Field Guide

Sampling insect pests, damaged and diseased plants, and beneficial organisms in the rice field

DEVICES AND TECHNIQUES

DEPARTMENT OF AGRICULTURE 1898

PHILRICE

RICE COMPETITIVENESS
RCEF
ENHANCEMENT FUND
EXTENSION PROGRAM

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Foreword

With the Rice Competitiveness Enhancement Fund - Rice Extension Services Program (RCEF-RESP) that DA-PhilRice co-implements, we see it imperative to equip agricultural technologists and other stakeholders with skill and knowledge on pest management. An integral part of managing rice enemies is pest sampling.

Through RCEF-RESP, agricultural technologists and farmers are trained on PalayCheck system – an integrated rice crop management system that presents the best key technology and management practices as Key Checks. Specifically, Key Check 7 in this system highlights the interaction of the rice crop with biotic factors and the agroecosystem and presents the correct identification of pests and application of ecologically sound strategies to prevent pest damages caused by pests.

Our Crop Protection Division has mastered the techniques discussed in this field guide, which can help farmers decide on how to manage pests. This field guide outlines all the advantages and disadvantages of each technique in helping the end-users choose which one is suited for a specific condition. This guide was also used as basis of the Pest Risk Identification and Management (PRIME) project, which aims to recognize the risk factors for pest outbreaks and identify efficient management strategies and approaches to reduce crop losses.

We hope that this field guide helps rice pest managers toward effective pest management through the use of appropriate techniques and devices.

JOHN C. DE LEON

Executive Director

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Introduction

Sampling is done by collecting, counting, or inspecting a small part of the population, which determines population trends of organisms. Sampling should be done properly for it to represent the population of insects in the field. For example, the population of insect pests and crop damage are generally randomly distributed that later aggregate into clumps. This may be caused either by the migration of adults or by concentration of eggs laid on a plant before the insect moves to the next. This situation is also pertinent in insect-transmitted viral diseases.Therefore, good estimate of population density depends on taking enough samples and systematic field random sampling. To emphasize, sampling is only an instrument to achieve a goal and not an end result in itself.

Sampling is done for research and pest management decision-making purposes. Sampling for research purposes is costly, time- and effort-intensive. Pest management sampling is not as demanding. It may consider conditions of the neighboring fields. There is no universal sampling method but there are a variety of techniques and devices available depending on work objective.

This booklet aims to familiarize researchers and extension workers with the range of sampling techniques available for studying arthropods and diseased plant populations and with pest management decision-making in rice fields. Limitations of the different sampling devices are also cited.

Categories of sampling methods

A. Aerial Sampling

It monitors insect abundance in the general environment of the crop. It provides general information about seasonal activity of the insects useful in planning pest management programs. For surveillance, the number of insects caught in traps may serve as an indicator of insect immigration or pathogen movement. This may also indicate the actual population density to be expected in the crop.

There are two types of sampling for arthropods in the general environment: (a) behaviorally neutral trap (suction, net, water, and sticky traps), and (b) attractive trap (light and pheromone traps). These are also used to monitor insect vectors of plant diseases. Various environmental factors affect light trapping such as lunar phase variations.

For instance, during full moon, trap catches are relative, not absolute, with respect to actual population density. Light traps only capture winged insects. Sticky traps are recommended for sampling flying insects that intercept insects while in flight. Traps are sometimes used to catch marked insects to measure the distance reached since the time of release. Sex-pheromone traps are effective in sampling male adults of the same species, and often used as indicator for efficient timing of control measures.

Aerial sampling is also used to trap bacterial and fungal spores in the air. Sterilized container, usually Petri plate with appropriate culture media for the target microorganism, is exposed at designated time and brought to the laboratory for incubation and isolation. Sometimes, live plants, usually susceptible seedlings, are used as traps.

B. Field Sampling

The following are methods of sampling field populations. They provide estimates of the level of insect infestation or damage and disease incidence on the crop:

Absolute method

It estimates density per unit area in a habitat. It is assumed that virtually all target species in the sample unit area are collected. This is normally used for research purposes. It is laborious, needs specialized techniques, and time-consuming. Absolute samples are taken to: (a) determine the population density of the pest (insects and diseases) and natural enemies, (b) establish economic threshold, (c) estimate effectiveness of control measures, (d) evaluate resistant varieties, and (e) determine flight activity or movements of insects.

