

Practical Manual
B. Sc. (Hons.) Agriculture
Weed Management
Course No: ASAG2105
Credit: 2(1+1)
Semester: 3rd



Centurion
UNIVERSITY

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

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

August, 2022

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Certificate

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

Mr./ Ms. _____

Regd. No. _____ in B. Sc. (Hons.) Agriculture degree programme,

*Course No. ASAG2105 entitled "Weed Management" during 3rd semester of the academic
year 2022-23.*

Date:

Faculty In charge

Evaluation System
Weed Management
Course No.: ASAG2105

Sl. No.	Marks distribution*	Total marks	Marks obtained
1	Record	5	
2	Attendance	5	
3	Assignment	5	
4	Herbarium	10	
Total (25 marks)			

Signature of faculty in-charge

List of Experiments

Exp. No.	Date of Exp.	Date of Submission	Title	Page No.	Signature	Remark
1			Techniques of weed preservation			
2			Identification of weeds			
3			Weed loss studies			
4			Biology of important weeds viz., nut sedge, bermuda grass, carrot grass etc.			
5			Study of herbicide formulations and mixture of herbicides			
6			Herbicide and agrochemical study			
7			Shift of weed flora study in long term Experiment			
8			Study of methods of herbicide application			
9			Study of herbicide spraying equipment's			
10			Calculations of herbicide doses			
11			Calculations on weed control efficiency and weed index			
12			Weed survey			
13			Weed vegetation analysis			
14			Field visit to farm to observe the effect of various weed management practices in different crops			

Techniques of Weed Preservation

1.1 Objectives

To study the method of collection of weeds, preparation of herbarium and preservation of weeds.

1.2 Weed herbarium

Herbarium is a collection of plants that are dried, pressed and preserved on herbarium sheets and arranged in a sequence in accordance of specific purpose for future reference, record and study.

1.3 Materials required

- i. Vasculum or polythene bag
- ii. Slanted slips of thick paper
- iii. Knife
- iv. Field press
- v. Blotting paper/ News paper
- vi. Cello tape
- vii. Field notebook

1.4 Herbarium collection

- 1) Collect the specimen at flowering stage.
 - 2) It is desirable to maintain all the plant parts intact (leaf, stem, flowers and fruits)
 - 3) Collect fresh part of the plant but not diseased preferably apical part.
 - 4) While collecting roots are kept in herbs but excluded in shrubs, trees and vines.
- Specimen:** The specimen represents a plant that is, free from damages due to pest and mechanical injuries.
- 5) The large, specimens are fragmented in to 2, 3 or more parts and bent into a V, N or W shape.
 - 6) Short stature weeds should be collected with entire root system whereas, long stature plants are to be collected atleast with inflorescence part or with pods.

1.5 Pressing and drying

For pressing, lay a piece of paper/old notebook. Put a sample/weed on blotting paper/newspaper paper followed by another blotting paper/newspaper paper above the specimen. Repeat this sequence until all specimens are arranged and the pile is large enough to be pressed conveniently. Make sure that specimen is spread uniformly in the newspaper. Continuously monitor the pressed weeds in newspaper 3 to 4 times in a week so that they will not be spoiled by fungal attack because of moisture availability in plants. If possible change the newspaper containing specimens after 24hrs, 48hrs and 72hrs till the specimen is dried completely.

1.5 Mounting

The mounting sheets are made from heavy, long lasting white card sheets in uniform size of 11.5cm x 16.5cm or 42 cm x 28 cm. The root portion of the specimen should be at bottom of the sheet. Keep the specimen in center and spread properly. Fix the specimen to the sheet with glue/ gum/ tape.

1.6 Identification and Labelling

The specimens are identified by botanical name and family referring to weed flora monographs or illustrated books or with help of competent plant taxonomist. After identifying and mounting of specimen, the labelling should be done in the herbarium sheet provided at right corner space in the page. Labelling was done with the following use trial information.

Sl. No.	Particulars
1	Vernacular name/ local name
2	Scientific name
3	Common name
4	Family
5	Habitat
6	Name of the standing crop
7	Morphological feature
8	Date of collection
9	Place of collection
10	Signature of the Student

Note: Arrange the herbarium sheets according to group into terrestrial and aquatic weeds, sub group them into monocots and dicots and further into annuals, biennials and perennials. Write the index for herbarium.

1.7 Assignment to students on herbarium preparation

- Collect 50 weeds for herbarium preparation.
- Prepare the herbarium as per the above mentioned guidelines.
- Finally submit the herbarium at the time of practical examination for evaluation.

1.8 Conclusion

Signature of faculty in-charge

Experiment No. 2

Date-----

Identification of weeds

2.1 Objectives

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

To gain an idea regarding biological and ecological adaptations of weeds.

2.2 Materials required

- i. Note book and pencil
- ii. Polythene bags with rubber bands
- iii. Magnifying glass

2.3 Procedure

Visit in and around the campus and Instructional Farm, Bagusala, Paralakhemundi at scheduled practical class with the teacher and identify the weed species.

2.4 Observation

Table 2.1 Record the identified weeds in tabular manner to make the lists of weeds

Sl No.	Local names	Common name	Scientific name	Family	Habitat, morphological feature	Mode of propagation
1.						
2.						
3.						
4.						
5.						
6.						
7.						
8.						
9.						
10.						
11.						

12.						
13.						
14.						
15.						
16.						
17.						
18.						
19.						
20.						
21.						
22.						
23.						
24.						
25.						

