VOL VIII

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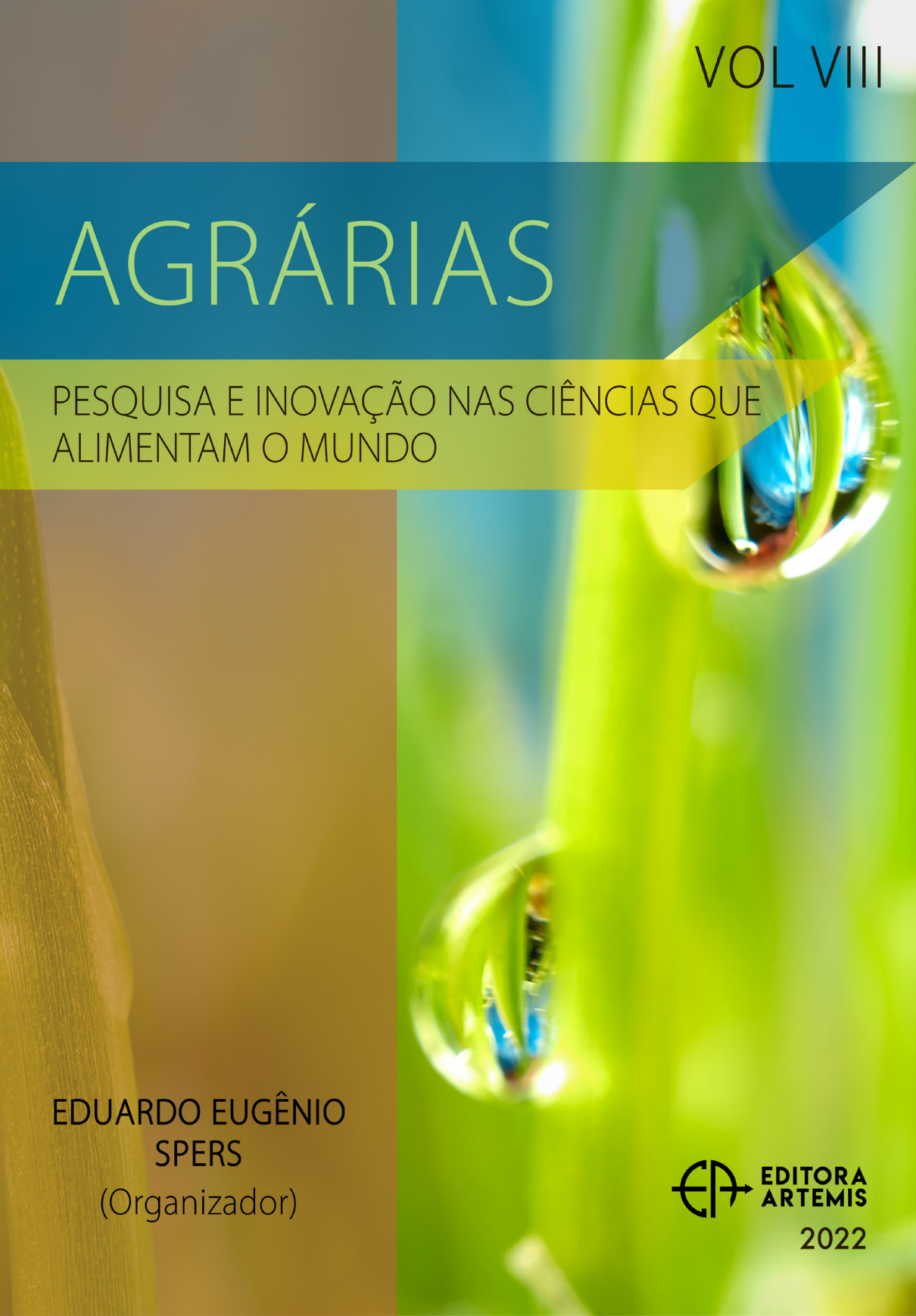
PESQUISA E INOVAÇÃO NAS CIÊNCIAS QUE ALIMENTAM O MUNDO



