A Farmer's Toolbox for Integrated Pest Management

AGRI/2020/OP/0003

Case study

Biological agents to reduce herbicide use LT

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Abstract

The objective of the project successfully implemented by the Lithuanian Chamber of Agriculture together with researchers from Botany Institute, Nature Research Centre was to address the problems of improving soil quality, reducing the use of nitrogen fertilizers and increasing the yield and quality of production in order to increase crop efficiency and resource sustainability. The project envisaged increasing the profitability of farms by reducing the use of nitrogen fertilizers, maintaining or even improving the yield of production thanks to a new generation of microelements and improving (restoring) soil structure and product quality with the help of microorganisms**.** The results are showing very good effect of using plant biostimulant products especially in cereals.

The results of the planned research will provide new scientific information and further develop knowledge on the effects of biological agents on the growth and development of cereal and bean crops and will help farmers to choose environmentally friendly plant protection products. However, due to the fact that the project has just started, concrete results on the action of the Biogel product in reducing pesticide use by strengthening the defence of plants are not available yet.

This project is planning to explore the potential of an innovative plant biostimulant product, BioGel, a preparation made from biohumus (Vermicompost) and water containing free amino acids of plant origin, macro (N, P, K), micro (Mg, Mn, Fe, Zn, Cu, B, Fe) elements, vitamins (B1, C, B2, A, E, PP), humic acids, and enzymes.

1. Introduction

Overall presentation of the initiative and activities

This project is planning to explore the potential of an innovative plant biostimulant product, BioGel, a preparation made from biohumus (Vermicompost) and water containing free amino acids of plant origin, macro (N, P, K), micro (Mg, Mn, Fe, Zn, Cu, B, Fe) elements, vitamins (B1, C, B2, A, E, PP), humic acids, and enzymes.

The use of BioGel is expected to stimulate the development of the test plants (spring, winter wheat and beans), making them more resistant to weeds, thereby reducing the risks to human health and the environment stemming from herbicides, while also bringing economic benefits.

Initial studies on the effect of this product regarding the growth of spring wheat and the increase in productivity have already been carried out, while demonstration trials would explore the potential for reduction of pesticide use following the application of the product.

Context and background information

Increasing the productivity of agricultural crops and their productivity has been and remains one of the most important challenges for agricultural production and science. Modern intensive plant growing technologies, which are currently unthinkable without the use of chemical plant protection products, allow for abundant yields. However, the irresponsible use of plant protection products poses a threat to the stability of ecosystems and risks to human and animal health and the environment. In order to avoid the threat of pesticides to human health and the environment, not to pollute water bodies, groundwater and soil, the search for alternative plant protection measures is relevant.

Control of crop diseases and weeds is one of the most important factors in achieving the highest productivity of crops. With the advent of new active substances such as metamitron, phenmedipham or ethofumesate since the 1960s, chemical weed control has become the main method of weed control due to its effectiveness. High rates of active substances have been used, and it was not until the 1970s that it was decided to reduce them for economic and ecological reasons, Studies in Germany have shown that weed control increases plant yields by 24 percent. The harmfulness of different weeds in agricultural crops is not the same. Their significance for agricultural plants is often defined in the scientific literature by economic limits of harmfulness, i. y. with a minimum number of weeds of 1 m2, where the cost of the herbicide used is paid for by the yield supplement obtained. Plant diseases are known to be caused by pathogenic microorganisms (fungi, viruses, bacteria) under unfavourable environmental conditions. Diseases negatively affect plant quality and productivity, as well as affect the economy. Plant diseases can destroy the plant or cause damage to individual plant organs, necrosis, weaken the plant. Plant diseases are grouped into types according to the signs of lesions: spots - caused by non-parasitic causes, viruses, bacteria, fungi, deformations - uncharacteristic changes on stems, leaves, fruits, growths on stems, leaves, roots, plaque - caused by fungi (Project proposal 2021).

