Relative efficiency of some selected insecticide formulations on yellow stemborer, *Scirpophaga incertulas* (walk.) In rice field at Murshidabad, West Bengal, India

Israrul Hoque Mondal and Kaushik Chakraborty

Abstract

Experiment in field condition was carried out to assess the relative efficacy of three selected plant extracts *i.e.* neem, tobacco, akando and two selected chemical insecticides *i.e.* Dursban 20 EC and Fipronil against the incidence of yellow rice stem borer (YSB), *Scirpophaga incertulas* (Walk.) at Murshidabad, West Bengal, India, during three consecutive kharif crop seasons of 2013-2015. Grossly the experiment had six treatments that were replicated four times in each year in randomized complete Block Design (RCBD). Plant extracts significantly control *S. incertulas* population that is comparable with chemical insecticides. Fipronil showed the reduction of 56.28% dead hearts (DH) and 65.27% white head (WH) over control after 35 days of spraying. While the result for dursban was 30.01% DH and 40.27% WH. Neem extract reduced DH and WH by 38.33% and 48.14% respectively. The result from tobacco (22.18% DH and 24.30% WH), akando (15.33% DH and 16.89% WH) are appreciable. Fipronil and Dursban treated plot showed yield of 3.18 and 3.04 t/ha respectively. While in neem, tobacco and akando extracts treated plot the yield was 3.07, 2.86 and 2.68 t/ha respectively. The result indicates that out of the insecticides of plant origin, application of neem formulation effectively reduces *S. incertulas* infestation in consideration to chemical insecticides.

Keywords: RCBD, Yellow stem borer, Plant extracts, Yield, Botanicals

Introduction

Rice (*Oryza sativa* L.) is regarded as an important food crop supporting food security for 50% of the global population [22, 27]. In Asia, about 2.5 billion people depend on rice as principal food source [23]. Globally, about 90% of the rice cultivable land is in Asia [38]. Rice shares one fifth of the world crop land that is employed for cereal production [51].

Damages by the insect pests are considered as one of the prime causes of low yield generation of rice in the tropical Asian countries [41]. Grossly 128 species of insects are recorded to damage the rice fields. Out of these, in consideration of crop damage, 15 to 20 insect species are economically important [34]. Stem borers (SBs) are regarded as key group of insect pests of rice [21]. Yellow stem borer (YSB), *Scirpophaga incertulas* Walker is reported throughout India and is considered as the most dominating and destructive pest species out of the all species of stem borers [40]. West Bengal tops the list in consideration of rice production in India. YSB is reported to ravage in all of the agro-ecological regions of West Bengal sharing about 89.50% of the total rice borer population [12]. Yellow stem borer, *Scirpophaga incertulas* (Walker) (Lepidopter: Pyralidae) is a monophagous rice pest. Larval infestation during reproductive growth stage of rice causes the damage of the growing panicle resulting in ‘white head’ symptoms. After entering within the stem by successful boring/tunnelling, the larvae matures and subsequently pupates [58]. Severe infestation by YSB often results in complete crop failure [39].

Conventionally control of rice stem borer is generally done by the application of different insecticides of newer brands [37]. However recurrent resistance in the insect pest species, repeated insect pest resurgence, [44] and wide spread environmental hazards [60], residual toxicity of synthetic pesticides [68, 71] have indulge us to trust upon insecticides of plant origin [37, 39, 57]. Several brands of inorganic insecticides had been tested to check YSB menace which conceives no definite plant protection schedule appropriate for all of the Indian agro-ecological zones.
In spite of that synthetic insecticides are still the most trusted way to control YSB incidence [53, 59]. Under this situation pesticides of biological origin are reported to be harmless to human [4] and also imparts no ecological toxicity [36, 37]. Research on medicinal plants as an alternative source of insecticides for insect pest management gets momentum because threat to the environment from their application or to human health is insurmountable [1]. Further plant extracts are non-pollutant [6], less toxic [48] and easily bio-degradable [28]. Experiment on the efficacy of neem and its derivatives and few other bio-pesticides on YSB incidence have tested with variable range of success [18, 25]. The neem seed kernel extract (NSKE) suppresses the feeding, growth and reproduction of insects [41]. Neem products can be recommended for many programmes for integrated pest management [33, 13]. Similarly application of tobacco and akando as insecticide is used at restricted scale. Miranpuri [42] have also reported the efficacy of some bio-pesticides for pest suppression. Calotropis procera belongs to family Asclepiadaceae and has very wide range of ecological amplitude. The akando plant extract is effective against lepidopterous and sucking pest of several crop [43]. Extract of akando plant containing insect toxic components such as cardenolides, cardiac glycioides, flavonoids, gigantcine and other cytotoxic components which are effective against an array of insect pest [49]. A lectin called Nicotaina tabacum agglutinin (NICTABA) was explored from the leaves of tobacco [16]. Nictaba-related proteins have been studied and characterized for their biological properties and physiological role. Nictaba may be utilized for the crop as it has entomotoxic effects on Lepidoptera larvae [30]. Considering the above facts the present three consecutive years (2013-2015) research work is designed to determine relative efficacy of different insecticides and plant extracts to control yellow stem borer.

