

NATIONAL ACADEMY OF AGRARIAN SCIENCES

INSTITUTE OF RICE

APPROVED

by Director of Institute of Rice,

NAAS, Ukraine

V.V. Dudchenko

REPORT

on studying the BIOGEL-PLUS biological product effect on crops productivity (rice, soybean, winter wheat), crops yield and possible reduction of pesticide load due to combined application of fungicides, herbicides and BIOGEL-PLUS biological product under irrigation in the southern steppe zone of Ukraine (rice irrigation systems or irrigation by sprinkling machines)

ORDERED

by S.B. Osipenko, individual entrepreneur

EXECUTED
Ukraine

by Technology Department of the Institute of Rice, NAAS,

Skadovsk, 2018

Experiment 1. Studying the efficiency of disease control on winter wheat for the purpose of reducing the rate of chemicals due to *BIOGEL-PLUS* application

1. Place of the experiments: field 3, Institute of Rice, NAAS, Ukraine, Skadovsk district, Kherson region; the field is irrigated by *Dnepr 120* sprinkling machine.
2. Soil-climatic zone: southern steppe
3. Soil: dark-chestnut, alkaline combined with saline (30-50%), pH (water) of soil solution in the 0-40 cm layer – 6.16; humus content (according to Tyurin) – 1.97%; movable phosphorous forms (according to Machigin) – 3.16 mg/100 g soil; exchangeable potassium (according to Machigin) – 43.85 mg/100 g soil; easily hydrolyzed nitrogen (according to Tyurin-Kononova) – 4.06 mg/100 g soil. So the soil according to the State Standards is rather fertile and provided with basic nutrients.
4. Crop: *Shchedrist* winter wheat variety.
5. Precursor: sunflower.
6. Sowing rate: 220 kg/ha, date of sowing: 02.10.17. Sowing was carried out with a trailed seeding machine (Amazone AD-P Super), the spacing of 18 cm.
7. Farming techniques in the experiment were those commonly used for growing winter wheat under irrigation in the southern steppe of Ukraine. The basic soil cultivation was disking in 2 tracks to a depth of 14-16 cm; fertilization: N₆₀₊₅₁ - 300 kg / ha of ammonium sulfate for pre-sowing cultivation and 150 kg / ha of ammonium nitrate in early spring fertilization on frozen soil; chemical protection – disease control – according to the experiment scheme; weed control – *Derby* herbicide at the rate of 0.06 l/ha.
8. Irrigation – by sprinkling, 4 times (including autumn sprinkling), the total irrigation rate being 1500 m³/ha.

9. Scheme of experiments and terms of protectants application:

There was a single spraying at the stage of wheat stem elongation

1. Control (no protectants)
 2. *Abakus*®, 1.0 l/ha (100% rate, 05.05.2018)
 3. *Abakus* ®, 0.7 l/ha (70% rate, 05.05.2018) + *BIOGEL-PLUS*, 1.5 l/ha (05.05.2018)
 4. *BIOGEL-PLUS*, 1.5 l/ha, applied on 05.05.2018.
10. Experiment was carried out on small plots; sown area: 5.0 x 0.5 m²; discount area: 2.0 x 5.0 m². Replication: 3 times. Systematic distribution.

11. Equipment used: sprayer with electric compressor, on compressed air. Working solution consumption (fungicide and BIOGEL-PLUS solution): 250 l/ha.
12. Method of recording: records of winter wheat disease spread and development, in particular septoriosi, were made after spraying and on the 21st day after it.
13. The yield record in all experiment variants was conducted on 25.06.2018 by totally thrashing discount areas (combining with the *Yanmar* small combine harvester). The yield data is given according to standard indicators (100% purity, 14% humidity).
14. Experiment results and analysis:

As a result of the field trials the positive effect of BIOGEL-PLUS biological product has been shown to increase fungicide effectiveness and crop productivity (table 1.3).

Recording pests (disease development and number of weeds) was performed according to generally accepted methods.

