PRACTICAL MANUAL

INTRODUCTION TO MAJOR FIELD CROPS

HNR 334 Credit Hours 2(1+1)

for

B. Sc. (Horticulture) III Year (V Semester)

Dr. Artika Singh
Dr. Anil Kumar Rai

2021

Department of Agronomy, College of Agriculture
Rani Lakshmi Bai Central Agricultural University
Jhansi-284 003

Course: Introduction to Major Field Crops: HNR 334 2(1+1)

Identification of crop plants, seeds and weeds. Preparation of cropping scheme. Application of herbicides in field crops.

Name of Student .....

Roll No. .....

Batch .....

Session .....

Semester .....

Course Name : .....

Course No. : .....

Credit .....

Published: 2021

No. of copies: ……..

Price: Rs.

CERTIFICATE

This is to certify that Shri./Km. .....ID No..... has completed the practical of course.....course No. ..... as per the syllabus of B.Sc. (Hons.) Agriculture/ Horticulture/ Forestry ..... semester in the year.....in the respective lab/field of College.

Date: Course Teacher

Contents

Experiment No. 1

Objective: To study field crops of India

S. No.	Crop Name	Botanical Name	Family
		I. Cereals	
1	Paddy		
2	Wheat		
3	Maize		
4	Sorghum/Great millet		
5	Barley		
6	Bajra/Pearl millet		
7	Finger millet		
8	Indian or Foxtail millet		
9	Kodo millet		
10	Little millet		
11	Proso millet		
12	Barnyard millet		
		II. Pulses	
1	Pigeon pea/Arhar/Tur		
2	Green gram (Moong)		
3	Black gram (Urd)		
4	Kidney bean (Rajmash)		
5	Cowpea (Lobia)		
6	Horse gram (Kulthi)		
7	Chickpea (chana		
8	Lentil (Masoor)		
9	Lathyrus (Khesari/ Grasspea)		
		III. Oilseeds	
1	Groundnut		
2	Sesamum		
3	Castor		
4	Sunflower		
5	Soybean		
6	Rapeseed & Mustard		

7	Linseed		
8	Sesame		
IV. Forage crops			
1	Barseem		
2	Stylo		
3	Siratro		
4	Velvet bean		
V. Fibre crops			
1	Cotton		
2	Jute		
3	Sunhemp		
VI. Sugar crops			
1	Sugarcane		
2	Sugarbeet		
VII. Miscellaneous crops			
1	Potato		
2	Tobacco		

Experiment No. 2

Objective: To identify *kharif* cereal crops

Materials and methods: Crop plants in field for identification

A large number of crops or varieties are grown in India. Many of these crops have great morphological similarity in their seeds and plants, although they belong to different taxonomic groups. Varieties also differ among each other in plant and seed characteristics. Therefore, it is necessary to identify these crops on the basis of the morphological characteristics, which are given below.

Write down important characteristics of crops:

Crops	Leaf	Stem	Branches	Flowers	Juncture points (Collar region)	Fruits/ Seeds	Special points

Experiment No. 3

Objective: To identify *Rabi* cereal crops

Materials and methods: Crop plants in field for identification

Crops	Leaf	Stem	Branches	Flowers	Juncture points	Fruits/Seeds	Special points

Experiment No. 4

Objective: To identify *Kharif* pulse crops

Materials and methods: Crop plants in field for identification

Crops	Leaf	Stem	Branches	Flowers	Juncture points	Fruits / seeds	Special points

Experiment No. 5

Objective: To identify *Rabi* pulse crops

Materials and methods: Crop plants in field for identification

Crops	Leaf	Stem	Branches	Flowers	Juncture points	Fruits / seeds	Special points

Experiment No. 6

Objective: To identify *Kharif* oilseed crops

Materials and methods: Crop plants in field for identification

Crops	Leaf	Stem	Branches	Flowers	Juncture points	Fruits / seeds	Special points

Experiment No. 7

Objective: To identify *Rabi* oilseed crops

Materials and methods: Crop plants in field for identification

Crops	Leaf	Stem	Branches	Flowers	Juncture points	Fruits / seeds	Special points

Experiment No. 8

Objective: To identify seeds of various crops

Materials and methods: Crops seeds for identification from genebank

Crops	Size	shape	Color	Nature of seed surface	Shape and position of the attachment scar	Presence of hair

Experiment No. 9

Objective: To identify seeds of seasonal weeds

Materials and methods: Seeds for identification

Crops	Size	shape	Color	Nature of seed surface	Shape and position of the attachment scar	Presence of hair

Experiment No. 10

Objective: To identify crop weeds during *Kharif* season

Introduction: To identify weeds on the basis of specific characteristics given below:

S. No.	English name	Scientific name	Family

Experiment No. 11

Objective: To identify crop weeds during *Rabi* season

Introduction: To identify weeds on the basis of specific characteristics given below:

S. No.	English name	Scientific name	Family

Experiment No. 12

Objective: To identify annual crop weeds in Bundelkhand region

Introduction: To identify weeds on the basis of specific characteristics given below:

S. No.	English name	Scientific name	Family

Experiment No. 13

Objective: To collect weeds and prepare herbarium for their identification

Introduction: ……

……..

Materials Required: ……

……

Procedure:

Collection of weed sample: ……

……

……

……

……

……

……

……

Pressing and drying of collected specimen:

……

……

……

……

……

……

……

……

……

Mounting on herbarium sheet: ……

……

……

……

……

……

……

……

……

……

Details of the specimen and tagging

Particular	
Ref. No.	
Location and Habitat:	
Common name (English):	
Local Name:	
Scientific Name:	
Description:	
Collectors Address:	
Date & Time:	

Preservation……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

Experiment No. 14

Objective: To study classification and formulations of herbicides

Introduction: Any chemical used for weed control is called as weedicide or herbicide. Herbicides belonging to one chemical family tend to have similar modes of action on plants and behaviour in soils. Therefore, to have systematic understanding of possible behaviour of new herbicides belonging to a particular group or family, the classification ion of herbicides is essential.

To become familiar with different groups or families of herbicides.

S.No.	Common Name	Trades Name	Formulation	Manufacturer

Experiment No. 15

Objective-To Study about the equipment used for application of herbicides

- Herbicides are largely applied as spray. Several types of sprayers are available from small hand operated to large ground and aerial sprayers.
- Identification of sprayer's parts and their uses.

Activity1: Students first identify the sprayer and write about their functions

Pump ……

……

……

……

……

……

Power source: ……..……..

……

……

…...……

Tank: ……

……

……

……

Agitator ……..……..……

……

……

……

……..……

Distribution system: ……..……

……

……

……

Pressure ……..……

……

……

Pressure regulator: ……..……..……

……

Activity 2: Draw diagrams of different types of nozzles used for spraying agro-chemicals

Experiment No. 16

Objective: To study of herbicide spray equipment

Introduction: A spray is defined as liquid discharged in particles and scattered as dispersed droplets. Sprayer is an appliance which atomizes the spray fluid which may be a suspension, an emulsion or a solution. Different sprayers for different purposes and conditions are available in the market. Knowledge of sprayers is essential for effective application of herbicide and their proper maintenance.

