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Plant Oils for Control of Cotton Aphid (*Aphis gossypii* Glov.) in Greenhouse Cucumbers

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Abstract

Botanical pesticides are an alternative of synthetic chemical pesticides for pest control in modern ecological technologies. These products are not a threat for the environment and human health. Plant products have a number of advantages that make them preferable in modern organic agriculture. The range of these products is constantly expanding, which requires the mechanism of their action to be well known. During the period 2013-2014 a number of studies were conducted for establishment of the effectiveness of plant oils from mustard (*Sinapis alba* L.), hemp (*Cannabis sativa* L.) and yarrow (*Achillea millefolium* L.) in concentration 0.5% and 1% against the cotton aphid (*Aphis gossypii* Glov.) in cucumber variety Kiara F1, grown in greenhouses. Chemical product Mospilan 20 SP 0.0125% (a. i. acetamiprid) was included as a standard. The 1% plant oils from hemp and yarrow demonstrate a good effectiveness (over 90%) to cotton aphid. The highest values of biological activity of the plant oils, included in the study were observed at 5th-7th day after treatment. The good effectiveness shown by the plant oils, gives us another alternative to control this pest in greenhouse cucumbers.

Keywords: *Aphis gossypii,* cucumber, plant oils, effectiveness

Introduction

Cotton aphid (*Aphis gossypii* Glov.) is one of the basic pests in cucumber grown in greenhouses. Frequently the use of chemical insecticides results in negative consequences. The botanical pesticides are an alternative for control of pests in modern ecological technologies. They do not carry the threat for the environment and human health. The spectrum of these products continuously expands that requires recognition of the mechanism of their action (Isman, 2000; Isman, 2006). The plant extracts contain alkaloids, esters, glycosides etc. and they have phytopesticide properties (Mateeva, 2000). Some of the plant substances are used towards the pests as antifeedants and repellents (Isman, 2006).

Many plant essential oils show a broad spectrum of activity against pest insects ranging from insecticidal, antifeedant, repellent, oviposition deterrent, growth regulatory and antivector activities. Recent investigations indicate that some chemical constituents of these oils interfere with the octopaminergic nervous system in insects. They cover the criteria for "reduced risk" pesticides. These plant oils are well accepted in the agricultural practice as "green pesticides" that could be effective enough particularly for biological foods production. Further, while resistance development continues to be an issue for many synthetic pesticides, it is likely that resistance will develop more slowly to essential-oil-based pesticides owing to the complex mixtures of constituents that characterize many of these oils (Koul et al., 2008).

The plant products possess a range of priorities that make them preferable in modern biological agriculture. It is studied the effect of different essential oils and water extracts towards *A. gossypii* (Zhou et al., 2004; Ebrahimi et al., 2013).

The aim of the study was to establish the effectiveness of plant oils from Mustard (*Sinapis alba* L.), Hemp (*Cannabis sativa* L.) and

Yarrow (*Achillea millefolium* L.) in concentrations 0.5% and 1% against cotton aphid (*Aphis gossypii* Glov.) in cucumber grown in greenhouses.

Table 1. Three-way analysis of variance and influence of variation factors on the effectiveness of plant protection products against *Aphis gossypii* Glov.

Source of Variation	Sum of Squares	Degree of freedom	Mean Square	Sig.	Power of influence η%
Days after treatment (A)	16460.2	5	3292.0	***	23.86
Year (B)	80.1	1	80.1		0.12
PPP (C)	32409.3	6	5401.6	***	46.97
A x B	819.4	5	163.9	***	1.19
A x C	5039.6	30	168.0	***	7.30
B x C	5162.7	6	860.4	***	7.48
A x B x C	2603.0	30	86.8	***	3.77
Error	6423.1	252	25.5	***	9.31

R Squared = 0.907 (Adjusted R Squared = 0.876)
p<0.05; ** - p<0.01; *** - p<0.001

Materials and Methods

The experiments were conducted during the period 2013-2014 in growing of cucumber variety Kiara under unheated greenhouses at the Maritsa Vegetable Crops research Institute, Plovdiv. The trials were carried out in natural population density of cotton aphid (*Aphis gossypii* Glov.), in four replications on total area 40 m^2. The treatments were made as the number of living individuals was recorded before spraying and in intervals of 1, 3, 5, 7, 10 and14 days after spraying. The effectiveness (E%) was calculated by the Henderson-Tilton formula.

