



PLANT PROTECTION AND HARVESTING

Plants are susceptible to bacteria, insects, fungi and other organism-induced infections, just like human bodies. Pests are tiny insects, animals, or even some types of parasitic plants that feed on crops, damaging them and making it unhealthy for consumption. Diseases in plants are usually caused by harmful bacteria, viruses, or fungi that spread through air, water, or soil, making the plants weak or sick. Successful harvest of agricultural produce depends heavily on the accurate detection and early prevention of these plant pathogens as well as proper timing and method of harvest. Learning about disease pests and harvesting techniques helps us to understand the importance of keeping our plants afresh, healthy and tasty so everyone can have enough to eat!



LEARNING OUTCOMES

After studying this lesson, the learner:

- defines the insects, pests, diseases and their life cycle;
- explains the importance of integrated pest management in managing ecological imbalance;
- distinguishes common disease symptoms of plants; and
- identifies the appropriate method and suitable time for harvesting of plant produces.

8.1 PEST MANAGEMENT

Agriculture production system is an ecosystem called agro-ecosystem comprising of interactive biotic and abiotic components. Plants, insects, macro and micro-organisms living in both above and below soil environment comprise the biotic components.

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Abiotic components include soil, water, solar radiation, temperature, nutrients, and soil pH, etc. Forest, grassland, uncultivated waste lands, etc. are natural ecosystems wherein ecosystem functions operate naturally without human interference. On the contrary, agro-ecosystem is a 'managed ecosystem' where the producer manages resources and processes, restricting natural interaction among organisms. Ecosystem balance in agro-ecosystem is affected because of manipulation of system as favourable crops are being grown for maximizing productivity.

Plant's environment consists of some organisms which are beneficial to crop plants and some others are destructive. These harmful organisms damage the crop causing economic losses to farmers and are called as 'pests'. A pest may be any living organisms directly or indirectly causing economic losses to human and their belongings. Crop pests that include insects, diseases, weeds, nematodes, and rodents, etc. are the major constraints to the increased food grain production. However, such organisms may not assume the status of a pest in another place or season or year. The word pest though literally refers to insects, diseases, weeds, nematodes, rodents etc., but conventionally it is used for insects. It is important to understand the behavior, nature and biology of these organisms in order to manage these pests.

8.1.1 Insect-pests

Insect-pests are widely adapted and spread all over the agro-ecosystem of world. Insects belong to the class Insecta (true insects) under the phylum Arthropoda. The true insects along with mites belonging to the class Arachnida constitute most of the crop pests. The insect orders that are important to crop production are: Lepidoptera, Coleoptera, Hymenoptera, Diptera, Thysanoptera and Hemiptera. Study of certain life cycle, feeding habits and damage symptoms of insects are important principle of management strategy.

8.1.2 Life Cycle and Feeding Habit

Insect **life cycle** comprises of different stages of growth and development, from egg to adult. Those stages are egg, larva, pupa and adult. They pass through the process of gradual changes in shape from one stage to another, called **metamorphosis**. The type of metamorphosis is not same for insects of all orders. Young stage is named differently for different orders, such as larva, nymph, and naiad, etc.



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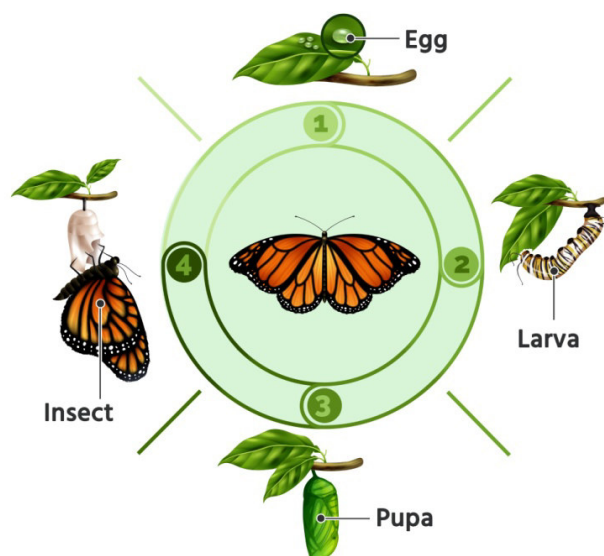


Fig. 8.1: Different growth stages of an insect

In accordance with the feeding behavior of the insects the damage symptoms are manifested.

1. **Chewing insects** chew during feeding with their chewing mouth parts. Insects belonging to this group are leaf folder, leaf miner, borers, tobacco caterpillar, semi-looper etc., leading to symptoms like defoliation, boring, and mining etc.



Fig. 8.2: Leaf mining and boring by chewing insects

2. Some other insects puncture plant tissues and suck saps during feeding which are called **sap feeders** with **piercing and sucking mouth parts**. These include aphids, mealybugs, plant hoppers, leaf hoppers, white fly and scale insects. Few of them act as vectors of viral diseases by transmitting them while sucking the sap. Symptoms are seen as yellowing, leaf curling, puckering, gall formation and deformation, etc.

