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Insecticidal Activity of the Phyto-extracts Derived from Different parts of the trees of *Fabaceae* family against *Hyblaea puera* Cramer (Lepidoptera: Hyblaeidae)

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ABSTRACT : The larvicidal and ovicidal activity of the extracts of the seeds and leaves of Acacia concinna (Willd.) DC. and seeds and flowers of *Butea monosperma* (Lam.) Taub, prepared from the organic solvents, *viz.* petroleum ether, chloroform, methanol, ethyl alcohol, ethyl acetate, acetone and water were evaluated against the teak defoliator, *Hyblaea puera* Cramer. The result showed that the methanol and ethyl acetate extract of the seeds of *A. concinna* and the ethyl acetate extract of the leaves of *A. concinna* were the most effective among all the extracts causing 100% larval mortality even with least concentration (0.25%). All the extracts of the seeds of *A. concinna* showed 100% egg hatch inhibition at lowest concentration (0.5%), whereas all the extracts of the leaves of *A. concinna* were ineffective as ovicides except petroleum ether extract which exhibited 40% egg hatch inhibition at highest concentration (2%). The ethyl acetate extract of the seeds of *B. monosperma,* was the most effective among all the extracts causing 100% larval mortality even with least concentration (0.25%). Highest egg hatch inhibition (80%) was recorded at highest concentration (2%) for the chloroform extract of the seeds of *B. monosperma.* All the organic solvent extracts of the flowers of *B. monosperma* did not show any larvicidal and ovicidal activity.

Keywords : *Acacia concinna* (Willd.) DC., *Butea monosperma* (Lam.) Taub, Larvicidal, Ovicidal, Hyblaea puera Cramer.

INTRODUCTION

Plants are a rich source of organic chemicals also known as secondary metabolites. The secondary metabolites of plants have been exploited by man since time immemorial in the form of medicines, cosmetics, dyes and pesticides. Agriculture and forestry play vital role in the economy and sustainable development of the country. Pests not only affect the quality and quantity of the agricultural products but, are of major concern in forestry sector also. An estimated 14% of the crop losses worldwide are caused by insect pests. Although use of synthetic pesticides has prevented further loss, repeated indications of pesticide toxicity and insect resistance have forced researchers to look for newer eco-friendly, more potent and safer insecticides, especially from plant sources. The present study is taken up with the objective of exploring the insecticidal activity of seeds and leaves of *Acacia concinna* (Willd.) DC. and seeds and flowers of *Butea monosperma* (Lam.) Taub.

MATERIALS AND METHODS

Study plants : The seeds and leaves of *Acacia concinna* (Willd.) DC. and the seeds and flowers of *Butea monosperma* (Lam.) Taub were selected for the study. Plant materials for the study were collected from the Botanical Garden at the University of Agricultural Sciences campus, Bangalore.

Preparation of the plant extract : Organic solvent extraction of the plant material was done using the soxhlet extractor using standard procedures as outlined by Harborne (1998) and Cseke et al. (2006). The plant material except flowers of *B. monosperma* were shade dried. The flowers of *B. monosperma* were sprinkled with alcohol to prevent fungal infestation and then were oven dried. The dried plant material was powdered in a blender/ mixer/ pulverizer depending upon the nature of the plant material. 100g of the plant material was dissolved in 250 ml of each of the solvent of increasing polarity namely petroleum ether, chloroform, methanol, ethyl alcohol, ethyl acetate, acetone and water and kept for 48 hours in sealed round bottom flasks. After 48 hours, it was extracted in soxhlet apparatus until the eluting solvent turned colourless. The solvent was evaporated and the dry crude extract obtained was weighed and stored in refrigerator.

Preparation of the test concentrations from the crude extract : A known amount of crude extract obtained from the above process was dissolved in respective solvent in 1:1 proportion and serially diluted with water to obtain the desired concentrations of 0.25%, 0.5%, 1%, 2% and 4%. One drop of emulsifier (0.005%) (Tween 20, Sigma Chemical Company) was added to the extract to ensure complete dispersion of the active ingredient.

