Repellency and toxicity of three *Impatiens* species (Balsaminaceae) extracts on *Myzus persicae* Sulzer (Homoptera: Aphididae)

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ABSTRACT

The extracts of *Impatiens noli-tangere*, *I. parviflora* and *I. glandulifera* (Balsaminaceae) were evaluated for their effect on green peach aphid (*Myzus perssicae*), an important insect pest of many plants. All the extracts showed insecticidal and repellent activity. After 54 h of exposure, the most active extract was *Impatiens parviflora* with 99.7 and 90.0 % mortality at 0.5 and 0.1 % concentrations, respectively, and with highly percent repellency (90-100%) at different times. The extract of *I. parviflora* contained tryptophan (2.13 mg/g); 2-methoxy-1,4-naphthoquinone (0.02 mg/g), total flavone (7.64 mg/g) and total derivatives of caffeic acid (15.60 mg/g).

Keywords: Impatiens, repellency, plant extracts, *Myzus persicae*, aphids, toxicity

INTRODUCTION

Impatiens noli-tangere L. (IN), *Impatiens parviflora* DC. (IP), *Impatiens glandulifera* Royle (IG) (Balsaminaceae) identification (Kubát *et al.*, 2002), leaves were used in this experiment. The IN is antiseptic, diuretic, strongly emetic, laxative and vulnerary (Grieve, 1984; Launert, 1981). It has been used in the treatment of stranguary and hemorrhoids. IP is antidote and parasiticide, the treatment for strings and wart (Schofield, 1989). *I. glandulifera* is used in Bach flower remedies (Chancellor, 1985). The above ground parts of *I. glandulifera*, *I. noli-tangere*, *I. parviflora* contain naphthquinone (Lobstein *et al.*, 2001; Šerá *et al.*, 2005), flavones and caffeic acid derivatives (Šerá *et al.*, 2005).

Over 250 species of the superfamily Aphidoidea feed on agricultural and horticultural crops throughout the world. The green peach aphid, *Myzus persicae* Sulzer, has an extremely wide host range of over 100 plants including a wide variety of vegetable and ornamental crops (Baker, 1982). The aphid control measures have largely been depending on the use of chemical pesticides including chlorinated hydrocarbons, organophosphates and carbamates (Shetlar, 2001), which besides causing resistant development in the target population (Han and Li, 2004) affect adversely the natural enemies of aphids in the field (Holland *et al*, 2000). In addition, increasing documentation of negative environmental and health impact of synthetic insecticides and increasingly stringent environmental regulation of pesticides was reported by Isman (2000). Many plant extracts have been reported bioactive against *A. craccivora* and other related species (Ofuya and Okuku, 1994; Abdallah *et al*., 2004, Tewary *et al*., 2005). Recently, *Thymus vulgaris, Veronica officinalis* and *Agrimonia eupatoria* were investigated against the cabbage aphid, *Brevicoryne brassicae* (Homoptera: Aphididae) under laboratory conditions (Görür *et al*., 2008). We have resulted in renewed interest in the development and use of botanical pest management products for controlling aphid pest. In the present investigation, impact of methanol extract of I. *noli-tangere*, *I. Parviflora* and *I. glandulifera* on *Myzus persicae* Sulzer repellency and mortality were studied.

MATERIALS AND METHODS

The aphids used in the experiment came from clone of the species Green Peach Aphid (*Myzus persicae* Sulzer), kept on tomato plants in a temperature chambers with a photoperiod of 16:8 h (light: dark) and temperature of 21 ± 1 °C. *Impatiens noli-tangere* L. (IN), *I. parviflora* DC. (IP), *I. glandulifera* Royle (IG) (Balsaminaceae) identification (Kubát *et al.*, 2002), leaves were collected in one location between the Stropnice river and mixed forest, •elízkovo údolí village, Ostrolovský újezd village, the Czech Republic, voucher specimens were deposited in Crop

Research Institute and they were assigned as IN, IP, and IG respectively. Evaporated methanolic extracts from *Impatiens* species were used in the experiment. A repellence experiment was carried out to assess the selection response of Green Peach Aphid (*M. persicae*) individuals when these are exposed in equal conditions to plants leaves treated with *Impatiens* extracts. To this, the residues were dissolved in acetone (0.5 and 0.1 %) and 10 leaves of the tomato plants (*Lycopersicon lycopersicum* (L.) Karst ex Farm. Cv. Tornádo) were submerged in each of these using 2 discs of leaves (1 cm diameter) were obtained for each treated leaf. A total of 10 Petri dishes (10 cm in diameter) were prepared by placing on them two layers of damp filter paper, then two leaf discs for each treatment.

