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Botanical Products against Powdery Mildew on Cucumber in Greenhouses

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Abstract

During the period 2013-2014, studies for establishment of effective alternative means for control of powdery mildew (*Podosphaera xanthii* U. Braun & N. Snish. Comb. Nov. Syn. *Sphaerotheca fuliginea*) on cucumbers grown in greenhouses were conducted. Plant oils of white mustard (*Brassica alba* L.), hemp (*Cannabis sativa* L.) and wild yarrow (*Ahillea millefolium* L.) were tested in two concentrations 0.5% and 1.0%. The phytopesticides HF 250 ml/da (extract from dill (*Anethum graveolens* L.) and AlgoVital Plus 0.3% (extract of brown seaweed *Ascophyllum nodosum* (L.) Le Jolis) were also included in this study. The effect of botanical products is compared with a standards Bayfidan 250 EC 0.02% (a.i. triadimenol) and Domark (a.i. tetraconasol 40 g/L) 0.05%. It was established a high efficacy of the studied products compared to that of the standard. Biological activity of Biofa is less expressed. Studied products are suitable for including in organic and integrated systems for control of powdery mildew in cucumber.

Keywords: *Podosphaera xanthii*, *Cucumis*, phyto pesticides, plant oils, effectivness

Introduction

Powdery mildew is wide-spread and economically important disease on cucumbers, grown in cultivation facilities and in open field. It is caused by *Podosphaera xanthii* (syn. *P. fusca* (Castagne) U. Braun & Shiskoff, *Sphaerotheca fuliginea* (Schlecht.) Pollacci). It develops every year and could result in yields decrease from 20 to 50% and the degree of infestation could reaches to 50-70% (Velkov, 2007; El-Naggar et al., 2012). The fungi attack the leaves, stems and fruits of the cucumbers (*Cucumis sativus* L.) (Bettiol et al., 2008). The control was performed by treatment with chemical plant protection products (PPP); biological and botanical PPP and development of resistant varieties. The chemical PPP registered for use in the world are sufficient. Their excessive use however could result in appearance of resistant populations from *P. xanthii* (McGrath, 1996; McGrath et al., 1996), as well as to pollution of the environment and foods. This enforces to be found alternative means for control of this pathogen. Masheva

(2008) has developed integrated system for control including chemical and botanical PPP. Koitabashi (2005) has developed a new method for powdery mildew control in parsley by fungus strain Kyu-W63, producing volatile antifungal substances. The cultivation of resistant varieties is a radical method for control of this pathogen. The first announcements for resistant varieties have been since 1948 by Smith (cited by Kooistra (1968). During the last decade especially attention has been pied to the phytopesticides because of their good effectiveness, rapid effect and short after-action that make them suitable for vegetable crops. Yankova et al. (2009) has established a high effectiveness of Trilogy and NeemAzal T/S, extracts from Neem tree against powdery mildew and leaf aphids on cucumber. Good biological activity has been also registered in use of mineral oils (Daughtrey et al., 1993); plant oils and plant extracts (Locke and Stave, 1992; Masheva et al., 2012); combination of reduced doses of chemical PPP and mineral oils (Masheva et al., 2012).

Different alternative means and approaches for control of this dangerous pathogen including mineral salts, essential oils, plant extracts, biological agents and resistant varieties are studied during the last decades in order to protect the foodstuffs free of pesticides

(Simmonds et al., 1992; Copping and Menn, 2000; Belanger and Labbe, 2002; Istvan, 2002; Kiss, 2003; Yankova et al., 2009; Masheva et al., 2012).

The purpose of the investigation is to study the effectiveness of botanical products, plant oils and phytopesticides against the causal agent of powdery mildew.

Materials and Methods

The experiments were carried out during the period 2013-2014 with long type cucumber variety Vihra, susceptible to powdery mildew in the conditions of natural infestation with powdery mildew. The plants were grown by the technology for early production without heating. Number of plants per square meter – 1.8.

I. Effectiveness of plant oils against the agent of powdery mildew:

It was studied 3 plant oils in two concentrations 0.5% and 1.0%:

- White mustard (*Brassica alba* L.);
- Hemp (*Cannabis sativa* L.);
- Wild yarrow (*Ahillea millefolium* L.)
- Domark (tetraconasol 40 g/L) – 0.05% - standard. It is a chemical plant protection product used against this pathogen.
- Bayfidan 250 EC (triadimenol 250 g/L) -0.02% – standard. Bayfidan 250 EC is a chemical plant protection product used against this pathogen.