Relevance for the Pilot Project

Biological preparations (biostimulants) containing biologically active substances such as amino acids, humic and fulvic acids, vitamins, peptides, proteins, enzymes, polysaccharides, and other active compounds, as well as micro-nutrients, such as the one subject of this study, are being developed as an alternative to the use of chemicals in agriculture. However, due to the fact that the project is just prepared for funding, concrete results on the action of the Biogel product in reducing pesticide use by strengthening the defence of plants are not available yet.

2. Research theme

The main problem faced by agricultural operators is the intensive use of pesticides, which contaminates groundwater and soil, and the accumulation of pesticide residues in agricultural crops, which poses a threat to human health. High levels of persistently rising pesticides increase the cost of production and reduce the profitability of operations, and farmers who grow organic or exceptional quality products and do not use pesticides face the problem of low yields.

As an alternative to the use of chemicals in agriculture, there are biological preparations based on microorganisms that do not cause adverse effects on the environment or human health. Currently, the use of biological preparations in agriculture is not widespread due to their higher cost, and the search for effective biological preparations that can be used for plant protection has remained relevant.

High levels of persistently rising pesticides increase the cost of production and reduce the profitability of operations, and farmers who grow organic or exceptional quality products and do not use pesticides face the problem of low yields.

The project would contribute to the implementation of the priority action plan, as the project will explore innovative, technological, environmentally effective biological agents that ensure a sustainable environment.

The results of the research will provide new scientific information and further develop knowledge on the effects of biological agents on the growth and development of cereal and bean crops and will help farmers to choose environmentally friendly plant protection products.

3. Methodology

The proposal for the case study was submitted by the Lithuanian Chamber of Agriculture: Interviews took place with Sigitas Dimaitis, Director, Sonata Kiseliene, Head of Rural Development and Information Division, Paulius Astrauskas, Head Head of Aricultural Technologies division, Dr, Edita Karbauskiene, Sen. Specialist for Plant production, Dr. Laura Masilionyte Self-governance Organizer in Pasvalys region. They informed, that in the case study proposal presented project has not started yet because of funding. They also explained about project preparation and when implementation is planned, gave opinion about innovativeness of already implemented project results and how they were disseminated.

For the project scientific part Dr. Sigita Jurkoniene, Head Laboratory of Plant Physiology, Botany Institute, Nature research Centre was contacted. She was leading team of researchers who were implementing trials for the project with the new plant biostimulants. She commented obtained results of already implemented project and why it was decided to test the

effectiveness of these products on weeds. She shared the project report and the draft scientific publications where projects results are going to be published. The most relevant data are used for this case study.

In order to check if these new product are really effective Assoc. Prof. Of Agricultural Academy, Vytautas Magnus University Dr. Sonata Kazlauskaite was also interviewed. He is specializing in pest and disease control to check if these products are effective. Dr. Roma Semaskiene, Institute of Agriculture Lithuanian Research Center for Agririculture and Forest Sciences was also interviewed. This was made together with reference search made using internet, publicly available publications, Ministry of Agriculture project database.

It was identified that these methods by research team were used for evaluation effectiveness of biopreparations:

- Laboratory, small field, field test methods. Evaluation of biological activity of test compounds.
- Morphometric methods. During the full maturity stage of the plants, measurements of the height of the studied plants, studies of the formation of productivity elements were performed, estimating the number of seeds in the plant and the weight of the seeds. Forty plants were analyzed for each replicate.
- Biochemical methods. Spectroscopically - the content of chlorophyll in the leaves of the studied plants was determined; Kjeldahl - qualitative analysis of grain.
- Vegetable parameters in the initial growth stages were evaluated under laboratory conditions.
- The parameters of vegetables and berries grown under natural field conditions were evaluated - beet and carrot measured during the intensive vegetation stage: height of the ground, diameter of emerging roots and berries, green and dry as well as lyophilized berry mass.
- The amounts of carotenoids, sugars, nitrates were determined by spectrophotometric method.
- Ascorbic acid content was determined by high-performance thin-layer chromatography (CAMAG), antioxidant activity in vegetables was evaluated (DPPH method), and anthocyanins were quantified in berries.

