ENTOMOPHAGA 42 (1/2), 1997, 277-282

EFFECT OF SOME PLANT EXTRACTS ON TWO COCCINELLID PREDATORS OF THE COWPEA APHID, *APHIS CRACCIVORA* (*HOM.: APHIDIDAE*)

T. I. OFUYA

Department of Crop Production, The Federal University of Technology, P.M.B. 704, Akure, Nigeria

This study was conducted to examine the effects of some aphicidal biologically active plant compounds on the natural enemies of the cowpea aphid, *Aphis craccivora* Koch. In the laboratory, acetone extracts of *Cymbopogon citratus* (DC) Stapf., *Momordica charantia* L., *Zingiber officinale* Rose and *Aframomum melegueta* (Rose) K. Schum, were tested for toxicity to two coccinellid species, *Cheilomenes lunata* (Fabricius) and *Cheilomenes vicina* (Mulsant) predaceous on the aphid. All the extracts were highly ovicidal to eggs of the two coccinellid predators. None of the extracts caused mortality of either *C. lunata* or *C. vicina* fourth-instar larvae after 24 h. Larvae treated with the extracts consumed fewer aphids in 24 h than untreated larvae. Ability to pupate was also significantly reduced in larvae treated with the extracts. No morphological deformities were observed in adults emerging from treated larvae.

KEY-WORDS: insecticidal plants, toxicity, predators.

Use of synthetic insecticides for pest control has serious drawbacks, such as the development of resistant strains, toxic residues, workers' safety and increasing costs (Gullan & Cranston, 1994). Hence, pest control strategies for the future need reviewing and safer alternatives may need to be sought. In recent years, there have been concerted international efforts at developing non-toxic, safe and biodegradable alternatives to synthetic insecticides from the vast store of chemical substances in plants (Olaifa *et al.*, 1987; Benner, 1993). However, far more attention has been focused on the insecticidal properties of plants or plant constituents on pestiferous insect species than on their natural enemies. Toxicity to useful parasitoids and predators is one of the major disadvantages of many of the broad spectrum synthetic insecticides. Therefore, alternative chemicals should be tested for insecticidal action against useful natural enemies. Ofuya & Okuku (1994) reported insecticidal activity of extracts of some indigenous Nigerian plants against the cowpea aphid, *Aphis craccivora* Koch, an important pest of cowpeas and groundnuts in Africa. This paper reports on the toxicity of some of these extracts to two coccinellid beetles, *Cheilomenes lunata* (Fabricius) and *Cheilomenes vicina* (Mulsant) which are predaceous on the cowpea aphid, *Aphis craccivora* Koch in different agroecosystems.

MATERIALS AND METHODS

PLANT EXTRACTS

Particulars of plants from which extracts were obtained are given in table 1. *Cymbopogon citratus* was obtained from the Teaching and Research Farm of The Federal University

of Technology, Akure, Nigeria whilst the others were bought from a local market in Akure. All were oven dried and milled into powder. The powders were extracted using acetone in a soxhlet extractor. The extracts were concentrated by exposure to the air in Petri dishes, after which they were stored in a refrigerator 8°C until needed. The same concentration was used for all extracts: 0.2 g of each was diluted with 10 ml of acetone, which is aphicidal (Ofuya & Okuku, 1994).

TABLE I

Particulars of plants from which extracts were obtained

Botanical name	Family	Part used
Cymbopogon citratus (DC) Stapf.	Poaceae	Leaves
Momordica charantia L.	Cucurbitaceae	Leaves
Zingiber officinale Ros.	Zingiberaceae	Rhizomes
Aframomum melegueta (Rose) K. Schum	Zingiberaceae	Seeds

CULTURE OF APHID AND PREDATORS

Colonies of *A. craccivora,* derived from field-collected individuals, were established and maintained on cowpea seedlings (Ife Brown variety) planted in 0.79 l plastic cups in screened cages in the laboratory. Ageing seedlings were regularly replaced with fresh ones.

Cultures of *C. lunata* and *C. vicina* were also established and maintained in the laboratory. Field-collected larvae were reared into adults in glass Petri dishes (0.9 cm diameter) containing aphid infested cowpea leaflets on moistened filter paper. Copulating adults were fed in Kilner jars containing aphid infested cowpea shoots. Eggs laid were incubated in Petri dishes containing moistened filter paper.

