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Studies on the insecticidal efficacy of certain botanicals against rice stem borer *Scirpophaga incertulas* (Walker)

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Abstract
Bio efficacy studies conducted under semi field conditions using sixteen botanical preparations against rice stem borer revealed that neem oil soap solution 10% concentration most effective and followed by Ginger - Garlic - Chilli - extract 10% and sida leaf extract where less effective.

Keywords: rice stem borer, botanicals, non-insecticidal managements.

Introduction

Rice (*Oryza sativa* L.) is a stable food for millions of people all over the world. Approximately 148 million hectares of land are globally under rice cultivation with a production of 483 million tonnes (FAO, 2012) [1] and nearly 90 per cent of the area falls in Asian continent.

India, the second largest producer of white and brown rice, is accounting for 20 per cent of world rice production. Rice is the preeminent crop in Tamil Nadu and its cultivation receives the foremost attention than other crops. There are eight different seasons followed in Tamil Nadu to grow rice and it accounts for almost 35 per cent of total cropped area in the state (Thiyagarajan and Kalaiyarasi, 2012) [12]. In Tamil Nadu 1.85 million ha are kept under rice cultivation (FAO, 2012) [1].

A number of insect pests (more than 300 species) are reported to ravage the rice fields in tropics, but most are not economically damaging enough to require any management practices because of the strong compensatory abilities of rice plants in vegetative stage to recover from such injuries (Rubia *et al.*, 1996) [9]. However, a few-species of insect pests are able to cause crop losses and mostly when they occur in high densities, they then affect production and threaten to food security.

The relative importance of rice insect pests varies from country to country. Major rice-producing countries such as China, Vietnam, India, and Thailand have experienced serious problems with different insect pests then and there. Globally, 10.2, 15.1 and 12.2 per cent loss of attainable yield in rice was estimated due to weeds, insect pests and diseases respectively (Oerke, 2006) [6]. In India it was established that the attainable yield of rice reduced even up to 80 and 21 to 51 per cent due to severe infestation of sucking pests (Rajendran *et al*., 1986) [8] and borers and leaf feeders (Lal, 1996) [3] respectively. The yellow stem borer, *Scirpophaga incertulas* (Walker), is monophagus and dominant in most tropical and subtropical areas, while the striped stem borer, *Chilo suppressalis* (Walker) occurs mainly in temperate rice. *S. incertulas* is infesting rice from seedling to maturity. The extent of borer induced yield losses have been estimated to a range from 30 to 70% in outbreak years and from 2 to 20% in non outbreak years in Bangladesh and India respectively. Every per cent increase in white ear normally results in 1.3 % yield loss (Satpathi *et al*., 2012) [11].

Pest control is at least as old as agriculture, as there has always been a need to keep crops free from pests. The green revolution in India that began in the 1960s triggered a cascade of technological events in plant protection. In particular, pesticide use on rice, increased with the adoption of rice varieties that lacked resistance to many pests.

Disturbance in rice ecosystem by the insecticides created a favorable environment for the development of pests. By the 1980s, insecticide resistance became an alarming problem, especially for organophosphates and carbamates that were replacing organochlorines. But farmers responded by increasing dosages or by combining several insecticides. As a result, predators and parasitoids were vanished, insecticide resistance buildup was accelerated and human health and the environment were further threatened. Other factors affecting the resilience of rice ecosystems, that have been associated with measures taken to increase rice

production profitably, are year-round cultivation of rice on the same land and higher nitrogen applications to the higher-yielding rice varieties (Rajappan *et al.,* 2000; and Norton *et al.,* 2010) [7, 5]. Current pest management practices, which are heavily dependent on insecticides, with a sale of approximately 145 million US$ ever year, for managing insect pests, still results in yield losses of 10-15% Thus a suitable alternate management protocol befit to the crop ecology is urgently needed.

