Integrated Pest Management of food crops

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Several hundred species of insects are known to damage agricultural crops and inflict severe losses in food production. Different pests feed on all parts of the plants, transmit diseases and damage the produce in storage.

Insects account for an average of 10 - 15% yield losses. There is no accurate information on yield losses caused by insect pests and available data are based only on few random studies carried out in specific location by various workers (Table 1).

Table 1: Crop losses by insects

Crop	Pest	Extent of damage	Reference
Cabbage	Cabbage caterpillars	12-13%	Jesudasan and Yogaratnam,1985
Brinjal	Brinjal pod borer	50%	Mylvaganam, 1983
Beans	Beanfly	40-50%	Anon., 1990
Legumes	Beanfly	15-30%	Subasinghe and Amarasena,1983
Soya bean	Pod borer	05%	-
Black gram	Pod borer	18%	Anon., 1984
Cowpea	Pod borer	23%	-
Rice	Brown planthopper	3.1%	Kudagamage and Nugaliyadda 1990

Need for alternative method

There is a need for control measures to be adopted to prevent damage caused by insect pests. Most often insecticides are used as a first line of defence against insects. Today many who continued to practice chemical farming relying solely or heavily on pesticide inputs are confronted with many problems and an increasing threat of non-sustainability.

Disruption of Natural Enemy complex: Pest species are kept below damage threshold by the action of natural enemies comprising parasites, predators and other pathogenic organism. Insecticides can disrupt natural enemy complexes and result in pest out breaks.

Change in pest species: Prior to the 1970s, one of the major pests of rice, rice brown plant hopper (Bph) was a minor pest. However, use of broad spectrum insecticides for the control of stemborers, then one of the important pest, resulted in the destruction of natural enemies of Bph and as a result Bph became a major pest of rice. Generally speaking insecticide treatments brought about an imbalance in the agro-ecosystem, that is a decrease in total number of species but with an unexpected increase in the population density of few pest species.

Insecticide Resistance: . Continuous use of insecticides result in the development of insecticide resistance. When insecticides are used majority of insect populations die leaving behind few individuals capable of withstanding the insecticide due to its genetic nature. These few individuals breed and produce the next generation of individuals exhibiting more resistance than the previous generation. This process continues and within few generation most of the individuals in the population are resistant to insecticides. The tomato leaf minor, ***Lariomyza trefoil*** is virtually resistant to all available insecticides.

Hazards: An approach of pest management solely dependent on insecticides will have many drawbacks. For instance farmer may use a wrong concentrations. When a lower dosage is used, the insecticide may not be effective. If a higher concentrations used it will increase the cost. Additionally there are some application problems such as insecticidal drift and health hazard to applicators. Insecticidal drift result in contamination of water ways, range lands and parks. Insecticides like organochlorines accumulate in the food chain killing wild life like birds. Residues that remain on harvested products can result in various health hazards. Contaminated products may be rejected by the exporting countries. For example, in Germany, Tea will not be accepted if they detect pesticide residues in processed tea.

INTEGRATED PEST MANAGEMENT APPROACH

Integrated Pest Management (IPM) is a broad ecological approach to pest management utilizing variety of control strategies compatibly in a single pest management system.

In IPM stress is placed on the importance of realistic economic injury levels which are used to determine the need for control actions. At the sametime everything possible is done to protect and preserve naturally occurring biotic mortality factors such as parasites, predators and pathogens. When artificial control measures are needed for example chemical pesticide application, they are employed in a selective manner as possible and only when their use is economically and ecologically justified. The ultimate objective of the IPM is to produce optimum crop yield of high quality at minimum cost, taking into consideration the ecological and sociological constraints in that particular agro-ecosystem and the long term preservation of the environment.

Complete freedom from insect attack is neither necessary in most cases for high yields nor appropriate for insect pest management. Nearly all plants can tolerate a substantial degree of leaf destruction without appreciable effects on plant vigour. Hence estimate of the pest density should be available which delineate the pest population level below which damage is tolerable and above which specific interventions are needed to prevent a pest outbreak and to avert significant crop injury.

This quantitative insect density is given by the economic injury level. This is defined as the critical population density where the loss caused by the pest equals in value of the available control measure. Economic threshold is another important parameter defined as the density of the pest population at which control measures should be applied to prevent an increasing pest population from reaching economic injury level. The economic threshold always represents a pest density lower than that of economic injury level, to allow the initiation of control measures so that they can take effect before the pest density exceeds the economic injury level.