According to the results of the observations and records it has been established that from the complex of the crop diseases the septophoresis has become most widespread. In early May the development of this disease on the lower three leaves reached an average of 20.7-66.8% (Table 1.1).

At that time there were conducted sprayings with the *Abakus* fungicide and the combination of the fungicide and BIOGEL-PLUS biological product according to the experiment scheme.

Table 1.1

Record of the winter wheat septophoresis development before spraying with chemical protectants (05.05.2018)

Replication	Degree of leaf damage,%, average per 30 stems					Septophoresis development per leaf, %				
	1	2	3	4	5	1	2	3	4	5
05.05.2018										
I	-	-	16.0	16.0	54.1	-	-	1.9	30.0	18.0
II	-	-	25.0	29.1	72.6	-	-	1.9	31.9	52.6
III	-	-	21.2	81.6	73.7	-	-	7.8	42.6	11.5
On average	-	-	20.7	42.2	66.8	-	-	3.8	34.8	27.4

The next record of the leaf damage degree and disease development was carried out on the 21st day (26.05.2018) after the experiment variants spraying with the

fungicide and BIOGEL-PLUS product, the results of the record are given in table 1.2

If at the time of spraying the plant lower leaf was 66.8% affected, on the last day in the variants where no fungicide was used the lower leaf (5) completely died out; in the other two variants this leaf almost did not function either (the development of septoriosiis was 95.4-98.2%). Therefore for the determination of the average disease development in the crop only 4 live leaves were taken into account in the experimental variants. If at the record of 05.05.2018 two upper leaves were not damaged, at the end of May septoriosiis also spread to the upper leaves. However, in the variants where fungicide was applied at the rate of 100% and the same fungicide at the rate of 70% in combination with the BIOGEL-PLUS biological product the disease development was reduced by 0.8-10.9% compared to the control.

On average the septoriosiis development after spraying with *Abakus* fungicide, the rate being 1.0 l/ha, the disease development decreased by 22.8%, the protection effectiveness in this variant was 67.2%. If the fungicide rate was reduced to 70% (*Abakus*, 0.7 l/ha) and BIOGEL-PLUS was added, the disease development was reduced by 21.8%. Thus the protection effectiveness in this variant was 64.3%.

A single application of BIOGEL-PLUS contributed to a slight decrease in the rate of disease development (by 7.7%), but the efficiency was low - 22.6%.

Table 1.2

Record of septoriosiis development in winter wheat crop on the 21st day after applying fungicide and BIOGEL-PLUS biological product (26.05.2018)

Experiment variant	Replication	Septoriosiis development, % per leaf					Development on average per plant, %,	Effectiveness, %
		1	2	3	4	5		
Control, spraying	I	0	5.1	64.6	52.4	100		
	II	0	22.2	53.3	71.1	100		
	III	0	18.3	48.9	64.3	100		
	on average	2.6	15.2	55.6	62.6	100	34.0	—
<i>Abakus</i> , 1.0 l/ha (100 % rate)	I	-	-	-	3.2	96.1		
	II	1.9	1.9	11.5	23.3	98.8		
	III	3.5	9.5	23.3	26.1	91.5		
	on average	1.8	3.8	11.6	27.4	95.4	11.2	67.2
<i>Abakus</i> ,	I	0.7	1.2	7.9	30.0	98.9		

0.7 l/ha (70 % rate) + <i>BIOGEL-PLUS</i> , 1.5 l/ha	II	1.2	3.4	11.7	25.3	95.6		
	III	3.8	8.3	20.9	31.4	100		
	on average	1.9	4.3	13.5	28.9	98.2	12.2	64.3
<i>BIOGEL-PLUS</i> , 1.5 l/ha	I	2.0	7.2	18.8	35.9	100		
	II	2.6	15.1	28.6	69.4	100		
	III	2.6	17.6	36.9	79.2	100		
	on average	2.4	13.3	28.1	61.5	100	26.3	22.6

It should be noted that in general a single application of fungicide to winter wheat crops at a fairly high percentage of disease development, even at the maximum recommended fungicide rate had a slight effect.

