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ASSESSMENT OF THE EFFECTIVENESS OF PLANT-DERIVED PESTICIDES IN CONTROLLING THE BLACK CHERRY APHID *Myzus cerasi* F. IN ORGANIC GROWING OF SWEET CHERRY

Summary

In 2013-2014, a study was conducted to assess the effectiveness of plant extracts in controlling the black cherry aphid (Myzus cerasi F.) in an ecological orchard. The tested decoctions were prepared from the field horsetail (Equisetum arvense), white mustard (Sinapis alba), Indian mustard (Brassica juncea), garlic (Allium sativum) and the wood of Quassia amara. In addition, an extract from the seeds of Azadirachta indica and horticultural potassium soap were also tested. The used extracts showed to have varied influence on aphid mortality. The highest mortality rates were obtained with the Q. amara decoction (50% – 2013, and 63.4% – 2014) and the Azadirachta indica extract (45.5% – 2013, and 49.7% – 2014). The other extracts had less influence on the mortality of the black cherry aphid, which ranged from 7.1 to 32.2%.
***Key words**: Myzus cerasi, plant extracts, controlling aphids, ecological orchard*

OCENA SKUTECZNOŚCI PREPARATÓW ROŚLINNYCH W ZWALCZANIU MSZYCY CZEREŚNIOWEJ *Myzus cerasi* F. W EKOLOGICZNYM SYSTEMIE UPRAWY CZEREŚNI

Streszczenie

W latach 2013-2014 oceniano skuteczność preparatów roślinnych w zwalczaniu mszycy czereśniowej (Myzus cerasi F.) w sadzie ekologicznym. Zastosowano przygotowane we własnym zakresie napary z ziela skrzypu, nasion gorczycy białej i sarepskiej, główek czosnku oraz wywar z drewna krzewu Quassia amara. Dodatkowo zastosowano gotowe preparaty, ekstrakt z miodli indyjskiej (Azadirachta indica) oraz mydło ogrodnicze potasowe z dodatkiem wrotyczu. Wykazano zróżnicowany wpływ zastosowanych preparatów na śmiertelność mszycy. Najwyższą śmiertelność w obydwu latach prowadzenia badań zanotowano dla wywaru z Quassia amara, która wyniosła 50% (2013) i 63,4% (2014) i nieznacznie niższą dla ekstraktu z miodli indyjskiej (Azadirachta indica), która wyniosła 45,5% (2013) i 49,7% (2014). Pozostałe preparaty wykazały zdecydowanie mniejszy wpływ na śmiertelność mszycy czereśniowej, która kształtowała się od 7,1 do 32,2%.
***Słowa kluczowe**: Myzus cerasi, wyciągi i napary roślinne, zwalczanie mszycy, sad ekologiczny*

1. Introduction

The black cherry aphid (*Myzus cerasi* F.) is commonly found in Poland [42] and other European countries, and also in some parts of Asia, Australia, New Zealand and North America [4, 5, 18, 30, 35, 38]. It is a holocyclic and heteroecious (host-alternating) species [42]. In the autumn, females of the cherry aphid lay their eggs at the base of buds, in crevices of the bark, and on young shoots [4]. In the spring, wingless individuals hatch from the eggs and develop quickly. In the initial period, they feed on the buds, gradually moving to young leaves and shoots [37]. In early summer, winged individuals migrate to secondary host plants [3, 21]. In Poland, the black cherry aphid migrates from sour cherry and sweet cherry trees to various *Galium* and *Veronica* species [42]. In areas where the cherry aphid occurs, excluding Poland, several dozen species of secondary hosts of this pest are distinguished [3, 23]. In the autumn, the adult winged individuals of the cherry aphid migrate from their summer hosts to sour cherry and sweet cherry trees, on which they lay overwintering eggs [4]. In Poland, this pest can produce from a few to a dozen or more generations in one growing season [28]. Aphids form the largest group of virus vectors. It includes more than 200 species of these pests, which transmit a total of over 300 plant viruses [17]. The black cherry aphid is considered to be the most commonly occurring virus vector worldwide [10, 20, 30, 42]. The presence of this aphid species in commercial orchards brings with it a number of risks. The feeding activity of cherry aphids on leaves and young shoots causes them to become severely twisted, inhibits their growth, and sometimes leads to withering [2, 36]. It may also cause fruitlets to grow smaller and fall off [34]. Increased incidence of the cherry aphid in orchard nurseries causes large losses resulting from the dying of growth apices of maiden sour cherry and sweet cherry trees [9]. The risk threshold for this pest in production orchards is one tree with colonies in a sample of 50 trees [13, 34].

