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## **Pests and disease control in Plants**

Pests are living organisms that cause damage to crops in form of quality and quantity.

### **Ways by which pests cause damage the crops**

- Eat the buds, flowers, shoot, fruits e.g. grasshopper, caterpillars and beetles eat leaves/cause defoliation. Reducing fruit production and rate of photosynthesis.
- Introduce toxins to plants
- They bore into fruits and seeds e.g. bean bruchid/weevil, maize weevil etc. and eat inside causing holes, discoloring the tubers and causing them to have bitter taste e.g. sweet potato weevils.
- Suck plant sap and reduce plant vigor e.g. aphids, mealybugs and scales
- Transmit diseases e.g. maize leaf hopper, white flies etc.
- Change crop's growth habits e.g. sorghum shoot flies
- Cause discoloration and bad smell reducing acceptability by customers
- They penetrate and damage plant roots thus preventing absorption of water and nutrients
- They reduce the yield of crops.
- Cause rotting of seeds hindering germination
- Contaminate products with their excreta

### **Characteristics that make pests successful in nature**

- Have high rate of multiplication e.g. lay very many eggs.
- Most of them are small making it easy to hide
- They resemble the host crop for easy camouflage
- Have hard cuticle to protect them from adverse conditions
- Most fly leading fast dispersal
- Have defense mechanisms such as production of offensive smell
- Undergo metamorphosis such that different stages occupy different ecological niches to reduce competition
- Develop resistance to pesticides
- Have alternative source of food
- Have modified mouth parts to feed on crops such as mandibles for cutting and proboscises for sucking

- Resistant to diseases.

## **Pest control measures**

### **1. Principles of pest management and control**

These are factors that need to be considered in order to fight a pest

- Taxonomy: identifying the pest
- Ecology the way of life of the pest to understand the effect of weather and seasons on the pest in order to identify the best time to attack the pest
- The biology: how the pest reproduces to identify the best stage to attack it.
- Estimating the population to identify the economic threshold of the pest.

### **2. Method of controlling of controlling crop pests**

#### **(a) Cultural methods of controlling crop pests**

Cultural pest control refers to the manipulation of the crop production system or cultural practices to reduce or eliminate pest populations. These include: -

- Proper seed bed preparation: repeated tillage either exposes soil borne pests to their natural enemies on the surface or buries the pests very deep in the soil where they are suffocated and die.
- Crop rotation: this controls pests which feed on specific crops; by not growing such crops, pests either migrate or die due to lack of food
- Closed seasons: this involves foregoing cropping seasons without planting so as to control the build-up of pests in the field. Cropping is suspended for specific period to derive pests out of the host plants.
- Use of resistant crop varieties that tolerate pests. The resistant varieties have characteristics such as hairiness, thick or hard epidermis, unattractive color and/or smell to the pest and early maturation
- Destruction of crop residues after harvesting to eliminate breeding sites and kill the pests.
- Use of certified seeds and planting materials that carry no pests
- Regular weeding of the crops to eliminate breeding, hiding sites and alternative hosts.
- Proper spacing reduces spread of pests from one crop to another
- Proper pruning removes infected branches and micro habitats for the pests
- Thinning prevents overcrowding and spreading of pests
- Proper application of fertilizers ensures that crops grow faster or are able to tolerate pests
- Rogueing eradicates pests by removing and destroying pest affected crops from the garden.
- Mulching especially with black polythene controls nematodes in pineapple fields.
- Timely planting ensures that the crops grow and mature before destructive stages of the pest.
- Timely harvesting prevents attack of mature grains such as in millet, sorghum, rice and maize.
- Destroying volunteer plants i.e. plants that provide alternative source of food or breeding ground.

- Intercropping discourages spreading of pest from one crop to another and some crops like tobacco produce natural pest repellants.

#### Advantages of cultural pest control

- It is cheap and feasible for low value crops
- Does not pollute the environment
- It offers opportunity for integration of other methods
- Effect method of preventing pest establishment

#### Disadvantage of cultural method of pest control

- Does not eliminate pests
- Applied before pest attack thus reluctantly used
- Requires repeated use

### (b) **Physical methods of pest control**

These involve use of specific physical/mechanical measures to reduce the number of pests. They include

- Hand picking and destruction of pests
- Construction of physical barriers e.g. greenhouse and screen houses
- Use extreme (high or low) temperatures to kill pests
- Use of radiations
- Dehydration of pest
- Use of irritating sound
- Use scarecrows
- Use insect traps

### (c) **Chemical pest control**

It a pest control measures that involve use of chemical/pesticides. Natural chemicals used includes a mixture of urine and ash, some plant extracts etc. Synthetic chemicals include DDT, ambush, deldrine, malathion etc.

#### **Terminologies relating use of pesticides**

- (i) Lethal dose (LD50) is the dose of agricultural chemical that will kill 50% of the pest/animal in a test population.
- (ii) Selective pesticide is one that kills only the target organism but has little effects on others.
- (iii) Pre-harvest period: it the duration/length of time which must elapse before crops sprayed with agricultural chemical can be consumed
- (iv) Persistence: the period of time a pesticide remains in the environment (including within the organism) before being broken down.

- (v) Specificity refers to the range of organism that a pesticide can affect/kill. Broad spectrum pesticides is one that kill many species of pests such as DDT while a narrow spectrum pesticide kills few species.
- (vi) Tolerance limit refers to the maximum quantity of the chemical residues that is acceptable in the environment.

