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# Evaluation of different insecticides and botanical extracts against yellow stem borer, *Scirpophaga incertulas* in rice field

**Md. Shazzadul Islam[1], Shimul Das[1*], Khandakar Shariful Islam[2], Arifa Rahman[1], Md. Nazmul Huda[1], Prosanta Kumar Dash[1]**

[1]*Agrotechnology Discipline, Khulna University, Khulna, Bangladesh*

[2]*Department of Entomology, Bangladesh Agricultural University, Mymensingh, Bangladesh*

**Key words:** Botanical extracts, insecticides and rice yellow stem borer.

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**Abstract**

The effect of three commonly available botanical extracts and two insecticides with different concentrations was determined in the field against yellow stem borer, *Scirpophaga incertulas*. The treatments include three botanical extracts viz., Tobacco extracts, Neem extracts, and Karonja extracts at 15ml/L concentration and two insecticides named Acephate 75 SP at 2g/L and Fipronil (Nema 50 SC) at 2 ml/L. The botanicals and chemicals caused a significant difference in their effect against the rice pest, *S. incertulas*. Maximum number of dead hearts and white heads were recorded in control plot. A highly significant result was observed in Fipronil treatment after 21 days of spraying which showed the reduction of 51.89% dead heart and 65.05% white head over control. Neem extracts reduced dead heart and white head by 38.38% and 58.08% respectively. Considering the efficacy and eco-friendly nature of Neem extract it could be considered as an effective botanical in successful management of the pest yellow rice stem borer, *S. incertulas*.

* **Corresponding Author:** Shimul Das ✉ shimul04atku@gmail.com

**Introduction**

Rice (*Oryza sativa* L.) is one of the most important crops in the world, providing food for nearly half of the global population (Khuhro, 1988; FAO, 2004). Rice is grown on over 145 million hectares in more than 110 countries. It occupies one fifth of the world crop land under cereal (Pathak and Khan, 1994). Almost 90 % of the rice is grown and consumed in Asia. It is used as a food more than two billion people in developing countries of Asia (FAO, 1995; Khush and Brar, 2002).

More than 90% of the world's rice is grown and consumed in Asia, where 60% of the earth's people live. This crop accounts for 35%–60% of the calories consumed by 3 billion Asians (Khush, 1997).Rice is the staple food of about 135 million people of Bangladesh. It provides nearly 48% of rural employment, about two-third of total calorie supply and about one-half of the total protein intakes of an average person in the country. Rice sector contributes one-half of the agricultural GDP and one-sixth of the national income in Bangladesh.About 75% of the total cropped area and over 80% of the total irrigated area is planted to rice. Thus, rice plays a vital role in the livelihood of the people of Bangladesh.

Rice Yellow stem borers, *Scirpophaga incertulas* Wlk. attack the crop right from seedling stage till harvest and cause complete loss of affected tillers (Salim & Masih, 1987). In Asia, yield losses due to the two most important species, the yellow and striped stem borers range from 1-20%. However, during outbreak conditions, yield losses may range from 30 to 100%. Farmers depend upon a great deal of insecticide applications, even though a lot of insecticide applications are not effectual (Sarwar *et al.* 2005).Insect pests are among the principal causes of low yields of rice in the major rice growing areas of the world (Anonymous, 1970).

In the vegetative stage of the rice plant, yellow stem borers' larvae bore into and feed on the leaf sheath causing broad longitudinal whitish areas at the feeding sites. This prevents the central leaf whorls from unfolding, causing them to turn brownish and die, bringing about the condition known as "dead hearts". During the reproductive stage of the rice plant, the stem borers' larvae cut the growing parts leading to the condition known as "White heads" (Gupta and O' toole, 1986).

Successful control of stem borers of rice has been achieved through the use of a number of the conventional insecticide (Gupta and O' toole, 1986). But the indiscriminate use of insecticides have resulted in a number of undesirable side effects such as the emergence of resistant species of insects, environmental pollution and hazards to farmers, to mention a few (Hassall, 1990). Also, the cost of agro-chemicals can limit their use by resource-poor farmers.

