

Investigations

Developing a System of Organic Farming Technologies to Obtain Environmentally Clean Agricultural Products (Organic Food) in the Steppe Zone of the Kostanai Region

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Abstract: The goal of the research is to study the opportunity to produce environmentally clean agricultural products (organic food) under the conditions of the Kostanai Region. The researches were made in two crop rotations: cereal laying fallow, two-field crop rotation (1 – biologized fallow – mustard, 2 – wheat) and cereal laying fallow, two-field crop rotation (1 – biologized fallow – grass sorghum, 2 – wheat). Both are formed on stubbles and shredded straw, where wheat cultivation technologies are used. Experimental variants of wheat cultivation are classified into saving organic technologies. Over the 2012-2014 researches, biologized fallows of the Sudan grass happened to be the best forecrops when fighting against weediness of crops both at the fallow stage and for the next crop after the fallow. The cocurrent observations allowed revealing the tendency of improving the erosion resistance of biologized fields occupied by the mustard and Sudan grass for crop residue. Data on the yield for three years say about the efficiency of short crop rotations with biologized fields. Thus, the wheat yield after the grass sorghum for the years of researches made up 17.9 c/ha – technology 1, 18.7 c/ha – technology 2 and 17.1 c/ha – technology 3. After mustard it was 17.0 c/ha – technology 1, 17.9 c/ha – technology 2 and 19.6 c/ha – technology 3. The denial from applying pesticides, along with biologization of fallow fields and applied cultivation technologies made it possible to decrease the content of trace quantities of pesticides in soil and wheat samples at the initial stage of the three years' period and to entirely clean the experimental field and yield from toxic remnants by the end of the three years' researches.

Keywords: Organic Farming, Biologized Farming, Crop Rotation, Soil Preparation, Technology, Straw, Grain, Yield

Introduction

The biological usefulness and food safety are the most important factors that define the state of health and level of the population working capacity. Safety and quality of products define the state prestige and are the basis for meeting needs of every person and the society as a whole. It is the most important component of competitiveness (Remele, 2015; Li *et al.*, 2015).

Over the recent decade in many countries of the world the yield of agricultural crops has increased 2.0-2.5 times due to both the cultivation of varieties of intensive type and using fertilizers and pesticides. The focus of plant farming intensification on resources and

power saving, ecological safety and profitability is stipulated by the need to optimize the use of chemical means in agrobiogeocenoses, first of all, due to biologization and ecologization of production functions of agroecosystems (Atandi *et al.*, 2017; Jeločnik *et al.*, 2015; Andersen *et al.*, 2015; Pašová *et al.*, 2014).

Organic farming (alternative farming) is a reasonable approach to land and plants. Due to it, stable yields are achieved with the minimum expenses and without applying mineral fertilizers and toxic chemicals (Litterick and Watson, 2017; Markuszewska and Kubacka, 2017).

Green fertilizers, stubble and mulch left on the field in case of alternative (organic) farming are the only sources of organic substances in soil that provide intensity of the

microorganisms' and fauna activity. Green fertilizers themselves are among the basic points the organic farming is based on (Zhirmuskaya, 2006; Bunna *et al.*, 2011; Frøseth *et al.*, 2014; McCalla and Army, 1961).

There is the next important effect of green fertilizers. Their over-ground biomass creates a dense sheet that protects the soil from erosion and mineralization of the organic substance and maintains nutritional chemicals in the upper productive horizon (Mathur *et al.*, 2016; Adnan *et al.*, 2017).

Green fertilizers also play an important sanitary role. Firstly, they suppress the growth of weed. Secondly, some types of green fertilizers contribute to cleaning soil from depredators and diseases. For example, thick planting of mustard considerably decreases the number of wireworms (Green Fertilizer, n. d., 2017).

In its turn, it is necessary to note the compliance with crop rotations under organic farming that provide a higher efficiency of cultivated crops, increase soil fertility and phytosanitary state of fields and decrease the number of depredators, diseases and weediness of crops (Gossen, 1974; Benaragama *et al.*, 2016).

These measures aim at improving the intensity of microbiological processes. Due to them, soil metabolism takes place. As a whole, now the improvement of ecological state of agrocoenosis is one of the main tasks of both the science and practice.

Materials and Methods

In 2012-2014 field experiment with two two-field crop rotations at cereal laying fallows were conducted. The wheat was seeded after two forecrops – biologized fields after Sudan grass and mustard.

