PRACTICAL MANUAL

For

WEED MANAGEMENT

AES 294 3(2+1)

For B. Sc. (Agriculture) II Year (IV Semester)

Dr Yogeshwar Singh
Dr Neelam Bisen

2020

Department of Agronomy
College of Agriculture
Rani Lakshmi Bai Central Agricultural University
Jhansi-284003

Syllabus AES 294 3(2+1):
Techniques of weed preservation. Weed identification and their losses study. Biology of important weeds. Study of herbicide formulations and mixture of herbicide. Herbicide and agrochemicals study. Shift of weed flora study in long term experiments. Study of methods of herbicide application, spraying equipments. Calculations of herbicide doses and weed control efficiency and weed index.
Note: Students should submit 50 pressed and well-mounted specimens.

Name of Student .....

Roll No. .....

Batch .....

Session .....

Semester .....

Course Name : .....

Course No. : .....

Credit .....

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Date: Course Teacher

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15.	To study weed control efficiency	
16.	To study weed index	

PRACTICAL No. 1

Objective: To study techniques of weed preservation

Materials Required: ……

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Procedure:

Collection of weed sample: ……

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Pressing and drying of collected specimen: ……

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Mounting on herbarium sheet ……..

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Preparation and tagging

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

Preservation……..…….....

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PRACTICAL No. 2

Objective: To identify weeds

Activity: Collect thirty 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	*Cynodon dactylon*	Narrow leaf	Poaceae	Perennial, adventitious roots, stolon

Materials Required:……
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Procedure:……

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List of identified weeds

S.No.	English name	Scientific name	Group	Family	Remarks
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40.					

PRACTICAL No. 3

Objective: To study losses incurred due to weeds

Activity: The yield losses due to weeds can be estimated as below:

Estimation of losses due to weeds in major crops

Particular	Yield from weedy plot	Yield from treated plot	% Yield losses
Maize			
Moong Bean			
Urd Bean			
Wheat			
Mustard			

Conclusion:

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PRACTICAL No. 4

Objective: To study loss in quality incurred due to weeds

Activity: The loss in quality due to weeds can be estimated as below:

Weed seed counts in crop seeds (No/kg seed)

Crop	Name of the weed species					
	1	2	3	4	5	6

Conclusion:

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PRACTICAL No. 5

Objective: To study biology of important weeds

Activity: The students will study biology of 8 most common weeds representing monocots and dicots present in Agronomy farm. They will note down the salient characteristics given below:

	Weed	Biology	
1.		Leaf	
		Stem	
		Branches	
		Flower	
		Roots	
		Fruits	
		Seed	
		Special Point	
		Growth duration	
		Category	
		Nature	
		Leaf	
		Stem	
		Branches	
		Flower	
		Roots	
		Fruits	
		Seed	
		Special Point	
		Growth duration	
		Category	
		Nature	
		Leaf	
		Stem	
		Branches	
		Flower	
		Roots	

		Fruits	
		Seed	
		Special Point	
		Growth duration	
		Category	
		Nature	
5		Leaf	
		Stem	
		Branches	
		Flower	
		Roots	
		Fruits	
		Seed	
		Special Point	
		Growth duration	
		Category	
		Nature	
		Leaf	
		Stem	
		Branches	
		Flower	
		Roots	
		Fruits	
		Seed	
		Special Point	
		Growth duration	
		Category	
		Nature	
		Leaf	
		Stem	
		Branches	
		Flower	

		Roots	
		Fruits	
		Seed	
		Special Point	
		Growth duration	
		Category	
		Nature	
		Leaf	
		Stem	
		Branches	
		Flower	
		Roots	
		Fruits	
		Seed	
		Special Point	
		Growth duration	
		Category	
		Nature	
		Leaf	
		Stem	
		Branches	
		Flower	
		Roots	
		Fruits	
		Seed	
		Special Point	
		Growth duration	
		Category	
		Nature	

PRACTICAL No. 6

Objective: To study herbicide formulations and mixtures of herbicides

Activity: Identify the given herbicide and study about its formulation

S. No.	Common Name	Trades Name	Formulation	Manufacturer

PRACTICAL No. 7

Objective: To study herbicide and nutrient compatibility

Procedure:……..……..……

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Observation:

S.No.	Herbicide	Fertilizer	Compatible/Non-compatible

Interpretation: ……..