Variants (plant protection products-PPP)

Control (untreated)

Insecticide:

Mospilan 20 SP 0.0125% (a.i. acetamiprid) (standard)

Plant oils:

Mustard (*Sinapis alba* L.) 0.5%

Mustard (*Sinapis alba* L.) 1%

Hemp (*Cannabis sativa* L.) 0.5%

Hemp (*Cannabis sativa* L.) 1%

Yarrow (*Achillea millefolium* L.) 0.5%

Yarrow (*Achillea millefolium* L.) 1%

The plant oils included in the study were given by Agriflor Ltd, Sofia.

Agro-climatic conditions during treatment:

2013 r. – temperature of trial set was 25°C (04.09.2013), average day temperature for the experimental period 22.86°C; minimal temperature 14°C; maximum temperature 38°C. 2014 r. – temperature of trial set was 24°C (07.07.2014); average day temperature for the experimental period 26.23°C; minimal temperature 18°C; maximum temperature 40°C. The obtained data were processed mathematically by a three-way analysis of variance (Lidanski, 1988). It was made comparative analysis by the method of Duncan's multiple range test (Duncan, 1955).

Results and Discussion

Studies for determining of the effectiveness of three plant oils from Mustard, Hemp and Yarrow were performed in two concentrations 0.5 % and 1 % against cotton aphid (*Aphis gossypii* Glov.) in cucumber variety Kiara, grown in greenhouse. The product Mospilan 20 SP 0.0125% was used as a standard.

The results from the three-way analysis of variance show that the factors Days after treatment (A), Plant protection products (PPP) (C) and interaction between the three basic factors have considerable influence on the effectiveness (Table 1). The factor Plant protection product exerts the strongest influence (46.97%) on the variation of effectiveness. Strong influence (23.86) was also observed in the factor Days after treatment. The factor Year (B) has no significant influence on the effectiveness of the plant protection products which demonstrates that the studied products react with similar effectiveness during the individual years.

Table 2. Effectiveness of some plant oils towards cotton aphid (*Aphis gossypii* Glov.) in greenhouse cucumber

Variants, Concentration (%)	Effectiveness (%) ... days after treatment					
	1st day	3rd day	5th day	7th day	10th day	14th day
Mospilan 20 SP 0.0125%	83.84±5.37 a	99.38±0.31 a	100.00±0.00 a	100.00±0.00 a	100.00±0.00 a	100.00±0.00 a
Mustard 0.5%	55.65±2.75 c	69.16±2.34 d	76.54±0.78 d	75.89±0.71 d	73.87±1.52 c	71.95±3.56 c
Mustard 1%	74.94±6.91 b	86.49±3.08 b	89.33±3.06 c	89.97±2.25 b	85.99±2.39 b	83.51±2.81 b
Hemp 0.5%	61.68±6.01 c	72.59±4.12 cd	79.07±4.50 d	79.30±6.03 cd	74.15±8.42 c	69.86±8.55 c
Hemp 1%	83.17±2.77 a	88.57±0.89 b	92.18±2.29 bc	90.90±1.51 b	83.87±3.20 b	81.66±3.23 b
Yarrow 0.5%	45.57±3.08 d	60.69±2.93 e	80.09±2.09 d	80.34±1.42 c	68.63±1.44 c	67.81±1.45 c
Yarrow 1%	59.37±2.81 c	73.19±1.11 c	94.19±1.48 b	91.89±1.74 b	86.11±2.24 b	84.29±3.11 b

a, b, c …e – Duncan's multiple range test ($p < 0.05$)

Table 3. Status of the population from cotton aphid (*Aphis gossypii* Glov.) in greenhouse cucumbers treated with plant oils

