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FORMATION OF PRODUCTIVITY AND QUALITY INDICATORS OF SOYBEAN GRAIN DEPENDING ON THE ELEMENTS OF ORGANIC CULTIVATION TECHNOLOGY

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Abstract

The article presents the results of studies of the influence of weed control measures and seed inoculation on the productivity and quality of soybean varieties under organic cultivation. The highest level of grain yield in the varieties Angelica, ES Visitor and Ezra was obtained by hilling soybean plants in the phase of the 1st true leaf - 2.11, 2.43 and 2.48 t/ha. The maximum grain yield was obtained in the variety Ezra - 2.19 t/ha, in ES Visitor it was 2.10 t/ha, and in Angelica - 1.81 t/ha. The maximum number of beans per plant (31.8 pcs.), number of seeds per plant (38.6 pcs.), their weight (7.99 g) and weight of 1000 seeds (165.6 g) was obtained in the variety Ezra for inoculation with the preparation Hystik soya against the background of hilling soybean plants in the phase of the 1st true leaf. Among the studied soybean varieties, the maximum protein content was 41.8-44.1% in Angelica, and 21.0-23.0% in ES Visitor. Weed control measures did not affect the fat and protein content of soybean grain.

Key words*: soybean, variety, organic technology, seed inoculation, weed control measures.*

INTRODUCTION

Soybeans (*Glycine max* L.) are one of the five crops that dominate global agriculture, along with corn, wheat, cotton and rice. Among oilseeds, soybeans are the world's largest producer (Nendel et al., 2023). Soybeans demonstrate the greatest potential for increasing acreage due to their high protein content (39-48%), the ability to grow in a wide temperature range, and a significant amount of agronomic and biological data on this crop (Karges et al., 2022). In 2021-2022, more than 70 countries produced 355.7 million tonnes of soybeans. In 2020-2021, the European Union produced 2.7 million tonnes of soybeans, and European non-EU countries produced another 8.4 million tonnes (Eurostat, 2021). The few areas in Europe where soybeans are grown are concentrated between 45° and 50°N, with the largest production in Eastern Europe: Ukraine (3.7 million tons), Serbia (0.7 million tons), Romania (0.4 million tons) and the Northern Mediterranean: Italy (1.0 million tons), France (0.4 million tons) (FAOSTAT, 2019).

In the EU, the volume of organic production of crop raw materials for livestock is steadily growing. The area of agricultural land for organic production has increased tenfold over the past 10 years. It is expected that by 2030, the quota for organic products will reach 30%. This will have a positive impact on the environment, climate, biodiversity and animal welfare. Increased organic farming also has a direct impact on reducing and eliminating the use of mineral fertilisers, pesticides, fungicides, genetically modified organisms and antibiotics (Vonder Crone, 2022).

At the same time, organically grown soybeans account for less than 0.1% of total global soybean production. In the US, in 2011, certified organic soybeans were grown on 53 thousand hectares or 0.17% of the total soybean area (32 million hectares) (Willer & Lernoud, 2017). In general, there is a gradual increase in the production of organically grown soybeans in the world. This is due to the increase in human consumption of soy products, as well as the growing demand for organic soybean meal for

the production of organic animal products (Hartman et al., 2016).

Ukraine is a country with an underdeveloped organic agriculture sector. The main reason for this is the limited purchasing power of the domestic population (Voskobiinyk & Havaza, 2013). As of 2017, the total share of organic farmland was insignificant (less than 1% of total agricultural land). However, at the same time, our country ranks 11th in Europe in terms of the area of agricultural land with organic production (Grabovska et al., 2021). In 2013-2017, the area under organic production increased by 1.5 times. About 45.5% of all organic areas in 2017 were sown with grain crops (AgroPolit.com, 2019). At the same time, the growth of organic production in Ukraine is one of the highest in the world: the growth rate is 5.5 times higher than in Europe and 4.9 times higher than in the world (AgroPortal, 2019). In the organic sector, in 2012-2017, the share of cereals and legumes decreased by 2.5%, while soybeans increased by 5.1% (Ostapenko et al., 2020; Grabovskyi et al., 2023).

In organic production, it is important to select soybean varieties that have the following characteristics: fast and efficient nitrogen fixation and high competitive resistance to weeds (Vollmann et al., 2010). Based on the evaluation of 12 soybean varieties over 10 years, the genotype-environment interaction was tested for a number of soybean yield components. This helped to identify varieties with the above characteristics (Cober & Morrison, 2015).