In agriculture, plants for controlling harmful insects have been used for thousands of years. For example, in the times of ancient China and the Roman Empire, chrysanthemums (Chrysanthemum spp.) were used for this purpose. Agricultural textbooks of the seventeenth century contained advice on how to use plants to protect arable crops. Over the last decades, in addition to extensive research on synthetic pesticides, studies have also been conducted on the insecticidal properties of substances contained in plants [14]. In Poland, studies of this type were conducted already in the 1970 by Witkowski W., Miętkiewski R. and Janowicz J. [1]. The development of organic farming, which has increased interest in preparations of plant origin was a further stimulus. The lack of plant protection products intended for controlling aphids in ecological agriculture in Poland [43] was the reason for performing

assessments of the effectiveness of various plant-derived preparations in reducing the numbers of the black cherry aphid under organic orchard conditions.

2. Material and Methods

The study was conducted in 2013-2014 in the IO Experimental Ecological Orchard in Nowy Dwór-Parcela near Skierniewice. In 2013, the colonization of sweet cherry trees by the black cherry aphid made it possible to carry out the experiment under field conditions; however, poor development of colonies was observed. The experiment consisted of a total of 112 trees, with 16 trees in each combination (4 replicates with 4 trees each). Treatments were performed three times at 7-day intervals using a motorized backpack sprayer able to deliver 750 litres of working liquid per 1 ha. After the treatments, the number of new colonies in all the combinations was assessed and samples of leaves and shoots with cherry aphid colonies were collected. The leaves were assessed in terms of aphid mortality using a stereomicroscope. In 2014, because of a very uneven distribution of colonies in the experimental part of the orchard, it was not possible to perform the experiment in the field. Shoots with colonies were therefore cut off from the trees inhabited by the cherry aphid, and on the same day they were sprayed with previously prepared plant-derived preparations. In each combination there were eight shoots with aphid colonies. Aphid mortality was assessed after 48 hours using a stereoscopic microscope. The treatments involved the use of own plant decoctions and infusions, as well as ready-made preparations of plant origin. In both experiments, a total of 7 combinations of preparations were tested: (1) infusion of field horsetail, (2) infusion of garlic bulbs, (3) horticultural potassium soap with the addition of tansy, (4) infusion of white mustard seeds, (5) decoction from the wood of *Quassia amara* (L.) bush, (6) extract from the seeds of the neem tree (*Azadirachta indica* L.), and (7) the control. In 2014, an eighth combination was added – an infusion of Indian mustard seeds. The results, the mortality rates of the black cherry aphid, were statistically analyzed by analysis of variance, which was performed on numerical data transformed with the Bliss formula. The results were compared with Statistica 10 software using Duncan's test at $p = 0.05$.

3. Results and Discussion

The plant-derived preparations used to control the black cherry aphid showed varying effects on the mortality of individuals of this pest. In both years, the highest aphid mortality was obtained following the applications of the *Quassia amara* (L.) decoction and extract from neem seeds. In 2013, the resulting mortality rates were 50% and 45.5% (Table 1), and in 2014 – 63.4% and 49.7%, respectively (Table 2). The other preparations, including the potassium soap, were less effective. The use of the garlic infusion contributed to the mortality of aphids at a similar level in both years, whereas the infusion from the horsetail proved ineffective. The largest variation in the results was obtained for the horticultural potassium soap.

In the absence of available plant protection products for organic fruit-growing to control the black cherry aphid, the selection of cultivars may be one of the methods of avoiding colonization of sweet cherry trees by this pest.

