

Practical Manual
B. Sc. (Hons.) Agriculture
Fundamental of Agronomy
Course Code: ASAG1101
Course Credits: 3 (2+1)
Semester: 1st



Centurion
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*Shaping Lives...
Empowering Communities...*

Department of Agronomy and Agroforestry
M. S. Swaminathan School of Agriculture
Centurion University of Technology and Management, Paralakhemundi
www.cutm.ac.in

2021-22

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Paralakhemundi**

Certificate

Certified that this is a bonafide record of practical work done by

Mr./ Ms. _____

Regd. No. _____ *in B. Sc. (Hons.) Agriculture degree programme, Course No.*
ASAG1101 entitled "Fundamental of Agronomy" during 1st semester
of the academic year 2021-22.

Date:

Faculty In-charge

Evaluation System
Fundamental of Agronomy
Course Code: ASAG1101

Sl. No.	Marks distribution*	Total marks (25)	Marks obtained
1	Record	10	
2	Attendance	5	
3	Lab work	5	
4	Viva voce	5	
Total (25 marks)			

Signature of Faculty In-charge

List of Experiments

Exp. No.	Date of Exp.	Date of Submission	Title	Page No.	Signature	Remark
1			Identification of crops and seeds			
2			Identification of fertilizers			
3			Identification of pesticides			
4			Identification of tillage and sowing implements			
5			Study of agro climatic zones of India and Odisha			
6			Identification of major weeds in crops			
7			Methods of fertilizer and herbicide application			
8			Study of yield contributing characters and yield estimation			
9(A)			Seed germination test			
9(B)			Seed viability test			
10			Numerical on fertilizer requirement and plant population			
11			Numerical on herbicides and water requirement			
12			Visit for on-farm and on station field crops			

Identification of Crops and Seeds

1.1 Aim

To identify the crops and seeds

1.2 Agronomic classification of field crops

Field crops can be classified according to their economic importance as follows:

1.2.1 Cereals

A cereal is any of the edible components of the grain (botanically, a type of fruit, called a caryopsis) of cultivated grass, composed of the endosperm, germ, and bran. Cereal grains are grown in greater quantities and provide more food energy worldwide than any other type of crop and are therefore staple crops. Edible grains from other plant families, such as buckwheat (Polygonaceae), quinoa (Amaranthaceae) and chia (Lamiaceae), are referred to as pseudo cereals.

The word 'cereal' is derived from Ceres, the Roman goddess of harvest and agriculture.

Millets are a group of highly variable small-seeded grasses, widely grown around the world as cereal crops or grains for fodder and human food.

Millets are important crops in the semiarid tropics of Asia and Africa (especially in India, Mali, Nigeria, and Niger), with 97% of millet production in developing countries. The crop is favoured due to its productivity and short growing season under dry, high-temperature conditions.

Table 1.1 Identification of different cereals and millets crops

Table with 4 columns: Sl. No., Common name, Botanical name, Family. Includes a header row for 'Cereals' and three empty rows for data entry.

4.			
Millets			
1.			
2.			
3.			
4.			
5.			
6.			
7			
8.			

1.2.2 Pulses

The term "pulse", as used by the United Nations' Food and Agriculture Organization (FAO), is reserved for crops harvested solely for the dry seed. This excludes green beans and green peas, which are considered vegetable crop. A **legume** is a plant in the family *Fabaceae* or *Leguminosae*, the fruit or seed of such a plant called **pulse**.

Table 1.2 Identification of different pulse crops

Sl. No.	Common name	Botanical name	Family
1.			
2.			
3.			
4.			
5.			
6.			
7.			

1.2.3 Oilseeds

Crops that seeds are rich in fatty acids, are used to extract vegetable oil to meet various requirements are known as oilseed crops. This crop is important both for consumption and industrial purposes. In the human diet, the fat portion is supplied by oils, which gives the necessary energy for metabolism, besides it also adds taste to the food.

Table 1.3 Identification of different oilseed crops

Sl. No.	Common name	Botanical name	Family
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			

1.2.4 Sugar crops

Crops grown for the production of sugar and starch, such as sugarcane and sugar beet.

Table 1.4 Identification of different sugar crops

Sl. No.	Common name	Botanical name	Family
1.			
2.			

1.2.5 Fibre crops

Crop plants those are grown for obtaining fibres, traditionally used to make paper, cloth, rope etc. Fibre may be obtained from the seed of the plant (seed fibre) such as cotton and stem or bark of the plant (bast fibre) such as jute, mesta, sunhemp etc.

Table 1.5 Identification of different fibre crops

Sl. No.	Common name	Botanical name	Family
1.			
2.			
3.			

1.2.6 Narcotics

Crop plants or their products that are used for stimulating effects are known as narcotic crops e.g. tobacco, cannabis etc.

Table 1.6 Identification of different narcotics crops

Sl. No.	Common name	Botanical name	Family
1.			
2.			
3.			
4.			

1.3 Seed: Seed is a unit of reproduction of a flowering plant, capable of developing in to another such plant.

Table 1.7 Identification of different seeds

Sl. No.	Crop	Scientific Name	Family	Colour	Seed size
1.					
2.					
3.					
4.					
5.					
6.					
7.					
8.					
9.					
10.					
11.					
12.					
13.					
14.					
15.					

1.4 Conclusion

Signature of Faculty In-charge

Identification of Fertilizers**2.1 Aim**

The student should be able to

- To study, identify and acquaint with different classes fertilizers.

Plants absorb a large number of elements from the soil and other sources during their growth and development. According to the present state of our knowledge, seventeen mineral elements are found to be essential in plant nutrition, these elements are known as essential plant nutrients. The growing plants have three sources from which they get nutrients as listed below:

Table 2.1 Sources for micro and macro nutrients to plants

Macro nutrients	Source	Micro (trace) nutrients	Source
Carbon	Air	Iron	Soil
Oxygen	Air	Manganese	Soil
Hydrogen	Water	Boron	Soil
Nitrogen (Major)	Soil	Zinc	Soil
Phosphorous (Major)	Soil	Copper	Soil
Potassium (Major)	Soil	Molybdenum	Soil
Calcium (Secondary)	Soil	Chlorine	Soil
Magnesium (Secondary)	Soil		
Sulphur (Secondary)	Soil		

From the above table of plant nutrients it is seen that most of the nutrient are absorbed by plant from the soil. The absorption of macro nutrients is relatively high. If these nutrients are not added to the soil, the fertility status of soil goes down. Hence, these elements must be added to the soil through manures and fertilizers.

2.2 Fertilizers

Any artificially manufactured material added to the soil in order to supply one or more plant nutrients is known as fertilizer. The term is generally applied to inorganic material.

