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RESEARCH REPORT

“BIO-GEL biological effect on buckwheat and millet crops”

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SUMMARY

Object of study. Formation of buckwheat and millet productivity potential depending on doses and periods of applying BIO-GEL.

Subject of study. “Omriyane” millet variety, “SIN 3/02” buckwheat variety, BIO-GEL preparation, crop yields.

Research methods. The research has been based on scientific and special research methods: *field methods* – studying the effect of the preparation and weather conditions on the object of study; *laboratory methods* – crop yields estimation; *statistical methods: variance analysis* – determining the reliability of the experimental data.

Purpose of study. Establishing the BIO-GEL preparation effectiveness on buckwheat and millet crops.

Conditions of study. The biological effect of the preparation has been studied on buckwheat and millet crops in the northern forest-steppe (Chabany, Kiev Region) on gray forest loamy soils. Millet predecessor was winter wheat; buckwheat predecessor was spring barley. The cultivation technology was standard for organic agriculture in the forest-steppe zone, except for the elements under study.

Results of study.

1. It has been established that under 2015 weather conditions BIO-GEL preparation proved most effective when used once for spraying vegetating millet plants in tillering stage, the dose being 1.0 l/ha. The yield proved to be the highest and amounted to 5.70 t/ha, the yield increase being 28.1% compared to the untreated crops.

2. Millet seeds treatment with BIO-GEL proved ineffective. The yield did not differ from the control (untreated seeds) and varied within 3.58 – 3.60 t/ha depending on the preparation dose.

3. BIO-GEL application to buckwheat crops appeared most effective in the form of spraying in the flowering stage, the dose being 1.0 – 1.5 l/ha. This ensured the crop yield of 2.13 – 2.15 t/ha, the yield increase being 31.0 – 31.6% compared to the untreated crops.

***Key words**: millet, buckwheat, micro-fertilizer, organics, humic substances, BIO-GEL, natural adaptogen, phase of growth and development, organogenesis stage, seeds treatment, plants treatment, yield.*

INTRODUCTION

Buckwheat and millet are crops with short vegetation period which amounts to 75-80 days for early and mid-ripening varieties. This period includes the whole cycle of a plant individual development consisting of 9 phenological stages and 12 organogenesis stages. Sequence and dynamics of physiological and morphological changes in plants specify scientifically substantiated approaches to optimal conditions for applying such agricultural methods that would promote the plants development.

Among methods aimed at higher yields and better grain quality of primary importance is fertilization. By no chance it is the basic condition of the whole technological process irrespective of soil characteristics and cultivation area. The negative effects of natural and anthropogenic factors are mitigated by timely and optimal provision of plants with nutrients.

As buckwheat and millet development stages differ, the application of fertilizers should be different too due to, first, their belonging to different species and, second, their different needs at different stages of development. These species differ not only in their ability to absorb nutrients but in the reaction to certain nutrients.

To ensure millet and buckwheat better provision with nutritive elements, water soluble fertilizers are applied additionally during their vegetation periods. This is most effective in sufficient moisture areas on sandy or loamy soils as well as when no basic or row fertilization is provided.

The application of nitrogen, phosphorous and potassium fertilizers with no microfertilizers added often prove ineffective as they do not compensate for the lack of trace elements, especially in sandy and sandy-loam soils. That is why in order to get high and quality yields, basic fertilization is to be accompanied by trace elements application. Experiments show that cereals need such trace elements as boron, copper, molybdenum, zinc and manganese.

Recently attention has been drawn to such long forgotten fertilizers as humates, which is due to the growing interest in organic farming.

Scientists started considering these problems in the late 40-ies early 50-ies of the XX century. In 1947 L.A. Khristeva proved that physiologically active substances in humic acids contribute to better assimilation of mineral elements, especially when application rate is insufficient. Humic acids appeared to be effective with both nitrogen overdose and phosphorous deficiency [1].

Besides, studies have been carried out of humic substances physiological effect on the restoration of plants affected with pesticides. For example, according to A.G. Azanov et al (1973) the degree of plant inhibition with Granozan herbicide of various concentrations is decreased many times if it is applied together with sodium humate. Also there is evidence confirming the positive effect of such preparations when they accompany fungicides and insecticides application.

