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A Review of the Integrated Approach to Insect Pest Management in Agriculture

By

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Abstract

Insect pests are responsible for a substantial crop yield reduction in agriculture. An effective control represents one of the most important and demanding tasks facing mankind today. Although, it is possible to consider each individual insect pest control tactics as a problem to tackle separately, it is always desirable to regard them as a complex requiring an integrated control approach. Only rarely can these interactions be managed within an integrated control system so that they result can increase agricultural productivity. This paper attempts to review the nature of these interactions among insect pests. It site examples of many types of interactions including biological, physical and chemical approaches. Conclusion and suggestions are given on insect management strategies.

As a result of the problem with pesticides in intensified agriculture, a new approach to pest management has evolved in the past 50 years which attempts to make the most use of economical and environmentally safe pest control methods, and to minimize pesticide use (Glass, 1975). This approach is called Integrated Pest Management (IPM).It involves the use of all available tactics to control pest and generally resort to non-chemical methods of control with chemicals being used only as a last resort (Oka, 1982). Pimentel (1982), reported that IPM offers the best prospects for meeting needs for better pest management in support of increased crop production.

Insect pests interfere with our food production processes both in the field and on storage. They are also vectors of numerous diseases like malaria, river-blindness, yellow fever, plague, etc. On the other hand, because of their pollinating activities, insects are of paramount important to many agricultural crops and are useful as producers of honey, wax, silk, shellac and dyes (Dennis, 1997).

To fight against insect pests, an array of control tactics have to reduce the pest population and minimize competition for food. Meyer, (2003) reported the following management tactics in controlling insect pests.

1) Mechanical and physical control
2) Cultural control
3) Genetic control
4) Biological control
5) Chemical control
6) Legislative and regulatory control.

When more than one of these control methods are applied together as a means of managing pest attack it is referred to as integrated pest management approach (Meyer, 2003).

Insect Pests Management Approaches

As contained in "green methods" (2011), mechanical and physical measures are some of the most ancient, expensive in time and energy and rather inefficient on large scale. The four types of physical and mechanical control measures are described below.

Hand Destruction

Gilberg (1993), reported that hand destruction is simple to destroy an insect by hand. An example is a swatter employed against a fly. Other examples includes hand-picking of lemon butterfly (*Papilio democus*) larvae from citrus seedlings; swatting of clustered nymphs of citrus shield bug (*Rhynchocoris* sp.) on citrus trees.

Mechanical Exclusion

This involves excluding insects from an area by some mechanical device (Mahr and Ridway, 1993). Examples of mechanical exclusion devices include: window screens which exclude flies and mosquitoes; digging trenches which form barriers and preventing migration by crawling or walking insects; and placing collars at the bases of young trees and plants to prevents insect attack. Bagging of fruits like jackfruits to deter flies from oviposition is another example of mechanical exclusion.

Mechanical Traps

This are devices employed when collecting or monitoring insects. Meers (2008), reported that in same areas the traps may serve to suppress insect populations. Use of pheromone trapping in citrus orchards is a good way of exterminating fruit fly populations. Flying beetles can be collected with light trap especially at night.

Temperature

Insects subjected to excessive heat or cold for long periods will be eliminated, especially when they are in vulnerable stages (Meyer,2003).This method is applicable to stored product insect pests. Drying of grains reduces moisture content and results in lowering infestation rates.

Cultural Control

The manipulation of crop cultivation practices to control insect pest problem is known as cultural control. According to Kogan (1998), these tactics are usually known as cultural control practices because they frequently involve variations in standard cultivation practices. Since these control tactics usually modify the relationship between a pest population and its natural environment, they are also known, less commonly, as ecological control methods. They cultural control practices includes: tillage (Glass,1975);crop sanitation (Hardison, 1980);crop rotation (Pimentel,1982); mixed cropping (Dempster and Coaker,1974);manipulation of planting dates (Glass,1995); fertilizer and water management practices (Stoll, 1996; Elwell and Mass, 1989) among others.

Biological Control

Natural control strategies that employ biological agents for pest suppression are generally classified as biological control tactics. In conventional usage, this term usually refers to the practiced of rearing and releasing natural enemies: parasites, predators, or pathogens. Therefore, biological control could be defined as "the manipulation of parasites, predators, or pathogens to manage the density of insect populations" (Bellows and Fisher, 1999).

Clausen (1958),stated that bio control agents include a wide variety of life forms, including vertebrates, invertebrates, fungi, and microorganisms. These beneficial species are common in most natural communities and, although their presence is often unnoticed, they help maintain the balance of nature by regulating the density of their host or prey population. Insect species became "pest" when this ecological balance is disrupted by natural events or human intervention.

According to Oka (1982), conservation refers to any practice that avoids the destruction of natural enemies and enhances the population density of biological control agents. Modification of cultural practices may conserve and enhance natural biological control agents. Examples are trip cropping, reducing or eliminating insecticide applications to avoid killing natural enemies, or providing shelter, over-wintering sites, or alternative food sources to improve survival of beneficial species.

Often natural enemies of pests can be increased by releasing additional biological agents which have been reared and colonized in laboratories (Stoll,1996) . Such a manipulation of a controlling agent is called augmentation or colonization (Clausen,1958). An example of augmentation is the release of laboratory reared populations early in the crop season, before field populations of the same natural enemies appear, in order to establish the natural enemy on the pest population before it grows too large to control (Oka, 1982).

