B.Sc. AGRICULTURE LAB MANUAL

4th Semester

Prepared By

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Agriculture

MIDNAPORE CITY COLLEGE

Lab Manual: Crop Production Technology –II (Rabi Crops)

Title: Comprehensive Study on Rabi Crops: Sowing Methods, Weed Identification, Morphology, Yield Analysis, and Experiments

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- Definition and significance of rabi crops.
- Examples: Wheat, sugarcane, mustard, barley, and gram.
- Climatic requirements and suitable soil conditions.
- Importance in the agricultural economy.

2. Sowing Methods for Wheat and Sugarcane

Wheat:

- **Broadcasting:** Manual scattering of seeds; suitable for small-scale farms.
- **Line Sowing:** Use of seed drills for uniform spacing.
- **Zero Tillage:** No ploughing; direct sowing to conserve soil moisture.

Sugarcane:

- **Ridge and Furrow Method:** Planting setts on ridges; effective for drainage.
- **Trench Method:** Deep furrows for higher yields.
- **Pit Method:** Planting setts in circular pits; suitable for areas with high rainfall.

3. Identification of Weeds in Rabi Season Crops

- Common weeds in wheat: Wild oat (Avena fatua), Phalaris minor.
- Common weeds in sugarcane: Bermuda grass (Cynodon dactylon), Nutgrass (Cyperus rotundus).
- Use of manuals and herbarium for weed identification.
- Techniques for weed control: Manual, mechanical, and chemical methods.

4. Morphological Characteristics of Rabi Crops

- Detailed study of plant parts: roots, stems, leaves, flowers, and seeds.
- Examples:
    - **Wheat:** Hollow stem, alternate leaves, spikelet inflorescence.
    - **Sugarcane:** Jointed stem, sheath leaves, panicle inflorescence.

5. Yield-Contributing Characters of Rabi Season Crops

- Definition and importance of yield-contributing factors.
- Parameters to study:
    - Plant height, number of tillers, and grain weight for wheat.
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- **Yield Measurement:**
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Lab Manual: Production Technology for Ornamental Crops, MAP and Landscaping

I. Identification of Ornamental Plants

Objective:
To learn the process of identifying various ornamental plants used in landscaping and aesthetic gardening.

Materials Required:

- Field guidebooks on ornamental plants
- Digital camera for capturing plant features
- Identification chart (leaf shape, flower color, plant size, etc.)
- Notebook for observations

Procedure:

1. **Observation**: Begin by observing plants in a garden or nursery setting.
2. **Key Features for Identification**:
    - **Leaves**: Shape, size, color, arrangement (simple or compound).
    - **Flowers**: Color, symmetry, size, and structure (petals, stamens, pistils).
    - **Growth Habit**: Shrubs, vines, trees, or ground covers.
    - **Stem and Bark**: Texture, color, and branching pattern.
3. **Record Data**: Record the characteristics of each plant observed.
4. **Consult Guides**: Use plant identification guides or apps to verify your observations.
5. **Practice**: Identify plants in a local nursery or botanical garden, noting down their features and names.

Expected Outcome: By the end of the exercise, students should be able to recognize at least 10 ornamental plants based on key identifying features.

II. Identification of Medicinal and Aromatic Plants (MAPs)

Objective:
To familiarize students with the identification and classification of medicinal and aromatic plants used for various health and flavoring purposes.

Materials Required:

- Herbarium samples of MAPs
- Identification charts or field guides for medicinal plants
- Magnifying glass
- Notebook for record keeping

Procedure:

1. **Visual Observation**: Study the leaves, flowers, and stems of medicinal and aromatic plants.
2. **Identify Key Characteristics**: Focus on:
    - **Leaves and Flowers**: Shape, size, and arrangement.
    - **Aroma**: Smell the plant to identify aromatic characteristics (for aromatic plants).
    - **Uses**: Learn about the plant's medicinal properties or culinary uses.
3. **Verification**: Cross-check with books or online databases for accurate plant identification.
4. **Field Visit**: Visit a local garden or medicinal plant nursery to observe real-time examples.

Expected Outcome: Students should be able to identify at least 5 medicinal and aromatic plants by their morphology and uses.

III. Nursery Bed Preparation and Seed Sowing

Objective:
To understand the methods of preparing a nursery bed and sowing seeds for ornamental, medicinal, and aromatic plants.

Materials Required:

- Seeds of ornamental, medicinal, or aromatic plants
- Nursery soil (rich in organic matter)
- Watering can
- Measuring tools (ruler, spatula, trowel)
- Polythene sheets (optional for protected environment)

Procedure:

1. **Preparing the Nursery Bed**:
    - Choose a well-drained location with sufficient sunlight.
    - Clear the area of weeds and debris.
    - Loosen the soil and mix in compost or organic fertilizer.
2. **Seed Sowing**:
    - Measure the spacing between seeds according to the species.
    - Sow seeds uniformly in rows or scatter them lightly.
    - Cover with a thin layer of soil.
3. **Watering**:
    - Water gently using a fine nozzle to avoid disturbing the seeds.
4. **Care**:

- Maintain the moisture level in the soil.
- Monitor the bed regularly for pest infestation and weeds.

Expected Outcome: The students should be able to prepare a seedbed and sow seeds effectively, ensuring the optimal conditions for germination.

IV. Training and Pruning of Ornamental Plants

Objective:
To understand the techniques of training and pruning ornamental plants to enhance their growth and aesthetic appeal.

Materials Required:

- Pruning shears
- String and stakes (for training plants)
- Protective gloves

Procedure:

1. **Pruning Techniques**:
   - Identify dead or damaged branches and remove them.
   - Prune plants for shape, especially for hedges and topiaries.
   - Thin out overcrowded branches to improve airflow and sunlight penetration.
2. **Training Plants**:
   - Use stakes and strings to guide young plants or climbers to grow in a desired direction.
   - Regularly check the plant to adjust the ties and ensure no damage to the stems.
3. **Post-Pruning Care**:
   - Water the plant immediately after pruning.
   - Apply a balanced fertilizer to promote healthy regrowth.

Expected Outcome: Students should demonstrate proficiency in the pruning and training of ornamental plants for better aesthetics and health.

V. Planning and Layout of Garden

Objective:
To learn how to plan and design a garden space for ornamental and MAPs, taking into account space, light, and plant compatibility.

Materials Required:

- Paper or garden design software
- Measuring tape

- Plant catalogues (for species selection)

Procedure:

1. **Planning**:
    - Determine the size of the garden and its environmental conditions (sunlight, wind, etc.).
    - Choose plants based on their growth habits and aesthetic appeal (color, texture, etc.).
2. **Layout Design**:
    - Draw a scaled layout of the garden on paper, marking areas for ornamental plants, medicinal plants, and aromatic plants.
    - Consider plant heights, spread, and blooming seasons for visual harmony.
3. **Implementation**:
    - Dig beds according to the layout and transplant or sow the selected plants accordingly.

Expected Outcome: Students should be able to design and implement a basic garden plan that accommodates different types of plants harmoniously.

VI. Protected Structures – Care and Maintenance

Objective:
To understand the importance and maintenance of protected environments (like greenhouses) for plant growth, especially for medicinal and aromatic plants.

Materials Required:

- Greenhouse or other protected structure
- Temperature and humidity control devices
- Pruning and watering tools

Procedure:

1. **Setting Up**:
    - Install a greenhouse with appropriate heating, cooling, and humidity control systems.
    - Monitor light levels and adjust shading as required.
2. **Daily Maintenance**:
    - Check temperature and humidity levels daily.
    - Inspect for pests or diseases.
    - Water plants as needed.
3. **Ventilation**:
    - Ensure proper airflow to prevent fungal diseases.
    - Open vents in the early morning or late afternoon to regulate temperature.

Expected Outcome: Students will gain hands-on experience in managing a protected growing environment and maintaining optimal conditions for plant growth.

VII. Intercultural Operations in Flowers and MAP

Objective:
To perform various intercultural operations like weeding, mulching, and irrigation to promote healthy growth in flower and MAP beds.

Materials Required:

- Hoe or hand weeder
- Mulching material (e.g., straw, leaves)
- Irrigation system or watering can
- Fertilizers

Procedure:

1. **Weeding**:
    - Regularly remove weeds to prevent competition for nutrients and water.
2. **Mulching**:
    - Apply a layer of mulch around plants to conserve moisture, control temperature, and suppress weeds.
3. **Irrigation**:
    - Water plants using drip irrigation or overhead sprinklers.
    - Apply fertilizers as per the specific needs of the plants.

Expected Outcome: Students should learn how to properly maintain a healthy garden environment by performing intercultural operations.

VIII. Harvesting and Post-Harvest Handling of Cut and Loose Flowers

Objective:
To learn the techniques for harvesting cut flowers and MAPs, as well as handling and storing them to ensure quality preservation.

Materials Required:

- Sharp scissors or knives
- Clean buckets
- Flower preservatives
- Packaging material

Procedure:

1. **Harvesting**:

- Harvest flowers in the early morning or late afternoon when they are most hydrated.
- Cut flowers at the appropriate stage of bloom for maximum freshness.

2. **Post-Harvest Handling**:
    - Immediately place flowers in water to prevent wilting.
    - Use preservatives to prolong freshness.
    - Store flowers in a cool, dry place until sale or distribution.

Expected Outcome: Students should be able to harvest and store flowers properly to maintain their quality.