The amount of the saved winter wheat crop on applying the *Abakus* fungicide recommended rate (1.0 l/ha) as well as on the applying the reduced (by 30%) fungicide rate in combination with *BIOGEL-PLUS* (1.5 l/ha) was practically the same – 18.0-21.5%, variance within the experiment error (table 1.3).

The development of septoriosiis in the variant with no fungicide but with *BIOGEL-PLUS* applied was higher compared with the variants where the fungicide was used but much lower than the control. Apparently, the biological product stimulates certain immunological properties of plants and positively influences their further growth and development. In this variant a significant increase in the grain yield was obtained compared to the control but it was less than in the variant with fungicidal spraying.

Table 1.3

Experiment variant	Replication			On average	Yield gain, t/ha / %
	I	II	III		
1. Control, no spraying	6.16	6.16	6.21	6.18	–
2. <i>Abakus</i> , 1.0 l/ha (100 %)	7.0	6.98	7.39	7.29	+ 1.11 / 18.0
3. <i>Abakus</i> , 0.7 l/ha (70 %) + <i>BIOGEL-PLUS</i> , 1.5 l/ha	7.76	7.32	7.44	7.51	+ 1.33 / 21.5
4. <i>BIOGEL-PLUS</i> , 1.5 l/ha	7.04	6.40	6.93	6.79	0.61 / 9.9

HIP₀₅ =

0.32 t/ha

Experiment 2. Studying the efficiency of disease and weed control on rice if chemicals rate is reduced and BIOGEL-PLUS biological product is applied

1. Place of the experiments: field 7 of rice crop rotation, Institute of Rice, NAAS, Ukraine, Skadovsk district, Kherson region
2. Soil-climatic zone: southern steppe
3. Soil: dark-chestnut, alkaline combined with saline (30-50%), pH (water) of soil solution in the 0-40 cm layer – 6.89; total salts content - 0,118%; humus content (according to Tyurin) – 2.04%; movable phosphorous forms (according to Machigin) – 3.18 mg/100 g soil; exchangeable potassium (according to Machigin) – 24.6 mg/100 g soil; easily hydrolyzed nitrogen (according to Tyurin-Kononova) – 5.98 mg/100 g soil. So the soil according to the State Standards is rather fertile and provided with basic nutrients.
4. Crop: *Ukraine 96* rice variety, mid-season, bred by the Institute of Rice, NAAS
5. Precursor: soybean
6. Sowing rate: 9 million grains/ha (280 kg/ha), date of sowing – 03.05.2018, initial inundation – 04-05.05. Sowing was carried out with an attached seeding machine (width – 4.0 m), seeding depth – 1.5-2.0 cm.
7. Farming techniques in the experiment were those commonly used for growing rice under irrigation in the southern steppe of Ukraine. The main tillage was 2 tracks disking to a depth of 12-14 cm. Fertilization: N₁₃₂₊₆₉ P₄₀ – 200 kg/ha carbamide and 200 kg/ha thioammophos broadcasted during pre-sowing tillage and 150 kg/ha carbamide as extra nutrition at the stage of rive full tillering. Chemical protection: according to the experiment scheme.
8. Irrigation: constant inundation starting from crop coming-up to full grain ripening at the rate of 19 000 m³/ha.
9. **Experiment scheme and terms of products application**

The following products were used in the experiment: *Topshot* herbicide against specific weeds in the rice irrigated fields, one-time application at the stage of coming-up; *Tilt* and *Rias* fungicides, two-time application at the end of tillering and at the stage of full stem elongation.

Experiment variants:

1. Control (no herbicide applied, 100% fungicide rate)
2. **Standard**: *Topshot*™, 3.0 l/ha (100% rate – 01.06.2018) + a) *Tilt*, 0.5 l/ha (100% rate – 04.-7.2018) + b) *Rias*, 0.8 l/ha (100% rate – 18.07.2018).