20 aphids were released in the center of each dish. The dishes were then covered and sealed to prevent the aphids escape and were placed on a flat surface with uniform lighting, at room temperatures of 22 ± 1 ° C. The assessments consisted in at different times (5, 10, 20, 30 and 40 h) the number of aphids on each leaf disc. As control was used discs treated only water. Percent repellency values were computed using the formula: PR (%) = [(C-T)/(C+T)] x1 00 Where: C- the number of aphids on control discs, and T - the number of aphids on treated discs.

The effect of the treatments on aphid mortality was determined. Fifty first-instar nymphs of *M. perssicae* were placed on a tomato plants freshly treated with extracts or alone acetone (control). Mortality was taken for 8, 24, 30, 48 and 56.hours. This procedure was replicated 10 times for each extract and the control. Data were examined using analysis of variance (ANOVA), percentage data being transformed with an arcerinesquare-root transformation before analysis, and means were separated using the Tukey honestly significant difference (HSD) multiple comparisons test ($P<0.05$).

Extracts were analyzed using high pressure liquid chromatography, Hewlett-Packard 1050 instrument using Agilent DAD detector G1315B on Phenomenex Luna C18(2), 3 mm, 2 x 150 mm column. The mobile phase A: 5% acetonitrile + 0.1% o-phosphoric acid; the mobile phase B: 80% acetonitrile + 0.15% trifluoroacetic acid. The gradient was from 0 to 45% B in 55 min and from 45% B to 80% B for 10 min; flow rate 0.25 ml/min. The quercetin and caffeic acid derivatives were detected at 220 nm, 2-methoxy-1,4-naphthoquinone at 280 nm.

RESULTS AND DISCUSSION

The results of repellent activity presented in Tables 1 reveals that repellent activity of the *Impatiens* species was concentration and time dependent. Among the three *Impatiens* species, *I. parviflora* replled the aphid more strongly and significantly ($P < 0.05$) followed by IN and IG. No mortality was observed after 8 hours of exposure except in *I. Parviflora* treatment. As observed for repellency, the mortatlity of aphid on *Impatiens* extract treatment was also does dependent. Maximum mortality was caused by IP followed by IN and IG (Table 2). Presence of caffeic acid and high flavone content of *I. parviflora* might be the reason for more mortality in aphid.

Table 1. Percent repellency of aphids (mean) at different times their release on the leaf discs.

Treatments	Concentrations (in %)	Exposure time (in Hrs.)				
		5	10	20	30	40
IP	0.5	82.9^{a}	100.0a	94.4^{a}	100.0^{a}	100.0^{a}
IG		61.8^{b}	74.0^{b}	70.3^{b}	62.1^{C}	47.1^{C}
IN		73.2^{ab}	55.8c	84.4^{b}	91.7^{b}	93.8^{b}
IP	0.1	50.3^{B}	91.7^{A}	100.0^{A}	87.5^{A}	100.0^{A}
IG		45.2^{B}	40.3^{B}	42.7^{C}	31.8^{B}	26.4^{C}
IN		57.2^{A}	46.8^{B}	66.6^{B}	93.8^{A}	90.0^{B}

Different letters in same column indicate significant differences ($P<0.05$) between treatments according to ANOVA and Tukey (HSD) test.

Table 2. Percentage of aphid mortality (mean) at different times

Treatments	Concentrations (%)	Mortality after exposure (in Hrs)				
		8	24	30	48	54
IP	0.5	6.2^{a}	36.2^{a}	68.5^{a}	82.1^{a}	99.7^{a}
IG		0.0^{b}	12.5^{b}	31.5^{c}	55.2^{c}	75.1^{b}
IN		0.0^{b}	35.0^{a}	50.0^{b}	68.7^{b}	82.5^{ab}
IP	0.1	0.0^{A}	13.7^{B}	46.25^{A}	77.5^{A}	90.0^{A}
IG		0.0^{A}	11.2^{B}	27.5^{B}	52.5^{B}	70.0^{B}
IN		0.0^{A}	20.3^{A}	27.3^{B}	51.2^{B}	67.5^{B}
control		$0.0b^{A}$	0.0^{cC}	0.0^{dC}	$3.2d^{C}$	5.1^{cC}

Different letters in same column indicate significant differences ($P<0.05$) between treatments according to ANOVA and Tukey (HSD) test.

It has been well recognized that plant based secondary chemicals could be developed into products suitable for integrated pest management because many of them are selective to pests, have no or few harmful effects on non target organisms and the environment.These products may be applied to the plant in the same way as other chemical pesticides. This study could contribute to the assessment of possibility of using medicinal plants as potential insecticides (Pavela, 2007). The extracts were evaluated for their effect on *M. perssicae*, an important insect pest of many plants (van Munster *et al*., 2003). All the extracts showed insecticidal and repellent activity. The results obtained have provided evidence to the potential use of *Impatiens* sp. as insecticide.

