect on the root mass of Favorit and Kamyshanka-3 wheat, Volgogradskii-12 barley, Volgogradskii 5/95 tomatoes and Dar Zavolzhia tomatoes. The increase in the root mass of the studied cultures can be explained by the absorption of a small fraction of humic substances by the roots of these plants, leading to an increase in the number of lateral roots and their root hairs.

Keywords: Gumavit, seed treatment, germination energy, germination capacity, grain crops, tomatoes, moistening sand, length and mass of sprouts.

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1. Introduction

The current level of development of agriculture and food production is, first of all, the broad development and practical application of the concept of organic farming. Organic agriculture provides for such a form of land management in which the land user deliberately minimizes the use of synthetic fertilizers and growth regulators, pesticides and feed additives [1]. Developing this trend in modern agriculture, the agrarians today rely on a wide range of applications of various physical effects that stimulate seeds

before sowing [2], affect the growth and development of plants [3], help to harvest a high-quality crop [4], improve the ecology of places of cultivation [5] and at the same time minimize the use or completely abandon application of pesticides, growth stimulants of artificial origin and other components like that.

An important component of organic farming is also the use of humic fertilizers and preparations, which are catalysts for the occurrence of natural biochemical processes in the soil [6]. Humic fertilizers and preparations have a positive effect on the soil and its structure [7], are able to be effectively absorbed by plants [8]. The introduction of humic fertilizers into the soil leads to an increase in its microbiological activity, both directly in the year of use and in the years following application [7].

The use of humic fertilizers can increase the yield of grain, fodder, industrial and vegetable crops, on average, by 10-30% and increase seed germination capacity, seedling vigor and uniformity of their germination [9].

Currently, the production capacities of fertilizer factories both in Russia and in a number of foreign countries are redirecting their attention to the production of biostimulants based on humic substances and similar organic compounds. One of the options for the production of humic preparations is liquid humic fertilizers based on peat, the composition and properties of which vary depending not only on the source of humic raw materials (peat, coal, etc.), but also on the characteristics of the deposit and the technology for producing humic products from organic raw materials [10].

Technologies for the production of humic fertilizers based on the alkaline extraction of humic substances from peat with their subsequent extraction and purification are widely known and are often used in production [11].

In the process of handling peat during the production of liquid humic preparations, the most significant process is the activation of peat [12], which can cause and/or enhance various biological, physical or chemical processes due to cavitation [13]. A promising method for the activation of peat for its chemical modification is cavitation treatment in an aqueous medium in cavitation apparatus [7]. In the process of cavitation dispergation, several processes occur simultaneously: grinding of peat particles, diffusion, dissolution of humic substances and their washing out into solution [11].

At present, several methods of cavitation treatment of biological objects in the aqueous environment are known, i.e. ultrasonic [11-15], hydrodynamic [11-16], electrohydraulic [17-19] methods.

One of the new ways of activating peat is the shock pulse method, which is based on highly efficient (almost stoichiometric) burning of natural gas over a water-peat mixture.

With this method of formation of cavitation phenomena, the shock energy of the gas-air mixture is directly transferred to the treated water-peat solution, which causes its mechanical deformation with the occurrence of intense cavitation in the volume of the mixture. In the experimental setup of a shock pulse generator, the power of action on the water-peat mixture reaches 70 W/cm2. The study of the effect of Gumavit liquid humic fertilizer based on peat, obtained by the above method on seeds of agricultural crops should be considered a very urgent and timely task, the solution of which will justify the rationality and standards for the use of this fertilizer in agriculture.

The purpose of the study is to investigate the effect of Gumavit liquid fertilizer on the germination energy, germination capacity and biometric parameters of seedlings of barley, wheat and tomatoes in a laboratory experiment.

2. Methods and Equipment

2.1. Methods

Research was carried out in 2018 in the conditions of the production laboratory of Radiotekhnika LLC (Moscow). The material used for the study was seeds of the following varieties of plants, cultivated in agriculture: Favorit spring wheat, Kamyshanka-3 winter wheat, Volgogradskii-12 spring barley, tomatoes Volgogradskii 5/95 and Dar Zavolzhia.

