Draft Study Material

Oilseed Crop Grower

(Qualification Pack: Ref. Id. AGR/ Q0201)

Sector: Agriculture

Grades 12

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NCERT

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Preface

Vocational Education is a dynamic and evolving field, and ensuring that every student has access to quality learning materials is of paramount importance. The journey of the PSS Central Institute of Vocational Education (PSSCIVE) toward producing comprehensive and inclusive study material is rigorous and time-consuming, requiring thorough research, expert consultation, and publication by the National Council of Educational Research and Training (NCERT). However, the absence of finalized study material should not impede the educational progress of our students. In response to this necessity, we present the draft study material, a provisional yet comprehensive guide, designed to bridge the gap between teaching and learning, until the official version of the study material is made available by the NCERT. The draft study material provides a structured and accessible set of materials for teachers and students to utilize in the interim period. The content is aligned with the prescribed curriculum to ensure that students remain on track with their learning objectives. The contents of the modules are curated to provide continuity in education and maintain the momentum of teaching-learning in vocational education. It encompasses essential concepts and skills aligned with the curriculum and educational standards. We extend our gratitude to the academicians, vocational educators, subject matter experts, industry experts, academic consultants, and all other people who contributed their expertise and insights to the creation of the draft study material. Teachers are encouraged to use the draft modules of the study material as a guide and supplement their teaching with additional resources and activities that cater to their students' unique learning styles and needs. Collaboration and feedback are vital; therefore, we welcome suggestions for improvement, especially by the teachers, in improving upon the content of the study material. This material is copyrighted and should not be printed without the permission of the NCERT-PSSCIVE.

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Module 1: Field Preparation and Package of Practices

Module Overview

The oilseed is the most significant food crops after cereals and pulses, playing a vital role in ensuring nutritional security and supporting the agricultural economy. These crops are cultivated primarily for the extraction of edible oils, which are essential components of the human diet, as well as for various industrial uses. Proper field preparation and the adoption of recommended package of practices are crucial for optimum yield and quality in oilseed cultivation.

This module introduces students to the essential agronomic practices required for successful oilseed crop cultivation. It focuses on proper field preparation and the recommended package of practices followed during different cropping seasons. In Session 1, students will learn about the importance of field preparation, including land clearing, ploughing, leveling, and soil conditioning to create a suitable seedbed for oilseed crops. Session 2 explains the package of practices for Kharif season oilseed crops, covering aspects such as suitable varieties, sowing time, seed treatment, nutrient management, irrigation, and pest and disease control. Session 3 focuses on the package of practices for Rabi season oilseed crops, highlighting season-specific cultivation techniques, crop management practices, and methods to achieve higher productivity.

Learning Outcomes

After completing this module, you will be able to:

- Explain the importance and methods of proper field preparation for oilseed crop cultivation.
- Describe the recommended package of practices for Kharif season oilseed crops.
- Describe the recommended package of practices for Rabi season oilseed crops

Module Structure

Session 1: Field Preparation

Session 2: Package of Practices of Kharif Season Oilseed Crops

Session 2: Package of Practices of Rabi Season Oilseed Crops

Session 1: Field Preparation

Field preparation involves tillage in order to provide a favorable soil environment for the crop establishment and proper plant growth. A well-prepared field further helps in weed control and provides congenial condition for direct seeding and for transplanting where necessary. Field preparation involves ploughing, harrowing and leveling of field. Traditionally, draft animals were used to operate harrows; however, today, in an era of mechanization, tractor operated implements are used for land preparation.

With introduction of modern technology in agriculture, innovative development of various machines and tools makes oilseed cultivation easier and more profitable than in past. Shortage of labour force and high labour wages increases the cost of cultivation. Secondly, labour is often not available at the time they are most required. This results in loss of yield and income to the cultivator. These factors motivate the farmer to switch towards mechanized farming. By itself, mechanized farming has several advantages, like it completes tasks in less time, saves labour cost, ease of operations and ease of availability when needed.

Ploughing

Ploughing is a primary and important tillage operation. Timely ploughing is very important to achieve timeliness in all subsequent field operations. It is done soon after a rain and/or after a normal irrigation. During kharif season, early ploughing helps in moisture retention and controls weeds. The crops weed biomass thus incorporated into soil gets converted into manure that may actually improve soil health.

Advantage of Ploughing

- Proper seed germination, crop establishment, good penetration and contact of roots with the soil.
- Enhance soil fertility by incorporating crop residues, stubbles and root in to soil.
- Uproot, cut and destroy weeds
- Create conducive soil conditions for soil aeration.
- Helps in destroying the insect, harmful pathogens.

Harrowing

It is a secondary tillage operation performed after the ploughing. In this, soil is tilled at a shallow depth with the help of harrows which smoothen and pulverizes soil by breaking large clods (lumps of soil) into smaller fine soil structures suitable for seed sowing. Harrowing also helps mixing of farmyard manure and compost in the soil and also in cutting up weeds in the field,

Land leveling

Leveling helps to modify existing undulations of land for efficient agricultural production system and to provide adequate slope to a cropped area for surface irrigation coupled with unrestricted drainage.

Purpose of Leveling

- Efficient application of irrigation water.
- Enhancing the conservation of rain water.
- Minimizing soil erosion.
- Encouraging the efficient mechanization.

Tools and Implements Used in Field Preparation and Sowing

There are some important tools and equipment which are used during field preparation and sowing.

1. **Mouldboard plough:** Mouldboard plough consist of carbon steel or steel alloy in a concave curved structure to cut and turn the soil upside down. This plough is prepared on right angle triangle base. The size of mould board plough is measured by the width of the furrow that is opened by the plough. Generally, it can open a furrow of about 20 cm. Tractor driven mould board ploughs can cut bigger slices and can be outfitted with more than one mould board plough at a time depending ipon soil types & tractor power.

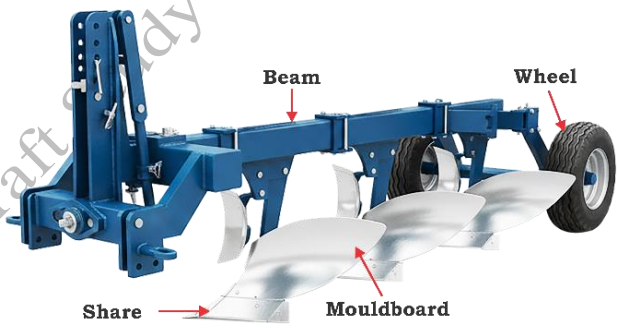

Fig. 1.1: Mouldboard plough

2. **Disc plough:** It consists of the moving circular edged steel discs of varying sizes (by its diameter and thickness). Discs in different ploughs used are 50-90 cm in diameter. Discs cut, turn and break furrow slices. It can work well in sticky soil as well as in too hard and dry soil. It is much heavier and leaves soil in rough and cloddy conditions.

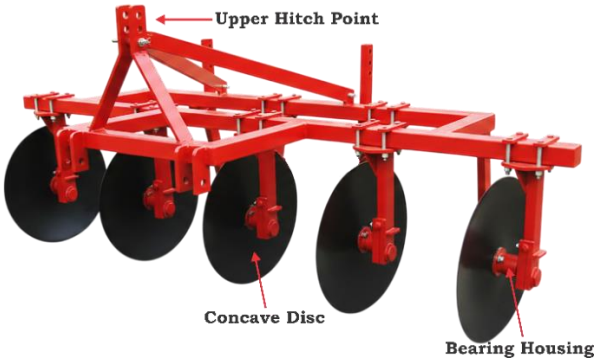

Fig. 1.2: Disc plough

3. **Rotavator**: It consists of moving blades on triangular base. It is a tractor drawn implement. As the tractor moves forward, the rotavator spins its many tines to pulverize any packed soil and remove large obstructions. It is used for preparing fine tilth and incorporation of crop residues and weeds into the soil. This is a heavy-duty version of cultivators with a deeper and stronger operation power.

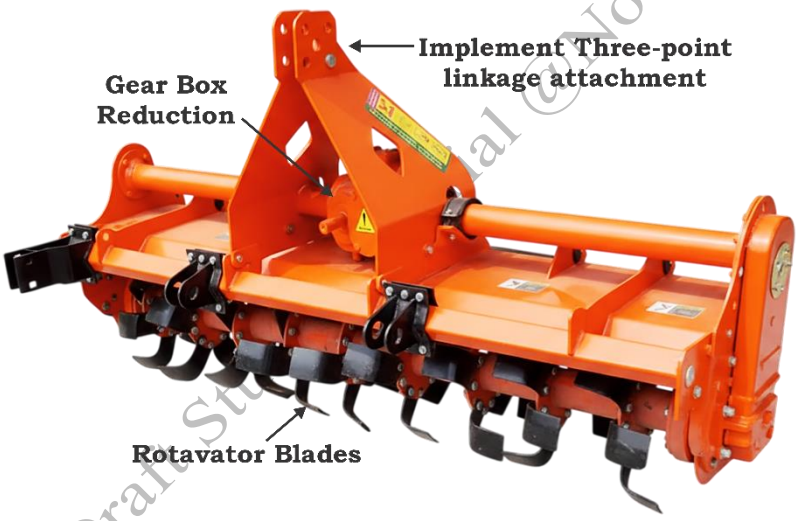

Fig. 1.3: Rotavator

4. **Cultivator**: They are used to stir and loosen the soil, breaking the clods and destroying the weeds in surface soil (15-18 cm). Cultivator performs the intermediary ploughing and harrowing. It also maintains the good tilth on soil surface, adequate aeration, prevent surface run off, and evaporation losses. Cultivators may be shovel, disc and blade types. DuTines and spike cultivators are used to prepare tilth on soils

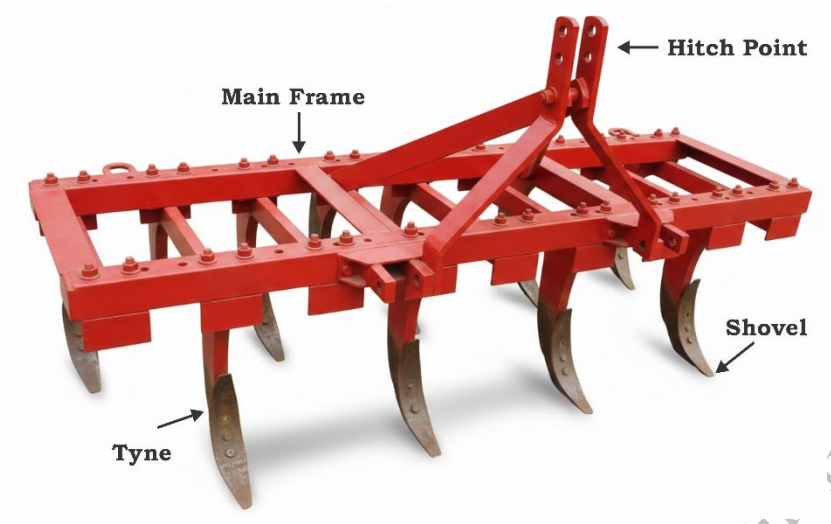

Fig. 1.4: Cultivator

5. **Harrows**: These are used for preparation of finer soil by breaking clod, cutting weeds, pulverising the soil surface during field preparation, called harrowing. The harrows may be disc, spike, spring or blade types.

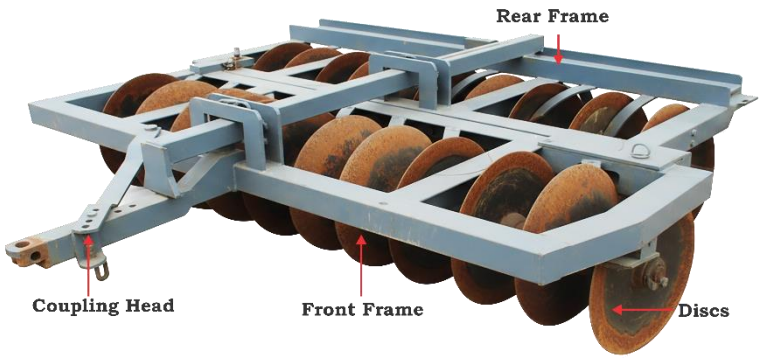

Fig. 1.5: Disc Harrows

6. **Plank**: It is a heavy wooden log, generally used for compacting and leveling used for seed-bed and field preparation for sowing the seeds. Planks are also used immediately after sowing the seeds, to ensure proper coverage of seeds with soil.
7. **Seed cum Fertilizer drill:** It is a line sowing equipment used for direct sowing of oilseed and application of fertilizer simultaneously. It requires 30 – 45 hp tractors to operate depending upon soil types. Important features are

   i. Adjustment of seed rate and fertilizer rate

   ii. Seed and fertilizer is placed at right soil depth

   iii. It helps to provide band placement of fertilizer (at a specified distance from seed) if necessary.

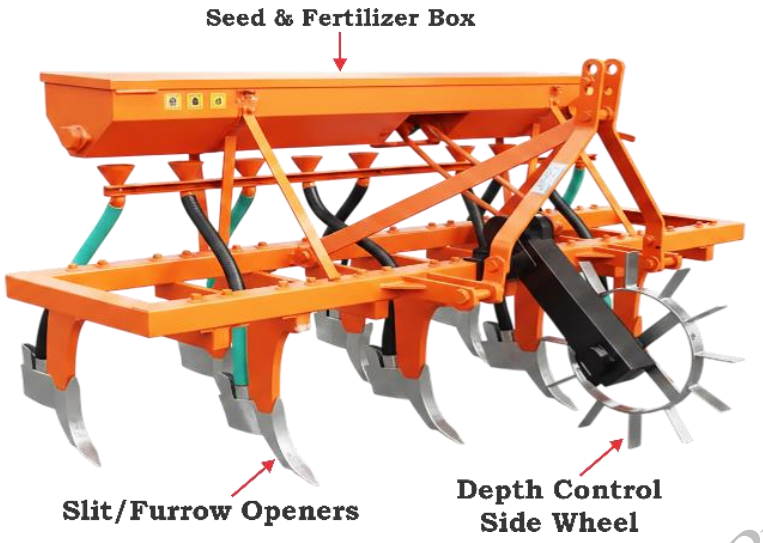

Fig. 1.6: Seed-cum-fertiliser drill

Bund maker: It is used to divide large cultivated field in to small leveled plots so that interculture operations and irrigations can be managed properly. It is very useful in field bunding to capture *in situ* conservation of rain water and not allowing excess water to run off from the field. Field bunds are often required for piecemeal irrigation. Slopy lands may require bunding for contour making this is required in all such situations.

Activities

Activity 1: Identify tools and implements used for field preparation

Materials Required: Practical note book, pencil, pen, implements, *etc.*

Procedure: Write following information

- Identify different types of tools and implement
- Write the name of the tools and implements
- Use of tools and implements
- Draw a diagram, and show different parts of tools and implements

Activity 2: Demonstration of field preparation

Materials Required

Plough, harrow, leveller or plank, field area, etc.

Procedure:

1. Visit nearby field for demonstration.
2. Observe the condition of the soil before preparation.
3. Collect different implements used for field preparation.
4. Demonstrate ploughing and explain how it loosens and turns the soil.

5. Demonstrate harrowing to break soil clods into fine particles.
6. Show leveling of the field using a leveller or plank.
7. Remove weeds and crop residues from the field.
8. Write down the observations and uses of each implement.

Check Your Progress

Fill in the Blanks

1. Field preparation involves _____ to provide a favorable soil environment.
2. Ploughing is a _____ and important tillage operation.
3. Early ploughing during kharif season helps in moisture _____.
4. Harrowing is a _____ tillage operation performed after ploughing.
5. Seed cum fertilizer drill requires _____ hp tractors to operate.

Multiple choice Questions

1. Which operation is done soon after rain or irrigation?
    a) Leveling
    b) Ploughing
    c) Sowing
    d) Bunding
2. Which implement works well in sticky and hard dry soil?
    a) Cultivator
    b) Rotavator
    c) Disc plough
    d) Plank
3. Harrowing helps in:
    a) Harvesting crops
    b) Breaking large soil clods
    c) Irrigation
    d) Transplanting
4. Rotavator is mainly used for:
    a) Cutting crops
    b) Harvest storage

c) Water drainage

d) Preparing fine tilth

5. Cultivator is used to loosen soil up to:

a) 5–10 cm

b) 10–12 cm

c) 15–18 cm

d) 25–30 cm

6. Plank is mainly used for:

a) Compacting and leveling

b) Spraying

c) Harvesting

d) Weeding only

Match the Following

Column A	Column B
1. Harrow	a. Divides field into plots
2. Rotavator	b. Breaks clods into fine soil
3. Bund maker	c. Prepares fine tilth
4. Seed cum fertilizer drill	d. Line sowing and fertilizer application

Subjective Questions

1. Describe various types of implements used for field preparation.

2. Write in brief on following topics:

i) Harrow

ii) Cultivator

3. Describe ploughing and its advantages.

4. Explain purpose of levelling.

Session 2: Package of Practices of Kharif Season Oilseed Crops

Soybean

Soybean (*Glycine max* L.) is a relatively new crop in Indian agriculture, introduced during the early 1970s from Mississippi, USA. The crop is originated in China, where several wild species, particularly of *Glycine soja*, are indigenous. One of the first widely adopted soybean varieties was Bragg,

which played a key role in popularizing the crop. Soybean seeds are a rich source of protein (about 40%) and oil (20–25%). In India, soybean is cultivated over an area of approximately 12.9 million hectares, with a production of about 15.26 million tonnes and an average productivity of around 1179 kg /ha. The major soybean-growing states include Madhya Pradesh, Maharashtra, Rajasthan, Chhattisgarh, Karnataka, Telangana, and Gujarat.

Varieties

Some of the promising high yielding and disease- resistant varieties include: JS 23-03, JS23-09, NRC-149, Pusa Soybean 21, NRC-197, JS 20-94, JS 20-116, SL-955, SL-979, NRC 127, JS 20-98, Raj Soya-24, Pant Soya 21, JS 20-69, Pant Soybean 26, Pant Soybean 25, SL-979, SL-955, JS 335, JS95-60, JS 20-34.

Climate

Soybean is mostly cultivated during *kharif* season (June- October) in the country as per agroclimatic suitability when the night temperature is around 25°C with relative humidity of 60-70 % with intermittent rain and exposure to sun.

Soil

Soybean can be grown in a wide range of soils ranging from sandy to clayey soils, though most suitable ones are well-drained loamy soils rich in organic matter with gentle slope to avoid water stagnation and having a pH range of 6.0–8.0.

Land preparation and sowing

A well pulverised, weed free and levelled seedbed is required for soybean cultivation. To achieve desired tilth, the field should be cross ploughed to a depth of about 30 cm, followed by harrowing and planking. Well decomposed farmyard manure (FYM) at the rate of 5-10 tonnes per hectare should be mixed thoroughly in the soil before ploughing. Raised bed/BBF (broad bed furrow) and ridge and furrow systems are effective in heavy soils. Poorly drained soils or fields prone to waterlogging during rainy season should be avoided as the crop is sensitive to excess moisture.

Spacing: The crop is cultivated under rainfed conditions and a spacing of 30 × 10 cm for short duration varieties and 45 × 10-15 cm for medium and long duration varieties is recommended. The seeds should be sown at a depth of 3-5 cm to ensure proper germination.

Seed rate: Certified seeds of suitable variety should be used at the rate of 60-80 kg/ha depending upon the seed size, spacing and variety.

Seed treatment: Seed treatment should be done with Thiram or Carbendazim @ 2.5 g/kg seed to protect the crop from soil borne pathogens or *Trichoderma viride* @ 4 g/kg seed can also be done for protecting the crop against soil

borne pathogens. Rhizobium and PSB inoculation should also be done for facilitating biological nitrogen fixation and enhancing nutrient use efficiency.

Sowing time

The crop is cultivated during *kharif* season under rainfed conditions and is sown with the onset of monsoon during late June–July, if sowing is delayed due to late onset of monsoon, short duration varieties should be cultivated to reduce the risk.

Manures and fertilisers

Soil test based balanced nutrient application is an important aspect of crop production that plays a pivotal role in final production of the crop. Application of FYM 5-10 tonnes at the time of field preparation and N: 20-30 kg/ha, P_2O_5: 50-60 kg/ha (through SSP), K_2O: 30-40 kg/ha and Sulphur: 20–25 kg/ha, if SSP is not applied. All the fertilizers should be applied as basal at the time of sowing with the help of seed cum fertilizer drill. Micronutrients should be applied as per soil test values.

Water Management: Soybean is drought-tolerant and mostly cultivated as rainfed crop during *kharif* season. Life-saving irrigation during critical stages should be given at flowering, and pod filling stages in case moisture deficiency is there.

Weed Management: The crop being slow growing during initial growth phase is susceptible to severe weed competition during the first 20-30 days and resulted in drastic reduction in seed yield to the tune of 40–70%. Weeds can be managed by Pre-emergence application of pendimethalin @1.0 kg a.i./ha followed by Post-emergence application of imazethapyr @0.1 kg a.i./ha at 20-25 DAS and intercultural operation at 45 DAS. In case of predominance of grassy weeds post emergence application of Propaquizafop at the rate of 0.1 Kg ai/ha can be done at 25-30 DAS.

Disease Management: The crop is susceptible to diseases like Yellow Vein Mosaic Virus (YVMV), rust, *Cercospora* leaf spot, charcoal rot *etc.* and can cause significant reduction in crop yield. Use of resistant varieties and seed treatment with suitable fungicides can be done to ensure good crop health. Yellow Mosaic is vector borne disease and the spread can be reduced by spray of Imidacloprid/ Thiamethoxam @ 0.5 ml /lit of water. For soil born diseases, seed treatment with *Trichoderma* + furrow application of *Trichoderma* with vermicompost @ 250 kg/ha followed by foliar spray of fungicides like Carbendazim + Mancozeb @ 2g/lit of water is effective.

Insect Management: A number of insect pests infest the crop and bring substantial reduction in crop yield. The major insect pest of soybean includes hairy caterpillar, semilooper, leaf defoliators, white fly, stem fly, pod fly & pod borer etc. Adoption of IPM with resistant varieties, seed treatment, and spray

of insecticides is recommended lke Chloropyriphos or Profenophos @2ml/l water or Emamectin benzoate @ 0.6 g/l water is effective in management of lepidopteron insects and Imidacloprid/ Thiomethoxam @0.5 ml/lit for the control of sucking pests.

Harvesting & post-harvest management

The crop matures in 90-110 days after sowing and should be harvested when pods turn yellow and begin to dry but before shattering of pods in the field to avoid yield losses. The crop is harvested with the help of sickle from the base and stack for 4–5 days for uniform drying, then threshing should be done with the help of power thresher.

Seed yield: The crop yield under rainfed conditions during *kharif* season varies from 1200–1500 kg/ha.

Storage: Proper drying (6-8% moisture) is required for ensuring long term storability.

Groundnut

Groundnut (*Arachis hypogaea* L.), commonly known as peanut, has been cultivated in India for several centuries. The crop originated in South America and subsequently introduced in India, where it has become one of the most important oilseed crops. Groundnut seeds contain about 40% oil and 20–25% protein, making it a valuable source of edible oil and dietary protein. India is one of the largest producers of groundnut in the world, with the crop cultivated over an area of approximately 5.7 million hectares, producing about 11.9 million tonnes, and an average productivity of around 2073 kg /ha (pods). The major groundnut-growing states in India include Gujarat, Maharashtra, Rajasthan, Karnataka, Telangana, Andhra Pradesh, Madhya Pradesh, and Uttar Pradesh.

Varieties

Some of the promising high yielding, short-duration, non-shattering, and disease-resistant varieties cultivated include:

VRI–10, Gujarat Mungfali-24, Gujarat Mungfali-42, Sahyadri Durga, Pratap Mungfali-4, ICAR–Girnar-6 (NRCGS-637), Konark, Chhattisgarh Trombay Groundnut (CGTM), Mungfali CO-8, Kadiri Lepakshi, TMV-14, Dh256, TCGS-894, Gujarat Groundnut HPS2, Girnar 4, Girnar 5, GG 39, GJG 32, TCGS 1157, TCGS-894, Raj Mungfali-3, HNG-123, ICGV 06189 *etc.*

Climate

Groundnut can be cultivated round the year in different parts of the country as per agro climatic suitability. However, the crop is predominantly grown during the *Kharif* season, when night temperatures are around 25 °C, relative humidity

ranges between 60–70%, and the crop receives intermittent rainfall along with adequate sunshine.

Soil

Groundnut can be grown in a wide range of soils ranging from sandy to clayey soils, though most suitable ones are well-drained sandy loams to loamy soils rich in organic matter with gentle slope to avoid water logging and having a pH range of 6.0–8.0. Black cotton soils or vertisols are not suitable because of excessive water holding capacity and difficulty in intercultural operations, poor pod development and harvesting of crop.