The study insect : *Hyblaea puera* Cramer (Lepidoptera: Hyblaeidae) is the most important defoliator pest of teak in India. Teak is its principal food plant, but it has several alternative hosts on which it thrives. It feeds on all the leaf tissues leaving only the major veins. *H. puera* causes extensive damage to plantations, resulting in reduced productivity.

Bioassay with the crude extracts : To study the insecticidal properties of the various extracts from all the test plants, bioassays for contact toxicity were conducted. To evaluate the contact toxicity effects of crude extracts of all the plants selected for study, two bioassays namely, larvicidal and ovicidal action were conducted.

Larvicidal action : For bioassays to evaluate larvicidal action of crude extracts early 3rd instar larvae of *H. puera* of uniform age and weight range (9-13 mg) obtained from laboratory culture were used. Contact toxicity was tested with 0.25%, 0.5%, 1%, 2% and 4% concentrations. Five replications with 10 individuals each were used for each concentration. Larvae were introduced into sterilized plastic petriplates. The test solutions were applied on larvae, as topical spray using a TLC (Thin Layer Chromatography) sprayer. The petriplates were covered with the lid. In blank group the larvae were sprayed with water and in the control group the larvae were sprayed with respective solvent. Tween 20 also served as a control. Observations were made on the behaviour of the larvae and mortality was observed at 2hr, 4hr and 6hr.

Ovicidal action : 12-hour-old eggs were carefully taken on a small piece of muslin cloth using fine camel hair brush. 5 replications with 5 eggs each were used for the experiment. The extract was prepared at a concentration of 2%, 1% and 0.5%. It was sprayed on the egg using a micropipette. The cloth with the eggs after complete drying was introduced into glass vials and covered with muslin cloth. Treatment with water and respective solvents served as control. The eggs were observed for hatching after 48 hours.

Statistical Analysis : Percentage of larval mortality was calculated. Mortality in the control was corrected using Abbott's formula (Abbott, 1925). The percentage values were transformed to ensure normality and variance homogeneity using an arcsine transformation (Zar, 1999). The data was subjected to analysis of variance (ANOVA) and the means separated using Least Significant Difference (LSD). LC 50 values were calculated using probit analysis according to calculations outlined in Finney (1971). Probit analysis was carried out using SPSS Software program version 12 and Anova was done with AGRES statistical package.

RESULTS

Larvicidal action

Acacia concinna leaf

The larvicidal activity of the leaf of *A. concinna* against the 3rd instar larvae of H. puera varied among the different extracts. However, the mortality in each extract was dose dependent. All the treatments were significantly different from the control. The larvae treated were not as active as the control larvae. The ethyl acetate extract was the most effective among all the extracts causing 100% mortality even with least concentration (0.25%). The petroleum ether, methanol, acetone and water extract of the leaf of A. concinna show less insecticidal activity at least concentration. Ethyl alcohol and chloroform extract were on par with ethyl acetate with respect to mortality (100%) at higher concentration (4%, 2% and 1%). The other extracts are effective at highest concentration, acetone and petroleum ether extract being almost on par with ethyl acetate extract (Table 1).

The LC50 values recorded is presented in Table 2. The LC50 value is least for ethyl acetate extract (0.03%) proves that the ethyl acetate extract has best performance as contact toxicant among all the other extracts of A. concinna leaf. The water extract is inferior to all other extracts with respect to LC50 (0.89%), followed by petroleum (0.7%).

Acacia concinna seed

The larvicidal activity of the seeds of *A. concinna* against the 3rd instar larvae of *H. puera* varied among the different extracts. There was dose dependent mortality in each extract. All the treatments were significantly different from the control. The methanol and ethyl acetate extract were the most effective among the three extracts causing 100% mortality even with least concentration (0.25%). The methanol, ethyl acetate and acetone extracts of the seeds of *A. concinna* were on par, with respect to mortality (100%) at higher concentration (4%). The other extracts are not effective in causing mortality to the test insect and were on par with control (Table 3).

