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EFFECT OF PLANT EXTRACTS ON SOME STORED-PRODUCT INSECT PESTS

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Key words: *Sitophilus granarius*, *S. oryzae*, *Tribolium castaneum*, essential oils of plants.

Abstract

The aim of the study was to determine the effect of aqueous and aqueous-alcohol extracts from the following plants: *Crataegus oxyacantha, Sambucus nigra, Hypericum perforatum, Cheliodonium maius, Artemisia absinthium, Centaurea cyanus, Achillea millefolium, Tussilago farfara, Matricaria chamomilla*, on stored-product pests.

The experiment was conducted on three species of storage insects: *Sitophilus granarius* L., *Sitophilus oryzae* L. and *Tribolium castaneum* Herbst, using aqueous (1:10) and aqueous-alcohol (1:7:3) plant extracts. The extracts were found to repel *Sitophilus granarius* L. and Tribolium castaneum Herbst. None of the essential oils of plants produced a repellent effect on the beetles of Sitophilus oryzae L. Moreover, This species of stored-product pests was attracted by the extracts from Sambucus nigra, Hipericum perforatum and Matricaria chamomilla.

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Słowa kluczowe: *Sitophilus granarius*, S. *oryzae*, *Tribolium castaneum*, wyciągi roślinne.

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Abstrakt

Celem pracy było określenie wpływu wyciągów wodnych i wodno-alkoholowych otrzymanych z następujących gatunków roślin: *Crataegus oxyacantha, Sambucus nigra, Hypericum perforatum, Cheliodonium maius, Artemisia absinthium, Centaurea cyanus, Achillea millefolium, Tussilago farfara, Matricaria chamomilla*, na wybrane szkodniki magazynowe.

Eksperyment prowadzono na trzech gatunkach szkodników magazynowych: *Sitophilus granarius* L., *Sitophilus oryzae* L. i *Tribolium castaneum Herbst.*, stosując roślinne ekstrakty wodne (1:10) i wodno-alkoholowe (1:7:3). Stwierdzono, że ekstrakty te działają odstraszająco na *Sitophilus granarius* L. i *Tribolium castaneum Herbst*, natomiast nie odstraszają chrząszczy *Sitophilus oryzae* L. Na tego szkodnika działają atraktanty w postaci ekstraktów z *Sambucus nigra, Hipericum perforatum* i *Matricaria chamomilla*.

Introduction

The loss attributed to stored-product pests is not limited to the loss of weight of stored food products, but is compounded by their depressed consumption quality. Dead insects, larval exuviae and products of metabolism make infested stored food products inedible (NAWROT et al. 1982). Although various pesticides of different chemical composition are applied, no species of storage pest has been completely eradicated until present. This can add to the growing interest in the issues dealt with by a new branch of sciences – chemical ecology. An important group of substances examined by chemical ecologists comprises antifidants, repellents, attractants and arrestants (SOBÓTKA, NAWROT 1988).

Several research projects carried out on essential oils of plants has demonstrated that such oils can affect the growth and reproduction of some insects (IGNATOWICZ, GERSZ 1997, RĄKOWSKI, IGNATOWICZ 1997, MUKHERJEE, JOSEPH 2001). Such findings have encouraged the authors of the present paper to examine the effect of some aqueous and aqueous-alcohol mixtures of essential oils from some plants on the behaviour of common cereal stored-product pests.

Material and Methods

Material

1. Insects

The object of the research consisted of adults (imagines) of the following beetles: *Sitophilus granarius* L., *Sitophilus oryzae* L., and *Tribolium castaneum* Herbst., originating from the mass breeding collection maintained at the Chair of Phytopathology and Entomology of the University of Warmia and Mazury in Olsztyn, Poland. The insects were reared under the optimal conditions for their development.

2. Plants

The tests involved aqueous and aqueous-alcohol essentials of oils from 9 species of plants, which belonged to five families. Aqueous extracts (1:10) and aqueous-alcohol extracts (1:7:3) were prepared from the oils of plants listed in Table 1. Aqueous extracts were obtained by pouring 10 g of macerate over with 100 ml H_2O. Aqueous-alcohol extracts were made according to the method cited by KIEŁCZEWSKI et al. (1979).