2.5 Conclusion

Signature of faculty in-charge

Experiment No. 3

Weed Loss Studies

Date-----

3.1 Objectives

To estimate the yield losses due to competition of weeds with crop due to various growth factors like nutrient, moisture, light and space.

To study the losses caused by weeds in agriculture.

3.2 Introduction

Competition occurs between crop and weeds for a growth factor which becomes in short supply. Weeds compete with crop plants for water, light, nutrients, space, air and the ultimate effect is reduction in yield. In general weeds cause 5% loss in agricultural production in developed countries, 10% loss in less developed countries and 25% loss in least developed countries. In India, yield losses due to weeds are more than those from insect and diseases. Generally, weeds deprive the crops by 47% N, 42% P, 50% K, 39% Ca and 24% Mg of their nutrient uptake.

3.3 Effects on crop growth and yield

1. Crop growth and yield is affected
2. Leaf area is reduced
3. Reduce the water use by the crop
4. Lowers the input response
5. Crop suffers from nutritional deficiency
6. Yield attributes will be lowered
7. Causes yield reduction
8. More occurrence of pest attack

3.3.1 Computation of yield losses due to weeds

Yield losses in percentage due to weeds in a particular treatment from best treatment is calculated as follows.

Percentage reduction in yield: It is a measure of the efficacy of particular treatment when compared with weed free treatment and is expressed as percentage reduction in yield. Higher in % yield reduction means greater loss due to weeds:

Formula

$$\text{Percent yield reduction} = \frac{X - Y}{X} \times 100$$

Where, X is yield from weed free plot and Y is yield from treated plot

Problems:

1. A weed free plot of Sorghum has given yield of 1500 kg ha⁻¹ whereas atrazine have given yields of 1400 kg. Calculate the % yield reduction?

2. A weed free plot of maize has given yield of 2100 kg ha⁻¹ whereas, simazine treated plot had given the yield of 1450 kg ha⁻¹. Calculate the % yield reduction?

3.4 Observation

Table 3.1 Write the critical periods of crops

Crop	Reduction in Yield (%)	Critical period	Crop	Reduction in Yield (%)	Critical period
Direct seeded rice	15-90		Red gram	20-40	
Transplanted rice	15-45		Chickpea	15-25	
Wheat	20-40		Jute	50-80	
Maize	40-60		Potato	30-60	
Bajra	15-60		Groundnut	40-45	
Jowar	15-40		Sun flower	30-60	
Sugar cane	20-30		Soyabean	40-60	
Cotton	20-40		Castor	30-35	
Greengram & black gram	25-50		Seasamum	15-40	

3.5 Conclusion

Signature of faculty in-charge

Experiment No. 4

Date-----

Biology of important weeds viz., Nut Sedge, Bermuda grass, Carrot grass, witch weed and water hyacinth

4.1 Objectives

To study the biology and habitat.

To study the management strategies.

4.1.1 Procedure

Before study of weed biology, follow the teacher to identify the weeds correctly.

4.2 Identification of the weed nut sedge / plant characteristics

Scientific name:

Common name:

Family:

Common name:

Scientific name:

Family:

a. Habitat:

b. Root:

c. Stem:

d. Leaf:

e. Mode of propagation:

Biology:

It is persistent perennial sedge. It is considered as world's worst weed as it occurs in almost all the crops. It is native of India and widely distributed throughout tropics and subtropics. The slender underground runners grow out from the base of stem and form series of black irregular shaped or nearly round tubers which may grow up to 2 cm length. The tubers sprout to produce new plants while still attached to the parent plant. These tubers act as dispersal units.

Yellow nut sedge propagates through seeds. It has yellowish-brown or straw-colored inflorescence which is arranged along an elongated axis in the shape of a bottle brush. It has pale green leaves which grow upright with long needle-shaped leaf tips.

Purple nut sedge propagates through tubers having red, reddish-brown, or purplish-brown loosely arranged inflorescence, dark green leaves which grow low to the ground with boat-shaped leaf tips.

The tubers are oval to spherical in shape and have 3 - 10 buds arranged spirally. Generally 80% of tubers can be found in the top 15 cm of soil. The majority can survive for 1 to 3 years. It has the ability to thrive under very adverse conditions and is very difficult to be eradicated due to prolific production of tubers.

4.3 Identification of the bermuda grass / plant characteristics

Common name:

Scientific name:

Family:

a. Habitat:

b. Root:

c. Stem:

d. Leaf:

e. Mode of propagation:

Biology:

It is one of the world worst weed. It occurs throughout tropics and subtropics and semi arid regions of world. It is a perennial weed that propagates through seeds, rhizomes and runners. Rhizomes can penetrate 40-50 cm deep in clay soil and 70-80 cm in sand soil. Lifespan is 3-4 months. Foliage is dense and varies greatly from 3-20 cm in length. Inflorescence consists of 4-5 slender purple spikes of 10 cm long. Some varieties used as lawn grass/ it propagate vegetative more than by seeds. It is susceptible to competition and shading. Single plant produces 170 seeds. One kg contains around 45 lakh seeds.

4.4 Identification of the carrot grass / plant characteristics

Common name:

Scientific name:

Family:

a. Habitat:

b. Root:

c. Stem:

d. Leaf:

e. Mode of propagation:

Biology:

It is a noxious exotic weed. It generally germinates after rain at any season. It starts flowering after 6 to 8 weeks of flowering. The stem is branched and covered with trichomes. Leaves are pale green, lobed, hairy, initially forming a basal rosette of strongly dissected leaf that are up to 30 cm in length. Flower heads are creamy white, about 4 mm across arising from the leaf forks. Reproduces by small seeds lasting up to 20 years in soil, induced dormancy on burial. The plant is capable of flowering when one month old and remains in flower for 6 to 8 months. It produces 5000-10000seeds/plant.

