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TOXICOLOGICAL EFFECT OF *CANAVALIA VIROSA* ON FEEDING BUDGET OF *PERICALLIA RICINI*

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Toxic effect of plant leaf extract of *Canavalia virosa* on the feeding budget of *Pericallia ricini* was studied, using different concentrations of leaf alkaloid viz. 100, 200, 300, 400, 500, 1000, 1500 and 2000 ppm. Leaf extract concentration from 100 to 2000 ppm showed a significant negative correlation. An extended larval and pupal growth were observed at the highest dose of leaf extract (2000 ppm). Concentrated leaf alkaloid drastically affected feeding and organic constituents of the test insect *P. ricini.*

INTRODUCTION

Chemical pesticides, when applied on the field, affect the survival, growth, metabolism and reproduction of non-target organisms (Ragsdale & Kuhr, 1987). Even some can form even more toxic compounds i.e. secondary metabolites by undergoing photochemical alteration (Raghavan, 1979). Continuous application of pesticides for pest eradication can develop resistance power against the pesticides (Ahmed *et al.*, 1987). Thus either requiring higher doses or less effective on pesticide resistant target organisms. Now-a-days plant origin pesticides are physiologically active, non-toxic to non-target organisms, safer in usage, without phytotoxic properties and also leave no residue in the environment.

Most of the plant extracts exhibit antifeedant properties *e.g.* Azadaractin, a neem seed extract inhibited the feeding of fall army worm (Warthern *et al.*, 1978), it mostly interfered with the insect's moulting process (Elois S. Carcia *et al.*, 1986) and also inhibit the morphogenesis and vitellogenic oocycte development in *Trogoderma granarium* Everts (Chellayan & Karnaver, 1990). Eucalyptus leaf extract is found to have herbicidal activity like phenols and tanins (Hills, 1966). Saxena & Tikku (1990) have found that a chemical compund extracted from plumbagin inhibits growth and development of haemocytes of *Dysdercus koenigii.* Lepidopteran insects treated with many plant extracts have shown a reduction of adultoids (Rajendran, 1977). The present investigations stimulated to study the toxic effect of *Canavalia virosa* leaf extract on feeding profiles of *Pericallia ricini.*

MATERIALS AND METHODS

Eggs of *P. ricini* were collected from local garden and kept in the laboratory at room temperature (28 ± 1^{0}C). Eggs were hatched after 1.0 ± 0.5 day of incubation and took 7.5 ± 0.5 days to complete I and II instar stages. Third instar larvae, before the treatment, were weighed in a monopan balance (accuracy 0.01mg). Then the test larvae were fed with castor leaves and allowed to transform into pupae.

Extract and application : Plant extract of *C. virosa*, commonly called sword bean, was screened for its insecticidal, antifeedant and growth regulating effects. The leaves of C. virosa were dried at room temperature in shade and then pulverized in a grinder. About 25 g of dried and powered material was extracted in soxhlet apparatus, using acetone as the solvent, for 8 hrs at 55^{0}C. The extract was again redistilled, concentrated in a water bath, weighed accurately and it was stored in a refrigerator for further use.

Different concentrations *viz.* 100, 200, 300, 400, 500, 1000 and 1500 and 2000 ppm of the plant extract were prepared by dissolving in distilled water. Control solution was prepared by adding 1 ml of acetone with distilled water. The test insect larvae were segregated into eight different groups according to the plant extract concentrations used for the present investigation.

Newly moulted III instar larvae of the experimental insect were introduced in separate containers and they were fed with castor leaves soaked in selected concentrations of the plant extract and duplicate were maintained in each group. The larvae were maintained till pupation.

Bioassay : The effective dosage level to reduce larval growth to 50% of control weight (ED 50 value) was calculated for the extract used for the present study. Each instar, the initial weight was taken and then they were fed with castor leaves soaked in different concentrations of the extract. At the end of each larval instar, the final weight was taken just few hours before moulting and the difference in weight indicated the growth and this was compared with control weight. The dosage required for growth inhibition of 50% than in the control weight is shown as ED 50 value.

The amount of food consumed, assimilated, defaecated and converted were calculated directly following the IBP formula (Petruzewics & Macfedyen, 1970).

$$C = P + F + U$$

Where

C = Food consumption
P = Production (Conversion)
F + U = Loss of energy through faeces and nitrogenous excretory products.

