Environment & Ecology 35 (1B) : 495—500, January—March 2017
Website: environmentandecology.com ISSN 0970-0420

Comparative Study of Some Plants Against Feeding, Growth and Development Activity of *Spilarctia obliqua* and *Spodoptera litura*

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Received 4 May 2016; Accepted 10 June 2016; Published online 23 June 2016

Abstract An experiment was conducted to determine antifeedant, growth and development activity of seven plants viz., *Toona ciliata, Syzygium cumini, Ocimum grattisimum, Punica granatum, Thuja, orientalis, Citrus aurantifolia, Vitex negundo* against *S.litura* and *S. obliqua.* Among all the extracts at 10% concentration *V. negundo* (hexane, diethyl ether and acetone) and *O. grattisimum* (hexane, diethyl other and acetone) extracts were found to be most effective as antifeedants. Among selected extracts at 10% concentration *V. negundo* (Hexane) and *O. grattisimum* (Hexane) showed better effect against growth and development activity of *S. litura* and *S. obliqua* respectively.

Keywords Plant extracts, Antifeedant, Growth and development, *S.litura, S. obliqua.*

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Introduction

Plants produce various secondary metabolites those are important in the plant defense against herbivores. Insecticidal activity of many plants have been demonstrated against several insect pest. About 2,121 plant species possess pest control properties. Out of which 1,005 species have insecticidal, 384 antifeedant, 297 repellents, 27 attractants and 31 growth inhibitory properties [1]. Plant products as toxicants, attractants, repellants, solvent for insecticides used from ancient times. The botanical insecticides are generally pest-specific, biodegradable and are relatively harmless to non-target organisms and environment. They are the slow-acting protecting compounds of natural occurrence, usually safer to humans with minimal residual effects than pesticides, act on both behavioral and physiological processes [2]. Many medicinal as well as weed plants that have been occasionally attacked by the pests were screened and reported to contain bio-active property [3]. The detrimental effects of plant extracts or pure compounds on insects can be manifested in several manners including toxicity, mortality, antifeedant, growth inhibitor, suppression of reproductive behavior, reduction of fecundity and fertility [4—6]. In the present investigation effect of some plant extracts against antifeedant, growth and development parameters against the larvae of *S. litura* and *S. obliqua* were studied.

(The authors are thankful to the Medicinal Plant Research and Development Center (MRDC) and Head Entomology, College of Agriculture GBPUA & T Pantnagar for providing the necessary facilities).

Table 1. Effect of eight medicinal plants on feeding behavior of 7 d old larvae of Tobacco caterpillar, *S. litura* and Bihar Hairy Caterpillar,*S.obliqua*. MLAC=Mean leaf area consumed, **=Highly significant, EA=Extremely antifeedant, MA=Mederately antifeedant, SA= Strongly antifeedant, SLA-Slightly antifeedant.