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PRACTICAL No. 8

Objective: To study shift of weed flora in long term experiments

Activity:

Season	Treatment	Weed flora			Relative proportion (%)		
		Initial years	Middle years	Current Status	Initial	Middle	Current
Kharif							
Rabi							
Zaid							

Interpretation:……

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PRACTICAL No. 9

Objective: To study methods of herbicide application

SOIL APPLICATION

Surface application:……

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Subsurface application: ……

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Band application:……

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Fumigation Application……

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Herbigation:……

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FOLIAR APPLICATION

Blanket spray:……

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Directed spray: ……

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Protected spray: ……

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Spot treatment……

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PRACTICAL No.10

Objective: To study about the equipment used for application of herbicides.

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

Pump ……

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Power source: ……

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Tank: ……

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Agitator: ……

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Distribution system: ……

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Pressure ……

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Pressure regulator: ……

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Activity2:

Draw the diagram of Knapsack spryer

PRACTICAL No.11

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

PRACTICAL No.12

Objectives: To study cleaning and maintenance of sprayers

Maintenance of Sprayers: …………………………………………………………………………………………………

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Cleaning of Sprayers: ……………………………………………………………………………………..………………..

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PRACTICAL No. 13

Objective: Calculation of herbicide doses

Materials: ……

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Procedure:……

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

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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 ..... ha.

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

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PRACTICAL No.14

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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Observation

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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. 15

Objective: To study weed control efficiency

Procedure:……

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Weed control efficiency :…… …… ……

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Acitivity 1: In a weed control experiment in groundnut, dry weight of weeds in weedy check plot was .....kg ha^{-1}, whereas, for herbicides x and y, it was ..... and ..... kg ha^{-1}, respectively. Find out which herbicide is better.

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PRACTICAL No. 16

Objective: To study weed index

Procedure:……

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Weed Index: …… …… …… …

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Activity 1: A weed free plot of maize has given yields of ..... kg/ha, whereas atrazine and simazine treated plots have given yields of ..... kg and ..... kg/ha respectively, calculate weed index and give which herbicide is better in the two?

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TECHNIQUES OF WEED PRESERVATION

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

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 specimen dries 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.

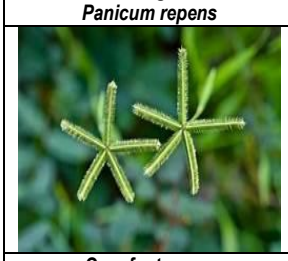
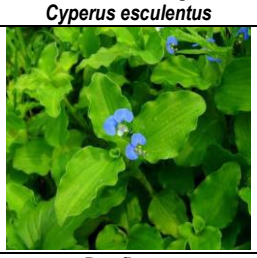
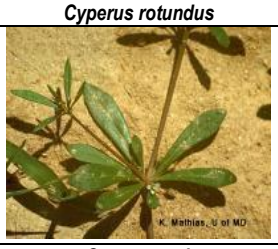
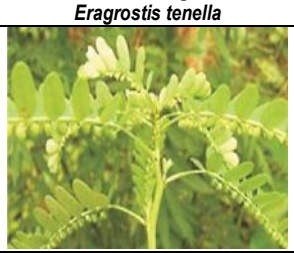
This includes special use, preference shown by insect-pest, industry, special control measure, anything special about dissemination and propagation.