Materials Methods

Field layout and outline of experiment: Field experiment was conducted with transplanted 35-day old healthy seedlings of widely cultivated variety Swarna mashuri (MTU 7029) during three consecutive kharif seasons of 2013-2015 at Murshidabad [24°22’ 90” (N) – 88°24’ 61” (W)], West Bengal. The soil of the field was sandy loam with pH value 6.8 and EC value 0.31mmhos/cm. Field N, P2O5 and K2O was 363, 67 and 368 kg/ha respectively. Triple super phosphate (TSP), Muriate of potash (MOP), gypsum and zinc sulphate was added basally to the main field at the rate of 120, 80, 60 and 10 kg/ha as and when needed. Experiment was conducted by randomized block design at 15x10 cm seedling spacing during 2013-2015. There were six treatments, each with four replications for each year. Each plot was 26.75x 10.50 m in size and is separated from the nearby plot by a distance of 0.60 m. Insecticide formulation in the main field was applied at two times; during 35 and 60 days after seedling transplantation (DAT) respectively. Fertilizer inputs, irrigation, weeding and other necessary field management were carried out in due course of time following the national protocol with necessary modification as and when required.

Observation of stem borer population (SBs): Randomly selected 15 plots, 3 from each of the 5 insecticide treated fields, having no history of insecticide application were periodically inspected to register the incidence of stem borers (SBs). SBs were collected by a fine nylon cloth sweep net of 35 cm in diameter. Sweeping was carried out at the plant canopy level including the interspaces between the rice hills and the basal region of the plants as far as possible. In each field, 10 complete sweeps for each plot were made. A complete sweep includes one forward and one reverse sweep. Sweeping was mostly conducted at the early morning and early evening. There are five replications for each of the four rice growth stages namely (i) seedling, (ii) tillering (iii) milk maturation stage (iv) grain hardening stage from the randomly selected rice hills in each fields. SBs that were collected from each field were separated and accordingly counted.

Preparation of plant extracts pesticide formulation (Table 1): Leaves and barks of neem (Azadirachta sp.) of about 5kg in weight were cut into small pieces and mixed with 10 liter water. The water was then boiled for 30-50 minutes. The solution was then cooled and then filtered. The stock solution is diluted and applied in the field (T1). Similarly, 3 kg tobacco (Nicotiana sp.) leaf were cut into small pieces and mixed with 8 liters of water and subsequently boiled for 30-50 minutes which was then cooled for another 2 hours. The solution was then filtered through muslin cloth and the stock solution was thus prepared (T2). In the same manner akando (Calotropis sp.) formulation was also prepared (T3). Grades of inorganic pesticide formulations were prepared following standard protocol for field application (T4 and T5). Same volume of water without the insecticides was applied in the control field (T6).