Most of these methods are going to be used in the new project.

4. Activities and results

4. 1 Objectives

The objective of the project, which was implemented by the Chamber of Agriculture together with Botany Institute, Nature Research Centre, was to address the problems of improving soil quality, reducing the use of nitrogen fertilizers and increasing the yield and quality of production in order to increase crop efficiency and resource sustainability. The project envisages increasing the profitability of farms by reducing the use of nitrogen fertilisers, maintaining or even improving the yield of production thanks to a new generation of microelements and improving (restoring) soil structure and product quality with the help of microorganisms**.**

The main objective of the planned new project is to combine the knowledge, capabilities and experience of advisory, scientific institutions and agricultural entities to perform demonstration tests to solve the problems of reducing pesticide use and increasing productivity, partially replacing pesticides with BioGel for plant protection against diseases and weeds.

4.2 Governance and functioning of the initiative

Project "Improvement (restoration) of soil structure and quality using microorganisms. Reducing the emission of nitrogen compounds while preserving plant productivity by using a new generation of microelements" No. 35BV-KK-15-1-07891-PR001 was implemented in accordance with the rules for the implementation of the Lithuanian Rural Development Program 2014–2020 measure "Cooperation" activity area "Support for the establishment and development of EIP activity groups". This research was supported by project of European Commission EIP-AGRI Rural development for Operational Groups.

The Agricultural Chamber implemented the project in cooperation with a scientific institution - the Botany Institute, Nature Research Center and 11 farmers - entities engaged in agricultural activities (7 cereals, 2 horticultural, 2 berry farms).

During the implementation of the project, tests were carried out on 11 farms: in the organic farm of Šiauliai district, which is located in favourable areas for farming, the culture is tested - beans; In Joniškis district, in a conventional farm located in favourable areas for farming, the culture is tested - beans; In Ukmergė district, in an organic farm located in less-favoured areas, the culture is tested - beans; In Vilkaviškis district, in a conventional farm located in favourable areas for farming, the culture is tested - oats; In Anykščiai district, barley is being tested in a conventional farm located in less-favoured areas; In Šalčininkai district, barley is being tested on a conventional farm located in less-favoured areas; In Šalčininkai district, in the organic farm, which is located in less-favored areas, the culture is tested - buckwheat; In Pasvalys district, a carrot and cabbage crop is being tested on a farm producing national quality products in favourable areas; In Pasvalys district, in an organic farm located in favourable areas for farming, the culture is tested - carrots, cabbage; In Šiauliai district, in a conventional farm located in favourable areas for farming, the culture is tested - strawberries; In the Biržai district, black currants are being tested in an organic farm located in favourable areas for farming.

4.3 Results (and successes)

Investigations of grain growth, yield and its quality formation under the influence of ProbioHumus and NaturGel

Researchers of the State Botanical Research Institute, Nature Research Center dr. Virgilija Gaveliene, Sigita Jurkoniene, engineer Nijole Bareikiene, dr. Jurga Jankauskiene, dr. Rima Mockeviciute implemented the project. Dr. Virgilija Gaveliene explained the peculiarities of cereal growth, yield and its quality formation under the influence of ProbioHumus and NaturGel. She indicated several interesting positive results.

After evaluating the effect of Humata on the growth and development of winter oilseed rape seedlings, the most active compound was found - NaturGelis. Experiments with spring wheat in an organic farm in Šiauliai district, which is favorable for farming, showed that the use of NaturGel + Probio Humus promotes the formation of structural elements of crop yield: the

number of grains in the penis increased by 18% and the weight of 1000 seeds by 3%. (Table 1).