One of the most important aspects of soybean cultivation is weed control. Due to its slow growth in the initial period, it is particularly sensitive to weed competition from two to eight weeks after emergence (Absy & Yacoub, 2020; Andrade et al., 2019). Competition for resources such as light, water, and nutrients can lead to significant yield losses and deterioration of crop quality (Rüdell et al., 2021). The impact of weeds on soybean plants has already been sufficiently studied, which demonstrates the importance of effective methods of weed control (Ball et al., 2019). Further research on the development of new mechanical weed control measures will help to improve their effectiveness and increase soybean yields.

According to data obtained in Canada in 2014-2015, yield losses of organically grown soybeans due to weeds ranged from 20 to 44%, while these losses were lower than in the case of timely weed removal. The average yield of soybean varieties ranged from 1.38 to 1.81 t/ha. Organic soybean yields were more influenced by growing conditions and to a lesser extent by varietal characteristics (Carkner & Entz, 2017).

Mechanical weed control has a direct effect on weeds, but does not lead to complete removal of the segetal vegetation (Malone et al., 2022). Mechanical weed control depends on the equipment and is a compromise between optimising weed control and minimising damage to soybean plants. Local climatic and soil conditions, initial development, and weed growth stage are factors that influence the success of mechanical weed removal and soybean yields (Gonçalves et al., 2021; Zanon et al., 2016).

Alternative methods to mechanical weed control, such as mulching and intercropping, have been investigated but have shown little effectiveness due to specific environmental conditions (Datta et al., 2017). Intercropping can be seen as a promising method of weed control. For soybeans, this involves growing together with plants that can compete with weeds, but not so much with soybean plants (Cheriere et al., 2020).

According to the results of studies conducted in Luxembourg in 2018-2019, it was found that soybean grain yields were almost the same in the variants with inter-row cultivation and hand weeding, and were similar between cultivation with needle harrows and without weed control (Richard et al., 2023).

The increase in fat and protein content in soybean seeds by an average of 0.7-1.6% was facilitated by pre-sowing inoculation of seeds. Compared to crude protein content, the range of fat content fluctuations was smaller. In addition, there is an inverse relationship between crude fat and protein content (Mosyondz, 2014).

Under organic cultivation, the maximum gross yield of fat (0.59-0.74 t/ha) and protein (1.17-1.36 t/ha) in soybean varieties in Ukraine is ensured by pre-sowing inoculation of seeds with phosphonitragin, inter-row cultivation with a Haruwy-1032 RS/L2.1 cultivator, as well as

foliar feeding of crops with Azotophyt (50.0 ml/ha) (Pindus et al., 2022).

The development of organic production in Ukraine requires relevant research on soybean cultivation as one of the most important crops in organic crop rotations.

The aim of our research was to study the effect of weed control measures and seed inoculation on the formation of productivity and grain quality of soybean varieties under organic cultivation.

MATERIALS AND METHODS

The research was carried out in 2022-2023 at the Training and Production Centre of Bila Tserkva National Agrarian University according to the following scheme: Factor A. Soybean varieties: Angelica, ES Visitor, Ezra. Factor B. Weed control measures: no (control), inter-row cultivation, hilling of soybean plants in the cotyledon phase, hilling of soybean plants in the phase of the 1st true leaf. Factor C. Seed inoculation: without inoculation (control), Legum Fix, Risaktiv soya, Hystik soya.

The soil of the experimental plot is typical leached chernozem, medium-deep, low-humus, coarse-loamy-loamy on carbonate loess. The area of the sowing plot was 30 m^2, the accounting plot was 25 m^2, the experiment was replicated three times, and the placement of variants was systematic.

The technology of soybean cultivation in the experiment corresponded to the basic principles of organic production and was carried out in accordance with the requirements of the current legislation of Ukraine (Law of Ukraine, 2018). The predecessor was winter wheat. The sowing method was wide-row with a row spacing of 45 cm. Soybean seeds were inoculated before sowing. Plant density was 600 thousand plants/ha. Inter-row tillage was carried out in the phase of the first trifoliate leaf and before closing the rows. Other measures to control the number of weeds were carried out according to the scheme of the experiment.