IX. Processing of MAP

Objective:
To understand the methods of processing medicinal and aromatic plants for various uses.

Materials Required:

- Drying racks or dehydrator
- Grinding mill (if necessary)
- Storage containers

Procedure:

1. **Drying**:
    - Harvest leaves, flowers, or seeds and dry them using air-drying or mechanical methods.
2. **Grinding**:
    - For some MAPs, grind dried material into powders for use in medicines or oils.
3. **Storage**:
    - Store dried plants in airtight containers, away from sunlight and moisture.

Expected Outcome: Students will gain an understanding of how to properly process medicinal and aromatic plants for long-term use.

X. Visit to a Commercial Flower/MAP Unit

Objective:
To observe and learn about the commercial production and processing of flowers and medicinal plants in a professional setting.

Procedure:

1. **Pre-visit Preparation**:
    - Research the commercial flower or MAP unit being visited.
2. **During the Visit**:

- Observe the cultivation practices, harvesting methods, and processing techniques.
- Ask questions regarding market trends and challenges in the industry.

3. **Post-Visit Reflection**:
   - Write a report on the visit, highlighting key takeaways and practical applications.

Expected Outcome: Students should gain real-world insights into the commercial aspects of flower and MAP cultivation and processing.

Lab Manual: Renewable Energy and Sustainable Technologies

Objective:

To understand the concepts, functioning, and applications of renewable energy technologies and their potential in various sectors, including agriculture. This manual provides step-by-step procedures for practical experiments and studies related to renewable energy systems.

Experiment 1: Familiarization with Renewable Energy Gadgets

Objective:

To study and understand the functionality of renewable energy gadgets used in daily life and industries.

Procedure:

1. Identify the various renewable energy gadgets available in the lab.
2. Note down their specifications, working principles, and applications.
3. Prepare a report summarizing their roles in sustainable energy development.

Observations:

- List the gadgets and their key features.
- Document observations with diagrams or photographs.

Conclusion:

Discuss the importance of these gadgets in promoting renewable energy usage.

Experiment 2: Study of Biogas Plants

Objective:

To study the design, components, and operation of a biogas plant.

Procedure:

1. Observe the working model or schematic of a biogas plant.
2. Identify the key components: digester, inlet tank, gas outlet, and slurry outlet.
3. Understand the process of anaerobic digestion and biogas production.

Observations:

- Record the type of feedstock used.
- Note the quantity of biogas generated and its composition.

Conclusion:

Evaluate the potential of biogas plants in waste management and energy production.

Experiment 3: Study of Gasifiers

Objective:

To understand the working principle and applications of gasifiers.

Procedure:

1. Study the construction and working mechanism of a gasifier.
2. Identify the types of gasifiers: updraft, downdraft, and fluidized bed.
3. Observe the process of biomass conversion to producer gas.

Observations:

- Note the efficiency and types of biomass used.
- Record the producer gas composition.

Conclusion:

Discuss the role of gasifiers in biomass energy conversion.

Experiment 4: Production Process of Biodiesel

Objective:

To study the process of biodiesel production from vegetable oils or animal fats.

Procedure:

1. Collect the required raw materials: oil, alcohol, and catalyst (e.g., NaOH).
2. Perform transesterification to produce biodiesel.
3. Separate biodiesel and glycerin layers.

Observations:

- Note the yield and quality of biodiesel.
- Record the reaction time and conditions.

Conclusion:

Analyze the feasibility of biodiesel as a renewable fuel.

Experiment 5: Study of Briquetting Machine

Objective:

To understand the operation and benefits of a briquetting machine.

Procedure:

1. Observe the working model of a briquetting machine.
2. Identify the feedstock materials suitable for briquetting.
3. Study the process of compacting biomass into briquettes.

Observations:

- Record the efficiency of the machine.
- Note the quality and size of briquettes produced.

Conclusion:

Highlight the advantages of briquettes in energy conservation.

Experiment 6: Production Process of Biofuels

Objective:

To study the production process of biofuels like ethanol and biodiesel.

Procedure:

1. Observe the raw materials and steps involved in biofuel production.
2. Note the fermentation and distillation processes for bioethanol.
3. Record the transesterification process for biodiesel.

Observations:

- Document the yield and properties of biofuels.

Conclusion:

Evaluate the potential of biofuels as sustainable energy resources.

Experiment 7: Familiarization with Solar Energy Gadgets

Objective:

To study the working and applications of various solar energy gadgets.

Procedure:

1. Examine the gadgets like solar water heaters, solar lights, and solar cookers.
2. Understand their working principles and installation requirements.

Observations:

- Note the efficiency and practicality of these gadgets.

Conclusion:

Discuss the role of solar energy in reducing dependency on conventional energy sources.

Experiment 8: Study of Solar Photovoltaic System

Objective:

To study the components and applications of solar photovoltaic (PV) systems.

Procedure:

1. Observe the setup of a solar PV system.
2. Identify the components: solar panels, charge controller, inverter, and battery.
3. Note the applications such as solar lighting, pumping, and fencing.

Observations:

- Record the output and efficiency under different conditions.

Conclusion:

Discuss the potential of solar PV systems in energy generation.

Experiment 9: Study of Solar Cooker

Objective:

To study the working of a solar cooker and its applications.

Procedure:

1. Observe the design and working principle of the solar cooker.
2. Test its performance by cooking simple food items.

Observations:

- Note the time required for cooking.
- Record the temperature achieved inside the cooker.

Conclusion:

Evaluate the feasibility of solar cookers in reducing fuel consumption.

Experiment 10: Study of Solar Drying System

Objective:

To study the operation of solar drying systems for agricultural produce.

Procedure:

1. Observe the design of a solar dryer.
2. Test its efficiency by drying selected items.

Observations:

- Record the drying time and quality of dried products.

Conclusion:

Discuss the advantages of solar drying in preserving agricultural produce.

Experiment 11: Study of Solar Distillation and Solar Pond

Objective:

To study the processes of solar distillation and the working of solar ponds.

Procedure:

1. Observe the design and functioning of a solar distillation unit.
2. Study the construction and working of a solar pond.

Observations:

- Record the output and efficiency of both systems.

Conclusion:

Highlight the potential of these technologies in water purification and heat storage.

Lab Manual: Problematic Soils and their Management

To study the chemical properties of problem soils, evaluate the quality of irrigation water, and determine the amendment requirements for saline, sodic, and acid soils.

Experiment 1: Determination of pH, EC, and ESP of the Saturation Extract of Saline Soil

Objective:

To measure the pH, electrical conductivity (EC), and exchangeable sodium percentage (ESP) of the saturation extract of saline soil.

Materials Required:

- Saline soil sample
- Distilled water
- pH meter
- EC meter
- Reagents for ESP calculation

Procedure:

1. Prepare a soil saturation paste using the saline soil sample and distilled water.
2. Extract the saturation extract by filtration.
3. Measure the pH of the extract using a pH meter.
4. Measure the EC of the extract using an EC meter.
5. Calculate the ESP using sodium adsorption values from the extract.

Observations:

- Record the pH, EC, and calculated ESP values.

Conclusion:

Discuss the soil's salinity status and its impact on crop growth.

Experiment 2: Determination of SAR and Gypsum Requirement of Sodic Soils

Objective:

To calculate the sodium adsorption ratio (SAR) and determine the gypsum requirement of sodic soils.

Materials Required:

- Sodic soil sample
- Distilled water
- Reagents for calcium and magnesium estimation
- Gypsum calculation chart

Procedure:

1. Extract the soil solution using a sodic soil sample.
2. Measure sodium, calcium, and magnesium concentrations in the extract.
3. Calculate SAR using the formula:
4. Use the SAR value to determine gypsum requirement from standard charts.

Observations:

- Record the SAR value and gypsum requirement.

Conclusion:

Discuss the reclamation needs of sodic soils for sustainable agriculture.

Experiment 3: Determination of Lime and Gypsum Requirements of Problem Soils

Objective:

To calculate the lime and gypsum requirements for the amendment of problem soils.

Materials Required:

- Acidic and sodic soil samples
- Reagents for lime and gypsum tests
- Standard charts for amendment calculations

Procedure:

1. For acidic soils, measure pH and buffer pH to determine lime requirement.
2. For sodic soils, use SAR values to determine gypsum requirement.
3. Follow standard laboratory procedures to calculate amendment quantities.

Observations:

- Record the lime and gypsum requirements for each soil sample.

Conclusion:

Highlight the importance of amendments in improving soil fertility.

Experiment 4: Parameters of Quality of Irrigation Water

Objective:

To evaluate the quality parameters of irrigation water, including pH, EC, SAR, and total dissolved solids (TDS).

Materials Required:

- Irrigation water samples
- pH meter
- EC meter
- Reagents for SAR and TDS determination

Procedure:

1. Measure the pH of the water sample using a pH meter.
2. Measure EC using an EC meter.
3. Calculate SAR using sodium, calcium, and magnesium concentrations.
4. Measure TDS using gravimetric or conductivity methods.

Observations:

- Record values for pH, EC, SAR, and TDS.

Conclusion:

Assess the suitability of the water sample for irrigation purposes.

Experiment 5: Determination of Lime Requirement of Acid Soils

Objective:

To determine the lime requirement of acid soils to neutralize their acidity.

