Biocidal activities of selected flora of Andaman and Nicobar Islands against Rice stem borer, *Scirpophaga incertulas* (Walker)

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ABSTRACT

Antifeedant and insecticidal properties of thirty plants suggested by the tribes of Andaman and Nicobar Islands were studied by conducting laboratory bioassay against third instar of *Scirpophaga incertulas* (W.) (Lepidoptera). The higher antifeedant activity was noticed in *Annona muricata* L. (*Magnoliales*) (82.97%), *Amomum fenzlii* K. (Zingiberales) (82.11%) and *Oroxylum indicum* V. (Lamiales) (81.66%). Insecticidal activity was more pronounced in *Derris scandens* B. (*Fabales*) (66.66%) and *Tetracera sarmentosa* L. (Dilleniales) (53.33%).

Keywords: *Scirpophaga incertulas*, botanical insecticide, antifeedant activity.

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INTRODUCTION

Andaman and Nicobar Islands (Bay islands) are a group of 572 islands at the connection of the Bay of Bengal and Andaman Sea. Great Andamanese, Jarawa, Onge and Sentinelese (Negrito origin) (Awasthi, 1991) and Nicobarese and Shompens (Mongoloid origin) (Sharief and Rao, 2007) are the tribes of Andaman and Nicobar Islands and known for traditional wisdom and culture. Andaman and Nicobar Islands are rich in floral diversity. Pandey and Diwakar (2008) published an integrated check-list flora of Andaman and Nicobar Islands, which reports 2654 flora, including 228 infraspecific taxa under 1083 genera in 237 families belonging to 4 different plant groups, namely bryophytes, pteridophytes, gymnosperms and angiosperms. Poaceae (194 taxa), Orchidaceae (153 taxa), Rubiaceae (143 taxa), Euphorbiaceae (135 taxa), Fabaceae (110 taxa), Cyperaceae (106 taxa), Annonaceae (64 taxa), Moraceae (63 taxa), Asteraceae (49 taxa) and Arecaceae (46 taxa) are the top ten dominant families. The total geographical area of these islands is about 8249 sq.km. in which only 6% is cultivable land. Among which, rice occupies the maximum area of about 8,390 ha followed by vegetables, pulses and spices and rice is the major food of the island populations (Gautham, 2013). The moderate temperature, high humidity and abundant rainfall provides niche for perpetuation of pests in these Islands. *Leptocorisa acuta* T. (Hemiptera), *Cnaphalocrocis medinalis* G. (Lepidoptera), *Scirpophaga incertulas* W. (Lepidoptera) and *Nilaparvata lugens* S. (Hemiptera) are the major pests on paddy. Already various botanicals were tested against field insects such as Neem (*Azadirachta indica*), bel (*Aegle marmelos*), pyrethrum(*Tanacetum cinerariifolium*) tobacco (*Nicotiana tabacum*), karanj (*Pongamia glabra*), mahua (*Madhuca indica*), sweet flag (*Acorus calamus*) *etc*.,(Prakash *et al*., 2008). To go with organic way of pest control, a research was initiated to utilized flora of Pesticidal value. A survey conducted among the tribes of Andaman and Nicobar Islands assisted to select 30 plant species of pesticidal value. However, literature related to the pesticidal properties of flora of Andaman and Nicobar Island is scanty. Few species of Zingiberaceae endemic to Andaman Nicobar Islands were used as a bee repellent for honey hunt (Anju *et al*., 2018) and even for repel insects (Ahmad, 1981). In this research

laboratory studies were conducted to decode the Pesticidal properties of 30 plant species suggested by the tribes against *S. incertulas* as test insect and find out the effective botanicals and dose levels by conducting bioassays against test insects .