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Fig. 8.3: Sucking of saps from plant tissues by white fly

**INTEXT QUESTIONS 8.1**

1. Which class do true insects belong to?
 - a) Arachnida
 - b) Insecta
 - c) Crustacea
 - d) Myriapoda
2. Which of the following insects is classified as a chewing insect?
 - a) Aphids
 - b) Mealybugs
 - c) Tobacco caterpillar
 - d) Whiteflies
3. State whether statement is true or false.
 - a. Chewing insects primarily cause symptoms such as yellowing and leaf curling.
 - b. Boring insects create tunnels in plant tissues, leading to structural damage.



8.2 INTEGRATED PESTMANAGEMENT

Chemical pesticides have no doubt played major role in controlling of insect-pests. However, their indiscriminate and inappropriate use by farmers in our agro-ecosystem since green revolution times has led to pest resistance, resurgence, problem residue retention and ecological imbalance by killing predators and parasitoids. A number of insect-pests management methods are used to minimize their incidence. These methods include physical, cultural, biological and chemical measures. No single method can achieve desired level of insect-pests control. Therefore, it was felt to integrate feasible methods which combinedly can prove more effective in managing the insect-pests. It led to the development of concept of Integrated Pest Management (IPM).

IPM is the careful selection and integration of all available pest control techniques that discourage the development of pest populations. It combines biological, chemical, physical and/or cultural management strategies and minimize the use of pesticides. The main principle of IPM is not to eliminate all the pests rather to manage their population to a level at which they do not cause significant losses. Prevention of entry of pests following good agronomic practices or cultural methods is given prime importance. Curative measures such as pesticides are only used when pest population reaches at economic threshold level (ETL). The **Economic Threshold (ET)** is the level of pest population at which control measures should be initiated to prevent the pest population from reaching the **Economic Injury Level (EIL)**. EIL is the pest population level at which expected crop damage exceeds the cost of implementing control measures. An IPM strategy for pest management may include use of resistant varieties, modifying agronomic practices, biological control and other measures to reduce pest infestation and need-based and judicious use of pesticides.

A. Cultural Methods

These comprise of modification of agronomic management practices such that the crop environment becomes unfavourable for the growth of targeted pests. Some of those cultural practices are use of resistant varieties, summer ploughing, line sowing, adjustment of time of sowing or planting, bund trimming, crop rotation, weed control, field sanitation, and balanced fertilizer application, etc.

B. Physical Methods

Physical control methods include removal and destruction of egg masses, larvae, pupae and adults of insect-pests, use of traps for insects, rope dragging for dislodging leaf eating larvae, installation of bird perches in the field for sheltering birds to prey upon immature insects etc.

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Notes**C. Biological Methods**

Biological control is based on the principle of employing natural enemies for the management of insects. It involves the use of living organisms or products derived from living materials to control pests. Different bio-agents like parasitoids, predators or pathogens are used to manage the insect population. Parasitoids are the organisms which lay eggs and complete their life cycles on host bodies as a result of which hosts die. Predators are the organisms which prey upon other organisms for their food. Predators may be different species of spiders, dragon flies, damsel flies, lady bird beetles, birds etc. Pathogens are micro-organisms such as fungi, viruses and bacteria which infect and cause diseases in their hosts as a result of which hosts are killed. These bio-agents can be mass multiplied in the laboratory in liquid or powdered formulations that can be sprayed like ordinary chemical pesticides. These formulations are known as bio-pesticides.

D. Behavioral Control

The behaviour of insects is controlled by the chemicals produced by insects to send signals to others over a large area. Sex pheromones can be used to confuse male insects and disrupt mating.

E. Chemical Control

A pesticide is designed to kill, control, repel, attract, or manage pests. They can be selective or non-selective. Selective pesticides are toxic to some species, with little or no effect on other species. Non-selective pesticides are toxic to a range of species. Here both beneficial and harmful organisms are harmed.

Use of chemical pesticides should be the last resort when all other methods fail to keep the pest population below economic loss. Therefore, use of pesticides should be need based, judicious, based on pest surveillance and economic threshold level (ETL) to minimize not only the cost involved, but also to reduce associated problems. While going for chemical control, we must understand thoroughly what to spray, when to spray, where to spray, how much to spray and how to spray.

**DO YOU KNOW**

People of India is practicing agriculture, animal husbandry, fisheries for thousands of years. Over this long period, Indian farmers have learnt to survive and grow food in difficult situations using natural products and practices. These knowledges are developed through careful observation and practical experience with nature. Such type of knowledge is termed as **Traditional Knowledge or Indigenous Technical Knowledge (ITK)**.

