Agri Articles
(e-Magazine for Agricultural Articles)
Volume: 04, Issue: 01 (JAN-FEB, 2024)
Available online at http://www.agriarticles.com
©Agri Articles, ISSN: 2582-9882

Eco-Friendly Pest Management for Sustainable Agriculture

(*Mahaveer Meena, Pawan Ahari and Hemant Swami)
Rajasthan College of Agriculture, MPUAT, Udaipur, Rajasthan
*Corresponding Author's email: mahaveermeena575@gmail.com

The management of insect pests is necessary to ensure food security. The yield loss caused by both field and storage insect pests is estimated to be 20 to 30%. Indiscriminate use of chemical pesticides has resulted in environmental pollution and ecological imbalance causing insecticide resistance, pest resurgence and pesticide residue in food and environment. Integrated Pest Management (IPM) is an environmentally friendly approach that integrates different practices and strategies for control of pests. IPM aims to suppress pest populations below the economic injury level (EIL). EIL is the lowest pest population density that will cause economic damage. IPM is a method for analysis of the agro-ecosystem and the management of its different elements to control pests and keep them at an acceptable level with respect to the economic, health and environmental requirements (FAO). There has been a shift to more ecologically sustainable strategies and Bio-intensive IPM viz., Agro Eco System Analysis (AESA) based IPM and Ecological Engineering for Pest Management. Agro-Eco System Analysis (AESA) is a process in which farmers observe the crop, analyze the field situation and take crop management decisions based on field observations. Ecological Engineering for pest management is a new paradigm to enhance the natural enemies of pests in an agro ecosystem and relies on use of cultural techniques to bring about habitat manipulation and enhance natural enemies of pests in the crop micro and macro environment. IPM combines cultural, mechanical, physical, biological and chemical methods for pest control. Cultural methods rely on a strategy to make the crop unacceptable to pests through practices like mixed cropping, crop rotation, management of trap crops to divert insects away from the main crop. The emphasis of Bio intensive IPM is on proactive measures to redesign the agricultural ecosystem to the disadvantage of a pest and to the advantage of its parasite and predator (Dufour, 2001)

Agro-Eco System Analysis (AESA) based Plant Health Management

Agro Ecosystem Analysis (AESA) is an approach, which can be employed by extension functionaries and farmers to analyze the field situations and monitor the population of pests, defenders, soil conditions, plant health and the influence of climatic factors to make informed decisions for growing a healthy crop. In AESA, farmers observe the crop, analyze the field situation and take decisions for crop management based on field observations. Focus in AESA based IPM is on pest-defender dynamics, abilities of plants to compensate for the damage caused by pests and the influence of abiotic factors on pest build up. The health of a plant is determined by its environment which includes abiotic factors (sun, rain, wind, soil nutrients etc.) and biotic factors (*ie*. pests, diseases, weeds etc.). These factors play a role in the balance which exists between insects and their natural enemies. Understanding these interactions can help in pest management.

Principles of AESA based Integrated Pest Management (IPM):

- Grow a healthy crop:
- Observe the field regularly:
- Plant Compensation Ability:
- Understand and Conserve defenders:
- Insect zoo: Pest:
- Defender ratio (P: D ratio):

Ecological Engineering for Pest Management

Ecological Engineering (EE) for pest management is a new paradigm to enhance the natural enemies of pests in an agro ecosystem and is being considered an important strategy for promoting Bio intensive Integrated Pest Management (BIPM). This approach relies on use of cultural techniques to bring about habitat manipulation and enhance biological control. Ecological Engineering emerged as a paradigm for considering pest management approaches that are based on cultural practices and informed by ecological knowledge rather than on high technology approaches such as synthetic pesticides and genetically engineered crops. (Gurr, et al 2004).

