American-Eurasian J. Agric. & Environ. Sci., 12 (6): 764-768, 2012
ISSN 1818-6769

DOI: 10.5829/idosi.aejaes.2012.12.06.63178

Antifeedant Activity of Plant Extracts Against *Spodoptera litura* (Fab.) (Lepidoptera: Noctuidae)

[1]*S. Arivoli and* [2]*Samuel Tennyson*

[1]Department of Advanced Zoology and Biotechnology,
Loyola College, Chennai 600-034, Tamil Nadu, India
[2]Department of Zoology, Madras Christian College, Chennai 600 059, Tamil Nadu, India

Abstract: Botanicals act not only as insecticides but also function as antifeedants, oviposition deterrents and ovicides. The present investigation reports on the antifeedant property of leaf components of *Curculigo orchioides*, *Evolvulus alsinoides*, *Phyllanthus deblis, Swertia corymbosa* and *Zanthoxylum limonella*. Solvent residues of these leaf components obtained from different solvent extracts dissolved in acetone were separately tested at 1000 ppm continuously for 24, 48 and 72 hours on the third instar larvae of the army worm, *Spodoptera litura*. The results indicate the presence of antifeedant effect which was maximum *Z. limonella*. This was inferred from the lower food consumption ingested by the caterpillar on castor leaves containing solvent residues of these botanicals. Larval mortality was also observed when the caterpillars were fed on treated castor leaves, implying death due to either malnutrition or toxicity of these botanicals.

Key words: *Spodoptera litura* % Antifeedant Activity % Plant Extracts

INTRODUCTION

Spodoptera litura (Fab.) (Lepidoptera: Noctuidae) is a polyphagous insect pest of cosmopolitan distribution [1] that has about 150 host species [2, 3] and is reported to attack more than 112 different species of cultivated crop plants throughout the world of which 40 species are known in India [4, 5]. *S. litura* is an economically important polyphagous pest in India, China and Japan causing considerable economic loss to many vegetable and field crops [6, 7] since the larvae of *S. litura* can defoliate many economically important crops [8].

Use of botanical pesticides for protecting crops from insect pests has assumed greater importance in recent years owing to the growing awareness of indiscriminate use and consequent harmful effects of the chemical pesticides [9]. Natural plant products are comparatively less toxic, easily biodegradable and have made them to be the best alternate to the synthetic pesticides. Effective insecticidal properties were investigated in several plant species of various families [10]. Antifeedant compounds impair development or reproduction and may involve chronic as well as acute toxic effects over *S. litura* [11-13]. In the present investigation, antifeedant effect of leaf extracts of five different plant species (*Curculigo orchioides*, *Evolvulus alsinoides*, *Phyllanthus deblis, Swertia corymbosa* and *Zanthoxylum limonella*) was studied against the third instar larvae of *S. litura* reared on the leaves of *Ricinus communis* and the present study aims not only on evaluation of the effectiveness of the selected botanicals in their antifeedant activity but also for their larval and pupal toxicity.

MATERIALS AND METHODS

Collection of Larvae: Egg batches and different developmental stages instars of *S. litura* larvae collected from cultivated farm fields near Chennai, Tamil Nadu, India were reared in the laboratory on leaves of *R. communis* at room temperature (30 ±3°C). The third instar larvae were preferred for the experiment as they are voracious feeders.

Collection of Plants: Leaves of *C. orchioides*, *E. alsinoides*, *P. deblis, S. corymbosa* and *Z. limonella* collected from Siruvani hills of Western Ghats and Kolli hills of Eastern Ghats, Tamil Nadu, India were shade dried in the laboratory and were individually ground to a fine

Corresponding Author: Dr. S. Arivoli, Department of Advanced Zoology and Biotechnology, Loyola College, Chennai 600-034, Tamil Nadu, India.

powder. Each powdered plant materials were sieved using a strainer. One kilogram of each powdered plant material was sequentially extracted with hexane, diethyl ether, dichloromethane, ethyl acetate and methanol for a period of 72 hours each and then filtered. The filtered content was then subjected to rotary vacuum evaporator until solvents were completely evaporated to get the solidified crude extracts. The crude extracts thus obtained were stored in sterilized amber coloured bottles maintained at 4°C in a refrigerator. Standard one per cent stock solution (1000 ppm) was prepared by dissolving 100 mg of crude extract in 100 ml of acetone.