MATERIALS AND METHODS

Preparation of botanical extracts

The plant parts intended to study were collected from Andaman and Nicobar Islands with the help of tribes/local healers and shade dried for two weeks, brought to the laboratory for assessment. Leaves of *Calophyllum inophyllum* (Calophyllaceae), *Macaranga tanarius*, *Mallotus Philippensis, Excoecaria agallocha* (Euphorbiaceae), *Pometia pinnata* (Sapindaceae), *Murraya paniculata*, *Atalantia monophylla* (Rutaceae), *Chukrasia tabularis* (Meliaceae), *Cerbera odollam* (Apocynaceae), *Hibiscus tiliaceus* (Malvaceae), *Rhizophora mucronata* (Rhizophoraceae), *Canarium euphyllum* (Burseraceae), *Hornstedtia fenzlii*, *Amomum fenzlii* (Zingiberaceae), *Orophea katschallica*, *Annona muricata* (Annonaceae), *Aegiceras corniculatum* (Primulaceae), *Avicennia marina* (Acanthaceae), *Grewia calophylla* (Tiliaceae), *Alstonia kurzii* (Apocynaceae), Bark of *Oroxylum indicum*, *Pajanelia longifolia* (Bignoniaceae), *Aglaia spectabilis*, *Barringtonia assiatica* (Lecythidaceae), Stem of *Duabanga grandifloria* (Lythraceae), Seeds of *Caesalpinia bonduc* (Caesalpiniaceae), Nuts of *Semecarpus prainii* (Anacardiaceae), Leaves of *Astragalus hamosus*, roots of *Derris scandens* (Fabaceae), *Tetracera sarmentosa* (Dilleniaceae), Then plants parts were ground using electric blender (Bajaj HM 01 Hand Mixer) each separately. Powdered plant parts were packed as 100g pockets using Whatman No. 40 filter paper. These pockets were extracted with HPLC grade water at room temperature in round-bottom (5 L. capacity) stopper flasks. After 72 hrs, the paper packets were removed from the flasks and the extracts were labeled and stored in a refrigerator. For 100 g powder 1 L HPLC grade water were used to obtain 10% concentration (100g in 1000mL) this is considered as stock material and used in bioassays at 2 and 5 per cent dilution.

Culturing of *S. incertulas*

Adults of *S. incertulas* were collected from the field of Annamalainagar (11.3921° N, 79.7147° E) were released on 50-days old potted rice plants (variety- TN1) kept in oviposition cages (5’ x 3’ x 3’) (3 pots /cage and 20 to 25 tillers/ pot). For each cage ten pairs of newly emerged adult moths were released and feed with 10% honey water soaked in cotton wool. Egg masses laid on the leaves were collected by cutting off the entire leaf. Petiole of the cut leaves were wrapped by moist cotton wool and placed on moist filter papers in the laboratory under controlled conditions (25 ± 1°C temperature, 70 ± 5% relative humidity and 12L:12D photoperiod) until hatching. Newly emerged larvae were transferred to cut stalks of 50days old rice plants (variety - TN1). The stalks were cut in 12 to 15 cm sections in such a way that each cut stalk had a node about 2 to 3 cm from the bottom. The stalks were packed tightly in clay pots (40 to 50 cut stalks/pot)- and placed in plastic trays which contained water up to 3 cm height and covered using muslin cloth held by elastic band. Water permeates the bottom of the clay pots and provides high humidity whereas the upper halves of the pots remain relatively dry. The larvae (25/pot) released were allowed to bore into cut stalks. Later, larvae which left the stalks and crawled to the rims of the pot in search of food were picked up with a fine camel's hair brush and transferred to another pot containing fresh cut stalks. Stalks were normally changed about 2 times in a week. Pupation took place in the cut stalks where they fed and the stalks hold the pupae were transferred to the oviposition cage (Waldbauer and Marciano, 1979). The culture was maintain continuously and when ever needed third instars were taken and used in experiments.

Antifeedant and insecticidal assay

Fifty days old TN1 rice plants were selected and stalks at the length of 15cm with a node about 2 to 3 cm from the bottom used for this experiments. Based on earlier work dose were

fixed and extracts were sprayed @ 5% concentration. 10 stalks/pot were packed tightly and placed in small mud pot these pots were kept in a plastic tray which contained water up to the height of 5 mL and covered using muslin cloth. Then third instars @ 5/pot were released. Treated cut stalks were observed after 6 hrs and 12 hrs on the establishment of larvae. The experiment was completed when the stalks was completely scraped in control. The stalks from the experiments were collected and length of stem feeding was measured. Each treatment was replicated thrice. There were 32 treatments including absolute and positive controls. Per cent stalk length protection over control was computed using the below mentioned formula and graded. The method described for antifeedant assay was followed for insecticidal assay but 2% concentration of extracts was used. After 48 hrs fresh stalks were supplied by withdrawing the treated stalks and reared up to adult emergence. Mortality in the larval and pupal stages was recorded once in 24hrs and the cumulative mortality was furnished. Each treatment was replicated thrice.