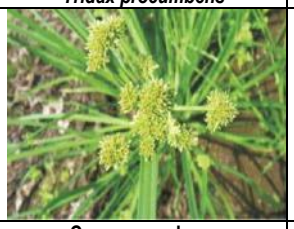
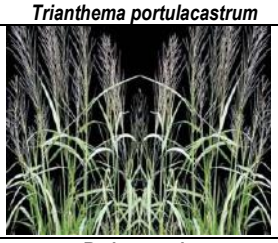
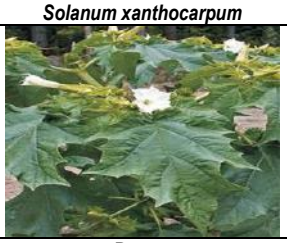
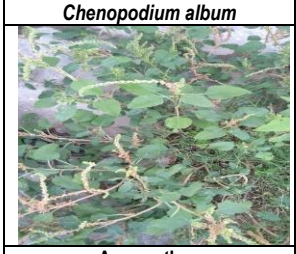
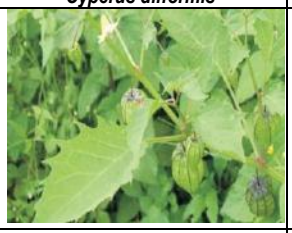
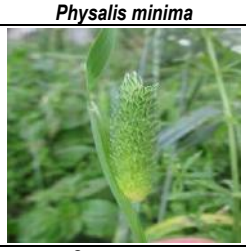
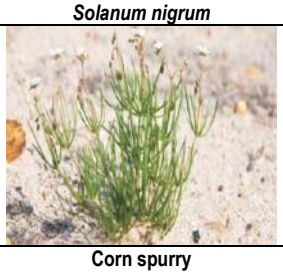
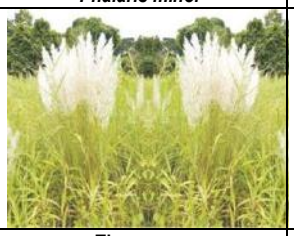
Format of identification label: The lower right-hand corner of the herbarium sheet should bear the label containing the information as described in the exercise.

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.

IMPORTANT COMMON WEEDS

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

			
Sickle pod ***Cassia tora***	**Tridex daisy** ***Tridax procumbens***	**Pattarchatta** ***Trianthema portulacastrum***	**Yellow berried nightshade** ***Solanum xanthocarpum***
			
Lambs quarter ***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***	**Canarygrass** ***Phalaris minor***	**Wild oat** ***Avena fatua***	**Corn spurry** ***Spergula arvensis***
			
	Tigergrass ***Saccharum spontaneum***	**Field bind weed** ***Convolvulus arvensis***	

WEED BIOLOGY

Morphology of the plant

Leaf: Colour, size, shape, arrangement

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

Branches: Branched, unbranched, pattern and arrangement

Flowers: Colour, size, type of inflorescence

Roots/underground parts: Shallow, deep, tap root, adventitious, root colour, rhizomes, 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.

