An Expert KEM System for the Integrated Pest Management of Yellow Stem Borer in the Sri Lankan Paddy Industry

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Abstract: Paddy cultivation development continues to remain the most important objective of Sri Lankan planning and policy. In the process of development of paddy cultivation, pesticides have become an important tool as a plant protection agent for boosting food production. In this paper, a KEM with IPM and pesticide application in the process of rice production investigated for the purpose of benefit of integrated pest management. In the first part of the main results, the sufficient condition for the global stability of the susceptible pest-eradication periodic solution is obtained, which means if the release amount of infective prey and predator satisfy the condition, then the pest specially Yellow Stem Borer (YSB) have been controlled. The sufficient condition for the permanence of the system is also obtained subsequently, which means if the method is profitable without damaging to the environment and future strategies for the rational use of pesticides and minimizing the problems related to health and environment. The analysis shows that the use of biological control with KEM method allows substantial cuts in chemical treatments, inspection effort and control costs required to meet YSB control targets in Sri Lanka.

Key words: KEM • Integrated Pest Management • Yellow Stem Borer • Paddy cultivation

INTRODUCTION

Rice is the staple food of the country and it is cultivated predominantly as a wetland crop. However, this cultivation is spread all over the country covering dry zone too. Paddy is cultivated during two main cultivation seasons, namely 'Maha' and 'Yala'. Cultivation during ‘Yala’ is mostly confined to the wet zone and major irrigated areas in the dry zone. The total land area under Paddy is about 736,000 hectares [1, 2]. About 75% of the cultivated area is irrigated during both seasons. The increase of the volume in production of rice is an immediate requirement in Sri Lanka due to its rapidly growing population. However, achieving this task seems impossible due to various obstacles. One of the main problems is the different kind of pest attacks on the rice fields. According to this issue, one of the important rice pests in Sri Lanka is the rice stem borer [3].

Rice stem borers occur in different ecosystems. In Sri Lanka three species of stem borers attack deepwater rice, but the major pest is undoubtedly the Yellow Stem Borer (YSB) (Scirpophaga incertulas). YSB could attack most of the growing stages of rice plant, beginning with seedling through tillering and up to ear setting in Sri Lanka [4]. S. incertulas caterpillars bore into the rice stem and hollow out the stem completely. The damage symptoms vary according to the stage of growth of the plant [5].

Natural ecosystems and their component species are experiencing catastrophic and rapid loss as habitat is destroyed for human use and invaded by species from other bio-geographical areas [6]. Here we focus on the benefits of using classical biological control such as KEM methods in Sri Lanka as a tool for controlling YSB, especially given the fact that more biological control projects will be needed in the future to correct damage from the using Insecticides that are establishing in new communities world-wide. As a result reliable methods of developed and efforts should be make bio-control agents available on demand to farmers to help them adopt...
Integrated Pest Management (IPM) system in the true spirit by encouraging higher yield with more income. Concern about the adverse effects of chemical pesticides due to their indiscriminate use is growing. IPM approach, being promoted since 1985, is an eco-friendly strategy of pest containment by exploiting the role of natural agents/forces in harmony with other pest management tactics and with the sole aim to effect minimum disturbance to environment.

KEM is a kind of IPM which is specific to Sri Lanka and with paddy cultivation less work was done [7]. Traditional knowledge has been used down the line from one generation to the other in rice paddy cultivation. This knowledge, which contains a very specific traditional method called “Kem Krama”, is widely used even in this modern time by Sri Lankan farmers. There is no specific word for “Kem Krama” in the English language; however, the meaning could be elaborated as a “tactful, traditional method of treatment and prevention”. These practices are followed in a very peculiar manner, mostly in a secretive way and the knowledge is shared only among close relatives and friends. The traditional farmer had a belief that if these methods were revealed to the public, the power or the effectiveness of those methods could be reduced or gone [8]. These traditional methods have come into practice as a result of long term experience in rice farming. However, the latest technology in farming is becoming more common in a developing country like Sri Lanka and more and more farmers tend to use agrochemicals and fertilizers in their farming practices. These traditional methods were closer to nature and its balance. Most of the materials used in practicing these techniques were found from the natural environment. Therefore the negative effects on the nature were minimum.

