Effect of Cropping Systems on Insect Pest Management

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Introduction

At present, with the development and spread of modern agricultural techniques, the trend has been towards a more intensive monoculture system. Large and uniform stands of single species monoculture systems have obvious advantages in modern agriculture, especially with the introduction of machineries and selective herbicides. However, these developments have seriously eroded the advantages of the biodiversity provided by multi-species flora and fauna communities by predisposing towards single species communities, which have led to high levels of damage by pests and diseases. Losses from many well-known diseases, which have become increasingly difficult and expensive to control, are continuing. However, there are various cropping systems that can be used to lessen crop loss by pests and diseases.

One such approach to reduce pest populations through cultural practices is through crop diversification in space and time. Crop diversification is also part of a 'risk aversion' strategy or to minimise risks and has been practiced by traditional farmers. In a farming system where crop diversification or multiple cropping is practiced, pests and diseases can be controlled to below their economic threshold levels through increases in self-regulatory mechanisms. This includes a variety of factors such as olfactory inhibition, which masks the searching of host plants by herbivore insect. Crop diversification also functions as physical barriers, thereby restricting the movement of insect pests and fungal pathogens between adjacent rows. The diverse vegetation in a multiple cropping system will also add essential resources for predators or parasites, which in turn keep the pest and pathogen population in balance. Multiple cropping and the diversification in space is practical in conditions that are favourable for crop growth throughout the year. Initially, multiple cropping was used by farmers in Malaysia to increase the productivity of their farms. Several types of diversified multiple cropping systems are being practiced in this country namely, mixed cropping, intercropping, relay cropping, alternate cropping, successive cropping and crop rotation.

Multiple cropping: Multiple cropping' means growing two or more crops on the same field in a year. The types of multiple cropping are intercropping, relay cropping, alternate cropping, successive cropping and crop rotation.

Advantages of multiple cropping

1. Reduces the risk of total loss from pests and diseases due to an increase of self-regulatory
2. Mechanisms and the distribution of risk. At least some of the crops can escape infestation of pests and diseases.
3. Optimises crop production from small plots and thus increases total productivity per area under cultivation.
4. The legumes included in the cropping pattern helps to maintain soil fertility and often contribute in attracting natural enemies.
5. In different seasons of the year, different crops can be grown depending on the climate and weather conditions
6. Nutrients stored at different root levels of the soil can be tapped and activated for recycling by some crops such as legumes, which have deep root systems and can pump up nutrients, which otherwise may not be accessed. Through the recycling of organic matter, the top soil gets enriched again.

Influence of diversified multiple cropping on crop pests and Diseases

Pest populations are higher and consequently cause greater crop losses in monocultures than in multiple cropping systems. This is because the

ecosystems in the multiple cropping systems are more stable than monocultures. Thus, the system can be used to ameliorate pest problems by increasing crop diversity through the different types of cropping systems.

Effect on insect pests

The level of damage by an insect pest to a crop depends on the following factors namely, (i) ability of the insect pest in finding the crop, (ii) the ability to remain on the crop and reproduce after founding crop, (iii) the number of offspring they produce, (iv) the rate. The insect pest feed and (v) the duration of feeding. All these factors can be influenced by the diversity of the crops. For many insect pests the discovery of a suitable host plant is an essential phase in their life cycles. Insects use complex visual and olfactory methods to search for food. Disruption of the searching behaviour through multiple cropping systems can be a useful tool in insect pest control. In brief, the outbreaks of insect pests may be less severe when there is less food usable by the particular insect pest. Therefore, an approach to reduce the colonisation of insect pests by reducing the attractiveness of the crop to insect pest attack is vital. It has been shown that increasing crop diversity also enhances natural enemies by providing foods such as nectar, pollen and honeydew and providing shelter or microclimate favourable for those natural enemies from an extreme environment.

