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Pest management in rice through integrated pest management practices

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Rice is the seed of the monocot plants *Oryza sativa* (Asian rice) or *Oryza glaberrima* (African rice). As a cereal grain, it is the most important staple food for a large part of the world's human population, especially in Asia and the West Indies. It is the grain with the second-highest worldwide production, after maize (corn), according to data for 2010 (FAOSTAT, 2006).

What is integrated pest management?: Integrated pest management (IPM) is a broad based approach that integrates a range of practices for economic control of pests. IPM aims to suppress pest populations below the economic injury level (EIL). The Food and Agriculture Organization of the UN defines IPM as "the careful consideration of all available pest control techniques and subsequent integration of appropriate measures that discourage the development of pest populations and keep pesticides and other interventions to levels that are economically justified and reduce or minimize risks to human health and the environment. IPM has been urged by entomologists and ecologists for adoption of pest control for many years (Knipling, 1972). IPM allows for a safer means of controlling pests. This can include controlling insects, plant pathogens and weeds. IPM emphasizes the growth of a healthy crop with the least possible disruption to agro-ecosystems and encourages natural pest control mechanisms (www.fao.org).

Globalization of markets and increased movements of people all over the world are allowing for increasing numbers of invasive species to be brought into countries (Perrings *et al.*, 2000 and Clercq *et al.*, 2011). Appropriate responses to these pests are needed and development and implementation strategies should be arranged. It is essential that the option that poses the least risks while maximizing benefits is needed and that the strategy may include all components related to integrated pest management strategies (Wright *et al.*, 2005).

Why IPM? : In order to minimize the indiscriminate and judicious use of chemical Pesticides, IPM has been formulated as principle of plant protection in over all crop protection programmes under the National Agriculture policy of the Govt. of India for sustainable crop production without affecting environment.

How do IPM programs work?: IPM is not a single pest control method but, rather, a series of pest management evaluations, decisions and controls. In practicing IPM, growers who are aware of the potential for pest infestation follow a four-tiered approach. The four steps include:

Set action thresholds: Before taking any pest control action, IPM first sets an action threshold, a point at which pest populations or environmental conditions indicate that pest control action must be taken. Sighting a single pest does not always mean control is needed. The level at which pests will either become an economic threat is critical to guide future pest control decisions.

Monitor and identify pests: Not all insects, weeds, and other living organisms require control. Many organisms are innocuous, and some are even beneficial. IPM programs work to monitor for pests and identify them accurately, so that appropriate control decisions can be made in conjunction with action thresholds. This monitoring and identification removes the possibility that pesticides will be used when they are not really needed or that the wrong kind of pesticide will be used.

Prevention: As a first line of pest control, IPM programs work to manage the crop, lawn, or indoor space to prevent pests from becoming a threat. In an agricultural crop, this may mean using cultural methods, such as rotating between different crops, selecting pest-resistant varieties, and planting pest-free rootstock. These control methods can be very effective and cost-efficient and present little to no risk to people or the environment.

Control: Once monitoring, identification, and action thresholds indicate that pest control is required, and preventive methods are no longer effective or available, IPM programs then evaluate the proper control method both for effectiveness and risk. Effective, less *risky* pest controls are chosen first, including highly targeted chemicals, such as pheromones to disrupt pest mating, or mechanical control, such as trapping or weeding. If further monitoring, identifications and action thresholds indicate that less risky controls are not working, then additional pest control methods would be employed, such as targeted spraying of pesticides. Broadcast spraying of non-specific pesticides is a last resort.

Principles of integrated pest management: An American IPM system is designed around six basic components (Smith and Smith, 1949).

Acceptable pest levels: The emphasis is on *control*, not *eradication*. IPM holds that wiping out an entire pest population is often impossible, and the attempt can be expensive and environmentally unsafe. IPM programmes first work to establish acceptable pest levels, called action thresholds, and apply controls if those thresholds are crossed. These thresholds are pest and site specific, meaning that it may be acceptable at one site to have a weed such as white clover, but at another site it may not be acceptable. By allowing a pest population to survive at a reasonable threshold, selection pressure is reduced. This stops the pest gaining resistance to chemicals produced by the plant or applied to the crops. If many of the pests are killed then any that have resistance to the chemical will form the genetic basis of the future, more resistant, population. By not killing all the pests there are some un-resistant pests left that will dilute any resistant genes that appear.

