

PRACTICAL MANUAL

For

Weed Management in Horticultural Crops

c - 2(1+1)

for B.Sc. Horticulture II year III Sem



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2020

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Syllabus HFS 202 - 2(1+1):

Identification of weeds; Survey of weeds in crop fields and other habitats; Preparation of herbarium of weeds; Calculations on weed control efficiency and weed index; Herbicide label information; Computation of herbicide doses; Study of herbicide application equipment and calibration; Demonstration of methods of herbicide application; Preparation of list of commonly available herbicides; Study of phytotoxicity symptoms of herbicides in different crops; Biology of nut sedge, bermuda grass, parthenium and celosia; Economics of weed control practices; Tours and visits of problem areas.

Note: Students should submit 40 pressed and well-mounted specimens.

Name of Student

Roll No.

Batch

Session

Semester

Course Name :

Course No. :

Credit

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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

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11.	To prepare list of commonly available herbicides	
12.	To study of phytotoxicity symptoms of herbicides in different crops	
13.	To study biology of nut sedge	
14.	To study biology of bermuda grass	
15.	To study biology of <i>parthenium</i>	
16.	To study biology of <i>celosia</i>	
17.	To calculate economics of the weed control practices	
18.	To visits of problem areas	

Practical No. 1

Objective: To identify weeds

Activity: Collect forty weed plants from the nearby areas and prepare herbarium with the following details in it:

S. No.	English name	Local name	Scientific name	Group	Family	Remarks
1	Bermuda grass	Doobh	<i>Cynodon dactylon</i>	Narrow leaf	Poaceae	Perennial, adventitious roots, stolon

Materials Required:.....

Procedure:.....

List of identified weeds

S.No.	English name	Scientific name	Group	Family	Remarks
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Objective: Survey of weeds in crop fields and other habitats

Materials Required: quadrat, notebook, polythene bag, pen tag etc.

Procedure: First select the crops and cropping systems for the weed survey. The study must be started before weeding or weed control practices and after weeding or application of treatment during crop season. Random quadrat sampling is a most common method for obtaining various types of data on weed cover generally a square quadrat measuring 1 m x 1m is sufficient to represent the composition of an agricultural field. In each field site, lay down 5-10 or more quadrats of 1 m² for each crop and cropping system. Collect and identify all the weeds from each quadrat and kept them in polythene bags separately.

Observations:

Quantitative study of weed flora through quadrat sampling: Record the data for individual weed species in a tabular form. Compare, co-relate and explain the competitive effects of weeds through indices and formula.

Plant Species	No. of plants in given quadrat (no.)					Total No. of plants	No. of quadrat of occurrence	Total No. of quadrat studied
	1	2	3	4	5			

Calculations:

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Objective: To study of preparation of herbarium of weeds

Materials Required

Procedure

The scientific method of weed collection and preparation of herbarium consists of the following important steps:

Collection of weed sample:

Pressing and drying of collected specimen:

Mounting on herbarium sheet

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Preparation and tagging

Collection of **information:**

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Location:.....

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Date:

Habitat:.....

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Occurrence of weeds:.....

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Essential characteristics:.....

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Features of special reference:.....

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Miscellaneous points of interest:

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Preservation.....

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Note: After having complete practical demonstration on weed preservation, each student of weed management will prepare weed album by his/ her own. The students will also update the weed herbarium of the department.

Practical No. 4

Objective: Calculations on weed control efficiency and weed index

Materials required:.....

Procedure:.....

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Calculations:

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Activity 1. Calculate the weed index for alachlor and Fluorochloridone applied in the okra from the following data:
Yield of okra from weed free plot = 20 q/ha
Yield of okra from alachlor treated plot = 18 q/ha
Yield of okra from Fluorochloridone treated plot = 19 q/ha

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Activity 2. In a weed control experiment in chilli crop, dry-weight of weeds in unweeded plots was 500 kg/ha, whereas in pendimethalin @ 3.3 lit/ha or fluchloralin @ 2 lit/ha it was 250 and 150 kg/ha, respectively. Find out the WCE and report which one herbicide is better.

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Practical No. 5

Objective: To study herbicide label information

Materials Required.....

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Activity 1: Describe the following:

Herbicide label:

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Signal Words.....

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Precautionary Statements

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First Aid.....
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Directions for Use
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Storage Disposal
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Activity 2. Take herbicide packets or container and note down the following formulation:

Item	Herbicide			
	1	2	3	4
Chemical name				
Common name				
Trade name				
Manufacturers address				
Per cent (%) of a.i.				
Per cent (%) Carrier, filler & adjuvant				
Difference between products containing the same a.i. type of formulation				
Net content if given				
Treatment for accidental exposure to poisoning				
Date of manufacturer				
Date of expiry				
Directions for use if any				
Storage and disposal of the product if any				
Warrant statement if any				
Precautionary statements if any				
Name of the crops for which the herbicide is recommended				

Practical No. 6

Objective: To study computation of herbicide dose

Activity: 1. Calculate the amount of Atrazine (50 % WP) in kg/ha, if rate of application is 1.0 kg a.i./ha.

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Activity: 2. Suppose Na salt of 2.4-D contains 80% a.i. and if 1 ½ kg of a.i. per ha is to be sprayed. The quantity of Na salt required will be?

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Activity: 3. Determine amount of isoproturon 75% WP for spraying 12.5 ha wheat crop (Given dose of isoproturon is 1.25/ha)

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Objective: To study herbicide application equipment

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Procedure.....
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Activity1: Identification of the sprayer.

Sprayer:.....
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Kinds of sprayers

Knapsack sprayers.....
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Foot sprayers:.....
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Tractor powered:
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Activity 2:
Draw the diagram of Knapsack sprayer



Draw the diagram of foot sprayer



Activity 3 Write down the components of a sprayer and their functions

	Components	Functions
Tank		
Agitator		
Filter		
Pump		
Power source		
Pressure Gauge		
Valves		
Hose		
Spray lance		
Spray cut		

off devices		
Booms (spray bar)		
Nozzles		

Table 2. Classification of spray volume as per Indian standard institute (ISI) norms

Class	Volume (lit./ha)	Droplet size (micron)	Nature of spray	Equipment
High volume				
Medium volume				
Low volume				
Ultra-low volume				
Ultra-Ultra low volume				

Observations: Necessary information has recorded during working and demonstration of sprayer:

Name of sprayer	
Manual or power operated	
Parts of sprayer	
Spray tank capacity	
Type of nozzle attached	
Area covered in one spray (By same tank full spray liquid)	
Drawback/demerit of sprayer, if any	
Other related information, if any	

Objective: To study spray nozzle

Flat fan:.....
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Solid cone:
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Flooding:
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Tripe action.....
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Broadcast fan:
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Blast Nozzel.....
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Activity: Draw the diagram of spray nozzle



Objective: To study calibration of spray pump

Materials.....
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Method of calibration: Preparation of sprayer
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Determination of nozzle discharge
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Determination of spray volume
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Determination of walking speed
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Determination of swath

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Calculation:.....

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Activity: If 50 metres were covered while spraying a solution (water) of 4 litres with a swath width of 1 metre, the volume required for one hectare would be?

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Practical No. 10

Objective: Demonstration of herbicide application methods

Materials:

Procedure:

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Results

Collect and systematically note down the information.

Particulars	Description
About herbicide	
Trade name	
Quantity of formulated product for a given area and crop	
Stage of application	
About requirement	
Name of equipment	
Working condition	
Type of nozzle	
Walking speed	
Spray volume for given area	

Objective: Preparation of list of commonly available herbicides

Activity:

Chemical name	Trade name	Formulation (%)	Source

Practical No. 12

Objective: To study of phytotoxicity symptoms of herbicides in different crops

Materials required.....

Procedure.....

