

**Practical Manual**  
**M.Sc. (Agronomy)**  
**Principles and Practices of Weed Management**  
**Course No: AGRO - 0503**  
**Credit: 3(2+1)**  
**Semester: 1<sup>st</sup>**

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*Certificate*

*Certified that this is a bonafide record of practical work done by Mr./ Ms.*

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*Regd. No. \_\_\_\_\_ in M.Sc. (Agronomy) degree programme, Course No.  
AGRO – 0503 entitled “Principles and Practices of Weed Management” during 1<sup>st</sup> semester of  
the academic year 2022-23.*

**Date:**

**Faculty In charge**

**Evaluation System**  
**Weed Management**  
**Course No.: AGRO - 0503**

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

**Signature of faculty in-charge**

## List of Experiments

<b>Exp. No.</b>	<b>Date of Exp.</b>	<b>Date of Submission</b>	<b>Title</b>	<b>Page No.</b>	<b>Signature</b>	<b>Remark</b>
1			<b>Identification of important weeds of different crops.</b>			
2			<b>Preparation of weed herbarium</b>			
3			<b>Weed survey and crops, cropping systems</b>			
4			<b>Study of crop weed competition in ongoing research experiments</b>			
5			<b>Preparation of spray solutions of herbicides for high and low volume sprayers</b>			
6			<b>Use of various types of spray pumps and nozzles and calculations of swath width</b>			
7			<b>Bio assay of herbicide residue</b>			
8			<b>Calculate of herbicide dose requirement</b>			
9			<b>Economic analysis of weed management practices in different crops and cropping systems</b>			

# Experiment No. 1

Date \_\_\_\_\_

## Identification of important weeds of different crops

### 1.1 Objectives

- To study, identify and acquaint with the common weeds of the locality.
- To gain an idea regarding biological and ecological adaptations of weeds.

### 1.2 Materials required

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

### 1.3 Procedure

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

### 1.4 Observation

**Table 1.1 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.						

**1.5 Conclusion:**

**Signature of faculty in-charge**

## **Preparation of Weed Herbarium**

### **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 Labeling

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.

<b>Sl. No.</b>	<b>Particulars</b>
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**



## Weed Survey of crops and cropping systems

### 3.1 Objectives

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

### 3.2 Materials required

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

### 3.3 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 1<sup>st</sup>, 2<sup>nd</sup> and 3<sup>rd</sup> in each category of grasses, sedges and broadleaved weeds in order to know the prevalence of weeds in that locality/ region/ farm.

### 3.4 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 3.1 Observation on survey of weeds**

<b>Particulars</b>	<b>No. of weeds in a quadrat</b>	<b>% Occurrence of a weed</b>	<b>Ranking for dominance</b>
<b>Grasses</b>			
<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>			
<b>Total of grasses</b>			
<b>Sedges</b>			
<i>Cyperus rotundus</i>			
<i>C. difformis</i>			
<i>C. iria</i>			
<i>Fimbristylis miliacea</i>			
<b>Total of sedges</b>			
<b>Broad leaved weeds</b>			
<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>Phyllanthus niruri</i>			
<i>Portulacaoleracea</i>			
<i>Trianthemaportulacstrum</i>			
<b>Total of broad leaved weeds</b>			
<b>Parasitic weeds</b>			
<i>Cuscutachinensis</i>			
<b>Gross total (Grasses +sedges + dicots)</b>			

### 3.5 Conclusion

Signature of faculty in-charge

**Study of crop weed competition in ongoing research experiments****Introduction**

Competition is the action of endeavoring to gain what another endeavours the gain at the same time. On agricultural lands, weeds compete with crops for nutrients, moisture, light and space. The nature of crop weed competition is highly crop specific and varies with several weed factors including time of weed occurrence, weed density, critical period for weed competition etc. and other crop factors. Generally the crops are weaker competitor and weeds exploit most of the natural resources as well as the applied inputs. Therefore, the study of crop weed competition and its effect on crop plants for obtaining optimum and remunerative crop yields deserves attention. Further, we also need to evaluate or compare the effectiveness of different weed control practices including herbicides using different indices and methods to reach a good decision.

**Objectives**

- (i) To estimate the competitive effect of weeds on crop growth.
- (ii) To demonstrate the effect of competition among weeds and crop plants.
- (iii) To study the weed and crop response to weed control treatments.
- (iv) To study efficacy of herbicides.
- (v) To determine efficacy of intercropping on suppression of weed.
- (vi) To calculate the crop-weed competition using different indices

**Calculation of effectiveness / efficiency of different weed control treatments**

Procedure: Record the data on dry matter production of weeds in unweeded and treated plots or from intercropped plot and sole crop plots and crop yield from unweeded and treated plots of the experimental area.

