Surveillance and Sampling

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Introduction

- Pest surveillance is important for the purpose of decision-making in pest management program.
- Types of survey: detection of presence, population determination, dispersion and dynamics.
- Characteristics of survey: Qualitative survey, and quantitative survey.
- Qualitative survey -- mainly for pest species detection, and their general abundance in 3 categories: abundant, common, rare.
- Quantitative survey -- numerically determine the abundance of the pest population in time and space to predict future trends and to assess damage potentials.
- Because of the measurement of insects is required, but of the great number, it is not possible to count every single individual, population is sampled and estimated.

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Sampling units and sample

- **Sampling unit** -- a proportion of a habitable space from which insect counts are taken.
- The size of sampling unit is determined by the sampler, and must be distinct and not overlap. When all sampling units are combined, it become a population.
- Because it is not possible to count all insects in all sampling units, only a group of such units is taken into account, and use to estimate to the entire population. This group of sampling units is known as **sample**.

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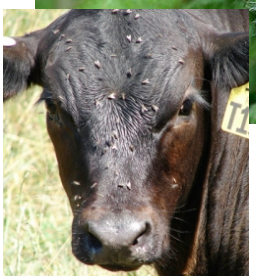
Sampling techniques and sampling program

- Sampling technique -- ***method*** used to collect information from a single sampling unit.
- Types of sampling techniques: (1) In situ counts, (2) Knockdown, (3) Netting, (4) Trapping, (5) Extraction from soil, (6) Indirect techniques
- Sampling program -- the ***procedure*** that employs that sampling technique to obtain a sample and estimate the population density.
- This include the insect stage to be sampled (eg. larval stage), sampling unit number, spatial pattern to obtain the sampling units, (4) timing of samples.

Sampling Techniques
In situ counts

- Refers to direct counts/observation.
- Usually the no. insects are relatively low, and the area to be viewed is not large.
- Eg. no. insects per leaf, no. termites in a 1 m^2 area.
- This method is the most widely used with plants because of its immobility, while use of this technique with poultry and other animals is limited.

In situ counting



Sampling techniques (2)

- **Drop sheet** - Non-flying insects are dislodged by shaking 12 - 18 inches of row of crop plants onto a muslin sheet placed between the rows beneath the plants. This is useful in crops where sweeping might damage the crop plants, or where insects are situated too low on the plant to be picked up in a sweep net sample.
- **D-vac** - a vacuum system that vacuums insects out of the field.

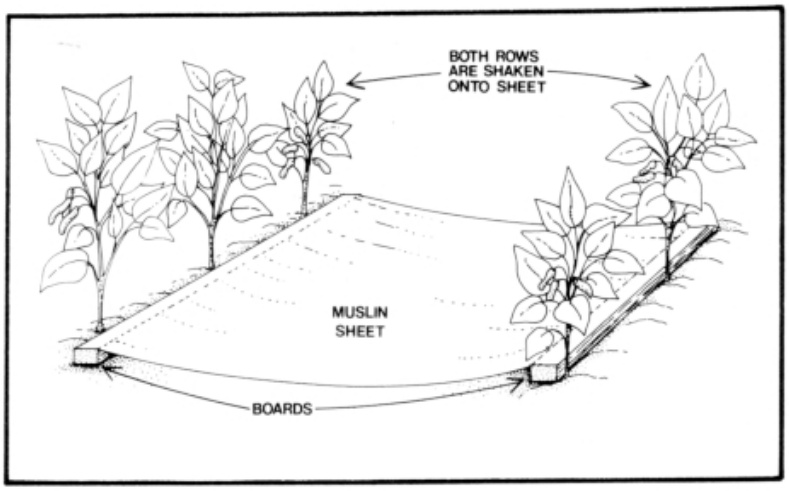


FIGURE 7-7. Sampling with the drop sheet shake method. A muslin sheet, stretched between two boards of a specified length, is placed between rows of plants, and foliage of plants from either side of the row is shaken onto the sheet. Insects drop from plants onto sheet and are counted.