The LC50 values recorded is presented in Table 4. The LC50 value is least for methanol extract (0.00518%) proves that the methanol extract has best performance as contact toxicant among all the other extracts of *A. concinna* seed. The acetone extract is inferior to other extracts with respect to LC50 (1.02%).

Butea monosperma seed : The larvicidal activity of the seeds of *B. monosperma* against the 3rd instar larvae of *H. puera* varied among the different extracts. However, the mortality in each extract was dose dependent. All the treatments were significantly different from the control. The ethyl acetate extract was the most effective among all the extracts causing 100% mortality even with least concentration (0.25%), followed by chloroform extract (86%)

and methanol extract (84%). Chloroform and methanol extract were on par with ethyl acetate with respect to mortality (100%) at higher concentration (4% and 2%). The other extracts are effective at highest concentration, acetone and water extract being almost on par with ethyl acetate extract (Table 5).

The LC50 values recorded is presented in Table 6. With ethyl acetate extract, the lowest concentration tested (0.25%) itself yielded 100% mortality, hence LC50 could not be calculated. The LC50 value is least for chloroform and methanol extract (0.06%) proves that these extracts have best performance as contact toxicant among all the other extracts of *B. monosperma.* The ethyl alcohol extract is inferior to all other extracts with respect to LC50 (0.74%), followed by acetone extract (0.42%).

Butea monosperma flower

The larvicidal activity of the flowers of *B. monosperma* against the 3rd instar larvae of *H. puera* did not vary among the different extracts. There was no mortality of larvae in any of the extract tested and were on par with the control.

Ovicidal action

Acacia concinna leaf

The ovicidal activity of the leaf extracts of *A. concinna* varied among the different extracts. All the treatments did not show any activity and were on par with control except petroleum ether extract which exhibited highest egg hatch inhibition (40%) at highest concentration (2%) (Table 7). The LC50 calculated is 3.45% (Table 8).

Acacia concinna seed

The ovicidal activity of the seed extracts of *A. concinna* on *H. puera* did not vary among the different extracts. All the treatments exhibited 100% egg hatch inhibition at all concentrations (Table 9). With all the extracts, the lowest concentration tested (0.5%) itself yielded 100% mortality, hence LC50 could not be calculated.

Butea monosperma seed

The ovicidal activity varied among the different extracts. All the treatments showed varied activity. Highest egg hatch inhibition (80%) was recorded at highest concentration (2%) by chloroform extract followed by ethyl acetate extract (72%), petroleum ether (60%) and ethyl alcohol (52%) (Table 10). The least LC50 (0.86%) shows that chloroform possess most effective ovicidal action, followed by petroleum ether (1.149) (Table 11).

Table 1: Percentage mortality of 3rd instar larvae of *H. puera* on contact toxicity with various extracts of *A. concinna* leaf.