Though a list of alternate approaches have been suggested by many researchers, when comes to availability and adaptability, botanicals obtained from plant sources are promising. In this experiment certain botanicals which are already used by organic farmers in field level are validated for their efficacy against *S. incertulas.*

Materials and Methods

Mass rearing of *S. incertulas* (pyralidae: Lepidoptera)

Adults of *S.incertulas* collected from the field in and around Annamalainagar were released on to 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). Ten pairs of moths were released per cage and 10% honey water soaked in cotton wool was kept as food. 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.

Hatched larvae were transferred to cut stalks of 50 days 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) [13]. The culture was maintain continuously and when ever needed third instars were taken and used in experiments. In our culture larvae completed five instars in 30 ± 2 days. Pupal period and adult longevity were 8 ± 1 and 7 ± 1 day respectively. Egg period was 7 to 8 days and fecundity varied from 2 to 3 egg masses/female.

Preparation of Botanical Extracts

Eight extracts such as *Andrographis paniculata* Nees extract, *Sida acuta* Burm extract, *Adhatoda vasica* Nees extract, Five plants extract, ginger – garlic - chili extract, Neem seed kernel extract, Neem cake extract and Neem oil soap solution were prepared by following the methods acquired from the organic farmers at Sirkazhi taluk of Nagapettinam district, Tamil Nadu.

Preparation of *A. paniculata, S.acuta* and *A. vasica* extracts

Unflowered plants of *A.paniculata, S.acuta* and *A.vasica* collected in and around Annamalainagar were washed; air dried and macerated using electric blender individually. Then macerated plants were transferred to wide mouthed brass vessels individually and added with distilled water. For a hundred gram of plant material 400 ml of distilled water was used. Then the content was boiled under a low flame until it reduced to 100 ml, cooled and filtered using muslin cloth.

Preparation of five plants extract

In five plants extract, leaves of *A.vasica, Vitex negundo* L., *Azadirachta indica* A. Juss, *Ricinus communis* L. and *Pongamia glabra* L. were used. One kilogram of fresh leaves from each plant were taken and macerated individually and transformed to a wide mouthed mud pot of 10 l capacity, which contained 2 l of water and 0.5 l of fermented cow's urine. (Collected 48 h before use). The mouth of the pot was covered with muslin cloth and kept as such for ten days. The content was stirred daily by using a wooden stick. After ten days the product was filtered by using muslin cloth and the volume was made into 2 l by adding water.

Preparation of ginger, garlic and chili extract

Garlic (1 kg), ginger (0.5 kg) and green chilies (0.5 kg) were washed, macerated individually and mixed with 7 l of water. Then after six hours the content was filtered using muslin cloth.

Preparation of Neem seed kernel extract

Three kilograms of newly harvested neem seeds were pound and placed in an earthen pot which contained 10 l of water. After three days, the content was filtered using muslin cloth.

Preparation of Neem cake extract

Three kilograms of powdered neem cake was packed in muslin cloth pouch @ 500g/pouch and soaked overnight in 10 l of water. The pouches were squeezed well in the next day.

Preparation of Neem oil soap solution

Organic based neem oil soap flakes obtained from Centre for Indian Knowledge System, Sirkazhi was diluted with required amount of water and used.

Bioassay against *S.incertulas*

Cut stalks (15 cm length with a node about 2 to 3 cm from the bottom) of fifty days old TN1 rice plants were sprayed (5ml/ pot) with 5 and 10 % concentrations of botanical extracts individually and packed tightly in small clay pots @ 10 stalks/pot and placed in plastic trays which contained water up to the height of 5 ml and covered using muslin cloth. Then third instars @ 3/pot were released.

Observations were made on the establishment of the larvae on the treated cut stalks after 6 hours. Then after 36 hours, fresh untreated stalks were supplied by withdrawing the treated stalks and reared up to adult emergence. The length of stem feeding was measured in the withdrawn stalks. Mortality and malformations in the life stages of the insect were recorded once in 24h and the cumulative mortality was furnished. Each treatment was replicated thrice totally and there were 17 treatments including control

Result and Discussion

Per cent adult emergence was 100 in T_3-Neem seed kernel extract 5%, T_5- Neem cake extract 5%, T_7- Five plants extract 5%, T_9- *Sida* extract 5%, T_{11}- *Adhatoda* extract 5%, T_{12}- *Adhatoda* extract 10%, T_{13}- *Andrograpis* extract 5% and T_{17}- Control.