Sampling Techniques
Knockdown

- In this method, the insects are removed from the habitat by jarring, chemicals, or heating, and then counted.
- **Jarring** -- Insects are dislodged off from the plant onto a cloth or tray placed on the ground, by shaking the plant, or beating the branch.
- **Chemicals** -- By putting the plant into an enclosed container and treated with insecticide vapors or quick knockdown insecticides, the insects could be dislodged and counted.
- **Heating** -- Plant samples placed in a Berlese funnel that heats the sample, and causing it to dry out. The insects will move out from the plant material and fall through the funnel into a container.

Jarring

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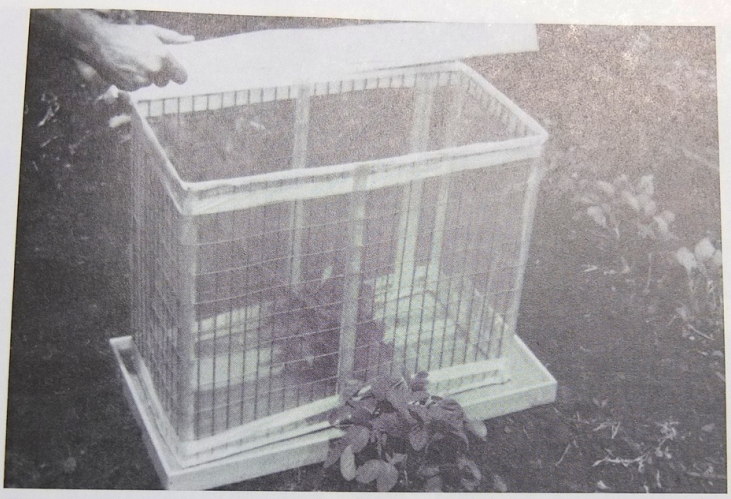

Figure 6.7 Polyethylene enclosures are sometimes used with insecticides to kill or knock down insects for sampling purposes. After insecticidal action, the lid is removed, and dead insects are shaken into the receptacle at the base of the plants. Counts are made from insects in the receptacle.

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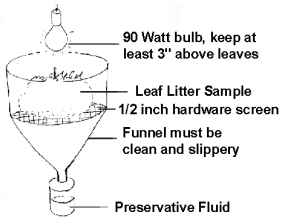
Heating

Berlese Funnel



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Netting

- One of the most widely used inexpensive sampling method that can be used against a variety of pests and their natural enemies.
- Sweep-netting.
- Vacuum insect net.

Trapping (1)

- Most important sampling technique especially for mobile insects.
- Trap must be able to hold captured insects.
- Traps are set, left unattended for a period, and then visited to check on the catch.
- Can be either 'attractive' or 'passive' in action.
- Attractive traps (eg. visual trap, bait traps) rely on a physical or chemical attractant to lure insects into them.
- Passive traps (eg. pitfall, Malaise and suction traps) collect the insects incidentally.

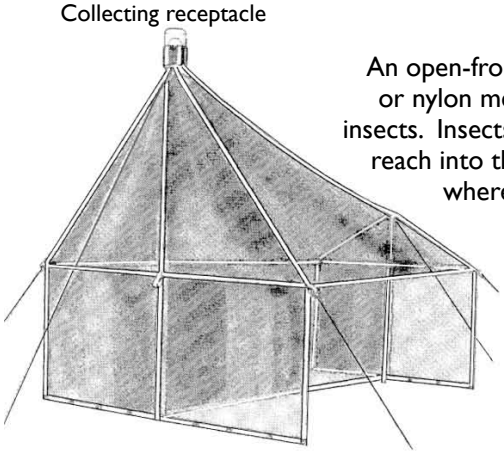
Trapping (2)

- Light trap - most widely used visual trap, especially against moths and mosquitoes.
- For moths, blacklight (emitting UV light) are widely used, while for mosquitoes, blacklight and CO_2 for attraction and a suction fan are used.
- Bait traps rely on olfaction (smell) for attraction.
- The attractants can be in the form of food bait, and pheromones.
- For passive traps, Malaise trap is used against flying insects.