Write down different types of sprayers ……

……

……

……

……

……

……

……

……

……

Write down about dusters ……

……

……

……

……

……

Draw diagrams of followings:

Manually operated sprayer

Tractor powered sprayers

Experiment No. 17

Objective: To calculate herbicidal requirement for field crops

Requirement of a herbicide depends upon the type of herbicide, formulation, percent of active ingredient, area to be sprayed and volume of water. Further, the method of calculation of herbicide dose will be different for aquatic situation (water body) in comparison to unit area of land. All the herbicide recommendations are based on active ingredient (a.i.). Once the a.i. is known, herbicides requirement can be calculated for given area.

Materials: Herbicide formulation, area to be treated (land surface), measuring tape, weighing balance

Write formula/procedure to calculate dose of the herbicide based on a.i. for any herbicide and crop

……

……

……

……

……

……

Active Ingredient (a.i.): ……

……

……

Acid equivalents (a.e.):

……

……

……

……

……

1: Determine the amount of formulated product Glycel 41 SL required to treat 2 ha of land if the recommendation of glyphosate is 0.5 kg a.i. /ha.

……

……

……

……

……

……

……

……

……

……

……

……

……

……

2: A herbicide contains active ingredient of 0.4 kg/litre and the desired rate of application is 1.5 kg/ha. Calculate the quantity of herbicide required for 1 ha.

……

……

……

……

……

……

……

……

……

……

……

……

3: Calculate amount of 2,4-D amine salt required for spraying a pond 40 m in length, 20 m width and 5 m average depth infested with water hyacinth. Recommended dose of herbicide is 10 ppm.

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

……

PRACTICAL No. 18

Objective: To study various cropping systems of the region

Cropping System: The term 'cropping system' refers to the crops, crop sequences and management techniques used on a particular agricultural field over a period of years. It includes all spatial and temporal aspects of managing an agricultural system. It is an important component of a farming system. It represents cropping pattern used on a farm and their interaction with farm resources, other farm enterprises and available technology which determine their makeup.

Cropping Pattern: It is a dynamic concept because it changes over space and time. It can be defined as the proportion of area under various crops at a point of time. In other words, it is a yearly sequence and spatial arrangement of sowing and fallow on a given area.

What are the potential cropping systems of this region? ……..

……

……

Mono Cropping ……

……

……

……

Multiple Cropping ……

……

……

Intercropping: ……

……

……

……

Mixed Cropping: ……

……

……

……

Sequence Cropping: Parallel Cropping: ……

……

……

……

Multi-Storied/Multi-Tiered Cropping/ Multi-Level: ……

……

……

……

APPENDICES

S. No.	Crop Name	Botanical Name	Family
		I Cereals	
1	Paddy	*Oryza sativa* (L)	Gramineae/poaceae
2	Wheat	*Triticum aestivum*	Gramineae/poaceae
3	Maize	*Zea mays* (L)	Gramineae/poaceae
4	Sorghum/Great millet	*Sorghum bicolor* (L) moench	Gramineae/poaceae
5	Barley	*Hordeum vulgare*	Gramineae/poaceae
6	Bajra/Pearl millet	*Pennisetum glaucum*	Gramineae/poaceae
7	Finger millet	*Eleusine coracana* (L)	Gramineae/poaceae
8	Indian or Foxtail millet	*Setaria italic*	Gramineae/poaceae
9	Kodo millet	*Paspalum scrobiculatum*	Gramineae/poaceae
10	Little millet	*Panicum millare*	Gramineae/poaceae
11	Proso millet	*Panicum miliaceum*	Gramineae/poaceae
12	Barnyard millet	*Echinochloa frumentacea*	Gramineae/poaceae
		II Pulses	
1	Pigeon pea/Arhar/Tur	*Cajanus cajan*	Leguminoseae/Fabaceae
2	Green gram	*Vigna radiate*	Leguminoseae/Fabaceae
3	Black gram	*Vigna mungo*	Leguminoseae/Fabaceae
4	Moth bean	*Phaseolus aconitifolius*	Leguminoseae/Fabaceae
5	Cowpea	*Vigna sinensis*	Leguminoseae/Fabaceae
6	Horse gram	*Macrosylemee uniflorum*	Leguminoseae/Fabaceae
7	Chickpea	*Cicer arietinum*	Leguminoseae/Fabaceae
8	Lentil	*Lens esculenta*	Leguminoseae/Fabaceae
		III Oilseeds	
1	Groundnut	*Arachis hypogeal*	Leguminoseae/Fabaceae
2	Sesamum	*Sesamum indicum*	Pedaliaceae
3	Castor	*Ricinus communis*	Euphorbiaceae
4	Sunflower	*Helianthus annus*	Compositae
5	Soybean	*Glycine max*	Leguminoseae/Fabaceae
6	Rapeseed and mustard	*Brassica spp.*	Cruciferae
		IV Forage crops	
1	Cowpea	*Vigna sinensis*	Leguminoseae
2	Stylo	*Stylosanthes lamata*	Leguminoseae
3	Siratro	*Phaseolus macroptinium*	Leguminoseae
4	Velvet bean	*Stizolobium deeringianum*	Leguminoseae
		V Fibre crops	
1	Cotton	*Gossypium* spp.	Malvaceae
2	Jute	*Corchorus* spp.	Tiliaceae
3	Sunhemp	*Crotolaria juncea*	Fabaceae
		VI Sugar crops	
1	Sugarcane	*Sachharum officianarum*	Graminae
2	Sugarbeet	*Beta vulgaris*	Chenopodiaceae
		VII Miscellaneous crops	
1	Potato	*Solanum tuberosum*	Solanaceae
2	Tobacco	*Nicotiana* spp.	Solanaceae

MORPHOLOGY

A large number of crops or varieties are grown in India. Many of these crops have great morphological similarity in their seeds, although they belong to different taxonomic groups. Varieties also differ among each other in seed characteristics. therefore, it is necessary to identify these crops on the basis of the morphological characteristics, which are given below,

Morphology characteristics

Leaf: Colour, size, shape, arrangement
Stem: Colour, size, nature (erect, prostrate, angular trailing etc.) nodes and internodes, solid, hollow, woody, tender
Branches: Branched, unbranched, pattern and arrangement
Flowers: Colour, size, type of inflorescence
Roots/under: Shallow, deep, tap root, adventitious, root colour, rhizomes, ground parts: nuts, bulb etc.
Juncture points: Note the colour, shape, size of any plant part like hair, ligule, auricle, glands etc. present at the joining point of stem with root, leaf with stem, inflorescence with the main stem / branch etc.
Fruits / seeds: Colour, size, shape
Special points: Nature of plant sap (milky, juicy, gum etc.) and its colour, special modification on the plant etc.

SEED

An in-depth knowledge of botany of a plant as well as its seed is necessary, for correct identification of a particular species. In systematic botany or taxonomy, the closely related or similar type of plant are grouped into a single category. These groups are: family, genus, species etc. In seed identification the particular seed in question must be identified up to the species level.

The seed is a mature ovule consists of an embryo a protective covering and stored food as endosperm. The identification of seed is usually by comparison, comparing the seeds with a mental image of what something should be, with specimens in a reference collection or with illustration of seeds. In most cases, the useful clues for the identification of seed came from the following characters:

1. The size, shape and color of seeds
2. The nature, arrangement and pattern of markings that is lines, ridges, pits, projection on the seed surface
3. The shape and position of the attachment scar
4. The presence of wings, hair or scale, spines etc.
5. The internal structure, position and size of the embryo, presence or absence of the endosperm

Seed keys are developed on the basis of characters pertaining to family, genus, and species. Once the seed is characterized for a particular family, identification of the seed could easily be made by studying the above-mentioned seed characters. Quite often it is difficult to identify the seeds as such. In such situation, growing it to a plant could do identification of seed. The original seed sample of the species is always helpful in identification of unknown unconventional crop and weed seeds.

