AgriCos e-Newsletter
ISSN: 2582-7049
AgriCos e-Newsletter
Open Access Multidisciplinary Monthly Online Magazine
Volume: 04 Issue: 10 October 2023 Article No: 15

Habitat Management in Pest Control: Objectives and Technique

Chaitra Sarawad[1] and Archana Anokhe[2]
[1]Division of Plant Pathology, ICAR- Indian Agricultural Research Institute, New Delhi
[2]Division of Entomology, ICAR- Indian Agricultural Research Institute, New Delhi

SUMMARY

Habitat management has emerged as a pivotal strategy in the effective control of pests and diseases in agricultural ecosystems. This abstract delves into the historical evolution, definition, pressing need, overarching objectives, diverse approaches, and innovative habitat manipulation techniques, such as intercropping, strip cropping, cover cropping, trap cropping and many other techniques. Some habitat management techniques like, strips which are tall have more natural enemies' population compared to recently harvested strips. Kairomone extracts from scales of H.armigera enhances the effectiveness of predator Chrysoperla sp. and egg parasitoid Trichogramma sp. when applied to cotton fields. The establishment of an elevated "Beetle Bank" featuring perennial grasses within the field will furnish a conducive overwintering habitat for numerous natural enemies. Habitat management approaches are top down control, bottom up control and ecological engineering techniques. Effect of cultural practices on biodiversity of natural enemies and abundance of insect pests is also been discussed. In conclusion habitat management plays an integral role in modern pest and disease control strategies, aligning with the principles of sustainable agriculture.

INTRODUCTION

Habitat management is combination of two words 'habitat' and 'management'. Habitat is derived from Latin word habitare meaning "to live", and it is defined as an area with specific environmental conditions in which an organism lives and reproduces, for example Raft spider found in acidic bog habitat. Hence, habitat management refers to the deliberate manipulation of the environment surrounding crops to disrupt pest and disease life cycles, reducing their impact on agricultural yields (Kumar *et al*., 2013). Habitat can be managed within-crop, within-farm or at the landscape level (Landis *et al*. 2000). It involves altering crop arrangements, crop diversity, and other environmental factors to create unfavorable conditions for pests and diseases (Gurr *et* al. 2017). Habitat modification encompasses the adjustment of the agricultural environment to bolster or amplify the efficiency of indigenous predators and parasitoids. Numerous mature parasitoids and predators derive advantages from nectar sources and the safety offered by sanctuaries like hedge rows, cover crops, and weed borders. The inclusion of various plant species within the cultivation can elevate habitat variety, furnishing supplementary sustenance and refuge options for indigenous natural enemies.

Two potential mechanisms or habitat management approaches by which plant diversification can modify the behavior of herbivores or improve biological control have been identified:

1. Natural enemies' hypothesis (Russell 1989): predators and parasitoids are more abundant in mixed cropping than pure monocrop stand. This is also known as 'top–down' by Hunter and Price, (1992). Because, here herbivores (second trophic level) are suppressed by the natural bio-agents (third trophic level).

2. Resource concentration hypothesis (Root 1973): Specialist herbivores are more likely to find, remain on and successfully reproduce in pure stands than in mixed plant assemblages. In other words, it states that the probability of finding preferred prey/hosts by herbivores is reduced in diversified plant assemblages which can lead to reduced damage to the main crop. It is also known as ' bottom- up approach ' because, in this approach, manipulation within crop, such as green mulches and cover crop (first trophic level) will act on pests directly. (Kumar et al., 2013)

History:

For over 2000 years Chinese farmers have used straw shelters for overwintering spiders, which can support spider communities in cyclic farming disturbances (Dong and Xu, 1984). In Burma (1770s) farmers used connecting bamboo canes between citrus trees to enable predatory ants to move between the trees. Likewise, trap cropping (i.e., in which a preferred trap crop is grown next to the main crop to attract, repel or intercept insect pests) was practised over 200 year ago in Europe where people used trap trees or wood logs to attract and 'capture' the spruce bark beetle, *Ips typographus* DeGeer (Coleoptera: Curculionidae) (Bakke and Riege 1982). In Vietnam, Thailand and China, rice farmers have started to use rice bunds to sow sesame, *Sesamum indicum L*. (Pedaliaceae) to improve the biological control of the rice brown planthopper, *Nilaparvata lugens* (Hemiptera: Delphacidae) (Gurr *et al*. 2016) and other pests.

Objectives:
1. Reduce pest and disease populations.
2. Minimize reliance on chemical pesticides.
3. Enhance biodiversity within agroecosystems.
4. Improve soil health and nutrient cycling.
5. To create suitable ecological infrastructure.
6. For enhancing habitat suitability for natural enemies.

Different types of habitat management or habitat manipulation techniques:

1. Intercropping:

It is more beneficial to generalist species of natural enemies than to specialists. Intercropping decreased the pest population in 56% of cases. This form of habitat management also acts by creating a physical barrier, restricting inter-plant pest movement, or providing floral resources for the pests' natural enemies (Smith and McSorley, 2000)

Ex: Intercropping chickpea with coriander was found to increase the activity of *Campoletis chloridae* (larval endoparasitoid wasp) and decrease the population *Helicoverpa armigera.*

2. Trap cropping:

Trap crops have been strategically utilized to allure, redirect, intercept, and/or confine insect pests with the aim of mitigating their harm to the primary crop. After the pests have congregated in the trap crop, they can be effectively controlled through the implementation of highly focused pesticide applications or by physically eliminating the supplementary vegetation and the pests within it (Hokkanen 1991, Pickett et al. 2014, Reddy 2017). In chinese cotton fields, the 'weed' velvetleaf *(Abutilon theophrastis* Medicus, Malvales: Malvaceae) harbored B*emisia tabaci* Gennadius (Hemiptera: Aleyrodidae). Applying insecticides to the velvet leaf after pests accumulated on it was enough to control them in commercial cotton fields.