Bioassay: Leaf discs (4cm dia) of *R. communis* were used for bioassay tests, after washing it with tap water. The leaf discs were sprayed with 1000 ppm concentration of each of the plant extracts for twenty seconds, air dried at room temperature and kept in petri plates (9cm dia). The pre starved (24 h) larvae were allowed to feed on the treated leaf discs for 24, 48 and 72 hours. For each treatment, ten replicates with one control were maintained. At the end of the experiment, the uneaten area of the leaf discs was measured with leaf area meter. Larval mortality and pupal deformities were also recorded. The per cent antifeedant activity was calculated based on the formula of Singh and Pant [14] and the data was subjected to analysis of variance.

$$\text{Per cent antifeedant activity} = \frac{\text{Leaf disc consumed by the larvae in the control - Leaf disc consumed by the larvae in the treated}}{\text{Leaf disc consumed by the larvae in the control+ Leaf disc consumed by the larvae in the treated}} \times 100$$

$$\text{Per cent larval mortality} = \frac{\text{Number of dead larvae}}{\text{Total number of treated larvae}} \times 100$$

RESULTS

Antifeedant property of each of the plant extracts was assessed by comparing the averages of the leaf area consumed in the treated leaves that of control. Efficacy of plant extracts was assayed with against the third instar larvae of *S. litura* for their antifeedant activity.

Table 1: Per cent antifeedant activity of plant extracts against the third instar larvae of *Spodoptera litura*

	Hexane			Diethyl ether			Dichloro methane			Ethyl acetate			Methanol		
Plants	24h	48h	72h	24h	48h	72h	24h	48h	72h	24h	48h	72h	24h	48h	72h
Curculigo orchioides	32.61	36.50	29.33	52.51	52.15	52.38	8.61	19.60	17.58	9.56	13.48	6.56	13.19	13.04	21.62
Evolvulus alsinoides	27.62	29.56	26.64	16.73	12.11	21.75	19.07	19.92	20.23	4.33	20.68	4.69	12.66	13.89	21.28
Phyllanthus deblis	14.61	28.30	26.12	40.53	41.48	50.56	6.25	10.76	4.71	7.47	18.14	9.51	30.02	30.30	31.06
Swertia corymbosa	54.90	54.97	58.08	49.58	44.30	49.01	30.93	30.75	30.17	16.98	31.88	19.16	20.14	19.69	22.95
Zanthoxylum limonella	77.52	70.42	68.93	64.42	62.43	61.54	43.57	46.07	46.65	15.93	20.07	24.16	42.76	41.29	44.11
Control	4.24	6.31	6.78	3.24	3.98	5.60	2.30	3.12	4.71	2.68	3.42	3.90	1.96	2.74	4.88
Two - Way ANOVA															
P-Value of Plants	3.29853E-08**			1.60175E-09**			1.78813E-08**			0.002651**			4.66751E-09**		
P-Value of Hours	0.598758372			0.093106149			0.126326153			0.017296*			0.005128197**		

**P value # 0.01, *P value # 0.05

Table 2: Antifeedant effects of plant extracts on the third instar larvae of *Spodoptera litura*

Plants	Hexane	Diethyl Ether	Dichloro methane	Ethyl acetate	Methanol
Curculigo orchioides	++	+++	-	-	-
Evolvulus alsinoides	++	-	-	-	-
Phyllanthus deblis	+	++	-	-	+
Swertia corymbosa	+++	+++	++	+	+
Zanthoxylum limonella	++++	+++	+++	+	++
Control	-	-	-	-	-

Total leaf area of castor plant provided to the third instar larvae at the start of every experiment is 1350 sq.mm

- above 800 sq.mm.