4.5 Identification of witch weed/ plant characteristics

Common name:

Scientific name:

Family:

- a. Habitat:**
- b. Root:**
- c. Stem:**
- d. Leaf:**
- e. Mode of propagation:**

Biology:

It is an annual parasitic herb propagating from seeds. Flowers are reddish to purplish or white in color. Seeds are extremely small. Striga seeds require stimulus continuously for 24 - 28hrs from host plant to trigger the germination of striga seeds. After germination it produces 2-3 mm long radicles. These radicles form haustoria's and harm the host roots involving the whole root system of host plant. The affected crops look drought affected despite the presence of adequate soil moisture. Each Striga plant may produce a million seeds within 30 days of after emergence. Striga causes a reduction of 15 -75% in the yield of sorghum and pearl millet.

4.6 Identification of water hyacinth/ plant characteristics

- a. Habitat:**
- b. Root:**
- c. Stem:**
- d. Leaf:**
- e. Mode of propagation:**

Common name:
Scientific name:
Family:

Biology

It is a free floating aquatic weed. It is introduced into India from Brazil. It contains broad, thick, glossy, ovate leaves. The leaves are 10–20 cm length and float above the water surface. They have long, spongy and bulbous stalks. The inflorescence is a distinct aerial spike growing to 30 cm. The seeds remain viable for over 15 years in the bottom of soil each flower produce 3000 to 4000 seeds. Single plant is capable of infesting an area of one acre in a year.

Exercise:

- 1. Bio agent used to control nut sedge?**

2. Cultural practices used to control these grasses?

3. Why weeds have to be controlled before flowering?

4. Bio agent used to control parthenium?

5. Trap used to control striga weed?

4.7 Conclusion

Signature of faculty in-charge

Study of herbicide formulations and mixture of herbicide

5.1 Objectives

To acquaint with different herbicide formulations available in the market and herbicide mixture

5.2 Procedure

Read the information given on the labels attached to the herbicide containers.

5.2.1 Types of formulations

a) **Emulsifiable Concentrate (EC)**

b) **Solution Concentrate (SC)**

c) **Wettable Powder (WP):**

d) Soluble Powder (SP):

e) Flowable Concentrate (FC):

f) Granule (G) and Pellets (P):

g) Fumigants:

5.4 Herbicide mixture

Herbicide mixture is the mixing of two or more herbicides having different mode of action. Pre and post emergence herbicides are mixed to increase the spectrum of weeds control over a longer period of time. It prevents herbicide resistance development in weeds and weed flora shift in crops and cropping system to selected herbicides.

5.4.1 Types of herbicide mixture

5.4.1.1 Factory mix:

5.4.1.2 Field mix:

5.4.2 Interaction effects of mixture

a) Synergistic effect:

.

b) Additive effect:

d) Independent effect:

e) Enhancement effect:

f) Antagonistic effect:

Herbicide rate calculations:

Formula for calculating herbicide required to an area.

$$\text{Herbicide required (Kg)} = \frac{\text{Recommended dose}}{\text{Active ingredient (a.i/a.e)}} \times 100 \times \text{Area in ha}$$

Problem

1. Pre-emergence application of pretilachlor (50% EC) + bensulfuron methyl (60% DF) @ (1000+660) g/ha is effective in controlling grassy weeds. Find out the required herbicides for 1.25 ha.

2. Post emergence application of almix(20% WP)+ bispyribac sodium(10% SC) @ (4+20)g/ha effectively controls grass, broad leaves and sedges. Calculate the required herbicide for 0.75 ha.

- 3. Herbicide combination atrazine (50 % WP) + pendimethalin (30% EC) @ 0.5 kg/ha + @ 0.5 kg/ha is applied as pre emergence spray in maize. Find out the quantities of herbicide will be required for 1.25 ha.**

5.5 Conclusion

Signature of faculty in-charge

Experiment No. 6

Herbicide and agrochemicals Study

Date-----

6.1 Objectives

To study about the identification and common agrochemicals available in the market.

6.2 Materials required

- i. Herbicides container bearing labels
- ii. Sample labels of various types of commercial herbicides

6.3 Procedure

Read the information on the labels attached to the herbicide containers. Record the information in a systematic manner.

6.4 Observation

Record the following observations in tabular form indicating common name, trade name, formulation and manufacturing company of agrochemicals.

Table 6.1 Identification of herbicides, insecticides, fungicides, bactericides and acaricides

List of commonly available agrochemicals and their manufacturing companies

S. No	Common Name	Trade Name	Formulation	Time of application
Herbicides				
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				
11.				
12.				
13.				
14.				
15.				
Insecticides				

16.				
17.				
18.				
19.				
20.				
Fungicides				
21.				
22.				
23.				
24.				
Bactericides				
25.				
26.				
27.				
Acaricides				
28.				
29.				
30.				

6.5 Conclusion

Signature of faculty in-charge

Shift of Weed Flora Study in Long Term Experiment

7.1 Objectives

To study and gain knowledge in shift of weed flora in long term experiments

7.2 Relevant information

A weed shift is the change in the composition or relative frequencies of weeds in a weed population or community in response to natural or human-made environmental changes in an agricultural system. Susceptible weeds are largely eliminated over time with continued use of the same cultural practice or herbicide. This allows inherently tolerant weed species to remain, which often thrive and proliferate with the reduced competition.