Sl. No.	Plant species scientific name (Common name and Family)	Plant part used	Solvents used	*S. litura* MLAC (cm^2) 5%	*S. litura* MLAC (cm^2) 10%	Preference index 5%	Preference index 10%	Antifeedant category 5%	Antifeedant category 10%
1	Toon, *T. ciliata* (Meliaceae)	Leaves	Hexane	9.45 (3.15)^{d}	7.52 (2.83)^{d}	0.66	0.57	M.A.	M.A.
			Diethyl ether	7.92 (2.90)^{de}	6.98 (2.73^{de}	0.59	0.54	M.A.	M.A.
			Acetone	7.24 (2.78)^{ef}	6.25 (2.60)e^{f}	0.55	0.49	M.A.	S.A.
2.	Jamun, S. cumini (Myrtaceae)	Leaves	Hexane	6.45 (2.64)^{fg}	5.29 (2.41)^{f}	0.51	0.43	M.A.	S.A.
			Diethyl ether	4.28 (2.19)^{ij}	3.25 (1.94)^{h}	0.37	0.29	E.A.	S.A.
			Acetone	5.29 (2.41)^{hij}	4.72 (2.28)^{g}	0.43	0.40	S.A.	S.A.
3.	Van Tulsi, *O. grattisimum* (Lamiaceae)	Leaves	Hexane	2.92 (1.85)^{m}	1.73 (1.49)^{i}	0.26	0.16	S.A.	E.A.
			Diethyl ether	2.32 (1.87)^{lm}	1.48 (1.36)^{ij}	0.21	0.14	R.A.	E.A.
			Acetone	3.01 (1.68)^{m}	1.34 (1.41)^{ij}	0.27	0.13	S.A.	E.A.
4.	Anar, *P. granatum* (Punicaceae)	Leaves	Hexane	11.97 (3.53)^{c}	10.27 (3.28)^{c}	0.77	0.70	M.A.	M.A.
			Diethyl ether	12.24 (3.57)^{b}	11.92 (3.52)^{b}	0.78	0.77	SL.A.	SL.A.
			Acetone	12.01 (3.54)^{c}	11.04 (3.40)^{c}	0.78	0.74	M.A.	M.A.
5.	Morpankhi, *T. orientalis* (Cupressaceae)	Leaves	Hexane	4.21 (2.53)^{fgh}	3.01 (2.34)^{g}	0.36	0.27	S.A.	S.A.
			Diethyl ether	4.97 (2.34)^{hij}	3.28 (1.94)^{h}	0.41	0.29	S.A.	S.A.
			Acetone	5.92 (2.17)^{kl}	4.97 (1.87)^{h}	0.47	0.41	S.A.	S.A.
6.	Nimbu, *C. aurantifolia* (Rutaceae)	Leaves	Hexane	5.72 (2.49)^{jkl}	4.65 (2.27)^{g}	0.46	0.39	S.A.	S.A.
			Diethyl	4.25 (2.18)^{jhl}	3.37 (1.97)^{h}	0.36	0.30	S.A.	S.A.
			Acetone	4.72 (2.28)^{hij}	3.68 (2.04)^{h}	0.40	0.32	S.A.	S.A.
7.	Nirgundi, *V. negundo* (Verbenaceae)	Leaves	Hexane	2.42 (1.71)^{m}	1.08 (1.26)^{j}	0.22	0.10	E.A.	S.A.
			Diethyl ether	2.67 (1.78)^{m}	1.25 (1.32)^{ij}	0.24	0.12	E.A.	E.A.
			Acetone	3.04 (1.88)^{m}	1.72 (1.49)^{i}	0.27	0.16	E.A.	E.A
8.	Control			18.76 (439)^{a}	18.76 (4.39)^{a}	1	1	Preferred plant	Preferred plant
	SE ±			0.122	0.087				
	CD at 5%			0.348	0.249				
	F value			**	**				

Table 1. Continued.

