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Technologies of Protection and Nutrition in Agrophytocenoses of Legumes for Organic Seed Production

Inna Horodyska*, Yurii Ternovi, Artem Chub, Alla Lishchuk, Maryana Draga

The Institute of Agroecology and Environmental Management of NAAS of Ukraine,
12, Metrolohichna str., Kyiv, 03143, Ukraine

*Corresponding author: anni0479@gmail.com

According to the legislation of Ukraine, one of the requirements of organic crop production is the use of organic seeds and organic planting material. High productivity and quality of sowing material for organic production of agricultural products can only be obtained with the full supply of plants and soil to nutrients and the protection of plants from diseases, pests and weeds. The purpose of the work was to study the technologies of protection and nutrition of legumes (peas and soybean) with the use of domestic biopreparations in seminal organic agrophytocenoses. The research was carried out in the right-bank forest-steppe of Ukraine. The influence of technologies of the use of complexes of biological products of natural origin on the productivity of the seed material of peas and soybeans, its seed quality and phytosanitary condition of crops were studied. The study evaluated the potential of legume crops by main economic characteristics in the conditions of use of organic production technologies in different phases of ontogenesis of plants. Positive influence of technologies of complexes of biological preparations on growth and development of cultivated plants, which was reflected on their biometric indices, is established, finally forming the yield of peas and soybeans and high crop quality. In general, the use of all investigated technologies using biopreparations on peas and soybeans ensured obtaining quality organic seed material that meets the requirements of DSTU 2240-93 for reproductive seed.

Keywords: organic products, legume crops, organic seed production, biological preparations.

Introduction

Because of the reorientation of the export market of Ukraine to the EU market in the country, the number of agricultural producers willing to produce organic products has steadily increased in recent years. The demand for organic farming in the European Union is quite large and organic products have a stable price, which is an attractive factor for many agricultural enterprises in Ukraine. Today, in the country, there are more than 600 farms, which have switched to the production of organic products or are in the transition period (Semenda and Semenda, 2014).

A special niche in organic production is occupied by legume crops. Legumes due to valuable chemical composition of grain have a great industrial and raw material value. Cereals, flour, various confectionery, food and feed concentrates are produced from legume crops. Legumes play an important role in improving soil fertility. Due to this, they are one of the best precursors in crop rotation for cereals and industrial crops.

For the production of organic products (raw materials), seeds and planting material obtained by organic production are used, namely the maternal and paternal forms of plants that have been grown in accordance with detailed rules during one generation. Organic seeds are seeds produced in ecologically safe conditions in accordance with world standards and intended for production of organic products. The production and sale of such seeds is carried out for a limited set of varieties and hybrids.

In accordance with Article 12 of Council Regulation (EC) No. 834/2007 of June 28, 2007 (Council Regulation (EC) 2007) according to organic production and labelling of organic products, only seeds and vegetative planting material obtained by organic production methods should be used for the production of products except seeds and vegetative planting material. That is, the maternal plant for the seed and the paternal plant of vegetative planting material should be grown in accordance with the *Production Rules for Plant Production* laid down in this Regulation for at least one generation or, in the case of perennial crops, during two vegetation periods.

In the Ukrainian legislation, the bases of organic production and labelling of organic products are prescribed in Article 17 of the Law of Ukraine *On the production and circulation of organic agricultural products and raw materials* (the Law of Ukraine *On the basic principles...*, 2019).

According to this Law, organic produce is used for the production of organic products (raw materials), namely the maternal and paternal forms of plants grown in accordance with detailed rules for one generation, and in the case of perennial crops, for two vegetation periods.

Both legislative documents indicate only which seeds may correspond to the organic status, but they do not specify criteria and indicators that would ensure the high quality of the sowing material for organic production of agricultural products.

In the traditional production, the main criteria for determining the quality of the seed material are seed quality of seeds, which includes purity, similarity, energy, weight of 1000 seeds and varietal qualities. Seed quality of seeds is characterized by laying on the genetic level of homogeneity and the alignment of the basic characteristics inherent in the variety. Using high quality seeds according to these criteria is an important step for increasing wheat seedling density and as a result obtaining high quality harvest.