Zero per cent adult emergence were recorded in treatments *viz.*,T_1- Neem oil soap solution 5%, T_2- Neem oil soap solution 10%, T_4-Neem seed kernel extract 10%, T_8- Five plants extract 10%, T_{10}- *Sida* extract 10%, T_{14}- *Andrograpis* extract 10%, T_{15}- Ginger-garlic-chilli extract 5% and T_{16}- Ginger-garlic-chilli extract 10%.

Neem oil soap solution 5% (T_1) and Neem oil soap solution (T_2) recorded cent per cent larvae mortality. This was followed by T_8- Five plants extract 10%, T_{10}- *Sida* extract 10%, T_{14}-*Andrograpis* extract 10% and T_4-Neem seed kernel extract 10% where 66.66, 66.66, 55.55 and 11.11% larval mortality were recorded respectively. Per cent pupal mortality was recorded in T_8- Five plants extract 10% and T_{10}- *Sida* extract 10% and this was followed by T_4-Neem seed kernel extract 10% and T_{14}- *Andrograpis* extract 10% where 88.99 and 44.44% pupal mortality was observed respectively.

Our findings are in corroboration with the results of Huo-Zhang Yang *et al.* (2004) [2] who studied the biological activity of azadirachtin against *S. incertulas* and showed that newly hatched larvae were sensitive to azadirachtin.

Table 1: Influence of certain botanicals on the growth and development of life stages of *S. incertulas* (Feeding assay)

Tr. No.	Treatment and concentration	Cumulative per cent		
		Larval mortality	Pupal mortality	Adult emergence
T_1	Neem oil soap solution 5%	100 (90.0)^a	0.00 (0.00)^d	0.00 (0.00)^b
T_2	Neem oil soap solution 10%	100 (90.0)^a	0.00 (0.00)^d	0.00 (0.00)^b
T_3	Neem seed kernel extract 5%	0.00 (0.00)^d	0.00 (0.00)^d	100 (90.0)^a
T_4	Neem seed kernel extract 10%	11.11 (11.75)^c	88.99 (62.74)^b	0.00 (0.00)^b
T_5	Neem cake extract 5%	0.00 (0.00)^d	0.00 (0.00)^d	100 (90.0)^a
T_6	Neem cake extract 10%	0.00 (0.00)^d	0.00 (0.00)^d	100 (90.0)^a
T_7	Five plants extract 5%	0.00 (0.00)^d	0.00 (0.00)^d	100 (90.0)^a
T_8	Five plants extract 10%	66.66 (54.73)^b	100 (90.0)^a	0.00 (0.00)^b
T_9	*Sida* extract 5%	0.00 (0.00)^d	0.00 (0.00)^d	100 (90.0)^a
T_{10}	*Sida* extract 10%	66.66 (54.73)^b	100 (90.0)^a	0.00 (0.00)^b
T_{11}	*Adhatoda* extract 5%	0.00 (0.00)^d	0.00 (0.00)^d	100 (90.0)^a
T_{12}	*Adhatoda* extract 10%	0.00 (0.00)^d	0.00 (0.00)^d	100 (90.0)^a
T_{13}	*Andrograpis* extract 5%	0.00 (0.00)^d	0.00 (0.00)^d	100 (90.0)^a
T_{14}	*Andrograpis* extract 10%	55.55 (48.24)^b	44.45 (26.39)^c	0.00 (0.00)^b
T_{15}	Ginger- garlic-chilli extract 5%	100 (90.0)^a	0.00 (0.00)^d	0.00 (0.00)^b
T_{16}	Ginger- garlic-chilli extract 10%	100 (90.0)^a	0.00 (0.00)^d	0.00 (0.00)^b
T_{17}	Control (untreated)	0.00 (0.00)^d	0.00 (0.00)^d	100 (90.0)^a
CD (0.05%)		9.6250	10.8601	8.9589

Values are mean of three replications
Values in parentheses are arc sine transformed
Values with various alphabets differ significantly

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