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PLANT EXTRACTS IN CROP PEST CONTROL

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Key words: *Rheum officinale Baill. (Polygonaceae), Azadirachta indica Juss. (Meleaceae), plant extracts, Sitotroga cerealella Oliv., spider mite*

INTRODUCTION

The role of insecticides in human society is very important. Phytophagous insects can cause very significant damage to grown crops, which may range anywhere between 10 and 90% (with an average of 35–40%) for all potential food and fibre crops [1,2,3]. The use of plant secondary metabolites synthesized by some plant species as part of their natural self-defense against pathogens and pests seems to be an excellent alternative. Biopesticides, together with botanical insecticides, are more and more popular with food manufacturers and consumers equally. Many experts forecast a huge growth in the sales of botanicals over the next decade. Biopesticides could grow from 4–5% of the global pesticide market to as much as 20% by 2025. Growth in botanicals may perhaps be even higher, going from 1–2% of the market share to somewhere possibly around 7% of the total market share [1,4]. According to its share of the global market, Neem products are likely to come first, which are based on *Azadirachta indica* Juss seed oil. (*Meleaceae*). The important bioactive compounds of neem seed oil belong to the limonoid class of triterpenoids, such as Azadirachtin, which is recognized as the best biopesticide in the world. It is characterized by high efficiency, low toxicity, broad spectrum, less impact on natural enemies, no obvious toxicity for vertebrates and phytotoxicity for crops, as well as rapid degradation in the environment. Azadirachtin has an anti-feeding, repellent, systemic and inhibitory effect on growth and development. It mainly acts on the endocrine system of insects and reduces the release of ecdysone. It can also directly destroy the epidermal structure or prevent the formation of chitin in the epidermis, disrupt respiratory metabolism, and affect the development of the reproductive system. The mechanism of action is special, and there are many sites of action, and it is not easy for pests to induce drug resistance.

Extracts of rhubarb roots and leaves are a source of various biologically active substances such as emodin, quercetin and oxalic acid. An important natural function of phenols (emodin) in mediating plant-animal interactions is a deterrent factor. In relatively low concentrations, emodin reduces nutrition and lengthens the development of the gypsy moth larvae, and in high concentrations, it causes severe mortality. Selective insecticidal agents have already been developed on the basis of oxalic acid and oxalates. However, the mechanisms of all these substances action as insecticides are still under investigation. Determination of the plant extracts biological effectiveness for the control of agricultural crops pests was carried out in laboratory conditions.

The aim of our research was the determination of the possibility of using plant extracts as agricultural pest control agents.

MATERIAL AND METHOD

The subjects of our research were the bioactive substances of *Rheum officinale* and *Azadirachta indica* plant extracts. In the course of research were used the roots and leaves of plants rhubarb manual collection. Stored and processed plant raw materials, dried to an air-dry state, in accordance with the requirements of regulatory enactments [5]. We used German-made (Neemöl-Rimulgan) neem seed oil (Figure 1).

Research objects

Spider mites (*Tetranychus urticae* Koch., *Tetranychidae*), moving from one culture to another, feeds on the contents of plant cells, as a result of which the intensity of the photosynthesis process in plants decreases. Spider mites can be detected by the presence of a thin cobweb and white dots on the underside of the leaves. With severe infection, the leaf blades are covered with a white bloom, are wrapped entirely in cobwebs, and on the shoots you can find a massive accumulation of small spider mites. In addition to the harm caused to plants, spider mites can be a carrier of various viral and fungal infections and, in particular, often infects crops with gray rot. The mite infects *Cucumis sativus* L plants during fruiting and the use of chemical control agents is problematic. The threshold of harmfulness is 20 individuals / leaf [6].

The grain moth (*Sitotroga cerealella* Oliv., *Lepidoptera*) is a pest of stocks**.** Butterflies appear in march - april. During her life (5-13 days), the female lays eggs one by one or in groups of up to 15 pcs. on the grains. Eggs develop from 4 to 28 days, depending on the ambient temperature. The hatching caterpillar gnaws through the shell of the grain and penetrates inside, where it feeds on the endosperm and finishes development to a butterfly. Only one seed is required for full development. The development of the pupa continues in the summer from 7 to 10 days, in the autumn to 14-15, in the winter it can be very delayed. Favorable temperature 27-28°C, minimum temperature of development 13°C, optimum humidity of the environment 15-16%, fertility up to 283 eggs, generations per year 3-8. Harmfulness coefficient 1.1.