3.Providing refugia crops:

Plants that provide refuge for natural enemies during adverse periods, such as winter at elevated altitudes or dry spells in tropical regions, are designated as such. Man-made grassy mounds, often referred to as "Beetle banks," are meticulously sown on raised earth banks (Thomas et al. 1992). These banks are typically planted with perennial grass species, including Cocksfoot (*Dactylis glomerata*) and Yorkshire fog (*Holocus lanatus*).

4.Cover crop:

In contrast to regions of exposed, ploughed soil, cover crops were observed to bring down the soil temperature, elevate the levels of relative humidity (RH), and enhance the accessibility of free water. But predicting the impact of a specific cover plant on the population of natural predators can often be a challenging task (Letourneau, 1998; Barbosa and Wratten, 1998).

5. Micro climate:

Uncovered soil tends to be less conducive for a variety of natural predators due to its elevated temperature, diminished relative humidity, and reduced soil moisture content. The cultivation of rye grass *(Lolium multiflorum)* proves beneficial in mitigating the heat of the soil surface within maize *(zea mays)* fields. This, in turn, augments the viability and persistence of *Trichogramma brassicae*, a parasitic wasp that plays a pivotal role in pest control. Mulching with straw or plastic is beneficial to natural enemies (Mathews et al. 2004, Zehnder et al. 2007)

6.Transgenic Crops:

The infusion of desired genetic traits into crops, which encode proteins lethal to pests, has successfully been accomplished in cotton, corn, and potato cultivations. By and large, transgenic crops are safer to predators and parasitoids within the ecosystem.

7. Cropping practices: like_

(i) Tillage: Intensity of soil tillage, the method used, the number of operations, the frequency, and the period of soil cultivation have an impact on predatory arthropods. Abundance and diversity of the soil fauna tend to increase with decreasing tillage intensity

(ii) Strip Harvesting*:* leaving a small portion of crops in a field during harvesting to provide natural enemy refuges. The harvest method of strip-cutting in Lucerne was discovered to boost the population of predators and parasitoids. Strips exhibiting taller vegetation harbored a higher abundance of natural enemies compared to recently harvested ones. This observation highlights that the predation of *Helicoverpa armigera* eggs by *Trichogramma spp*. is more pronounced in undisturbed strips with a dense population of parasitoids (Kumar et al.,2013).

(iii) Fertilization*:* Aphid populations associated with Brassica crop plants are particularly known to increase in response to higher soil nitrogen levels (Altieri and Nicholls, 2003). It was demonstrated that parasitoid, *Diadegma insulare* (Cresson) a wasp parasitoid of the oilseed rape pest, *Plutella xylostella* (Diamond back moth) performed better on plants grown with high levels of fertilizer.

(iv) soil management*:* The soil serves as a significant repository for insect pathogen inoculum. As explained by Kumar, L *et al*., 2013, the Nuclear Polyhedrosis Virus (NPV) targeting the cabbage looper *(Trichoplusia ni)*, which exhibits greater longevity in soils with lower acidity levels. It has been advised to apply lime to the soil as a measure for conserving this virus.

(v) Water management*:* Adjusting the levels of relative humidity and regulating periods of moisture exposure (by means of crop arrangement and irrigation techniques), along with considering factors like phylloplane composition including pH, amplifies the presence of pathogens among arthropods. Proper watering can heighten the effectiveness of *Verticillium lecanii* in controlling aphids within a greenhouse environment (Yogi, M. K., and Jagdish, J., 2013).

*(***vi) Crop residue management***:*.The retention of unburnt sugarcane crop residues in the field has proven to be a beneficial strategy for enhancing the population of parasitoids such as *Epiricania melanoleuca* and *Parachrysocharis javensis*, which target *Pyrilla perpusilla.* This approach to crop residue management, as highlighted by Odum (2003), has demonstrated effectiveness in supporting the populations of these natural enemies, ultimately contributing to pest control in sugarcane fields.
fields.

Constraints and Future Prospects:

- Need to strengthen the research in improving the efficiency of the natural enemies. Integration of the conservation and manipulation techniques in the IPM modules should be done and be tested for proper pest management practices for different crop pests.
- Periodically conducting training programs for extension workers and farmers.
- A concerted research effort between different disciplines like Plant breeders, Agronomists, Soil scientists, Pathologist and Entamologists is needed to develop technologies for conserving and increasing efficiency of natural enemies.
- Studies should be conducted in larger area so that it inspires adoption by large number of farmers, by generating good amount of data.
- Removal of extension gap between researchers and farmers is important for the success of conservation and manipulation techniques. Convincing farmers to avoid clean cultivation, burning of crop residues and deep ploughing as these cause severe damage to natural enemy population.
- It is socially acceptable, economical and environmentally safe technique. Hence, habitat management play major role in future prospects and strategies of pest management.

CONCLUSION

Habitat management is human activity that modifies the environment according to ecological principles. It is the form of augmentation and conservation of natural enemies in which cropping systems are altered accordingly. The effect of habitat management on trophic interactions show that farming practices play an important role in regulating natural enemy and pest populations. Adult parasitoids and predators significantly benefited from source of nectar and the protection provided by refuge (hedge rows, cover crops and weedy borders). Mixed planting increase the diversity of habitats and provide more effective shelter and alternative food source to predators and parasites. Pesticides toxicity risks can be avoided by following habitat management, which inturn increases encourages natural biological control. Future of IPM lies in increasingly sophisticated ecological and habitat management techniques.

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