Observations

Phytotoxicity symptoms in tomato after a week

Effect or damage observed	Ratings	Description of Phytotoxicity	
		Weed	Crop

Phytotoxicity symptoms in fenugreek after a week

Effect or damage observed	Ratings	Description of Phytotoxicity	
		Weed	Crop

Objective: To study biology of Bermuda grass

Activity: Collect the specimen from the field, described the identifying characteristics in following head and draw the diagram of the plant

Scientific name:

Common name:

Family:

Weed Description:

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Seedling:.....
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Leaves:

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Stems:

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Roots:

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Flowers:

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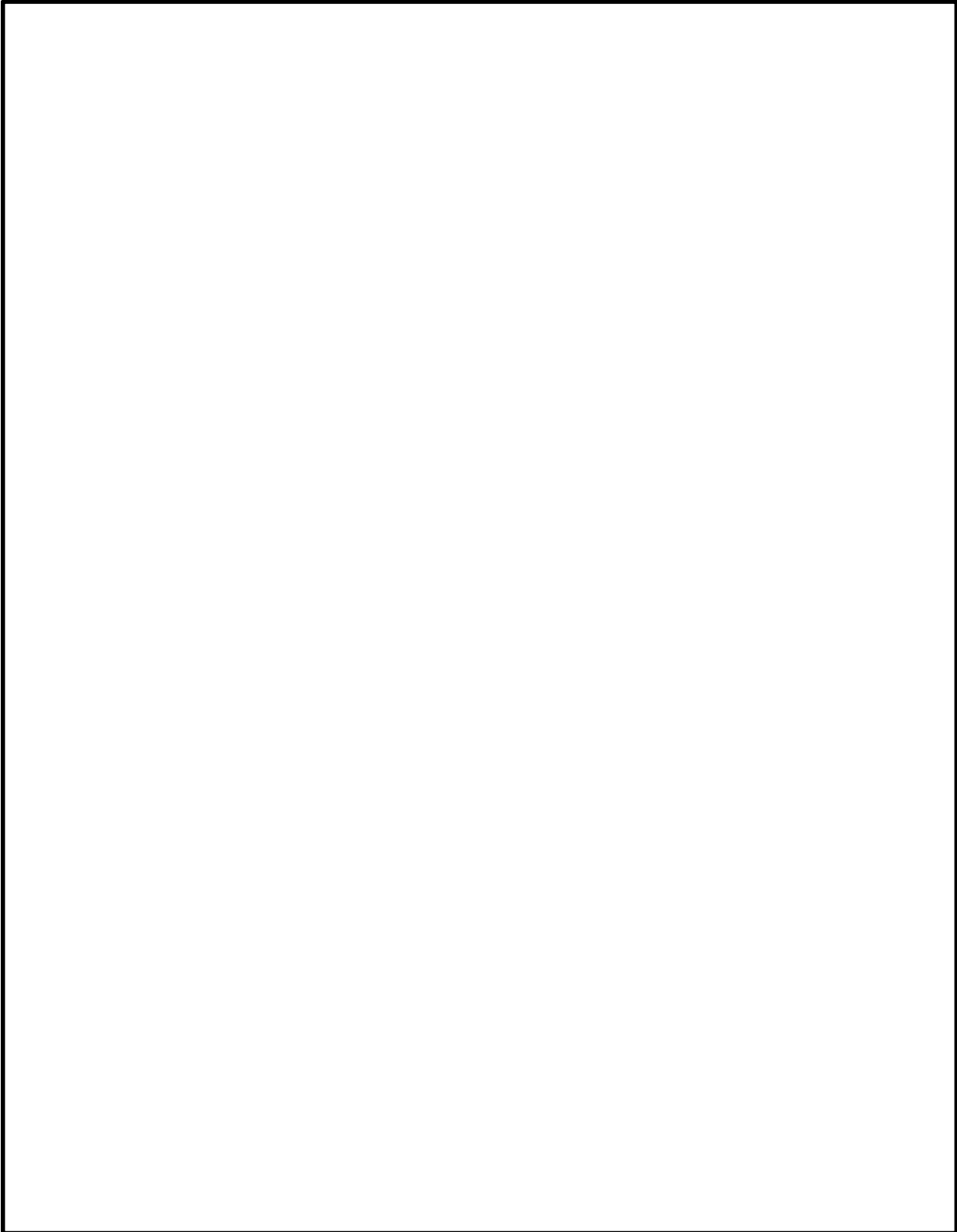
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Activity 2: Draw the line diagram of Bermuda grass



Objective: To study biology of nut sedge

Activity: Collect the specimen from the field, described the identifying characteristics in following head and draw the diagram of the plant

Purple nut sedge

Scientific name:

Family:

Yellow nut sedge

Scientific name:

Family :

Weed Description:

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Seedling:.....

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Leaves:

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Stems:

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Roots:
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Objective: To study biology of *parthenium*

Activity: Collect the specimen from the field, described the identifying characteristics in following head and draw the diagram of the plant

Scientific name:

Common name:

Family :

Weed Description:

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Seedling:.....

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Rosette stage.....

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Leaves:

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Stems:

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Roots:

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Flowers:

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Fruit and Seeds:

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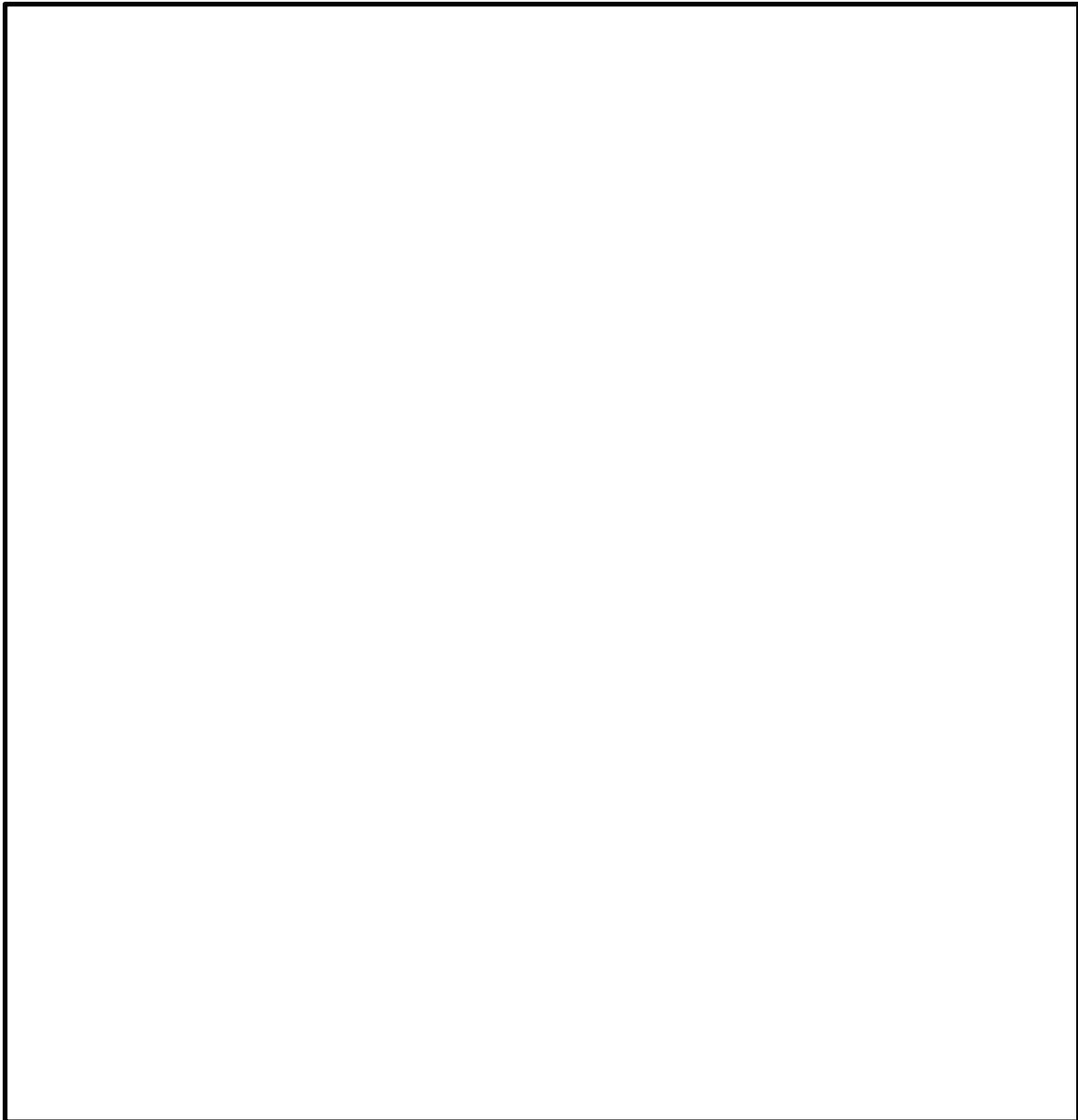
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Draw the line diagram of *parthenium*



Objective: To study biology of *Celosia*

Activity: Collect the specimen from the field, described the identifying characteristics in following head and draw the diagram of the plant.