Negative effects on human health led to a resurgence in interest in botanical insecticides because of their minimal costs and ecological side effects. Botanicals are encouraging over broad-spectrum conventional pesticides. They affect only target pest and closely related organisms, effective in very small quantities, decompose quickly and provide the residue free food and a safe environment to live. When incorporated in integrated pest management programs, botanical pesticides can greatly decrease the use of conventional pesticides or used in rotation or in combination with other insecticides, potentially lessening the overall quantities applied and possibly mitigating or delaying the development of resistance in pest populations (Khater, 2012).

Plant- based insecticides induce not only acute toxicity to pests but also deterrence and/or repellence which may contribute to overall efficacy against insect pests that cause great economic losses to the crop. Botanical insecticides are desirable alternatives to synthetic chemical insecticides for controlling pests. They are best suited for use in organic food production in industrialized countries but can play a much greater role in developing countries as a new class of ecofriendly products for controlling pests. Therefore, the present study was conducted to know

the nature of damage by Yellow stem borers, *S. incertulas*, to determine the efficacy of specific botanical extracts and insecticides against the insect, and finally to find out the best product to control Yellow stem borer.

**Materials and methods**

Methods and procedures followed for continuing this study are briefly described in this chapter. Valid and reliable data were collected to achieve a meaningful result and conclusion. The experiments were conducted in the Entomology Field Laboratory of Entomology Department, Bangladesh Agricultural University, Mymensingh.

*Characteristics of soil*

The soil of the experimental area was silty loam belonging to the Old Brahmaputra Floodplain Alluvial Tract under the Agro Ecological Zone. The selected site was a well drained medium high land having soil pH 6.8. The nutrient status of the soil under the experimental plot at depth of 0-30 cm was analyzed at the Humboldt Soil Testing Laboratory, Department of Soil Science, Bangladesh Agricultural University, Mymensingh.

*Weather*

The experimental area was characterized by tropical rainfall during the month of March to June and scattered rainfall during the rest of the year. Monthly minimum and maximum temperature, relative humidity, total rainfall and total sunshine were recorded during the period of the present study.

*Planting Material*

To test the efficacy of botanical extracts and chemicals in the experimental plots T11 rice variety was used. After planting, recommended agronomic practices and fertilizer dose were applied.

The various botanical treatments, at the specified concentrations and insecticide were applied twice, first at the tillering stage and the second at the panicle initiation stage. At each application, plants were sprayed to run-off point.

$$\%\ \text{of Dead heart/ White head} = \frac{\text{No of Dead hearts / White heads in 10 stands}}{\text{Total no of the productive tillers in the 10 stands}} \times 100$$

Dead heart counts were taken just before the booting stage, 35 days after transplanting by counting the number of tillers showing dead heart in ten alternate stands taken diagonally in each plot. The total numbers of tillers in the same ten stands were also counted, a method used by Lazaro *et al.* (1993). White head counts were taken 60 days after transplanting from ten alternate stands, which taken diagonally in the plots. The total numbers of productive tillers in the same ten stands were counted. The percentage dead hearts and white heads were computed by using the Abbotts (1925) formulae.

*Design of the field experiment*

In field, the above 6 treatments were laid out in a Randomized Complete Block Design (RCBD) with 3 replications arranged in field plots. The whole experimental plot was 26.75 m × 9.05 m, which was divided into 3 equal blocks. Each block was divided into 6 plots where 6 treatments were allotted at random. Thus, there were 18 (6×3) unit plots altogether in the experiment. Distance between replication to replication was 0.60 m. Border between the plots was 0.60 m was kept to facilitate different intercultural operations.

*Plant extracts Preparation*

*Neem ( Azadirachta indica) Extract*

Leaves and small branches of neem (5 kg) were cut into small pieces and mixed with 10 liter water. The water was boiled for 30-50 minutes. The solution was kept to become cool for about 2 hours then filtered.