The basic principles of the production and circulation of seeds and planting material, as well as the procedure for exercising state control over them, are defined in the Law of Ukraine *On Amendments to the Law of Ukraine "About Seeds and Planting Material"* No. 5397-VI dated October 2, 2012 (the Law of Ukraine *About Seeds...*, 2012; Zakharchuk, 2013). For the production of commodity products (raw materials), as a rule, sowing material of the first reproduction grown in specialized seed farms is used.

Thus, for the production of organic seeds, it is best to use dairy (elite) unprocessed seeds and get reproductive (Ternovyi et al., 2018). Quality indicators for reproductive seeds are determined and regulated by the State Standard of Ukraine DSTU 2240-93 (DSTU 2240, 1993). Such indicators for soybeans and peas are given in Table 1.

The main provisions of the legislative documents (Council Regulation (EC) No. 834/2007; the Law of Ukraine *On the basic principles...*, 2019) do not affect the process of primary seed production of legume crops, but radically change the technology of organic seed production, which will significantly affect the crop quality.

On seed crops of leguminous crops, it is important to adhere to all the requirements of the technology (Mykhaylov et al., 2012). Under such crops, the most fertile and unpolluted weed areas stand out. Sowing is carried out

Table 1. Basic indicators of quality of seeds of legumes (DSTU 2240-93)

Culture	Category of seed	Varietal purity, %, min	Seed content			Germination, %, min	Humidity, %, max
			Main cultures, %, min	Other species pcs/kg, max			
			Cultural	Weeds	Including heavy separated		
Pea	RS*	98	98	15	3	92	15
Soybean	RS	98	95	8	10	80	14

*RS – reproductive seed

by selective high-quality seeds at optimal time on carefully prepared fields. A very important technological tool for growing all legumes is the careful alignment of the surface of the field. In addition, for seed crops, the optimum system of nutrition and protection is used in order to obtain high quality seeds and good phytosanitary condition. For solving these issues in organic production, a completely different system of protection and nutrition of seminal agrophytocenoses of legumes is used (Chorna, 2015).

The purpose of the work was to study the technologies of protection and nutrition of legumes with the use of domestic biopreparations in seminal organic agrophytocenoses.

Materials and methods

Studies were conducted in the conditions of the right-bank forest-steppe of Ukraine based on the Skvyrska Research Station of Organic Production of the Institute of Agroecology and Environmental Management of NAAS

(SRSOP IAEM of NAAS) at the field demonstrations site for organic production. This site was created in 2013 within the framework of the Ukrainian-Swiss project *Development of the organic market in Ukraine*, together with the Institute of Organic Agriculture FiBL (Switzerland). In 2016, this landfill received a certificate in accordance with the European standards for the production of organic agricultural products. The area of the landfill is 40 hectares, in which there is a 6-way crop rotation in which the legume crop is up to 35%.

Research of influence of technologies in which domestic preparations of a natural origin are used on the yield of soybean and peas seeds, their quality and phytosanitary condition was carried out. The potential of soybean varieties of domestic and foreign origin according to the main economic features under the conditions of the use of technologies of organic production was estimated.

The technology of using biological preparations on pea of the Starter variety (selection and seed company “Norddeutsche Pflanzenzucht Hans-Georg Lembke KG”

Table 2. Complex of technological operations within the cultivation of soil for legume crops

Type of work	Aggregate
Cutting the stubble to a depth (6–8 cm)	YuMZ-6L
Plowing to the depth (23–25 cm)	T-150 + PLN-5-35
Closing the moisture	MTZ-80 + harrows BZTS-1
Cultivation at depth (10–12 cm)	MTZ-80 + KS-4.2
Pre-sowing cultivation at depth (6–8 cm)	MTZ-80 + KS-4.2
Harvesting before sowing (2 times)	MTZ-80+ spring harrow
Sowing to a depth (3–4 cm)	MTZ-80 + SZT-3.6
Harrowing before seedlings	MTZ-80 + spring harrow
Harrowing after seedlings (3 times)	MTZ-80 + spring harrow

Table 3. Biological preparations used in technologies for growing organic legumes