Characteristic of some common seeds

Family: Caryophyllaceae

***Spergula arvensis*:** The seed 1-15mm diameter lens shaped, dull black, thin, flattish with wing. Embryo, Linear, 'U' shaped without endosperm.

Family: Chenopodiaceae

Chenopodium album (*Bathua*): The seed is circular, flat and round; diameter 1-11/2mm, black, smooth and shiny surface.
Chenopodium mural (*Bathua*): Similar to C. album but slightly bigger in size and dull in appearance.

Family: Convolvulaceae

Convolvulus arvensis (Field weed): The seed colour, dull grayish brown, length, 4 to 4 1/2mm; surface roughened with fine tubercles or short wavy lines. Back side convex and lateral plane, scar: inverted 'U' shape and at right angles to the seed's long axis.
Ipomea hederacea*:* The seed diverse in shape (trigonous wedge, two inner faces are equal): size (lanceolate, ovoid to globose surface; smooth and colour: brown black. Scar: horse shoe shape and usually parallel to long axis.

Family: Poaceae

Phalaris minor Retz. (Little seed canary grass, Canary grass, *Gulli danda*): Seeds hard, with pallet covering the grain, which is oval with an acute angle at one end and about 3-5mm long. Glossy and brownish grey in colour.
Avena fatua (Wild oat): The seed consists of mature floret, narrowly cylindrical, tapering at apex, bears a twisted and bent dorsal awn, ventral side flat with fine grooves; colour: grey, brown or black, yellow to white.

Panicum spp: The seed unit consists of one seeded spikelet. The grain surrounded by glumes (thin and papery). Lemma and Palea (hard, smooth and shiny, size: 1 1/2 to 2 3/4 mm usually lance shape.
Setaria etalica: The seed unit consists of one seeded spikelet. The grain surrounded by glumes (thin, papery and smooth). Lemma and Palea (hard, smooth and shiny)

Family: Liliaceae

Asphodelus tennuifolius (wild onion): The seed 1 1/4 long, flattened elliptical three angled. (sharp) acute and black (crustraceous) testa.

Family: Papaeraceae

Argemone mexicana L (Maxican poppy, Satyanashi): Seeds nearly 2 mm long, ovoid, spherical surface with angular depression and a crest along one side, blackish brown in colour
Fumaria parviflora: Fruit very small, globose, one seeded, indehiscent nutlet, rugose when dry and rounded at the top with two pits, color usually green.

Family: Papillionaceae

Medicago sativa (Lucerne): The seed roughly oval (scar lies in board indentation near one end or kindly shape twisted the cong axes (scar lies in middle of a distinct notch). Colour greenish yellow or light brown, length 1½ mm and width 2½ mm to 3mm.
Melilotus alba (white sweet clover): The seed is identified by size (bigger length about 2 ½ mm and width 1½ mm), shape oblong to oval and translucent in appearance), and colour. (golden yellow to light brown). Scar lies in shallow indentation near top.

Family: Polygonaceae

Rumex sp. (wild spinach): Seed three sided acute as both ends, brown, spinning segments if present with long, fine teeth on the margins.

Family: Compositae

Helianthus spp. (Wild Sunflower): Seeds are, long in size, trigonous, very small hairs present on seed surface and dark brown to black in colour.
Cichorium intybus (Coffee chicory, Large rooted chicory, Chicory): Seeds are up to 3mm long, trigonous wedge shaped, pale brown to gray and white in colour, pappus of scales present.
Carthamus oxycantha (Wild safflower): Seeds are smaller than that of cultivated safflower, elongated in shape, grayish in colour with variegation/mottling on seed coat.

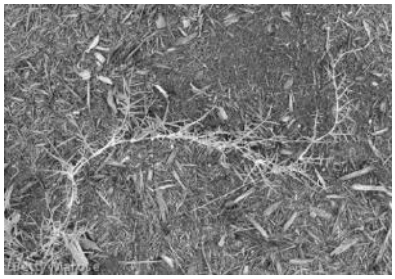
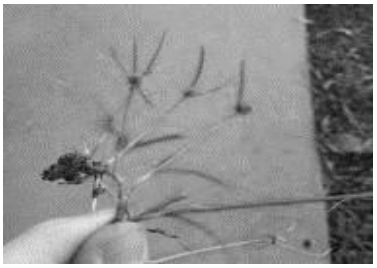
WEEDS

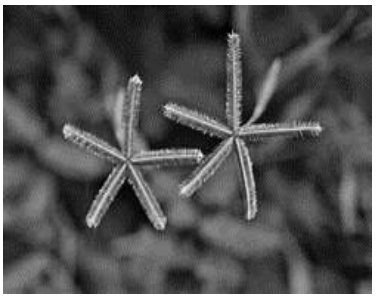
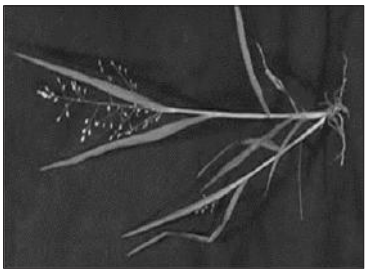
S.No.	English name	Scientific name	Family
***Kharif* weeds**			
1.	Goose grass	*Acrachnera cemosa*	Poaceae
2.	Running grass	*Brachiaria reptans*	Poaceae
3.	Crow foot grass	*Dactyloctenium aegyptium*	Poaceae
4.	Crab grass	*Digitarias anguinalis*	Poaceae
5.	Indian goose grass	*Eleusine indica*	Poaceae
6.	Red sprangletop	*Leptochloa chinensis*	Poaceae
7.	Water grass	*Echinochloa colona*	Poaceae
8.	Barnyard grass	*Echinochloa crusgalli*	Poaceae
9.	Love grass	*Eragrosti spilosa*	Poaceae
10.	Feather love grass	*Eragrostis tenella*	Poaceae
11.	Knot grass	*Paspalum distichum*	Poaceae
12.	Seashore paspalum	*Paspalum vaginatum*	Poaceae
13.	Rough bristle foxtail	*Setaria verticillata*	Poaceae
14.	Green foxtail	*Setaria viridis*	Poaceae
15.	Hedgehog sedge	*Cyperus compressus*	Cyperaceae
16.	Rice flat sedge	*Cyperus iria*	Cyperaceae
17.	Erect horse weed	*Conyza stricta*	Astereceae
18.	Jimson weed	*Datura stramonium*	Solanaceae
19.	Smooth pigweed	*Amaranthus viridis*	Amaranthaceae
20.	Spiny pigweed	*Amaranthus spinosus*	Amaranthaceae