Materials Required:

- Acid soil sample
- Buffer solution
- pH meter
- Lime calculation charts

Procedure:

1. Measure the initial pH of the acid soil sample.
2. Add a known quantity of buffer solution and measure the buffer pH.
3. Use the pH and buffer pH values to calculate lime requirement using standard charts.

Observations:

- Record the initial pH, buffer pH, and calculated lime requirement.

Conclusion:

Discuss the role of lime in improving the fertility of acid soils.

Lab Manual: Production Technology for Fruit and Plantation Crops

I. Seed Propagation

Objective:
To learn the techniques of seed propagation, focusing on the preparation, sowing, and germination of various seeds.

Materials Required:

- Seeds of fruit or plantation crops
- Seed trays or containers
- Well-draining potting mix or soil
- Watering can
- Plant labels
- Plastic covers (optional)

Procedure:

1. **Preparation of Soil**:
    - Choose a well-draining soil mix that is light and airy.
    - Fill seed trays or containers with the prepared soil mix.
2. **Seed Sowing**:
    - Space seeds according to the type of crop. Small seeds may be scattered on the surface, while larger seeds should be planted at a depth of 1-2 times their size.
    - Cover lightly with soil or sand to ensure the seeds remain in contact with moisture.
3. **Watering**:
    - Water gently with a fine nozzle to avoid disturbing the seeds. Maintain a consistent moisture level.
4. **Germination**:

- Place trays in a warm location with indirect sunlight.
- Maintain humidity by covering the trays with plastic or a glass cover.
- Monitor the seeds daily for germination and remove any unwanted weeds.

Expected Outcome: Students will understand how to propagate seeds and ensure their successful germination for growing fruit and plantation crops.

II. Scarification and Stratification of Seeds

Objective:
To learn how to improve the germination of hard or dormant seeds through scarification and stratification techniques.

Materials Required:

- Seeds with hard coatings (e.g., mango, citrus, or avocado)
- Files, sandpaper, or acid for scarification
- Containers or trays for stratification
- Moist sphagnum moss or sand
- Refrigerator (for stratification)

Procedure:

1. **Scarification**:
    - **Mechanical Method**: Use a file or sandpaper to nick or scratch the hard seed coat, taking care not to damage the seed itself.
    - **Chemical Method**: Immerse the seeds in a weak acid solution (such as sulfuric acid) for a few minutes to break the hard coating. Rinse thoroughly afterward.
2. **Stratification**:
    - Place seeds that require cold treatment in a moist medium (e.g., sphagnum moss or sand).
    - Store the container in a refrigerator at a temperature between 1-5°C for a specified period (usually 30-90 days, depending on the species).
    - After stratification, sow the seeds in trays or pots with appropriate soil.
3. **Germination**:
    - After scarification or stratification, follow the standard seed propagation method to initiate germination.

Expected Outcome: Students will understand the importance of scarification and stratification in improving seed germination for challenging species like fruit crops.

III. Propagation Methods for Fruit and Plantation Crops

Objective:
To explore various vegetative propagation methods for fruit and plantation crops, including cutting, grafting, and budding.

Materials Required:

- Healthy parent plant material
- Pruning shears or knives
- Rooting hormone (optional)
- Grafting knives
- Grafting tape or rubber bands
- Containers for rooting (for cuttings)
- Moist soil or growing medium

Procedure:

1. **Cuttings**:
    - **Stem Cuttings**: Take healthy stem cuttings, typically 4-6 inches long, and remove excess leaves.
    - **Rooting Hormone**: Dip the cut end into rooting hormone to promote root development.
    - **Planting**: Insert the cutting into a well-draining potting mix and water lightly.
2. **Grafting**:
    - Select a scion (young shoot) and rootstock (established plant) that are compatible.
    - Make a matching cut on both the scion and rootstock (e.g., wedge or tongue graft).
    - Join the two parts together and secure with grafting tape or rubber bands. Seal the graft to prevent desiccation.
3. **Budding**:
    - Choose a healthy bud from a desired cultivar and prepare the rootstock.
    - Make a T-shaped incision on the rootstock and insert the bud under the bark.
    - Wrap with tape to secure the bud in place.

Expected Outcome: Students will learn and practice different propagation techniques, such as cutting, grafting, and budding, to propagate fruit and plantation crops effectively.

IV. Description and Identification of Fruit

Objective:
To familiarize students with the identification, description, and classification of commonly grown fruit crops.

Materials Required:

- Samples of various fruits (mango, citrus, guava, banana, etc.)
- Magnifying glass
- Plant identification guidebook
- Field notebook for recording observations

Procedure:

1. **Examine the Fruit**:
    - Observe the fruit's size, shape, color, texture, and taste.
    - Take note of the skin, flesh, and seed characteristics.
2. **Identify Key Features**:
    - **Flowers**: Examine flower structure and determine if it is a complete or incomplete flower.
    - **Leaves**: Assess the leaf shape, size, arrangement, and venation pattern.
    - **Seeds**: Identify seed shape, size, and number.
3. **Classification**:
    - Use a plant guidebook or database to identify the fruit and classify it according to genus and species.

Expected Outcome: By the end of the lab, students will be able to identify and describe various fruit crops based on their morphological traits.

V. Preparation of Plant Bio-Regulators and Their Uses

Objective:
To understand how to prepare plant bio-regulators (growth hormones) and how they affect plant growth, particularly in fruit and plantation crops.

Materials Required:

- Auxins, gibberellins, and cytokinins (commercial preparations or natural extracts)
- Measuring equipment
- Water and mixing containers
- pH test kit (optional)
- Fertilizer solution

Procedure:

1. **Preparation of Bio-Regulators**:
    - Prepare a diluted solution of plant hormones (e.g., gibberellic acid for seed germination or rooting hormone for cuttings).
    - Mix the solution carefully, ensuring even distribution of the hormone.
2. **Application**:
    - For **cuttings**: Dip the cut ends of plant stems in rooting hormone before planting.
    - For **seed germination**: Soak seeds in gibberellic acid solution before sowing.
    - For **fruit set**: Apply cytokinin or auxin solutions to enhance fruit setting.
3. **Observation**:
    - Monitor the effects of bio-regulator treatments on plant growth, noting any differences in rooting, germination, or fruiting.

Expected Outcome: Students will gain hands-on experience in preparing and using plant bio-regulators to influence plant growth, propagation, and fruiting.

VI. Important Pests, Diseases, and Physiological Disorders of Fruit and Plantation Crops

Objective:
To learn to identify common pests, diseases, and physiological disorders that affect fruit and plantation crops and how to manage them.

Materials Required:

- Pest and disease samples (or photographs)
- Insect identification chart
- Hand lens or magnifying glass
- Neem oil, insecticidal soap, fungicides
- First aid kit (for safety)

Procedure:

1. **Pest Identification**:
    - Observe symptoms like leaf holes, discoloration, or webbing caused by pests such as aphids, caterpillars, or mealybugs.
2. **Disease Identification**:
    - Look for signs of fungal or bacterial infections, such as leaf spots, blights, or wilt.
3. **Physiological Disorders**:

- Diagnose issues like blossom drop, fruit rot, or nutrient deficiencies based on plant appearance and growth.

4. **Management**:

    - Apply appropriate pest control measures like organic insecticides (e.g., neem oil) or fungicides for disease control.
    - Use cultural practices like proper spacing, irrigation, and pruning to prevent disorders.

Expected Outcome: Students will be able to recognize and manage common pests, diseases, and physiological disorders affecting fruit and plantation crops.

VII. Visit to a Commercial Orchard

Objective:
To observe and learn the practical aspects of commercial fruit cultivation and orchard management.

Procedure:

1. **Pre-visit Preparation**:

    - Research the orchard's management practices (e.g., organic or conventional).
    - Prepare a list of questions regarding crop care, pest control, and harvest techniques.

2. **During the Visit**:

    - Observe various stages of fruit development and orchard care.
    - Speak with the farm manager or horticulturists about techniques used for propagation, pest management, and harvesting.

3. **Post-visit Reflection**:

    - Write a report summarizing observations and learning from the visit.
    - Compare commercial orchard practices to those learned in class.

Expected Outcome: Students will gain real-world insight into commercial fruit production, the challenges faced by growers, and the practical applications of the techniques they have learned.

Lab Manual: Principles of Seed Technology.

Seed Production in Major Cereal Crops

Objective:
To understand the processes involved in seed production for major cereal crops like Wheat, Rice, Maize, Sorghum, and Bajra.

Materials Required:

- Seed samples of wheat, rice, maize, sorghum, and bajra
- Field notebook
- Soil test kit
- Fertilizers
- Irrigation system
- Crop protection tools

Procedure:

1. **Wheat Seed Production:**
    - **Selection of Seeds**: Choose disease-free, high-quality wheat seeds from a certified source.
    - **Land Preparation**: Prepare the soil by ploughing and harrowing to create a fine seedbed.
    - **Sowing**: Sow seeds using a seed drill at the recommended depth and spacing.
    - **Irrigation & Fertilization**: Apply the required amount of water and fertilizers.
    - **Harvesting**: Harvest seeds when the wheat plant reaches physiological maturity. Ensure proper threshing and cleaning of seeds.
2. **Rice Seed Production:**
    - **Land Preparation**: Use puddled land for rice cultivation, ensuring proper irrigation.
    - **Seed Sowing**: Direct seeding or transplanting can be used depending on the variety.
    - **Crop Management**: Regularly monitor for pests and diseases. Apply fertilizers and water as needed.
    - **Harvesting**: Harvest rice at physiological maturity to maintain seed quality.
3. **Maize Seed Production:**
    - **Land Preparation**: Prepare well-drained, fertile soil.
    - **Seed Sowing**: Use a mechanical planter or hand sowing. Maintain recommended spacing between plants.