Estimation of food consumption was made following the method of Mathavan & Pandian (1974). From the mean dry weight of faeces ejested, the food consumption was calculated by adding the consumption of each larva per day, the total food consumption was estimated. Similarly, the mean faecal weight per instar, food assimilated [C - (F + U)] and metabolized (R = A - P) were calculated.

RESULTS

Assessment of efficiency of plant extract : Experimental assay was confined to III, IV and V instars of the test organism due to the maximum consumption of the food consumed by the advanced instars than the early instars (I and II instars).

C. virosa leaf extract showed distinct growth promoting and insecticidal properties against *P. ricini* and the results obtained are presented in Tables I and II.

Impact of plant exract on larval and pupal duration : The impact of *C. virosa* on the larval duration of III to V instars of the experimental insect are exhibited in the Table III.

The advanced and late ages refer to III-V instars. Application of 100 ppm of leaf extract increased the duration of late age larva of the test insect by 3.5 days than that of the control. Likewise, the cumulative larval duration was prolonged by 7.75, 8.75 and 11.25 days when treated with 200, 300 and 400 ppm of leaf alkaloid, respectively. As the concentration of leaf extract of

C. virosa increased, the toxic influence on the larval growth of the test organism was also enhanced proportionately (Table I). Overall larval duration prolonged to 13.75, 15.5 and 20.00 days among 500, 1000 and 1500 ppm treated advanced age larva, respectively (Table II). Remarkably, highest extension of cumulative larval duration (23.50 days) was recorded for the larva subjected to highest dose of plant extract (2000 ppm). This study indicated an enhancing larval duration as maximum in the V instar than in earlier larval instars (Table III).

The application of leaf alkaloid also extended pupal duration. The pupal duration was enhanced from 9.5 to 11.25 days when the experimental insect larvae were subjected to 100 to 400 ppm whereas at doses of 500 to 2000 ppm, this parameter elevated from 12.5 to 17.5 days. An enhanced pupal duration from 8.5 ± 1.0 days in the control to 17.5 ± 0.5 days in the test insect subjected to a dose of 2000 ppm of leaf extract was also observed (Table I and II).

Food utilization pattern

Food utilization parameters of the test insect were presented in Table I and II.

Consumption rate : Overall feeding rate in the advanced age larva subjected to different concentrations *viz.* 100 to 400 pp of leaf extract of *C. virosa* was studied. Further a significant rate of fall in the parameter occurred due to the impact of plant extract at doses of 500 to 2000 ppm. Remarkably, this parameter was declined to its minimum 2000 ppm (52.18 mg/g live wt/day).

Assimilation rate : *C. virosa* leaf extract showed a significant impact on assimilation rate of the test organism. Cumulative assimilation rate of the late age larvae due to the application of 100 to 400 ppm leaf extract, declined from 36.38 to 20.43 mg/g live wt/day (Table I). Likewise, the alkaloids treated larva assimilated the food at the total rate of 18.82, 16.39, 13.16 and 11.34 mg/g live wt/day at doses of 500, 1000, 1500 and 2000 ppm, respectively. This parameter, however,

Table I : Effect of *C. virosa* leaf extract on the feeding budget of III-V instars of *P. ricini*. Each value represents an average performance (mean ± S.D.) of fifteen individuals.

Parameters	Treatment (concentration in ppm)				
	Control	100	200	300	400
Larval duration (day)	20.75±0.75	24.25±0.25	28.50±0.50	30.00±0.50	32.00±1.00
Consumption*	591.06±0.07	469.34±4.71	400.84±0.42	369.49±3.24	324.95±3.88
Assimilation*	247.00±0.03	184.28±0.10	148.06±4.66	134.76±0.57	117.03±1.21
Production*	107.39±0.02	72.58±0.05	56.74±0.90	50.10±0.12	41.81±0.93
Metabolism*	139.61±0.01	111.70±0.05	91.32±3.82	84.66±0.45	75.22±0.50
Consumption rate**	102.99±3.71	92.49±0.06	69.47±1.06	63.66±0.37	56.72±0.97
Assimilation rate**	43.04±1.33	36.32±0.33	25.65±0.60	23.22±0.41	20.43±0.42
Production rate**	18.71±0.48	14.30±0.13	9.83±0.06	8.63±0.14	7.30±0.09
Metabolic rate**	24.33±0.75	22.02±0.20	15.82±0.54	14.59±0.27	13.14±0.35
Assimilation	41.79±0.00	39.27±0.39	36.94±1.20	36.48±0.45	36.02±0.54
Efficiency (%)					
Gross conversion	18.17±0.00	15.46±0.15	14.18±0.25	13.56±0.15	12.87±0.26
Efficiency (%)					
Net conversion	43.42±0.05	39.39±0.09	38.41±0.59	37.18±0.07	35.72±0.48
Efficiency (%)					

Values expressed as * = mg/larva; ** = mg/g live wt/day.

drastically declined to its minimum at a dose of 2000 ppm (Table III). It is discernible from the standard deviation data that a significant inverse relationship noticed between the mean cumulative rate of assimilation of the test insect and the various tested doses of the plant extract (Tables I and II).