Preventive cultural practices: Selecting varieties best for local growing conditions, and maintaining healthy crops, is the first line of defense, together with plant quarantine and 'cultural techniques' such as crop sanitation (*e.g.* removal of diseased plants to prevent spread of infection).

Monitoring: Regular observation is the cornerstone of IPM. Observation is broken into two steps, first; inspection and second; identification (Center Acosta, 1995-2006). Visual inspection, insect and spore traps, and other measurement methods and monitoring tools are used to monitor pest levels. Accurate pest identification is critical to a successful IPM program. Record-keeping is essential, as is a thorough knowledge of the behavior and reproductive cycles of target pests. Since insects are cold-blooded, their physical development is dependent on the temperature of their environment. Many insects have had their development cycles modeled in terms of degree days. Monitor the degree days of an environment to determine when is the optimal time for a specific insect's outbreak.

Mechanical controls: Should a pest reach an unacceptable level, mechanical methods are the first options to consider. They include simple hand-picking, erecting insect barriers, using traps, vacuuming, and tillage to disrupt breeding.

Biological controls: Natural biological processes and materials can provide control, with minimal environmental impact, and often at low cost. The main focus here is on promoting beneficial insects that eat target pests. Biological insecticides, derived from naturally occurring microorganisms (*e.g.*: *Bt*, entomopathogenic fungi and entomopathogenic nematodes), also fit in this category.

Responsible pesticide use: Synthetic pesticides are generally only used as required and often only at specific times in a pest's life cycle. Many of the newer pesticide groups are derived from plants or naturally occurring substances (*e.g.*: nicotine, pyrethrum and insect juvenile hormone analogues), but the toxophore or active component may be altered to provide increased biological activity or stability. Further 'biology-based' or 'ecological' techniques are under evaluation.

IPM strategies:

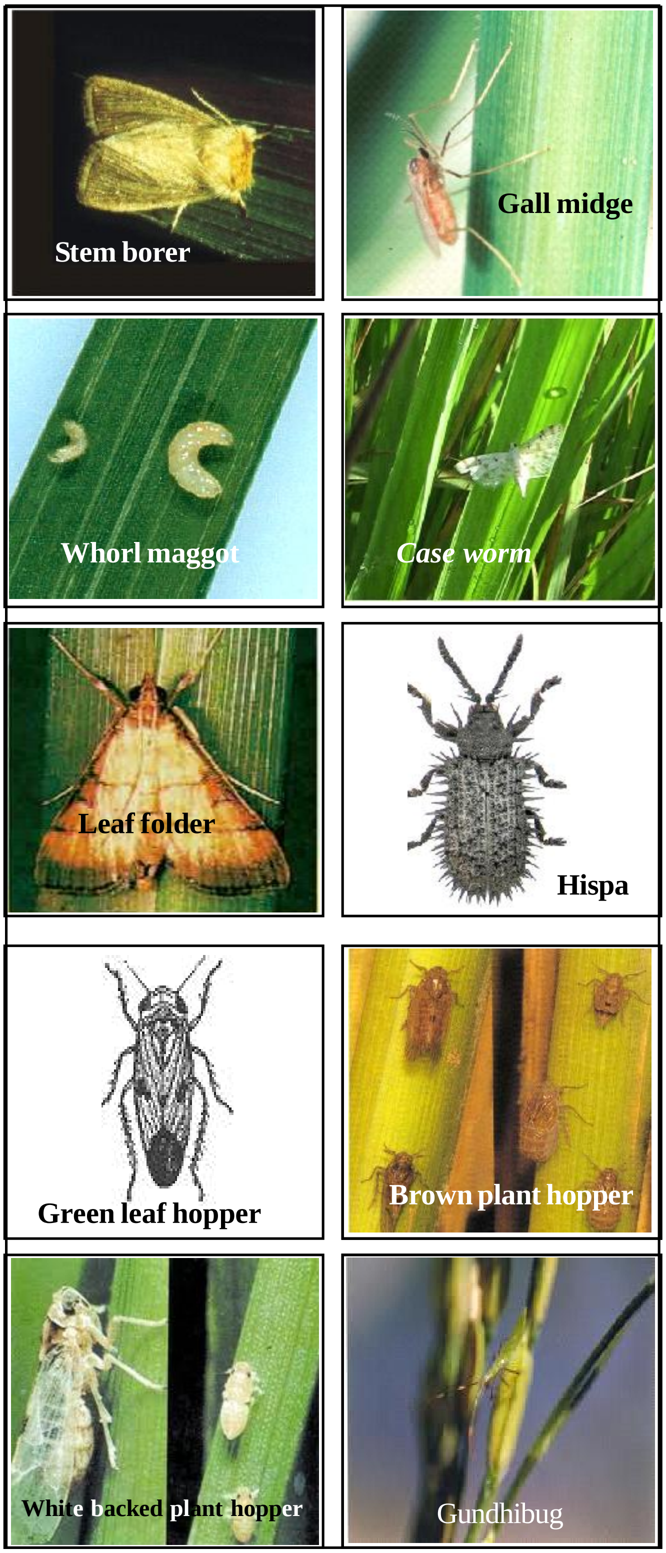
Cultural practices: Cultural practices are integral part of IPM. Summer ploughing, selection of healthy seeds, timely planting, raising of healthy nursery, removal of weed from field, balanced use of fertilizers as per recommendations are the important cultural practices that are followed for pest management in paddy.