*Tobacco (Nicotina tobacum) Extract*

The Tobacco leaf (3kg) was purchased from shop and mixed with 8 liters of water, which was boiled for 30-50 minutes, the solution was allowed to cool for about 2 hours then filtered.

*Karanja (Pongamia glabra) Extract*

Leaves and small branches of Karanja (5 kg) were cut into small pieces and mixed with 10 liter water. The

water was boiled for 30-50 minutes. The solution was kept to become cool for about 2 hours then filtered.

Acephat 75 SP

Acephate is an organophosphate foliar insecticide of moderate persistence with residual systemic activity of about 10–15 days at the recommended use rate.

Fipronil (Nema 50 SC)

Fipronil is a broad spectrum insecticide that disrupts the insect central nervous system by blocking the passage of chloride ions through the GABA receptor and glutamate-gated chloride (GluCl) channels, components of the central nervous system.

*Methodology for testing botanicals and chemical insecticide*

*Efficacy of three selected botanical extracts in controlling Yellow stem borer of Rice*

The efficacy of three botanical extracts viz., Neem extract, Tobacco extract and Karanja extract, each having single dose along with control was tested against Yellow stem borer, *Scirpophaga incertulas* on standing rice plant at the place of Bangladesh Agricultural University Campus, Mymensingh. The trial was conducted in a Randomized Complete Block Design and was replicated 3 times. Each botanical extract was tested at the dose of 15ml/L and efficacy of the doses on yellow stem borer was compared.

The spraying of botanical extracts was made with the help of a hand-operated sprayer it was sprayed. Care was taken to avoid spray drift on adjacent plants. The spraying was done in such a way that the spray droplet did not coalesce and drain down in the soils and whole plot was thoroughly covered by spray material. After spraying each botanical extract with designed dose the sprayer was washed and cleaned properly. Before, each application, the sprayer was calibrated in order to use the right dose on the plants without wastage of botanical extracts by determining the quantity of water required for rice plant. The control plots were not sprayed with anything.

Pre-treatment data were recorded one day before application of botanical extract. For recording the data 10 hills were randomly selected from the plot selected for respective botanical extracts treatment and 10 hills were observed from each plot.

The data per 10 hills were recorded after 7, 15, 21 days of spraying of botanical extracts. The data were analyzed statistically and the mean values were separated using DMRT.

*Effectiveness of two selected insecticide in controlling Yellow stem borer of Rice*

Two Insecticides viz. Acephate 75 SP and Fipronil (NEMA 50 EC) were sprayed to control the yellow stem borer. The effectiveness of the insecticides on the yellow stem borer population was recorded. The experiment was designed in a Randomized Complete Block Design in the standing rice plant and was replicated 3 times. Each insecticide was tested with a single dose and efficiency of the dose on yellow stem borer was compared.

The spraying of insecticide doses was done with the help of a hand-operated sprayer it was sprayed. Care was taken to avoid spray drift on adjacent plots. The spraying was done in such a way that the spray droplet did not coalesce and drain down in the soils and whole plant was thoroughly covered by spray material. After spraying each insecticide with designed dose the sprayer was washed and cleaned properly. Before, each application, the sprayer was calibrated in order to use the right dose on the plants without wastage of insecticides by determining the quantity of water required for each plot. The control plots were not sprayed with anything.

The data per 10 hills were recorded after 7, 15 and 21 days after of spraying of chemicals. The data were analyzed statistically and the mean values were separated using DMRT.

**Results and discussion**

Experiments were conducted in developing control tactics for rice yellow stem borer, *Scirpophaga incertulas* in the field. Efficacy of insecticides and botanical extracts were evaluated against yellow stem

borer, *S. incertulas*. The results of this experiment have been presented and discussed under the following sub-headings.

