Southern Governmental Agricultural Research Station

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Approved by

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RESEARCH REPORT

on the topic: “Studying the effect of BIO-GEL (old name HUMATE-GEL) natural humate-concentrate on growth conditions and yields of vegetables and melon crops”

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INTRODUCTION

Ukrainian agriculture greatly depends on the rising fuel prices and, consequently, rising prices of mineral fertilizers. Thus, of paramount importance is the search for alternative agrotechnical methods conducive to higher yields and lower production prices. So, along with traditional fertilizers, the third millennium fertilizers are increasingly used, which contain modern water-soluble combined mineral and organic supplements to ensure plants top-dressing.

In practice there are several ways of supplying plants with trace elements, various fertilizer supplements, top-dressing, presowing seed treatment being most widespread. At that, presowing seed treatment is the cheapest and most effective. When seeds treated with trace elements get into soil, these trace elements dissolve much more easily than those in the soil. Thus, trace element salts on getting into the seeds activate the hydrolyzing enzymes, which makes seeds more viable, more ready for germination and intensive development.

Recently a new class of fertilizers has appeared: humic preparations which are characterized by the presence of humic acid salts. In general terms humates are readily soluble, physiologically acceptable salts of humic acids. Humic acids together with fulvic acids are known to be the basis of humus which is the most important factor of soil fertility. Organic fertilizers are composed of macro- and micro-elements, various physiologically active substances, microorganisms, antibiotics, etc.

At present Ukrainian agrarian market abounds in humic preparations made both by well-established foreign and domestic companies and by amateurs. Only research can reveal their effectiveness and provide sound recommendations for their use.

Research methods and soil, climatic and agro-technical conditions

Field studies of BIO-GEL natural concentrate effectiveness have been carried out in watermelon, melon, eggplant fields on the experimental farm (Veliky Klin, Kherson). This territory belongs to the Tsyurupinsk agricultural area which is situated on sandy upland terraces of the Dnieper River, the soil being southern black soil with sandy-loam containing little humus. The humus profile makes up to 76 cm, the humus content amounting to 1.0%.

The farm is situated in the southern agroclimatic area, its climate is very hot and dry. The average annual rainfall is 328 mm. The hydrothermic coefficient is 0.5.

Experiment 1. Studying the effect of BIO-GEL natural humate-concentrate on growth conditions and yields of watermelons on rainfed lands.

Table 1. Experiment 1 scheme

Variant	Treatment	Spraying in the period of		
		Leaves formation	Blossoming	Fruitification
1 (к1)	-	-	-	-
2 (к2)	Water	-	-	-
3	Potassium humate (20 ml/1l)	1.0 l/ha	1.0 l/ha	1.0 l/ha
4	BIO-GEL (20 ml/1l)	1.0 l/ha	1.0 l/ha	1.0 l/ha
5	BIO-GEL (40 ml/1l)	2.0 l/ha	2.0 l/ha	2.0 l/ha

The research has been performed using Khersonsky watermelon variety. The sowing scheme is 1.75 x 0.8 m (1.4 m^2 fertilization area). Plant density is 7100 per a hectare. Land area is 100 m^2. Total experimental area is 3.0 ha.

Experiment 2. Studying the effect of BIO-GEL natural humate-concentrate on growth conditions and yields of melons on rainfed lands.

Table 2. Experiment 2 scheme

Variant	Treatment	Spraying in the period of		
		Leaves formation	Blossoming	Fruitification
1 (к1)	-	-	-	-
2 (к2)	Water	-	-	-
3	Potassium humate (20 ml/1l)	1.0 l/ha	1.0 l/ha	1.0 l/ha
4	BIO-GEL (20 ml/1l)	1.0 l/ha	1.0 l/ha	1.0 l/ha
5	BIO-GEL (40 ml/1l)	2.0 l/ha	2.0 l/ha	2.0 l/ha

The research has been performed using Olvia melon variety. The sowing scheme is 1.75 x 0.8 m (1.4 m^2 fertilization area). Plant density is 7100 per a hectare. Land area is 100 m^2. Total experimental area is 3.0 ha.

Experiment 3. Studying the effect of BIO-GEL natural humate-concentrate on growth conditions and yields of eggplants under trickle irrigation.