The classification of various fertilizers is given below :

2.2.1 Straight fertilizer

When fertilizer contain only one primary plant nutrient, it is known as straight fertilizer. They are also termed as incomplete or special fertilizers.

e.g. (a) Nitrogenous fertilizer (b) Phosphatic fertilizer (c) Potassic fertilizer

A) Nitrogenous fertilizers

Nitrogenous fertilizer may be classified into four groups on the basis of chemical form

(i) Nitrate containing : Nitrogen is combined as NO_3^- (nitrate) with other elements.

e.g. Sodium nitrate or Chilean nitrate (16% N), Calcium nitrate (15.5% N).

(ii) Ammonium containing: In these fertilizers nitrogen is combined in ammonium (NH_4^+) form with other elements.

e.g. Ammonium sulphate (20% N), Ammonium phosphate (20% N), Ammonium chloride (24 to 26%N), Anhydrous ammonia (82% N) Ammonium solution (20 to 25% N)

(iii) Nitrate and Ammonium containing: These fertilizers contain nitrogen in the form of nitrate as well as ammonium.

e.g. Ammonium nitrate (34% N), Calcium ammonium nitrate (26% N), Ammonium sulphate nitrate (26% N)

(iv) Amide containing: these fertilizers contain nitrogen in amide form.

e.g. Urea (46% N) and Calcium cyanamide (21% N)

B) Phosphatic fertilizers

Phosphatic fertilizers can be classified into three groups depending on the form in which phosphoric acid is combined with calcium.

Phosphatic fertilizers containing water soluble phosphoric acid or monocalcium phosphate $\text{Ca}(\text{H}_2\text{PO}_4)_2$ which can be absorbed quickly by the plant roots.

e.g. Single super phosphate (16% P_2O_5), Double super phosphate (32% P_2O_5), Triple super phosphate (48% P_2O_5), Ammonium phosphate (20% P_2O_5).

C) Potassic fertilizer

Potassic fertilizers can be classified into two groups depending upon the form of K in fertilizer.

(i) Fertilizers having K in Chloride form :

e.g. Muriate of potash (60% K_2O)

(ii) Fertilizers having K in non chloride form:

e.g. Sulphate of potash (48 to 52% K_2O)

2.2.2 Complex fertilizers

Incomplete complex fertilizers:

Ammonium phosphate (20-20-0)

Diammonium phosphate (18-46-0)

Urea ammonium phosphate (28-28-0)

Complete complex fertilizer:

Sulphala (15-15-15)

Suphala (18-18-9)

NPK (12-32-16)

2.2.3 Mixed fertilizers

A mechanical mixture of two or more straight fertilizer materials is referred as mixed fertilizer or fertilizer mixture.

Table 2.2 Identify different fertilizers and fill the given particulars

Sl. No.	Name of the fertilizer	Nutrient Content (%)	Colour	Physical Form
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				

11.				
12.				
13.				
14.				
15.				

2.3 Conclusion

Signature of Faculty In-charge

Identification of Pesticides

3.1 Aim

To gain knowledge and identify different pesticides used in Agriculture

3.2. Pesticide

A pesticide is any substance used to kill, repel or control certain forms of plant or animal life that are considered to be pests. The term pesticide includes all of the following: herbicide, insecticides, nematocide, molluscicide, avicide, rodenticide, bactericide, insect repellent, animal repellent, anti- microbial, fungicide.

Table 3.1 Types of pesticides

Type of pesticide	Target pest group
Algicides	Algae
Avicides	Birds
Bactericides	Bacteria
Fungicides	Fungi
Herbicides	Plant
Insecticides	Insects
Miticides or Acaricides	Mites
Molluscicides	Snails
Nematicides	Nematodes
Rodenticides	Rodents
Virucides	Viruses

3.2.1 Pesticide label information

The pesticides are available either in solid or liquid form. The label of the containers will read a.e = Acid equivalent or a.i. = active ingredient for solids and gm/lit a.i. or a.i. for liquids.

3.2.2 Acid Equivalent

It refers to that part of a formulation that theoretically can be converted into acid. In this case the acid equivalent is given as the active ingredient or acid equivalent is given on label.

3.2.3 Active Ingredient

It is that part of a chemical formulation which is directly responsible for pesticidal effect. Thus the commercial pesticide production is made up of two parts i.e. the effective part and the inert part. Since all the recommendations are made on the basis of a.e. or a.i. certain amount of calculations becomes necessary to find out the quantity of commercial product to be required for a given area.

Table 3.2 Identify different pesticides and fill the given particulars

Sl. No.	Chemical Name	Trade Name	Active ingredient (a.i. %)
Herbicides			
1.			
2.			
3.			
4.			
5.			
6.			
Insecticides			
1.			
2.			
3.			
4.			
5.			
Fungicides			
1.			
2.			
3.			
4.			
5.			
Bactericides			
1.			

2.			
3.			
Nematicides			
1.			
2.			
3.			

3.3 Conclusion

Signature of Faculty In-charge

Identification of Tillage and sowing Implements

4.1 Aim

The student should be able to

- Acquire knowledge about different primary tillage, secondary tillage and inter cultural tillage implements
- Identify different tillage implements.

A) Primary tillage implements may be tractor drawn or animal drawn implements. Animal drawn implements mostly include indigenous plough and mouldboard plough. Tractor drawn implements include mouldboard plough, disc plough, subsoil plough, chisel plough and other similar implements.

4.2. Plough and types

The main implement for primary tillage is plough, used for ploughing operations. Different types of plough are used at different places. They may be classified as: (1) Indigenous plough (2) Mouldboard plough (3) Disc plough (4) Chisel plough (5) Sub soiler (6) Rotary plough.

4.2.1 Indigenous plough

Indigenous plough is most commonly used in India. The shape and size of the plough varies with places and regions due to variation in soil types and tillage requirements. The main parts of the plough are: (i) Body (ii) Shoe (iii) Share (iv) Beam and (v) Handle (VI) Wedge.

(i) Body: It is the main frame to which the shoe, beam and handle are attached. It provides necessary weight for penetration of share in the soil.

(ii) Shoe: It is usually pyramid shape piece fixed to the body. This holds the share in position. Its function is to wide the furrow opened by the share and to keep the implement in a balanced condition at the time of working.

(iii) Share: It is a narrow steel bar attached to the upper surface of the shoe longitudinally along the centre line while its front end is projecting beyond the point of shoe. It penetrates into the soil and breaks it to open it.

(iv) Beam: Beam is either straight or curved. Beam is meant for transmitting power to the implement. The length of beam varies between 2.4 to 3.6 meter.

(v) Handle: The handle is generally attached to the body of the plough. It is used for guiding or managing the implements and also for applying the pressure while working for getting the depth of ploughing.

(vi) Wedge: Wedge is a small wooden piece utilized for fixing the share tightly in the body and shoe so proper fitting is obtained to work efficiently.

