Pest Management in Horticultural Ecosystems
Vol. 25, No.2 pp 206-210 (2019)

Insecticidal properties of solvent extracts of *Andrographis paniculata* against the Diamondback moth, *Plutella xylostella* (L.)

R. SANGAVI [1]*, Y. S JOHNSON THANGARAJ EDWARD[2], S. JEYARAJAN NELSON [2], M. PARAMASIVAM [2] and C. MEENAMBIGAI [3]

[1*]Ph. D. Scholar, Department of Agricultural Entomology, Navsari Agricultural University, Navsari, Gujarat, India

[2]Department of Agricultural Entomology, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India

[3]Department of Agricultural Entomology, Bidhan Chandra Krishi

Viswavidyalaya, Nadia, West Bengal, India

***E-mail:** sangavi.sabi@gmail.com

ABSTRACT: Diamondback moth, *Plutella xylostella* (Linnaeus.) is a key pest on *Brassicaceae* crops causing severe yield loss worldwide. Insecticidal properties of the solvent extracts of *Andrographis paniculata* against diamondback moth were studied as an alternative to insecticides. Among the extracts tested, cent per cent mortality was observed in hexane extract of *A. paniculata* at 0.6 per cent concentration. Maximum of 65.00 and 90.00 per cent mortality was observed in ethanol and ethyl acetate extract at 0.6 per cent concentration respectively.

Keywords: Diamond back moth, plant extract, efficacy

INTRODUCTION

In India, a total of 37 insect pests have been reported to feed on cabbage, of which the Diamondback moth (DBM), *Plutella xylostella* (L.) causes the loss of about 35 per cent with intensive control measures (Mohan and Gujar, 2003). Estimated total costs associated with damage and management of DBM worldwide was 4-5 billion US$ per annum (Zalucki *et al.,* 2012) and in India, the estimated cost for the control of DBM is about 16million US$ per annum. Utilization of conventional synthetic insecticides posed certain problems such as adverse effects on natural enemies, development of resistance in target pests and pest resurgence. Hazardous implications of these pesticides and their residue at various tropic levels have also caused incalculable damage to every aspect of environment, globally. In India, the first report of *P. xylostella* resistance to insecticides (DDT and parathion) was made by Verma and Sandhu (1968) in Punjab. Some populations of *P. xylostella* developed resistance to new generation insecticides such as spinosad, avermectins, indoxacarb, emamectin benzoate and *Bacillus thuringiensis, B. t.* Cry toxins in the field (Pu *et al.,* 2010). Hence there is a need to explore alternative means of pest management and botanicals are one such option.

MATERIALS AND METHODS

Soxhlet extraction

Studies were conducted to evaluate the insecticidal properties of the solvent extracts of *Andrographis paniculata* against diamondback moth. The powdered leaf of *A. paniculata* (100g) was sequentially extracted with 700 ml of hexane (non polar), ethyl acetate (medium polar) and ethanol (high polar) solvent on soxhlet's extraction apparatus for 24 - 72 hours according to the plants used. The solvents were evaporated in a rotary vacuum evaporator at 40°C. The obtained extracts were pale yellow to pale brown in colour, viscous liquid, having a pleasant woody and spicy odour.

Evaluation of Solvent Extracts

The leaf dipping bioassay method described by Tabashnik and Cushing (1987) was adopted to evaluate the insecticidal action of solvent extract against *P. xylostella* larvae. Cabbage leaves were washed with distilled water and dried for about 10 minutes. Solvent extract of *A. paniculata* were tested at three concentration *viz.,* 0.2, 0.4 and 0.6 per cent along with NSKE 5 per cent as standard check. Completely untreated leaves and ethyl acetate treated leaves were used as control. Fresh cabbage leaf discs (7.5 cm diameter) were cut from fully expanded cabbageleaves. The discs were dipped for 60 seconds in the test solutions. These treated and air dried leaves were placed in a petriplates lined with moist

Table 1. Effect of hexane extract of *A. paniculata* on the growth and development of the diamondback moth, *P.xylostella*