*Effect of Botanical Extracts and Insecticides on Dead hearts and white heads after different days of spray*

*Pre treatment data for dead hearts, white heads of yellow stem borer of rice*

Pre-treatment data for dead hearts revealed that all the plots of respective treatments were non-significant before treatment. The number of dead hearts observed in plots of Tobacco, Karanja, and Neem extracts was 1.86 and Fipronil was 1.85 (Table 2). The analysis of the data regarding pretreatment effect for white heads revealed that all the plots of respective treatments were non- significant before treatment and the maximum number of white heads was 4.39 (Table 2). After obtaining of pretreatment data plants which, showed both symptoms were removed from the plot and then the data of post treatment were collected.

**Table 1.** Detail of treatments.

| Sl. No. | Treatments | Chemicals/ Plant Extract | English Name | Scientific Name | Dose |
|---|---|---|---|---|---|
| 1 | $T_1$ | Acephate 75 SP | | | 2 g/L |
| 2 | $T_2$ | Tamak | Tobacco | *Nicotina tobacum* | 15 ml/L |
| 3 | $T_3$ | Fipronil (NEMA 50 SC) | | | 2 ml/L |
| 4 | $T_4$ | Karanja | Indian Beech | *Pongamia glabra* | 15 ml/L |
| 5 | $T_5$ | Neem | Neem | *Azadirachta indica* | 15 ml/L |
| 6 | $T_6$ | Control (Untreated) | | | |

*Effect of Botanical Extracts and Insecticides on Dead hearts after 7 Days of Spray*

The percent of dead hearts was significantly influenced by the application of botanical extracts and insecticides after 7 days of spray ((Table 3). The maximum reduction percent of dead heart was observed in Fipronil 17.29%. A similar result was found by Panda *et al.* (2004) and Saljoqi *et al.* (2002), Neem extract showed a reduction of 15.59%, which was statistically similar with Fipronil. The botanical Karanja extract reduced only 1.07%, which was statistically similar with Acephate 75 SP 5.98%. The dead heart percent was increased in control treatment by 9.78%.

**Table 2.** Effect of Different Botanical extract and Insecticides on damage of Yellow Stem Borer at Different Days After Spraying.

| Treatment | Number of dead heart and white head at different time intervals | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Pre-Treatment | | 7 Days After Spraying | | 15 Days After Spraying | | 21 Days After Spraying | |
| | Dead Heart | White Head | Dead Heart | White head | Dead Heart | White head | Dead Heart | White Head |
| Acephate 75 SP | 1.84 | 4.20 | $1.73^{ab}$ | $3.54^{ab}$ | $1.53^{a}$ | $3.50^{a}$ | $1.48^{b}$ | $3.49^{ab}$ |
| Tobacco extract | 1.86 | 3.91 | $1.86^{ab}$ | $4.45^{a}$ | $1.77^{a}$ | $4.48^{a}$ | $1.64^{ab}$ | $4.45^{ab}$ |
| Fipronil | 1.85 | 3.92 | $1.53^{b}$ | $3.13^{b}$ | $1.20^{b}$ | $2.41^{b}$ | $0.89^{b}$ | $2.44^{b}$ |
| Karanja extract | 1.86 | 3.80 | $1.84^{ab}$ | $3.42^{ab}$ | $1.58^{a}$ | $3.49^{a}$ | $1.56^{ab}$ | $3.98^{ab}$ |
| Neem extract | 1.86 | 4.39 | $1.57^{b}$ | $3.6^{ab}$ | $1.25^{b}$ | $2.92^{ab}$ | $1.15^{ab}$ | $2.49^{b}$ |
| Control | 1.84 | 4.43 | $2.02^{a}$ | $5.42^{a}$ | $2.64^{a}$ | $4.44^{a}$ | $2.65^{a}$ | $5.52^{a}$ |
| LS | NS | NS | ** | ** | ** | ** | * | * |
| CV (%) | | | 8.24 | 13.51 | 12.26 | 12.35 | 5.09 | 11.23 |

Means in a column followed by same letter(s) are not significantly different.