3. *Topshot*, 2 l/ha (70% rate – 01.06.2018) + *BIOGEL-PLUS*, 1.5 l/ha (01.06.2018) and 2 sprayings with fungicides (100% rate – 04.07.2018 and 18.07.2018).
4. a) *Tilt*, 0.35 l/ha (70% rate – 04.07.2018) + *BIOGEL-PLUS*, 1.5 l/ha (04.07.2018); + b) *Rias* 0.56 l/ha (70% rate – 18.07.2018) + *BIOGEL-PLUS*, 1.5 l/ha (18.07.2018) and herbicide (100% rate – 01.06.2018).
5. a) *BIOGEL-PLUS*, 1.5 l/ha (04.07.2018) + b) *BIOGEL-PLUS*, 1.5 l/ha (18.07.2018) (100% herbicide rate, no fungicide – 01.06.2018)
10. Experiment was carried out on small plots; sown area: 5.0 x 0.5 m²; discount area: 2.0 x 5.0 m². Replication: 4 times. Systematic distribution.
11. Equipment used: sprayer with electric compressor, on compressed air. Working solution consumption (fungicide, herbicide and *BIOGEL-PLUS* solution): 250 l/ha.
12. Method of recording: records of rice diseases (rice blast in particular) spread and development were made before spraying and on the 21st day after it.
13. At the coming-up stage before herbicide application and before harvesting records were taken of the number of hydrophilic and marsh group weeds to determine the effectiveness of protective measures against these pests.
14. The yield record in all experiment variants was conducted on 26.09.2018 by totally thrashing discount areas (combining with the *Yanmar* small combine harvester). The yield data is given according to standard indicators (100% purity, 14% humidity).
15. Experiment results and analysis:

As a result of the field trials the positive effect of *BIOGEL-PLUS* biological product has been shown to increase fungicide and herbicide effectiveness and crop productivity (table 2.3).

As for weeds, their recording was made at the stage of rice full coming-up (31.05), before applying chemical plant protectants and before harvesting in every variant replication.

It has been established that applying the *Topshot* herbicide 100% rate (3.0 l/ha) reduced the number of hydrophilic and marsh group weeds by 92.6-94.0% (table 2.1).

Practically the same result was obtained in the variant in which 70% *Topshot* rate and *BIOGEL-PLUS* biological product (1.5 l/ha) were applied.

It should be noted that the effect of the *Topshot* herbicide (even its maximum rate) on cockspur grass was only 94% which is due to cockspur grass high resistance.

Marsh group weeds sprout after herbicide application.

Table 2.1

Records of weed number at the stage of rice coming-up, before applying chemical plant protectants and at the time of harvesting

Experiment variant	Weed number before spraying, pc/m ²		Weed number before harvesting, pc/m ²		Effectiveness, %	
	cockspur grass	marsh weeds	cockspur grass	marsh weeds		
1. <i>Control</i> (no herbicides, 100 % fungicide rate)	342	105	199	54	–	–
2. <i>Standard</i> <i>Topshot</i> , 3.0 l/ha (100 %) + a). <i>Tilt</i> , 0.5 l/ha + b). <i>Rias</i> , 0.8 l/ha (100 % rate)	324	133	12	4	94.0	92.6
3. <i>Topshot</i> , 2.1 l/ha (70 %) + BIOGEL-PLUS, 1.5 l/ha (+ 2-time fungicide application, 100 % rate)	397	206	16	5	92.0	90.7

The first spraying of rice crops according to the experiment scheme was conducted on July, 4, 2018. The *Tilt* fungicide (0.5 l/ha), the mixture of the fungicide (0.35 l/ha) and BIOGEL-PLUS (1.5 l/ha) and just BIOGEL-PLUS (1.5 l/ha) were applied. The records of damaged plants (leaves) carried out before spraying revealed spots of various origin but no signs of rice blast were observed. However, the weather conditions (precipitation, high air humidity, temperature regime) at that time were favorable for the development and spread of this disease agent. Therefore, the plants were sprayed to prevent it.

