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ECOLOGICAL ENGINEERING AS A NEW PARADIGM IN PEST MANAGEMENT

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Injudicious and improper use of pesticides over several decades has caused declining natural enemy populations and the development of pest populations that are increasingly resistant to insecticides. Moreover agricultural lands at a global scale have become depleted of functionally important species such as pollinators and predatory amphibians. On the contrary side loss in biodiversity and the loss of services provided by the natural fauna in crop fields are predicted to reduce ecosystem stability and resilience; this will lead to less efficient responses to perturbations such as the insecticide-related physiological resurgence of pests, or climatic-driven increases in pest densities. Scientists are currently faced with the challenges of increasing food security while at the same time dealing with climatic uncertainly that requires resilient ecosystems, and a need to conserve or restore biodiversity and optimize ecosystem functions (Horgan *et al*., 2016). Environmental designing or living space control has arisen as a worldview for considering pest management approaches that depend on social practices educated by natural information on pest management (Gurr *et al*., 2004). Habitat management can be considered as a division of conservation biological pest management strategies that changes living spaces to further develop accessibility of the assets needed by bioenemies for their effective performance. Habitat management might happen at the inside crop and landscape levels (Landis *et al*., 2000). The primary objective in Ecological engineering is to make environment of the Agro-ecosystem suitable for the better survival of natural enemies of pests. Habitat manipulation aims to provide natural enemies of pests with nectar, pollen, physical refuge, alternate prey, alternate hosts and living sites. This can be through plantation of appropriate companion plants like floral trap crops and repellent crops, through which the population of pollinators, predators and parasitoids can be enhanced to manage the herbivorous insect pests. Ecological Engineering (EE) strategies focus on pest management both below ground and above ground level. The main emphasis is to improve the soil health below ground by developing soils rich in organic matter and microbial activity and above ground plant health by habitat manipulation to increase the biodiversity of beneficial natural enemies.

ECOLOGICAL ENGINEERING FOR PEST MANAGEMENT – ABOVE GROUND

The main focus is to make the habitat less suitable for pests and more attractive for the natural enemies.

- Growing flowering plants along the border of the main crop field by planting shorter ones 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 source for various bio-control agents. Trap crops and repellent plants can also be grown along with the main crop.
- Keeping naturally growing flowering weed plants like *Tridax procumbens*, *Ageratum* sp, *Alternanthera* sp etc. as they act as a nectar source for natural enemies,
- Up to when the Pest defender (P:D) ratio is favourable no application of chemical insecticides should be done. As soon as the pest ratio surpluses defenders number botanical insecticides should be applied.

ECOLOGICAL ENGINEERING FOR PEST MANAGEMENT – BELOW GROUND

This practice mainly focuses on improvement of soil health

- Keeping soils covered round the year with organic mulch or straw mulches.
- Addition of organic matter in the soil by applying farm yard manure (FYM), Vermicompost which enhance below ground biodiversity.
- Adoption of resource conservation technology by practicing zero till or no till cultivation so that hibernating natural enemies can be saved.
- Applying balanced dose of nutrients following soil test based recommendation.
- Application of *Trichoderma* spp. and *Pseudomonas fluorescens* as seed/seedling/planting material treatment, nursery bed treatment and soil application. These practices strengthen the ability of the crops to withstand pest attack and also help to improve soil fertility and crop productivity.

The different types of plants that can be included in ecological engineered plots are classified into four broad categories.

1. **Attractant Plants**: Examples will include Mustard, sunflower, buckwheat, carrot, marigold, French bean, maize/corn, cowpea, spearmint. The actual selection of flowering plants should be based on availability, agro-climatic situation and soil types.
2. **Trap Crop**: Examples will include • Basil and marigold as a border crop (main crop- Garlic and tomato) controls thrips and nematodes • 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 biocontrol application 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. **Repellent Plants**: • Basil repels flies, mosquito, 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:** Examples will include Sorghum, maize, bajra, setaria etc (Rao, C.S. 2019).

CONCLUSION

Ecological engineering can well be fitted with the Bio-intensive Pest Management programme where proper selection of farmscaped plants is very crucial. Proper knowledge and awareness among the farming community is needed to be ensured.

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