

Ex No. 2

Date:

SAMPLING TECHNIQUES FOR THE ESTIMATION OF INSECT POPULATION AND DAMAGE

Objective:

To understand sampling techniques for the estimation insect pest population and their damage

Estimation of Insect Population

Population studies are helpful in pinpointing the factors that bring about numerical changes in the natural population and also in understanding the functions of the life-system of the pest species. Extensive studies over a large area are needed to understand the distribution patterns of a pest population, to predict the damage it is likely to cause to initiate control measures and to relate changes in the pest population to certain climatic or edaphic factors. The type of population estimation will depend on the objectives in view. The estimates are of three types.

- I) Absolute estimates
- II) Relative estimates
- III) Population indices

I. Absolute estimates

The total number of insects per unit area (acre or hectare) is the absolute population. The numbers per unit area of the habitat (per plant, per shoot or per leaf) indicates the density of population. The estimates of absolute population and population density are useful to know and analyze the key mortality factors.

The following methods are commonly employed for knowing the absolute estimates.

1. Quadrate method

Small areas or quadrates will be chosen at random from a large area which contains the population. The area of the quadrate relative to the whole area is estimated and also population in the quadrate is known exactly. From a quadrate the insects can be counted or collected directly and their number can be correlated directly with the field population. The reliability of estimates made from this method depends on how representative the quadrates are of the whole population and how close one gets to count the numbers.

2. Line-transect method

In this method a person will walk in a straight line at a constant speed through a habitat, the number of individuals encountered can be counted. The data based on such encounters can be

used in estimating the absolute population of locusts and grasshoppers. The number of encounters is influenced by the speed of person, the speed of individuals comprising the population, the distance over which they can be perceived and the density of the population under studies.

3. Capture, Marking, Release and the Recapture Technique

The number of flying insects can not be assessed by any of the methods described earlier. The capture-recapture method can be used for these studies. The losses or gains in a population over a period can be determined with the help of this method.

For the effective application of capture-recapture technique in population estimations the following conditions must be satisfied.

1. The marking of individuals should not lead to changes in their behavior or longevity and marks do not get lost easily.
2. The marked individuals after being released becomes completely mixed up with the unmarked individuals of the population.
3. The population is sampled randomly with respect to its mark status.
4. The method of marking should be such as to distinguish between different dates of capture.

a) Group marking methods

The most important prerequisite in the technique is that there should be no influence on the longevity or behavior and the natural camouflage of the marked individuals.

The different marking methods are as follows :

- i. Paints and solutions of dyes:** Different colours of paints can be used for marking moths, locusts and grasshoppers, beetles and many other insects. Florescent pigments with gum Arabic glue can also be used.
- ii. Dyes and fluorescent substances in powder form:** The hairy insects can be marked by dusting them with various dyes.
- iii. Labels:** The locusts and butterflies have often been marked by attaching small labels as a part of their wing.
- iv. Mutilation:** Clipping the wings of lepidopterans, damaging the elytra of beetles by incising edges or cutting small holes are some of the examples.
- v. Radioactive isotopes:** There are two methods of marking with isotopes. Those may be used as labels outside the organism or alternatively can be fed and incorporated in the

tissues radioactive metals such as, cobalt (Co^{60}) and Tantalum (Ta^{182}) are widely used. In recapture studies the marked individuals can be detected by the use of Geiger Muller tube or by autoradiography.

b) Individual marking methods:

In these methods individuals are marked singly and they provide good information on the longevity and dispersal of marked individuals. It involves the use of small labels which may be attached to wings or by having a combination of spots in various positions on the body and by the use of different colours.

II. Relative estimates

In these estimates the population is measured in indeterminate units which allow comparison. The relative estimates are obtained by catch per unit time by using various traps. Various types of collection nets are available for use in different habitats and the sweep net is most widely used for sampling the insects from vegetation. Only those individuals on the top of the vegetation and those that do not fall off or fly away on the approach of the collector can be caught with a sweep net. Various traps like, flight aquatic traps, pit fall trap, light trap can be used to collect insects and their trap catch can be correlated with the actual population existing in the field.

III. Population indices

In this type the bio products of pests such as exuviae, nests, webs, frass or their effects (damage to the host) are considered instead of pests themselves.

Estimation of Insect Pests Damage

A species that interferes with activities of plant and cause damage to yield is known as pest. The total yield losses by different pests to all agricultural crops at global level are estimated to be 42.1% of attainable production.

Estimation of crop losses caused by insects to economic crops are exceedingly difficult because,

1. They variable in nature of damage.
2. Insect population fluctuates both in time and space.

The nature of damage caused by insect pests of crop plants is a function of pest population. So it is mostly insect capacity to increase in number rather than the nature of damage.

The following four points should be kept in view to estimate the losses.

1. Any insect which cause some kind of the damage to crop can become pest when its population increase above a critical level. The critical level depends upon the nature of the damage caused by the insect.

E.g. In case of leaf feeders, the leaf eaten is near index of the losses caused by caterpillars.

In case of insect vectors of virus of disease a very small population of infective individuals can spread the disease to whole crop.

2. The losses caused vary both in time and space from 0 to 100%. The estimation is fairly easy at these two extremes, but there are large numbers of factors which tend to invalidate any estimation in between these extreme limits.

3. The loss may be either quantitative or quality. In case of quantitative loss reduced yield is observed, whereas in qualitative loss, quality may be affected.

E.g. In case of wheat bug (*Eurygaster integriceps*) is known to affect adversely the baking quality of wheat.