To determine the structure of the crop, before harvesting soybeans, sheaf samples of 25^2 plants per sheaf were taken in two places of the plot from an area of 0.25 m. In laboratory conditions, plant height, number of branches, number of beans per plant, height of attachment of the first bean, number of seeds per bean, number of seeds per plant, seed weight per plant were determined.

The fat and protein content of soybean grain was determined by infrared spectrometry using an infrared analyser NIP 450 Scanner 4860.

Grain yield was measured in plots by the method of continuous threshing with direct combining using a Massey Ferguson 16 MF combine, by weighing seeds from each plot at full grain maturity.

RESULTS AND DISCUSSIONS

The height of attachment of the first soybean beans varied depending on the variety. Its highest values were recorded in the variety Ezra, it varied from 14.8 to 18.0 cm, with an average value of 16.2 cm. In the varieties Angelica and ES Visitor, the height of attachment of the first bean was in the range of 14.0-16.7 and 12.3-14.8 cm, with average values in the experiment of 15.1 and 13.2 cm (Tables 1-3).

Table 1. Influence of the studied factors on the formation of elements of the structure of soybean yield of Angelica variety (average for 2022-2023)

Weed control measures	Inoculation of seeds	Attachment height of the first bean, cm	Number of beans per plant, pcs.	Seed weight, per plant, g	Weight of 1000 seeds, g
Control	without inoculation	14.0	13.2	3.56	110.1
	Legum Fix	14.2	14.1	3.81	112.9
	Risaktiv soya	14.3	14.3	3.78	109.8
	Hystic soya	14.1	14.4	3.98	114.1
Inter-row cultivation	without inoculation	14.2	24.2	5.45	126.6
	Legum Fix	14.3	25.6	5.92	134.3
	Risaktiv soya	14.5	25.1	5.68	130.4
	Hystic soya	14.3	26.1	5.98	135.4
Hilling soybean plants in the cotyledon phase	without inoculation	15.1	25.2	6.11	142.0
	Legum Fix	15.2	26.7	6.68	143.9
	Risaktiv soya	15.2	26.0	6.44	143.8
	Hystic soya	15.0	26.4	6.79	144.7
Hilling soybean plants in the 1st true leaf stage	without inoculation	16.5	25.6	6.31	146.5
	Legum Fix	16.7	26.8	6.71	149.0
	Risaktiv soya	16.6	26.5	6.57	148.0
	Hystic soya	16.7	27.0	6.82	151.1
Average		15.1	23.0	5.66	134.2

Inoculation of seeds did not affect the height of attachment of the first bean. A more significant

impact on the formation of this indicator was made by measures to control the number of weeds.

Thus, in the variants with inter-row cultivation, the height of attachment of the first bean in the Angelica variety increased by 1.2%, the ES Visitor variety - by 2.03%, and Ezra - by 3.1% compared to the control.

Table 2. Influence of the studied factors on the formation of elements of the yield structure of soybean variety ES Visitor (average for 2022-2023)

Weed control measures	Inoculation of seeds	Attachment height of the first bean, cm	Number of beans per plant, pcs.	Seed weight per plant, g	Weight of 1000 seeds, g
Control	without inoculation	12.3	15.2	3.78	104.5
	Legum Fix	12.5	16.0	4.02	108.0
	Risaktiv soya	12.4	16.1	3.98	105.7
	Hystic soya	12.0	16.5	4.08	110.8
Inter-row cultivation	without inoculation	12.6	28.4	6.13	129.3
	Legum Fix	12.7	29.5	6.52	132.1
	Risaktiv soya	12.4	29.1	6.45	131.4
	Hystic soya	12.5	29.8	6.60	133.5
Hilling soybean plants in the cotyledon phase	without inoculation	13.4	29.6	6.88	137.1
	Legum Fix	13.6	30.2	7.21	141.4
	Risaktiv soya	13.7	30.0	7.15	142.5
	Hystic soya	13.5	30.6	7.25	143.0
Hilling soybean plants in the 1st true leaf stage	without inoculation	14.3	29.8	7.06	143.8
	Legum Fix	14.8	30.7	7.25	144.7
	Risaktiv soya	14.5	30.6	7.20	145.5
	Hystic soya	14.3	31.1	7.31	146.6
Average		13.2	26.5	6.18	127.7

When hilling soybean plants in the cotyledon phase, this indicator increased by 6.9, 10.2 and 12.1%, and when hilling soybean plants in the phase of the 1st true leaf - by 17.5, 17.9 and 20.1%, respectively.