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Generic and/or Scientific name of insecticide</th>
<th>Active substance for insect pest control</th>
<th>Source</th>
<th>Mode of application</th>
<th>Type</th>
<th>Applied dose/ha</th>
<th>Total volume applied</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>Neem (Azadirachta indica)</td>
<td>Azadiractin</td>
<td>Leaf and bark</td>
<td>spray</td>
<td>---</td>
<td>15ml/L</td>
<td>1.5L</td>
</tr>
<tr>
<td>T2</td>
<td>Tobacco (Nicotiana tabacum)</td>
<td>Nicotin</td>
<td>Leaf</td>
<td>spray</td>
<td>---</td>
<td>15ml/L</td>
<td>2.3L</td>
</tr>
<tr>
<td>T3</td>
<td>Akando (Calotropis procera)</td>
<td>Calotropin-</td>
<td>Leaf and stem</td>
<td>spray</td>
<td>---</td>
<td>15ml/L</td>
<td>2.5L</td>
</tr>
<tr>
<td>T4</td>
<td>Dursban</td>
<td>Chlorpyrifos</td>
<td>Spray</td>
<td>20EC</td>
<td>4ml/L</td>
<td>3.2L</td>
<td></td>
</tr>
<tr>
<td>T5</td>
<td>Fipronil</td>
<td>Fipronil</td>
<td>---</td>
<td>spray</td>
<td>0.3G</td>
<td>1.0 kg</td>
<td>4.5Kg</td>
</tr>
<tr>
<td>T6 (control)</td>
<td>Water</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>2.3L</td>
</tr>
</tbody>
</table>

(---):not applicable

Assessment on pest incidence following insecticidal input

Incidence and occurrence of pest population was taken from three growth stages, i.e. (i) seedling (ii) tillering (iii) milk maturation stage (iv) grain hardening stage and was averaged. Infestation of YSB results in dead hearts (DH) and white head (WH) during vegetative and reproductive growth stages of rice plant respectively. Incidence of DH (%) and WH (%) was recorded from 50 hills that was diagonally selected from each plot during vegetative and panicle formation stage of rice plant respectively. percentage of damage is calculated following formula as described by Singha [67].
formulations

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Insecticide SE(±)

significantly in consideration of different growth stages of Pink borer (PSB):

occurrence of PSB population differed sweep) respectively.

sweep) and lowest at grain hardening stage (1.26 individuals/sweep). Maximum and minimum incidence was recorded at tillering stage (2.66 individuals/sweep) and tillering growth stage of rice plant had supported maximum number of WSB population (0.68 individuals/sweep) while the least is noted at grain maturation stage (0.91 individuals/sweep).

Yellow stem borer (YSB): The incidence of YSB differed considerably among different rice growth stages. Grossly the relative abundance is 24.67%. Maximum number of YSB incidence was recorded at tillering stage (2.66 individuals/sweep) and lowest at grain hardening stage (1.26 individuals/sweep) respectively.

Pink borer (PSB): Occurrence of PSB population differ significantly in consideration of different growth stages of rice plant. The relative abundance was 8.08%. The mean population ranges from 1.26 to 0.98/sweep. Maximum and minimum number of PSB population was recorded at tillering (1.26 individuals/sweep) and grain hardening stage (0.65 individuals/sweep) respectively.

White borer (WSB): Incidence of WSB is very low throughout the growth stages of rice plant. The relative abundance is 4.91%. Tillering growth stage of rice plant had supported maximum number of WSB population (0.68 individuals/sweep) while the least is noted at grain maturation stage (0.91 individuals/sweep).

Dark headed stem borer (DHSB): The relative abundance of DHSB is 3.36%. Numerically maximum number of DHSB was recorded at tillering stage (1.54 individuals/sweep) and lowest was recorded in grain hardening stage (0.91 individuals/sweep).

Stripped stem borer (SSB): Incidence of SSB differed considerably among different rice growth stages. The value of relative abundance is 1.75%. The highest number of stripped stem borer was found at tillering stage (0.47 individuals/sweep) and lowest in seedling stage (0.15 individuals/sweep).

Ragini [55] had recorded three rice stem borer species, i.e. the YSB (Scirpophaga incertulas), PSB (Sesamia inferens) and DHSB (Chilo partellus). Out of that YSB was the most predominant species during June to September (60.0%) followed by October to January (48.43%). PSB was the second most dominant species during June-September (35.21%). During October to January incidence of PSB was least (18.23%). However throughout the season DHSB was least abundant (4.29-7.18%).

Table 2: Extents of yellow stem borer infestation and yield generation of paddy cultivar Swarna Mashuri under different pesticide treatments.