Variant №	Manufacturers of preparations	Name of preparation	Origin of preparation	Direction of action
1	TD "Enzim Agro"	BiNitro Pea	<i>Rhizobium leguminosarum</i>	Biological inoculant for legumes
		Trichodermin	Spores and mycelium of the antagonist fungus of the genus <i>Trichoderma</i>	Biofungicide for cereals and legumes
		Biomag soya	<i>Bradyrhizobium japonicum</i>	Microorganism – inoculant for soy
		Urozhay Organic	Cu – 8.5 g/L; Fe – 3.8 g/L; Zn – 2.0 g/L; Mn – 25 g/L; Mo – 0.2 g/L; B – 2.2 g/L	Chelate-based microfertilizer for cereals and legumes
		Biophosphoryn	<i>Bacillus megaterium</i>	Phosphorus and potassium supply of cereals and legumes
		PhytoDoctor	<i>Bacillus subtilis</i>	Protection of cereals and legumes from diseases
2	BTU-Center Ltd.	Mico-Help	<i>Bacillus subtilis</i> , <i>Azotobacter chroococcum</i> , <i>Trichoderma viride</i> , <i>Trichoderma lignorum</i> (<i>Trichoderma harsianum</i>)	To protect plants from a wide range of fungal and bacterial diseases, to stimulate plant growth and development
		Groundfix	<i>Bacillus subtilis</i> , <i>Bacillus megaterium</i> var. <i>phosphaticum</i> , <i>Azotobacter chroococcum</i> , <i>Enterobacter</i> , <i>Paenibacillus polymyxa</i>	Soil biofertilizer for mobilization of phosphorus and potassium from insoluble compounds, nitrogen fixation and increase of efficiency of use of mineral fertilizers
		Enposam	<i>Paenibacillus polymyxa</i> 1718	Fertilizer for crop production as a mobilizer of phosphorus and potassium and as a stimulator of plant growth
		Mico-Help	<i>Trichoderma</i> , <i>Bacillus subtilis</i> , <i>Azotobacter</i> , <i>Enterobacter</i> , <i>Enterococcus</i>	Treatment and prevention of fungal diseases, stimulation of root system growth
		Organic balance	<i>Azotobacter chroococcum</i> , <i>Bacillus subtilis</i> , <i>Paenibacillus polymyxa</i> , <i>Enterococcus</i> , <i>Lactobacillus</i>	Fertilizer for crop production
		Azotophyte R.	<i>Azotobacter chroococcum</i>	Stimulator of natural origin for plant growth, fixes the molecular nitrogen of the atmosphere, increases the stress resistance of plants
		HelpRost nasinnya	<i>Bacillus subtilis</i> , <i>Enterococcus</i>	For pre sowing treatment seeds of cereals and legumes
Enposam	<i>Paenibacillus polymyxa</i>	Biological product-fertilizer for plant nutrition and protection		
3	Center for Effective Technologies Ltd.	BIO AG "Emochka rodyuchist"	Complex of microorganisms, based on uterine cultures SCD ProBio Balance Plus	The drug is used to restore soil fertility
		Emochka original	Photosynthetic and lactic acid bacteria, yeast, actinomycetes, fermenting fungi	The drug increases the biological activity of the soil, stimulates the growth and development of plant

Variant №	Manufacturers of preparations	Name of preparation	Origin of preparation	Direction of action
4	AF Kolos Ltd.	Microbiophyte	<i>Bradyrhizobium japonicum</i> IMB B-7540	For soil bacterialisation
		Vermibogumate	Humic-containing fertilizer obtained by extracting humic acids of compost	For soil bacterialisation
5	Private Enterprise "NVP "Eco-Garant"	BioNorma (anti stress)	<i>Pseudomonas fluorescens</i> , <i>Pseudomonas putida</i> , <i>Paenibacillus polymyxa</i> , <i>Azospirillum lipoferum</i>	Acceleration of plant and soil regeneration after the destructive impact of man-made factors
		Biopolycid	<i>Paenibacillus polymyxa</i>	Inhibits the development of phytopathogenic fungi, promotes the growth processes, increases plant immunity
		Rizoactive Peas	<i>Rhizobium leguminosarum</i> , <i>Sinorhizobium meliloti</i> , <i>Bradyrhizobium lupini</i> , <i>Rhizobium galegae</i> , <i>Mesorhizobium ciceri</i>	Presowing treatment of legume seeds
6	MEF Aqua Vitae	Riverm	Micro- and macroelements, nitrogen and phosphobacteria	Fertilizer for cereals and legumes
7	EMU Green Ltd.	Amineon	Amino acids – 47 g/L; carboxylic acids – 159 g/L; sugars – 23 g/L; N – 15 g/L; P ₂ O ₅ – 4 g/L; K ₂ O – 39 g/L; S – 2 g/L; Mg – 3 g/L; Zn – 0.1 g/L; Cu – 0.002 g/L	Foliar feeding for cereals and legumes