Peat from the the Klepikovsky district of the Ryazan region, settlements of Bolon, Makeevskii mys, was taken as the raw material for the production of Gumavit. To prepare the solutions to treat the seeds of the plants and moisten the sand, Gumavit of the following chemical composition was used: humic acids 20 g/l, nitrogen total 2.0 g/l, potassium 12 g/l (K2O), phosphorus 15g/l (P2O5).

To determine the germination energy and germination capacity of grains and tomatoes, four groups were formed with the seeds of these plants: one control and three experimental groups, in each of which four batches of seeds of 100 pieces were selected. The arithmetic mean of the results in the experiments was taken as the final result of the research.

The analysis of germination capacity and germination energy of barley, wheat, and tomato seeds was carried out in accordance with GOST 12038-84. Barley and wheat grains were germinated in Petri dishes, placing them between layers of filter paper at a temperature of + 20 ° C, in the dark, the value of germination energy was determined on the 3rd day, of germination capacity - on the 7th day.

Tomato seeds were also germinated in Petri dishes, placing them between layers of filter paper at a temperature of + 25 ° C, in the dark, the value of tomato germination energy was determined on the 5th day, of germination capacity - on the 10th day.

To determine the effect of Gumavit on the germination energy and germination capacity of the above crops, their seeds were moistened with a Gumavit solution (of humic acids (HA)) according to the 1: 1 scheme): control - seed treatment with tap water; 2) 1-experimental group - Gumavit 0.4% (of HA); 3) 2-experimental group - Gumavit 0.2% (of HA); 4) 3-experimental group - Gumavit 0.02% (of HA).

Sprouted grain seeds on the 4th day, and tomato seeds after 10 days were planted in sand, specially prepared for this in accordance with GOST 12038-84.

Due to the fact that humic substances have a stimulating effect on the treated plants at low concentrations (0.1-0.001%), but at higher concentrations an inhibitory effect is manifested, the sand was moistened according to the 2: 1 scheme) control - the sand was moistened with tap water; 2) 1-experimental group - the sand was moistened with Gumavit 0.1% (of HA); 3) 2-experimental group - the sand was moistened with Gumavit 0.01% (of HA); 4) 3-experimental group - the sand was moistened with Gumavit 0.001% (of HA).

The influence of Gumavit on barley, wheat and tomato plants obtained from germinated seeds was revealed after germinating them in sand for 14 days. The plants were kept in sand at room temperature (+22°C), and periodically (as the sand was drying out), it was moistened with Gumavit solutions. After this, the plants were removed from the sand, washed with tap water, and the length and mass of parts of the plants (roots, sprouts) were measured. The fresh mass of parts of plants (roots, sprouts) of wheat, barley, and tomatoes was determined by weighing on an analytical balance.

3. Results

In the experimental groups of Favorit wheat seeds, the highest indices in terms of the germination energy of 80% and the germination capacity of 84% were observed in the 2-experimental group (0.2% of HA), and the smallest - in the 1-experimental group (0.4% of HA). Germination energy and germination capacity in the 2-experimental group were higher than in the control group by 40 and 21%, respectively.

The germination energy and germination capacity of seeds of wheat variety Kamyshanka-3 in the experimental groups was higher than in the control. The maximum germination energy and germination rate was also noted when treating seeds with a solution (0.2% of HA), 62 and 65% respectively, and the values of these indicators were

Table 1: Effect of Gumavit on the germination energy and germination of seeds of grain crops

Group	Concentration of humic acids	Сорт					
		wheat Favorit		wheat Kamyshanka-3		barley Volgogranskii-12	
		germination energy, %	germination capacity, %	germination energy, %	germination capacity, %	germination energy, %	germination capacity, %
Control	tap water	57	69	48	57	71	83
1-Experimental	0.4%	36	42	51	59	91	92
2-Experimental	0.2%	80	84	62	65	95	96
3-Experimental	0.02%	71	80	52	59	73	87
X avg.		61.0	68.8	53.3	60.0	82.5	89.5
V, %		31.4	27.5	11.4	5.8	14.9	6.4

higher than in the control group by 29 and 14%. The lowest value of the germination energy of seeds of wheat of the Kamyshanka-3 variety was noted in the 1st experimental group, however, this indicator was higher than in the control group by 8%.