Draw diagram of indigenous plough and mention its parts

Uses:

4.2.2 Mouldboard plough

A mouldboard plough is very common implement used for primary tillage operation. This plough performs several functions at a time.

Components: The main components of mouldboard plough are- (i) Mouldboard (ii) Share (iii) Landside (iv) Frog and (v) Tail piece.

(i) Mouldboard: It is the curved part which lifts and turns the furrow slice. The mouldboard is of following types: i). General purpose ii). Stubble type iii). Sod or Breaker type and iv). Slat type

(ii) Share: It is that part of the plough bottom which penetrates into the soil and makes a horizontal cut below the surface.

(iii) Land side: It is the flat plate which bears against and transmits the rear side lateral thrust of the plough bottom to the furrow wall.

(iv) Frog: It is the part to which other components of the plough bottom are attached.

(v) Tail piece: It is an adjustable extension, which can be fastened to the rear of a mould board to help in turning.

Draw diagram of Mouldboard plough and mention its parts

Uses :

4.2.3 Disc plough

It is a plough which cuts, turns and in some cases breaks furrow slices by means of separately mounted large steel discs. A disc plough is designed with a view to reduce friction by making a rolling plough bottom instead of sliding plough bottom. A disc plough works well in the conditions where mould board plough does not work satisfactorily.

Advantages of disc plough:

- i. A disc plough can be forced to penetrate into the soil which is too hard and dry for working with a mould board plough.
- ii. It works well in sticky soil in which a mould board plough does not scour.
- iii. It is more useful for deep ploughing.
- iv. It can be used safely in stony and stumpy soil without much danger of breakage.
- v. A disc plough works well even after a considerable part of the disc is worn off in abrasive soil.
- vi. It works in loose soil also (such as peat) without much clogging.

Draw diagram of disc plough and mention its parts

Uses:

4.2.4 Other ploughs

i. Chisel plough:

It is a plough used to cut through hard soils by means of a number of narrow tynes. It is used before using the regular plough. It is useful for breaking hard layers of soil just below the regular ploughing depth. This layer of soil which is called hard pan or plough sole is very tough and hard.

ii. Sub soiler:

It is a plough designed to penetrate the soil to depths more than those achieved during normal ploughing operation. Usually the plough depth may be 40 cm or more. It helps in breaking up of hard pan thus facilitating drainage of heavy soils, stimulating deep root growth, to help crops withstand drought conditions by moisture absorption from deeper layers and aeration of soil.

iii. Rotary plough:

It is a plough used to cut and pulverize the soil by impact of force with the help of a number of rotary tynes or knives which are mounted on a horizontal rotor. Rotary plough is also called as rotary tiller. It is suitable for shallow cultivation and weed control.

iv. Rotavator (Tractor mounted):

It is used for seed bed preparation, weed control, mixing of crop residue and fertilizer in the soil and puddling of soil.

B) Secondary tillage implements are used to create proper soil tilth for seeding and planting. They include different types of harrow, cultivators, levelers, clod crushers and similar implements.

4.3 Harrow and types

A harrow is an implement that cuts the soil to a shallow depth. There are several types of harrows used in India, such as

(1) Disc harrow (2) Spring tooth harrow (3) Spike tooth harrow (4) Blade harrow (Bakhar) etc.

4.3.1 Disc harrow

Disc harrow is most commonly used in India. It performs the harrowing operations by means of a set (or a number of sets) of rotating steel discs, each set being mounted on a common shaft. Disc harrows are of two types depending upon the source power.

- (a) Tractor drawn
- (b) Animal drawn.

Components

Disc harrow is used for breaking clods while preparing seed beds. It has usually six or eight discs fixed in two gangs. There is a strong frame made of mild steel, on which gangs with the discs are mounted. An operator's seat is also provided on the frame. Usually transport wheels are provided for easy movement of the harrow from place to place.

The animal drawn disc harrow mainly consists of : (i) Disc (ii) Gang frame (iii) Beam (iv) Gang angle mechanism (v) Scraper (vi) Spacer (spool) (vii) Clevis (viii) Axle (ix) Middle tyne and (x) Bearings.

Draw diagram of disc harrow and mention its parts

4.3.2 Blade harrow:

Blade is commonly used for performing various functions in upland agriculture.

Blade harrows are used for different purposes like-

- (i) Removal of weeds and stubbles
- (ii) Crushing of clods
- (iii) Working of soil to shallow depth, covering the seeds,
- (iv) Intercultivation and harvesting of groundnut etc.

Draw diagram of blade harrow and mention its parts

4.3.3 Other harrows

(A) Spike tooth harrow

It is a harrow with pegs as working part fitted on a rigid articulated or flexible frame. The peg shaped teeth of diamond cross section is attached to a rectangular frame.

Draw diagram of spike tooth harrow and mention its parts

Functions of harrow

4.4. Cultivator

It is a common implement used throughout the country for conducting various secondary tillage operations. Cultivator can be either tractor drawn or animal drawn. Tractor drawn cultivator has two rows of tynes attached to its frame in a staggered form. The main object of providing two rows in a staggered position is to provide clearance between tynes so that clods and plant residues can freely pass through without blocking. Further cultivator can be of following types- (i) Disc cultivator (ii) Rotary cultivator (iii) Tyne cultivator.

Draw diagram of cultivator and mention its parts

Functions of cultivator

C) Intercultural tillage Implements

Hoes are most commonly used implements for interculture operations. There are various type of hoes like animal drawn hoes, wheel hoes, hand hoes etc.

(i) Animal drawn hoes

They are really miniature form of harrows. They are frequently used to conduct interculture operations in various wide spaced crops.

Parts of the hoes

Following are the principal parts of hoes.

(i) Head Piece (ii) Prongs (iii) Blade (iv) Beam (v) Handle with grip

Head piece is made of rayan or babul wood. The size of the head piece and blade is varying according to the distance at which the various crops are raised. Prongs and blades are made of iron.

(ii) Wheel hoe

It is a hoe with one or two wheels. Wheel hoe is used for interculture purposes in between rows of crops. There is a wheel attached to the two handles, to which a working tool is attached. Wheel is helpful in guiding the tool and maintaining proper depth. It is useful for kitchen gardens. It consists of: (i) Wheel (ii) Axle (iii) Frame (iv) Working tool.

(iii) Hand hoe or hoe cum rake

It is a hand tool with blade (s), tine (s) and sometimes disc (s) attached to a frame.

Draw diagram of handhoe and mention its parts

Uses:

(D) Paddy weeder

Paddy weeder is important equipment for interculture, used in paddy cultivation. Improved varieties of paddy crops are grown in rows and to keep down the weeds, this implement is used. It is used for uprooting weeds and burying them in puddled soil between crop rows.