## Formula and Calculation:

1. **Weed infestation:** It refers to the percentage of weeds in the composite population of weed and crop plants.

$$\text{Weed infestation (\%)} = \frac{\text{Total number of weeds in unit area}}{\text{Total numbers of weeds and crop plants in the same area}} \times 100$$

2. **Weed index / weed competition index:** It refers to the reduction in crop yield due to the presence of weeds in comparison to weed-free crop:

$$\text{Weed infestation (\%)} = \frac{\text{Yield from weed free plot} - \text{yield from treated plot}}{\text{Yield from weed free plot}} \times 100$$

This is used to assess the efficacy of herbicide. Lesser the weed index, better is the efficiency of herbicides and vice versa.

**Example:** Calculate the weed competition index for alachlor and pendimethalin applied in green gram from the following data

1. Yield of green gram from weed free plot = 18 q ha<sup>-1</sup>
2. Yield of green gram from alachlor treated plot = 16 q ha<sup>-1</sup>
3. Yield of green gram from pendimethalin treated plot = 14 q ha<sup>-1</sup>

## Calculations:

$$\text{i) Weed index for alachlor} = \frac{18 - 16}{18} \times 100 = 11.11\%$$

$$\text{i) Weed index for alachlor} = \frac{18 - 14}{18} \times 100 = 22.22\%$$

**Results:** The weed index is lesser for alachlor, so it is a better herbicide than pendimethalin.

**3. Weed control Efficiency (WCE):** It indicates the efficiency of the applied herbicide or other practices to control weeds. It is the percentage reduction in weed dry matter by any weed control treatment in comparison to weedy check plot. This index is used to compare the different weed control treatments. Higher the WCE of any treatment, better is the treatment, and vice versa.

$$\text{WEC (\%)} = \frac{\text{Dry matter of weeds in unweeded plot} - \text{Dry matter of weeds in treated plot}}{\text{Dry matter of weeds in unweeded plot}} \times 100$$

Or

$$\text{WEC (\%)} = \frac{\text{Weed count in unweeded plot} - \text{Weed count in treated plot}}{\text{Weed count in unweeded plot}} \times 100$$

Example: In a weed control experiment in groundnut, dry weight of weeds in weedy check plot was 570 kg ha<sup>-1</sup>, whereas, for herbicides x and y, it was 355 and 240 kg ha<sup>-1</sup>, respectively. Find out which herbicide is better.

$$\text{WCE (\%)} = \frac{X - Y}{X} \times 100$$

$$1) \text{ Weed control efficiency for herbicides x (\%)} = \frac{570 - 355}{570} \times 100 = 37.72 \%$$

$$2) \text{ Weed control efficiency for herbicides y (\%)} = \frac{570 - 240}{570} \times 100 = 59.90 \%$$

**Results:** Since WCE of herbicide y is higher than x, hence it is better than x

**4. Weed smothering efficiency (WSE):** It is used to determine the effect of intercropping on suppression of weeds in comparison to pure stand crops.

$$\text{WSE (\%)} = \frac{\text{Dry matter of weeds from pure stand crop} - \text{Dry matter of weed intercropped plots}}{\text{Dry matter of weeds from pure stand crop.}} \times 100$$

**Problems:**

**1. Calculate the weed competition indices in mustard with the help of following details.**

- (i) Yield of weed free plot = 18.5 q ha<sup>-1</sup>
- (ii) Yield of fluchloralin ( 1.0 kg ha-1 ) treated plot = 15.0 q ha<sup>-1</sup>
- (iii) Yield of pendimethalin ( 1.0 kg ha-1 ) treated plot = 14.32 q ha<sup>-1</sup>
- (iv) Yield of oxyfluorfen treated plot = 15.8 q ha<sup>-1</sup>
- (v) Yield of weedy check plot = 8.5 q ha<sup>-1</sup>

**Which herbicide will you recommend to the farmers?**

**2. Application of 2, 4-D at 1.0 kg ha<sup>-1</sup> in wheat field gave a seed yield of 45.0 q ha<sup>-1</sup>. If weed index is 10%, then calculate the yield of weed free plot.**

**3. Calculate the weed control efficiency of alachlor and nitrofen in soybean with the help of following information**

- i. Weed dry matter in weedy check plots =  $17.25 \text{ q ha}^{-1}$
- ii. Weed dry matter in alachlor ( $1.5 \text{ kg ha}^{-1}$ ) treated plots =  $5.70 \text{ q ha}^{-1}$
- iii. Weed dry matter in nitrofen ( $1.0 \text{ kg ha}^{-1}$ ) treated plots =  $4.50 \text{ q ha}^{-1}$ .