The main objective of this study is identifying the relation between IPM and traditional ‘Kem’ methodology and how to control the pest such as YSB in paddy field using traditional ‘Kem’. Still there is no proper research done regarding traditional ‘Kem’ methodology with paddy cultivation in Sri Lanka. Finally main aim of the article is to objectively highlight, in good faith, a set of KEM methods concerned regarding production system research that could improve scientific rigour and effectiveness.

**MATERIALS AND METHODS**

**Field Site Description:** Our study site was a one acre rice paddy in the village of Matugama, Agalawaththa and Meegahathenna (from latitude 6° 43´0” N, longitude 80° 3´36”) in Sri Lanka [9, 10]. We rented the paddy, one of several hundred in a remote area devoted to rice agriculture, from a local farmer. Rice is grown synchronously over large areas in two seasons per year with a long dry-fallow period from July to October. Rice grown here supports not only the local population, but it is also main source of income. Furthermore it is considered as low country wet zone rice cultivation area in Sri Lanka. Within the selected area, farmers apply zero to four insecticide applications per rice growing season (around 110 days). Our rented paddy had been a zero-spray IPM with KEM field for the past several seasons, but its immediate neighbors represented a general mix of management techniques. All paddies in the irrigation basin featured essentially synchronous planting/harvesting schedules.

**Rice Variety and Generalists as Biological Control Agents:** Seeds of one rice variety, Suduru Samba (Indica rice) which is a traditional variety in Sri Lanka, were sown in batches in soil in 1 acre lands. Ten seedlings, each with five leaves, were transplanted into 0.3m diameter pots. Our research focused on the community impacts of a species of lycosid tiger spider (*Poecilotheria regalis*)[11]. While, there are other important guilds of generalist predators (e.g., predaceous beetles, water surface-dwelling hemipterans), these tiger spiders are the most commonly found and are well known to and easily recognized by the indigenous farmers in Sri Lanka. For instance, tiger spiders prey on a variety of important pest species in rice and often reach high densities (over 25 adults per m²) in rice paddies early in the season.

**Experimental Procedure and Application of Kem:** Fifteen days after the rice had been transplanted (from the hand cultivated “seed beds” used in rice agriculture), we erected 40 open-top cages measuring 2m / 1m / 1m (length / width / height) constructed of coconut leaf and bamboo supports (materials available locally). To prevent disruption by bad weather, we staked the cages and separated them from each other by at least 2m. Kem is believed to be an effective mechanism developed in folklore to protected man, crops and livestock using plants, amulet, talisman, medicinal plants, Pirith, Suthra and Gatha. Kem methods are dynamic and therefore various methods were developed and sustained in the society for long period according to the problem faced by the society in different eras. Basically some belief comes from the long years back and it may have scientific background or not. After sunset the farmer comes to the paddy field and lights the fire, take it and go five times
around the paddy field. For fire they use ‘Kakuna Oil (Canarium zeylanicum)’ or ‘Dummala (Canarium madagascariense)’. The scientific background of the this ‘kem’ is in while lighting the Kakuna Oil there is very bad odor because of that pest are go away from the paddy. The Kem was applied during the early face until the harvest period. These traditional methods have come into practice as a result of long term experience in rice farming. Although the coconut leaf substantially reduced arthropod dispersal across cage boundaries, we left the cages open at the top to minimize cage effects like solarization. Thus, this cage design was a compromise between completely enclosed cages with their concomitant cage effects and barrier free plots where high levels of arthropod dispersal might mask some effects of our treatments. Each cage enclosed 36 rice plants in a 9 / 4 array. We arranged the cages in 10 blocks of 4 cages each to control for paddy edge effects and heterogeneity within the rented paddy. One cage in each block was assigned to each of treatment: both KEM and tiger spiders added. Our experiment was a one-way factorial with 10 replicates per cell in the design.

