PLANT PROTECTION AND STORAGE PPRODUCTS

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Gazalov V.S.[1] *, Shabaev E.A.[2], Ponomareva N.E.[3], Belenov V.N.[4], Ragimov A.A.[5]

[1, 2, 3, 4, 5] Azov-Black Sea Engineering Institute, branch of the Don State Agrarian University, Zernograd, Russia

* Corresponding author (pantukhina[at]mail.ru)

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THE USE OF THE OPPOSITE PHOTOTAXIS ACTION OF ELECTRO-OPTICAL INSTALLATIONS IN THE SYSTEM OF PROTECTION OF GARDEN PLANTS

Research article

Abstract

The article presents methods and technologies that are used in the system of protection of garden plants from insect pests. The analysis of technologies and electro-optical installations in the system of protection of garden plants from insect pests indicates the prospects of using optical radiation for these purposes.

Electro-optical converters, which are a component of the electrical technology of protecting garden plants from insect pests, have the disadvantage that they are all based on the use of radiation with a positive phototaxic effect and do not use radiation with a negative phototaxic effect. At the same time, electro-optical converters with negative phototaxis do not contain a damaging device, are simple and can significantly reduce the cost of installation, therefore, reduce costs in the protection system of garden plants while maintaining the quality of protective measures.

Keywords: methods of protection of garden plants, electro-optical installations, positive and negative phototaxis action, insect pests.

Газалов В.С.[1] *, Шабаев Е.А.[2], Пономарева Н.Е.[3], Беленов В.Н.[4], Рагимов А.А.[5]

[1, 2, 3, 4, 5] Азово-Черноморский инженерный институт, филиал Донского государственного аграрного университета, Зерноград, Россия

* Корреспондирующий автор (pantukhina[at]mail.ru)

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ИСПОЛЬЗОВАНИЕ ПРОТИВОПОЛОЖНОГО ФОТОТАКСИСНОГО ДЕЙСТВИЯ ЭЛЕКТРООПТИЧЕСКИХ УСТАНОВОК В СИСТЕМЕ ЗАЩИТЫ САДОВЫХ РАСТЕНИЙ

Научная статья

Аннотация

В статье приведены способы и технологии, которые применяются в системе защиты садовых растений от насекомых-вредителей. Анализ технологий и электрооптических установок в системе защиты садовых растений от насекомых-вредителей свидетельствует о перспективности использования оптического излучения в этих целях.

Электрооптические преобразователи, являющиеся составляющей электротехнологии защиты садовых растений от насекомых-вредителей, обладают тем недостатком, что все они основаны на использовании излучения обладающего положительным фототаксисным воздействием и не используют излучение с отрицательным фототаксисным воздействием. Вместе с тем электрооптические преобразователи с отрицательным фототаксисным воздействием не содержат поражающего устройства, просты и позволяют значительно уменьшить стоимость установки, следовательно, снизить затраты в системе защиты садовых растений при сохранении качества защитных мероприятий.

Ключевые слова: способы защиты садовых растений, электрооптические установки, положительное и отрицательное фототаксисное действие, насекомые вредители.

1. Introduction

One of the tasks that arises in the development of a system for the protection of garden plants is to develop a set of measures and technical means that ensure effective protection of garden plants from insect pests, and as a result, provide an increase in yield by reducing crop losses.

In the system of plant protection against pests, four main methods are distinguished: agrotechnical, mechanical, biological and chemical. At various stages of scientific and technological progress, the role of these methods in the overall package of pest control measures has changed significantly and each of the methods has various kinds of shortcomings [7, P. 199-200].

Currently, the integrated plant protection system is increasingly used, as it involves special tactics for the use of exterminative means: chemical means of protection are used only when the number of insect pests exceeds the economic threshold of harmfulness, that is, when the costs of crop protection are compensated by its increase or compensation for losses.