Scientific name: **Common name:**
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Family :

Weed Description:

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Leaves:

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Stems:

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Roots:

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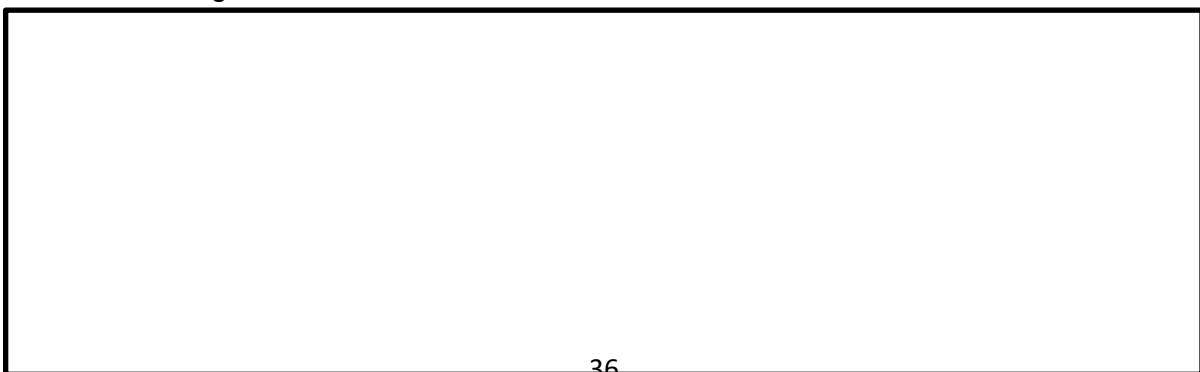
Flowers:

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Seeds.....

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Draw the line diagram of *Celosia*



Objective: To Study the economics of weed control

Activity 1: Write formulae

Net returns:

Benefit cost ratio:

Activity 2: An experiment conducted by Dwivedi et al. 2019 and they found following cost and return of weed managements in linseed crop. Calculate the Net return and B: C ratio and suggest which treatment is best suited for weed management.

Treatment	Cost of Cultivation (x10 ³ /ha)	Gross Returns (x10 ³ /ha)	NMR (x10 ³ /ha)	B:C ratio
Metribuzin + oxyfluorfen (250 g + 125 g/ha) 1 DAS	20.03	77.50		
Oxyfluorfen (125 g/ha) 1 DAS	19.60	74.70		
Oxadiargyl (80 g/ha) 1 DAS	19.80	73.17		
Imazethapyr (75 g/ha) 22 DAS	19.67	67.56		
Metsulfuron-methyl (4 g/ha) 22 DAS	19.27	84.96		
Isoproturon (1 kg/ha) 22 DAS	20.36	82.34		
Isoproturon + metsulfuron-methyl (1 kg + 4 g/ha) 22 DAS	20.63	87.31		
Pendimethalin (1 kg/ha) 1 DAS fb metsulfuron-methyl (4 g/ha) 22 DAS	20.33	82.97		
Hand weeding twice 21 and 45 DAS	22.80	88.17		
Weedy check	18.80	62.25		

*DAS = Days after seeding; *fb* = followed by; NMR = Net monetary return

Conclusion:

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Objective: To visit problem areas of weeds

Materials: Note book, pencil, pen etc.

Procedure:
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Observations: Note down the following observations:

Name of the field :.....
Characteristics of the soil:
Texture:.....
pH:.....
Colour:
Season *kharif / rabi* :.....
Rainfed / irrigated :.....
Source of irrigation ,if irrigated:
Name of the crops being grown:.....
Weed flora present in the locality:.....

Annual	Biennial	Perennial

COMMON WEEDS

			
Bermuda grass <i>Cynodon dactylon</i>	Crab grass <i>Digitaria anginalis</i>	Foxtail <i>Setaria viridis</i>	Goose grass <i>Eleusine indica</i>
			
Quack grass <i>Panicum repens</i>	Spikesedges <i>Kyllinga brevifolia</i>	Water grass <i>Echinochloa colona</i>	Yellow nutsedge <i>Cyperus esculentus</i>
			
Crowfoot grass <i>Dactyloctenium aegyptium</i>	Barnyard grass <i>Echinochloa crusgalli</i>	Nut grass <i>Cyperus rotundus</i>	Day flower <i>Commelina benghalensis</i>
			
Canada thistle <i>Cirsium arvense</i>	Common chickweed <i>Stellaia media</i>	Carpe tweed <i>Mulogo verticillata</i>	Chicory <i>Cichorium intybus</i>
			
Goat weed <i>Ageratum conyzoides</i>	Blue pimpernel <i>Anagallis arvensis</i>	Feather love grass <i>Eragrostis tenella</i>	Common cocklebur <i>Xanthium strumarium</i>
			
Dandelion <i>Araxacum officinale</i>	Bhrung Raj <i>Eclipta alba</i>	Gulf leaf flower <i>Phyllanthus niruri</i>	Wild carrot weed <i>Parthenium hysterophorus</i>

			
Sickle pod <i>Cassia tora</i>	Tridax daisy <i>Tridax procumbens</i>	Pattarchatta <i>Trianthema portulacastrum</i>	Yellow berried nightshade <i>Solanum xanthocarpum</i>
			
Lambs quarter <i>Chenopodium album</i>	Common sedges <i>Cyperus difformis</i>	Red sprangle <i>Leptochloa chinensis</i>	Datura <i>Datura stramonium</i>
			
Amaranthus <i>Amaranthus viridis</i>	Ground cherry <i>Physalis minima</i>	Wild jute <i>Corchorus tridens</i>	Black nightshade <i>Solanum nigrum</i>
			
Alligator weed <i>Alternanthera philoxeroides</i>	Canarygrass <i>Phalaris minor</i>	Wild oat <i>Avena fatua</i>	Corn spurry <i>Spergula arvensis</i>
			
	Tiger grass <i>Saccharum spontaneum</i>	Field bind weed <i>Convolvulus arvensis</i>	

COMMON WEEDS

English name	Scientific name	Family
	KHARIF	
Running grass	<i>Brachiaria reptans</i>	Poaceae
Crow foot grass	<i>Dactyloctenium aegyptium</i>	Poaceae
Crab grass	<i>Digitaria sanguinalis</i>	Poaceae
Indian goose grass	<i>Eleusine indica</i>	Poaceae
Red sprangletop	<i>Leptochloa chinensis</i>	Poaceae
Water grass	<i>Echinochloa colona</i>	Poaceae
Barnyard grass	<i>Echinochloa crusgalli</i>	Poaceae
Love grass	<i>Eragrostis pilosa</i>	Poaceae
Feather love grass	<i>Eragrostis tenella</i>	Poaceae
Knot grass	<i>Paspalum distichum</i>	Poaceae

Seashore paspalum	<i>Paspalum vaginatum</i>	Poaceae
Rough bristle foxtail	<i>Setaria verticillata</i>	Poaceae
Green foxtail	<i>Setaria viridis</i>	Poaceae
Hedgehog sedge	<i>Cyperus compressus</i>	Cyperaceae
Rice flat sedge	<i>Cyperus iria</i>	Cyperaceae
Erect horse weed	<i>Conyza stricta</i>	Astereaceae
Jimson weed	<i>Datura stramonium</i>	Solanaceae
Smooth pigweed	<i>Amaranthus viridis</i>	Amaranthaceae
Spiny pigweed	<i>Amaranthus spinosus</i>	Amaranthaceae
False amaranth	<i>Digera arvensis</i>	Amaranthaceae
False amaranth	<i>Digera muricata</i>	Amaranthaceae
Creeping chaff	<i>Alternanthera sessilis</i>	Amaranthaceae