Studies have also been carried out of plant resistance under adverse weather conditions, namely, with the deficit of moisture in soil, high temperatures, nutrients shortage in the fertilizer system, soil solution reaction, etc. Generally, humic compounds can be considered as natural plant adaptogens to unfavorable environment conditions.

On the basis of these studies we can conclude that the greater are the environment factors deviations from the optimal characteristics, the more significant is the humate physiological effect. Due to this, humate effectiveness should be studied on separate crops in order to determine the preparation doses and periods of application as well as its compatibility with preparations of other chemical nature.

At the same time, we should underline humic substances special effectiveness in organic farming. Nourishing nitrogen fixing bacteria with humic compounds stimulates substantially their development, which makes it possible to decrease chemical load on fertile soil due to giving up nitrogen fertilizers in the first place.

Organic farming permits the use of sodium, potassium, iron, etc humates obtained by chemical reactions. In our opinion, such contradiction between organic farming and chemical ways of making humates can be explained only by the absence of non-chemically obtained humates on the market. Because of this, studying the BIO-GEL bacterial microflora biostimulant is of interest. It is produced from peat and sapropel of organic origin using high pressure and low temperatures but no chemical additives.

Under processing, as a result of organic hydrolysis, a part of natural material turns into available forms of humates and lignin. Natural microelements (Fe, Mg, B, Mn, etc) become more available, which increases substantially the efficiency of humic and lignin compounds.

In the course of processing due to the oxidation by oxygen in the air a great part of humic compounds turns into fulvic acids or fulvates which promote the diffusion of beneficial substances through plant cell membranes. The field studies carried out on melons [4] testified convincingly to the BIO-GEL advantages over chemically produced potassium and sodium humates. Thus, the amount of useful microflora increased 1.6-1.7 times compared to untreated soils. The intensity of soil bacteria increase was determined by measuring the quantity of carbon dioxide produced by bacteria per square meter.

Appendix 1 [5] contains the main quality and safety characteristics of the BIO-GEL organic humic compound.

SECTION 1

RESEARCH METHODS AND CONDITIONS

1.1 Research scheme and methods

Field experiments with buckwheat and millet have been carried out at the Intensive technology department, Institute of Agriculture, NAAS, in Kiev Region belonging to the northern part of Ukrainian forest-steppe area. The experiments have been conducted according to the scheme given in tables 1.1 and 1.2.

Table 1.1 Scheme of experiment on studying the effect of BIO-GEL on buckwheat crops

Variant №	Period of treatment with BIO-GEL	BIO-GEL dose, l/ha
1	Spraying vegetating plants at the stage of two true leaves	No treatment (control)
2		Treatment with distilled water
3		BIO-GEL treatment , 0.5 l/ha at the stage start + 0.5 l/ha at the full stage
4		BIO-GEL treatment, 1.0 l/ha
5		BIO-GEL treatment, 1.5 l/ha
6	Spraying vegetating plants at the stage of budding	No treatment (control)
7		Treatment with distilled water
8		BIO-GEL treatment, 0.5 l/ha at the stage start + 0.5 l/ha at the full stage
9		BIO-GEL treatment, 1.0 l/ha
10		BIO-GEL treatment, 1.5 l/ha
11	Spraying vegetating plants at the flowering stage	No treatment (control)
12		Treatment with distilled water
13		BIO-GEL treatment, 0.5 l/ha at the stage start + 0.5 l/ha at the full stage
14		BIO-GEL treatment, 1.0 l/ha
15		BIO-GEL treatment, 1.5 l/ha

The experimental plot has gray forest loamy soil with the following fertility characteristics: humus content – 1.15-1.20% nitrogen which is easily hydrolyzed – 7.5-8.6 mg/100 g soil, movable phosphorous and metabolic potassium – 11.4-13.7 and 10.3-12.1 mg/100 g soil, respectively, pH – 5.3.