Production rate : Test larva treated with 100 to 400 ppm plant extract exhibited a reducing tendency in the overall mean rate of production from 14.30 to 7.30 mg/g live wt/day, whereas at doses 500 to 2000 ppm this parameter was highly dropped. Significantly, this parameter for late age larva at 2000 ppm was less than that of control (15.5 mg/g live wt/day).

Metabolic rate : Advanced age larva of the test organism exhibited the total mean rate of larval metabolism declining from 12.24 to 8.12 mg/g live wt/day among the larvae subjected to 100 to 400 ppm leaf alkaloid (Table I); similar pattern was observed for this parameter in treatments 500 to 2000 ppm. A drastic reduction in this parameter in the test larvae occurred at a dose of 2000 ppm (16.21 mg/g live wt/day) than that of control (Table II).

Efficiencies of assimilation and production

Cumulative assimilation efficiency for advanced age test insect larva in treatments 100 to 400 ppm dropped from 34.27 to 36.02%. The experimental larvae, however, showed a reducing tendency in this parameter *viz.* 34.97, 29.79 and 27.77% at doses of 500, 1000, 1500 and 2000 ppm, respectively. Significantly this parameter diminished to its minimum at a dose of 2000 ppm leaf alkaloid (14.02%) lesser than that of control.

At doses of 100 to 400 ppm extract, the total gross production efficiency for late age larvae declined from 15.45 to 12.87% and at doses ranging from 500 to 2000 ppm of leaf alkaloid this parameter significantly diminished from 12.22 to 7.88%. Remarkably, this parameter was

Table II : Effect of *C. virosa* leaf extract on the feeding budget of III-V instars of *P. ricini*. Each value represents an average performance (mean ± S.D.) of fifteen individuals.

Parameters	Treatment (concentration in ppm)				
	Control	500	1000	1500	2000
Larval duration (day)	20.75±0.75	34.50±0.75	36.50±0.75	40.75±0.50	44.00±0.25
Consumption*	591±0.07	294.44±0.05	261.74±5.57	245.37±1.82	234.42±2.82
Assimilation*	247.00±0.03	102.96±0.19	84.66±0.08	73.03±0.05	65.10±0.20
Production*	107.39±0.02	35.99±0.09	28.43±0.03	23.15±0.04	18.74±0.09
Metabolism*	139.61±0.01	66.97±0.10	56.73±0.05	49.88±0.09	46.63±0.13
Consumption rate**	102.99±3.71	53.81±0.97	50.66±1.07	44.23±0.85	40.81±0.39
Assimilation rate**	43.04±1.33	18.82±0.37	16.39±0.38	13.16±0.17	11.34±0.02
Production rate**	18.71±0.48	6.58±0.13	±5.500.13	4.17±0.04	3.21±0.05
Metabolic rate**	24.33±0.75	12.24±0.24	10.89±0.25	8.99±0.12	8.12±0.02
Assimilation	41.79±0.00	34.97±0.06	32.36±0.67	29.79±0.18	27.77±0.30
efficiency (%)					
Gross conversion	18.17±0.00	12.22±0.03	10.80±0.22	9.45±0.08	7.88±0.07
efficiency (%)					
Net conversion	43.42±0.05	34.95±0.03	33.70±0.76	31.70±0.07	28.37±0.08
efficiency (%)					

Values expressed as * = mg/larva; ** = mg/g live wt/day.

drastically reduced to its minimum at a dose of 2000 ppm (10.29%) lesser than that of control.

A maximum reduction in the net production efficiency occurred for late age worm at a dose of 2000 ppm. The test insect treated with 100 to 400 ppm and 500 to 2000 ppm leaf alkaloid showed a reducing tendency in this parameter occurred for the experimental organism (15.05%) at 2000 ppm than that of the control.