Relative method

It generates density estimates based on sampling from a unit of habitat. It is not necessary to collect all insects. This method is selective and does not require much time and effort. Intensive knowledge on the ecology, life history, and behavior of the species concerned, their distribution pattern, and growth stage is important prior to the development of a sampling program. It is generally used in pest management programs.

Population indices

The target organisms are not counted. Instead, damaged plants or plant parts are sampled. These are also used in pest management decision-making programs.

Common arthropod sampling devices and techniques in rice research and pest management decision-making

Sampling devices for pest management should be easy-to-use, practical, cheap, and reliable. The common sampling devices are as follows:

- Advantages (blue)
- Disadvantages (red)

A. Sampling insects in the general environment of the crop

Sticky Trap

- Economical; measures insect movement and colonization.
- Caught insects are messy to handle and record due to the sticker on the board; does not catch non-flying insects.

Light Trap

- Involves varying size samples; good for comparing seasonal and yearly populations of insects.
- Catches are subject to changes in insect behavior; does not catch non-flying insects

Yellow Pan Trap

- Economical; measures insect migration; easy sorting and sample counting.
- Attraction is due to color stimulus; does not catch non-flying insects.

Sex-Pheromone Trap

- Catches are very specific; mostly males are attracted; detects early-season arrival of insects; can be used as tool for effective timing of interventions.

- Catches are very specific; limited availability of commercial pheromones.

B. Sampling insects in the field

Motorized sampling devices commonly used for research:

D-VAC Suction machine

- Catches adult hoppers including the strong fliers; sampling time is faster and shorter.
- Expensive; heavy; poor catch of early-instar nymphs of planthoppers and leafhoppers on water surface.

UNIVAC Suction machine

- Catches adult hoppers including the strong fliers; sampling time is faster.
- Expensive; heavy; poor catch of early-instar nymphs of planthoppers and leafhoppers on water surface.

FARMCOP

- Catches small hopper nymphs and arthropods on water surfaces; low-cost, lightweight; samples are preserved right in the field.

- Batteries need recharging; needs two people to operate; not uniform suction power when battery is weak; needs temporary storage of collected insects.

Modified Blow/Vac

- Provides good suction; lightweight; easy-to-operate; collects arthropods above and below water surface.

- Needs temporary storage of collected insects.

C. Simple tools and techniques used in the field

Mouth Aspirator

- Economical; fast; efficient for not highly mobile insects that stay on the canopy and base of the crop.
- Tedious sampling; poor catch of insects in the water; used primarily for collecting specific insects.

Visual Counting

- Economical (labor cost only); data recording can be done on-field.
- Human error (identification); only rough estimates of insect density are obtained.

Sweep Net

- Economical and fast; good for highly mobile insects staying in the canopy of the plants.
- Human error due to variability; poor catch of insects at the base of the plant and water surface.

Procedures and techniques for sampling arthropods and insect damage

1. Rice stem borers

(a) Adults. Light-trap catches are used to determine the seasonal abundance of their different species. The flight activity of the striped stem borer, *Chilo suppressalis*, can be measured by sex-pheromone traps, which are generally more effective than light traps for pest management purposes.

(b) Egg mass density. Count and record the number of egg masses on all leaves from hills selected randomly or systematically in a plot. Depending on the objective of sampling, usually 25-100 hills are enough.

(c) Larvae and pupae. Hills are selected systematically or randomly and examined for signs of borer damage. Damaged or infested hills are removed from the paddy, tillers counted, and all tillers dissected. Larvae of stem borers collected from the dissection are then counted and computed:

$$\text{No. of borers/100 tillers} = \frac{\text{No. of infested hills}}{\text{Total no. of hills examined while collecting samples of 25 infested hills}} \times \frac{\text{No. of borers obtained from hills sampled}}{\text{Total no. of tillers in sample of 25 hills}} \times 100$$

The above method may not include borers in hills that seemed not infested. A more accurate method involves selecting certain number of hills and dissecting all tillers for borer larvae and pupae. Next, calculate percentage infested tillers and numbers of borers per hill.