Table 1

List of plants tested

Family, species	Family, species	Part of plant
Rose family common hawthron	***Rosaceae*** *Crataegus oxyacantha* L.	 flower
Honeysuckle family elder	***Caprifoliaceae*** *Sambucus nigra* L.	 flower and fruit
St. Johnswort family St. Johns wort	***Hypericaceae*** *Hypericum perforatum* L.	 stem and leaves
Poppy family swallow-herb	***Papaveraceae*** *Cheliodonium maius* L.	 stem and leaves
Aster family wormwood cornflower yarrow coltsfoot common camomile	***Asteraceae*** *Artemisia absinthium* L. *Centaurea cyanus* L. *Achillea millefolium* L. *Tussilago farfara* L. *Matricaria chamomilla* L.	 stem and leaves flower stem and leaves flower flower

*

3. The laboratory experiment

The repellency of the plant extracts was tested using a modified version of the method described by LAUDANI et al. (1955) and MCDONALD et al. (1970). The observations were performed in Petri dishes, 9 cm in diameter, lined with circles of filter paper, cut in half. One half of the circle was treated with an extract of plant oils, while the other half was left untreated. Both halves were joined with a cellulose strip. Ten specimens of a given species of pests were placed on each circle. The experiment was conducted with 4 replications. The insects found on either half of the filter paper were counted after 0.5, 2, 4 and 24 hours. The repellence coefficient was computed from the following formula:

$$RI = (N_t - N_k) / (N_t + N_k), \text{ where:}$$

N_t – the number of beetles on the plant extract treated half of the circle,
N_k – the number of beetles on the untreated half of the circle.

The value of *RI* ranging from 0 to –1.0 meant that the plant extract tested had repellent properties (IGNATOWICZ, WESOŁOWSKA 1996). Tuckey's test was applied for the purpose of analysing and evaluating the mean values of the response coefficient *RI*.

Results and Discussion

It was found out that the aqueous and aquoues-alcohol essentials of plant oils showed predominantly repellent properties, with only some attractant effect observed. The response of the beetles to the essential plant oils applied varied. *Sitophilus granarius* responded most strongly to the aqueous plant extracts. The strongest reaction of this species was caused by the extract of *Artemisia absinthinum*, followed by the extracts of *Cheliodonium maius* and *Matricaria chamomilla* (Table 2). Essential oils of these plants can serve as efficient repellents for granary weevil (NAWROT *et al.* 1982). Extracts from *Artemisia absinthium* and *Matricaria chamomilla* can completely inhibit the development of the F_1 generation of *Acanthoscelides obtectus* (RĄKOWSKI, IGNATOWICZ 1997). Regarding the aqueous-alcohol plant extracts, the strongest response was produced by *Tribolium castaneum* (Table 3). The highest response coefficient was determined for the essential oils of *Artemisia absinthium* and *Achillea millefolium* as well as *Tussilago farfara*. *Sitophilus oryzae* was found to have responded most weakly to the plant extracts applied.

The attractant effect of the plant essential oils was revealed when the aqueous extracts from flowers and fruits of *Sambucus nigra*, *Hypericum perforatum* and *Matricaria chamonilla* were applied to *Sitophilus oryzae* (Table 2). Only one treatment combination, the aqueous-alcohol extract from flowers of *Sumbucus nigra* applied to *Tribolium castaneum*, was determined to have produced no attractant effect on the insects.

The analysis of variance of the results showed that the value of the coefficient RI was highly significantly affected by the influence of pests and time of the treatment with essential plant oils. In addition to this, a significant pests x time of treatment interaction was found, which means that the value of RI coefficient varied depending on how long the pest species were treated with the extracts. The analysis of variance also revealed a significant interaction between the pests and the type of extracts, which implies that RI coefficient assumed different values for each pest species depending on the type of an extract (Figure 1).

Applicability of controlling *Callobruchus maculatus* using essential oils of plants has been recently tested in India. The results obtained for extracts from *Melia azadirachta*, *Cyperus rotundus* and *Hyptis suaveolens* were promising (RAJA *et al.* 2001).

When using essential oils of plants, it is worth remembering that the advantage of plant extracts over chemicals lies in the fact that the former can quickly disappear in the environment without leaving any trace.