weed		
Alligator weed	<i>Alternanthera philoxeroides</i>	Amaranthaceae
Blistering ammannia	<i>Ammannia baccifera</i>	Lythraceae
Pink node flower	<i>Caesulia axillaris</i>	Astereceae
Day flower	<i>Commelina benghalensis</i>	Commelinaceae
Spreading day flower	<i>Commelina diffusa</i>	Commelinaceae
Slender day flower	<i>Commelina erecta</i>	Commelinaceae
Wild jute	<i>Corchorus tridens</i>	Tiliaceae
Pill pod spurge	<i>Euphorbia hirta</i>	Euphorbiaceae
Painted spurge	<i>Euphorbia heterophylla</i>	Euphorbiaceae
Petty spurge	<i>Euphorbia prostrata</i>	Euphorbiaceae
Shrubby spurge	<i>Euphorbia microphylla</i>	Euphorbiaceae
Ground cherry	<i>Physalis minima</i>	Solanaceae
Cockle bur	<i>Xanthium strumarium</i>	Astereceae
Indian turnsole/ Devil weed	<i>Heliotropium indicum</i>	Boraginaceae
Black nightshade	<i>Solanum nigrum</i>	Solanaceae
False Daisy	<i>Eclipta alba</i>	Astereceae
Yellow spider flower	<i>Cleome viscosa</i>	Brassicaceae
Purslane	<i>Portulaca oleracea</i>	Portulacaceae
Desert horse purslane	<i>Trianthema portulacastrum</i>	Aizoaceae
Puncture vine	<i>Tribulus terrestris</i>	Zygophyllaceae
Gulf leaf flower	<i>Phyllanthus niruri</i>	Euphorbiaceae
Indian sorrel	<i>Oxalis corniculata</i>	Oxalidaceae
Rattle pod	<i>Crotalaria medicaginea</i>	Fabaceae
RABI		
Wild oat	<i>Avena fatua</i>	Poaceae
Sweet grass	<i>Poa annua</i>	Poaceae
Beard grass	<i>Polypogonmon speliensis</i>	Poaceae
Poison rye grass	<i>Lolium temulentum</i>	Poaceae
Canary grass	<i>Phalaris minor</i>	Poaceae
Wild onion	<i>Asphodelus tenuifolius</i>	Liliaceae
Barrel clover	<i>Medicago truncatula</i>	Fabaceae
California bur clover	<i>Medicago polymorpha</i>	Fabaceae
Toothed bur clover	<i>Medicago denticulate</i>	Fabaceae
Wild fenugreek	<i>Trigonella polycerata</i>	Fabaceae
Common lambsquarter	<i>Chenopodium album</i>	Chenopodiaceae
Nettle leaf	<i>Chenopodium murale</i>	Chenopodiaceae
Green field-Speedwell	<i>Veronica agrestis</i>	Scropulariaceae
Stone seed	<i>Lithospermum arvense</i>	Boraginaceae
Canagire dock	<i>Rumex hymenosepalus</i>	Polygonaceae
Sour dock	<i>Rumex dentatus</i>	Polygonaceae
Dock/Sorrel	<i>Rumex spinosus</i>	Polygonaceae
Blue daisy	<i>Cichorium intybus</i>	Astereceae
PERENNIAL WEEDS		
Nut grass	<i>Cyperus rotundus</i>	Cyperaceae
Jhonson grass	<i>Sorghum halepense</i>	Poaceae
Tiger grass	<i>Saccharum spontaneum</i>	Poaceae
Bermuda grass	<i>Cynodon dactylon</i>	Poaceae
Field bind weed	<i>Convolvulus arvensis</i>	Convolvulaceae
Blush morning glory	<i>Ipomoea carnea</i>	Convolvulaceae
Prickly pear	<i>Opuntia dillenii</i>	Cactaceae
Canada thistle	<i>Cirsium arvense</i>	Astereceae
Kidney weeds	<i>Dichondra repens</i>	Convolvulaceae
PARASITIC WEEDS		

Coffee weed/ Sickle pod	<i>Cassia tora</i>	Fabaceae
Creeping indigo	<i>Indigo feralinnaei</i>	Fabaceae
Tiger foot morning glory	<i>Ipomoea pestigridis</i>	Convolvulaceae
Blue morning glory	<i>Ipomoea nil</i>	Convolvulaceae
Wild carrot weed	<i>Parthenium hysterophorus</i>	Astereceae
Tridax daisy	<i>Tridax procumbens</i>	Astereceae
Hair sedge	<i>Bulbostylis barbata</i>	Cyperaceae
Grasslikefimbry	<i>Fimbristylis tenera</i>	Cyperaceae
Common sedge	<i>Cyperus difformis</i>	Cyperaceae
Yellow berried night shade	<i>Solanum xanthocarpum</i>	Solanaceae
Golden daisy	<i>Vicoa indica</i>	Astereceae
Chicken weed	<i>Euphorbia thymifolia</i>	Euphorbiaceae
Common spurge	<i>Croton sparsiflorus</i>	Euphorbiaceae
Purslane	<i>Portulaca grandiflora</i>	Portulacaceae
Purslane	<i>Portulaca quadrifida</i>	Portulacaceae
Pink wood sorrel	<i>Oxalis maritiana</i>	Oxalidaceae
Little ironweed	<i>Vernonia cinerea</i>	Asteraceae
Wild buckweed	<i>Polygonum glabrum</i>	Polygonaceae
Small knotweed	<i>Polygonum plebeium</i>	Polygonaceae
Coffee senna	<i>Cassia occidentalis</i>	Fabaceae
Arrowhead	<i>Sagittaria sagittifolia</i>	Alismaracese
Frogfruit	<i>Lipian odiflora</i>	Verbenaceae
Hairy slitwort	<i>Linderniaciliata</i>	Serofulariaceae
Purple spikerush	<i>Eleocharis atropurpurea</i>	Cyperaceae
Green foxtail	<i>Setariag lauca</i>	Poaceae

Wild safflower	<i>Carthamus oxyacantha</i>	Asteraceae
Maxican poppy	<i>Argemone mexicana</i>	Papaveraceae
Perennial saw thistle	<i>Sonchus arvensis</i>	Asteraceae
Little mellow	<i>Malvaparviflora</i>	Malvaceae
Meadow pea	<i>Lathyrus aphacaora</i>	Fabaceae
Grass pea	<i>Lathyrus sativus</i>	Fabaceae
Blue pimpernel	<i>Anagallis arvensis</i>	Primulaceae
Chickweed	<i>Stellaria media</i>	Caryophyllaceae
Hairy vetch	<i>Vicia hirsute</i>	Fabaceae
Vetch	<i>Vicia Sativa</i>	Fabaceae
Yellow sweet clover	<i>Melilotu sindicus</i>	Fabaceae
White sweet clover	<i>Melilotus alba</i>	Fabaceae
Fumatory	<i>Fumaria parviflora</i>	Fumariaceae
Garden cress	<i>Coronopus didymus</i>	Brassicaceae
Corn spurry	<i>Spergula arvensis</i>	Caryophyllaceae
Cutleaf evening primrose	<i>Oenotheralaciniata</i>	Onagraceae
Wild dog flower	<i>Antirrhinum orontium</i>	Scrophulariaceae

Maddar root	<i>Calotropis procera</i>	Asolepiadaceae
Lantana	<i>Lantana camara</i>	Verbinaceae
Goat weed	<i>Ageratum conyzoides</i>	Astereceae
Halfa grass	<i>Desmostachya bipinnata</i>	Poaceae
Congo grass	<i>Imperata cylindrica</i>	Poaceae
Marvel grass	<i>Dichanthium annulatum</i>	Poaceae
Spiderling	<i>Boerhavia diffusa</i>	Nyctaginaceae
Alyce clover	<i>Alysicarpus vaginalis</i>	Fabaceae
Spanish needle	<i>Bidens pilosa</i>	Astereceae
Dallis grass	<i>Paspalum dilatatum</i>	Poaceae
Caesar's weed	<i>Urena lobata</i>	Malvaceae
Loranthus	<i>Loranthus micranthus</i>	Loranthaceae

Dodder	<i>Cuscuta reflexa</i>	Convolvulaceae
Dodder	<i>Cuscuta chinensis</i>	Convolvulaceae
Dodder	<i>Cuscuta europaea</i>	Convolvulaceae
Witch weed	<i>Striga lutea</i>	Scrophulariaceae
AQUATIC WEEDS		
Water hyacinth	<i>Eichhornia crassipes</i>	Pontederiaceae
White water lily	<i>Nymphaea alba</i>	Nymphaeaceae
Water lettuce	<i>Pistia stratiotes</i>	Araceae
Four leaf water clover	<i>Marsilea hirsuta</i>	Marsileaceae
Common reed	<i>Phragmites australis</i>	Poaceae
Arrowhead	<i>Sagittaria subulata</i>	Alismataceae
Cattail	<i>Typha latifolia</i>	Typhaceae
Narrow leaf cattail	<i>Typha angustifolia</i>	Typhaceae
Hydrilla	<i>Hydrilla verticillata</i>	Hydrocharitaceae
Hornwort	<i>Ceratophyllum demersum</i>	Ceratophyllaceae
Pond weed	<i>Potamogeton perfoliatus</i>	Potamogetonaceae
Parrot's feather	<i>Myriophyllum aquaticum</i>	Haloragaceae
Mosquito fern	<i>Azolla filiculoides</i>	Salviniaceae
Crested floating heart	<i>Nymphaeoides cristata</i>	Menyanthaceae
Water spangles	<i>Salvinia minima</i>	Salviniaceae