**If metribuzin ( $0.7 \text{ kg ha}^{-1}$ ) controlled the weeds to the extent of 85%, compute the weed dry matter accumulated under this treatment. Which herbicide is recommendable to the farmers?**

**Signature of faculty in-charge**



## **Experiment No. 5**

Date \_\_\_\_\_

### **Preparation of spray solutions of herbicides for high and low Volume sprayers**

#### **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:**

**i) Independent effect:**

**j) Enhancement effect:**

**k) Antagonistic effect:**



- 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

Date \_\_\_\_\_

### Use of various types of spray pumps and nozzles and calculations of swath width

#### 6.1 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.

#### 6.2 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.

## **6.3 Study of sprayers**

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

### **6.3.1. Manually operated**

- i) Compressed air sprayer
- ii) Hydraulic sprayer

### **6.3.2. Power operated**

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

**But generally hand operated sprayers are used by common farmer.**

### **6.3.3 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/ cm<sup>2</sup>**. 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 7-8 m .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 21 kg/cm<sup>2</sup>. 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:

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

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

1. The following details have been generated from a sprayer calibration attempt. Spray swath - 1.2 m; distance traveled - 60 cm 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:

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

$$\frac{\text{Band width (cm)} \times \text{Broadcast rate (1/ha)}}{\text{Band application rate (1/ha)}} = \frac{\text{Row spacing (cm)}}{\text{Area (ha) = W (m) x T (hr) x S (km/hr) x 0.1}}$$

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

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

**Exercise:**

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

<b>S. No</b>	<b>Hydraulic sprayer</b>	<b>Pneumatic knapsack sprayer</b>

**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 litre/m/nozzle. Calculate its application rate in litre/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. 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.**
- 9. 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.**

## **6.4 Conclusion**

**Signature of faculty in-charge**

## Experiment No. 7

Date \_\_\_\_\_

### Bio assay of herbicide residue

**Objectives:** To study about bioassay of herbicide resistance.

**Herbicide Bioassay:** The bioassay is an efficacy test performed on plant or seeds that screens for tolerance to a specific herbicide. The plant/seeds are exposed to the herbicide and after a period of growth, time, area rated as tolerant or susceptible.

#### Herbicide residue:

- Number of herbicides that have long lasting activity in soil.
- Those herbicides are often applied directly to the soil prior to planting crops are known as pre-plant incorporation herbicides.
- Residual herbicides rely on moisture microbial activities to breakdown.

#### Herbicide residue estimation:

Herbicide residue in soil can be determined by

1. Chemical [Gas Liquid Chromatography (GLC), High Performance Liquid Chromatography (HPLC)]
2. Biological (Bioassay)

##### 1. Chemical Method (GLC, HPLC of residue estimation)

- It involves complex chemical procedures as required trained man-powers for chemical analysis.
- It gives very accurate estimate of herbicide residue in soil up to nano gram level.
- The safe limit of residue of herbicide to certain plant could hardly be detected since there is no indicator plant crop involved.
- Chemical method is exclusively laboratory based.
- It is costlier since costly and sophisticated equipments are required.
- Toxic metabolites of the herbicide may be bypass/escape from detection by chemical method.
- Soil collection procedure and herbicide may influence the awareness of result.
- Herbicide residues in soil, water and even in the plant could be monitored since it determines the residues to the level of nano grams.

##### 2. Biological Method (Bioassay)

- Bioassay combines bio-living system; Assay – Method/Procedure
- Bioassay simply represents a method of determining the level/among of chemical present in soil employing using highly sensitive biotic system plant or animal.

- Bioassay may be used to study the active moment persistence of herbicide in soil and the influence of various soil and climatic condition on them.
- Bioassay could be of two types:-
  - Laboratory pot culture
  - Field bioassay
- Field bioassay technique involves treating a field plot with herbicide and then planting a test crop at various time intervals crop response is used as an indication of the continued presence or absence of herbicide.