Land preparation and sowing

A well pulverised, weed free and levelled seedbed is required for groundnut cultivation. To achieve desired tilth the field should be cross ploughed to a depth of about 30 cm, followed by harrowing and planking. Well decomposed farmyard manure (FYM) at the rate of 10-15 tonnes per hectare should be mixed thoroughly in the soil before ploughing. Poorly drained soils or fields prone to waterlogging during rainy season should be avoided as the crop is sensitive to excess moisture.

Spacing

The crop is cultivated under rainfed conditions and a spacing of 30 × 10 cm for bunch type varieties and 45 × 10-15 cm for spanish varieties is recommended. The seeds should be sown at a depth of 4-5 cm to ensure proper germination.

Seed rate

Certified seeds of suitable variety should be used 80-120 kg/ha is required depending upon the seed size, spacing and variety.

Seed treatment

Seed treatment should be done with Thiram or Carbendazim @ 2.5 g/kg seed to protect the crop from soil borne pathogens, *Trichoderma viride* @ 4 g/kg seed can also be done for protecting crop against soil borne pathogens. *Rhizobium* and PSB inoculation should be done for facilitating biological nitrogen fixation and enhancing nutrient use efficiency.

Sowing time

The crop is cultivated during the *Kharif* season under rainfed conditions and is sown with the onset of the monsoon during late June–July. Under irrigated conditions, it is grown during October–November in *Rabi* season and during February–March in summer season. The crop can be sown in lines either by the dibbling method or using a seed-cum-fertilizer drill at desired spacing.

Manures and fertilisers

Soil test based balanced nutrient application is an important aspect of crop production that plays a pivotal role in final production of the crop. Application of FYM (10-15 tonnes) at the time of field preparation and N: 20-30 kg/ha, P_2O_5: 50-60 kg/ha (through SSP), K_2O: 30-40 kg/ha and Sulphur: 20–25 kg/ha, if SSP is not applied. All the fertilizers should be applied as basal at the time of sowing with the help of seed cum fertilizer drill. Micronutrients can be applied as per soil test values. Foliar sprays of micronutrients during flowering/pod formation stage improves yield in areas where soil is deficient in these nutrients.

Water Management

Groundnut is mostly cultivated as rainfed crop during *kharif* season. Life-saving irrigation during critical stages should be given at flowering, pegging and pod filling stages in case moisture deficiency is there. During *rabi/ summer* season the crop should be irrigated at an interval of 15-20 days as per soil type.

Weed Management

The crop being slow growing during initial growth phase is susceptible to severe weed competition during the first 20-30 days which resulted in drastic reduction in seed yield to the tune of 40–70%. Weeds can be managed by Pre-emergence application of Pendimethalin @1.0 kg a.i./ha followed by Post-emergence application of Propaquizafop of Fenoxaprop @100g a.i./ha at 20-25 DAS in case of predominance of grassy weeds.

Earthing and intercultural operation

Earthing and intercultural operation should be done at 40-45 DAS when peg development begins to facilitate easy penetration of the pegs in the soil and pod development.

Disease Management

The crop is susceptible to diseases like tikka, rust, *Cercospora* leaf spot, charcoal rot, etc., which cause significant reduction to the crop yield. Use of resistant varieties and seed treatment ensure good crop health. Seed treatment with *Trichoderma* + furrow application of *Trichoderma* with vermicompost @ 250 kg/ha followed by foliar spray of fungicides like Carbendazim + Mancozeb @ 2g/l water is effective.

Insect Management

A number of insect pests infest the crop and bring substantial reduction in crop yield. The major insect pest of groundnut includes hairy caterpillar, semilooper, leaf defoliators, white grub etc. Application of Chloropyriphos, Profenophos @2ml/l water or Emamectin benzoate @ 0.6 g/lit water is

effective in management of these insect pests. Use integrated pest management including resistant/tolerant varieties is beneficial.

Harvesting & post-harvest management

The crop matures in 100-120 days after sowing and should be harvested when leaves turn yellow, pods have matured and the soil is at optimum moisture level to facilitate easy digging to avoid damage to pods and yield losses. The crop is harvested manually or with the help of digger and stack for 4–5 days for uniform drying of pods in the sun to bring it to safe moisture levels for storage and afflatoxin development.

Seed yield: The crop yield under rainfed conditions during kharif season varies from 1500–2000 kg/ha.

Storage: Proper drying (8% moisture) is required for ensuring long term storability and prevent afflatoxin development.

Sesame

Sesame (*Sesamum indicum L.*) is one of the most ancient oilseed crops known to humankind, with evidence of cultivation going back over 5,000 years, often referred to as the "queen of oilseeds" due to its high oil quality, nutritional value, and stability. The crop is considered to have a dual centre of origin; the primary centre of origin is believed to be Africa, particularly Ethiopia, where several wild species of *Sesamum* exists, while secondary centre of domestication is considered to be the Indian subcontinent, where *Sesamum indicum* was first cultivated on a large scale. Archaeological evidence shows sesame seeds were used in the Indus Valley Civilization (Harappa, Mohenjo-Daro, ~3000 BCE), mainly for oil extraction and trade. From India, sesame spread to Mesopotamia, China, and eventually to the rest of the world. Globally it is cultivated in about 13.74 million hectares with production of nearly 6.74 million tonnes and productivity of about 500 kg/ha. Sesame seeds are rich in oil (45–50%), protein (20–25%), antioxidants (sesamin, sesamol, sesamolin), and micronutrients, sesame is often recognized as a superfood. Sesame is important both in domestic and in international markets, considering its importance in bakery, confectionary, and export of hulled and white-seeded varieties. In India the crop is being cultivated in an area of 1.5–1.7 million hectares with production of about 0.8–0.9 million tonnes and productivity of 560 kg/ha.

Varieties

Some of the promising high yielding, short-duration, non-shattering, and disease-resistant varieties cultivated includes:

- **White seeded:** GT-9, Subhra, DS-5, GJT 5, SVT-222, RT-372, RT-351, RT-125, RT-103, TKG-22, TKG-308, JLS-67, VRI 3, VRI 5, Swetha Til, Sekhar, DS-5 *etc.*
- **Black seeded:** Sabour Til-1, GT-11, GT-10, Siddhi black**,** Surya, Krishna *etc.*
- **Brown seeded:** Unnat Rama, Tanjila, TMV-7, VRI-2, VRI 4, JT-11 *etc.*

Climate

Sesame can be grown round the year in the country as per agroclimatic suitability in different parts during *kharif* season (June- October) and during *rabi* (Nov–March) and summer (Feb -June) when the night temperature is around 15–20°C with relative humidity of 50–60 % with intermittent rain and exposure to sun.

Soil

Sesame can be grown in a wide range of soils ranging from sandy to clayey soils, though most suitable ones are well-drained sandy-loam, or loamy soils rich in organic matter with gentle slope to avoid water stagnation and having a pH range of 6.0–8.0.

Land preparation

To make a fine tilth of soil, field should be ploughed at least twice to a depth of about 30 cm, followed by planking after every ploughing. Well rotten farmyard manure (FYM) at the rate of 5–10 tonnes per hectare should be mixed thoroughly in the soil before ploughing. Raised bed/BBF (broad bed furrow) systems are effective in heavy soils to avoid excess moisture during *kharif* season.

Spacing

The crop is cultivated under low input rainfed conditions and a spacing of 30 × 10-15 cm is recommended. Under irrigated/high-input conditions spacing of 45 × 15 cm is recommended.

Seed rate: 2.5-3.0 kg/ha (line sowing); 5–6 kg/ha (broadcasting).

Seed treatment: Seed treatment should be done with Thiram or Carbendazim @ 2.5 g/kg seed to protect the crop from soil borne pathogens, *Trichoderma viride* @ 4 g/kg seed and PSB inoculation should also be done for protecting the crop and enhancing nutrient use efficiency.

Sowing time:

- *Kharif*: June–July (with onset of monsoon)
- *Rabi*: December - January
- *Summer*: February -March

Manures and fertilisers

Soil test based balanced nutrient application is an important aspect of crop production that plays a pivotal role in final production of the crop. Application of FYM 5-10 tonnes at the time of field preparation and N: 60 kg/ha, P_2O_5: 40–50 kg/ha (through SSP), K_2O: 20–30 kg/ha and Sulphur: 20–25 kg/ha, if SSP is not applied. Phosphorus and potassium are given as a basal dose and nitrogen in 2 split doses 50% at the time of sowing and the remaining 50% as top dressing at 25-30 DAS. Micronutrients can be applied as per soil test values.

Water Management: Irrigation requirements depend upon prevailing weather conditions, type of soil, and season of the crop grown. Sesame is drought-tolerant and mostly cultivated as rainfed crop during *kharif* season and as irrigated crop during rabi/summer season. The crop should be irrigated at flower initiation, capsule formation and seed filling stages in case moisture deficiency is there.

Weed Management The crop being a very delicate and slow growing during initial growth phase is susceptible to severe weed competition during the first 30–40 days and drastic reduction in seed yield to the tune of 40–70%. Weeds can be managed by Pre-emergence application of Metolachlor @0.75 kg a.i./ha or Pendimethalin @0.75 kg a.i./ha followed by intercultural operations at 20 & 40 DAS.

Disease Management: The crop is susceptible to diseases like Phyllody, *Macrophomina* stem and root rot, *Alternaria* leaf spot & wilt, which causes significant reduction in crop yield. Phyllody is vector borne disease and the spread can be reduced by spray of neem oil, Dimethoate/ Imidacloprid/ Thiamethoxam insecticides for other diseases seed treatment with *Trichoderma* + furrow application of Trichoderma with vermicompost @ 250 kg/ha followed by foliar spray of fungicides like Carbendazim + Mancozeb is effective.

Insect Management: A number of insect pests infest the crop and bring substantial reduction in crop yield. The major insect pest of sesame includes hairy caterpillar, leaf roller & capsule borer, plant hoppers and hawk moth. Adoption of IPM with resistant varieties, seed treatment, and vector management is recommended. Application of Chloropyriphos, Profenophos @2ml/lit water or Emamectin benzoate @ 0.6 g/lit water is effective in management of these insect pests.

Harvesting & post-harvest management

The crop matures in 90-100 days after sowing and should be harvested when capsules turn yellow and begin to dry but before shattering of capsules in the field to avoid yield losses. The crop is harvested with the help of sickle from the base and stack for 4–5 days for uniform drying, then threshing should be done by beating with stick on threshing floor.

Seed yield: The crop yield under rainfed conditions during *kharif* season varies from 500–700 kg/ha and 900–1200 kg/ha during *rabi*/summer irrigated conditions.

Storage: Proper drying (6-8% moisture) is required for ensuring long term storability and reduces oil rancidity.

Castor

Castor (Ricinus communis L.) is one of the most important non-edible oilseed crops cultivated in India, primarily valued for its high-quality industrial oil. The crop is believed to have originated in Africa and has been grown in India since ancient times under diverse agro-ecological conditions. Castor seed contains about 45–50% oil, rich in ricinoleic acid, a unique fatty acid that imparts exceptional chemical stability, lubricity, and viscosity to castor oil. Owing to these distinctive properties, castor oil finds extensive use in the manufacture of lubricants, paints, coatings, pharmaceuticals, cosmetics, soaps, nylon-11, and biodiesel.

India is recognized as a major castor-growing country due to the availability of improved hybrids, favourable agro-climatic conditions, and a well-developed processing sector. During 2024–25, castor was cultivated over an area of about 9.65 lakh hectares, with a production of 17.86 lakh tonnes and an average productivity of 1852 kg/ha, reflecting the crop's high yield potential under appropriate management. The crop is predominantly grown under rainfed conditions and is well adapted to semi-arid and marginal environments, making it an important option for dryland agriculture, crop diversification, and income generation, particularly in regions with limited irrigation resources.

Varieties / Hybrids

Some of the popular high-yielding and widely cultivated castor hybrids and varieties include:

Hybrids: ICH-6, ICH-5, ICH-66, GCH-9, GCH-8, YRCH-2, GNCH-1, HCH-6, PCH-222

Varieties: GAC-11, YTP-1, JC-22, JC-24, JC-4, Pragathi, GC-3

Climate

Castor is a warm-season crop that thrives well under tropical and subtropical climates. It performs best at temperatures ranging between 20–30°C with moderate rainfall. The crop is tolerant to drought but sensitive to frost and waterlogging. Bright sunshine during flowering and capsule development favours higher productivity.

Soil

Castor can be grown on a wide range of soils, from sandy loams to clay loams, provided good drainage is ensured. Well-drained loamy soils with a pH of 5.5–8.0 are most suitable. The crop does not tolerate prolonged waterlogging and performs poorly on saline and highly alkaline soils.

Land Preparation and Sowing

A well-prepared, weed-free seedbed is essential for castor cultivation. One deep ploughing followed by two harrowings and planking is sufficient. Incorporation of well-decomposed FYM @ 10–15 t/ha during land preparation improves soil structure and nutrient availability.

Spacing

Recommended spacing varies with hybrids and growing conditions:

Rainfed: 90 × 60 cm

Irrigated: 120 × 60 cm

Seed Rate

A seed rate of 5 kg/ha is sufficient for hybrids, while 5-7 kg/ha is recommended for varieties.

Seed Treatment

Seeds should be treated with Thiram or Carbendazim @ 2.5 g/kg seed to protect against soil-borne diseases. Seed inoculation with *Azotobacter* and PSB helps in improving nutrient use efficiency.

Sowing Time

Kharif: June– Last week of July (with onset of monsoon)

Rabi: September- Last week of October (under irrigated conditions)

Manures and Fertilisers

Fertilizer application in castor should be based on soil test values to ensure balanced nutrition and higher yield. Incorporation of well-decomposed FYM or compost @ 5 t/ha is recommended 2–3 weeks before sowing. In general, the fertilizer requirement for rainfed castor is 40–60 kg N, 15–60 kg P_2O_5 and 15–30 kg K_2O per hectare, while for irrigated castor, 80–120 kg N, 30–60 kg P_2O_5 and 30 kg K_2O per hectare, along with 20 kg sulphur per hectare, is recommended to obtain higher seed and oil yield.

Water Management

Castor is mainly grown as a rainfed crop. Protective irrigation during flower initiation, spike formation, and capsule development stages improves yield. Under irrigated conditions, irrigation at 15–20 day intervals is recommended.

Weed Management

Castor is highly sensitive to weed competition during the early stages of crop growth. Inter-cultivation with blade harrow 2–3 times starting from about 25 days after sowing, followed by 2–3 hand weedings at 15–20 day intervals, effectively controls weeds and improves crop growth. For chemical weed control, pre-emergence application of pendimethalin @ 3.3 L/ha or alachlor @ 2.5 L/ha, mixed in about 600 L of water per hectare, should be applied under assured soil moisture conditions. Integration of herbicide application with mechanical weeding ensures effective, economical, and sustainable weed management in castor.

Disease Management

Castor is mainly affected by diseases such as seedling blight, Alternaria blight and powdery mildew. Seedling blight can be minimized by avoiding poorly drained fields and by seed treatment with Trichoderma viride @ 4 g/kg seed or metalaxyl @ 3 g/kg seed. Alternaria blight is managed through the use of healthy seed, seed treatment with thiram @ 4 g/kg seed, and foliar spray of mancozeb @ 2.5 g/L at 15-day intervals after symptom appearance. Powdery mildew, common under dry conditions, can be effectively controlled by spraying wettable sulphur @ 3 g/L or hexaconazole @ 1 ml/L at fortnightly intervals.

Insect Management

Major insect pests of castor include semilooper, hairy caterpillar, capsule borer and sucking pests such as jassids, thrips and whiteflies. For early-stage defoliators, spraying neem seed kernel extract (NSKE) 5% is effective and eco-friendly. In case of severe infestation of foliage feeders and capsule borer, malathion 50 EC @ 2.0 l/ha may be applied as per need. Sucking pests can be managed through seed treatment with imidacloprid 70 WS @ 5 g/kg seed for early protection.

Harvesting & Post-harvest Management

The crop matures in 150–180 days. Harvesting should be done when capsules turn brown and dry. Capsules are dried, threshed, and seeds are cleaned before storage.

Seed Yield

Average seed yield ranges from 1000–1500 kg/ha under rainfed conditions and 2000–2500 kg/ha under irrigated conditions.

Storage

Seeds should be dried to 7–8% moisture before storage to ensure safe keeping and maintain oil quality.

Activities

Activity 1- Demonstrate Seed Treatment of Soybean with Rhizobium

Materials required: Soybean seeds, Rhizobium culture packet, clean water, bowl or bucket, plastic sheet or tray, jaggery/sugar solution, stick for mixing, notebook, pen/pencil.

Procedure:

1. Take the required quantity of clean and healthy soybean seeds.
2. Prepare a jaggery or sugar solution by mixing it in a small amount of water (this helps the Rhizobium culture stick to the seeds).
3. Spread the soybean seeds on a clean plastic sheet or tray.
4. Sprinkle the jaggery/sugar solution lightly over the seeds and mix properly.
5. Add the required quantity of Rhizobium culture to the seeds.
6. Mix the seeds gently so that all seeds are uniformly coated with the culture.
7. Dry the treated seeds in shade for about 20–30 minutes.
8. Use the treated seeds for sowing in the field.

Activity 2 – Demonstrate Harvesting of Groundnut

Materials required: Groundnut crop in field, digging tools (spade/hoe), basket or bag, notebook, pen/pencil.

Procedure:

1. Visit the groundnut field at the time of maturity.
2. Identify the mature plants (yellowing and drying of leaves, fully developed pods).
3. Loosen the soil around the plant using a spade or hoe.
4. Carefully pull out the whole plant from the soil along with the pods.
5. Shake the plant gently to remove excess soil from the pods.
6. Collect the harvested plants and keep them in small heaps in the field.
7. Allow the plants to dry for a few days before separating the pods from the plants and note the following information:
    - Stage of harvesting
    - Date of sowing
    - Date of harvesting
    - Method of harvesting
    - Post-harvest practice

Check Your Progress

Fill in the Blanks

1. Soybean contains about _____% protein.
2. Sesame is known as the "_____ of oilseeds."
3. The recommended seed rate of sesame under line sowing is _____ kg/ha
4. Soybean should be sown at a depth of _____ cm.

Multiple Choice Questions

1. Soybean is mainly cultivated during which season?
   a) Kharif
   b) Summer
   c) Rabi
   d) Winter
2. The ideal pH range for soybean cultivation is:
   a) 4.5–5.5
   b) 5.0–6.0
   c) 6.0–8.0
   d) 8.5–9.0
3. Groundnut seeds contain approximately:
   a) 10% oil
   b) 25% oil
   c) 60% oil
   d) 40% oil
4. The recommended spacing for sesame under irrigated conditions is:
   a) 30 × 10 cm
   b) 30 × 15 cm
   c) 45 × 15 cm
   d) 60 × 20 cm
5. Phyllody disease is important in which crop:
   a) Seasme
   b) Groundnut
   c) Mustard
   d) Linseed
6. The seed rate of soybean generally ranges from:
   a) 20–30 kg/ha
   b) 40–50 kg/ha
   c) 100–120 kg/ha

d) 60–80 kg/ha

7. Sesame seeds contain about:

a) 15–20% oil

b) 45–50% oil

c) 25–30% oil

d) 35–40% oil

Subjective Questions

1. Explain the nutrient management practices recommended for groundnut.
2. Discuss weed and water management practices in sesame.
3. Write a detailed note on following:
   - seed treatment in sesame
   - seed treatment in soybean.
4. Explain harvesting and post-harvest management of groundnut.

Session 3: Package of Practices of Rabi Season Oilseed Crops

Mustard

Rapeseed–mustard (various *Brassica* and *Brassica*-relatives such as *B. juncea, B. rapa, B. napus,* and *B. carinata*) have been grown in South Asia for millennia. Oilseed sarson (*B. rapa* type) was being cultivated in India by at least 1500 BCE, and different *Brassica* forms were domesticated across Eurasia for oil, leafy vegetables and roots. India is one of the world's largest producers of rapeseed–mustard. Rapeseed–mustard production in India is about 12.67 million tonnes from about 8.56 million hectares and the productivity of 14.63 q/ha. The average productivity of rapeseed–mustard fluctuates with season and region; improved cultivars and good management in favourable areas achieve potential yield up to 20 q/ha or more under timely sown irrigated condition, while rainfed areas report lower yields. Major producing states include Rajasthan, Uttar Pradesh, Haryana, Madhya Pradesh and Gujarat. Yield and area both vary year-to-year depending on sowing window, temperatures at germination/flowering, and moisture availability.

Improved varieties

- **Indian Mustard (*Brassica Juncea*)-** BPM11, Radhika, Brijraj, BPMQ47, Pusa Mustard 26, Pusa Bold, Varuna
- **Yellow Sarson (*Brassica rapa* var. yellow sarson) :** RMYS1, RMYS-2, Pant Sweta, Pant Girija

- **Toria (*Brassica napus* var. toria) :** TKM-14-2, RSPT-6, Tripura Toria 1, Tapeswari, Raj Vijay Toria 1, Pant Toria-508, Pant Hill Toria-1
- **Brown Sarson (*Brassica rapa* var. brown sarson) :** Shalimar Sarson-3 (KBS-3), Shalimar Sarson-2 (KBS-49), HPBS-1, Pusa Mustard 34, Kosi, BSH-1, Punjab Season 1.
- **Taramira (*Eruca sativa*):** Jwala Tara (RTM-1355), Jobner Tara (RTM-1351), Vallabha Taramira1
- **Gobhi Sarson (*Brassica napus*):** ONK-1, GSC-7, RSPN-25

Soil: The crop grows well under a wide range of soils, but thrives best on well-drained light loam soils with neutral pH.

Land preparation: Deep ploughing followed by 2–3 harrowings to make a fine seedbed; free of weeds and stubbles for easy sowing and ensuring proper germination.

Climate: Mustard is a winter season crop requiring a cool and moderate climate. An optimum temperature of around 16–25 °C favours growth, with slightly higher temperatures during the vegetative phase and cool, clear weather during the reproductive stage being essential for better seed development and oil content.

Spacing: Row spacing of 30–45 cm with 10–15 cm between plants is commonly recommended. Line sowing is preferred as it facilitates better weed control and efficient fertilizer placement.

Seed rate: The recommended seed rate is 6 kg /ha for mustard and 8 kg /ha for toria to ensure optimum plant population and uniform crop establishment.

Seed treatment: Seed should be treated with Thiram or Carboxin @ 2.5 g /kg of seed to control seed-borne diseases and ensure healthy crop establishment.

Sowing time: Sowing generally ranges from mid-September to mid-November, with toria sown earlier and Indian mustard/yellow sarson in October. Sowing should be avoided during abnormally high night temperatures.

Manures and fertilisers: Mustard requires 40–80 kg N /ha, applied in two split doses, 40–60 kg P_2O_5 /ha and 20–40 kg K_2O /ha as basal application. Sulphur @ 20–40 kg /ha is essential for oil synthesis and should be applied at sowing. 50% of nitrogen should be applied at sowing, with the remaining dose top-dressed at early vegetative stages. Application of FYM or compost @ 8–15 t /ha, where available, helps improve soil fertility and crop performance.

Water Management: Rapeseed and mustard are generally grown under rainfed conditions; however, when irrigation is available, it should be applied in interval of 25-30 days as pre flowering and siliqua forming stages to enhance yield. Waterlogging should be strictly avoided, as the crop is sensitive to excess moisture.

Insect Management: Major insect pests of rapeseed–mustard include mustard aphid, diamond back moth, mustard sawfly, painted bug, and leaf webber. Mustard aphid can be controlled by spraying Dimethoate 30 EC @2 ml/litor Imidacloprid @ 0.5 ml/l water at flowering. Diamond back moth and leaf webber are effectively managed with Chloropyriphos @2.5ml/l water or Emamectin Benzoate @0.5gm/l of water. Mustard sawfly and painted bug can be controlled by spraying Quinolphos 25 EC @ 2.5 ml/ha. Early sowing, clean cultivation, summer ploughing, and conservation of natural enemies such as ladybird beetles, lacewings, and parasitoids should be integrated for effective and sustainable pest management.

