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Effect of Medicinal Plant Extracts on Growth and Development of Tobacco Caterpillar, *Spodoptera litura* (Fabricius)

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Abstract

The present investigation was undertaken with the objective to evaluate the potential of different medicinal plants to explore their effect on growth and development of *S. litura*. Five medicinal plants species *viz*., Tulsi, *O. sanctum*; Tejpatra, *C. tamala*; Dalchini, *C. zeylanicum*; Eucalyptus, *E. citriodora*; Karanj, *P. pinnata* were tested at the conc. of 15 mg of acetone powder/ml of water. Preference index calculations at 15 mg/ml indicated that, *C. tamala, C. zeylanicum and P. pinnata* extracts exhibited 'extreme antifeedant' reaction while *O. sanctum* and *E. citrodora* extracts exhibited 'strong antifeedant' reaction. The acetone powder of *O. sanctum* at this concentration had no significant impact on the larval weight however *C. tamala, C. zeylanicum, E. citrodora and P. pinnata* could significantly reduce the weight gain in the larvae of *S.litura*. All the plant extracts caused a significant reduction in pupal weight over control. *O.sanctum* (15 mg/ml) could favour growth and development parameters of *S.litura* non significantly over control whereas other plant extracts *C. tamala, C. zeylanicum, E. citriodora* and *P. pinnata* proved detrimental to the larvae showing lethal effects at later developmental stages. Maximum larval mortality, lowest pupation and lowest adult emergence were observed in *P. Pinnata*

Highlights

- Active compounds isolated from different medicinal plants will be useful for controlling economically important insect pest
- Effect of plant extracts on growth and development of *Spodoptera litura* (Fabricius)

Keywords: Medicinal plant,plant extract, *spodoptera litura* (Fabricius)

Insect pests and diseases are important limiting factors of agricultural production across the globe. Amongst the insect pests, the tobacco caterpillar *Spodoptera litura* (Fab.) (Lepidoptera: Noctuidae) is an important polyphagous pest widely distributed throughout Asia **(**Hadapad *et al*. 2001; Sahayraj *et al*. 2008**).** It has a wide range of host, feeding on 112 plant species worldwide, of which 40 species are known from India. Traditional farmers have been used synthetic pesticides to eliminate *S. litura* but this pest has developed resistance against most of the commonly used pesticides. Besides the use of new insecticides and insecticide mixtures, there is a need of holistic approach towards insect pest management which includes the use of botanicals such as plant products to combat resistance problem.

In recent years, great emphasis is given on the use of natural products, which are non-toxic, safe, low cost and biodegradable alternative to the conventional control of insects by synthetic pesticides. Earlier studies have indicated that antifeedant compounds derived from seeds, flowers, fruits, leaves and

roots of the plants could be used as effective bio-compounds against the growth and metamorphosis of the noxious insects. There is an imperative need for the development of safer, alternative crop protectants such as botanical insecticides and antifeedants. Plants are rich source of natural substances that can be utilized in the development of environmentally safe methods for insect control (Sadek 2003).

The introduction of less hazardous, safe and biodegradable synergist of natural origin to complement our reliance of synthetic pesticides could be of great benefit both economically and ecologically since, the tests conducted over the years have shown that synergists increase the efficacy of insecticides (Ramarethinam *et al.* 2008).

Material and Method

Culture of tobacco caterpillar, S. litura

Adults of test insect S. litura were collected from Norman E. Borlaug Crops Research Centre (NEBCRC), G. B. Pant University of Agriculture and Technology Pantnagar and light sources nearby hostels. Insects were transferred separately to glass jars (dia. 20 cm, height 15 cm) having an inner lining of white paper. Cotton soaked in 10 % sucrose solution kept in a plastic container was put in the jar for adult feeding. The top of the jar was covered with muslin cloth. The eggs were kept in plastic boxes (10 x 10 x 14cm). In order to provide proper humidity, a lining of wet filter paper was kept at the bottom. The neonate larvae were transferred to plastic tubs (dia. 36cm, ht approx. 14cm) containing fresh and soft leaves of castor, R.communis with the help of fine brush. Fresh food was supplied daily and proper hygienic conditions were maintained. A wet piece of cotton swab was used to wrap the petiole to protect it from drying. The larvae were used for conducting the experiments (Chauhan and Srivastava, 2014).

Preparation of medicinal plant extracts (acetone powder)

Preparation of medicinal plant extracts (acetone) All the medicinal plant samples were collected from Medicinal Plant Research and Development Center (MRDC), Pantnagar. The fresh plant leaves were washed in running tap water and a known quantity was weighed. These plant samples were macerated with the glass mortar and pestle or in electric grinder into a fine paste and dipped in acetone in separate conical flasks, kept at room temperature, after 3-4 days the extract was filtered through Whatman filter paper, evaporated under electric fan and brought in the desired volume in acetone. The acetone extract was kept in sealed glass vials, stored in refrigerator and was used as and when required. A test solution (on dry wt/volume basis) was prepared for each extract by dissolving appropriate amount of extract in definite volume of acetone (Pandey 2011).

