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Ecological Engineering: An Innovative Approach for Pest management

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Abstract

The ecological and behavioural interactions of the pestiferous species with elements in the environment and through investigation and information about the susceptible links in the pest life cycle helps us to devise innovative pest management approaches. Ecological Engineering or manipulation of the environment in which pest proliferates is one such example of Conservation Biological Control that aims to favour the natural enemy population within the agricultural ecosystem. The natural enemy is provided with quality food resources, suitable shelter, alternative hosts under adverse condition of absence of hosts, supplementary resources and host plant characteristics are selectively manipulated to favour natural enemy population, enhancing bio control potential of the agro ecosystem. This brief review thus details about the augmentative strategies to be considered for biological intensification of agro-ecosystems.

Keywords: Agro-ecosystem, Biological control, Ecological engineering, Habitat manipulation

Introduction

Ecological engineering is defined as the environmental manipulation by man using small amounts of supplementary energy to control systems in which the main energy drives are still coming from natural sources (Odum, 1962). Therefore, ecological engineering is a technical design developed by humans that is compatible and symbiotic with natural environment. This emerging technology makes a conscious effort to boost up the plant and natural enemy diversity of an area, maintaining sufficient refugia (hedge rows, cover crops, pest-susceptible plants, weeds) for magnification of natural enemy population, habitat manipulation by alteration in existing cropping systems, mixed plantings etc all of which provide natural enemies with abundant pollen, nectar, alternative hosts/prey items, physical

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refugia, moderate microclimate, shelter, overwintering and lekking sites that favour their health and reproduction potential. Therefore, the prime philosophy of the technique is to effectively manipulate the agro ecosystem with consistent ecological experimentation and low input of energy and materials to escalate bio control potential of a system.

Habitat Manipulation

There are basically two approaches to manipulate a given agro-ecosystem:

- **Top-down approach**: In this approach natural enemies or bio-agents belonging to the third trophic level exert a control over the pest population or insect herbivores.
- **Bottom-up approach:** It deals with suppression of the pest species resulting from non-natural enemy effect as diluting the resources available for pest consumption, enhancement in plant diversity, inclusion of cover crops or mulches that harbour natural enemies, modification of morphological and physiological traits of plants to tolerate or resist pest attacks.

Examples as use of straw shelters for spider refugia, using bamboos to facilitate movement of predatory ants in citrus orchards and overwintering sites during cyclic farming disturbances.

Techniques of Ecological Engineering

Enhancement of the biodiversity in the area, judicious and selective use of pesticides, alternate food source as host/prey, maintaining refugia, improvement in microclimate, behavioural manipulation, host plant resistance, other cultural practices are the basic underlying principles of ecological engineering. Other alternative strategies can be quoted as planting of herbal rows within crops, hedgerows, mixed cropping patterns, field margins and border crops, polycultures and encouraging agroforestry activities inexorably enhances ecosystem diversity leading to pest suppression.

- **Providing natural enemies with quality resources:** Selection of crops with high natural enemy visitation rates, extra-floral nectaries, floral resource subsidies, honey dew, nectar, floral weeds, pollens etc provide carbohydrates and proteins to natural enemies.
- **Alternative food sources:** Floral nectar, extra-floral nectar (cotton, faba beans), Honeydew producing insects, food sprays (For instance, Envirofeast attracts

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Coccinellidae, Lygaeidae, Nabidae, Chrysopidae, Melyridae) and hymenopteran and dipteran parasitoids.

- **Shelter and Microclimate:** Accumulating leaf debris of peppermint on orchard floor, putting vegetable debris at bases of apple trees, etc, followed by minimising temperatures and increment of humidity by inter planting crops as rye grass in the maize field augment natural enemy population.
- **Floral Strip cropping:** Buckwheat and alyssum floral strips are to favour fecundity, longevity, reproduction, and fitness of natural enemies by providing pollen, nectar, shelter etc.
- **Beetle banks:** These are the raised earth banks for overwintering beetle population with perennial grasses. Non-host crops may also serve as oviposition substrate for natural enemies.
- **Alternate prey or hosts; management of residues,** stubbles and organic matter increase detritivores and generalists as carabids and chrysopids apart from improving soil properties.
- **Integration of multiple mechanisms** mentioned above may suitably enhance pest population.
- **Avoiding negative side effects:** Risk of such type can be managed by selectively provisioning food plants that favour natural enemy but not the pest or herbivore.
- **Other cultural methods:** Field sanitation, crop residue management, soil management, effective and timely irrigation, timely planting, etc helps to maintain healthy ecosystems.
- **Erecting Wind-break designs:** Natural enemy population as those of carabids and staphylinids concentrates at the edge of multi-row wind-breaks.
- **Enhancement of natural enemy diversity:** High vegetation as trees maintains the vertical structure needed for spiders and birds, small herbs, shrubs etc favour ichneumonids, and syrphids improving structural and cultural diversity.
- **Chocolate-box ecology:** The colourful floral display by the flowering plants to enhance the diversity of natural enemies and biological control is referred as chocolate-box ecology. The appropriate botanical composition of the filed must be

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determined after employing suitable selection criteria stressing on the quality of diversity.

- **Push-pull or stimulo-deterrent diversion strategy:** Behavioural manipulation by combined use of suitable attractant trap crops and deterrents to repel the pests from the crop and attract them towards suitable trap crop which are subsequently removed is the main idea of push-pull strategy. For e.g., for maize stem borers, Napier and Sudan plants serve as trap crops whereas molasses and Desmodium are known to repel them.

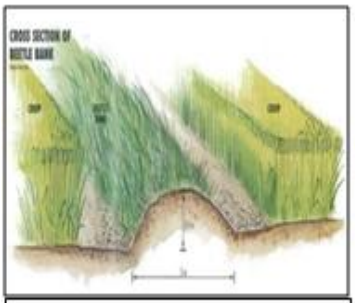

Fig 1. Beetle bank

Fig 2.Chocolate box ecology

Fig 3. Push-pull

- **Ecological Engineering as a Tool for managing above ground pests**: Raising flowering plants around orchard based on canopy height with the low plants towards main crop and high plants away from it prevent pest migration and attract natural enemies, growing weedy florals in the internal bunds, and limited use of broad-spectrum insecticides can manage above ground pests.
- **Ecological Engineering as a Tool for managing below ground pests:** Add organic matter and crop residue to soil, maintain cover crops, minimise tillage operations, optimum inputs of fertilisers, strengthening the microbial consortia in soil ecosystem helps to manage below ground pests.

Constraints and Future Prospects

Research investigating tri-trophic interaction and role of natural enemies in pest control needs to be strengthened, integration of conservation and manipulation techniques for proper pest management needs to be stressed, development of viable technologies to enhance natural enemy interactions, culminating the extension gap between lab and land, wide area acceptance of semio-chemicals must be implemented to make Ecological Engineering a viable option for acceptance in IPM programme.

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Conclusion

Ecological Engineering encompasses integrated human efforts for manipulation of environment following ecological principles to develop agro-ecosystems that are sufficiently stable and diverse. This technology magnifies bio-agents and natural enemies released by classical or augmentative methods and maximise their impact on pest population of a given area protecting fragile agricultural environments. Such strategies also discourage the use of broad-spectrum pesticides, enhancing biodiversity and facilitates soil conservation and fertility maintenance, improves rural income, and empowers women subsequently ameliorating the quality of life.

Reference

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