Sl. No.	Plant species scientific name (Common name and Family)	Plant part used	Solvents used	MLAC (cm^2) 5%	MLAC (cm^2) 10%	*S. obliqua* Preference index 5%	*S. obliqua* Preference index 10%	Antifeedant category 5%	Antifeedant category 10%
1	Toon, *T. ciliata* (Meliaceae)	Leaves	Hexane	7.92 (2.90)^{c}	7.65 (2.85)^{c}	0.59	0.57	M.A.	M.A.
			Diethyl ether	7.45 (2.82)^{c}	7.02 (2.74)^{c}	0.56	0.54	M.A.	M.A.
			Acetone	7.01 (2.74)^{ed}	6.30 (2.61)^{cd}	0.54	0.50	M.A.	S. A.
2.	Jamun, *S. cumini* (Myrtaceae)	Leaves	Hexane	6.02 (2.55)^{de}	5.30 (2.41)^{de}	0.48	0.44	S.A.	S.A.
			Diethyl ether	3.97 (2.11)^{hi}	3.75 (2.06)^{fghi}	0.34	0.33	S.A.	S.A
			Acetone	5.03 (2.35)^{ef}	4.92 (2.33)^{defg}	0.42	0.41	S.A	S.A
3.	Van Tulsi, *O. grattisimum* (Lamiaceae)	Leaves	Hexane	1.78 (1.66)^{i}	1.50 (1.56)^{i}	0.17	0.14	E.A	E.A.
			Diethyl ether	2.24 (1.56)^{j}	1.92 (1.50)^{j}	0.21	0.18	E.A.	E.A.
			Acetone	1.92 (1.51)^{j}	1.75 (1.41)^{j}	0.18	0.17	E.A.	E.A.
4.	Anar, *P. granatum* (Punicaceae)	Leaves	Hexane	11.23 (3.42)^{b}	10.97 (3.39)^{b}	0.74	0.73	M.A.	M.A.
			Diethyl ether	12.25 (3.57)^{b}	11.99 (3.53)^{b}	0.79	0.77	SL.A.	SL.A.
			Acetone	12.04 (3.54)^{b}	11.92 (3.52)^{b}	0.78	0.77	SL.A.	SL.A.
5.	Morpankhi, *T. orientalis* (Cupressaceae)	Leaves	Hexane	6.92 (2.72)^{cd}	5.02 (2.35)^{def}	0.53	0.42	M.A.	S.A.
			Diethyl ether	4.27 (2.18)^{fgh}	3.62 (2.03)^{ghi}	0.37	0.32	S.A.	S.A.
			Acetone	4.02 (2.13)^{ghi}	3.24 (1.93)^{i}	0.35	0.29	S.A.	S.A
6.	Nimbu, *C. aurantifolia* (Rutaceae)	Leaves	Hexane	4.95 (2.33)^{fg}	4.72 (2.28)^{efgh}	0.41	0.40	S.A.	S.A
			Diethyl ether	4.24 (2.18)^{fg}	3.75 (2.06)^{fghi}	0.36	0.33	S.A.	S.A.
			Acetone	4.01 (2.12)^{hi}	3.46 (1.99)^{hi}	0.35	0.31	S.A.	S.A.
7.	Nirgundi, *V. negundo* (Verbenaceae)	Leaves	Hexane	2.03 (1.59)^{j}	1.75 (1.50)^{j}	0.19	0.17	E.A.	E.A
			Diethyl ether	2.29 (1.67)^{i}	1.92 (1.56)^{i}	0.21	0.18	E.A.	E.A.
			Acetone	3.25 (1.94)^{i}	2.00 (1.58)^{j}	0.29	0.19	S.A.	S.A
8.	Control			18.76 (4.39)^{a}	18.76 (4.39)^{a}	1	1	Preferred plant	Preferred plant
	SE ±			0.080	0.111				
	CD at 5%			0.229	0.319				
	F value			**	**				

Materials and Methods

Maintenance of insect culture

Wild population of *S. litura* and *S. obliqua* were collected from Norman E. Borlaug Crop Research Center (NEBCRC), Pantnagar. Rolling culture of test insects was maintained on castor leaves, under laboratory conditions (temperature 28 ^{0}C and relative humidity 88%). Then required larvae were taken from the culture, as and when required. All the experiments were conducted in Department of Entomology, College of Agriculture, and Govind Ballabh Pant University of Agriculture and Technology Pantnagar.

Preparation of plant extracts

The fresh plant parts of plants viz., Toon, Toonaciliata (Meliaceae), Jamun, *Syzygium cumini* (Myrtaceae), Van Tulsi, *Ocimum grattisimum* (Lamiaceae), Anar, *Punica granatum* (Punicaceae), Morpankhi, *Thujaorientalis* (Cupressaceae), Nimbu, *Citrus aurantifolia* (Rutaceae), Nirgundi, *Vitexnegundo* (Verbenaceae) were washed in running tap water and dried in shade for a week. The dried plant samples were weighed and macerated in electric grinder into a fine paste, each powdered plant materials were sieved using strainer, and 100 g powdered plant material was sequentially extracted with hexane, diethyl ether for a period of 72 hours each and then filtered. The filtered content of plant extracts 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 colored bottles maintained at 4^{0}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 [7].

Feeding activity

Two concentrations (5% and 10%)) of above mentioned medicinal plants were tested using 'no-choice feeding' bioassay method. Control consisted of *Ricinus communis* leaf discs. The treated leaf discs (5 × 5 cm^2) were kept in the center of presterilized corning glass petri dishes (diameter 9 cm) containing an inner lining of moist filter paper. All the treatments were replicated three times. Control consisted of *Ricinus communis* leaf disc treated with distilled water. Prestarved (3h) and freshly moulted larvae (n=2) of same age were released in each Petridis and were allowed to feed until more than 75% of the leaf disc area was eaten away in control. The observations on leaf area consumed was recorded on graph paper sheets and used for calculations of other parameters [8].

