

कृषि महाविद्यालय

Practical Manual on Weed Management

Prepared by :

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College of Agriculture
INDIRA GANDHI KRISHI VISHWAVIDYALAYA
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Chomda Shukheer Patel

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Practical -1

Title: Identification of weeds and their seeds

**Objective: 1. To know different weeds grown in the locality.
2. To know seed of different weeds**

Identification of weeds:

- Identify the weeds collected with help of their morphological characters, seeds and different plant parts.
- Get the help of herbaria, books, taxonomist and teachers for identification of weeds.

Make list of identified weeds with their specific salient features.

List of common weeds

Sl No.	Botanical name	Local / Common name	English name	Family	Life cycle	Season
1	<i>Acalypha indica</i>	Kupi khokhli	Indian copper leaf	Euphorbiaceae	Annual	Kharif
2	<i>Acanthospermum hispidum</i>		Bristly starbur, sandbur	Asteraceae	Annual	Kharif
3	<i>Achyranthes aspera</i>	Chirchita	Prickly chafflower, snake's tail	Amaranthaceae	Annual	Kharif
4	<i>Ageratum conyzoides</i>	Mahkua	Goat weed	Asteraceae	Annual	Kharif
5	<i>Alternanthera triandra</i>	Reshimkata	Sessile joyweed	Amaranthaceae	Annual	Kharif, Rabi
6	<i>Amaranthus spinosus</i>	Jangli kateli chaulai	Spiny pigweed	Amaranthaceae	Annual	All seasons
7	<i>Amaranthus viridis</i>	Jangli chauli	Slender amaranthus	Amaranthaceae	Annual	Kharif, rabi
8	<i>Anagallis arvensis</i>	Krishnaneel	Scarlet pimpernel	Primulaceae	Annual	Rabi
9	<i>Argemone mexicana</i>	Satyanashi	Mexican prickly poppy	Papavaraceae	Annual,	Kharif, Rabi
10	<i>Asphodelus fistulosus or A. tenuifolius</i>	Ban piazi	Onion weed	Liliaceae	Biennial	Kharif, Rabi
11	<i>Asteracantha longifolia</i>	Mokhala, Mokhana	Waterleaf	Acanthaceae	Annual	Kharif
12	<i>Avena fatua</i>	Jangali jai	Wild oat	Poaceae	Annual	Rabi
13	<i>Bidens pilosa</i>	Chikta	Hairy begger stick, Spanish needles	Asteraceae	Annual	Rabi
14	<i>Boerhavia diffusa</i>	Biskhapra	Red spiderling	Nyctaginaceae	Annual	Kharif
15	<i>Brachiaria cruciformis</i>	Shipi	Sweet signal grass	Poaceae	Annual	Kharif
16	<i>Brassica arvensis</i>	Jangli sarson,	Wild mustard, Ball mustard	Cruciferea	Annual	Rabi