Treatment	***Concentration in %***				
	4	***2***	***1***	***0.5***	***0.25***
Petroleum ether extract	88.00±4.47 (69.94)^{ab}	70.00±7.07 (56.91)^{cde}	62.00±8.37 (52.02)^{cdefg}	22.00±4.47 (27.89)^{m}	44.00±5.48 (41.54)^{hijkl}
Chloroform extract	100.00±0.00 (80.90)^{a}	100.00±0.00 (80.90)^{a}	100.00±0.00 (80.90)^{a}	76.00±5.48 (60.78)^{bcd}	34.00±5.48 (35.62)^{klm}
Methanol extract	76.00±5.48 (60.78)^{bcd}	70.00±0.00 (56.79)^{cde}	60.00±7.07 (50.82)^{defgh}	50.00±7.07 (44.99)^{ghijk}	36.00±5.48 (36.82)^{jklm}
Ethyl alcohol extract	100.00±0.00 (80.90)^{a}	76.00±16.73 (61.86)^{bcd}	56.00±16.73 (48.69)^{efgh}	52.00±38.99 (46.38)^{fghij}	44.00±43.36 (40.13)^{hijkl}
Ethyl acetate extract	100.00±0.00 (80.90)^{a}	100.00±0.00 (80.90)^{a}	100.00±0.00 (80.90)^{a}	98.00±4.47 (79.03)^{a}	96.00±5.48 (79.17)^{a}
Acetone extract	92.00±17.89 (74.87)^{ab}	92.00±10.95 (73.91)^{ab}	68.00±30.33 (58.20)^{bdef}	36.00±21.91 (35.51)^{jklm}	28.00±17.88 (30.67)^{lm}
Water extract	78.00±4.47 (62.10)^{bc}	64.00±5.48 (53.18)^{cdefg}	54.00±5.48 (47.31)^{fghi}	38.00±4.47 (38.03)^{ijklm}	26.00±5.48 (30.55)^{m}
Blank	0.00 (9.10)	0.00 (9.10)	0.00 (9.10)	0.00 (9.10)	0.00 (9.10)
Control (Respective solvent)	0.00 (9.10)	0.00 (9.10)	0.00 (9.10)	0.00 (9.10)	0.00 (9.10)
Tween 20	0.00 (9.10)	0.00 (9.10)	0.00 (9.10)	0.00 (9.10)	0.00 (9.10)
	SED		CD (0.05)		CD(0.01)
Treatment	0.39163		0.77446		1.02271
Concentration	0.33098		0.65454		0.86435
T*C	0.87570		1.73174		2.28686

Mean ± SD represents mean percentage mortality of 5 replicates with 10 individuals each. Means followed by the same alphabet does not differ significantly at 5% level of significance. Values in parentheses are arcsine transformed values.

Table 2: Dose-mortality response of *H. puera* on contact toxicity with leaf of *A. concinna.*

Treatment	LC 50	Fiducial limits		Slope ± S.E	Intercept ± SE	Chi-square
		Lower Limit	Upper Limit			
Petroleum ether extract	0.71557	0.53008	0.92623	1.49863 ± 0.21400	0.21782 ± 0.08607	1.318
Chloroform extract	0.32052	0.27226	0.3661	4.42548 ± 0.68505	2.18685 ± 0.32175	1.471
Methanol extract	0.55453	0.284	0.84473	0.88546 ± 0.19631	0.22674 ± 0.08216	0.259
Ethyl alcohol extract	0.45359	1.33E-12	1.18348	1.40660 ± 0.22299	0.48294 ± 0.08972	11.283
Ethyl acetate extract	0.02903	-	-	1.81571 ± 1.15046	2.79115 ± 0.58304	0.418
Acetone extract	0.58195	0.45323	0.72	1.94625 ± 0.23809	0.45759 ± 0.09455	4.772
Water extract	0.89415	0.62579	1.24691	1.15915 ± 0.20099	0.05632 ± 0.08283	0.142

The Chi-square value is less than 7.815 (Df = 3) is not significant (P > 0.05).

The Chi-square value is less than 11.34 (Df = 3) is not significant (P > 0.01).

Table 3: Percentage mortality of 3rd instar larvae of *H. puera* on contact toxicity with various extracts of *A. concinna* seeds.

Treatment	Concentration in %				
	4	2	1	0.5	0.25
Methanol extract	100.00 ± 0.00 (81.86)[a]	98.00 ±4.47 (79.80)[a]	98.00 ±4.47 (79.80)[a]	94.00 ± 8.94 (76.11)ab	94.00 ± 8.94 (76.11)[ab]
Ethyl acetate extract	100.00 ± 0.00 (81.86)[a]	100.00 ± 0.00 (81.86)[a]	98.00 ± 4.47 (79.80)[a]	94.00±8.94 (76.11)[ab]	94.00±5.48 (75.68)[ab]
Acetone extract	100.00 ± 0.00 (81.86)[a]	80.00 ± 29.15 (66.38)[b]	24.00 ± 37.15 (27.37)[c]	24.00 ± 13.42 (28.50)[c]	14.00±16.73 (20.84)[c]
Blank	0.00 (9.10)	0.00 (9.10)	0.00 (9.10)	0.00 (9.10)	0.00 (9.10)
Control (Respective solvent)	0.00 (9.10)	0.00 (9.10)	0.00 (9.10)	0.00 (9.10)	0.00 (9.10)
Tween 20	0.00 (9.10)	0.00 (9.10)	0.00 (9.10)	0.00 (9.10)	0.00 (9.10)
	SED		CD (0.05)		CD(0.01)
Treatment	0.40133		0.80278		1.06770
Concentration	0.51812		1.03639		1.37840
T*C	0.89740		1.79508		2.38745