Indigenous agricultural systems often prioritize harmony with the environment, biodiversity conservation, climate adaptation and promotion of social and cultural value. Since traditional knowledge is primarily passed down orally, systematic documentation is essential for its preservation. In field of agriculture, such indigenous practices are available for pest management, soil and water management and rainwater harvesting. India is also a very rich sources of medicinal plants like ashwagandha, brahmi, kalmegh, aloe vera etc. Traditional knowledge of these medicinal and aromatic plants led to the development of **Ayurveda**, an alternative medicine system in Indian subcontinent.

*Notes***INTEXT QUESTIONS 8.2**

1. The Economic Threshold (ET) indicates the level of pest population at which control measures should be initiated to prevent reaching the _____.
2. Chemical pesticides have played a major role in controlling insect-pests, but their indiscriminate use has led to _____.
3. What is the main principle of biological control?
 - a) Using chemical pesticides to eliminate pests
 - b) Employing natural enemies for pest management
 - c) Increasing the use of fertilizers
 - d) Focusing solely on physical barriers

8.3 DISEASE PESTS

A disease interferes normal functioning of plants, resulting in a disrupted structure, growth, functions, or other parameters. Plant disease is defined as the state of local or

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systemic abnormal physiological functioning of a plant, resulting from the continuous, prolonged 'irritation' caused by phyto-pathogenic organisms or environmental factors. **Infectious** plant diseases are mainly caused by pathogenic organisms such as fungi, bacteria, viruses, nematodes and protozoa. Such diseases spread from one susceptible host to another, since the infectious agent can reproduce in the plant or on its surface.

Plant diseases are also **non-infectious**, caused by unfavorable abiotic factors such as adverse soil and environmental conditions. Since pathogens are not involved, they are not transmitted from a diseased plant to a healthy one.

8.3.1 Pathogens and Disease Symptoms

Microorganisms which have ability to cause plant diseases with development of symptoms are called pathogens. Causative organism may be fungi, bacteria, viruses, protozoa or nematodes. The external or internal reactions or alterations of a plant as a result of a disease are manifested as symptoms specific to the disease. The symptoms of the disease may depend on its cause, nature, and the location of the impact site.

- A. Fungi:** Fungi are spore forming, non-chlorophytic, eukaryotic organisms; some of them are parasitic fungi causing diseases in crop plants. Fungal parasites are by far the most prevalent plant pathogenic organisms. Fungi are found in all ecological niches and can cause significant damage. The important symptoms of fungal diseases are illustrated in figure 8.4.

Table 8.1: Common disease symptoms of plants

Name of disease	Description
Wilting	Loss of cell turgidity
Leafspot	Spot or lesions on leaf or stem due to necrosis of invaded cells
Anthrachnose	Ulcer like lesion that can be necrotic and sunken
Canker	Localized necrotic lesion on woody tissue
Dampingoff	Collapse and death of very young seedlings
Scab	lesion on tubers and other plant parts
Blight	Browning and death of leaves
Rusts	Many small lesions on stems or leaves giving rust appearance
Dieback	Progressive death of shoots generally starting at the tip
Powdery and downy mildews	Formation of mycelium, fruiting bodies and necrotic tissue

