INTEGRATED PEST MANAGEMENT PERTAINING TO THE G.C.E. (ADVANCED LEVEL) ZOOLOGY SYLLABUS

JAYANTHI P. EDIRISINGHE
Dept. of Zoology, Faculty of Science,
University of Peradeniya.

Integrated Pest Management (IPM) is one of the topics listed under Pest Management (Unit 10.3.3) in the current G.C.E. (A/Level) Zoology syllabus. The purpose of this article is to present the concept of IPM, and to lead a discussion on how it came into being and the principles underlying its application.

Integrated Pest Management is a concept that came into being following the problems that arose due to the total reliance on synthetic organic insecticides for pest control. Chemical control which was used extensively until recently made no consideration to the ecosystem, changing population levels of the pest insects and the health hazards. More over, the use of a single method of control was found to be inadequate to solve the complex pest problem. Hence, the idea to "integrate" different methods of pest control and to "manage" insect populations rather than to control them was proposed. The integrated approach to pest control is now accepted as the best strategy and it attempts to achieve a compromise between chemical control and other methods of pest control.

Integrated pest Management

Integrated Pest Management is defined as the utilization of all suitable techniques and methods, in a compatible manner to maintain the pest population at levels below those causing economic injury to the crop.

An IPM programme is implemented on a crop to manage the different pest species that cause economic injury to that crop. The implementation of an IPM programme on a crop has to be carried out in stages involving the following steps.

(1) Determine whether the insect species that causes damage to the crop has reached the pest status".

(2) Study the population dynamics (or population changes) of the pest species over a period of time in order to establish Economic Threshold and Economic Injury Levels, at which control methods are to be initiated.

(3) Determination of the possible effective methods of control of the pest.

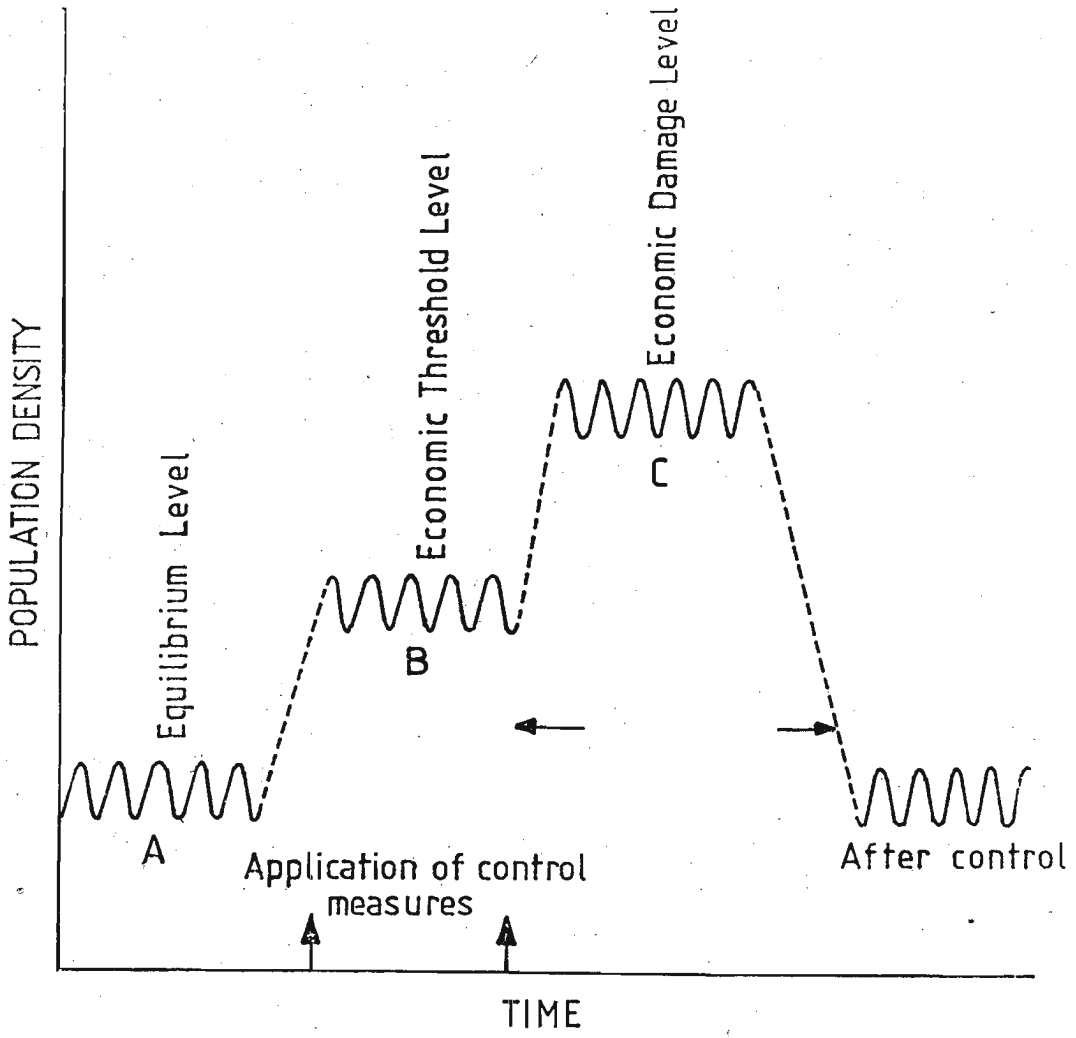


Fig.1 Fluctuations in an Insect population

Integrated Pest Management is defined as the utilization of all suitable techniques and methods, in a compatible manner to maintain the pest population at levels below those causing economic injury to the crop.