The pest population fluates above and below the general equilibrum position. This is the average population density over a long period of time as affected by the temporary intervention of pest control. The economic injury level may be at any level from well below to well above the general equilibrium position. Insects can be grouped into four general categories in this regard (Figure I).

1. Many insect pest species feed on cultivated crops without ever reaching densities high enough to cause economic injury. Examples include grasshoppers and aphids feeding on rice (Figure I A).

2. Another large group of insects are occasional pests and exceed economic injury levels only when their populations are affected unusually by weather conditions or injudicious use of insecticides. Examples include rice ear cutting caterpillar, ***Mythimna, seperata*** and white back-plant hopper ***Sogatella furcipera*** (Figure 1 B).

3. A third group of insects has economic injury level only shortly above the general equilibrium position and intervention is necessary at nearly every upward population fluctuation. Examples include rice brown plant hopper, ***Nilaparvata lugens*** and pod borers of legumes (Figure 1 C).

4. Severe pests are found in a group of insects having economic injury levels below general equilibrium position. Examples include various fruit fly species - infesting various fruits and mosquitoes which act as vectors of human diseases. Regular and constant interventions usually with insecticides are required to produce marketable crops (Figure 1D).

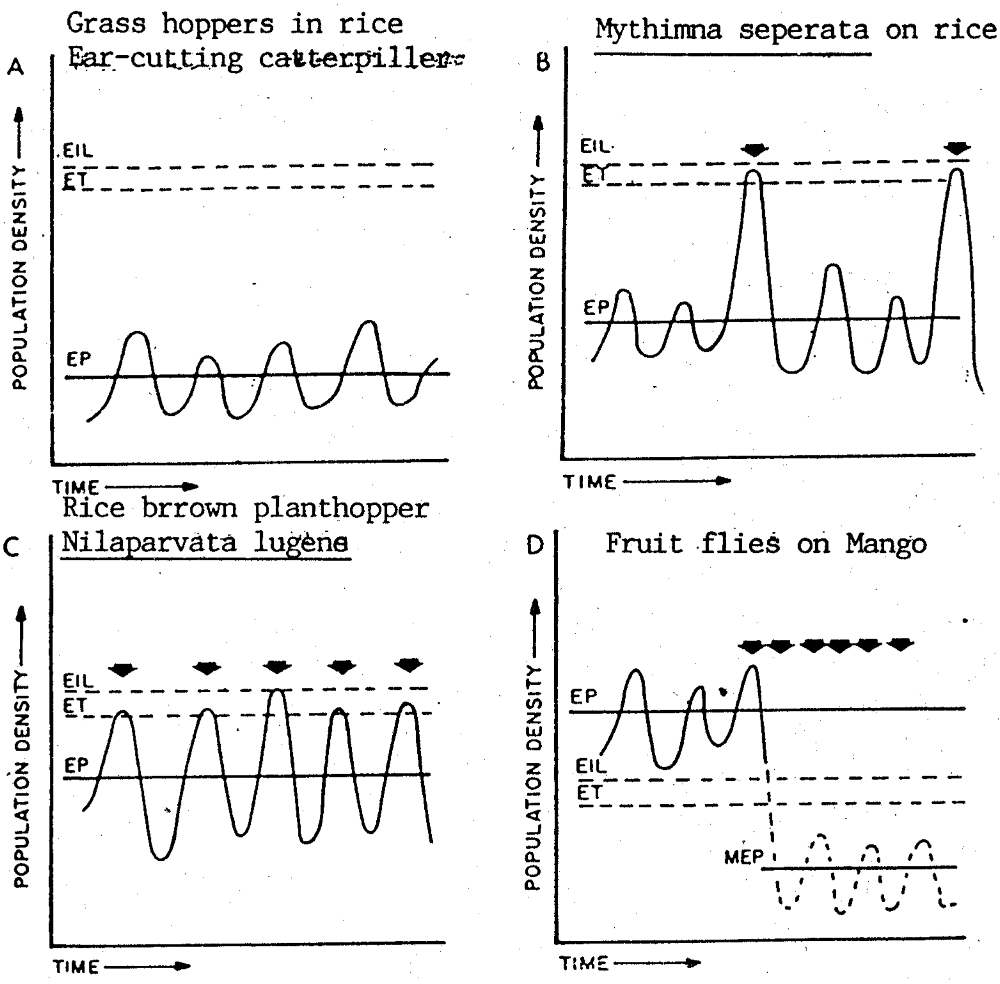

Fig. 1. Economic injury levels and economic thresholds for typical insect pest situations. EIL, economic injury level; ET, economic threshold; EP, equilibrium position; MEP, modified equilibrium position; arrowheads, pest-control intervention. (Modified after Stern 1965.)