Table 1.2 Scheme of experiment on studying the effect of BIO-GEL on millet crops

Variant №	Period of treatment with BIO-GEL	Preparation dose, l/ha
1	Seed treatment	No treatment (control)
2		Treatment with distilled water
3		BIO-GEL treatment, 0.5 l/ha
4		BIO-GEL treatment, 1.0 l/ha
5		BIO-GEL treatment, 1.5 l/ha
6	Spraying vegetating plants at the tillering stage	No treatment (control)
7		Treatment with distilled water
8		BIO-GEL treatment, 0.5 l/ha at the stage start + 0.5 l/ha at the full stage
9		BIO-GEL treatment, 1.0 l/ha
10		BIO-GEL treatment, 1.5 l/ha
11	Spraying vegetating plants at the shooting stage	No treatment (control)
12		Treatment with distilled water
13		HGUMATE-GEL treatment, 0.5 l/ha at the stage start + 0.5 l/ha at the full stage
14		BIO-GEL treatment, 1.0 l/ha
15		BIO-GEL treatment, 1.5 l/ha
16	Spraying vegetating plants at the panicle stage	No treatment (control)
17		Treatment with distilled water
18		BIO-GEL treatment, 0.5 l/ha at the stage start + 0.5 l/ha at the full stage
19		BIO-GEL treatment, 1.0 l/ha
20		BIO-GEL treatment, 1.5 l/ha
21	Spraying vegetating plants at the flowering – grain ripening stage	No treatment (control)
22		Treatment with distilled water
23		BIO-GEL treatment, 0.5 l/ha at the stage start + 0.5 l/ha at the full stage
24		BIO-GEL treatment, 1.0 l/ha
25		BIO-GEL treatment, 1.5 l/ha

Millet predecessor was winter wheat; buckwheat predecessor was spring barley. The cultivation technology was standard for organic agriculture in the forest-steppe zone, except for the elements under study. Buckwheat was sown on April, 27, while millet was sown on May, 10 when the soil temperature at the seeding depth was optimal.

The BIO-GEL research object has been provided by TEKMASH Institute in order to study its effect on millet (“Omriyane” variety) and buckwheat (“SIN 3/02” variety) yields. The experimental plot area was 12 m^2, accounting area was 10 m^2, the experiment was repeated three times, the method of the experiment laying was consistent with a shift. The number of variants in studying the BIO-GEL effect was 25 with millet and 15 with buckwheat; the number of plots was 75 and 45, respectively.

1.2 Weather conditions during millet and buckwheat vegetation periods in 2015

In 2015 the vegetation period differed from long-term characteristics both in temperature rate and in rainfalls: the duration of the hot period was quite long and there were very few rainfalls starting from the sowing and up to the harvesting. Temperature rise was rather intensive starting from April. From April through August the rainfall amounted to only 107.4 mm.

Higher temperature in late April was favorable to millet and buckwheat early sowing. The rainfall did not exceed 5.6 mm, which resulted in 43.4 mm moisture deficit. Hot weather and no substantial rainfalls in the second and third ten-day periods caused soil moisture reduction.

Daily average temperatures in May which exceeded the norm (+14.9°C) by 1.2°C and sufficient rainfall (86.2%) contributed to the active emergence of seedlings, their growth and development.

In June daily average temperatures exceeded the norm (+17.9°C) by 2.9°C, the rainfall amount was only 13.4% of the norm (9.8 mm). Such hot weather, especially during the first ten-day period (+21.5°C as against +16.8°C average long-term rate) and the second ten-day period (+21.2°C as against +17.8°C average long-term rate) accompanied by insufficient rainfalls coincided with millet tillering and shooting stages. Under such conditions the plants could not increase vegetative mass. Hydrothermic coefficient (HTC) at the shooting stage was = 0.

In July daily average temperature was +19.0°C (about the norm), while the rainfalls were 44.5% of the norm (88 mm), which reduced the duration of interphase periods.

August was also hot and dry, the rainfall amounted to just 8.0 mm, which is by 61.0 mm less than monthly average norm.

Table 1.3 Weather conditions during buckwheat and millet vegetation periods in 2015