- **Crop Care**: Provide irrigation, apply fertilizers, and control pests and diseases.
- **Harvesting**: Harvest maize when the kernels reach the desired moisture content for seed storage.

4. **Sorghum Seed Production:**

    - **Land Preparation**: Prepare the field with proper soil tilth and weed control.
    - **Sowing**: Plant seeds at the correct depth and spacing to encourage healthy plant growth.
    - **Crop Care**: Regular irrigation, fertilization, and pest control should be done throughout the growing season.
    - **Harvesting**: Sorghum seeds are harvested when the grain becomes hard and dry.

5. **Bajra Seed Production:**

    - **Land Preparation**: Prepare the soil well and incorporate organic matter.
    - **Seed Sowing**: Use a seed drill or hand sow the seeds.
    - **Irrigation and Fertilization**: Provide adequate irrigation and apply fertilizers as required.
    - **Harvesting**: Harvest the bajra seeds once they are mature, and thresh carefully to maintain seed integrity.

Expected Outcome: Students will gain hands-on experience in seed production techniques for cereals, including field preparation, sowing, crop management, and harvesting.

II. Seed Production in Major Pulses

Objective:
To learn the methods of seed production in major pulses like Urd, Mung, Pigeonpea, Lentil, Gram, and Fieldpea.

Materials Required:

- Seed samples of pulses (Urd, Mung, Pigeonpea, Lentil, Gram, and Fieldpea)
- Soil testing kit
- Field tools for sowing and harvesting
- Fertilizer and irrigation systems

Procedure:

1. **Urd (Black Gram) Seed Production:**

    - **Land Preparation**: Prepare soil by plowing, followed by harrowing to form a fine seedbed.
    - **Sowing**: Sow seeds at the recommended depth and spacing, ensuring proper seed-to-soil contact.

- **Crop Management**: Monitor for pests, diseases, and nutrient deficiencies. Apply appropriate pesticides and fertilizers.
- **Harvesting**: Harvest when the pods turn yellow and dry.

2. **Mung (Green Gram) Seed Production:**

    - **Land Preparation**: Till the soil adequately and make ridges or furrows for sowing.
    - **Sowing**: Plant mung seeds at the correct depth and spacing.
    - **Crop Care**: Ensure proper irrigation, pest control, and disease management during the growing season.
    - **Harvesting**: Harvest mung beans when the pods mature and are dry.

3. **Pigeonpea (Toor Dal) Seed Production:**

    - **Land Preparation**: Prepare the field with proper irrigation facilities and drainage.
    - **Sowing**: Use direct sowing or transplanting methods for pigeonpea.
    - **Management**: Apply fertilizers and control pests and diseases. Ensure good weed management.
    - **Harvesting**: Harvest when the pods are mature and dry.

4. **Lentil Seed Production:**

    - **Land Preparation**: Ensure well-drained, fertile soil for lentil cultivation.
    - **Sowing**: Sow lentil seeds at appropriate depths and spacing.
    - **Crop Care**: Irrigate when necessary, and manage pests and diseases.
    - **Harvesting**: Harvest lentil seeds when the plants start to mature and the pods are dry.

5. **Gram (Chickpea) Seed Production:**

    Land Preparation: Prepare the soil by tilling and leveling.

    Sowing: Sow seeds in rows or broad casts based on the recommended seed rate.

    Irrigation & Fertilization: Apply adequate water and fertilizers to ensure healthy growth.

    Harvesting: Harvest when the plants turn yellow, and seeds are fully mature.

6. **Field pea Seed Production:**

    - **Land Preparation**: Ensure good drainage and well-tilled soil.
    - **Sowing**: Use row planting for better management of the crop.
    - **Crop Management**: Water, fertilize, and control pests and diseases.
    - **Harvesting**: Harvest when the pods are mature, and seeds are dry.

Expected Outcome: Students will learn the step-by-step process of seed production for pulses, ensuring good seed quality and yield.

III. Seed Production in Major Oilseeds

Objective:
To explore the techniques of seed production in major oilseeds like Soybean, Rapeseed, and Mustard.

Materials Required:

- Seed samples of oilseeds (Soybean, Rapeseed, Mustard)
- Fertilizer, irrigation tools
- Field management equipment

Procedure:

1. **Soybean Seed Production:**

   Land Preparation: Ensure the soil is well-drained and rich in organic matter.

   Sowing: Sow soybean seeds using a seed drill or hand sowing at the correct depth and spacing.

   Crop Care: Monitor for pests and diseases, applying control measures as necessary.

   Harvesting: Harvest when the plants are mature and the seeds rattle inside the pods.

2. **Rapeseed and Mustard Seed Production:**

   - **Land Preparation**: Prepare the field with adequate tillage and organic matter.
   - **Sowing**: Sow seeds in rows or broadcast them, depending on the variety.
   - **Crop Care**: Apply irrigation and fertilizers as required, and monitor for pests and diseases.
   - **Harvesting**: Harvest mustard and rapeseed when the pods turn yellow and dry.

Expected Outcome: Students will be able to understand and implement seed production techniques for oilseed crops, focusing on land preparation, sowing, and pest management.

IV. Seed Production in Vegetable Crops

Objective:
To understand the methods of seed production for vegetable crops.

Materials Required:

- Seed samples of vegetable crops (e.g., tomato, onion, carrot, etc.)
- Soil testing kit
- Fertilizer and irrigation systems

Procedure:

1. **Land Preparation**:
    - Prepare the soil with proper drainage and fertility for vegetable seed production.
2. **Sowing**:
    - Use appropriate planting techniques (direct seeding, transplanting, etc.) for the specific vegetable crop.
3. **Crop Management**:
    - Regularly irrigate, fertilize, and control pests and diseases.
4. **Harvesting**:
    - Harvest seeds from mature vegetable plants when the fruits or flowers have reached full maturity.

Expected Outcome: Students will learn the procedures involved in seed production for various vegetable crops, from sowing to harvesting.

V. Seed Certification: Procedure, Field Inspection, and Preparation of Field Inspection Report

Objective:
To understand the process of seed certification, including field inspection and the preparation of the field inspection report.

Materials Required:

- Certification guidelines and forms
- Field notebooks
- Seed samples from certified and non-certified sources

Procedure:

1. **Certification Procedure**:
    - Understand the certification requirements for different seed types.
    - Study the standards for purity, germination, and quality of seeds.
2. **Field Inspection**:
    - Inspect fields to verify seed quality, plant health, and management practices.
    - Check for any contamination, weed growth, or pest infestations.
3. **Field Inspection Report**:
    - Prepare a detailed inspection report outlining the findings, including plant variety, seed quality, and any recommendations for certification or rejection.

Expected Outcome: Students will learn how to conduct field inspections for seed certification and prepare accurate reports.

VI. Visit to Seed Production Farms, Seed Testing Laboratories, and Seed Processing Plants

Objective:
To gain practical knowledge of the seed production process, including the testing and processing of seeds in commercial settings.

Procedure:

1. **Pre-visit Preparation**:
    - Research the practices of seed production, testing, and processing used by commercial farms and laboratories.
2. **During the Visit**:
    - Observe the seed production techniques, testing methods, and processing systems.
    - Learn about seed quality assurance, storage, and packaging.
3. **Post-visit Reflection**:
    - Write a report summarizing key learnings from the visit, with a focus on seed certification and seed quality management.

Expected Outcome: Students will gain real-world insights into the practices of seed production, testing, and processing, enhancing their understanding of commercial seed production.

Lab Manual: Agricultural Marketing Trade & Prices

I. Plotting and Study of Demand and Supply Curves and Calculation of Elasticities

Objective:
To understand the concepts of demand and supply curves, and how to calculate and interpret the elasticities of demand and supply for various commodities.

Materials Required:

- Data on price and quantity for selected commodities
- Graph paper or computer with graphing software (e.g., Excel)
- Calculator

Procedure:

1. **Plotting Demand Curve**:

- Collect data on the price and quantity demanded of a selected commodity at different price points.
- Plot the price on the y-axis and quantity demanded on the x-axis.
- Connect the points to create the demand curve.

2. **Plotting Supply Curve**:
    - Similarly, collect data on the price and quantity supplied of the same commodity at different price points.
    - Plot the price on the y-axis and quantity supplied on the x-axis.
    - Connect the points to form the supply curve.
3. **Calculating Elasticity**:
    - **Price Elasticity of Demand (PED)**: Use the formula: PED=%ΔQ%ΔP where ΔQ\Delta QΔQ is the change in quantity demanded and ΔP\Delta PΔP is the change in price.
    - **Price Elasticity of Supply (PES)**: Use the formula: PES=%ΔS%ΔP where ΔS\Delta SΔS is the change in quantity supplied.

Expected Outcome: Students will learn how to plot the demand and supply curves and calculate the elasticities of demand and supply for various agricultural commodities.

II. Study of the Relationship Between Market Arrivals and Prices of Selected Commodities

Objective:
To examine how the arrival of a commodity in the market affects its price and the overall market equilibrium.