This method of plant protection involves the collection of information on the number of populations of both harmful and beneficial insects in the array of the entire garden, determining the numerical ratio of harmful and beneficial insects (biotic index), determining the timing of insect harmfulness, deciding on the need for protective measures and planning the timing of their implementation. To account for the number of some pests, various kinds of attractive traps are used. Subsequently, pesticides are selected that act only on insects that are in the harmful phase.

In our country, there are several ways to monitor the summer of insect pests: a method of monitoring using satellite imagery, monitoring with the help of unmanned aerial vehicles, monitoring based on the use of electro-optical converters. Each of these methods has its advantages and disadvantages [1], [4], [8].

The disadvantages of monitoring using satellite imagery include the fact that images need to be ordered in advance; such pictures do not provide the necessary accuracy, and on certain days associated with weather conditions, the quality of shooting leaves much to be desired; services for satellite imagery are quite expensive [1, P. 626-627].

Methods of monitoring with the help of unmanned aerial vehicles and electro-optical converters have become more widely used. The basis for monitoring is the patterns of changes in species diversity and dynamics of the number of insects of pests of crops, the cyclical nature of their appearance in a certain region and the features of distribution [1, P. 629], [4, P. 150].

Corresponding to the required qualitative scientific and methodological level in forecast systems, electrophysical plant protection devices against insect pests are used to collect information, which make it possible in the forecast system to have reliable information about the number of populations of all insects included in the agrobiocenosis of an industrial garden, have a stable attractive effect, the maintenance of these devices does not require large labor costs, their work can be automated.

When analyzing existing methods of plant protection, it was revealed that the electrophysical method is applicable at any stage of plant development and its use makes it possible to register sharp outbreaks of the population of individual species of insect pests and adjust the timing of protective measures.

Based on this, two methods of electrophysical plant protection have arisen: the use of electro-optical converters for direct control of insect pests and for determining the dynamics of the summer of insects allowing the use of chemical means of protection only when the number of insect pests exceeding the economic threshold of harmfulness is reached, the use of selective means of controlling insect pests, taking into account and using natural regulatory mechanisms insect abundance.

The main advantage of the electrophysical method of insect pest control is the reduction of the amount of residual pesticides and their metabolites in the product and soil. Reducing pollution by chemicals applies to the entire sphere of habitat of living organisms, including humans [4, P. 149].

However, the insufficient knowledge of the behavior of insects in the field of optical radiation, of influence of various parameters of optical radiation on the attraction of insects and the fight against diseases of garden plants, the lack of effective methods for using electro-optical converters in the plant protection system necessitate the continuation of work on the creation, improvement and research of installations for electrophysical protection of garden plants and methods of their use.

The relevance of the work is due to the insufficient elaboration of the use of electro-optical converters for the comprehensive protection of garden plants from insect pests and diseases.

The purpose of the study is to determine the measures and the choice of technical means that ensure the effective protection of garden plants from insect pests and diseases.

2. Research material and methodology

Devices for electrophysical protection of plants against insect pests make it possible in the forecast system to have reliable information about the number of populations of all insects included in the agrobiocenosis of an industrial garden, have a stable attractive effect, the maintenance of these devices does not require large labor costs, their work can be automated [6].

The principle of operation of existing electro-optical converters for the control of insect pests is as follows: at night, insect pests are attracted by optical radiation that has a positive phototaxis effect, then they fall into the zone of action of the striking device and are destroyed.

According to the type of striking device used, installations can be divided into the following types: installations with an aerodynamic striking device; installations in which a high-voltage grid serves as a striking organ; installations with passive screens.

But it should be noted that the efficiency of the installations is affected not only by their design features, but also by the layout of the installations in the garden array.

The results of assessing the quality of protection of garden plants using electro-optical converters, depending on the method of their location, are given in the works of Gazalov V.S. Three options for the location of electro-optical converters were investigated: on the tops of the rhombus, in the line and a double line with displacement [3], [11], [12].