Deadheart (DH) and whitehead (WH). These are damages caused by stem borers and are normally presented in percentage. In reporting stem borer damage, it is important to show the formula:

$$\text{DH or WH (\%)} = \frac{\text{No. of DH or WH}}{\text{No. of tillers or panicles}} \times 100$$

The above method is commonly used for varietal screening programs. The standard formula used by ecologists for years, and as suggested by statisticians, is given below with sample size of 25 randomly selected hills:

$$\text{DH or WH (\%)} = \frac{\text{No. of damaged hills}}{\text{Hills sampled (25 hills)}} \times \frac{\text{Damaged tillers or panicles}}{\text{Total tillers or panicles}} \times 100$$

2. Plant and leafhoppers

Normally, their nymphs and adults are sampled at the same time using the same techniques and devices. Sweep net is probably the most common device for sampling leafhoppers in rice. It is easy to use; usually 10-25 sweeps per plot are made. Mouth aspirator, visual count, and suction machines are commonly used for planthoppers. When studying migration and seasonal fluctuation of these insects, researchers use yellow pan, aerial nets, and light traps.

3. Rice leaffolders

Light and sex-pheromone traps are used to monitor adults of rice leaffolders. Since their eggs are very small, larvae and damaged leaves in 10 randomly selected hills are usually sampled in the field. Damaged leaves (%) and number of larvae per unit area are calculated. For yield loss studies, the degree of damage from each leaf is recorded.

4. Caseworms

As caseworms cut the leaves of the rice plant and make cases where they could hide themselves, counting the number of larvae and or cases per unit area may be the best method for determining density and damage. In some cases, calculating the percentage of cut leaves on several scattered hills works.

5. Rice whorl maggots

One of the many ways to measure the damage they cause is the overall visual grading (0 - no damage, 9 - severely damaged) of the whole plot. This can be done while standing on a levee. However, observers may have different interpretations of the level of damage, making the visual grading quite relative. This is commonly used in varietal screening.

For population density studies, youngest leaf per tiller of the 25 randomly selected hills is graded, and the average leaf damage is calculated. Suggested method for yield loss studies is to grade all leaves of the 25 hills at the time of maximum damage, usually at 25-30 days after transplanting.

6. Rice bugs

Rice bugs are quite active and highly mobile when disturbed; sampling of this insect is normally done early morning or late afternoon. Nymphs and adults are counted from the 25 randomly selected hills or in a $1m^2$ spot. Sampling per unit area should be replicated at least four times. The number of bugs per panicle is taken in yield loss studies. When yield is not part of sampling, sweep net is usually used. Sampling is normally done from flowering to soft dough stages.

7. Rice Black Bugs (RBB)

Suggested method and tool for sampling RBB:

(a) Light trap (ordinary bulb)

- To determine the presence or absence of RBB in the area
- To determine seasonal/yearly RBB population fluctuations
- RBBs are attracted to light trap from 2 days before and 3 days after full moon
- During high RBB population, high-intensity light bulbs could be used to trap and kill the adults

(b) Pest management decision-making

- Sample 25 randomly selected hills per field (in transplanted rice) or 25 quadrants (25cm x 25cm in direct-seeded rice) per farmers' field by walking diagonally in the field. Count and record egg masses, nymphs, and adults of RBB. Record crop growth stage; if possible, record variety planted and pest management strategies implemented by the farmer in the field being sampled.
  If there are more than five RBB/hill, intervention is needed.
- Sample 10 randomly selected fields per barangay to have a good estimate of RBB in the area.
- Record visible damage caused by RBB feeding like DH, WH, and bugburn in severe cases

(c) Estimating damage (DH or WH)

Randomly sample 25 hills and record the number of DH or WH and number of tillers or panicles. Below is the suggested method of computing percentage DH or WH:

$$\%\text{ DH or WH} = \frac{\text{Infested Hills}}{25} \quad \frac{\text{No. of DH or WH}}{\text{Total tillers or panicles (in 25 hills)}} \quad \text{X } 100$$

Incidence | Severity

Note: Usually, only severity is being considered in estimating stem borer and RBB damages. The above formula included severity and incidence of damage, which gives us better estimate of damage in the field. However, whichever method is used, it is important to include the formula used in the calculation of damage when preparing the report.