(Germany)) and on soybean varieties such as the Suzirya (National Science Center "Institute of Agriculture of the National Academy of Agrarian Sciences of Ukraine") and Kent (presented in Ukraine by Saatbau Linz) was studied.

Terms of conducting research were close to the field study. The general agrotechnical measures consisted of conducting technological operations for each investigated culture timely for the right bank forest-steppe of Ukraine (Table 2). For protection against weeds, only agrotechnical measures were used, i.e., the spring harrow of the German company "Treffler".

During sowing and during vegetation of legumes, the effectiveness of various biological preparation complexes on the productivity and quality of peas and soybeans was investigated. The domestic market is represented by many companies that are manufacturers of complexes of biological preparations, offering a variety of technologies for their application on a particular culture.

In experiments with organic pea, seven promising technologies for the use of biological drugs were used (Table 3).

Treatment by the preparations was carried out before sowing and during the three phases of development of plants according to the technological maps presented by the producers for this culture (Table 4–5).

In experiments with soybeans, two varieties of soybean and three technologies for the use of biological preparations were applied. The soybean varieties differ in the length of the vegetation period: for Suzirya, it is 110–115 days, and for Kent, it is 120–125 days. The technology of cultivating soy crops is similar to the corresponding technology for peas (Table 6–7).

Treatments with the aforementioned preparations were also carried out in the flowering and bean phases according to the standards given in Table 7.

Each accounting area was 1000 m², repeatability was fourfold, and the predecessor was winter wheat. All received results were compared with the control variant (without treatment with preparations).

The structure of crop yields was determined by analyzing test sheaves from 50 plants, which were taken

Table 4. Biological preparations for presowing treatment of pea

Variant №	Manufacturers of preparations	Name of operation	Name of preparation	Dose	
				L/t	L/ha
1	TD "Enzim Agro"	Seed treatment	BiNitro Pea (biological inoculant for legumes)	0.7	–
			Biophosphoryn	1.0	–
			PhytoDoctor	1.0	–
2	BTU-Center Ltd.	Soil treatment	Mico-Help	–	2.0
			Groundfix	–	7.0
			Enposam	–	0.5
		Seed treatment	Mico-Help	2.0	–
			Organic balance	1.0	–
			Azotophyte R.	0.5	–
			HelpRost nasinnya	1.0	–
Enposam	0.5	–			
3	Center for Effective Technologies Ltd.	Soil treatment	BIO AG "Emochka rodyuchist"		20.0
		Seed treatment	Emochka original	15.0	–
4	AF Kolos Ltd.	Soil treatment	Microbiophyte (for soil bacterialisation)	–	2.0
			Vermibiogumate (for soil bacterialisation)	–	2.0
		Seed treatment	Microbiophyte	0.6	–
			Vermibiogumate	1.2	–
5	Private Enterprise "NVP "Eco-Garant"	Soil treatment	BioNorm (anti stress)	–	2.0
		Seed treatment	Biopolycid	1.0	–
			Rizoactive Peas	2.0	–
6	MEF Aqua Vitae	Seed treatment	Riverm	0.6	–
7	EMU Green Ltd.	Seed treatment	Amineon	1.0	–

Table 5. Treatment by biopreparations during vegetation of pea

Variant №	Manufacturers of preparations	Phases of ontogenesis					
		Four leaves		Budding		Formation of beans	
		Name of preparation	Dose, L/ha	Name of preparation	Dose, L/ha	Name of preparation	Dose, L/ha
1	TD "Enzim Agro"	Treatment was not carried out		Trichodermin	2.0	Trichodermin	2.0
				PhytoDoctor	1.0	PhytoDoctor	1.0
				Urozhay Organic	1.5	Urozhay Organic	1.5
2	BTU-Center Ltd.	Organic balance	0.5	Phyto Help	0.5	Organic balance	0.5
		Enposam	0.3	Organic balance	0.5	HelpRost	1.0
				HelpRost	1.0	Enposam	0.3
				HelpRost Bor	0.5	–	–
				Enposam	0.3	–	–