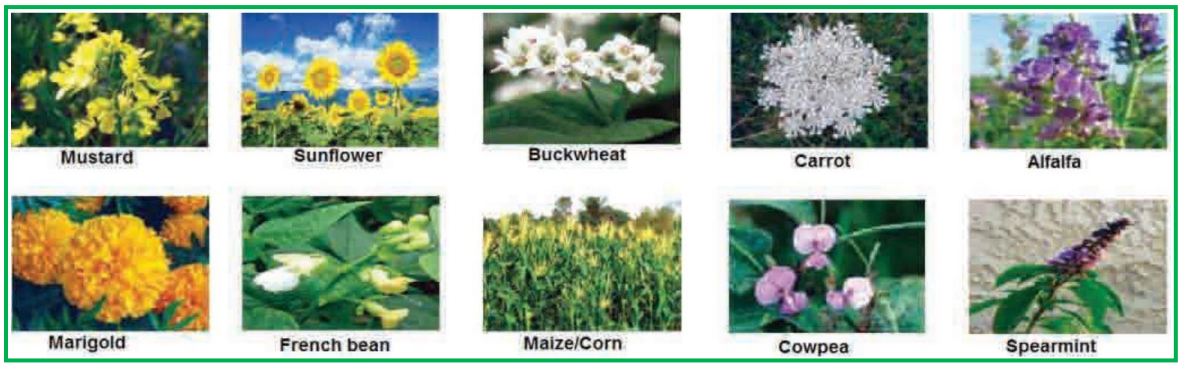
EE for Pest Management – Above Ground

- Focus is on making the habitat less suitable for pests and more attractive to natural enemies.
- Raising flowering plants along the border by arranging shorter plants towards main crop and taller plants towards the border to attract natural enemies as well as to avoid immigrating pest population
- Inter-cropping, border-cropping and mix cropping of the flowering plants provide nectar/ pollen as food for various bio-control agents. Trap crops and repelling crops for pests are also grown as intercrop along with the main crop.
- Not uprooting weed plants which are growing naturally like *Tridax procumbens*, *Ageratum* sp, *Alternanthera* sp etc. as they act as a nectar source for natural enemies,
- Not applying chemical pesticides, when the P: D ratio is favorable. The compensation ability of the plant should also be considered before applying chemical pesticides.

Different types of Plants used in Ecological Engineering

These can be classified into 4 categories.

1. **Plants which attract Natural Enemies of Pests:** These include Mustard, sunflower, buckwheat, carrot, marigold, French bean, maize/corn, cowpea, spearmint. The actual selection of flowering plants could be based on availability, agro-climatic conditions and soil types.



Due to enhancement of biodiversity by the flowering plants, the number of parasitoids and predators (natural enemies) also increase due to availability of nectar, pollen, fruits, insects,

etc. The major predators are a wide variety of spiders, ladybird beetles, long horned grasshoppers, Chry*soperla*, earwigs, etc.

2. **Trap Plants :** A trap crop is a crop that is planted to lure insect pests away from the main crop. Basil and marigold as a border crop (main crop- Garlic) controls Thrips. Castor plant as a border crop in Cotton and chilli field, controls Tobacco caterpillar. Legume as inter / alternate crops in sugarcane enhances the population of fungal and bacterial BCA for the management of nematodes & other soil borne diseases. Inter crop rows of Tridax procumbens in paddy crop enhances the natural parasite and predator populations.
3. **Repellant Plants which repel harmful insect-pests:** Grown either as border crop or main crop, these repel the pests away from the crop mainly due to the release of volatile repellent plant chemicals. Basil repels flies, mosquito and tomato borer. Garlic repels beetles, aphids, weevils, spider mites, carrot fly. Radish deter cucumber beetle. Mint repel cabbage moth. Marigold repels beetles, cucumber beetles, nematodes
4. **Barrier/ Border plants which attract insect-pests and reduce pest population on main crop :** These protect the main crop against small soft bodied flying insects which migrate from one field to other field such as whiteflies, hoppers, aphids, mealybugs, thrips etc. Eg. Maize, Sorghum, Bajra, Redgram etc. as barrier crops.

EE for Pest Management – Below Ground

- This focuses on improvement of soil health
- Keeping soils covered round the year with living vegetation and/or crop residue.
- Adding organic matter in the form of farm yard manure (FYM), Vermicompost,
- crop residue which enhance below ground biodiversity.
- Reducing tillage intensity so that hibernating natural enemies can be saved.
- Applying balanced dose of nutrients using biofertilizers.
- Applying *mycorrhiza* and plant growth promoting rhizobacteria (PGPR)
- Applying *Trichoderma* spp. and *Pseudomonas fluorescens* as seed/seedling/planting material, nursery treatment and soil application.

These practices strengthen the ability of crops to withstand pests and also help improve soil fertility and crop productivity.

Push-pull strategy for managing stem borers in Africa

A push-pull strategy for managing cereal stem borers in Africa was developed by scientists of the International Centre of Insect Physiology and Ecology (ICIPE) in Kenya and Rothamsted Research in the United Kingdom, in collaboration with other research organizations in eastern Africa. Push-Pull uses a combination of legume repellent plants to deter the pest from the main crop ("push") and trap crops to attract the repelled pest ("pull"). Plants that have been identified as effective in the push-pull tactics include Napier grass, Sudan grass, molasses grass, and desmodium. Napier grass and Sudan grass are trap plants, whereas molasses grass and desmodium produce chemical compounds which repel stem borers. On the other hand, during dusk Napier grass produces other chemical substances that evaporate easily, some of which are good attractants for stem borers to lay eggs. Fortunately, Napier grass produces a gummy substance which traps the resulting stem borer larvae, and only few survive to adulthood, thus reducing their population. Push-Pull has increased maize yields of farmers in Kenya by an average of 20 - 30 percent in areas with only stem borers, and by more than 100 percent in areas with both stem borers and Striga. (Amudavi David et al., 2007)

Biological Control

An integral part of Integrated Pest Management is Biological control, i.e. Control of insect pests and diseases through biological means. Biological control deals with the use of natural

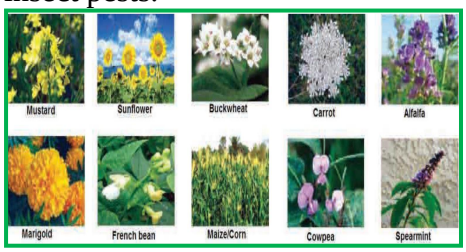
enemies or biological control agents like predators, parasitoids and pathogens for the management of insect pests.