REQUIREMENT OF PEST MANAGEMENT DECISIONS:

1. A pest management should be able to identify the different pests that infest the crop at different stages. He should be able to categorize different insects infesting different crops as explained in the above section so that pest status of the insect can be evaluated.

2. The actions, reactions and interactions of components of agro-ecosystems that affect significantly the target pest species should be known. IPM emphasises existing factors in the ecosystem which check the pest's numerical growth: Limited resources (food, space, shelter), periodically inclement weather or other hazards (heat, cold wind, drought, rain) competition within the species or with other plants and animals and natural enemies.

3. Pest populations are dynamic, some times, more than doubling in a day or decreasing at comparable rate. Because of weather, crop growth, natural enemies and other factors that affect population growth and decline, pest population and parts of the environment influencing their abundance must be monitored frequently in order to determine when to apply or relax various control measures. Only through monitoring can the real need for control be known and the natural control maximized.

4. An assessment of potential ecological or environmental hazards that may occur with control measures.

COMPONENTS OF IPM

There are several methods of insect control. The methods currently available and proved effective are cultural, biological, host plant resistance and chemical control. The combining of several of these into a comprehensive IPM programme can provide better suppression of key pest species and at the same time place less demand on any one method.

Cultural Control

Cultural control is the use of cultural practices associated with crop production to make the environment less favourable for survival, growth or reproduction of the pest species.

Cultivation of Soil: Many insects live or hibernate in the soil, selecting suitable temperature and humidity conditions. These conditions can be disturbed by ploughing which creates temporary drought conditions in the upper layer of soil and may even expose larvae and pupae to the radiation of the sun and promote activity of predators.

Clean Cultivation: Standard farm hygiene is important for pest control. The destruction of crop removes residual pests such as the stemborer pupae. The elimination of weeds deprives the pest of it's alternate hosts.

Manuring: Rapid healthy plant growth generally compensates for some damage by pests while weak deprived plants may easily be killed by an equivalent attack.

However, excessive use of nitrogen fertilizer should be avoided and a balanced fertilizer mixture containing potassium and phosphorous should be used. Application of organic manure reduces infestation in crops.

Irrigation: Many workers describe pest control effects of excessive irrigation or watering. Pests may be washed off the plants, drowned or suffocated. Soil insects may be killed by the pressure of colloidal particles in saturated soil. Partial control of rice thrips is possible by the temporary submergence of the crop. A reduction in the population of brown hopper is made possible by draining the fields when the crop is infested with brown plant hoppers.

Crop Rotation: The objective of the crop rotation is to isolate the pest from its host plant. Rotation is most effective against soil pests (e.g. wireworm and white grubs) which take a long time for maturity. It is also effective against pests like nematodes with low migratory capacity like nematodes.

Planting - harvesting dates: Variation of sowing date can control pests. Most of the pests exhibit seasonal frequency. Thus, either by the crop avoiding the egg laying period of the time pests appear, pest infestation is evaded. Timely cultivation can avoid infestation by thrips. Early harvesting removes pests from the field before they can emerge and perpetuate the population.

Varietal Resistance

The growing of crop varieties which are less attacked than others or yield well in spite of attack is a very good pest control measure. Once such varieties are available, the control requires no extra labour or materials and is therefore economical. Moreover, the environment is not affected from side effects of the control measure.

Insect resistance is most likely to be used as an adjunct to other control measures. Resistant varieties will need fewer treatments of pesticides. The presence of a low level of pests on a resistant variety enable the predators and parasites to maintain the pests below economic thresholds. Therefore, resistant varieties can be used along with bio-control.

One of the drawbacks of resistant varieties is the formation of biotypes. When genetically uniform crops are cultivated over a large geographical area, a few individuals that survive on these resistant varieties can multiply and produce a virulent biotype that is capable of surviving on previously resistant varieties. Such cases of biotype development has occurred on resistant gallmidge varieties in rice.

Biological Control

Biological control of insect pests reduces pest numbers by predators, parasites or pathogens. There are two aspects of bio-control important for an integrated pest management program. The first avoids insect control practices which disturb the biological control resulting from naturally occurring predators, parasites and pathogens already in the field. The second involves human efforts to enhance biological control, either through the introduction of natural enemies or through direct efforts to improve the efficiency of those already present.