Table 2

Deterrent effect of aqueous plant extract on grain weevil (*Sitophilus granarius* L.), riceweevil (*Sitophilus oryzae* L.) and red flour beetle (*Tribolium castaneum* Herbst), means from 5 replications

Pest	Time of observation (h)	Response coefficient value *RI*									
		1	2	3	4	5	6	7	8	9	10
Grain weevil (*Sitophilus granarius* L.)	0.5	-0.04	0.00	-0.64	-0.40	-0.06	-0.60	-0.48	-6.00	-0.40	-0.56
	2	0.00	0.14	-0.84	-0.52	-0.24	-0.48	-0.40	-0.64	-0.32	-0.52
	4	0.16	0.00	-0.48	-0.28	-0.56	-0.40	0.08	-0.44	-0.04	-0.52
	24	0.12	0.00	-0.52	-0.24	-0.72	-0.08	-0.08	0.16	-0.20	-0.48
Rice weevil (*Sitophilus oryzae* L.)	0.5	0.28	0.26	-0.64	0.52	0.48	0.12	-0.16	-0.56	-0.44	0.56
	2	0.60	0.46	0.12	-0.08	0.52	-0.20	-0.12	-0.36	0.00	0.56
	4	0.60	0.20	0.44	0.04	0.44	-0.20	-0.16	-0.36	0.12	0.12
	24	0.40	0.14	0.08	0.32	0.36	-0.20	-0.12	-0.04	0.20	-0.12
Red flour beetle (*Tribolium castaneum* Herbst)	0.5	-0.12	-0.12	0.16	0.36	0.29	-0.08	-0.36	-0.36	-0.12	0.08
	2	-0.20	0.00	-0.16	-0.48	-0.20	-0.12	-0.28	-0.44	-0.12	-0.24
	4	0.20	-0.08	-0.36	-0.08	-0.48	-0.32	-0.36	-0.40	-0.12	-0.40
	24	0.36	0.08	-0.48	-0.12	0.32	-0.32	-0.40	-0.44	-0.12	-0.24

1 – European elder (flower)
2 – European elder (fruit)
3 – Wormwood
4 – Blue cornflower
5 – St John's wort
6 – Swallow-herb
7 – Common hawthron
8 – Yarrow
9 – Coltsfoot
10 – Common camomile

Table 3

Deterrent effect of aqueous-alcohol plant extracts on grain weevil (*Sitophilus granarius* L.), rice weevil (*Sitophilus oryzae* L.) and red flour beetle (*Tribolium castaneum* Herbst), means from 5 replications

Pest	Time of observation (h)	*RI* response coefficient value									
		1	2	3	4	5	6	7	8	9	10
Grain weevil (*Sitophilus granarius* L.)	0.5	-0.20	-0.22	-0.36	-0.40	-0.04	-0.22	0.08	0.16	-0.36	-0.34
	2	-0.04	-0.24	-0.32	0.36	-0.08	-0.48	-0.28	-0.28	-0.36	0.00
	4	-0.24	-0.22	-0.32	0.24	-0.08	-0.32	0.00	-0.08	-0.52	-0.20
	24	-0.36	-0.28	-0.72	0.00	-0.04	-0.28	-0.22	-0.52	-0.60	0.00
Rice weevil (*Sitophilus oryzae* L.)	0.5	-0.04	0.00	-0.64	0.12	0.00	-0.12	0.12	-0.12	-0.32	-0.08
	2	-0.12	-0.04	-0.16	-0.04	0.04	0.08	-0.08	-0.12	-0.44	-0.08
	4	0.04	-0.16	-0.14	0.06	0.00	-0.08	-0.20	-0.40	-0.44	-0.08
	24	0.08	-0.20	-0.20	0.12	-0.12	-0.32	0.08	-0.04	-0.12	0.20
Red flour beetle (*Tribolium castaneum* Herbst)	0.5	-0.20	-0.14	-0.14	-0.06	0.14	0.26	-0.40	-0.20	0.34	-0.44
	2	0.14	0.00	-0.60	-0.40	-0.46	-0.40	-0.46	-0.54	-0.46	-0.06
	4	-0.60	-0.40	-0.46	-0.26	-0.40	-0.60	0.36	-0.46	-0.74	-0.20
	24	0.46	-0.46	-0.40	-0.26	-0.14	-0.66	-0.86	-0.34	-0.60	-0.34

1 – European elder (flower)
2 – European elder (fruit)
3 – Wormwood
4 – Blue cornflower
5 – St John's wort
6 – Swallow-herb
7 – Common hawthron
8 – Yarrow
9 – Coltsfoot
10 – Common camomile