Ten-day period	Temperature, t			Norm	Rainfalls, mm		Norm percentage,%	Relative humidity,%	
	average	max	min		Real	rate		real	Min
April									
I	5.3	18.3	-1.1	7.2	1.2	15.0	8	63	49
II	9.5	20.6	2.8	8.2	4.2	19.0	22.1	73	32
III	13.1	24.4	4.1	10.8	0.2	15.0	1.3	57	21
Per month	9.3	21.01	1.9	8.3	5.6	49.0	11.4	64.3	34
May									
I	13.6	18.2	9.2	13.7	21.0	17.0	123.5	66	45
II	14.9	20.6	9.1	15.7	14.8	13.0	113.8	61.4	39.2
III	19.8	25.3	14.9	15.9	9.0	22.0	40.9	63.1	44.0
Per month	16.1	21.3	11.0	14.9	44.8	52.0	86.2	63.5	42.7
June									
I	21.5	27.0	15.9	16.8	0	23.0	0	51.1	34.5
II	21.2	25.8	16.4	17.8	0	24.0	0	54.4	38.3
III	19.9	20.1	19.6	19.5	9.8	26.0		50.3	50
Per month	20.8	24.3	17.3	17.9	9.8	73.0	13.4	51.9	40.9
July									
I	23.1	33.4	17.4	18.7	7.8	21.2	20	57	37
II	19.0	34.2	14.0	19.7	2.6	22.4	10	65	43.9
III	22.7	35.7	17.8	19.5	28.8	23.7	125.2	65.6	45.8
Per month	19.0	23.6	13.9	19.0	39.2	88.0	44.5	61.1	43.6
August									
I	24.7	34.9	18.6	20.1	2.2	18.0	12.2	48.2	30.0
II	21.8	33.4	17.6	18.9	5.8	27.0	21.5	56	39.2
III	22.3	28.9	16.3	17.4	0	24.0	0	49.3	33.0
Per month	22.6		18.1	18.3	8.0	69.0	11.6	52.1	38.0

On the whole, the weather conditions in 2015 were not favorable for buckwheat because the flowering period was hot, the maximal temperature in the daytime being +34°C, which caused leaf wilting. While during the period of mass flowering the weather changed and the temperature was +19.9°C, there were no rainfalls. During the whole flowering – ripening period the rainfalls amounted to only 9.8 mm, the norm being 73.0 mm (less than 14%).

The weather conditions were favorable for millet. It was sown into warm and wet soil, the HTC being 2.09. Budding started in the second half of June, the temperature rose and there were no rainfalls. Thus millet vegetative mass did not increase greatly. During the budding – shooting periods HTC equaled 0. There were insignificant rainfalls during the periods of panicle formation and grain formation (HTC = 1.12). But as millet is a drought-enduring plant, its yield was quite high, namely 4.3 – 5.7 t/ha.

SECTION 2

RESEARCH RESULTS

2.1 BIO-GEL effect on millet

An important element of millet cultivation technology is optimization of fertilizers application which consists in using various doses and periods of applying micro- and macro-elements and studying their effect on the crop productivity. It considers the whole scope of the biological organism and environment interactions: ambient temperature, moisture deposits, fertilization, etc.

The research has found out the substantial dependence of millet yield on the time and dose of BIO-GEL application, especially when it is used for vegetating plants treatment (table 2.1). No effect of the seed treatment with the preparation has been established. The difference between the experiment variants has been within the experiment error ($HIP_{0,5}$ = 0,28 т/га). It should be noted that the yield increased by 0.51 t/ha after treating seeds with distilled water at 10 l/t. This can be explained by seeds water requirement to ensure millet germination (<25% of seeds weight), so a small amount of water could be conducive to good and chorus sprouts in this variant. As for the lack of millet reaction to the seeds treatment with BIO-GEL, especially taking into account their moistening with 10 l/t solution, there is no single answer and further research is required.

Further research was aimed at establishing BIO-GEL effect on millet plants treatment during the whole vegetation period. One of the most important stages in plant growth and development is tillering. It is during this period that the main inflorescence axis in the plant growth cone is formed, panicle size and its branching as well as the synchronization of different plant layers are predetermined. A great number of fully formed panicle branches is a determining factor for getting high yields.

According to our experiments it is the application of BIO-GEL in this very period that ensured the highest millet yield – 5.70 t/ha (28.1% higher than the control). This productivity was due to the plants treatment, the dose being 1.0 l/ha.