Effect of plant extracts against growth and development of *S. litura* and *S. obliqua*

Selected plants on the basis of their antifeedant activity were further studied for growth and developmental parameters of 6 d old larvae of *S. litura* and *S. obiliqua.* The experiment was conducted under laboratory conditions in plastic boxes (10 larvae/box). Prestarved (2h) and freshly moulted larvae of same age were released. The fresh leaves of the castor were provided daily.The boxes containing an inner lining of moist filter paper covered with thin muslin cloth. First three days treated leaves/leaf discs were provided after that fresh leaves every day until pupation. All the treatments were replicated three times [9].

Statistical analysis

The data collected in laboratory were statistically analyzed following the standard methods. The percentage data were transformed to angular while simple means transformed to square root. The data were analyzed by one way Analysis of Variance (ANOVA) and the means were separated using. Duncan Multiple Range Test (DMRT) based SPSS16 computer program at the Computer Center, College of Basic Science and Humanities of this University.

Results and Discussion

An experiment was conducted to determine antifeedant activity of eight medicinal plants against 7d old larvae of *S. litura* and *S. obliqua* presented in Table 1. Present study illustrated that at 10% concentration *V. negundo* (hexane, diethyl ether and acetone) and *O. grattisimum* (hexane, diethyl ether and acetone) extracts were found to be most effective as antifeedants. On the basis of described no-choice

Table 2. Effect of medicinal plants on development of 6 d old larvae of tobacco caterpillar, *S.litura.* ns=non-significant, *=significant, **=Highly significant.

Sl. No.	Plant species	Mean weight/ larva (g)	Mean weight/ larva 3 DAF (g)	Larval period (d)	Terminal larval mortality (%)	Pupal period (d)	Mean pupal weight (g)	Pupation (%)	Adult emergence (%)
1.	Van tulsi, *O. grattisimum* (Lamiaeae) (Diethyl ether)	0.336 (0.914)	0.325 (0.908)	11.33 (3.43)	16.66 (23.85)	18.66 (4.37)	0.194 (0.833)	73.33 (59.00)	43.33 (41.15)
2.	Van tulsi, *O. grattisimum* (Lamiaceae) (Acetone)	0.369 (0.932)	0.314 (0.902)	12.33 (3.58)	23.33 (28.78)	19.33 (4.45)	0.177 (0.822)	60.00 (50.85)	40.00 (39.14)
3.	Nirrgundi, *V. negundo* (Verbenaceae (Hexane)	0.331 (0.911)	0.278 (0.882)	13.33 (3.71)	40.00 (39.14)	20.66 (4.60)	0.122 (0.789)	40.00 (39.14)	23.33 (28.78)
4.	Nirgundi, *V.negundo* (Verbenaceae) (Diethyl Ether)	0.323 (0.907)	0.301 (0.895)	12.66 (3.62)	30.00 (33.00)	20.00 (4.52)	0.125 (0.790)	46.66 (43.07)	33.33 (35.21)
5.	Control	0.358 (0.926)	0.601 (1.049)	11.66 (3.48)	0.00 (0.00)	17.66 (4.26)	0.230 (0.854)	96.66 (83.85)	96.66 (83.85)
	SEm ±	0.006	0.006	0.333	0.082	0.394	0.006	0.217	0.189
	CD at 5%	0.020	0.021	1.050	0.257	1.242	0.019	0.683	0.597
	F value	**	**	*	**	**	**	**	**

feeding experiments four medicinal plant extracts viz., diethyl ether and acetone extract of *O. grattisimum*, hexane and diethyl ether extracts of *V. negundo* were examined against the growth and development of 6 day old larvae of *S. litura* and *O. grattisimum* and *V. negundo* (hexane and acetone) extracts against 6 day old larvae of *S. obliqua* presented in Tables 2 and 3 respectively. All the treatments were found to be highly significant against *S. litura* and *S. obliqua*. In case of *S. litura* order of mean weight gain larva/3 DAF (gm) *V. negundo* (hexane) (0.278 g) <*V. negundo* (diethyl ether) (0.301) <*O. grattisimum* (Acetone) (0.314) <*O. grattisimum* (Diethyl ether) (0.325). Among all the treatments *V. negundo* (Hexane) extract was found to be most effective against the larvae of *S. obliqua* as it shows maximum larval period, pupal period and terminal larval mortality (13.33 d, 20.66d and 40.00%) respectively, minimum mean pupal weight (0.122 gm), pupation (40.00%) and adult emergence (23.33%). While *O. grattisimum* (Diethyl ether) was

Table 3. Effect of medicinal plants on development of 6 d old larvae of Bihar hairy caterpillar, *S. obliqua*. ns=non-significant, *=significant,**=Highly significant.