Growth duration: Annual / biennial/perennial

Categorization in broad groups: Grasses / sedges /broadleaf

Nature: Associated, crop bound, parasitic, facultative, obligate

COMMON WEEDS

S.No.	English name	Scientific name	Family
	KHARIF		
1.	Running grass	*Brachiaria reptans*	Poaceae
2.	Crow foot grass	*Dactyloctenium aegyptium*	Poaceae
3.	Crab grass	*Digitaria sanguinalis*	Poaceae
4.	Indian goose grass	*Eleusine indica*	Poaceae
5.	Red sprangletop	*Leptochloa chinensis*	Poaceae
6.	Water grass	*Echinochloa colona*	Poaceae
7.	Barnyard grass	*Echinochloa crusgalli*	Poaceae
8.	Love grass	*Eragrostis pilosa*	Poaceae
9.	Feather love grass	*Eragrostis tenella*	Poaceae
10.	Knot grass	*Paspalum distichum*	Poaceae
11.	Seashore paspalum	*Paspalum vaginatum*	Poaceae
12.	Rough bristle foxtail	*Setaria verticillata*	Poaceae
13.	Green foxtail	*Setaria viridis*	Poaceae
14.	Hedgehog sedge	*Cyperus compressus*	Cyperaceae
15.	Rice flat sedge	*Cyperus iria*	Cyperaceae
16.	Erect horse weed	*Conyza stricta*	Astereceae
17.	Jimson weed	*Datura stramonium*	Solanaceae
18.	Smooth pigweed	*Amaranthus viridis*	Amaranthaceae
19.	Spiny pigweed	*Amaranthus spinosus*	Amaranthaceae
20.	False amaranth	*Digera arvensis*	Amaranthaceae
21.	False amaranth	*Digera muricata*	Amaranthaceae
22.	Creeping chaff weed	*Alternanthera sessilis*	Amaranthaceae
23.	Alligator weed	*Alternanthera philoxeroides*	Amaranthaceae
24.	Blistering ammannia	*Ammannia baccifera*	Lythraceae
25.	Pink node flower	*Caesulia axillaris*	Astereceae
26.	Day flower	*Commelina benghalensis*	Commelinaceae
27.	Spreading day flower	*Commelina diffusa*	Commelinaceae
28.	Slender day flower	*Commelina erecta*	Commelinaceae
29.	Wild jute	*Corchorus tridens*	Tiliaceae
30.	Pill pod spurge	*Euphorbia hirta*	Euphorbiaceae
31.	Painted spurge	*Euphorbia heterophylla*	Euphorbiaceae
32.	Petty spurge	*Euphorbia prostrata*	Euphorbiaceae
33.	Shrubby spurge	*Euphorbia microphylla*	Euphorbiaceae
34.	Ground cherry	*Physalis minima*	Solanaceae
35.	Cockle bur	*Xanthium strumarium*	Astereceae
36.	Indian turnsole/Devil weed	*Heliotropium indicum*	Boraginaceae
37.	Black nightshade	*Solanum nigrum*	Solanaceae
38.	False Daisy	*Eclipta alba*	Astereceae
39.	Yellow spider flower	*Cleome viscosa*	Brassicaceae
40.	Purselane	*Portulaca oleracea*	Portulaceae
41.	Desert horse purslane	*Trianthema portulacastrum*	Aizoaceae
42.	Puncture vine	*Tribulus terrestris*	Zygophylaceae
43.	Gulf leaf flower	*Phyllanthus niruri*	Euphorbiaceae
44.	Indian sorrel	*Oxalis corniculata*	Oxalidaceae
45.	Rattle pod	*Crotalaria medicaginea*	Fabaceae
46.	Coffee weed/ Sickle pod	*Cassia tora*	Fabaceae
47.	Creeping indigo	*Indigo feralinnaei*	Fabaceae
48.	Tiger foot morning glory	*Ipomoea pestigridis*	Convolvulaceae
49.	Blue morning glory	*Ipomoea nil*	Convolvulaceae
50.	Wild carrot weed	*Parthenium hysterophorus*	Astereceae
51.	Tridex daisy	*Tridax procumbens*	Astereceae
52.	Hair sedge	*Bulbostylis barbata*	Cyperaceae
53.	Grasslikefimbry	*Fimbristylis tenera*	Cyperaceae