On fields of the two-field crop rotation at cereal laying fallows (biologized fallow by seeing mustard – wheat) three types of wheat cultivation were laid. The same cultivation technologies were laid on fields of the second two-field crop rotation at cereal laying fallows (biologized fallow by sowing Sudan grass – wheat):

1. The biologized technology is a zero technology that allows using glyphosates containing preparations during the presowing period to fight against weed vegetation and seeds fall. Operations on chemical crop tending, as well as seed treatment before sowing are entirely excluded. Harvesting (hay cutting) is carried out by blending crop residues and distributing on the field
2. Biologized technology allows elements to minimize soil processing. Direct sowing by using the A blade is allowed to replace chemical preplanting cultivation. Operations on chemical crop tending, as well as seed treatment before sowing are entirely excluded. Harvesting (hay cutting) is carried out by blending crop residues and distributing on the field

3. Zero technology. Mechanical and chemical tilling is entirely excluded. Only direct sowing by SKP-2.1 seeders reequipped with anchor coulters is carried out. Fight against weed vegetation both in the fallow and for the crop is not allowed. Tilling the material for sowing is not allowed, either. Fertility is supported by leaving all after-harvesting residues in the field

During the research the above technologies were called as technology 1, technology 2 and technology 3, respectively.

The experiment was made three times. The area of the crop rotation fields was 0.09 ha (25×36 m). Between the fields there were headlands with the width of 15 m. The crop rotation fields were located at random.

The researches were made at experimental areas of the Kostanai Agricultural Research Institute LLC near the settlement of Zarechnoye. They were located at the hollow sloping plain of the upper terrace above flood-plain of the right bank of Tobol. They consisted of quaternary alluvial deposits, sand clays, sands, argillaceous clays, clayey soils and clays. The area under research had been used for agricultural production for a long time.

Results

The climate in the research zone is extremely continental with a cold winter with little snow and hot dry summer. Long cold in spring, early fall of temperature in autumn and late summer rainfalls are typical for the region climate and differentiate it from other dry regions (for example, Povolzhye). Great insolation, stark comparison of day and night temperature, low air humidity, little cloud coverage and frequent winds cause intensive water evaporation that 2-5 times exceeds the total of atmospheric falls. The end of May and most of June when spring corns are at the tillering stage – stem elongation – are especially dry. Before rainfalls crops have to use quickly disappearing reserves of water accumulated in the soil as a result of winter falls. All climate factors greatly vary from year to year but by tension and time of occurrence.

According to the data for many years, the annual norm of falls in the area of the experiments is 340 mm. Falls of the warm period (April-October) make up 71.2% of the annual number. Most of them fall down in the latter half of summer.

Weediness of Wheat Depending on Cultivation Technology

One of the main tasks grain producers face when using the organic method of farming is to suppress weediness of crops. Under other equal conditions, the growth of weediness of crops always causes a yield decrease.

The only possible alternative to modern chemical pesticides in terms of farming ecologization is an

integrated method of crops protection. One of its variants is the use of biologized fallows with green fertilizers for crop residues where the density of crops is increased and there are no favorable conditions for weed vegetation.

Weediness of crops at the stage of fully germinated wheat was observed annually (Table 1).

According to the data for three years, the wheat after mustard was mostly weeded. At the same time perennial weed vegetation prevailed. In terms of technologies, wheat after mustard was mostly weeded when technology 2 was used - 8.7 pcs./m² with many wet and dry weed vegetation. On the fields where technologies 1 and 3 were used weediness of crops was considerably lower – 3.9-5.7 pcs./m².

In case of technology 3 (2.1 pcs./m²) with the weight of weed vegetation – 7.5-1.8 g, wheat after Sudan grass was the most weeded.

Sowing of Sudan grass and mustard at the full germination phase were weeded almost equally both by quantity and weed vegetation weight. However, in case of Sudan grass, there was equal species composition of weed vegetation, while on mustard fields yearling fields prevailed.

It is also necessary to note that on fields where technologies 2 (8.5 pcs./m²) and 3 (10.4 pcs./m²) were used, Sudan grass was more weeded than on fields were

technology 1 (3.2 pcs./m²) was used. It was the same with mustard fields when fields with technologies 2 and 3 (13.7-6.9 pcs./m²) used were more weeded than the field with technology 1 (2.2 pcs./m²) used.