21.	False amaranth	*Digera arvensis*	Amaranthaceae
22.	False amaranth	*Digera muricata*	Amaranthaceae
23.	Creeping chaff weed	*Alternanthera sessilis*	Amaranthaceae
24.	Alligator weed	*Alternanthera philoxeroides*	Amaranthaceae
25.	Blistering ammannia	*Ammannia baccifera*	Lythraceae
26.	Pink node flower	*Caesulia axillaris*	Astereceae
27.	Day flower	*Commelina benghalensis*	Commelinaceae
28.	Spreading day flower	*Commelin adiffusa*	Commelinaceae
29.	Slender day flower	*Commelin aerecta*	Commelinaceae
30.	Wild jute	*Corchorus tridens*	Tiliaceae
31.	Pill pod spurge	*Euphorbia hirta*	Euphorbiaceae
32.	Painted spurge	*Euphorbia heterophylla*	Euphorbiaceae
33.	Petty spurge	*Euphorbia prostrata*	Euphorbiaceae
34.	Shrubby spurge	*Euphorbia microphylla*	Euphorbiaceae
35.	Ground cherry	*Physalis minima*	Solanaceae
36.	Cockle bur	*Xanthium strumarium*	Astereceae
37.	Indian turnsole/Devil weed	*Heliotropium indicum*	Boraginaceae
38.	Black nightshade	*Solanum nigrum*	Solanaceae
39.	False Daisy	*Eclipta alba*	Astereceae
40.	Yellow spider flower	*Cleome viscosa*	Brassicaceae
41.	Purselane	*Portulaca oleracea*	Portulaceae
42.	Desert horse purslane	*Trianthema portulacastrum*	Aizoaceae
43.	Puncture vine	*Tribulus terrestris*	Zygophylaceae
44.	Gulf leaf flower	*Phyllanthus niruri*	Euphorbiaceae
45.	Indian sorrel	*Oxalis corniculate*	Oxalidaceae
46.	Rattle pod	*Crotalaria medicaginea*	Fabaceae
47.	Coffee weed/ Sickle pod	*Cassia tora*	Fabaceae
48.	Creeping indigo	*Indigo feralinnaei*	Fabaceae
49.	Tiger foot morning glory	*Ipomoea pestigridis*	Convolvulaceae
50.	Blue morning glory	*Ipomoea nil*	Convolvulaceae
51.	Wild carrot weed	*Parthenium hysterophorus*	Astereceae
52.	Tridex daisy	*Tridax procumbens*	Astereceae
53.	Hair sedge	*Bulbostylis barbata*	Cyperaceae
54.	Grasslikefimbry	*Fimbristy listenera*	Cyperaceae
55.	Common sedge	*Cyperus difformis*	Cyperaceae
56.	Yellow berried night shade	*Solanum xanthocarpum*	Solanaceae
57.	Golden daisy	*Vicoa indica*	Astereceae
58.	Chicken weed	*Euphorbia thymifolia*	Euphorbiaceae
59.	Common spurge	*Croton sparsiflorus*	Euphorbiaceae
60.	Purslane	*Portulaca grandiflora*	Portulaceae
61.	Purslane	*Porlulaca quadrifida*	Portulaceae
62.	Pink wood sorrel	*Oxalis maritiana*	Oxalidaceae
63.	Little ironweed	*Vernonia cinerea*	Asteraceae
64.	Wild buckweed	*Polygonum glabrum*	Polygonaceae
65.	Small knotweed	*Polygonum plebeium*	Polygonaceae
66.	Coffee senna	*Cassia occidentalis*	Fabaceae
67.	Arrowhead	*Sagittariasa gittifolia*	Alismaracese
68.	Frogfruit	*Lipiano diflora*	Verbenaceae
69.	Hairy slitwort	*Lindernia ciliata*	Serofulariaceae
70.	Purple spikerush	*Eleocharis atropurpurea*	Cyperaceae
71.	Green foxtail	*Setaria glauca*	Poaceae
Rabi Weeds			
1.	Wild oat	*Avena fatua*	Poaceae
2.	Sweet grass	*Poa annua*	Poaceae
3.	Beard grass	*Polypogonmon speliensis*	Poaceae
4.	Poison rye grass	*Lolium temulentum*	Poaceae
5.	Canary grass	*Phalaris minor*	Poaceae
6.	Wild onion	*Asphodelus tenuifolius*	Liliaceae

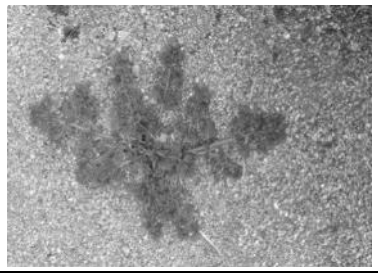
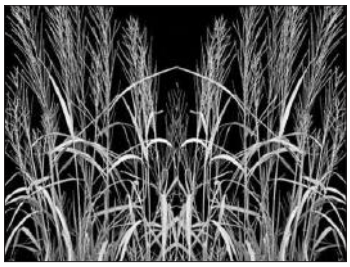
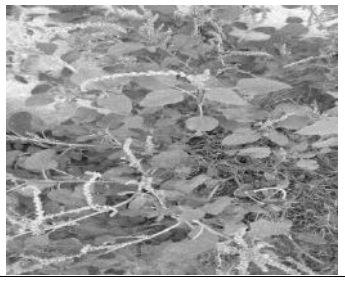
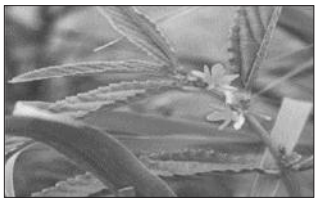
7.	Wild mustard	*Sisymbriu mirio*	Brassicaceae
8.	Barrel clover	*Medicago truncatula*	Fabaceae
9.	California bur clover	*Medicago polymorpha*	Fabaceae
10.	Toothed bur clover	*Medicago denticulata*	Fabaceae
11.	Wild fenugreek	*Trigonella polycerata*	Fabaceae
12.	Common lambsquarter	*Chenopodium album*	Chenopodiaceae
13.	Nettle leaf	*Chenopodium murale*	Chenopodiaceae
14.	Green field-Speedwell	*Veronica agrestis*	Scropulariaceae
15.	Stone seed	*Lithospermum arvense*	Boraginaceae
16.	Canaigre dock	*Rumexhymeno sepalus*	Polygonaceae
17.	Sour dock	*Rumex dentatus*	Polygonaceae
18.	Dock/Sorrel	*Rumex spinosus*	Polygonaceae
19.	Blue daisy	*Cichorium intybus*	Asteraceae
20.	Wild safflower	*Carthamus oxyacantha*	Asteraceae
21.	Maxican poppy	*Argemone mexicana*	Papaveraceae
22.	Perennial saw thistle	*Sonchus arvensis*	Asteraceae
23.	Little mellow	*Malvapar viflora*	Malvaceae
24.	Meadow pea	*Lathyrus aphacaora*	Fabaceae
25.	Grass pea	*Lathyru sativus*	Fabaceae
26.	Blue pimpernel	*Anagallis arvensis*	Primulaceae
27.	Chickweed	*Stellaria media*	Caryophyllaceae
28.	Hairy vetch	*Vicia hirsuta*	Fabaceae
29.	Vetch	*Vicia Sativa*	Fabaceae
30.	Yellow sweet clover	*Melilotus indicus*	Fabaceae
31.	White sweet clover	*Melilotus alba*	Fabaceae
32.	Fumatory	*Fumariapar viflora*	Fumariaceae
33.	Garden cress	*Coronopus didymus*	Brassicaceae
34.	Corn spurry	*Spergula arvensis*	Caryophyllaceae
35.	Cutleafeveningprimrose	*Oenotherala ciniata*	Onagraceae
36.	Wild dog flower	*Antirrhinum orontium*	Scrophulariaceae