+600 to 800 sq.mm.

++400 to 600 sq.mm.

+++ 200 to 400 sq.mm.

++++ Below 200 sq.mm.

Table 3: Morphogenetic effects of some plant extracts on the third instar larvae of *Spodoptera litura*

Parameters	*Curculigo orchioides*	*Evolvulus alsinoides*	*Phyllanthus deblis*	*Swertia corymbosa*	*Zanthoxylum limonella*	Control
Number of larvae tested	50	50	50	50	50	50
Number of dead larvae	20	17	11	24	28	5
Mortality (%)	40	34	22	48	56	10
Pupation (%)	60	66	78	52	44	90
Number of deformed pupae	9	9	11	7	8	3
Number of emerged adults (%)	42	48	56	38	28	84

The average food consumption in the control was between 1301.2 and 971.4 sq.mm. When compared with control, reduced food intake was observed in all plant extract treated leaf discs consumed by *S. litura.* The highest per cent antifeedant activity was observed in the hexane extract of *Z. limonella* (77.52) followed by *S. corymbosa* (58.08) (Table 1). Table 2 shows the varying degrees of the antifeedant activity of the plant extracts against *S. litura* as indicated in the increasing number of plus signs. The third instar was provided on 1350 sq.mm leaf area of each of the selected plants at the starting of the experiment. The feeding deterrent reflected in this study was judged by the decreasing quantity of leaf consumption by the larvae.

Table 3 represents the morphogenetic effects of the plant extracts on third instar larvae of *S. litura.* The larval mortality among the fifty larvae tested in the present study ranged between 56 for *Z. limonella* and 22 per cent for *P. deblis* pointing out two possibilities *viz*., toxicity to these plant extracts and malnutrition of larvae. The treated larvae were reduced in size and lethargic in nature when compared to those in the control. Successful pupation of the treated larvae was observed to be in the range of 44 (*Z. limonella*) and 78 per cent (*P. deblis*). The formation of deformed pupae indicates defects in the moulting process. Furthermore, adult moths which emerged showed some malformations in the wing.

DISCUSSION

Antifeedant activity of botanicals against insects has been studied in many countries. Quantification of antifeedant effect of botanicals is of great importance in the field of insect pest management [15]. Several investigators have reported that botanicals offer antifeedant activity against *S. litura* [16, 17]. Antifeedant activity against *S. litura* was reported in the acetone leaf extracts of *Azadirachta indica* [18]. Juvenalising effect of the ethanol leaf extracts of *Tribulus terrestris* on *S. litura* larvae resulting in morphological deformities in pupae and adults was reported by Gunasekaran and Chellaiah [19]. Narendran *et al.* [20] observed several deformities in head size, body length, remains of old cuticle, darkened colouration on wings of *S. litura* when treated with bark extracts of *Cassia fistula* and leaf extracts of *Murraya koenigii* at 1000 ppm.

Sahayaraj [21] reported that plant extracts of *A. indica*, *Citrus sinensis*, *Vitex negundo* and *Zingiber officinale* were evaluated for their antifeedant and growth inhibition of *S. litura*. Deterrent effects were found in all plant extracts and the strongest deterrent effect was found in *V. negundo* and he also found out the root extracts of *Pedalium murex* to exhibit good antifeedant property [22]. Rathi and Gopalakrishnan [23] also reported the toxic effects of methanol extracts of *Synedrella nodiflora* against *S. litura*.

Recently many researchers have reported botanicals and certain medicinal plant essential oils [24] possessing antifeeedant property against *S. litura* by leaf disc bioassay which includes the ethyl acetate leaf extract of *Syzygium lineare* [25] and *C. fistula* flower extract [26]. Significant antifeedant activity against *S. litura* was also observed with crude acetone extracts of *Tectona grandis*, *Tamarindus indica*, *Madhuca indica*, *Momordica charantia* and *Jatropha curcas* [27]. Pavunraj *et al*. [28] also stated the ethyl acetate leaf extract of *Pergularia daemia* to possess good antifeedant activity against *S. litura*.