Disease Management: In rapeseed–mustard, effective disease control relies mainly on timely chemical protection along with basic cultural practices. Alternaria blight can be managed by seed treatment with carbendazim or mancozeb @ 2–3 g/kg seed and foliar spray of mancozeb @ 2.5 g L^{-1} or chlorothalonil @ 2 g L^{-1} at 15–20 day intervals. White rust is controlled by spraying metalaxyl or mancozeb @ 0.25% during favourable wet conditions, while resistant varieties are preferred wherever available. Downy mildew can be effectively managed by spraying metalaxyl @ 0.25% or dimethomorph @ 0.2% at early disease appearance. Sclerotinia stem rot should be controlled through crop rotation, destruction of infected residues, and spraying carbendazim or thiophanate-methyl @ 0.1% at flowering stage. Integrated adoption of chemical control with crop rotation and clean seed ensures effective disease management.

Weed Management: The crop is primarily infested by a mixed population of weeds, including broad-leaved species like *Chenopodium album* (Bathua) and *Fumaria parviflora* (Gajri), grassy weeds such as *Phalaris minor* (Gulli danda) and *Cynodon dactylon* (Doob grass), and the parasitic weed *Orobanche aegyptiaca*. Because mustard grows slowly during its first 4–8 weeks, it is highly vulnerable to competition, making the period between 20 and 40 days after sowing (DAS) critical for management. Integrated Weed Management (IWM) approach is the most effective and economical; this typically involves applying a pre-emergence herbicide like Pendimethalin (0.75–1.0 kg ai/ha) or Oxadiargyl (0.09 kg ai/ha) within 0–2 days of sowing, followed by one hand weeding at 30 DAS. Cultural practices such as straw mulching (5–10 t/ha) can further suppress weed density while conserving soil moisture, ultimately preventing yield losses that can otherwise reach up to 70%.

Harvesting: Rapeseed and mustard should be harvested as soon as the pods turn yellowish-brown to avoid shattering losses. Threshing is carried out after proper drying, either by trampling with bullocks or by running a tractor over the dried plants. For safe storage, the seed moisture content should be reduced to about 8%.

Potential Seed yield: With the adoption of improved package of practices, a yield of 15–18 q /ha in rapeseed and 18–20 q /ha in mustard can be obtained under normal growing conditions.

Storage: The seed should be dried properly to safe moisture (~8%) before storage to reduce losses. Store in clean, dry, fumigated godowns or airtight containers as appropriate.

Safflower

Safflower (*Carthamus tinctorius* L.) is a traditional, multipurpose oilseed crop cultivated in India for centuries. Initially grown for the orange-red dye (carthamin) extracted from its flowers, it is now mainly valued for its high-quality oil rich in linoleic acid (70–80%). The crop has diverse uses: tender leaves and shoots are consumed as vegetables, flowers possess medicinal value, and seeds and by-products are used for food, fodder, and industrial purposes. Safflower is highly drought tolerant and well suited to semi-arid and arid regions with low moisture availability. Botanically, the genus *Carthamus* comprises of several species, of which only *C. tinctorius* (2n = 24) is cultivated. Despite its wide adaptability and multipurpose utility, safflower remains a minor oilseed crop due to limited awareness and adoption of improved production technologies. Safflower is cultivated in India in an area of about 0.64 lakh hectares, with a production of 0.43 lakh tonnes and an average productivity of 672 kg /ha.

Improved varieties and Hybrids

- **Varieties:** ISF-764, ISF-1, SSF-12-40, NARI-96, NARI-57, PKV-Pink, SSF-708, PBNS-40
- **Hybrids:** NARI-H-23, MRSA-521, NARI-H-15

Soil

Safflower requires moderately to highly fertile, fairly deep, moisture-retentive, and well-drained soils with a neutral soil reaction. The crop is highly sensitive to waterlogging, and even short periods of poor drainage or prolonged rains can predispose plants to root rot and wilt, resulting in substantial yield losses. Therefore, heavy soils with poor drainage should be avoided, particularly under irrigated conditions. Safflower is, however, fairly tolerant to saline soils.

Land preparation

The field should be prepared by deep ploughing followed by one to two harrowings to obtain a fine and level seedbed. Weeds and stubbles should be removed, and well-decomposed FYM or compost @5-10 t/ha should be incorporated before final levelling, wherever available.

Climate

Safflower is well suited to semi-arid climates, requiring cool and dry conditions during early vegetative growth and warm, dry weather during flowering and maturity. An optimum temperature of 15–20 °C for germination and 24–32 °C during flowering is ideal. Low humidity and an annual rainfall of about 350–450 mm favour healthy crop growth, reduce disease incidence, and ensure higher seed and oil yield.

Spacing

A spacing of 45 × 20 cm is recommended to obtain a healthy plant stand; closer/ dense sowing should be avoided as it increases disease incidence. Sowing may be done using a seed drill or by dibbling, ensuring a uniform sowing depth of 3–4 cm.

Seed rate

A seed rate of 15-20 kg /ha for small seeded and 30-40 kg/ha for bold seeded varieties is recommended for line sowing.

Seed treatment

Seeds should be treated with Thiram or Carbendazim @ 3 g /kg seed to protect against seed- and soil-borne diseases. Greater care should be taken while using hybrids or low-germination seed lots.

Sowing time

The optimum sowing time for safflower in India is from the last week of October to the first week of November during the *Rabi* season; however, in some dry regions, sowing from mid-September is also adopted for better crop establishment and yield.

Manures and fertilizers

Apply 5-10 t /ha of well-decomposed FYM or compost about 2–3 weeks before sowing for balanced nutrition. Fertilizer application should be based on soil test values, following state-specific recommendations. Generally, the crop requires application of 60 kg Nitrogen, 40 kg Phosphorus and 20 kg Potassium per hectare. Under rainfed conditions, dual inoculation with *Azospirillum* and *Azotobacter* along with 50% of the recommended nitrogen can save up to 30 kg N /ha. Application of sulphur @ 15–30 kg /ha is

beneficial for improving seed yield and oil content, particularly in sulphur-deficient soils.

Water Management

Provide a light pre-sowing irrigation if soil moisture in the seed zone is inadequate for germination. In vertisols, irrigate before cracks develop to ensure efficient moisture utilization. When only one irrigation is available, it should be applied before soil moisture becomes critically low at 30-40 DAS. During irrigation, avoid wetting the above-ground parts of plants to minimize the spread of diseases.

Insect Management

Safflower is mainly affected by aphids, bud fly, caterpillars, cutworms, wireworms, and weevils. Pest incidence can be minimized through early sowing, crop rotation, field sanitation, removal of infested plant parts, and timely harvesting. Conservation and release of natural enemies such as Chrysoperla (1–2 per plant) help in aphid control. In case of severe infection, spray Dimethoate 30 EC @ 2.5 ml/ha or Imidacloprid @ 0.5 ml/l for aphids and bud fly. Caterpillars and cutworms can be controlled with deep ploughing and intercropping with non-host crops. Wireworms and weevils are managed through deep tillage, crop rotation, residue removal, and need-based insecticide application. An integrated approach combining cultural, biological, and chemical measures ensures effective pest management in safflower.

Disease Management

Major diseases of safflower include wilt, root rot, Alternaria leaf spot, and Cercospora leaf spot. Disease incidence can be reduced through crop rotation, good drainage, timely irrigation, and field sanitation. In endemic areas, seed treatment with Trichoderma @ 10 g /kg seed is effective for managing wilt, while seed treatment with thiram or mancozeb @ 3 g /kg seed helps control root rot. Alternaria leaf spot can be managed by spraying mancozeb @ 2.5 g L^{-1} or carbendazim @ 1 g L^{-1} + mancozeb @ 2 g L^{-1}. For Cercospora leaf spot, spraying copper oxychloride @ 3 g L^{-1} or mancozeb @ 2.5 g L^{-1} provides effective control. Adoption of resistant varieties along with seed treatment and need-based fungicidal sprays ensures effective disease management in safflower.

Weed management

Safflower requires early weed control due to its slow initial growth. Weed infestation can be reduced through slightly delayed sowing, proper spacing, and inter-row cultivation. Pre-emergence application of Pendimethalin @ 0.75 kg ai/ha effectively controls major weeds. Hand weeding or hoeing at 20–25 and 40–45 days after sowing ensures effective weed control.

Harvesting

Harvest when most heads have matured and seeds are hard. Harvest safflower preferably during early morning hours by cutting plants at the base with sickles or uprooting in black soils. Stack the harvested plants in small, compact heaps in the field until fully dried. Threshing may be done by beating with sticks, bullock-drawn stone rollers, tractor, or power-operated threshers, followed by winnowing to obtain clean seed.

Seed yield: The seed yield potential ranges from about 800 to 1200 kg/ha under scanty moisture conditions and about 1200 to 1500 kg/ha under irrigated conditions.

Storage: Safflower seed should be stored at a moisture content of about 7.5–8.0% in clean, dry, and cool conditions to prevent deterioration and loss of viability. Protection from insects and moisture are essential to maintain seed quality during storage.

Niger

Niger (*Guizotia abyssinica.*) is one of the minor oilseed crops cultivated under rainfed conditions in tribal dominated regions and is known by local names such as *Ramtil*, *Karale*, *Sorguja* or *Jagni* in different parts of India. Niger is native of Africa and the centre of origin is considered to be Ethiopia where large number of wild relatives are still found and the crop was later spread to India. The seeds are small dark brown to black in colour containing oil (32-38%) known for its high linoleic acid content (70–75%), nutritional and medicinal properties and as bird feed. In India the crop is being cultivated in Madhya Pradesh, Chhattisgarh, Odisha, Maharashtra, Karnataka, Jharkhand, and Gujarat covering an area of 90-100 thousand hectares with production of about 35-40 thousand tonnes and productivity of about 400 kg/ha.

Varieties

Some of the promising high yielding, short-duration, disease-resistant varieties developed under ICAR- AICRP on Sesame & Niger suitable for cultivation in different parts of the country includes DNS-4, JNS-30, IGPN-8004, JNS 28, GNNIG 3, JNS 2016-1115, JNS 2015-9, JNS 521, JNS 2016-1413, GNNIG-4, JNS 2017-13, KBN-2, GA-10, JNC-9, N-160, IGP-76, NB-21, GNNIG-1114, ONS-150 *etc.*

Climate

Niger can be grown during *kharif* to late *kharif* season in different parts of the country as per agroclimatic suitability. The crop performs well in warm (18–30°C) and moderately humid (60–80%) climate. The crop is cultivated under rainfed condition in areas receiving annual rainfall of about 1000–1300 mm.

Soil

Niger crop prefers a well-drained light to medium soils rich in organic matter content with gentle slope to avoid water stagnation, though the crop can also be grown on poor, acidic, or lateritic soils where other crops fail to perform.

Land preparation and sowing

To obtain a fine tilth of soil, field should be ploughed at least twice to a depth of about 30 cm, followed by planking after every ploughing. Well rotten farmyard manure (FYM) at the rate of 5–10 tonnes per hectare should be mixed thoroughly in the soil before ploughing. The crop is sown either by broadcasting method in hill slopes and line sowing with the help of seed drill. The crop is also grown as an intercrop with millets or pulses in tribal regions.

Spacing

The crop is cultivated under low input rainfed conditions and a spacing of 30 to 45 cm row to row and 15 cm plant to plant.

Seed rate: 4–5 kg/ha (line sowing); 6–8 kg/ha (broadcasting).

Seed treatment: Seed treatment should be done with Thiram or Carbendazim @ 3 g/kg seed to protect the crop from soil borne pathogens and PSB + *Azospirillum* for improving establishment, enhancing nutrient use efficiency and yield.

Sowing time: *Kharif*: Mid July to September

Manures and fertilisers

Soil test based balanced nutrient application is important for obtaining higher crop yield. The crop is cultivated under low fertility conditions and responds to nutrient application. Incorporation of FYM 5-10 tonnes at the time of field preparation and N: 30-40 kg/ha, P_2O_5: 20-30 kg/ha (through SSP), K_2O: 15-20 kg/ha is sufficient. 50% nitrogen and full quantity of phosphorus and potassium are applied as a basal dose while the remaining nitrogen is applied as top dressing at 30 DAS. Foliar spray of nano DAP (4ml/lit water) at flowering improves yield.

Water Management: Irrigation requirements depend upon prevailing weather conditions, type of soil, and season of the crop grown. Niger is drought-tolerant and mostly cultivated as rainfed crop during *kharif* season. The crop should be irrigated at flower initiation and seed filling stages in case moisture deficiency is there.

Weed Management The crop being a very delicate and slow growing during initial growth phase is susceptible to severe weed competition during the first 20–30 days and results in drastic reduction in seed yield to the tune of 50–70% if weeds are not managed. Weeds can be managed by Pre-emergence

application of Pendimethalin @1.0 kg ai/ha followed by intercultural operations at 30 & 50 DAS. *Cuscuta* is a major parasitic weed associated with the crop and seeds free of *Cuscuta* seeds should be selected for sowing to avoid infestation. Soaking of seeds in 2% brine solution for separation of *Cuscuta* seeds is also beneficial.

Disease Management: The crop is susceptible to diseases like *Alternaria* leaf spot and powdery mildew which cause significant reduction in crop yield. Foliar spray of fungicides like Carbendazim + Mancozeb @ 2 gm/lit or Propiconazole 0.1% at 10-day interval is effective.

Insect Management: The major insect pest of Niger includes hairy caterpillar, leaf-eating caterpillar and aphid. Application of Chlorantraniliprole 18.5 SC @ 0.5 ml/l or Spinosad 45 SC @ 0.5 ml/l or Emamectin benzoate @ 0.6 g/lit water is effective for lepidopteran insects and Imidacloprid 17.8 SL @ 0.5 ml/l for management of aphid is effective.

Harvesting & post-harvest management

The crop matures in 90-120 days after sowing and should be harvested when the heads turn brown and seeds are black and hard but before shattering of seeds from head in the field to avoid yield losses. The crop is harvested with the help of sickle from the base and stack for 4–5 days for uniform drying, then threshing should be done by beating with stick on threshing floor.

Seed yield: The crop yield under rainfed conditions varies from 400–600 kg/ha.

Storage: Proper drying (6-8% moisture) is required for ensuring long term storability and reduces oil rancidity.

Sunflower

Sunflower (*Helianthus annuus* L.) is a relatively new oilseed crop in India compared to traditional oilseeds such as mustard and groundnut. It was introduced during the late 1960s, with the first commercial cultivation reported around 1969. Initially, sunflower cultivation relied on open-pollinated varieties introduced from abroad, while later indigenous hybrids and improved varieties were developed through coordinated research efforts under AICRP (Sunflower) and ICAR-IIOR. Sunflower in India is cultivated over an area of 1.94 lakh hectares, with a total production of 2.36 lakh tonnes and an average productivity of 1214 kg /ha. Karnataka is the leading sunflower-producing state, followed by Haryana, Odisha and Telangana. National average productivity remains modest, though yields of 1.5-2 t /ha or higher are achievable with improved hybrids and better management.

Improved varieties and hybrids

- **Varieties:** COH-4, IIOSH-15-20, RSFH-700, KBSH-88, PDKVSH-964

- **Hybrids:** Tilhantech- SUNH-3, KBSH-90, DRSH-1, DSFH-3, LSFH-171, KBSH-78

Soil

Sunflower grows well in a wide range of soils, provided they are well drained. Loamy to sandy loam soils, including red and alluvial soils, are most suitable. The crop is sensitive to waterlogging, and a neutral to slightly alkaline soil reaction (pH 6.5–8.0) is considered ideal for optimum growth and yield.

Land preparation

The field should be prepared by deep ploughing followed by one to two harrowings to obtain a fine and well-pulverized seedbed. Organic manures or compost @10-15 tonnes/ ha should be incorporated before the final tillage. Previous crop residues should be removed, and the field should be properly levelled to ensure uniform moisture distribution and good crop establishment.

Climate

Sunflower grows best in a warm, sunny climate with 6–8 hours of sunshine and an optimum temperature of 21–26 °C. Sowing should be done when soil temperature exceeds 10 °C. Although drought tolerant, adequate moisture (500–1,000 mm) is essential, especially during flowering and seed filling.

Spacing

A spacing of 60 × 30 cm is recommended for hybrids, while 45 × 30 cm is suitable for varieties to ensure optimum plant population and better growth.

Seed rate

Under rainfed conditions, the recommended seed rate is 8-10 kg /ha for varieties and 5-6 kg /ha for hybrids, while under irrigated conditions, it is 6-8 kg /ha for varieties and 4-5 kg /ha for hybrids.

Seed treatment

Seeds should be treated with *Trichoderma* @ 4 g /kg of seed just before sowing; this treatment is compatible with biofertilizers and such seeds should not be treated with chemical fungicides. Alternatively, seeds may be treated with Carbendazim or Thiram @ 2 g /kg of seed to protect against seed-borne diseases.

Sowing time

Under rainfed conditions, sunflower should be sown during *Kharif* from 15 July to 15 August, late *Kharif* from 16–31 August, pre *Rabi* from 15–30 September, and *Rabi* from 1–15 October. Under irrigated conditions, sowing is recommended during *Rabi* (October) and summer (January) seasons also.

Manures and fertilisers

Fertilizer requirements in sunflower vary with moisture availability. Under rainfed conditions, application of 60 kg N, 60 kg P_2O_5, and 30 kg K_2O /ha is recommended. Under irrigated conditions, hybrids require 60 kg N, 90 kg P_2O_5, and 40 kg K_2O /ha. Application of sulphur @ 13 kg /ha in sulphur-deficient soils improves seed yield and oil content. Micronutrient deficiencies may be corrected through foliar sprays of Copper Sulphate or Manganese Sulphate @ 2–3 g L^{-1}, and Borax @ 2 g L^{-1} at ray floret opening to enhance seed filling.

Water Management

Sunflower should be irrigated immediately after sowing, followed by irrigation at an interval of 10-15 days, depending on soil and climatic conditions. Adequate moisture is critical during seedling establishment, flowering, and seed development, particularly two weeks before and after flowering, to achieve higher yield.

Insect Management

Major insect pests of sunflower include jassids, whitefly, leaf-eating caterpillar (*Spodoptera litura*), and gram caterpillar (*Helicoverpa armigera*). Jassids can be controlled by spraying Dimethoate @ 2 ml L^{-1}, while whitefly may be managed using Thiomethoxam @0.5ml/l water. Leaf-eating caterpillar can be controlled with Chloropyriphos @ 2 ml/l at early stages and Emamectin Benzoate @ 0.5g/l at later stages, whereas gram caterpillar is effectively managed by HaNPV @ 500 LE /ha. Cultural and biological practices such as deep ploughing, field sanitation, pest monitoring, use of neem-based botanicals, light/pheromone traps, and conservation of natural enemies should be integrated for sustainable pest management.

Disease management:

Important diseases of sunflower include *Alternaria* blight, rust, downy mildew, charcoal rot, and powdery mildew. *Alternaria* blight is managed by seed treatment with Captan @ 3 g /kg seed and spraying Mancozeb @ 2 g L^{-1} at 10-day intervals. Rust can be controlled by crop rotation and Mancozeb @ 2 g L^{-1} spray. Downy mildew is managed through Metalaxyl seed treatment @ 6 g /kg seed and Ridomil @ 2 g L^{-1} spray. Charcoal rot can be reduced by seed treatment with *Trichoderma viride* @ 4 g /kg seed, while powdery mildew is controlled by spraying Wettable Sulphur @ 3 g L^{-1}. Adoption of clean seed, crop rotation, and field hygiene is essential for effective disease management.

Weed Management

Weeds in sunflower can be effectively controlled by pre- emergence application of Pendimethalin @ 1kg ai /ha followed by one hand weeding at 30–35 days after sowing.

Harvesting

Sunflower is ready for harvest when the bracts on the back of the capitulum turn lemon yellow and the heads become hard. To minimize bird damage, the use of reflective ribbons is effective. Harvesting should be done by cutting only the capitula (flower heads). After harvest, the heads should be sun-dried for about 3 days, spread in a thin layer, and turned every 3 hours to ensure uniform drying before threshing and cleaning.

Seed yield : The potential seed yield of sunflower varies with moisture availability and management practices, ranging from 800–1000 kg /ha under rainfed conditions to 1500–2000 kg /ha or higher under irrigated and well-managed conditions.

Storage

For short-term storage (8–9 months), sunflower seeds should be stored in gunny or cloth bags with a seed moisture content of 8–9%. For medium-term storage (12–15 months), polylined gunny bags are recommended with seed moisture maintained at 7–8%. For long-term storage (more than 15 months), seeds should be stored in 700-gauge polythene bags with moisture content below 7% to maintain seed viability and quality.

Linseed

Linseed (*Linum usitatissimum* L.), also known as flaxseed, is an important oilseed crop cultivated for its seeds and oil. The crop belongs to the family Linaceae and is one of the oldest cultivated crops in the world. In India, linseed is primarily grown for oil production and plays a significant role in traditional farming systems, particularly under rainfed and marginal conditions. Linseed seeds contain about 35–40% oil and 20–25% protein, making them nutritionally valuable. The oil is rich in alpha-linolenic acid (ALA), an omega-3 fatty acid known for its health benefits.

Linseed oil is widely used in the manufacture of paints, varnishes, linoleum, printing inks, soaps, and wood preservatives, owing to its excellent drying properties. Linseed cake, a by-product of oil extraction, is a valuable protein-rich feed and organic manure. At present, linseed is cultivated over an area of about 1.69 lakh hectares, with a total production of 1.12 lakh tonnes and an average productivity of 666 kg per hectare. Despite being cultivated largely under low-input conditions, productivity can be significantly improved by adopting improved varieties and scientific crop management practices.

Linseed is cultivated in states such as Madhya Pradesh, Uttar Pradesh, Maharashtra, Bihar, Rajasthan, and West Bengal, mostly during the *Rabi* season. The crop is well adapted to cool and dry climates, low fertility soils, and limited moisture conditions, making it suitable for dryland agriculture. With the availability of improved varieties and better production technologies, linseed offers considerable scope for enhancing productivity and farm income.

Climate and Soil

Linseed is a cool-season crop and performs best under cool and dry climatic conditions. A temperature range of 15–25°C during growth is ideal. Excessive rainfall, high humidity and frost during flowering adversely affect yield. The crop grows well on well-drained loam to clay loam soils with a pH of 6.0–7.5. Waterlogging should be avoided.

Varieties

Birsa Tisi-1, Sabour Tisi-2, SHUATS Alsi-2, TL-99, Hima Palam, Alsi-1, Rajan, Kota Barani Alsi-5, Suvee, Kota Alsi-6, Kota Barani Alsi-6, BUAT Alsi-4, Aparna, RLC-164, RLC-167, Sabour Tisi-3, SHUATS Alsi-2, Sabour Tisi-2, Birsa Tisi-1.

Land Preparation

The field should be ploughed 2–3 times followed by 2–3 harrowings to obtain a fine tilth. After each good rainfall, hoeing is recommended to create a soil mulch and conserve moisture. Well-drained sandy loam to silty clay loam soils with a pH range of 5.5–7.0 are considered most suitable for linseed cultivation.

Sowing Time

Linseed should be sown during second fortnight of October to first fortnight of November. Delayed sowing reduces yield due to poor vegetative growth and increased pest–disease incidence.

Seed Rate and Spacing

- Seed rate: 40 kg/ha
- Spacing: 30 cm × 10 cm
- Line sowing is preferred over broadcasting for better crop management.

Seed Treatment

Seeds should be treated with Thiram or Carbendazim @ 2.5 g/kg seed to protect against seed-borne and soil-borne diseases. Biofertilizer inoculation with *Azotobacter* and PSB may be done to improve nutrient availability.

Nutrient Management

Fertilizer application should be based on soil test values. In general, application of 40–60 kg N, 20–30 kg P_2O_5 and 20 kg K_2O per hectare is recommended. Entire phosphorus and potassium and half nitrogen should be applied as basal dose, while the remaining nitrogen is top-dressed at 30–35 DAS. Incorporation of 5 t/ha FYM before sowing improves soil structure and nutrient availability.

Water Management

Linseed is mostly grown as a rainfed crop. However, one irrigation at flowering stage significantly enhances seed yield. Under irrigated conditions, 2–3 irrigations at critical stages (branching, flowering, and capsule formation) are beneficial. Excess irrigation should be avoided as the crop is sensitive to waterlogging.

Weed Management

The crop is sensitive to weed competition during the first 30–45 days. One hand weeding at 20–25 DAS followed by another at 40 DAS is effective. Where labour is limiting, pre-emergence application of Pendimethalin @ 1.0 kg a.i./ha may be adopted.

Activities

Activity: Demonstrate Post-Harvest Practices in Rabi Oilseed Crops

Materials required: Harvested samples of Rabi oilseed crops (mustard, linseed, safflower, etc.), tarpaulin or plastic sheet, threshing tools or machine, winnowing basket, storage bags, notebook, pen/pencil.

