Bioefficacy of botanicals against *Spodoptera litura* and *Helicoverpa armigera* on tobacco

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The tobacco caterpillar, *Spodoptera litura* and tobacco bud worm, *Helicoverpa armigera* are the major limiting factors of productivity of Flue Cured Virginia tobacco (FCV) in Andhra Pradesh. There are very stringent regulations on the use of chemical insecticides on tobacco and the guidance residue levels of insecticides on the cured leaf are very low. It has been a major research concern to evolve eco-friendly botanical insecticides against major pests of FCV tobacco so as to reduce the insecticide load on the crop and avoid their residues. The present study was initiated in this direction and three plant species, *Andrographis paniculata, Phyllanthus amarus* and *Clerodendron inerme* were tested for their bioactivity against the two major lepidopterous pests, *S. litura* and *H. armigera* so as to identify an effective botanical pesticide against them.

The culture of *S. litura* was maintained on castor and that of *H. armigera* was reared on bengalgram flour based artificial diet at 25 ± 5 °C and 75 ± 5% relative humidity. Both the test insects were acclimatized to tobacco leaves before they were used in the bioassays with the plant extracts.

Preparation of organic solvent extracts Hexane, dichloromethane, ethyl acetate and methanol extracts of the medicinal plants, *A. paniculata*, *C. inerme* and *P. amarus* were prepared by Soxhlet extraction, concentrated using a flash evaporator and dissolved in a suitable solvent.

Bioassays for antifeedant activity. Antifeedant property of organic solvent extracts was assessed through leaf disc method under no-choice situation. Single early third instar larva of the test insect was confined with the treated leaf disc in a Petri dish overnight and allowed to feed for 12 h. Five replicates were maintained for each treatment. The area fed was quantified using a digital leaf area meter.

Except the hexane extract of *A. paniculata* leaf powder at 0.5% concentration, all the extracts significantly reduced feeding by *S. litura* larvae compared to control (Table 1).

Table 1. Antifeedant activity of organic solvent extracts of botanicals against *S. litura*

Treatment	Leaf area consumed (cm^2)
Andrographis paniculata (H) 0.5%	3.27* (9.75)
A. paniculata (H) 1.0%	1.48 (1.40)
Clerodendron inerme (H) 0.5%	1.27 (0.67)
C. inerme (H) 1.0%	1.00 (0.00)
Phyllanthus amarus (H) 0.5%	2.19 (3.92)
P. amarus (D) 1.0%	1.40 (0.97)
A. paniculata (D) 0.5%	2.43 (5.03)
A. paniculata (D) 1.0%	1.88 (2.53)
C. inerme (D) 0.5%	1.02 (0.03)
C. inerme (D) 1.0%	1.00 (0.00)
P. amarus (D) 0.5%	1.90 (2.67)
P. amarus (D) 1.0%	2.53 (5.50)
A. paniculata (E) 0.5 %	2.51 (5.42)
A. paniculata (E) 1.0%	2.02 (3.17)
C. inerme (E) 0.5%	1.16 (0.37)
C. inerme (E) 1.0%	1.24 (0.58)
Control	3.20 (9.30)
CD (P=0.01)	0.186
CV %	17.36

*square root (x+1) transformed values; figures in parentheses are original treatment means; H = hexane, D = dichloromethane, E = ethyl acetate and M = methanol extract

Total inhibition of feeding by *S. litura* larvae was noticed in case of dichloromethane and hexane extracts of *C. inerme* leaf powder. The ethyl acetate extract of the same plant also recorded significantly higher feeding inhibition compared to control at both the concentrations (0.5 and 1.0%) tested. The hexane and dichloromethane extracts of *A. paniculata* could also inhibit feeding of *S. litura* larvae significantly at 1.0 per cent concentration. Significant feeding inhibition was observed when dichloromethane and hexane extracts of *C. inerme* leaf powder were tested even at concentrations