Volgogradskii-12 barley seeds also responded well to the use of Gumavit, showing a high germination energy and germination capacity in all experimental groups. The maximum germination energy of 95% and the germination capacity 96% of barley were obtained in the 2-experimental group, where the seeds were treated with Gumavit (0.2% of HA). The values of these indicators were higher than in the control group by 33 and 15%, respectively. In the 1st and 3rd experimental groups, the germination energy and germination capacity of seeds were lower than in the 2nd experimental group, but higher than in the control group. The results of these studies are presented in table 1.

Under the conditions of the experiment, the degree of variation in the values of the germination energy and germination capacity of the Favorit wheat variety was significant (31.4 and 27.5%), other indicators varied in the medium (11.4 and 14.9%) and insignificant (5.8 and 6.4%) degree.

Simultaneously, experiments were conducted to determine the effectiveness of Gumavit on the germination of tomato seeds of Volgogradskii 5/95 and Dar Zavolzhia varieties. The research results are shown in table 2.

The maximum germination energy (55%) and germination capacity (93%) of Volgogradsky 5/95 tomato seeds were observed in the second experimental group, where Gumavit (0.2% of HA) was used; these indicators were higher than in the control group by 66.6 and 13% respectively. In the 1st experimental group, the germination energy (49%) and germination capacity (91%) of the seeds were lower compared to the 2nd

Table 2: Effect of Gumavit on the germination energy and germination capacity of tomato seeds

Group	Concentration of humic acids	Variety			
		Volgogradskii 5/95		Dar Zavolzhia	
		Germination energy, %	Germination capacity, %	Germination energy, %	Germination energy, %
Control	tap water	33	82	60	83
1-Experimental	0.4%	49	91	61	86
2-Experimental	0.2%	55	93	62	89
3-Experimental	0.02%	30	88	61	85
X avg.		42	89	61	86
V, %		29.1	5.4	1.3	2.9

experimental group by 18.6 and 2% respectively, but higher than in the control. In the 3-experimental group, the germination energy was lower than in the control variant by 9%.

As it can be seen in table 2, when using Gumavit (0.2% of HA), tomato seeds of the Dar Zavolzhia variety in the 2-experimental group had higher germination energy (62%) and germination capacity (89%) than in the control group by 3% and 7%, respectively. However, these indicators in the experimental groups for tomato seeds Dar Zavolzhia practically did not differ from similar indicators of the control group. The germination energy and germination capacity of tomato seeds of the Volgogradskii 5/95 variety were lower than that of the Dar Zavolzhia variety, however, these indicators in the experimental groups were significantly different from those in the control group. In the experiment with tomatoes, a strong degree of variation of the trait (germination energy) was noted for the variety Volgogradskii 5/95 (29.1%), in other indicators the degree of variation was insignificant (1.3-5.4%).

The results of studies on the formation of sprouts in the sand indicate that the length and mass of the roots, as well as the shoots of the Favorit wheat variety in the 2-experimental group were higher than in the control group by 44 and 54%, and also by 5% by 24% respectively. In the 1-experimental group, all indicators were higher than in the control and 3-experimental group, but less than in the 2-experimental group. All parameters of wheat of the Favorit variety in the 3rd experimental group were minimal (table 3).

The data in Table 3 indicate that the shoot length changed to a very small extent (7.5%) due to a change in the concentration of Gumavit for the Favorit cultivar, the remaining indicators varied significantly (21.6-24%).

Table 3: Effect of Gumavit on the length and mass of Favorite wheat sprouts

Group	Concentration of humic acids	Root length, m	Root mass, g	Shoot length, m	Shoot mass, g
Control	Tap water	0.204	0.0779	0.246	0.1802
1-Experimental	0.1%	0.284	0.1005	0.240	0.2176
2-Experimental	0.01%	0.294	0.1200	0.259	0.2245
3-Experimental	0.001%	0.193	0.0714	0.216	0.1356
X avg.		0.24	0.09	0.24	0.19
V, %		21.6	24.0	7.5	21.6

Table 4: Effect of Gumavit on the length and mass of sprouts of wheat variety Kamyshanka-3

