INSECTICIDAL ACTIVITY OF AERIAL PARTS OF SYNEDRELLA NODIFLORA GAERTN (COMPOSITAE) ON SPODOPTERA LITURA (FAB.)

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ABSTRACT

Spodoptera litura (Fabricius) is the most serious pest of many cultivated and non-cultivated crops and it developed resistance against many synthetic pesticides. The impact of a Compositae annual weed, Synedrella nodiflora Gaertn. solvent extracts on the fourth instar larvae of S. litura has been evaluated by leaf dip method. The LD_{50} results revealed that methanol extract is the most toxic to the pest followed by benzene and chloroform, petroleum ether ($40^0 – 60^0$ C) and water. Qualitative phytochemical analysis has also been performed.

KEY WORDS: Spodoptera litura, Synedrella nodiflora, insecticidal activity, phytochemistry

INTRODUCTION

The large-scale use of chemical pesticides in agriculture and public health leads to adverse effects such as development of pesticide resistance, frequent pest out breaks, emergence of new pests, pollution and health hazards. In order to search an environmentally safe alternative, scientists considered the pesticides of biological origin (bio-pesticides) in the place of synthetic insecticides. Replacement of synthetic insecticides by bio-rational insecticide is an universally acceptable and practicable approach worldwide. Throughout history, plant products have been successfully exploited as insecticides, insect repellents, and insect antifeedants. Recent plant protection researchers, particularly of the last decade revealed the importance of plant products that disrupt the normal insect growth and development [1].

Spodoptera litura Fab. is the most serious pest of many cultivated and non-cultivated crops throughout South and Southeast Asia and Australia. It is one of the important polyphagous crop pests distributed throughout south and eastern world infesting 112 species of plants belonging to 44 families, of which 40 species are known from India [2]. In India S. litura has been reported as an increasingly important pest during the rainy seasons causing heavy yield loss throughout India [3]. S. litura developed resistance to commonly used insecticides [4][5] and hence, it is difficult to manage this pest with synthetic pesticides.

Synedrella nodiflora Gaertn. belongs to the family Compositae. It is a small, annual weed of cultivation, native to tropical America, found in the plains of India and in the Andamans. The leaves are used as poultice for sore rheumatism; the juice of the leaves is used for earache. Compositae species like Ageratum conyzoides [6 – 9] and Rudbeckia hirta [10] are known to possess insecticidal activity against many insect pests. The ethanolic extracts from Chromolaena christieana (stem and bark), Achyrocline satureoides (leaves and flowers) and Mikania cordifolia (root and stem) have moulting inhibition activity [11] against a hematophagous insect. However no information is available about the insecticidal activity of Synedrella nodiflora on any pests. In the present study, effect of petroleum ether (40^0 – 60^0 C), benzene, chloroform, methanol and water extracts of Synedrella nodiflora aerial parts have been tested with the median lethal dose (LD_{50}) [12] on the fourth instar larvae of *Spodoptera litura*. Furthermore, qualitative analysis of phytochemicals [13] present in the petroleum ether (40^0 – 60^0 C), benzene, chloroform, methanol and water extracts and quantitative analysis of tannins [14] and phenolic compounds [15] have also been performed.

MATERIALS AND METHODS

Insects

Larval stages of S. litura were collected from the groundnut fields in Tirunelveli District, Tamil Nadu, India and were used to maintain the laboratory nucleus cultures. All the larvae were maintained on castor leaves under laboratory conditions (29 ± 1°C temperature; 70 ± 5 % relative humidity and 11L : 13D hour photoperiod) in plastic troughs (21.0 × 28.0 × 9.0 cm). Laboratory emerged fourth instar larvae were used for the experiments.

Phytochemical Tests

Aerial parts of Synedrella nodiflora was collected from Puliarai, Tirunelveli District, Tamil Nadu, India and were washed twice with tap water and once with distilled water and then shade-dried for two weeks. It was successively extracted with petroleum ether (40^0 – 60^0 C), benzene, chloroform, methanol and water by using Soxhlet apparatus (250 g, 500 ml). The last trace of the solvent was removed under reduced pressure distillation and the crude extract was dried in a vacuum desiccators and used for the experiments. The different extracts were tested for steroids, alkaloids, reducing sugars, phenolic compounds, saponins, xanthoproteins, tannins and flavonoids [13]. Total amount of tannins [14] and phenolic compounds [15] were also determined.

Preparation of Plant Extracts

Different concentrations of the plant extracts viz., 0.01, 0.02, 0.04 and 0.08 per cent solutions were prepared by adding respective solvents and used for the study. These different concentrations were prepared on the basis of quantity of plant extract in 100 ml solvents and the actual concentration of active ingredients were not taken into consideration.

Treatment

The grams of fresh castor leaves were dipped in the different concentrations of plant extracts (0.01, 0.02, 0.04 and 0.08 %) separately for 15 minutes. For control, the leaves were dipped in the respective solvents. After 15 minutes the leaves were taken out and shade-dried for 20 minutes and supplied to the pest larvae. Laboratory reared fourth instar S. litura larvae were released in four numbers each to plastic vials containing Synedrella nodiflora treated castor leaves and the plastic vials were covered by muslin cloth. Same number of S. litura larvae, released into the vials having respective solvent treated castor leaves and served as control. Five replications were made for each concentration and control respectively. The larvae were allowed to feed the respective solvent treated leaves as well as solvent extracts of Synedrella nodiflora treated leaves for a period of 4 days continuously. Observations were taken at 24 h