Procedure:

1. Collect the harvested plants of Rabi oilseed crops from the field.
2. Dry the harvested plants in the sun for a few days to reduce moisture content.
3. Carry out threshing by beating the dried plants with sticks or using a threshing machine to separate the seeds.
4. Perform winnowing to remove chaff, dust, and other impurities from the seeds.
5. Dry the cleaned seeds properly under sunlight to make them safe for storage.
6. Store the dried seeds in clean and dry bags or containers in a proper storage place.

Check Your Progress

Fill in the Blanks

1. The optimum temperature for mustard growth is about _____ °C.
2. Safflower oil is rich in _____ acid.
3. The recommended seed rate for mustard is _____ kg/ha.
4. The ideal pH range for sunflower cultivation is _____.

Multiple Choice Questions

1. The major mustard producing state in India is:
   a) Karnataka
   b) Rajasthan
   c) Odisha
   d) Tamil Nadu
2. The recommended spacing for safflower is:
   a) 45 × 20 cm
   b) 30 × 10 cm
   c) 60 × 30 cm
   d) 30 × 30 cm
3. Niger seeds contain about:
   a) 10–15% oil
   b) 20–25% oil
   c) 32–38% oil
   d) 50–60% oil
4. Sulphur is important in mustard mainly for:
   a) Root growth
   b) Oil synthesis
   c) Weed control
   d) Seed germination
5. The seed rate of niger under line sowing is:
   a) 2–3 kg/ha
   b) 12–15 kg/ha
   c) 8–10 kg/ha
   d) 4–5 kg/ha

Subjective Questions

1. Describe the climate and soil requirements for mustard cultivation.
2. Explain nutrient and water management practices in safflower.
3. Discuss insect and disease management in sunflower.

Module 2: Integrated Insect-Pest and Disease Management in Oilseed Crops

Module Overview

Oilseed crops are susceptible to different types of insect-pests and diseases. The yield loss of Oilseed crop incurs due to various insect-pests and diseases. Insect-pests and diseases are interlinked and complement each other. Individually, each one of these is responsible for a considerable loss by itself but if one remains neglected, it gives rise to the infestation of the other. Pesticides are synthetic compounds that kill insects-pests in crops. They are hazardous for the environment and for non-target insects too. Indiscriminate use and improper application of pesticides create ecological imbalances due to the destruction of beneficial insects and the emergence of pesticide resistant pulses and strains. In the past, a single approach to control pests and diseases was in practice, which was neither economical nor safe. Therefore, a systematic approach of Integrated Pest or Disease Management (IPM or IDM) was adopted.

This module introduces students to the major insect pests and diseases that affect oilseed crops and the strategies used to manage them effectively. It emphasizes the concept of integrated management practices to minimize crop losses while promoting sustainable agriculture. In Session 1, students will learn about the important insect pests of oilseed crops, their identification, nature of damage, and various control measures including cultural, mechanical, biological, and chemical methods. Session 2 focuses on the major diseases affecting oilseed crops, their symptoms, causes, and effective control measures to prevent and manage disease outbreaks in the field.

Learning Outcomes

After completing this module, you will be able to:

- Identify the major insect pests of oilseed crops and explain their control measures.
- Identify the common diseases of oilseed crops and describe appropriate management practices for their control.

Module Structure

Session 1: Insect-pests of oilseed crops and their control measures

Session 2: Diseases of Oilseed crops and their Control Measures

Session 1: Insect-pests of oilseed crops and their control measures

Among the various constraints for the low productivity level, damage due to insect pests is one of the most important factors. More than hundreds of species of insect pests associated with oilseeds crop, they are attacking on different plant parts at different phenological stages of plant growth. For the management of these insect pests, farmers solely depend on chemical pesticides. Chemical control is one of the effective and quicker methods in reducing pest population where farmer gets spectacular result within a short time. However, over reliance and indiscriminate use of pesticides leads to pesticides residue in food and forage, contamination and environment pollution, destruction of nontarget beneficial insects, hazards to person involved in application, domestic animals and wildlife.

Besides, this over and extensive use of pesticides causes pest resistance, pest resurgence and secondary pest outbreak. All these problems contributed to a new way of thinking concerning pest control practices, i.e. the integrated approach of pest control. IPM is a multidisciplinary ecological approach to the management of pest population which utilizes a variety of control tactics compatibly in a single coordinated pest management system. FAO (1967) has define the Integrated Pest Management (IPM) is a system that, in the context of associated environment and population dynamics of the pest species, utilizes all suitable techniques and methods in as a compatible manner as possible and maintains pest populations at levels below those causing economic injury.

Components of Integrated Pest Management

There are seven components of IPM

1. **Cultural Control:** All the crop production and management techniques utilized by farmers to maximize their crop productivity and farm income are known as cultural practices. These include decisions on crops/varieties to be grown, time and method of sowing, tillage, seed rate, plant spacing, intercultural operations, clean cultivation/weed management, fertilizer dose and application timing, water management, intercropping, trap cropping, crop-rotation harvesting times and procedures, and even off-season operations in fallow or cropped fields. Manipulating these practices in such a way which either destroy the pests or prevent them to reduce or avoid pest damage to crops is known as cultural control. Like Sowing mustard crops in the first week of October can help avoid peak aphid activity. Balanced fertilizer application helps plants grow healthily, making them less susceptible to sucking insect pests like aphids, whiteflies, and jassids.
2. **Mechanical Control:**The reduction or suppression of insect pests population by means of manual forces, tools or devices or machines is known as

mechanical method of pest control. It includes: Collection and destruction (killed by manual or mechanical forces) of different life stages of the insects**.** Use of mechanical barriers to prevents access of pests to host like fencing (Putting electric fences around crop fields in the normal ways or charged with low voltage electricity will key away non insect pests like rats, jackles, monkey etc.), netting, wrapping of fruits, use of different kind of traps like **Light trap:** Light traps are a very useful tool in insect pest management as they are used to attract nocturnal insects. It helps us by tracking initial outbreaks, seasonal patterns, and pest activity, and even trapping and killing them. **Sticky trap:** different types of sticky traps are used to attract and kill different insects like cotton white fly, aphids and thrips prefer yellow color similarly leafhopper prefer to attract on blue color. The insects are attracted to different color and trapped on the sticky materials. **Bait trap** (In bait trap attractants are placed to attract the insects and kill those using insecticides), **pheromone trap** (Synthetic sex pheromones are placed in traps to attract mostly males)**.** Use of trench for trapping of marching larvae of red hairy caterpillar, Scare crow**,** Drumming etc.

3. **Physical Control:** Insects require a specific range of physical environment. Altering the physical environment to reduce or prevent pest issues is known as physical control. For example, **Manipulation of temperature:** (Sun drying the seeds to kill the eggs and hidden stages of stored product pests). Use of flame throwers against locusts, use of burning torch against hairy caterpillar etc. **Manipulation of moisture (**Drying of seeds below 10% moisture level affect insect development (rice weevil, pulse beetle). **Manipulation of light** (Behavioural orientation is influenced by light), **Use of irradiation** (Gamma irradiation from Co^{60} is used to sterile the insects in laboratory)**, Use of abrasive dust** (abrasive dusts like activated clay causes injury to the insects wax layer, resulting in loss of moisture leading to death), **Visible and ultraviolet** (UV to blue-green (350-560 nm) region of the spectrum is the most effective in attracting insects), **Use of sound energy** (Acoustical device (Bird scarer/acetylene exploders) produces sudden loud sound which frighten birds).
4. **Genetic Control :** Genetic control encompasses a range of techniques that exploit different methods for managing pest populations. These include:
    - Selection of comparatively pest-resistant/tolerant varieties
    - Use of genetically modified seeds, e.g., B.t. cotton
    - Release of sterile males of insects in sufficient numbers in the field to compete with fertile males. Sterility in males is induced in the laboratory either through chemosterilants or through radiation. Sterile pest control falls under autocidal control, which refers to the

destruction of members of the same species or reduction of its population through reduced reproductive capacity.

5. **Biological Control:** Using living organisms like parasites, predators, and pathogens to manage insect pests by introducing, multiplying, and augmenting natural enemies through human intervention is called biological control. Use of different insects for the management of different insect pests like **predators** *Coccinella septempunctata* against aphid, *Chrysoperla carnea* against aphids and other soft bodied insect, *Cryptolaemus montrouzieri* against mealy bugs, Praying mantis against flies, moths and other insects. **Parasite like** *Nosema locusta*against grasshopper and locust,*Leptus spp.* parasitize leafhoppers, bugs and spiders, *Heterorhabditis bacteriophora* (parasitic nematode) used against caterpillars and whitegrubs etc. **Parasitoids like** *Trichogramma chilonis against eggs of lepidopteron insect pests,* ***Aphidius colemani*** **against aphids,** *Campoletis chloridae against* Diamond back moth etc.**Pathogens like** *Bacillus thuringiensis* (Bt) against caterpillars, beetles, and other insects, *Beauveria bassiana* against whiteflies, aphids, and other insects.

6. **Legislative Control:** The term quarantine originates from the Latin word "Quarantum", meaning 'forty (40). Plant quarantine refers to the legal enforcement of measures designed to prevent the spread of pests or to contain their multiplication in newly infested areas. Plant quarantine refers to the restriction of movement of plants or plant parts from one country (International quarantine) to another country or from one state to another within the same country (Domestic quarantine). The exchange of plant parts or plant material is only possible with a phytosanitary certificate issued by the officers of the agriculture department of the exporting country, confirming that the consignments are pest-free.

7. **Chemical Control:** Use of chemicals for the control of insect pests is known as chemical control. The chemical used for the control of pests (insects, animals, mites, diseases, weeds etc.) is known as pesticides. Pesticide is a broad term it include **Insecticides**- A pesticide that is used to kill insects, or to disrupt their growth or development. **Acaricides:** These are the substances that are used to kill the mites and tick. Nematicides are the substances that are used to kill the nematodes. **Rodenticides:** substances used to kill the rats. **Weedicides**: substances used to kill the weeds. **Fungicides**- used to kill the fungus is known as fungicide.

In IPM, the chemical pesticides shall be used, only when preventive cultural, mechanical and other methods fail to keep the pest population below the economic threshold level and pest multiplies to economic threshold level. The pesticides to be used should be selective and eco friendly, which may kill

the target species of the pests and relatively safe to beneficial organisms like parasites and predators.

Major Insect-pests of oilseed crops and their control measures

S. No.	Common Name and Scientific Name	Nature of damage and symptoms of damage	Control measures
		Groundnut	
1.	**White grub** *Holotrichia consanguinea ,Holotrichia serrata*  Fig. 2.1, White Grub	• This is one of the most important insect pests of groundnut especially when grown in moist and humid climates under sandy-loam and light-red soils. • Both grub and adults of this pest caused the damage. • The grubs feeds on root and root nodules in patches leading to stunted or wilted plants can be seen at different patches.	• Deep ploughing of the field from the end of April to middle of May to expose the hibernating grubs and pupae to sunlight and predatory birds. • Collection and destruction of adult beetles from neem and ber trees around the field immediately after the early rains. • Application of EPN (entomopathogenic nematodes) @ 1 billion/acre is effective for the management of white grub. • Seed treatment with Imidacloprid 48FS @ 2 ml/kg of seed is found to be effective for managing white grubs at an early stage of plant growth.
2	**Groundnut leaf miner ,** *Aproaerema modicella*)	• This is one of the major insect pests of groundnut especially when grown in rainfed conditions.	• Rotate the crop with a non-leguminous crop or a non-host crop. • Growing soybean as a trap crop.

	 Fig. 2.2: Leaf Miner Symptoms	• Newly hatched caterpillar mines into the tender leaflets or it webs together adjacent leaflets and feed on green tissues resulting in brownish dried up patches. Later instars caterpillars fold the leaves together and feed on the green tissues by remaining inside.	• Setting of light and pheromone traps to attract the adult insects. • Foliar spray of profenophos 50EC @ 1000 ml/ha or spinosad 45% SC @ 150 ml/ha or Flubendiamide 39.35SC @ 75-100 ml/ha or Quinalphos 25EC @ 1000 ml/ha.
3.	**Red hairy caterpillar** *Amsacta albistriga*  *Fig.2.3: Red hairy caterpillar*	• The incidence of these hairy caterpillars is noticed from the onset of monsoon from July to October. • The body of the caterpillar remains covered with hairs with varied colour *viz.*, reddish, orange or brownish orange. • The adult female of this insect lays their eggs in groups on lower surface of leaves. • After hatching the eggs in 2to 3 days, the newly emerged larvae feed gregariously by scraping chlorophyll content leaving the papery white skeletonised leaf. • Later the larvae move to another plants and start individual /solitary feeding and defoliate the plants leaving only the stem.	• Hand picking and destruction of egg masses and gregarious stages of larvae along with damaged leaves. • Install one light trap/ha to catch the adults of hairy caterpillar. • Foliar spray of NSKE 5% or nuclear polyhedrosis virus (NPV) @ 250 LE/ha or *Bacillus thuringiensis* var kurstaki @ 1000 g/ha or Single foliar spray of Chlorantraniliprole 18.5SC @ 125 ml/ha or Flubendiamide 39.35% SC @ 100 ml/ha or Novaluron 10EC @ 500 ml/ha.
4.	**Thrips**	• These are minute insect, both nymphs and adults of	• This insect can be effectively managed by

	Scirtothrips dorsalis	thrips lacerate and suck oozing out sap from the plant tissues. • Infested leaves showed pale white yellow patches and curling of tender leaves. • It also acts as a vector for peanut bud necrosis virus disease.	intercropping of groundnut with lablab in a 4:1 ratio. • Foliar spray of imidacloprid 17.8SL @ 150 ml/ha or thiacloprid 480% SC @ 125 ml/ha or thiomethoxam 25% WG @ 100 g/ha or acetamiprid 20% SP @ 100 g/ha.
5.	**Aphids,** *Aphis craccivora*	• Both nymphs and adults cause damage by sucking sap from tender plant parts especially the underside of leaves, apical twigs, flowers and pods. • Aphids excrete honeydew, which promotes sooty mold growth and interferes with the normal photosynthesis process by reducing the green area of the leaf.	• Foliar application of NSKE 5% (Neem Seed Kernel Extract). • Release *Cheilonenes sexmaculata* at 1250/ha. Or *Chrysoperla carnea* grubs at 5000 / ha.
6.	**Leafhopper** *Empoasca kerri*  Fig 2.4 Leafhopper	• Nymph and adults both suck sap from the underside of the tender leaves. • Whitening of the veins is the initial sign of the attack of this pest. • Leaves tips become chlorotic (yellow) in critical V shaped and curl down wards.	• Intercropping with groundnut + pearl millet. • Foliar spray of NSKE 5% or imidacloprid 17.8SL @ 150 ml/ha or thiomethoxam 25% WG @ 100 g/ha or acetamiprid 20% SP @ 100 g/ha.
		Soybean	
1.	**Girdle beetle** *Oberea brevis* 	• This is a monophagous insect pest of soybean and attacked on the crop from germination to maturity.	• For the management of this pests use bird porches @ 10-12/ha, • Foliar spray of thiacloprid 21.7% SC @ 750 ml/ha or

	Fig. 2.5: Girdle beetle	• Both the grub and adult stages of this insect pest are destructive to the crop. • For the laying of eggs, the adult female makes two rings or girdles at a distance of 3 to 7 cm on the stem, branches, and petioles. As a result, the part of the plant above the girdle starts drooping and slowly dries up. • The full-grown grub cuts the stem from a height of 15-25 cm at the time of harvesting and feeds inside the stem and completely hollowing it out.	profenophs 50% EC @ 1250 ml/ha or chlorantraniliprole 18.5% SC @ 150ml/ha in 400-600 liter water.
2.	**Bihar Hairy Caterpillar,** *Spilarctia obliqua*	• Young larvae of this pest feed gregariously by scrapping chlorophyll content mostly on the under surface of the leaves. • In later stages the larvae eat the leaves from the margin. The leaves of the plant give an appearance of net or web.	• Collection and destruction of egg masses and early instar larvae is very helpful for the management of this pest. • Chemicals suggested for the management of girdle beetle is also effective for the management of Bihar hairy caterpillar.
3.	**Gram pod borer** *Helicoverpa armigera*  Fig. 2.6: Gram pod borer	• It is a polyphagous pest and attacked a variety of plants. • Larva is the damaging stage of this pest. • Early stage larvae feed on the leaves by nibbling the leaf tissues. Later they grow and cut the leaves causing defoliation of the plants. • During the flowering stage larvae feed on the flowers	• Install pheromone trap @ 5 trap/ha to monitor the gram pod borer. • Foliar spraying of chlorantraniliprole 18.5 SC @ 125 ml/ha or flubendiamide 39.35 SC @ 100 ml/ha or novaluron 10EC @ 500 ml/ha is effective for the management of this pest.

		however at the pod or capsule formation stage, they feed on the seeds from developing pods.	
4.	**Tobacco caterpillar,** *Spodoptera litura*  Fig. 2.7: Tobacco caterpillar	• This is a polyphagous insect pests and attacks all most all the major oilseeds crops. • This is a major problem in soybean, groundnut, sunflower, safflower and castor crops. • The activity of this insect pest is noticed from seed germination to crop maturity. • This pest is nocturnal in habit and hides on the surface of leaves or in the soil during the day.	• Set up pheromone trap @ 12 trap/ha to attract and kill the male moth. • Collect egg masses and gregarious larvae and destroy them. • Foliar spray of NSKE 5% or NPV @ 250 LE/ha with crude sugar 2.5 kg/ha at 7 days intervals or profenofos 50 % EC @ 1ml/l.
5.	**Termites,** *Odontotermes obesus, Microtermes obesi*	• Termites prefer sandy and red soils and live in termitaria (termite mounds). • The worker caste (other castes like the king, queen and soldiers do not take part in causing damage) causes damage by penetrating and hollowing the taproot, causing wilting and premature death of plants. • They also feed on pod-shell by removing the corky stuff between veins resulting in 'scarification, this makes them prone to invasion by soil fungi, *Aspergillus flavus* that produces aflatoxin.	• Frequent intercultural operations and irrigation of field before sowing. • Field sanitation, timely disposal of previous crop stables and undecomposed plant parts. • Seed treatment with imidalcoprid 600 FS @ 5ml/kg of seed • Application of fipronil 0.3% G @ 30 Kg/ha.

6.	**Whitefly,** *Bemisia tabaci*	• Both nymph and adults cause the damage by sucking the plant sap from under surface of leaves. • Infested plants showed yellowing and drying of leaves. Severe infestation results in premature defoliation, shedding of flowers and pods.	• Follow judicious irrigation management and nitrogenous fertilizer application to arrest the excessive vegetative growth and pest buildup. • Foliar spray of NSKE 5% or imidacloprid 17.8SL @ 150 ml/ha or thiomethoxam 25% WG @ 100 g/ha or acetamiprid 20% SP @ 100 g/ha are effective measures.
	Mustard		
1.	**Mustard aphid,** *Lipaphis erysmi*  Fig. 2.8: Mustard aphid	• This is the regular and most dangerous insect pest of mustard. • This pest is active from the last week of October to March. • Both nymphs and adults cause the damage by suck the cell sap from leaves, flowers and developing siliqua/pods. • They secrete honeydew on the leaves, which leads to the development of sooty mold, also known as black fungus.	• Early sowing before 15th October are escape the incidence of this pest. • Installation of yellow sticky traps. • Foliar spraying of NSKE 5% or imidacloprid 17.8 SL or thiamethoxam 25 WG @ 0.3 ml/l or clothianidin 50 WDG @ 0.2 ml/l of water is very helpful for the management of this pest.
2.	**Mustard sawfly,** *Athalia lugens proxima*	• This is the major insect pest of mustard and primarily causes damage during the crop's vegetative stage (October-November).	• Collection and destruction of larva and affected plant parts.

	 *Fig. 2.9: Mustard saufly*	• A black coloured larva (On touch the larva falls to ground and feigns death) of this pest feed at seedling stage of the crop by cutting irregular holes in leaves. • Damaged plants can be identified solely by the presence of the midrib. Severe attack of this pest may necessitate re-sowing of the crop.	• Use of an antifeedant made from bitter gourd seed oil. • Release larval parasitoid *Perilissus cingulator*.
3.	**Painted Bug,** *Bagrada hilaris*	• Both nymphs and adults use their needle-like mouthparts to pierce and suck sap from leaves, shoots, and developing pods/seeds, causing wilting and loss of plant vigor. • They also excrete a resinous substance that damages the pods.	• To manage this pest, delay the first irrigation until 3-4 weeks after sowing, as this can significantly reduce the bug population.
	Sesame		
1.	**Leaf webber***Antigastra catalaunalis*  Fig.2.10: Sesame leaf and capsule due to leaf webber and capsule borer	• The leaf webber and capsule borer, *A. catalaunalis* is the most serious and a regular insect pest of sesame. • The initial incidence of this pest usually noticed when the crop is 10 to 15 days old and continued till maturity. • The larvae of this pest feed all parts of sesame, except the roots. • In early stage of plant growth the caterpillar webbed the few top leaves and makes a leaf webb by webbing a few top leaves and feed inside.	• Early sowing in the Ist week of July is escape the major incidence of this pest. • Intercropping with sesame + green gram/black gram (3:3). • Erection of bird perches @ 40-50/ha. • Collection and destruction of leaf webbs, shoots, flowers and capsules. • Two foliar sprayings of profenofos 50 EC (2 ml/l) or spinosad 45

		• In the flowering stages the larvae bore in to the flower buds and flowers however at capsules stage bore in to the capsule and feed on the developing seeds.	SC (0.15ml/l) or chlorantraniliprole 18.5 SC (0.4 ml/l) or novaluron 10EC (2 ml/l) at 30 and 45 days after sowing is found effective for the management of this pest.
2.	**Til hawk moth or Sphinx moth,** *Acherontia styx*	• The adult moth is large reddish brown, robust thick set moth with a characteristic Death head mark (skull marking) on the thorax and violet yellow bands on the abdomen. • The damage is caused by the larvae which feed voraciously on leaves and defoliate the plants. • The moth is also harmful and known as honey robbers as it sucks honey from the honey combs in apiaries.	• Collection and destruction of caterpillars. • Spray NSKE 5%. • Chemicals suggested for the management of leaf webber and capsule borer is also effective for the management of hawk moth.
3.	**Gall fly** *Asphondylia sesami*   Fig.2.11: Affected	• The sesame gall fly is one of the most serious insect pests of sesame and also known as the sesame gall midge. • The female fly lays their eggs in the ovaries of the flower buds. After hatching of eggs, the larvae starts feeding, and the irritation caused by the feeding of the larvae resulting in the flower abortion or developing abnormal/malformed gall like buds up to 6 mm in diameter which in turn do	• Intercropping of sesame with pearl millet, mung bean, moth bean and groundnut (6:3). • Foliar spray of Neem seed kernels extract (5%) or Neem oil 2% (two rounds) or Neem gold and nimbicidine (5 ml/l).

	sesame capsule due to gall fly	not develop in to the seed capsule.	
4.	**Leaf Hoppers** *Orosius albicinctus*  Fig. 2.12 : Phyllody affected sesame plant and adult leafhopper	• Leafhopper is a serious pest of sesame and is known to transmit phyllody disease. • The phyllody affected sesame plants become stunted and the floral parts get modified into leafy structures bearing no fruits and seeds, causing yield loss up to 100 per cent.	• Intercrop sesame and pigeon pea in a 3:1 ratio. • Remove and destroy the phyllody affected plants. • Seed treatment with imidacloprid 600 FS (5 ml/kg seed) and two foliar sprays of NSKE 5% or thiamethoxam 25 WG @ 0.25 g/l or imidacloprid 17.8 SL @ 0.25ml/l is effective for the management of this pest .
Sunflower			
1.	**Head borer/ Capitulum borer** *Helicoverpa armigera*	• Head borer is one of the important pest of sunflower and cause considerable damage to developing grains in the head capsule. • The young larvae after hatching first attack on the tender parts of the plants like bracts and petals and later they attack on the flower heads. • Mature larvae mostly feed on the developing seeds. Star bud stage is the most preferred stage for the attack of this pest.	• Install bird perches @ 50/ha. • Install light trap @1/ha. • Release of egg parasitoid *Trichogramma* spp. and egg larval parasitoid *Chelonous blackburnii* to control head borer. • Foliar spraying of chlorantraniliprole 18.5 SC @ 125 ml/ha or flubendiamide 39.35 SC @ 100 ml/ha or novaluron 10EC @ 500 ml/ha is effective for the management of this pest.