17	<i>Caesulia axillaris</i>	Belonda, hukwa	Caesulia	Commelineaceae	Annual	Kharif
18	<i>Calotropis gigantean</i>	Aak, Madar	Giant Swallow wort	Asclepiadaceae	Perennial	All
19	<i>Calotropis procera</i>	Aak, Madar	Swallow wort	Asclepiadaceae	Perennial	All
20	<i>Cardiospermum halicacabum</i>	Gubbara bel	Balloonvine	Sapindaceae	Annual	Kharif
21	<i>Carthamus oxycantha</i>	Pohli	Wild safflower	Asteraceae	Annual	Rabi
22	<i>Cassia tora</i>	Charota	Sicklepod, coffee weed	Leguminosae	Annual	Kharif
23	<i>Celosia argentea</i>	Siliari, Safed murg	Cocks comb, Safed murg	Amaranthaceae	Annual	Kharif
24	<i>Chenopodium album</i>	Bathua	Common lambs quarter	Chenopodiaceae	Annual	Rabi
25	<i>Cichorium intybus</i>	Kasani	Blue daisy	Asteraceae	Annual	Rabi
26	<i>Cleome viscosa</i>	Hulhul	Tick weed	Capparidaceae	Annual	Kharif
27	<i>Commelina benghalensis</i>	Kankaua	Dayflower, Tropical spider weed	Commelinaceae	Annual	Kharif
28	<i>Commelina nudiflora</i>	Kena	Spreading dayflower	Commelinaceae	Annual	Kharif
29	<i>Convolvulus arvensis</i>	Hirankhuri	Field bind weed	Convolvulaceae	Perennial	All seasons
30	<i>Corchorus acutangulus</i>	Machharia	Wild jute	Tiliaceae	Annual	Kharif
31	<i>Corchorus olitorius</i>	Machharia	Wild jute	Tiliaceae	Annual	Kharif
32	<i>Corchorus trilocularis</i>	Machharia	Wild jute	Tiliaceae	Annual	Kharif
33	<i>Cuscuta chinensis</i>	Amarvel	Dodder	Convolvulaceae	Perennial	All seasons
34	<i>Cuscuta reflexa</i>	Amarvel	Dodder	Convolvulaceae	Perennial	All seasons
35	<i>Cynodon dactylon</i>	Hariali, Doob ghas	Bemuda grass	Poaceae	Perennial	All seasons
36	<i>Cynotis axillaris</i>	Waghnalla	Cynotis	Cyperaceae	Annual	Kharif
37	<i>Cyperus difformis</i>	Motha	Small flower umbrella sedge	Cyperaceae	Annual	Kharif
38	<i>Cyperus esculantus</i>	Motha	Yellow nutsedge	Cyperaceae	Annual	Kharif
39	<i>Cyperus iria</i>	Motha, Jalmotha	Rice flat sedge	Cyperaceae	Annual	Kharif
40	<i>Cyperus rotundus</i>	Nagar motha	Purple nut sedge	Cyperaceae	Perennial	All seasons
41	<i>Dactyloctenium aegyptium</i>	Somna, Karwat	Crowfoot grass	Poaceae	Annual	Kharif

42	<i>Datura fastuosa</i>	Kala datura	Thorn apple	Solanaceae	Annual	Kharif
43	<i>Datura stramonium</i>	Datura	Thorn apple	Solanaceae	Annual	Kharif
44	<i>Digera arvensis</i>	Latbhuriya	Digera	Amaranthaceae	Annual	Kharif
45	<i>Digitaria sanguinalis</i>	Ghor chhabba	Large crab grass	Poaceae	Annual	Kharif
46	<i>Echinochloa colona</i>	Sawa	Jungle rice	Poaceae	Annual	Kharif
47	<i>Echinochloa crusgalli</i>	Bada sawa	Barnyard grass	Poaceae	Annual	Kharif
48	<i>Eclipta alba</i>	Bhengara, Bringraj	False daisy	Asteraceae	Annual	Kharif
49	<i>Eichhornia crassipes</i>	Jalkumbhi	Water hyacinth	Pontederiaceae	Perennial	All seasons
50	<i>Euphorbia geniculata</i>	Badi dudhi	Wild poinsettia	Euphorbiaceae	Annual	Kharif
51	<i>Euphorbia hirta</i>	Dudhani	Garden spurg pill pod spurg	Euphorbiaceae	Annual	Kharif
52	<i>Euphorbia thymifolia</i>	Chhoti dudhi	Little leaf spurg	Euphorbiaceae	Annual	Kharif
53	<i>Fimbristylis miliacea</i>	Bandarpuchhia	Lesser fimbristylis	Cyperaceae	Annual	Kharif
54	<i>Fumaria indica</i>	Gajri	Fumaria	Fumariaceae	Annual	Rabi
55	<i>Helianthus argyrophyllus</i>	Safed surajmukhi	Wild sunflower	Asteraceae	Annual	Kharif
56	<i>Heliotropium indicum</i>	Hathi sund	Indian heliotrope	Boraginaceae	Annual	Rabi
57	<i>Heteropogon contrortus</i>	Kalimuchh ghass	Spear grass, Pill grass	Poaceae	Annual	Kharif
58	<i>Hydrilla verticillata</i>	Hydrilla	Hydrilla	Hydrochariaceae	Perennial	All seasons
59	<i>Hyptis suaveolens</i>	Jangli tulsi	Wildspikenard	Lamiaceae	Annual	Kharif
60	<i>Ipomoea cornea</i>	Besharam	Morning glory	Convolvulaceae	Perennial	All seasons
61	<i>Ipomoea purpurea</i>	Besharam	Morning glory	Convolvulaceae	Perennial	All seasons
62	<i>Ischaemum rugosum</i>	Badauri	Wrinkled duck-beak	Poaceae	Annual	Kharif
63	<i>Lagasca mollis</i>	Jangli geera	Acute	Asteraceae	Annual	Kharif
64	<i>Lathyrus aphaca</i>	Jangli matar	Yellow vetching	Fabaceae	Annual	Rabi
65	<i>Lathyrus sativus</i>	Akari	Grass pea	Fabaceae	Annual	Rabi
66	<i>Leptochloa chinensis</i>	American ghas	Red sprangletop	Poaceae	Annual	Kharif
67	<i>Leucas aspera</i>	Gumma	Leucas	Lamiaceae	Annual	Kharif
68	<i>Lindernia parviflora</i>			Scrophulariaceae	Annual	Kharif