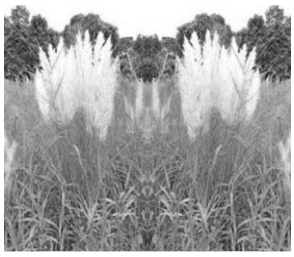
WEED ALONG WITH THEIR PHOTOGRAPHS

<table>
<tr><td>  </td><td>  </td><td>  </td></tr>
<tr><td>Bermudagrass Cynodon dactylon</td><td>Crabgrass Digitarias anguinalis</td><td>Foxtail Setaria viridis</td></tr>
<tr><td>  </td><td>  </td><td>  </td></tr>
<tr><td>Goosegrass Eleusine indica</td><td>Quack grass Panicum repens L.</td><td>Spikesedges Kylling abrevifolia</td></tr>
</table>

		
Water grass Echinochloa *colona*	Yellow nutsedge *Cyperus esculentus*L	Crowfoot grass *Dactyloctenium aegyptium*
		
Barnyard grass *Echinochlo acrusgalli*	Nut grass *Cyperus rotundus*	Day flower *Commelina benghalensis*
		
Canada thistle *Cirsium arvense*	Common chickweed *Stellaia media*	Carpetweed *Mullogo verticillate*
		
Chicory *Cichoriumin tybus*	Goatweed *Ageratum conyzoides*	Blue pimpernel *Anagallis arvensis*
		
Feather love grass *Eragros tistenella*	Common cocklebur *Xanthium strumarium*	Dandelion *Araxacum* officinale

		
Bhrung Raj *Eclipta alba*	Gulf leaf flower *Phyllanthusniruri*	Wild carrot weed *Parthenium hysterophorus*

		
Sickle pod *Cassia tora*	Tridex daisy *Tridax procumbens*	Pattarchatta *Trianthem portulacastrum*
		
Yellow berried nightshade *Solanum xanthocarpum*	Lambsquarter *Chenopodium album*	Common sedges *Cyperus difformis*
		
Red sprangle *Leptochloa chinensis*	Datura *Datura stramonium*	Amaranthus *Amaranthus viridis*
		
Ground cherry *Physalis minima*	Wild jute *Corchorus tridens*	Black nightshade *Solanum nigrum*
		

Alligator weed *Alternanthera philoxeroides*	Canary grass *Phalaris minor*	Wild oat *Avena fatua*
		
Corn spurry *Spergula arvensis*	Tiger grass *Saccharum spontaneum*	Field bind weed *Convolvulus arvensis*

CHARACTERISTICS OF WEEDS

Different weeds are present in field and can be identified on the basis of the characteristics

(A) Morphology of the plant

Leaf: Colour, size, shape, arrangement

Stem: Colour, size, nature (erect, prostrate, angular trailing etc.) nodes and internodes, solid, hollow, woody, tender

Branches: Branched, unbranched, pattern and arrangement

Flowers: Colour, size, type of inflorescence

Roots/under: Shallow, deep, tap root, adventitious, root colour, rhizomes,

Ground parts: nuts, bulb etc.

Juncture points: Note the colour, shape, size of any plant part like hair, ligule, auricle, glands etc. present at the joining point of stem with root, leaf with stem, inflorescence with the main stem / branch etc.

Fruits / seeds: Colour, size, shape

Special points: Nature of plant sap (milky, juicy, gum etc.) and its colour, special modification on the plant etc.

(B) Growth duration: Annual / biennial /perennial

(C) Categorization in broad groups: Grasses / sedges / broadleaf

(D) Nature: Associated, crop bound, parasitic, facultative, obligate Some characteristics of persistent weeds

Nutsedge *(Cyperus* spp.): There are two common species of nutsedge, namely, *Cyperus esculentus* L (yellow) and *C. rotundus* (purple). A purple nutsedge plant possesses a prominent basal bulb just below the ground level .This basal bulb produces a chain of tubers which ramify as deep as 60 cm in the soil. But in yellow nutsedge, instead of basal bulb there are crown buds a little below the soil surface which give rise to cluster of short rhizomes ending in small tubers. When mother shoots of yellow nutsedge are destroyed by tillage, new aerial shoots are borne by these crown buds. Chief mode of propagation of yellow nutsedge is from seeds(nuts). Its tubers are small and slow growing. During the first one month of purple nutsedge, a mother tuber can produce four daughter tubers, and in three months the tuber population may reach almost 100. This makes purple nutsedge much more problematic than yellow nutsedge.

Carrot grass (*Parthenium hysterophorus*): Carrot grass is an annual plant with wide amplitude of ecological adaptability; being both photo and thermo insensitive. It reproduces itself freely from numerous seeds (5000-10000 per plant). When mother plant is cut, its crown bud produces new shoots. The weed is notorious for causing allergic dermatitis and mental depressions in human beings. The main toxin responsible is parthenin. In summers, carrot grass tends to stunt its growth and remain in rosette form. It shoots up new growth in the rainy season and grows fast through the winters, attaining a height up to 90 c, with profuse branching. The plant flowers and sets seeds throughout its growing period.

Safed murga (*Celosia argentia*): It is herbaceous annual weed. It propagates through seeds which germinate with the onset of rains. The inflorescence is pinkish- white and can be recognized from a distance in a crop field. The plants have numerous lateral roots just a few centimeters below the soil surface which enable efficient absorption of nutrients from the soil. The plant has shallow root system.

WEED HERBARIUM

A herbarium is a museum and a database of dried, pressed plant specimens. Each specimen is a voucher deposited for future reference because a herbarium is a repository of information: geographical distributions, taxonomic, biological and ecological data. Collection of weeds and keeping in herbarium is the foremost and best approach in weed science teaching,

research and extension. Rich collection of weeds is a reliable reference for weed researchers in the identification of weeds. Herbarium preparation is a very difficult task. It involves several steps from collection to identification. Collection Healthy and ideal plants which are free from insect-pests and diseases are selected. The specimen(s) should include if possible, all plant parts (underground parts, stems, leaves, flowers and fruits). As a general rule, sterile (non-flowering or -fruiting) specimens will not be accepted. When collecting, keep in mind that the "final" specimen, after pressing and drying has to fit on herbarium sheet of 41.5 x 29 cm. The collected plants are placed in polythene bags separately to avoid mixing of species. Two to three specimens may be collected to select the best one. Every species should be given identification number. The detail such as habitat, morphology etc., may be noted. The identification number should accompany throughout every stage of herbarium preparation process. The following information has to be recorded in the field note book,

a. Collection number
b. Vernacular name
c. Plant habit (erect or prostate, herbaceous or woody etc.)
d. Colour of leaves/flowers
e. Types of leaves/flowers
f. Habitat (soil, water regime, soil texture, associated crop etc)
g. Date of collection
h. Place of collection Also make notes on any plant characteristic that may not be obvious from the dried specimen; e.g., colour, fragrance, etc. Collection should be made during afternoon hours of sunny days.