2.	**Tobacco caterpillar** *Spodoptera litura*	• The freshly hatched larvae of this insect feed on the tender parts of the plants specially on leaves, shoots, bracts and petals. • Later, the larvae grow and spread in the field causing defoliation. The larvae also feeds on the developing seeds in capitulum and causing irreparable damage.	• Set up pheromone trap @ 12 trap/ha to attract and kill the male moth. • Foliar spray of NSKE 5% or NPV @ 250 LE/ha with crude sugar 2.5 kg/ha at 7 days intervals or profenofos 50 % EC @ 1ml/l.
3.	**Bihar hairy caterpillar** *Spilarctia obliqua*   Fig. 2.13: Adult female of Bhiar hairy caterpillar	• Young larvae feed gregariously mostly on the under surface of the leaves by scrapping of chlorophyll. Later caterpillars feed on leaves and defoliate the plants. Drying up of infected leaves and stunted plant growth is the main symptom.	• Collection and destruction of egg masses and early instar larvae is very helpful for the management of this pest. • Foliar spraying of NSKE 5% or nuclear polyhedrosis virus (NPV) @ 250 LE/ha or *Bacillus thuringiensis* var kurstaki @ 1000 g/ha or Chlorantraniliprole 18.5SC @ 125 ml/ha or Flubendiamide 39.35% SC @ 100 ml/ha or Novaluron 10EC @ 500 ml/ha.
4.	**Leaf hopper** *Amrasca biguttula biguttula*	• The nymph and adults both suck the plant sap mostly on the under surface of leaves. • The initial symptoms of leafhopper damage are yellowing of leaves. In case of severe infestation the leaves curl downwards. The leaf edges may turn light pinkish brown. The affected leaves become dry and drop down.	• Seed treatment with imidacloprid 600 FS (5 ml/kg seed) and two foliar sprays of NSKE 5% or thiamethoxam 25 WG @ 0.25 g/l or imidacloprid 17.8 SL @ 0.25ml/l is effective for the management of this pest .

Safflower			
1.	**Safflower caterpillar** *Perigea capensis*	• The injury is caused by the caterpillars which feed on the leaves and defoliate the plants. • The affected plants lose their vigour and become stunted.	• Intercropping with non-host crop like wheat. • Avoided excessive application of nitrogenous fertilizer • Spray indoxacarb 15% EC @ 0.3ml/l or Spinosad 45% EC @ 0.15ml/l as soon as the larvae noticed.
2.	**Safflower bud Fly,** *Acanthiophilus helianthi*	• The injury is caused by the maggots which feed upon the developing florets and thalamus as a result the flower buds fail to open. • The infested flower buds begin to rot and an offensive smelling fluid oozes at the apices giving a soaked appearance to the buds.	• Removal and destruction of the infected buds. • Foliar spraying of imidacloprid 17.8 SL @ 0.4 ml/l or thiamethoxam 25 WG @ 0.25g/l or clothianidin 50 WDG @ 0.2 ml/l
3.	**Safflower aphid,** *Uroleucon compositae*	• It is a regular and major pest on safflower. Both nymph and adult of this pests suck the sap from leaves, twigs, flowers and capsules. The affected plants loss their vigour and remain stunted and weak. They also secrete honeydew which favors the development of black sooty mould.	• Avoid delayed planting. • Foliar spraying of imidacloprid 17.8 SL @ 0.4 ml/l or thiamethoxam 25 WG @ 0.25g/l or clothianidin 50 WDG @ 0.2 ml/l or acetamaprid 20 SP @ 0.2 g/l at 15 days intervals depending upon the aphid incidence.
Niger			
1.	**Niger caterpillar**	• The pest is active in July-August	• Collect and destroy egg masses and early instars of caterpillar.

	Condica conducta	• Larvae of this pests feed on leaves and defoliate the plant.	• Install light traps to trap the adult.
2.	**Capsule fly** *Dioxyna sororcula*  Fig. 2.14: Niger capsule fly	• This is the most serious pest which directly affect the yield. • The female fly lay their eggs in the inflorescence inside the ovaries of disc florets by inserting its ovipositor. • The freshly hatched maggots feed on the contents of the developing seed, due to which the seed gets hollowed.	• Conserve Green bug (*Creontiades* sp) and mired bug (*Taylorilygus pallidulus*).
3.	**Aphids** *Uroleucon carthami*	• The nymphs and adults suck sap from the tender parts of the plant including leaves, shoots, flower and capitula. In severe infestation, the plants get stunted and seed production is adversely affected.	• Timely sowing of the crop, late sown crop suffer more. • Clean cultivation and crop rotation with non host crop. • Conserve predators lady bird beetle and chrysoperla
		Castor	
1.	**Castor semilooper** *Achaea Janata*  Fig. 2.15: Castor semilooper	• The castor semilooper is a regular and important pest of castor. • Both caterpillar and adult moth of this insect cause the damage. • The caterpillars are voracious leaf eaters and defoliate the plants within a short period of time. Caterpillar starts feeding from the edges inwards leave behind only the mid rib and the stalk.	• Installed pheromone and light traps • Release egg parasitoid *Trichogramma evanescens minutum* at 50000/acre and larval parasitoid *Microplitis maculipennis*. • Foliar spraying of NSKE 5% or chlorantraniliprole 18.5 SC @ 125 ml/ha or flubendiamide 39.35 SC @ 100 ml/ha or novaluron 10EC @ 500

		• The adult of this pest are fruit sucking moths and cause serious damage to citrus crop.	ml/ha is effective against this pest.
2.	**Castor Shoot and capsule borer,** *Conogethes punctiferalis*	• The shoot and capsule borer, is a serious pest of castor and attacking on castor crop at the time of flowering. • The damage is caused by the caterpillar, which bore into the shoots and capsules and cause extensive damage to the crop. • The attack of this pest is easily recognized by the presence of webbing of capsules along with excreta.	• Collection and destruction of infested shoots and capsules. • Intercropping of castor with cluster bean, cowpea, black gram, or groundnut (2: 1 ratio proportions). • Apply trichlorofon 5% Gr @ 8,000 g/acre or trichlorofon 5% dust @ 8,000 g/acre.
3.	**Slug caterpillar,** *Parasa lepida*	• Although called slug caterpillar but it is an insect larvae that cause severe damage to the castor crop. • The newly hatched larvae of this pest feed gregariously on lower surface of leaves leaving only the midrib and veins. • As the larvae grow they scattered and feed on the entire leaf and cause defoliation.	• Installed light traps to monitor and kill the adult moths. • Collection and destruction of all the stages of insect.
		Linseed	
1.	**Linseed gall midge** *Dasineura lini*	• This is a major insect pest of linseed. • The damaging stage of this pest is the maggot. • The adult female lays their eggs in the flower buds or flowers. After hatching of eggs, the tiny maggots feed on flower buds and flowers	• Hand picking and destruction of gall formed flower buds. • Foliar spray of Neem seed kernels extract (5%) or Neem oil 2% (two rounds) or Neem gold and nimbicidine (5 ml/l).

		tissues, injecting saliva that contains growth-regulating substances.	

Activities

Activity 1 - Identification of Insect of oilseed crops

Materials required – Pen, Notebook, Polythene Bag, Mobile etc.

Procedure

- Visit nearby oilseed crop field
- Note down the following observation:
    - Name of crop
    - Crop stage
    - Name of Insect
    - Stages of insect
    - Symptoms

Activity 2 - Identification of different life stages of insect pests of oilseed crops

Materials required – Pen, Notebook, hand lens, Charts or specimens showing different life stages, Mobile etc.

Procedure

- Visit nearby oilseed crop field
- Observe the different life stages of insect pests and note down the differences in size, shape and colours of : Eggs, Larvae, Pupae, Nymph, Adult

Activity 3- Demonstration of different cultural measures in Oilseed crops

Materials required – Pen, Notebook, Gloves, Spade, Rake, Khurpi.

Procedure

- Visit oilseed crops grown in your area
- Demonstrate cultural methods
    - Field sanitation using spade, khurpi, rake or other implement
    - Removal of weed plants
    - Removal of alternate host plant

Activity 4 - Demonstration of different mechanical measures in Oilseed crops

Materials required – Pen, Notebook, Gloves, Sticky Trap**,** Light Trap, Pheromone Trap

Procedure

- Visit oilseed crops grown in your area
- Observe leaves for egg masses and other stages of insect pests
- Hand collection and destruction of egg masses, small insect pests and affected plant parts.
- Use of physical barriers like nets or bags to prevent pests access
- Use different traps in field and note down following observations:
    - Number of insect pest trapped
    - Name of the insect trapped

Check Your Progress

Fill in the Blanks

1. IPM stands for _____ Pest Management.
2. FAO defined IPM in the year _____.
3. The Latin word "Quarantum" means _____.
4. White grub of _____ Crop feeds mainly on Roots and root nodules.
5. Phyllody disease of sesame is transmitted by _____.

Multiple Choice Questions

1. IPM aims to keep pest population below:
    a) Zero level
    b) Economic threshold level
    c) Maximum level
    d) Tolerance limit
2. Which is an example of biological control?
    a) Light trap
    b) Deep ploughing
    c) Release of Trichogramma
    d) Seed treatment

3. Mustard sawfly mainly damages the crop during:
   a) Germination
   b) Vegetative stage
   c) Harvest
   d) Storage
4. Whitefly causes damage by:
   a) Boring into stems
   b) Scraping roots
   c) Cutting seedlings
   d) Sucking plant sap
5. Seed treatment with imidacloprid is effective against:
   a) Termites
   b) Aphids
   c) Leaf miner
   d) Hairy caterpillar
6. Red hairy caterpillar is active mainly during:
   a) Summer
   b) Winter
   c) Monsoon
   d) Spring

Match the Following

Column A	**Column B**
1. Cultural control	a. Use of predators
2. Mechanical control	b. Plant quarantine
3. Biological control	c. Manipulation of sowing time
4. Legislative control	d. Light trap

Subjective Questions

1. Define Integrated Pest Management (IPM) and explain its importance.
2. Explain the nature of damage and management of mustard aphid.
3. Write a detailed note on insect pests of groundnut and their control measures.

Session 2: Diseases of Oilseed crops and their Control Measures

Oilseed crops are susceptible to disease, hence proper management of disease is an important for better crop production. Disease of oilseed crop can be manage based on symptom, causal organism and mode of transmission.

Components of Integrated Disease Management (IDM)

Integrated Disease Management (IDM) involves the combined use of different methods to control plant diseases in an economical and environmentally safe manner. The major methods include cultural, physical/mechanical, biological, and chemical approaches.

1. Cultural Methods

Cultural practices help prevent disease development by creating unfavorable conditions for pathogens.

- **Crop rotation** with non-host crops to break the life cycle of pathogens.
- **Use of certified, disease-resistant variety** to prevent introduction of seed-borne diseases.
- **Adjustment of sowing time and proper spacing** to reduce humidity and disease spread.
- **Field sanitation**, including removal and destruction of infected plant debris.

2. Physical / Mechanical Methods

These methods involve physical removal or destruction of pathogens and infected plant parts.

- **Removal** and destruction of diseased plants to prevent further spread.
- **Deep summer ploughing** to expose soil-borne pathogens to sunlight and heat.
- **Soil solarization** using polythene sheets to reduce pathogen population.
- **Hot water seed treatment** to eliminate seed-borne pathogens.
- **Use of clean tools and equipment** to avoid mechanical transmission of diseases.

3. Biological Methods

Biological control uses beneficial organisms to suppress plant pathogens.

- **Seed treatment with bio-agents** such as *Trichoderma spp.* to control soil-borne fungi.
- **Soil application of beneficial microbes** like *Pseudomonas fluorescens*.

4. Chemical Methods

Chemical control involves the use of pesticides in a safe and judicious manner.

- **Seed treatment** with recommended fungicides or bactericides before sowing.
- **Foliar spray of chemicals** at the initial stage of disease appearance.
- **Soil drenching** with appropriate chemicals to control soil-borne pathogens.
- **Vector control using insecticides** to manage virus-transmitting insects.

Important Diseases of Oilseed crops

A- Fungal diseases:

1. Leaf spots and Leaf blight:

Leaf spots, also called Tikka disease, show up first on the leaves about 30–60 days after sowing. You will see many small brown to black spots on the leaves; in early leaf spot, the spots start as tiny brownish marks on the top side of the leaf and often have a yellow halo (ring) around them, while in late leaf spot, the spots are darker, round and usually don't have a yellow ring and appear mostly on the lower side of the leaf. As the disease gets worse, these spots join together, the leaves may turn yellow, dry up and fall off early, and the plant weakens with fewer leaves. If very bad, the plant becomes sickly and gives lower yields

Control measures: To manage the disease field sanitation, eradication of infected plants, seed treatment with *Trichoderma harzianum* @ 10 gram per kg and use of resistant varieties such as Vamana, Naveen, GPBD-4, TNAU CO 6 and ALR-3 are effective measures. Foliar spray of Mancozeb or Chlorothalonil @ 2kg per hectare is also recommended.

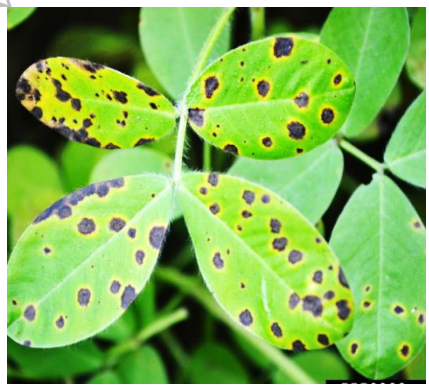

Fig. 2.16: Early Tikka spots

Fig. 2.17: Late Tikka spots

2- Alternaria leaf blight or Leaf spot (*Alternaria* species)

Alternaria leaf blight is a common disease seen in crops like mustard, groundnut, sunflower, sesame and others. The disease usually starts on the lower leaves as small, round brown spots. These spots slowly grow bigger and often show ring-like circles inside them. As the disease spreads, many spots join together to form large dry and dead areas, making the leaves look burnt (blighted). In severe cases, the leaves turn yellow, dry up and fall off early. Dark brown, long or round spots can also appear on stems and pods, and these spots may become bigger over time. Infected pods may produce small, shriveled and discolored seeds. The disease spreads more quickly in cool and humid weather, especially when there is frequent rainfall.

Control measures: To manage the disease field sanitation, eradication of infected plants, seed treatment with *Trichoderma harzianum* @ 10 gram per kg or Thiram @ 2 gram per kg seed are effective measures. Foliar spray of Tebuconazole 50% + Trifloxistrobin 25% @ 0.5 gram per litre (600 litre per hectare) is also recommended.

Fig. 2.18: Symptoms of Alternaria leaf spot on mustard and groundnut

3. Rusts (*Albugo candida*, *Puccinia* sp., *Melampsora lini*)

White rust is a common disease of mustard that usually appears during cool and humid months like December and January. The first sign of the disease is the appearance of small white or creamy raised spots (pustules) on the lower side of the leaves. These spots may join together to form larger white patches. As the disease becomes severe, it can spread to the whole plant and cause swelling and thickening of stems and flower parts. The infected flower buds become distorted and swollen, forming a structure called “stag head,” where the flowers look deformed and do not produce proper seeds. The plant may look unhealthy, weak, and may give a poor yield. The disease spreads faster in cool weather with high humidity and fog.

Control measures: To manage the disease field sanitation, eradication of infected plants, and use of resistant varieties as DRMRMJA 35, DRMR-2025 are effective measures. Foliar spray of Metalaxyl 8% + Mancozeb 64% WP @1000 g in 400 litres of water per acre is also recommended.


Fig. 2.19: White rust symptoms on leaf


Fig. 2.20: Stag head symptoms on mustard inflorescence

3.1. Rust of Groundnut: Rust of groundnut usually appears when the plants are about 6 weeks old. The disease mainly affects the leaves but can also be seen on stems and leaf stalks. The first symptom is the appearance of small brown to reddish-brown dusty spots on the lower surface of the leaves. These spots break open and release a powdery substance, making the leaf look rusty. On the upper surface of the leaf, small brown dead spots appear just above the dusty patches. As the disease becomes severe, many spots develop, the leaves turn yellow, dry up, and fall off early. In later stages, darker spots may also appear. Heavy infection makes the plant weak and results in small, shriveled groundnuts. The disease spreads quickly in cool, humid weather and during heavy rains.

Control measures: To manage the disease field sanitation, eradication of infected plant debris, and use of resistant variety as Utkarsh, ALR 3, VL-Mungphali-1, GJG 9 and GG 20 are effective measures. Foliar spray of Mancozeb @ 2 kg per hectare or Tridemorph 500ml or Chlorothalonil @ 2 kg/ha. is also recommended.

Fig. 2.21: Symptoms of Rust in Groundnut

3.2. Rust of Linseed: Rust of linseed appears as bright orange, powdery spots on the leaves, stems, and bolls, mostly on the lower side of the leaves. These orange spots look like small raised patches and can spread quickly over the plant. As the disease becomes older, the orange spots turn dark brown or black. If the infection happens early, the leaves may dry up and fall off completely, making the plant weak. Severe infection reduces the growth of the plant and results in low seed yield. The disease spreads mainly through wind, and it develops more in cool and humid weather.

Control Measures: Destruction of plant debris from the diseased field.Seed treatment with Oxycarboxin and foliar spray of fungicides like, Dithane M-45 or Cuman L are effective measures.

Fig. 2.22: Symptoms of Linseed rust

4. **Stem rot/ Collar rot/ Root rot** (*Sclerotium rolfsii, Sclerotinia sclerotiorum, Aspergillus niger, Macrophomina phaseolina):*

4.1. Foot/Root rot or Collar rot of Groundnut: Foot rot of groundnut is a serious disease that starts near the base (collar region) of the plant, close to the soil. The first sign is the sudden drying of one branch or the whole plant, especially the parts touching the soil. The leaves turn brown and dry but remain attached to the plant. Near the base of the stem, you can see a white cotton-like growth spreading on the stem and nearby soil. As the disease spreads, this white growth becomes more visible around the lower part of the

plant, and the plant may completely wilt and die. The developing pods may not grow properly, and infected pods often rot in the soil. The disease spreads more in warm, wet weather with high humidity and waterlogged soil.

Control measures: To manage the disease deep summer ploughing, field sanitation, eradication of infected plant debris, and use of resistant variety as CS-19, NRCG-CS-319, KRG-1, J-11, GPBD-4, and Kadiri-9 are effective measures. Foliar spray of Mancozeb @ 2 kg per hectare is also recommended.

Fig. 2.23: Symptoms of Collar rot disease in groundnut

4.2. Seedling blight or crown rot of Groundnut: This disease can affect groundnut at different stages of growth. In the beginning, infected seeds may show black powdery covering and the inside of the seed becomes soft and watery, leading to seed rot. When the seed germinates, the young seedlings may develop small brown circular spots on the seed leaves (cotyledons). These spots spread to the stem and collar region (base of the stem), where brown, discolored patches appear. The affected area becomes soft and rotten, causing the seedling to collapse and die. A black fungal growth may be seen around the collar region. In older plants, large dark lesions develop near the soil level and spread upward, causing drooping of leaves and wilting of the whole plant. The disease is more common in hot weather, deep sowing, and dry soil conditions.

Control measures: To manage the disease deep summer ploughing, field sanitation, eradication of infected plant debris, seed treatment with *Trichoderma harzianum* @ 2g per kg seed and use of resistant variety as RG-510, Girnar-2, TG-37A, and GC-131-1 are effective measures. Foliar spray of Mancozeb @ 2 kg per hectare is also recommended.

Fig. 2.24: Symptoms of Crown rot disease in groundnut

4.3. Charcoal Rot/ Black Rot or Macrophomona blight (Sesame & Soyabean): This disease first shows as yellowing of the lower leaves, followed by drooping and early falling of leaves. The stem near the ground level develops dark brown or black patches, and the bark around the collar region may look shredded or cracked. In severe cases, plants may suddenly dry and die in patches in the field. If young plants are infected, the stem can be easily pulled out from the soil because the roots are rotten. When the disease spreads to the pods, they may open too early, and the seeds inside become small, shriveled, and black in color. The roots and lower stem often look dark and rotten. The disease becomes more serious in hot weather, dry conditions, and after drought followed by heavy irrigation.

Control measures: To manage the disease deep summer ploughing, field sanitation, eradication of infected plant debris and apply farm yard manure or green leaf manure @ 10ton per hactare or neem cake 150 kg/hactre. Seed treatment with *Trichoderma harzianum* @ 2g per kg seed or fungicide ike Homai @ 0.25 % of dry weight and use of resistant variety are effective measures. Foliar spray of Copper oxychloride @ 3 kg per hectare is also recommended.

Fig. 2.25: Charcoal Rot or Macrophomona blight of Sesame

4.4. Stem rot of mustard: Stem rot of mustard starts near the base of the stem, close to the soil. The first sign is the appearance of long, water-soaked

(wet-looking) patches on the stem near the crown region. Later, a white cotton-like growth develops over these infected areas, making the lower part of the plant look whitish from a distance. As the disease spreads, the stem becomes weak, shredded, and may rot, and the plant shows wilting, early drying, and premature ripening. In advanced stages, small brown to black hard bodies can be seen on the infected stem parts. The disease develops more rapidly in cool weather with very high humidity.

Control measures: To manage the disease deep summer ploughing, field sanitation, eradication of infected plant debris, crop rotation and seed treatment with *Trichoderma harzianum* @ 2g per kg or Thiram @ 1gram per kg seed are effective measures. Foliar spray of Mancozeb @ 2 kg per hectare is also recommended.

Fig. 2.26: Symptoms of Stem rot disease in mustard

B-Bacterial Diseases:

Bacterial diseases in oilseed crops like sesame, groundnut, mustard, soyaben and sunflower is caused by mainly three bacterial species that is *Xanthomonas*, *Pseudomonas*, and *Erwinia* species. Common symptoms are formation of "V" shaped water-soaked lesion on leaves surrounded by yellow halo are the peculiar symptoms. Other symptoms are leaf and stem blights, wilts, stalk rots, brown/black spots, wilting and oozing etc. These bacteria impacts yield through reduced germination, stunted growth, and shriveled seeds.

1. Bacterial blight of sesame: Bacterial blight of sesame is a serious disease that mainly affects the leaves, stems, and capsules. The disease starts as small, water-soaked spots on the leaves. These spots later turn dark brown or black and may have a yellow border around them. As the infection spreads, the spots join together and form large dead patches, causing the leaves to dry and fall off early. Dark streaks can also appear on the stems and branches, which may lead to breaking or drying of plant parts. In severe cases, the capsules may become infected, resulting in poor seed formation and low yield. The disease spreads quickly during rainy, warm, and humid

weather.**Bacterial leaf spot:** Bacterial leaf spot appears as small, round, water-soaked spots on the leaves. These spots gradually turn brown or black and may be surrounded by a yellow halo. As the disease becomes severe, many spots join together, causing the leaves to turn yellow, dry up, and drop prematurely. Sometimes, similar spots may also appear on stems and pods. The plant becomes weak and growth is reduced. This disease spreads easily through rain splash, wind, infected seeds, and farm tools, especially under warm and humid conditions.

Control measures: To manage the disease use of resistant varieties, field sanitation, eradication of infected plant debris, crop rotation are effective measures. Foliar spray of Streptomycin sulphate or Oxytetracycline or Streptocyclin @100 gram per hectare is also recommended.

Fig. 2.27: Bacterial Leaf spot symptoms on sesame and Soybean

C-Viral Diseases:

Viral diseases in oilseed crops like groundnut, mustard, and sunflower are caused by different viruses such as **Groundnut Bud Necrosis Virus, Turnip Yellows Virus, Turnip Mosaic Virus, Cauliflower Mosaic Virus, and Tobacco Streak Virus.** These diseases commonly show symptoms like mosaic patterns (light and dark green patches) on leaves, yellowing, stunted growth, and necrotic (dead) spots. Infected plants may also show leaf curling, vein clearing, vein banding, distorted leaves, and reduced size. The plants become weak and produce fewer flowers and seeds, leading to low yield. These viruses mainly spread through insects like aphids, thrips, whiteflies, and mites, and sometimes through infected seeds.

1. Bud necrosis of groundnut: Bud necrosis is a serious viral disease of groundnut. The infected plants show yellowing and mottling of leaves with ring-like spots, and the leaves may become distorted and smaller in size. The most important symptom is the death of the central bud (growing tip), which stops the normal growth of the plant. As a result, the plant becomes short, bushy, and stunted. In severe cases, flowers and pods do not develop properly,

causing heavy yield loss. The disease spreads mainly through thrips insects and becomes serious when insect population is high.