Table 1. Mortality of the black cherry aphid (*Myzus cerasi*) following the use of plant-derived pesticides in 2013
Tab. 1. Śmiertelność mszycy czereśniowej po zastosowaniu preparatów roślinnych w roku 2013

Combination	Percentage of dead aphids
Control	3,0 a
Horticultural potassium soap with addition of tansy	11,8 b
Infusion of field horsetail	12,5 b
Infusion of garlic bulb	22,9 c
Infusion of white mustard seeds	32,3 c
Extract from the seeds of Neem (*Azadirachta indica*)	**45,5 d**
Decoction from the woods of *Quassia amara* bush	**50,0 d**

Source: own work / Źródło: opracowanie własne

Table 2. Mortality of the black cherry aphid (*Myzus cerasi*) following the use of plant-derived pesticides in 2014
Tab. 2. Śmiertelność mszycy czereśniowej po zastosowaniu preparatów roślinnych w roku 2014

Combination	Percentage of dead aphids
Control	3,9 a
Infusion of field horsetail	7,1 b
Infusion of Indian mustard seeds	21,5 c
Infusion of white mustard seeds	23,1 cd
Horticultural potassium soap with addition of tansy	26,1 de
Infusion of garlic bulb	27,5 e
Extract from the seeds of Neem (*Azadirachta indica*)	**49,7 f**
Decoction from the woods of *Quassia amara* bush	**63,4 g**

Source: own work / Źródło: opracowanie własne

Arnaudov and Kolev (2009) [6] list 10 sweet cherry cultivars with varying susceptibility to the black cherry aphid, but each of them is colonized to a lesser or greater extent. Another method of reducing populations of aphids in fruit crops recommended by Wiech et al. (2001) [46] includes cutting off the shoots colonized by aphids, while Suter and Graber (1995) [41] recommend abundant flushing of the colonies with water and sprinkling them with silica flour. Removal of the youngest shoots with aphid colonies has a negative impact on the development of cherry trees and is very time-consuming in large areas. The black cherry aphid can also be controlled with various types of preparations of plant origin. For many years research has been conducted worldwide on the use of plants in crop protection. Jacobson (1958, 1975) [25, 26] lists over 4,400 different species of plants with insecticidal or repellent properties. Dutka (2013) [19] describes the possibility of using the essential oils of plants to control pests. The oils used, such as those of lavender (*Lavandula* L.), goosefoot (*Chenopodium* L.), neem, or peppermint, produced varying effects on the mortality of aphids, or showed repellent properties. Górski and Kania (2010) [12] described the high efficacy of the essential oil of coriander and petitgrain (bitter orange, *Citrus aurantium* var. *amara* L.) in the control of the glasshouse potato aphid (*Aulacothum solani* Kaltenbach), while Kasiimi et al. (2012) [29] using the essential oils of thyme (*Thymus satureioides* Coss. & Ball.), oregano (*Origanum compactum* Benth.) and neem obtained a 60-90% mortality of