Materials Required:

- Data on market arrivals and corresponding prices of selected commodities (e.g., fruits, vegetables, grains)
- Graph paper or spreadsheet software

Procedure:

1. **Data Collection**:
    - Gather data on market arrivals (quantity) and corresponding prices of selected commodities over a specified time period.
2. **Analysis**:
    - Plot a graph with market arrivals on the x-axis and prices on the y-axis.
    - Observe the relationship between the two variables and look for trends such as how higher arrivals tend to lower prices and vice versa.

Expected Outcome: Students will gain insights into how market arrivals influence commodity prices and how this relationship affects the overall supply-demand dynamics in the market.

III. Computation of Marketable and Marketed Surplus of Important Commodities

Objective:
To understand the concept of marketable and marketed surplus and calculate these values for important commodities.

Materials Required:

- Data on total production and post-harvest losses of selected commodities
- Calculator or spreadsheet software

Procedure:

1. **Marketable Surplus**:
    - Marketable surplus refers to the portion of total production that is available for sale in the market after accounting for household consumption and post-harvest losses.
    - Use the formula: Marketable Surplus=Total Production− (Household Consumption+Post-harvest Losses
2. **Marketed Surplus**:
    - Marketed surplus refers to the actual quantity sold in the market, which may be influenced by factors like transportation and storage conditions.
    - Collect data on the actual quantity marketed and calculate the marketed surplus.

Expected Outcome: Students will learn how to compute the marketable and marketed surplus and understand the factors affecting the availability of commodities in the market.

IV. Study of Price Behaviour Over Time for Selected Commodities

Objective:
To analyze how the prices of selected commodities change over time and identify trends or cycles in pricing.

Materials Required:

- Historical price data for selected commodities
- Graph paper or spreadsheet software

Procedure:

1. **Data Collection**:

- Gather historical price data for a selected commodity (e.g., wheat, rice, or cotton) over a set period (e.g., one year, five years).

2. **Price Trend Analysis**:
    - Plot the prices on the y-axis and the time periods (e.g., months or years) on the x-axis.
    - Observe any trends, such as seasonal price fluctuations or long-term price increases or decreases.

Expected Outcome: Students will understand how price trends evolve over time and will learn to identify price behaviour patterns and their possible economic causes.

V. Construction of Index Numbers

Objective:
To understand the construction and interpretation of index numbers, commonly used to measure changes in economic indicators like prices and production.

Materials Required:

- Data on prices or production for a set of commodities over multiple periods
- Formula for constructing index numbers

Procedure:

1. **Price Index Construction**:
    - Use the formula for constructing an index number: Index Number= (Price in Current Period Price in Base Period) ×100
    - Index Number=(Price in Base Period Price in Current Period)×100
2. **Calculation**:
    - Collect price data for a set of commodities for different time periods.
    - Calculate the index number for each commodity and observe the changes over time.

Expected Outcome: Students will learn how to construct index numbers and interpret them to measure changes in prices or other economic indicators over time.

VI. Visit to a Local Market to Study Marketing Functions

Objective:
To observe and analyze the various marketing functions performed by different agencies in a local market.

Materials Required:

- Field notebook

- Camera for documentation (optional)

Procedure:

1. **Pre-visit Preparation**:
    - Research the local market and the different agencies involved in marketing, such as wholesalers, retailers, transporters, and packers.
2. **During the Visit**:
    - Observe the different marketing functions performed, including procurement, transportation, storage, packaging, and retailing.
    - Identify the marketing channels used for selected commodities, such as grains or vegetables.
3. **Data Collection**:
    - Collect data on marketing costs, margins, and price spreads for selected commodities.
    - Interview market participants (e.g., traders, retailers) to gather information on the functioning of the market.
4. **Post-visit Report**:
    - Compile the collected data into a report, presenting findings on marketing functions, costs, and price spreads.

Expected Outcome: Students will gain practical insights into the operations of local markets, including how various agencies contribute to the movement and marketing of goods.

VII. Visit to Market Institutions (NAFED, SWC, CWC, Cooperative Marketing Societies)

Objective:
To observe and study the organization, functioning, and role of market institutions in the agricultural marketing system.

Materials Required:

- Field notebook
- Access to relevant documents (if available)

Procedure:

1. **Pre-visit Preparation**:
    - Research the roles of market institutions such as NAFED (National Agricultural Cooperative Marketing Federation of India), SWC (State Warehousing Corporation), CWC (Central Warehousing Corporation), and cooperative marketing societies.
2. **During the Visit**:

- Observe the operations and services provided by these institutions, including storage, warehousing, price stabilization, and marketing of agricultural commodities.
- Meet with representatives to discuss their strategies for supporting farmers and ensuring fair market prices.

3. **Post-visit Reflection**:

    - Prepare a report on the findings, focusing on how these institutions contribute to improving the efficiency and fairness of agricultural marketing.

Expected Outcome: Students will understand the role of various market institutions in facilitating the marketing process and supporting agricultural producers.

VIII. Application of Principles of Comparative Advantage in International Trade

Objective:
To apply the principles of comparative advantage to analyze how countries benefit from international trade in agricultural commodities.

Materials Required:

- Data on production costs or output of agricultural commodities in different countries
- Calculator

Procedure:

1. **Understanding Comparative Advantage**:
    - The principle of comparative advantage suggests that a country should specialize in producing and exporting goods in which it has the lowest opportunity cost, while importing goods that it is less efficient at producing.
2. **Data Analysis**:
    - Collect data on production costs or output for agricultural commodities like wheat, rice, or coffee from different countries.
    - Compare the opportunity costs and determine the countries' comparative advantages.
3. **Application**:
    - Use the data to calculate and identify the commodities that each country should specialize in and trade.

Expected Outcome: Students will learn how the principle of comparative advantage applies to international trade and how it leads to more efficient global resource allocation.

Lab Manual: Introductory Agro-meteorology & Climate Change

I. Measurement of Bright Sunshine Hours, Total, Shortwave, and Longwave Radiation

Objective:
To measure and analyze bright sunshine hours and the different types of radiation (total, shortwave, and longwave) to understand their role in climate studies.

Materials Required:

- Sunshine recorder or Pyranometer (for radiation measurement)
- Solarimeter
- Digital thermometer
- Stopwatch

Procedure:

1. **Bright Sunshine Hours:**
    - Set up the sunshine recorder or pyranometer at a location that is unobstructed by any structure.
    - Record the time when bright sunshine is observed and the total duration of sunshine throughout the day.
2. **Radiation Measurement:**
    - **Total Radiation**: Use a pyranometer to measure the total incoming solar radiation.
    - **Shortwave Radiation**: Use a solarimeter to measure shortwave radiation (the energy from the sun in the form of electromagnetic waves).
    - **Longwave Radiation**: Measure longwave radiation, typically emitted by the Earth's surface. A specialized instrument (e.g., pyrgeometer) can be used for this.
3. **Data Recording**:
    - Record the readings at regular intervals throughout the day for each type of radiation and sunshine duration.

Expected Outcome: Students will learn to measure different types of radiation and sunshine hours and understand their importance in the climate system.

II. Measurement of Maximum, Minimum Air Temperatures and Soil Temperature

Objective:
To measure the maximum and minimum air temperatures as well as the soil temperature at different depths.

Materials Required:

- Maximum-minimum thermometer (for air temperature)
- Soil thermometer (for soil temperature)
- Depth markers (for soil thermometer)

Procedure:

1. **Air Temperature Measurement:**
    - Place the maximum-minimum thermometer in a shaded area away from any direct sunlight or heat sources.
    - Record the highest and lowest air temperatures at the same time every day.
2. **Soil Temperature Measurement:**
    - Insert a soil thermometer into the soil at different depths (e.g., 5 cm, 10 cm, and 15 cm).
    - Record the soil temperature at each depth at regular intervals throughout the day.

Expected Outcome: Students will learn how to measure air and soil temperatures and understand the importance of these measurements in agricultural and meteorological studies.

III. Measurement of Wind Speed and Wind Direction, Preparation of Wind Rose

Objective:
To measure the wind speed and direction and prepare a wind rose diagram to visualize the wind patterns.

Materials Required:

- Anemometer (for wind speed)
- Wind vane (for wind direction)
- Compass
- Graph paper or software for plotting

Procedure:

1. **Wind Speed Measurement:**
    - Use an anemometer to measure the wind speed at regular intervals.
    - Record the wind speed in meters per second or kilometers per hour.
2. **Wind Direction Measurement:**
    - Use a wind vane to measure the direction of the wind.

- Determine the wind direction in degrees or as cardinal directions (N, S, E, W).

3. **Wind Rose Preparation:**
    - Plot the wind directions on a circular graph with the frequency of wind from each direction.
    - Use the data to prepare a wind rose, which visually represents the dominant wind directions and their frequencies.

Expected Outcome: Students will be able to measure wind speed and direction and construct a wind rose to interpret local wind patterns.

IV. Determination of Vapor Pressure and Relative Humidity

Objective:
To measure vapor pressure and compute relative humidity from temperature and vapor pressure data.