#### **Ways of controlling storage pests.**

- Hand picking and destruction of pests
- Use extreme (high or low) temperatures to kill pests
- Use of radiations
- Dehydration of pest
- Use of irritating sound
- Pick a storage facility with a good pest control policy.
- Use plastic storage containers with tight lids.
- Keep the storage area clean.
- Maintain a cool, dry climate.
- Use preventive pest control products.
- Use safe/appropriate pesticides

#### **Desirable characteristics of a pesticide**

- toxic to the target organism
- specific to the target organism
- biodegradable not to accumulate in the environment
- harmless to the plants and animals
- cheap and readily available
- easy to store and transport
- readily soluble in water
- not accumulate in ecosystem

#### **Precautions to be taken by the farmers to ensure safe use of pesticides**

- Read the instructions on the container or leaflet before using the pesticide
- Wear protective clothes such as overalls, gloves, rubber boots, head masks and eye shields.
- Chemical should be stored in safe places away from children.
- Do not eat or drink while working with pesticides
- Wash any spillage from your body as soon as possible
- Clean the equipment after use
- Dispose of empty containers safely as instructed by the manufacturer.
- Do not use empty containers for edible substances.

#### **Factors that affect efficiency of a pesticide**

- Concentration of the pesticide
- Timing of application or stage of the pest to which the pest is applied

- Weather conditions at the time of application. Usually rain/dew may dilute the pesticides leading to ineffectiveness.

### **Pesticide resistance**

Pesticide resistance is the decreased effectiveness of a pesticide in controlling a pest population that was previously susceptible to it.

### **Factors that promote pesticide resistance in pest populations**

- Genetic factors; high genetic variation promote resistance
- Mutation
- Prolonged use of a single pesticide
- Unwarranted use of pesticides
- Use of broad spectrum pesticides such as DDT that kill natural enemies of the pests.
- Use of sub-lethal concentration of pesticides
- High population of pesticide
- Non-uniform application of pesticides in the field

### **Advantages of chemical pest control**

- It is very effective
- Easy to apply
- Chemicals are broad spectrum
- Easy to access

### **Factors that limit the use of or disadvantages pesticide by farmers**

- they and application equipment are expensive
- application of pesticides requires skill especially in measuring and mixing
- Lead to chemical resistant pests on prolonged use of same pesticide
- They kill beneficial organism as well for example pollinator.
- They pollute the environment
- They lower the value and/quality of products
- Some pesticides can interfere with hormone systems, potentially leading to developmental and reproductive problems.
- They are poisonous to the farmer and livestock
- Lead to chemical resistant pests on prolonged use of same pesticide
- Some pesticides are inflammable and may cause fire hazards
- Some pesticides such as DDT accumulate in food chain leading to toxic levels and may eliminate organisms in top trophic levels.
- Exposure during pregnancy can increase the risk of birth defects and developmental delays in children

#### **(d) Biological pest control**

This is the control of the pest population below the economical threshold using their natural enemies in form of predator, pathogen, parasite etc.

##### **Qualities of a good biological pest control agent**

- Must have high searching ability
- Should be adaptable to wide range of environments
- Should be host specific
- Should have ability to multiply in order to control the target organism
- Should not cause a lot of damage to crops and animals
- Should be easily raised artificially
- Should be easy to distribute/apply

##### **Advantages of controlling pest using biological control method**

- It requires less labor
- It is selective to the target organism
- Long lasting from season to season
- Can be easily employed to remote areas
- cheap

##### **Methods of using biological control agent**

- (i) **Introduction:** here the natural enemy is introduced from another area in the area of interest to control the pest.
- (ii) **Conservation:** the natural enemy exists but there is still an outbreak of the pest. Conservation therefore refers to the adjustment of the farming system to favor multiplication of the agents
- (iii) **Argumentation:** requires introduction of additional of the natural enemy to the existing population

#### **(e) Integrated pest management (IPM)**

It is a pest control measure involving use of a wide range of methods to control pests without harming the environment using methods such as biological control, burying/burning infected plant parts etc. use of chemicals is minimized.

##### **Advantage of integrated pest management**

- it reduces environmental pollution
- has less health side effects
- ensure complete destruction of the pest at all stages of development
- Conservation/protection of important insects such as bees, lady bird beetles, true spiders and rove beetles etc. is achieved.

- Pest infestation can be controlled in the a very short time i.e. quick control pest is achieved.
- In build resistance of some pest to a certain control method is eradicated more than one method is used.
- The system is cost effective in the long run.

### **Disadvantage of integrated pest management**

- Requires skill
- Farmer are reluctant to use prevention measures
- Does not eliminate the pests

### **Crop diseases**

A disease is any sub-normality or malfunctioning that occur in plants and becomes harmful to any part of its part or systems.

#### **Effects of diseases on crop plants.**

- Stunted growth
- Malformation of plant
- cause plant death
- Reduced crop yield
- Reduced quality of crop yield

#### **Ways by which disease spread in crops**

- Through wind/air current blow spores from one diseased crop to another
- Through rain splash
- Contact between health and diseased plant
- Infected planting materials/seedlings/cuttings
- Pruning knives, pangas carry disease causing organisms
- Transfer of disease causing organisms by pests and vectors
- Irrigation with contaminated water
- Application of infected mulches
- Through infected crop wastes/residues
- Through infected organic manure
- Through contact with infected animals

#### **Cultural methods that can be used to control crop diseases**

- Plant resistant/tolerant plants to diseases
- Timely weeding to remove alternative hosts or breeding grounds
- Crop rotation to prevent building up host specific diseases
- Spraying with recommended chemicals to control vectors or to kill disease causing agents
- Seed dressing can be used to destroy spores on the seeds
- Heat treatment can be used to destroy spores on the seeds.

- Sterilizing soil by heat to kill pathogens
- Early planting to escape buildup of pests and diseases
- Proper spacing to minimize spreading of diseases
- Quarantine to restrict movement of diseased plant materials
- Destruction of crop residues that contain pathogens
- Pruning to reduce micro-climate that favor growth of microorganisms
- Disinfect tools to prevent spread of diseases
- Proper hygiene

### Symptoms of plant disease

- (a) **Mosaic:** these are yellow patches on the leaves forming a mosaic pattern, followed by leaf curling. They are caused by viruses e.g. cassava and tomato mosaic.