Depending on the varietal characteristics, the number of beans per plant also varied. In the varieties Angelica and ES Visitor, this indicator ranged from 13.2-27.0 and 15.2-31.1, and the maximum values were obtained in the variety Ezra - 16.3-31.8.

The effectiveness of seed inoculation with strains of active microorganisms in increasing the number of beans per plant was, on average, 2.7-5.7% when using Legum Fix, 2.5-4.2% when using Risaktiv soya, and 4.2-6.5% when using Hystik soya. In the variants with inter-row cultivation, this indicator increased by 76.9-83.0%, when hilling soybean plants in the cotyledon phase by 83.0-88.7%, and when hilling soybean plants in the phase of the 1st true leaf - by 85.1-91.2% compared to the control.

Table 3. Influence of the studied factors on the formation of elements of the yield structure of soybean variety Ezra (average for 2022-2023)

Weed control measures	Inoculation of seeds	Attachment height of the first bean, cm	Number of beans per plant, pcs.	Seed weight per plant, g	Weight of 1000 seeds, g
Control	without inoculation	15.0	16.3	4.02	128.1
	Legum Fix	14.9	17.0	4.88	134.3
	Risaktiv soya	14.8	17.2	4.78	130.3
	Hystic soya	15.0	17.4	4.94	135.2
Inter-row cultivation	without inoculation	15.2	29.2	6.45	140.4
	Legum Fix	15.3	30.2	6.91	147.6
	Risaktiv soya	15.4	30.0	6.84	147.1
	Hystic soya	15.5	30.7	6.98	148.5
Hilling soybean plants in the cotyledon phase	without inoculation	16.4	30.6	7.45	154.7
	Legum Fix	16.8	31.2	7.86	160.0
	Risaktiv soya	16.8	31.0	7.84	158.2
	Hystic soya	16.9	31.5	7.97	163.2
Hilling soybean plants in the 1st true leaf stage	without inoculation	17.8	30.8	7.67	157.9
	Legum Fix	18.0	31.7	7.98	163.9
	Risaktiv soya	18.0	31.4	7.91	161.7
	Hystic soya	17.9	31.8	7.99	165.6
Average		16.2	27.4	6.78	135.4

The weight of seeds per plant averaged 5.66 g in the Angelica variety, 6.18 g in the ES Visitor variety, and 6.78 g in the Ezra variety. Under the influence of inoculation of seeds of the studied varieties with Legum Fix, an increase in seed weight per plant was observed by 4.8-8.0%, Risaktiv soya - by 3.9-7.0%, Hystik soya - by 5.8-10.0%. In the variants with inter-row cultivation, this indicator increased by 46.0-62.0%, when hilling soybean plants in the cotyledon phase by 67.1-79.6%, and when hilling soybean plants in the phase of the 1st true leaf - by 69.4-81.7%, compared to the control.

The weight of 1000 seeds in the variety ES Visitor was the smallest in the experiment and averaged 131.2 g with a range of variation from 104.5 to 146.6 g, in the variety Angelica larger seeds were formed (133.9 g), and the maximum weight of 1000 seeds was in the variety Ezra - 149.8 g.

Under the influence of inoculation of seeds of the studied varieties with Legum Fix, an

increase in the weight of 1000 seeds was observed by 2.3-4.2%, Risaktiv soya - by 1.3-2.8%, Hystik soya - by 3.8-5.4%, compared to the control. In the variants with inter-row cultivation, this indicator increased by 10.5-22.7%, when hilling soybean plants in the cotyledon phase by 20.4-31.5%, when hilling soybean plants in the phase of the 1st true leaf - by 23.0-35.4%.

The maximum number of beans per plant (31.8 pcs.), the number of seeds per plant (38.6 pcs.) and their weight (7.99 g) and the weight of 1000 seeds (165.6 g) were obtained in the variety Ezra for inoculation with the preparation Hystik soya against the background of hilling soybean plants in the phase of the 1st true leaf.

Our research has shown that among the soybean varieties studied, Angelica had the highest protein content of 41.8-44.1%, and ES Visitor had the highest fat content of 21.0-23.0% (Table 4).