Table 2.1 BIO-GEL effect on millet yield, 2015, t/ha

№	Period of treatment with BIO-GEL	BIO-GEL dose per 2 ha, l	Repetition			Average value
			I	II	III	
1	Seeds treatment	No treatment (control)	3.58	3.64	3.60	3.61
2		Treatment with distilled water	3.81	4.31	4.23	4.12
3		BIO-GEL treatment, 0.5 l/ha	3.62	3.69	3.49	3.60
4		BIO-GEL treatment, 1.0 l/ha	3.51	3.69	3.60	3.60
5		BIO-GEL treatment, 1.5 l/ha	3.54	3.67	3.53	3.58
HIP$_{0.5}$,t/ha						***0.28***
6	Spraying vegetating plants at the tillering stage	No treatment (control)	4.40	4.50	4.44	4.45
7		Treatment with distilled water	3.70	3.78	3.80	3.76
8		BIO-GEL treatment, 0.5 l/ha at the stage start + 0.5 l/ha at full stage	3.89	3.98	3.95	3.94
9		BIO-GEL treatment, 1.0 l/ha	5.54	5.71	5.85	5.70
10		BIO-GEL treatment, 1.5 l/ha	4.58	4.66	4.62	4.62
HIP$_{0,5}$, t/ha						***0.15***
11	Straying vegetating plants at the shooting stage	No treatment (control)	3.90	4.12	3.98	4.00
12		Treatment with distilled water	4.74	4.85	4.77	4.79
13		BIO-GEL treatment 0.5l/ha at the stage start+ 0.5 l/ha at the full stage	4.97	4.55	4.79	4.77
14		BIO-GEL treatment, 1.0 l/ha	4.89	5.10	5.21	5.07
15		BIO-GEL treatment, 1.5 l/ha	4.61	4.93	4.83	4.79
HIP$_{0.5}$, t/ha						***0.27***
16	Spraying vegetating plants at the panicle formation stage	No treatment (control)	3.92	4.04	3.93	3.96
17		Treatment with distilled water	4.68	4.64	4.66	4.66
18		BIO-GEL treatment, 0.5 l/ha at the stage start + 0.5 l/ha at the full stage	4.38	4.26	4.35	4.33
19		BIO-GEL treatment, 1.0 l/ha	5.18	5.21	5.22	5.20
20		BIO-GEL treatment, 1.5 l/ha	5.46	5.54	5.50	5.50
HIP$_{0.5}$, t/ha						***0.08***
21	Spraying vegetating	No treatment (control)	4.24	4.20	4.05	4.16
22		Treatment with distilled water	4.10	4.16	4.18	4.15

23	plants at the flowering – grain forming stage	BIO-GEL treatment, 0.5 l/ha at the stage start + 0.5 l/ha at the full stage	4.16	4.12	4.32	4.20
24		BIO-GEL treatment, 1.0 l/ha	5.29	5.22	5.28	5.26
25		BIO-GEL treatment, 1.5 l/ha	4.18	4.25	4.19	4.21
$HIP_{0.5}$, t/ha						***0.19***

The dose increase to 0.5 l/ha did not give the desired effect but, on the contrary, decreased the yield by 1.08 t/ha. Also inefficient was fractionated application (0.5 l/ha at the stage start + 0.5 l/ha at full stage). In this variant the yield was 3.94 t/ha, the control (without treatment) being 4.45 t/ha.

Contrary to popular belief, no positive effect was established on treating millet with water. Just the reverse, in this case the millet yield was the lowest – 3.76 t/ha. In our opinion, it was because of rainfall deficit (9.0 mm, the norm being 22.0 mm) and high temperatures which sometimes exceeded 25°C. Under such conditions millet plants suffered great stress (though the treatment was conducted in early morning) and could not resist its effects. But the BIO-GEL dose of 1 l/ha favored the plant resistance to stress.

This conclusion is confirmed by L.A. Khristeva (1962), M.M. Kononova, K.V. Dyakova (1960), D.S. Orlova (1990) who state that physiologically active substances of humic nature stimulate plant resistance not only to certain negative environmental phenomena but increase their hardiness in general, or, in other words, cause nonspecifically increased overall resistance of the plant [1, 2, 3]. Thus, the preparation under study can be considered as a natural plant growth adaptogen to unfavorable environment conditions.

At the stage of shooting the metabolic processes in millet plants get more complicated. The plants become more resistant to unfavorable weather conditions and certain irritant factors. This is confirmed by weak reaction of millet yield to BIO-GEL dose (V=8.6% against 16.9% at the tillering stage) though there was practically no rainfall. In this period spraying vegetating plants with the preparation at the 1.0 l/ha dose proved most effective. The yield increased by 1.07 t/ha, or by 26.7% compared to the untreated plants, their yield amounting to 4.00 t/ha. There was no difference between spraying plants with water or with BIO-GEL at various doses during this period, the yields being within 4.77-4.79 t/ha.