Variant №	Manufacturers of preparations	Phases of ontogenesis					
		Four leaves		Budding		Formation of beans	
		Name of preparation	Dose, L/ha	Name of preparation	Dose, L/ha	Name of preparation	Dose, L/ha
3	Center for Effective Technologies Ltd.	BIO AG "Emochka rodyuchist"	10.0	BIO AG "Emochka rodyuchist"	10.0	BIO AG "Emochka rodyuchist"	10.0
4	AF Kolos Ltd.	Microbiophyte Pea	1.0	Microbiophyte Pea	1.0	Microbiophyte Pea	1.0
		Vermibio-gumate	2.0	Vermibio-gumate	2.0	Vermibio-gumate	2.0
5	Private Enterprise "NVP "Eco-Garant"	BioNorma	1.0	BioNorma	2.0	Treatment was not carried out	
6	MEF Aqua Vitae	Riverm	7.5	Riverm	4.5	Riverm	4.5
7	EMU Green Ltd.	Amineon	2.0	Amineon	2.0	Amineon	2.0

Table 6. *Presowing use of biological preparations for soybean*

Variant №	Manufacturers of preparations	Name of operation	Name of preparation	Dose	
				L/t	L/ha
1	TD "Enzim Agro"	Seed treatment	Biomag soya	4.0	–
			Biophosphorin	2.0	–
			PhytoDoctor	1.0	–
2	BTU-Center Ltd.	Soil treatment	Mico-Help	–	2.0
			Groundfix	–	7.0
			Enposam	–	0.5
		Seed treatment	Mico-Help	2.0	–
			Organic balance	1.0	–
			Azotophyte R.	0.5	–
			HelpRost nasinnya	1.0	–
			Enposam	0.3	–
Riso Line	2.0	–			
3	Center for Effective Technologies Ltd.	Soil treatment	BIO AG "Emochka rodyuchist"	–	20.0
		Seed treatment	Emochka original	15.0	–

Table 7. *Treatment of soybean plants by biopreparations during the ontogenesis phases of the triple leaf*

Variant №	Manufacturers of preparations	Name of preparation	Dose, L/ha
1	TD "Enzim Agro"	Biomag	0.5
		Urozhay Organic	1.0
2	BTU-Center Ltd.	Organic balance	0.5
		Enposam	0.3
3	Center for Effective Technologies Ltd.	BIO AG "Emochka rodyuchist"	10.0

before harvesting from five sites (points) of the plot. Statistical processing of the research results of was carried out by B. A. Dospekhov (1985).

Results and discussion

The yield and seed quality of legume seed crops depend on a complex set of factors and are the most important criteria for evaluating each variant of the experiment.

Unlike traditional technologies, in which chemical preparations contribute to the elimination of the adverse effects of pests, weeds and diseases that endanger the development of a cultivated plant, in organic technologies, preparations of biological origin prevent the emergence of a negative factor or improve the immunity of the plant to it. According to our research, companies use different technologies for the application of biological products. Most

of them use 1–2 preparations during the entire vegetation period of a cultivated plant. Several companies use a whole range of drugs whose application technology varies during the growing of culture. It was established that these technologies had a definite influence on the growth and development of a cultivated plant, which was reflected in its biometric parameters, resulting in the increase of the yield of peas and seed quality. Significant influence on the growth of plants (maximum up to 51 cm) by the use of biopreparations manufacturers Private Enterprise “NVP “Eco-Garant” (BioNorma, Biopolycid and Rizoactive Peas) and EMU Green Ltd. (Amineon) was shown. Using these technologies ensured the formation of up to 52 seeds per pea plant. On control variants without treatment by biological preparations, it was only 47 seeds per pea plant (Table 7).

The yield of plants is a synthesis indicator of all environmental factors that have an effect on the plant.