Importation refers to the collection of a biological agent from one geographical area and importing it to another geographical area where it will be use as a control agent (Clausen, 1958). As contained in Oka (1982),foreign exploration is conducted to identify and collect natural enemies in the country from which an exotic pest has been introduced. Suitable candidates are reared and released in the new habitat with the hope that they will become established and suppress the pest population. Importation is employed against pest species that have been accidentally imported into an area and have few or no natural enemies in their new environment. This form of introduction is refer to as classical biological control.

There have been many instances of complete or partial success in control of pests through introduction of natural enemies. The classical illustration of success was the importation of the Vedalia Lady Beetle to control the cottony cushion scale was accidentally introduced into California from Australia. In the absence of natural enemies it quickly spread throughout the California citrus industry. Investigations was found that Cottony Cushion Scale in Austraila was being controlled by a small lady beetle called the Vadelia beetle. The beetle has subsequently been shipped from California to Floreda, and to many countries, where it has reduced Cottony Cushion Scale to non-pest status.

Chemical Control

The control of pest with chemicals constitutes chemical control and according to Avav and Ayuba (2006) "a pesticide is any substance that is deliberately released to the environment to harm or kill organisms that are defined as pests". They chemicals used for pest control are classified based on type of pest controlled and the mode of action.

Class	**Target Pest Controlled**
Insecticide	insects
Fungicides	fungi
Nematicide	nematodes
Rodenticide	rodents(rat, mice, porcupine etc)
Herbicides	weeds
Acaricides	mites, ticks
Miticide	mites

Adams (1995) and Pest management Qiudeline (2011), stated that the classification of insecticides by mode of action(the way they enter or affect the pests) includes: contact poison, systemic, stomach poison, fumigant and suffocating materials.

Negative effects can however, be observed in pesticides as reported by Thayer and Houliham (2004). This include:

1) Elimination of beneficial natural enemies
2) Emergence of secondary pests
3) Resistance to pesticides
4) Pest resurgence
5) Increased health risks and environmental pollution

Regulatory and Legislative Control

One method of crop protection is to prevent the pests into an area in which host plants are growing (Thayer and Houlihan, 2004). This method of exclusion of pest is enforced through certain legal measures commonly known as quarantine (Anthony, 1991). Oka (1982) stipulated that the knowledge and methodology of exclusion are utilized and practiced by a legally constituted authority to:

A) Prevent the introduction of foreign insect pest
B) Prevent or retard spread within a country
C) Enforce control and eradicative measures
D) Enforce certification of the materials.

Genetic Control

Gould (1988) and Bartlett (1990)reported that genetic control refers to the control of insect pests by manipulating the genetic make-up of either the pest or the host. An example of manipulation of genetic material in the pest is such as the one where an insect is subjected to radiation, chemicals and other procedures (Bennett et al,2005). This process is often called autocidal control. With regard to the manipulation of the genetic material of the host plant, it involve the conferring resistance to the plant by breeding. Such a tactic is referred to as host plant resistance(Meeusen and Warren, 1989).

Autocidal Control

Radiation or chemosterilants can be used to sterilize insects which, if released in sufficient numbers, can reduce reproductive success and lower or even eliminate pest problems. Lethal genes may be used in the same way. This is an expensive operation, requiring massive factory scale production of sterile insects to be effective. Screw worm was successfully eradicated from the USA and now efforts are being made to eradicate it from Mexico. The screw-worm project is referred to as the sterile insect technique because it employed a technique of sterilizing flies by radiating them.

In Africa, considerable research has been done on autocidal methods of control of tsetse, *Glossina* spp (Bartlett,1990). The high cost of this method makes it viable only under special circumstances and where the target pest is amenable as with flies which mate once. As a means for continual application for widespread pest it is too costly and not practicable.

Plant Breeding

According to Meeusen and Warren (1989) a second type of genetic manipulation involves the host plants of insects and is called host plant resistance. In this control tactic the genetic make-up of a plant is altered by selective breeding to make it less susceptible to pest damage. The three basic mode of plant resistance are antixenosis, non-preference, antibiosis and tolerance(Gould, 1988).

Conclusion

This paper shows that it will be erroneous to suggest that integrated pest control is a panacea. The method is logical but calls for concerted effort if it is to be widely applicable on food crops, and the implementation demands considerable flexibility. The plea at this time must be for more base data to be gathered on food crops in the small farmer situation. Of particular importance is intensification of work on plant resistance to insects both in developing countries and developed countries. The latter could greatly assist in carrying out some of the more sophisticated analyses on bases of resistance. Little is known currently of pest populations or their parasites and predators. The host insect parasite/predator relationships in sprayed and unsprayed situations need to be more extensively studied in peasant farmer's fields.

Work is required on timing of spray applications, and on suitable techniques for application and insecticide formulations for tropical food crops. Actual information on received doses by insects in tropical food crops is almost non-existent. To ensure the more rapid acceptance of Integrated Pest Management strategies, it is vital that the involvement of many disciplines- plant breeding, agronomy, pesticide chemistry, socio-economic, economic etc., is encouraged. This is crucial in the interests of formulating strategies which are in the long term, environmentally, politically and economically best for local consumption.

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