Effect of medicinal plant extracts (acetone powder) on the growth and developmental parameters of S. litura.

The experiment was conducted under laboratory conditions in the plastic boxes (size l 22 X w 14 X ht 8 cm) provided with two layers of moist filter paper. This was done to ensure proper relative humidity inside the boxes. The boxes were covered with a piece of thin muslin cloth in order to ensure proper aeration. The laboratory reared larvae were used for conducting experiment on growth and development. The solution (15 mg/ml) was prepared in tap water from acetone powder of plant species as per the requirement. Control consisted of water only. Each of the treatments was replicated three times and for each replication 10 larvae of same age group and size were taken in each experimental box. The fresh and matured leaves were plucked, thoroughly washed and dried with the help of filter paper and the leaf discs (area = 4 x 4 cm2) were cut from them. The leaf discs were later dipped in the extracts for approx. 4 to 5 minutes and air dried for a while. The larvae were fed with fresh treated leaf discs continuously for three days and, thereafter with fresh untreated leaves until pupation. The observations were recorded on following parameters- larval weight (g), larval period (d), pupal period (d), terminal larval mortality (%), pupal weight (g) and adult emergence (%). The data was analysed using completely randomized design (CRD) and computations were made on following :-

Growth and survival parameters

1. Weight gain/larva = Wt. of single larva 2/3 DAF – Initial wt of single larva

(DAF = Days after feeding)

2. Mortality (%) $\frac{\text{(Number of dead larvae before pupae formation)}}{\text{Total larvae taken}} \times 100$

Developmental parameters

1. Larval period (d) : No.of days required from hatching to the development of full grown larva.
2. Post larval period or Pupal period (d) : The period between the commencement of pupae formation and adult emergence.
3. Adult emergence(%) $\frac{\text{No.of healthy adults emerged}}{\text{No.of healthy pupae formed}} \times 100$

Statistical analysis

The experiment was conducted in completely randomized design (CRD) (Gomez and Gomez, 1984**)** and the data was analyzed by one way Analysis of Variance (ANOVA) following Snedecor and Cochran (1967**)**. The means were separated using Duncan's Multiple Range Test (DMRT) based SPSS16 computer programme (Duncun 1955).

Result and Discussion

The present investigation was undertaken with the objective to evaluate the potential of different medicinal plants to explore their effect on growth and development of *S. litura*. Five treatments were selected for their effect on growth and development of 6d old larvae of *S. litura*. Five medicinal plants species *viz*., Tulsi, *O. sanctum*; Tejpatra, *C. tamala*; Dalchini, *C. zeylanicum*; Eucalyptus, *E. citriodora*; Karanj, *P. pinnata* were tested at the conc. of 15 mg of acetone powder/ml of water. The larvae were fed with treated leaf discs (size: 4×4 cm^2) for three days and thereafter with untreated fresh castor leaves. Control larvae were fed with fresh castor leaves only. The observations were recorded on dry wt of leaves consumed, weight gain/ larva (g), larval period (d), terminal larval mortality (%), pupal period (d), pupation (%), pupal mortality (%) and adult emergence (%). The data has been presented in table (1 and 2).

Growth and development parameters

Preference index calculations at 15 mg/ml indicated that, *C. tamala, C. zeylanicum and P. pinnata* extracts exhibited 'extreme antifeedant' reaction with C value of 0.15, 0.18 and 0.15 respectively while *O. sanctum* and *E. citriodora* extracts exhibited 'strong antifeedant' reaction with C value of 0.30 and 0.32 respectively.

The acetone powder of *O. sanctum* at this concentration had no significant impact on the larval weight (were at par with control at p=0.05) however *C. tamala, C. zeylanicum, E. citriodora and P. pinnata* could significantly reduce the weight gain in the larvae of *S. litura*. The observations on mean weight gain/larva at two days after feeding (DAF) indicated that all the plant extracts except *O. sanctum* were effective in reducing the larval weight significantly over control (0.034g). Minimum weight gain (0.009g/larva) or maximum reduction in weight gain was observed in *C. tamala* (73.53%) at 2 DAF in comparison of control. This was followed by *P. pinnata* (47.06%), *E. citriodora* (44.12%) and *C. zeylanicum* (17.65%). The *O. sanctum* extract at 15mg/ml conc. caused 20.58 % increase in larval wt over control indicating the presence of growth promoting substance.