Table 4. Protein and fat content in soybean grains (average for 2022-2023)

Weed control measures	Inoculation of seeds	Protein content, %			Fat content, %		
		Angelica	ES Visitor	Ezra	Angelica	ES Visitor	Ezra
Control	without inoculation	41.8	37.4	40.5	20.2	21.0	20.6
	Legum Fix	43.5	39.3	41.9	21.3	22.1	21.4
	Risaktiv soya	44.0	39.6	42.1	21.4	22.2	21.5
	Hystic soya	43.2	39.2	42.0	21.4	22.2	21.5
Inter-row cultivation	without inoculation	41.5	37.0	40.1	20.4	21.4	20.7
	Legum Fix	43.8	39.2	41.6	21.5	22.3	21.8
	Risaktiv soya	44.0	39.4	41.9	21.7	22.6	22.0
	Hystic soya	43.7	39.0	41.8	21.5	22.6	22.0
Hilling soybean plants in the cotyledon phase	without inoculation	41.6	37.6	40.6	20.0	21.6	20.3
	Legum Fix	43.6	39.7	42.3	21.2	22.8	21.6
	Risaktiv soya	44.1	40.0	42.6	21.5	23.0	21.8
	Hystic soya	44.0	39.8	42.2	21.4	23.0	21.7
Hilling soybean plants in the 1st true leaf stage	without inoculation	42.0	37.8	40.7	20.3	21.7	20.3
	Legum Fix	43.7	39.8	42.4	21.4	22.8	21.5
	Risaktiv soya	44.1	40.1	42.6	21.4	23.2	21.8
	Hystic soya	44.0	40.0	42.4	21.6	23.2	22.0
Average		43.3	39.1	41.7	0.41	21.1	22.4

It should be noted that weed control measures did not affect the protein and fat content. In the variants with seed inoculation, an increase in the content of protein and fat in the grain, on average by varieties, was observed by 1.6-2.3% and 1.1-1.3%, respectively, compared to the variants without it.

On average, over two years, the maximum yield was obtained in the variants with pre-sowing inoculation of seeds with Hystik soya preparation. The average grain yield, on average, for weed control measures, was 1.90 t/ha in the Angelica variety, 2.22 t/ha in the ES Visitor variety and 2.29 t/ha in the Ezra variety, with values in the control variants of 1.59, 1.88 and 1.97 t/ha (Tables 5-7).

Table 5. Grain yield of soybean variety Angelica, t/ha

Weed control measures (A)	Inoculation of seeds (B)	2022	2023	Average
Control	without inoculation	1.05	1.26	1.16
	Legum Fix	1.35	1.52	1.44
	Risaktiv soya	1.38	1.56	1.47
	Hystic soya	1.39	1.59	1.49
Inter-row cultivation	without inoculation	1.43	1.7	1.57
	Legum Fix	1.68	1.96	1.82
	Risaktiv soya	1.67	1.95	1.81
	Hystic soya	1.67	1.98	1.83
Hilling soybean plants in the cotyledon phase	without inoculation	1.64	1.89	1.77
	Legum Fix	1.85	2.2	2.03
	Risaktiv soya	1.87	2.23	2.05
	Hystic soya	1.88	2.25	2.07
Hilling soybean plants in the 1st true leaf stage	without inoculation	1.75	1.99	1.87
	Legum Fix	2.02	2.28	2.15
	Risaktiv soya	2.06	2.34	2.20
	Hystic soya	2.09	2.38	2.24
LSD (P≤0.05)	A	0.07	0.08	
	B	0.03	0.03	
	AB	0.09	0.12	

When using Legum Fix and Risaktiv soya preparations, the yields of these varieties were 1.86, 2.15 and 2.25 t/ha and 1.88, 2.18 and 2.26 t/ha, respectively. The yield increase from inoculation of Legum Fix seeds, depending on the variety and weed control measures, ranged from 0.24 to 0.31 t/ha, Risaktiv soya - from 0.28 to 0.33 t/ha, Hystic soya - from 0.30 to 0.41 t/ha. It should be noted that there was no significant difference in the years of research between the variants with inoculation of seeds with Risaktiv soya and Hystik soya.