54.	Common sedge	*Cyperus difformis*	Cyperaceae
55.	Yellow berried night shade	*Solanum xanthocarpum*	Solanaceae
56.	Golden daisy	*Vicoa indica*	Astereceae
57.	Chicken weed	*Euphorbia thymifolia*	Euphorbiaceae
58.	Common spurge	*Croton sparsiflorus*	Euphorbiaceae
59.	Purslane	*Portulaca grandiflora*	Portulaceae
60.	Purslane	*Porlulaca quadrifida*	Portulaceae
61.	Pink wood sorrel	*Oxalis maritiana*	Oxalidaceae
62.	Little ironweed	*Vernonia cinerea*	Asteraceae
63.	Wild buckweed	*Polygonum glabrum*	Polygonaceae
64.	Small knotweed	*Polygonum plebeium*	Polygonaceae
65.	Coffee senna	*Cassia occidentalis*	Fabaceae
66.	Arrowhead	*Sagittaria sagittifolia*	Alismaracese
67.	Frogfruit	*Lipian odiflora*	Verbenaceae
68.	Hairy slitwort	*Linderniaciliata*	Serofulariaceae
69.	Purple spikerush	*Eleocharis atropurpurea*	Cyperaceae
70.	Green foxtail	*Setariag lauca*	Poaceae
		RABI	
71.	Wild oat	*Avena fatua*	Poaceae
72.	Sweet grass	*Poa annua*	Poaceae
73.	Beard grass	*Polypogonmon speliensis*	Poaceae
74.	Poison rye grass	*Lolium temulentum*	Poaceae
75.	Canary grass	*Phalaris minor*	Poaceae
76.	Wild onion	*Asphodelus tenuifolius*	Liliaceae
77.	Barrel clover	*Medicago truncatula*	Fabaceae
78.	California bur clover	*Medicago polymorpha*	Fabaceae
79.	Toothed bur clover	*Medicago denticulate*	Fabaceae
80.	Wild fenugreek	*Trigonella polycerata*	Fabaceae
81.	Common lambsquarter	*Chenopodium album*	Chenopodiaceae
82.	Nettle leaf	*Chenopodium murale*	Chenopodiaceae
83.	Green field-Speedwell	*Veronica agrestis*	Scropulariaceae
84.	Stone seed	*Lithospermum arvense*	Boraginaceae
85.	Canaigre dock	*Rumex hymenosepalus*	Polygonaceae
86.	Sour dock	*Rumex dentatus*	Polygonaceae
87.	Dock/Sorrel	*Rumex spinosus*	Polygonaceae
88.	Blue daisy	*Cichorium intybus*	Asteraceae
89.	Wild safflower	*Carthamus oxyacantha*	Asteraceae
90.	Maxican poppy	*Argemone mexicana*	Papaveraceae
91.	Perennial saw thistle	*Sonchus arvensis*	Asteraceae
92.	Little mellow	*Malvaparviflora*	Malvaceae
93.	Meadow pea	*Lathyrus aphacaora*	Fabaceae
94.	Grass pea	*Lathyrus sativus*	Fabaceae
95.	Blue pimpernel	*Anagallis arvensis*	Primulaceae
96.	Chickweed	*Stellaria media*	Caryophyllaceae
97.	Hairy vetch	*Vicia hirsute*	Fabaceae
98.	Vetch	*Vicia Sativa*	Fabaceae
99.	Yellow sweet clover	*Melilotu sindicus*	Fabaceae
100.	White sweet clover	*Melilotus alba*	Fabaceae
101.	Fumatory	*Fumaria parviflora*	Fumariaceae
102.	Garden cress	*Coronopus didymus*	Brassicaceae
103.	Corn spurry	*Spergula arvensis*	Caryophyllaceae
104.	Cutleaf evening primrose	*Oenotheralaciniata*	Onagraceae
105.	Wild dog flower	*Antirrhinum orontium*	Scrophulariaceae
		PERENNIAL WEEDS	
106.	Nut grass	*Cyperus rotundus*	Cyperaceae
107.	Jhonson grass	*Sorghum halepense*	Poaceae