EFFECT OF EXTRACTS ON EGGS OF PREDATORS

The prepared concentration of the extracts was applied by means of a trigger operated washbottle with adjustable nozzle which produces a fine spray, to treat fifty-3 days old predator eggs incubated in Petri dishes. There was an untreated control and another treatment involving use of acetone alone. Each treatment was replicated five times. The number of hatched eggs at eclosion was recorded.

EFFECT OF EXTRACTS ON LARVAE OF PREDATORS

With the aid of microsyringes 0.2 ml of the prepared concentration of each extract was applied to the abdominal region of fresh fourth-instar larvae (0-8 h post-eclosion) of *C. lunata* and *C. vicina*. Each larva was then placed on a cowpea leaflet infested with 100 first/second-instar nymphs of *A. craccivora* in a Petri dishes. Prior to treatment, the insects were starved for 12 h to standardize their levels of hunger. A treatment comprised 20 larvae of each predator. There was also an untreated control and another treatment with acetone. Each treatment was replicated five times. Observations were: mobility of larvae, the level

of predation (number of aphids eaten) and mortality in 24 h. The number of larvae that could pupate were also noted. Emerging adults were observed for any morphological deformities.

DATA ANALYSIS

Data were subjected to analyses of variance. Percentage data were arcsine transformed before analysis.

RESULTS AND DISCUSSION

The results of this study was summarized in tables 2 and 3 which show the effects of the extracts on *C. lunata* and *C. vicina* respectively. The trend in the effect of the extract on the two predators was similar. The extracts were highly toxic to the eggs of the predators. Eggs of both *C. lunata* and *C. vicina* treated with *M. charantia, Z. officinale* and *A. melegueta* extracts did not hatch at all. The extracts could not cause death in fourth-instar larvae of both predators 24 h after treatment. It was however observed that treated larvae were subsequently sluggish and inactive whereas untreated larvae were active and more aggressive. Treated larvae therefore consumed significantly fewer number of aphids than untreated larvae. Ability to pupate was also significantly lower in the treated larvae than in the untreated. Most of the treated larvae died in the pre-pupal stage.

TABLE 2

Effect of aphicidal extracts from different plants on eggs and larvae of C. lunata

Extract	Mean % egg hatch	Mean % larval mortality in 24 h	Mean no. aphids consumed by larvae in 24 h	Mean % of treated larvae that pupated
C. citratus	10.6 ± 2.63a	0.0	48.3 ± 2.81b	19.8 ± 1.23a
M. charantia	0.0a	0.0	36.2 ± 3.02ab	8.4 ± 1.03a
Z. officinale	0.0a	0.0	32.1 ± 2.89a	13.5 ± 1.86a
A. melegueta	0.0a	0.0	70.2 ± 3.12c	54.8 ± 2.64b
Acetone	68.4 ± 3.04b	0.0	70.2 ± 4.04c	54.8 ± 2.12b
Control	86.4 ± 3.84b	0.0	84.6 ± 2.31c	65.8 ± 3.46b

Figure within the same vertical column followed by the same letters are not significantly different at the 5% level by Duncan's multiple range test.

The contemporary world-wide interest in sourcing plants for chemical compounds with insecticidal properties is because these compounds may be used without the many problems associated with synthetic chemicals (Arnason *et al.*, 1989). One widely studied plant in this context is the neem tree, *Azadirachta indica* (A.) Juss (Schmutterer, 1990). Olaifa *et al.* (1987) demonstrated the insecticidal action of some essential oils from some Nigerian plants to selected crop field pests. Ofuya & Okuku (1994) found that acetone extracts of *Z. officinale, A. melegueta, M. charantia* and *C. citratus* exhibited high aphicidal activity against *A. craccivora*. Observations made in this study show that these extracts also have adverse effects on the coccinellids, *C. lunata* and *C. vicina* which are predaceous on

TABLE 3

Effect of aphicidal extracts from different plants on eggs and larvae of C. vicina

