Brazilian Journal of Biology®

ISSN 1519-6984 (Print)
ISSN 1678-4375 (Online)

Original Article

Protecting spring wheat plants using selenium and pesticides

Protegendo plantas de trigo de primavera usando selênio e pesticidas

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Abstract

The research was carried out in order to find ways to optimize the system of protection of spring wheat crops. In the conducted studies, the effect of combinations of sodium selenite and various pesticides, differing in the specifics of action and biological activity, on the yield and quality of spring wheat of the Yubileinaya 80 variety was studied. Currently, there is a need to achieve a sufficient effect of the action of chemical plant protection products and to obtain a minimum impact on human health and the environment. *The purpose of the research* is to study the influence of various combinations of chemical plant protection products and methods of using sodium selenite on the yield and grain quality indicators of spring wheat variety Yubileinaya 80. The studies were carried out under the conditions of a vegetative experiment with spring wheat variety Yubileinaya 80. Two methods of using sodium selenite and chemical plant protection agents of different specifics of action were studied: fungicide, herbicide, and insecticide, which were applied in different combinations and at different times. As a result of the studies, the phytotoxicity of the studied preparations of chemical plant protection was revealed, which apparently manifests itself as a result of inhibition of the morphometric indicators of the growth of the root system and vegetative organs of wheat plants, resulting in a violation of the processes of accumulation of assimilates and their outflow to the reproductive organs. Optimal combinations of pesticides and sodium selenite have been established, allowing to obtain reliable changes in yield and quality indicators of wheat grain. It was revealed that the use of selenium treatment before sowing seeds contributed to a decrease in the phytotoxicity of the studied pesticides, as a result of stimulating the processes of absorption by plants and the redistribution of nitrogen to the reproductive organs of wheat, which had a positive effect not only on the yield and quality of spring wheat of the Yubileynaya 80 variety, but also on the external surface microstructure of the fruit shell of the grain. The noted features of the surface of the fruit shell of the grain will reduce losses during grain processing and obtain processed products from such grain of higher quality.

Keywords: plant protection system, spring wheat.

Resumo

A presente pesquisa foi realizada com o objetivo de encontrar formas de otimizar o sistema fitofarmacêutico para culturas de trigo de primavera. Nos estudos aqui realizados, foi investigado o efeito de tratamentos combinados de selenito de sódio e diversos pesticidas, diferindo nas especificidades de ação e atividade biológica, assim como no rendimento e na qualidade do trigo de primavera da variedade Yubileinaya 80. Atualmente, existe uma demanda por produtos fitofarmacêuticos que tenham tanto uma ação eficiente quanto um mínimo impacto na saúde humana e no meio ambiente. O objetivo desta pesquisa é estudar a influência de diversas combinações de produtos fitofarmacêuticos e diferentes manejos do selenito de sódio nos indicadores de rendimento e qualidade dos grãos do trigo de primavera da variedade Yubileinaya 80. Os estudos foram realizados conforme as condições da propagação vegetativa com trigo de primavera variedade Yubileinaya 80. Foram pesquisados dois métodos de utilização de selenito de sódio e agentes fitofarmacêuticos com diferentes especificidades de ação: fungicidas, herbicidas e inseticidas, aplicados em diferentes combinações e momentos. Como resultado destes estudos, a fitotoxicidade das preparações fitofarmacêuticas aqui estudadas foi revelada, aparentemente se manifestando como resultado da inibição dos parâmetros morfométricos do crescimento do sistema radicular e dos órgãos vegetativos das plantas de trigo, resultando em uma interrupção dos processos de alocação dos assimilados e transporte dos mesmos para os órgãos reprodutivos. Foram estabelecidas as combinações ideais de pesticidas e selenito de sódio, permitindo obter alterações confiáveis nos indicadores de rendimento e de qualidade do grão de trigo. Concluiu-se que a utilização do tratamento com selênio antes da semeadura contribuiu para a diminuição da fitotoxicidade dos agrotóxicos estudados, por estimular os processos de absorção e redistribuição do nitrogênio para os órgãos reprodutivos do trigo, gerando um efeito positivo não apenas para o rendimento e qualidade do trigo de primavera da variedade Yubileynaya 80, mas também para a microestrutura da superfície externa do epicarpo do grão. As características observadas do epicarpo permitem uma redução das perdas durante o processamento do grão e a obtenção de produtos processados de maior qualidade a partir deste grão.