69	<i>Ludwigia octovalvis</i>	Laung ghash	Primerose millow	Onagraceae	Annual	Kharif
70	<i>Medicago denticulata</i>	Chinauri	Burclover, Rough medik	Fabaceae	Annual	Rabi
71	<i>Melilotus alba</i>	Safed senji	White sweet clover	Fabaceae	Annual	Rabi
72	<i>Melilotus indica</i>	Pili senji	Yellow sweetclover	Fabaceae	Annual	Rabi
73	<i>Mimosa pudica</i>	Lajwanti	Touch me not	Leguminoceae	Perennial	All seasons
74	<i>Monochoria vaginalis</i>	Monocharia, Panari	Heart shaped false pickerel weed	Pontederiaceae	Annual	Kharif
75	<i>Ocimum canum</i>	Jangli tulsi	Hoarybasil	Lamiaceae	Perennial	All seasons
76	<i>Orobanche aegyptica</i>	Babakhoo, Sarso band	Broom rape	Orobanchaceae	Annual	Kharif
77	<i>Oxalis corniculata</i>	Khata patta	Creeping wood sorrel	Oxalidaceae	Perennial	All seasons
78	<i>Oxalis latifolia</i>	Khata patta	Wood sorrel	Oxalidaceae	Perennial	All seasons
79	<i>Parthenium hysterophorus</i>	Gajar ghas	Parthenium	Asteraceae	Annual	All seasons
80	<i>Paspalum disticum</i>	Hadda	Wire grass	Poaceae	Annual	Kharif
81	<i>Phalis minor</i>	Gehu ka mama	Little seed canary grass	Poaceae	Annual	Rabi
82	<i>Phaseolus trilobus</i>	Jungli moong	Wild moong	Fabaceae	Annual	Kharif
83	<i>Phyllanthus niruri</i>	Hajardana	Niruri	Euphorbiaceae	Annual	Kharif
84	<i>Physalis minima</i>	Chirpoti, Banmakoi	Ground cherry	Solanaceae	Annual	Kharif
85	<i>Portulaca oleracea</i>	Kulpha, Badi nuni, Lunuk	Common purselane	Portulacaceae	Annual	All
86	<i>Psoralea carylifolia</i>	Bawachi		Leguminoceae	Annual	Rabi
87	<i>Rumex dentatus</i>	Jangli palak	Sour dock	Polygonaceae	Annual	Rabi
88	<i>Saccharum spontaneum</i>	Kans	Tiger grass	Poaceae	Perennial	All seasons
89	<i>Salvinia molesta</i>	Water fern	Water fern	Salvinaceae	Annual	Kharif
90	<i>Setaria glauca</i>	Banra banri	Yellow foxtail	Poaceae	Annual	Kharif
91	<i>Sida acuta</i>	Baliari	Sida	Malvaceae	Annual	Kharif
92	<i>Sida spinosa</i>	Baliari	Spiny sida	Malvaceae	Annual	Kharif
93	<i>Solanum nigrum</i>	Kangani, Makoy	Black night shade	Solanaceae	Annual	Kharif
94	<i>Solanum xanthocarpum</i>	Bhatkatiya	Wild brinjal	Solanaceae	Annual	Kharif, rabi
95	<i>Sonchus arvensis</i>	Sonchus	Perennial sowthistle	Asteraceae	Perennial	Rabi