4. Insect losses in terms of money are also objected. That the selling price of the commodity would be reduced, if insect infestation were to be greater extent.

The measures generally followed for estimating the losses caused by insect pests are based on either growing a crop as free from insect infestation as possible or then comparing its yield with that of check crop in which insect activity has been normal, or by making use of differential infestation and comparing the yield.

The above ones are used in the following methods for estimating the crop losses. The methods are as follows,

1. Mechanical protection of crop from insect pest damage
2. Chemical protection of the crop
3. Comparison of yields in different fields having different degrees of pest infestation
4. Comparison of average yield of healthy plant with that of infested plants
5. The average amount of damage caused by individual insect
6. Manipulation of natural enemies
7. Simulated damage

1. Mechanical protection of crop from insect pest damage:

The crop is grown under the enclosures of wire gauze or cotton cloth. These enclosures keep the pest away from the crop. Then, the yield of crop under such enclosures is compared with the yield obtained from the infested crop under similar conditions.

This technique has been used with that various modifications for estimating the losses caused by leafhoppers and whitefly to cotton

Flaw:

a. The limitation in the case of enclosures is that the plants generally become pale and weak due to changes in micro environment.

b. This technique can not be adopted on an extensive scale because it is very time consuming and impracticable on a field scale.

2. Chemical protection of the crop:

The crop is protected from pest damage by best scheduled chemical recommendation of pesticides. Then, the yield of treated crop is compared with that subjected to normal insect infestation.

This technique has been very widely used and it can be adopted on a large scale in cultivator's field.

Flaw:

The crop treated with the chemical protection can also be physiologically affected for better or worse because of the effect of the chemical protectant.

3. Comparison of yields in different fields having different degrees of pest infestation:

The yield is determined per unit area in different fields having different degrees of pest infestation. The correlation between the yield and degrees of infestation is worked out to estimate the loss in yield.

Israel (1959) estimated the damage by stem borer at two stages of plant growth *i.e.*, dead hearts in early vegetative growth phase and white ears produced at flowering stage. Then, the following equations were obtained

$$Y = 2110.85 - 5.935X_1 \quad \text{-----} \quad \text{Dead heart stage.}$$

$$Y = 22 - 3.41 X_2 \quad \text{----} \quad \text{White ears stage}$$

Where,

Y = Yield of paddy, X_1 and X_2 = Degree of pest incidence

There was 0.28% loss in yield per unit increase in dead hearts and 0.624% loss in yield per unit increase in white ear heads. This technique can be used for estimating crop loss due to different pests and diseases over a large area.

Flaw:

The yield in different fields can also be influenced by the soil heterogeneity

4. Comparison of the average yield of healthy plants with that of attacked plants:

In this process individual plants from the same field are examined for the pest incidence and their yield is determined individually. The loss in yield is estimated by comparing the average yield of healthy plants with that of plants showing different degrees of infestation. The same data can also be used for working out the correlation between the yield and infestation on the basis of infested individual plants.

Pradhan and Prasad worked out the correlation between damage by *Chilo partellus* and the yield of sorghum in the following equation;

$$Y = 6.6204 X_1 - 0.9257X_2 - 27.17$$

Where,

Y = Yield of sorghum grain per plant

X₁ = Number of ears per plant

X₂ = Percentage of stalk length infested

Advantage:

The advantage of this technique over the above method is soil heterogeneity factor is considerably reduced

Flaw:

a. The different plants showing various degrees of infestation in itself is a proof that plants differ from one another in some unknown factors due to which they carried different degrees of infestation. This factor may be genetic or physiological or it may be mere soil heterogeneity in the same field.

b. It is a time consuming and involves lot of labor.

5. The average amount of damage caused by individual insect:

For this method, the preliminary information is obtained from studies on biology of the pest species. The details regarding the amount of damage caused by different stages or stages of the insect, and the exact nature and amount of loss caused are then worked out.

E.g. It has been estimated in the case of phadka grasshopper (*Hieroglyphus negrorepletus*). It consumes on average 42 grams of green leaves of maize during its life time. It was estimated that this insect would cause 18% loss in yield of maize at a population level of 10 grasshoppers per square yard.

Flaw: It is very difficult to use this technique over large area and it is time consuming.

6. Manipulation of Natural Enemies:

The manipulation of natural enemies of a pest species offers a means of evaluating plant damage. This technique has not been widely used. The pest is controlled by introducing predators or parasites into the field and the yield of such crop is compared that on which no such pest control measures have undertaken.

This method is feasible only in small plots and is not practicable on field.

7. Simulated damage:

Many investigators have attempted to simulate pest injury by removing or injuring leaves or other parts of the plant. The simulated damage may not always be equivalent to the damage caused by an insect. Insects may persist over a period of time or inject long acting toxins rather than producing their injury. Feeding on margins of leaf may not be equivalent to tissue removal from the centre of the leaves. Insect feeding is usually extended over a period of time and is difficult to incorporate the concept of rate of injury.

E.g. simulated damage studies have been conducted on the spotted boll worm on cotton. Detopping of cotton plant reduces the monopodial branches by 9.69%. The number of sympodial branches, squares and flowers increased by 14.5, 47.8, 2.54 %. Shedding of fruiting forms was greater in detopped plant that is 83.5% than control plant 71.4%. This results in 12.8 to 22.1 reduction in boll formation and yield of cotton.

Record Work:

Visit the near by crop field, observe and record the populations of a available insect pests, their nature and extent of damage.