Management of pests and diseases using repellent, companion and trap crops

The rejuvenation of the multiple cropping systems approach to pests and diseases has renewed interests in using repellent, companion and trap plants. Many plants contain substances in their roots, flowers, leaves and fruits, which can repel and attract insects. These plants are usually not toxic to insects, but interfere with their normal behaviour and thereby keep the insects from causing damage to the crop. There are many varieties of herbs that have been used as repellent, companion and trap plants to prohibit, reduce and delay pest population from increasing. Generally, repellent, companion and trap plants are used in insect pest management. However, combinations of some plants can also protect against fungal and bacterial diseases by restricting the movement of fungal or bacterial spores between adjacent rows.

Repellent or pest influencing plants

Repellent plants are plants that produce allelochemicals which interfere with the feeding habits of pests. Extracts of the plants can also act as antifeedants thus, discourage insects from further feeding after the first bite. This type of repellent plant produces cyanogenic glycosides and enzymes that liberate cyanide from the cyanogenic glycosides. Cyanogenic glycoside and the necessary enzyme (a b-glycosidase) when combined during structural damage of the leaf, as would happen during insect feeding, will liberate cyanide. In most cyanogenic plants, the cyanogenic glycosides are located within the vacuoles of cells, while the enzymes are attached to the outside of the cell wall. Therefore, for cyanogenesis to occur, cells must be broken and the intracellular contents including the vacular contents, must spill into the intercellular spaces. Because cyanide is toxic to so many insect species, cyan genesis acts as a defence against many potential insect pests

Companion plants

A companion plant is one that discourages pests from feeding on the main crop. It also provides favourable conditions for plant growth and the reproduction of natural enemies. Companion plants also comprise of plants, which are able to improve soil fertility and beneficial micro flora, act as a barrier, modify the microclimate for better plant growth and increase natural enemies. For example, legumes used as companion crops are able to add and conserve soil fertility by adding nitrogen to the soil. The planting of herbaceous barriers in strips or inter planted with the main crop provides wind protection and reduces pest attack through olfactory cues inhibition and visual effect. Most companion crop combinations attract a wide range of beneficial insects. Intercropping chilli with maize, okra or brinjal was found to enhance the adults of ladybird beetles, lacewing and spiders respectively

Trap crops

Trap crops are plants that attract and retain a pest species. They also provide a more favourable habitat for increasing the populations of natural enemies. Usually, trap crops have less economic value than the main crop. The presence of a trap crop is important for preventing the key crop from attack by herbivorous insects. The odour released by a trap crop acts as a chemical message to elicit behavioural

response by a pest to infect the trap plant. After infesting the trap plant, the pest will emit aggregation pheromone for more individuals to colonize the trap crop. The colonised pests are then killed using bio pesticides or physical methods. Trap plants are also used to control nematodes. However, the mode of defence is different from the above. Essentially, there are two modes of defence employed by trap crops against nematodes.

i. The use of green manure plants, yellow mustard and buckwheat have been found to stimulate egg hatching and larvae penetration for nematode to complete its life cycle. Proper timing of harvesting or destruction of these plants will result in the nematodes dying due to starvation, before they have time to reproduce.
ii. Marigold (*Tagetes* sp.) has also been used as trap crop to control nematodes. It is thought that roots of marigold secrete a chemical compound, alpha-terthienyl into the soil that kills nematodes and thus, the planting of marigold around the main crop will prevent infection. Moreover, nematodes that enter the roots of marigold are unable to complete their life cycles. Hence, the trapped nematodes will die without reproducing.

Conclusion

All plants in an agro-ecosystem have their own functional roles. These include plants that are considered to be either weeds, repellent, trap or companion crops. The value of these crops in pest management is currently appreciated. The realisation of potential benefits of these crops depends on how effectively the crops are designed at farm level. Yield advantages from multiple cropping are obtained from a better use of the space and the growth resources. Improved pest and disease control have been shown to occur in multiple cropping systems where natural enemies are found in abundance. In the era of increasing costs of agriculture inputs and accelerating concern about the contamination of the environment, these approaches provide alternatives on farms of all sizes.

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