Determination of plant extracts biological effectiveness in the control of cucumber seedlings infection with spider mites

In a laboratory greenhouse, the seedlings of *Cucumis sativus* L were planted and artificially infested with spider mites. Plants were treated once a week with plant extracts in 4-fold repetition according to the options:

Variant 1 = 1% N; Variant 2 = 0,5% L; Variant 3 = 1% R. Control plants were not treated.

To take into account the plants damage by pests, a certain number of plant leaves were examined and the degree of damage to each plant was assessed on a four-point scale (Figure 2):

score 0 - no damage,

point 1 - minor damage (no more than 25% of the leaf surface);

score 2 - significant damage (up to 50% of leaves);

point 3 - plants are badly damaged (more than 50% of the leaf surface is damaged by insects).

The biological effectiveness of protective measures was assessed by comparing the infestation of plants on treated and control plants. The difference in the infestation of control and treated plants (Eb, %) is determined by the formula

$$Eb = (100\,(Bk - B0)) / Bk, \text{ where} \quad (1)$$

Bk is an indicator of the prevalence or development of the disease in the control plot;

B0 - a similar indicator on the experimental site.

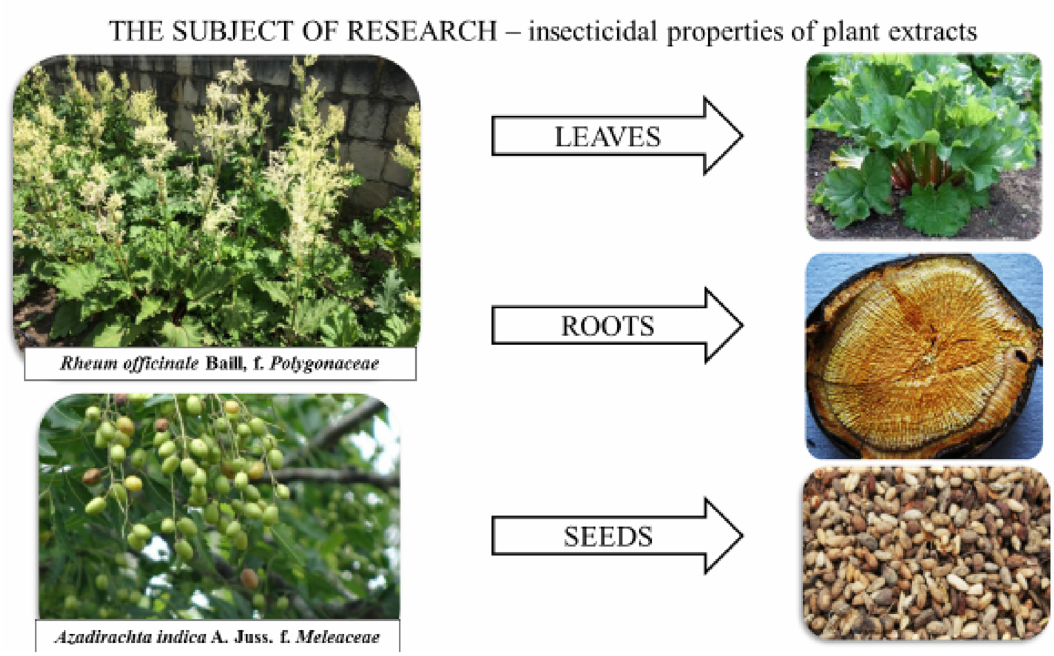

Figure 1. Plant extracts: *Rheum officinale* roots; L - *Rheum officinale* leaves; N - *Azadirachta indica* seeds

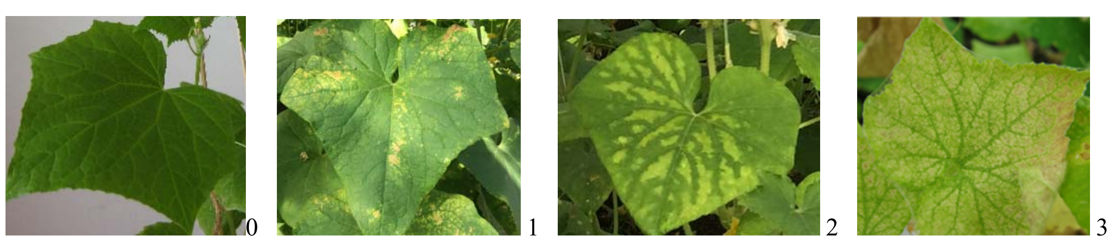

Figure 2. The degree of damage with spider mites to each plant leave was assessed on a four-point scale