Treatment	Larval mortality (%)					Pupal mortality (%)	Adult emergence (%)	
	1 DAT	2 DAT	3 DAT	4 DAT	5 DAT		Normal	Malformed
Hexane extract (0.2%)	5.00 (12.92)^{c}	15.00 (22.78)^{d}	40.00 (39.22)^{c}	75.00 (59.98)^{b}	80.00 (63.41)^{b}	5.00 (12.92)^{b}	15.00 (22.78)^{d}	-
Hexane extract (0.4%)	20.00 (26.55)^{b}	50.00 (44.98)^{b}	50.00 (44.98)^{b}	70.00 (56.77)^{c}	70.00 (56.77)^{c}	20.00 (26.55)^{a}	10.00 (18.43)^{e}	-
Hexane extract (0.6%)	55.00 (39.22)^{a}	55.00 (47.85)^{a}	100.00 (89.96)^{a}	100.00 (89.96)^{a}	100.00 (89.96)^{a}	0.00 (4.05)^{c}	0.00 (4.05)^{f}	-
NSKE (5%)	20.00 (26.91)^{b}	20.00 (26.91)^{c}	25.00 (29.98)^{d}	30.00 (33.19)^{e}	30.00 (33.19)^{e}	0.00 (4.05)^{c}	70.00 (56.77)^{b}	-
Hexane control	0.00 (4.05)^{d}	0.00 (4.05)^{e}	25.00 (29.99)^{d}	60.00 (50.75)^{d}	60.00 (50.75)^{d}	0.00 (4.05)^{c}	40.00 (39.22)^{c}	-
Untreated control	0.00 (4.05)^{d}	0.00 (4.05)^{e}	0.00 (4.05)^{e}	0.00 (4.05)^{f}	0.00 (4.05)f	0.00 (4.05)^{c}	100.00 (89.96)^{a}	-
SE	0.18	0.15	0.21	0.52	0.35	0.10	0.13	-
CD(0.05)	0.38	0.32	0.44	1.10	0.74	0.21	0.28	

filter paper. In each petriplate 10 third instar larvae was released using a camel hair brush and allowed to feed for 48 hours. After 48 hours, treated leaves were removed and fresh untreated leaves were given. Three replications of each of the treatment with 10 larvae per replicate were maintained. Readings were taken at 24 hours intervals up to adult emergence for larval mortality, pupal mortality and adult emergence. Any malformation in the treatments was also observed.

Statistical analysis

The data collected in the experiments were analysed by Completely Randomized

Block Design (Gomez and Gomez, 1985). The data on per cent values and numbers were transformed into arcsine and square root values, respectively before subjecting them to statistical analysis.

RESULTS AND DISCUSSION

Effect of hexane extract of *A. paniculata* on growth and development of *P. xylostella*

The mortality of *P. xylostella* when treated with different concentrations of hexane extract of *A. paniculata* is furnished in Table 1**.** On 1 DAT, the highest mortality (55.00 %) was recorded at 0.6 per cent, while 0.2 per cent concentration of *A. paniculata* caused only 5.00 per cent mortality. On 3 DAT, the mortality of *P. xylostella* due to *A.paniculata*, was cent per cent at 0.6 per cent while at 0.4 and 0.2 per cent concentrations, the mortality increased gradually as 40.00 and 50.00 per cent, respectively. After 5 DAT, more than 70.00 per cent mortality was recorded in all the concentrations of *A. paniculata* which was higher than hexane control and NSKE (60.00 and 30.00%, respectively) while the untreated check showed no mortality. The pupal mortality observed at 0.2 and 0.4 per cent concentrations of hexane extract of *A. paniculata* was 5.00 and 20.00 per cent respectively. The least adult emergence was noticed in 0.6 and 0.4 per cent of *A. paniculata* (0.00 and 10.00 % respectively), while highest in NSKE (70.00 %).

Effect of ethanol extract of *A. paniculata* on growth and development of *P. xylostella*

At 1 DAT, no mortality was observed in all the three

Table 2. Effect of ethanol extract of *A. paniculata* on the growth and development of the diamondback moth, *P. xylostella*