Palavras-chave: sistema fitofarmacêutico, trigo de primavera.

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Received: August 9, 2023 – Accepted: November 4, 2023

1. Introduction

Currently, due to an increase in the anthropogenic load on the environment, obtaining high, stable yields of good quality is limited, in addition to weather conditions and lack of nutrients, by a large number of pathogens of various nature (pests, diseases, weeds) (Vigilyansky et al., 2020). The priority direction of scientific research is the development of an integrated system of plant protection, including a theoretical and methodological justification for the integrated use of chemical and biological means and methods of plant protection (Goncharov et al., 1985; Surinsky et al., 2013; Zhelezova et al., 2017). In various studies, the toxic effect of chemical protective agents on various metabolic processes has been revealed, as a result of which the intensity of the synthesis and decay of organic substances, as well as the activity of enzyme systems, is disrupted. This activates a cascade of physiological reactions in plant cells, resulting in stress and a decrease in the resistance of cultivated crops to the effects of phytopathogens (Pronina, 2000; Nadezhkina, 2016; Vigilyansky et al., 2019, 2020; Seregina et al., 2022).

Modern technologies for the use of pesticides are limited by the requirements of technical regulations in order to achieve a sufficient effect of the preparations and have a minimal impact on human health and the environment. At the same time, there are serious concerns about the existence of a risk to human health, which is caused by the ingress of pesticide residues into food and drinking water (Podgornaya, 2009; Taimetov. 2016)]. In addition, the use of plant protection chemicals causes environmental pollution, which prevents the production of environmentally friendly crop products, and is also dangerous for beneficial insects (Koshkin, 2010; Chursina, 2012; Glinushkin and Beloshapkina, 2013; Glinushkin et al., 2015; Seregina and Nilovskaya, 2015; Vigilyansky, 2020).

In modern conditions of agricultural production, a pressing issue is to find ways to increase the effectiveness of chemical plant protection products when combined with various microelements, which are of high relevance and practical significance.

In this regard, one of the main directions of modern science is to find ways to improve plant protection systems by optimizing combinations of not only various pesticides that differ in specific action and biological activity, but also by studying the optimal combinations of pesticides with other agrochemicals. This will increase crop yields and technological indicators of grain quality (Seregina and Nilovskaya, 2015; Glinushkin et al., 2015; Meerovsky et al., 2017; Vigilyansky, 2020; Seregina et al., 2022).

Due to the lack of information on this issue, the purpose of our research was to study the effect of various combinations of sodium selenite and pesticides. This issue has not been studied previously.

2. Research Methodology

The object of research was spring wheat (Triticum aestivum L.) variety Yubileinaya 80. The studies were carried out from 2019 to 2022. To study the effect of various combinations of selenium fertilizers and pesticides on the yield and quality of spring wheat variety Yubileynaya 80, a vegetative experiment was carried out in soil culture.

Spring wheat variety Yubileinaya 80 is characterized by high yield, resistance to lodging and drought. The wheat variety Yubileinaya 80 is practically resistant under natural conditions to dusty and smut, leaf rust and powdery mildew. The variety meets the requirements for strong and valuable wheat (Ignatieva et al., 2019). Variety Yubileinaya 80 is a standard variety zoned in the Non-Chernozem zone.