Table 7. Elements of the pea harvest structure depending on the use of biological products (average for 2016–2018)

Variant №	Technologies of manufacturers of preparations	Stem length, cm	Number of beans per plant, pcs.	Number of seeds from the plant, pcs.	Yield, t/ha
1	TD “Enzim Agro”	48	10	48	2.20
2	BTU-Center Ltd.	50	10	50	2.35
3	Center for Effective Technologies Ltd.	50	10	51	2.40
4	Agrofirma Kolos Ltd.	49	10	49	2.30
5	Private enterprise “NVP” Eco-Garant”	51	10	52	2.40
6	MEF Aqua Vitae	49	10	48	2.25
7	EMU Green Ltd.	51	10	52	2.60
8	Control	47	9	47	1.75
	LSD _(.05)	1.6	0.4	0.9	0.6

The yields are influenced both by the components of biocenosis and by agroclimatic factors. In the variant without the use of biopreparations, the yield of peas for three years of research averaged to 1.75 t/ha. The use of biological products provided a significant increase in seed yield in all variants. A minimum increase in the yield was provided by a complex of preparations from TD Enzim Agro. The maximum yield in an average of three years (2.6 t/ha) was obtained in the variant with

the introduction of the preparation Amineon. The action of the preparations provided an increase in the number of seed germ and their mass.

The action of biopreparations contributed to the improvement of the seed quality of peas, both the size of seeds and germination. The mass of 1000 seeds in 200 g and over after using preparations on pea sowings was provided by manufacturers of biopreparations “Center of Effective Technologies” Ltd., Private enterprise “NVP

“Eco-Garant” and EMU Green Ltd. (Table 8). The preparations of these companies are mainly microfertilizers for foliar nutrition, and their composition includes a variety of trace elements and amino acids, which significantly affect the quality of indicators for the formation of pea beans.

The energy of germination of pea seeds increased by 4–5% in all variants compared with control. All technologies allowed obtaining organic seed material of peas with germination of seeds greater than 92%, which corresponds to DSTU 2240-93 *Seeds of agricultural crops. Varietal and sowing qualities. Specifications for reproductive seeds* (DSTU 2240, 1993).

The greatest attention in Ukraine is given to the production of organic soybeans, as a valuable product for organic livestock breeding. Organic production involves a large varietal potential of this crop. But, unfortunately, there is no organic seed material of the varieties that have best proved themselves in the organic production of commodity products (Horodyska et al., 2018a).

The highest values in the organic production of legumes are demonstrated by the high protein varieties. Varieties of legumes with a long period of vegetation (mid-late ripe, middle-late ripe and late ripe varieties) have high protein content. According to previous researches conducted at the SRSOP IAEM of NAAS for the cultivation of

Table 8. Indicators of quality of organic pea sowing material, depending on the technologies of using biopreparations (average for 2016–2018)

Variant №	Manufacturer of preparation	Weight of 1000 seeds, g	Germination energy, %	Germination, %
1	TD “Enzim Agro”	194	85	95
2	PP “BTU-Center”	195	84	95
3	Center for Effective Technologies Ltd.	201	84	95
4	Agrofirma Kolos Ltd.	194	84	94
5	Private enterprise “NVP” Eco-Garant”	200	85	95
6	MEF Aqua Vitae	195	85	94
7	EMU Green Ltd.	201	84	95
8	Control	183	80	91
	LSD _(0,05)	6.7	2.3	2.6

organic soybeans under the conditions of the right-bank forest-steppe of Ukraine shown as the optimal period for sowing was established on May 20; however, the date may vary depending on weather and climate conditions of a particular year (Ternovyi et al., 2018; Plaksyuk et al., 2017). During this period, the soil warms up to no less than 15°C, which promotes the rapid seedlings of soybeans, growth of this culture and increases its competitiveness to weeds. Thus, due to late sowing periods, late soybean varieties with a period of vegetation of more than 125 days in organic production are not capable of reaching the phases of technical ripeness in some years. As a result, the question of the study of technologies for the use of biological preparations capable of providing high yield

and quality characteristics of seeds of soybean varieties with a period of vegetation of less than 125 days has been investigated. A team of authors (Horodyska et al., 2018b; Horodyska et al., 2018c; Draga et al., 2017) have studied the influence of the use of biological products on yield and quality of soybean in conditions of organic production.