Analysis of dependencies showed that the least lesion of the fruits by apple moth is achieved by placing electro-optical transducers on the tops of the rhombus. But when performing these works, the properties of optical radiation sources with negative phototaxis action were not taken into account.

In this regard, studies have been conducted on the technology of garden plant protection, which consists in the fact that the series of electro-optical converters with a positive phototaxis effect alternate with a series of electro-optical converters with a negative phototaxis effect. Insect pests from the area of operation of the electro-optical transducer with a negative phototaxis effect was forced into the zone of operation of an electro-optical transducer with a positive phototaxis effect, equipped with a damaging organ. The installations were evenly located at a distance of 80 meters from each other along a plot of garden area of 2.56 hectares (Figure 1). Electro-optical transducers were located on the tops of the diamond.

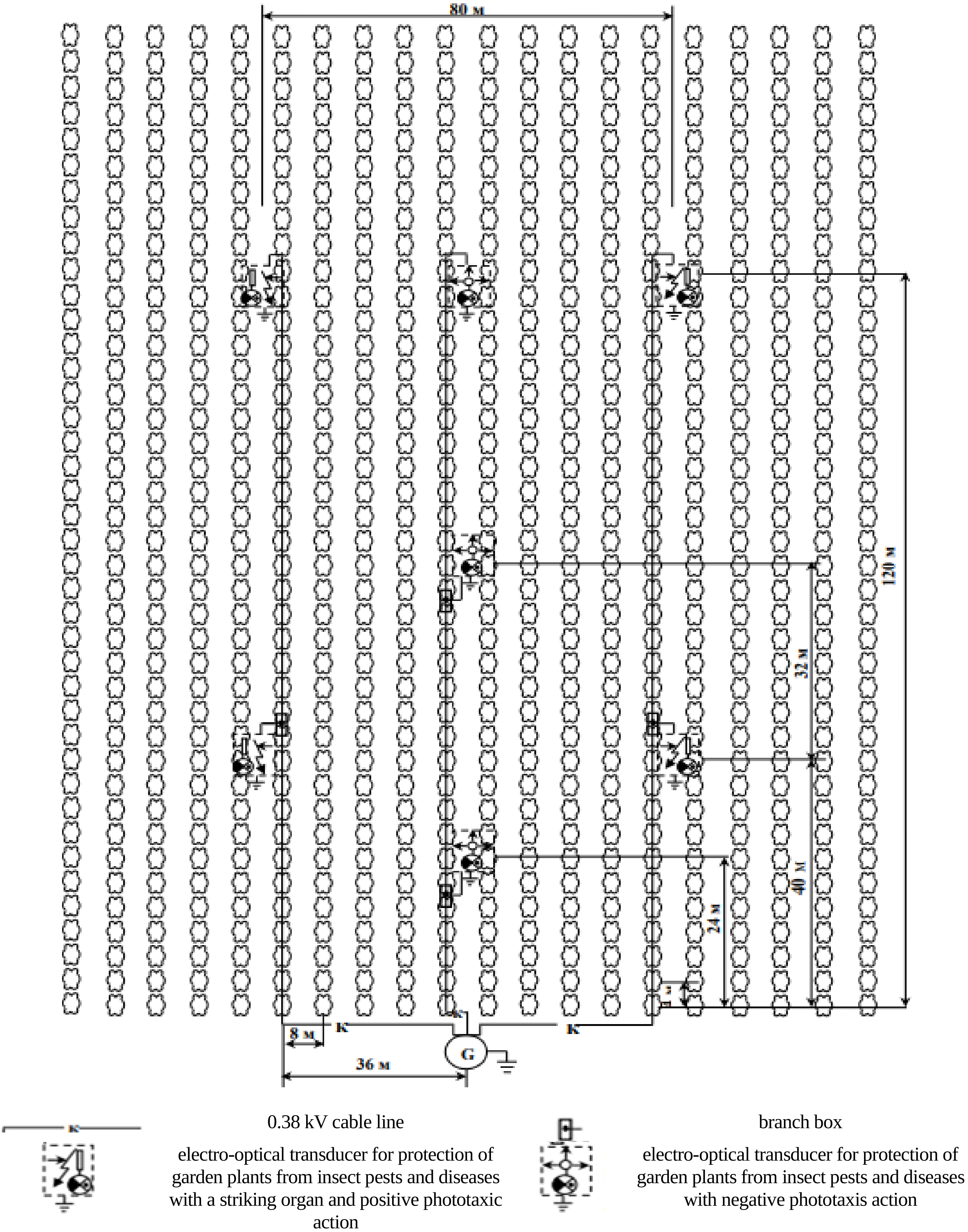


Fig. 1 – Scheme of the location of installations in the garden

The types by used of the electro-optical converters are shown in Figures 2 and 3b. Additionally, electro-optical transducers with phototaxis exposure of the opposite direction were equipped with pulsed radiation devices. Electro-optical transducers with positive phototaxis effects, equipped with devices with pulsed radiation were located at the edges of the test site, and in the center of the test site were installed electro-optical converters with negative phototaxis effects, also equipped with devices with pulsed radiation (Figure 3 a).

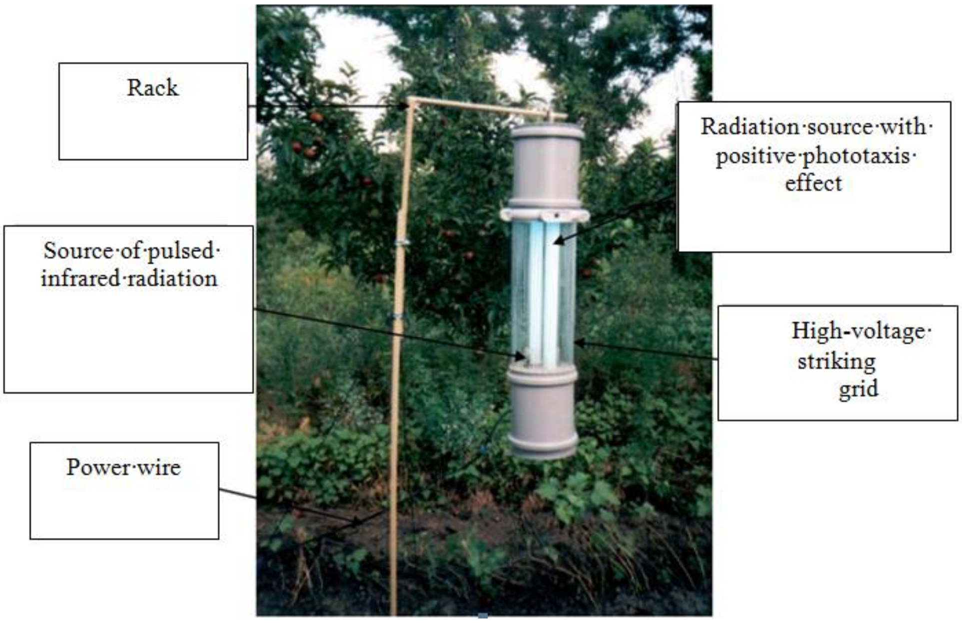
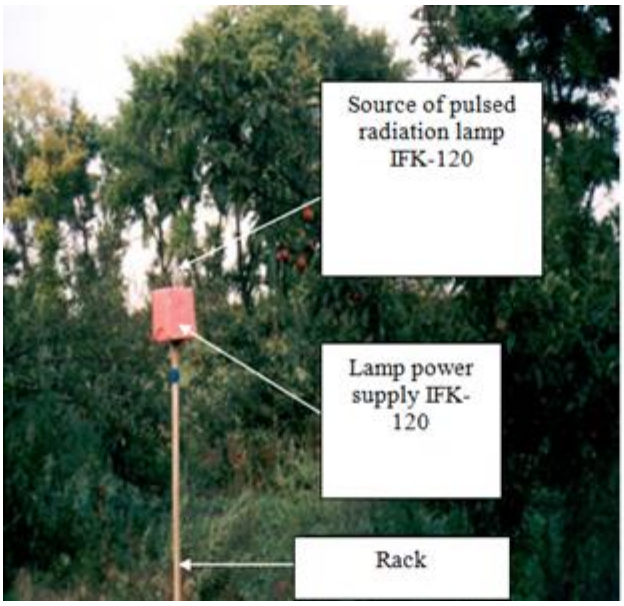