Egyptian broomrape	<i>Orobanchae aegyptiaca</i>	Orbanchaceae
Broomrape	<i>Orobanchae cernua</i>	Orbanchaceae
Hemp broomrape	<i>Orobanchae ramosa</i>	Orbanchaceae

Duckweed	<i>Wolffia arrhizal</i>	Lemnaceae
Common duck weed	<i>Lemna minor</i>	Araceae
Eel grass	<i>Vallisneria spiralis</i>	Hydrocharitaceae
Pond weed	<i>Potamogeton perfoliatus</i>	Potamogetonaceae
Pond weed	<i>Potamogeton crispus</i>	Potamogetonaceae
Hornwort	<i>Ceratophyllum demersum</i>	Ceratophyllaceae
Lotus	<i>Nelumbolutea</i>	Nymphaeaceae
Great duck weed	<i>Spirodela polyrhiza</i>	Lamnaceae
Bulrushes	<i>Cyperus papyrus</i>	Cyperaceae
Indian pennywort	<i>Centella asiatica</i>	Umbelliferae
Water hyssop	<i>Bacopamonnieri</i>	Scrophulariaceae
Chinese water chestnut	<i>Trapanatans</i>	Trapaceae
Blue speedwell	<i>Veronica anagallis</i>	Plantagonaceae
Water primrose	<i>Ludwigia repens</i>	Onagraceae
Water primrose	<i>Ludwigia inclinata</i>	Onagraceae
Water primrose	<i>Ludwigia ovalis</i>	Onagraceae
Water primrose	<i>Ludwigia palustris</i>	Onagraceae
Water primrose	<i>Ludwigia pantanal</i>	Onagraceae

PREPARATION OF HERBARIUM OF WEEDS

Materials: Herbarium sheets (Appendix), wooden block press, blotting papers or newspapers, pencil or marker, adhesive tape etc.

Procedure: The scientific method of weed collection and preparation of herbarium consists of the following important steps:

Collection of weed sample: The weeds with height of about 15 to 20 cm are uprooted carefully along with roots. The specimen should contain all parts of the weed plant including root, stem, leaves, flowers and fruits. For good identification, no part of the plant should be excluded. A large plant may be divided into 2 or more sections, each pressed separately. However, excess branches or leaves may be removed provided remaining leaves and branches truly represent the plant. If the plants are very small, more number of specimens of the sample plant should be collected.

Pressing and drying of collected specimen: The weed specimens uprooted are first cleaned and kept on blotting/newspaper paper by keeping the leaves, roots and flowers in proper position and covered by another paper. Plants with long stem or leaves may be folded into V, N or W bends. Sufficient weight should be kept on the upper paper to press the weeds. All the moisture is absorbed by these two blotting papers from the weed sample overnight. Next day the weight is removed and the weeds are transferred to another dry paper, by changing the position of the sample exactly reverse and are covered with dry blotting paper. Again, sufficient weight is kept to press the sample. In this way the paper is changed 2 to 3 times by changing the position, of weed every time to absorb moisture from all parts of weed plant. When the specimens dry completely, it is ready for preservation.

Mounting on herbarium sheet: After the weed samples are dried, they are mounted on herbarium sheets. The herbarium sheet should be of good quality and medium in weight. The specimens are placed in the center of the sheet. Glue or narrow strips of adhesive tape (preferably both sided) are used to mount the specimens on the herbarium sheet.

PREPARATION AND TAGGING

Collection of information: The collector of weed specimen should record useful information at the time of the sample collection. The data may be written either on the edge of same paper in which weed specimen will be brought from field to laboratory or a diary may be used citing some reference number for a particular weed specimen. The following information should be gathered.

Location: Name of the village or town nearby the field and its distance and direction from the known town for exact location, the district may be mentioned.

Date: The date should be clearly mentioned with day, month and year.

Habitat: Name of place with ecological conditions viz., field, pasture, roadside weeds, hillside, sand dune, canal side, sun or shade, moisture conditions (dry, moist, wet. etc.) should be mentioned.

Occurrence of weeds: A weed under consideration should be described in relativity of number of other species of weeds. For this purpose, an arbitrary scale of comparison using terms like rare, occasional, frequent, common and abundant may be followed.

Noting of essential characteristics: Nature - Annual, biennial, perennial; Root - Tap, fibrous, adventitious, shallow, deep; Stem/branches - Woody, herbaceous, erect, spreading, trailing, prostrate; Leaves - Simple, compound, narrow, broad; Flower - Shape, colour, fragrance

Features of special reference: Some plants in nature are known for their special characteristics in terms of fragrance, colour, leaf curling, stinging hairs, presence of thorns, double colour of leaves, milky juice of stem or leaves, habitat of growth, stickiness etc. The specific characteristics of plant along with right stage of growth and development of the plant should be mentioned.

Miscellaneous points of interest: A collector by his own wisdom or discussion with local people may collect valuable and rare information about a weed specimen. This includes special use, preference shown by insect-pest, industry, special control measure, anything special about dissemination and propagation.

Format of identification label: The lower right-hand corner of the herbarium sheet should bear the label containing the information as,

Preservation: The individual labelled specimens should be arranged in weed albums when the collections are small and or herbarium cabinets for large collections and long-term preservation. Album is a book with blank pages for the insertion and preservation of weed collections. A weed herbarium (plural: herbaria) is a collection of preserved weeds mounted, labelled, and systematically arranged for use in scientific study. Certain weeds plants are soft, bulky, or otherwise not amenable to drying and mounting on sheets. For these plants, other methods of preparation and storage may be used. For example, conifer cones and palm fronds may be stored in labelled boxes. Representative flowers, fruits, fleshy roots or stems may be pickled in formaldehyde to preserve their three-dimensional structure. Weed seeds are often air-dried and packaged in small paper/polythene envelopes or kept in small glass jars. No matter the method of preservation, detailed information on where and when the plant was collected, habitat, colour (since it may fade over time), and the name of the collector is usually included.

SURVEY OF WEEDS IN CROP FIELDS AND OTHER HABITATS

Materials Required: quadrat, notebook, polythene bag, pen tag etc.

Procedure: First select the crops and cropping systems for the weed survey. The study must be started before weeding or weed control practices and after weeding or application of treatment during crop season. Random quadrat sampling is a most common method for obtaining various types of data on weed cover generally a square quadrat measuring 1 m x 1m is sufficient to represent the composition of an agricultural field. In each field site, lay down 5-10 or more quadrats of 1 m² for each crop and cropping system. Collect and identify all the weeds from each quadrat and kept them in polythene bags separately.

Formulas for estimation of quantitative parameter:

Weed density: Count the number of individuals of particular weed species per unit area and determine the relative density.

$$\text{Density (D)} = \frac{\text{Total number of weeds in all quadrats}}{\text{number of quadrats studied}} \times 100$$

Relative Density (RD)

$$\text{Relative Density (RD)} = \frac{\text{Number of individuals of a given weed species}}{\text{Total number of individuals of all the weed species}} \times 100$$

Weed Frequency: This parameter determines the degree of dispersion of a given weed species in an area

$$\text{Frequency (F)} = \frac{\text{Number of quadrats of occurrence of a species}}{\text{Total number of quadrats studied}} \times 100.$$

Weed dominance: It refers to the ground coverage of a given weed species in relations to density of the given weed species

$$\text{Weed dominance} = \text{Average basal area of a given weed species} \times \text{density}$$

Weed abundance: It can be calculated by the following formula

$$\text{Weed abundance} = \frac{\text{Total number of weed species in all quadrats}}{\text{Number of quadrats of occurrence of a species}} \times 10$$

WEED CONTROL EFFICIENCY AND WEED INDEX

Need to measure weed density: It is necessary to know the number and nature of weeds competing with the crops. The weed density gives an estimate of biological stress subjected to the crops.

Measurement of weed density: There are 2 methods normally adopted for the measurement of weed density.

Counting method: Here different species of weeds are counted by using the quad rat in a crop field.

Dry matter weight: By this method, the weeds are cut at the base and record the fresh weight immediately and the dry weight, after drying in an oven are taken to compute the weed density.