Spring wheat was grown on soddy-podzolic medium loamy soil. Agrochemical characteristics of the soil: humus content according to Tyurin 1.5%, pHKCl 5.7 (class 6) (GOST 26483-85), hydrolytic acidity of the soil (according to Kappen) is 1.2 mg-eq / 100 g of soil (GOST 26212- 91); mg/kg (grade 3) (GOST 26107-84). The content of mobile forms of phosphorus in the soil is 180 mg/kg (grade 5). The content of mobile forms of potassium is 150 mg/kg (grade 5) (according to Kirsanov, GOST 54650-2011). The content of mobile forms of selenium was 0.08 mg/kg of soil (grade 1).

The studies were carried out according to the methods of (Kobzarenko et al., 2015). The research was carried out in a growing house. The growing house consists of two parts. One part of the house is under glass. The second part of the house is under the net. When it rains, plants are placed in containers on trolleys under a glass roof. In hot weather, the vessels are rolled out on trolleys under the roof, which consists of a mesh. Wheat plants were grown in metal Mitscherlich vessels with a capacity of 5 kg of soil. The vessels were placed in groups of 18 on trolleys. The trolleys were located under a glass roof. 30 wheat seeds were sown in vessels, followed by thinning to 20 plants during the tillering phase. Soil moisture in the vessels was maintained under optimal conditions (65-70% of PV) by watering. The duration of the experiment was 72-82 days.

Conditions for mineral nutrition were created using ammonium nitrate (NH_4NO_3), dipotassium phosphate (KH_2PO_4), and potassium chloride (KCl) at the rate of N100P100K100 mg/kg of soil.

Selenium was introduced in the form of sodium selenite (Na_2SeO_3) by 2 methods - seed treatment before sowing and foliar treatment of vegetative plants. Seed treatment before sowing was carried out by soaking with 0.01% (100 ppm) sodium selenite solution. Foliar treatment of vegetative plants was carried out at the beginning of the VI stage of organogenesis (the phase of entry into the tube) with a solution of the same concentration. Variants without addition of selenium served as control. The repetition in the experiment is fourfold.

To study the effect of selenium on wheat when using pesticides, the following preparations were used: Bunker fungicide, Aminka herbicide and Dishans insecticide. All drugs were used in accordance with the recommended dosages and timing in accordance with the "Directory of Pesticides and Agrochemicals". Complex treatment included the use of fungicide, insecticide and herbicide in one version.

The main indicators of the quality of spring wheat grain were determined on the SpectraStar 2500XL-R instrument. Sampling and preparation for analysis using

the method of near infrared spectroscopy were carried out in accordance with GOST 32040-2012. The vitreousness of the grain was determined using a diaphanoscope brand DSZ-2 in accordance with GOST 10987-76. The reliability of the research results was assessed using the method of analysis of variance by calculating a significant difference - a value that indicates the boundary of possible random deviations in the experiment. This is the minimum difference in yields between the averages, which in this experiment is recognized as significant at a 5% significance level (Kobzarenko et al., 2015).

3. Research Results and Discussion

As the results showed, the use of chemical plant protection products had a significant impact on the grain yield of spring wheat cv. Compared to a control variant in which wheat plants were not treated with pesticides (Table 1, Figure 1). The use of the insecticide provided an increase in the grain yield by 16%, and the treatment of plants with the herbicide contributed to an increase in grain mass by more than 1.4 times. It was found that the complex treatment, consisting of fungicidal treatment of seeds, insecticidal and herbicidal treatment of spring wheat plants, provided an increase in yield by 1.9 times more than that obtained in the control variant without the use of chemical plant protection products. Under the same conditions, the use of seed treatment with fungicide did not have a significant change in yield compared to the control variant without the use of the drug.