Treatment	Larval mortality (%)					Pupal mortality (%)	Adult emergence (%)	
	1 DAT	2 DAT	3 DAT	4 DAT	5 DAT		Normal	Malformed
Ethanol extract (0.2%)	0.00 (4.05)^{b}	15.00 (22.78)^{b}	25.00 (29.99)^{c}	60.00 (50.75)^{b}	70.00 (56.77)^{a}	0.00 (4.05)^{c}	30.00 (33.20)^{c}	0.00
Ethanol extract (0.4%)	0.00 (4.05)^{b}	0.00 (4.05)^{c}	35.00 (36.26)^{a}	55.00 (47.85)^{c}	60.00 (50.75)^{c}	20.00 (26.55)^{a}	20.00 (26.55)^{d}	0.00
Ethanol extract (0.6%)	0.00 (4.05)^{b}	15.00 (22.78)^{b}	30.00 (33.20)^{b}	65.00 (53.71)^{a}	65.00 (53.71)^{b}	15.00 (22.78)^{b}	20.00 (26.55)^{d}	0.00
NSKE (5%)	15.00 (22.77)^{a}	30.00 (33.19)^{a}	35.00 (36.25)^{a}	45.00 (42.11)^{d}	50.00 (44.98)^{d}	0.00 (4.05)^{c}	50.00 (45.27)^{b}	0.00
Ethanol control	0.00 (4.05)^{b}	0.00 (4.05)^{c}	0.00 (4.05)^{d}	0.00 (4.05)^{e}	0.00 (4.05)^{e}	0.00 (4.05)^{c}	100.00 (89.96)^{a}	0.00
Untreated control	0.00 (4.05)^{b}	0.00 (4.05)^{c}	0.00 (4.05)^{d}	0.00 (4.05)^{f}	0.00 (4.05)^{e}	0.00 (4.05)^{c}	100.00 (89.96)^{a}	0.00
SE	0.04	0.14	0.44	0.36	0.23	0.08	0.16	
CD(0.05)	0.09	0.31	0.93	0.77	0.49	0.17	0.35	

Table 3. Effect of ethyl acetate extract of *A. paniculata* on the growth and development of the diamondback moth, *P. xylostella*

Treatment	Larval mortality (%)					Pupal mortality (%)	Adult emergence (%)	
	1 DAT	2 DAT	3 DAT	4 DAT	5 DAT		Normal	Malformed
Ethyl acetate extract (0.2%)	40.00 (22.78)^{c}	45.00 (42.11)^{c}	55.00 (47.85)^{c}	75.00 (59.98)^{b}	65.00 (53.71)^{d}	5.00 (12.92)^{a}	30.00 (33.20)^{c}	0.00
Ethyl acetate extract(0.4%)	50.00 (44.98)^{b}	60.00 (50.75)^{b}	65.00 (53.71)^{b}	70.00 (56.77)^{c}	95.00 (77.05)^{a}	0.00 (4.05)^{b}	5.00 (12.92)^{d}	0.00
Ethyl acetate extract (0.6%)	70.00 (56.77)^{a}	70.00 (56.77)^{a}	90.00 (71.54)^{a}	90.00 (71.54)^{a}	90.00 (71.54)^{b}	5.00 (12.92)^{a}	5.00 (12.92)^{d}	0.00
NSKE (5%)	15.00 (22.77)^{d}	30.00 (33.19)^{e}	35.00 (36.25)^{d}	40.00 (67.18)^{d}	40.00 (39.21)^{e}	0.00 (4.05)^{b}	60.00 (50.74)^{b}	0.00
Ethyl acetate control	40.00 (22.78)^{c}	40.00 (22.78)^{d}	55.00 (47.85)^{c}	70.00 (56.77)^{c}	70.00 (56.77)^{c}	0.00 (4.05)^{b}	30.00 (33.20)^{c}	0.00
Untreated control	0.00 (4.05)^{e}	0.00 (4.05)^{f}	0.00 (4.05)^{e}	0.00 (4.05)^{e}	0.00 (4.05)^{f}	0.00 (4.05)^{b}	100.00 (89.96)^{a}	0.00
SE	0.37	0.16	0.65	1.25	1.25	0.04	0.12	
CD(0.05)	0.78	0.35	1.38	2.63	2.63	0.10	0.25	

concentrations of ethanol

extract of *A. paniculata*. However, on 2 DAT, 15.00 per cent mortality was observed at 0.2 and 0.6 per cent concentrations of *A. paniculata.* On 5 DAT, 70.00 per cent mortality was recorded at 0.2 per cent, while the mortality at 0.4 and 0.6 per cent concentrations increased gradually to 60.00 and 65.00 per cent, respectively. The pupal mortality was recorded in 0.4 and 0.6 per cent concentrations (20.00 and 15.00 % respectively). The normal adult emergence was recorded in the ethanol check which was found to be on par with untreated check (100 %) followed by NSKE at 5 per cent (50.00 %). Least adult emergence was observed at 0.4 and 0.6 per cent (20.00 %) which was on par with each other (Table 2).