Per cent stem length protection over control = Per cent protection in treatment - Per cent protection in control

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(++++), 50-80 - Medium Inhibition (+++), 20-50 - Weak Inhibition (++) and < 20 - Insignificant inhibition (+) (Rani and Arivudainambi, 2013).

Statistical Analysis

Result was expressed as mean ±standard deviation (SD). Statistical comparison were made using the student t- test by one way analysis of variance (ANOVA) Snedeeor and Cochran (1997).

RESULTS AND DISCUSSION

Antifeedant activity

The data obtained from antifeedant assay @ 5% concentration against larvae of *S. incertulas* showed that among thirty plants leaf extracts, *A. muricata* (82.97%) exhibited strong inhibition followed by leaf extract of *A. fenzlii* 82.11% and bark extracts of *O. indicum* (81.66%). The highest antifeedant activity in *A. muricata* may be due to the presence of cyclohexapeptides and acetogenins which were reported as the major phytochemical compound (Gajalakshmi et al., 2012). Sonali *et al.* (2006) reported tranquilizing property of *A. fenzlii* and Dev *et al.* (2010) antifeedant property of *O. indicum* due to the presence of alkaloid, glycoside, flavanoids and phenolic compounds.

About 15 treatments showed moderate inhibition with the range from 51.53 to 75.55%. Least per cent stalk length protection over control was observed in *C. tabularis* and *M. philippensis* @ 5%, whereas maximum per cent stalk length protection over control was observed in *B. assiatica.*

Our findings coincide with the finding of Syahputra (2013) who indicated the extract of *B. assiatica* possess antifeedant activity against cabbage head caterpillar. *Atlantia monophylla* (72.50%) and *Semecarpus prainii* (70.32%) nuts showed medium inhibition. Ahmad *et al*. (1981) isolated the tetrahydroamento flavones from the genus of *Semecarpus*. Muthu *et al*. (2009) revealed that the hexane extracts at 5% of *Atlantia monophylla* showed pronounced effect against *Earias vitella*. Thirteen treatments showed weak antifeedancy and ranges from 26.19 to 47.64%. *Tetracera sarmentosa* root extracts revealed 47.64% antifeedancy. Uddin Mazumdar *et al*. (2017) reported that *T. sarmentosa* contain phenol, flavonoids, saponins and steroid.

Insecticidal activity

Regarding insecticidal activity @ 2%, the highest larval mortality was found in *Derris scandens* (66.66%) which was followed by *Tetracera sarmentosa* (53.33%) and *Barringtonia assiatica* (46.66%). Rani *et al*. (2013) reported prenylated isoflavones of *Derris scandens* as insecticidal. It was cleared that *Annona muricata* possessed strong antifeedant activities followed by *Amomum fenzlii* and *Oroxylum indicum* against *Scirpophaga incertulas*. Whereas *Derris scandens, Tetracera sarmentosa* and *Barringtonia assiatica* were also contain insecticidal properties among thirty plants. Secondary metabolites present in plants

Table 1. Antifeedancy of certain botanicals against *S. incertulas*

Treatments (5% concentration)	**Per cent Stalk area fed**	**Per cent stalk length protection over control**	**Antifeedant grading**
Calophyllum inophyllum	23.1±1.54	70.32	+++
Macaranga tanarius	53.99±1.57	29.26	(++)
Mallotus Philippensis	37.33±1.59	51.53	(+++)
Excoecaria agallocha	43.1±1.64	44.10	(++)
Oroxylum indicum	14.44±1.70	81.66	(++++)
Pajanelia longifolia	36.22±1.69	53.71	(+++)
Pometia pinnata	33.78±1.76	55.89	(+++)
Murraya paniculata	26.89±1.83	63.32	(+++)
Atalantia monophylla	21.81±1.89	72.50	(+++)
Aglaia spectabilis	55.99±1.92	51.53	(+++)
Chukrasia tabularis	37.33±1.95	51.53	(+++)
Duabanga grandifloria	26.44±2.05	65.50	(+++)
Rhizophora mucronata	37.55±2.12	51.96	(+++)
Cerbera odollam	29.55±2.24	62.89	(+++)
Hibiscus tiliaceus	31.55±2.34	57.21	(+++)
Caesalpinia bonduc	42.44±2.47	43.23	(++)
Canarium euphyllum	45.14±2.62	40.60	(++)
Hornstedtia fenzlii	19.1±2.73	74.68	(+++)
Amomum fenzlii	13.33±2.87	82.11	(++++)
Orophea katschallica	56.22±2.82	26.19	(++)
Annona muricata	13.33±2.98	82.97	++++
Semecarpus prainii	23.1±2.85	70.32	(+++)
Alstonia kurzii	56.22±2.87	26.19	(++)
Astragalus hamosus	51.77±3.12	32.74	(++)
Derris scandens	42.22±3.48	44.53	(++)
Tetracera sarmentosa	39.99±3.98	47.64	(++)
Aegiceras corniculatum	50.22±4.64	34.49	++
Avicennia marina	50.22±5.56	34.49	(++)
Grewia calophylla	50.2±6.4	34.49	(++)
Barringtonia assiatica	19.93±9.22	75.55	+++
Positive control	23.33±11.87	69.43	+++
Control	76.66±0.00		