A comparative assessment of the effect of various methods of applying selenium on the yield of spring wheat, depending on the use of pesticides, revealed an increase in the grain weight of spring wheat variety Yubileynaya 80 by more than 1.7 times with the combined use of pre-sowing seed treatment with selenium and fungicide Bunker compared to the variant without using fungicide. The use of treatment before sowing seeds with selenium together with spraying plants with an insecticide provided an increase in the mass of spring wheat grain by 1.8 times compared to the control variant without the use of an insecticide. With the combined use of pre-sowing treatment of seeds with selenium and spraying of spring wheat plants with a herbicide, an increase in grain mass by more than 2 times was noted in relation to the control variant without the use of a herbicide. Joint presowing treatment of seeds with selenium and complex pesticide treatment of spring wheat cv. Yubileynaya 80 ensured an increase in grain weight by more than 2 times in relation to the control variant with treatment of wheat seeds with selenium before sowing.

It was found that in the control under these research conditions, the effectiveness of spraying plants with sodium selenite on yield was higher than pre-sowing seed treatment with selenium. In the variant with the use of spraying plants with selenium, an increase in yield by almost 1.5 times was obtained, compared with the control variant, without the use of selenium. However, the combined use of spraying vegetative plants with sodium selenite with pesticides showed a positive effect on the yield value only when combined with a herbicide. This variant shows an increase in grain weight by 26% (8.8 g/vessel versus 7.0 g/vessel in the control variant without herbicide).

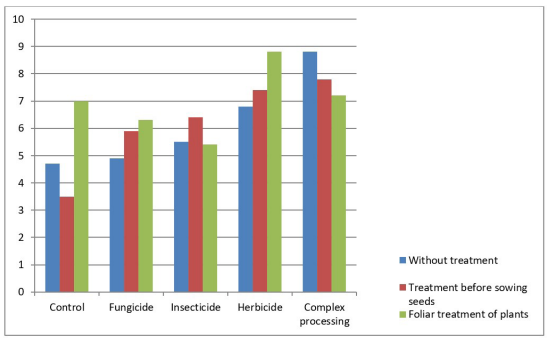

Figure 1. Effect of various combinations of pesticides and sodium selenite on spring wheat yield.

Table 1. The effect of various combinations of sodium selenite and pesticides on the yield of spring wheat variety Yubileynaya 80 (g/vessel).

Application pesticides	Application selenite sodium						
	Without treatment		Treatment before sowing seeds		Foliar treatment of plants		SD_{05} factor B***
	weight grain	share of grain*	weight grain	share of grain *	weight grain	share of grain *	weight grain
Control	4.7	19.7	3.5	18.9	7.0	27.1	0.4
Fungicide	4.9	22.4	5.9	25.5	6.3	22.9	0.4
Insecticide	5.5	22.6	6.4	25.0	5.4	25.2	0.4
Herbicide	6.8	25.6	7.4	23.7	8.8	30.3	0.5
Complex processing	8.8	31.9	7.8	33.3	7.2	33.6	0.6
SD_{05} factor A**	0.4		0.6		0.4		

SD_{05} - significant differences - a value that indicates the limit of possible random deviations in the experiment; this is the minimum difference in yields between the averages, which in this experiment is recognized as significant at a 5% significance level. *The share of grain in the structure of the above-ground mass of wheat plants; **Significant difference 05 factor A – the minimum difference in yields between the average in the pesticide application options, which in this experiment is considered significant at a 5% significance level; ***Significant difference 05 factor B – the minimum difference in yields between the average in the options for using sodium selenite, which in this experiment is considered significant at a 5% significance level.

A comparative evaluation of the action of sodium selenite against the background of the use of a specific pesticide showed that the yield of spring wheat depended on the method of using selenium. When using the Bunker fungicide treatment, the greatest effect was manifested when combined with the treatment of vegetative plants with selenium. In this case, an increase in grain yield of 28% was obtained (6.3 g/vessel versus 4.9 g/vessel in the variant with only fungicidal treatment of wheat plants). Against the background of the use of an insecticide, sodium selenite showed the greatest effect when treated by treating seeds before sowing. In this case, the grain mass increased by 16% compared to the variant without selenium. Against the background of the use of the herbicide, a positive effect was observed with both methods of using sodium selenite. With a combination of herbicide + treatment with selenium before sowing seeds, the increase in grain yield was 9%, with a combination of herbicide + folar treatment of vegetative plants with selenium, the increase was 29% compared to the variant without the use of sodium selenite. It has been suggested that the effectiveness of various combinations of sodium selenite and pesticides depends on the chemical composition of the studied plant protection products, as well as on the timing of treatment with specific drugs.