<table>
<thead>
<tr>
<th>Insecticide formulations</th>
<th>Extent of infestation (%)</th>
<th>Yield(t/ha)</th>
<th>Application Efficacy (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>DH</td>
<td>WH</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2013</td>
<td>2014</td>
<td>2015</td>
</tr>
<tr>
<td>T1</td>
<td>3.81</td>
<td>3.68</td>
<td>3.85</td>
</tr>
<tr>
<td>T2</td>
<td>4.72</td>
<td>4.78</td>
<td>4.81</td>
</tr>
<tr>
<td>T3</td>
<td>5.24</td>
<td>5.15</td>
<td>5.19</td>
</tr>
<tr>
<td>T4</td>
<td>4.31</td>
<td>4.21</td>
<td>4.37</td>
</tr>
<tr>
<td>T5</td>
<td>3.21</td>
<td>2.12</td>
<td>2.62</td>
</tr>
<tr>
<td>T6</td>
<td>6.20</td>
<td>6.12</td>
<td>6.08</td>
</tr>
<tr>
<td>SE(±)</td>
<td>0.11</td>
<td>0.17</td>
<td>0.21</td>
</tr>
<tr>
<td>CD (P&lt;0.05)</td>
<td>0.35</td>
<td>0.34</td>
<td>0.45</td>
</tr>
</tbody>
</table>
In consideration of yield generation (Table 2): Maximum yield generation was noted from T5 (3.18t/ha). This was followed by T1 (3.07t/ha), T4 (3.04t/ha), T2 (2.86 t/ha), T3 (2.68t/ha) respectively in descending order. The lowest yield of 2.41 t/ha was registered from insecticide untreated field.

All of the results varied considerably on synthetic pesticides causes’ ecological difficulty and health related problems [39, 70]. All of the results varied considerably on synthetic pesticides causes’ ecological difficulty and health related problems [39, 70]. All of the results varied considerably on synthetic pesticides causes’ ecological difficulty and health related problems [39, 70].

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In consideration of yield economics (Table 5): Cost of input and value of return per hectare for rice production was considered in the value of rupees. Expenditure was done primarily due to the cost of insecticide and other usual field management procedure. Grossly, field management cost for all the treatments remained more or less constant except for the ‘control’ fields. As there was no insecticidal input in the ‘control’ field, thus the expenditure related to insecticide application was merely ‘nil’. In consideration of input cost, the maximum value is noted in T4 (Rs. 31,230). The next highest input cost was registered in T5 (Rs. 30,930). This was respectively followed by T2 (Rs. 28,710), T3 (Rs. 28,610), T1 (Rs. 28,330), T6 (Rs. 27,730) in descending order. But, in consideration of gross return maximum value was noted in T5 (42,165). The next highest return was possible from T4 (Rs. 40,690). This was followed by T1 (Rs. 38,250), T2 (Rs. 37,065), T3 (Rs. 35,910), T6 (Rs. 33,005) in descending order. In consideration of monetary return, ‘net profit’ was maximum in T5 (10,235). It was seconded by T1 (Rs. 9,920).This was followed by T4 (Rs. 8,460), T2 (Rs. 8,355), T3 (Rs. 7,300), T6 (Rs. 5,275) in descending order. Maximum cost benefit value (CBR) was noted case of T5 (1.36). This is followed by T1 (1.35), T4 (1.30), T2 (1.29) and T3 (1.25) in descending order.

The least CBR value was noted in case of T5 (1.36). This is followed by T1 (1.35), T4 (1.30), T2 (1.29) and T3 (1.25) in descending order. The least CBR value was noted in case of control field (1.19).

