

Effect of crude root oils of *Inula racemosa* and *Saussurea lappa* on feeding, survival and development of *Spodoptera litura* (Lepidoptera: Noctuidae) larvaeS.S. BHATHAL¹, DARSHAN SINGH¹, SWARANJIT SINGH² and RANJIT S. DHILLON²Department of Entomology¹ and Chemistry², Punjab Agricultural University, Ludhiana – 141 004, India**Feeding deterrence, plant extracts, *Inula racemosa*, *Saussurea lappa*, mortality, Lepidoptera, *Spodoptera litura***

Abstract. The crude oils from roots of *Inula racemosa* Hook. F. and *Saussurea lappa* Clarke at four concentrations (from 0.625 to 5%) significantly reduced the leaf damage done by *Spodoptera litura* (Fabricius) larvae. The rate of feeding deterrence measured after treatment with oils of *I. racemosa* and *S. lappa* at these concentrations ranged from 20 to 72% and 18 to 62%, respectively. The rate of mortality during larval and prepupal stages was greater than 50% at the 5% concentration. Pupation was adversely affected only at the highest concentration of both oils. Pupal weight was normal, while adult emergence was marginally affected by both oil treatments.

Introduction

The problems associated with the use of broad-spectrum conventional insecticides have stimulated the search for effective, biodegradable plant-based agrochemicals. Many secondary plant metabolites interfere with the feeding, development, diapause, reproduction and behaviour of insects. We report here the results of the feeding deterrent and biocidal activity of crude oils from the roots of *Inula racemosa* Hook. F. and *Saussurea lappa* Clarke (both belonging to Asteraceae) on the larvae of *Spodoptera litura* (Fabricius), a serious polyphagous pest.

Material and Methods

The roots of *I. racemosa* and *S. lappa* were cut into small pieces, dried and ground to a powder. The powdered roots were extracted in column with petroleum ether (40–60°C) at room temperature. The extract was concentrated under a vacuum, to yield oil.

The oils were dissolved in acetone and the desired concentrations (5, 2.5, 1.25 and 0.625%) were prepared in water to which an emulsifier, Teepol, was added @ 0.2%. Castor (*Ricinus communis* L.) leaf discs (8 cm dia.) were dipped in the liquid and air-dried. Four third-instar larvae of *S. litura* reared in the laboratory at 27 ± 2°C and 75 ± 5% RH were released into Petri dishes, each of which contained a leaf disc treated at one of the specified concentrations. The control larvae were released onto leaf discs dipped in water alone. There were five repetitions of each treatment. After 24 hours the leaf discs were replaced with freshly-treated ones. Thereafter, the larvae were fed on fresh untreated leaf discs until pupation. During the first two days, the unconsumed area of each leaf discs was measured with an electronic leaf area meter (Li-3050 A model, LI-COR Ltd., Lincoln, NE, USA), and feeding deterrence was calculated:

$$\% \text{ of feeding deterrence} = \frac{\text{Average leaf area consumed in control} - \text{Average leaf area consumed in treatment}}{\text{Average leaf area consumed in control}} \times 100$$

The number of dead larvae, pupae, emerged adults and deformities, if any, were recorded.

Results and Discussion

During the first 24 hours of feeding, both oils at all concentrations significantly checked the leaf damage done by *S. litura* larvae (Table 1). During the next 24 hr, the extent of damage increased for all treatments, and the oils had a significant effect only at concentrations of 2.5 and 5%. The rate of feeding deterrence during the first 24 hr of feeding ranged between 19.8 to 72% and 18 to 61.2% at the various

concentrations of *I. racemosa* and *S. lappa* oils, respectively. The mortality rate in the larval and prepupal stages was appreciable (around 50%) only at the 5% concentration. There were no further effects on pupation and pupal weight, with the exception of pupal formation at the 5% concentration of both oils. Adult emergence seemed marginally affected, compared to the untreated control; this was more apparent in treatments with *I. racemosa* oil.

TABLE 1. Effect of different concentrations of *Inula racemosa* and *Saussurea lappa* root oils on feeding and development of *Spodoptera litura* larvae.

Oil source	Concentration	Consumed leaf area (%)		Feeding deterrence (%) after		Mortality (%) in		Mean pupal wt. (mg)	Adult emergence (%)
		24 hr	48 hr	24 hr	48 hr	Larval stage	Prepupal stage		
<i>I. racemosa</i>	0.625	65.4(54.6)	92.6(76.2)	19.8	5.1	0	5	252.0±43.3	78
	1.25	55.8(48.4)	81.4(65.3)	31.5	16.6	0	10	266.6±67.8	44
	2.5	34.7(36.0)	51.0(45.6)	57.4	47.7	10	15	300.2±69.7	67
	5.0	22.8(28.2)	10.4(18.1)	72.0	89.3	35	20	310.1±69.4	78
<i>S. lappa</i>	0.625	66.8(55.4)	97.0(82.2)	18.0	0.6	5	0	269.7±51.0	90
	1.25	55.6(48.3)	95.4(79.0)	31.7	2.3	5	0	289.7±52.9	78
	2.5	54.0(47.3)	59.0(50.3)	33.7	39.5	15	0	265.5±66.0	69
	5.0	31.6(33.9)	18.2(24.8)	61.2	81.4	50	0	230.5±49.0	60
Control	—	81.5(64.9)	97.6(83.1)	—	—	0	5	282.4±64.3	90
LSD (p = 0.05)		(10.0)	(8.6)						

Figures in parentheses are the values after arcsine $\sqrt{\text{percentage}}$ transformation and means of five replications with four third-instar larvae in each. LSD = least significant difference.

The results thus indicate that the crude oils of *I. racemosa* and *S. lappa*, besides causing death, also had a pronounced feeding-deterrent activity on the larvae of *S. litura*. A terpenoid lactone, alantolactone, isolated from *Inula helenium* L. was reported to deter feeding in *Tribolium confusum* Duv. (Picman et al., 1978). Likewise, a sesquiterpene lactone, encelin, isolated from *Encelia actoni* Elmer and *E. asperifolia* (S.F. Blake) Clark & Kyhos was also said to possess toxic and feeding-deterrent effects on the larvae of *Spodoptera littoralis* (Boisd.) (Srivastava et al., 1990). The crude extract from *S. lappa* had earlier been observed to have insecticidal activity in the mustard aphid, *Lipaphis erysimi* (Kaltenbach), under field conditions (Nigam et al., 1990). Similarly, some terpenoid lactones isolated from *S. lappa* roots proved toxic and caused deformities in *L. erysimi* (Arora et al., 1982).

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