Draw diagram of paddy weeder and mention its parts

4.5 Implements for sowing

4.5.1 Seed Drill

Seed drill consists of a wooden beam to which 3 to 6 tynes are fixed. These tynes open the furrows into which the seeds are dropped. Holes are made into these tynes and into these holes, the bottom ends of bamboo or metal seed tubes are fitted. These seed tubes are connected at the top to a wooden seed receptacle called hopper. The seeds are fed at a uniform rate 'into this hopper by skilled labour walking behind the seed drill.

Draw diagram of Seed drill and mention its parts

Uses:

4.5.2 Ferti-cum-Seed Drill

Fertilizers are placed at a depth of 5 cm and 5 cm away from seed rows for effective utilization of fertilizers. Both operations *viz.* drilling seeds and fertilizers are done simultaneously by ferti-cum-seed drill. It is similar to seed drill, but with extra tynes and hopper for drilling fertilizers.

Draw diagram of fertilizer-cum-seed drill and mention its parts

Uses:

4.5.3 Mechanical Seed Drill

The seed drill consists of a seed drum with holes in the bottom plate corresponding to the number of seed tubes for passing the seed into the seed tubes. A rotating disc has holes in a circular path and it is kept over a bottom plate. When the holes of rotating disc and bottom plate coincide, seed falls into the tube on its way into the soil. The distance between two holes in rotating disc is proportional to the inter-row spacing of crop.

4.6 Conclusion

Signature of Faculty In-charge

Study of Agro-climatic Zones of India and Odisha**5.1 Aim**

To gain knowledge about different agro-climatic zones of India and Odisha and suitable crops for each zone.

5.2 Agroclimatic Zones of India

The Planning Commission, as a result of the mid-term appraisal of the planning targets of the Seventh Plan, has divided the country into **fifteen broad agro-climatic zones** based on physiographic, soils, geological formation, Climate, cropping patterns, and development of irrigation and mineral resources for broad agricultural planning and developing future strategies. Fourteen regions were in the main land and the remaining one in the islands of Bay of Bengal and the Arabian Sea. The main objective was to integrate plans of the agro climatic regions with the state and national plans to enable policy development based on techno-agro-climatic considerations. In the agro-climatic regional planning, further sub-regionalization was possible based on agro-ecological parameters.

- Agro climatic zone is a land unit in terms of major climates suitable for a certain range of crops and cultivars.

1. Western Himalayan region

- This region extends over

-
- Annual rainfall-
 - Important crops-

Major constraints

- The main problems of this region are poor accessibility, soil erosion, landslides, inclement weather and inadequacy of marketing and storage facilities.
- The population is generally rural-based and poor.

Measures to develop this region

- Intensify the soil and water conservation planning.
- Land utility planning should be implemented.
- Good storage for transportation, marketing & processing.
- Irrigation management like water harvesting technique.

2. Eastern Himalayan Region

- This region extends over
-

- Annual rainfall-
- Important crops-

Measures To Develop This Region

- Soil and water conservation for each watershed.
- Educate the people about the harmful effect of land erosion.
- Facilities of good supply of inputs, marketing, transportation, processing & storage.
- Adoption of integrated farming system.

3. Lower Gangetic Plain

- This region extends over
-

- Annual rainfall-
- Important crops-

Major Constraints

- Lack of good water management.
- Use of local variety.
- Less use of HYV.
- Inadequate supply of inputs.
- Poor marketing and processing.
- Dependent on monsoon.
- Uneducated and poor farmers.