Group	Concentration of humic acids	Length of roots, g	Weight of roots, g	Length of shoot, m	Weight of shoot, g
Control	Tap water	0.195	0.0753	0.273	0.1288
1-Experimental	0.1%	0.145	0.0666	0.261	0.1216
2-Experimental	0.01%	0.216	0.1034	0.267	0.1363
3-Experimental	0.001%	0.144	0.0735	0.262	0.1162
X avg.		0.18	0.08	0.27	0.13
V, %		20.7	20.4	2.1	6.9

From the analysis of the data of table 4 we see that the length and mass of the roots of wheat variety Kamyshanka-3 in the 2-experimental group was greater than in the control by 11 and 37%, respectively. The shoot length in all experimental groups remained virtually unchanged, but was less than in the control. The mass of the shoot in the 2-experimental group was 6% more than in the control group and it was also greater than in the 1- and 3-experimental groups. The root length in 1- and 3-experimental groups was lower than in the control, by 17 and 16%, respectively.

A distinctive feature of the Kamyshanka-3 variety was that a change in the concentration of Gumavit strongly influenced the development of the root system and had practically no effect on the shoots. As can be seen from the data presented in table 5, in the 2-experimental group, where Gumavit was used (0.01% of HA), the length and mass of the roots of barley of Volgogradskii-12 variety was 25 and 29% more than in the control group, respectively, but the length of the shoot and its mass was less than in the control group by 6 and 12%, but more than in the 1- and 3-experimental groups. Root length and mass in all experimental groups was greater than in the control, and that of the shoots in all experimental groups was less than in the control.

The results of studies on the germination of tomato variety Volgogradsky 5/95 in the sand are shown in table 6.

Table 5: Effect of Gumavit on the length and mass of barley shoots

Group	Concentration of humic acids	Barley Volgogradskii-12 variety			
		Root length, m	Root mass, g	Shoot length, m	WShoot mass, g
Control	Tap water	0.196	0.0956	0.289	0.3364
1-Experimental	0.1%	0.233	0.1175	0.249	0.2779
2-Experimental	0.01%	0.245	0.1234	0.271	0.2968
3-Experimental	0.001%	0.224	0.1152	0.257	0.2922
X avg.		0.22	0.11	0.27	0.30
V, %		9.3	10.7	6.6	8.3

Table 6: Effect of Gumavit on the length and mass of tomato roots and shoots

Group	Concentration of humic acids	Tomato Volgogradskii 5/95 variety			
		Root length, m	Root mass, g	Shoot length, m	Shoot mass, g
Control	Tap water	0.39	0.0827	0.37	0.1991
1-Experimental	0.1%	0.38	0.0873	0.37	0.1972
2-experimental	0.01%	0.39	0.1109	0.40	0.2238
3-Experimental	0.001%	0.40	0.0936	0.38	0.1985
X avg.		0.39	0.09	0.38	0.20
V, %		2.1	13.2	3.7	6.3

The data in the table indicate that root length of tomato Volgogradskii 5/95 variety practically did not differ from each other in all groups, and their mass in the 2-experimental group was greater than in the control group by 34%, and by 5 and 13% more than in 1- and 3-experimental groups. Shoot length of Volgogradskii 5/95 tomato also insignificantly differed from each other in all groups (experimental and control), but shoot mass in the 2-experimental group was higher than in the control group by 12.4%.

The results of research on the germination of tomato Dar Zavolzhia are shown in table 7.

Tomato Dar Zavolzhia responded to the use of Gumavit by the fact that root and shoot mass in the 2-experimental group were 28% and 19% more than in the control group, respectively, root and shoot length were at the level of the control group. Root length and mass of in the 1- and 3- experimental groups changed insignificantly in relation to the control group.

The treatment of Favorit wheat seeds with Gumavit (0.2% of HA) had a positive effect on germination energy and germination capacity. At the same time, when treating them with Gumavit with a concentration of humic acids of 0.02%, the result obtained practically

Table 7: Effect of Gumavit on the length and mass of tomato roots and shoots

Group	Concentration of humic acids	Tomato dar Zavolzhia variety			
		Root length, m	Root mass, g	Shoot length, m	Shoot mass, g
Control	Tap water	0.48	0.0951	0.48	0.1836
1-Experimental	0.1%	0.48	0.0909	0.47	0.1898
2-experimental	0.01%	0.42	0.1222	0.45	0.2192
3-experimental	0.001%	0.47	0.0961	0.48	0.1985
X avg.		0.46	0.10	0.47	0.20
V, %		6.2	14.1	3.0	7.9

did not differ from the results in the control group. When using Gumavit (0.4% of HA), lower results were obtained than in the control group.