Mean ± SD represents mean percentage mortality of 5 replicates with 10 individuals each. Means followed by the same alphabet does not differ significantly at 5% level of significance. Values in parentheses are arcsine transformed values.

Table 4: Dose-mortality response of *H. puera* on contact toxicity with seeds of *A. concinna.*

Treatment	LC 50	Fiducial limits		Slope ± S.E	Intercept ± SE	Chi-square
		Lower Limit	Upper Limit			
Methanol extract	0.00518	0.0000	0.05931	0.86253 ± 0.43884	1.97176 ± 0.19089	1.021
Ethyl alcohol extract	0.1730	1.108	0.10090	1.21585 ± 0.54932	2.14214 ± 0.24727	1.382
Acetone extract	1.02367	0.23739	8.18396	2.48311 ± 0.26243	- .02523 ± 0.09526	21.546

The Chi-square value is less than 7.815 (Df = 3) is not significant (P > 0.05).

The Chi-square value is more than 11.34 (Df = 3) is significant (P < 0.01).

Table 5: Percentage mortality of 3rd instar larvae of *H. puera* on contact toxicity with various extracts of *B. monosperma* seed.

Treatment	*Concentration in %*				
	4	***2***	***1***	***0.5***	***0.25***
Petroleum ether extract	60.00 ± 10.00 (50.86)^{fghi}	58.00 ± 8.37 (49.66)^{ghi}	54.00 ± 5.47 (47.30)^{hijk}	48.00 ± 4.47 (43.84)^{ijklm}	44.00 ± 5.48 (41.53)^{lm}
Chloroform extract	100.00 ± 0.00 (81.86)^{a}	100.00 ± 0.00 (81.86)^{a}	98.00 ± 4.47 (79.80)^{ab}	90.00±7.07 (71.99)^{bcd}	86.00±8.94 (68.60)^{cd}
Methanol extract	100.00 ± 0.00 (81.86)^{a}	100.00 ± 0.00 (81.86)^{a}	94.00 ± 5.48 (75.67)^{abc}	86.00 ± 19.49 (70.62)^{cd}	84.00 ± 18.17 (68.56)^{c}
Ethyl alcohol extract	62.00 ± 4.47 (51.97)^{efgh}	56.00 ± 5.48 (48.46)^{ghij}	52.00 ± 4.47 (46.15)^{ijkl}	46.00 ± 5.48 (42.68)^{kjlm}	44.00 ± 5.48 (41.53)^{lm}
Ethyl acetate extract	100.00 ± 0.00 (81.86)^{a}	100.00 ± 0.00 (81.86)^{a}	100.00 ± 0.00 (81.86)^{a}	100.00 ± 0.00 (81.86)^{a}	100.00 ± 0.00 (81.86)^{a}
Acetone extract	86.00 ± 5.48 (68.31)^{cd}	84.00 ± 5.48 (56.91)^{d}	70.00 ± 0.00 (55.83)^{e}	46.00 ± 5.48 (53.17)^{klm}	42.00 ± 4.47 (49.61)^{lm}
Water extract	86.00 ± 5.48 (68.30)^{cd}	70.00 ± 7.07 (56.91)^{e}	68.00 ± 10.95 (55.83)^{ef}	64.00 ± 5.48 (53.17)^{efg}	58.00 ± 4.47 (49.61)^{ghi}
Blank	0.00 (9.10)	0.00 (9.10)	0.00 (9.10)	0.00 (9.10)	0.00 (9.10)
Control (Respective solvent)	0.00 (9.10)	0.00 (9.10)	0.00 (9.10)	0.00 (9.10)	0.00 (9.10)
Tween 20	0.00 (9.10)	0.00 (9.10)	0.00 (9.10)	0.00 (9.10)	0.00 (9.10)
	SED		CD (0.05)		CD(0.01)
Treatment	0.19302		0.38171		0.50406
Concentration	0.16313		0.32260		0.42601
T*C	0.43161		0.85352		1.12712

Mean ± SD represents mean percentage mortality of 5 replicates with 10 individuals each. Means followed by the same alphabet does not differ significantly at 5% level of significance. Values in parentheses are arcsine transformed values.