EDUARDO EUGÊNIO SPERS
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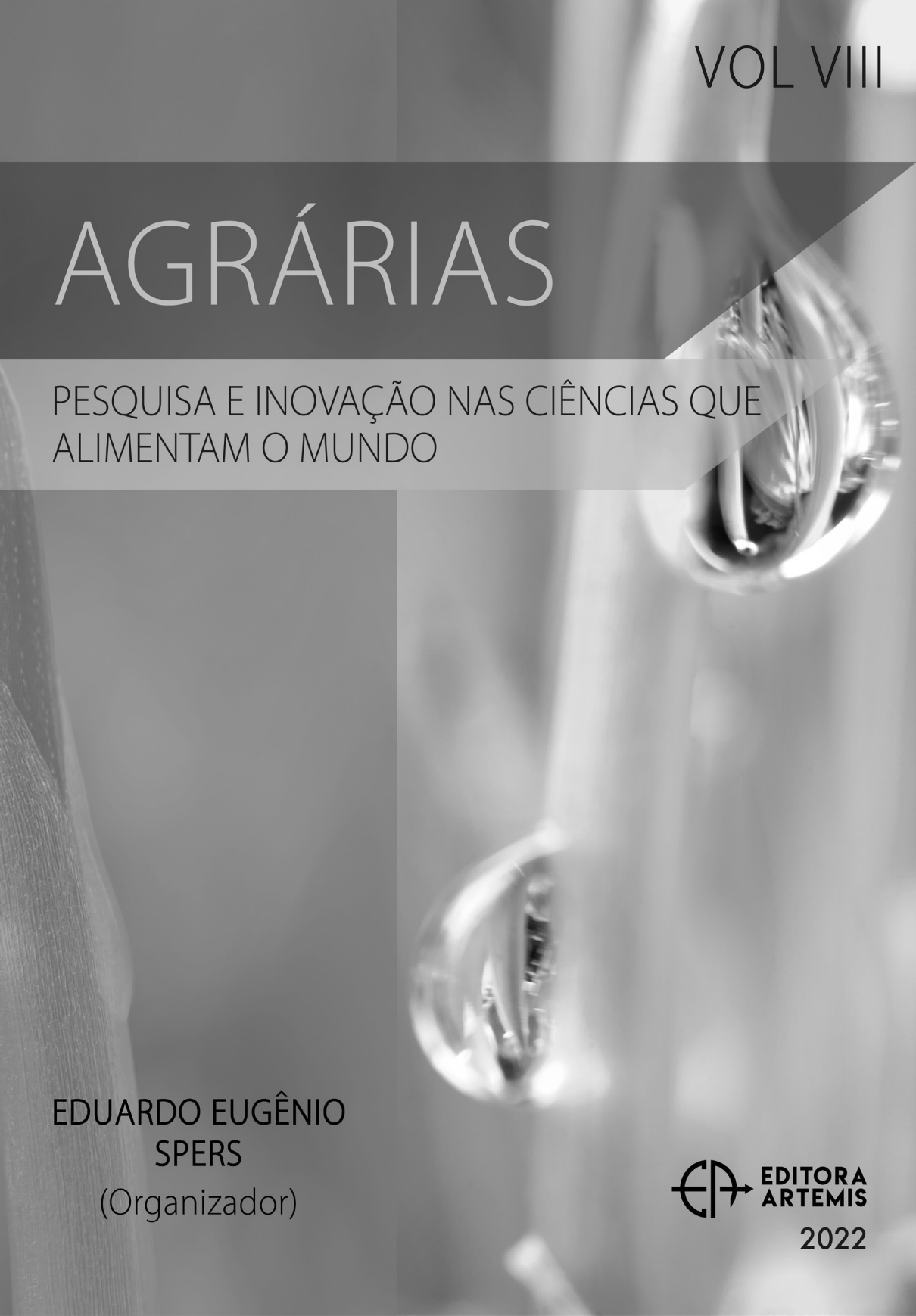

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APRESENTAÇÃO

As Ciências Agrárias são um campo de estudo multidisciplinar por excelência, e um dos mais profícuos em termos de pesquisas e aprimoramento técnico. A demanda mundial por alimentos e a crescente degradação ambiental impulsionam a busca constante por soluções sustentáveis de produção e por medidas visando à preservação e recuperação dos recursos naturais.