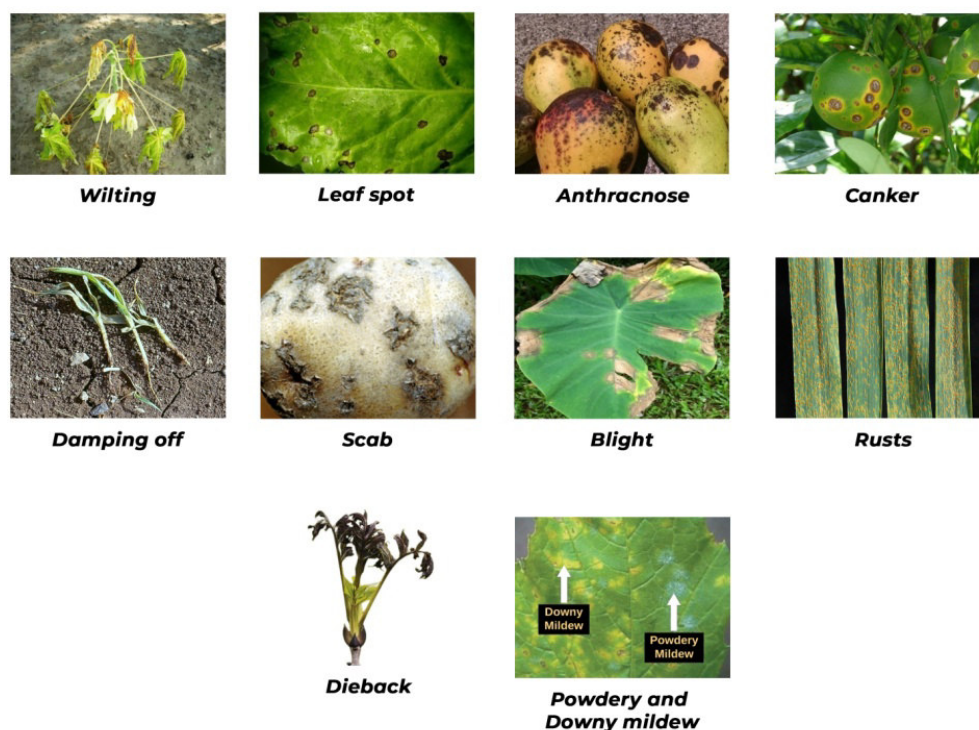


Fig. 8.4: Common disease symptoms of plants

- B. Bacteria:** Bacteria are microscopic, single-celled prokaryotic organisms, without a defined nucleus, that reproduce asexually by binary fission (one cell splitting into two). They occur singly or in colonies of cells. Symptoms of bacterial infection in plants are much like the symptoms in fungal plant disease. They include leaf spots, blights, wilts, scabs, cankers and root rot, fruit rot and overgrowth.
- C. Viruses:** Viruses are non-cellular infectious agents that need a host tissue to stay alive (i.e. obligate parasites). Unlike true animals they are incapable of digestion and respiration. Viruses consist of nucleic acid, either RNA or DNA at the core protected by a protein coat called capsid. Viruses infect all types of organisms, from plants and animals to bacteria. Most of plant viruses are RNA viruses. Sucking insects like aphids and chewing insects such as thrips transfer viral diseases from infected plants to healthy ones through feeding. Such insects are called as vectors. Besides insects, certain mites, nematodes, and fungi also transmit plant viruses. The symptoms of viral diseases can be of different types, such as growth suppression (reduced growth of the entire plant or its leading shoots), discoloration (mosaic, chlorotic rings, leaf chlorosis, and variegation), deformations (leaf wrinkling, corrugation, thread like leaves), necrosis and impaired reproduction (flower sterility, parthenocarpy, shedding of flowers and ovaries).

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Fig. 8.5: Leaf mosaic and leaf curling due to viral infection

8.3.2 Disease Management

Pesticides are also given major importance for control of plant diseases like insecticides. Fungicides and antibiotics are used as curative measures for control of fungal and bacterial plant diseases. Vector management is the first line defense for control of viral diseases.

Management of diseases through integrated approach is also applicable to manage plant diseases. It focuses on long term prevention of pests or their damage through a combination of techniques such as biological control, habitat manipulation, and modification of cultural practices and use of resistant varieties.

Management of pathogen involves the practices directed to exclude, reduce or eradicate inoculums. Management of the host involves the practices directed to improve plant vigor and induce resistance through nutrition, introduction of genetic resistance through breeding and providing need based protection by chemical means. Management of environment involves the practices that modify the environment which is not favorable to pathogen or disease development and does not predispose host to attack.



DO YOU KNOW

Before the discovery of chemical pesticides, different plant and animal-based materials were commonly used for agricultural pest and disease management in India. These materials are eco-friendly in nature and include neem, turmeric, tulsi, salt, lime solution, castor oil, mustard oil, cow dung, cow urine, ghee, lemon, methi, bael, curd, asafoetida, mint etc. Apart from pest management, they have other utilities also. Out of these materials, neem (*Azadiracta indica*) is most famous for its anti-microbial properties. Various types of neem-based bio-pesticides (e.g., Vijay Neem) and fertilizers (e.g., neem coated urea) are available in market.

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|------------------|--|
| 1. Neem | Neem-seed extract is used for controlling insect pests of cotton, pigeonpea and chickpea. Neem cake is used for control of termite and early stem borer in rice. |
| 2. Turmeric | Used for storing rice seed and curing injuries of animal |
| 3. Cow dung | Used for increasing organic matter content in soil, seed treatment of desi cotton and wilt control in ginger |
| 4. Cow urine | Used to manage smut disease in sorghum, termite attack in wheat |
| 5. Ash | Used for supplying potassium in soil and controlling root disease in fruit trees |
| 6. Tobacco | Control of white fly in cotton and leaf spot in banana |
| 7. Lime solution | Used for better germination of groundnut and control of white grub |
| 8. Salt | Used to control weed, khaira and blast disease in rice field |

(Source: Handbook of Agriculture, ICAR, New Delhi)

**INTEXT QUESTIONS 8.3**

- Which fungal disease is characterized by ulcer-like lesions that can be necrotic and sunken?
 - Canker
 - Scab
 - Anthraxnose
 - Blight
- The fungi are classified as?
 - Prokaryotic
 - Eukaryotic
 - Chlorophytic
 - Non-spore forming

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3. Fungi are chlorophytic organisms that can photosynthesize (True/False).
4. Most plant viruses are classified as _____ viruses.