Table 6. Grain yield of soybean variety ES Visitor, t/ha

Weed contro measures (A	Inoculation of seeds (B)	2022	2023 p.	Average
Control	without inoculation	1.33	1.52	1.43
	Legum Fix	1.58	1.77	1.68
	Risaktiv soya	1.60	1.82	1.71
	Hystic soya	1.61	1.84	1.73
Inter-row cultivation	without inoculation	1.69	2.03	1.86
	Legum Fix	1.99	2.37	2.18
	Risaktiv soya	1.96	2.37	2.17
	Hystic soya	2.02	2.43	2.23
Hilling soybean plants in the cotyledon phase	without inoculation	1.90	2.20	2.05
	Legum Fix	2.10	2.46	2.28
	Risaktiv soya	2.14	2.51	2.33
	Hystic soya	2.21	2.56	2.39
Hilling soybean plants in the 1st true leaf stage	without inoculation	2.01	2.33	2.17
	Legum Fix	2.36	2.60	2.48
	Risaktiv soya	2.40	2.64	2.52
	Hystic soya	2.44	2.67	2.56
LSD (P≤0.05)	A	0.06	0.07	
	B	0.04	0.03	
	AB	0.11	0.10	

When using Legum Fix. the grain yield was 0.03-0.07 t/ha less than in the third and fourth variants with seed inoculation.

Table7. Grain yield of soybean variety Ezra, t/ha

Weed control measures (A)	Inoculation of seeds (B)	2022	2023	Average
Control	without inoculation	1.39	1.66	1.53
	Legum Fix	1.56	1.93	1.75
	Risaktiv soya	1.58	1.98	1.78
	Hystic soya	1.59	1.99	1.79
Inter-row cultivation	without inoculation	1.79	2.22	2.01
	Legum Fix	2.09	2.49	2.29
	Risaktiv soya	2.05	2.47	2.26
	Hystic soya	2.13	2.51	2.32
Hilling soybean plants in the cotyledon phase	without inoculation	1.91	2.34	2.13
	Legum Fix	2.16	2.66	2.41
	Risaktiv soya	2.2	2.7	2.45
	Hystic soya	2.23	2.75	2.49
Hilling soybean plants in the 1st true leaf stage	without inoculation	2	2.47	2.24
	Legum Fix	2.38	2.69	2.54
	Risaktiv soya	2.39	2.72	2.56
	Hystic soya	2.41	2.74	2.58
LSD (P≤0.05)	A	0.06	0.06	
	B	0.02	0.03	
	AB	0.10	0.10	

The soybean varieties under study responded positively to weed control measures. Thus. when using inter-row cultivation. the increase in soybean grain yield was 22.5-35.4% compared to the control.

When hilling soybean plants in the cotyledon phase. this increase was 35.0-43.9%. The highest productivity of the crop was obtained by hilling soybean plants in the phase of the 1st true leaf - 2.11. 2.43 and 2.48 t/ha. which is 0.71-0.83 t/ha more than in the control. Among the varieties. on average for two years. the maximum grain yield was obtained in Ezra - 2.19 t/ha. in ES Visitor it was 2.10 t/ha. and in Angelica - 1.81 t/ha.

CONCLUSIONS

It was found that under the influence of seed inoculation and weed control measures. The number of beans per plant increased by 2.5-6.5% and 76.9-91.2%. The number of seeds per plant by 3.7-9.6% and 26.0-37.4%. The weight of seeds per plant by 3.9-10.0% and 46.0-81.7 %. the weight of 1000 seeds by 1.8-5.4 % and 10.5-35.4 %. compared to the control variants. Inoculation of seeds did not affect the height of attachment of the first bean. and when applying measures to control the number of weeds. it increased by 1.2-20.1%. The maximum number of beans per plant (31.8 pcs.). the number of seeds per plant (38.6 pcs.) and their weight (7.99 g) and the weight of 1000 seeds (165.6 g) was obtained in the variety Ezra for inoculation with the preparation Hystik soya against the background of hilling soybean plants in the phase of the 1st true leaf.

It was found that among the soybean varieties studied. Angelica had the highest protein content of 41.8-44.1%. and ES Visitor had the highest fat content of 21.0-23.0%. Weed control measures did not affect the protein and fat content of soybean grain. In the variants with seed inoculation. an increase in protein content in grain was observed by 1.6-2.3%. and fat content by 1.1-1.3%. compared to the variants without their use.

The highest level of grain yield in the varieties Angelica. ES Visitor and Ezra was obtained by hilling soybean plants in the phase of the 1st true leaf - 2.11. 2.43 and 2.48 t/ha. which is 0.71-0.83 t/ha higher than in the control

variants. On average. over two years. the highest grain yield was obtained in Ezra - 2.19 t/ha. in ES Visitor it was 2.10 t/ha. and in Angelica - 1.81 t/ha.

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