- (b) **Rusts:** these are rusty orange/white colored sports that result in rupturing of the epidermis and formation of swellings. They are caused by fungi that attack leaves and stems e.g. coffee rust, bean rust



- (c) **Smuts** are black dusty masses that resemble soot normally found in cereals like maize, wheat, sugar cane and sorghum. They are caused by fungi.



(d) **Anthracnose** are small sunken water soaked lesions on leaves, stems and ponds. They caused by fungi e.g. bean anthracnose.



(e) **Rots** are degeneration of plant tissues due attack by pathogens. They are common in vegetables and fruits



(f) **Rosette** occurs in leaves and makes the leaves to be grouped closely and packed together with limited spaces and there appears to be no internodes. E.g. groundnut rosette cause by viruses.



- (g) **Galls** are swellings along the structure of a plant that may interfere with transportation and absorption of water and nutrients. They are caused by nematodes and fungi.



- (h) **Chlorosis** is the uniform yellowing of leaves



- (i) **Necrosis** is the death of plant tissues resulting from attack by pathogens.



- (j) **Wilts**: plant tissues become flaccid and drop/collapse caused by fungi.



- (k) **Leaf spot and blights** are limited non-expanding necrosis patches on leaves. If the spots are fast spreading, they kill the whole part of the plant and become blights.



- (l) **Dumping off** is the rotting or collapse of the seedlings at the ground level. It is caused by fungi.



Dumping is promoted by

- Heavy soil/poor drainage
- Very high plant population
- Heavy weed infestation
- Excess soil moisture and nitrogen

- (m) **Mildew** is the massive production of spores and mycelia that rapidly covers the leaf surface producing a powdery substance e.g. downy mildew.



(n) **Cankers** are wounds created on plant tissue due to attack by pathogens



(o) **Hypotrophy** is the production of small sized cells induced by pathogens.

(p) **Hypertrophy** is the **abnormal increase in the size of the plant organs** due to increase in the size of the cells of a particular tissue

(q) **Hyperplasia** is the abnormal increase in the size of the plant organs due to increase in the number of cells of which the tissue or organ is composed, owing to increased cell division.

(r) **Phyllody** is the abnormal development of floral parts into leafy structures

(s) **Mottling** is the yellowing of leaves but with no pattern.

### The environmental factors that cause diseases in plants

(a) Temperature

- Sun scald exposed sites of fresh fruits and vegetables
- Wilting due to high evaporation
- Over sweetening of potatoes due to low temperature

(b) Soil

- Cause stunted growth due to inadequate nutrients
- Increase yellowing and leaf senescence due to lack of water
- Rotting due to too much water
- Chlorosis and early senescence due to inadequate supply of nitrogen

(c) Lack of soil moisture cause wilting and stunted growth

(d) Limited sunshine/shadows causes etiolation and weakening of plant stems

(e) Air pollutants such as sulphur dioxide cause plant lesions

### **The nursery bed maintenance and how they can contribute to pest management**

- Irrigation and water leads to healthy seedlings that can tolerate pests.
- Appropriate and regular watering wash off pests from seedlings
- Weeding eliminate weeds that act as breeding ground for pests
- Thinning reduces congestion and spread of pests
- Monitoring and picking out infected seedlings prevents spread of pests and diseases
- Spraying kills pesticides
- Application of fertilizers boost seedlings vigour which help them to tolerate pests and diseases
- Soil sterilization by heating soil kills pest

### **Factors that make fungi the most successful plant pathogens**

- They have wide range of host
- They are saprophytic in nature and thus have food available
- Produce vast amount of spores to increase chance of survival
- Light spore is easily dispersed
- Can exist in different forms
- Readily undergo mutation
- Resistant to chemicals

### **Factors that contribute to the prevalence (increase) of pests in tropics**

- **Crop improvement** that has made crops of better quality which favor multiplication of pests.
- **Change in farming system** the introduction of large supply of food to pests hence favoring their existence.
- **Decline in species diversity** elimination of species diversity disturbs the ecosystem through bush burning deforestation hence increasing pressure of pests to crops.
- **Climatic change** that leads to destruction of ecosystem and habitats for the organism.
- **Introduction of new crops** that come with new crop pests.
- **Increased use pesticides** leading to pesticide resistance.
- **Crop storage** that enables pests to hide for long time
- **Improved transport** that enable transport of pests.
- Change in demand patterns for crops; crops that are not in demand are neglected and their pests left to multiply for instance it happens with coffee when prices fall.

### Revision question

1. Painting of wood on a farm structure is done in order to
  - A. Block entry of air
  - B. Prevent termites attack
  - C. Block penetration of moisture
  - D. Seal off wood defects
2. Frequent use of pesticide like DDT in an ecosystem is discouraged because it
  - A. Accumulates in consumer tissue
  - B. Cause migration of beneficial organisms from the areas
  - C. Leads to emergence of secondary pests in an area
  - D. Is too strong and cannot be diluted
3. The best way of controlling scale insect pest in a sugar cane plantation is to
  - A. Spray the field with soil sterilants
  - B. Fumigate the soil
  - C. Crop rotation with legume
  - D. Expose them to their predators
4. Which of the following does not affect sprayer performance
  - A. Operating pressure
  - B. Forward speed of operator
  - C. Height of the crop
  - D. Distance from the crop
5. The best way of controlling scale insects pest in a sugar cane plantation is to
  - A. Spray the field with soil sterilants
  - B. Fumigate the soil
  - C. Crop rotation with legumes
  - D. Expose them to their predators
6. Which one of the following does not affect sprayer performance?
  - A. Operating pressure
  - B. Forward speed of operator
  - C. Height of the crop
  - D. Distance from the crop
7. Which of these sets of diseases given below are protozoan?