The next record was taken after 14 days. At that time the rice was at the beginning of the panicle stage. The results of the record revealed the lesion by rice blast

agents (table 2.2). The disease was least developed in the variant where the full rate of fungicide was applied; in the variant where the reduced rate of the fungicide (70%) in combination with BIOGEL-PLUS was applied the signs of the disease were a bit more obvious than in the previous variant but also not significant. In the variant where the crops were sprayed with just BIOGEL-PLUS the rice blast development was the highest. On the same day re-treatment of rice crops was carried out according to the research scheme. In order to prevent the pathogen addiction the *Rias* fungicide was used, the rate being 0.8 l/ha and 0.56 l/ha combined with the biological product.

Table 2.2

Record of rice blast spread and development depending on products applied and their rates (18.07.2018)

Experiment variant	Leaves		Panicles	
	spread, %	development, %	spread, %	development, %
1. <i>Standard</i> <i>Topshot</i> , 3.0 l/ha (100 % rate) + a). <i>Tilt</i> , 0.5 l/ha + b). <i>Rias</i> , 0.8 l/ha (both fungicides 100 % rates)	1.5	0.3	1.5	0.2
2. a). <i>Tilt</i> , 0.35 l/ha (70 %) + <i>BIOGEL-PLUS</i> , 1.5 l/ha b). <i>Rias</i> , 0.56 l/ha (70 %) + <i>BIOGEL-PLUS</i> , 1.5 l/ha, (Herbicide 100 % rate)	2.8	0.4	2.5	0.3
3. <i>BIOGEL-PLUS</i> , 1.5 l/ha + <i>BIOGEL-PLUS</i> , 1.5 l/ha (herbicide 100 % rate, no fungicides)	7.0	0.6	5.0	0.6

The record taken 10 days later testified to insignificant spread of rice blast spores only in the variant where the biological product was applied without fungicide.

The record of rice yield according to the experiment variants is given in the next table (table 2.3).

It has been established that the combined application of BIOGEL-PLUS (1.5 l/ha) and the selective rice herbicide (its rate reduced by 30%) contributed to 16.8% increase in the crop yield compared to the variant where the herbicide was applied separately at the maximum recommended rate.

The same effect was observed in the variant where the fungicide reduced rate in combination with BIOGEL-PLUS was applied.

Separate application of BIOGEL-PLUS without fungicides caused a decrease in the yield compared to the variant where BIOGEL-PLUS was used with fungicide as a result of less effective control of the disease spread.

Table 2.3

Rice yield depending on the protectants applied and their rates

Experiment variant		Replication				on average	Saved yield, t/ha
		I	II	III	IV		
1	<i>Control</i> (no herbicides, 100 % fungicide rate)	2.0	1.75	1.26	1.82	1.71	–
2	1. Standard <i>Topshot</i> , 3.0 l/ha (100 % rate) + a). <i>Tilt</i> , 0.5 l/ha + b). <i>Rias</i> , 0.8 l/ha (fungicides 100 % rate)	5.64	6.61	7.44	7.13	6.72	5.01
3	<i>Topshot</i> , 2.1 l/ha (70 %) + BIOGEL-PLUS, 1.5 l/ha (+ 2 sprayings with fungicide, 100 % rate)	7.20	7.98	7.06	8.0	7.56	5.85
						Deviations from the standard	
4	a). <i>Tilt</i> , 0.35 l/ha (70 %) + <i>BIOGEL-PLUS</i> , 1.5 l/ha b). <i>Rias</i> , 0.56 l/ha (70 %) + BIOGEL-PLUS, 1.5 l/ha (100% herbicide rate)	7.63	7.76	7.81	7.16	7.59	+ 0.87
5	<i>BIOGEL-PLUS</i> , 1.5 l/ha + <i>BIOGEL-PLUS</i> , 1.5 l/ha (100 % herbicide rate, no fungicide)	6.04	6.32	6.67	6.89	6.48	- 0.24

HIP₀₅ = 0.76 t/ha

Experiment 3. Studying the efficiency of disease and weed control on soybean crops if chemicals rate is reduced and BIOGEL-PLUS biological product is applied

1. Place of the experiments: field 2 of rice crop rotation, Institute of Rice, NAAS, Ukraine, Skadovsk district, Kherson region
2. Soil-climatic zone: southern steppe