7.3 Weed shift in crops and cropping system

With a foliar herbicide without residual activity like glyphosate, there could also be a shift within a weed species to a late emerging biotype that emerges after application. Growing rice under alternating flooding regimes and residual soil moisture conditions prevalent in the Cauvery Delta region of Tamil Nadu, red sprangletop (*Leptochloa chinensis* L.) and European water clover (*Marsilea quadrifolia* L.) became predominant in rice fields by replacing barnyard grass (*Echinochloa* sp.). In the eastern Indo-Gangetic Plains, adoption of zero tillage has resulted in an increase in population of globally-significant perennial weeds such as purple nutsedge (*Cyperus rotundus*) and Bermuda grass (*Cynodon dactylon*)

7.4 Effect of continuous use of herbicides on weed shifts in rice-wheat system

In long-term experiment on rice-wheat cropping system, continue use of herbicides (butachlor + 2,4-D) and rotational use of herbicides (butachlor/pretilachlor (cyhalofop-butyl) in later years) + 2,4-D in rice and continue use of (isoproturon + 2,4-D) and rotational (clodinafop/isoproturon) use of herbicides in wheat were tested in rice - wheat cropping system.

During winter season, *Phalaris minor*, *Avena ludoviciana*, *Vicia sativa*, *Anagallis arvensis* and *Coronopus didymus* were dominant weeds in wheat. Population density of all these weeds decreased in later years. *Coronopus didymus* was not observed after use of above herbicides. Again after 3-4 years, *Poa*, *Lolium* and *Ranunculus* were appeared. *Poa* and *Lolium* had alarming proportion in the later years while *Ranunculus* disappeared after 2-3 years. Again, after five years of experimentation, *Polygonum* and *Alopecurus* were the new invaders. In the later years, *Trifolium*, *Stellaria*, *Lathyrus*, *Plantago* and *Daucus carota* had little infestation in the experimental field. In kharif, *Echinochloa crusgalli*, *Panicum dichotomum* and *Cyperus iria* were the main weeds initially. The population of these weeds decreased over the years. Lately *Digitaria*, *Ischaemum*, *Aeschynomene*, *Commelina*,

Study on Methods of Herbicide Application**8.1 Objectives**

To study the herbicide application methods.

Methods of herbicide applications are decided based on their mode of action and selectivity. Most important methods to crop and non-crop lands are given below

8.2 Method of herbicide application

The herbicide application is grouped into the following ways:

A) Soil active herbicides

It is applied primarily to the soil rather than to the vegetation. Therefore, in crop fields a soil-active herbicide eliminates early weed-crop competition for the period of 4 to 8 weeks, depending upon the herbicide and its rate used. Eg: Simazine, Alachlor, Trifluralin and EPTC. On non-crop lands, the soil-active herbicides used are soil sterilants and fumigants.

Different soil application methods:

a) **Surface application:**

b) **Sub surface layering**

c) **Broadcast and band application:**

g) **Soil fumigants**

Depending upon the nature of the soil fumigant it can be applied either by-

- (i) Soil injection (Ex: Chloropicrin)
- (ii) Releasing under sealed plastic covers (Ex: Methyl bromide)
- (iii) Soil surface application (Ex: Metham)

B) Foliage active herbicides

These herbicides are applied to weeds after their emergence from the soil. They are absorbed by the plant foliage and these are translocated to the other plant parts. Ex: 2,4,5-T, Paraquat, Diquat, MCPB, Amitrole.

Different foliage application methods:

a) **Blanket application**

b) **Directed spraying**

c) **Protected spraying:**

d) **Spot treatment:**

D. Other methods of herbicides application

a) **Direct contact application (DCA):**

b) Soil injection:

Exercise:

1. Write down the precautionary measures to be followed while spraying a herbicide?
2. Why spraying should not be carried against the wind direction? Substantiate?
3. Differentiate between blanket applications and directed spraying?

8.3 Conclusion

Signature of faculty in-charge

Study of Herbicide Spraying Equipment's**9.1 Objectives**

To study the different Sprayers and functions of different parts of equipment.

To calculate correct amount spray liquid needed per unit area.

To acquaint with proper handling of sprayers and familiarize with various mechanism of sprayers to increase the spraying efficiency.

9.2 Major components of sprayers

The important components of sprayers are (i) pump (ii) powers source (iii) tank (iv) agitator (v) distribution system (vi) pressure gauge and (vii) pressure regulator.

Pump

Any spray liquid must be atomized before it leaves the spray nozzle. A pump provides the necessary pressure for this purpose. Two kinds of pumps are generally used in herbicide sprayers.

Air compression or pneumatic pumps: These pumps force air into an airtight tank containing the spray liquid .The air pressure moves the spray liquid into the nozzle where it gets atomized before leaving the sprayers as fine spray.

Hydraulic or positive Displacement pumps: These pumps take in a definite volume of spray liquid and force it through the delivery system under pressure. The pumps differ in the pressure they produce.

Source of power

A source of power is needed to run the sprayer **pumps** this source of power may be (a) manual (b) traction (c) motor or (d) tractor and aircraft engines.

Spray tank

A sprayer has either a built in tank or separate tank to carry the spray liquid. The tank should be large enough to avoid frequent refilling. Depending upon the kind of sprayer, the tank size varies from 25 to 2250 liters and sometimes even more. A tank is provided with a large opening, fitted with strainer and a cap to fill the spray liquid. Small tank opening can make filling and cleaning of the tank difficult.