In research sites, the use of biologics did not have a significant effect on the length of the stem compared with the control variant, but contributed to the increase in the number of germ beans and, as a result, an increase in the number of seeds per plant up to 4–7 seeds in the variety Suzirya and 3–5 seeds in the variety Kent (Table 9).

An increase in the number of seeds contributed to an increase in yields of 0.10–0.25 t/ha in soybeans of the

Table 9. Elements of soybean crop structure depending on the technology of using biological productions (average for 2016–2018)

Variant №	Factor A (varieties)	Factor B (manufacturer of complexes of preparations for soybean)	Stem length, cm	Number of beans per plant, pcs.	Number of seeds from the plant, pcs.	Yield, t/ha
1	Suzirya	TD “Enzim Agro”	68	41	110	2.5
2		PP “BTU-Center”	70	42	112	2.6
3		Center for Effective Technologies Ltd.	70	42	113	2.7
4		Control	69	38	106	2.4
5	Kent	TD “Enzim Agro”	59	35	99	2.7
6		PP “BTU-Center”	61	34	100	2.7
7		Center for Effective Technologies Ltd.	60	34	101	2.8
8		Control	59	31	96	2.3
LSD _(.05)			0.9	1.2	3.8	0.3

Suzirya variety compared with the control variant. On soybean plants of Kent variety, the effect of used preparations significantly increased yields (by 0.35–0.50 t/ha) compared with the control by increasing the size of seeds. In addition, soybean plants of Kent variety more efficiently used the biopreparations which caused an increase of soybean seeds yield compared with the soybean of Suzirya variety. The maximum increase in the yield of soybean seeds in both varieties was provided by the technology using the preparations BIO AG “Emochka rodyuchist” and “Emochka original”.

Also, the use of these preparations contributed to an increase in the weight of 1000 seeds of both sorts of soy, in particular, in soybean plants of the Suzirya variety by

4–6 grams and Kent variety by 5–8 grams. Biopreparations provided an increase of energy of germination of seeds of both soybeans varieties by 3–4% (Table 10). The most effective use of biotechnologies of all producers increased the germination of soybean seed of variety Kent – by 6–8%. This is due to the fact that, according to its characteristics, Kent variety is close to late ripe soy varieties and needs a 10 days longer vegetation period to produce high quality seeds than Suzirya variety.

In general, the use of all investigated technologies on soybean crops, including on control variants without using biological preparations, allowed obtaining organic seed material that meets the requirements of DSTU 2240-93 for reproductive seed (DSTU 2240, 1993).

Table 10. Indicators of quality of organic soybean sowing material depending on the use of biological preparations (average for 2016–2018)

Variant №	Factor A (varieties)	Factor B (manufacturer of complexes of preparations for soybean)	Weight of 1000 seeds, g	Germination energy, %	Germination, %
1	Suzirya	TD “Enzim Agro”	174	83	91
2		PP “BTU-Center”	176	84	92
3		Center for Effective Technologies Ltd.	176	84	93
4		Control	170	80	88
5	Kent	TD “Enzim Agro”	184	78	88
6		PP “BTU-Center”	185	78	89
7		Center for Effective Technologies Ltd.	187	79	90
8		Control	179	75	82
LSD _(.05)			6.5	3.2	4.8

Conclusions

The research established the positive effect of technologies using all complexes of biological preparations on the yield of legumes as well as on the seed quality of the studied crops. When selecting soybeans for organic production, the main criterion in the conditions of right-bank forest-steppe of Ukraine is the period of vegetation. It was found that late ripe soy varieties are at risk zone because of the formation of not high quality of crop yield, both of commercial products and of the sowing material.

It has been proved that such elements of the technology of cultivating the seed material as fertilizers and the

control of diseases, pests and weeds ensure the production of organic seeds of leguminous crops with high seed quality. Alternatives to the use of these elements in the organic production of seeds can be biological protection products, soil improvers, agrotechnics of soil preparation, scientifically grounded crop rotation and selection of adapted and resistant varieties. The main criteria for obtaining organic sowing material of legume crops is matching the technology to the basic principles of organic production, its ability to provide seed with high sowing and varietal qualities, the absence of contamination and damages by diseases and pests.

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