*Effect of Botanical Extracts and Insecticides on Dead hearts after 15 Days of Spray*

Effect of Botanical Extracts and Insecticides on dead hearts after 15 Days of Spray was significant at 5% level (Table 3).The maximum reduction of dead heart

was obtained from Fipronil treatment 35.13%. A similar result was found by Mayabini-Jena (2004), The effect of Fipronil was statistically similar with Neem extracts 32.79%. Acephate 75 SP caused 16.84% reduction which was identical with Karanja extract 15.05%. Tobacco extracts reduced the dead heart 4.84%. The dead heart percent was increased in the treatment control 43.0%.

*Effect of Botanical Extracts and Insecticides on Dead hearts after 21 Days of Spray*

Effect of Botanical Extracts and Insecticides on dead hearts after 21 Days of spray was highly significant at 1% level. The maximum reduction of dead heart was obtained from the insecticide Fipronil 51.89%. A similar result was found by Sheng-Chengfa *et al.* (2003). Neems extract result in similar reduction 38.38% of Fipronil. Misra (2010) reported this range of reduction. Acephate 75 SP reduced 19.56% dead heart symptom that was statistically similar with Karanja extract 16.13% and Tobacco extract 11.67%. The dead heart percent was increased to 43.54% in untreated plot.

**Table 3.** Effect of Different Botanical extracts and Insecticides on reduction or increase of dead heart symptom of Yellow Stem Borer at Different Days After Spraying.

| Treatment | Reduction or increase of dead heart at different time intervals | | |
|---|---|---|---|
| | 7 DAS<br>% Dead Heart | 15 DAS<br>% Dead Heart | 21 DAS<br>% Dead Heart |
| Acephate 75 SP | $^{-}5.98^{ab}$ | $^{-}16.84^{ab}$ | $^{-}19.56^{ab}$ |
| Tobacco extract | $0.00^{c}$ | $^{-}4.84^{b}$ | $^{-}11.67^{b}$ |
| Fipronil | $^{-}17.29^{a}$ | $^{-}35.13^{a}$ | $^{-}51.89^{a}$ |
| Karanja extract | $^{-}1.07^{b}$ | $^{-}15.05^{ab}$ | $^{-}16.13^{ab}$ |
| Neem extract | $^{-}15.59^{a}$ | $^{-}32.79_{a}$ | $^{-}38.38^{a}$ |
| Control | $^{+}9.78^{d}$ | $^{-}43.01^{c}$ | $^{+}43.54^{c}$ |
| Level of Significance | ** | ** | * |

% Reduction / increase were calculated using the pretreatment mean data of Dead Heart.
Negative sign (-) indicate % of reduction while positive sign (+) indicate % of increase in Dead heart.
DAS- stands for days after spraying. Means in a column followed by same letter(s) are not significantly different.

*Effect of Botanical Extracts and Insecticides on white heads after 7 Days of Spray*

Effect of Botanical Extracts and Insecticides on white head reduction percentage was observed in 7 days after applications of botanical extracts and insecticides (Table 4).The maximum reduction percent of white head was observed in Fipronil 20.16%. A similar result was found by Saljoqi *et al.* (2002) and Firake *et al.* (2010), which was statistically similar with Neem extract 16.40%. Reduction found in Acephate 75 SP was 15.71% which was statistically similar with Tobacco extract 13.81% and Karanja extract 10.00%. The white head percent was increased to 22.34% in Control treatment.

*Effect of Botanical Extracts and Insecticides on white heads after 15 Days of Spray*

Significant relation was found in case of white head reduction percentage after 15 days of spray. The maximum reduction percent was found in case of Fipronil 35.13% which was similar with the findings Mayabini-Jena (2004). A statistically similar result with Neem extracts 32.79% was found in this experiment. On the other hand Acephate 75 SP caused reduction percentage of 16.84% which was similar with Karanja extract 15.05% Tobacco extracts reduced the percentage by 4.48 % only. The white head percent was increased in Control treatment by 43.01%.