(i) Fowl pox	(iv) black quarter
(ii) Trypanosomiasis	(v) anaphlasmosis
(iii) Riderpest	(vi) Hog cholera

  - A. (i), (iv) (v)

- B. (ii), (iv)
  - C. (i), (iii), (iv)
  - D. (iii), (vi)
8. Which of the following types of pesticides is the most effective in controlling aphids?
- A. Contact pesticide
  - B. Surface sterilants
  - C. Fumigants
  - D. systematics
9. one of the reasons for not treating millet seeds with chemicals during storage is the
- A. it is difficult to clean off chemicals before consumption
  - B. the grain embryo is easily killed by chemicals
  - C. the tough grain coat resist pest attack
  - D. the small grain sizes discourage pest attack
10. Pesticide like DDT have been discouraged mainly because
- A. They are highly toxic to use
  - B. They are not easily degraded
  - C. They kill beneficial insects
  - D. They are not expensive
11. Anaphlamosis is caused by
- A. Ticks
  - B. Protozoa
  - C. Bacteria
  - D. viruses
12. Which one of the following is a vector of the lift valley disease of sheep?
- A. Mosquito
  - B. Tick
  - C. Tsetse fly
  - D. snail
13. Which of the following is an example of an irregular pest?
- A. Aphids
  - B. Locust
  - C. Grasshopper
  - D. White flies
14. Which of the following agricultural chemicals is out of place
- A. Agrocide
  - B. Gramoxone
  - C. Dalapon
  - D. agroxone
15. which of the following pesticides is most suitable for controlling sap sucking pests

- A. Contact pesticide
  - B. Surface sterilant
  - C. Systematic pesticide
  - D. fumigant
16. The animal disease that is vector borne is
- A. Anthrax
  - B. Foot and mouth
  - C. Rinderpest
  - D. Trypanosomiasis
  - E.
17. The bean characterized by brown, sunken and soaked lesions on the pod is
- A. Bean mosaic
  - B. Bean rust
  - C. Bean anthracnose
  - D. Angular leaf spot
18. The fungus that causes browning in cotton lint is transmitted by
- A. *Typhlocyba* sp.
  - B. *Dysdercus* sp.
  - C. *Empoasca* sp.
  - D. *Cryptophlebia* sp.
19. Which one of the following is a vector of Nairobi sheep disease?
- A. Mosquito
  - B. Tick
  - C. Tsetse fly
  - D. snail
20. Which of the following is a disinfectant on the farm?
- A. Copper sulphate
  - B. Deknav
  - C. Terramycin
  - D. Dithane
21. Maize streak is characterized by
- A. Dark brown patches on the underside of leaves
  - B. Papery lesion on leaves
  - B. Narrow yellow stripes parallel to the leaf veins
  - C. Sooty appearance on the cob
22. A cotton pest controlled by growing the hairy cotton variety is
- A. Cotton stainer
  - B. American boll worm

- C. Jassids
  - C. Spiny boll worm
23. Scale and mealy bugs cause damage to crops through
- D. Sucking
  - A. Chewing
  - B. Biting
  - C. Boring
24. How does close spacing of ground nuts prevent rosette?
- A. So much moisture kill virus
  - E. Aphids are controlled
  - B. Host plants are suppressed
  - C. Maximum use of nutrients hinder viral growth
25. The best option for prevention of fusarium within banana plantation is to kill the disposing factors using
- A. Bacteria
  - B. Virucides
  - C. Nematocides
  - F. fungicides
26. How a noxious weed such as stringa best is be controlled? By
- G. Uprooting and burning
  - H. Crop rotation
  - I. Use of contact-non selective herbicide
  - J. Proper spacing

Answers to objective questions

1B	2C	3D	4D	5D	6D	7B	8D	9C	10B	11B	12A	13C
14A	15A	16D	17C	18B	19B	20A	21C	22C	23A	24B	26D	26B

27. (a) Give five desirable characteristics of a pesticide

Should be

- toxic to the target organism
- specific to the target organism
- biodegradable not to accumulate in the environment
- harmless to the plants and animals
- cheap and readily available
- easy to store and transport
- readily soluble in water
- not accumulate in ecosystem

(b) State five factors that limit the use of pesticide by farmers

- they and application equipment are expensive
- application of pesticides requires skill especially in measuring and mixing
- they kill beneficial organism as well for example pollinator.
- They pollute the environment
- They lower the value and/quality of products
- They are poisonous to the farmer and livestock
- Lead to chemical resistant pests
- Accumulate in ecosystem

28. What is biological control?

This is the control of the pest population below the economical threshold using their natural enemies in form of predator, pathogen, parasite etc.

29. (a) Give the meaning of the following as applied in pesticide use

- Pre-harvest period: it the duration/length of time which must elapse before crops sprayed with agricultural chemical can be consumed
- Lethal dose 50 (LD50) is the dose of agricultural chemical that will kill 50% of the pest/animal in a test population.

(b) Explain characteristics that make pests successful in nature

- Have high rate of multiplication e.g. lay very many eggs.
- Most of them are small making it easy to hide
- They resemble the host crop for easy camouflage
- Have hard cuticle to protect them from adverse conditions
- Most fly leading fast dispersal
- Have defense mechanisms such as production of offensive smell
- Undergo metamorphosis such that different stages occupy different ecological niches to reduce competition
- Develop resistance to pesticides
- Have alternative source of food
- Have modified mouth parts to feed on crops such as mandibles for cutting and proboscises for sucking
- Resistant to diseases.