Since this experiment does not provide herbicide preparation of sowing, by the harvest the number of weed vegetation in wheat has increased (Table 2).

The analysis of Table 2 says that for the years of researches the greatest weediness of crops before harvesting was found on wheat after mustard, the least was found on wheat fields of Sudan grass both by quantity and weight. It says about the efficiency of Sudan grass as a forecrop when fighting against weed vegetation.

Erosion Resistance of the Fallow Field

Fallow fields in experiments were seeded with Sudan grass and mustard. One of the research goals was to determine the optimal forecrop to fight against water, wind erosion.

In 2012-2014 the sowing was carried out on the wheat stubble + shredded straw both by cultivation technologies and depending on the forecrop. The results of accounting the crop weight before the fallow by the background are shown in Table 3.

Table 1: Fully germinated weediness of crops, pcs./ m² (2012-2014)

Fields of crop rotation	Technology	Amount of weed vegetation (pcs./m ²)				Weight of wet mass (g)	Weight of dry mass (g)
		In total	Including				
			Yearling	Perennial			
Wheat after mustard	Technology 1	3.9	0.2	3.7	11.3	2.7	
	Technology 2	8.7	3.3	5.3	17.5	3.2	
	Technology 3	5.7	0.8	4.9	8.5	1.7	
Wheat after Sudan grass	Technology 1	0.6	0.1	0.5	2.4	0.5	
	Technology 2	0.5	–	0.5	6.5	1.3	
	Technology 3	2.1	0.8	1.3	7.5	1.8	
Sudan grass	Technology 1	3.2	0.4	2.9	7.2	1.6	
	Technology 2	8.5	4.9	3.6	13.4	4.0	
	Technology 3	10.4	5.3	5.1	13.3	3.3	
Mustard	Technology 1	2.2	1.6	0.5	2.4	0.8	
	Technology 2	13.7	11.4	2.3	14.4	3.7	
	Technology 3	6.9	4.7	2.2	7.8	3.4	

Table 2: Weediness of crops before harvesting, pcs./m² (2013-2014)

Fields of crop rotation	Technology	Amount of weed vegetation (pcs./m ²)				Weight of wet mass (g)	Weight of dry mass (g)
		In total	Including				
			Yearling	Perennial			
Wheat after mustard	Technology 1	40.9	39.9	1.0	83.3	22.4	
	Technology 2	90.3	42.8	3.5	83.1	22.7	
	Technology 3	25.5	20.5	5.0	74.7	18.8	
Wheat after Sudan grass	Technology 1	15.8	29.0	1.3	32.6	8.4	
	Technology 2	12.3	7.8	4.5	57.4	12.2	
	Technology 3	12.3	9.3	3.0	17.5	5.8	

Table 3: Content and structure of residues before fallow in the soil layer of 0-5 cm (2012-2014)

Fields of crop rotation	Technology	Weight of residues (g/m ²)	Including by fractions		Number of crops fragments (pcs./m ²)		Average length of residues (cm)
			Stubbles with roots	Residues without roots	Stubbles with roots	Residues without roots	
Wheat after Sudan grass	Technology 1	1.016	286	730	177	4,105	13.0
	Technology 2	824	229	588	172	2,884	12.1
	Technology 3	635	175	460	168	3,040	12.4
Wheat after mustard	Technology 1	778	227	550	183	3,477	10.1
	Technology 2	678	189	438	178	2,982	9.6
	Technology 3	573	168	410	176	3,297	9.6

The analysis of the research data obtained for 2012-2014 showed that when cultivating by using technology 1 at the beginning of fields biologized fallow with Sudan grass, there was more accumulated stubble both by the weight (1,016 g/m²) and size and number of fractions. When cultivating by using technologies 2 and 3, these indicators decreased and equaled.

Density of the Arable Layer of Soil, Food Regime of Soil

Southern light loamy black soils have a satisfactory composition both in the cultivable and humous layers of the soil (up to 60-70 cm). In case of ordinary agricultural technique, such soils preserve the composition given by the main preparation for a long time.