Materials Required:

- Hygrometer (for relative humidity)
- Psychrometer (for calculating vapor pressure)
- Thermometer

Procedure:

1. **Vapor Pressure Measurement:**
    - Use a psychrometer (with a wet and dry bulb) to measure the air temperature and wet-bulb temperature.
    - Calculate the vapor pressure using the wet-bulb temperature and standard psychrometric tables.
2. **Relative Humidity Calculation:**
    - Calculate the relative humidity using the formula: RH=(EEs)×100RH = \left(\frac{E}{E_s} \right) \times 100RH=(EsE)×100 where:
        - EEE = Vapor pressure,
        - EsE_sEs = Saturation vapor pressure at the dry bulb temperature.

Expected Outcome: Students will understand how to measure vapor pressure and calculate relative humidity, which are essential in weather and climate studies.

V. Measurement of Rainfall

Objective:
To measure the amount of rainfall and understand its variability.

Materials Required:

- Rain gauge (e.g., standard cylindrical rain gauge)
- Measuring container (for collecting rainfall)
- Ruler or measuring tape

Procedure:

1. **Rainfall Collection:**
    - Place the rain gauge in an open area away from obstructions like buildings or trees.
    - Measure the depth of rainfall accumulated in the rain gauge after each rainfall event.
2. **Recording Rainfall:**
    - Measure the amount of rainfall in millimeters at regular intervals (e.g., daily, weekly).
    - Empty the rain gauge after each measurement to ensure accurate readings.

Expected Outcome: Students will learn how to measure and record rainfall data accurately for climatological analysis.

VI. Analysis of Rainfall Data for Climatological Studies

Objective:
To analyze rainfall data and understand its patterns and variability over time.

Materials Required:

- Collected rainfall data
- Statistical analysis software (e.g., Excel or SPSS)

Procedure:

1. **Data Analysis**:
    - Analyze rainfall data to determine annual, seasonal, and monthly rainfall totals.
    - Calculate the mean, standard deviation, and coefficient of variation to assess rainfall variability.
2. **Graphical Representation**:
    - Plot graphs to visualize rainfall trends over time (e.g., monthly rainfall trends, annual variations).
    - Use histograms, pie charts, or bar graphs for better interpretation.

Expected Outcome: Students will gain skills in analyzing rainfall data and interpreting rainfall patterns for climatological studies.

VII. Measurement of Pressure

Objective:
To measure atmospheric pressure and understand its relationship with weather patterns.

Materials Required:

- Barometer (e.g., mercury or aneroid barometer)

Procedure:

1. **Pressure Measurement:**
    - Use the barometer to measure atmospheric pressure in millibars or inches of mercury.
    - Record the atmospheric pressure at regular intervals (e.g., daily).
2. **Data Interpretation**:
    - Observe changes in atmospheric pressure and relate them to weather conditions (e.g., low pressure indicating storms, high pressure indicating fair weather).

Expected Outcome: Students will learn how to measure atmospheric pressure and interpret its influence on weather conditions.

VIII. Estimation of Heat Indices

Objective:
To estimate heat indices (apparent temperature) that combine air temperature and humidity to indicate human comfort.

Materials Required:

- Wet and dry-bulb thermometer
- Heat index formula (or calculator)

Procedure:

1. **Heat Index Calculation**:
    - Measure the air temperature and relative humidity.
2. **Interpretation**:
    - Use the calculated heat index to assess the level of discomfort and potential heat stress.

Expected Outcome: Students will understand how heat indices are calculated and their relevance to human comfort and health.

IX. Measurement of Open Pan Evaporation

Objective:
To measure the evaporation rate from an open pan, which is used to estimate potential evapotranspiration (PET).

Materials Required:

- Standard open pan evaporimeter
- Ruler or tape measure

Procedure:

1. **Evaporation Measurement**:
    - Place the open pan evaporimeter in an open area.
    - Measure the decrease in water level in the pan over a set period (e.g., daily or weekly).
2. **Data Recording**:
    - Record the amount of evaporation in millimeters per day.

Expected Outcome: Students will learn how to measure evaporation and understand its importance in water balance and agricultural planning.

X. Computation of PET and AET

Objective:
To compute potential evapotranspiration (PET) and actual evapotranspiration (AET) based on climatic data.

Materials Required:

- Climate data (temperature, humidity, wind speed, radiation)
- Evapotranspiration calculation software or formulae

Procedure:

1. **PET Calculation**:
    - Use the Penman-Monteith or other relevant formulas to calculate PET from climatic data.
2. **AET Estimation**:
    - Estimate AET using the available water content in the soil and climatic conditions.

Expected Outcome: Students will understand how to compute PET and AET and how these values are used in agricultural and environmental management.

Lab Manual: Agrochemicals

Objective:

To study sampling, application technology, and chemical analysis of fertilizers and pesticides to ensure effective and safe use in agricultural practices.

Experiment 1: Sampling of Fertilizers and Pesticides

Objective:

To understand the correct procedures for sampling fertilizers and pesticides for laboratory analysis.

Materials Required:

- Fertilizer and pesticide samples
- Sampling tools
- Sampling containers

Procedure:

1. Divide the bulk material into smaller, equal portions.
2. Collect random samples from different parts of the batch.
3. Mix the samples thoroughly and take a representative sample for analysis.
4. Label and store the sample properly.

Observations:

- Record the sampling method and any variations in the sample.

Conclusion:

Discuss the importance of representative sampling in quality analysis.

Experiment 2: Pesticide Application Technology

Objective:

To study various pesticide application technologies and appliances.

Materials Required:

- Sprayers (knapsack, tractor-mounted, power sprayers)
- Dusters
- Pesticide formulations

Procedure:

1. Examine different pesticide application appliances.
2. Understand their working principles and suitable uses.
3. Demonstrate calibration of the appliances.
4. Record the application rate and coverage.

Observations:

- Note the specifications and effectiveness of each appliance.

Conclusion:

Evaluate the efficiency of different pesticide application methods.

Experiment 3: Quick Tests for Identification of Common Fertilizers

Objective:

To perform quick tests for identifying common fertilizers.

Materials Required:

- Fertilizer samples
- Reagents for specific identification tests

Procedure:

1. Test for ammonium nitrate using Nessler's reagent.
2. Test for urea by heating and smelling for ammonia.
3. Test for phosphates using ammonium molybdate reagent.
4. Test for potash using flame photometry.

Observations:

- Record the results of each test.

Conclusion:

Discuss the practical applications of quick identification tests.

Experiment 4: Identification of Anions and Cations in Fertilizers

Objective:

To identify anions and cations in fertilizer samples.

Materials Required:

- Fertilizer samples
- Reagents for anion and cation analysis

Procedure:

1. Perform qualitative tests for anions like chloride, nitrate, and phosphate.
2. Perform qualitative tests for cations like ammonium, calcium, and potassium.
3. Record the observations for each test.

Observations:

- Note the presence of specific anions and cations.

Conclusion:

Evaluate the nutrient composition of the fertilizers.

Experiment 5: Calculation of Doses of Insecticides

Objective:

To calculate the appropriate doses of insecticides for field application.

Materials Required:

- Insecticide samples
- Field data (area, pest population)
- Measuring tools

Procedure:

1. Note the recommended dose of the insecticide from the label.
2. Calculate the amount required based on field area.
3. Prepare the working solution as per the calculated dose.

Observations:

- Record the calculated dose and application volume.

Conclusion:

Discuss the importance of accurate dose calculation for effective pest control.

Experiment 6: Study of Insecticide Formulations

Objective:

To study and identify various insecticide formulations available in the market.

Materials Required:

- Market samples of insecticide formulations
- Labels and technical bulletins

Procedure:

1. Examine the insecticide samples.
2. Identify the active ingredient and its concentration.
3. Classify the formulations (e.g., EC, WP, SC).

Observations:

- List the formulations and their specifications.

Conclusion:

Understand the suitability of different formulations for various applications.

Experiment 7: Estimation of Nitrogen in Urea

Objective:

To estimate the nitrogen content in urea fertilizer.

Materials Required:

- Urea sample
- Distillation apparatus
- Titration setup

Procedure:

1. Hydrolyze the urea to release ammonia.
2. Distill the ammonia into a known volume of acid.
3. Back-titrate the remaining acid to estimate nitrogen.

Observations:

- Record the volume of acid consumed.

Conclusion:

Calculate the percentage of nitrogen in the sample.

Experiment 8: Estimation of Water-Soluble and Citrate-Soluble P2O5 in Single Super Phosphate

Objective:

To estimate water-soluble and citrate-soluble P2O5 in single super phosphate (SSP).

Materials Required:

- SSP sample
- Reagents for P2O5 analysis

Procedure:

1. Extract water-soluble P2O5 and analyze using spectrophotometry.
2. Extract citrate-soluble P2O5 and analyze similarly.

Observations:

- Record the values for water-soluble and citrate-soluble P2O5.

Conclusion:

Evaluate the phosphate content in the SSP sample.

Experiment 9: Estimation of Potassium in Muriate of Potash (MOP) or Sulphate of Potash (SOP) by Flame Photometer

Objective:

To estimate potassium content in MOP or SOP using a flame photometer.

Materials Required:

- MOP/SOP sample
- Flame photometer

Procedure:

1. Prepare a standard potassium solution.
2. Calibrate the flame photometer.
3. Analyze the potassium content in the fertilizer sample.

Observations:

- Record the potassium concentration.

Conclusion:

Assess the nutrient value of the sample.

Experiment 10: Determination of Copper Content in Copper Oxychloride

Objective:

To determine the copper content in copper oxychloride.