DISCUSSION

Of many parameters, generation time and number of larval instars are important parameters of pests which are considered to be indirect methods in assessing the damage caused to the crops.

Larval duration prolonged by one day when the test insect larvae treated with 100 ppm leaf extract as against 6.75 days at 2000 ppm than that of the control during III instar, whereas during IV and V instars this value fluctuated between 10 and 6.5 days. The prolongation in larval duration may be due to low protein content in the insect body tissues similar to those of other insects (Zaazou *et al.*, 1973; Gupta, 1981). In fact, an extension in larval growth increased the generation time and exposes the larva to diseases and predation, resulting in a higher rate of natural mortality (Chan *et al.*, 1978). Chockalingam *et al.* (1986) demonstrated that *Euclyptus globulis* extract increased the larval period by two days in *Spodoptera litura*. In addition to this, presence of excess ash and phenolic contents in the food plants was also known to enhance the generation time (Manoharan *et al.*, 1984).

From the foregoing information, it is understood that the application of leaf extract has a profound effect on generation time, which inturn affects larval growth by increasing the larval mortality of the test organism.

Different doses of leaf extract of *C. virosa* found to inhibit the feeding parameters such as consumption, assimilation and production pattern of *P. ricini*. This extract also showed maximum antifeedant activity by reducing food consumption pattern by 86.46, 88.24 and 67.26% during III, IV and V instars, respectively rather then than of control. Similar results were obtained when *Dysdercus cingulatus* (Rajendran, 1977) and *Euproctus fraterna* (Manoharan *et al.*, 1984) fed on leaves treated with *C. roseus* leaf extract.

Table III : Effect of *C. virosa* leaf extract on the larval and pupal of III-V instars of *P. ricini*. Each value represents an average performance (mean ± S.D.) of fifteen individuals.

Concentration of leaf extract (ppm)	Larval duration (day)			Pupal Duration (day)
	III Instar	IV Instar	V Instar	
Control	4.25±0.25	4.50±0.50	12.00±0.25	8.50±1.00
100	5.00±0.25	6.50±0.25	12.75±0.25	9.50±0.50
200	6.00±0.25	7.50±0.25	15.00±0.50	10.00±0.25
300	7.00±0.25	8.50±0.25	15.25±0.25	10.50±0.25
400	7.50±0.00	9.00±0.50	15.50±0.50	11.25±1.00
500	8.50±0.00	10.00±0.50	16.00±0.25	12.50±0.50
1000	9.00±0.25	10.75±0.50	16.50±0.25	14.00±0.75
1500	10.25±0.25	13.00±0.25	17.25±0.25	15.50±0.50
2000	11.00±0.00	14.75±0.25	18.50±0.50	17.50±0.50

The activity of plant was discovered entirely in its alkaloid constituents and these were found to be potent phagodeterrents for phytophagous insects (Chapman, 1974). Even *C. roseus* is the source of 80 indole alkaloids (Morton, 1977). Svoboda *et al.* (1975) discovered that leaf alkaloids are found to have more phagodeterrent activity. Karel (1989) however, discovered that all the neem formulations except seed kernel dust provided effective protection from *Ooetheca bennigeni* up to 5 days after the treatment. Hence, *C. virosa* leaf extract acts as a phagodeterrent by reducing the food consumption of the test organism and this antifeedent nature may be due to a behavioural antifeedent effect on the insect's peripheral chemoreceptors as reported for other insects (Bernays, 1981).

Larva of the test insect showed an initial increase in the consumption and consumption rate (Cr) at the lower concentrations of *C. verosa* leaf extract similar to the effect of neem seed oil and leaf extract on *E. fraterna* (Chockalingam *et al.*, 1987). This indicated that such enhancement in these two parameters might be an adoptive mechanism to overcome the toxic effect produced by the toxins present in the leaf extract.

Reduction in overall production rate (Pr) at 2000 ppm leaf extract treated test organism observed (2.21mg/g live wt/day) than to that of control (18.71 mg/g live wt/day), while cumulative gross and net production efficiencies drastically affected at this concentration and the obtained values fluctuated between 7.85 and 28.37% than that of control (18.17 and 43.41%, respectively) during III to V larval instars.

The rate of production (Pr) and efficiencies of production (gross and net) were thus uniformly declined in all the treated individuals of the test organism which indicated that the larval growth was impaired by *C. virosa* leaf extract treatment. Hence, it has been recommended that *C. virosa* leaf alkaloid may be applied to control the lepidopteran pest *Pericallia recini*.

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