Mustard, hemp and yarrow oils are provided for experimental purposes by the company Agriflor Ltd Sofia.

II. Efficacy of botanical pesticides against powdery mildew:

It was studied 2 commercial botanical PPP compared to the standards Bayfidan 250 EC – 0.02% and Domark 0.05%:

- AlgoVital Plus (Biofa AG) – 0.3%. AlgoVital Plus is an extract of brown seaweed (*Ascophyllum nodosum*). Improves the adsorption of nutrients and raises the tolerance to frost and stress. Develop natural resistance to disease and pest.
- HF-Pilzvorsorge® – 2500 L/ha. It is a mixture of plant extracts and plant oils of Fennel (*Foeniculum vulgare* Mill.). These substances serve the original plant as a protector and an inhibitor to pathogens. It is recommends for foliar treatment against fungal diseases, mainly powdery mildew and Botrytis.
- Bayfidan 250 EC – standard – 0.02%.

Domark – standard – 0.05%

- Biofa and HF-Pilzvorsorge® are products of company BIOFA- AG, Germany.

The experiments were performed by the block method in 3 replications including 10 plants in each replication at natural occurrence of infestation with powdery mildew. Three treatments were conducted.

III. Recorded indexes:

- Degree of attack from powdery mildew by 5-rating scale (0-4). The readings were made before each treatment and 5 days after the last treatment.

- Index of infestation was processed by McKinney and effectiveness – by Abbott.

Phyto-toxicity was not observed during the vegetation.

Data were processed by two way analysis of variance. It was applied Duncan's multiple range test by a programme product SPSS.

Results and Discussion

I. Effectiveness of plant oils against powdery mildew:

Two-way analysis of variance demonstrates significant effect of the studied plant oils и PPP (Product (A), which have power of influence 99.64% (Table 1). The factor Year (B) has also significant effect ($p<0.05$) on the variation of the infestation from powdery mildew regardless of the slight power of influence 0.05%. The interaction of the two factors (AxB) has no significant effect on the variation of the index of powdery mildew infestation. These results show that the studied products manifest well expressed effect on the progress of powdery mildew which depends on the year slightly. The absence of the interaction of the product is an indicator for the specific action of each one of the studied products i.e. specific product is described with definite inhibition effect on the powdery mildew towards the other ones.

Table 1. Two-way analysis of variance and effect of the factors on the index of infection of powdery mildew in cucumbers

Source of Variation	*SS*	*df*	*MS*	*F*	*Power of influence* η%	*F crit*
Product (A)	23318.12	8	2914.77	23318.12	***99.64	2.21
Year (B)	11.33	1	11.33	11.33	*0.05	4.11
Interaction (AxB)	7.97	8	1.00	7.97	0.03	2.21
Within	64.41	36	1.79	64.41		
Total	23401.82	53		23401.82		

* - p<0.05; *** - p<0.001

Table 2. Index of infestation and effectiveness of plant oils against powdery mildew (*Podosphaera xanthii*) on cucumber, grown in greenhouses 2013 - 2014

No	PO and PPP	Concentration %	Index of damage %		
			2013	2014	Average
1.	White mustard (oil)	0.5	17.70 c	18.18 cde	17.94 cd
2.	White mustard (oil)	1.0	16.47 c	16.91 e	16.69 d
3.	Hemp (oil)	0.5	20.76 b	20.45 b	20.60 b
4.	Hemp (oil)	1.0	17.79 c	18.75 b-e	18.27 cd
5.	Wild yarrow (oil)	0.5	19.08 bc	19.92 bc	19.50 cd
6.	Wild yarrow (oil)	1.0	16.83 c	18.66 b-e	17.74 cd
7.	Domark – standard	0.05	16.22 c	17.37 de	16.80 d
8.	Bayfidan 250 EC - standard	0.02	16.59 c	19.01 bcd	17.80 cd
9.	Control - untreated	-	83.97 a	84.40 a	84.18 a

a, b, c – Duncan's multiple range test (p < 0.05)
PO – Plant Oils
PPP – Plant Protection Products

