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Exploring Innovative Ecological Engineering Approaches for Insect Pest Management

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Abstract

Ecological engineering has recently emerged as a paradigm for considering pest management practice based on cultural practices that are guided by ecological knowledge rather than unilateral approach such as synthetic pesticides and genetically modified crops. The development of ecological engineering is explored ranging from simple first approximation that diversity is beneficial, to contemporary understanding that diversity can have adverse effect on pest management. Components of biodiversity are better understood and exploited to supress pest activity. Pest suppression *via* Ecological engineering is placed in the border context of ecosystem services provided by farmland diversity including nitrogen fixation and the conservation of natural enemies, pollinators species and wildlife.

Introduction

Hundred years ago, there were no chemical pesticides/insecticides for the management of insect pests and chemical fertilizers for improvement of plant growth and development. In the recent years, their usage has been increased and farmers are practicing monoculture, cultivation of single crop, which led to increase in the pest population and shift in their food habits and habitats. Presently farming community solely depends on only chemical pesticides/insecticides for their management (Gurr *et al*., 2004).

Indiscriminate use of chemical pesticides results in pollution of natural resources like water, soil, reduced density of beneficial insects and soil microorganisms, reduction of pollinators and natural enemies like predators and parasitoids, which play a significant role in suppression of pest population. Due to spraying of spurious chemicals on fresh vegetable crops, pesticide residues remain in the produce, causing health hazards to human beings and also leading to the development of resistance and resurgence in pests (Gopi *et al*., 2019). The high

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levels of pesticide residues have been detected in cabbage, cauliflower, tomato, capsicum, leafy greens, okra and brinjal. Therefore, it is the need of the hour to develop alternate methods for pest management. In this context, integrated pest management with special reference to Ecological engineering/Crop diversification/Habitat manipulation seems to be the most appropriate approach to achieve sustainability in production.

Ecological engineering

The ecological engineering means, it is the manipulating farm habitats by planting various nectar and pollen yielding flowering plants around main field as inter crop, border crop, trap crop, repellent crop, attractive crop, barrier crop, hedge rows, shelter beds *etc*., making less favorable for multiplication and survival of pests and more attractive to the beneficial insects like predators, parasitoids and pollinators. The goal of ecological engineering is to implement suitable crop diversification, which protects crops from insect pest damage by promoting biocontrol service. Previous studies on habitat manipulation significantly augmented the entomophages and increased natural suppression of pests in okra and cotton (Deepika, 2016).

Concept of Ecological engineering

Ecological engineering is an important integral tool of the IPM which includes the integration of barrier, trap, border and inter crops along with the main crop in which border crops act as physical barrier and prevent the movement of sucking pests movement from one field to another. Further, trap crops attract the insects like fruit borers so as to escape the egg laying or infestation by borers on main crop. Similarly, intercrops during effective flowering period encourages the conservation of natural enemies by providing food source like pollen, nectar and shelter. Repellent crop by its odor repels the insect pests movement away from the main crop and during its flowering period attracts the pollinators and natural enemies which helps in pollination in cross pollinated crops and often cross pollinated crops (Gopi *et al*., 2019).

Approaches

a. **Top down:** Targeting 2nd tropic level (herbivorous pests) by attracting 3rd tropic level (natural enemies) by 1st tropic level plants by planting/ practicing habitat manipulation.
b. **Bottom up:** Targeting 1st tropic level, manipulation of agro ecosystem and conservation of natural enemies.

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Prerequisites to develop Ecological engineering

1. Identification of insect pests attacking on particular crop and its natural eniemies exisistance
2. Study of biology of insect pests and natural eniemies
3. Identification of insectary plants in particular area, plants should provide rich source of nectar and pollen
4. Matching and planting of particular insectary plants against insects and natural enemies.

Thumb rule for choosing an insectary plant:

1. Plants should bloom continuously thought the year.
2. Maintaining plant, flower color, flower size and flower diversity around the field.
3. Native flowering/traditional verities should be grown.

Suitable crops for Ecological engineering and their role:

1. Sowing of maize or sorghum 25 days before planting or sowing of main crop acts as a barrier crop around the field and gives protection against sucking insect pests like aphid, leaf hoppers, whiteflies, thrips, mealy bugs and hemipteran bugs. Further cobs can be harvested and marketed which is an alternative income for the farmers.
2. Planting of 25 days old marigold as trap/inter or border crop attracts the adult moths and avoids the egg laying and feeding on main crop. Planting of one or two rows of marigold for every 25 rows of tomato (1:25 or 1:15) was recommended for attracting and trapping of *Helicoverpa armigera*. Planting of muster seeds were recommended as trap crop in cabbage and cauliflower for trapping of diamond back moth. Planting of castor as trap crop around main field was recommended to trap *H. armigera*
3. Planting of cow pea as inter crop (1:5 or 1:10) attracts the syrphid flies and coccinellid beetles which are predators and they actively catch the insects and helps in pest reduction in the field. During flowering stage syrphid fly adults are attracted and it is a good pollinator which wills increases the yield and fixes the atmospheric nitrogen in the soil.
4. Sowing of coriander seeds 25 days before planting or sowing main crop as inter crop (1:5 or 1:10) repels the insect pests of main crop and attracts beneficial insects during flowering stage by providing nectar, pollen and shelter (Push pull method). Sowing of coriander was recommended in in brinjal to repel the leafhopper damage.

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Eco-friendly techniques followed in Ecological engineering to minimize pest attack before and after sowing/planting:

1. Summer ploughing and incorporation of green leaf manures in to the soil during field preparation.
2. Application of neem cake at 2.5 q/ha and FYM during field preparation which gives protection against sucking pests.
3. Seed treatment with imidacloprid 600 FS at 10 ml/kg seeds gives protection against sucking pests.
4. Installation of pheromone traps.
5. Limited and selective use of green labelled pesticides if needed after trying with botanicals, bio rations and bio control agents which are safe.

Advantages of Ecological engineering

- Reduced the toxic load in agro ecosystem, residues in produce, development of insecticide resistance and resurgence of pests.
- Reduces the environmental pollution.
- Conservation of natural enemies like predators, parasitoids and pollinators.
- Provides the micro climate for the multiplication of natural biological agents like *Metarhizium anisopliae*, *Beauveria bassiana*, *Metarhizium relyi* and *Lecanicillium lecanii* etc.
- Cost effective and easily adoptable for sustainable pest management.

Conclusion:

From the foregoing discussion, it can be concluded that Ecological engineering is another form of conservation of natural enemies and pest management in which cropping system is altered to enhance the effectiveness of the natural enemies. Adult parasitoids and predators significantly benefited from source of nectar and the protection provided by the refuge. Mixed cropping system increase the diversity of habitats and provide more effective shelter and alternative food source to natural enemies.

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