(c) State the qualities of a good biological agent for pest control

- Must have high searching ability
- Should be adaptable to wide range of environments
- Should be host specific
- Should have ability to multiply in order to control the target organism
- Should not cause a lot of damage to crops and animals
- Should be easily raised artificially
- Should be easy to distribute/apply

30. Give the advantages of controlling pest using biological control method

- It requires less labour
- It is selective to the target organism
- Long lasting from season to season
- Can be easily employed to remote areas
- cheap

31. Explain the environmental factors that cause diseases in plants

(a) Temperature

- Sun scald exposed sites of fresh fruits and vegetables
- Wilting due to high evaporation
- Over sweetening of potatoes due to low temperature

(b) Soil moisture

- Cause stunted growth due to inadequate nutrients
- Increase yellowing and leaf senescence due to lack of water
- Rotting due to much water
- Chlorosis and early senescence due to inadequate supply of nitrogen

(c) Limited sunshine/shadows

- Causes etiolation and weakening of plant stems

(d) Water scarcity/drought/lack of rainfall

- Causes stunted growth

32. (a) What is meant by biological control of a crop pest (02marks)

(b) Explain characteristics of a good biological control agent (09marks)

(c) Give the advantages of controlling pest using biological control method (09marks)

33. (a) Outline the various ways in which pests cause damage the crops

(b) Explain the cultural methods of controlling crop pests (12marks)

- Proper seed bed preparation: repeated tillage either exposes soil borne pests to their natural enemies on the surface or buries the pests very deep in the soil where they are suffocated and die.
- Crop rotation: this controls pests which feed on specific crops; by not growing such crops, pests either migrate or die due to lack of food
- Closed seasons: this involves foregoing cropping seasons without planting so as to control the build-up of pests in the field. Cropping is suspended for specific period to derive pests out of the host plants.
- Use of resistant crop varieties that tolerate pests. The resistant varieties have characteristics such as hairiness, thick or hard epidermis, unattractive color and/or smell to the pest and early maturation
- Destruction of crop residues after harvesting to eliminate breeding sites and kill the pests.
- Use of certified seeds and planting materials that carry no pests
- Regular weeding of the crops to eliminate breeding, hiding sites and alternative hosts.

- Proper spacing reduces spread of pests from one crop to another
- Proper pruning removes infected branches and micro habitats for the pests
- Thinning prevents overcrowding and spreading of pests
- Proper application of fertilizers ensures that crops grow faster or are able to tolerate pests
- Rogueing eradicates pests by removing and destroying pest affected crops from the garden.
- Mulching especially with black polythene controls nematodes in pineapple fields.
- Timely planting ensures that the crops grow and mature before destructive stages of the pest.
- Timely harvesting prevents attack of mature grains such as in millet, sorghum, rice and maize.
- Destroying volunteer plants i.e. plants that provide alternative source of food or breeding ground.
- Intercropping discourages spreading of pest from one crop to another and some crops like tobacco produce natural pest repellants.

34. (a) Describe the dangers associated with the use of pesticides in agricultural production

- Pesticides can be poisonous to farmers and their animals
- Pollute the environment i.e. water, land and air
- Some pesticides are inflammable and may cause fire hazards
- Some pesticides such as DDT accumulate in food chain leading to toxic levels and may eliminate organisms in top food levels.
- Continuous use of same pesticides leads to resurgence due to development of resistance.
- Eliminate non-targeted organism such as pollinators that are useful to the farmers.
- Expensive

(b) Outline the precautions to be taken by the farmers to ensure safe use of pesticides

- Read the instructions on the container or leaflet before using the pesticide
- Wear protective clothes such as overalls, gloves, rubber boots, head masks and eye shields.
- Chemical should be stored in safe places away from children.
- Do not eat or drink while working with pesticides
- Wash any spillage from your body as soon as possible
- Clean the equipment after use
- Dispose of empty containers safely as instructed by the manufacturer.
- Do not use empty containers for edible substances.

35. (a) What is meant by pesticide resistance

It is a situation where the pest population remains relatively unaffected by application of a recommended pesticide in the right quantities and concentrations. Or it is a situation where pests

acquire characteristics/traits that enable them to survive despite the recommended levels of pesticides.

(b) Describe the factors that promote pesticide resistance in pest populations

- Genetic factors; high genetic variation promote resistance
- Mutation
- Prolonged use of a single pesticide
- Unwarranted use of pesticides
- Use of broad spectrum pesticides such as DDT that kill natural enemies of the pests.
- Use of sub-lethal concentration of pesticides
- High population of pesticide
- Non-uniform application of pesticides in the field

36. (a) Write short notes on the following

(i) Integrated pest management (IPM)

It is a pest control measure involving use of a wide range of methods to control pests without harming the environment using methods such as biological control, burying/burning infected plant parts etc. use of chemicals is minimized.

(ii) Biological control

(iii) Cultural pest control

It is a pest control measure involving application of agronomic practices that interfere with the life cycle of pests such as proper seed bed, early planting, crop rotation, proper hygiene during harvesting and use of resistant varieties.

(iv) Chemical pest control

It is a pest control measure that involves use of chemicals. Natural chemicals use includes a mixture of urine and ash, some plant extracts etc. Synthetic chemicals include DDT, dieldrin, malathion etc.

(b) Discuss the nursery bed maintenance and how they can contribute to pest management

- Irrigation and water leads to healthy seedlings that can tolerate pests.
- Appropriate and regular watering wash off pests from seedlings
- Weeding eliminate weeds that act as breeding ground for pests
- Thinning reduces congestion and spread of pests
- Monitoring and picking out infected seedlings prevents spread of pests and diseases
- Spraying kills pesticides
- Application of fertilizers boost seedlings vigour which help them to tolerate pests and diseases
- Soil sterilization by heating soil kills pest

37. (a) How can disease spread in crops?

- Through wind/air current blow spores from one diseased crop to another
- Through rain splash
- Contact between healthy and diseased plant

- Infected planting materials/seedlings/cuttings
- Pruning knives, pangas carry disease causing organisms
- Transfer of disease causing organisms by pests and vectors
- Irrigation with contaminated water
- Application of infected mulches
- Through infected crop wastes/residues
- Through infected organic manure
- Through contact with infected animals

(b) Describe the methods that can be used to control crop diseases

- Plant resistant/tolerant plants to diseases
- Timely weeding to remove alternative hosts or breeding grounds
- Crop rotation to prevent building up host specific diseases
- Spraying with recommended chemicals to control vectors or to kill disease causing agents
- Seed dressing can be used to destroy spores on the seeds
- Heat treatment can be used to destroy spores on the seeds.
- Sterilizing soil by heat to kill pathogens
- Early planting to escape buildup of pests and diseases
- Proper spacing to minimize spreading of diseases
- Quarantine to restrict movement of diseased plant materials
- Destruction of crop residues that contain pathogens
- Pruning to reduce micro-climate that favor growth of microorganisms
- Disinfect tools to prevent spread of diseases
- Proper hygiene