96	<i>Sonchus oleracious</i>	Dodock dudhi	Annual sowthistle	Asteraceae	Annual	Rabi
97	<i>Sorghum halepense</i>	Baru	Johnson grass	Poaceae	Perennial	All seasons
98	<i>Sphaeranthus indicus</i>	Gorakhmundi	East Indian globe thistle	Compositae	Annual	Kharif
99	<i>Sphenoclea zeylanica</i>	Mirchbooti	Goose weed	Sphenocleaceae	Annual	Kharif
100	<i>Spilanthus acmella</i>	Jangli akalkara	Pungent weed	Asteraceae	Annual	Kharif
101	<i>Striga asiatica</i>	Striga	Witchweed	Scrophulariaceae	Annual	Kharif, Rabi
102	<i>Tephrosia purpurea</i>	Ban neel		Febaceae	Perennial	All
103	<i>Trianthema portulacastrum</i>	Lal-sabuni	Horse purselane	Aizoaceae	Annual	Kharif, Rabi
104	<i>Tridax procumbens</i>	Phulani	Mexican daisy, coat buttons	Asteraceae	Annual	Kharif, Rabi
105	<i>Typha latifolia</i>	Typha	Common cattail	Typhaceae	Perennial	All seasons
106	<i>Vernonia cinerea</i>	Sahadevi, Sadodi	Purple fleabane	Asteraceae	Annual	Kharif
107	<i>Vicia hirsuta</i>	Akri	Tiny vetch	Fabaceae	Annual	Rabi
108	<i>Xanthium strumarium</i>	Gokhru	Cocklebur, burweed	Asteraceae	Annual	Kharif
109	<i>Zizyphus rotundifolia</i>	Wild ber	Wild jujube	Rhamnaceae	Perennial	All

Practical - 2

Title: Preparation of Weed herbarium

**Objective: 1. To know the technique of preservation of weeds
2. To prepare the weed herbarium.**

Weed herbarium: A file where pressed and dried weed specimens have been taxonomically identified, classified, and mounted on herbarium sheet and preserved for future reference.

Preparation of weed herbarium comprised of following:

1. Collection of weed sample.
2. Preparation of weed sample for weed herbarium.
3. Pasting of weed sample on herbarium sheet.
4. Labeling of weeds on the herbarium sheet. and
5. Indexing of weed herbarium.

1. Collection of weed sample:

- Uproot the gently the weed without disturbing different plant parts i.e. root, stem, leaves, flowers and seeds or fruits.
- In case, soil is dry and there are chances of destruction of roots, irrigate the surrounding of weed to be collected. Wait for some time so that the soil becomes loose. Uproot gently the weed. Remove the soil attached to roots by gentle washing. Remove excess moisture by putting the weed in blotting /news paper. Change the blotting paper or news paper, if required replace it for proper drying of the weeds sample.

2. Preparation of sample for weed herbarium.

- Use full size white and thick paper for preparation of weed herbarium.
- Always select and use properly dried weed samples for preparation of weed herbarium.
- In case, weed sample is larger than the sheet, cut the sample in such a way that all parts will be displayed properly on herbarium sheet.

3. Pasting of weed sample on herbarium sheet

- Always paste the weed sample diagonally from bottom left corner to top right corner direction of the herbarium sheet.
- Paste the weed sample having all plant parts i.e. root, stem, leaves, flowers/inflorescence, fruits/capsule/berry etc.
- Paste weed sample with transparent adhesive tape.
- Use separate sheet for each weed sample.

4. Labeling of weeds on the herbarium sheet

- Information related to weed sample must be displayed at the bottom right corner of the herbarium sheet.