Table 2. Antifeedant property of organic solvent extracts of *C. inerme* at lower concentrations against *S. litura*

Treatment	Leaf area consumed (cm^2)
Clerodendron inerme (H) 0.25%	1.86* (2.47)
C. inerme (H) 0.10%	1.91 (2.67)
C. inerme (H)) 0.05%	2.19 (3.83)
C. inerme (H)) 0.01%	2.75 (6.58)
C. inerme (D) 0.25%	1.02 (0.03)
C. inerme (D) 0.10%	1.16 (0.37)
C. inerme (D) 0.05%	1.83 (2.50)
C. inerme (D) 0.01%	2.59 (5.75)
Control	4.54 (19.75)
CD (P=0.01)	0.678
CV %	12.89

*square root (x+1) transformed values; figures in parentheses are original treatment means; H = hexane and D = dichloromethane

as low as 0.01 per cent (Table 2). In a previous study, two clerodene diterpenes, Clerodendrin B and C, which exhibit growth inhibitory and antifeedant properties were isolated from the hexane extract of *C. inerme* and their structures were established by NMR spectral analysis (Rao *et al.*, 1993). Leaf extracts of *C. inerme* were also found to be effective against *Amsacta morei* in the field in Gujarat (Patel *et al.*, 1993). An antifeedant compound 14- deoxy andrographolide against diamond backed moth, *Plutella xylostella* was isolated from hexane layer of an extract from dried powder of *A. paniculata* (Hermawan *et al.*, 1997).

When tried against *H. armigera*, except dichioromethane extract of *P. amarus*, ethyl acetate extract of *A. paniculata* and methanol extract of *C. inerme*, rest of the extracts inhibited feeding significantly (Table 3). Highest feeding inhibition was observed in case of ethyl acetate extract of *C. inerme* followed by hexane extract of *P. amarus* and dichloromethane extract of *C. inerme*. Ethanolic extract of *P. amarus* was shown to have strong insecticidal activity against *T. castaneum* (Khanna *et al.*, 2003). The hexane extracts of the plants, *C. inerme* and *A. paniculata* exhibited very strong antifeedant property to both the test insects and hence hold promise as sources for developing a potent biopesticide for the integrated management of these pests.

Table 3. Antifeedant property of organic solvent extracts of botanicals against *H. armigera*

Treatment	Leaf area consumed (cm^2)
Clerodendron inerme (H) 0.5%	1.27* (0.67)
C. inerme (H) 1.0%	1.24 (0.58)
C. inerme (D) 0.5%	1.89 (2.67)
C. inerme (D) 1.0%	1.06 (0.13)
C. inerme (E) 0.5%	1.83 (2.38)
C. inerme (E) 1.0%	1.01 (0.03)
Andrographis paniculata (H) 0.5%	2.26 (4.25)
A. paniculata (H) 1.0%	2.09 (3.38)
Phyllanthus amarus (H) 0.5%	1.15 (0.33)
P. amarus (D) 1.0%	1.04 (0.08)
A. paniculata (D) 0.5%	1.64 (1.72)
A. paniculata (D) 1.0%	1.15 (0.33)
P. amarus (D) 0.5%	2.73 (6.48)
P. amarus (D) 1.0%	2.71 (6.37)
A. paniculata (E) 0.5%	2.76 (6.63)
A. paniculata (E) 1.0%	2.49 (5.22)
A. paniculata (M) 0.5%	1.22 (0.50)
A. paniculata (M) 1.0%	1.29 (0.74)
C. inerme (M) 0.5 %	2.38 (4.73)
C. inerme (M) 1.0 %	1.94 (2.80)
Control	2.86 (7.17)
CD (P=0.01)	0.44
CV %	11.61

*square root (x+1) transformed values; figures in parentheses are original treatment means; H = hexane, D = dichloromethane, E = ethyl acetate and M = methanol extract

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