### **Terminologies used in bioassay of herbicides**

Sensitive indicator plants:

- ✓ Sensitive indicator plants are also called bioassay material.
- ✓ Using sensitive indicator plant safe limit levels of herbicide residue which could be tolerated by crop grown in succession could be detected.
- ✓ Under bioassay plant species, which produce small and relatively weak seedlings are generally not as useful as those produce vigorously growing seedlings.

### **Sensitive indicator plants for herbicide bioassay**

<b>Sl. No.</b>	<b>Herbicides</b>	<b>Sensitive indicator plant species</b>
1.	Atrazine	Oat, Cucumbers, Soybean
2.	Dalapan	Barley, Mustard, Oat
3.	Diuron	Millet, Sorghum, Buck wheat
4.	Linuron	Ray grass, Sorghum, Cucumber
5.	Alachlor	Crab grass, Cucumber
6.	Fluchloralin	Grain sorghum
7.	2,4 -D	Cotton, Mustard

### **Crops and treatments:**

- ✓ Choose the herbicide for which residue is to be determined.
- ✓ Sulphosulfuron (Leader 75 G), Sulphonyl-urea herbicides.
- ✓ Choose one or few sensitive bioassay plants, four plants (Sunflower, Maize, Oat, Mung bean).
- ✓ Herbicide sulphosulfuron treatment R<sub>6</sub> (T<sub>1</sub> – 0 ppb, T<sub>2</sub> – 0.5 ppb, T<sub>3</sub> – 1.0 ppb, T<sub>4</sub> – 2.0 ppb, T<sub>5</sub> – 4.0 ppb, T<sub>6</sub> – 8.0 ppb)

### **Plastic pot / big petriplate requirements:**

- ✓ Two crops are to be put together in each petriplate or plastic pot for one herbicide concentration treatment. Two pots or petriplates are required for four crops.

- ✓ If there are five replications for one treatment, total number of pots / petri plates required =  $2 \times 5 = 10$
- ✓ For six treatments, total number of pots / petriplates required =  $2 \times 5 \times 6 = 60$
- ✓ Thus plastic pots required = 60 (2 crops in 1 pot / petriplate) and 120 (1 crop in 1 pot / petriplate).

### Soil requirement

- ✓ Soil will be collected from the field previously applied with sulphosulfuron from 0.5 cm, 5-10 cm and 10-15 cm depth for residue estimation if assay is not possible.
- ✓ It is essential to dry the sample under shade and store at sub-zero temperature until bioassay. Fresh untreated soil also needs to be collected from the field not applied with any herbicide previously. If 1 pot requires 500 g soil, each treatment has 10 pots require 5 kg soil therefore soil required is 30 kg for 6 treatments.

### Herbicide stock solution (160 ppm) preparation:

- ✓ The concentration of sulpho sulfuron (Leader 75 G).
- ✓ Stock solution = 160 ppm
- ✓ To prepare 160 ppm stock solution, add 160 mg sulpho sulfuron in 1 l of water.
- ✓  $160 \times (1 \text{ lakh} \times 75000) \text{ mg product (Leader 75 G) in 1 l of water}$
- ✓  $160 \times (100/75) = 213 \text{ mg product in 1 l of water}$

Treatments (ppb)	Stock soil (g)	Untreated fresh soil (g)	Total soil (g)	Total no. of pots
0	0	5000.000	5000	10
0.5	15.625	4984.375	5000	10
1.0	31.25	4968.750	5000	10
2.0	62.50	4937.500	5000	10
4.0	125.00	4875.000	5000	10
8.0	250.00	4750.000	5000	10

### Stock soil (160 ppb) preparation:

1 kg stock soil has to be prepared with 160 ppb concentration.