Table 3. Experiment 3 scheme

Variant	**Treatment**	**Spraying seedlings before planting**	**Entering through trickle tape in the period of**		
			budding	**blossoming**	**fruitification**
1	Control (water)	-	-	-	-
2	Д2М organic	0.1%	1 l/ha	1 l/ha	1 l/ha
3	Potassium humate	0.1%	1 l/ha	1 l/ha	1 l/ha
4	BIO-GEL	0.1%	0.1 l/ha	0.1 l/ha	0.1 l/ha
5	BIO-GEL	1%	1 l/ha	1 l/ha	1 l/ha
6	BIO-GEL	2%	2 l/ha	2 l/ha	2 l/ha

The research has been performed using Khersonsky eggplant variety. The sowing scheme is 1.75 x 0.25 m (0.44 m^2 fertilization area). Plant density is 23000 per a hectare. Land area is 20 m^2. Total experimental area is 0.15 ha.

EXPERIMENT RESULTS

Soil biological activity

The main component which stimulates life in soil is microorganisms. They cause gradual changes in soil composition and agriculturally useful soil properties influenced by environment. The intensity of soil microorganisms activity is accompanied by the liberation of certain amount of carbon dioxide, its registration testifying to the soil biological activity.

The soil biological activity beginning from the water melon vegetation start (stage of shoots) and up to its end (stage of ripening) is characterized by its stable changes. Microorganisms activity peak falls on the blossoming beginning irrespective of the experiment variants.

It has been established that at the time of watermelon and melon shoots the soil microbiological activity was higher after presowing seed treatment than when such treatment was not used. Thus, in control variants 1 and 2 the soil biological activity under watermelons was 60.7 and 63.9 mg CO_2/m^2x hour while it was 87.9 and 96.7 mg CO_2/m^2x hour when treated with humic fertilizers, that is, by 37.5 – 59.3% higher (table 4).

Table 4 Soil microbiological activity, mg CO_2/m^2x hour

Experiment variant	**Seed treatment**	**Plant development stages**		
		Shoots	**Blossoming**	**Ripening**
Experiment 1 (Watermelon)				
1 (k1)	-	60.7	61.9	60.1
2 (k2)	Water	63.9	64.4	62.8
3	Potassium humate (20 ml/1l)	87.9	89.9	87.7
4	BIO-GEL (20 ml/1l)	92.3	94.1	93.0
5	BIO-GEL (40 ml/1l)	96.7	99.5	97.9
Experiment 2 (melon)				
1 (к1)	-	58.6	63.7	56.1
2 (к2)	Water	60.6	66.1	62.2
3	Potassium humate (20 ml/1l)	83.2	86.6	79.5
4	BIO-GEL (20 ml/1l)	90.6	92.2	88.8
5	BIO-GEL (40 ml/1l)	93.2	95.7	91.1

In control variants 1 and 2 soil biological activity under melons is 58.6 and 60.6 mg CO_2/m^2x hour, whereas it was from 83.2 to 93.2 mg CO_2/m^2x hour, depending on the humate treatment, thus rising by 37.0-59.0%. The highest soil microbiological activity was achieved during the watermelon and melon shoots period after the seeds were treated with BIO-GEL

solution (40g/l), rising by 59.3% and 59% compared to the control. At that, this experiment variant shows higher soil microbiological activity also in the later periods of melons development. Thus, in the watermelon blossoming period it is 99.5 mg CO_2/m^2x hour (60.7% growth compared to control 1), in the ripening period it is 97.9 mg CO_2/m^2x hour (+62.9%); in the melon blossoming period it is 95.7 mg CO_2/m^2x hour (+50.2%), in the ripening period it is 91.1 mg CO_2/m^2x hour (+62.3%).

Formation of melon assimilation area

It has been established that watermelon and melon leaves development during the whole vegetation period can be divided into four stages. First a plant slowly forms 3-5 leaves which contribute to accumulating substances to enhance growth. After that maximal leaf area is formed to ensure plant assimilating potential which contributes to forming plant generative organs. After that the intensity of the leaf area growth slows down considerably and the assimilated growth potential is redirected to the generative organs. Later the leaf area increases most slowly.

At the leaf formation stage the largest leaf area both with melons and watermelons was formed in variant 5 (BIO-GEL used) amounting to 75 m^2/ha and 86 m^2/ha, respectively (table 5).