Table 6: Dose-mortality response of 3rd instar larvae of *H. puera* on contact toxicity with seed of *B. monosperma.*

		Fiducial limits				
Treatment	***LC 50***	***Lower Limit***	***Upper Limit***	***Slope ± S.E***	***Intercept ± SE***	***Chi-square***
Petroleum ether extract	0.085	-	-	0.35268 ± 0.18761	0.07099 ± 0.07967	0.085
Chloroform extract	0.06573	0.00352	0.14316	1.688895 ± 0.51846	1.99678 ± 0.23819	1.382
Methanol extract	0.06821	0.00618	0.14728	1.48728 ±0.40901	1.73437 ± 0.17966	2.841
Ethyl alcohol extract	0.73847	0.00054	3.03527	0.38651 ± 0.18785	.05089 ± 0.07970	0.092
Acetone extract	0.42485	0.25456	0.59512	1.23068 ± 0.21034	0.45752 ± 0.08724	2.348
Water extract	0.13876	0.00353	0.33987	0.60468 ± 0.20116	0.51866 ± 0.08454	1.816

The Chi-square value is less than 7.815 (Df = 3) is not significant (P > 0.05)

Table 7: Ovicidal activity of various extracts of *A. concinna* seed.

Treatment	*Concentration in %*		
	2	*1*	*0.5*
Petroleum ether	100.00±0.00 (90.00)	100.00±0.00 (90.00)	100.00±0.00 (90.00)
Chloroform	100.00±0.00 (90.00)	100.00±0.00 (90.00)	100.00±0.00 (90.00)
Methanol	100.00±0.00 (90.00)	100.00±0.00 (90.00)	100.00±0.00 (90.00)
Ethyl alcohol	100.00±0.00 (90.00)	100.00±0.00 (90.00)	100.00±0.00 (90.00)
Ethyl acetate	100.00±0.00 (90.00)	100.00±0.00 (90.00)	100.00±0.00 (90.00)
Acetone	100.00±0.00 (90.00)	100.00±0.00 (90.00)	100.00±0.00 (90.00)
Water	100.00±0.00 (90.00)	100.00±0.00 (90.00)	100.00±0.00 (90.00)
Control	0.00(0.00)	0.00(0.00)	0.00(0.00)

Table 8: Ovicidal activity of petroleum ether extract of *A. concinna* leaf.

Treatment	*Concentration in %*		
	2	*1*	*0.5*
Petroleum ether	40.00 ± 37.41 (39.23)	32.00 ± 30.33 (34.45)	20.00 ± 34.64 (26.56)

SED-1.0832, CD (0.05)-2.3601, CD-3.3089

Mean ± SD represents mean percentage mortality of 5 replicates with 5 individuals each. Values within parentheses are angular transformed values.

Table 9: Dose-mortality responses of *H. puera* on contact toxicity with *A. concinna* leaf.

Treatment	*LC 50*	*Slope ± S.E*	*Intercept ± SE*	*Chi-square*
Petroleum ether extract	3.45	0.96642 ± 0.63050	-0.51982 ± 0.15402	0.016

The Chi-square value is less than 3.841 (Df = 1) is not significant (P > 0.05).

Table 10: Ovicidal activity of various extracts of *B. monosperma*.