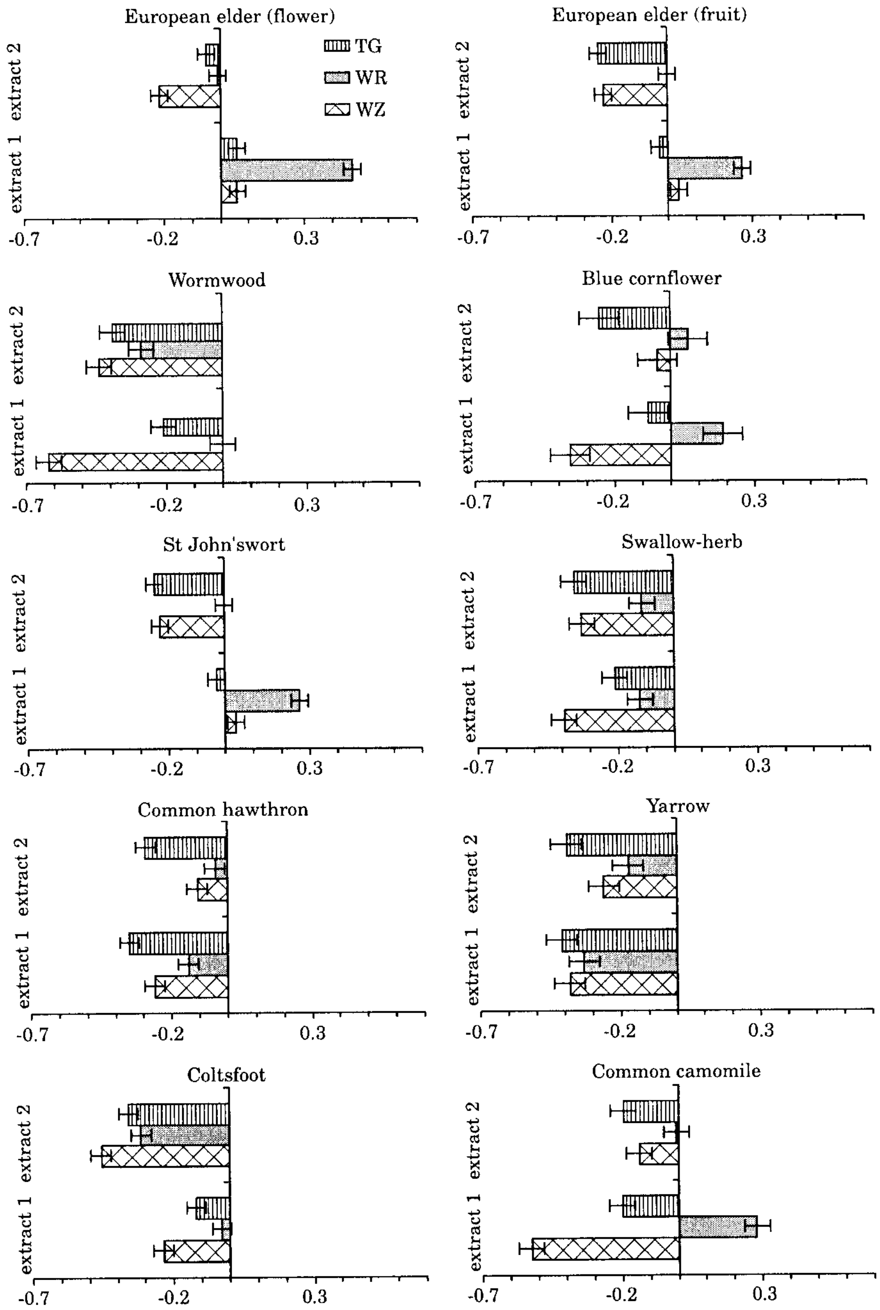

Fig. 1. Response of grain weevil (WZ), rice weevil (WR) and red flour beetle (TG) to the plant extracts: extract 1 – aqueous, extract 2 – aqueous-alcohol (Range of error corresponds to LSD for the extract x pest interaction at p=0.01)

Conclusions

1. The strongest repellent properties towards *Sitophilus granarius* L. and *Tribolium castaneum* Herbst. were demonstrated by the aqueous and aqueous-alcohol extracts of essential oils from *Artemisia absinthium*.

2. None of the plant extracts tested served as a repellent for *Sitophilus oryzae* L.

3. The attractant properties of flowers and fruits of *Sambucus nigra*, *Hypericum perforatum* and *Matricaria chamomilla* were revealed only in the case of *Sitophilus oryzae* L.

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