A obra **Agrárias: Pesquisa e Inovação nas Ciências que Alimentam o Mundo** compila pesquisas atuais e extremamente relevantes, apresentadas em linguagem científica de fácil entendimento. Na coletânea, o leitor encontrará textos que tratam dos sistemas produtivos em seus diversos aspectos, além de estudos que exploram diferentes perspectivas ou abordagens sobre a planta, o meio ambiente, o animal, o homem e a sociedade no ambiente rural.

É uma obra que fornece dados, informações e resultados de pesquisas tanto para pesquisadores e atuantes nas diversas áreas das Ciências Agrárias, como para o leitor que tenha a curiosidade de entender e expandir seus conhecimentos.

Este Volume VIII traz 26 artigos de estudiosos de diversos países, divididos em quatro eixos temáticos: *Cultura e Sociedade no Contexto Rural; Produção Sustentável; Produção Vegetal e Solos e Aquacultura, Produção Animal e Veterinária*.

Desejo a todos uma proveitosa leitura!

Eduardo Eugênio Spers

SUMÁRIO

CULTURA E SOCIEDADE NO CONTEXTO RURAL

CAPÍTULO 11

THE QUALITY OF APPLE FRUIT PRODUCTS WHEN USING THE GROWTH BIOREGULATOR ALBIT IN THE SYSTEM OF PROTECTION

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ABSTRACT: The quality of apple fruit products when using the biostimulant Albit as one of the ways to reduce the environmental risk of application pesticides on fruit plantations in the integrated plant protection system, was investigated. The active ingredient of the preparation Albit is a natural biopolymer poly-beta-hydroxybutyric acid from soil bacteria Bacillus megaterium. The Albit mode of action is based on the stimulation of plant natural defense reactions. The research was carried out on apple trees of the 'Renet Simirenko' variety. We used the Albit five times in general protection system in the following plant growth stages: inflorescence emerge; beginning of flowering; end of flowering; fruit size up to 10 mm; fruit size up to 20 mm; ripening of fruits. With five-fold application of the preparation Albit at a rate of 100 ml/ha in the apple tree protection system with low and moderate progression of diseases (up to 35.0%), the biological effectiveness in protection against scab consisted of: on leaves - 87.0 % and on fruits – 81.8 %; when protecting against powdery mildew: on shoots - 81.8 % and on leaves - 81.3 %. The positive effect of Albit on growth and generative development of apple trees (increase in the leaf area - by 11.8-49 %, annual shoot growth - by 8-12 %, average fruit weight - by 16.8-30 %) was observed. It was found that using of the preparation Albit promoted to an increase in the total chlorophyll content of apple leaves by 9.7 %, relative to the control. The analysis of experimental data showed that five-fold application of the preparation Albit helped to improve the conditional parameters of fruits. With regard to the control, the content of dry matter increased by 6.3 %, mass concentration of sugars - by 8.6 %; while mass concentration of titratable acids decreased by 17.4 %.
KEYWORDS: Productivity. Conditional parameters. Biological effectiveness. Fruits. Immune.

A QUALIDADE DOS PRODUTOS DE MAÇÃ AO USAR O BIORREGULADOR ALBIT DE CRESCIMENTO NO SISTEMA DE PROTEÇÃO

RESUMO: Foi investigada a qualidade dos produtos da macieira ao utilizar o bioestimulante Albit como uma das formas de reduzir o risco ambiental da aplicação de agrotóxicos em frutíferas no sistema fitossanitário integrado. O ingrediente ativo da preparação Albit é um ácido poli-beta-hidroxibutírico biopolímero natural da bactéria do solo Bacillus megaterium. O modo de ação Albit é baseado na estimulação das reações de defesa natural da planta. A pesquisa foi realizada em macieiras da variedade 'Renet Simirenko'. Utilizou-se o Albit cinco vezes no sistema de proteção geral nas seguintes fases de crescimento das plantas: inflorescência emergente; início da floração; final da floração; tamanho do fruto até 10 mm; tamanho do fruto até 20 mm; amadurecimento dos frutos.