4. Middle Gangetic Plain

- This region extends over
-

- Annual rainfall-

- Important crops-

5. Upper Gangetic Plain

- This region extends over

- Annual rainfall-
- Important crops-

6. Transgangetic Plain

- This region extends over

- Annual rainfall-
- Important crops-

7. Eastern Plateau and Hills

- This region extends over

- Annual rainfall-
- Important crops-

8. Central Plateau and Hills

- This region extends over

- Annual rainfall-
- Important crops-

9. Western Plateau and Hills

- This region extends over

- Annual rainfall-
- Important crops-

10. Southern Plateau and Hills

- This region extends over

- Annual rainfall-
- Important crops-

11. East Coast Plains

- This region extends over

- Annual rainfall-
- Important crops-

12. West Coast Plains and Ghats

- This region extends over

- Annual rainfall-
- Important crops-

13. Gujarat Plains and Hills

- This region extends over

- Annual rainfall-
- Important crops-

14. Western Dry Region

- This region extends over

- Annual rainfall-
- Important crops-

15. Island Regions

- This region extends over
-
-
- Annual rainfall-
- Important crops-

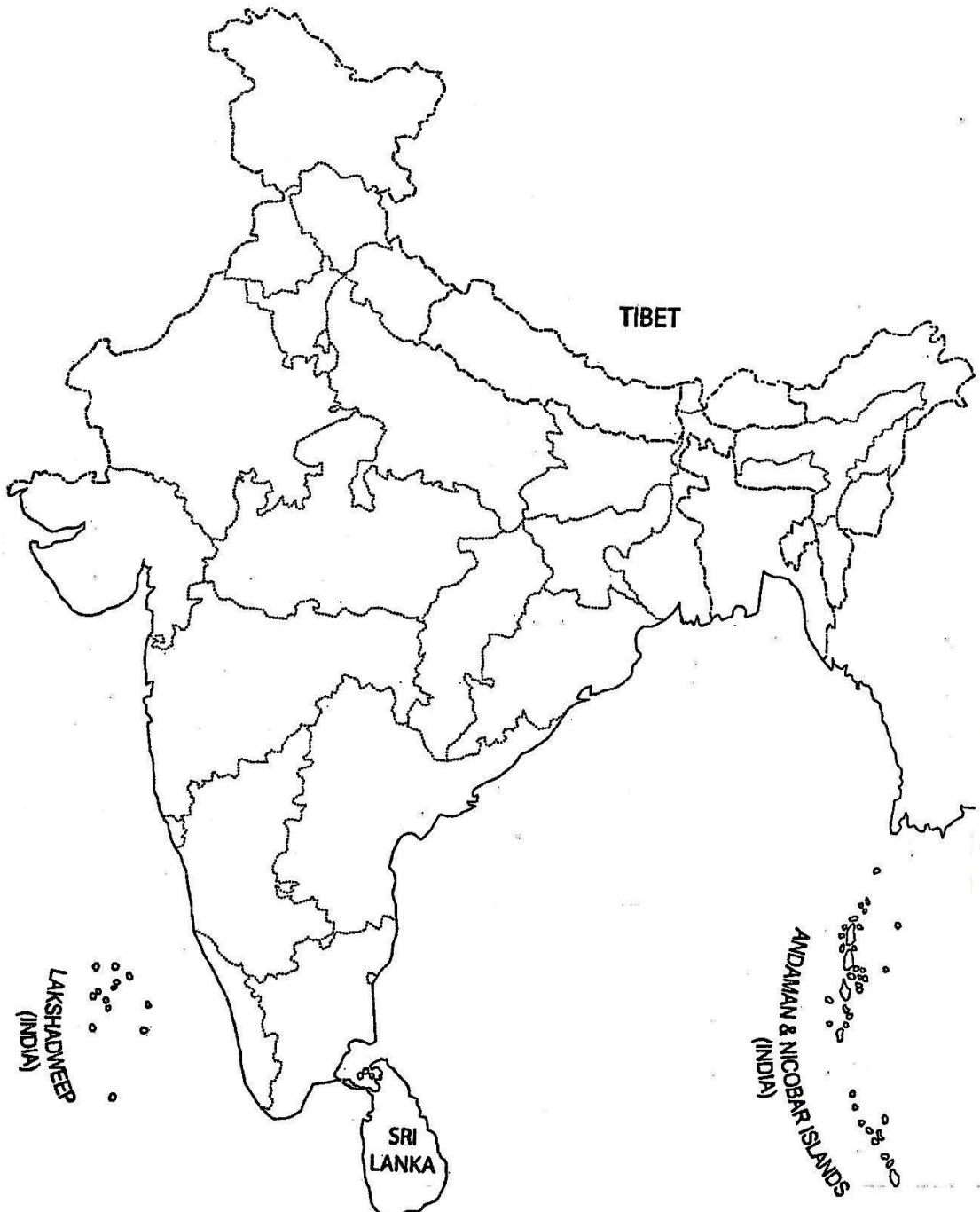


Figure 5.1 : Point out the Agroclimatic zones of India in the map

5.3 Agroclimatic zones of odisha

Background of Odisha

The State of Odisha is located between the parallels of 17.49’N and 22.34’N latitudes and meridians of 81.27’E and 87.29’E longitudes. It is bounded by the Bay of Bengal on the east; Madhya Pradesh on the west and Andhra Pradesh on the south. It has a coast line of about 450 kilometres. It extends over an area of 155,707 square kilometres accounting for about 4.87% of the total area of India. Odisha is the eleventh most populous state in India as per the 2011 Census with about 42 million people contributing 3.47 % to the total population of India. Over the last decade, the state has witnessed a 14 % growth in its population. Most of this population is concentrated in the rural areas with the urban population constituting only 17 %.

India is divided into 15 major Agro Climatic Regions/Zones. Odisha falls under Agro-Climatic Zone VII. Further, the state of Odisha has been divided into 10 Agro-Climatic Zones based on the basis of soil structure, humidity, elevation, topography, vegetation, rainfall and other Agro-Climatic factors.



Figure 5.2 : Point out the Agroclimatic zones of Odisha in the map

Table 5.1 Agro-Climatic Zones in Odisha

Sl. No.	Agro-climatic Zone	Districts	Mean annual rainfall (mm)	Broad Soil Groups
1.	North Western Plateau			
2.	North Central Plateau			
3.	North Eastern Coastal Plain			
4.	East & South Eastern Coastal Plain			
5.	North Eastern Ghat			
6.	Eastern Ghat High Land			
7.	South Eastern Ghat			
8.	Western Undulating Zone			
9.	Western Central Table Land			
10.	Mid Central Table Land			

5.4 Conclusion**Signature of Faculty In-charge**

Experiment No. 6

Date-----

Identification of Major Weeds in Crops

6.1 Aim

To study, identify and acquaint with the common weeds of the locality.

Weed is an unwanted plant growing out of place, where it is not desired. Weeds deplete crop environment for nutrients, crop and light. Weeds interfere and cause inconvenience to agricultural operations. Crop yields and quality of produce are reduced considerably due to weeds infestation. So there is a need to identify weeds and take proper control measures.

6.2 Observation

Table 6.1 Identification of different weeds

Sl. No.	Common name	Botanical name	Family
1.			
2.			
3.			
4.			
5.			
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6.3 Conclusion

Signature of Faculty In-charge

Methods of Fertilizer and Herbicide Application**7.1 Aim**

To ensure the methods of application of fertilizer and herbicide.

7.2 Time of fertilizer application**7.2.1 Basal application****A. Before preparatory tillage**

Bulky organic manures, green manures, soil amendments and soil conditioners are applied before preparatory tillage for thorough mixing with the soil.

B. Basal dressing

Application of manures and fertilizers before last ploughing / puddling or before sowing or planting.

C. At sowing or planting

Concentrated organic manures, readily soluble and higher mobile fertilizers, slow release fertilizers, starter dose of N fertilizer to legume crops and fertilizer for specific nutrient deficient soil are applied during this time.

7.2.2 Top dressing

It is the application of manures and fertilizers to the established crop within crop duration. Top dressing may be done to the soil or to the foliage. Split application of nitrogen and potassium is done throughout the cropping period to increase the fertilizer use efficiency.

7.3 Methods of solid and liquid fertilizer application**7.3.1 Methods of solid fertilizer application****A) Broadcasting**

Even and uniform spreading of manure or fertilizers by hand over the entire surface of field while cultivation or after the seed is sown in standing crop, termed as broad casting.

i) Broadcasting at planting

Broadcasting of manure and fertilizers is done at planting or sowing of the crops with the following aim to distribute the fertilizer evenly and to incorporate it with part of, or throughout the plough layer and to apply larger quantities that can be safely applied at the time of planting/sowing with a seed-cum-fertilizer driller.

ii) Top dressing

It is the application of manures and fertilizers to the established crop within crop duration. Top dressing may be done to the soil or to the foliage. Split application of nitrogen and potassium is done throughout the cropping period to increase the fertilizer use efficiency.