Agitator

Most spray tanks carry an agitator. It may be either a mechanical or hydraulic type .The agitator keeps the spray liquid components in homogenous mixture. The mechanical agitators are usually made in the shape of metal rod with a fan or rings at its distant end.

In hydraulic agitation, there is a pipe with several side holes but closed at its free-end. It is placed in the spray tank and is fed under pressure with the spray liquid from the pumps. The jet of liquid thus formed provides the necessary agitation to the spray material. Hydraulic sprayers are provided only in large, tractor-mounted spray tanks. Agitators are most essential for the application of herbicide emulsions and suspensions.

9.3 Study of sprayers

Sprayers are of two types depending upon the type of force required

9.3.1. Manually operated

- i) Compressed air sprayer
- ii) Hydraulic sprayer

9.3.2. Power operated

- i) Gaseous energy sprayers –motorized knapsack sprayers
- ii) Centrifugal energy sprayers –Controlled droplet and micron herbisprayer
- ii) Tractor mounted power driven sprayers
- iii) Aerial sprayers

But generally hand operated sprayers are used by common farmer.

9.3.3 Hand operated sprayers

Compressed air or Pneumatic sprayer

i) **Knapsack sprayers:** The knapsack sprayers are loaded on the back of the applicator. Three types of knapsack sprayers are available (a) hydraulic (b) manual pneumatic and (c) motorized pneumatic.

a) **Hydraulic knapsack sprayers:** It works under hydraulic pressure. The tank capacity varies from 5 to 15 liters with the provision of mechanical agitation of the spray liquid. The operator operates the lever with his left hand and pumps the spray liquid in to the lance held by his right hand. While operation it is usually possible to deliver the spray at almost constant pressure. The hydraulic knapsack sprayer could spray at pressure of **3 to 5 kg/ cm²**. This sprayer is of low cost, easy to maintain and is a small holding farmer sprayer. It is more suitable for spot and band application of herbicides.

b) **Pneumatic or compressed knapsack sprayer:** This sprayer does not require pumping during spraying and is not pressurized before loading on the back of the worker. It is filled up as per the capacity of the sprayer. Then it is pumped either with a built in pump or from an external source like a charge pump or carbon dioxide cylinder. The main disadvantage of this sprayer is that uniform delivery pressure cannot be maintained due to decreasing spray pressure during the spraying operation. This may cause uneven spray.

c) **Motorized pneumatic sprayer:** It is a low volume sprayer suitable for spraying concentrated spray liquids. A blast of air acts as a carrier of herbicide concentrates in these sprayers is called blowers. The air is forced through the spraying jet of the delivery hose of the blower and the nozzle tube ejects the spray liquid. In this type, the air blast atomizes the spray liquid into tiny drops. The atomization is more vigorous when the air is pumped at faster rate in to the spraying unit.

The herbicide is lost as spray drift as the blower produces the droplet size of 50-100 microns. The main advantages of knapsack blowers are low volume spray resulting in reduction in loss of time in refilling the tank and fast spraying. It has a swath of 7-8m .There is requirement of 60 litres of spray liquid for spraying one hectare.

e) **Foot sprayers:** Foot sprayers are used for application of herbicides in larger holdings. The pump lever of a foot sprayer has a pedal conveniently worked with a foot. The pedal pump sprayer has an external spray tank through an intake pipe fitted with a sieve at its sucking end. The working pressure may range between 17 to 21kg/cm². Foot sprayers have provision of long delivery hoses fitted with a lance. The suction spout is dipped in a container filled with herbicide spray solution which acts as an external tank.

ii) **Hand held sprayers:** The hand carried lighter weight low volume battery operated sprayers are suitable in smaller holding size in tropical and subtropical countries. Two types of such spray are available to the farmers.

a) **Controlled droplet applicator (CDA):** In this type, the spray droplet size is 250 microns which is more effective and adequately drift tolerant. The controlled size droplets are known as ultra low volume sprayer. It has a rotary atomizer and a spinning disc with a serrated edge which revolves at a speed of 2000 revolutions per minute (rpm) to produce droplet size of 250 micron. The herbicide spray solution is gravity fed to the disc from a plastic container of 2.5 litres capacity. The atomizer is driven by a small electric motor which is attached to the tube carrying the batteries that provide power for the motor. The spray volume is 15-20 litres/ha. This sprayer is more handy for small holdings, treating rough topography land and wet paddy fields. The sprayer covers the swath of 1.2 m wide with a walking speed of 3 to 5 km/hr. This method is particularly useful in case of foliage applied systemic herbicides.

Calibration of sprayers:

$$\text{Volume of water required (L/ha)} = \frac{\text{Volume sprayed (lt)}}{\text{Area sprayed (ha)}}$$

$$\text{Area sprayed (ha)} = \frac{\text{Spray swath (m) x distance traveled (m)}}{10,000}$$

1. The following details have been generated from a sprayer calibration attempt. Spray swath - 1.2 m; distance traveled - 60 and volume sprayed – 3L. Calculate the volume of water required for spraying 1 ha.

