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HABITAT MANIPULATION- A TOOL TO MANAGE INSECT PESTS

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ABSTRACT

Habitat manipulation results in diversification of habitats and enables natural enemies to access resources. Effective conservation biological control provides tactics that enhance the relative abundance of effective predator among the predators. Varying types of resources provide protection, suitable microclimatic conditions, oviposition sites and plant-provided food (pollen and nectar) by increasing vegetation diversity which favour the attraction and retention of natural enemies. Landscape management may be important if successful biocontrol has to rely on a wide range of natural enemies. The density of some common species can indeed be increased through enlarging the community, however species richness is often determined by the landscape composition. The intercrop may create the favourable microclimate to hasten the activity of predators and parasitoids while hindering the pest survival. The choice of the intercrop also plays a significant role for the effectiveness of biocontrol.

Key words: Habitat manipulation, microclimate, intercropping, covers crops, natural enemies, predators, biological control, cultural practices

Habitat manipulation, often known as "Ecological Engineering", focuses on reducing natural enemy mortality, giving more resources, and changing host plant characteristics for the benefit of natural bioagents. It can be accomplished by improving plant diversity within the agroecosystem by providing suitable refugia. Habitat manipulation is a new concept in biological control that increases biodiversity and leads to agro-ecosystem stability and sustainability (Kumar et al., 2013). The enhancement of natural enemy populations by agricultural system changes is also part of habitat manipulation. The addition of extra resources for natural enemies, like pollen, nectar or alternate prey, through habitat diversity, has shown to increase the percentage of natural enemies in the field (Landis et al., 2005). Agricultural habitats will be changed in order to increase predator population or diversity, with the ultimate goal of improving biological pest management (Root, 1973; Barbosa, 1998; Landis et al., 2000). Shifting the cropping system to increase the effectiveness of a natural enemy is known as habitat manipulation. Many adult parasitoids and predators like nectar sources, so refuges such as grasses, thin borders and cover crops provide refuge. Mix crops can increase the diversity of ecosystems and present natural enemies with alternate food sources and refuge. The key to effective biological control in conservation is to create strategies that increase the relative abundance of the most effective predator within the predator community, as well as various expanding vegetation diversity, we can supply more resources like as refuge, oviposition sites, acceptable microclimatic conditions, and plant-provided food (nectar and pollen) (Straub and Snyder, 2006; Andow, 1991).

In agricultural settings, where wide monocultures are typical, providing any non-crop plant or resource from which a natural enemy can benefit is essential. For example, the cultivation of strip crops around a wheat field may provide the floral resources required by hover flies adults, reducing the amount of space the adults must forage for food and possibly increasing the number of hover flies in the region. It has been observed that predators and parasitoids aggregate around plants with rich various sources (Berndt et al., 2002; Hickman and Wratten, 1996; Hooks et al.,1998; Root, 1973; Van Emden, 1963) and other research shows that floral resources help parasitoids increase their reproductive success by increasing their longevity and fecundity (Arthur, 1945; Dyer and Landis, 1996; Jacob and Evans 2000; Heimpel et al., 1997; Jervis et al., 1993; Wheeler, 1996), which this might cause reduced number of pests in the field (Irvin et al., 2000; Patt et al., 1997). Natural enemies will be highly polyphagous to utilize other diets during periods of low pest population, even if they do not demonstrate life-history omnivory. On farms, habitat alteration may provide natural enemies with nutrients such as pollen and non-pest herbivores until pest numbers begin to improve. The main function of these strategies is to improve diversity while also preventing insect pest attacks caused by vegetation.

Intercropping is defined by Andrews and Kassam (1976) as the planting of two or more crops in same region, as its supplementary crop sown in rows or strips within the primary crop. Due to the close proximity of appropriate refugia, intercropping has the benefit of promoting natural enemy dispersal to the most crop. The ideal supplementary crop placement should be determined to increase natural enemy transmission out of the most crop, allowing for maximum predation or parasitism rates. Insect pest outbreaks are more likely in monocultures than in diversified crop conditions, which has long been associated as a potential for pest management through habitat manipulation. According to Root (1973), pest densities were found to be lower in poly-culture of cabbage (kale) and grassland flora than in crops of cabbage. Numerous habitat manipulation studies such as the incorporation of various flowering plants into crops have shown the potential and applicability of this pest control method (Baggen and Gurr, 1998; Bostanian et al., 2004; Lee and Heimpel, 2005; Irvin et al., 2006). Strip harvesting was discovered to be advantageous to natural enemies in Lucerne. Strips that grew taller had a greater population of predators and parasitoids than strips that were harvested recently (Kumar et al., 2013).