<table>
<thead>
<tr>
<th>Common English name</th>
<th>Scientific name</th>
<th>Family</th>
<th>Order</th>
<th>Extent of incidence (%) (in consideration of numerical abundance)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yellow stem borer</td>
<td>Scirpophaga incertulas (Walker)</td>
<td>Pyralidae</td>
<td>Lepidoptera</td>
<td>24.67</td>
</tr>
<tr>
<td>Pink stem borer</td>
<td>Sesamia inferens (Walker)</td>
<td>Pyralidae</td>
<td>Lepidoptera</td>
<td>8.08</td>
</tr>
<tr>
<td>Dark headed stem borer</td>
<td>Chilo partellus (Walker)</td>
<td>Pyralidae</td>
<td>Lepidoptera</td>
<td>4.91</td>
</tr>
<tr>
<td>Striped stem borer</td>
<td>Chilo suppressalis (Walker)</td>
<td>Pyralidae</td>
<td>Lepidoptera</td>
<td>1.75</td>
</tr>
</tbody>
</table>

Table 3: Important insect pests of rice at Murshidabad, West Bengal

<table>
<thead>
<tr>
<th>Growth stage of rice</th>
<th>YSB</th>
<th>PSB</th>
<th>WSB</th>
<th>DHSB</th>
<th>SSB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seedling</td>
<td>1.68 (1.48)</td>
<td>0.98 (1.22)</td>
<td>0.54 (1.02)</td>
<td>1.22 (1.27)</td>
<td>0.16 (0.82)</td>
</tr>
<tr>
<td>Tillering</td>
<td>2.66 (1.78)</td>
<td>1.26 (1.33)</td>
<td>0.68 (1.09)</td>
<td>1.54 (1.43)</td>
<td>0.47 (0.99)</td>
</tr>
<tr>
<td>Milk maturation stage</td>
<td>1.82 (1.52)</td>
<td>0.7 (1.10)</td>
<td>0.44 (0.97)</td>
<td>1.092 (1.26)</td>
<td>0.378 (0.94)</td>
</tr>
<tr>
<td>Grain hardening stage</td>
<td>1.26 (1.33)</td>
<td>0.658 (1.08)</td>
<td>0.39 (0.94)</td>
<td>0.91 (1.19)</td>
<td>0.15 (0.81)</td>
</tr>
</tbody>
</table>

Table 4: Incidence and abundance of different stem borer species at different growth stages in rice crop field without insecticide input

In consideration of yield generation (Table 2): Maximum yield generation was noted from T5 (3.18t/ha). This was followed by T1 (3.07t/ha), T4 (3.04t/ha), T2 (2.86 t/ha), T3 (2.68t/ha) respectively in descending order. The lowest yield of 2.41 t/ha was registered from insecticide untreated field (T6). In consideration of yield increase over control, maximum efficacy was calculated for T5 (30.29%). This was then followed by T1 (27.38%), T4 (26.14%), T2 (18.67%), T3 (11.20%) in descending order.

In consideration of yield economics (Table 5): Cost of input and value of return per hectare for rice production was considered in the value of rupees. Expenditure was done primarily due to the cost of insecticide and other usual field management procedure. Grossly, field management cost for all the treatments remained more or less constant except for the ‘control’ fields. As there was no insecticidal input in the ‘control’ field, thus the expenditure related to insecticide application was merely ‘nil’. In consideration of input cost, the maximum value is noted in T4 (Rs. 31,230). The next highest input cost was registered in T5 (Rs. 30,930). This was respectively followed by T2 (Rs. 28,710), T3 (Rs. 28,610), T1 (Rs. 28,330), T6 (Rs. 27,730) in descending order. But, in consideration of gross return maximum value was noted in T5 (42,165). The next highest return was possible from T4 (Rs. 40,690). This was followed by T1 (Rs. 38,250), T2 (Rs. 37,065), T3 (Rs. 35,910), T6 (Rs. 33,005) in descending order. In consideration of monetary return, ‘net profit’ was maximum in T5 (10,235). It was seconded by T1 (Rs. 9,920).This was followed by T4 (Rs. 8,460), T2 (Rs. 8,355), T3 (Rs. 7,300), T6 (Rs. 5,275) in descending order. Maximum cost benefit value (CBR) was noted case of T5 (1.36). This is followed by T1 (1.35), T4 (1.30), T2 (1.29) and T3 (1.25) in descending order. The least CBR value was noted in case of control field (1.19).