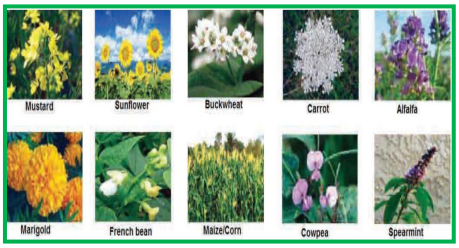
Biological Control Agents

Predators

Predators like Coccinellid beetles in vegetable ecosystem, Spiders in rice ecosystem, dragon flies, damsel flies, lady bird beetles, lacewings, birds etc., have proved helpful in protecting crops.

• **Ladybird beetle**: Ladybird beetles - grubs and adults feed on aphids and other soft bodied insect pests.





Coccinella septumpuncta – a common lady bird beetle adult and grub eating aphids

• **Mealy bug Ladybird:** *Cryptolaemus montrouzieri* feeds on mealy bugs on citrus, guava, grapes, coffee, mango, custard apple and green shield scale on mango, guava.

Cryptolaemus montrouzieri (lady bird beetle adult and grub) eating mealy bugs

• **Ground beetles** target Coconut black headed caterpillar and rice brown plant hopper

• **Green lace wing:** The larvae of Green lace wing (*Chrysoperla carnea*) feed on soft bodied insects like aphids, jassids, white flies, mealybug etc.

• **Praying mantis**: Both Nymphs & Adults feed on Caterpillars & grasshoppers. Predatory insects can be mass multiplied in the laboratory and released in the field. However, for effective management of insect pests, farmers must be conscious with respect to the time of release of predators and the stage of crop at which release has to be made.

Parasitoids: Parasitoids include a number of species of wasps, fly etc. which lay eggs in or on the bodies of their insect host, and complete their life cycles on host bodies ultimately killing the host. Parasitoids may be of different type's viz., egg, egg-larval, larval, pupal and adult depending on the developmental stage of the host in/on which it completes its life cycle. Examples are different species of *Trichogramma, Bracon, Chelonus*, etc.

Pathogens for Insect Pest Management

Entomopathogenic Bacteria:- These are parasitic organisms that grow on/in insects, often killing them in the process. Pathogenic bacteria of insects which have potential for use in biological pesticides include *Bacillus thuringiensis, B. sphaericus* and *B. papillae*.

Entomopathogenic Virus:- The infected insects stop feeding and the larvae turns into pinkish white on the ventral side. If the infection continues, larva become flaccid, skin becomes fragile and finally ruptures. The diseased larvae in the field crawl to the tip of the plant and from that position it hangs upside down. This symptom is called tree top disease. Eg. *Ha* NPV against *Helicoverpa armigera, SL* NPV against *Spodoptera litura*.

Entomopathogenic Fungi: - Entomopathogenic fungi directly penetrate the outer protective covering/ layer. Once it attaches to the host, fungus penetrates the insect body wall. The cause of the insect's death is extensive fungal growth and poisoning by fungal toxin. *Metarrhizum anisoplae* develops disease (green color fungal growth) in root grubs and rhinocerous beetles.

Entomopathogenic Nematodes (EPN):- EPNs can be formulated as dust, sprays, capsules, granules, etc. and applied through spraying suspension or through irrigation system. In spite of their benefits in managing insect pests, utilization of EPN in India is low due to lack of awareness and non-availability of EPN at reasonable cost. NIPHM has developed simple low cost technologies for mass multiplication of EPN that can be adopted by farmers as well as by commercial establishments and is popularizing EPN through capacity building programs for scientists, extension officers and interested progressive farmers. This low cost method requires less space; host larvae are infected much earlier and is a quicker method for mass production of EPNs; does not require periodic inspection; results in higher yield; there is no need of harvesting on a daily basis; can be learned by farmers easily; easy to scale up; ensures 100% infection of insect larvae; easy to mass produce, highly effective, durable bio-control formulation

Microbial Bio pesticides:- Microbial bio pesticides are produced, formulated and applied in the field to control target pests. They are target specific/host specific and are eco-friendly. To ensure availability of quality bio pesticides at farmer's level, various organizations including NIPHM are popularizing easy, low cost and simple on farm production technology for mass production of bio pesticides for easy adoption by farmers. *Trichoderma* and *Pseudomonas* are important bio control agents for protecting crops against several soil and air borne plant pathogens and can be produced at the farm level. They also stimulate plant growth, enhance germination, plant survival rate and growth of roots and shoots. NIPHM has prepared special media for mass production of fungal and bacterial bio agents.