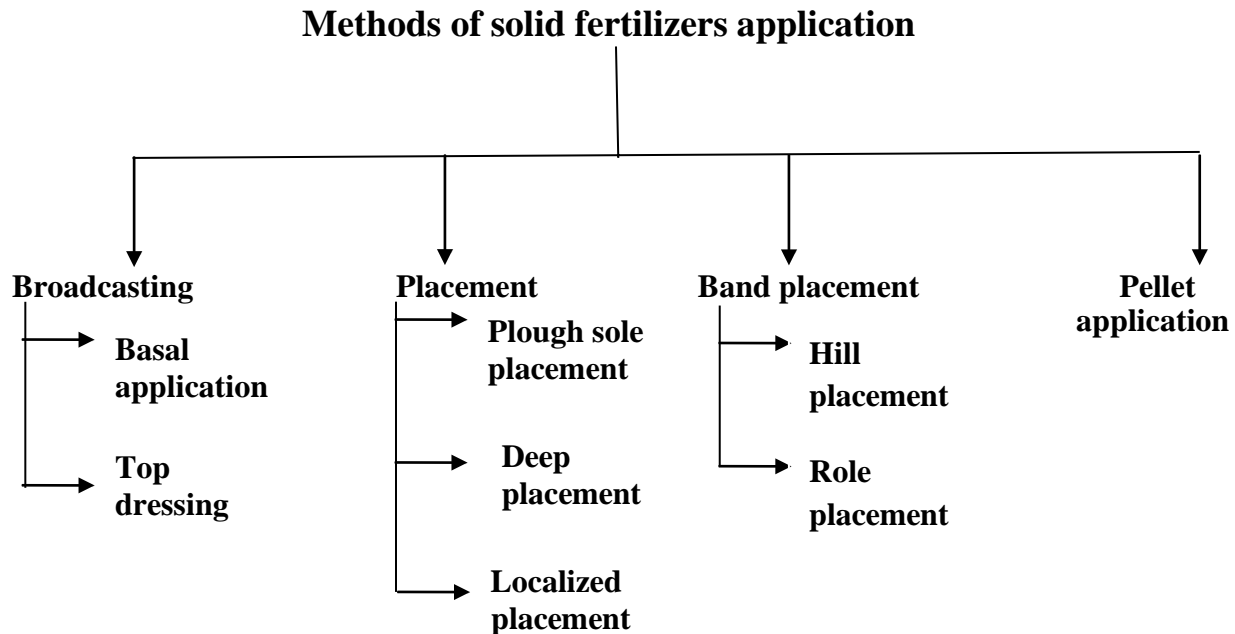


Fig. 7.1 Methods of application of solid fertilizers

B) Placement

It refers to the placement of fertilizers in soil at a specific place with or without reference to the position of the seed. Placement of fertilizers is normally recommended when the quantity of fertilizers to apply is small, development of the root system is poor, soil has a low level of fertility and to apply phosphatic and potassic fertilizer.

i) Plough sole placement

In this method, fertilizer is placed at the bottom of the plough furrow in a continuous band during the process of ploughing.

ii) Deep placement

It is the placement of ammonical nitrogenous fertilizers in the reduction zone of soil particularly in paddy fields, where ammonical nitrogen remains available to the crop.

iii) Localized placement

It refers to the application of fertilizers into the soil close to the seed or plant in order to supply the nutrients in adequate amounts to the roots of growing plants. The common methods to place fertilizers close to the seed or plant are as follows:

1) Drilling

In this method, the fertilizer is applied at the time of sowing by means of a seed-cum- fertilizer drill. This places fertilizer and the seed in the same row but at different depths.

2) Side dressing

It refers to the spread of fertilizer in between the rows and around the plants. The common methods of side-dressing are placement of nitrogenous fertilizers by hand in between the rows of crops like maize, sugarcane, cotton etc., to apply additional doses of nitrogen to the growing crops.

C) Band placement

It refers to the placement of fertilizer in bands.

Band placement is of two types.

i) Hill placement

It is practiced for the application of fertilizers in orchards. In this method, fertilizers are placed close to the plant in bands on one or both sides of the plant.

The length and depth of the band varies with the nature of the crop.

ii) Row placement

When the crops like sugarcane, potato, maize, cereals etc., are sown close together in rows, the fertilizer is applied in continuous bands on one or both sides of the row, which is known as row placement.

D) Pellet application

It refers to the placement of nitrogenous fertilizer in the form of pellets 2.5 to 5 cm deep between the rows of the paddy crop. The fertilizer is mixed with the soil in the ratio of 1:10 and made small pellets of convenient size to deposit in the mud of paddy fields.

7.3.2 Methods of liquid fertilizer application

A) Starter solutions

It refers to the application of solution of N, P₂O₅ and K₂O in the ratio of 1:2:1 and 1:1:2 to young plants at the time of transplanting, particularly for vegetables. Starter solution helps in rapid establishment and quick growth of seedlings.

B) Foliar application

It refers to the spraying of fertilizer solutions containing one or more nutrients on the foliage of growing plants. Foliar application is effective for the application of minor nutrients like iron,

copper, boron, zinc and manganese. Sometimes insecticides are also applied along with fertilizers.

C) Application through irrigation water (Fertigation)

It refers to the application of water soluble fertilizers through irrigation water.

D) Injection into soil

Liquid fertilizers for injection into the soil may be of either pressure or non-pressure types. Anhydrous ammonia must be placed in narrow furrows at a depth of 12-15 cm and covered immediately to prevent loss of ammonia.

E) Aerial application

In areas where ground application is not practicable, the fertilizer solutions are applied by aircraft particularly in hilly areas, in forest lands, in grass lands or in sugarcane fields etc.

7.4 Methods of Application of Herbicides

Soil-Active Herbicide A soil-active herbicide is one that is applied primarily to the soil rather than to the vegetation. Inside the soil it kills weeds as they germinate or inhibits sprouting of their rhizomes, stolons, and tubers.

Eg: simazine, alachlor, trifluralin, and EPTC

7.4.1 Different soil application methods are

- Surface application method
- Sub-Surface Layering
- Band Application
- Soil fumigation

7.4.2 Methods of Application of Foliage-Active Herbicides

A Foliage-active herbicide is applied to weeds after their emergence from the soil. They are absorbed by the plant foliage and these are translocated to the other plant parts.

Eg 2,4,5-T, paraquat, diquat, MCPB, amitrole, and herbicidal oils are common examples of foliage-active herbicides. There may be some herbicides that are both soil-active and foliage-active, for example, 2,4-D, picloram, and atrazine.

A) Blanket Application: Blanket (or over-the-top) it is uniform application of herbicides to standing crops with disregard to the location of the crop plants. Only highly selective herbicides are applied by this method, e.g. 2,4-D in wheat, rice, MCPB in pea, 2,4-DB in Lucerne, and picloram in sugarcane cf. surface application of herbicide

B) Directed Spraying: It is the application of herbicide to weeds, which are growing in the inter-rows of crop avoiding the crop foliage as much as possible. One important prerequisite of directed spraying is that farmer must get his row crops well grown over the weeds at the time of treatment. Orchards and plantations are good venues of directed herbicide sprays. Usually, the directed spraying is adopted with herbicides that are partially selective to the treated crops.

C) Spot treatment: Spot treatment is the application of herbicides to small patches of weeds, leaving the weed-free gaps untreated. This is used for treating patches of noxious, perennial weeds in certain crop fields with potent herbicides. Spot treatment is of value also in the non-crop areas to prevent wastage of herbicide in the weed-free spaces.

D) Protected Spraying: Non-selective herbicides can be employed to obtain selective weed control in distantly planted vegetables and ornamentals either by covering the non-target plants before application of the herbicide with plastic or metallic covers or by spraying herbicide underneath a hooded or shielded sprayer. This method is called protected spraying.

Table 7.1. List out the different methods of fertilizer application in different crops.