108.	Tiger grass	*Saccharum spontaneum*	Poaceae
109.	Bermuda grass	*Cynodon dactylon*	Poaceae
110.	Field bind weed	*Convolvulus arvensis*	Convolvulaceae
111.	Blush morning glory	*Ipomoea carnea*	Convolvulaceae
112.	Prickly pear	*Opuntia dillenii*	Cactaceae
113.	Canada thistle	*Cirsium arvense*	Astereceae
114.	Kidney weeds	*Dichondra repens*	Convolvulaceae
115.	Maddar root	*Calotropis procera*	Asolepiadaceae
116.	Lantana	*Lantana camara*	Verbinaceae
117.	Goat weed	*Ageratum conyzoides*	Astereceae
118.	Halfa grass	*Desmostachya bipinnata*	Poaceae
119.	Congo grass	*Imperata cylindrica*	Poaceae
120.	Marvel grass	*Dichanthium annulatum*	Poaceae
121.	Spiderling	*Boerhavia diffusa*	Nyctaginaceae
122.	Alyce clover	*Alysicarpus vaginalis*	Fabaceae
123.	Spanish needle	*Bidens pilosa*	Asteraceae
124.	Dallis grass	*Paspalum dilatatum*	Poaceae
125.	Caesar's weed	*Urena lobata*	Malvaceae
	PARASITIC WEEDS		
126.	Loranthus	*Loranthus micranthus*	Loranthaceae
127.	Dodder	*Cuscuta reflexa*	Convolvulaceae
128.	Dodder	*Cuscuta chinensis*	Convolvulaceae
129.	Dodder	*Cuscuta europaea*	Convolvulaceae
130.	Witch weed	*Striga lutea*	Scropulariaceae
131.	Egyptian broomrape	*Orobanche aegyptiaca*	Orabanchaceae
132.	Broomrape	*Orobanche cernua*	Orabanchaceae
133.	Hemp broomrape	*Orobanche ramosa*	Orabanchaceae
	AQUATIC WEEDS		
134.	Water hyacinth	*Eichhornia crassipes*	Pontederiaceae
135.	White water lily	*Nymphaea alba*	Nymphaeaceae
136.	Water lettuce	*Pistia stratiotes*	Araceae
137.	Four leaf water clover	*Marsilea hirsuta*	Marsileaceae
138.	Common reed	*Phragmitesaustralis*	Poaceae
139.	Arrowhead	*Sagittaria subulata*	Alismataceae
140.	Cattail	*Typha latifolia*	Typhaceae
141.	Narrow leaf cattail	*Typha angustifolia*	Typhaceae
142.	Hydrilla	*Hydrilla verticillata*	Hydrocharitaceae
143.	Hornwort	*Ceratophyllum demersum*	Ceratophyllaceae
144.	Pond weed	*Potamogeton perfoliatus*	Potamogetanaceae
145.	Parrot's feather	*Myriophyllum aquaticum*	Haloragaceae
146.	Mosquito fern	*Azolla filiculoides*	Salviniaceae
147.	Crested floating heart	*Nymphoide scristata*	Menyanthaceae
148.	Water spangles	*Salvinia minima*	Salviniaceae
149.	Duckweed	*Wolffia arrhizal*	Lemnaceae
150.	Common duck weed	*Lemna minor*	Araceae
151.	Eel grass	*Vallisneria spiralis*	Hydrocharitaceae
152.	Pond weed	*Potamogetonpe ctinatus*	Potamogetonaceae
153.	Pond weed	*Potamogeton crispus*	Potamogetonaceae
154.	Hornwort	*Ceratophyllum demersum*	Ceratophylaceae
155.	Lotus	*Nelumbolutea*	Nymphaceae
156.	Great duck weed	*Spirodela polyrhiza*	Lamnaceae
157.	Bulrushes	*Cyperus papyrus*	Cyperaceae
158.	Indian pennywort	*Centella asiatica*	Umbelliferae
159.	Water hyssop	*Bacopamonnieri*	Scrophulariaceae
160.	Chinese water chestnut	*Trapanatans*	Trapaceae
161.	Blue speedwell	*Veronica anagallis*	Plantagonaceae

162.	Water primrose	*Ludwigiarepens*	Onagraceae
163.	Water primrose	*Ludwigia inclinata*	Onagraceae
164.	Water primrose	*Ludwigia ovalis*	Onagraceae
165.	Water primrose	*Ludwigia palustris*	Onagraceae
166.	Water primrose	*Ludwigia pantanal*	Onagraceae

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.

TYPES OF FORMULATIONS:

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, eg. Butachlor Granules.

TRADE NAME AND FORMULATION OF COMMON HERBICIDES

S. No.	Common Name	Trades Name	Formulation	Manufacturer
1.	Fenoxaprop	Acclaim Extra	0.57E	Bayer
2.	Quizalofop	Assure II	0.88EC	Corteva
3.	Pinoxaden	Axial	0.83EC	Syngenta
4.	Clethodim	Envoy	0.94EC	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	0.42EC	Syngenta
10.	Sethoxydim	Poast	1.5 EC	Microflo
11.	Sethoxydim	Poast Plus	1 EC	Microflo
12.	Quizalofop	Provisia	0.88EC	BASF
13.	Fenoxaprop	Ricestar HT	0.58EW	Bayer
14.	Clethodim	Select	2 EC	Valent
15.	Clethodim	TapOut	1 EC	Helena
16.	Quizalofop	Targa	0.88C	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

JAR TEST FOR COMPATIBILITY

The jar test may be used to test the compatibility of herbicides with each other or herbicides and other pesticides with liquid fertilizers.