3. Soil: dark-chestnut, alkaline combined with saline (30-50%), pH (water) of soil solution in the 0-40 cm layer – 6.89; total salts content - 0,118%; humus content (according to Tyurin) – 2.04%; movable phosphorous forms (according to Machigin) – 3.18 mg/100 g soil; exchangeable potassium (according to Machigin) – 24.6 mg/100 g soil; easily hydrolyzed nitrogen (according to Tyurin-Kononova) – 5.98 mg/100 g soil. So the soil according to the State Standards is rather fertile and provided with basic nutrients.
4. Precursor: soybean
5. Crop: *Sonyachna* soybean variety (transgenic), mid-ripening
6. Rate of sowing: 150 kg/ha; date of sowing: 126.04.2018; sowing was carried out with the Amazone D9 attached sowing machine, 25 cm space between rows.
7. Farming techniques in the experiment were those commonly used for growing soybean in rice-paddies. The main tillage is plowing to a depth of 20-22 cm. Fertilizers: N₃₀P₃₀ – 150 kg/ha thioammophos during pre-sowing tillage. Before sowing seed inoculation with *BTY-T* biological inoculant, 1.5 kg/t, was carried out. Weed chemical control: herbicide containing *Gliphosate* (2 l/ha). During the vegetation period the following pesticides were applied: *Nisoran* acaricide, 0.5 l/ha, (against pests) and *Borey Neo* insecticide, 0.15 kg/ha; disease control was ensured according to the experiment scheme.
8. Irrigation was conducted by two-time short-term flooding of paddy at the rate of 3600 m³/ha).

9. Experiment scheme and terms of products application

1. Control (no spraying)
2. Two-time crop spraying with *Amistar Extra* fungicide, 0.5 l/ha (100% rate, 05.06 and 25.06.2018).
3. Two-time spraying crop spraying with *Amistar Extra*, 0.35 l/ha (70% rate) + BIOGEL-PLUS, 1.5 l/ha (05.06 and 25.06.2018).
4. Two-time crop spraying with BIOGEL-PLUS, 1.5 l/ha (05.06 and 25.06.2018).
10. Experiment was carried out on small plots; sown area: 5.0 x 0.5 m²; discount area: 2.0 x 5.0 m². Replication: 4 times. Systematic distribution.
11. Equipment used: sprayer with electric compressor, on compressed air. Working solution consumption (fungicide and BIOGEL-PLUS solution): 250 l/ha.
12. Method of recording: records of soybean diseases (septoriosis, blackspot, downy mildew) spread and development were made before spraying and on the 21st day after it.

13. The yield record in all experiment variants was conducted on 26.09.2018 by totally thrashing discount areas (combining with the *Yanmar* small combine harvester). The yield data is given according to standard indicators (100% purity, 14% humidity).

14. Experiment results and analysis:

As a result of the field trials the positive effect of BIOGEL-PLUS biological product has been shown to increase fungicide effectiveness and crop productivity (table 3.3).

According to the observations and records the level of the soybean leaves affection with septoriosiis in early June was 28.3-39.4% (table 3.1).

On June 5th the first crop spraying was carried out according to the experiment variants.

Table 3.1

Record of soybean disease spread and development at the moment of fungicide and BIOGEL-PLUS application

Record repetition on plots	Septoriosiis, development 05.06.2018, %	Blackspot, development 25.06.2018, %	Downy mildew, development 25.06.2018, %
1	37.8	9.0	5.5
2	39.4	8.6	6.3
3	31.5	4.1	8.0
4	36.7	2.2	11.0
5	28.3	5.0	8.0
6	38.3	5.5	8.3
7	36.7	4.6	9.0
8	34.3	9.4	6.0
on average	35.4	6.1	7.8

All variants of the soybean crop spraying (both the fungicide application at the full rate and the combined application of the fungicide at the reduced rate with the biological product as well as application of BIOGEL-PLUS, 1.5 l/ha alone) were quite effective as far as septoriosiis control was concerned (table 3.2).