**ACTIVITY 8.1**

You must have some favourite plants at your home garden or near playground. Suppose you are on a mission to protect your favourite plants from attack of pests. But you can not apply chemicals here because it may kill the other friendly insects living in the garden. Use your creative thinking and knowledge to design an insect pest management plan for the environmentally safe garden.

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8.4 HARVESTING

The economic parts of the crops need to be harvested by the farmer to earn the profit from the crop production enterprise. The process of removal of economic parts or the whole plant at right maturity is called harvesting. The economic parts may be grain, stem, leaf, root, flower or the whole plant. Crop must be harvested at right time, by right method and stored in right way for obtaining maximum profit from market. Crops are harvested when they are considered as 'mature'. Two types of maturity used by scientists are physiological maturity and harvest maturity.

- I. Physiological maturity:** It refers to the stage of the crop growth when the plants reach maximum dry weight. Application of inputs at this stage does not produce additional yield. In grain crops it relates to hard dough stage where grain moisture content will be around 40%. If crop is harvested at this stage, the grain will shrivel upon drying lowering the quality of produce.
- II. Harvest maturity:** It refers to the stage when the grain or respective economic part is at highest quality and quantity. In rice, the crop is harvested when grain moisture content is between 20 and 25%. When grain squeezed between the teeth it should feel firm but not brittle.

8.4.1 Criteria for Harvesting of Crops

The right time to harvest a crop depends on the economic part, use of the product and post-harvest operations. The maturity indicator and criteria of harvesting of few major crops are given in table 8.2.

Table 8.2: Criteria of harvesting for different agricultural crops

Crop	Harvesting criteria
Rice normally	80-85% of the grains are straw colored (yellow coloured); occurs at 30-35 days after heading stage
Wheat	Hard dough stage, Yellowing of spikelets and straw becomes dry
Maize grain	Husk turns pale brown in colour, 25 to 30 days after tasseling, moisture level is between 20-25%
Sorghum	40 days after flowering, grain moisture content is less than 28%, yellow coloured ears with hard grains
Finger millet	Brown coloured ears with hard grains
Chickpea	Leaves dry up and shedding starts, plants turn reddish brown
Pigeonpea	35-40 days after flowering, 80-85% of pods turn brown
Greengram and blackgram	Pods turn brown or black, dried pods with hard seeds inside
Groundnut	Yellowing of leaves, dark coloured patches inside the shell, kernels turn red or pink
Rapeseed-mustard	75-80% siliqua turn yellow, seed moisture content at 30%, seeds are firm if pressed between fingers
Sugarcane	Drying of lower leaves, brix between 18 to 20%, sucrose about 15%
Cotton	Well dried and fully opened bolls

8.4.2 Harvesting Methods and Processes

Harvesting of field crops comprises of sequence of operations which can be done in individual steps or in combination mechanically. These include reaping, drying, threshing,



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cleaning and bagging. Harvesting may be carried out manually or mechanically using machines. Manually harvested produce maintains better quality and fetches premium prices, whereas mechanical harvesting should be performed when grain reaches right moisture content. Manual harvesting is carried out with sickle which is tedious and labour intensive. Mechanical harvesting may either be accomplished at different steps such as reaping the crop using power reaper and threshing with axial flow thresher or electrical thresher. On the other hand, several operations can be carried out at a time in combine harvester machine. It performs multiple processes of reaping the crop, threshing and cleaning the produce in one pass.

Reaping: It is the process of cutting the mature crop about 10-15 cm above ground. Left over portion of the crop is called as stubble. For manual operation, sickles are usually used whereas mechanically it is done through power reapers.

Field drying: Here the cut crop is left in the field, exposing it to the sun for drying. It is conventionally followed when crop is harvested manually. When combine harvester machine is used, drying is done after threshing. Besides sun drying, different other types of driers are also used for this purpose.

Threshing: Here grains are separated from the reaped crop. Traditionally farmers thresh the harvested crop by beating the bundled crop against wooden or bamboo made structures. Now-a-days, human operated, electrical threshers and tractor operated axial flow threshers are being used.

Cleaning: Chaffy (unfilled) grains, half-filled grains, non-grain materials or trashes and dust are removed through the process of winnowing. A blower or an air fan can be used to remove lighter impurities. However, larger sized stones and smaller weed seeds as mixed with grains can be removed through sieves or screens of different sizes.

Bagging: Finally, the threshed and clean grain is put in bags for transport or for safe storage.

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The farmer utilized farm machine & tools in the vedic period. The tools 'srni' and 'datra' (sickle) was used for harvesting in Rigveda period. *Khanitra* (shovel) was used for digging of soil. The vedic people also record the use of 'surpa' for winnowing of paddy and barley.