2. Soybean Yellow Mosaic Virus (SYMV): Soybean Yellow Mosaic Virus is a viral disease of soybean that causes clear yellow mosaic patterns on the leaves, where light yellow and green patches appear unevenly. Infected leaves may become small, wrinkled, and slightly curled, and the plant shows stunted growth. As the disease becomes severe, the whole plant may look pale and weak. Flowering and pod formation are reduced, and the pods that develop may have small or poorly filled seeds, leading to low yield. The disease usually spreads through insect vectors like whiteflies and sometimes through infected seeds, and it becomes more serious in warm weather when insect activity is high.

Control measures: For viral diseases use of resistant varieties, field sanitation, and eradication of weed hosts, crop rotation and spray of suitable insecticide for control of insect vectors are effective measures.

Grow grow resistant varieties, Infected plants should be removed and destroyed early to prevent further spread. Since viruses are mainly spread by insects like aphids, thrips, and whiteflies, controlling these insects is essential. Seed treatment with systemic insecticides before sowing helps protect young seedlings. During crop growth, spraying insecticides.

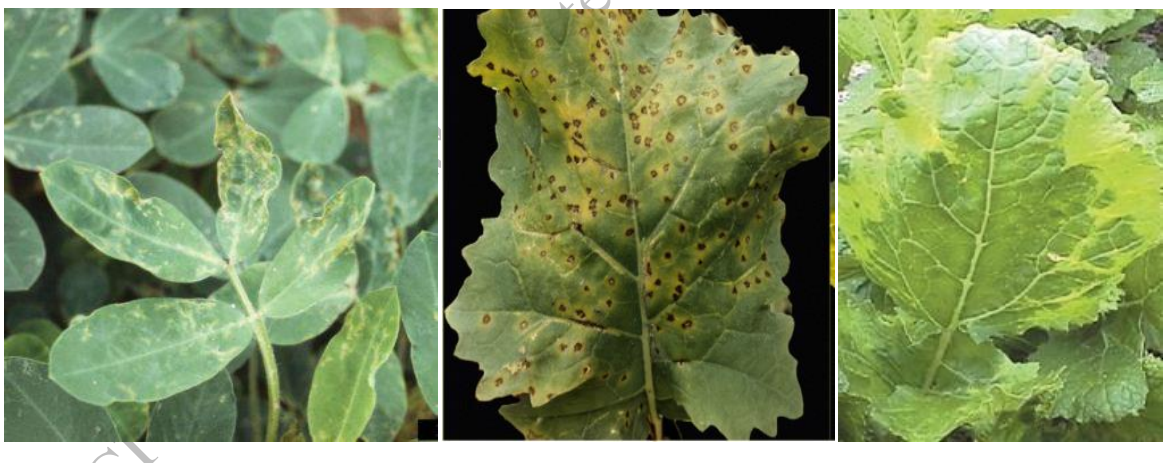

Fig. 2.28: Symptoms of Viral diseases of groundnut, soybean and mustard

Activities

Activity – Identify the disease samples of pulse crops.

Material required: Diseased samples of different Oilseed crops, Pen, pencil and notebook etc.

Procedure:

1. Collect the disease sample of different Oilseed crop
2. Note the following information.

- Name of the crop
- Name of disease
- Causal organism
- Control measures

Check Your Progress

Fill in the Blanks

1. Viruses are mainly spread by insects like aphids, thrips, and _____.
2. Infected plants should be removed and _____ early.
3. Seed treatment with _____ insecticides helps protect young seedlings.
4. Yellow sticky traps are used to monitor insect _____.

Multiple Choice Questions

1. Viral diseases in oilseed crops are mainly controlled by:

a) Irrigation

b) Fertilizer application

c) Prevention and vector control

d) Deep ploughing

2. Which insect is a major vector of viral diseases?

a) Termite

b) Whitefly

c) Earthworm

d) Beetle grub

3. Yellow sticky traps are useful for:

a) Killing rodents

b) Monitoring insect vectors

c) Harvesting

d) Threshing

4. Which of the following helps reduce insect population during crop growth?

a) Manual harvesting

b) Deep sowing

c) Flood irrigation

d) Spraying insecticides

5. Removing infected plants helps to:

a) Increase moisture

b) Prevent further spread

c) Improve soil fertility

d) Increase weed growth

6. Crop rotation is practiced to:

a) Reduce disease spread

b) Increase pest attack

c) Increase humidity

d) Delay harvesting

Match the Following

Column A	**Column B**
1. Certified seeds	a. Virus-free planting material
2. Yellow sticky traps	b. Monitor insect vectors
3. Imidacloprid	c. Systemic insecticide
4. Infected plants	d. Remove and destroy

Subjective Questions

1. Describe different component of integrated disease management in oilseed crops.
2. Describe two fungal disease of oilseed crop and its control measures.

Module 3: Harvesting, Processing and Marketing of Oilseed Crops in India

Module Overview

Proper harvesting, threshing, post-harvest processing and marketing are important aspects of oilseed cultivation for harnessing maximum benefit from cultivation of crop. It helps in minimizing field losses and maintaining the oil quality in the produce. Selection of appropriate method of harvesting and suitable machineries for harvesting and threshing implements can not only reduce the drudgery but also save the time and cost significantly thus help in enhancing the efficiency and profitability of oilseed cultivation and reduce dependency on imported edible oils in the country.

This module introduces students to the important post-production activities involved in oilseed crop cultivation, including harvesting, processing, and marketing. It highlights how proper post-harvest practices help maintain seed quality, reduce losses, and improve farmers' income. In Session 1, students will learn about the appropriate methods and timing of harvesting and threshing of oilseed crops to ensure maximum yield and quality. Session 2 focuses on the importance of post-harvest management, including drying, cleaning, grading, storage, and processing techniques to minimize post-harvest losses. Session 3 explains the classification of agricultural markets and different marketing channels through which oilseed crops reach consumers and industries.

Learning Outcomes

After completing this module, you will be able to:

- Explain the proper methods of harvesting and threshing of oilseed crops.
- Describe the importance of post-harvest management in maintaining quality and reducing losses.
- Classify different types of agricultural markets and explain the marketing channels for oilseed crops.

Module Structure

Session 1: Harvest and threshing

Session 2: Importance of post-harvest management

Session 3: Classify markets and marketing channels

Session 1: Harvest and threshing

Harvesting

The process of collection of mature plants along with pods/ capsules intact from the field either manually or with the help of machines like combine harvesters is called harvesting. Harvesting at the optimal time maximises the seeds and oil yield, whereas harvesting the crop before it reaches physiological maturity results in production of immature and shrivelled seeds with low oil content, reduce the keeping quality and can lead to development of mould and aflatoxin in the produce while over maturity results in shattering of seeds in the field.

Methods of Harvesting

Field conditions, crop under consideration and topography of the field play a crucial role in selection of method for harvesting the crop. Besides this several other factors including farm size, labour availability, and economic considerations also influence the choice of suitable harvesting method. Farmers with large size land holdings (>10 hectares) prefer mechanical harvesting depending upon the crop under consideration for higher efficiency, time saving and to achieve higher economic returns while small and medium size farmers rely either on manual method when family labour is available/ cheaper labour is available or on custom heiring services on payment basis for harvesting when labour is not available at cheaper prices.

1. Manual Harvesting

The most common method adopted by farmers for harvesting of oilseed crops in India is through manual method. The crop is harvested with the help of sickles, knives other sharp harvesting equipment in case of most of the oilseeds except in case of groundnut. Manual harvesting should preferably be done in the morning hours when the plants are damp due to presence of dew, this helps in reducing the shattering losses, in shattering prone crops like sesame, soybean and mustard.

2. Mechanical Harvesting

Mechanical harvesting is adopted in crops like soybean and mustard, cultivated in large scale by the farmers. Usually, combine harvesters or reapers are used for quick harvesting, avoid delay, reduce shattering losses, efficient harvesting and save money. Mechanical harvesting with combine harvester should be carried out when the crop attains full maturity for easy separation of seeds from the pods/capsules. Mechanical harvesting can be performed any time depending upon crop and field conditions.

3. Uprooting (for Groundnut)

This method is specifically employed in case of groundnut where crop is harvested by uprooting manually or with the help of diggers. The uprooted plants along with pods are kept for drying in the field for few days before pods are separated from the haulm to bring the moisture level appropriate for safe storage.

Method and Time of Harvesting for different oilseed crops

- **Groundnut:** The crop usually takes 100-120 days to mature in the field depending upon the variety cultivated. The crop should be harvested when the leaves turn pale yellow in colour and 70–75% of pods are mature; the inner shell of the pods turns dark brown and kernels are firm when pressed. The crop is harvested by uprooting or by digging and is kept inverted keeping pods exposed to sun after harvesting for proper drying in the field for 4-5 days.
- **Mustard and Rapeseed:** The crop usually takes 90-110 days to mature in the field depending upon the variety cultivated. The crop should be harvested when the leaves turn yellow and shed off and 70–75% of siliqua turn yellowish-brown and seeds begin to rattle inside the siliqua on shaking. The crop is harvested during morning hours with the help of sickles and spread in the threshing floor for drying for 4-5 days.
- **Soybean:** The crop usually takes 80-120 days to mature in the field depending upon the variety cultivated. The crop should be harvested when the leaves shed off and most of the pods turn yellow to brown and the kernels are firm when pressed. The crop is harvested either manually with the help of sickles or with the help of harvesters. The harvested produce should be kept in the sun after harvesting for proper drying in the field for 4-5 days before threshing.
- **Sunflower:** The crop usually takes 100-120 days to mature in the field depending upon the variety cultivated. Harvesting of the heads is done with the help of sharp sickle or knife when the back of the head turns lemon yellow. The heads are separated from the plant and kept on the stalk for drying in the field till the moisture content in the seed reaches 10–12% level.
- **Sesame:** The crop usually takes 90-110 days to mature in the field depending upon the variety cultivated. Harvesting should be done when the leaves turn yellow and the lower capsules turn yellow and the upper ones still remains greenish yellow. Over maturity should be avoided as the capsules begins to burst and shattering losses are there. The harvested crop is kept in stacks in sunlight for 4-5 days for drying before threshing to ensure easy separation of seeds from the capsules.

- **Safflower and Niger:** Harvest when majority of heads turn brown and dry the crop should be harvested.

Precautions in harvesting

- Harvesting should be avoided when it is raining and the relative humidity is high.
- The harvested crop should be properly staked in a clean, dry place for sun drying to prepare the produce for threshing.

Threshing

Threshing is the physical process of separating the edible seeds in pods, heads, or capsules from straw after harvesting and sun drying of the produce in the field or on threshing floor for few days (3-5 days) to reduce moisture content, facilitate easier seed detachment, avoid damage to seeds and to maintain high germination and oil quality in the seeds. Traditionally, manual threshing is done by beating the plants or by trampling by bullock but modern methods use mechanical threshers or combine harvester for quick separation of the seeds from the waste material effectively and economically.

Methods of threshing

(a) Manual Threshing- Manual threshing is the separation of seeds from their capsules, pods, or heads using physical force by hand or hand-held tools by small farmers following traditional systems. This method is labour intensive but suitable for small-scale farming. The common practices involving separation of seeds include

a. **Beating with Stick:** The harvested crop is spread on a clean hard threshing floor, canvas, or tarpaulin and beaten repeatedly with a pliable bamboo or wooden stick to extract the seeds without damaging them.
b. **Striking on Hard Surface:** the dried bundles of the crop are held by the stalks and repeatedly struck against a hard surface, such as a wooden platform or a metal drum to extract the seeds without damaging them.
c. **Trampling:** the harvested crop is spread on a clean threshing floor, and the crop is trampled either manually or under bullocks' foot to crush the pods and extract the seeds. Light tractors can also be used and run over the material for e extraction of seeds from crop in a small scale.

(b) Mechanical Threshing -The use of specialized machinery for quick and efficient separation of seeds from plant material is called mechanical threshing, this is more efficient and cheaper than manual threshing. Dried crop material is fed into the thresher fitted with specially designed rotating threshing drum with pegs, teeth or bars that beat the crop material resulting in bursting and forcing seeds out through the pods. The seeds are then further

screened and cleaned through sieves and separated from chaff and dust by blowers to enable to collect the clean seed. The various types of mechanical thresher include power threshers or multi-crop threshers, combine harvesters, groundnut pod strippers and sunflower seed extractors.

Precautions in threshing

- The produce should be properly dried before threshing for easy separation of seeds from pods.
- The physical force for threshing should be gentle enough to bring the seeds out of pods without minimal seed breakage to ensure proper germination of the seeds.
- The threshing equipment should be clean and free from other crop or variety seed to prevent admixture.

Activities

Activity – Visit the farmer field and observe the harvesting and threshing

Material required: Notebook, pen/pencil, camera/mobile (optional).

Procedure:

1. Visit a nearby farmer's field during the harvesting season.
2. Observe the harvesting and threshing operations carried out in the field.
3. Note the following information:
   - Name of the crop
   - Stage of crop at harvesting
   - Method of harvesting
   - Method of threshing
   - Tools or machines used
   - Time taken for harvesting and threshing
   - Precautions taken by farmers during harvesting and threshing

Check Your Progress

Fill in the Blanks

1. Over maturity of crop results in _____ of seeds in the field.
2. In groundnut, harvesting is done by _____ method.
3. Mustard crop is harvested when 70–75% of _____ turn yellowish-brown.

4. Sunflower heads are harvested when the back of the head turns _____ yellow.
5. Threshing helps to reduce _____ content for easy seed separation.

Multiple Choice Questions

1. Harvesting at optimal time helps to:
   a) Increase moisture
   b) Maximize seed and oil yield
   c) Increase shattering
   d) Reduce seed quality
2. Manual harvesting is preferably done in:
   a) Afternoon
   b) Evening
   c) Morning
   d) Night
3. Groundnut crop matures in about:
   a) 50–60 days
   b) 70–80 days
   c) 150–160 days
   d) 100–120 days
4. Sesame should be harvested when:
   a) Lower capsules turn yellow
   b) All capsules burst
   c) Leaves remain green
   d) Seeds fall on ground
5. Threshing is the process of separating seeds from:
   a) Soil
   b) Roots
   c) Straw and pods
   d) Leaves only
6. Beating with stick is a method of:
   a) Mechanical harvesting

b) Manual threshing

c) Mechanical threshing

d) Uprooting

Subjective Questions

1. Describe different methods of harvesting with advantages and limitations.
2. Discuss the method and time of harvesting of major oilseed crops.

Session 2: Importance of post-harvest management

The post-harvest management refers to the series of operations carried out after harvesting of the crop until its consumption or processing at the consumer level. Effective post-harvest management of oilseed crops is essential to reduce the quantitative and qualitative losses of the produce, and ensure better profitability. The clean seeds obtained after threshing of the crop should be sun dried to bring the moisture content in the produce to safe range (6–10%) for long term storage to prevent fungal attack and rancidity in the seeds. The properly cleaned, dried and graded seed should be stored in a cool, dry, and aerated warehouse. Adoption of scientific storage methods, pest control measures, and improved infrastructure will reduce the post-harvest losses and reduce dependency on imports of edible oil in the country. It includes drying, cleaning, grading, storage, transportation, processing, and marketing.

Post-Harvest Losses in Oilseeds

Oilseed crops are highly prone to post-harvest losses due to their high oil content, which makes them sensitive to moisture, temperature, pest infestation, fungal infection and aflatoxins. Post-harvest losses in oilseeds due to various factors are estimated to be around 10-15%, which includes both quantitative losses due to reduction in weight and qualitative losses due to decline in oil content, germination and taste.

Major Causes of Post-Harvest Losses

1. When the harvesting is delayed or the crop is over ripening seed shattering takes place in the field, making it difficult to collect the fallen seeds besides quality deterioration. It is often observed that during kharif season crop maturity coincides with late season rainfall resulting in sprouting of seeds in the pods itself or making seeds prone to fungal attack due to high moisture content or humidity.
2. Seeds containing higher moisture leads to fungal infection, rancidity, and aflatoxin contamination in crops like groundnut and sesame.

3. The damaged seeds during threshing and handling of the crop after harvesting are prone to infestation by store grain pest and fungal infections.
4. Use of old and not properly sanitized storage containers and bags containing insect pests.
5. Loose storage of seeds in the warehouse and improper storage infrastructure leading to high moisture and dampness resulting in qualitative deterioration.
6. Improper warehouse structures having cracks or holes, and have rough floor to allow pests and rodent attack in the stored material and causes damage.

Management of Post-Harvest Losses

Managing post-harvest losses in oilseeds involves timely harvesting, proper drying, safe storage, and efficient processing to reduce damage and spoilage. To reduce losses and maintain seed and oil quality, the following measures should be adopted:

1. Harvest the crop at physiological maturity to avoid shattering, fungal infection and reduce losses. Use of appropriate machines and tools to avoid physical damage to the seeds during harvesting, threshing, cleaning and packing.
2. The crop should be dried properly before storage or selling in the market. Seeds should be sun dried during the day time to bring the moisture content in the produce to 8 – 12 % level and the seeds should be stored in bags in the evening to prevent mould growth and spoilage during storage. Mechanical dryers or solar dryers can be used to dry the seeds under humid conditions.
3. The produce to be stored should be properly cleaned and graded before packing and keeping in warehouse to remove dirt, chaff, and broken seeds to reduce the possibility of pest infestation safe storage for longer duration and higher market value.
4. Store only clean, dry, and healthy seeds in moisture-proof containers in cool, dry, and well-ventilated warehouse.
5. Use clean, dry, and insect-free bags or improved seed storage containers viz. metal bins, Pusa bin, CAP storage, or modern silos instead of traditional jute bags.
6. Ensure storage facilities have no cracks or holes, and have a smooth floor to prevent pests and moisture from entering.

7. Regular periodical inspection of the warehouse should be done to check for pests, moulds, and moisture buildup in the storage.
8. Do not store new seeds lots with old ones in the warehouse as the old seeds might be affected by insect's pests and other infection.
9. Processing of the produce before storage for value addition and extending the shelf life of the produce.

Methods of Storage

Different storage methods are adopted based on the scale of cultivation and duration of storage.

(a) Traditional Methods: The method is suitable for short term storage of cleaned and graded produce. The produce is kept either in clean properly sanitized gunny bags or earthen bins and are kept in air tight godowns. The method is common in rural areas though it is less effective against damage due to moisture and pests during storage.

(b) Improved Methods: Improved seed storage methods are typically used for long term storage or storage on large scale for reducing losses from pests, mould, moisture, avoiding use of pesticides or fumigants during long term storage, preserving the nutritional and commercial value of the produce during storage. These include warehouses, silos, and cold storage facilities, which are designed to provide better protection against pests, diseases, and environmental factors. These structures typically include airtight and moisture proof metal bins or drums, bins made of galvanized iron sheets like pusa bin, poly lined bags, warehouses and cold storage and controlled atmosphere storage by modifying gas composition inside warehouse to limit insect activity and oxidation.

Optimum moisture level in seeds of different oilseed crops for safe storage

Safe and long-term storage of seeds in the warehouse depends upon the optimum moisture content in the seed for maintaining their viability, vigour, and quality during storage. It varies with the type of seed/grain to be stored, intended duration of storage and the storage environment. Proper moisture levels in the seeds inhibit biological activities that leads to spoilage and deterioration. Moisture content above 12% leads to a rapid decline in quality and longevity due to enhanced microbial activity, pest Infestation, germination of seeds in storage, increased respiration and heating in the store and accelerated aging and deterioration of the seeds. On the other hand, too low moisture content (below 4%) can also be detrimental to seeds causing damage due to extreme desiccation and hard seediness where the seed coat becomes impermeable to water, hindering proper germination even under optimal conditions.

Sr.No.	Crop	Moisture content in seed (%)	
		Short-term storage (< 1 year)	Long-term storage (>1 year)
1.	Groundnut	8–10%	4-6%
2.	Mustard	10–12%	6-8%
3.	Soybean	10-12%	6-8%
4.	Sesame	6–8%	4-6%
5.	Sunflower	6–8%	5-6%
6.	Safflower	8–10%	6-8%
7.	Niger	8–10%	6-8%

Storage Grain Pests of Oilseeds

Proper management of stored grain pests is important because they cause significant losses (10-15%) during storage by eating the seeds, contaminating them with waste, microorganisms, reducing the nutritional value and causes deterioration in quality, quantity and economic value. Hence, protecting the seeds and grains from pests in storage is important for preventing post-harvest losses. The major insects' pests attack stored oilseeds seeds are as under.

Crop	Common Name	Scientific Name	Nature of Damage
Soybean & sunflower	Pulse beetle	*Callosobruchus chinensis*	Bore into seeds
Groundnut	Groundnut bruchid	*Caryedon serratus*	Larvae bore into pods and kernels
Rice moth	All oilseeds	*Corcyra cephalonica*	Larvae web seeds together
Rapeseed, mustard	Mustard weevil	*Ceutorhynchus assimilis*	Feed on stored seeds
Oil cakes, stored seed	Red flour beetle	*Tribolium castaneum*	Feed on broken or powdered seeds
All stored seeds	Rodents and mites		Cause mechanical and contamination losses

Management of storage pests

Management of storage pests is important for preserving food safely, preventing economic losses, and protecting public health. Effective pest management ensures reduced post-harvest losses and minimizes the health risks associated with pest-borne diseases and mycotoxins. The various pest management options are as under

(a) Preventive Measures: Preventive measures are economical, ecological and non-chemical methods for managing storage pests because they reduce economic losses, prevent contamination, and protect public health by not allowing the pest to cause infestations in the storage. Key preventive strategies include proper drying, thorough sanitation of storage areas, use of clean godowns and equipment before storage, proper stacking and use of proper storage structures to create a less favorable environment for pests.

(b) Curative Measures: When preventive measures are not enough to take care of pest infestation in storage then curative measures are required for management of storage pest by controlling existing infestations, prevent further damage and contamination, and safeguard the quality and safety of stored food. The common curative methods include insecticidal treatments like fumigation with aluminium phosphide tablets, for eco-friendly pest control use of inert dusts like neem seed powder or diatomaceous earth and physical controls like exposure to heat kills insects or temperature modification to eliminate pests after they have appeared, thus preventing food spoilage, disease transmission and economic losses.

Activities

Activity – Enlist the Post-Harvest Losses and Identification of Storage Pests

Materials required: Samples of stored grains, hand lens/magnifying glass, notebook, pen/pencil, storage pest charts or pictures.

Procedure:

1. Collect samples of stored grains from a storage structure (godown, granary, or farmer's storage).
2. Observe the grains carefully for any signs of damage caused by storage pests.
3. Identify the pests with the help of charts or reference materials.
4. Note the following information:
    - Name of the stored crop/grain
    - Type of post-harvest loss observed
    - Name of the storage pest

- Nature of damage caused by the pest
- Control or preventive measures

Check Your Progress

Fill in the Blanks

1. Safe moisture content for long-term storage of oilseeds is about _____ %.
2. Post-harvest losses in oilseeds are estimated to be around _____ %.
3. Seeds with moisture above _____ % decline rapidly in quality.
4. Aluminium phosphide tablets are used for _____ in storage.

Multiple Choice Questions

1. Post-harvest management includes:
   a) Irrigation
   b) Sowing
   c) Drying and storage
   d) Ploughing
2. Aflatoxin contamination is common in:
   a) Wheat
   b) Groundnut
   c) Sugarcane
   d) Cotton
3. Moisture-proof containers are recommended for:
   a) Field preparation
   b) Safe storage
   c) Sowing
   d) Irrigation
4. Rice moth larvae cause damage by:
   a) Cutting stems
   b) Webbing seeds together
   c) Sucking sap
   d) Boring roots
5. Traditional storage method commonly uses:

a) Silos

b) Cold storage

c) Gunny bags

d) Controlled atmosphere

6. Controlled atmosphere storage helps in:

a) Increasing moisture

b) Limiting insect activity

c) Promoting germination

d) Increasing respiration

Subjective Questions

1. What is the major causes of post-harvest losses in oilseeds?
2. Describe different storage methods and their advantages.

Session 3: Classify markets and marketing channels

Market

The word market is derived from the Latin word "marcatus" which means merchandise or trade or a place where buying and selling of goods is conducted. A market is a place or system where buyers and sellers come together to exchange goods or services for money. In agricultural context, it refers to all arrangements that facilitate the sale and purchase of farm produce such as oilseeds, grains, fruits, etc. Efficient market and well-developed marketing channels are essential for fair price realization, reduction in exploitation of farmers by middlemen, and strengthening the oilseed economy. There are three marketing functions involved in marketing of oilseeds, i.e., assembling, preparation for consumption and distribution. Marketing of any agricultural commodity depends on factors like the demand of the product at that time, availability of produce and storage etc. In modern day marketing a number of new concepts including direct marketing, FPO participation, and digital platforms (like e-NAM) are utilized to bring transparency and profitability in oilseed marketing by eliminating the role of middlemen and commission agents.