Table 5 formation of plant leaf area, m^2/ha

Experiment variant	**Development periods**		
	Leaves formation	**Blossoming**	**Fruitification**
Experiment 1 (watermelon)			
1 ($к_1$)	62	3635	4085
2 ($к_2$)	64	3885	4160
3 potassium humate	70	4615	4885
4 BIO-GEL	71	4585	4990
5 BIO-GEL	75	5005	5160
Experiment 2 (melon)			
1 ($к_1$)	65	3501	3720
2 ($к_2$)	66	3535	3800
3 Potassium humate	83	4385	4610
4 BIO-GEL	83	4500	4720
5 BIO-GEL	86	4935	5015

The same experiment variant demonstrates the largest leaf area also in the later periods of melons development: at the stage of watermelon blossoming it is 5005 m^2/ha, at the fruitification stage it is 5160 m^2/ha; at the stage of melon blossoming it is 4935 m^2/ha, at the fruititifcation stage it is 5015 m^2/ha. Thus, seeds treatment with BIO-GEL solution (40 ml/l) and triple top-dressing with BIO-GEL (2 l/ha) contributes to the watermelon leaf area increase by 1075 m^2/ha, while with melons it increases by 1295 m^2/ha compared to the control.

Melons yields

The same positive effect of humic fertilizers has been observed in the period of fruit formation. Potassium humate application (variant 3) to watermelon increased its yield by 3.6 t/ha compared to the control and was similar to the BIO-GEL effect (variant 4). The watermelon yield in variant 3 was 15.2 t/ha, while in variant 4 (seed treatment with BIO-GEL solution (20 ml/l) and triple top-dressing with it (1l/ha)) the yield was 15.0 t/ha with HIP_{05} 0.31 t, that is, the difference was within the experiment error (table 6).

Table 6. Melons yields, t/ha

Variant	Replication				Average
	I	II	III	IV	
Watermelon					
1 ($к_1$)	11.9	12.4	12.0	10.3	11.6
2 ($к_2$)	11.8	12.0	12.3	12.0	12.0
3 Potassium humate	14.0	16.0	15.6	15.1	15.2
4 BIO-GEL	13.9	15.1	16.0	14.9	15.0
5 BIO-GEL	16.8	17.6	18.2	15.9	17.1
HIP 05 0.31 t					
Melon					
1 ($к_1$)	9.6	9.4	7.4	7.4	8.4
2 ($к_2$)	8.8	9.2	7.4	7.5	8.2
3 Potassium humate	11.0	10.4	8.9	10.8	10.3
4 BIO-GEL	11.2	12.9	9.6	11.0	11.2
5 BIO-GEL	12.4	12.8	10.9	11.6	11.9
HIP 05 0.21 t					

The highest watermelon yield was in variant 5 when higher BIO-GEL doses (seed treatment with BIO-GEL (40 ml/l) and triple top-dressing with BIO-GEL (2 l/ha) were applied. In this case the yield was 17.1 t/ha, which is by 5.5 t/ha or by 47.4% higher than the control.

The effect of humic fertilizers on watermelon and melon yields was different. The melon response to BIO-GEL was much better than to potassium humate. The seed treatment with BIO-GEL solution (20 ml/l) and triple top-dressing with it (1 l/ha) (variant 4) contributed to the yield increase by 2.8 t/ha or by 33.3% compared to the control 1, whereas potassium humate application increased melon yield only by 1.9 t/ha or by 22.6%. The highest melon yield (similar to watermelons) was obtained in variant 5 (seed treatment with BIO-GEL (40 ml/l) and triple top-dressing with BIO-GEL (2 l/ha)) and made 11.9 t/ha, that is, by 3.5 t/ha or by 41.7% higher than control 1.

We should note different effect of presowing seed water steeping on melons and watermelons (variant 2 (control 2)). In experiment 1 presowing watermelon seed water steeping

increased the yield significantly (12.0 t/ha against 11.6 t/ha), while in experiment 2 melon yields difference in both controls was within the experiment error (8.4 and 8.2 t/ha at HIP_{05} 0,21 t).

Experiment 3. Experiment 3. Studying the effect of BIO-GEL natural humate-concentrate on growth conditions and yields of eggplants under trickle irrigation.

Organic fertilizers effect on eggplant biometric characteristics

Of great importance in crop cultivation is the process of plant growth which is influenced by natural and agrotechnical factors and can contribute to the crop productivity. Plants are sensitive to weather changes which influence the plant physiological and biological as well as bioelectrical potentials, that is, their adaptive characteristics, which should be considered in optimizing the crop cultivation. The formation of highly productive agrocoenosis should meet the physiological needs of specific plant varieties with regard to the environment due to improved cultivation technologies.

Analyzing the effect of organic fertilizers on eggplant biometric characteristics (table 7), it should be noted that their values are the highest in the fruitification period, while the maximal effect of the intensive growth is observed in the interphase period between blossoming and fruitification.