Pressing-The purpose is to extract the moisture, so that plants do not rot or go moldy. Pressing and drying preserve the morphological integrity of the plants, which can be then mounted on herbarium paper and stored for a long time. Pressing plants immediately after collection results in the best herbarium specimens. Wash the specimens with fresh water. Wipe them with a dry cloth. Press the specimen when it is still fresh. The specimens are carefully arranged in folded newspapers. Each newspaper should hold one weed specimen with an accompanying label. The specimen should not be larger than the herbarium sheet. Thinning of some branches and leaves is done to avoid excess overlapping. Specimen should not be folded or crumbled. Long specimens should be cut in pieces at the most in three. The plant should be arranged exactly as it is to be shown on the herbarium. A plant press consists of a wooden frame (for rigidity), corrugated cardboard ventilators (to allow air to flow through the press), blotter paper (to absorb moisture), and folded newspaper (to contain the plant material). For pressing the specimens, lay a piece of corrugated cardboard over a wood or steel frame. Follow this by a blotting paper containing plant specimen and then another blotting paper. Repeat this sequence until all specimens are arranged and the pile is large enough to be pressed conveniently. Press the pile gently between a pair of wooden presses by applying light pressure. Tie the pile and an identifying tag.

Drying- The pressed plants must be thoroughly dried prior to storage and mounting. Best results are obtained with the use of an electric drier that holds the presses and provides steady bottom heat between 45°C and 60°C. In the absence of a drier make sure you replace the blotter paper periodically until the specimens are dry. Rapid drying promotes the best retention of plant color, but excessively high temperatures or long drying periods can result in blackened, discolored, and brittle specimens. Sun drying is slower than artificial drying but natural colour retention is achieved. In sun drying corrugated cardboards are 24 used on top and bottom of the pile. The absorbent papers need to be changed every day to prevent mould growth on specimens.

Poisoning- In warm countries herbarium are frequently prone to termite attack. It is very difficult to control these pests due to humid weather. The weed specimen once dried need chemical treatment to protect them from insect attack and other destructive organisms. Thus, dipping of specimens is essential. The following solutions are used for the treatment. 1. Mercuric chloride (25 g) + cresol (25 g) in one litre industrial alcohol. 2. Mercuric chloride (15 g) + phenol crystals (10 g) in one litre denatured alcohol. 3. 20% lauryl pentachloro phenate in methylated sprits. The plants are re-dried as discussed earlier. These solutions are corrosive and proper care is needed to handle them. Mounting After the specimens are dried and poisoned, they are mounted on herbarium sheets. Generally, the size of the herbarium sheet is 42 cm x 29 cm. The herbarium sheet should be of good quality and medium in weight. The specimens are placed in the centre of the sheet. Glue or narrow strips of adhesive tape (preferable transparent) are used to mount the specimens on the herbarium sheet. Several herbarium glues are available in the market. If these are not available prepare the following gum, 1. 500 g gum Arabic, 200 g sugar and 15 g phenol dissolved in 1 litre of 8% methylated spirit solution. 2. Dissolve the 500 g gum Arabic in 800 ml boiling water. Add 30 g mercuric chloride and 15 g phenol. Glue is applied to plant specimen only. The lower right-hand corner of the herbarium sheet should bear the label containing the information as, 1. Vernacular name 2. Common name 25 3. Scientific name 4. Family 5. Place of collection 6. Date of collection Storage The herbarium sheets are stored in closed containers. To prevent further insect attack, a handful of 1:1 mixture of paradichlorobenzene and naphthalene should be placed in cloth bag in the container. This is replenished at regular intervals. The place of keeping herbarium cabinets need spray of mild insecticides regularly.

Identification- To identify a given species and family refer to previously identified specimens in herbarium, manuals, weed flora monographs, illustrated books or seek the assistance of competent plant taxonomist. The specimens those cannot be identified, it is necessary to send them to experts/specialists. Weeds are identified by scientific names. Arrangement of

specimens in the cabinet for larger collections it is better to use family wise system. The weed species belong to one family should be placed in the one rack and then arranged in alphabetically order. For small collections weeds are arranged alphabetically by scientific name. It is a necessity to arrange weed specimens by standard methods to enable easy retrieval for future reference. For long lasting collection, the weeds should be kept in metal cabinets. They should be frequently fumigated to protect them from insect damage.

CLASSIFICATION OF HERBICIDES

1. Based on chemical structure

Inorganic herbicides – Inorganic herbicides do not contain carbon atoms in their molecules, For example, Arsenic acid, sulphuric acid, sodium arsenate, sodium chlorate, borax, copper sulphate.
Organic herbicides – Organic herbicides contain carbon atoms in their molecules. They may be oils or non-oils. Majority of the present-day herbicides are organic compounds which are non-oils.

2. Based on selectivity

Selective: Selective herbicides kill only target plants or weeds while crops are not affected e.g., Simazine, atrazine, 2,4-D, MCPA, butachlor, alachlor, flutolanil etc.
Non-Selective: Non-selective herbicides kill all vegetations that they come in contact with irrespective of whether it is a crop or weed, e.g., Paraquat and diquat.

3. Based on translocation

Systemic – Systemic herbicides move within the plant either through xylem or phloem. Most of the herbicides are selective at recommended rates, Example, Altrazine, simazine, 2,4-D etc.
Contact herbicides kill plants when they come in contact with plants. They kill the part of the plant that is in contact with herbicides e.g., Paraquat, diaquat.
Type of herbicide formulations: The first way in which formulations are classified is LIQUID or DRY. All liquids are applied through sprayers or spot applicators. Dry products can be diluted in water and applied as a spray, or applied directly as granules or pellets. The different types of formulations are given below:
Emulsifiable concentrate (E.C.): An emulsifiable concentrate formulation usually contains the active ingredient, one or more petroleum solvents, and an emulsifier that allows the formulation to be mixed with water. When an emulsifiable concentrate herbicide is added to water, the mixture becomes 'milky'. Emulsions require some degree of agitation to prevent separation. *e.g.,* Basalin 45 EC.
Wettable powder (W.P.): Herbicide materials of low solubility may be milled into fine powder that makes stable suspension in water. Wettable powders require continuous agitation to prevent their setting and to give a uniform level of chemical in the spray *e.g.,* Atrazine 50 %WP.
Soluble powder (S.P.): These can be dissolved in convent amounts of water and sprayed efficiently. Salts of most herbicides are soluble in water *e.g.*, Dalapon and sodium salt of 2,4-D etc.
Soluble concentrate (S.C.): Herbicides which are available in the form of soluble liquids and can be easily added to water, e.g. Dicamba and 2,4-D.
Granules (G.): The granules are small pellets formed from various inert clays and sprayed with a solution of the toxicant to give the desired content. After the solvent has evaporated the granules are packed for use, e.g., Butachlor granules.

	Common Name	Trades Name	Formulation	Manufacturer
1.	Fenoxaprop	Acclaim Extra	0.57 E	Bayer
2.	Quizalofop	Assure II	0.88 EC	Corteva
3.	Pinoxaden	Axial	0.83 EC	Syngenta
4.	Clethodim	Envoy	0.94 EC	Valent
5.	Fluazifop	Fusilade DX	2 EC	Syngenta
6.	Diclofop	Hoelon	3 EC	Bayer
7.	Diclofop	Illoxan	3 EC	Bayer
8.	Fluazifop-P	Ornamec	0.5 EC	PBI Gordon
9.	Pinoxaden	Manuscript	0.42 EC	Syngenta
10.	Sethoxydim	Poast	1.5 EC	Microflo
11.	Sethoxydim	Poast Plus	1 EC	Microflo
12.	Quizalofop	Provisia	0.88 EC	BASF
13.	Fenoxaprop	Ricestar HT	0.58 EW	Bayer
14.	Clethodim	Select	2 EC	Valent
15.	Clethodim	TapOut	1 EC	Helena
16.	Quizalofop	Targa	0.88 EC	Gowan
17.	Sethoxydim	Vantage	1 EC	BASF; Microflo
18.	Nicosulfuron	Accent Q	54.5 DF	Corteva