Table 1: Effects of humate on the growth and development of winter oilseed rape seedlings Laboratory tests (per plant) Fading (5µl; 10 µl / 1ml), Spraying (0.333; 0.5ml / 100ml)

Variants	Height of the plant		Raw weight		Dry weight	
	cm	%	g	%	g	%
Control	18.3±1.9	100	1.51±0.02	100	0.11±0.01	100
NaturGelis	19.4±2.0	106	1.91±0.02	126	0.14±0.01	127
NaturGelis_H23	17.0±1.6	93	1.58±0.01	105	0.12±0.01	109
NaturGelis_H23-F1	19.5±1.9	107	1.82±0.01	120	0.13±0.01	120
NaturGelis_H23-F4	16.8±2.0	92	1.41±0.025	93	0.09±0.008	90
NaturGelis_H23-F7	17.4±2.5	95	1.28±0.02	85	0.08±0.008	80
NaturGelis_2H	16.0±1.6	87	1.17±0.02	78	0.08±0.008	80
NaturGelis_2H-F1	18.3±2.3	100	1.36±0.03	91	0.08±0.008	80
NaturGelis_2H-F4	17.3±1.7	99	1.50±0.01	100	0.11±0.01	100
NaturGelis_2H-F7	16.4±1.9	90	1.47±0.02	98	0.11±0.01	110
ProbioHumus	18.6±1.8	102	1.57±0.02	105	0.09±0.01	90

Buckwheat growth and development under the influence of HumatGel compounds were tested (small field tests in 2018 Nature Research Center test station, Vilnius district Gulbinai. There 10 HumatGel compounds and ProbioHumus were tested. As a result of the tests, the increase in buckwheat seed weight was promoted by NaturGelis. Similar tests in 2018 were made with soja. The results are shown in Table 2.

Table 2: Effects of NaturGel and ProbioHumus on growth and productivity of different soybean cultivars

Variant	Height of the plant		Number of pods in the plant		Weight of 1000 seeds	
	cm	%	vnt.	%	g.	%
Control 1 variety	32.6 ± 0.12	100	5.1 ± 0.03	100	107.2±1.1	100
ProbioHumus+NaturGel	32.5 ± 0.28	100	6.1 ± 0.07	120	113.1±1.2	105
Control 2 variety	35.2 ± 0.40	100	6.1 ± 0.12	100	99.6± 1.2	100
ProbioHumus+NaturGel	32.2 ± 0,.1	102	6.9 ± 0.05	113	103.1±1.2	104
Control 3 variety	30.1 ± 0.34	100	5.5 ± 0.12	100	115.2±1.0	100
ProbioHumus+NaturGel	33.0 ± 0.31	103	6.5 ± 0.16	118	119.2±0.5	103
Control 4 variety	37.7 ± 1.32	100	6.9 ± 0.31	100	111.5±0.4	100
ProbioHumus+NaturGel	40.8 ± 1.30	108	7.2 ± 0.15	104	101.7±0.3	91
Control 5 variety	33.5 ±0.27	100	5.2 ± 0.14	100	113.1±0.2	100
ProbioHumus+NaturGel	32.9 ± 0.33	98	5.1±0.06	98	116.3±0.1	103

Table 3: Effects of ProbioHumus and NaturGel on winter wheat stem growth and grain yield at maturity (conventional farming)

Variant	*Height of the plant stem*		*Number of grains in the plant*		*Weight of the grains (of the one plant)*		*Weight of 1000 grains*		*Yield*
	cm	*%*	*vnt.*	*%*	*g*	*%*	*g*	*%*	*t/ha*
Control (1)	*83±2.5*	*100*	*42±2.0*	*100*	*4.1±0.4*	*100*	*62±2.8*	*100*	*8.76*
ProbioHumus (2)	*85±3.0*	*102*	*43±2.3*	*102*	*4.0±0.5*	*105*	*58±1.3*	*94*	*7.81*
NaturGel (3)	*84±3.5*	*101*	*45±1.1*	*107*	*4.0±0.4*	*105*	*59±5.3*	*95*	*8.71*
NaturGel+ProbioHumus (4)	*84±1.9*	*101*	*46±1.3*	*109*	*4.1±0.4*	*108*	*64±5.4*	*103*	*8.58*