Com aplicação quíntupla do preparado Albit na proporção de 100 ml/ha no sistema de proteção da macieira com progressão baixa e moderada de doenças (até 35.0%), a eficácia biológica na proteção contra a sarna consistiu em: nas folhas – 87.0 % e nas frutas – 81.8 %; ao proteger contra o oídio: nos rebentos – 81.8 % e nas folhas – 81.3 %. Foi observado o efeito positivo de Albit no crescimento e desenvolvimento generativo de macieiras (aumento da área foliar – 11.8-49 %, crescimento anual da parte aérea - 8-12 %, peso médio do fruto – 16.8-30 %). Verificou-se que o uso da preparação Albit promoveu um aumento no teor de clorofila total das folhas de macieira em 9.7 %, em relação ao controle. A análise dos dados experimentais mostrou que a aplicação quíntupla da preparação Albit ajudou a melhorar os parâmetros condicionais dos frutos. Com relação ao controle, o teor de matéria seca aumentou 6.3%, a concentração de açúcares em massa - 8,6%; enquanto a concentração de massa de ácidos tituláveis diminuiu 17.4%.
PALAVRAS CHAVES: Produtividade. Parâmetros condicionais. Eficácia biológica. Frutos. Imunidade.

1 INTRODUCTION

In connection with expansion of the list of environmental problems associated with traditional agriculture, scientists all over the world began to pay special attention on the necessity to reduce using mineral fertilizers and synthetic pesticides by combining them with biological fertilizers and pesticides of new generation, or replacing chemical fertilizers and synthetic pesticides with organic preparations. This is especially true for agricultural production, located in recreation areas (Mushinskiy et al., 2018; Volynkin et al., 2021). The Crimean Peninsula is a favorable place for production of environmentally friendly products (Volkova et al., 2020).

Recent years, apple plantations are under a large number of stress factors due to extreme meteorological conditions and severe pesticide loading in the plant protection system. All the above affects general physiological condition and productivity of plants (Ryabchinskaya et al., 2003).

An important technique for reducing negative consequences of the complete use of chemical fungicides is the introduction of biologically active substances - growth and immune stimulants, into the plant protection systems against a complex of phytopathogens (Batukaev et al., 2019). Using of mineral and organic fertilizers has a significant effect on the growth and development of plants, especially under stress conditions, and helps to increase cropping capacity, improves product quality and disease resistance (Boiko et al., 2021; Belash et al., 2021; Stranishevskaya et al., 2018; Stamenković et al., 2018; Jivan et al., 2014).

However, most farmers prefer to use mainly chemical fertilizers and pesticides instead of organic ones, since they are not sure about the effectiveness of the former and

are afraid of losing part of the yield (Wang et al., 2018; Stranishevskaya et al., 2016; Volkov et al., 2016). The solution to this problem is the development of optimal technologies for using organic fertilizers in the system of intensive farming, allowing not only to achieve long-term high productivity of agricultural crops, but also to maintain soil biodiversity and fertility (Qaswar et al., 2020; Klimenko et al., 2020).

A new promising preparation of the group of immune and growth stimulants, which has a fungistatic effect against the causative agent of apple scab, is the Albit. Its main active ingredient is the metabolic product of the bacterium Pseudomonas aureofaciens - poly-beta-hydroxybutyric acid (6.2 g/ha), the stimulating effect of which on plants is enhanced by micro-additives of mineral fertilizers: magnesium sulfate + potassium phosphate + potassium nitrate + carbamide (Zlotnikov et al., 2008).

The goal of the research is to study the all-around effect of the preparation Albit, FP on apple trees and develop regulations for its use on this culture in order to improve physiological condition of plants and increase their productivity, and expand the assortment of agents, alternative to chemical fungicides, and reduce pesticide pressure on the crops. The inclusion of this ecologically safe preparation in the apple garden protection systems against scab will contribute to the total improvement of phytosanitary condition of agrocenoses due to sanitation of plants and enhancement of the activity of various natural defensive reactions with a general increase in their productivity (Stranishevskaya et al., 2020).

2 MATERIALS AND METHODS

The research was carried out in the piedmont zone of the Republic of Crimea, in Bakhchisarai district, Kashtany village, in agro-industrial enterprise “Sady Alminskoy Doliny”, in apple plantations of the ‘Renet Simirenko’ variety in 2019. According to the goals, the experiment had three treatments: I. The control - without using means of chemical protection; II. The Albit, FP, 100 ml/ha at the following growth stages: inflorescence emerge – 100 % protection system + Albit, FP; end of flowering – 100 % protection system + Albit, FP; fruit size up to 10 mm -75 % of fungicides + Albit, FP; fruit size up to 20 mm -75% of fungicides + Albit, FP; ripening of fruits - 0% of fungicides + Albit, FP. III. The production standard is the plant protection application system adopted in farming.