Variants, Concentration (%)	Population density - average number of aphids/one leaf... days after treatment						
	Before	1st day	3rd day	5th day	7th day	10th day	14th day
Control	74.75±9.00 b	79.88±7.78 a	81.50±8.26 a	85.88±8.95 a	92.13±8.19 a	100.50±7.65 a	108.50±7.95 a
Mospilan 20 SP 0.0125%	103.25±20.58 ab	17.00±3.24 f	0.63±0.25 e	0.00±0.00 d	0.00±0.00 d	0.00±0.00 f	0.00±0.00 e
Mustard 0.5%	108.13±27.73 ab	51.63±14.24 cd	35.75±10.02 c	28.00±7.27 b	31.50±7.06 b	37.13±7.69 c	43.13±6.61 c
Mustard 1%	107.50±15.67 ab	27.00±4.02 ef	15.38±2.87 d	12.63±3.09 c	13.50±3.16 c	20.25±3.93 e	25.38±3.90 d
Hemp 0.5%	93.50±17.31 ab	39.5±13.73 de	28.38±7.44 c	22.00±4.10 b	23.50±5.43 b	32.00±7.67 cd	40.25±7.90 c
Hemp 1%	109.63±13.22 ab	18.88±4.37 f	12.75±1.44 d	9.62±2.95 c	11.62±2.14 c	22.00±3.49 de	27.00±3.49 d
Yarrow 0.5%	123.50±37.95 a	70.75±16.5 ab	52.12±15.52 b	29.5±10.27 b	31.50±10.07 b	49.38±14.11 b	54.38±14.50 b
Yarrow 1%	127.63±15.11 a	56.63±9.12 bc	36.75±2.39 c	7.75±2.39 cd	11.25±2.22 c	20.25±3.57 e	24.87±4.57 d

a, b, c …f – Duncan's multiple range test ($p < 0.05$)

The interaction of the factors Days after treatment (A) and Year (B) has a slight influence (1.19%), but it was proven very good ($p<0.001$). The interaction of the factors Days after treatment (A) and PPP (C) has also proven influence on the pest infestation i. e. definite PPP have stronger toxic effect during the fixed period of recording. The interaction of factors Year (B) and PPP (C) has power of influence 7.48%, which means that the specific product has stronger or smaller expressed effectiveness in certain years. The interaction between the three factors A x B x C is proven very good with power of influence 3.77%. The effectiveness of some products could be higher or lower during the individual stages of recording and in the defined years (Table 1).

Three studied plant oils in the lower concentration (0.5%) showed significantly lower effectiveness against *A. gossypii*. The best biological activity at this concentration showed Yarrow (E=80.34% 7th day after treatment), followed by the variants with Hemp (E=79.30% 7th day after treatment) and Mustard (E=76.54% 5th day after treatment) (Table 2).

Relatively good efficacy was reported at higher concentration (1%) of the plant oils, included in the study. The highest effectiveness was recorded in the variant of plant treatment with Yarrow in concentration of 1% (94.19% 5th day after treatment), close to the maximum reported in standard Mospilan 20 SP 0.0125% (100%). It is followed the variants with Hemp 1% with 92.18% effectiveness 5th day after treatment and with Mustard 1% - effectiveness 89.97% 7th day after treatment. Very good initial effectiveness was observed in treatment with Hemp 1%, as it was over 80% after the first day of treatment and kept relatively high 14 days after it. Very good biological activity was demonstrated by the tested plant oils at a concentration 1% against *A. gossypii* between 5th – 7th day after treatment and therefore they could be involved in plant protection systems as an alternative to control this pest (Table 2).

Changes in the density were observed in the cotton aphid population during the days of recording after treatment. The number was considerable low at the fifth day after treatment in the variants with the standard and the included plant oils (Yarrow 1% and Hamp 1%) while in the control it increases (Table 3).

According to the results of the performed experiments the three plant oils in concentration 1% have potential to be used in the programme for control of cotton aphid in cucumber grown in cultivation facilities. They are an alternative possibility, contextualized of the pest management by botanical insecticides suitable for application in biological and integrated vegetable production.

Conclusion

The results from the three-way analysis of variance demonstrate that the factors Days after treatment (A) and Plant Protection Products (C) have considerable influence on the effectiveness of the studied plant oils (Mustard, Hemp, Yarrow).

High effectiveness (over 90%) of plant oils Yarrow 1% and Hemp 1% towards cotton aphid (*Aphis gossypii* Glov.) was established in the period 5th – 7th day after treatment.

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