CDC CO2-baited light trap for mosquitoes (left), Moth black-light trap (center), human-baited trap for mosquitoes (right)

Malaise trap

Collecting receptacle



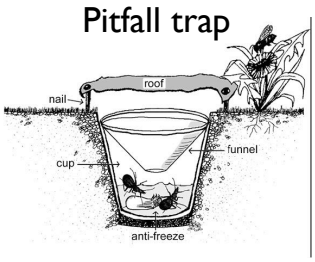
An open-fronted tent made of cotton or nylon mesh that intercepts flying insects. Insects tend to move upward and reach into the receptacle at the peak where they will be held.

Trapping (3)

- Water pan and sticky trap are also example of passive trap. Pan with soapy water is used against flying insects that are attracted to lights. Sticky trap is a trap with adhesive on its surface.
- Pitfall traps are used to capture ground-moving insects such as beetles and cockroaches.
- The insects will fell into the trap which may be collected in a receptacle with a preservative (eg. ethanol).
- Pitfall traps may have problem with overflow of receptacle's content and loss of collected specimen during raining season.

Water pan trap

Pitfall trap



Extraction from soil

- Soil samples are collected and placed into Berlese funnel.
- This method is useful to sample soil insects such as springtails, beetles as well as mites.
- It relies on insect movement for extraction.
- The soil can also be sieved to sample the insects.

Sampling Program

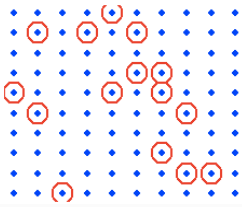
- Kinds of estimates: (1) absolute (2) relative.
- **Absolute estimates** - measure the actual number in the population.
- Eg. number of insects per m^2.
- Absolute estimates are very useful in insect population dynamics, but because of their cost, they are less favorable in pest management program.
- **Relative estimates** differ from absolute estimates because they do not translate directly to no. insects per area.
- eg. number of insects per sweep, no. insects per trap.
- Because the estimate is relative, it depends on the technique used to collect the data.

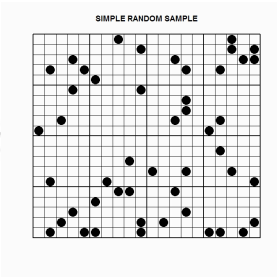
Monitoring and sampling

- There are 2 kinds of monitoring programmes for development of IPM:
  1. Monitoring for research purposes (eg. to establish economic threshold; to evaluate the influence of weather, natural enemies; to gauge the effectiveness of a potential control action).
  2. Monitoring by pest managers in operational commercial IPM situation - quick, inexpensive and simple in execution.
- Currently there are many ways to sample pest insects:
  1. Random sampling. 2. Point sampling.
  3. Trap sampling. 4. Sequential sampling.
  5. Systematic sampling. 6. Stratified sampling

Random Sampling

- Most commonly used.
- Can be used to determine pest numbers and/or damage per sample unit.
- Counts of pest numbers, damaged are taken at random spots in the field, forest section, or other managed unit.
- Usually about 10 spots are randomly chosen for sampling in a 16 to 32-hectare field.
- Spots should be chosen so they are not too close to the edge of the field, and if samples are taken from irregular areas, these irregularities should be noted along with sampling results.



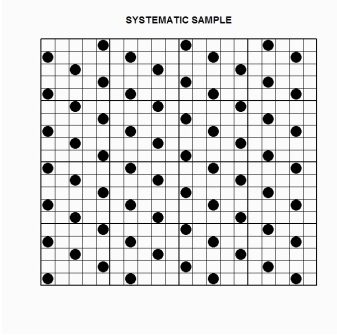


Point sampling

- Pest manager will choose at random 3 rows of plants in the field.
- Then he will examine the first 50 squares (fruiting buds) along each row, checking them for numbers of pests, pest eggs, and % damaged squares among the first 50 encountered.

Systematic sampling

- Any sample drawn from a list using a random start and a fixed sampling interval.
- This differs from simple random sampling in not giving equal probability of selection to all possible samples which could be taken from the population.



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Stratified sampling

- In this method of sampling, the population is first divided into different stratum (eg. male and female), before subjected to random or systematic sampling.