Figure 1: Visual treatments with Effects of ProbioHumus and NaturGel effect on winter wheat

Experiments with spring wheat in the organic farm in Ukmergė district, which is located in less-favored areas, showed that the most intensive plants grew in the field with NaturGel, and the highest seed mass was in the field with ProbioHumus. Result obtained: the weight of 1000 seeds increased to 5 percent. In the conventional farm in Anykščiai district, which is located in less-favored areas, experiments with spring wheat showed that in the fields where NaturGelis and ProbioHumus were used, the weight of 1000 grains increased on average by 10%. In the non-organic farm in Telšiai district, which is in favorable areas for farming, it was found that the height of oat plants in the field with ProbioHumus was 20% higher (Table 4).

Table 4: Effects of ProbioHumus and NaturGel on spring wheat stem growth and grain yield at full maturity (conventional farming)

Variant	*Height of the plant stem*		*Number of grains in the plant*		*Weight of the grains (of the one plant)*		*Weight of 1000 grains*		*Yield*	
	cm	%	vnt.	%	g.	%	g	%	t	%
Control	62±1.5	100	26±0.8	100	3.0±0.3	100	41±1.8	100	4.04	100
ProbioHumus	64±1.0	103	23±0.3	88	3.1±0.1	103	44±1.3	107	4.86	120
NaturGel	68±1.5	110	25±0.5	96	3.2±0.1	105	45±0.3	109	4.46	110
NaturGel+ProbioHumus	66±0.9	106	24±0.3	92	3.1±0.2	103	42±1.4	102	5.05	125

Growth and yield quality of vegetables and berry plants by exposure to ProbioHumus and NaturGel

Probiohumus and the effect of NaturGel on the growth and yield quality of vegetables and berry plants were studied by the same researchers of the Botany Research Institute, Nature Research Center: dr. Virgilija Gaveliene, Sigita Jurkoniene, engineer Nijole Bareikiene, dr. Jurga Jankauskiene, dr. Rima Mockeviciute and Gabija Armalytė. Dr. Sigita Jurkonienė, presenting the results of the research noted, that the effect of ProbioHumus and NaturGel increased the content of carotenoids in roots by 8%, sugars by 24%, and ascorbic acid by 12%. Nitrate accumulation changed little compared to controls. Experiments with strawberries showed that the test compounds affected the development of strawberries: an average increase of 23% in berry weight compared to controls. A slight increase in vitamin C content was obtained in berries grown in the field with NaturGel + ProbioHumus. In non-organic farms, ProbioHumus (twice for 3 l / ha spraying) was the most intensive driver of carrot development and yield formation - the average unit weight increased by 21%.

The highest increases in sugars (24%) and ascorbic acid (12%) were observed in the probioHumus + NaturGelis test variant. An increase in antioxidant activity (33%) was obtained with ProbioHumus. The tested substances slightly reduced the accumulation of nitrates in carrots compared to the control. In the organic farm, both NaturGelis and ProbioHumus (3 l / ha twice for spraying berry bushes) promoted the development of black currant berries. The berry weight increased by 28% and 45% compared to the control, respectively, with an increase in dry matter accumulation of 38% and 57%. The antioxidant activity in the berries of the affected berry bushes increased insignificantly - within the margin of error, the analysis of the anthocyanin composition did not show any differences between the test variants. Ascorbic acid levels in blackcurrants treated with ProbioHumus were comparable to controls, and in the test variant with ProbioHumus + NaturGel increased by 44%.