Some of the definitions of market are:

1. A market is the sphere within which price determining forces operate.
2. A market is area within which the forces of demand and supply converge to establish a single price.

3. Market means a social institution which performs activities and provides facilities for exchanging commodities between buyers and sellers.
4. Economically interpreted, the term market refers, not to a place but to a commodity or commodities and buyers and sellers who are in free intercourse with one another.

Components of Market

There are certain components which are essential for a market to exist, and these conditions must be fulfilled and thus termed as the components of a market. They play a significant role in marketing of agricultural produce by ensuring fair prices tom the farmers, access to quality produce to the consumers, and operating an efficient supply chain. These components ensure smooth exchange functions, like buying and selling; physical functions, such as storage, transportation, and processing; and facilitating functions, like providing market information and financing. The important components include

1. The existence of goods or commodity for transactions (physical existence is, however, not necessary)
2. The existence of buyers and sellers;
3. Business relationship or interaction between buyers and sellers; and
4. Demarcation of area such as place, region, country or the whole world.

Classification of Market

Markets can be classified on several bases, depending on the location, volume of transactions, type of products, time of transaction, and degree of competition. The produce may be sold directly in the market or it may be stored locally for some time before being sold in the market. The market may extend to a locality, village town, region or a country according to the demand of a commodity. The market may be a physical entity, or may be a virtual. It may be local or global, perfect and imperfect, daily, weekly, monthly or seasonal depending upon their existence and occurrence.

1-On the Basis of Place		
Type of Market	**Description**	**Example**
Village Market	Small markets in villages where farmers sell small quantities directly to consumers.	Local village fairs

Primary Market	Where farmers sell their produce to traders or commission agents soon after harvest.	Mandis or haats
Secondary or Wholesale Market	Where large quantities are sold by village traders to wholesalers or processors.	District-level APMC markets
Terminal Market	Large markets where final transactions occur for domestic consumption or export.	Mumbai, Kolkata, Delhi oilseed markets
International Market	Trade beyond national boundaries.	Export markets for sesame, groundnut oil, etc.

2-On the basis of time span of markets		
Type	**Duration**	**Example**
Daily Market (Very short period markets):	Operates for a few hours on daily basis, meant for buying and selling of highly perishable goods like fruits, vegetables, fish, milk, etc..	Local fairs, mandis These markets held for few hours on daily basis and are perishable commodities
Weekly (Short-period Market)	Operates at periodical or at weekly interval at a specified place and time, where both perishable and non-perishable foods can be traded.	Weekly haats
Seasonal (Long-period Market)	Permanent market where non-perishables produce like cereals, oilseeds and pulses are traded in large quantities.	Regulated APMC markets

3-On the Basis of Volume of Transactions	
Type	**Description**
Wholesale Market	Large-scale buying and selling transactions between traders or processors takes place in these markets for further processing and trading.

Retail Market	These are small-scale markets where farmers or retailers' sale ready to consume produce directly to the consumers.

4-On the Basis of Nature of Commodities	
Type	**Description**
Commodity Market	Trade in a single or related commodity group (e.g., oilseeds).
General Market	Trade in multiple types of commodities.

5-On the Basis of Degree of Competition	
Type	**Description**
Perfect Market	Large number of buyers and sellers; uniform prices.
Imperfect Market	Monopoly, oligopoly, or monopolistic competition; price variation common.

6-On the Basis of Regulation		
Type	**Description**	**Example**
Regulated Market	Operates under government rules to ensure fair trade and standard weights.	APMC markets
Unregulated Market	Operates without formal regulation; middlemen may exploit farmers.	Village or rural haats

Marketing Channels

Marketing channels are the ways through which goods and services are made available to the consumers. The task of distribution system is to meet the supply with the existing demand. All goods go through a series of channels of distribution before being delivered to final consumer, the channel of distribution depends upon the nature of goods in question and availability of produce will depend on the way your desired produce is being distributed.

It is the route taken by a product in its passage from its first owner i.e. producer to the last owner, the ultimate consumer. A marketing channel may be defined as the chain of intermediaries through whom the various food grains pass from producers to consumers and constitutes their marketing channels or it is the alternate routes through which a product flows from producers to consumers. The length of the channel varies from commodity to commodity, depending on the quantity of the produce to be distributed. In marketing, goods can be distributed using two main types of channels *viz.* direct distribution channels and indirect distribution channels.

Direct Distribution

A distribution channel is said to be direct when the product or service from the producer or manufacturer reaches directly to the consumer without involvement of any middlemen. This occurs, more often than not, with the sale of services. For example, in agriculture direct distribution takes place when the producer himself markets produce directly to the consumers. Such transaction takes place in products which needs little or no processing before marketing or in case of perishable produce which needs to be sold within a specified period of time such as vegetables, milk etc.

Indirect Distribution

Indirect distribution occurs when middlemen or intermediaries are involved in the distribution channel. In agricultural produce marketing and distribution, the intermediaries would be the farmer, local dealer who collects the produce from farmers, the wholesaler who collects or buys the produce from local dealers and sells it to retailers, and the retailer who sells the produce to the consumers. The larger the number of intermediaries within the channel, the higher the price is likely to be for the final customer. Depending upon the intermediaries involved in distribution, the channel of distribution may be

Factors considered while choosing a Channel:

1. Nature of the product.
2. Price of the product.
3. No. of units of sale.
4. Characteristics of the user.
5. Buyers and their buying units.

- Low priced articles with small units of sale are distributed through retailers.
- High price special items like radios, sewing machines etc are sold by manufactures and then agents.

- Public services like gas, electricity and transport are usually sold directly to the consumer.

Types of Marketing Channels (for Oilseeds)

Channel I: Direct Marketing - Producer → Consumer

This channel is common in village markets and is suitable for small-scale sales. It eliminates the middlemen and farmers get better prices by selling limited quantities of produce.

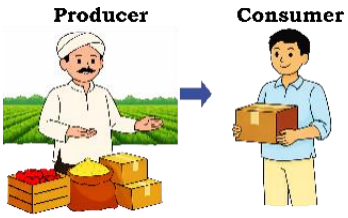

Fig. 3.1: Channel I

Channel II: Producer → Processor → Consumer

This channel is common where farmers sell their produce directly to the oil mills for processing. Produce like groundnut, mustard, and soybean are being traded by this channel. It ensures quick sale and steady demand.

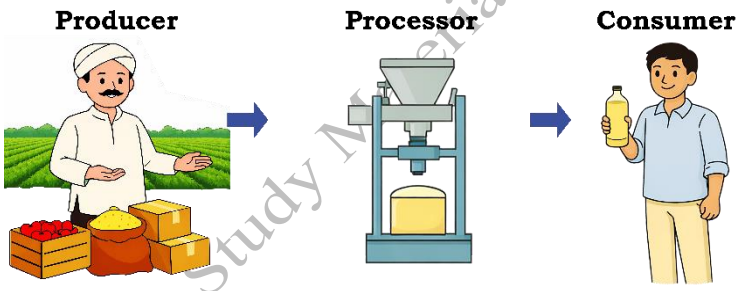

Fig. 3.2: Channel II

Channel III: Producer → Village Trader → Processor → Wholesaler → Retailer → Consumer

The traditional system for large-scale oilseed marketing where multiple intermediaries are involved. This channel reduces farmer's share in consumer price.

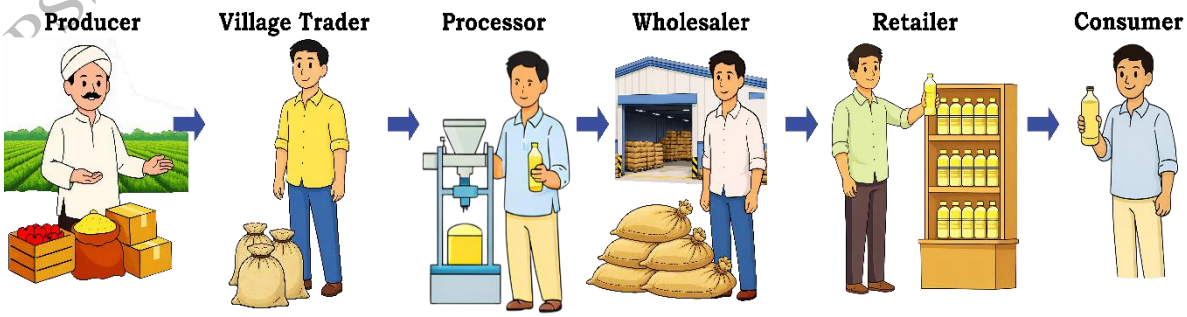

Fig. 3.3: Channel III

Channel IV: Producer → Cooperative Society/FPO → Processor → Consumer

Cooperative or farmer producer organizations (FPOs) help in collective marketing. The farmers gets better prices in consumer price and it reduces exploitation and improves bargaining power of the farmers.

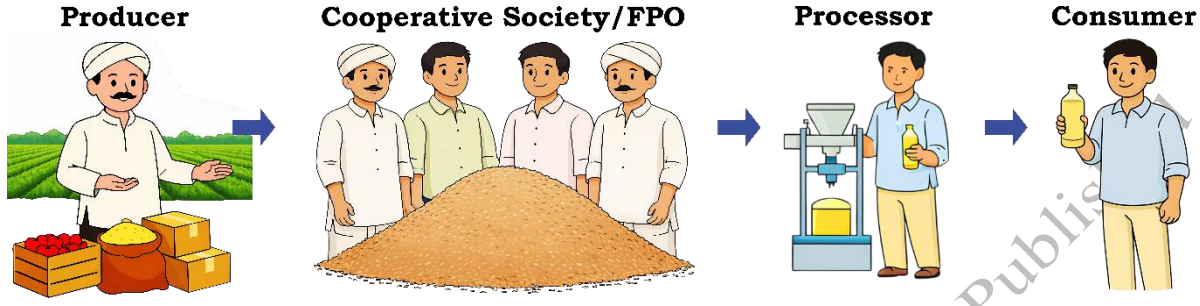

Fig. 3.4: Channel IV

Channel V: Producer → APMC Market → Commission Agent → Wholesaler → Retailer → Consumer

The most common organized system under regulated markets, ensures standard weights, fair price, and grading facilities.

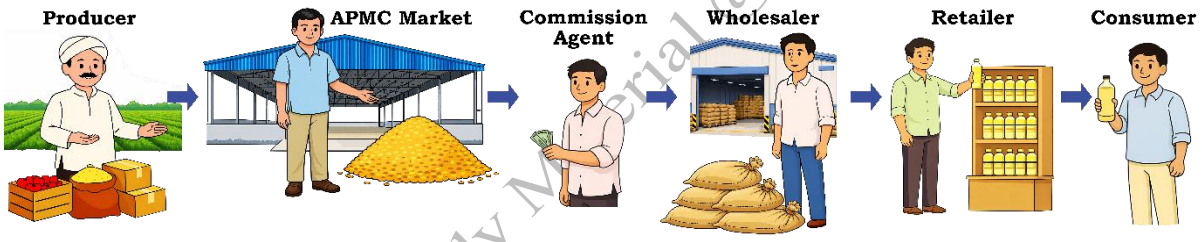

Fig. 3.5: Channel V

Factors Affecting Choice of Marketing Channel

- Distance from market
- Quantity and quality of produce
- Price offered and market information
- Storage and transportation facilities
- Farmer's financial condition and bargaining pow

Basic Market Information

We are living in era of information technology where global information's are shared live. Accurate and timely market information helps exporters, importers and traders to estimate the demand and making future decisions, it helps farmers in planning their cropping systems and thus forms the backbone of an efficient oilseed marketing system. Market Information refers to the systematic collection of current and historical data, analysis, and dissemination of data related to prices, supply, demand, arrivals, and other

market conditions that help stakeholders involved in marketing of agricultural commodities to take rational marketing and production decisions.

Importance of Market Information

Oilseed crops such as groundnut, soybean, rapeseed-mustard, sunflower, sesame, safflower, and niger play a vital role in India's agricultural and industrial economy. To ensure efficient marketing and fair price realization, accurate and timely market information is essential. It helps farmers, traders, processors, and policymakers make informed decisions on production, storage, processing, and marketing of oilseeds and their products and reduce risks, and stabilize prices. Strengthening digital market intelligence, real-time data sharing, and farmer access to information will play a key role in making India self-reliant in edible oils.

Farmers: Market information enables farmer and producers in strategic diversification and planting by using historical and real time data in line with projected consumer demand for specific crops and varieties. It also helps in making better decision to decide on when to sell, where to sell, negotiate with traders and enhances their market competitiveness on deciding in through whom they should sell based on price information to realize better returns.

Market middlemen (Traders): Middlemen can plan and make decisions for better purchases, storage, and sales by understanding market trends, price fluctuations, and supply and demand dynamics. It helps in mitigating risk involved in oilseed trading and make better decisions about when to sell or store goods and make more profits.

Policymakers: Market information provides a clear price signal from consumers to producers and helps policymakers to frame policy and helping to distribute products more efficiently between rural and urban areas. It is essential for the growth of the entire agricultural sector by linking production systems with supply chains and encouraging diversification and address challenges like funding infrastructure.

Sources of Market Information

Market information is collected and disseminated through several sources, both institutional and technological. Sources of market information are crucial in agriculture to draw informed decisions for farmers, traders, and policymakers, leading to greater efficiency and profitability. It improves price decisions, strengthens the agricultural sector, and supports commercialization and economic growth

Government Sources

1. **Directorate of Marketing and Inspection (DMI)** – Collects and publishes daily/weekly market reports.
2. **AGMARKNET (Agricultural Marketing Information Network)** – Provides online market price and arrival data from regulated markets (APMCs) across India.
3. **National Agricultural Cooperative Marketing Federation (NAFED)** – Provides data on procurement, prices, and arrivals of oilseeds.
4. **Department of Agriculture & Farmers Welfare (DA&FW)** – Publishes crop area, production, and price trends.
5. **Indian Council of Agricultural Research (ICAR)** and **Directorate of Oilseeds Research** – Provide market outlooks and policy recommendations.

Private and Institutional Sources

1. **Commodity exchanges** – e.g., NCDEX (National Commodity and Derivatives Exchange) provides futures prices of oilseeds and oils.
2. **Processing industries and oil mills** – Collect information on raw material supply and price movements.
3. **Trade associations and cooperatives** – Maintain local market records.
4. **Media and digital platforms** – Newspapers, television, and mobile apps give daily price updates.
5. **Farmer Producer Organizations (FPOs)** – Share collective market intelligence and forecasts.

Technological and Online Sources

- **e-NAM (National Agriculture Market):** Online trading platform integrating APMCs across states.
- **Kisan Call Centres and Mobile Apps:** Provide farmers with real-time price and demand information.

Demand and Supply of Oilseeds

The demand and supply of oilseeds are crucial for agriculture planning because they are a vital source of edible oils and protein, support a significant portion of the agricultural economy, and impact a country's food security and trade balance. This is particularly more important because India has a significant demand-supply gap in oilseeds, with demand growing faster than domestic production. Although, the production has increased to a record 41.35 million tonnes in 2022–2023, the country still depends on imports to the extent of over 57% of its edible oil requirements.

(a) Demand: Demand for oilseeds arises mainly from three sectors:

1. Edible Oil Consumption: Major share used for cooking and food processing industries.
2. Industrial Use: In paint, soap, cosmetics, and biofuel industries.
3. Export Demand: India exports sesame, groundnut, and castor oil to global markets.

(b) Supply: Supply of oilseeds depends on:

- Area under cultivation and yield levels.
- Seasonal and climatic factors (rainfall, temperature).
- Availability of inputs like seeds, fertilizers, and irrigation.
- Government policies on MSP, procurement, and imports.
- Post-harvest and marketing efficiency (storage, processing).

Relationship Between Demand and Supply

- When demand > supply, prices rise, encouraging farmers to expand oilseed cultivation.
- When supply > demand, prices fall, discouraging cultivation in the next season.
- Efficient market information systems help balance demand and supply through better planning and timely interventions (such as buffer stock, imports, or export incentives).

Activities

Activity – Visit Nearby Oilseed Market and Observe Different Marketing Mechanisms

Materials required: Notebook, pen/pencil, camera/mobile (optional).

Procedure:

1. Visit a nearby Oilseed market.
2. Observe the different activities involved in selling and buying Oilseed.
3. Interact with vendors or shopkeepers to understand the marketing process.
4. Note the following information:
   - Name of the Oilseed observed
   - Method of selling
   - Type of packaging used

- Price variation among different fruits
- Storage or preservation methods used by vendors

Check Your Progress

Fill in the Blanks

1. The word market is derived from the Latin word _____.
2. The existence of buyers and _____ is an essential component of a market.
3. A market may be physical or _____.
4. In a perfect market, there are a large number of buyers and sellers with _____ prices.
5. In direct distribution, the producer sells goods directly to the _____.

Multiple Choice Questions

1. Which of the following is a component of a market?
   a) Only storage
   b) Only transport
   c) Existence of goods
   d) Advertisement only
2. Which market operates for a few hours daily and deals mainly with perishable goods?
   a) Daily market
   b) Wholesale market
   c) Seasonal market
   d) International market
3. In which type of market is there monopoly or oligopoly?
   a) Perfect market
   b) Regulated market
   c) Retail market
   d) Imperfect market
4. Which organization provides futures prices of oilseeds?
   a) ICAR
   b) NCDEX

c) NAFED

d) DMI

5. When demand is greater than supply, prices generally:

a) Fall

b) Remain constant

c) Rise

d) Stop

Match the Following

Column A	Column B
1. Regulated Market	a. Small-scale sale to consumers
2. Retail Market	b. Operates under government rules
3. Wholesale Market	c. Large-scale transactions
4. e-NAM	d. Online trading platform

Subjective Questions

1. Explain the important components required for the existence of a market.
2. Describe different types of marketing channels used for oilseeds.
3. Discuss the importance of market information for farmers and policymakers.

Module 4: Maintain Health and Safety at Work Place

Module Overview

Different work places have different levels of challenges especially in terms of physical hazards inherent in the nature of work or the workplace. Workplace accidents deal a heavy, harmful, unfortunate & counterproductive impact on workers, their co-workers, and their families. They suffer pain, disability, stress and in some cases even loss of employment. Hazard is defined as a dangerous condition or event that portends or has the potential to cause injury, threaten life, damage property, etc. Hazards in agriculture include mechanical hazards, ergonomic hazards, chemical hazards, accidents, hazards related to the occupancy of confined places, occupational diseases and various other hazards arising from associated land, water and air. All efforts are necessary for personal safety of the workers and users of agrochemicals & farm machinery on ethical, health and professional grounds.

Accidents may occur while actually at work in the field, transporting animals and crops, or by falling, slipping, tripping, drowning, machinery hits or even bad/ unhealthy work practices. Hazards caused by human factors, such as those caused by awkward postures and damage to muscles and tendons, mainly due to poorly designed tools, are of common occurrence at agricultural farms.

This module introduces students to the fundamental concepts of oilseed crops and highlights their importance in agriculture, nutrition, and the economy. In Session 1, students will learn about the importance and scope of oilseed crop cultivation, including their role in farming systems, crop diversification, and contribution to national agricultural development. Session 2 focuses on the nutritional and commercial importance of oilseeds, emphasizing their value in human diets, edible oil production, industrial applications, and income generation for farmers.

Learning Outcomes

After completing this module, you will be able to:

- Explain the importance and scope of oilseed crop cultivation in agriculture and rural development.
- Describe the nutritional value and commercial uses of major oilseed crops.

Module Structure

Session 1: Safe Use of Agrochemicals

Session 2: Safe use of Agricultural Machinery

Session 1: Safe Use of Agrochemicals

Chemical hazards in agriculture are related to the dangerous pesticides during use, as well as in maintenance of plant protection equipment's and spraying of pesticides. The term 'pesticides' is indeed a non-specific and broad- based one, and includes as diverse group of chemicals as herbicides, fungicides, insecticides, nematicides, rodenticides, molluscicides, acaricides, plant growth regulators, and chemical fertilizers, commonly used in agriculture.

Harmful effects of agrochemicals

Majority of the pesticides can cause severe to very severe damage to central nervous system, kidney or cause increased risk of cancer. Initial symptoms may be variable and misleading such as muscular weakness, headache, dizziness and nausea. Continuous use of certain agrochemicals, especially pesticides with which our body comes in contact or is exposed, result in long term damage to organs like kidney, liver or the nervous and the endocrinal system inside our body.

Pesticides should not, but often do enter into food products due to following reasons:

- Indiscriminate and extensive use of chemical pesticides
- Non-observance of prescribed safety norms
- Discriminate or indiscrimate sourcing/use of unsafe or sub-standard pesticides
- Wrong advice and supply of pesticides to the farmers by vendors of agrochemicals.
- Leakage or lack of care in disposal of agrochemicals or its waste bye-products by manufacturers.
- Unclean or improper maintenance of the premises of agrochemical storage and preparation area by farmers
- Not using appropriate apparels necessary for personal safety of the field operators and many other factors.

a. Safety procedures in pesticide usage

Individuals who handle and use pesticides should review safety procedures on a regular basis. These are generally exhibited on pesticide container labels or in the literature provided with the market product.

Some important Do's and Don'ts:

- Read and follow label information and directions carefully
- While working with hazardous products, do wear clean personal protective equipment
- Do remove contact lenses before handling pesticides
- Do wash hands after you have handled or have had a contact with a pesticide especially & more so, before eating, drinking, smoking, or using the toilet after handling pesticide
- Do remove and wash off contaminated clothing and any spilled pesticide on an affected person.
- Do Shower and wash the hair and clean under-fingernails at the end of each day.
- Do take proper care in respect of pesticide as per toxicity labels marked on the pesticide packing.

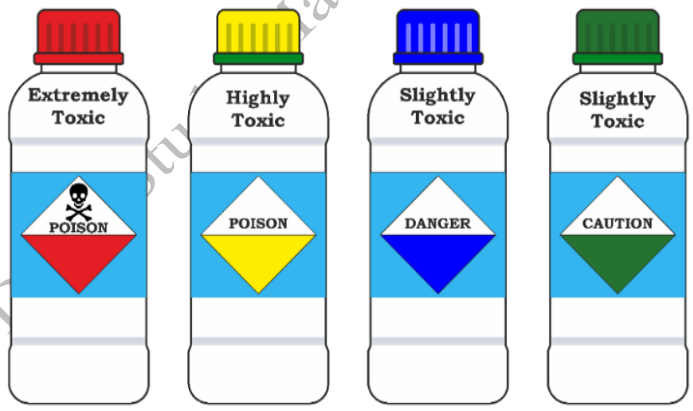

Fig.4.1: Labels of Colours showing toxicity of pesticide

b. Selecting and buying right Pesticides and in required quantity

Safety begins with choosing and buying a pesticide as per need only.

Carry out following check before buying a pesticide:

- Label shows the pesticide as approved for the intended use
- Pesticide can be used in an integrated pest management programme.
- Purchase just as much as is needed by carefully calculating on the basis of cropped or storage area to be covered.

- Read and follow the instructions that come with the agrochemicals.

c. Properly protecting oneself while using equipments

Several articles of personal dressing or covering are essential while using hazardous chemicals or working with powered machines, viz., rubber gloves, respiratory guards/filters, full overalls but not loose fitting (missing buttons/zips), etc.

Fig.4.2: Safety apparel for preparing spray solutions

d. Safety protocol for mixing or applying a pesticide

- Pesticides should be mixed and used at prescribed/recommended rates.
- Use pesticides under favourable weather conditions only; avoid bad weather.
- Don't use muddy unclean water for mixing with pesticide and for personal clean up.
- Whenever handling pesticides, clean water tanks should be nearby.
- Never smoke or eat in between or while mixing or applying pesticides.
- Some pesticide products are flammable. Take care against fire breaking out due to smoking or other use of matchsticks or fireplace.
- Read and follow the instructions on the user guide/label properly
- Use correct pesticide for the pest/disease for which it is meant

e. Use the recommended dose and quantity only

* For preparing the aqueous solution of the pesticide, use outdoor open space

- Use the recommended amounts and recommended dilutions strictly.
- Do not prepare larger amounts than are necessary for field application on a given day only; never try to store for possible future use.

f. During application of pesticides:

- Don't undertake pesticide spraying on a windy day.