The soil density has various influences on a plant. Its excessive tightening can complicate the growth of roots. If the density of heavy soils is 1.5-1.6 g/cm³, the level of inaccessible moisture for plants dramatically increases. The optimal density fluctuation margin for basic crops cultivated in the north of Kazakhstan is within 1.1-1.3 g/cm³. According to numerous researches, the optimal volume weight for cereals is 1.10-1.20 g/cm³ and it is close to the balanced density of these soils (1.17-1.25 g/cm³).

In our researches the volume weight of the cultivable layer was defined at the beginning of the fallow, on cereals fields – before sowing according to backgrounds (Table 4).

As a whole, the analysis of the obtained samples of the volume weight said about the optimal density in practice and no distinct dependence between cultivation technologies was observed for 2012-2014.

Assessment of the initial state of the soil by the content of the main elements of mineral nutrition in the spring from 2012-2014. Before sowing, the nitrogen content of nitrate (N-NO₃) and Phosphorus Oxide (P₂O₅) in the “arable” soil layer was determined. The results of analyze of the crop rotation for the years 2012-2014 are summarized in Table 5.

Analysis of soil samples by years shows that the wheat fields after the Sudan grass in the 0-40 cm layer

by the nitrogen content of the nitrate have a low degree of supply. According to the content of phosphorus oxide, the fields have increased safety.

Yield of Spring Wheat Depending on Cultivation Technology

One of the tasks of this research is to obtain environmentally clean agricultural products under the decrease in the irreparable power consumption, the decrease in the intensity of the humus mineralization and due to fuller use of residues, accumulation of the organic substance in the upper soil layer and optimization of water and physical features. Along with this, it is necessary to obtain the maximum yield without applying any mechanical interference, except for sowing to prevent erosion processes in soil.

In order to obtain the maximum yield, it is also of great interest to use non-synthesized modern biopreparations that ensure efficiency and safety for people and the environment. Thus, since 2012 to 2014 a number of non-synthesized preparations such as Humilife, Zircon and Riverm have been applied. All of them are made of vegetable stock. The preparations were applied by sprinkling vegetative plants at the tillering phase and under the spring wheat earing. Table 6 shows the data on the yield.

In 2012 the yield was obtained on the general background of wheat stubble and blended crop residues. That year the Zircon non-synthesized preparation was applied.

Considering the table data, in terms of applying the growth regulator, considerable growth is observed from applying the Zircon preparation. In case of technology 1, the use of the growth stimulator added +1.6 cm (or 19.5%) as to the control (Technology 1 without using Zircon). In case of technology 2+Zircon, the yield was 10.1 c/ha and +0.7 c/ha or 7.4% was added, which in terms of fertilizers was considerable. The growth was also observed in case of technology 3+Zircon as to the control (technology 3 without preparation). Here the yield (11.0 c/ha) exceeded the control variant by 1.6 c/ha or 17.0%.

Table 4: Volume weight of soil before sowing and at the beginning of fallow by fields of crop rotation in the layer of 0-30 cm (2012-2014)

Fields of crop rotation	Cultivation technology	Density (g/cm ³)			Average in 2012-2014
		2012	2013		
Wheat after Sudan grass	Zero	1.10	1.20	1.18	1.15
	Minimum	1.09	1.21	1.18	1.16
Wheat after mustard	Zero	1.09	1.09	1.14	1.11
	Minimum	1.09	1.15	1.10	1.11
Sudan grass	Zero	1.09	1.16	1.16	1.13
	Minimum	1.09	1.14	1.18	1.14
Mustard	Zero	1.09	1.21	1.12	1.14
	Minimum	1.09	1.21	1.11	1.13

Table 5: Content of basic nutrients in the soil layer 0-20, 20-40 cm, before sowing (2012-2014)

Crop rotation fields	Technology options	Layer of soil (cm)	Contains mg/kg of soil	
			N-NO ₃	P ₂ O ₅
Wheat after Sudan grass	Technology 1	0-20	8,0	142,7
		20-40	6,9	121,8
		0-40	7,5	132,3
	Technology 2	0-20	9,2	125,1
		20-40	8,5	98,5
		0-40	8,9	111,8
	Technology 3	0-20	9,0	133,7
		20-40	8,5	114,0
		0-40	8,8	123,9
Wheat after mustard	Technology 1	0-20	10,1	152,0
		20-40	9,5	120,2
		0-40	9,8	136,0
	Technology 2	0-20	10,3	140,5
		20-40	10,0	117,5
		0-40	10,2	129,0
	Technology 3	0-20	10,5	142,3
		20-40	10,7	135,3
		0-40	10,6	138,8