The objectives of the activities have been fully met. The results and achievements of the initiatives have been communicated/disseminated outside the initiative. Sigitas Dimaitis, Director of the Chamber of Agriculture, noted that the results of the project will be available to farms in various agricultural sectors (cereals, horticulture, berry, etc.), as well as farms growing organic or national quality products. "The project not only encourages farmers to use innovations, improve the economic performance of farms, but also to influence climate change processes and protect and improve the soil." Lithuanian Chamber of Agriculture organized several seminars for farmers and other specialists https://zur.lt/zur-rupi-dirvos-kokybe/ , https://zur.lt/pristatyti-tarpiniai-projekto-rezultatai-2/, field days https://zur.lt/naujos-kartos-mikroelementu-nauda/ , https://zur.lt/i-lauko-diena-traktoriumi/,. In the Botany Institute, Nature Research Center foreign students via ERASMUS had a chance to learn about methods used and project results: https://zur.lt/zur-projekto-deka-nauda-ir-uzsienio-studentams/ .

New research project

The above-mentioned project was successfully implemented, The most interesting and promising results were obtained with cereals. That is why based on the findings was decided and planned to evaluate how these preparations are effecting weed control in cereals. **The main objective of the planned new project** is to combine the knowledge, capabilities and experience of advisory, scientific institutions and agricultural entities to perform demonstration tests to solve the problems of reducing pesticide use and increasing productivity, partially replacing pesticides with BioGel for plant protection against diseases and weeds.

In the project proposal is stated, that Lithuania's climate is favourable for growing spring wheat. They have a suitable granulometric composition, acidity, sufficient moisture and heat for the soils of most areas. Therefore, they are grown by farmers not only with heavier but also lighter soils. Still, in order to grow a clean and good quality crop, you need to choose the right technological solutions. Intensive cultivation techniques are used to grow spring wheat, and the spread of weeds and diseases is combated at different stages of plant growth. Weeds increase labour and energy costs. Even 30 percent. all labour costs consumed in agriculture are borne by weed control. In the case of weedy crops, grain yield losses in various countries are 6–12 or even 20 percent or more. Spring wheat diseases also affect the economy by negatively affecting plant quality and productivity. The leaves of these plants are damaged almost every year during the vegetation period by powdery mildew, which manifests itself in the covering of diseased leaves by a white fungus. Spring wheat also suffers from leaf and bell septoriosis, which can damage plants from the seedling stage. In addition to cereals, legume cultivation has become popular in Lithuania over the last decade.

Currently, in Lithuania, by the decision of the European Commission, 2 percent support is granted for the cultivation of these crops. By reducing dependence on soybeans imported to Lithuania, farmers are encouraged to obtain their own protein feed. In addition, legumes are particularly important in agriculture due to crop rotation, which encourages farmers to pursue greening policies. Plant protection also makes up a significant part of the cost of beans. Both weeds and disease-grown beans attack at all stages of their development. Therefore, when growing beans, plant protection is very important, and beans are more sensitive plants than bell cereals. With the expansion of bean crop areas in Lithuania, the risk of diseases inevitably increases. The plant affected by pathogens changes, its individual parts or the plant itself stops growing or, conversely, grows abnormally, changes colour, and so on. Economically important bean fungal diseases include ascochytosis (Ascochyta fabae) and brown (chocolate) spot (Botrytis cinerea, B. fabae), and rust (Uromyces viciaefabae) has been added to that list in recent years.

The process of reducing the spread of diseases and weeds or eradicating them in agricultural crops is complex, as their resistance to some active substances or even groups of them develops quite rapidly. The long-term use of the same selective preparations also has a major impact on this, but pesticides still remain the main plant protection product. The World Health Organization (WHO) is developing a strategic approach to international and systematic chemicals management, promoting by 2025 move to a system for the production and use of chemicals that poses minimal risk to nature and human health.