38. (a) Explain six ways through which crop diseases spread on farms. (06marks)

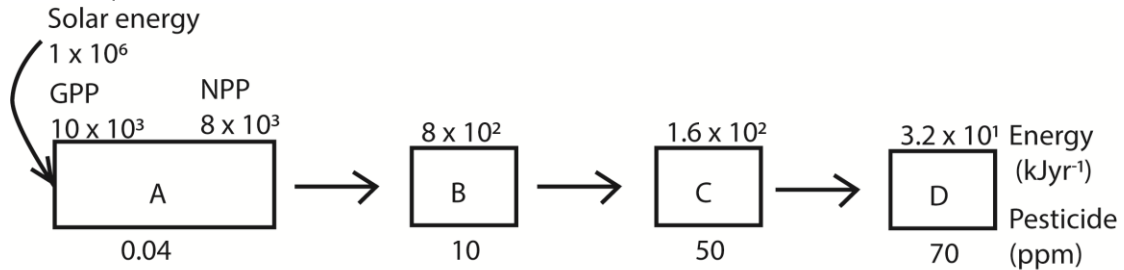
- Through wind/air current blow spores from one diseased crop to another
- Through rain splash
- Contact between health and diseased plant
- Infected planting materials/seedlings/cuttings
- Pruning knives, pangas carry disease causing organisms
- Transfer of disease causing organisms by pests and vectors
- Irrigation with contaminated water
- Application of infected mulches
- Through infected crop wastes/residues
- Through infected organic manure
- Through contact with infected animals

(b) Suggest four conditions necessary for successful disease infection of a crop in a field? (04marks)

- There must be pathogen host contact
- Plant must be susceptible to the pathogen

- The pathogen must be in pathogenic stage
- Presence of favorable temperature
- Favorable humidity

39. The figure below shows the transfer of energy in kJyr<sup>-1</sup> (on top) and the amount of pesticide in parts per million (at the bottom) at different levels in the food chain in an ecosystem. Study the figure and answer the questions that follow:



Key: GPP = Gross primary production  
NPP = Net primary production

(a)(i) What organisms occupy A on the diagram?

Producers

(ii) What is the percentage of incident energy absorbed by the organisms at level A?

$$\text{Percentage} = \frac{GPP}{\text{solar energy}} \times 100\%$$

$$= \frac{10 \times 10^3}{1 \times 10^6} \times 100\% = 1\%$$

(iii) Where does the rest of the energy which is not absorbed at level A go?

It is reflected into the atmosphere as heat or absorbed by non-living organism

(b) Calculate the percentage of energy of the net primary production in the organism at level A which is transferred to organism at

(i) Level B

$$\frac{8 \times 10^2}{8 \times 10^3} \times 100\% = 10\%$$

(ii) Level C

$$\frac{3.2 \times 10^1}{8 \times 10^3} \times 100\% = 0.4\%$$

(c) What conclusions can be made from your answer in (b) about the transfer of energy along trophic levels?

The energy transfer from producers along the trophic levels reduces

(d) Explain why all the energy at one trophic level is not transferred to the next trophic level

- Energy is lost through respiration, excretion, egestion death and decomposition
- Not all materials ingested is digested.

(e) (i) Describe the trend of the pesticide concentration from organisms at level A to those of level D.

In pesticide concentration in organisms increases with the increase in trophic levels from A to D.

(ii) Explain the trend of the concentration of pesticide in e(i)

The consumer at high trophic eats several organism and accumulates the pesticide in its tissues

(iii) Suggest one property of the pesticides. Explain your answer

It is non-biodegradable because it accumulates in the organisms along the trophic levels.

(f) What is meant by pesticide resistance

It is a situation where the pest population remains relatively unaffected by application of a recommended pesticide in the right quantities and concentrations. Or it is a situation where pests acquire characteristics/traits that enable them to survive despite the recommended levels of pesticides.

(g) Describe the factors that promote pesticide resistance in pest populations

- Genetic factors; high genetic variation promote resistance
- Mutation
- Prolonged use of a single pesticide
- Unwarranted use of pesticides
- Use of broad spectrum pesticides such as DDT that kill natural enemies of the pests.
- Use of sub-lethal concentration of pesticides
- High population of pesticide
- Non-uniform application of pesticides in the field

-

### Revision question

1. Painting of wood on a farm structure is done in order to
  - E. Block entry of air
  - F. Prevent termites attack
  - G. Block penetration of moisture
  - H. Seal off wood defects
2. Frequent use of pesticide like DDT in an ecosystem is discouraged because it
  - E. Accumulates in consumer tissue
  - F. Cause migration of beneficial organisms from the areas
  - G. Leads to emergence of secondary pests in an area
  - H. Is too strong and cannot be diluted
3. The best way of controlling scale insect pest in a sugar cane plantation is to
  - E. Spray the field with soil sterilants

- F. Fumigate the soil
  - G. Crop rotation with legume
  - H. Expose them to their predators
4. Which of the following does not affect sprayer performance
- E. Operating pressure
  - F. Forward speed of operator
  - G. Height of the crop
  - H. Distance from the crop
5. The best way of controlling scale insects pest in a sugar cane plantation is to
- E. Spray the field with soil sterilants
  - F. Fumigate the soil
  - G. Crop rotation with legumes
  - H. Expose them to their predators
6. Which one of the following does not affect sprayer performance?
- E. Operating pressure
  - F. Forward speed of operator
  - G. Height of the crop
  - H. Distance from the crop
7. Which of these sets of diseases given below are protozoan?
- |                     |                    |
|---------------------|--------------------|
| (iv) Fowl pox       | (iv) black quarter |
| (v) Trypanosomiasis | (v) anaphlasmosis  |
| (vi) Riderpest      | (vi) Hog cholera   |
- E. (i), (iv) (v)
  - F. (ii), (iv)
  - G. (i), (iii), (iv)
  - H. (iii), (vi)
8. Which of the following types of pesticides is the most effective in controlling aphids?
- E. Contact pesticide
  - F. Surface sterilants
  - G. Fumigants
  - H. systematics
9. one of the reasons for not treating millet seeds with chemicals during storage is the
- E. it is difficult to clean off chemicals before consumption
  - F. the grain embryo is easily killed by chemicals
  - G. the tough grain coat resist pest attack
  - H. the small grain sizes discourage pest attack
10. Pesticide like DDT have been discouraged mainly because