Table 7. Eggplant biometric characteristics

Variant	Entering through trickle tape in the period of								
	budding			blossoming			fruitification		
	Basic stem height, m	Number of side stems	Leaf area, m^2	Basic stem height, m	Number of side stems	Leaf area, m^2	Basic stem height, m	Number of side stems	Leaf area, m^2
1	0.41	7.1	0.46	0.52	9.5	0.52	0.70	10.5	0.73
2	0.44	7.2	0.51	0.57	9.8	0.54	0.77	10.8	0.76
3	0.50	7.5	0.53	0.61	10.1	0.64	0.82	11.1	0.90
4	0.43	7.2	0.48	0.55	9.6	0.53	0.74	10.6	0.74
5	0.46	7.5	0.52	0.58	9.8	0.63	0.78	10.8	0.88
6	0.48	7.7	0.54	0.61	9.9	0.65	0.82	10.9	0.91

Increased doses of BIO-GEL organic fertilizer (from 0.1 l/ha to 2 l/ha) contribute to higher eggplant biometric characteristics.

Maximal biometric characteristics values were observed when applying BIO-GEL with trickle irrigation, the dose being 2 l/ha, in the periods of budding, blossoming and fruitification which was combined with spraying seedlings with 2% solution before their

transplanting. At that, the plant assimilating area amounted to 20900 m^2/ha, while in the control (water treatment) it amounted only to 16.7 m^2/ha (20% less).

It should be noted that potassium humate had a great effect too. Thus top-dressing with 0.1% solution before transplanting as well as triple application through trickle tape, the dose being 1 l/ha, ensured the assimilating area of 20700 m^2/ha.

Meanwhile, the application of Д2М Organic did not influence significantly the biometric characteristics, which can be explained by its insufficient quantity.

Eggplant yield dependence on various organic fertilizers

Productivity is the main criterion of various cultivation technology elements which characterize the technology in general. Our research has been aimed at assessing various organic fertilizers in this respect.

Analyzing table 8, we can come to the conclusion that the regularities revealed in the biometric studies are observed in the crop productivity as well.

Table 8. Organic fertilizers effect on Khersonsky eggplant yield in 2015, t/ha

Variant	Yield				Average yield
	I	II	III	IV	
1 (к)	49.1	47.5	48.8	47.0	48.1
2	51.4	49.5	51.0	50.2	50.5
3	52.9	51.0	52.6	53.0	52.4
4	48.2	48.6	49.0	48.8	48.7
5	52.0	51.8	51.4	51.7	51.7
6	54.0	53.6	54.6	53.1	53.8
HIP $_{05}$ t/ha = 0,96					

The maximal yield has been registered in variant 3 with BIO-GEL top-dressing (2% concentration) before transplanting seedlings in combination with its triple application simultaneously with watering in the periods of budding, blossoming and fruitification, the dose being 2 l/ha, which ensured the yield of 53.8 t/ha (5.7 t/ha or 12% higher than the control).

The application of potassium humate according to the experiment scheme ensures the yield of 52.4 t/ha, which is 8.9% higher than the control.

As to Д2М Organic, its effect on eggplant yield was not essential, the yield being 50.5 t/ha, which is by 4.9% higher than the control.

CONCLUSIONS FROM EXPERIMENTS 1, 2, 3

1. Presowing treatment of watermelon seeds with 0.4% BIO-GEL solution increases the soil microbiological activity by 59.3% - 62.9% compared to the control.

2. Presowing treatment of melon seeds with 0.4% BIO-GEL solution increases the soil microbiological activity by 50.2% - 62.3% compared to the control.

3. Seed treatment with BIO-GEL solution (40 ml/l) together with triple top-dressing (2 l/ha) contributes to greater watermelon leaf area (by 1075 m^2/ha) and greater melon leaf area (by 1295 m^2/ha) in the fruitifacation period compared to the control.

4. Plant treatment with 2% BIO-GEL solution together with triple top-dressing (2 l/ha) contributes to greater eggplant leaf area (by 20%) in the fruitification period compared to the control.

5. The highest watermelon yield has been obtained on applying higher BIO-GEL doses (treatment of seeds with BIO-GEL (40 ml/l) and triple top-dressing (2 l/ha), amounting to 17.1 t/ha, which is by 5.5 t/ha or 47.4% higher than the control.

6. The highest melon yield has been obtained on treating the seeds with BIO-GEL solution (40 ml/l) and triple top-dressing (2 l/ha), amounting to 11.9 t/ha, which is by 3.5 t/ha or 41.7% higher than control 1.

7. By applying 2% BIO-GEL solution to eggplant seedlings before their transplanting together with its triple application simultaneously with watering, the dose being 2 l/ha, in the periods of budding, blossoming and fruitification contributed to the yield of 53.8 t/ha, which is by 12% higher than the control.