At the panicle formation stage the gametogenesis processes which predetermine pollen fertility and the number of ovaries in a panicle are greatly intensified. The optimal BIO-GEL dose at this stage was 1.5 l/ha. Millet yield amounted to 5.50 t/ha, which is 38.9% higher than the control. Smaller dose (1.0 l/ha) applied either whole or fractionated reduced the preparation effectiveness. In the first case the yield decreased by 0.30 t/ha (5.4%), in the second case – by 1.17 t/ha (21.3%). The repeated application of 0.5 l/ha dose reduced the yield even compared to distilled water spraying.

Greater efficiency of the BIO-GEL higher dose (1.5 l/ha) at this stage can be due to the changes in the metabolic processes direction caused by plant transition from vegetating to generating stage as well as to the BIO-GEL chemical composition.

The following stage is characterized by millet flowering and grain ripening which take place simultaneously not only in one agrocenosis but also quite often in one panicle. During this period the stem stops growing in height, while fertilization and corcule formation take place which influence the number of grains in the panicle and its fullness. At this stage the BIO-GEL optimal dose was 1.0 l/ha, the yield was 5.26 t/ha (+26.4%), the control yield being 4.16 t/ha. As opposed to the previous period, no substantial difference between other variants as to millet yield was observed (4.15-4.21 t/ha).

Thus, the studies results testify to the fact that the most effective BIO-GEL dose under the weather conditions in 2015 was 1.0 l/ha applied one-time for spraying vegetating plants at the tillering stage. In this case the yield was the highest and amounted to 5.70 t/ha (+28.1%) compared to the control.

Millet seeds treatment with BIO-GEL proved ineffective, the yield in this case approaching the control (no treatment) and varying within 3.58-3.60 t/ha depending on the dose.

2.2 BIO-GEL efficiency on buckwheat

Buckwheat yields depend greatly on meteorological conditions. Two periods in buckwheat growth are critically dependent on weather conditions and predetermine its yield. These periods are sowing – shooting and flowering – grain formation.

In 2015 the vegetation period in northern forest-steppe region was the most unfavorable within the last ten years time. Sowing took place in late April, the soil temperature was 17.5°C. The topsoil moisture was 25.4 mm, while in the sowing layer it amounted to 11 mm. After sowing during the first ten-day period of May the rainfall made up 21.0 mm, the norm being 17.0 mm. Low temperatures at night (up to 9°C) caused prolonged germination (12 days) and 60-78% germination capacity.

Buckwheat flowering started in hot weather (up to 34°C in the daytime) which caused leaves wilting. The period of mass flowering – grain formation took place under favorable temperature (19.9°C) but with no rainfall (9.8 mm) which makes 13.4% norm (73.0 mm). The hydrothermic coefficient equaled 0.50. Air relative humidity was also low: 40.9%. In such conditions buckwheat plants could not increase vegetative mass, thus remaining low with small assimilating surface, they accumulated little dry substance, bees did not attend to them, inflorescences withered. All these factors affected the yield which was low compared to other years.

In 2015 buckwheat yield depending on the BIO-GEL doses and terms of application varied from 1.74 to 2.15 t/ha while the control yields were 1.36 – 1.47 t/ha (table 2.2).

At the stage of two real leaves buckwheat germinative stem forms nodes, internodes where in the pockets the third and subsequent outgrowths appear. This stage is characterized by forming numerous organs, which makes it very important.

Plant treatment in this period made it possible to increase yields by 0.49-0.54 t/ha, the control yield being 1.40 t/ha. The application doses were not essentially important, the difference between variants was within $HIP_{0,5}$ = 0,16 t/ha. As opposed to millet, buckwheat reacted positively to its treatment with water at all stages, which may be due to the general buckwheat reaction to moisture and the decreased stress load on the plant.

Spraying buckwheat with BIO-GEL solution in the period of budding caused changes in the plant reaction compared to the previous stages. The optimal dose was 1.0 l/ha which ensured 46.3% yield gain compared to the control. The fractionated application of the same dose (0.5 l/ha twice) did not cause the yield rise compared to the variants of plants treatment with distilled water (1.74 – 1.76 t/ha), though compared to the control the gain was substantial 0.38 – 0.40 t/ha.