- Position yourself in a way that the wind drift blows pesticide spray (or dust) away from your face.
- Before indoor spraying, close the doors and windows of hall/home.
- During the spray operation, keep the nozzle close to the target plants to avoid waste of solution by drift
- Spraying excess quantities will be wasteful and leave residual harmful amounts on the produce, which if consumed will be detrimental to the health of the consumer

While preparing spray solution of pesticide, try to stay away from an open well used to draw drinking water

Fig.4.3: Caution

Figure 4.4: Signage for pesticide applied at field

Cleaning and disposal of empty pesticide containers

Pesticide containers should be cleaned when emptied, removing pesticide residues before they dry. When emptying a pesticide container:

- For liquids, transfer the pesticide into a spray tank or mixing tank. Let the last drop get emptied. Use a strong nozzle to triple rinse or pressure rinse metal, plastic, or glass containers, unless otherwise instructed on the label.
- Likewise, for solids, gently shake the bag into tank or hopper until no loose foggy dust is visible. Gently single rinse bags if possible, unless otherwise instructed on the label.

Pesticide Disposal

Disposal of Concentrated Pesticide

Planning your pesticide purchases will minimize excess pesticide concentrates left over after an application or use season. Review records of prior applications. Use the pesticide that is on hand before buying more. Contact the pesticide manufacturer or a local vendor to be sure that old stocks are still effective.

It is best to prepare just the right quantity of pesticide concentrate or solution to avoid disposal problems. It is safer to prepare less quantity than to prepare excess which may have to be disposed of unsafely.

Unopened containers may sometimes be returned to the manufacturer or local dealer. Applicators can also contact the pesticide regulatory body for advice on proper disposal of unused pesticides. If excess quantities are left in storage, either use yourself or let a neighbouring farmer use it, if possible.

- Don't stockpile –buy and use as per need.

  If you must have to store pesticides, keep high enough out of reach of children. Do lock all pesticides in a cabinet in a well-ventilated utility area or farm shed.

Disposal of surplus tank mixture:

'Prevention is better than cure' has to be the guiding principle.

- Accurately measure the area to be treated
- Confirm application rates of agrochemicals
- Calibrate application equipment

Best if mixing tank is emptied by using up all the solution prepared. If there is still something left in tank mix at the end of an application, use it according to label directions on another area that requires the same pesticide.

First Aid, Treatment and Safety Equipment's

Accidents might happen in spite of all precautions and care. It is essential for the students to know about immediate medical aid for a chemical accident and to learn about the safety devices to prevent them.

Fig.4.5: First Aid Box

Chemical poisoning and first aid measures

Chemical poisoning may result from continuous contact, absorption through skin, inhalation of toxic vapour or swallowing it directly. Common symptoms of pesticide poisoning are headache, nausea, vomiting, tremors, convulsion, and difficulty in respiration. A first-aid kit with necessary antidotes should be available at work site for each type of poisoning. Antidotes are always mentioned on the pesticide containers.

Treatment for simple chemical poisoning

i. **Swallowed poison:** If the poison has been swallowed, induce vomiting immediately. Mustard oil or table salt in a glass of warm water is good for this purpose. Touching the throat internally with finger or any smooth, blunt and hard spatula will also induce vomiting. Vomiting process should be continued till clear liquid starts coming out of the stomach. If the patient goes into convulsions or in unconscious state, vomiting should be induced. If the poison is due to ingestion of mercury compounds, egg white and milk should be given first and then vomiting should be induced. At the end of inducing vomiting, soothing substances like raw egg white (mixed with water), butter or cream milk should be given.

I. **Skin contamination:** Contaminated clothes may at once be removed. Contaminated skin should be washed with soap and water also flushed with plenty of water to reduce the extent of injury.

II. **Eye poisoning:** Eyes of the victim may be flushed with plenty of water, keeping the eye-lids open. A quick decisive action is desirable, as a delay of a few seconds may greatly increase the extent of injury. Refer to an eye specialist immediately.

III. **Inhaled poisons:** The victim of inhaled poison should be immediately exposed to open area with fresh air. Keep the patient quiet as far as possible. Provide a blanket to avoid chilling. If breathing is stopped, artificial respiration technique through mouth may be used.

Safety and protective devices

Protective and safety devices will minimize chances of a major accident. The protective and safety equipment essentially include a gas mask, hand gloves, shoes, eye shields, head gear, protective clothing, respiratory devices, *etc.*

i. Gas mask: It is a device to protect the eyes and respiratory tract from toxic gases, and aerosols. It gives clean air to the operator by removing contamination from ambient air by using a filter or bed of absorbent material.

ii. Hand gloves: Always use rubberized waterproof gloves, not ones made of leather, cotton or any fluid-absorbing materials.

iii. Shoes: Shoes made of rubber or any synthetic waterproof materials are used instead of leather or canvas shoes.

iv. Eye shields -: Must be worn to prevent eye poisoning

v. Protective clothing: The skin should be protected by wearing an apron while working with treated crops. Wash clothing before reuse.

Fig. 4.6: Common PPE required for farm workers

Health and safety awareness in the workplace

- Encourage seniors to keep an eye on those working at the workplace.
- Use charts and visuals to demonstrate commitment to health and safety.
- Safe work practices, discouraging unsafe work practices.
- Even at the cost of repetition, do communicate that safety is of prime importance while at work.
- Those new to undertaking spray or pesticide applications, must be supervised or advised to report immediately, any adverse developments concerning health of the operator.
- Respond and act promptly to all health and safety concerns.
- Set example in use of all preventive and protective materials and practices.
- Keep children away from operational area or superwise them personally to ensure they are not close to a working machinery or handling devices and equipments for which they are not trained to use.

Amenities and environment

- Train all workers rotationally in use of first aid equipment and provide first aid kits at easily accessible points.
- Insist on first aid training for all field workers.

- There should be a free access to wash room and toilet facilities with running water or stored clean water.
- There should be free access to potable, clean and cool drinking water.
- As far as possible, take steps to prevent entry of poisonous creatures like scorpions, snakes, leeches, *etc.*
- Don't keep flammable materials in large quantities or in easily approachable/accessible areas prone to fire hazard.

Emergency response

- Train a task force for emergency response action for the workplace (e.g. snakebite, fire, confined space entry, heat stress or chemical spill).
- Keep safety awareness level of workers high at all times.
- Maintain emergency response equipment.

Manual tasks for personal safety

- When and where required, use appropriate restraint systems.
- Take care to avoid crush injuries to hands.
- When and where possible use aids to lift or move down/injured animals.
- Try and minimise risk of slips, trips and falls; provide non-slip flooring.

Activities

Activity- Demonstration of safety devices and measures to be followed.

Materials Required: First-aid kit, Gas mask, Protective clothing, Eye shields, Hand gloves, Shoes and pictorial charts.

Procedure:

1. Identify the different types of protective devices used while handling and applying chemicals.
2. Understand their use through pictorial charts.
3. Identify and understand about each item and its uses.
4. Discuss about different types of chemical poisoning. What are the immediate symptoms?
5. Demonstrate the use of different protective devices.
6. Prepare chart showing different protective devices and their use.

Check Your Progress

Fill in the Blanks:

1. To induce vomiting _____and _____can be used.
2. On contaminated skin _____ should be done.
3. To protect eyes and respiratory tract from toxic gases _____is used.
4. Hand gloves made up of _____should are used to handle chemicals.
5. For inhaled poisons first aid can be_____.

Multiple choice questions:

1. Common symptoms of pesticide poisoning are:

(a) Headache

(b) Vomiting and Nausea

(c) Difficulty in respiration

(d) All of these

2. To prevent hazards at working place following materials should be ensured:

(a) SDS

(b) First aid kits

(c) Protective clothing

(d) All of these

3. Emergency services are comprised of:

(a) Ambulance

(b) Fire brigade

(c) Both a and b

(d) None of these

4. Potentially dangerous creatures around house and office buildings include:

(a) Lizards

(b) Snakes

(c) Spiders and Scorpions

(d) All of these

5. What safety measures are required during application of pesticides to the crop?

(a) Mixing of correct quantity of pesticide and clean water and spray during evening time

(b) Use of any type of nozzle and spray mixture

(c) Spraying of insecticides with flat nozzle against the direction of wind

(d) Spraying at any time during the day

6. What safe pesticide handling practices are required to be followed by the farmers?

(a) Wearing clean personal protective equipment (PPE)

(b) Wash hands with clean water before any activity which involves food intake or use of area around mouth, eyes, nostrils, etc.

(c) If an insecticide or its solution happens to fall on the clothing or body of an individual, give a proper wash to remove the pesticide as completely as possible

(d) All of the above

Subjective questions

1. What are the first aid treatment measures for chemical poisoning?
2. What protective devices are meant for protection in agriculture field?
3. Define agro-chemicals?
4. Discuss various types of harmful effects of agro-chemicals?

Match the Column

Column A	Column B
1. Eye	a. Rubber
2. Shoe	b. shield
3. Protective Clothes	c. Apron

Session 2: Safe use of Agricultural Machinery

Agricultural field operations today are dependent on various agricultural machinery, tools and equipment's. Use of machinery demands great care with all necessary safe guards.

The accidents associated with agricultural machineries are caused due to the following reasons:

- Lack of adequate or proper training to operators
- Poor maintenance of tools and machinery
- Using a machine that is not right or suitable for the task at hand
- Failure in following proper norms of a safe system of work
- Failing to follow safe operating or 'safe stop' procedures
- Missing or defective safety devices or machine guards, thus exposing workers to accidents
- Unsafe methods for clearing blockages on the premises or for making adjustments.

Checking the tools and machinery before use

Before starting to work with a tool or machinery, one should carry out a check to make sure that it is in good working condition and is safe to use. While specific needs would vary with the machine to be used, basic checks must always be adopted/exercised:

Check the operator manual of the machine for pre-operative instructions and follow them as advised

- Particular attention is warranted to items like brakes, wheels, moving parts of machine (if openly visible) and tires of tractors/vehicles.
- Make sure that guards and protective covers are securely positioned so that these would not come out lose or allow catching loose articles or body parts
- Promptly repair or replace defective/damaged parts of machine, if any
- Stopping devices should be functioning correctly, e.g., brakes, emergency stops (electric switches).
- While coupling/engaging/attaching equipment or a part to machines, make sure that the coupling/attachment is properly fit and is of appropriate size/specification & is not lose. Don't use wrong/makeshift coupling devices/pieces.
- Vehicular type machines must have clear rear view mirrors and fit, fine, properly working reversing aids.
- If guards over moving parts of a machine are missing, get them fitted out and properly covered before using the machine

Daily/periodic mandatory inspections for use of machinery

1. Check water, fuel, fan belts, *etc.*
2. Inspect hydraulic lines for kinks, cracks and general wear & tear.

3. Once engine is running, check hand and/or air brakes, this ensures that brakes will hold while loading.
4. Inspect the cracks in the metal which may cause equipment to break or parts may come off unexpectedly.
5. Keep a safe distance from the equipment when loading or unloading.
6. Take care if there are any overhead power lines, particularly during loading and offloading or while lift-removing of produce or materials.
7. Do discuss any unsafe actions that come to notice of supervisors so that preventive measures can be taken.

Safety precautions during harvesting and threshing machinery

Guidelines to avoid accidents & enhance safety while at work:

- Familiarize yourself with safety risks & measures to overcome the same.
- Harvesting and threshing machines are most prone to debilitating accidents, *viz.*, crushing, cutting, seizing of body parts, especially hands, feet, trunk.
- Caution operators accordingly
- During field operations with moving vehicles, machinery with moving parts, handling a moving part of a machine, do ensure to wear tight clothing and head/hair cover to avoid entanglement.
- Never clean, maintain, adjust or clear jams when the machine is on.
- Stay clear of outlets, discharges, and all moving parts of machine.
- If equipment breaks down, don't just improvise, get it repaired.
- Avoid coming close to moving parts of a powered machine
- Don't leave a machine with engine running – never.
- Don't let children come near a machine while at work
- Don't refuel machine with engine running
- Don't let flammable articles or substances (like fuel, straw, *etc.*) close to working area or machine in operation
- Do not oil, grease, or adjust the machine during operation. Wait for engine & moving parts to come to a full stop before doing this. Remember, the feeding area of a thresher is the most dangerous. Do not let your hand or a loose sleeve of shirt enter feeding area of a thresher.

- Totally avoid working a petrol or diesel driven machine in a closed shed or garage. Exhaust fumes are dangerous to your health

Health and safety during Combine harvesting

Following points may be mentioned even at the cost of repetition as most of the steps are common to all the heavy duty machines with moving parts.

- Never attempt to lubricate, clean, adjust, or unplug harvesters when the machine or engine is running
- Do not allow anyone to climb onto the machine while it is in motion
- Keep children at a safe distance from the machine
- Always have a fire-extinguisher at hand on engine-operated equipment
- Ensure that the fuel system has no leaks
- While refueling, stop the engine and do not smoke
- When operating around machinery, wear work clothes that fit snugly.

Protective measures during operating machinery

Use of protective clothing is an extra measure of protection. All workers operating machines must wear protective clothing or personal protective equipment as a protection against accident/hazards. Also make sure that the protective dress is safe and fitting to body (not loose or with loose ends). Features of Protective dress and equipment:

- Good fit, appropriate and cleaned/well maintained.
- Safe and preventive storage to avoid damage, cuts, insect infestation
- No rough edges
- Overall body and coverage using overalls, aprons, vests, socks, gloves
- Avoid/prevent noise pollution while at work.
- Hard hats are always desirable for head protection
- Make sure protective clothing is available for different parts of the body.
- Kept clean, fully functional, and sanitized.

Activities

Activity- Demonstrate general inspections for use of the machinery.

Materials required: Different types of equipments, users guide, pen, and notebook.

Procedure:

- Identify and select the machinery
- Check the different parts of machinery
- Identify the open moving parts or feeding parts which pose hazard
- Check assembling of each part of the equipments
- Demonstrate use of machinery after inspection.

Check Your Progress

Fill in the blanks

1. During harvesting ensure that the operators should wear _____ and secure their _____to avoid entanglement.
2. Need to protect not to allow anyone to _____ onto the machine while it is in motion.
3. Operators must wear _____clothing.

Multiple choices question

1. What is necessary to check machinery before start**?**
   (a) Farm operations
   (b) Fill the fuel
   (c) check the tires
   (d) check the lights
2. What type of care is required to avoid any machinery accident?
   (a) Using a machine that is unsuitable for the task
   (b) Using unsafe methods for operations
   (c) Guards and other safety devices missing or defective
   (d) Using safe operating procedures
3. Which of the following safety precautions are necessary while refueling of tractor or other machinery?
   (a) Engine in running condition
   (b) Engine in off position
   (c) Engine in off and no open flame nearby
   (d) All of these

Subjective questions

1. Enlist the general inspections of the machinery before use.
2. Describe the health and safety during combine harvesting.
3. Describe the use of protective clothing during machinery operations.

Glossary

Aeration: The process of increasing the movement of air within the soil, which supplies oxygen to plant roots and soil microorganisms and improves root growth and soil biological activity.

Aflatoxin: A toxic substance produced by certain fungi that grow on oilseeds under high moisture and warm conditions, causing contamination and health hazards.

APMC (Agricultural Produce Market Committee) : A government-regulated market system that ensures fair trade practices, standardized weights, and transparent pricing for agricultural produce.

Assembling: The marketing function of collecting agricultural produce from different farmers or locations to prepare it for sale or further distribution.

Autocidal Control: A pest management method in which the pest species itself is used to reduce its population, usually by releasing sterile males that reduce reproduction.

Band Placement of Fertilizer: A method of applying fertilizer in narrow bands at a specified distance from the seed or plant roots to improve nutrient uptake and reduce losses.

Clods: Large lumps or masses of soil formed after ploughing or drying that need to be broken into smaller particles for proper seedbed preparation.

Combine Harvester: A machine that performs harvesting, threshing, and cleaning of crops in a single operation.

Commodity Market: A market where trade takes place in a specific type of commodity or a group of related commodities such as oilseeds.

Commission Agent: An intermediary who facilitates the sale of agricultural produce on behalf of farmers or traders in return for a commission.

Crop Residues: The remains of crops such as stalks, leaves, roots, and stubbles left in the field after harvesting.

Crop Rotation: The practice of growing different types of crops in a sequential order on the same land to improve soil fertility and reduce pest and disease incidence.

Direct Marketing: A marketing method in which producers sell their products directly to consumers without involving intermediaries.

Drainage: The removal of excess water from agricultural land to prevent waterlogging and to maintain favorable conditions for crop growth.

e-NAM (National Agriculture Market) : An online trading platform that connects different agricultural markets across India to facilitate transparent price discovery and trading.

Economic Injury Level: The pest population density at which the cost of damage caused by pests equals the cost of controlling them.

Farmyard Manure (FYM): A decomposed mixture of cattle dung, urine, bedding materials, and farm waste used as an organic fertilizer to improve soil fertility.

Farmer Producer Organization (FPO): A collective group of farmers organized to improve their bargaining power, access markets, and obtain better prices for their produce.

Field Sanitation: The practice of removing and destroying infected plant parts, crop residues, and weeds from the field to reduce pest and disease spread.

Fine Tilth: A well-prepared soil condition where the soil is loose, finely pulverized, and suitable for seed germination and plant growth.

Fungal Infection: A plant disease caused by fungi that affects plant growth, yield, and quality.

Furrow: A narrow trench or groove made in the soil by a plough or tillage implement for sowing seeds or irrigation purposes.

Grading: The process of sorting agricultural produce based on quality, size, or other standards to ensure uniformity in the market.

Indirect Marketing: A distribution system in which agricultural products pass through intermediaries such as traders, wholesalers, and retailers before reaching consumers.

Intercultural Operations: Agricultural practices carried out between crop rows during the growth period, such as weeding, loosening the soil, and fertilizer application.

Market: A place or system where buyers and sellers interact to exchange goods and services for money.

Market Information: Data related to prices, supply, demand, arrivals, and other market conditions that help farmers and traders make informed decisions.

Marketing Channel: The route through which a product moves from the producer to the final consumer through various intermediaries.

Mechanical Control: The reduction of pest populations through manual methods, tools, or machines such as traps, barriers, and hand collection.

Mechanized Farming: A farming system that uses machinery and equipment like tractors and implements to perform agricultural operations instead of manual labor or animal power.

Middlemen: Intermediaries involved in the buying and selling of agricultural products between producers and consumers.

Moisture Content: The amount of water present in seeds or grains, usually expressed as a percentage of their total weight.

Pesticides: Chemical substances used to kill or control pests including insects, weeds, fungi, rodents, and nematodes.

Pesticide Resistance: The ability of pests to survive exposure to pesticides that were previously effective in controlling them.

Pest Resurgence: The rapid increase in pest population after pesticide application due to the destruction of natural enemies.

Phenological Stage: A specific stage in the growth and development of a plant such as germination, flowering, or maturity.

Plant Quarantine: Legal measures taken to prevent the introduction and spread of pests and diseases from one region or country to another.

Post-Harvest Losses: The reduction in quantity or quality of agricultural produce after harvesting due to factors like pests, moisture, fungi, and improper storage.

Predator: An organism that feeds on other insects or pests and helps in naturally controlling their population.

Primary Market: A market where farmers sell their produce directly to traders or commission agents soon after harvesting.

Processor: An individual or industry that converts raw agricultural produce into processed products such as edible oils.

Pulverization: The process of breaking soil clods into fine particles to prepare a suitable seedbed for sowing.

Regulated Market: A market that operates under government supervision to ensure fair trading practices and protect farmers from exploitation.

Retail Market: A market where goods are sold directly to consumers in small quantities.

Seed Treatment: The process of applying chemical or biological agents to seeds before sowing to protect them from pests and diseases.

Seedbed: The prepared upper layer of soil where seeds are sown to ensure proper germination and early plant growth.

Shattering: The natural breaking or opening of pods or capsules at maturity resulting in the loss of seeds in the field.

Solarization: A method of controlling soil-borne pests and pathogens by covering moist soil with transparent plastic sheets to trap solar heat.

Supply: The quantity of a commodity that producers are willing and able to sell at a given price during a specific period.

Surface Runoff: The flow of excess rainwater or irrigation water over the soil surface when it cannot be absorbed by the soil.

Terminal Market: A large market where final transactions take place for consumption, processing, or export.

Threshing: The process of separating seeds or grains from the harvested crop plants.

Tilth: The physical condition of soil in relation to its suitability for planting and supporting plant growth.

Transplanting: The practice of transferring seedlings grown in a nursery to the main field for further growth.

Undulations: Irregular rises and depressions on the land surface that affect water distribution and field operations.

Weedicide: A chemical substance used to destroy or control unwanted plants or weeds.

Answer Keys

Unit 1, Session 1

Fill in the Blanks

1. Tillage
2. Primary
3. Retention
4. Secondary
5. 30–45

Multiple Choice Questions

1-b, 2-c, 3-b, 4-d, 5-c, 6-a

Match the Following

1 – b, 2 – c, 3 – a, 4 – d

Unit 1, Session 2

Fill in the Blanks

1. 40
2. Queen
3. 2.5–3.0
4. 3–5

Multiple Choice Questions

1-a, 2-c, 3-d, 4-c, 5-a, 6-d, 7-b

Unit 1, Session 3

Fill in the Blanks

1. 16–25
2. Linoleic
3. 5-6
4. 6.5–8.0

Multiple Choice Questions

1-b, 2-a, 3-c, 4-b, 5-d

Unit 2, Session 1

Fill in the Blanks

1. Integrated
2. 1967
3. Forty
4. Groundnut
5. Leafhopper

Multiple Choice Questions

1-b, 2-c, 3-b, 4-d, 5-a, 6-c

Match the Following

1 – c, 2 – d, 3 – a, 4 – b

Unit 2, Session 2

Fill in the Blanks

1. Whiteflies
2. Destroyed
3. Systemic
4. Vectors

Multiple Choice Questions

1-c, 2-b, 3-b, 4-d, 5-b, 6-a

Match the Following

1 – a, 2 – b, 3 – c, 4 – d

Unit 3, Session 1

Fill in the Blanks

1. Shattering
2. Uprooting
3. Siliqua
4. Lemon
5. Moisture

Multiple Choice Questions

1-b, 2-c, 3-d, 4-a, 5-c, 6-b

Unit 3, Session 2

Fill in the Blanks

1. 6–10
2. 10–15
3. 12
4. Fumigation

Multiple Choice Questions

1-c, 2-b, 3-b, 4-b, 5-c, 6-b

Unit 3, Session 3

Fill in the Blanks

1. Marcatus
2. Sellers

3. Virtual
4. Uniform
5. consumer

Multiple Choice Questions

1-c, 2-a, 3-d, 4-b, 5-c

Match the Following

1 – b, 2 – a, 3 – c, 4 – d

Unit 4 Session 1

Fill in the Blanks

1) Table Salt and Mustard Oil
2) Wash with soap
3) Gas Mask
4) Rubber
5) Artificial Respiration

Multiple Choice Questions

1.- d, 2.- d, 3.- c, 4.- d, 5.- a, 6.- d

Match the Following

1-b, 2- a, 3- c

Unit 4 Session 2

Fill in the Blanks

1. Tighen clothes
2. Climb
3. Protective

Match the Following

1-c, 2-d, 3- d

List of Credits

DAAH, PSSCIVE, Bhopal

Fig. 1.1
Fig. 1.2
Fig. 1.3
Fig. 1.4
Fig. 1.5
Fig. 1.6
Fig. 3.1
Fig. 3.2
Fig. 3.3
Fig. 3.4
Fig. 3.5
Fig. 4.1
Fig. 4.5
Fig. 4.6

Dr. Anand Kumar Pandey, CSAUAT, Kanpur, Uttar Pradesh

Fig. 2.10
Fig. 2.11
Fig. 2.12
Fig. 2.13
Fig. 2.14

Dr. Subha Trivedi, RLBCAU, Jhansi, Uttar Pradesh

Fig. 2.16
Fig. 2.17
Fig. 2.18
Fig. 2.19
Fig. 2.20
Fig. 2.21
Fig. 2.22
Fig. 2.23
Fig. 2.24
Fig. 2.25
Fig. 2.26
Fig. 2.27
Fig. 2.28

Creative Common

Fig. 2.1: https://shorturl.at/V8w0E
Fig. 2.2 : https://shorturl.at/gTJsi
Fig. 2.3 : https://shorturl.at/og2qB
Fig. 2.4 : https://shorturl.at/Ch0ro
Fig. 2.5 : https://shorturl.at/hqwYj
Fig. 2.6 : https://shorturl.at/6dVmL
Fig. 2.7 : https://shorturl.at/Guwlq
Fig. 2.8 : https://shorturl.at/PuGY4
Fig. 2.9 : https://shorturl.at/aFrR0
Fig. 2.15 :https://shorturl.at/JAcVH
Fig.4.2: https://goo.gl/ygxajB
Fig.4.3: https://goo.gl/uixDC7
Fig. 4.4: https://goo.gl/XzFfqn

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