Label the weed sample on herbarium sheet in following order:

- 1) Local name
- 2) Botanical name
- (3) Family
- 4) Season
- (5) Ontogeny
- (6) Crop associated/wasteland
- 7) Economic importance
- (8) Place of collection
- (9) Date of collection
- 10) Name of collector

5. Indexing of weed herbarium.

Prepare the index of all the collected weeds as follows on the basis of family of weeds.

INDEX

Sl. No.	Botanical Name	Local/Common name	English Name	Page No.
I	Family: Amaranthaceae			
1				
2				
II	Family:			
1				
2				

Finally arrange the weed herbarium as per index and attach index on the top of the file.

Practical - 3

Title: Survey of weeds in crop fields.

Objective: To know the weed flora associated with different crops of the region.

In order to know weed flora present in different crops of the region in particular season, it is necessary to have basic information of weeds present in crops. This information can be obtained by performing weed survey in different crops of the locality. It is also necessary for devising weed management practice for particular crop in particular season.

Material required for weed survey

1. Road map of the area
2. Quadrate of 1.0 m X 1.0 m
3. Weed press
4. Blotting paper/Used news paper
5. Labels
6. Book(s) having photographs of weeds

Procedure for weed survey

- Collect the road map of the area to be surveyed. Decide the benchmark of survey point.
- At each point, survey on either side of the road.
- Select the place which is representing the field or habitat.
- Place the quadrate and uproot the weed species-wise.
- Count the number of weeds of that particular species /quadrate.
- Continue this till all weed species are uprooted.
- Repeat the procedure at least four to five places at one location in each crop.
- Unidentified weed species must be tagged by giving accession number.
- Put blotting/used news papers on base of weed press.
- Put the weed species and cover by another blotting/used news paper.
- Close the weed press.
- Remove weeds species after drying and same be placed on weed herbarium with detail information.
- Weed survey should be made separately for different habitats i.e. roadside, bunds, aquatic, crop fields etc.

Precaution to be taken during weed survey of crops

Weed survey, particularly in crop fields must be made minimum 200 metres after on either side of the road. This avoids the effect of dissemination of weeds through road transport.

Information to be collected and registered during the weed survey

- Name of the locality
- Soil : type and situation
- Rainfall : Rainfall pattern, Seasonal and annual rainfall
- Crops and cropping system
- Irrigated or rainfed,
- Source of irrigation

The weed survey of each habitat should be recorded separately in the following format.

Location :
 Habitat :
 Name crop :

Sl.No.	Weed species	Weed count				
		Quadrat 1	Quadrat 2	Quadrat 3	Quadrat 4	Quadrat 5
1	<i>Echinochloa colona</i>					
2						
3						
4						
5	<i>Cyperus difformis</i>					
6						
7						

- Weed survey helps in identification of
- (1) Important weeds of the region,
 - (2) Important weeds of the crops of the region,
 - (3) Important weeds of different habitats of the region, and
 - (4) Devising weed management practice (s) in crops or different habitats of the region.

It also exhibits the weed control efficiency of different weed management practices.

Practical- 4

Title: Assessment of efficacy of weed control treatments against weed and crop growth

Objective: To study the effect of weeds on growth and yield of crop.

Procedure:

- Demarked the area minimum of 200 m² for assessing the weeds on growth and yield of crop.
- Follow all the recommendations of the crop except weed control treatments.
- Sow the crop and divide the field in two/three equal halves (100 m² each) as per treatment. In one of the plot do not carry any weed control operation and allow weeds to grow naturally. In the other plots, carry out weed control operation as per treatment i.e. hand weeding/weed free, mechanical weeding/ hoeing or application of herbicide for management of weeds. Specify each treatment clearly.
- Periodically record the observations of each treatment to assess the effect of weeds on growth and yield of crop selected.
- Determine the weed control efficiency and weed index.

Weed control efficiency shows the effectiveness of weed management practice(s) in managing weeds as compared with untreated or unweeded/weedy check. Higher the weed control efficiency more is the effectiveness of weed management practice.

Weed index exhibit the loss of economical yield in weed management practice due to weed competition as compared to the best treatment of weed management or weed free treatment where maximum yield was obtained. Lower the weed index lesser is the yield loss or more effectiveness of weed management practice.