Boom sprayer calibration

Three factors govern the amount of spray liquid applied through a boom sprayer. These factors are: swath width (W); nozzle discharge rate (NDR) and the ground speed (S). The nozzle capacity is governed by the size of the nozzle and the pressure developed at the nozzle by the pump. The nozzle manufacturers provide data sheets showing the nozzle capacities at variable pressures. Alternatively, a blank run can be made for a minute and the discharge collected at a constant pressure can be measured. For a given spray pressure, the above variables of application rate (R) of the spray liquids are related as follows:

$$R \text{ (1/ha)} = \frac{600 \times \text{NDR (1/min per nozzle)} \times N \text{ (No. of nozzles)}}{W \text{ (m)} \times S \text{ (km/hr)}}$$

$$\text{Band application rate (1/ha)} = \frac{\text{Band width (cm)} \times \text{Broadcast rate (1/ha)}}{\text{Row spacing (cm)}}$$

$$\text{Area (ha)} = W \text{ (m)} \times T \text{ (hr)} \times S \text{ (km/hr)} \times 0.1$$

$$\text{Area (ha)} \text{ hr}^{-1} = \frac{\text{Walking speed (km hr}^{-1}) \times \text{m km}^{-1} \times \text{Spray width (m)}}{\text{m}^2 \text{ ha}^{-1}}$$

$$T \text{ (hr)} = \frac{A \text{ (ha)} \times 10}{W \text{ (m)} \times S \text{ (km hr}^{-1})}$$

Exercise:

1. Write the differences between hydraulic sprayer and pneumatic knapsack sprayer?

S. No	Hydraulic sprayer	Pneumatic knapsack sprayer

2. Draw the knapsack sprayer and mention its parts?

3. Draw the foot sprayer and mention its parts?

- 4. A sprayer, equipped with two nozzles on a 1m, 50 cm long boom was found to deliver the herbicide spray at 3 l/mt/nozzle. Calculate its application rate in l/ha when the sprayer was run at a ground speed of 6 km/hr.**
- 5. It is decided to apply a herbicide to wheat with a tractor-mounted sprayer at an application rate of 200 l/ha. The sprayer has two nozzles placed on a 50 cm long boom. Calculate the nozzle capacity required in l/m. If the sprayer was to be run at a ground speed of 8 km/hr.**
- 6. A sprayer is equipped with a pump of 30 l/min capacity. It has a 7 m long boom and is run at a ground speed of 8 km/hr. Assuming a 20% loss in by-pass hydraulic agitation, calculate the potential application rate of the sprayer in l/ha.**

- 7. A sprayer carried a 7 m wide swath. When driven over a distance of 290 m it was found to spray 90 litres of the herbicide emulsion. Calculate the application rate achieved in l/ha.**
- 8. In a test run, a measured course of 110 m length is found to require 54 seconds the traveling forward, and 56 seconds for returning to the starting point. The sprayer carried a tank of 450 litres capacity and a 12 nozzles' boom, with nozzles placed 50 cm apart. After completing the run, it was found it consumed 45 litres water from the tank. Calculate the (i) swath width (ii) area covered by the sprayer during the test run, (iii) application rate of water, and (iv) area that could be covered if it was decided to consume the tank full water.**

9. What length of boom is required on a sprayer operating at 8 km/hr to permit spraying in 32 ha crop area in 8 hrs? Calculate 30% time lost in filling the tank and on the turns.

10. What minimum size of pump is required to apply a spray at 90 l/ha with sprayer traveling at 8 km/hr and equipped with a 8 m long boom? The spray tank has mechanical agitation.

9.4 Conclusion

Signature of faculty in-charge

Calculations of Herbicide Doses

Herbicides have ample scope to use on both croplands and non-cropland. On crop lands total quantity of chemical reaching the target area, where as in non-cropped area herbicide rates in terms of their spray concentration.

10.1 Objectives

To learn about calculations of herbicide doses
 To determine quantities of herbicide required for weed control in crops

10.2 Introduction

Rate of application: It is the amount of active ingredient or acid equivalent of herbicide applied to a unit area of land or water body. It is usually given in terms of kg *ai* / *a.e* / ha. The herbicides are available either in solid or liquid form.

Active ingredient:

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

Acid equivalent (*a.e*): Refers to that part of a formulation that theoretically can be converted to the acid. Eg. Some herbicide structures are active organic acids. Eg. Phenoxy alkanoic, picloram is acids but they are prepared in the form of their salts and esters for the ease of their field application. Eg: For instance 2,4-D in acid form is water insoluble then we have to use its sodium and amine salts and esters. The acid equivalent (*a.e*) of sodium salt of 2,4-D is 92.5%. It indicates that 2,4-D dichloro phenoxy acetic acid is 92.5% in sodium salt of 2,4-D.

10.3 Calculation for required weight of commercial product

Formula for calculating herbicide required to an area.

$\text{Herbicide required (Kg)} = \frac{\text{Recommended dose}}{\text{Active ingredient (a.i/a.e)}} \times 100 \times \text{Area in ha}$

Problems

- 1. Post emergence application of 2,4-D Na salt containing 80% WP @ 0.5 kg of per ha is sprayed. Find out the quantity of 2,4-D Na salt is required for a hectare.**
- 2. Define acid equivalent?**
- 3. Farmer wants to apply diuron (Karmex 80%) at 1 kg/ha. Find out the quantity of commercial produce required per ha.**
- 4. Calculate the amount of Eptam-6EC containing 0.6 kg of active ingredient (S-ethyl dipropyl thiocarbomate) per litre, for an area of 5 ha. The application rate is 1.5 kg a.i./ha.**

- 5. If in area of 0.5 ha is to be sprayed with Atrazine (50 % WP) @ 1 kg/ha, what would be the quantity of commercial herbicide required?**
- 6. Pendimethalin (Stomp 30 EC) is to be applied at the rate of 1 kg/ha in groundnut as pre-emergence application. If the amount of water to be mixed is 500 l /ha. Calculate the amount of pendimethalin to be required.**
- 7. In transplanted rice, pretilachlor 50 EC @ 0.5 kg /ha is applied as pre emergence spray followed by 2, 4 - D Na salt 80 WP @0.50 kg/ha as post emergence spray. Calculate the quantities of herbicide are required in 1.50 ha.**

8. Calculate the amount of alachlor containing 500g a.i/lit required for 2 acres of maize. The desired rate of application is 1.25 kg/ha.