Spring wheat and beans are widely grown in Lithuania, because the granulometric composition, acidity and climatic conditions of the soils of most districts are suitable for the growth and development of these agricultural plants. Disease and weed control is one of the most important factors in achieving the highest productivity of agricultural crops. Without timely application of plant protection products, crop losses average around 30% and can reach 50% or more under favourable conditions for the spread of pests. The use of plant protection products is therefore a necessary component of all agricultural plant production technologies. Lithuanian farmers are constantly analyzing the weed and disease control strategies used on their farms.

The current state of plant protection is much more complex than it was 10-20 years ago, when studies of pesticide residues in agricultural production were not relevant. At present, farmers have to choose a control strategy that is compatible with the requirements of organic farming.

Proper farming requires not only good crop yields, but also the cultivation of crops with the least possible negative impact on the environment. Many plant protection products not only affect pests (pathogens) but can also affect the environment and human health. Therefore, their use is regulated and must be economically justified. Chemicals (pesticides) used to protect plants from diseases, pests and weeds can not only be toxic to humans and fauna, but also contaminate water bodies, groundwater and soil with dangerous pollutants.

The application of integrated pest management in Lithuanian farms would reduce the extent of pesticide use and the potential risks of pesticides to the environment. An integrated pest management approach to protect crops from pests can be used to select the least environmentally harmful plant protection products, using biological preparations based on micro-organisms that do not adversely affect the environment or human health.

The proposal for the new project was submitted for funding for Lithuanian Ministry of Agriculture in 2021 but is not granted yet. The results presented in this report are available only about evaluation the effect of ProbioHumus and NaturGel on the growth and yield of different types of cereals from already implemented project.

4.4 Barriers (to implementing the project)

In Lithuania several research institutions are capable to implement high quality research projects. There is working qualified research staff, laboratories are equipped with the newest modern equipment. Farmers are interested in the results obtained by independent research institutions, tested in experimental fields and tested in the farming conditions. This shows a good potential to search and develop alternative IPM products capable to replace conventional pesticides used for pest and weed control. The main barrier is currently available funding for nationally implemented projects. This financial barrier was indicated not only by researchers but also by famers representatives.

5. Discussion and conclusions

After evaluating the effect of Humatate on the growth and development of winter oilseed rape seedlings, the most active compound was determined - NaturGel (2 l / ha for seed wrapping, 2 l / ha for spraying).

In organic farm in Šiauliai district, which is in favourable areas for farming, after tests with spring wheat it was found that the use of NaturGel + Probio Humus promotes the formation of structural elements of crop yield: the number of grains in the penis increased by 18 poc. o 1000 seed weight - 3% Result obtained: although a higher seed weight was found in the test field, the yield remained unchanged compared to the control.

In an organic farm in Ukmergė district, which is located in less-favoured areas, experiments with spring wheat showed that the most intensive plants grew in the field with NaturGel, and the highest seed mass was in the field with ProbioHumus. Result obtained: although in field no. 3 The weight of 1000 seeds increased to 5%, but fields no. 1, no. 2, no. 3 and no. 4 Yield remained unchanged.

In a conventional farm in Anykščiai district, which is located in less-favored areas, after tests with spring wheat, it was found that in the fields where NaturGelis (No. 2) and ProbioHumus (No. 3) were used, the weight of 1000 grains increased on average by 10%. yield of affected

fields compared to field no. 1 increased, the highest supplement reached 1 t / ha, at the same time no costs were incurred for fertilizers, therefore profitability increased - 140 Eur / ha.

In the conventional farm in Joniškis district, which is located in favourable areas for farming, after the tests with winter wheat, the greatest impact on plant growth and yield formation was found in the field with NaturGel. Result obtained: field no. 2 yield compared to field no. 1 did not increase, but no costs for fertilizers were incurred, therefore the profitability increased - 100 Eur / ha.