Table 3.2

Record of disease spread and development on the 21st day after applying BIOGEL-PLUS and fungicides

Experiment variant	Septoriosiis		Blackspot		Downy mildew	
	development, %	effect, %	development, %	effect, %	development, %	effect, %
Control	43.1	–	12.0	–	12.6	–
<i>Amistar Extra</i> , 0.5 l/ha (2 times)	9.1	78.9	4.1	65.5	4.5	64.3
<i>Amistar Extra</i> , 0.35 l/ha + <i>BIOGEL-PLUS</i> , 1.5 l/ha (2 times)	9,7	77,5	5,8	51,7	5,1	59,5
<i>BIOGEL-PLUS</i> , 1.5 l/ha (2 times)	12.4	71.2	6.3	47.5	5.8	53.9

The repeated use of the same variants of soybean spraying on June 25, 2018 in the phase of flowering beginning almost equally controlled the development of blackspot and downy mildew. The effectiveness of blackspot control was 47.5-65.5%, that of downy mildew was 53.9-64.3%. A bit less efficient was the variant where *BIOGEL-PLUS* was applied twice without fungicides. As a result of the above, the yield of soybeans was practically the same in all variants (table 3.3).

Table 3.3 Soybean yield depending on the protectants applied, t/ha

Experiment variant		Replication				average	Saved yield, t/ha
		I	II	III	IV		
1	Control (no sprayings)	4.40	4.62	5.02	4.27	4.58	–
2.	<i>Amistar Extra</i> , 0.5 l/ha (2 times)	4.78	5.22	5.47	5.62	5.27	0.69
3.	<i>Amistar Extra</i> , 0.35 l/ha + <i>BIOGEL-PLUS</i> , 1.5 l/ha (2 times)	4.75	4.98	5.65	5.87	5.31	0.73
4	<i>BIOGEL-PLUS</i> , 1.5 l/ha (2 times)	4.79	4.95	5.18	5.40	5.08	0.5

HIP₀₅=0.43

t/ha

1. Place of the experiment on studying *BIOGEL-PLUS* effectiveness in soybean crop protection against weeds: field 2 with drip irrigation, Institute of Rice, NAAS, Ukraine, Skadovsk district, Kherson region.
2. Soil-climatic zone: southern steppe

3. Soil: dark-chestnut, alkaline combined with saline (30-50%), pH (water) of soil solution in the 0-40 cm layer – 6.16; humus content (according to Tyurin) – 1.97%; movable phosphorous forms (according to Machigin) – 3.16 mg/100 g soil; exchangeable potassium (according to Machigin) – 43.85 mg/100 g soil; easily hydrolyzed nitrogen (according to Tyurin-Kononova) – 4.06 mg/100 g soil. So the soil according to the State Standards is rather fertile and provided with basic nutrients.
4. Precursor: rice
5. Crop: the *Aratta* soybean variety, mid-ripening, bred by the Institute of Irrigated Farming
6. Rate of sowing: 140 kg/ha; date of sowing: 18.04.2018. sowing was carried out with the Amazone D9 attached sowing machine, 25 cm space between rows.
7. Farming techniques in the experiment were those commonly used for growing soybean under irrigation in the southern steppe of Ukraine. The main tillage is plowing to a depth of 16-18 cm. Fertilization: N₄₀ – 200 kg/ha ammonium sulphate during pre-sowing tillage. Before sowing seeds were inoculated with *BTY-T* biological inoculant, 1.5 kg/t. Weed chemical control: according to the experiment scheme. During the vegetation period the following pesticides were used: *Nisoran* acaricide, 0.5 l/ha, (against pests) and *Borey Neo* insecticide, 0.15 kg/ha; *Impakt K*, fungicide, 0.6 l/ha (disease control).
8. Drip irrigation from 30.05 to 01.09.2018, the total irrigation rate – 3775 m³/ha.
9. **Experiment scheme and terms of products application**
 1. Control (no spraying)
 2. *Flame*, 0.5 l/ha (11.06.2018) + *Fuzilad Forte*, 1.0 l/ha (18.06.2018), 100% herbicide rate against broad-leaved and cereal weeds, respectively.
 3. *Flame*, 0.35 l/ha + *BIOGEL-PLUS*, 1.5 l/ha (11.06.2018) and *Fuzilad Forte*, 0.7 l/ha (18.06.2018) + *BIOGEL-PLUS*, 1.5 l/ha, 70% herbicide rate against broad-leaved and cereal weeds, respectively.
10. Experiment was carried out on small plots; sown area: 5.0 x 0.5 m²; discount area: 2.0 x 5.0 m². Replication: 4 times. Systematic distribution.
11. Equipment used: sprayer with electric compressor, on compressed air. Working solution consumption (fungicide and BIOGEL-PLUS solution): 250 l/ha.
12. Methods of recording: records of monocotyledonous and broad-leaved weeds number were made at the coming-up stage, before herbicide