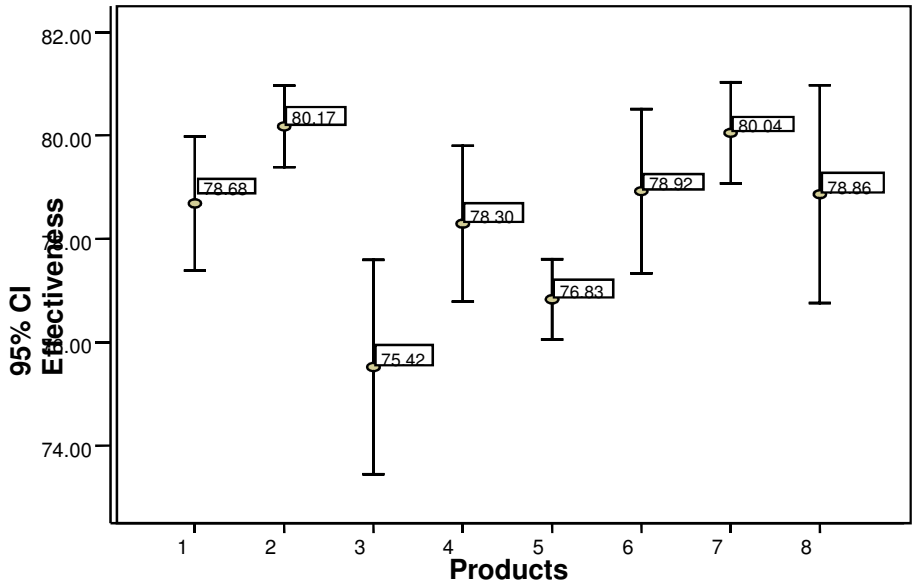

Figure1. Effectiveness of the products average for the period and confidential intervals in level of significance 95%.
*(the names of the products from 1 to 8 are given in Table 2)

Table 3. Two-way analysis of variance and effect of the factors on the index of infection of powdery mildew in cucumbers

Source of Variation	*SS*	*df*	*MS*	*F*	*Power of influence* $\eta_{\%}$	*F crit*
Product (A)	20035.52	4	5008.88	1607.16	***99.47	2.87
Year (B)	14.88	1	14.88	4.78	*0.07	4.35
Interaction (AxB)	28.85	4	7.21	2.31	0.14	2.87
Within	62.33	20	3.12			
Total	20141.58	29				

* - p<0.05; *** - p<0.001

Table 4. Index of infestation and efficacy of botanical pesticides against powdery mildew (*Podosphaera xanthii*) on cucumbers in greenhouses

No	PPP	Concentration %	Index of infestation %		
			2013	2014	Average
1.	HF	2,5 L/ha	17.14 c	21.59 c	19.36 c
2.	AlgoVital Plus (Biofa)	0,3 %	27.41 b	26.00 b	26.70 b
3.	Domark – standard	0,05	16.22 c	17.37 d	16.80 c
4.	Bayfidan 250 EC - standard	0,02	16.59 c	19.01 cd	17.80 c
5.	Control - untreated	-	83.97 a	84.40 a	84.18 a

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

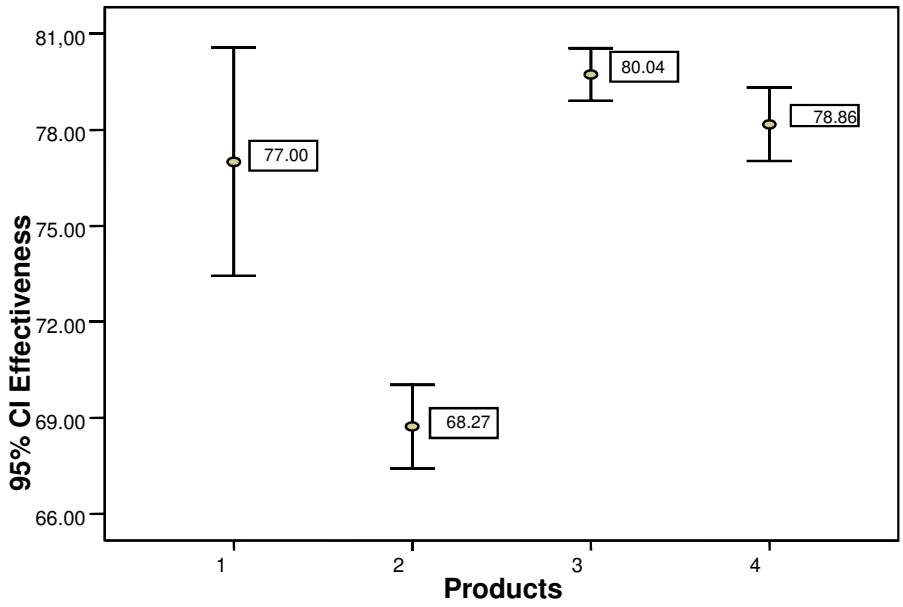

Figure2. Effectiveness of the products average for the period and confidential intervals in level of significance 95%.
*(the names of the products from 1 to 4 are given in Table 4)

The results from the Duncan's test show that in 2013 it is recorded the lowest index of infestation after treatment with Domark, Bayfidan 250 EC, White mustard (oil) 0.5%, White mustard (oil), 1% and Hemp (oil) 1%, that are in the same group of significance (Table 2). Hemp (oil) 0.5% has significantly slighter effect on the powdery mildew – 20.76%. The

strongest infestation was recorded in the control variant – 83.97%.