Determination of plant extracts insecticidal activity for the control of the *Sitotroga cerealella* Oliv stocks pest

In Petri dishes were placed 100 grains of barley, which were treated with plant extracts, in 4 replicates, in different versions:

Variant 1 - 50% R;
Variant 2 - 50% L;
Variant 3 - 6% N;
Variant 4 - 40% R + 50% L;
Variant 5 - 6% N + 50% L;
Variant 6 - 6% N + 40% R;
Variant 7 - 40% R + 50% L + 3% N;
Variant 8 - 40% R + 50% L + 6% N. Pelecol (1%) was used as an ecological standard. Control grains were not processed.

Then, the barley grains were infected with equal weighed portions of the eggs of the *S. cerealella* and placed in a thermostat. The final accounting was carried out in a month. The number of pest specimens hatched from eggs was determined.

Under laboratory conditions, when the number of pests between observation in the control practically does not change, the biological activity of the insecticide extracts was calculated using the

Abbot formula:

$$C = 100 (A-B) / A, \quad (2)$$

where C - is the percentage of pest's mortality,

A - is the average number of pests before processing,

B - is the average number of pests after processing.

The Microsoft Office Excel software package was used to construct graphic materials. Mathematical processing and assessment of the scientific data reliability obtained was carried out using the ABC Pascal platform.

RESULTS AND DISCUSSIONS

Determination of the plant extracts biological effectiveness in the control of *Cucumis sativus* L seedlings infection with spider mites

In a laboratory greenhouse, planted seedlings of *Cucumis sativus* L (artificially infested with spider mites) were treated weekly with plant extracts.

A month later, the degree of damage to the plants by the pest was determined.

As a result, it was found that oil extract of neem seeds (82,4%) and rhubarb root extract (73,5%) have the maximum biological effectiveness in the control of spider mites (Table 1; Figure 3).

Table 1. Biological effectiveness of plant extracts in the control of the infestation of *Cucumis sativus* L seedlings by spider mites

Variant	Intensity of the defeat, %	Biological effectiveness, %
Control	68	
V 1= 1% N	12	82,4
V 2 =0,5% L	28	58,8
V 3 =1% R	18	73,5
$HCP_{0,05}$	7,4	

Legend. Extracts: R - *Rheum officinale* roots; L - *Rheum officinale* leaves; N - *Azadirachta indica* seeds

The most harmful spider mite is in greenhouse, where it gives up to 20 generations within a year.

However, the use of chemicals leads to the emergence of pest resistance to many insecticides and their pollution of the environment. The plant extracts that we used in our research demonstrated high insecticidal efficacy (58,8-82,4%). The ability to protect plants from spider mites by treating them with plant extracts together with beneficial arthropods is a promising area of biological plant protection.

Determination of plant extracts insecticidal activity for *Sitotroga cerealella* Oliv. pest control

Determination of plant extracts insecticidal activity for the control of the *Sitotroga cerealella* Oliv. pest of agricultural crops carried out in laboratory conditions (Figure 4).

The neem extract showed the maximum insecticidal activity, almost completely suppressing the hatching of *Sitotroga cerealella* adults (0,003 pcs / grain) (Table 2; Figure 5).

Table 2. Insecticidal activity of plant extracts for *Sitotroga cerealella* Oliv. pest control

Variant	Quantity of adults /1 grain
Control	0,9
Standard - Pelecol 1%	0,7
V1 – 50%R	0,6
V2 – 50%L	0,7
V3 – 6% N	0,003
V4 – 40%R +50%L	0,7
V5 – 6% N + 50%L	0,1
V6 – 6% N + 40%R	0,003
V7 – 40%R + 50% L + 3% N	0,4
V8 - 40%R + 50% L + 6% N	0,02
$HCP_{0,05}$	0,08

Legend.
Extracts: R - *Rheum officinale* roots; L - *Rheum officinale* leaves; N - *Azadirachta indica* seeds

a b c

Figure 3. a) control plants *Cucumis sativus* L infected with spider mites; b) signs of leaf damage by a pest; c) microscopic examination of a spider mite