- E. They are highly toxic to use
  - F. They are not easily degraded
  - G. They kill beneficial insects
  - H. They are not expensive
11. Anaphlamosis is caused by
- E. Ticks
  - F. Protozoa
  - G. Bacteria
  - H. viruses
12. Which one of the following is a vector of the lift valley disease of sheep?
- E. Mosquito
  - F. Tick
  - G. Tsetse fly
  - H. snail
13. Which of the following is an example of an irregular pest?
- E. Aphids
  - F. Locust
  - G. Grasshopper
  - H. White flies
14. Which of the following agricultural chemicals is out of place
- E. Agroicide
  - F. Gramoxone
  - G. Dalapon
  - H. agroxone
15. which of the following pesticides is most suitable for controlling sap sucking pests
- E. Contact pesticide
  - F. Surface sterilant
  - G. Systematic pesticide
  - H. fumigant
16. The animal disease that is vector borne is
- F. Anthrax
  - G. Foot and mouth
  - H. Rinderpest
  - I. Trypanosomiasis
  - J.
17. The bean characterized by brown, sunken and soaked lesions on the pond is
- E. Bean mosaic
  - F. Bean rust
  - G. Bean anthrocnose

- H. Angular leaf spot
18. The fungus that causes browning in cotton lint is transmitted by
- E. Taybrigus sp.
  - F. Dysdercus sp.
  - G. Emposca sp.
  - H. Cryptophlebia sp.
19. Which one of the following is a vector of Nairobi sheep disease?
- E. Mosquito
  - F. Tick
  - G. Tsetse fly
  - H. snail
20. Which of the following is a disinfectant on the farm?
- K. Copper sulphate
  - E. Deknav
  - F. Terramycin
  - G. Dithane
21. Maize streak is characterized by
- D. Dark brown patches on the underside of leaves
  - E. Papery lesion on leaves
  - L. Narrow yellow stripes parallel to the leaf veins
  - F. Sooty appearance on the cob
22. A cotton pest controlled by growing the hairy cotton variety is
- D. Cotton stainer
  - E. American boll worm
  - M. Jassids
  - F. Spiny boll worm
23. Scale and mealy bugs cause damage to crops through
- N. Sucking
  - D. Chewing
  - E. Biting
  - F. Boring
24. How does close spacing of ground nuts prevent rosette?
- D. So much moisture kill virus
  - O. Aphids are controlled
  - E. Host plants are suppressed
  - F. Maximum use of nutrients hinder viral growth
25. The best option for prevention of fusarium within banana plantation is to kill the disposing factors using

- D. Bacteria
- E. Virucides
- F. Nematocides
- P. fungicides

26. How a noxious weed such as stringa best is be controlled? By

- Q. Uprooting and burning
- R. Crop rotation
- S. Use of contact-non selective herbicide
- T. Proper spacing

Answers to objective questions

1B	2C	3D	4D	5D	6D	7B	8D	9C	10B	11B	12A	13C
14A	15A	16D	17C	18B	19B	20A	21C	22C	23A	24B	26D	26B

## SECTION B

1. (a) Give five desirable characteristics of a pesticide

Should be

- toxic to the target organism
- specific to the target organism
- biodegradable not to accumulate in the environment
- harmless to the plants and animals
- cheap and readily available
- easy to store and transport
- readily soluble in water
- not accumulate in ecosystem

(b) State five factors that limit the use of pesticide by farmers

- they and application equipment are expensive
- application of pesticides requires skill especially in measuring and mixing
- they kill beneficial organism as well for example pollinator.
- They pollute the environment
- They lower the value and/quality of products
- They are poisonous to the farmer and livestock
- Lead to chemical resistant pests
- Accumulate in ecosystem

2. What is biological control?

This is the control of the pest population below the economical threshold using their natural enemies in form of predator, pathogen, parasite etc.

3. (a) Give the meaning of the following as applied in pesticide use

- (iii) Pre-harvest period: it the duration/length of time which must elapse before crops sprayed with agricultural chemical can be consumed
- (iv) Lethal dose 50 (LD50) is the dose of agricultural chemical that will kill 50% of the pest/animal in a test population.

(b) Explain characteristics that make pests successful in nature

- Have high rate of multiplication e.g. lay very many eggs.
- Most of them are small making it easy to hide
- They resemble the host crop for easy camouflage
- Have hard cuticle to protect them from adverse conditions
- Most fly leading fast dispersal
- Have defense mechanisms such as production of offensive smell
- Undergo metamorphosis such that different stages occupy different ecological niches to reduce competition
- Develop resistance to pesticides
- Have alternative source of food
- Have modified mouth parts to feed on crops such as mandibles for cutting and proboscises for sucking
- Resistant to diseases.