Materials Required:

- Copper oxychloride sample
- Reagents for copper analysis

Procedure:

1. Dissolve the sample in acid.
2. Analyze copper content using titration or spectrophotometry.

Observations:

- Record the copper concentration.

Conclusion:

Evaluate the efficacy of the copper-based fungicide.

Experiment 11: Determination of Sulphur Content in Sulphur Fungicide

Objective:

To determine the sulphur content in sulphur-based fungicides.

Materials Required:

- Sulphur fungicide sample
- Reagents for sulphur analysis

Procedure:

1. Oxidize the sulphur to sulphate.
2. Precipitate the sulphate and measure its concentration.

Observations:

- Record the sulphur content.

Conclusion:

Assess the quality of the fungicide.

Experiment 12: Determination of Thiram Content

Objective:

To determine the thiram content in thiram-based formulations.

Materials Required:

- Thiram sample
- Reagents for thiram analysis

Procedure:

1. Extract thiram from the sample.
2. Analyze using spectrophotometry or titration.

Observations:

- Record the thiram concentration.

Conclusion:

Evaluate the effectiveness of the fungicide.

Experiment 13: Determination of Ziram Content

Objective:

To determine the ziram content in ziram-based formulations.

Materials Required:

- Ziram sample
- Reagents for ziram analysis

Procedure:

1. Extract ziram from the sample.
2. Analyze using appropriate chemical methods.

Observations:

- Record the ziram concentration.

Conclusion:

Assess the quality of the ziram formulation.

Lab Manual: Biopesticides & Biofertilizers

Isolation and Purification of Important Biopesticides (Trichoderma, Pseudomonas, Bacillus, Metarhizium, etc.)

Objective:
To isolate, purify, and study the production methods of important biopesticides used in agricultural pest management.

Materials Required:

- Soil or plant samples from infected fields or laboratories
- Sterile petri dishes
- Potato dextrose agar (PDA) or specific media for biopesticides
- Incubator
- Sterile pipettes, test tubes, and culture flasks
- Microscope

Procedure:

1. **Sample Collection**:
    - Collect soil or plant samples from areas known to have pest infestations or fungal diseases.
    - Use a sterile method to ensure no contamination during collection.
2. **Isolation of Biopesticides**:
    - Inoculate the collected soil or plant samples onto selective agar media (e.g., PDA or King's B agar for Pseudomonas, or selective media for Trichoderma, Bacillus, etc.).
    - Incubate at the appropriate temperature (typically 25-30°C) for 3-7 days.
    - Observe for fungal or bacterial growth.
3. **Purification**:
    - Isolate individual colonies of the desired biopesticide from mixed cultures using the streak plate method.
    - Subculture these isolates on fresh media plates to obtain pure cultures.
    - Confirm identity under the microscope based on morphological characteristics.
4. **Biopesticide Production**:
    - Prepare liquid culture medium (e.g., for Trichoderma or Bacillus).
    - Inoculate the purified cultures into the medium and incubate under optimal conditions (e.g., 28°C for fungal cultures, 30°C for bacterial cultures).

- Harvest the culture after a specified incubation period (usually 7-14 days), and concentrate the biopesticide for use.

Expected Outcome: Students will learn the techniques for isolating and purifying biopesticides and understand the production methods used in their application.

II. Identification of Important Botanicals

Objective:
To identify and understand the properties of important botanicals that are used as biopesticides.

Materials Required:

- Botanical samples (leaves, roots, or seeds)
- Microscopes
- Field guides or identification keys
- Herbarium sheets

Procedure:

1. **Collection**:
    - Collect botanical samples of interest (e.g., neem, garlic, eucalyptus, etc.) from the field or herbarium.
2. **Identification**:
    - Use a microscope to examine the structure of the plant parts (e.g., trichomes, glandular cells) that might be responsible for biocidal activity.
    - Use identification keys or field guides to correctly identify the botanical species.
3. **Documenting Properties**:
    - Record the botanical properties, including any known insecticidal, fungicidal, or herbicidal effects of the plant.

Expected Outcome: Students will become familiar with the identification of key botanicals and their role in biopesticide development.

III. Visit to Biopesticide Laboratory in Nearby Area

Objective:
To observe the practical applications of biopesticide production and understand the working of a biopesticide laboratory.

Materials Required:

- Notebook for observations
- Camera (optional)

Procedure:

1. **Preparation**:
    - Research the laboratory you will visit, including the biopesticide types produced and the technologies used.
2. **Observation**:
    - Observe the various stages of biopesticide production, from isolation to mass production.
    - Note the equipment used for cultivation, purification, and packaging of biopesticides.
3. **Discussion**:
    - Engage with the laboratory staff to understand their methodologies for quality control, product formulation, and application.

Expected Outcome: Students will gain real-world insights into biopesticide production and quality control practices.

IV. Field Visit to Explore Naturally Infected Cadavers

Objective:
To observe naturally infected cadavers and identify entomopathogenic entities in the field.

Materials Required:

- Field kit (magnifying lens, collection vials, notebooks)
- Camera (optional)

Procedure:

1. **Visit Location**:
    - Visit a field or natural habitat where pest-infected plants or animals are present.
2. **Collection of Samples**:
    - Collect cadavers (insects, larvae, etc.) that show signs of parasitic infection by entomopathogens (e.g., fungal mycosis or bacterial infection).
3. **Identification**:
    - Examine the collected cadavers under a magnifying lens or microscope to identify any entomopathogenic fungi or bacteria that caused the infection.

Expected Outcome: Students will learn to identify naturally occurring entomopathogenic organisms in the field and understand their role in pest management.

V. Identification of Entomopathogenic Entities in Field Condition

Objective:
To identify entomopathogenic fungi, bacteria, and nematodes that occur naturally in the field and can be used as biocontrol agents.

Materials Required:

- Field microscope
- Collection vials
- Notebook

Procedure:

1. **Field Observation**:
    - Visit pest-prone areas and observe insects or larvae showing signs of disease or fungal infection.
2. **Sample Collection**:
    - Collect infected insects or soil samples that may contain entomopathogenic organisms.
3. **Microscopic Examination**:
    - Examine the samples under a microscope to identify the causative pathogens (e.g., Beauveria bassiana, Metarhizium spp., entomopathogenic nematodes).
4. **Data Recording**:
    - Record the species of entomopathogens observed and the signs of infection.

Expected Outcome: Students will be able to identify entomopathogenic organisms in the field and understand their significance in pest control.

VI. Quality Control of Biopesticides

Objective:
To understand and implement the quality control procedures required for biopesticide production.

Materials Required:

- Biopesticide samples
- Laboratory tools for microbial analysis
- Standards for biopesticide quality control (e.g., potency, purity, stability)

Procedure:

1. **Microbial Testing**:

   - Perform microbial tests (e.g., plate count, viability testing) to determine the concentration of active biopesticides (e.g., number of spores or colony-forming units).

2. **Formulation Testing**:
   - Test the formulation of the biopesticide for consistency in particle size, dispersibility, and shelf life.

3. **Stability Testing**:
   - Conduct stability tests by storing biopesticides under different conditions (temperature, humidity) and measuring changes in efficacy over time.

Expected Outcome: Students will learn the techniques for ensuring the quality and consistency of biopesticides for agricultural use.

VII. Isolation and Purification of Biofertilizers (Azospirillum, Azotobacter, Rhizobium, P-solubilizers, Cyanobacteria)

Objective:
To isolate and purify important biofertilizers that promote plant growth by fixing nitrogen or solubilizing phosphorus.

Materials Required:

- Soil samples from leguminous or non-leguminous plants
- Selective media for different biofertilizers (e.g., Ashby's medium for Azospirillum, YMA for Rhizobium)
- Incubator
- Sterile petri dishes and test tubes

Procedure:

1. **Isolation of Biofertilizers**:
   - Collect soil or plant root samples from fields known for nitrogen-fixing or phosphorus-solubilizing plants.
   - Inoculate the samples onto selective agar media and incubate at 30°C.

2. **Purification**:
   - Use streak plate or pour plate method to isolate pure colonies of the desired microorganisms.

3. **Confirmation**:
   - Perform biochemical tests (e.g., gram staining, fermentation tests) to confirm the identity of the isolated cultures.

Expected Outcome: Students will learn how to isolate and purify important biofertilizers for agricultural use.

VIII. Mass Multiplication and Inoculums Production of Biofertilizers

Objective:
To learn how to mass multiply biofertilizers and produce inoculums for large-scale agricultural applications.

Materials Required:

- Liquid culture media
- Fermentation tanks or flasks
- Nutrient broth
- Sterile containers for inoculum production

Procedure:

1. **Inoculum Preparation**:
    - Inoculate pure cultures of biofertilizers (e.g., Rhizobium, Azotobacter) into liquid culture media.
    - Incubate under optimal conditions for mass growth.
2. **Harvesting and Concentrating**:
    - After growth, harvest the biomass by centrifugation or filtration and concentrate the inoculum.
    - Prepare the inoculant in a form suitable for field application (e.g., slurry, powder).

Expected Outcome: Students will understand the process of large-scale production of biofertilizer inoculants.

IX. Isolation of AM Fungi (Wet Sieving Method and Sucrose Gradient Method)

Objective:
To isolate arbuscular mycorrhizal (AM) fungi from soil using different techniques.