8. Predators

Count predators per unit area or hill. Highly mobile predators such as mirid bugs and crickets are better sampled using the suction machines D-VAC, FARMCOP, or Modified BLOW/VAC, as they are efficient sampling devices for predators. Flooding a small area enclosed in metal frame is a good technique for sampling spiders during fallow and dry periods in the field.

9. Parasitoids

Normally, the pests or hosts of parasitoids are reared in the laboratory to determine percentage parasitization. For ecological studies, suction devices used for predators are also efficient for parasitoids.

10. Larvae of detritivores, filter feeders, and other aquatic larvae

The Blow/Vac and FARMCOP suction machines are the most appropriate devices for sampling aquatic insects in the rice field. Earlier studies showed that Blow/Vac suction machine gave a better estimate of aquatic larvae than FARMCOP.

11. Other insects

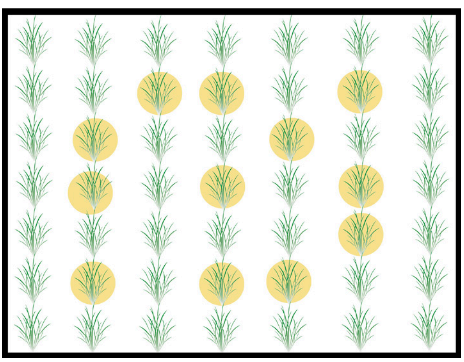
Do visual count of insects in 10 or more scattered hills. Another option is to sample all hills in an area, usually $1m^2$ replicated several times.

Procedures and techniques for sampling population of diseased rice plants

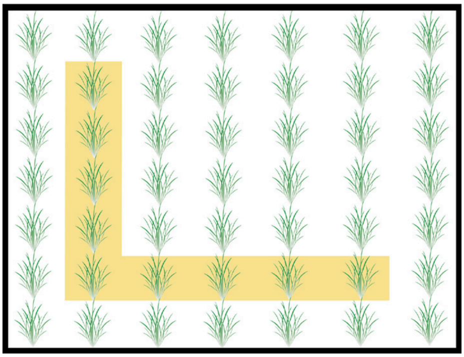
Rice diseases are caused by bacteria, fungi, and viruses. In the Philippines, viral diseases are all transmitted and spread by either leafhoppers or planthoppers. Bacterial and fungal diseases are spread primarily by wind and water. The onset of disease in a population is principally illustrated by the occurrence and spread of diseased plants (pathogenicity), not by the presence of the pathogen. The number of infected plants in the initial infection sites and the subsequent rate of spread influence disease incidence in the plant population (epidemiology). Disease incidence is the occurrence of the disease, while disease severity connotes its gravity in the host or in a population. Disease incidence is generally expressed in percentage and is derived by counting the number of infected plants, divided by the number of plants sampled, multiplied by 100. The degree of severity is conveyed in scale using a standard evaluation system (Ex. SES for Rice, 1980).

Disease spread can be rapid and wide. Determining the disease onset is vital in suppressing its speed of development. This can be done by conducting disease monitoring schemes. Appropriate sampling methods and techniques are essential for this purpose. These mechanisms and devices provide knowledge on the pathogen, disease symptoms, and disease epidemiology. The following sampling techniques can be used in determining disease incidence in the field:

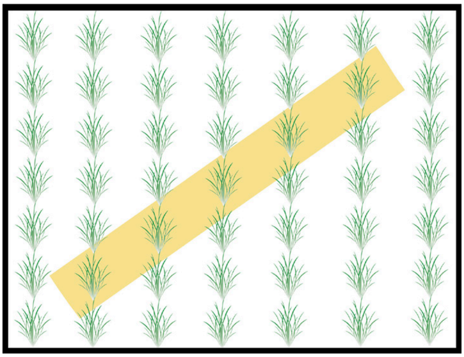
(a) **Individual Plant Sampling.** Repeated random scoring in several hills across the field is done. Lesser sampling time is needed, as it does not follow a sampling pattern. However, numerous samplings may limit the movement of the scorer. This may result in limited portion of the field covered and randomization may be compromised.