It was found that the studied preparations had a significant impact on the structure of the spring wheat crop (Table 1). An increase in the proportion of grain in the structure of the above-ground mass of plants was shown when spraying plants with sodium selenite as a result of a decrease in the proportion of straw. This indicates an improvement in the structure of the crop towards an increase in the agronomically valuable part of the product. An improvement in the structure of the yield was revealed in the treatment of plants with sodium selenite + insecticide and the treatment of plants with sodium selenite + herbicide.

In modern agricultural production of wheat, the most important aspect is to obtain not only stable yields, but also high quality grain. To assess the quality indicators of the obtained grain and determine its class according to the commodity classification, GOST R 52554-2006 is used. Evaluation of quality indicators of grain allows you to choose the appropriate storage conditions, processing methods and applications in the food industry. The most important technological quality indicators that determine the baking and flour-grinding characteristics of spring wheat grain are the content of crude protein, the amount and properties of crude gluten, vitreousness and mass fraction of moisture. Also, indicators are determined that characterize the nutritional and nutritional value of grain, among which the amount of crude fat, crude ash, and crude fiber is noted. The quality indicators of grain crops products are influenced by a complex of factors, the determining factors among them are the genetic characteristics of the variety and growing conditions (weather-climatic, soil, mineral nutrition conditions).

Assessing the data obtained in the vegetative experiment, it was found that chemical plant protection products had an ambiguous effect, in some cases negative, on the grain quality indicators of Yubileynaya 80 spring wheat (Table 2). In the control variant without the use of selenium and plant protection chemicals, the content of crude protein was 15%, the content of crude gluten was 34.6%, the vitreousness was 34.5%, and the content of crude fat was 1.3%. It was found that the use of fungicide and herbicide contributed to an increase in the content of crude protein, the value of which increased by 1.13 and 1.2 times, respectively, compared with the control without pesticides. In these variants, there was also an increase in the collection of crude protein with a wheat grain harvest by 1.17 times and 2.9 times, respectively.

Under the same conditions, the use of an insecticide and complex treatment of plants with pesticides did not lead to a significant change in the content of crude protein in wheat grain. However, the amount of crude protein harvest with wheat grain yield in the variant with the use of an insecticide did not significantly change, while in the variant with the use of complex treatment with pesticides it increased almost 2.4 times. It should be noted that the increase in the amount of crude protein harvest with the spring wheat grain yield in the variant where the plants were grown using complex pesticide treatment occurred as a result of an increase in yield.

One of the most important characteristics of the baking quality of grain is the content of raw gluten (Novikov, 2012). The results of the research in the experiment noted that when using the Bunker fungicide and insecticide in wheat grain, the amount of raw gluten decreased (Table 2). It was noted that in the variant with the use of the fungicide, the decrease turned out to be unreliable, but in the variant with the use of the insecticide, the decrease in the amount of raw gluten occurred by 20% compared to the variant without pesticides. In the variants with the use of a herbicide and complex treatment of plants with pesticides (fungicide + insecticide + herbicide), a significant increase in the content of raw gluten by 1.35 and 1.43 times was noted compared to the variant without the use of pesticides. At the same time, a change in grain vitreousness was revealed when pesticides were used. In the variants with the use of fungicide and insecticide, the vitreousness increased by 18% and 27%, respectively, compared with the control without pesticides. While the use of a herbicide and complex treatment of plants (fungicide+insecticide+herbicide) vitreousness decreased by almost 3 times, compared with the control variant, which indicates the production of floury grain and a decrease in flour yield and a deterioration in the quality of bread products (Chernyshev et al., 2017; Vigilyansky, 2020). In addition, it should be noted that in order to use for food purposes the grain grown in these conditions with the obtained indicators of vitreousness, it is necessary to use improvers, i.e. higher quality grain.