9. Find out the area sprayed by full tank of sprayer and herbicide dose required for that area from the following data.

**Recommended spray volume = 400 lt/ha, Volume of sprayer = 12 lt,
Recommended dose of nomine gold = 2.5kg/ha, a.i of nomine gold =25%**

10. Calculate the amount of atrazine required to spray for 30 plots with an a.i of 50%. Each plot size was 20m^2 . The desired rate of application is 1.5 kg/ha.

10.4 Conclusion

Signature of faculty in-charge

Calculations on Weed Control Efficiency and Weed Index**11.1 Objectives**

To find out the number of monocot and dicot weeds associated with the particular crop.
To compute the weed indices.

11.2 Materials required

- I. Quadrate of 0.5 m x 0.5m size.
- II. Observation note book.
- III. Pencil.

11.3 Need to measure weed density

It is necessary to know the number and nature of weeds competing with the crops.
The weed density gives the biological stress that the crops are subjected to.
It is easy to measure weed density during early stages (or) critical period of crop weed competition.

11.4 Measurement of weed density:

There are two 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.

11.5 Precautions

1. 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 quadrate.
2. Take care to note the name and number of weeds immediately.
3. Select at random, the location (or) site for placing quadrate in different places of the crop field.

11.5.1 Procedure

1. Select a field with young crop plants and weeds for taking weed count.
2. Place the quadrat at randomly selected place in the field.
3. First pull out all the dicotyledonous weeds inside the quadrat taking simultaneous counting.
4. Record the number of dicotyledonous weeds the observation note book.
5. Then pull out and count all the monocotyledons and record it.
6. Multiply the number of monocotyledonous weeds by 4 to find out the number of weeds

11.6 Quantitative method of evaluation methods

Count the number of weeds/ dry weight per unit area .Take the weight of samples and yield of crops. Yield may be grain, straw etc. This method is quite accurate but is time consuming. This is done as follows.

11.6.1 Weed Index (WI)

Weed index is the magnitude of yield reduction due to presence of weeds in comparison with weed free check. It is a measure of the efficacy of particular treatment when compared with weed free treatment. Higher weed index means greater loss due to weeds. Weed index was calculated in % by using following formulae.

$$\text{Weed index} = \frac{X-Y}{X} \times 100$$

X = Yield from weed free treatment and
Y = Yield of a particular treatment to be compared

Note: Lesser the weed index better is the efficacy of herbicide. We can also compare the efficacy the two herbicides with the help of weed index.

11.6.2 Weed control efficiency (WCE)

Weed control efficiency (WCE) denotes the magnitude of weed reduction due to weed control treatment. It is expressed in %.WCE is calculated by following formula.

$$\text{Weed control efficiency} = \frac{(DWC - DWT)}{DWC} \times 100$$

DWT = Dry weight of weeds in treated plot
DWC = Dry weight of weeds in unweeded control plot

Note: Higher the weed control efficiency better is the efficacy of herbicide.

Problems

- 1. Weed free check plot of sorghum has given the yield of 1500 kg/ha. Whereas, atrazine & simazine treated plots has given the yields of 1400 & 1450 kg/ha. Find the weed index?**

- 2. Weed freecheck plot has given the yields of 4000 kg/ha whereas, atrazine & pendimethalin treated plots has given the yields of 4620 & 4600 kg/ha. Find the weed index?**

- 3. In groundnut field the dry weight of weeds in weed free check plot is 620 kg/ha. Whereas, atrazine & pendimethalin treated plots has given 230 & 360 kg dry weight /ha. Find the weed control efficiency.**

4. In green gram plots the dry weight of weeds in weed free check plots is 780 kg/ha. Whereas, isoproturon & fluchloralin treated plots has given 480 & 460 kg/ha dry weight. Find the weed control efficiency.

11.7 Conclusion

Signature of faculty in-charge

Experiment No. 12

Date-----

Weed Survey in Crop Fields and Other Habitats

12.1 Objectives

To know the type of weed flora dominant in a region amongst grasses, sedges and broad leaved weeds

12.2 Materials required

1. Conveyance to visit area
2. Note book to note the information
3. Quadrat

12.3 Procedure

After reaching the site, select spots in the farm or in farmer's field of a village randomly. Take at least 10 minimal sample area of size 0.5 m x 0.5 m or 1.0 m x 1.0 m as per convenience with a quadrat. Identify the weeds associated with different crops and count. Collect data in the same way in different seasons as per the proforma. Calculate % occurrence of weeds with respect to total number of weeds. Find out the dominant weed species as per the % occurrence of weeds in different crops and other habitat. Provide ranking as 1st, 2nd and 3rd in each category of grasses, sedges and broadleaved weeds in order to know the prevalence of weeds in that locality/ region/ farm.