19.	Metsulfuron	Ally XP	60 DF	FMC
20.	Imazapyr	Arsenal A.C.	4 AC	BASF
21.	Primisulfuron	Beacon	75 DF	Syngenta
22.	Imazamox	Beyond	1 S	BASF
23.	Imazapic	Cadre	70 DG	BASF
24.	Sulfosulfuron	Certainty	75 DF	Valent
25.	Imazapyr	Chopper	2 SL	BASF
26.	Metsulfuron + chlor-Sulfuron (48% + 15%)	Cimarron Plus	63 DF	Bayer
27.	Chlorimuron	Classic	25 DF	Corteva
28.	Chlorsulfuron	Corsair	75 WDG	Nufarm
29.	Rimsulfuron + Thifensulfuron	Crusher	50 DF	Cheminova
30.	Trifloxysulfuron	Envoke	75 DG	Syngenta
31.	Florasulam	Defendor	0.42 SC	Corteva
32.	Metsulfuron	Escort	60 DF	Bayer
33.	Tribenuron	Express	50 SG	FMC
34.	Cloransulam	FirstRate	84 DF	Corteva
35.	Penoxsulam	Grasp	2 EC	Corteva
36.	Imazapyr	Habitat	2.0 lb/gal	BASF
37.	Halosulfuron	Halo Max 75	75 WG	Aceto
38.	Thifensulfuron	Harmony SG	50 DF	FMC
39.	Imazaquin	Image	1.5 EC	BASF
40.	Imazosulfuron	League	75 WG	Valent
41.	Flazasulfuron	Katana	25 DF	PBI Gordon
42.	Bensulfuron	Londax	60 DF	UPL-NA

EQUIPMENT USED FOR APPLICATION OF HERBICIDES

Pump: Any spray liquid must be atomized before it leaves the spray nozzle. The pump provides the necessary pressure for this purpose.

Types of Pumps:

a. Air Compression or Pneumatic pumps: These pumps force air into an air tight tank containing spray liquids thus moving the spray liquid under pressure through the nozzle for its atomization.
b. Hydraulic or Positive Displacement Pump: These pumps take in a definite volume of spray liquid and force it through the delivery system under pressure. The pump differs in pressure they produce.

Source of Power: It is needed to run the spray pumps. The source of power may be either Manual, Traction, Motor, Tractor and air craft engines.

Spray Tank: A sprayer may have either built in tank or a separate tank to carry spray liquid. The tank should be large enough to avoid frequent refilling but not unhandy to carry. The tank is provided with a large opening fitted with a strainer and cap to fill in the liquid. It is difficult to fill in liquid and clean the tank having small openings.

Agitator: It may be either mechanical or hydraulic purpose, to keep liquid spray homogenous. Mechanical agitators may be of metal fan or rod etc. Hydraulic agitator consists of a pipe with several side holes and closed at its free end is placed in the tank and it is fed with spray liquid from the pump. From these holes the liquid emerges as jets to provide agitation to the whole body of the liquid. This is called as 'By pass system'. Hydraulic agitation is not thorough but it is more convenient in power sprayers using on large tank size. Sprayer without agitator should not be used to apply pesticide emulsion and suspension.

5. Distribution System: It includes Nozzle, Spray lance, Spray boom, Hose

Nozzle: The function of spray nozzle is to break pressurized spray liquid into droplets for application to the target.
Lance: It is brass rod or 90 cm length attached to a delivery hose pipe of sprayer and fitted to its free end with a replaceable nozzle. A herbicide spray lance is bent at its nozzle to form a goose neck. At the hose end it is provided with trigger mechanism to control flow liquid for specific purpose. The spray lance may be fitted with plastic shields to prevent chemical from drifting
Spray bar or Boom: It consists of a horizontal pipe on which 2 or several nozzles are fitted and spaced at 50 cm apart. Boom length varies from 1 to 15 m. Short boom with 2-3 nozzles is used with manual sprayers, while longer ones with tractor sprayers. The main advantage of spray boom over spray lance is wide swath it covers in each trip of the sprayer over the field. Total width of land wetted by a boom can be adjusted to get either (i) Uniform spray (ii) Directed spray or (iii) Band spray

Pressure regulator: It is fitted to heavy duty sprayers and tractor driven sprayers so as to run the sprayers at constant pressure. Pressure gauge is provided to check pressure.

Nozzles are identified by Droplet size, Delivery and Spray pattern that they produce spray pattern is fixed for a herbicide work, eight kinds of spray nozzles are common e.g.

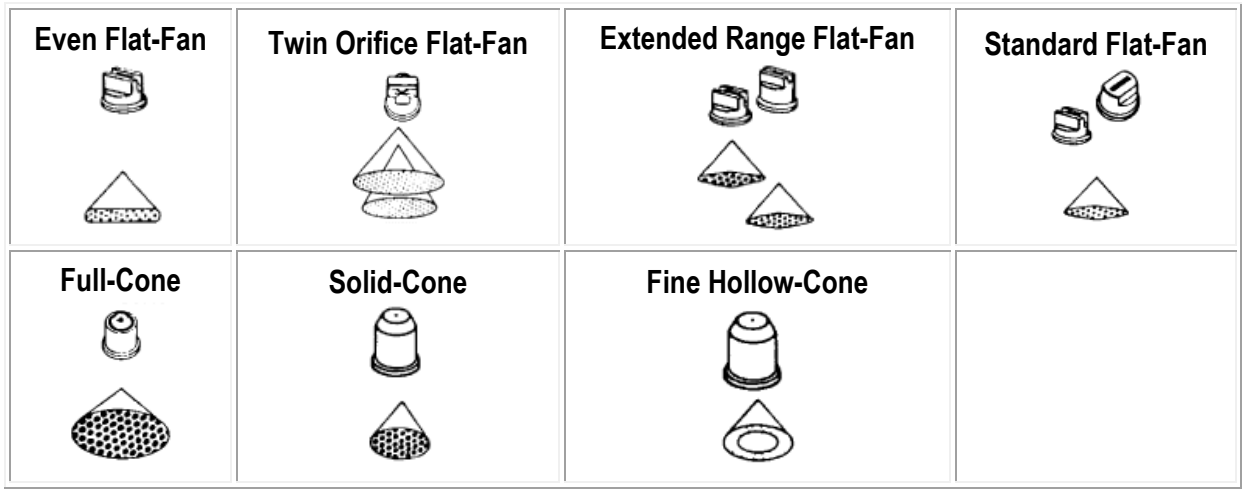
Flat fan: Flat fan nozzles are available in two spray patterns viz. the tapped edge pattern and rectangular pattern. Tapped edge pattern to apply pre- and post-emergence herbicide broadcasting, while rectangular pattern for the pre-emergence bank application of herbicides.

Solid cone nozzle produces medium size droplets. Good for pre- and post-emergence spray. Also used for surface application of herbicides which gives fan like spray.

Triple action nozzles-diameter of the sprays can be easily changed during operating to produce either coarse or fine spray.

Broad cast fan nozzles are used for spraying on unwanted vegetation, road side fence, rows etc. it gives wide coverage of 5 to 8 m with coarse droplets on emulsion to avoid drift.