Figure 4. Number of hatched *Sitotroga cerealella* Oliv. adults

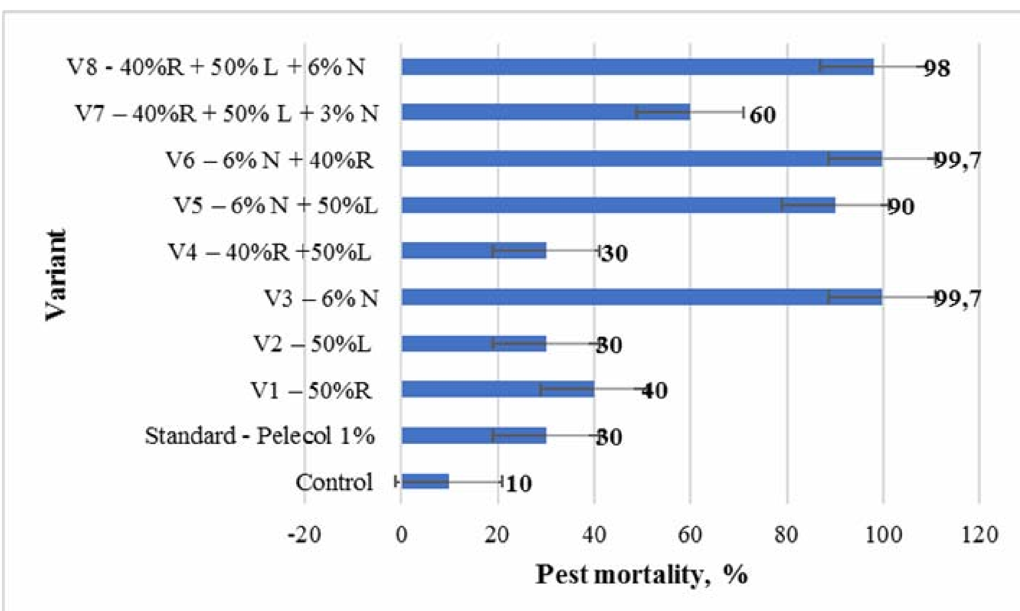

Figure 5. Insecticidal activity of plant extracts for *Sitotroga cerealella* Oliv. pest mortality

The results of the experiment correlate with the data of modern research on the mechanism of action of the extract from the seeds of neem. The oil is considered a contact insecticide exhibiting systemic and translaminar activity.

The use of rhubarb root extracts reduces the emergence of adults by almost 2 times (mortality 40%). The obtained results correlate with research data that emodin has a deterrent effect on a wide range of invertebrates, inhibits the action of intestinal enzymes (α-amylase and proteinase) of insect pests of the stock [7].

However, in our case, the rhubarb extract on the surface of the grains was in contact with the feeding larva for a very short time. The main development of the larva took place inside the grain, where the extract did not penetrate. Therefore, the contact extract effect manifested insufficiently. Rhubarb leaf extracts and combinations of rhubarb root and leaf extracts contributed to a pest mortality of 30%, which is comparable to the reference. The percentage of *Sitotroga cerealella* natural mortality in the control was 10%, in the standard - 30%.

CONCLUSIONS

The neem extract showed the maximum insecticidal activity, almost completely suppressing the hatching of *Sitotroga cerealella* adults (pest mortality – 99,7%) and reducing the infection of *Cucumis sativus* seedlings with spider mites by 82,4%.

The biological effectiveness of the rhubarb root extract (75,3%) in the control of *Cucumis sativus* L seedlings infection with a spider mite was determined. It was found that rhubarb root extract reduces almost twice the hatching of adults of *Sitotroga cerealella*.

Rhubarb leaf extract has insignificant insecticidal activity in the control of spider mites (58,8%), and of the *Sitotroga cerealella* (30%) pest mortality.

ABSTRACT

Natural pesticides are less harmful, biodegradable, less toxic to the non-target organism, and also economical. In order to produce organic products, studies were carried out on the properties of herbal extracts based on *Rheum officinale* Baill. (*Polygonaceae*) and *Azadirachta indica* Juss. (*Meleaceae*).

The aim of the work was the determination of the possibility of using plant extracts as pest control agents.

The neem extract exhibited the maximum insecticidal activity, almost completely suppressing the hatching of *Sitotroga cerealella* adults (the pest mortality was 99,7%) and reducing the infection of *Cucumis sativus* L seedlings with spider mites by 82,4%.

The biological effectiveness of the rhubarb root extract (75,3%) in controlling the infection of *C. sativus* seedlings with a spider mite was determined. It was found that rhubarb root extract almost halved the hatching of *S. cerealella* adults, compared with the control. The use of such plant protection products will reduce the number of chemical treatments, and hence the residual amount of pesticides in organic agricultural products.

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