**Insecticide Treatment for the Normal Paddy Cultivation:**
One day following cage construction, we added the insecticide monocrotophos at a rate of 1.5 L/ha (the standard application rate, which equals 0.15cc monocrotophos per m²) to insecticide treated fields to check the difference. We hand sprayed the insecticide directly on each plant to localize the application and to minimize surface water contamination. Monocrotophos is a fast-acting, broad spectrum organophosphate with a short half-life [12, 13]. To minimize subsurface mixing of the pesticide into the control cages, the field was selected to adjust of IPM field.

**Statistical Analysis:** We analyzed our data as a balanced one-way ANOVA with spiders (Yes or No). For statistical analysis, we transformed all our data using the Freeman–Tukey method [14] but rescaled the data to numbers per m² for presentation purposes.

**RESULTS AND DISCUSSION**

**Beneficial Insects:** In its efforts to present the case for a ‘modern’ agriculture, formal research has attempted on several occasions in recent years to make comparisons between rice production systems with traditional KEM method which is kind of well known as Integrated Pest Management system. A driving concern in some of the comparisons has been to limit and to economies on the pest management, but also the productivity of labor and other external inputs. However, such comparisons are very complex to perform practically in the field [15], as well as theoretically through crop growth modeling and other desk studies [16]. Both the modeling and field approaches deployed to compare rice production systems have relied on questionable theoretical assumptions and agronomic simplifications to overcome the lack of knowledge about some of the agro-ecological processes. Likewise the potentials of actual crop production systems, including the contributions of various interactions between production factors, as well as between these and the non-experimental variables inherent in the local conditions have received inadequate attention from scientists. We sampled roughly once of paddy surface and we concentrate here on the control responses of yellow stem borer (YSB) pest species. Paddy fields in Matugama, Agalawaththa and Meegahathenna fields typically harbour a rich diversity of YSB. In Sri Lanka up to 450/Acre YSB have been recorded in unsprayed fields and a significant proportion of these are harmful for paddy. In this KEM related IPM is partly because of the difficulty of identifying which of a multitude of predators are having significant impact and partly because large-scale unsprayed experiments, where natural controls can be quantified, are uncommon. One of the greatest impediments to development of KEM in IPM in paddy has been the lack of tools to control target pests without also disrupting these beneficial populations. Figure 1 explains the commonly used methods of IPM with KEM in Sri Lankan paddy field to optimize the beneficial insects.

**Table 1: Profit gain by 3 different methods**

<table>
<thead>
<tr>
<th>Task</th>
<th>KEM</th>
<th>Control</th>
<th>Chemical</th>
</tr>
</thead>
<tbody>
<tr>
<td>Busal/Acer</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>50</td>
<td>38</td>
<td>35</td>
<td></td>
</tr>
<tr>
<td>Kg/Acer</td>
<td>1025</td>
<td>790</td>
<td>710</td>
</tr>
<tr>
<td>Total yield in rice</td>
<td>683</td>
<td>498</td>
<td>564</td>
</tr>
<tr>
<td>Price/Kg</td>
<td>150</td>
<td>150</td>
<td>150</td>
</tr>
<tr>
<td>Income/Acer</td>
<td>102450</td>
<td>74700</td>
<td>84600</td>
</tr>
<tr>
<td>Expense/Acer</td>
<td>52024</td>
<td>36600</td>
<td>49000</td>
</tr>
<tr>
<td>Profit</td>
<td>50426</td>
<td>38100</td>
<td>35600</td>
</tr>
</tbody>
</table>
These finding suggest that the full application of an integrated control strategy with KEM is the most efficient means of control YSB. The integrated control strategy is superior economically as well as ecologically, in the short run as well as the long run; one should thus expect it to be used as widely as possible.

REFERENCES