(c) State the qualities of a good biological agent for pest control

- Must have high searching ability
- Should be adaptable to wide range of environments
- Should be host specific
- Should have ability to multiply in order to control the target organism
- Should not cause a lot of damage to crops and animals
- Should be easily raised artificially
- Should be easy to distribute/apply

4. Give the advantages of controlling pest using biological control method

- It requires less labour
- It is selective to the target organism
- Long lasting from season to season
- Can be easily employed to remote areas
- cheap

5. Explain the environmental factors that cause diseases in plants

(f) Temperature

- Sun scald exposed sites of fresh fruits and vegetables
- Wilting due to high evaporation
- Over sweetening of potatoes due to low temperature

(g) Soil moisture

- Cause stunted growth due to inadequate nutrients
  - Increase yellowing and leaf senescence due to lack of water
  - Rotting due to much water
  - Chlorosis and early senescence due to inadequate supply of nitrogen
- (h) Limited sunshine/shadows
- Causes etiolation and weakening of plant stems
- (i) Water scarcity/drought/lack of rainfall
- Causes stunted growth
6. (a) What is meant by biological control of a crop pest (02marks)
- (b) Explain characteristics of a good biological control agent (09marks)
- (c) Give the advantages of controlling pest using biological control method (09marks)
7. (a) Outline the various ways in which pests cause damage the crops
- Eat the buds, flowers, shoot, fruits e.g. grasshopper, caterpillars and beetles eat leaves/cause defoliation
  - They bore into fruits and seeds e.g. bean bruchid, maize weevil etc. and eat inside causing holes, discoloring the tubers and causing them to have bitter taste e.g. sweet potato weevils.
  - Suck plant sap and reduce plant vigour e.g. aphids, mealy bugs and scales
  - Transmit diseases e.g. maize leaf hopper, white flies etc.
  - Change crop's growth habits e.g. sorghum shoot flies
  - Cause loss of quality of crops
  - They penetrate and damage plant roots thus preventing absorption of water and nutrients
  - They reduce the yield of crops.
- (b) Explain the cultural methods of controlling crop pests (12marks)
- Proper seed bed preparation: repeated tillage either exposes soil borne pests to their natural enemies on the surface or buries the pests very deep in the soil where they are suffocated and die.
  - Crop rotation: this controls pests which feed on specific crops; by not growing such crops, pests either migrate or die due to lack of food
  - Closed seasons: this involves foregoing cropping seasons without planting so as to control the build-up of pests in the field. Cropping is suspended for specific period to derive pests out of the host plants.
  - Use of resistant crop varieties that tolerate pests. The resistant varieties have characteristics such as hairiness, thick or hard epidermis, unattractive color and/or smell to the pest and early maturation
  - Destruction of crop residues after harvesting to eliminate breeding sites and kill the pests.
  - Use of certified seeds and planting materials that carry no pests
  - Regular weeding of the crops to eliminate breeding, hiding sites and alternative hosts.

- Proper spacing reduces spread of pests from one crop to another
- Proper pruning removes infected branches and micro habitats for the pests
- Thinning prevents overcrowding and spreading of pests
- Proper application of fertilizers ensures that crops grow faster or are able to tolerate pests
- Rogueing eradicates pests by removing and destroying pest affected crops from the garden.
- Mulching especially with black polythene controls nematodes in pineapple fields.
- Timely planting ensures that the crops grow and mature before destructive stages of the pest.
- Timely harvesting prevents attack of mature grains such as in millet, sorghum, rice and maize.
- Destroying volunteer plants i.e. plants that provide alternative source of food or breeding ground.
- Intercropping discourages spreading of pest from one crop to another and some crops like tobacco produce natural pest repellants.

8. (a) Describe the dangers associated with the use of pesticides in agricultural production

- Pesticides can be poisonous to farmers and their animals
- Pollute the environment i.e. water, land and air
- Some pesticides are inflammable and may cause fire hazards
- Some pesticides such as DDT accumulate in food chain leading to toxic levels and may eliminate organisms in top food levels.
- Continuous use of same pesticides leads to resurgence due to development of resistance.
- Eliminate non-targeted organism such as pollinators that are useful to the farmers.
- Expensive

(b) Outline the precautions to be taken by the farmers to ensure safe use of pesticides

- Read the instructions on the container or leaflet before using the pesticide
- Wear protective clothes such as overalls, gloves, rubber boots, head masks and eye shields.
- Chemical should be stored in safe places away from children.
- Do not eat or drink while working with pesticides
- Wash any spillage from your body as soon as possible
- Clean the equipment after use
- Dispose of empty containers safely as instructed by the manufacturer.
- Do not use empty containers for edible substances.

9. (a) What is meant by pesticide resistance

It is a situation where the pest population remains relatively unaffected by application of a recommended pesticide in the right quantities and concentrations. Or it is a situation where pests

acquire characteristics/traits that enable them to survive despite the recommended levels of pesticides.

(b) Describe the factors that promote pesticide resistance in pest populations

- Genetic factors; high genetic variation promote resistance
- Mutation
- Prolonged use of a single pesticide
- Unwarranted use of pesticides
- Use of broad spectrum pesticides such as DDT that kill natural enemies of the pests.
- Use of sub-lethal concentration of pesticides
- High population of pesticide
- Non-uniform application of pesticides in the field

10. (a) Write short notes on the following

(i) Integrated pest management (IPM)

It is a pest control measure involving use of a wide range of methods to control pests without harming the environment using methods such as biological control, burying/burning infected plant parts etc. use of chemicals is minimized.

(ii) Biological control

(iii) Cultural pest control

It is a pest control measure involving application of agronomic practices that interfere with the life cycle of pests such as proper seed bed, early planting, crop rotation, proper hygiene during harvesting and use of resistant varieties.

(iv) Chemical pest control

It is a pest control measure that involves use of chemicals. Natural chemicals use includes a mixture of urine and ash, some plant extracts etc. Synthetic chemicals include DDT, dieldrin, malathion etc.

(b) Discuss the nursery bed maintenance and how they can contribute to pest management

- Irrigation and water leads to healthy seedlings that can tolerate pests.
- Appropriate and regular watering wash off pests from seedlings
- Weeding eliminate weeds that act as breeding ground for pests
- Thinning reduces congestion and spread of pests
- Monitoring and picking out infected seedlings prevents spread of pests and diseases
- Spraying kills pesticides
- Application of fertilizers boost seedlings vigour which help them to tolerate pests and diseases
- Soil sterilization by heating soil kills pest

Thank U

Dr. Bbosa Science