At 4 days after feeding (4 DAF) also all the plant extracts except *O. sanctum* were effective in reducing the larval weight significantly over control (0.0318g). Maximum reduction in weight gain was observed in *C. tamala* (58.79%) at 4 DAF. This was followed by *E. citriodora* (39.4%), *P. pinnata* (24.25%) and *C. zeylanicum* (7.28%). The larval fed on *O. sanctum* extract showed 3.03% increase in weight gain over control at 4DAF.

Leaf petroleum ether extract of *A. conyzoides*, collected at the flowering stage in Pusa, New Delhi, India, was evaluated for their antifeedant activity and effects on growth and development of fifth and sixth instar *S. litura*. Sixth instar larvae were found to feed on castor, *Ricinus communis* leaves painted with 10% whole plant petroleum ether extract, indicating lack of antifeedant activity. Topical application of the extract at 716.8 µg reduced adult emergence to 59.86%, while the leaf ethanol extract reduced adult emergence to 80% at 2000 µg and 85% at 4000 µg. The stem ethanol extract at 160 µg caused 44% larval mortality (compared to 29% in the control) and reduced adult emergence to 56.2% (compared to 71% in the control). Topical application of whole plant extract at 120 µg reduced larval weight gain, pupation, adult emergence, ovarian weight and increased larval mortality (Singh and Rao, 2000).

Table 1: Effect of some medicinal plant extracts (acetone powder) on growth of 6d old larvae of *Spodoptera litura* Fab.

S. No.	Plant species (Common name, family)	Dry wt of leaves consumed (g)	Mean wt gain/larva 2DAF (g)	Reduction in mean wt gain/larva over control 2DAF (%)	Mean wt gain/larva 3+1 DAF (g)	Reduction in mean wt gain/ larva over control 4DAF (%)	Terminal larval mortality (%)	Preference index	Antifeedent category*
1-	Ocimum sanctum L. (Tulsi , Lamiaceae)	00216ab	0.041d	- 20.58	0.34d	-3.03	6.66ab	0.308	SA
2-	Cinnamomum tamala Buch. (Tejpatra, Lauraceae)	0.011a	0.009a	73.53	0.136a	58.79	16.6b	0.15	EA
3-	Cinnamomum zeylanicum Nees (Dalchini, Lauraceae)	0.013a	0.028c	17.65	0.306d	7.28	10.0ab	0.18	EA
4-	Eucalyptus citriodora Hook (Eucalyptus, Myrtaceae)	0.023b	0.019b	44.12	0.20b	39.4	13.3ab	0.32	SA
5-	Pongamia pinnata (L) Pierre (Karanj, Fabaceae)	0.011ab	0.018b	47.06	0.25c	24.25	20.0b	0.15	EA
	Control	0.14c	0.034cd	-	0.33d	-	-	-	-
	SEM±	0.002	0.002	-	0.0103	-	4.08	-	-
	CD at 1 %	0.0114	0.0087	-	0.044	-	17.62	-	-
	CD at 5 %	0.0081	0.006	-	0.0318	-	12.57	-	-

All the plants were tested at the conc. of 15 mg of acetone powder/ml of water.

DAF- Days after feeding, 3+1 DAF= Feeding with treated leaves (3d) + untreated leaves (1d) *SA= Strong antifeedant, EA= Extremely antifeedant following Kogan and Goeden (1970). Means followed in the same column by the same letter are not significantly different. (Significance level at 5 % DMRT).

Table 2: Effect of some medicinal plant extracts (acetone powder) on development of 6d old larvae of *Spodoptera litura* (Fab.).

SI No.	Plant species (Common name, family)	Larval period (d)	Pupal period (d)	Pupal wt (g)	Reduction in mean pupal wt/larva over control (%)	Pupal mortality (%)	Pupation %	Adult emergence (%)
1	*Ocimum sanctum L.* (Tulsi, Lamiaceae)	13.20b	9.10b	0.24b	20	10ab	93.3c	92cd
2	*Cinnamomum tamala* Buch. (Tejpatra, Lauraceae)	14.0b	9.88a	0.23b	23.34	13.3ab	83.3b	77.7b
3	*Cinnamomum zeylanicum* Nees (Dalchini, Lauraceae)	11.0a	8.20a	0.20ab	33.40	13.3ab	86.6b	87.5bc
4	*Eucalyptus citriodora* Hook (Eucalyptus, Myrtaceae)	13.25b	10.33c	0.21ab	30.0	16.6ab	86.6b	80.76b
5	*Pongamia pinnata* (L) Pierre (Karanj, Fabaceae)	13.56b	10.40c	0.18a	40.0	33.3b	76.6a	56.52a
	Control	13.20b	9.30b	0.30c	-	0.0	100d	96.6d
	SEM±	0.66	0.12	0.0126	-	3.08	2.29	2.54
	CD value at 1 %	2.88	0.53	0.054	-	15.62	9.92	10.84
	CD value at 5 %	2.05	0.384	.03910	-	11.50	7.08	7.73

Means followed in the same column by the same letter are not significantly different. (Significance level at 5 % DMRT).