aphids occurring in the cultivation of watermelon. Apart from essential plant oils, various kinds of extracts, decoctions, infusions, or liquid manure have been used to control aphids. Wasina (1986) [45] lists white mustard (*Sinapsis alba* L.) and three varieties of garlic: the common garlic (*Allium sativum* L.), the ramsons (*A. ursinum* L.) and the victory onion (*A. victorialis* L.), while Boczek (1992) [11] includes the blue monkshood (*Aconitum napellus* L.), basil (*Ocimum basilicum* L.) and the cultivated tobacco (*Nicotiana tabacum* L.); Legutowska (2004, 2009) [32, 33] describes the common nettle (*Urtica dioica* L.), the field horsetail (*Equisetum arvense* L.), the common yarrow (*Achillea millefolium* L.), the common garlic, elder (*Sambucus nigra* L.), chamomile (*Matricaria chamomilla* L.), dandelion (*Taraxacum officinale* F. H. Wigg) and onion (*Allium cepa* L.), while Suter and Graber (1995) [41] add decoctions from *Quassia amara* and rhubarb (*Rheum*). The experimentally used decoctions, infusions and extracts produce different effects on aphids. Acheremowicz and Cież (1988) [1] used in their study extracts from 22 plants and applied them under laboratory conditions against the green peach aphid (*Myzus persicae* Sulzer), the cabbage aphid (*Brevicoryne brassicae* L.) and the black bean aphid (*Aphis fabae* Scopoli). The researchers obtained the highest efficacy, of up to 100%, in controlling these aphids by using extracts from sage (*Salvia officinalis* L.), wormwood (*Artemisia absinthium* L.), the cultivated tomato (*Lycopersicon esculentum* L.), the field horsetail and the common garlic. Bozsik (2007) [12] obtained a considerable decrease in the number of cherry aphid colonies after using a fermented extract of nettle (*Urtica dioica* L.). Jankowska (2008) [27], in turn, showed a significant reduction in the colonization of white cabbage by the cabbage aphid after the application of an aqueous extract of French marigold (*Tagates patula nana* L.). Kordan et al. (2013) [31] found no effect of the use of fenugreek (*Trigonella foenum-graceum* L.) on the pea aphid (*Acyrthosiphon pisum* Harris). Bahar et al. (2007) [8] studied the effects of extracts of tobacco, neem, garlic, eucalyptus (*Eucalyptus* L'Heritier) and mahogany (*Swietenia*) on the mortality of the black bean aphid. Depending on the extract used, the obtained mortality rate ranged from 25 to 73%. To control aphids in wheat crops, Iqbal et al. (2011) [24] used extracts of the sweet orange (*Citrus sinensis* L.), spiny gourd (*Momordica dioica* Roxb.), wild garlic (*Allium vineale* L.), marigold (Tagetes spp.), chili pepper (*Capsicum frutescens* L.) and the cultivated tobacco. The highest mortality of aphids was obtained after the application of extracts from tobacco (57.9%), garlic (57.91%) and orange (65.69%). Sohail et al. (2012) [40] tested the effects of extracts of garlic, neem and tobacco on aphids occurring in tea crops (*Camellia sinensis* L.). They demonstrated high mortality rates resulting from the use of these extracts – 52%, 61% and 89%, respectively. Andreev et al. (2008) [5] obtained an efficacy of 95%, and Badowska-Czubik et al. (2010) [7] of 82.9-90%, in controlling the black cherry aphid by using extracts from the neem tree. In the present study, the high effectiveness of garlic was not confirmed, but the experiments did confirm the high effectiveness of the neem extract. Şengonça and Brüggen (1991) [44] had demonstrated under laboratory conditions the mortality rates of the grain aphid *Macrosiphum avenae* (F.) and the bird cherry-oat aphid (*Rhopalosiphum padi* L.) at a level of approx. 95% as a result of using a *Quassia amara* extract, while Sallam et al. (2009) [39] achieved rates from 88% to 96% also in relation to the bird cherry-oat aphid and the rose-grain aphid (*Metopolophium dirhodum* Wlk.). The experiments conducted by us in 2013-2014 confirmed the validity of the use of *Quassia amara* for controlling the black cherry aphid in the ecological cultivation system. In Poland, the organic farming rules for controlling aphids permit the use of horticultural potassium soap, which is a fatty acid potassium salt (soft soap) authorized for use in the EU [15]. Dancewicz (2011) [16] had demonstrated a satisfactory performance of horticultural soap supplemented with an extract of garlic and tansy (*Tanaceum vulgare* L.) in reducing the feeding activity of the green peach aphid. Our tests did not confirm the usefulness of soap for controlling the black cherry aphid.

4. Conclusions

The results obtained in the course of the study confirm the suitability of the *Quassia amara* decoction and neem extract for controlling the black cherry aphid. The use of infusions from the greens of horsetail, seeds of white and Indian mustard, and from garlic bulbs does not produce the expected results of an effective reduction in the number of aphids on sweet cherry trees. Of a dubious nature is also the use of horticultural soap for controlling this aphid because of the wide variation in the results. When using own in-house made preparations derived from plants, one should be aware of their low and varied effectiveness despite the promising reports in the literature. What influences the effectiveness of made-up preparations is the chemical composition of the plants used, which can vary greatly depending on the harvest date, cultivation and weather conditions. In addition, the effectiveness of self-prepared decoctions or infusions is also affected by the very process of their preparation. The best solution would be to use plants of a known chemical composition and derive preparations from them through technological processes with strictly defined technical parameters. The unavailability of such preparations, or other plant protection products, for use in organic farming in Poland makes it vital to conduct further research on the control of pests with the help of decoctions, infusions and extracts from plants.

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