Thus the concept of IPM has to be discussed in terms of the pest status, population dynamics of the pest, pest management and methods available for pest control. I shall set out to define and explain each of these aspects within the frame of IPM.

Pest status

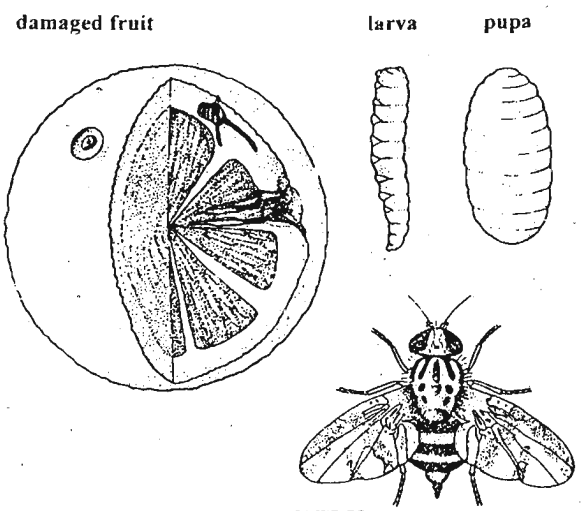
There are several definitions for the term pest. Most of these definitions emphasize two aspects of the pest, namely; their abundance on the crop and the degree of damage caused to the crop due to the activity of the pest. The abundance of a pest is described in terms of numbers of insects on the plant or the crop, while the degree of damage caused to the crop is described in economic terms.

The degree of damage or harm caused by insect pests to the crop is very variable and hence difficult to evaluate. It is dependent on several factors. Some of the important factors are;

(1) the species of insect concerned,
(3) the density of the pest insect population and
(3) the stage of growth of the crop,
(4) the economic value of the crop.

A few insects of a given species feeding on a specific crop may not cause sufficient damage to bring about an economic loss to the farmer. Hence, such an insect species would not be considered a pest. But when the insect numbers increase with time under certain conditions, the damage caused would lead to an economic loss and the insect species becomes a pest. Thus, the population level of a given insect species determines to a greater extent whether it is a pest or not.

Fig. 1 illustrates the changes in population level with time, that can be reached by an insect species on a given crop due to changing conditions. Line **A**, represents the population fluctuations achieved under non-pest conditions referred to as the General Equilibrium Level. A population is known to be at General Equilibrium due to external natural causes maintaining a balance in the insect population at a level that does not cause economic damage. Natural enemies such as parasitoids, predators, pathogens and weather conditions are some of the natural external factors that keep insect populations in check.



MEDITERRANEAN FRUIT FLY
(Ceratitis capitata)

However, due to several reasons such as changes in climatic conditions and man's activity, the population of a given insect species may continue to increase and go through a level represented by line **B,** referred to as the Economic Threshold Level. Below this level or at this level of population no economic damage to the crop would take place.

But if the population of the insect species continues to increase further, economic damage or a loss to the farmer is inevitable. This level of population is represented by line **C** and is referred to as the Economic Injury Level. At this level of population the insect species is said to have reached the pest status.

Pest Management

Methods to counter the increase in population of the insect species has to be brought in at the Economic Threshold Level, ie. well before their numbers increase to reach the economic injury level. Furthermore, the methods selected for this purpose should be applied in such away that the insect population is brought below the Economic Threshold Level to reach the Equilibrium Level and not to zero population level. This is the essence of pest management, where one does not attempt to completely eliminate the entire pest insect species from the crop. When the pest population is brought down to the Equilibrium Level, through pest management practices, it is expected that the natural forces would keep the population in balance.

One might wonder how one decides or finds out whether an insect species on a crop has reached the economic injury level and hence become a pest. The different population levels shown in Figure 1. are determined through experimentation by a long term study of the insect population on the crop. Furthermore, several factors such as

(1) the nature and economic value of the crop,
(2) field conditions and
(3) the type and degree of damage to the crop are considered in the determination of the Economic Threshold Level of a specific insect pest on a crop.

As an example of Economic Injury Level, I like to quote the case of the Brown Plant hopper (BPH) of paddy, namely, ***Nilaparvata lugens***. The Economic Injury Level of BPH has been determined as 5-8 hoppers per hill at the tillering stage of the paddy plant and 10 hoppers per hill at the nature stage of the plant. What this means in practical terms is that, when the number of hoppers reaches an average of 5-8 or 10 per tiller (depending on the stage of growth of the paddy plant) economic damage results in causing economic losses to the farmer. Hence, it is necessary to ensure that the hopper numbers are kept below these levels using suitable pest management methods.