Table 6: Yield of wheat grains depending on cultivation technology and applying non-synthesized preparations (2012)

Experiment variant	Average yield, c/ha	Yield growth	
		c/ha	%
Technology 1	8.2	–	100
Technology 2	9.4	+1.2	+14.6
Technology 3	9.4	+1.2	+14.6
Technology 1+Zirconium	9.8	+1.6	+19.5
Technology 2+ Zirconium	10.1	+0.7	+7.4
Technology 3+ Zirconium	11.0	+1.6	+17.0
HCP ₀₅ technology =	1.2;	HCP ₀₅ growth stimulator =	0.5

Table 7: Yield of wheat grains depending on cultivation technology and applying non-synthesized preparations (2013-2014)

Place of wheat in crop rotation		Technology 1				Technology 2				Technology 3			
		Control	Humilife	Zircon	Rivern	Control	Humilife	Zircon	Rivern	Control	Humilife	Zircon	Rivern
Wheat after Sudan grass	2013	15.0	15.3	16.7	15.5	14.1	14.7	14.7	14.6	14.4	13.8	14.0	14.3
	2014	20.9	21.3	20.8	19.7	22.7	21.1	21.0	22.1	19.7	19.6	16.8	17.8
Average	2013-2014	17.9	18.3	18.8	17.6	18.7	17.9	17.9	18.4	17.1	16.7	15.4	16.1
HCP ₀₅ technologies = 1.82; HCP ₀₅ fertilizer = 1.70.													
Wheat after mustard	2013	13.7	16.3	15.9	14.2	14.1	13.0	13.5	14.5	15.0	14.4	13.3	11.9
	2014	20.2	21.5	18.7	19.1	21.6	23.5	21.6	20.2	24.1	23.7	22.0	21.4
Average	2013-2014	17.0	18.9	17.3	16.7	17.9	17.3	17.6	17.4	19.6	19.1	17.7	16.7
HCP ₀₅ technologies = 2.09; HCP ₀₅ fertilizer = 1.06; HCP ₀₅ forecrop = 2.3													

Table 8: Remaining microquantity of pesticides in soil and grains samples (2012-2013)

Preparation	Active material	Content of active material (mg/kg)					
		Grains			Soil		
		2012	2013	2014	2012	2013	2014
Uragan forter	glyphosate*	0.00	0.00	0.00	0.00	0.00	0.00
Secator turbo	iodosulphrone	0.102	0.081	0.00	0.00	0.04	0.00
	amidosulphrone	0.00	0.00	0.00	0.00	0.00	0.00
Bars super	phenoxaprop-p-ethyl	0.00	0.00	0.00	0.00	0.00	0.00
Phalkon	spiroxamine	0.00	0.00	0.00	0.00	0.00	0.00
	tebuconazole	0.00	0.00	0.00	0.00	0.00	0.00
	triadimenol	0.00	0.00	0.00	0.00	0.00	0.00
Vitavaks	carboxin	0.00	0.00	0.00	0.00	0.00	0.00
	thiram	0.018	0.00	0.00	0.00	0.00	0.00
Karate	lambda-cyhalothrin	0.00	0.00	0.00	0.00	0.00	0.00

*– samples of grain and soil were selected from the technologies that do not allow using pesticides. However, the availability of glyphosate was defined both in technologies 2 and 3 and 1 where its use was allowed during the presowing period

During the next years in practiced several non-synthesized preparations that regulate the growth and development of plants were used. Table 7 shows the data.

The analysis of Table 7 showed that the average yield of wheat after Sudan grass for 2013-2014 was 17.9 c/ha with technology 1 applied; technology 2 – 18.7 c/ha; and technology 3–17.1 c/ha. No considerable difference between the technologies was revealed.

Residues of Microquantity of Pesticides in Soil and Wheat Grains Samples

It is necessary to consider the period when the soil and grains are entirely cleaned as the final stage of the experiment. According to the references, to clean soil and consequently the obtained products from the remaining microquantities of pesticides, three and more years are required.

Due to it, we selected samples of soil and grains to control subject to the remnants of pesticides. This control includes quantitative and qualitative analysis of data about using pesticides in the area under research during the previous years (at least 5 years), the selection itself and preparation of samples and analysis by using the chromatographic method. Table 8 shows the data obtained for 2012-2013.