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Trap sampling

- This sampling method is with the aid of trap.
- These are the most commonly employed for detecting the actual presence of pest species.
- It is valuable in detecting the first appearance of migrating insects, or to keep a check on the progress of adult egg-laying stages.
- Types of traps include light trap (attracts noctunal flying insects - moths and mosquitoes), sticky trap (eg. fly paper) and pheromone trap (traps that exploit the chemical olfactory stimulants insect use in communication).
- Example of pheromone attractants: methyl eugenol (oriental fruit fly), sugar and propiononitrile (house fly), sinigrin (diamond-back moth).

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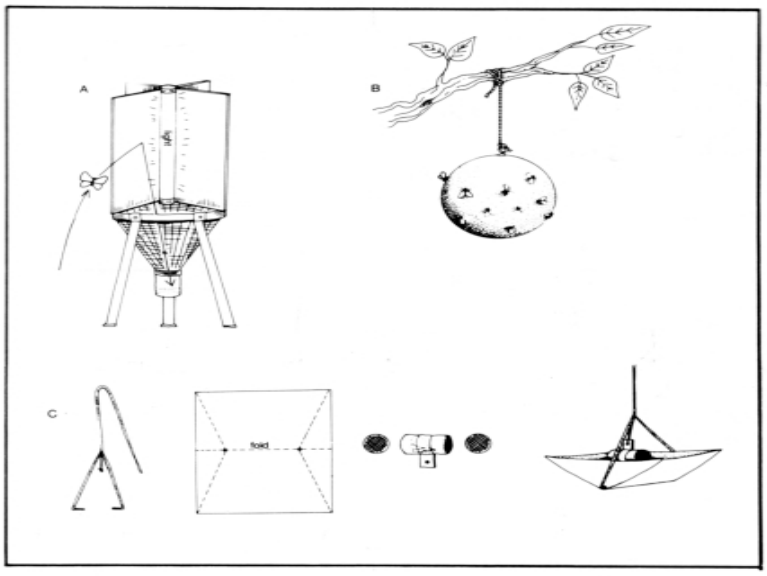

FIGURE 7-3. Useful traps for sampling and detecting pest insects. (A) A light trap. (B) A sticky red sphere. (C) A pheromone trap, showing how it can be made with wire and cardboard and baited with a virgin female placed in a small screened cage in the center.

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Sequential sampling

- Useful especially when pest populations are very high, or very low.
- The total number of samples is variable, depending upon whether the cumulative data falls inside or outside of predetermined confidence intervals.
- Relatively few samples would be needed if the population is very small (well below the economic threshold) or very large (well above the economic threshold).
- But a larger number of samples (higher confidence) would be needed to decide whether an intermediate population should be treated or not treated.
- If the number is far away from the threshold, the pest manager does not have to waste his time sampling on that plot, but instead move on to the next one. However, the number is closed to the action threshold, then more thorough sampling should be done.

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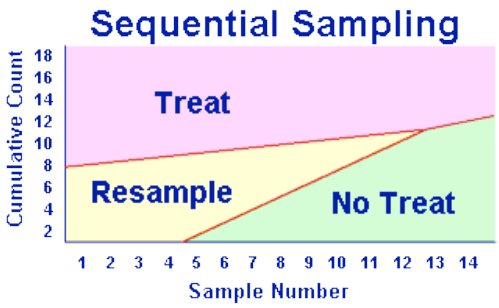

1. If the cumulative total of pests **exceeds an upper threshold value**, then conclude that the population is large enough to warrant control actions. Stop sampling and prepare to enact control measures.
2. If the cumulative total of pests is **beneath a lower threshold value**, then conclude that the population is small and warrants no control actions. Stop sampling (at least for awhile) and leave the population untreated.
3. If the cumulative total of pests is **between the upper and lower threshold values**, then no conclusion is possible yet. Sampling should continue until cumulative values reach the upper or lower threshold.

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Factors affecting sampling results

- Lack of uniformity between individuals in their sampling technique.
- Time of day when sampling takes place. Many insects are only active and present in the upper areas of the plant at certain period of the day.
- Size and stage of the pest commonly influence the number observed or taken by a sampling method. The stage of sampled insect is important in tabulating results and evaluating overall impact.
- Pest manager must recognize these shortcomings and design his own program to avoid as many of these problems as possible. This require some experimentations and some creativities.