Extract	Mean % egg hatch	Mean % larval mortality in 24 h	Mean no. of aphids consumed by larvae in 24 h	Mean % of treated larvae that pupated
C. citratus	20.8 ± 2.02b	0.0	50.8 ± 3.04b	28.6 ± 1.87b
M. charantia	0.0a	0.0	33.9 ± 2.43a	10.2 ± 1.44a
Z. officinale	0.0a	0.0	41.6 ± 2.18ab	12.6 ± 1.02a
A. melegueta	0.0a	0.0	35.2 ± 2.33a	15.3 ± 1.54ab
Acetone	70.4 ± 3.43c	0.0	54.4 ± 2.14b	48.6 ± 1.91c
Control	91.5 ± 3.62d	0.0	87.5 ± 3.81c	72.1 ± 2.84d

Figure within the same vertical column followed by the same letters are not significantly different at the 5% level of Duncan's multiple range test.

different aphids in different agroecosystems. These include toxicity to eggs, reduction in efficiency of predation in larvae and poor rate of pupation. Adverse effects of some biologically active plant extracts on beneficial organisms have been reported by many other workers. For instance, treating the Colorado potato beetle, *Leptinotarsa decemlineata* with neem-seed extract resulted in moulting delays and deformities in its predator, *Perillus bioculatus* (Hough-Goldstein & Keil, 1991). Also, neem-seed extract reduced the numbers of *Encarsia* spp. and *Aleurodiphilius* spp. parasitoids of the sweet potato whitefly, *Bemisia tabaci,* a major pest species for which azadirachtin shows promise as a control agent (Price & Schuster, 1991).

As is the case with many conventional insecticides, toxicity of biologically active plant extracts to beneficial organisms can be an undesirable side effect in their use for pest control. It is desirable for a candidate chemical to be selective for the pest and less toxic to predators and prasitoids. There are numerous examples in which some biologically active plant extracts, especially at low concentration, are not significantly detrimental to beneficial organisms. For instance, under laboratory conditions, low doses of azadirachtin (10 and 20 ppm) did not harm the hymenopteran parasitoid, *Apanteles glomeratus* but its host, final instar *Pieris brassicae* larvae, showed reduced feeding followed by a gradual death (Schmutterer, 1992). Also, coccinellids and many other beneficial agents similarly remain unaffected by neem oil and extracts (see Schmutterer, 1990 for review). Presumably, at lower concentration, the extracts used in this study may not have significant effects on the predaceous coccinellids tested. Nevertheless, biologically active plant extracts can be used judiciously in integrated pest management programmes in several other ways as with insecticides (Pfadt, 1985). These ways could similarly minimise the deleterious effects of pesticidal plant extracts on natural enemies.

The plants from which extracts were obtained have medicinal and pharmaceutical significance (Sofowora, 1982). The pesticidal components of *A. melegueta* has been shown to include gingerols, paradols and shogaols (Oloke *et al.,* 1988). Gingerols and shogaols also constitute the active insecticidal materials in *Z. officinale* rhizomes (Goto *et al.,* 1990). The terpene components of *C. citratus* (Krishnarajah *et al.,* 1985) and momordin-α in *M. charantia* seeds (Kimura *et al.,* 1991) have been proven for toxicity to insects.

Overall, the results of this study have shown the necessity of screening alternative plant chemicals for toxicity to natural enemies of pests so that adequate precautions may be followed in their field use.

ACKNOWLEDGEMENT

This study was supported by a Third World Academy of Sciences Research Grant No. BC 91-021 awarded to the author.

RÉSUMÉ

Effet de quelques extraits de plantes sur deux coccinelles prédatrices d'*Aphis craccivora* (Hom. : Aphididae)

Cette étude a été effectuée pour examiner les effets de quelques composés actifs de plantes naturellement aphicides sur les ennemis naturels d'*Aphis craccivora* Koch. En laboratoire, les extraits à l'acétone de *Cymbopogon citratus* (DC) Stapf., *Momordica charantia* L., *Zingiber officinale* Rose et *Aframomum melegueta* (Rose) K. Schum, ont été testés pour leur toxicité vis-à-vis de deux coccinelles *Cheilomones lunata* (Fabricius) et *Cheilomones vicina* (Mulsant) prédatrices de ce puceron. Tous les extraits ont une action hautement ovicide sur les deux espèces. Aucun extrait ne cause la mortalité des larves de 4° stade de *C. lunata* comme de *C. vicinata* après 24 h. Les larves traitées avec les extraits consomment moins de pucerons en 24 h que celles qui n'ont pas été traitées. La capacité à se nymphoser est aussi significativement réduite chez les larves traitées avec les extraits. Aucune malformation n'a été observée chez les adultes issus de larves traitées.