Treatment	*Concentration in %*		
	2	*1*	*0.5*
Petroleum ether	60.00±28.28 (50.77)bc	44.00±35.78 (41.55)d	40.00±28.28 (39.23)d
Chloroform	80.00±28.28 (63.44)a	68.00±33.47 (55.55)b	20.00±20.00 (26.56)g
Methanol	36.00±49.79 (36.87)e	36.00±32.86 (36.87)e	24.00±16.73 (29.33)f
Ethyl alcohol	52.00±33.47 (46.15)cd	48.00±22.80 (43.85)d	24.00±26.08 (29.33)f
Ethyl acetate	72.00±30.33 (58.05)ab	20.00±34.64 (26.56)g	20.00±20.00 (26.56)g
Acetone	28.00±38.98 (31.95)f	24.00±35.78 (29.33)f	12.00±17.89 (20.27)h
Control	0.00(0.00)	0.00(0.00)	0.00(0.00)
	SED	CD (0.05)	CD(0.01)
Treatment	0.56108	1.11850	1.48456
Concentration	0.39675	0.79090	1.04974
T*C	0.97183	1.93730	2.57133

Mean ± SD represents mean percentage mortality of 5 replicates with 5 individuals each. Means followed by the same alphabet does not differ significantly at 5% level of significance.

Values within parentheses are angular transformed values.

Table 11: Dose-mortality response of *H. puera* on contact toxicity with *B. monosperma*.

Treatment	*LC 50*	*Slope ± S.E*	*Intercept ± SE*	*Chi-square*
Petroleum ether extract	1.149	0.84210 ± 0.59575	–0.05094 ± 0.14592	0.239
Chloroform extract	0.86	2.81843 ± 0.67387	0.17892 ± 0.15858	2.010
Methanol extract	6.86	0.56477 ± 0.61914	–0.47234 ± 0.15139	0.301
Ethyl acetate	1.419	2.4578 ± 0.66115	–0.37383 ± 0.15909	*4.233
Ethyl alcohol extract	1.54	1.22993 ± 0.61185	–0.23022 ± 0.14872	0.797
Acetone extract	7.32	0.94494 ± 0.68281	–0.81665 ± .16636	0.252

The Chi-square value is less than 3.841 (Df = 1) is not significant (P > 0.05).

*The Chi-square value is more than 3.841 (Df = 1) is significant (P<0.05).

Flowers of *Butea monosperma* : The crude extracts of flowers of *B. monosperma* did not show any ovicidal activity and were on par with the control.

DISCUSSION

Contact toxicity of crude extracts

In the present study, bioassays reaffirmed the known pesticidal activity of the selected parts of *A. concinna* and *B. monosperma.* Contact toxicity tested by larvicidal and ovicidal action exhibited varying degree of insecticidal activity. Though more than 2000 plant species are known to possess insecticidal activity, neem is the only one widely used. As botanical insecticides are known to possess slow action their use is limited in field application. Botanicals are mostly used as behavior modifying agents rather than insecticidal agents. The immediate knockdown effect of insecticides is always appreciated in agriculture and forestry sector. Keeping in view the practicality for the use of botanicals in the field condition as contact toxicants rather than feeding toxicants, in the present study plant extracts were tested for contact toxicity.

Larvicidal action

The highest mortality (100%), lowest LC50 (0.03%) even with least concentration (0.25%) was recorded for ethyl acetate extract of the leaves of *A. concinna*. Ethyl alcohol and chloroform extract were on par with ethyl acetate with respect to mortality (100%) at higher concentration (4%, 2% and 1%). Insecticidal and antifeedant properties in its leaves against *R. dominica*, *S. cerealella* and *S. oryzae* have been documented by (Balasubramanian, 1982; Prakash *et al.*, 1987). This is again validated by the findings in the present study. The present study demonstrates that the leaf extract in various organic solvent possess highly significant larvicidal action against the 3rd instar larvae of *H. puera.*

The methanol and ethyl acetate extract of the seeds of *A. concinna* were the most effective causing 100% mortality even with least concentration (0.25%). Quadri (1973) reported the pods of this plant to be ineffective against the rice weevil, Sitophilus oryzae and the red flour beetle, *Tribolium castaneum.* Contradictory to the above study, the present study has proved that methanol extract of the seed of *A. concinna* has significant acute toxicity (LC50 0.00518%). This may be due to the presence of active ingredient in the methanol extract. The study of Reddy and Urs (1988) reported that dried seed powder and seed extract of this shrub reduced oviposition of the brown planthopper, *N. lugens* at 2% and 5% concentrations of this solution when sprayed on 40-day-old rice seedlings. This study supports the present finding that the pods of *A. concinna* have anti-insect activity.