Buckwheat flowering and grain formation stages coincide in time and last up to 35 days. During this period stems grow intensively, plants consume maximal amounts of nutrients. Thus, most efficient during this period was plants spraying with 1.0 and 1.5 l/ha BIO-GEL doses. In these cases, the yields appeared to be the greatest: 2.15 and 2.13 t/ha. In these variants the preparation application was most efficient, the yield gains being 0.66 – 0.68 t/ha or 44.9 – 46.2%, while distilled water resulted in just 19% gain, the control yield being 1.47 t/ha.

Thus, under 2015 conditions the most efficient BIO-GEL application was at the flowering stage, the doses being 1.0 – 1.5 l/ha, which ensured 2.13 – 2.15 t/ha yields. The yield gain amounted to 31.0 – 31.6% compared to the untreated variant.

Table 2.2 **– Buckwheat yield depending on the BIO-GEL doses and application terms, 2015, t/ha**

Variant №	Period of BIO-GEL treatment	BIO-GEL dose, l/ha	Repetition			Average value	±compared to the control	
			I	II	III		t/ha	%
1	Spraying vegetating plants at the stage of 2 real leaves	No treatment (control)	1.46	1.45	1.29	1.40	K_1	K_1
2		Treatment with distilled water	1.81	1.72	1.79	1.77	+0.37	+26.4
3		BIO-GEL treatment, 0.5 l/ha at the stage start + 0.5 l/ha at the full stage	1.90	1.95	1.93	1.93	+0.53	+37.8
4		BIO-GEL treatment, 1.0 l/ha	2.04	1.82	1.97	1.94	+0.54	+38.6
5		BIO-GEL treatment, 1.5 l/ha	1.91	2.00	1.75	1.89	+0.49	+35.0
***$HIP_{0.5}$*, t/ha**						***0.16***	-	-
6	Spraying vegetating plants at the budding stage	No treatment (control)	1.37	1.34	1.36	1.36	K_2	K_2
7		Treatment with distilled water	1.73	1.59	1.90	1.74	+0.38	+27.9
8		BIO-GEL treatment, 0.5 l/ha at the stage start + 0.5 l/ha at the full stage	1.94	1.66	1.61	1.74	+0.38	+27.9
9		BIO-GEL treatment, 1.0 l/ha	2.05	2.04	1.89	1.99	+0.63	+46.3
10		BIO-GEL treatment, 1.5 l/ha	1.74	1.85	1.68	1.76	+0.40	+29.4
***$HIP_{0.5}$*, t/ha**						***0.22***	-	-
11	Spraying vegetating plants at flowering stage	No treatment (control)	1.43	1.53	1.46	1.47	K_3	K_3
12		Treatment with distilled water	*1.74*	*1.88*	*1.64*	*1.75*	*+0.28*	*+19.0*
13		BIO-GEL treatment, 0.5 l/ha at the stage start + 0.5 l/ha at the full stage	1.66	1.85	1.88	1.80	+0.33	+22.4
14		BIO-GEL treatment, 1.0 l/ha	2.15	2.19	2.12	2.15	+0.68	+46.2
15		BIO-GEL treatment, 1.5 l/ha	2.16	2.10	2.12	2.13	+0.66	+44.9
***$HIP_{0.5}$*, t/ha**						0.15	-	-

CONCLUSION

1. As a result of the studies it has been established that under the 2015 conditions BIO-GEL proved to be most effective when applied for one-time spraying vegetating millet plants at the tillering stage, the dose being 1.0 l/ha. This ensured the highest yield of 5.70 t/ha, which is 28.1% higher than the control.

2. Treating millet seeds with BIO-GEL proved ineffective, the yield in this case equaling that in the control (no treatment). Depending on the preparation dose it amounted to 3.58 – 3.60 t/ha.

3. As for buckwheat, BIO-GEL proved most effective when it was used for spraying flowering plants, the dose being 1.0 – 1.5 l/ha. This ensured the yield of 2.13 – 2.15 t/ha, the yield gain amounting to 44.9 – 46.2%, respectively.

Thus, taking into account very unfavorable weather conditions during the buckwheat and millet cultivation periods, BIO-GEL organic preparation was beneficial for plants vitality and increased their yields 1.2 – 1.4 times.

We consider it appropriate to continue BIO-GEL studies next year regarding it as a natural adaptogen of organic origin.