Fig. 2 – Electro-optical transducer with positive phototaxis action and striking organ [5]



a

b

Fig. 3 – Electro-optical converters
a – with pulsed radiation source [11, C. 7]; *b* – with negative phototaxis action

To power the installations of protection of garden plants from insect pests and diseases, it is possible to use both gasoline-electric units and solar panels.

The first option for powering the installations requires the constant presence of maintenance personnel and significant costs for fuels and lubricants. The second option (Figure 4) involves the use of a solar battery, which in the daytime charges the battery, at night the energy stored in the battery through the inverter was used to power the installation of protection of garden plants from insect pests.

Before harvesting, the lesions of the fruit by insect pests on the trees of the experimental site of the garden massif was determined, and the distances from trees to electro-optical transducers were determined.

The data of the studies were compared with the data taken at the control site located next to the experimental one.

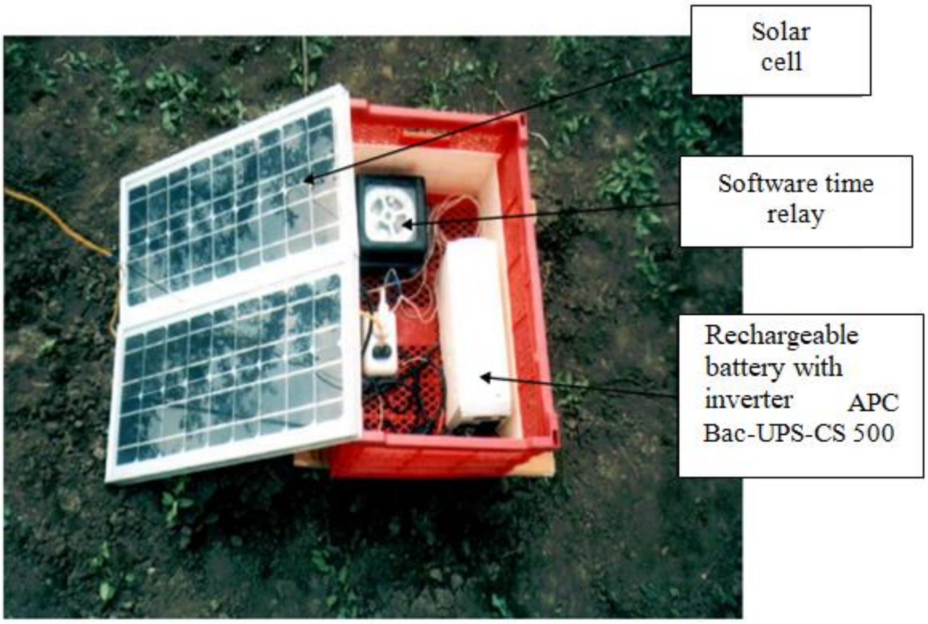


Fig. 4 – Power supply unit of installations for the protection of garden plants from diseases and insect

3. Results of the study

In accordance with the methodology described above, studies were conducted, the results of the studies are shown in tables 1 and 2 and in Figure 5.