The ethyl acetate extract of the seeds of B. monosperma was the most effective among all the extracts causing 100% mortality even with least concentration (0.25%). Patil *et al.* (1993) reported that cold alcohol extracts *B. monosperma* was ineffective against *Dactynotus carthami* and *Aphis gossypii* in the laboratory. But the present study proves that methanol extract (LC50 0.06%) has best performance as contact toxicant among all the other extracts of *B. monosperma*. Methanol extract may have larvicidal potency than cold extracts. Chloroform extract was on par with methanol extract. This work confirms previous observations (Tare and Sharma, 1991) that the seed oil of *B. monosperma* showed 100% toxicity to the 4th instar larvae of *Aedes aegyptii*, Culex fatigans and *Anopheles stephensi.*

The larvicidal activity of the seven extracts from the flowers of *B. monosperma* against the 3rd instar larvae of H. puera did not show any activity and were on par with the control. The report on the anti-insect activity of *B. monosperma* flower made by the earliar workers show that the flower extract have termiticidal action, growth inhibitory action and contact action (WOI, 1988; Raju, 1989; Baskaran and Narayanasamy, 1995) is not reaffirmed in the present study. The authors would have conducted the experiments with high concentration of the extract. The plant may be having good feeding toxicity rather than contact action.

Ovicidal action

All the extracts of the leaves of *A. concinna* did not show any activity and were on par with control except petroleum ether extract which exhibited highest egg hatch inhibition (40%) at highest concentration (2%). The leaves of the *A. concinna* have better larvicidal action and are not

effective as ovicides. With all the extracts, the lowest concentration tested (0.5%) itself yielded 100% mortality and the result shows that the seeds of *A. concinna* have better ovicidal activity. The study shows that *A. concinna* seed is not only a good larvicide but also a good ovicide. Highest egg hatch inhibition (80%) was recorded at highest concentration (2%) for the chloroform extract of the seeds of *B. monosperma* followed by ethyl acetate extract (72%), petroleum ether (60%) and ethyl alcohol (52%). The least LC50 (0.86%) shows that chloroform possess most effective ovicidal action, followed by petroleum ether (1.149). The crude extracts of flowers of *B. monosperma* did not show any ovicidal activity and were on par with the control which disagrees with the finding of Chockalingham *et al.* (1992) This is may be due to any variation in the concentration.

It is possible that these plant extracts may have one or more chemical substances, which may block the micropyle region of the egg thereby preventing the exchange of gases ultimately killing the embryo in the egg itself. The disturbance with egg cytoplasm was reflected in the form of dead eggs with black spot stage due to the arresting of further development of embryo inside the egg. Bhatnagar and Sharma (1994) and Elumalai et al. (2005) noticed similar anatomical and physiological disturbances of plant extracts on maize stem borer, *Chilo partellus.* Other plants like *Melia azadarach, Strychnous nux vomica, Jatropha curcas, Cassia fistula, Gnidia glauca, Ricinus communis, Vitex negunda, Derris indica, Clerodendron inermae, Lantana caftera, Semecarpus kathalekanesis* have been proved to produce varying degree of ovicidal activity on the eggs of *H. puera* (Javaregowda and Krishna Naik, 2007; Ramana, 2005).

CONCLUSION

From the above study, it is concluded that among the seeds and leaves of *A. concinna* and seeds and flowers of *B. monosperma* tested for their insecticidal activity, the seeds of *A. concinna* are highly effective as insecticides. *A. concinna* seeds are popularly used as anti-dandruffs. The study shows that the seed extract of *A. concinna* also has significant potential to be used as bio-pesticide.

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