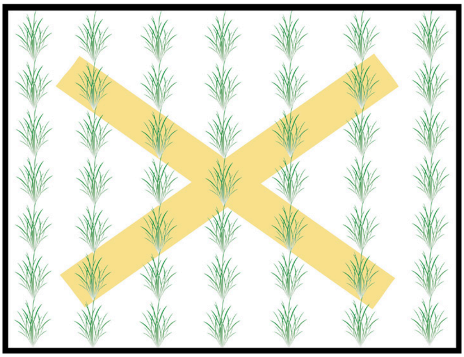
(b) Border Sampling. Hills near the border or those that can be easily seen are scored. It is generally used in field monitoring and at later stages of disease development. Less time and effort is exerted, but the symptoms are not clearly distinguished due to the plants' distance from the scorer. It does not provide satisfactory information about the disease's onset due to restricted randomization.



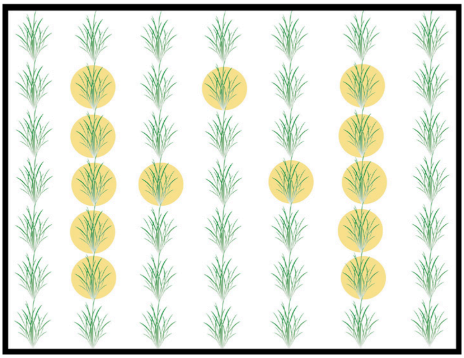
(c) Diagonal Sampling. Hills are randomly sampled by following a diagonal line. The rice hills after every five steps, on either side, are scored for infection. This is recommended for use in field experiments. It is not demanding as far as time and effort are concerned. It can readily distinguish infected plants and the initial site of infection due to nearness of the scorer to the sample plant. However, most of the sampled plants are confined at the middle of the field.



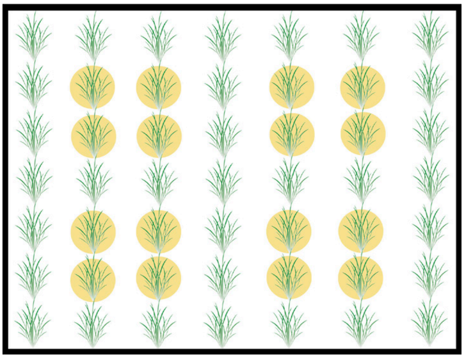
(d) Cross-Field Sampling. It is a variation of the diagonal sampling. Crosswise sampling path is made intersecting at the center of the field. The rice hills after every five steps, on either side, are scored for infection. This is recommended for field experiments owing to its high degree of randomization.



(e) W-Pattern. The rice hills are randomly sampled following a W-pattern. The plants after every five steps, on either side, are scored for infection. An ideal sampling procedure in field experiments, it covers the entire paddy field resulting in high level of sampling precision. Diseased plant is easily identified owing to the close proximity of the scorer to the plants. However, this requires more time and effort. It is not ideal for large-scale disease monitoring.



(f) Clump or Cluster Sampling. Rice hills, generally covering $1m^2$, are tagged and the plants in the sample area are scored. Setting four sampling points that are strategically spread in a paddy field or experimental plot is ideal. It is best for large-scale field experiments, where the sampling points may serve as replications. However, it requires more time and effort and not recommended for large-scale field monitoring.



Determining viruliferous insects

Insects carrying viruses (viruliferous) are morphologically indistinguishable from non-viruliferous ones. Simple greenhouse transmission test can identify them. The following steps may be considered:

1. Collect insects from the field by sweep net or mouth aspirator.
2. Introduce 3-5 insects into a caged healthy plant.
3. Remove the insects after 3-4 days.
4. Maintain the inoculated plant until symptoms develop.

The symptoms that will develop in the inoculated plant should be similar to those manifested by the plants in the field where the insects were obtained.

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Published by:
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We are a government corporate entity (Classification E) under the Department of Agriculture. We were created through Executive Order 1061 on November 5, 1985 (as amended) to help develop high-yielding and cost-reducing technologies so farmers can produce enough rice for all Filipinos. With our "Rice-Secure Philippines" vision, we want the Filipino rice farmers and the Philippine rice industry to be competitive through research for development in our central and seven branch stations, including our satellites, coordinating with a network that comprises 60 agencies strategically located nationwide. We have the following certifications: ISO 9001:2015 (Quality Management), ISO 14001:2015 (Environmental Management).

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