Table 5: Yield economics showing Cost Benefit value under different treatments

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Field management expenditure (a)</th>
<th>Income(Rs/ha)</th>
<th>CBR value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Gross (b)</td>
<td></td>
<td>Net (a-b)</td>
</tr>
<tr>
<td>A</td>
<td>B</td>
<td>Total</td>
<td>Grain</td>
</tr>
<tr>
<td>T1</td>
<td>600</td>
<td>27,730</td>
<td>28,330</td>
</tr>
<tr>
<td>T2</td>
<td>980</td>
<td>27,730</td>
<td>28,710</td>
</tr>
<tr>
<td>T3</td>
<td>880</td>
<td>27,730</td>
<td>28,610</td>
</tr>
<tr>
<td>T4</td>
<td>3,500</td>
<td>27,730</td>
<td>31,230</td>
</tr>
<tr>
<td>T5</td>
<td>3,200</td>
<td>27,730</td>
<td>30,930</td>
</tr>
<tr>
<td>T6</td>
<td>-</td>
<td>27,730</td>
<td>27,730</td>
</tr>
</tbody>
</table>

No definite observation on the impact of insecticide formulations on YSB incidence adjacent to Gangetic plains of West Bengal was carried out earlier. Works had done mostly superficial covering the assessment of efficacy of different newer inorganic insecticidal brands and side by side the estimation of YSB population in relation to high yielding cultivars. In the present study the extent of YSB infestation was on average 6.13% DH and 4.32% WH respectively in pesticide untreated field. Assessment on the relative efficacy of insecticidal formulations in relation to YSB incidence was also accounted at different agro-climatic zones [17, 37, 45, 46, 49, 52, 66]. Field experiments on the efficacy of synthetic pesticides of different newer brands have also been documented [37, 39, 53, 57, 59]. But no definite plant protection schedule applicable for all the agro-ecological zones could be evolved. Over dependence on synthetic pesticides causes’ ecological difficulty and health related problems [39, 70]. All of the results varied considerably in consideration of the ranges of success. In such back drop
bio-pesticides are reported to be safer to human health imparting no ecological toxicity [36, 37].

In the present experiment best result in consideration of the extent of pest suppression was found when Neem extract (@15ml/L) was applied. This was followed by fipronil 0.3G(1kg/ha), Dursban 20 EC(4ml/L), Akanda extract (15 ml/L), Tobacco extract (15ml/L) respectively in descending order. In parity to the pest suppression efficacy, best yield was obtained from fipronil formulation treated plot while the least was noted from tobacco applied field. Somewhat similar results from inorganic insecticide application were also documented [24, 50, 57]. Akondo formulation extract showed a reduction of 18.67% which statistically similar with the result when Akondo formulation. Prasad [52] from India had documented that in consideration of insect pest suppression capacity, monocrorrophos expressed good result out of the six selected pesticides they had tested. Dash [38] have documented that in Orissa condition efficacy of pesticide formulations differ considerably to suppress YSB incidence. In general for all of the rice cultivars, a limit of 10% tiller damage (DH+WH) is considered as ETL value of YSB incidence at pre harvest condition [53].

Though efficacy of neem derivatives and few other bio-pesticides on YSB incidence have tested elsewhere, it has resulted in only a variable range of success [18, 25]. The neem seed kernel extract (NSKE) is known to suppress the feeding, growth and reproduction of insects due to its bio-chemicals [27]. Neem products can be recommended for many programmes on integrated pest management [11, 31]. Miranpuri [42] have also reported the efficacy of some bio-pesticides for pest suppression. In this consideration efficacy of different pesticide formulation on the YSB incidence in diverse agro-ecological zone is needed to be explored [26, 39].

Conclusions

Botanical source insecticides may serve as alternatives to popularly used synthetic chemical insecticides. The result of the study on the effectiveness of different botanical extract and insecticides for the controlling of yellow stem borer of rice. The treatment viz. Dursban 20 EC, Fipronil, Tobacco, Akando, Neem extract and untreated control were included in this field test. Among the treatments Neem extract showed the best result which was statistically similar with Fipronil. Among the treatments Fipronil treated plot yielded highest amount of rice. Though the effectiveness of the botanicals was low than chemical insecticides. So Farmer may use neem based insecticide to produce rice which will ensure better yield and the conservation of beneficial insect in rice field ecosystem.

References


~ 475 ~


58. Sarwar M. Management of rice stem borers (Lepidoptera: pyralidae) through host plant resistance in early, medium