Table 1 – Dependence of the defeat of the fruit by apple moth on the distance from the electro-optical converter with a positive phototaxis effect from the tree

Distance from electro-optical transducer to wood, m	4	6	9	13	17	21,5	24
Average value of fetal lesions, %	0,4	0,15	0,3	0,5	0,95	1,37	1,8

Table 2 – Dependence of the defeat of the fruit by apple moth on the distance from the electro-optical converter with a negative phototaxis effect from the tree

Distance from electro-optical transducer to wood, m	4	6	9	13	17	21,5	24
Average value of fetal lesions, %	0,5	0,55	0,75	0,7	0,58	1,14	1,75

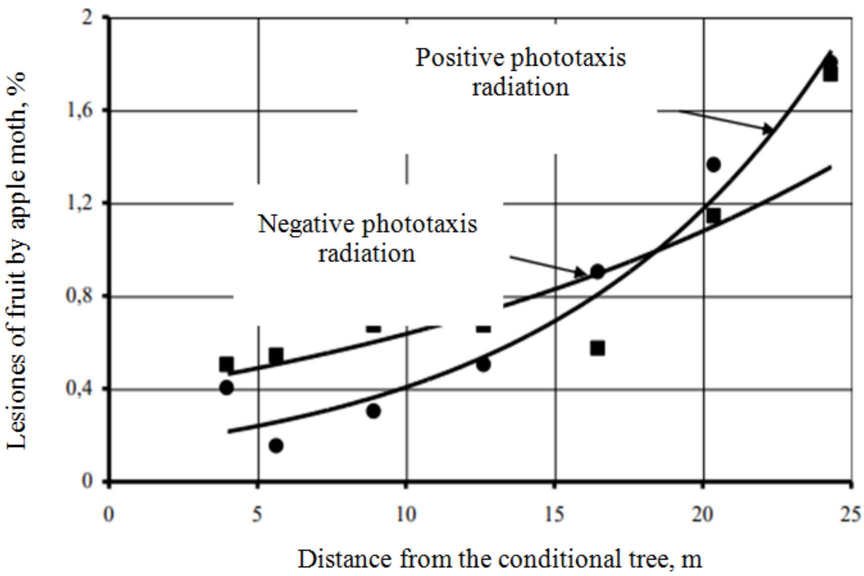


Fig. 5 – Dependence of the defeat of the fruit by apple moth on the distance from electro-optical transducer with negative and positive phototaxis effect to wood

The resulting dependencies are described by second-order equations. The dependence of the defeat of the fruit by apple moth on the distance from the electro-optical transducer with a positive phototaxis effect to the tree is as follows:

$$y = 0{,}0047x^2 - 0{,}0554x + 0{,}4406 \quad (1)$$

The dependence of the defeat of the fruit by apple moth on the distance from the electro-optical transducer with a negative phototaxis effect to the tree is described by the equation

$$y = 0{,}0047x^2 - 0{,}0832x + 0{,}8851 \quad (2)$$

The quality of the obtained models can be judged by the value of the coefficients of determination. In the first case, R2=0,98, in the second – R2= 0,85. Therefore, we can say that the obtained models can be used for forecasting.

Also, the analysis of the obtained dependencies shows that the average lesion of the defeat of the fruit by apple moth within the radius of operation of the electro-optical converter for converters with a positive phototaxis effect is – 1,3%, for converters with a negative phototaxis effect – 1,15%. At the control site, the incidence of apple moth fruit was 2,55%. At the same time, it should be noted that with almost the same quality of protection of garden plants, electro-optical converters with negative phototaxis exposure do not contain a damaging organ, which greatly simplifies the device and reduces the cost of a garden plant protection system.

4. Conclusion

Analysis of plant protection technologies against insect pests allows us to talk about the prospects of using optical radiation for these purposes, which improves the quality of plant protection, improves the ecological situation in gardens.

Electro-optical converters that displace insect pests from the coverage area do not require expensive damaging devices, are easy to manufacture, and have a low cost. Therefore, the proposed electrotechnology of protecting garden plants from insect pests using radiation with opposite phototaxis effects will significantly simplify and reduce the cost of the plant protection system and increase the effectiveness of the protective measure.

Conflict of Interest

None declared.

Конфликт интересов

Не указан.

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