It was interesting to note from the present study that several solvent extracts from different plants were effective as antifeedants at 1000 ppm. Therefore, the present investigation clearly suggests the usage of plant extracts/botanicals for effective control of pests at larval stages. Hence, isolation of the active ingredients responsible for such antifeedant activity and morphological deformities could possibly facilitate in new formulations for effective activity at lower concentrations, thereby making them economically low cost products. Use of such plant extracts in combination with other effective plant extracts could possibly cut down sharply the expenditure in pest management operations.

REFERENCES

1. Hadapad, A., C.S. Chaudhari, M. Kulye, A.G. Chaudele and G.N. Salunkhe., 2001. Studies on chitin synthesis inhibitors against gram pod borer, *Helicoverpa armigera* (Hub.). Journal of Natcon, 13(2): 137-140.
2. Rao, G.V.R., J.A. Wightman and R.V.D. Rao, 1993. World review of the natural enemies and diseases of *Spodoptera litura* (F.) (Lepidoptera: Noctuidae). Insect Science and its Application, 14: 273-284.
3. Muralikrishna, T., K. Devaki, R.K. Reddy and U. Venkateswarlu, 2008. Efficacy of certain new insecticide molecules against groundnut defoliator, *Spodoptera litura* (Fab.) (Noctuidae: Lepidoptera). Current Biotica, 2(2): 173-180.
4. Singh, A.K. Parasnath and J.K. Ojha, 1998. Antifeeding response of some plant extract against *Spodoptera litura* (Fab.) of groundnut. Indian Journal of Applied Entomology, 12: 9-13.
5. Paulraj, M.G., 2001. Integration of intercrops and plant product on chosen groundnut pests management. Ph.D thesis, St. Joseph’s College (Autonomous) Bharathidasan University. Trichy, Tamil Nadu, India.
6. Ferry, N., M.G. Edwards, J.A. Gatehouse and A.M.R. Gatehouse, 2004. Plant-interaction: molecular approaches to insect resistance. Current Opinion in Biotechnology, 15(2): 155-161.
7. Isman, M.B., C.M. Machial S. Miresmailli and L.D. Bainard. 2007. Essential oil based pesticides: new insights from old chemistry. In: Pesticide chemistry, H. Ohkawa and H Miyagawa, (Eds): Wiley, Weinheim, pp: 113.
8. CAB International., 2002: Crop protection compendium. Wallingford, UK.
9. Chari, M.S., G. Ramprasad, S. Sitaraman and P.S.N. Murthy, 1990. Bioefficacy of neem formulations against *Spodoptera litura* F. in Tobacco nurseries. Proceedings of the Symposium on Botanical Pesticides in Integrated Pest Management, pp: 145-153.
10. Koshiya, D.J. and A.B. Ghelani., 1990. Antifeedant activity of different plant derivatives against *Spodoptera litura* (Fab) on groundnut. Proceedings of the Symposium on Botanical Pesticides in Integrated Pest Management, pp: 270-275.
11. Desmukh, S.D. and M.N. Borle., 1975. Studies on insecticidal properties of indigenous plant products. Indian Journal of Entomology, 37: 11-18.
12. Joshi, B.G., G. Ramprasad and S. Nageswararao, 1984. Neem seed kernel suspension as an antifeedant for *Spodoptera litura* in a planted flue cured Virginia tobacco crop. Phytoparasitica, 12: 3-12.
13. Dhanapakiam, P. and A. Shanazbegum., 1995. Antifeedant properties of some leaf extracts against *Spodoptera litura* F (Noctuidae: Lepidoptera) on castor leaf. Journal of Environmental Biology, 16(4): 277-281.
14. Singh, R.P. and N.C. Pant, 1980. *Hymenocallis littoralis* Salisb as antifeedant to desert locust, *Schistocera gregaria* Forsk. Indian Journal of Entomology, 42(3): 460-464.
15. Pavunraj, M., K. Baskar and S. Ignacimuthu, 2012. Efficacy of *Melochia corchorifolia* L. (Sterculiaceae) on feeding behaviour of four Lepidopteran pests. International Journal of Agricultural Research, 7(2): 58-68.
16. Ulrichs, C.H., I. Mews, S. Adhikary, A. Bhattacharyya and A. Goswami., 2008. Antifeedant activity and toxicity of leaf extracts from *Portesia coarctata takeoka* and their effects on the physiology of *Spodoptera litura* (F.). Journal of Pest Science, 18: 79-84.
17. Sreelatha, T., A. Hymavathi, R.S.V. Rao, P. Devanand, P.U. Rani, M.J. Rao and S.K. Babu, 2010. A new benzil derivative from *Derris scandens*: Structure-insecticidal activity study. Bioorganic and Medicinal Chemistry Letters, 20: 549-553.
18. Jeyarajan, S.P., P.C. Sundarababu, G. Srimanarayan and Y. Geethanjali, 1990. Antifeedant and morphogenetic effects of azadirachtin rich fractions of *Spodoptera litura* F. Proceedings of the Symposium on Botanical Pesticides in Integrated Pest Management, pp: 33.
19. Gunasekaran, K. and S. Chellaiah, 1985. Antifeedant activity of *Andrographis paniculata* on *Spodoptera litura* F. Proceedings of the National Seminar on Behavioural Physiology and Appropriate Management of Crop Pests, TNAU, Coimbatore, pp: 31-33.
20. Narendran, S.T., S. Arivoli and S. Ignacimuthu, 1999. Evaluation of larvicidal and antifeedant activity of two plants, Proceedings of biopesticides in insect pest management. Phoenix Publishers, New Delhi, pp: 152-155.
21. Sahayaraj, K., 1998. Antifeedant effect of some plant extracts on Asian armyworm, *Spodoptera litura* (Fabricius). Current Science, 74(6): 523-525.