Sharma *et al.* (2009**)** tested the ethanol extract of eight plant species, namely *Azadirachta indica* A. Juss, *Melia azedarach* Linn., *Lantana camara* L. Moldenke., *Cannabis sativa* Linn., *Nerium indicum* Mill., *Eucalyptus sp*., *Ricinus communis* Linn. and *Solanum nigrum* Linn. for larvicidal effect against *Spodoptera litura* .They reported that seed extract of *A. indica* and *M. azedarach* were highly effective against *S. litura* giving statistically higher larvicidal effect, as compared to other plant extracts.

The plant extracts taken in the present investigation reflected different level of toxicity against *S.litura*. The terminal larval mortality (%) was maximum in the *P.pinnata* (20%) followed by *C.tamala* (16.6%), *E.citriodora* (13.3%), *C.zeylanicum* (10%) and *O. sanctum* (6.66%). No mortality was observed in control. All the plant extracts reduced or lengthen the larval and pupal period . Lowest larval period was observed in *C.zeylanicum* (11.0d) while highest larval period was observed in *C. tamala* (14.0d), which was statistically non significant in comparison of control (13.20d). Maximum pupal period was observed in *P.pinnata* (10.40d) which was significantly different in comparison of control while minimum pupal period was observed in *C.zeylanicum*.

Acetone extract (dry leaves @ 1g/ml) of sixteen plant species *viz., A. zeylanica*, *B. monnieri*; *E. ganitrus,B. montanum, P. zeylanica,, Elettaria sp., C. ternetea*, *I. coccinea, P. hysterophorus*, *A. conyzoides, C. acuitangutus, V. hirsute, B. orellana,, B. variegate,C. camphora* and *C. flexuosus* were tested for their effect on 5d old larvae of *S. litura* by residue contact method, indicated that among all the plant extracts *A. conyzoides* and*, P. zeylanica* at tested conc. exhibited high IGR activity against *S.litura*. These plant species could cause significant reduction in wt gain/larva with higher larval mortality. Similar plant extracts when tested against 1d old larvae of *S. litura* again *P. zeylanica* and *A. conyzoides* showed 100 % larval mortality and proved to be most toxic, with no impact on increase or decrease of larval weight (Pandey 2011).

The percent pupation was significantly reduced by all the plant extracts. Higher percent pupation was observed in control (100%) followed by *O. sanctum* (93.3%), *C. zeylanicum* (86.6%), *E. citriodora* (86.6), *C. tamala* (83.3), and *P. pinnata* (76.6%).

All the plant extracts caused a significant reduction in pupal weight over control. Minimum pupal wt (0.18g) or maximum reduction (40%) was observed in *P. pinnata* while minimum reduction (20%) was observed in *O. sanctum*. The increase in larval growth reflected in terms of mean larval wt gain/ larva, observed in *O. sanctum* at the conc. of 15 mg of acetone powder /ml of water; was not finally translated in terms of pupal weight gain. Instead, a reduction (20%) in pupal weight was observed in comparison of control. The percent adult emergence calculated on the basis of pupae formed, was adversely affected by some plant extracts viz., *P. pinnata* (56.52 %), *C. tamala* (77.7%), and *E. citriodora* (80.76%).

In the present investigation, *O. sanctum* (15 mg/ml) could favour growth and development parameters of S.litura non significantly over control whereas other plant extracts *C. tamala, C. zeylanicum, E. citriodora* and *P. pinnata* proved detrimental to the larvae showing lethal effects at later developmental stages. Out of five medicinal plant extracts used in the present investigation it has been observed that larval weight was increased by *O. sanctum* and maximum larval mortality, lowest pupation and lowest adult emergence was observed in *P. pinnata*.

Conclusion

Over all performance of all the plant extracts caused a significant reduction in pupal weight over control. Minimum pupal wt (0.18g) or maximum reduction (40%) was observed in *P. pinnata* while minimum reduction (20%) was observed in *O. sanctum*. The increase in larval growth reflected in terms of mean larval wt gain/larva, observed in *O. sanctum* at the conc. of 15 mg of acetone powder /ml of water; was not finally translated in terms of pupal weight gain. Instead, a reduction (20%) in pupal weight was observed in comparison of control. The percent adult emergence calculated on the basis of pupae formed, was adversely affected by some plant extracts viz., *P. pinnata* (56.52 %), *C. tamala* (77.7%), and *E. citriodora* (80.76%).

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