Blast nozzle: Motorized sprayers blowers employ blast nozzles. These nozzles feed the spray liquid into the air steam to split it into droplets and carry the droplets by the velocity of the wind.



PROCEDURE FOR CLEANING AND MAINTAINANACE OF SPRAYER

- Remove and clean all screens and boom extensions with kerosene and a small brush.
- Mix one box of detergent with 30 gallons of water in tank. Circulate through by pass system or 30 minutes and the drain out.
- Replace the screens and the boom extensions.
- Fill the tank 1/3 rd to ½ with one part of hose hold ammonia to 49 parts of water. Circulate this mixture through the pump and nozzles. Let the remaining solution stand overnight and then run it over through the nozzle.
- Flush with two tanks full of clean waters spraying through the boom with the nozzle removed.

Kinds of sprayers

Knapsack sprayers: They are loaded on the back of the worker during operation. Usually, they carry metallic tanks but nowadays also available in plastic tanks. There are three types of knapsack sprayers (i) Hydraulic sprayers (ii) Manual pneumatic sprayers and (iii) Motorized pneumatic sprayers.

Foot sprayers: Foot sprayers are very popular for application of herbicides on comparatively large holdings. The pump lever of a sprayer has a pedal. The sprayer has provision for 1-2 delivery hoses.

Tractor powered: Tractor mounted sprayers work under a spray pressure of 1.4-2.8 kg/cm2. It is very useful equipment for large holding farmers. Tractor mounted sprayers give high uniformity of the spray and utilization of tractor during idle time.

HERBICIDES APPLICATION

Requirement of a herbicide depends upon the type of herbicide, formulation, percent of active ingredient, area to be sprayed and volume of water. Further, the method of calculation of herbicide dose will be different for aquatic situation (water body) in comparison to unit area of land.

Materials and procedures: Herbicide formulation, area to be treated (land surface) measuring tape, weighing balance, given numerical etc.

Herbicide requirement for field crops: All the herbicide recommendations are based on active ingredient (a.i.). Once the a.i. is known, herbicides requirement can be determined by applying the following formula :

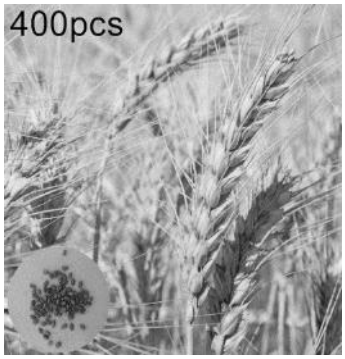
$$\text{Quantity of herbicide (kg/ha)} = \frac{\text{Recommended dose (kg a.i/ha) x Area to be treated (ha)}}{\text{\% a.i. in the formulation}} \times 100$$

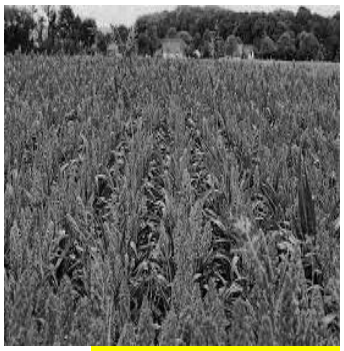
Commercially, the herbicides are available either in solid or liquid form. On the label of the containers you will found a.e.= Acid equivalent or a.i. active ingredient for liquids and g/lit solids

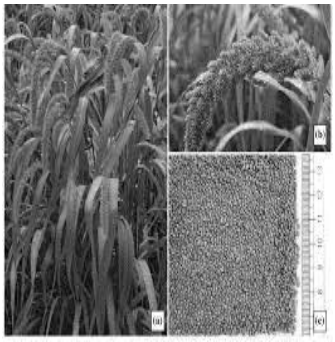
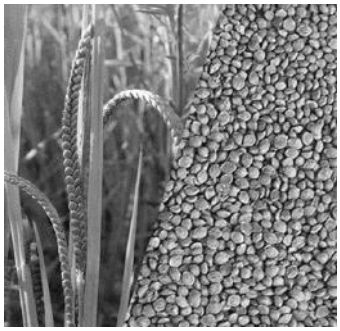
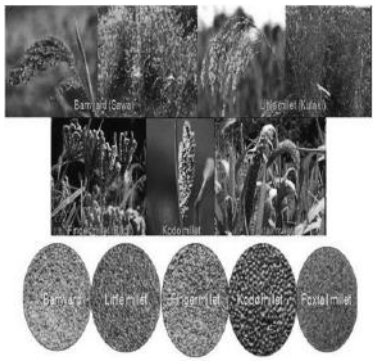
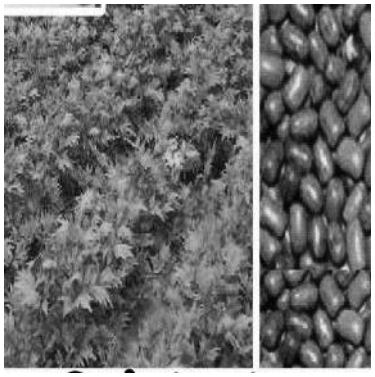
Active Ingredient (a.i.): It is that part of a chemical formulation which is directly responsible for herbicidal effect. Generally expressed as % by weight or by volume. Thus the commercial herbicide production is made up of two parts i.e. the effective part and the inert part.

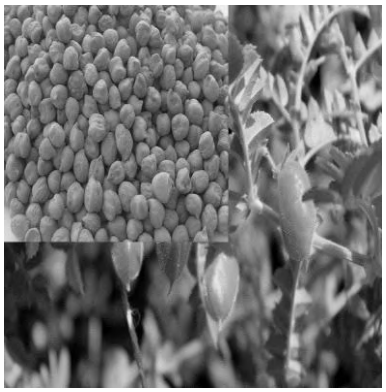
Acid equivalents (a.e.): Some herbicides like phenoxy acetic acid, picloram and chloramben etc. are active organic acid but many of these generally supplied in the form of their salts and esterase's., 2-4 D is available in the form of ester, sodium salt or amine salt. The theoretical yield of the acid in such herbicide formulation is called its acid equivalent. In case of Na salt of 2-4 D. The acid equivalent is 92.5%, which means 2-4 D is 92.5 % in sodium salt.

Crops along with their photographs

<table>
<tr>
<td> 
Paddy *Oryza sativa* (L)</td>
<td> 

Wheat *Triticum aestivum*</td>
<td> 
Maize *Zea mays*</td>
</tr>
<tr>
<td> 
Sorghum *Sorghum bicolor* (L) moench</td>
<td> 
Barley *Hordeum vulgare*</td>
<td> 
Bajra/Pearl Millet *Pennisetum glaucumhypogeal*</td>
</tr>
</table>

		
Finger Millet *Eleusine coracana* (L)	Foxtail millet *Setaria italic*	Kodo millet *Paspalum scrobiculatum*
		
Minor millets *Panicum millare*	Barnyard *Echinochloa frumentacea*	Pigeon Pea/Arhar/Tur *Cajanus cajan*
		
Greengram *Vigna radiate*	Black gram *Vigna mungo*	*Moth bean Phaseolus aconitifolius*

		
Cowpea *Glycine max*	Horse gram *Macrosylemee uniflorum*	Chick Pea *Cicer arietinum*

		
Lentil *Lens esculenta*	Groundnut *Arachis hypogeal*	Sesame *Sesamum indicum*
		
Castor *Ricinus communis*	Sunflower *Helianthus annus*	Soyabean *Glycine ma*