During the second year of study greater number of groups of significance between the individual variants was observed. The lowest infestation was recorded in White mustard (oil) 1% (16.91%). Significant stronger infestation was established in the products Bayfidan 250 EC, Wild yarrow (oil), 0.5% and Hemp (oil) 0.5%. The strongest infestation was recorded in the control variant – 84.40%.

The products could be grouped in three groups of significance averagely for the period. The strongest effect was observed in the untreated plants 84.18%. The infestation is lower in the variant, treated with Hemp (oil) 0.5%. The remaining variants have the greatest effect on the powdery mildew infestation as the differences in the index of infestation are insignificant statistically.

The effectiveness of the studied products shows considerable variation between the studied variants (Figure 1). The greatest effectiveness demonstrates White mustard (oil) 1% - 80.17%, which confidential intervals are in narrow limits. The lowest effectiveness of action shows the product Hemp (oil) 0.5% (75.42%), but the confidential intervals are in wider limits. Chemical standards Domark (0.05%) and Bayfidan 250 EC (0.02%) have good effectiveness (80.04% and 78.86%), as the last one is described with wider limits of confidential intervals. The other studied plant oils showed, in high concentrations, higher or same effectiveness to that of the chemical PPP – Domark and Bayfidan 250 EC. This confirms the results established by Moharam and Obiadallaali (2012), who has recorded effectiveness of plant extracts and essential oils against powdery mildew in okra identical to that of the conventional fungicides based on dinokap. Strong reducing of the infestation degree from powdery mildew was established in treatment of cucumber with plant and mineral oils (Nigella sativa, rape oil, mineral oil) (Hafez Y. M. 2008), essential oils (dill, eucalypt, etc) (Masheva at al., 2012). According McGrath and Shishkoff (1999) the identification of such products is a valuable contribution for control of this disease.

II. Efficacy of botanical pesticides against powdery mildew:

The results from the two-way analysis of variance in the second experiment are similar to those in the first experiment. The strongest effect on the variation of the powdery mildew infestation has the factor Product (A) (99.47%) (Table 3). The factor Year (B) has significant action (0.05), but it was with low power of effect (0.07%). The interaction between two factors (AxB) has no significant effect on the index of powdery milder which demonstrates similar response of the products in individual years

The studied botanical pesticides – HF and AlgoVital Plus (Biofa) demonstrated good biological activity against powdery mildew in cucumber. In the first year the significant lowest infestation was recorded in the variants Domark (16.22%), Bayfidan 250 EC (16.59%) and HF (17.14%). Slighter protection effect was observed in AlgoVital Plus (Biofa) (27.41%). The control variant is attacked strongly (83.97%), that demonstrates the availability of strong infestation background. In 2014 the infestation intensity is very high (84.40%), as the lowest attack was recorded in Domark (17.37%), Bayfidan 250 EC (19.01%). The botanical product HF is in particular group of significance and in third group of significance include AlgoVital Plus (Biofa) (26.00%). The strongest effect, average for the period, was observed in the products Domark (16.80%), Bayfidan 250 EC (17.80%) and HF (19.36%). The effect of botanical product against powdery mildew is significantly slighter.

The calculated effectiveness of the products shows a good effect of Domark (80.04%), Bayfidan 250 EC (78.86%) and HF (77.00%), as the last one is described with wider confidential intervals (Figure 3). The botanical product AlgoVital Plus (Biofa) manifests the slightest effectiveness (68.27%), but the confidential intervals are in narrow limits. The results from the both years of study are unidirectional. Good effect from the treatment with HF, included in the eco-programme for control of powdery mildew on vine, has been established by Zezlina et al. (2010).

Conclusion

The studied Plant Oils demonstrate good effect against the agent of powdery mildew in cucumber, as the greatest effectiveness is revealed in White mustard (oil) 1%.

The botanical products have good protection effect against powdery mildew but HF is with greater effectiveness.

The studied products could guarantee for good control of powdery mildew in the systems of biological and integrated production.

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