12.4 Calculation

The student should count the weed species present separately from all the 10 sample areas and find out the mean weed population species wise by averaging the data taken over the 10 sample areas. Then calculate the occurrence (intensity) of each type of weed species in the following ways.

$$\text{Intensity (\%)} = (\text{Gross total number of weeds} / \text{number of weeds of a species}) \times 100.$$

This gives an idea about the dominance of a particular weed species based on total weeds and also dominance of a weed from each category of grasses, sedges and broad leaved weeds.

Table 12.1 Observation on survey of weeds

Particulars	No. of weeds in a quadrat	% Occurrence of a weed	Ranking for dominance
Grasses			
<i>Echinochloa colonum</i>			
<i>E. crusgalli</i>			
<i>Digitaria sanguinalis</i>			
<i>Dactyloctenium aegyptium</i>			
<i>Sporobolus diander</i>			
<i>Cynodon dactylon</i>			
<i>Paspalum scrobiculatum</i>			
Total of grasses			
Sedges			
<i>Cyperus rotundus</i>			
<i>C. difformis</i>			
<i>C. iria</i>			
<i>Fimbristylis miliacea</i>			
Total of sedges			
Broad leaved weeds			
<i>Amaranthus viridis</i>			
<i>Ageratum conyzoides</i>			
<i>Alternanthera sessilis</i>			
<i>Ammania bacifera</i>			
<i>Borreria hispida</i>			
<i>Cleome viscosa</i>			

<i>Commelinabenghalensis</i>			
<i>Euphorbia hirta</i>			
<i>Eclipta alba</i>			
<i>Oldenlandiacorymbosa</i>			
<i>Phyllanthusniruri</i>			
<i>Portulacaoleracea</i>			
<i>Trianthemaportulacstrum</i>			
Total of broad leaved weeds			
Parasitic weeds			
<i>Cuscutachinensis</i>			
Gross total (Grasses +sedges + dicots)			

12.5 Conclusion

charge

Signature of faculty in-

Weed Vegetation Analysis

13.1 Objectives

To learn about weed sampling

13.2 Procedure

Select a field where the various weed management practices have been used. The instructor will assign the sampling size to different groups. Use the quadrat samplings for the determination of the following quantitative estimates. In list or census quadrat method, individual weed species are listed and actual number of species per unit area is counted. It is easier to account the number of annual weed species. The rooted sprouts of individuals are considered as individual number in case of weed species propagated by vegetative means. Care should be taken to count the species which roots remain with the quadrat only.

13.3 Non-destructive method

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

$$\text{Absolute density} = \frac{\text{Total number of individuals of a species in all quadrants}}{\text{Total number of quadrants used}}$$

2. **Relative density:** Relative density is the study of numerical strength of a species in relation to the total number of individuals of all the species. It can be calculated in following way.

$$\text{Relative density} = \frac{\text{Absolute density of a species}}{\text{Total absolute density of all species}} \times 100$$

3. **Frequency:** This is the degree of dispersion of individual species in an area and represents the number of sampling units in which the particular species occurred. It is expressed in terms of percent occurrence.

$$\text{Absolute frequency} = \frac{\text{Quadrat occurrence of a species}}{\text{Total number of quadrants used}} \times 100$$

4. **Relative frequency:** The degree of dispersion of individual species in an area in relation to the number of all the species occurred. It can be determined from the absolute frequency by the following formula

$$\text{Relative frequency} = \frac{\text{Absolute frequency of a species}}{\text{Total of absolute frequency of all species}} \times 100$$

5. **Weed abundance:** It is the study of the number of individuals of different species in the community per unit area. By quadrats method, samplings are made at random at several places and the number of individuals of each species was summed up for all the quadrats divided by the total number of quadrats in which the species occurred. It is represented by the equation.

$$\text{Absolute abundance} = \frac{\text{Total number of individuals of a species in all quadrates}}{\text{Total number of quadrates in which the species occurred}} \times 100$$

6. **Relative abundance:** It is the abundance of a species (by any measure) divided by the total abundance of all species combined.

Relative abundances can be expressed as a percentage.

$$\text{Relative abundance} = \frac{\text{Total absolute abundance of all species in all species}}{\text{Total number of individuals of a species in all quadrats}} \times 100$$

$$\text{Relative abundance} = \frac{\text{Total number of individuals of a species in all quadrats}}{\text{Total number of individuals of all species in all quadrats}} \times 100$$

7. **Importance Value Index (IVI):** This index is used to determine the overall importance of each species in the community structure. In calculating this index, the percentage values of the relative frequency, relative density and relative abundance are summed up together and this value is designated as the Importance Value Index or IVI of the species.

$$\text{IVI} = \text{Relative density} + \text{Relative Frequency} + \text{Relative Dominance}$$

13.4 Conclusion

Signature of faculty in-charge

Experiment No. 14

Date-----

Field Visit to Farm to observe the effect of various weed management practices in different crops

14.1 Objectives

To know the effect of weed management treatments in experimental field along with the problem areas where there is application of weed management treatments.

14.2 Procedure

A field trip provides an opportunity to students to acquaint themselves with the important crops of the locality. They are able to know the climate, soil type, irrigation methods, farm and field operations, implements.

14.3 Materials Required

- (i) Notebook
- (ii) Ball point pen or pencil

14.4 Observations

Crop -----

Major weeds -----

Weed on bund -----

Herbicide used in crop (stage of the crop) -----

Hand weeding-----

Yield of the crop-----

Others-----

14.5 Conclusion

Signature of faculty in-charge