4. Discussion

The treatment of Kamyshanka-3 wheat seeds with Gumavit (0.2% of HA) had a positive effect on germination energy and germination capacity, the treatment of seeds with Gumavit (0.02% of HA) had almost the same effect. In all experimental groups, indicators of germination energy and germination capacity were higher than in the control.

The treatment of Volgogradsky-12 barley seeds with Gumavit (0.2% of HA) had a positive effect on their germination energy and germination capacity, and when using Gumavit (0.4 and 0.02% of HA), the germination and germination energy was obtained at the level of the control group.

When treating Volgogradskii 5/95 tomato seeds with Gumavit (0.2% of HA), an increase in germination energy and germination capacity was observed. Dar Zavolzhia tomato did not respond to the use of Gumavit with various concentrations of humic acids.

When germinating cereals and tomatoes for 14 days in sand moistened with Gumavit, according to Scheme 2, the seeds of these crops responded differently to its use.

Favorit wheat sprouts planted in sand moistened with Gumavit (0.01% of HA) were distinguished by a greater length and mass than in the control group.

When the sand was humidified with Gumavit (0.01% of HA), the Kamyshanka-3 wheat variety reacted positively with root mass and length, while shoot length and mass were at the level of the control group.

The roots of barley of the Volgogradskii-12 variety, when sand was moistened with Gumavit (0.01% of HA), differed in mass and length more than in the control group, but shoot length and mass of these plants was less than in the control group.

For Volgogradskii 5/95 tomato cultivated in sand moistened with Gumavit (0.01% of HA), root length was at the level of the control group, but root mass was greater than in the control group. Shoot length and mass varied similarly.

Tomato Dar Zavolzhia, when the sand was wetted with Gumavit (0.01% of HA), had lesser length of roots and shoots, but their mass was greater than in the control group.

The positive effects are explained by the influence of humic substances on the physiological and metabolic processes in plants. The addition of humic substances stimulates the absorption of nutrients, cell permeability and, apparently, regulates the mechanisms involved in stimulating plant growth. Under certain conditions, humic substances can stimulate plant growth in terms of increasing plant length and their dry or fresh mass. These effects, apparently, depend on the concentration and source of humic substance on plant species, and age, as well as on cultivation conditions [8].

Many studies confirm the hypothesis of a direct effect of humic substances on plant physiology, in particular with respect to the formation of root hairs and the development of lateral roots [8]. Presumably, the mass of the roots increased due to the formation of lateral roots and root hairs.

5. Conclusion

On the example of barley of the Volgogradskii-12 variety, wheat of the varieties Kamyshanka-3, Favorit, it was experimentally established that the moistening seeds in Gumavit (0.2% of HA) before germination had a positive effect on their germination energy and germination capacity. Further germination of barley and wheat seeds in the sand showed that the use of Gumavit (0.01% of HA) for wetting the sand positively affected the growth and mass of plant roots.

The treatment with Gumavit (0.2% of HA) of tomato seeds of the Dar Zavolzhia and Volgogradskii 5/95 varieties also positively affected their germination energy and germination capacity. Wetting the sand, in which tomato plants were sprouted, with Gumavit (0.01% of HA), had a positive effect on the growth and mass of the roots, and the formation of plant mass in the first fourteen days of sprouting.

Gumavit liquid humic fertilizer based on peat, obtained by cavitation dispergation of peat in a shock pulse generator and subsequent alkaline extraction from a water-peat mixture of humic acids, did not adversely affect the seeds treated with it.

Sprouted seeds of the above-described varieties, planted in the sand moistened with Gumavit, reacted positively to the use of this fertilizer for fourteen days. However, further study of the influence of Gumavit on crops is required.

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Conflict of Interest

The authors have no conflict of interest to declare.

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