Precautions: The weed count should be taken after the emergence of weeds but at the initial stage of crop growth itself to facilitate the placement of quadrat. Take care to note the name and number of weeds immediately. Select at random, the location (or) site for placing quadrat in different places of the crop field.

Materials required: Quadrat of 0.5 m x 0.5m size, Observation note book, Pencil

Procedure: Select a field with young crop plants and weeds for taking weed count. Place the quadrat at randomly selected place in the field. First pull out all the narrow leaf weeds inside the quadrat taking simultaneous counting. Record the number of narrow leaf weeds the observation note book. Then pull out and count all the broad leaf and record them. Multiply the number of narrow leaf weeds by 4 to find out the number of weeds m⁻² in the same way, calculate the number of broad leaf weeds.

Calculations On the basis of above observations, calculate the following:

Area of the quadrat = 0.5 x 0.5 = 0.25 m²

No. of narrow leaf weeds/sq.m =

No. of broad leaf weeds/sq.m =

The percentage of narrow leaf weeds =

The percentage of broad leaf weeds =

No. of narrow leaf weeds /ha =

No. of broad leaf weeds /ha =

EVALUATION OF HERBICIDE EFFECTS

Weed Control Efficiency (WCE): It indicates the percentage reduction in weed population or dry weight of weeds under treated plot (herbicide) in comparison to untreated plot (weedy). This index is used to compare the different weed control treatment. Higher the WCE, better is the herbicidal/ weed control treatment.

$$\text{WCE (\%)} = \frac{[(W_{pc} - W_{pt})/W_{pc}] \times 100}{\text{or } [(W_{wc} - W_{wt})/W_{wc}] \times 100}$$

Assuming:

W_{pc} : Weed population under control

W_{pt} : Weed population under treatment (hand weeding, herbicide application etc.)

W_{wc} : Weed weight under control

W_{wt} : Weed weight under treatment (hand weeding, herbicide application etc.)

In this case, the effect of a treatment is assessed from the point of view of weeds only. A treatment may reduce the weed population but may not affect the yield of crop. The yield of crop may even decline due to phytotoxic effect of herbicide, despite very good weed control. Such effects are not reflected in these parameters.

Weed index (WI): This parameter helps to measure the absolute effect of a treatment to reduce weed competition. It may be defined as the reduction in yield due to the presence of weeds in comparison to no weed or weed-free treatment. In other words, weed index expresses the competition offered by weeds as measured by percent reduction in yield owing to their presence in the field. A negative value of WI indicates that yield is higher than in a weed-free treatment. This happens when a treatment influences the yield favourably not only by controlling weeds but also by promoting crop growth, possibly through hormonal effects of herbicide. Drawback in this parameter is that the effect of a treatment is considered only from crop yield point of view and not from weeds.

$$\text{Weed Index} = \frac{Y_a - Y_b}{Y_a}$$

Y_a = Yield from weed free plot

Y_b = Yield from the treated plot for which weed index is to be worked out

HERBICIDE LABEL INFORMATION

Materials: Herbicides available in the laboratory and farm and publications or literature on herbicides

Herbicide label: A herbicide label is a legal document providing important information about a herbicide, its appropriate use, and the precautions needed to avoid off-target movement and to protect environmental quality. A herbicide label answers the "what, where, when," and "how" questions about the product. Finding answers to these important questions is indispensable for achieving the economical use and optimum results from a product, and obligatory to avoid violation of

state or federal law. Specific attention should be paid to the rotational restriction before deciding the crop rotation plan. In addition, it is important to make sure that most recent herbicide label is consulted because sometimes they are updated.

Signal Words: The most prominent word on any herbicide package is the “signal word” – a ready indicator of the potential hazard the chemical can pose to humans unless used as instructed. “Danger” is the signal word for especially toxic chemicals, followed by “Warning” for those representing an intermediate level of risk and “Caution” for those with the lowest level of toxicity. Even if the product has a low potential to cause harm, it is essential that you follow all label directions.

Precautionary Statements: Follow all precautionary instructions precisely. Many labels include directions for the type of clothing and other protective gear needed when mixing and spraying. You might also be instructed to avoid contact with eyes, skin or clothing or to wash thoroughly with soap and water after handling the product.

First Aid: Look at this section of the label for practical advice on what to do if you accidentally ingest or inhale the product or get it in your eyes or on your skin. You might to call your doctor.

Directions for Use: The first sentence in this section of the label is required by the EPA: “It is a violation of federal law to use this product in a manner inconsistent with its labeling.” Because herbicides are designed to kill plants, the label may advise that you avoid application near desirable plants. It will also indicate suitable weather conditions and what equipment you should use when you apply the herbicide you’ve chosen. Herbicide is a concentrated product that needs to be mixed with water before application, the directions will tell you to calculate how much herbicide you’ll need for a given area or for spot treatments.

Storage: As every gardener knows, weeds have a bad habit of coming back. So, before you settle into a lounge chair and wait for your weeds to die, be sure to follow the instructions on how to store unused product for future use.

Disposal: Disposing of the container as instructed by the label is the final step in using herbicides responsibly. Some containers can be wrapped in newspaper and put in the trash – but not all. Read carefully. To dispose of leftover product, contact city or county officials about local “disposal day” events or visit a disposal site in your community that accepts pesticides.

CALCULATION OF COMMERCIAL QUANTITY OF HERBICIDES

Herbicides are usually applied in the form of solution or granules. Solution formulations are applied using sprayers. Granules are generally mixed in sand and applied manually or with the use of applicator. Correct dose of herbicide application is important for effective control of weeds.

To calculate the herbicide dose, first account for the dosage (Kg a.i./ha) of chemical required for the crop and active ingredient of herbicide to be used. The quantity of herbicide requirement may be computed by using the formula,

$$\text{Quantity of commercial formulation (kg or l/ha)} = \frac{\text{Dose (kg a.i./ha)}}{\text{Active ingredient (a.i.)}} \times 100$$

Commercially, the herbicides are available either in solid or liquid form. On the label of the containers, you will be 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, it 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 esters e.g., 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.

HERBICIDE APPLICATION EQUIPMENT

Materials: Different types of sprayers, Nozzles: Hydraulic, flat fan, cone nozzle (hollow cone and solid cone), centrifugal and pneumatic nozzle, Measuring containers, buckets and graduated cylinders.

Procedure: Prepare a list of sprayers available in the laboratory and make drawings of all sprayers naming their parts. Similarly, drawings of nozzles and their spray pattern are made. Students should operate sprayers filled with water, note down the spray pattern and spray angle with different nozzles. Observe the spray pattern and angle by spraying over dry soil. Spray output with different sprayers and operating pressures will be measured by collecting the water from the nozzles over constant period of time. Leakage and un-uniform spray pattern will be noted using worn out nozzles.

Sprayer: 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.

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.

Components of a sprayer:

No	Components	Functions
1	Tank	To contain spray fluid
2	Agitator	To keep the material in tank uniformly dispersed by mechanical stirring
3	Filters	To strain off dirt and coarse particles
4	Pump	To feed the spray fluid to delivery tubes and nozzles or to deliver fluids under pressure
5	Power source	To provide power to power operated sprayer
6	Pressure gauge	For adjusting the pressure required for spraying
7	Valves	To maintain direction of flow of the spray fluid
8	Hose	To deliver spray fluid from the sprayers to lance or from container to the sprayer (in case of no built-in tank)
9	Spray lance	Brass tubes screwed to hold nozzles
10	Spray cut off devices	To shut off flow of liquid
11	Booms (spray bar)	A horizontal tube to hold a number of nozzles simultaneously
12	Nozzles	To break up and disperse the liquid supplied from spray equipment in droplets and from spray

Classification of spray volume as per Indian standard institute (ISI) norms

Class	Volume (lit./ha)	Droplet size (micron)	Nature of spray	Equipment
High volume	560 or >	> 400	Coarse	Hydraulic sprayer
Medium volume	56 to < 560	201-400	Medium	Hydraulic sprayer
Low volume	5.6 to < 56	101-200	Fine	Mist blower
Ultra-low volume	0.56 to < 5.6	100	Mist	Micron sprayer or ULV sprayer
Ultra-Ultra low volume	< 0.56	< 50	Aerosol	Fogging machine, smoke and vapour generator

SPRAY NOZZLES

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.