REFERENCES

Arnason, J. T., Philogene, B. J. R. & Morand, P. (eds.) — 1989. Insecticides of plant origin. *ACS Symposium Series* No. 387. — American Chemical Society, Washington, D.C., USA 213 pp.

Benner, J. P. — 1993. Pesticidal compounds from higher plants. — *Pestic. Sci.*, 39, 95-102.

Goto, C., Kasuya, S., Koga, K., Othomo, H. & Kagel, N. — 1990. Lethal efficacy of extract from *Zingiber officinale* traditional Chinese medicine or 6 shogaol and 6 gingerol in *Anisakis* larvae in-vitro. *Parasitol. Res.*, 76, 653-656.

Gullan, P. J. & Cranston, P. S. — 1994. The Insects: An Outline of Entomology. — *Chapman & Hall*, London, 491 pp.

Hough-Goldstein, J. & Keil, C. B. — 1991. Prospects for integrated control of the Colorado potato beetle (Coleoptera: Chrysomelidae) using *Perillus bioculatus* (Hemiptera: Pentatomidae) and various pesticides. — *J. Econ. Entomol.*, 84, 1645-1651.

Kimura, Y., Minami, Y., Tokuda, T., Nakajima, S., Takaji, S. & Grunki, F. — 1991. Primary structures of N-linked oligosaccharides of momordin-∝ a ribosome-inactivating protein from *Momordica charantia* seeds. — *Agric. Biol. Chem.*, 55, 2031-2036.

Krishnarajah, S. R., Ganesalingam, V. K. & Senanayake, U. M. — 1985. Repellency and toxicity of some plant oils and their terpene compounds to *Sitotroga cereallela* (Olivier) (Lepidoptera: Gelechiidae). — *Trop. Sci.*, 25, 249-252.

Ofuya, T. I. & Okuku, I. E. — 1994. Insecticidal effect of some plant extracts on the cowpea aphid, *Aphis craccivora* Koch (Homoptera: Aphididae). — *Anz. Schadlingkde., Pflanzenschutz, Umweltschutz*, 67, 127-129.

Olaifa, J. I., Erhun, W. O. & Akingbohungbe, A. E. — 1987. Insecticidal activity of some Nigerian plants. — *Insect Sci. Applic.*, 8, 221-224.

Oloke, J. K., Kolawole, D. O. & Erhun, W. O. — 1988. The antibacteria and antifungal activities of certain components of *Aframomum melegueta* seeds. — *Fitoterapia*, 59, 384-388.

Pfadt, R. E. — 1985. Fundamentals of Applied Entomology. — *Macmillan Pub. C.*, New York. 742 pp.

Price, J. F. & Schuster, D. J. — 1991. Effects of natural and synthetic insecticides on sweetpotato whitefly, *Bemisia tabaci* (Homoptera: Aleyrodidae) and its Hymenopterous parasitoids. — *Fla Ent.*, 74, 60-68.

Schmutterer, H. — 1990. Properties and potentials of natural pesticides from the neem tree. — *Annu. Rev. Entomol.*, 35, 271- 298.

Schmutterer, H. — 1992. Einfluß von azadirachtin einer azadirachtin-freien fraktion eines alkoholischen niemsamenextraktes und von formulierten extrakten auf verpuppung, schlupf und imagines der kohlweilingsbrackwespe *Apanteles glomeratus* (L.) (Hym., Braconidae) *J. appl. Ent.*, 113, 79-87.

Sofowora, A. — 1982. Medicinal Plants and Traditional Medicine in Africa. — *John Wiley & Sons*, Chichester. 256 pp.