Sl. No.	Plant species	Mean weight/ larva (g)	Mean weight/ larva 3 DAF (g)	Larval period (d)	Terminal larval mortality (%)	Pupal period (d)	Mean pupal weight (g)	Pupation (%)	Adult emergence (%)
1	Van tulsi, *O. grattisimum* (Lamiaceae) (Hexane)	0.415 (0.956)	0.329 (0.910)	29.00 (5.43)	40.00 (39.14)	11.66 (3.48)	0.317 (0.904)	60.00 (50.85)	43.33 (41.15)
2.	Van tulsi, *O.grattisimum* (Lamiaceae) (Acetone)	0.420 (0.959)	0.378 (0.937)	28.33 (5.36)	33.33 (35.21)	11.33 (3.43)	0.325 (0.908)	66.66 (54.78)	53.33 (46.92)
3.	Nirgundi, *V. negundo* (Verbenaceae) (Hexane)	0.417 (0.957)	0.380 (0.938)	28.16 (5.35)	33.33 (35.21)	10.66 (3.34)	0.341 (0.917)	73.33 (59.00)	63.33 (52.77)
4.	Nirgundi, *V. negundo* (Verbenaceae) (Acetone)	0.412 (0.954)	0.385 (0.940)	27.66 (5.30)	26.66 (30.99)	10.33 (3.29)	0.361 (0.928)	76.66 (61.21)	66.66 (54.78)
5.	Control	0.419 (0.958)	0.620 (1.058)	27.33 (5.27)	0.00 (0.00)	10.16 (3.26)	0.375 (0.935)	96.66 (83.85)	96.66 (83.85)
	SEm ±	0.006	0.007	0.372	0.181	0.307	0.004	0.282	0.429
	CD at 5%	0.019	0.022	1.173	0.571	0.968	0.015	0.889	1.352
	F value	ns	**	*	**	*	**	**	**

found to be least effective with minimum larval period, pupal period and terminal larval mortality (11.33 d, 18.66 d and 16.66%) respectively maximum mean pupal weight (0.194 g), pupation (73.33%) and adult emergence (43.33%).

Order of mean weight gain larva/3 DAF (g) for *S. obliqua* is *O. grattisimum* (Hexane) (0.329) <*O. grattisimum* (Acetone) (0.378) < *V. negundo* (Hexane) (0.380) <*V. negundo* (Acetone) (0.385). Among all the treatments *O. grattisimum* (Hexane) extract was found to be most effective against the larvae of *S. obliqua* as it shows with maximum larval period, pupal period and terminal larval mortality (29.00d, 11.66 d, 40.00%) respectively, minimum mean pupal weight (0.317 g), pupation (60.00%)and adult emergence (43.33%). While *V. negundo* (Acetone) extract was found to be less effective than other treatment minimum larval period, pupal period and terminal larval mortality (27.66 d, 10.33 d, 26.66%) respectively, maximum mean pupal weight (0.361 g), pupation (76.66%) and adult emergence (66.66%). On the basis of study we can say that *V. negundo* (Hexane) and *O. grattisimum* (Hexane) showed better effect over *S. litura* and *S. obliqua* respectively against feeding as well as their growth and developmental activity. Some other related findings [10] on methanol extract of *V. negundo* was found to be the most toxic with maximum mortality (96.3%) recording lowest LD_{50} of 423 ppm. Methanol extract caused maximum reduction in pupal weight (45.15 to 72.60%) followed by acetone extract (34.52 to 70.00%) hexane, acetone and methanol extract (6%) caused the highest reduction of 96.51, 96.30 and 92.86% pupation over control. Gopalakrishnan et al. [11] evaluated herbal vermicompost (called biowash, viz., Annona, Chrysanthemum, Datura, Jatropha, Neem, Parthenium, Pongamia, Tridax and Vitax) and plant growth promoting (PGP) bacteria and fungus *(Metarhizium anisopliae)* were evaluated for their efficacy against *Helicoverpa armigera* and *Spodoptera litura* and found that six botanicals and five entomopathogens were so effective against *H. armigera* and *S. litura.*

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