The presence of apple scab – (Venturia inaedualis (Cooke) Wint.); apple powdery mildew (Podosphaera leucotricha Salm), was determined in the following plant growth stages: inflorescence emerge; beginning of flowering; end of flowering; fruit size up to 10 mm; fruit size up to 20 mm; ripening of fruits. The experiment: type of research -

field, small-plot technique. Plot size and location: 0.03 ha, randomized. The number of accounting trees is six per variant. Dates of application: 04.23., 05.06., 06.03., 06.24. and 08.20.2019. Date of harvesting: 09.25. Harvesting method: manual, fruits were harvested from each model plant.

Technological assessment was carried out according to the following parameters: the leaf-area duration of the shoot was determined in the field using method of measuring the diameter of each leaf on trees and selected shoots. The content of conditional parameters was determined using areometric method (total sugars) (Interstate Standard Fruit and vegetable products. Methods for determination of sugars, 1987), and titrimetric method (Interstate Standard "Fruit and vegetable products. Determination of titratable acidity" ,2013). The content of leave chlorophyll was determined using colorimetric method with wavelengths of 665 and 649 nm in ethanol extract of pigments from an average sample of leaves weighing 0.5 g, followed by re-calculation taking into account the extract volume and weighed sample (Chakchir B.A., Alekseeva G.M., 2002). To determine the significance of influence of Albit preparation in protection against scab and powdery mildew we analyzed the reliability (P-value at the level of <0.05 according to Fisher's test) in the SPSS Statistics 17.0 software.

3 RESULTS AND DISCUSSION

Favorable conditions for primary infection and development of scab came into existence in the second decade of April .2019, for secondary infection - in the third decade of May 2019. The first visual signs of disease development on the fruit ovary in the control variant were registered at the end of apple tree flowering.

The moderate development of scab on apple trees was observed. The intensity of the development of the disease was determined on a five-point scale, examining one hundred leaves and fruits on each accounting tree (four replicates of 4 plants), evenly distributed on 4 accounting branches of the first or second order, oriented to the cardinal points. The development of scab during the harvesting period in the control was 22.3 % on leaves and 29.7 % on fruits. In variants II and III, the development of scab was low and amounted: on leaves – to 2.9 % and 1.5% (P05 = 1.7) and on fruits – to 5.4 % and 3.7 % (P05 = 2.1), respectively. The most intensive development of scab was noted on a fruit drop - 23.8 % in the control, 3.2-5.6 % in variants II and III. The difference in the production standard and the variant with using the Albit, FP preparation for all studied parameters is insignificant, within the experimental error. Thus, five-fold using of the Albit, FP preparation during growing season (the last treatment, 36 days before harvesting - without using of

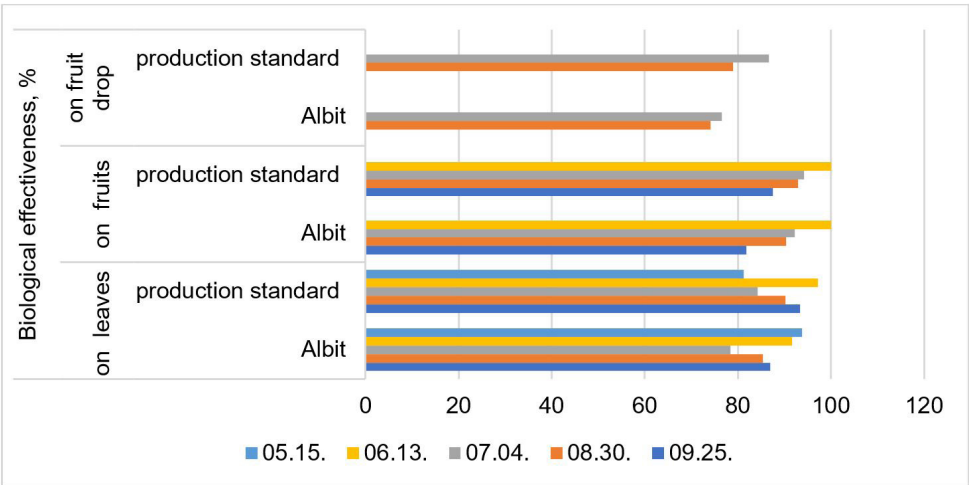
protective measures against scab and powdery mildew) made it possible to reduce the consumption rate of fungicides in variant II without reducing the effectiveness of protective measures carried out.