After successful harvesting of grains, farmers often select good and healthy seeds to store them for next season. Generally, a storage structure, i.e. bin, is used for long-term storage of grains. In Tamil Nadu, at the time of seed storage, leaves of notch (*Vitex negundo*), neem (*Azadirachta indica*) and pungam (*Pongamia pinnata*) are mixed. Apart from mixing, a few leaves are spread at the top of seeds. On the top of it, waste paper and paddy straw are spread to cover the surface. This practice helps to prevent pest attack. Pulse grains are stored in gunny bags after coating with mixture of red soil and leaf extract of malai vembu (*Melia azadirachta*) and thumbai (*Leucas aspera*). People in north Goa use a special type of bamboo structure called 'Tatho' for storage of rice grain.



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INTEXT QUESTIONS 8.4

1. Stage of crop growth where plant reaches maximum dry weight is termed as
 - a. Harvest maturity
 - b. Physiological maturity
 - c. Crop maturity
 - d. Field maturity
2. Sugarcane is harvested at brix rating of
 - a. 18-20
 - b. 10-14
 - c. 23-25
 - d. 0-5
3. What is reaping?
4. Define threshing.

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Notes**WHAT YOU HAVE LEARNT**

- A pest is any living organism which is directly or indirectly causing economic losses to human and their belongings. Crop pests include insects, diseases, weeds, nematodes, and rodents etc.
- Insect life cycle undergoes different stages of growth and development namely egg, larva, pupa and adult. This gradual change in shape and size is called metamorphosis.
- Various insects have unique feeding habits like leaf folder, borers chew the leaves while aphids, white fly and plant hoppers suck the plant sap from leaves.
- Several physical, chemical and biological methods are employed to control pests. Integrated Pest Management (IPM) is a novel technique where all available pest control techniques are integrated to discourage the development of pest populations so that they can't reach the Economic Injury Level (EIL).
- Infectious plant diseases are mainly caused by pathogenic organisms such as fungi, bacteria, viruses, nematodes and protozoa. Non-infectious plant diseases are caused by unfavorable abiotic factors such as adverse soil and environmental conditions.
- Plant disease management involves a variety of strategies to prevent, identify, and control diseases affecting plants. These methods include exclusion, reduction or eradication of inoculums, plant vigor improvement, induction of resistance through nutrition, and introduction of genetic resistance.
- Crop must be harvested at right time, by right method and stored in right way for obtaining maximum profit from market. Each crop should be harvested following the specific harvest criteria.
- Harvesting can be done either manually or mechanically with machines. Although manually harvested crops tend to maintain higher quality, it is labor-intensive and time-consuming process. Mechanical harvesting should occur when the grain has reached the appropriate moisture content.

**TERMINAL QUESTIONS**

1. Define agro-ecosystem and its components. Differentiate between natural ecosystems and agro-ecosystems.
2. Discuss the life cycle of insect pests.
3. Classify insects according to their feeding habit. Give suitable examples along with it.
4. Explain the concept of Integrated Pest Management (IPM) and its significance in agriculture.
5. Compare selective and non-selective pesticides. What are the implications of their use?
6. Define plant disease and explain the difference between infectious and non-infectious plant diseases.
7. What are pathogens? List the major types of pathogens that cause plant diseases.
8. How do viruses cause diseases in plants? Explain their mode of transmission and common symptoms.
9. Illustrate the typical symptoms of fungal and bacterial infection in plant.
10. How do you differentiate between physiological maturity and harvest maturity?
11. Mention the criteria of harvesting for following crops.
 - a) Cotton
 - b) Maize
 - c) Wheat
 - d) Groundnut
 - e) Chick pea

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ANSWERS TO INTEXT QUESTIONS

8.1

1. Insecta (option b)
2. Tobacco caterpillar (option c)
3. a. False, b. True

8.2

1. Economic Injury Level (EIL)
2. Pest resistance, resurgence, and ecological imbalance
3. Employing natural enemies for pest management (Option b)

8.3

1. Anthracnose (option c)
2. Eukaryotic (option b)
3. False
4. RNA

8.4

1. Physiological maturity (Option b)
2. 18-20 (Option a)
3. It is the process of cutting the mature crop about 10-15 cm above ground.
4. It is process of separation of grain from reaped crop.

GLOSSARY

Ecological Niche: It is sum of all activities and relationships of a species by which it uses the resources in its habitat for survival and reproduction. Therefore a niche comprises of habitat (where organism lives), function played by it and interrelationship with other organisms.

Ecosystem: An ecosystem is a functional unit of nature encompassing complex interaction between its biotic (living) and abiotic (non-living) components. For example- a pond is a good example of ecosystem.

Mite: A mite is a small arachnid belonging to the class Arachnida. These creatures are characterized by their eight legs and can be found in various habitats, including soil, plants, animals, and even indoor settings such as carpets and bedding.