Pest control through the ages

From the earliest times, farmers were engaged in the use of several, time-tested agricultural practices to reduce damage by insects. We now refer to these methods as cultural methods of control. Together with unhampered natural insect control methods that existed then, insects were not a problem to farmers. natural enemies of pest insects such as predators, parasitoids & pathogens and environmental factors that are not conducive to the build up of insect populations, acted as natural control methods.

With the advent of time and increase in human population, the demand for food production increased. This necessitated the growing of high yielding crop varieties and the use of chemicals against insects, to reduce pre-harvest and post harvest food losses. The chemicals that were used initially included inorganic compounds such coper and lead. With the need for

stronger and quick acting chemicals, synthetic organic chemicals came into usage. These included initially the organochlorides, followed by organophosphates, carbonates & pyrethroid insecticides.

However, the use of chemical methods of pest control resulted in several adverse effects in the long term, such as

(1) the development of resistance to insecticides
(2) creating new pests out of non pest species,
(3) rapid resurgence of pests,
(4) affect on non target organisms including man and
(5) environmental pollution.

Thus, the use of extensive and wide scale use of chemical pesticides instead of solving the pest problem has created new and difficult problems. It soon became clear that chemical pesticides alone cannot solve most pest problems. There was, therefore an urgent need to re-examine traditional cultural methods for pest control and to make greater use of naturally occurring control methods. In addition, new methods which are ecologically sound, long lasting and causing very little or no disturbance to man, other animals and the environment had to be examined.

The need to combine limited and specific use of chemical pesticides with other methods of pest control led to the development of the concept of Integrated Pest Management. The application of IPM involves the manipulation of the insect population by means of a variety of control methods in order to reduce their damage below economic injury level.

For the application of IPM it is necessary to obtain basic information about the pest species such as its abundance and distribution, biology and behaviour, natural enemies and effective control methods.

This knowledge about the pest would help in determining the

(1) vulnerable stage of the pest
(2) suitable time to initiate control measures
(3) most effective method of control

The major insect pest control methods that can be used in an integrated pest management programme can be broadly stated as cultural, chemical and biological methods. Of these methods, except chemical control, the other methods can be used together in a compatible manner. Although, chemical methods of control, act counter to biological methods, it is desirable to minimize the use of insecticides and avoid their misuse, rather than to ban them altogether. For this purpose, pesticides that are specific in action (that act only against target insects) and are less hazardous to animals and man are to be used in Integrated Pest Management Programmes. Furthermore, by the limited use of such insecticides, the numbers of insects on crop can be brought down to a manageable level at which biological control (and cultural control) can take over and act effectively.

As mentioned before, the main methods used in IPM are cultural, chemical and biological. These three methods are also included in the G.C.E. A-Level syllabus as methods of pest control to be discussed. Hence, I would very briefly state the principles underlying these methods of control.

The major insect pest control methods that can be used in an integrated pest management programme can be broadly stated as cultural, chemical and biological methods. Of these methods, except chemical control, the other methods can be used together in a compatible manner.

Cultural Control Methods

Methods that come under cultural control are mostly the traditional agricultural practices that have been carried out by farmers for generations. Some of the methods used in paddy cultivation are

(1) crop rotation
(2) crop sanitation
(3) growing of trap crops
(4) ploughing,
(5) water management and
(6) growing of resistant crop varieties

Chemical Control Methods

Use of chemicals that have insecticidal properties are used in this method of control. Insecticides are commercially available in the form of sprays, granules and dusts. The synthetic insecticides that are commonly use belong to 4 broad groups.

(1) Organochlorids such as BHC and Aldrin
(2) Organophosphates such as Malathion, Parathion
(3) Carbonates such as Carbofuran, Carbaryl
(4) Pyrethroid such as Permithrin, Pyrethrin

Biological Control Methods

The use of natural enemies of insects in the control of insect pests is termed biological control. Natural enemies of insects belong to three groups.

(1) Predators: insects that feed on other insects including the eggs, larvae, pupae or adults of prey insect.

(2) Parasitoids: insects that lay their eggs on other insects either on the egg, larval of pupal stages of the host insect.

(3) Pathogens: organisms that cause diseases in insects. These include the viruses, bacteria, fungi, nematodes, and protozoans.

Recently, under biological control methods are included methods that rely on (a) insect pheromones (that act in very small concentrations and hence called semio chemicals), (b) release of genetically altered insects into the population such as the Sterile Male Release Technique.

Integrated Pest Management is accepted as an ecologically safe method of reducing the number of insect pests on food & other crops. it involves the integration of cultural, chemical and biological methods of pest control. Through the use of IPM the population of pest insects are brought down to a level that is no longer economically harmful to the farmer. IPM which is now a universally accepted form of pest control in a given crop is widely used in the developed countries. It is being applied for the control certain rice pests in Sri Lanka.