Predators, parasitoids, and herbivores are examples of beneficial invertebrates that help increase or maintain crop production by reducing pest insect and weed populations. In many agricultural systems around the world, parasites, predators, and Entomopathogens are key factors of pest control for predatory insects, whereas larval herbivores and crop pathogens are used for biological weed control. Pest control by natural enemies is now a horny alternative due to rising chemical costs, a shrinking variety of accessible pesticides, and increased customer awareness of pesticide residues on fresh produce (Bostanian et al., 2004). Whenever natural enemies are given resources that are limited in agro-ecosystem (Barbosa 1998; Pickett and Bugg 1998; Gurr et al., 2004; Landis et al., 2000; Jonsson et al., 2008). This method can increase biological control, but it frequently needs a thorough understanding of natural enemies and, like a result, the most appropriate, selective resources to deploy.

Enhancement of natural enemies

As part of habitat management, natural enemies should be provided materials that are necessary for organisms but have no disadvantages. The presence rate of natural enemies inside the field was studied as a suitable technique of show vast numbers of food vegetation (Fiedler and Landis, 2007). This technique can provide information on the attractiveness of food crops, which is an important element when determining which vegetation kinds to supply for biocontrol.

Crop diversification

Herbivores, parasitoids, and predators may benefit from increased availability of food sources like nectar. Also as result, cautious plant selection is necessary to avoid increasing pest populations or providing an alternative host for a plant pathogen or other insect pests. A selective diversification with plants which are botanically unrelated to the crop is required Gurr et al., (1998), proposed a checklist approach that enables a semiquantitative assessment of hazards similarly as economic and biological factors. Food supplies are provided via wildflower strips (nectar, pollen, alternative prey, honeydew-producing insects). If there is enough alternative prey, generalist predator populations can develop foothold within a crop prior to the arrival and seasonal increase of pests (Van Emden, 1990). In order for natural enemies to succeed, habitat management must provide them with sources that are always limited for these organisms that do not provide anything new and exciting. Crop diversification can help the natural enemy population thrive during survival situations or off-seasons when their main food source is declining and not under cultivation. Every plant's attraction to natural enemies must be studied, which is an essential thought while choosing which crop species to grow for bio control. However, before selecting a suitable plant species for cultivation, consider the variety of natural enemies supported by the crop ecosystem, due to intra-guild predation or inter-specific communication, natural hazards enemies' diversity can sometimes have a negative impact on biocontrol (Rosenheim et al., 1993; Finke and Denno 2004, 2005; Costamagna et al., 2008). The target of IPM is to increase the impacts of parasitoids on pests (Holland and Thomas 1997; Furlong et al., 2004; Agarwal et al., 2007). Pesticides non-target impacts are reduced by altering the environment to increase habitat biodiversity (Gurr et al., 2004).

Habitat diversity: Crop diversification within a field can benefit over the duration of the crop cycle, and that in the case of field crops, the overall habitat is commonly diversified by the addition of perennial components to help in the survival of natural enemies. Hedgerows, shelterbelts, conservation headlands, and beetle banks will all be planted with permanent plants to promote habitat diversity (Gurr et al., 2004) if the diversity of species within the refuges and neighbouring areas can grow with the refuge's age (Frank, 1997), these structure might have to be conventional for several duration to manage their complete possible. The supply of beetle banks is one method for increasing natural enemy populations through habitat diversification. These are recognized by grass-covered soil banks in the central of grassland (Thomas et al., 1991, 1992). Tiger beetles (Cicindelinae), predatory carabids, rove beetles (Staphylinidae), sphecoid wasps, and even a number of the spiders that make nests in the ground can find protection and overwintering grounds in these places (Thomas et al., 1991, 1992) and variety (MacLeod et al., 2004). Although increasing predation has been recorded around beetle banks (Collins et al., 2002), this effect is not widespread (Prasad and Snyder, 2006).

The development of blooming strips to provide nectar from flowers as nutrients for natural enemies also is excellently technique of ecosystem management to protect natural predators (Pfiffner and Wyss, 2004; Gurr et al., 2005; Heimpel and Jervis, 2005). If effective biological control requires on a wide range of biological predators, landscape managing is important (Tscharntke et al., 2008). The density of such common species can be increased by management; however species richness is often determined by the landscape composition (Roschewitz et al., 2005; Schmidt et al., 2005; Schmidt et al., 2008). The addition of organic amendments to the soil, such as composts, crop grasses, or animal wastes, resulted in increased in the number of general predators in many agro-ecosystems (Badejo et al., 1995; Brust, 1993; Culliney and Pimentel, 1985; Litsinger and Ruhendi, 1984; Larsen et al., 1996; Pimentel and Warneke, 1989; Morris, 1922; Riechert and Bishop, 1990).