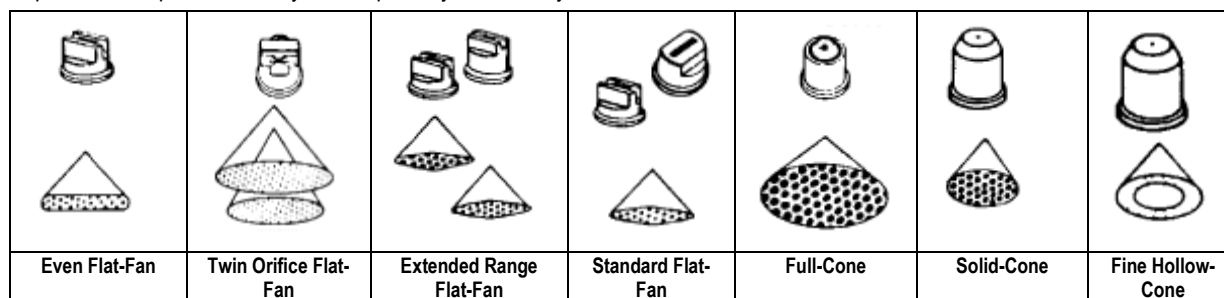
Flat fan: Flat fan nozzles are available in two spray patterns viz. the tapered edge pattern and rectangular pattern. Tapped edge pattern to apply pre- and post-emergence herbicide broadcasting, while rectangular pattern for the pre-emergence bank application of herbicides.

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 stream to split it into droplets and carry the droplets by the velocity of the wind.



CALIBRATION OF HERBICIDE SPRAY EQUIPMENT

Generally, herbicides are applied in the form of solution. Process of finding out the exact quantity of water required for spraying unit area is called calibration. Sprayer is the basic equipment used for application of herbicides. Proper application of herbicide depends upon the proper adjustment of all the basic components of a sprayer. Spray pattern varies according to nozzle type, orifice size, spraying pressure, nozzle spacing and boom height. Therefore, for uniform spraying of herbicides with good efficiency, it is necessary to calibrate the amount of water to be applied, speed of walking, pressure to be maintained etc. The main aim of calibration is to adjust the application pressure and application speed (walking speed) to get the desired volume.

Materials: Sprayer (Knapsack), buckets, water, measuring tape, graduated cylinders, timeclock.

Method of calibration: The method of calibration of a sprayer consists of following steps:

Preparation of sprayer

- Remove and clean the nozzle
- Rinse the pressure and fill up with clean water and build up pressure
- Flush pump, hoses and lance with the clean water after removing the nozzle and strainers.
- Readjust the nozzle and strainers.
- Refill tank
- Now sprayer is ready for spray operation

Determination of nozzle discharge

- Keep the sprayer on the ground, fill up it with water and build up pressure
- Now take a bucket and dip the nozzle in it. Spray water for 5 minutes into bucket. Shut off the valve exactly at the end of five minutes.
- Measure volume of water collected in bucket with the help of graduate cylinder
- Repeat the operation for three times.
- Determine the average reading. This is the nozzle discharge or flow rate expressed in litres / minute.

Determination of spray volume, measure and mark an area of 50sq.m with the help of a measuring tape. Spray the water in this measured area of 50 sq.m. Determine the volume of spray delivered from the tank.

Determination of walking speed

- Mark a starting point on bare soil surface with a stick.
- Adjust the prepared sprayer on the back and operate pumping, directing lance and nozzle within spray swath.
- Walk at a normal and constant speed exactly for five minutes.
- Measure the distance covered in five minutes.
- Repeat the operation for three times.
- Express the average walking speed in metres /minute.
- Do the same operation in the crop planted field and determine the average walking speed.

Determination of swath: Mark in the field an area having width equal to the swath (the distance up to which the spray falls on the ground on a fixed height). The spray lance could be held constant while walking forward but could be swung from left to right.

Observation: For proper calibration of a sprayer, following observations should be recorded.

- a) Total distance travelled = d metre
- b) Time taken for travelling distance 'd' metres = t min.
- c) Swath width = x metres
- d) Amount of water discharged at a given pressure = L litre.

Calculation

Spray volume =

$$\text{Spray volume (L/ha)} = \frac{\text{Water used in testing (litres)} \times 10000}{\text{Area covered during test run (m}^2\text{)}} \\ = \frac{\text{Water used in testing (litres)} \times 10000}{d \times x}$$

DEMONSTRATION OF HERBICIDE APPLICATION METHODS

Materials: Knapsack sprayer, crop field, herbicides, water, measuring scale etc.

Procedure

- Selection of proper herbicide.
- Measure the cropped area.
- Calibrate the knapsack sprayer as explained in previous exercise.
- Compute the herbicide needed.
- Put on hand gloves, eye glass and a cloth around the mouth.
- Measure the amount of herbicide and put it in a bucket and stir well.
- Add this solution to the water container of sprayer and make the desired volume.
- Undertake spraying operation.

COMMONLY AVAILABLE HERBICIDES

Chemical name	Trade name	Formulation (%)	Source
Alachlor	Lasso	50 EC	Monsanto
Anilofos	Aniloguard, Arozin	30 EC	Aventis
Atrazine	Atrataf, solaro	50 WP	Rallis
Butachlor	Machete	50 EC	Monsanto
2,4-D	Knock weed	Na Salt 80%	Rhone-poulenc
	Feroxone. Weedmar	Ethyl ester 34%	Herbicide India Ltd.
Chlorimuron	Kloben	20 WP	Dupont
Chlorosulfuron	Glean	75 WP	Dupont
Clodinafop	Topik	15 WP	Syngenta
Clomozone	Command	50 EC	Rallis
Diclofop-methyl	Illoxan	28 EC	Aventis
Diuron	Karmex, Hexuron	80 WP	Dupont
Dalapon	Hexapon	80 WP	BASF
Fluchloralin	Basalin	45 EC	BASF
Fonoxaprop-ethyl	Pumpasuper/whipsuper	12.5 EC	Aventis
Fluazifop-butyl	Fusilade	9 EC	Syngenta
Glyphosate	Round-up, Glycel	41 EC	Mosanto /Excell
Glufosinate-Ammonium	Basta/Liberty	15 SL	Aventis
Isoproturon	Arelon	50 & 75 WP	Dupont/Gharda
Imazethapyr	Pursuit	10 EC	Cynamide
Loctofen	Cobra	24 EC	Aventis
Linuron	Afalon	50 WP	Aventis
Metolachlor	Dual	50 EC	Syngenta
Metribuzin	Sencor	70 WP	Bayer
Metoxuron	Dosanex	80 WP	Seark Ind. Ltd.
Metsulfuron-methyl	Algrip	20 WP	Dupont
Oxadiazon	Ronstar	25 EC	Rhone-Poulenc
Oxadiargyl	Raft	6 EC, 80 WP	BASF
Oxyfluorfen	Goal	23.5 EC	Rohm & Hass
Paraquat	Gramoxone	24 EC	Syngenta
Pendimethalin	Stomp	30 EC	Cynamid
Pratilachlor	Rifit	50 EC	Syngenta
Pratilachlor+Safener	Sofit	50 EC	Syngenta
Sulfosulfuron	Leader	75 WP	Monsanto
Tralkoxydim	Grasp	10 EC	ICI Geneca
Thiobencarb	Saturn	50 EC	Pesticide Ind. Ltd.
Trifluralin	Teflan	48 EC	De-nocil/Gharda

PHYTOTOXICITY SYMPTOMS OF HERBICIDES

Introduction: Application of herbicides on field crops results some phytotoxicity symptoms. Higher doses of herbicides are also responsible for phytotoxicity. While conducting herbicidal spray utmost care should be taken regarding spray concentration and drift hazard.

Materials required Sprayer, water, 2,4-D, paraquat, bucket, measuring cylinder etc.

Methodology:

Quantitative observation: These are related observations on the plant height, number of leaves, leaf area, dry matter, time of flowering, ear head size, yield etc.

Qualitative observations: These are visual observations on greenness of crop/weeds yellowing necrosis, damaged parts. On the weeds, the observations are quantitative and also qualitative. Quantitative observations are related to weed species associated, their initial numbers and their increase in number (or) frequency, predominant / and dry matter at different time intervals. Qualitative observations like discoloration of leaves, drying of leaves, stunted growth, scorching of leaves, necrosis and drying of entire plants etc. and on their intensity.