Sl. No.	Crop	Method of application	Time of application
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7.5 Conclusion

Signature of Faculty In-charge

Study of Yield Contributing Characters and Yield Estimation**8.1 Aim**

To gain knowledge on yield attributes of different agronomic crops and the yield

Yield potentials of crops/varieties can be accessed on the basis of yield attributing characters. Different crops have different yield attributing characters. After collecting information on these attributes, theoretical yield can be calculated. These observations help farmers to choose a suitable crop or variety for cultivation.

Formula:

$$\text{Grain yield} = \text{Weight of single grain} \times \text{Number of filled grains/panicle} \times \text{Number of panicles (m}^2\text{)}$$

1. Calculate the rice grain yield /ha, with the following details

- a) Filled grain weight = 0.015 g
- b) Number of filled grains/panicle = 200 and
- c) Number of panicles/m² = 200

2. Calculate the rice grain yield /ha, with the following details

- a. Filled grain weight = 0.015 g
- b. Number of filled grains/panicle = 200 and
- c. Number of panicles/ hill = 8
- d. Number of hills/m² = 25

3. Calculate the rice grain yield /ha from the following observations

- a. Test weight = 20 g
- b. Number of filled grains/panicle = 180
- c. Number of panicles / hill = 7
- d. Spacing = 20 cm X 20 cm

Formula

$\text{Grain yield} = \frac{\text{Area (m}^2\text{)} \times \text{Test weight (g)} \times \text{No. of cobs/plant} \times \text{No. of grain /cob} \times \text{No. of seeds /row}}{\text{Spacing (m}^2\text{)} \times 1000 \times 1000}$

4. Calculate the expected yield of maize grain in kg /ha from the following details

- a. Spacing-75 cm x 30 cm
- b. Average no. of cobs/plant-3
- c. Average no. of grain rows/cob-10
- d. Average no. of seeds/grain row-20
- e. Test weight of seeds- 220 g.

Solution:

Yield of maize grains in kg/ha=

5. Calculate the expected yield from 1000 m²green gram plot from following observations

- a. Spacing : 30 cm X 10 cm
- b. Number of pods / plant : 20
- c. Number of seeds/ pod : 10
- d. 1000 seed weight : 30g

Solution :

8.2 Conclusion

Signature of faculty In-charge

Seed Germination Test**9.1 Aim:** To conduct germination and viability test

Germination is defined as the emergence and development from the seed embryo, of those essential structures, for the kind of seed in question, indicates its ability to produce a normal plant under favourable conditions.

9.2 Principles

Germination tests shall be conducted with a pure seed fraction. A minimum of 400 seeds are required in four replicates of 100 seeds each or 8 replicates of 50 seeds each or 16 replicates of 25 seeds each depending on the size of seed and size of containers of substrate. The test is conducted under favourable conditions of moisture, temperature, suitable substratum and light if necessary. No pretreatment to the seed is given except for those recommended by ISTA.

9.3 Materials required**Substratum**

The substratum serves as moisture reservoir and provides a surface or medium for which the seeds can germinate and the seedlings grow. The commonly used substrate are sand, germination paper and soil.

9.3.1 Sand**1. Size of sand particle**

Sand particles should not be too large or too small. The sand particles should pass through 0.80 mm sieve and retained by 0.05mm sieve.

2. Toxicity

Sand should not have any toxic material or any pathogen. If there is presence of any pathogen found then the sand should be sterilized in an autoclave.

3. Germination tray

When we use the sand, germination trays are used to carry out the test. The normal size of the tray is 22.5 x 22.5 x 4 cm. The tray may either zinc or stainless steel.

Method of seed placement**A) Seed in sand (S)**

Seeds are planted in a uniform layer of moist sand and then covered to a depth of 1 to 2 cm with sand.

B) Top of sand (TS)

Seeds are pressed in to the surface of the sand.

4. Spacing

We must give equal spacing on all sides to facilitate normal growth of seedling and to avoid entangling of seed and spread of disease. Spacing should be 1-5 times the width or diameter of the seed.

5. Water

The amount of water to be added to the sand will depend on size of the seed. For cereals, except maize, the sand can be moistened to 50% of its water holding capacity. For large seeded legumes and maize sand is moistened to 60% water holding capacity.

9.3.2 Paper

Most widely used paper substrates are filter paper, blotter or towel (kraft paper). It should have capillary movement of water, at vertical direction (30 mm rise / min.). It should be free from toxic substances and free from fungi or bacteria. It should hold sufficient moisture during the period of test. The texture should be such that the roots of germinating seedlings will grow on and not into the paper.

Methods

A) Top of paper (TP)

Seeds are placed on one or more layers of moist filter paper or blotter paper in petriplates. These petriplates are covered with lid and placed inside the germination cabinet. This is suitable for those seeds which require light.

B) Between paper (BP)

The seeds are germinated between two layers of paper. The seeds are placed between two layers of paper and rolled in towels. The rolled towels are placed in the germinator in an upright position

Formula

$$\text{Germination percentage} = \frac{\text{No. of seeds germinated}}{\text{Total no of seeds sown}} \times 100$$

9.4 Observation

Crop	Total no of seeds sown	No. of seeds germinated	Germination%

9.5 Conclusion

Signature of Faculty In-charge

Experiment no.9 (B)

Date -----

Seed Viability Testing

9.1 Aim

To determine the viability percentage with TZ solution.

9.2 Principle

TZ reaction is a biochemical reaction which is found in living embryo. 2, 3, 5- Triphenyltetrazolium chloride which is colourless, is changed into a red coloured, stable, non-diffusible 2, 3, 5-TriphenylTetrazoliumformazon. This change is done by the enzyme dehydrogenase.

9.3 Requirements

Over-night soaked seeds, watch glass, needle/ blade, 1% TZ solution, oven and dropper.

9.4 Preparation of buffer solution and 1% Tz solution with buffer

Solution no-1: 0.9078 g of KH_2PO_4 is added in 100 ml of distilled water.

Solution no- 2: 1.1876 g of Na_2HPO_4 in 100 ml distilled water.

Buffer solution: 30% solution from solution 1 and 60% of solution from solution 2 are mixed together. Now, buffer solution is prepared. PH of the buffer solution is between 6-8 and it is best for staining.

9.5 Procedure

At first overnight soaked seeds are de-coated with the help of a needle. Then 10 de-coated seeds are taken in a watch glass, with a dropper. 1% TZ solution is added with it. It is kept in the oven in darkness. Thus, it is kept for 1-2 hours and temperature is maintained within $35-40^\circ\text{C}$.

9.6 Results

The watch glasses are taken out of the oven, a no. of seeds retain red colour at embryo are counted. In this case out of 10 seeds treated, all retain red colour. The viability percentage was calculated by using the formula.