Nematode: Nematodes are commonly known as roundworms or eelworms. They belong to the phylum Nematoda and are characterized by their unsegmented, cylindrical, and elongated with a tapered body shape. Many species are important parasites of plants and animals, whereas others are beneficial to agriculture and the environment. One such plant parasitic nematode is root-knot nematode (*Meloidogyne* spp.) which causes root gall in plants.

Pest Resistance: It occurs when a population of pests evolves to become less susceptible to a pesticide that was previously effective.

Pest Resurgence: It is a phenomenon of reappearance pest populations after an initial decline due to pesticide application. Here pest reappears with higher density than initial population due to destruction of its natural enemies.

Sex Pheromone: Pheromones are chemical substances secreted by organisms that trigger specific behavioral responses in other individuals of the same species. They are distinct from hormones, which act within the body, as pheromones are released into the environment to communicate with others. Sex pheromones are released to attract individuals of the same species for mating purposes.

SUGGESTED READINGS

1. *Crop pests & stored grain pests & their management*, e-KrishiShiksha, Agricultural Education Division, Indian Council of Agricultural Research, New Delhi (<https://ecourses.icar.gov.in/>).

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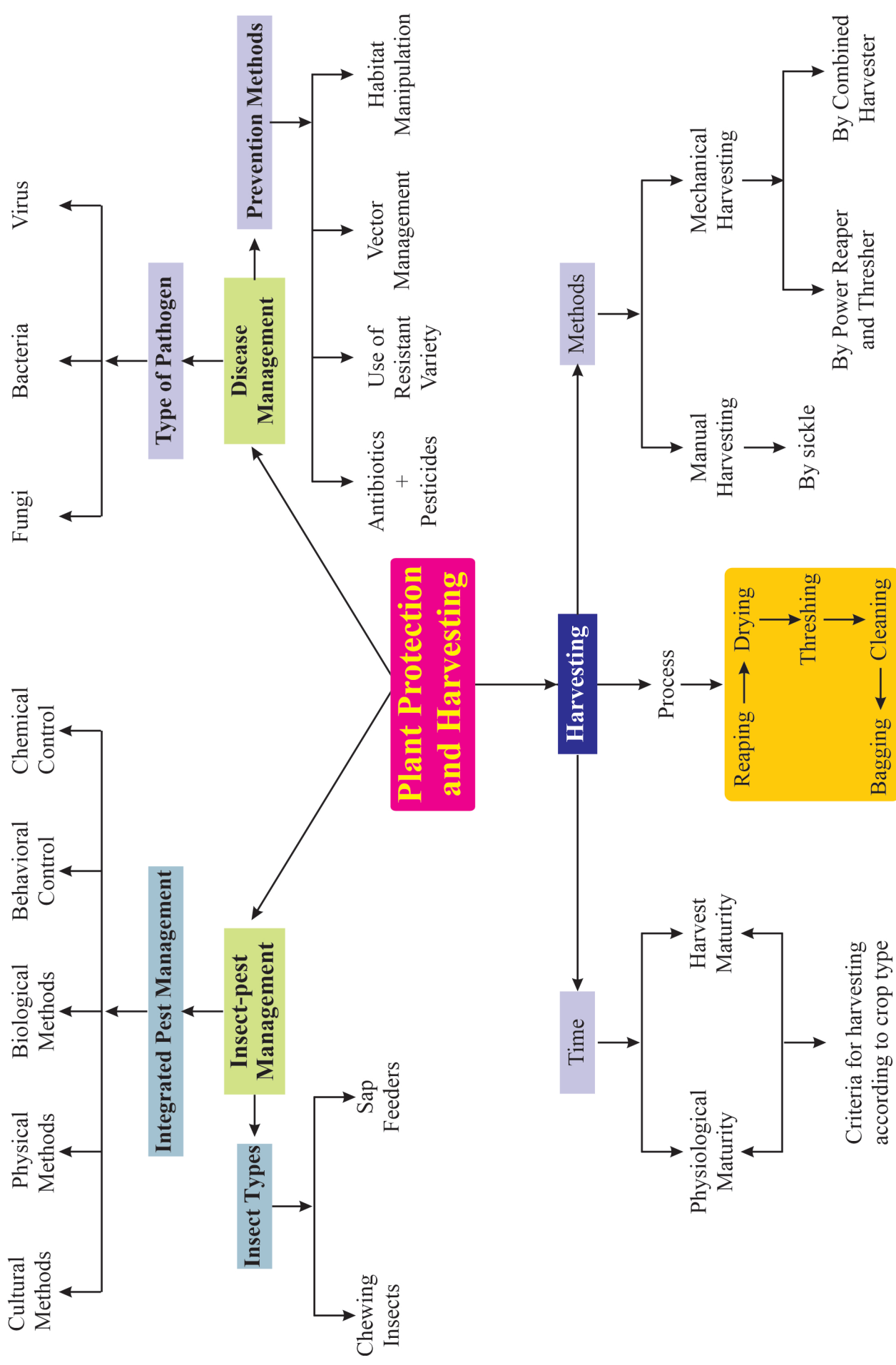
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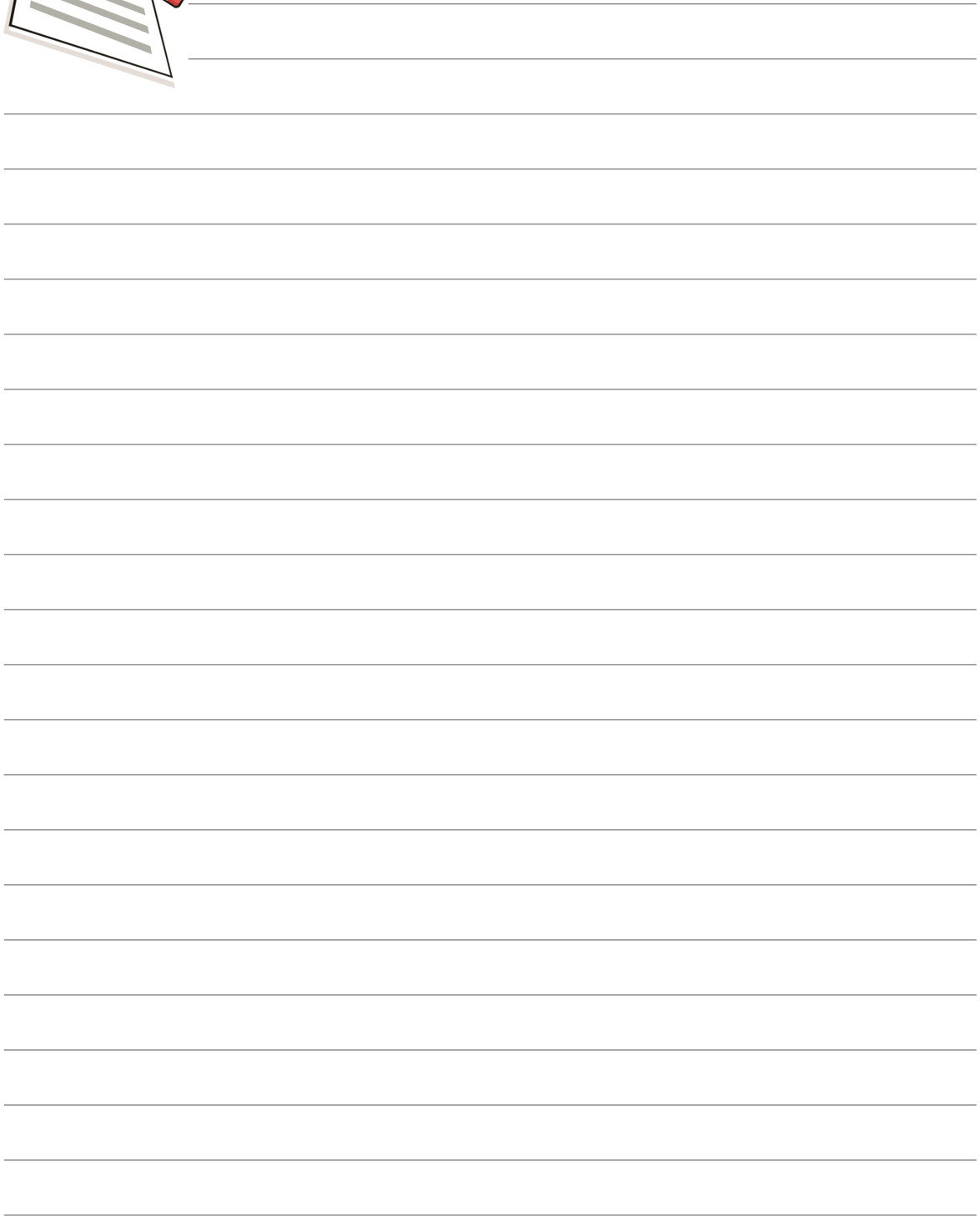
2. *Diseases of field crops and their management*, e-KrishiShiksha, Agricultural Education Division, Indian Council of Agricultural Research, New Delhi (<https://ecourses.icar.gov.in/>).
3. Reddy, T. Y. and Reddy, G. H. S. (2023). *Principles of Agronomy*, Kalyani Publishers, Ludhiana.

If you want to know more about indigenous agricultural practices, you may visit the following resources

- i. <https://vedicheritage.gov.in/vedic-heritage-in-present-context/agriculture-2/>
- ii. <https://icar.org.in/ITK>
- iii. Mishra, Anupam, Singh, S.R.K., Raut, A.A. (2020). Traditional Knowledge in Agriculture. Division of Agricultural Extension, ICAR, New Delhi. Pp.39.

WHAT YOU HAVE LEARNT





NOTE