1. Add 1 pint of carrier (water, liquid fertilizer) each to two-quart jars. Mark the jars with an identifiable letter, number or other means. Usually "with" and "without" is the most practical (representing with and without compatibility agent).
2. Add 1/4 teaspoon or 1.2 ml of compatibility agent to one jar (equivalent to 2 pints per 100 gallons of spray solution).
3. To each jar add the required amount of pesticide in the order suggested in the section on mixing herbicides Shake well after each pesticide addition to simulate continuous agitation.
4. When all ingredients are added, shake both jars for 15 seconds and let stand for 30 minutes or longer. Then inspect the mixture for flakes, sludge, gels, or non dispersible oils, all of which may indicate incompatibility.
   i. If, after standing 30 minutes, the components in the jar with no compatibility agent are dispersed, the herbicides are compatible and no compatibility agent is needed.
   ii. If the components are dispersed only in the jar containing the compatibility agent, the herbicide is compatible only if a compatibility agent is added.
   iii. If the components are not dispersed in either jar, the herbicide-carrier mixture is not compatible and should not be used.

SHIFT OF WEED FLORA STUDY IN LONG TERM EXPERIMENTS

Temporally repeated data sets can provide useful information about the management practices governing changes in the arable weed flora. Survey including floristic samplings to be done by the students in an ongoing long term weed control experiment are to be compared, analysed and interpreted in light of previous data set already published in the annual reports of AICRP-Weed Control, ICAR-DWR, Jabalpur. Simple proportional occurrence can be used to interpret the results of the initial, middle and current invasion in the particular season

EQUIPMENTS 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:

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.

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 **a) Manual b) Traction c) Motor d) 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 emerses 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.

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. 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.

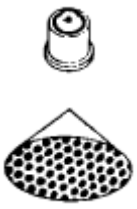
Flat fan: Flat fan nozzles are available in two spray patterns viz. the tapped edge pattern and rectangular pattern. Tapped edge pattern to apply pre and post emergence herbicide broadcasting, while rectangular pattern for the pre emergence bank application of herbicides.

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.

						
Even Flat-Fan	**Twin Orifice Flat-Fan**	**Extended Range Flat-Fan**	**Standard Flat-Fan**	**Full-Cone**	**Solid-Cone**	**Fine Hollow-Cone**

PROCEDURE FOR CLEANING AND MAINTENANCE OF SPRAYER

1. Remove and clean all screens and boom extensions with kerosene and a small brush.
2. Mix one box of detergent with 30 gallons of water in tank. Circulate through by pass system or 30 minutes and the drain out.
3. Replace the screens and the boom extensions.
4. 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.
5. Flush with two tanks full of clean waters spraying through the boom with the nozzle removed.

CALCULATING PROPER QUANTITIES 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,

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

Commercially, the herbicides are available either in solid or liquid form. On the label of the containers you will 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 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.

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 towhich 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 =

$$\text{Spray volume (L/ha)} = \frac{\text{Water used in testing (litres) x 10000}}{\text{Area covered during test run (m2)}}$$

$$= \frac{\text{Water used in testing (litres)x 10000}}{\boldsymbol{d\ x}}$$

Weed Control efficiency (WCE). It can also be worked out based on weed population or weed weight.

WCE (%) = [(Wpc – Wpt)/Wpc)] x 100
or [(Wwc – Wwt)/Wwc] x 100
Assuming:
Wpc : Weed population under control
Wpt : Weed population under treatment (hand weeding, herbicide application etc.)
Wwc : Weed weight under control
Wwt : 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.

$$\text{Weed Index} = \frac{Ya-Yb}{Ya}$$

Ya=Yield from weed free plot
Yb=Yield from the treated plot for which weed index is to be worked out