The results of the research showed that when applying treatment before sowing wheat seeds of the variety Yubileinaya 80 with selenium, the content of crude protein did not change, but the content of crude gluten increased by 10% compared to the control without the use of selenium and pesticides. The vitreousness of the grain also increased significantly by 1.4 times and amounted to 48.7%.

Table 2. The effect of combinations of sodium selenite and various pesticides on grain quality indicators of spring wheat variety Yubileynaya 80.

Application pesticides	Application selenite sodium														
	Without treatment					Treatment before sowing seeds					Foliar treatment of plants				
	Crude protein, %	Collection of crude protein with grain production, mg/m2	Crude gluten, %	Vitreousness, %	Crude fat, %	Crude protein, %	Collection of crude protein with grain production, mg/m2	Crude gluten, %	Vitreousness, %	Crude fat, %	Crude protein, %	Collection of crude protein with grain production, mg/m2	Crude gluten, %	Vitreousness, %	Crude fat, %
Control	15.0	34.6	33.2	34.5	1.3	15.0	24.0	36.6	48.7	1,1	15.5	51.0	40.4	36.6	1.2
Fungicide	16.9	40.5	32.3	40.6	1.1	14.9	43.2	31.9	51.6	1,3	14.3	41.3	29.3	33.2	1.1
Insecticide	14.0	34.9	26.7	43.7	1.5	16.5	51.1	37.3	46.7	1,0	17.4	45.3	36.5	38.5	0.9
Herbicide	18.0	101.1	44.9	10.7	0.9	18.4	138.2	40.6	17.0	0,8	19.9	131.1	43.0	11.2	0.5
Complex processing	15.7	81.5	47.4	11.3	0.6	14.9	73.2	47.1	40.6	1,2	13.6	58.3	33.4	42.1	1.4
SD_{05}	1.1	-	2.9	2.6	0.3	0.9	-	2.5	2.4	0,2	0.9	-	2.8	2.7	0.2

SD_{05}: significant differences - a value that indicates the limit of possible random deviations in the experiment; this is the minimum difference in yields between the averages, which in this experiment is recognized as significant at a 5% significance level.

It was found that in the variants with the combined use of pre-sowing seed treatment with selenium and an insecticide or herbicide, there was an increase in the content of crude protein by 10% and 23% and amounted to 16.5% 18.4%, respectively, compared with the control variant, which included treatment before sowing seeds selenium. At the same time, in the variants with a combination of seed treatment with selenium + fungicide Bunkers and treatment with selenium before sowing seeds + complex treatment of wheat plants with pesticides, the content of crude protein did not change compared to the variant without pesticides. It should be noted that the harvest of crude protein with a spring wheat crop when using combinations of treatment with selenium before sowing seeds with fungicide, insecticide, herbicide and complex treatment of plants with pesticides increased by 1.8 times, 2.1 times, 5.8 times and 3 times, respectively, compared to the option without the use of pesticides. This is due, on the one hand, to an increase in yield in these variants, and on the other hand, apparently, to an increase in the amount of nitrogen entering the plants and stimulation of the synthesis of protein compounds. Assessing the content of gluten proteins in the grain, a positive increase in their content was revealed in the variants using a combination of pre-sowing treatment with selenium + herbicide and pre-sowing treatment with selenium + complex treatment of plants with pesticides by 11% and 29% compared to the variant without pesticides. The vitreousness in these variants, when compared with the control without the use of pesticides, changed positively only with a combination of treatment before sowing seeds with the Bunker fungicide and selenium, in other combinations, a decrease in vitreousness was revealed.