Cover crops: Cover crops provide a ground cover and their flowers can act as attractants for the natural enemies by providing pollen and nectar other than altering the microclimate which is suitable for the natural enemy population. Cover crops, on the other side, can act as weeds if not managed effectively, competing with both the crops for nutrients and water (Bugg and Waddington, 1994; Meyer et al., 1992; Nyczepir et al., 1998), They'll likely improve production value or reduce yields (Brown and Glenn, 1999) , Annual plant vegetation, whether grown for nuts and seeds or moderately (perhaps designated areas for biological diversity), can create a complex environment, specifically when understory vegetation is present to provide various levels. These types of environment components can host combinations of beneficial and pest invertebrates with a wide range of trophic connections (Bugg and Waddington, 1994; Altieri and Schmidt, 1985). Recent events in study of selection processes appeared to be promising for identifying flower species that serve the needs of parasitoids while providing utility to pests. It's frequently difficult to forecast how a particular covering plant may affect the number of natural enemies (Letourneau, 1998; Barbosa and Wratten, 1998). Very less research has been carried on the usefulness of canopy crops in pest management because the primary function of such crops is to supply a ground cover and not the enhancement of the predator populations.

The effect of canopy crops on beneficial organisms may generally be examined by looking at insect-natural enemy complexes, which include insect and enemy dispersal capabilities, environment needs, and resources required for reproduction and survival (Ferro and McNeil, 1998). for example, Manipulation of land cover structure within a crop and its surrounding vegetation, such as, can improve biological control of certain arthropod pests. However, by intensifying other insect species, increasing a crop disease, or adding a weed species, it can have the opposite influence on the overall target of included production (Prokopy, 1994; Barbosa and wratten, 1998). Improved crop cover can sometimes induce hyper parasitism of natural enemies by attracting secondary parasites, resulting in an increase in pest numbers (Stephens et al., 1998). Pests of natural nemies adversaries can get in each other's way. Through a widespread effect below the trophic level, such impacts may result in reduced crop growth (Snyder and Wise, 2001).

Intercropping and mixed cropping: Intercropping is the farming of two or many crops in different field, with the supplementary crop often seeded in rows or sheets alternating within the main crops, whereas mixed cropping is the planting of various crops on the same piece of ground with no regard for row proportions (Andrews and Kassam, 1976). The proximity of adequate refugia facilitates natural enemy dissemination to the major crop, which is a major advantage of intercropping. This is ready to support a greater load of natural enemies through the provision of subsidies within the type of nectar and pollen to optimise movement of biological control into the major crop, so predation or parasitism rates succeed, the effective distance of secondary crops must be determined. Intercropping cereal crops through molasses grass (*Melinis minutiflora*) improved stem-borer parasitism by Cotesia sesamiae in Africa (Khan et al., 1997). Intercropping can produce refuge or nutritional sources for natural enemies by growing crop or non-crop plants in close proximity to the major crop. The intercrop can even create the favourable microclimate to hasten the activity of predators and parasitoids while hindering the pest survival. The choice of the intercrop also plays a significant role within the effectiveness of Bio control. Natural enemies were observed in wheat field follow maize crops rather than alfalfa crops. (Gallo and Pekar, 1999). As the period since pasture increased, beneficial insect numbers in a wheat agroecosystem reduced.

Other cultural practices: Ploughing, growing, and harvest are examples of cultural methods that can drastically affect the quantity of predators such as spiders, birds, and small animals. Clean cultivation of a fields or nearby trees can help crops survive, but it also kills animals, small rodents, insects, and carabids that rely on the vegetation for protection. Other cultural practices like soil management e.g., NPV of cabbage semilooper (*Trichoplusia ni*) is more persistent in less acid soils and liming of soil for virus conservation. Watering was found in increase efficacy of *Verticillium lecanii* in greenhouse aphids. Crop residue management is found effective for parasitoids viz. *Epiricania melanoleuca*, *Parachrysocharis javensis* on *Pyrilla perpusilla* if crop residues of sugarcane were left unburnt in field (Odum, 2003).

CONCLUSIONS

Habitat manipulation is a new technology in biological control that promotes biodiversity and ensures the stability and sustainability of the agro-ecosystem by enhancing predator species, which helps in pest biological control while also increasing food resources (nectar, pollen, alternative prey, honeydew-producing insects of natural enemy). The mixture of natural enemies supported by the crop ecosystem must even be considered before selecting an appropriate plant species for cultivation, Increased natural enemy diversity may have a negative influence on bio control agents in some situations because to intra-guild preying or inter-specific interaction. If bio control relies on a diverse spectrum of natural predators, landscape management could be critical. It may enhance the properties of some common species, however species diversity is usually determined by the community structure. Clean cultivation of a fields or surrounding trees can make crops grow, but it can also harm birds, smaller animals, insects, and carabids that depend on the trees and shrubs for refuge.

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