In the conventional farm in Telšiai district, which is located in favourable areas for farming, it was found that the height of oat plants in the field with ProbioHumus was the highest (20% higher than No. 1), but the most active crop formation was observed in the field with NaturGel. Result obtained: although in field no. 3 shows a higher seed weight, but fields no. 1, no. 2 and no. 3 Yield remained unchanged.

Tests performed with peas on the conventional farm in Vilkaviškis district, which is in favorable areas for farming, showed that the most intensive formation of crop structure elements was observed in field no. 2 and no. 3. The weight of 1000 seeds increased by 5 and 3 percent, respectively, the number of seeds in the pod - by 12-10 percent. The result obtained: in the field with ProbioHumus the protein content in the seeds increased by 7%, with a slight change in the total nitrogen content according to Kjeldahl. It was found that the yield of the test fields corresponded to the yield of the control fields, but due to the decrease in fertilizer costs, the profitability increased - 90 Eur / ha.

ProbioHumus (twice for 3 l / ha spraying) promoted carrot development and crop formation on the organic farm. The average unit weight increased by 21% with increasing dry matter accumulation. ProbioHumus and NaturGel increased carotenoids in roots by 8%, sugars by 24% and ascorbic acid by 12%. No changes in antioxidant activity were detected. Nitrate accumulation changed little compared to controls.

ProbioHumus (4 l / ha, for soil treatment, two times 3 l / ha for spraying) stimulated the yield of onions grown on non-organic farms - the average onion weight increased by 12%. In the test variant with ProbioHumus + NaturGel, the sugar content increased by 13% and the nitrate content remained unchanged compared to the control.

Experiments with strawberries showed that the test compounds influenced the development of strawberries: an average increase of 23% in berry weight compared to controls. A slight increase in vitamin C content was obtained in berries grown in the field with NaturGel + ProbioHumus.

In non-organic farms, ProbioHumus (twice for 3 l / ha spraying) was the most intensive driver of carrot development and yield formation - the average unit weight increased by 21%. The highest increases in sugars (24%) and ascorbic acid (12%) were observed in the probioHumus + NaturGelis test variant. An increase in antioxidant activity (33%) was obtained with ProbioHumus. The tested substances slightly reduced the accumulation of nitrates in carrots compared to the control.

ProbioHumus (two times 3 l / ha for spraying) promoted beet development and yield formation in organic farming. The average unit weight increased by 27%. Both ProbioHumus and ProbioHumus used in combination with NaturGel had no effect on the accumulation of sugars and ascorbic acid in roots. A slight increase in antioxidant activity (5%) was observed with

ProbioHumus. Nitrate levels in the experimental variants were slightly lower compared to the control.

In non-organic farms, probioHumus was used in combination with NaturGel (4 l / ha for soil treatment and 3 l / ha for spraying) to promote beet development and yield formation - the average unit weight increased by 29%. ProbioHumus + NaturGelis increased sugar (11-15%) content, antioxidant activity (22%), but ascorbic acid content was equal to control. Nitrate accumulation remained unchanged compared to controls.

In the organic farm, both NaturGelis and ProbioHumus (3 l / ha twice for spraying berry bushes) promoted the development of black currant berries. The berry weight increased by 28% and 45% compared to the control, respectively, with an increase in dry matter accumulation of 38% and 57%. The antioxidant activity in the berries of the affected berry bushes increased insignificantly - within the margin of error, the analysis of the anthocyanin composition did not show any differences between the test variants. Ascorbic acid levels in blackcurrants treated with ProbioHumus were comparable to controls, and in the test variant with ProbioHumus + NaturGel increased by 44%.

The new project proposal is prepared to use biopreparations for weed control in cereals. Project coordinator is the Lithuanian Chamber of Agriculture. Scientific part is going to be implemented by researchers of Botany Institute, Nature Research Center On the farms. It is expected that it will be approved and funded by Lithuanian Ministry Agriculture 2021. The implementation will start in 2022.

Annex I - Bibliography

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