Effect of ethyl acetate extract of *A. paniculata* on growth and development of *P. xylostella*

The mortality of *P. xylostella* when treated with different concentrations of ethyl acetate extract of *A. paniculata* is furnished in Table 3. On 1 DAT, 70 per cent mortality was recorded at 0.6 per cent followed by 0.2 and 0.4 per cent (40.00 and 50.00 % respectively). On 5 DAT, 95 per cent mortality was found in 0.4 per cent concentration of the *A. paniculata* followed by 0.6 and 0.2 per cent (90.00 and 65.00 % respectively) treatments while the treated check showed 70.00 percent mortality and NSKE (40.00 %). The pupal mortality was observed in 0.2 and 0.6 per cent (5.00 %) which was found to be on par with each other. Least adult emergence was observed at 0.4 and 0.6 per cent concentrations of ethyl acetate extract of *A. paniculata* (5.00 %) which were on par.

Similar result was reported by Govindarajan (2011), that methanol and ethyl acetate extracts of *A. paniculata* exerted cent per cent mortality at 200 ppm against *C. quinquefasciatus* and at 250 ppm against *A. aegypti*. Gautam *et al.* (2013) reported that flavonoid extract of flower buds of *A. paniculata* produced highest mortality (100%) at the concentration of 600 ppm for the late III or early IV instar larvae of *A. aegypti* and at the concentration of 200 ppm for the larvae of *A. stephensi*. Bright *et al.* (2001) reported that methanol and ethyl acetate extracts of *A. paniculata* at the concentrations (1000 ppm) lead to 72.01 and 67.69 per cent adult mortality of *Callosobruchus chinensis.* The alkaloid (14 deoxyandrographolide) present in *A. paniculata* which might be responsible for the larval mortality and anti-feedent activity (Hermawan, 1994).

The present study indicates that the hexane extract of *A. paniculata* recorded cent per cent morality of *P. xylostella* larvae at 0.6 per cent concentration, ethanol and ethyl acetate extracts at 0.6 per cent concentration registered 90.00 and 60.00 per cent mortality, respectively.

ACKNOWLEDGEMENT

The authors are grateful to the Department of Entomology, Tamil Nadu Agricultural University for providing facilities to conduct this research.

REFERENCES

Bright, A., Babu, S, Ignacimuthu, S and Dom, S. 2001. Efficacy of crude extracts of *Andrographis paniculata* Nees. on *Callosobruchus chinensis* L. during post harvest storage of cowpea. *Indian Journal of Experimental Biology,* **39:** 715-718.

Gautam, K., Padma, K and Poonia, S. 2013. Larvicidal activity and GC-MS analysis of flavonoids of *Vitex negundo* and *Andrographis paniculata* against two vector mosquitoes *Anopheles stephensi* and *Aedes aegypti*. *Journal of Vector Borne Disease,* **50**: 171-178.

Gomez, K. A. and Gomez, A. A. 1985. Statistical procedures for Agricultural research. John wiley and sons, Newyork. 680p.

Govindarajan, M. 2011. Evaluation of *Andrographis paniculata* Burm (Family : Acanthaceae) extracts against *Culex quinquefasciatus* (Say.) and *Aedes aegypti* (Linn .) (Diptera : Culicidae). *Asian Pacific Journal of Tropical Medicalogy,* **4(3)**: 176-181.

Hermawan, W., Kajiyama, S., Tsukuda, R., Fujisaki, K., Kobayashi, A. and Nakasuji, F. 1994. Antifeedant and anti oviposition activities of the fractions of extract from a tropical plant, *Andrographis paniculata* (Acanthaceae), against the diamondback moth, *Plutella xylostella* (Lepidoptera:Yponomeutidae). *Applied Entomology and Zoo*logy, **29**: 533-538.

Mohan, M. and Gujar, G. T. 2003. Local variation in susceptibility of the diamondback moth, *Plutella xylostella* (L.) to insecticides and role of detoxification enzymes. *Crop Protection,* **22:** 495-504.

Pu, X., Yang, Y. and Wu, Y. 2010. Characterization of abamectin resistance in a field evolved multiresistant population of *Plutella xylostella. Pest Managament Science* **66**: 371-378.

Tabashnik, B.E. and Cushing, N. L. 1987. Leaf residue vs. topical bioassays for assessing insecticide resistance in diamond back moth, *Plutella xylostella* L. *FAO Plant Protection Bullentin,* **35**:11-14.

Verma, A. N. And Sandhu, G. S. 1968. Chemical control of diamondback moth, *Plutella xylostella* (Curtis). *Journal of Research PAU,* **5:** 420-423.

Zalucki, M. P., Shabbir, A., Adamson, D. and Shu-Sheng, L. 2012. Estimating the economic cost of one of the world's major insect pests, *Plutella xylostella (Lepidoptera; Plutellidae):* just how long is a piece of string. *Journal of Economic Entomology,* **105:** 1115-1129.

MS Received 21 October 2019
MS Accepted 15 November 2019