ARTHROPOD PEST CONTROL IN AGRO ECOSYSTEMS BY HABITAT MANIPULATION: A BRIEF REVIEW

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Abstract

Habitat manipulation involves altering the cropping system to conserve, augment or enhance the effectiveness of a natural enemy. It is also called as ecological engineering, aims to improve the living conditions for natural enemies. The conservation and maintenance of biological control as an ecosystem service depends directly on the adoption of farm design and cultural practices that favour the local fauna of natural enemies. Therefore, there is a need for understanding multiple ecological interactions between natural enemies and biotic and abiotic components of agro ecosystems in order to prevent pest damage. This paper is a brief review on arthropod pest control in crops.

Keywords: Habitat, manipulation, arthropod, pest control

Introduction

Habitat manipulation, a form of conservation biological control, is an ecologically based approach aimed at favouring natural enemies and enhancing biological control in agricultural systems. The goal of habitat management by manipulation is to create a suitable ecological infrastructure within the agricultural landscape to provide resources such as food for adult natural enemies, alternative prey or hosts, and shelter from adverse conditions. Agricultural landscapes are dominated by novel habitats because the foundations of agro ecosystems, the crops themselves, are almost always exotic; for example nearly 90% of crops grown in the United States originated from elsewhere in the world [1].

Habitat manipulation involves altering the cropping system to conserve, augment or enhance the effectiveness of a natural enemy. Habitat manipulation also called as ecological engineering, aims to improve the living conditions for natural enemies within the agro ecosystem, by introducing resources needed for fulfilment of their vital requirements. To favour biological control, habitat manipulation in agro ecosystems should provide suitable resources and conditions for the conservation and maintenance of natural enemies in the farm level. The conservation and maintenance of biological control as an ecosystem service depends directly on the adoption of farm design and cultural practices that favour the local fauna of natural enemies. Therefore, there is a need for understanding multiple ecological interactions between natural enemies and biotic and abiotic components of agro ecosystems in order to prevent pest damage [2].

Ecological Engineering

Ecological Engineering is the emerging field of the use of ecological processes within natural or constructed imitation of natural systems to achieve engineering goals. The term "Ecological Engineering (EE)" was first used by Odum [3] to refer to the "as 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". Ecological engineering is a human activity that modifies the environment according to ecological principles. It is a useful conceptual framework for considering the practice of habitat manipulation for arthropod pest management. Ecological engineering takes advantage of the ecosystems as they combine natural resources and outputs from the economy to generate useful work.

Habitat management and pest control

Since the widespread employment of synthetic pesticides against plant pests from the middle of last century, the crop protection community has been searching for guiding principles, capable of responding both to the requirements of agricultural production and the constraints imposed by the need for sustainable development of the planet [4].

Pesticides have long overshadowed the importance of natural enemies in pest management programs. The World Health Organization estimates that there are three million severe acute poisoning worldwide each year and out of this, approximately 2,20,000 deaths are attributable to pesticides, out of which, 1% of these deaths occur in industrialized countries [5]. Most pesticides used in agriculture today are synthetic organic chemicals that act by interfering with a vital metabolic process in the organisms to which they are targeted [6]. It is estimated that nearly three fourths of deaths due to pesticides occur in developing countries [7]. The high efficacy, easy accessibility, and consistent performance of chemical controls have made them the tool of choice for growers in managing their pest problems. But frequent outbreaks of secondary pest after pesticide applications and the increasing prevalence of pesticide resistance in various pests have pointed out the risks of unilateral reliance on pesticides [8].

Environmental effects of pesticides

A majority of pesticides is not specifically targeting the pest only and during their application they also affect non-target plants and animals. Repeated application leads to loss of biodiversity. Many pesticides are not easily degradable, they persist in soil, leach to groundwater and surface water and contaminate wide environment. Depending on their chemical properties they can enter the organism, bio-accumulate in food chains and consequently influence also human health. Non target organisms such as plants, earthworms, termites, ant colonies, snakes, birds, toads, lizards and other amphibians have been affected negatively by pesticide use [9-12]. Organisms in ecosystems exist in complex interdependent associations such that losses of one keystone species as a result of pesticides (or other causes) can have far reaching and unpredictable effects. The many connections that a keystone species holds mean that it maintains the organization and structure of entire communities. The loss of a keystone species results in a range of dramatic cascading effects that alters trophic dynamics, other food-web connections and can cause the extinction of other species in the community.