$$V_1 = ?, V_2 = 1 \text{ kg soil (1 x 1000 g)}$$

$$S_1 = 160 \text{ ppm (160 x 1000 ppb), } S_2 = 160 \text{ ppb}$$

$$V_1 \times S_1 = V_2 \times S_2$$

$$V_1 = \frac{(V_2 \times S_2)}{S_1}$$



$$V_1 = \frac{1 \times 1000 \times 160}{160 \times 1000} \text{ ml}$$

$$V_1 = 1.0 \text{ ml}$$

Stock solution required = 1.0 ml

## **Soil preparation for required treatments:**

### **1. Stock solution requirement:**

Calculate the amount of stock of soil required for 0.5 ppb treatment

$$V_1 ?, V_2 = 5 \text{ kg,}$$

$$S_1 = 160 \text{ ppb, } S_2 = 0.5 \text{ ppb}$$

$$\text{Solution: } V_1 \times S_1 = V_2 \times S_2$$

$$V_1 = \frac{V_2 \times S_2}{S_1}$$

$$V_1 = \frac{5000 \times 0.5}{160} = \frac{2500}{160} = 15.625 \text{ g}$$

### **Mixing of stock and fresh untreated soil:**

- ✓ Put the required quantities of both stock and fresh soil into a big polythene/plastic bag and mix thoroughly by holding the plastic bag mouth tightly and turning the bag all around for each treatment separately.
- ✓ Then divide the total soil (500 g) of each treatment equally into 10 parts for 10 pots.
- ✓ 8-10 seeds of each of the test plant are to be sown in each plate and watered slowly.

### **Observations to be recorded:**

- ✓ Observations normally recorded are germination, mortality, phyto-toxicity, fresh and dry weight, height, root growth etc. of the bioassay indicator plants across the concentration of herbicide.

### **Conclusio**

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## Calculations of Herbicide Doses

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

### 8.1 Objectives

To learn about calculations of herbicide doses

To determine quantities of herbicide required for weed control in crops

### 8.2 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. Ex. Some herbicide structures are active organic acids. Eg. Phenoxyalkanoic, 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 dichlorophenoxy acetic acid is 92.5% in sodium salt of 2,4-D.

### 8.3 Calculation for required weight of commercial product

Formula for calculating herbicide required to an area.

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

## **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 dipropylthiocarbomate) 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. Calculate the amount of alachlor containing 500g a.i/l required for 2 acres of maize. The desired rate of application is 1.25 kg/ha.**

**8. Find out the area sprayed by fulltank 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%**

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

#### **8.4 Conclusion**

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**Economic analysis of weed management practices in different crops and cropping system**

**Objectives: To study about economics of weed control**

Economics of the weed management treatments can be control calculate by working out gross return, net return and B:C ratio of the treatments and that should be compared with weedy.

**Cost of cultivation:** Cost of cultivation is obtained by adding all the costs involved in each operation or input.

**Gross returns:** The total monetary return of the economic produce such as grain, tuber, bulb etc. obtained from the crops are calculated based on the local market price.

**Gross return (Rs/ha) =** Grain yield (q/ha) x market price (Rs/q) + straw yield (q/ha) x market price (Rs/q)

**Net return:** This is worked out by subtracting the total cost of cultivation from the return, this value give the actual profit obtained by the farmer.

**Net return (Rs/ha) = Gross return (Rs/ha) – cost of cultivation (Rs/ha)**

Net returns per rupee invested:

This is also called benefit cost ratio or input output ratio. It is obtained by dividing net return with the treatment wise cost of cultivation.

Benefit: cost ratio = Gross return (Rs/ha) / Cost of cultivation (Rs/ha)

**Cost of cultivation (Sugarbeet)**

Sl. No.	Input cost	Quantity	Price	Total
1.	Ploughing	8 hr	700	5600
2.	Planking	4 hr	700	2800
3.	Seed cost	2 kg	5000	10000
4.	Layout and sowing of seed	12 hr	200	2400
5.	Manures and fertilizer N @100 kg/ha P@ 50 kg/ha K@ 50 kg/ha			3250 2100 1408
6.	FYM	20 ton	1000	20000
7.	Gap filling and thinning	12 labour	200	2400
8.	Weeding	10 labour	200	2000
9.	Interculture	10		2000
10.	Plant protection Malathion	2.5 l	400	1000

	Mancozeb Chloropyriphos	2.5 kg 2500 ml	195 300	975 600
11.	Irrigation	2 times	1750	5250
12.	Harvesting	10 labours	200	2000
13.	Transporation	1 trp 2 labours	1500 200	1500 400
	Total		65683	

### Income

Yield from /ha = 80 -100 ton

Market price – 15 kg

10000 x 15= 150000

Gross return = 150000

Net profit = 150000 – 65683

= 84317 Rs.

Variable cost: -

Sl. No.	Treatment	Gross return	Cost of cultivation	Net return	B:C ratio
1.	Malathion	150000	65683+1000	83317	2.24
2.	Mancozeb	150000	65683+975	83342	2.25
3.	Chloropyriphos	150000	65683+600	83717	2.26
4.	Hand weeding (20 – 40 and 40-45 DAS)	150000	65683+2000	82317	2.21

### Conclusion:

Farmer should adopt weed control method for sugarbeet cultivation is chlorpyriphos is herbicide having highest benefit: cost Ratio.

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