The result obtained from the above table was calculated by one way ANOVA, F value is less than tabulated value at 31 and 64 degrees of freedom at 5% level of significance and the null hypothesis is accepted.

apparently function as defense (toxic), which inhibits reproduction and other processes (Rattan, 2010). Diwan and Saxena (2010) presence of flavonoid glycosides derived from *Tephrosia purpuria* showed insecticidal property against grubs of *C. maculatus*. Jose and Sujatha (2017) found that terpenoids, coumarin and phenols, present in the methanol extracts of *Gliricidium sepium* exhibited significant antifeedant activity.

Thus the detailed survey for Pesticidal value from the flora of Andaman and Nicobar Islands, revealed the availability of rich sources. The plants belonging to the family Annonaceae, Anacardiaceae and Zingeberaceae have pronounced Pesticidal value. Further characterization may end with the new molecule for the pesticide industry. This will support to save the environment in future by reducing the level of harmful residues. The farmers who are all involved in organic farming will be benefitted with the output of the research.

Table 2. Insecticidal activity of certain botanicals against *S. incertulas*

Treatment (2% concentration)	**Cumulative percent**	
	Larval Mortality	**Pupal mortality**
Calophyllum inophyllum	40.00±2.07	46.66±1.71
Macaranga tanarius	0.00±2.09	0.00±1.67
Mallotus Philippensis	0.00±2.14	33.33±1.69
Excoecaria agallocha	0.00±2.19	20.00±1.73
Oroxylum indicum	0.00±2.25	26.66±1.80
Pajanelia longifolia	40.00±2.30	13.33±1.84
Pometia pinnata	20.00±2.34	33.33±1.90
Murraya paniculata	13.33±2.41	26.66±1.93
Atalantia monophylla	40.00±2.50	40.00±1.99
Aglaia spectabilis	0.00±2.54	0.00±1.99
Chukrasia tabularis	0.00±2.63	0.00±2.04
Duabanga grandifloria	0.00±2.70	26.66±2.08
Rhizophora mucronata	40.00±2.81	20.00±2.15
Cerbera odollam	40.00±2.88	26.66±2.27
Hibiscus tiliaceus	13.33±2.94	40.00±2.35
Caesalpinia bonduc	0.00±3.10	0.00±2.35
Canarium euphyllum	0.00±3.24	13.33±2.44
Hornstedtia fenzlii	13.33±3.40	13.33±2.57
Amomum fenzlii	0.00±3.62	26.66±2.73
Orophea katschallica	0.00±3.81	0.00±2.87
Annona muricata	0.00±4.02	0.00±3.02
Semecarpus prainii	33.33±4.23	26.66±3.18
Alstonia kurzii	0.00±4.59	0.00±3.42
Astragalus hamosus	6.66±4.89	13.33±3.64
Derris scandens	66.66**±5.29	33.33±3.85
Tetracera sarmentosa	53.33*±4.82	46.66±4.15
Aegiceras corniculatum	6.66±4.39	6.66±3.61
Avicennia marina	6.66±5.05	0.00±4.15
Grewia calophylla	6.66±5.96	6.66±4.75
Barringtonia assiatica	46.66±7.21	33.33±5.70
Positive control -Neem commercial formulation (1500ppm Azadiractin)	26.66±6.56	26.66±6.56
Control	0.00±0	0.00±0

n = 32, Values are expressed as Mean ±S.E; *p >0.05; ** p>0.01

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