The effectiveness of apple scab protection system using the Albit, FP preparation on the 10th day after the last spraying, against the background of the moderate development of scab on leaves and fruits in the control, was high, at the production standard level of effectiveness, and amounted to 85.4 and 90.3%, on leaves and fruits, respectively (Figure 1). During the harvesting period, the effectiveness of system of protective measures under study was 87.0% on leaves. The difference with the standard (93.3%) was within the experimental error. On fruits ready for harvesting in the same period, the effectiveness of system of protective measures using the Albit, FP preparation was 81.8 % difference with the production standard (87.5%) was insignificant.

The development of powdery mildew in the control during the growing season of 2019 was observed on leaves and shoots. In both the control and treated variants, the first visual signs of disease development on shoots were noted in the second decade of May.

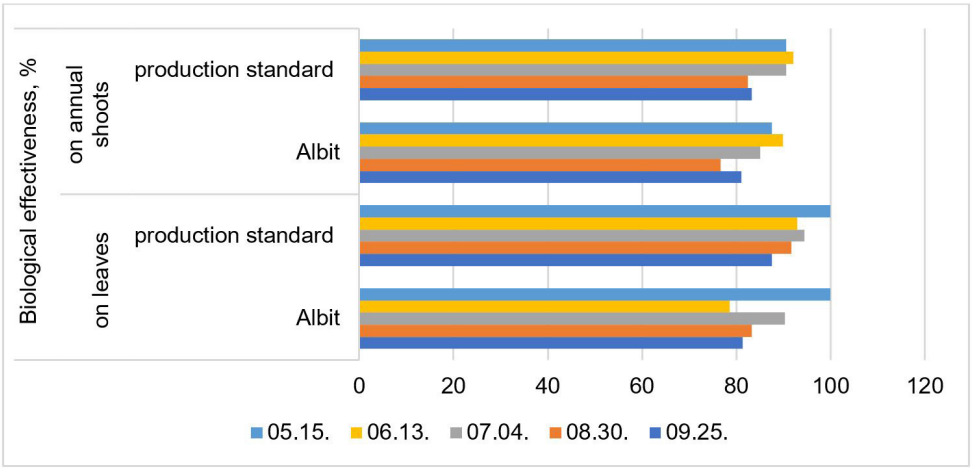
The development of powdery mildew on apple trees was weak to moderate. During the harvesting period in the control variant, the disease development on annual shoots and leaves was 22.2 and 12.8%, respectively; in the variant II, against the background of a decrease in pesticide loading, disease development was 5.3 times lower and amounted to 4.2% on annual shoots and 2.4% on leaves. The difference in the production standard (3,7 % on annual shoots and 1,6% on leaves) and the variant with using the Albit, FP at the rate of 100 ml/ha, was insignificant (P05 = 1.6), within the experimental error.

Figure 1. Biological effectiveness of protective measures against scab.



Biological effectiveness of the tested scheme of protective measures on annual shoots and leaves of apple trees against powdery mildew, including five-fold spraying of the Albit, FP at a rate of 100 ml/ha remained high throughout the entire period of protective measures and amounted to 76.6 and 83.2% in 10 days after the last application. During harvesting period, the effectiveness of schemes of protective measures using the Albit, FP preparation remained high and amounted to 81.1% on shoots and 81.3% on leaves. The obtained characteristic values were up to production standard level (Figure 2).

Figure 2. Biological effectiveness of protective measures against powdery mildew.



Any measures allowing increase the intensity of photosynthesis positively effect on the accumulation of macronutrients in the vegetative and generative plant organs.

The studies provided show that five-fold using of the preparation Albit, FP has a positive effect on the growth and development of apple trees.