Methanolic extracts from the dried leaves of IG, IN and IP contained mainly compounds similar to quercetin and caffeic acid and also 2-methoxy-1,4-naphthoquinone. The methanolic extracts were evaporated and contents of compounds were counted over on evaporated materials (residues). Evaporated materials contain tryptophan: 0.88 mg/g in IN, 2.13 mg/g in IP, in IG tryptophan was under detection limit; 2-methoxy-1,4-naphthoquinone: 3.01 mg/g in IN, 0.02 mg/g in IP, 13.56 mg/g in IG; total flavonols: 47.84 mg/g in IN, 7.64 in IP, 86.62 mg/g in IG; total derivatives of caffeic acid: 24.87 mg/g in IN, 15,60 mg/g in IP, minute amounts in IG. Bioassay-directed fractioning of the most active crude extracts and to identify responsible compounds of the insecticidal activity and their possible mechanism of action is in progress.

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REFERENCES

Abdallah, S.A., Barakat, A.A., Badawy, H.M.A. and Soliman, M. M.M. 2004. Insecticidal activity of different wild plant extracts against the cowpea aphid, *Aphis craccivora* Koch. Paper presented at the first Arab conference of applied biological pest control, April 5–7, Cairo, Egypt.

Baker, J. R. 1982. Insect and related pests of flowers and foliage Plants. The North Carolina Agricultural Extension Service. 75 **PP.**

Chancellor, P.M. 1985. Handbook of the Bach Flower Remedies. Daniel CW Co. Ltd., London, 251 **PP** .

Grieve, M.A. 1984. A modern herbal. Penguin, London. 920 **PP.**

Görür, G., Abdullah,, M.I. and I°ik· M. 2008. Insecticidal activity of the *Thymus*, *Veronica* and Agrimonia's essential oils against the cabbage aphid, *Brevicoryne brassicae*. *Acta Phytopathologica et Entomologica Hungarica*, **43** (1): 201 – 208.

Han, Z. and Li, F. 2004. Mutations in acetyl-cholinesterase associated with insecticide resistance in the cotton aphid, *Aphis gossypii* Glover. *Insect Biochemistry and Molecular Biology,* **34:**397–405.

Holland, J.M., Winder, L. and Perry, J.N. 2000. The impact of dimethoate on the spatial distribution of beneficial arthropods in winter wheat. *Annals of Applied Biology,* **136:** 93–105.

Isman, M. B. 2000. Plant essential oils for pest and disease, management. *Crop Protection*, **19:**603–608.

Kubát, K., Hrouda, L., Chrtek J. Jun, Kaplan, Z., Kirschner, J. and Štìpánek, J. 2002. Klíè ke kvìtenì Èeské republiky (eds). Academia, Prague, 928 **PP** .

Launert, E.1981. Edible and Medicinal Plants. Hamlyn, London. 288 **PP** .

Lobstein, A., Brenne X., Feist, E., Metz, N., Weniger, B. and Anton, R. 2001 Quantitative determination of naphthoquinones of *Impatiens* species. *Phytochemical Analysis*, **12:** 202 – 205.

Ofuya, T.I. and Okuku, I.E. 1994. Insecticidal effect of some plant extracts on the cowpea aphid *Aphis craccivora* Koch (Homoptera: Aphididae). Anzeir fuer Schaedlingskunde *Pflanzenschutz Umweltschutz*, **67:** 127–129.

Pavela, R. 2007. Possibilities of botanical insecticide exploitation in plant protection. *Pest Technology*, **1:** 47-52.

Shetlar, D.J. 2001. Aphids on trees and shrubs, HYG-2031–90. Ohio State University Extension Fact sheet. Department of Horticulture and Crop Science. Ohio State University, USA.

Schofield, J.J. 1989. Discovering Wild Plants - Alaska, W. Canada and the Northwest. Portlant: Alaska Northwert Book. 341 **PP**

Šerá, B., Vrcholová, N. and Tríska, J. 2005. Phenolic compounds in the leaves of alien and native *Impatiens* plants. Berlin: Introduction and Spread of Invasive Species, 281

Tewary, D.K., Bhardwaj, A. and Shanker, A. 2005. Pesticidal activities in five medicinal plants collected from mid hills of western Himalayas. *Indian Crop Production*, **2**(3):241–247

van Munster, M., Dullemans, A.M.,Verbenek, M., van den Neucel, J.F.J.M., Reinbold, C., Brault, V., Clérivet, A. and van der Wilk, F. 2003. A new virus infecting *Myzus persicae* has a genome organization similar to the species of the genus Densovirus . *Journal of General Virology*, **84 :** 165-172.

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