At present, producing large numbers of predators or parasites in the laboratory for field release to control economic infestations of pest insects, appear to be less promising than conservation of natural beneficial insects in the field. Beneficial insects must have food, shelter and protection from detrimental effects of chemicals, dust and so on, over which man has some control. These requirements can be fulfilled in most agro-ecosystems by careful attention to crop planting patterns, rotation, harvesting practices and the use of sound economic levels on which to base insecticide application decisions.

Chemical Control

The development of an effective, economical pesticide, has profoundly influenced man's continual battle with insects. In many cases, chemicals have served as tools in insect control programs without serious hazard to humans or to the environment. However, there has been a tendency to regard these tools as a cure-all and to believe that for every insect problem there is a chemical which will magically control it. This has resulted at times in unwise, uneconomical or hazardous applications of chemicals.

It should be the responsibility of every user to learn as much as possible about the insect to be controlled, the chemical to be used and the potential hazards involved and then apply pesticides to minimize or avoid hazards and ensure effective, economical control.

Experience with Rice IPM Programme

The inter-country rice IPM Programme was launched under the auspices of the food and agriculture organization (FAO) in 1984. The programme comprised training, preparation of communication and extension aids and evaluation.

Training: To begin the programme, a number of counterpart officers from research, extension and eduction and training division of the Department of Agriculture (DOA) was sent overseas for training on IPM. The senior staff of the DOA were first familiarized with the goals of the programme through 4-day IPM workshop. As a second step, a specially designed 2 week "training-the-trainer" course for the implementation of rice IPM at the village level was conducted for middle level field officers.

These officers are expected to train the village level workers on IPM methodology. Recently, season long training programme was held for trainers at Angunakolapelessa. These officers who graduated as IPM specialist trainers subsequently started IPM training activities with the latest techniques learnt through the season long training.

Training of farmers are based on farmer field school approach. The IPM farmer field school (FFS) brings farmers together to undergo intensive training on IPM methods and issues over the life-cycle of the crop.

The field school trains the farmers to become IPM experts in their own fields. Training is focused on the analysis of the agro-ecosystem of the crop. This analysis helps farmers gain insight into ecological interaction in the field. The combination of analytical methods, ecological insight and basic IPM principles such as growing a healthy crop provides farmers with a wider base for confidence in their decision making.

Each field school comprises about 25 farmers. Such field school has its own field of 1000 m^2. The learning field is divided into two sections. The first is treated according to the mandated intensification package recommendation and the second is treated following IPM principles. These 2 larger plots serve as the basis for agro-ecosystem studies that are carried out by field school participants. Extension worker and a IPM trainer facilitate the activities of each field school.

Once a week farmers meet in the field around 8.00 a.m. The twenty five farmers divide themselves into five groups and field monitoring carried out in selected locations of the fields. During this; status of the crop growth, pest species found on the crop together with their numbers and number of different predatory species are recorded. After field monitoring a group discussion is held as to the status of the pest infestation and action needed. This procedure is repeated one day a week for 12 weeks covering the entire growing season.

Preparation of communication aids: Following publications have been obtained and distributed to extension staff.

* Posters on natural enemies of insect pests of rice (Sinhala, Tamil and English)
* IRRI-field problems of Tropical rice (Sinhala)
* Friendly insects (English and Sinhala)
* Rice IPM manual for extension workers (Sinhala & Tamil)

Slide sets on rice pests have also been used for training purposes. Subject matter specialist (SMS) and subject matter officers (SM) were given training on pretesting of extension communication aids through several workshops.

Evaluation: **IPM** trainers when selecting a demonstration tract carry out a baseline survey at the beginning of the season to determine pre-training rice production practices, expenses and profits with special emphasis on pest control practices of 25 farmer trainees.

Parallel comparative data are collected for the training season, when IPM area farmed by the trainees constitute a large demonstration.

A test on rice IPM knowledge and skill is given to farmer trainees before IPM classes begin to determine level of their knowledge and guide extension agents in designing appropriate class seasons. Identical tests are given at season's end to determine how much the farmers have learnt.

The results of these evaluations all over of the country provide ample evidence that the cost of pest control can be significantly reduced through IPM. Moreover yields have also increased due to good management levels in IPM fields thus increasing the profit margin of IPM farmers.