Table 1: Percentage mortality of *Spodoptera litura* larvae in various solvent extracts of *Synedrella nodiflora*

Solvents	Concentration of extracts (%)			
	0.01	0.02	0.04	0.08
Petroleum ether ($40^0 - 60^0$ C)	40	45	70	80
Benzene	25	35	65	75
Chloroform	20	40	65	75
Methanol	85	85	95	100
Water	20	30	35	60

Table 2: Synedrella nodiflora solvent extracts on the LD_{50} (96 hours), regression equation, variance, r^2 and chi-square value for Spodoptera litura

Solvent	LD_{50}	Regression equation (n = 4)	Variance	Chi-square	r^2	Confidencial level	LFL	UFL
Petroleum ethe ($40^0 - 60^0$ C)	0.018	Y = 1.302x + 4.66	0.263	0.02	0.885	P < 0.059	0.008	0.032
Benzene	0.028	Y = 1.595x + 4.28	0.008	0.57	0.859	P < 0.072	0.018	0.042
Chloroform	0.028	Y = 1.718x + 4.22	0.007	0.35	0.829	P < 0.089	0.019	0.041
Methanol	0.003	Y = 1.458x + 5.82	0.266	0.80	0.905	P < 0.048	0.002	0.028
Water	0.061	Y = 1.130x + 4.11	0.299	0.78	0.977	P < 0.977	0.027	0.129

LFL – lower fiducial limit; UFL – upper fiducial limit

interval and dead larvae were removed daily. Moribund larvae were also considered as dead larvae.

Statistical Analysis

Statistical analysis of the experimental data was performed using probit analysis to find out the LD_{50}, regression, chi-square and variance [12]. The data was analysed by completely randomized, one-way Analysis of Variance (ANOVA) and the means were separated using Duncan's Multiple Range Test (DMRT). Correlation was performed to find the significance between the concentration and mortality of solvent extracts of all the tested plant extracts separately. All the statistical analyses were performed using System Statistics version 6.

RESULTS AND DISCUSSION

Mortality and LD_{50}

The percent of mortality of the fourth instar larvae against different concentrations of various solvent extracts of Synedrella nodiflora is shown in Table 1. It is evident from the results that methanol extract of Synedrella nodiflora was the most effective among all the tested extracts. The larval mortality was recorded as 100% in the case of methanol extract. Concentration dependent mortality was observed in all the extracts of Synedrella nodiflora. When a correlation was made between the concentrations and mortality of different solvent extracts of S. nodiflora, it was highly significant (r = 0. 94, 0.93, 0.91, 0.95 and 0.99 for petroleum ether, benzene, chloroform, methanol and water extracts, respectively). The LD_{50} results are presented in Table 2. It is evident from the results that water extract was found to be least toxic (0.061 %) to S. litura followed by both benzene and chloroform extracts which showed similar effect on the fourth instar larvae of S. litura (0.028 %). It is also clear from the results that the LD_{50} value of S. nodiflora water extract was about 20 times higher than that of the methanol extract. ANOVA analyses showed that the comparison between the methanol and water extracts were significant ($P < 0.05$). Similar pattern was also observed for the lower and upper fiducial values (Table 2). The order of toxicity was found to be methanol > benzene = chloroform > petroleum ether ($40^0 - 60^0$ C) > water. Application of methanol extract of S. nodiflora may be the most suitable form of application for protection of field crops which is attacked by S. litura.

Phytochemistry

The results of preliminary phytochemical analysis of the various extracts of the aerial parts of S. nodiflora are presented in Table 3. The methanol extract showed the presence of steroids, reducing sugars, phenolic compounds, saponins and tannins. Benzene and chloroform extracts showed the presence of steroids. Petroleum ether ($40^0 - 60^0$ C) extracts showed the presence of steroids and triterpenoids. All the other extracts caused more mortality than the water extract.

Table 3. Phytochemical analysis of the various extracts of the aerial parts of *Synedrella nodiflora*

Chemical	Petroleum ether (40-60 ^{0}C)	Benzene	Chloroform	Methanol	Water
Steroids	+	+	+	+	-
Triterpenoids	+	-	-	-	-
Reducing sugars	-	-	-	+	+
Alkaloids	-	-	-	-	+
Phenolic compounds	-	-	-	+	+
Saponins	-	-	-	+	+
Xanthoproteins	-	-	-	-	-
Tannin	-	-	-	+	+
Flavonoids	-	-	-	-	-
Anthraquinones	-	-	-	-	-
Aromatic acids	-	-	-	-	+

The water extract showed the presence of reducing sugars, alkaloids, phenolic compounds, saponins, tannins and aromatic acids. Quantitative phytochemical studies showed that 100 mg of the crude methanol and water extracts separately consists of 123.5 µg of phenolic compounds [15] and 73.13 µg of tannins [14], respectively. The secondary compounds of plants are a vast repository of compounds with a wide range of biological activities. Phenolic compounds directly affect the pest population of okra [16]. It has also been reported that mite infestation in okra is directly proportional to the quantity of total phenolic compounds present in the plant. Impact of phenolic compounds on the larvicidal activity has also been reported previously [17]. In addition to the phenolic compounds, tannins reduce the damage of Maruca testulalis Geyer. [18]. Steroids also act as insect growth regulators [19]. In the present study the water extract of S. nodiflora is not possessing steroids. This may be the reason for the lowest activity.

CONCLUSION

Various extracts of Synedrella nodiflora can be used effectively in evolving an ecologically sound, economically viable and socially acceptable pest management system. Among all the extracts of Synedrella nodiflora the methanolic extract is the most effective one.

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