During the foliar treatment of plants with a solution of selenium, the content of crude protein in the grain changed slightly and amounted to 15.5%, the content of crude gluten increased by 1.2 times to 40.4% against 33.2% in the control without selenium, vitreousness increased by 1.06 times up to 36.6% versus 34.5% in the control without selenium. When using a combination of treatment of plants with sodium selenite with pesticides, a positive effect on the content of crude protein in combination with insecticide and herbicide was revealed when compared with control without selenium and when compared with control options without pesticides. The harvest of crude protein with a grain yield increased significantly by 2.6 times in the variant with a combination of plant treatment with selenium + herbicide compared to the control without pesticides. This was due to a significant increase in yield and an increase in the content of crude protein in this variant. In the same variant, an increase in vitreousness up to 43% was shown against 40.4% in the control without herbicide.

In other combinations of plant treatment with selenium and pesticides, no significant changes in the amount of crude protein harvest with grain yield and vitreousness were noted.

It is known that the content of crude fat characterizes the nutritional value of grain and determines the conditions and duration of storage. Estimating the content of crude fat obtained in wheat grain under the studied conditions, it can be noted that its amount decreased with an increase in the content of crude protein.

In the variants where a high content of crude fat was found in the grain, the content of crude protein changed in the opposite direction. With an increase in the content of crude fat in the grain of spring wheat, the possibility of its long-term storage is reduced.

Thus, evaluating the results of the study, it was shown that the use of the herbicide in all variants increased the content of crude protein and increased the yield of crude protein with the harvest of spring wheat grain. It should be noted that the highest rates of crude protein collection were obtained in the variants using combinations of herbicide + treatment with selenium before sowing seeds and herbicide + treatment of vegetative plants with selenium. It should be noted that the use of herbicide and complex treatment of plants with pesticides in the control variants and in the variants with selenium resulted in the grain with the lowest vitreousness. In herbicide and herbicide+sodium selenite combinations, high grain yields were obtained, with a high content of crude protein and crude gluten, however, grain quality was limited by the lowest glassiness.

It was established that under these growing conditions in the variants without pesticides, using the Bunker fungicide and insecticide, as well as in the variants with a combination of fungicide + selenium and insecticide + selenium, grain was obtained that can be attributed to class 3. It is possible to use the obtained grain for food purposes with the addition of improvers, i.e. grains of the 1st or 2nd class.

4. Conclusion

The studies carried out under model conditions for growing spring wheat made it possible to establish that, in some cases, the use of various chemical plant protection agents has a negative effect on the quality indicators of spring wheat grain.

In these studies, it was proven that the use of a fungicide and insecticide in some cases helps to reduce the content of crude protein and gluten, while when using a herbicide and complex treatment of plants with pesticides, a sharp decrease in the glassiness of grain was obtained in all experiments. Vitreousness in variants with the use of herbicide and complex treatment of plants with pesticides ranged from 10 to 25% in vegetation and field studies.

For the first time, it was studied that the use of sodium selenite helped to reduce the negative effect of pesticides on the quality indicators of spring wheat grain. The results of the studies carried out made it possible to identify the optimal combinations of sodium selenite and pesticides.

For the first time, it was found that the combination of insecticide + sodium selenite in most cases made it possible to obtain grain that, in terms of quality, exceeded the quality of grain obtained in other research options. It can be concluded that when using sodium selenite, the conditions for the absorption of nitrogen from the soil by plants improved and the processes of its redistribution inside the plant from vegetative organs to reproductive organs were activated, which made it possible to obtain a high yield of good quality in this variant.

The conducted research allows us to make proposals for improving crop protection technologies. The use of various combinations of plant protection chemicals and sodium selenite can increase the efficiency of the plant protection system.

Acknowledgements

The research was carried out at the expense of the University Development Program within the framework of the Strategic Academic Leadership Program “Priority 2030”.

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