Pesticides and Human Health

Pesticides released into the environment may have several adverse ecological effects ranging from long-term effects to short-lived changes in the normal functioning of an ecosystem. Despite the good results of using pesticides in agriculture and public health, their use is usually accompanied with deleterious environmental and public health effects. Increasing evidence suggests that pesticides have intrinsic public health and environmental risks during their production, import, use, storage and disposal [13]. Many pesticides used in all societies have been associated with toxicity to human [14] and others are suspected to be carcinogenic, mutagenic, and endocrine disruptors [15].

Arthropod pest management by habitat management

Crop fields harbour mixed arthropod communities, comprising species that share evolutionary histories with either the crop species or with adjacent or nearby habitats, and many species that are entirely alien to the crop and the landscape; these exotic species are either adapted to frequently disturbed systems or particular stages of succession [16]. Because of this range of evolutionary histories, arthropod communities in agro ecosystems are challenging to manage sustainably, particularly when yield and crop quality are the ultimate goals. Since the 1970s, the evolution of plant protection has been driven by an improved understanding of the functioning of ecosystems [17].

Vegetational diversity, habitat manipulation and insect biological control

Habitat manipulation involves altering the cropping system to augment or enhance the effectiveness of a natural enemy. Habitat manipulation aims to provide natural enemies with resources such as nectar [18], pollen [19], physical refugia [20], alternative prey [21], alternative hosts [22] and lekking sites [23]. Habitat manipulation approaches provide these resources and operate to reduce pest densities via an enhancement of natural enemies.

Crop habitat management is to ensure that natural enemies are present in sufficient numbers when pests become established so that pests are suppressed below economically damaging densities. Vegetational diversity can also provide support for insect biological control at the local and landscape levels [24-27]. Farmers can make some simple changes to their crop systems to manipulate vegetational diversity, through addition of plants that provide specific functions [28-30].

Pest outbreaks tend to be less common in polycultures than in monocultures [31, 32]. Crop systems that are dominated by a single plant species only provide resources to those select organisms that can exploit that single plant species. Hence, monocultures are an example of agroecosystems with low diversity and may be more susceptible to pest or disease outbreaks [33, 34]. So increasing the diversity within crops is predicted to provide a greater number of opportunities for natural enemies to survive in agricultural systems.

It is necessary the adoption of farm designs and cultural practices that will favor the local fauna of natural enemies. Increasing the vegetational diversity at the plot level was one of the strategies aiming to attract and benefit natural enemies that received much attention in the last decades [32, 35]. This is because increasing plant diversity in and around cropped areas results in a higher availability of prey and alternative resources for natural enemies, given suitable conditions for their attraction and retention even when pests are absent [28, 29].

Some forms of habitat manipulation

a. **Introduction of plant-related food:** It is one of the most well-studied form of habitat manipulation for vegetables and fruit trees. Predatory insects use plant-derived food for survival when their preferred insects prey is scarce [36, 37] as a necessary complement to their carnivorous diet [38]. Sometimes as the primary food during one development phase for so-called life-history omnivores. Examples of this are common green lacewing, *Crysoperla* spp. and syrphids, whose larvae feed on insect prey while the adults feed on nectar, pollen and honey dew [39].
b. **Floral supplement supply:** Food derived from plants can be of great importance for natural enemy performance in the field. Most predators and parasitoids have the ability to utilise nectar or pollen as additional food. Feeding on sugar-rich compounds such as nectar has been proven to prolong the life of parasitoids and promote their reproduction capacity, host search efficacy and pest control ability [40-44]. Natural enemies may show preferences for certain plant species when searching for floral-derived food [45].
c. **Providing Shelter habitats:** They can provide natural enemies with a safe haven from man-made disturbances such as ploughing and harvesting. Providing shelter habitats within the field or at field edges is a strategy that can influence natural enemy abundance, diversity and distribution patterns within the crop during the growing season [46].
d. **Providing Alternative prey and host:** From a biological control perspective, alternative prey can be a key resource to maintain natural enemies within a production area at times when pest populations are low in the field or before the crop is planted and after it has been harvested. Availability of alternative prey in field margins early in the spring can increase the abundance of natural enemies and accelerate their colonisation of the crop field later on, when pest insect populations start to build up [22].

Conclusion

Habitat management/manipulation or Ecological engineering has recently emerged as a paradigm for considering pest management approaches that are based on cultural practices informed by ecological knowledge rather than on high technology approaches such as synthetic pesticides and genetically engineered crops [47, 48]. Habitat for natural enemies needs to be tailored to the region, crop, and management system being used to ensure the greatest potential for benefits and to minimize undesirable effects on crop yield, insect pest populations, or weed pressure [49, 50]. There is a need for deeper, long-term collaboration between growers, advisors and scientists in order to develop practical and functional systems. There is a need for deeper, long-term collaboration between growers, advisors and scientists in order to develop practical and functional systems.

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