**Table 4**. Effect of Different Botanical extract and Insecticides on reduction or increase of white head symptom of Yellow Stem Borer at Different Days After Spraying.

| Treatment | Reduction or increase of White head at different time intervals | | |
|---|---|---|---|
| | 7 DAS | 15 DAS | 21 DAS |
| | % White Head | % White Head | % White Head |
| Acephate 75 SP | -15.71a | -16.66ab | -16.90b |
| Tobacco extract | +13.81ab | +14.57ab | +13.81b |
| Fipronil | -20.16a | -38.52a | -65.05a |
| Karanja extract | -10.00b | -8.88b | +4.73bc |
| Neem extract | -16.40a | -33.48a | -58.08a |
| Control | +22.34c | +0.23c | +25.28d |
| LS | ** | * | * |

% Reduction / increase were calculated using the pretreatment mean data of White Head**.**

Negative sign (-) indicate % of reduction while positive sign (+) indicate % of increase in White head.

DAS-stands for days after spraying.

Means in a column followed by same letter(s) are not significantly different.

*Effect of Botanical Extracts and Insecticides on white heads after 21st Days of Spray*

Highly significant relationship was found in case of white head reduction percentage, the maximum reduction percentage was found in Fipronil 65.05%. A similar result was found by Sheng-Chengfa *et al.* (2003). The result of Fipronil was similar with Neem extracts 58.08%. The white head reduction in Acephate 75 SP 16.90% but it was statistically similar with Tobacco extracts 13.81%.In case of Karanja extract only 4.73% reduction was observed. The white head percent was increased in Control treatment by 25.28%.

*Relationship between Dead heart & White head (%) and Application Days of Fipronil*

Both the positive and negative linear relationship was observed between Dead heart and White head (%) and Days after application (Fig. 1) in case of Fipronil. This suggests that Dead heart (%) was dependent on Days after spray and 57% ($R^2$=0.571), which indicate a negative relationship, that, if we increase the application days it will continually suppress the Dead heart % but in case of White head % this relation leads to a positive relationship 42%($R^2$=0.042), that, if we increase the application days it will not continually suppress the White head % (Fig. 1).

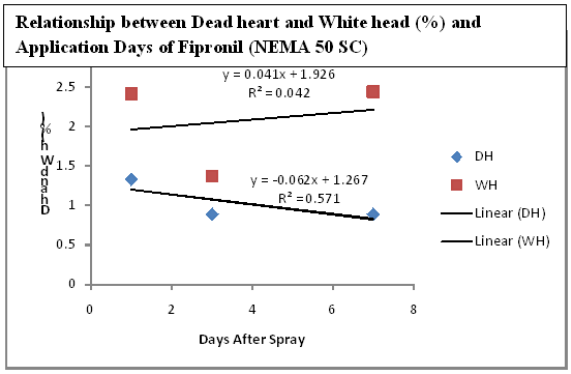


**Fig. 1.** Relationship between Dead heart & White head (%) and different day's interval of Fipronil**.**

*Effect on Yields by reducing the pest population*

Effect on Yields also observed after the end of the experiment, by reducing test insect as yellow stem borer, *S. incertulas* of rice by the application of botanical extracts and insecticides. The analysis showed significant level of success. The treatments viz., Acephate 75 SP, Tobacco extracts, Fipronil, Karanja extract, Neem extracts, and Control. Among the treatments Fipronil showed the best result which was statistically similar with Neem extract (Fig. 2) .On the other all the remaining treatment including control showed statistically similarities.

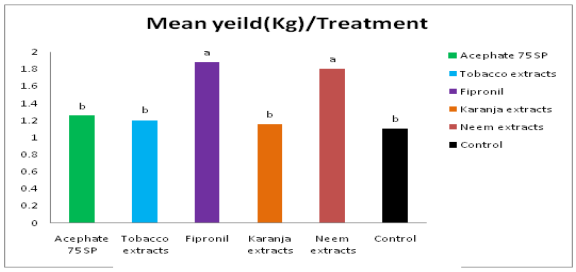


**Fig. 2**. Effect on Yields by reducing the pest population on different treatment plot.

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