Determining the leaf-area duration of the shoot in the harvesting period showed that the difference between variant II and the control reliably exceeded the parameters of the least significant difference and amounted to 1.5 (Table 1). The difference in the parameter “average shoot length” between the control and variant II (was also significant and amounted to 0.11 m (15.5%)).

Table 1. The effect of the preparation Albit, FP on the leaf-area duration and the amount of shoot growth, P-value <0.05.

Variant	Leaf-area duration, m^2 shoot	Average shoot length, m
1. Control	0,51	0,55
2. Albit, FP, 100 ml/ha	0,76	0,67
3. Production standard	0,68	0,62
P_{05}	0,09	0,06

Crops, harvested from the variant II, with five-fold spraying of the Albit, FP during the growing season, were corresponding to standards in 98% of cases. The proportion of the conditioned harvested crops in the standard variant was 96%. In the control this percentage was 71%.

A reliable increase in total cropping capacity by 29.7%, compared to the control, was observed in the variant II (Table 2). The difference with the production standard in terms of total cropping capacity amounted to 16.8% and was also reliable.

Table 2. Cropping capacity of apple plantations by the variants of experiment, P-value <0.05.

Variant of experiment	Distribution of crops by fractions, %				Sampling weight, kg	Increase in the yield, compared to the control, %
	less than 55 mm	55-60 mm	65-70 mm	more than 75 mm		
I. Control	43	19	32	6	11,8	100
II. Albit, FP	12	22	51	15	15,3	129,7
III. Standard	24	21	44	11	13,1	111,0
P_{05}	-	-	-	-	0,9	-

The analysis of experimental data showed that using of foliar application contributed to an increase in the total content of chlorophyll in apple leaves by 9.76%, compared to the control (Table 3).

Table 3. The capacity of conditional parameters and content of chlorophyll in leaves in 2019, P-value <0.05.

Variant of experiment	Mass concentration of sugars, g/100 cm^3	Mass concentration of titratable acids, g/dm^3	Dry matter content, %	Concentration of coloring agents, mg/l		
				Ca	Cb	Ca+b
I. Control	14,4	9,2	15,1	1,01	1,14	2,15
II. Albit, FP	15,3	7,6	16,4	1,20	1,16	2,36
III. Standard	15,0	8,2	16,1	1,17	1,15	2,32

4 CONCLUSION

Thus, it was found that inclusion of the Albit, FP preparation in the apple tree protection system, while simultaneously reducing the consumption rate of chemical fungicides, provides high biological effectiveness against diseases: in protecting leaves and fruits against scab - 87.0 and 81.8%, respectively; in protecting shoots and leaves against powdery mildew - 81.8 and 81.3%, respectively, as well as a significant increase in yield by 29.7 and 16.8%, relative to the control and standard variants, respectively.

The preparation showed positive effect on the quality of the yield: an increase in the proportion of conditioned crops (+ 25% to the chemical standard without Albit), an

increase in the mass concentration of sugars (+ 4.2%) and the content of dry matter (+ 1.8%) in fruits, a decrease in the mass concentration of titratable acids (–7.3%).

Using of the preparation Albit, FP also contributed to an increase in the total content of chlorophyll in apple leaves by 9.7%, compared to the control.

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SOBRE O ORGANIZADOR

EDUARDO EUGENIO SPERS realizou pós-doutorado na Wageningen University (WUR), Holanda, e especialização no IGIA, França. Possui doutorado em Administração pela Universidade de São Paulo (USP). Foi Professor do Programa de Mestrado e Doutorado em Administração e do Mestrado Profissional em Comportamento do Consumidor da ESPM. Líder do tema Teoria, Epistemologia e Métodos de Pesquisa em Marketing na Associação Nacional de Pós-Graduação e Pesquisa em Administração (ANPAD). Participou de diversos projetos de consultoria e pesquisa coordenados pelo PENSA e Markestrat. É Professor Titular no Departamento de Economia, Administração e Sociologia, docente do Mestrado em Administração e Coordenador do Grupo de Extensão MarkEsalq no campus da USP/Esalq. Proferiu palestras em diversos eventos acadêmicos e profissionais, com diversos artigos publicados em periódicos nacionais e internacionais, livros e capítulos de livros sobre agronegócios, com foco no marketing e no comportamento do produtor rural e do consumidor de alimentos.

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