Formula

$$\text{Viability percentage} = \frac{\text{No. of seed retain colour}}{\text{Total no. of seeds treated}} \times 100$$

9.7 Observation

Crop	Total no of seeds sown	No. of seeds germinated	Germination%

9.8 Conclusion

Signature of Faculty In-charge

Numerical Exercises on Fertilizer Requirement and Plant Population**10.1 Aim**

To understand the calculation of plant population and fertilizer requirement of crops.

10.2 Calculation of plant population

Number of plants in a particular area depends up on the canopy coverage of the individual plants. If the vigour of the plant is less, canopy coverage is less and requirement of plants per unit area will be more and vice versa.

Formula

$$\text{Plant population (m}^2\text{)} = \frac{\text{Area}}{\text{Row to Row distance (m) x Plant to plant distance (m)}}$$

Problem

1. Calculate the plant population/ ha, if the spacing of two crop species A and B are (i) 20 cm x 20 cm (ii) 15 cm x 15 cm,

2. Calculate the plant population /ha, if maize is dibbled at a spacing of
(i) 75 cm X 25 cm (ii) 60 cm X 25 cm

10.3 Calculation of fertilizer requirement

Fertilizer calculations help to compute the correct amount of fertilizer material to be applied to a given area at the recommended rate. For fertilizer calculations, following data are required:

1. Recommended rate of fertilizer
2. Nutrient content of fertilizer material
3. Area to be fertilized

Formula

$$\text{Amount of fertilizers (kg/ha)} = \frac{\text{Recommended dose of nutrient (kg/ha)}}{\text{Nutrient content in fertilizers (\%)}} \times 100$$

If fertilizer content two or nutrient

$$\text{Amount of nutrient (kg)} = \text{Amount of Fertilizer} \times \frac{\text{Nutrient content (\%)}}{100}$$

Problem

1. Calculate the amount of Urea, SSP and MOP to supply 40-40- 40 kg N-P₂O₅- K₂O in 1 ha area.

2. Calculate the amount of Urea, SSP and MOP to supply 40-40- 40 kg N-P₂O₅- K₂O per hectare in 5000 m² area.

3. Calculate the amount of Urea, SSP and MOP to supply 100-60- 50 kg N-P₂O₅- K₂O per hectare.

4. Calculate the amount of Urea, DAP and MOP to supply 40-40- 40 kg N-P₂O₅- K₂O in 1 ha area.

5. Calculate the amount of Urea, DAP and MOP to supply N-P₂O₅- K₂O @ 60-20-40 kg per hectare in 3 ha rice area.

10.4 Conclusion

Signature of Faculty In-charge

Numerical Exercises on Herbicides and Water Requirement**11.1 Aim**

To know the calculation of herbicide and water requirement of crops

11.2 Calculation of herbicide**Formula**

$$\text{Herbicide requirement (kg or lit)} = \frac{\text{Recommended rate (kg/ha)} \times \text{Area (ha)} \times 100}{\% \text{ of active ingredient}}$$

Problem

1. Calculate the amount of hitlachlor 50 EC to apply butachlor @ 1.5 kg/ha in 3 ha area.
2. Calculate the amount of hitlachlor 50 EC to apply butachlor @ 1.5 kg/ha in 1 ha area.

11.3 Calculation of water requirement of crops

The water requirement of crops is the amount of water that is required to meet the evapotranspiration rate so that crops may thrive. The evapotranspiration rate is the amount of water that is lost to the atmosphere through the leaves of the plant, as well as the soil surface. Therefore, in order to estimate the water requirement of a crop first we need to measure the evapotranspiration rate. The reference rate, ET_0 , is the estimate of the amount of water that is used by a well-watered grass surface that is roughly 8 to 15 centimeters in height. Once ET_0 is known, the water requirement of the crop can be calculated.

Methods to measure the evapotranspiration rates of crops

There are at least two methods that can be used to measure or predict the evapotranspiration rate of crops:

- Evaporation pan
- Using equations that predict the evapotranspiration rate based on climatic parameters.

- **Evaporation pan**

In this method, pan is filled with water and the loss of water from the pan is measured. Provided that there is no rainfall, the evaporation rate, which is recorded as millimeters per day, is quite easy to measure. This method of measurement takes into account wind, temperature, radiation and humidity, which are the same factors that affect crop transpiration rate.

Formula

$$ET_0 = K_{pan} \times E_{pan}$$

Estimating the water requirements of the crop

ET_0 represents the maximum, or potential, evapotranspiration rate that can occur. However, the water requirement of the crop is usually less than ET_0 , as there are factors of the crop itself that have to be taken into account.

These include the growth stage of the plant, the leaf coverage that provides shade to the ground, and other particulars of the crops that make them vary from each other. With these factors taken into account, ET_0 is converted into ET_c , through the crop-specific coefficient, K_c .

ET_c represents the evapotranspiration rate of the crop under standard conditions (no stress conditions).

When calculating ET_c , one must identify the growth stages of the crop, their duration and select the proper K_c coefficient that need to be used.

Formula

$$ET_c = K_c \times ET_0$$

ET_c = Crop water requirement

K_c = Crop coefficient

ET₀ = Evapotranspiration from free water surface

Problem

1. Calculate the water requirement of a crop:

Crop: potato

Growth stage: Initial growth

K_c for initial stage: 0.45

ET₀ (measured by a local meteorological station): 9 mm/day

2. Calculate the water requirement of a crop from the data given below

Crop: Maize

Growth stage: vegetative

K_c for vegetative stage: 0.8

ET₀ (measured by a local meteorological station): 9 mm/day

3. Calculate the water requirement of a crop from the data given below

Crop: Rice

Growth stage: vegetative

K_c for vegetative stage: 0.9

E_{Pan} (measured by a local meteorological station): 10mm/day

K_{Pan}: 0.7

11.4 Conclusion

Signature of Faculty In-charge

Experiment No. 12

Date-----

Visit For On-Farm and On-Station Field Crops

A field trip provides an opportunity to students to acquaint themselves with the important crops of the locality. They are able to know the climate, soil type, irrigation methods, farm and field operations, implements, latest varieties under cultivation, improved and indigenous implements, etc. They also come to know about the various steps involved in seed production in case this is one of the activities of the farm. Similarly, they can observe other activities going on at the farm.

12.1 Materials Required

- (i) Notebook
- (ii) Ball point pen or pencil
- (iii) Lunch box if necessary

12.2 Procedure

- Carry all the necessary things and reach the college in time.
- Get briefing on the visit from the teacher and leave the institution at the scheduled time so that you arrive well within time at the farm.
- Introduce yourself and discuss the purpose of your visit.

12.3 Observations

Table 12.1 Record the following observations in the table given below

Sl. No.	Name of the crop	Root	Stem	Leaf	Inflorescence	Height	Fruit/grain
1.							
2.							
3.							
4.							
5.							

12.4 Conclusion

Signature of Faculty In-charge

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