Some of the characters on the crop plants are also rated with the observations visually made on the effect of herbicide applied. Another way of rating of damage to herbicide (in %) is given by European Weed Research Council (1976) ratings both on the crops & weeds and is presented in table:

Ratings	% of crop injury	Verbal description
1.	0	No injury, no reduction in crop plant number
2.	1-3.5%	Slight discoloration in the crop

3.	3.5-7%	Moderate but not lasting damage
4.	7-12.5%	Moderate and more losing, they need more time to recover
5.	12.5-20%	Medium and lasting
6.	20-30%	Heavy damage
7.	30-50%	Very heavy in reduction in crop stand
8.	50-90%	Nearly destroyed
9.	100%	Completely destroyed

To quantify the herbicide effect like phytotoxic symptoms either on crop or weeds are generally projected with rating starting from 0 to 10 as indicated below: (European weed Research Council (1976)

Effect or damage observed	Ratings	Description of Phytotoxicity	
		Weed	Crop
No effect	0	No weed control	No injury
Light effect	1	Poor control	Slight leaf discoloration
	2	Poor control	Some stanch has lost
	3	Poor deficient control	Injury root pronounced, recovery is possible
Moderate	4	Deficient Control	Moderate injury, injury is distinct, but recovery is possible
	5	Deficient-moderate control	Recovery is doubtful, near severe injury
	6	Moderate control	No recovery is possible
Severe	7	Satisfactory control	Severe in dry and stand least
	8	Good control	Almost destroyed s very few plants left
	9	Good excellent control	Plant may be removed or ploughed
	10	Complete control	Complete crop destruction.

Procedure

1. Carry out spray operation in standing tomato crop with 2,4-D recommended dose.
2. Spray paraquat on fenugreek in *Cuscutta* infested field or blanket spray.

BIOLOGY OF BERMUDA GRASS

Scientific name: *Cynodon dactylon* **Common name:** Doob grass, bermuda grass, star grass **Family:** Poaceae

A perennial grass that has both rhizomes and stolons and is capable of forming a turf or mat of fine leaves. Several varieties of Bermuda grass are cultivated for use as lawn and pasture grasses; however, this weed has developed into a very troublesome and hard-to-control weed in agronomic crops, landscapes, nurseries, and turf grass.

Seedling: Leaves are rolled in the bud, leaf blades are smooth on both surfaces, and the ligules are a row of hairs approximately 1/2 mm long.

Leaves: Leaves are rolled in the bud, without auricles, and have a ligule that is a fringe of hairs approximately 1/2 mm long. Hairs occur at least on the leaf margins in the collar region (the region where the leaf blades join to the sheath). Leaf blades are approximately 2 to 7 inches long by 2 to 5 mm wide. Leaves emerge from opposite sides of the stem and have margins that are slightly rough.

Stems: Leaf sheaths are usually distinctly flattened with relatively long hairs (1 to 3 mm) near the collar only.

Roots: Rhizomes and stolons both occur on the same plant. Rhizomes are scaly and often form an almost impenetrable mat. Stolons are flat, smooth, usually bent and root at the nodes

Flowers: Inflorescence consists of 3 to 7 fingerlike spikes that originate from a single point. Individual spikes are approximately 1 to 3 inches long and flattened. Spikelets are arranged in 2 rows on each spike and each of these spikelets produces a single lance-shaped seed (1 -1/2 mm long)

BIOLOGY OF NUT SEDGE

Purple nut sedge

Scientific Name: *Cyperus rotundus*

Family: Cyperaceae

Yellow nut sedge

Scientific Name: *Cyperus esculentus*

Family: Cyperaceae

Weed Description: A perennial from rhizomes and tubers that may reach 2 1/2 feet in height. The stems are 3-sided and triangular in cross section and the leaves are yellow to green in color with a distinct ridge. Found throughout the southeastern United States as a common weed of agronomic and horticultural crops, nurseries, turf grass, and landscapes.

Seedling: Seedlings rarely occur. Most plants from rhizomes and/or tubers. Leaves do not have ligules or auricles and have a distinct ridge along the mid-vein, but are nevertheless often mistaken for grasses.

Stems: Stem is Erect, unbranched and 3-sided or triangular in cross section. Stems are usually solitary and produce terminal spikelets.

Leaves: Dark green in color and have a distinctly shiny appearance. Leaves are 5 to 8 mm wide and have a distinct ridge along the mid-vein. Leaves are produced in groups of 3 from the base of the plant. Leaves are without hairs (glaucous) and no auricles or ligules are present. The leaves of purple nut sedge taper abruptly to a sharp point, unlike the gradual taper of yellow nut sedge leaves.

Roots: Rhizomes and tubers occur on the same plants. Tubers are oblong, ridged, initially white in color, eventually turning brown or black, and are bitter to the taste. Purple nut sedge produces chains of tubers that develop along the entire rhizome. Yellow nut sedge produces solitary tubers that arise either from the basal bulb or from a rhizome.

Flowers: Spikelets occur at the ends of the solitary stems in a cluster where the flower stalks arise from a common point (umbel-like). Individual spikelets are reddish-purple to reddish-brown in color in purple nut sedge. Whereas individual spikelets are yellow to brown in color in case of Yellow nut sedge

Identifying Characteristics:

- Yellow Nut sedge (*Cyperus esculentus*) is very similar in appearance and growth habit to purple nut sedge, and the two are often confused.
- The leaves of yellow nut sedge taper to a point gradually whereas those of purple nut sedge taper to a point abruptly.
- Additionally, the seed head of yellow nut sedge is yellow in color, while that of purple nut sedge is purple.
- Lastly, the tubers of purple nut sedge are often connected in chains and bitter to the taste, while those of yellow nut sedge are solitary and sweet to the taste.

BIOLOGY OF PARTHENIUM

Scientific name: *Parthenium hysterophorus* **Common name:** Carrot grass, congress grass **Family:** Asteraceae

Seedlings: Normally germinate in spring and early summer with the onset of rain. A young seedling showing expanded cotyledons and with the first true leaves emerging.

Rosette Stage: Showing radial arrangement of leaves at ground level.

Mature Plant: Parthenium weed is an annual herb with a deep tap root and an erect main stem that becomes woody with age. As the plant matures, it produces many branches with flowers and may eventually reach a height of 2 m. Under favorable conditions it can germinate, mature and set seed in 4 weeks.

Stem: Mature stems are longitudinally grooved and covered with fine hairs.

Leaves: Juvenile Leaves are newly-emerged pubescent leaf (covered with fine hairs). Young leaves typically show prominent veins. Mature Leaves are pale green and deeply-lobed lower leaf. Mature leaves are branched alternately on the stems and are less hairy than young leaves.

Flowers: Are star-shaped with a white to creamy-white appearance. They are produced at the tips of the upper branches. Colour changes to light brown when seeds are mature and about to shed. Flowers have five petals like ray florets, each bearing a single seed.

Fruit and Seeds: Seeds are flattened achenes, dark brown to black in colour with white appendages. The seeds are protected in a straw-coloured fruit covering. A single plant can produce up to 28,000 seeds which are spread by vehicles, machinery, animals, pasture and crop seed lots, stock feed, wind and water.

BIOLOGY OF CELOSIA

Common name: White cock's comb **Scientific name:** *Celosia argentea* **Family:** Amaranthaceae

Weed Description: *Celosia argentea* (Syn. *C. plumosa*, *C. argentea* var *plumosa*) is a tender annual that is often grown in gardens. It is propagated by seeds. It is erect plant and grows to a height of 1.0 to 1.6 m under favorable condition.

Stem: Ridged, glabrous, branches up to 25 per plant, ascending.

Leaves: Alternate, simple and decreasing in size with height of the plant.

Root: It has numerous lateral roots below the soil surface. These enable it to efficiently absorb nutrients from the soil.

Inflorescence: a dense, many-flowered spike, at first conical but becoming cylindrical, up to 20 cm long, bracteate, silvery to pink, in ornamental forms completely or partly sterile and in many colours.

Seeds: The seeds are extremely small. It produces 2,000 to 3,000 seed/ plant which add to the soil seed bank.

VISIT OF PROBLEMATIC AREA

A field trip provides an opportunity to students to acquaint themselves with the important crops and weeds of the farm. They are able to know the kind, diversity and severity of weeds to an area. Similarly, they can also observe other activities going on at the farm.

Materials: Note book, pencil, pen etc.

Procedure

- Carry all the necessary things.
- After arrival at the site, contact the farm manager.
- Introduce yourself with the farm manager and discuss about the purpose of visit.
- Note down the crop being grown in the problem areas. Also note down the weeds of the locality.
- Seek clarification on any aspect or doubts, if required.