Discussion

Weediness of Wheat Depending on Cultivation Technology

On average for 3 years wheat sowing after Sudan grass was the cleanest at the beginning of the vegetation stage. Technologies 1 and 2 show a low number of weed vegetation (0.6-0.5 pcs./m²). However, on the field where technology 2 was used dry and wet number of weed vegetation was higher (6.5-1.3 g) than on the field where technology 1 was used (2.4-0.5 pcs./m²).

In terms of technologies the field with technology 2 used was weeded. Technologies 1 and 3 had equal weed vegetation by both forecrops.

Erosion Resistance of the Fallow Field

As a result of selecting stubble and mulch by technologies from wheat fields after mustard, it was revealed that the researched indicators for technology 1 prevailed both by the weight (778 g/m²) and fraction size. Technologies 2 and 3 inconsiderably lost by accumulating crop residues.

Density of the Arable Layer of Soil, Food Regime of Soil

It is necessary to note that based on the density indicators for 2012, there was a kind of its increase in 1.5 years at separate areas of fields. However, finally the data become equal and even a kind of its decrease was observed.

The wheat fields after the mustard (in the 0-40 layer) had average N-NO₃ indices at technologies 2 and 3 (10.2 and 10.6 mg/kg), the technology 1 was slightly inferior. According to the stocks of P₂O₅, wheat after the mustard had an increased level of safety.

Yield of Spring Wheat Depending on Cultivation Technology

The control cultivation of wheat after mustard (without preparations) for the years of the research made it possible to obtain the following yield: 17.0 c/ha – technology 1; 17.9 c/ha – technology 2; and 19.6 c/ha – technology 3. There was no considerable growth from the applied growth regulators as to the control variants.

Residues of Microquantity of Pesticides in Soil and Wheat Grains Samples

In 2014 the results of the analysis were obtained to say about the complete clearance of the soil area. The active

substances iodosulphrone-methyl-sodium and thiram were not found in samples of soil and wheat grains.

Conclusion

The Republic of Kazakhstan has a significant potential in the field of organic farming. The production of environmentally friendly products is an important direction for the development of the "green economy", approved by the Government and included in the country's program, signed with the international organization of FAO. In accordance with this project, environmental legislation is being introduced, a national strategic plan is being created and a system of environmental certification and rules for controlling organic production in the Republic of Kazakhstan is being formed. Today in Kazakhstan there are a number of farms that specialize in the production of organic products. In general, there are about 30 producers of organic products in the republic, of which 22 farms are certified for the production of organic products in Kostanay region, with a total area of 294878 hectares:

1. On average for the years of the research the wheat sowing after Sudan grass was the cleanest at the beginning of the vegetation. For the years of the research weediness of crops before harvesting was most found on fields with wheat seeded after mustard, least – on wheat field after Sudan grass both by the quantity and weight. In terms of technologies the field with technology 2 used was the most weeded. Fields with technologies 1 and 3 used were equally weeded by both forecrops
2. Mass accumulation of plant residues was found even after the wheat vegetation, which is a positive tendency on the way to the phytosanitary cleanness of fields and decrease in the humidity loss which naturally suppresses erodibility processes on the soil surface
3. At the moment of sowing the wheat fields after mustard were less puddled. Thus, on the fields where zero and minimum technologies were used, the soil density was the same - 1.11 g/cm³ and on fields where there was wheat after Sudan grass it was 1.15 g/cm³ with the zero technology used and 1.16 g/cm³ with the minimum technology used. However, this density is close to the balanced and is not an obstacle on the way to good yield
4. Applying non-synthesized preparations for the research years as to the control variant did not cause the yield growth. It is necessary to note that for the research years no yield differences between applied crop rotations have been revealed

5. The data obtained for 2012-2014 say about the decrease in the reserves of microquantity of pesticides due to natural processes in the soil on the experimental field up to full clearance. Besides, the fact that pesticides were exclusively used during the vegetation as a method of fighting against weed vegetation, diseases and wheat blasts also contributes to non-accumulation of a number of pesticides

According to the results of the conducted studies, it has been established that the best technology for the production of organic grains is technology 2, since it is the most complete set of research tasks.

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Author's Contributions

All authors contributed equally.

Ethics

Authors declared no conflicts of interest.

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