22. Sahayaraj, K., P. Selvaraj and G. Raju, 2003. Evaluation of biopesticidal property of *Christella parasitica* and *Ipomea cornea* on *Achaea janata*. Applied Zoological Research, 14(1): 48-50.
23. Rathi, M.J. and S. Gopalakrishnan, 2005. Insecticidal activity of aerial parts of *Synedrella nodiflora* Gaertn (Compositae) on *Spodoptera litura* (Fab.). Journal of Central European Agriculture, 6(3): 223-228.
24. Elumalai K., K. Krishnappa, A. Anandan, M. Govindarajan and T. Mathivanan, 2010. Antifeedant activity of medicinal plant essential oils against *Spodoptera litura* (Lepidoptera: Noctuidae). International Journal of Recent Scientific Research, 2: 062-068.
25. Jeyasankar, A., N. Raja and S. Ignacimuthu, 2010. Antifeedant and growth inhibitory activities of *Syzygium lineare* Wall (Myrtaceae) against *Spodoptera litura* Fab (Lepidoptera: Noctuidae). Current Research Journal of Biological Sciences, 2(3): 173-177.
26. Duraipandiyan, V., S. Ignacimuthu and M.G. Paulraj, 2011: Antifeedant and larvicidal activities of Rhein isolated from the flowers of *Cassia fistula* L. Saudi Journal of Biological Sciences, 18: 129-133.
27. Devanand, P. and P.U. Rani, 2008. Biological potency of certain plant extracts in management of two Lepidopteran pests of *Ricinus communis* L. Journal of Biopesticides, 1(2): 170-176.
28. Pavunraj, M., M. Chellaiah, S. Ignacimuthu, S. Janarthanan, V. Duraipandiyan, N. Raja and S. Vimalraj, 2011. Antifeedant activity of a novel 6-(4, 7-hydroxy-heptyl quinine from the leaves of the milkweed *Pergularia daemia* on the cotton bollworm *Helicoverpa armigera* (Hub.) and the tobacco armyworm *Spodoptera litura* (Fab.). Phytoparasitica, 39: 145-150.