Mechanical practices: Mechanical practices comprise of removal and destruction of pest infested plant parts, clipping of rice seedling tips and collection of egg masses and larvae of pest and their placement in bamboo cages for conservation of biocontrol agents.

Biological control practices: Biocontrol agents like coccinellids, spiders, damsel flies, dragonflies should be conserved. Chlorpyriphos is used for root dip treatment of rice seedlings. Egg, masses of borers are collected and placed in a bamboo cage cum percher till flowering. It permits the escape of egg parasites and trap and kill the hatching larvae.

Behavioural control : Pheromone traps are installed at the rate of 20 traps/ha to trap yellow stem borer at 10 days after transplanting.

Chemical control measures: Chemical control measures are used under IPM as a last resort. Application of pesticides has to be need based and proper crop health monitoring, observing ETL and conservation of natural biocontrol agents has to be ensured before deciding in favour or use of chemical pesticides.



Economic threshold levels (ETLs) of major insect pests of rice.

Insect pests of rice:

Stem borer: Moderate to severe in nursery, 5% dead hearts or one egg mass/m^2 at planting to tillering stages or one moth/m^2 at panicle initiation to booting or flowering stages.

Gall midge: One gall/m^2 in endemic areas or 5% affected tillers in non-endemic areas. 5% affected tillers is the ETL at mid tillering stage.

Whorl maggot: 20% damaged hills up to 30 days after planting.

Case worm: 1 to 2 cases per hill.

Leaf folder: One damaged leaf per hill or one larva per hill at planting and 1-2 freshly damaged leaf per hill at mid tillering or panicle initiation to booting stages.

Hispa: One adult or one grub per hill at planting to pretillering stages or one adult or 1 to 2 damaged leaves per hill at mid tillering stages.

Green leaf hopper: 2 insects per hill in tungro endemic areas, 10 insects per hill in other areas at tillering stage and 20 insects per hill at mid tillering to panicle initiation to booting stages.

Brown plant hopper: 5 to 10 insects per hill at tillering stage. At panicle initiation to booting stage 20 insects per hill, while 5-10 insects at flowering stage and after flowering.

White backed plant hopper: 10 insects per hill at tillering stage and 5-10 insects per hill at flowering stages and after flowering.

Gundhibug: One or two bugs per hill.

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