Materials Required:

- Soil samples from plant roots
- Sucrose solution
- Wet sieving apparatus (mesh sieves)
- Petri dishes and microscope

Procedure:

1. **Wet Sieving Method**:
    - Collect soil samples from rhizosphere areas.
    - Use a series of sieves and water to wash the soil and separate AM fungal spores.
2. **Sucrose Gradient Method**:
    - Prepare a sucrose gradient solution.
    - Place the soil sample in the gradient solution and centrifuge to separate spores.
3. **Identification**:
    - Examine the isolated AM fungal spores under a microscope.

Expected Outcome: Students will learn techniques to isolate AM fungi, which are beneficial for plant growth and nutrient uptake.

X. Mass Production of AM Inoculants

Objective:
To produce large quantities of AM fungi inoculants for use in agricultural applications.

Materials Required:

- AM fungal cultures
- Growth media (e.g., sterile soil or agar)
- Sterile containers
- Growth chambers

Procedure:

1. **Inoculum Preparation**:
    - Grow AM fungi in sterile soil or growth media in containers under controlled conditions.
2. **Harvesting and Packaging**:
    - After a few weeks of growth, harvest the inoculum, package it for storage, and prepare it for field application.

Expected Outcome: Students will learn how to mass-produce AM inoculants for agricultural use and enhance plant growth.

Lab Manual: Micro propagation Technologies

I. Identification and Use of Equipment in Tissue Culture Laboratory

Objective:
To familiarize students with the common equipment used in a tissue culture laboratory and their respective functions.

Materials Required:

- Laminar flow hood
- Autoclave
- Incubator
- Growth chambers
- Culture vessels (petri dishes, flasks, tubes)
- pH meter
- Magnetic stirrer
- Microscopes
- Sterile pipettes, forceps, scissors, and other small instruments

Procedure:

1. **Laminar Flow Hood**:
    - The laminar flow hood is used for aseptic operations, providing a sterile environment by filtering air.
    - Use it for transferring explants, preparing culture media, and subculturing.
2. **Autoclave**:
    - The autoclave is used for sterilizing equipment, media, and glassware by steam under pressure.
    - Sterilize all equipment before use in tissue culture.
3. **Incubator**:
    - The incubator is used to maintain optimal temperature for explant growth, usually 25-28°C, depending on the species.
4. **Growth Chambers**:
    - Growth chambers provide controlled temperature, humidity, and light conditions for plant tissue culture growth.
5. **Sterile Pipettes and Instruments**:
    - Use sterile pipettes, forceps, and scissors for aseptic handling of explants.

Expected Outcome: Students will be able to identify and correctly use tissue culture laboratory equipment.

II. Nutrition Media Composition

Objective:
To understand the composition and preparation of culture media used in plant tissue culture.

Materials Required:

- MS medium (Murashige and Skoog's)
- Sucrose
- Plant hormones (Auxins, Cytokinins)
- Agar (for solid media)
- Distilled water
- pH meter

Procedure:

1. **Prepare Stock Solutions**:
    - Dissolve individual stock solutions of micronutrients, macronutrients, and vitamins according to the MS medium formulation.
2. **Prepare Working Medium**:
    - Mix the stock solutions in the appropriate ratio to prepare the working media.
    - Add sucrose (typically 3-4%) as the carbon source.
3. **Adjust pH**:
    - Use a pH meter to adjust the pH of the media to 5.7-5.8 using HCl or NaOH.
4. **Agar Addition**:
    - Add 0.8-1.0% agar to solidify the medium if preparing solid media.
5. **Sterilization**:
    - Autoclave the medium at 121°C for 15-20 minutes.

Expected Outcome: Students will learn how to prepare the culture media required for tissue culture.

III. Sterilization Techniques for Media, Containers, and Small Instruments

Objective:
To understand the sterilization techniques used for culture media, containers, and tools in tissue culture.

Materials Required:

- Autoclave
- 70% ethanol
- Bleach solution (sodium hypochlorite)
- Sterile containers and instruments

Procedure:

1. **Sterilizing Media**:
    - Autoclave the prepared media at 121°C for 15-20 minutes.
2. **Sterilizing Containers**:
    - Sterilize all containers (e.g., petri dishes, culture tubes) in the autoclave.
3. **Sterilizing Small Instruments**:
    - Clean instruments thoroughly and sterilize using 70% ethanol followed by flaming (e.g., forceps, scissors).
    - Alternatively, autoclave small instruments.
4. **Sterilizing Explants**:
    - Surface sterilize explants by dipping them in a 10% bleach solution for 5-10 minutes, followed by rinsing with sterile water.

Expected Outcome: Students will understand the importance of sterilization and will be able to perform sterilization procedures correctly.

IV. Preparation of Stocks and Working Solutions

Objective:
To prepare stock and working solutions for plant tissue culture.

Materials Required:

- Chemicals and reagents for media preparation (e.g., micronutrients, macronutrients, hormones)
- Distilled water
- Weighing balance
- Storage containers

Procedure:

1. **Prepare Stock Solutions**:
    - Weigh out the required amounts of chemicals (e.g., salts, vitamins) for preparing stock solutions.
    - Dissolve in distilled water and store in labeled bottles.
2. **Prepare Working Solutions**:
    - Dilute stock solutions to the required concentration to prepare working solutions for medium preparation.
3. **Storage**:
    - Store stock solutions in a cool, dark place to preserve their efficacy.

Expected Outcome: Students will learn to prepare and store stock and working solutions for use in tissue culture.

V. Preparation of Working Medium

Objective:
To prepare a working culture medium using stock solutions and required additives.

Materials Required:

- Stock solutions (macro and micro nutrients, hormones)
- Sucrose
- Agar
- Distilled water
- pH meter

Procedure:

1. **Prepare the Medium**:
    - Mix the required amounts of stock solutions for macronutrients, micronutrients, and vitamins as per the protocol (e.g., MS medium).
    - Add sucrose and stir until fully dissolved.
2. **Add Plant Growth Regulators**:
    - Add the required plant hormones (e.g., auxins like IAA, cytokinins like BAP) as per the experimental requirement.
3. **Adjust pH**:
    - Use the pH meter to check and adjust the pH to 5.7-5.8.
4. **Add Agar**:

- Add 0.8-1.0% agar for solid medium, or leave it liquid for liquid cultures.

5. **Sterilize the Medium**:
    - Autoclave the medium at 121°C for 15-20 minutes.

Expected Outcome: Students will be able to prepare the working medium needed for plant tissue culture experiments.

VI. Culturing of Explants (Seeds, Shoot Tip, and Single Node)

Objective:
To learn the techniques for culturing different plant explants.

Materials Required:

- Sterilized explants (seeds, shoot tips, single nodes)
- Sterilized culture media
- Petri dishes, culture tubes, or jars
- Laminar flow hood
- Forceps and scalpels

Procedure:

1. **Seed Culture**:
    - Surface sterilize seeds and place them on the solidified medium.
    - Cover the petri dish and incubate in a growth chamber.
2. **Shoot Tip Culture**:
    - Surface sterilize the shoot tips and excise them using sterile forceps and scalpels.
    - Place the shoot tips on the media under aseptic conditions.
3. **Single Node Culture**:
    - Isolate a node from a plant and sterilize it.
    - Place the node on the medium in sterile culture vessels.

Expected Outcome: Students will understand the techniques required for culturing seeds, shoot tips, and nodes.

VII. Callus Induction

Objective:
To induce callus formation from explants for further regeneration or somatic embryogenesis.

Materials Required:

- Explants (e.g., leaf, root, or stem segments)
- Growth medium with auxins (e.g., 2,4-D, NAA)
- Petri dishes or culture vessels
- Growth chamber

Procedure:

1. **Inoculation**:
    - Place explants on the callus-inducing medium (containing auxins like 2,4-D).
    - Incubate the cultures in a growth chamber under controlled conditions (light/dark cycle, temperature).
2. **Observation**:
    - Observe the explants for callus formation after 2-4 weeks.
3. **Subculturing**:
    - Subculture the callus on fresh medium for further growth or differentiation.

Expected Outcome: Students will learn to induce callus from explants for use in further tissue culture processes.

VIII. Induction of Somatic Embryos and Regeneration of Whole Plants

Objective:
To induce somatic embryos from callus and regenerate whole plants from various explants.

Materials Required:

- Callus cultures
- Medium with low auxin and high cytokinin (e.g., BAP, Kinetin)
- Growth chamber

Procedure:

1. **Embryo Induction**:
    - Subculture the callus to a medium with low auxin and high cytokinin to induce somatic embryos.
2. **Plant Regeneration**:
    - After somatic embryos form, transfer them to a medium conducive to plant regeneration.
    - Allow the embryos to germinate and develop into whole plants.

Expected Outcome: Students will learn to regenerate whole plants from somatic embryos.

IX. Hardening Procedures

Objective:
To acclimatize tissue-cultured plants for transplanting into soil.

Materials Required:

- Tissue-cultured plantlets
- Greenhouse or shaded nursery area
- Potting soil
- Watering system

Procedure:

1. **Initial Hardening**:
    - Transfer plantlets to a greenhouse or shaded nursery with high humidity and low light intensity.
2. **Gradual Acclimatization**:
    - Gradually reduce humidity and expose plants to natural light conditions.
    - Water the plantlets as required.
3. **Transplanting**:
    - Once plantlets are acclimatized, transplant them into pots or the field.

Expected Outcome: Students will understand the hardening process, making tissue-cultured plants ready for field planting.