application and before harvesting with the purpose of determining the effectiveness of protective measures against these harmful organisms.

13. The yield record in all experiment variants was conducted on 01.10.2018 by totally thrashing discount areas (combining with the *Yanmar* small combine harvester). The yield data is given according to standard indicators (100% purity, 14% humidity).

14. Experiment results and analysis:

As a result of the field trials the positive effect of BIOGEL-PLUS biological product has been shown to increase herbicide effectiveness and crop productivity (table 3.5).

The records of weed number in soybean crops under drip irrigation made before herbicide application and before harvesting showed that effectiveness of the herbicide recommended rate as well as the herbicide rate reduced by 30% in combination with BIOGEL-PLUS biological product was about 89.0-94.6%, that is, almost the same.

Table 3.4

The records of monocotyledonous and broad-leaved weeds number in soybean crops at the stage of three triple leaves (11.06.2018) before herbicide application and before harvesting

Experiment variant	Number of weeds at the soybean stage of 3 triple leaves, before herbicide application, pc/m ²		Number of weeds before harvesting, pc/m ²		Effectiveness, %	
	monocotyledonous	broad-leaved	monocotyledonous	broad-leaved	monocotyledonous	broad-leaved
1. Control, no spraying	105	139	73	92	–	–
2. <i>Flame</i> , 0.5 l/ha + <i>Fuzilad Forte</i> , 1.0 l/ha (100 % rate)	97	123	5	7	93.2	92.4
3. <i>Flame</i> , 0.35 l/ha + <i>Fuzilad Forte</i> , 0.7 l/ha (70 % rate) + <i>BIOGEL-PLUS</i> , 1.5 l/ha	120	151	8	5	89.0	94.6

Almost identical (within the experiment error) was the soybean yield. The amount of the saved grain in these variants was 0.87-1.0 t/ha compared to the control (table 3.5).

Table 3.5

Soybean yield depending on the weeds chemical control, t/ha

Experiment variant		Replication				average	Saved yield, t/ha
		I	II	III	IV		
1	Control	2.94	3.22	3.80	3.94	3.48	–
2.	<i>Flame</i> , 0.5 l/ha + <i>Fuzilad Forte</i> , 1.0 l/ha (100 % rate)	4.05	4.73	4.64	4.50	4.48	1.0
3.	<i>Flame</i> , 0.35 l/ha (70 %) + <i>BIOGEL-PLUS</i> and <i>Fuzilad Forte</i> , 0.7 l/ha (70 %) + <i>BIOGEL-PLUS</i> , 1.5 l/ha	4.48	3.97	4.07	4.78	4.33	0.87

HIP₀₅=0.63 t/ha

Conclusions and suggestions

1. It is recommended to use the BIOGEL-PLUS biological product, the application rate being 1.5 l / ha for spraying and 2 l / ha for seed inoculation, in order to increase the productivity of winter wheat, soybean and rice crops and to decrease the pesticide load on these crops by reducing the rates of herbicides and fungicides by 30%.
2. In organic farming technologies (without herbicides and fungicides) the use of BIOGEL-PLUS is recommended at a rate of 1.5 l / ha. At the same time there is an increase in the yield of winter wheat by 10% and an increase in the resistance of crops to fungal diseases.