Name of Crop:

Variety:

Date of sowing:

Treatments:

Sl No.	Observation to be recorded	Treatments			
		Weedy Check	Hand weeding / Weed free	Mechanical	Herbicide
1	Germination at 14 day				
2	Height of crop 20 DAS/DAT 40 DAS/DAT 60 DAS/DAT At Harvest				
3	Weed density 20 DAS/DAT 40 DAS/DAT 60 DAS/DAT At Harvest				
4	Dry weight of weeds 20 DAS/DAT 40 DAS/DAT 60 DAS/DAT At Harvest				
5	No. of seeds or grains/plant				
6	Weight of seeds or grains/plant				
7	Test weight, g				
8	Grain yield (i) per plot (ii) per ha				
9	Straw or haulm yield (i) per plot (ii) per ha.				

Calculate the weed control efficiency and weed index under different treatment and record the results.

Weed control Efficiency (WCE):

It is calculated on the basis of (1) dry matter of weeds, as well as (2) weed density.

Weed control efficiency on the basis of dry matter production of weeds:

$$WCE (\%) = \frac{DMC - DMT}{DMC} \times 100 \quad -11-$$

Where,

DMC = Dry matter production of weeds under control or weedy plot.

DMT = Dry matter production of weeds under treatment.

Weed control efficiency on the basis of weed density:

$$\text{WCE, \%} = \frac{\text{WDC} - \text{WDT}}{\text{WDC}} \times 100$$

Where,

WDC = Weed density under control or weedy plot.

WDT = Weed density under treatment.

Weed Index (WI)

It is calculated on the basis of following formula:

$$\text{WI (\%)} = \frac{\text{YWF} - \text{YT}}{\text{YWF}} \times 100$$

Where,

YWF = Yield of crop under weed free treatment/ highest yield from the treatment

YT = Yield of crop under treatment.

Also record the weeds associated with the crop grown.

Exercise:

Record the observations from the allotted plot in the given format. On the basis of the observations recorded, calculate the weed control efficiency and weed index so as to find out suitable weed control treatment/practice.

Practical - 5

Title: Herbicide label information

Objective: To know the information of herbicide provided on the label and use the same for field operation.

Procedure:

Same herbicide is manufactured by different companies with different formulations, % of active ingredients and names. It is therefore, necessary to collect all the information of commercial available herbicide provided on the label.

The herbicide label mainly exhibit following herbicide information:

1. Common name of herbicide
2. Commercial name of herbicide
3. Name of company and address.
4. Formulation
5. Active ingredient
6. Herbicide toxicity rating/class
7. Time of application of herbicide
8. Recommended dose of application
9. Crops in which it can be used.
10. List of weeds susceptible/tolerant to this herbicide.
11. Net quantity of herbicide
12. Date of manufacturing.
13. Date of expiry.
14. Batch No.
15. Price of herbicide.
16. Symptoms of poisoning
17. Antidote
18. Caution.

Example:

Glyphosate is total killer and manufactured by different companies in different concentrations and formulations e.g. Glyphosate manufactured by Excel Crop Care Limited is available in the name of Glycel. The label information of this product is provided under:

Common name of herbicide	:	Glyphosate
Commercial name of herbicide	:	Glycel

Formulation : S.L. Active ingredient : 41 %
 Composition : Isopropilamine salt of Glyphosate 41 %
 : Inert material 59 %.
 Herbicide toxicity rating/class : Danger
 Color in lower portion of diamond : Blue
 Time of application of herbicide : Active growing stage of weeds
 Recommended rate of application : 2 to 3 litres glycel/ha
 Crops in which it can be used. : Tea -
 List of weeds susceptible/tolerant to this
 Herbicide : *Axonopus compressus, Cynodon dactylon, Digitaria sanguinalis, Imperata cylindrica, Paspalum scrobiculatum, Polygonum perfoliatum, Arundinella bengalensis and Setaria palmiflora*
 Net quantity of herbicide : 1 litre
 Name of company and address. : Excel Crop Care Limited
 Survey No. 200/1/2/60
 B. Nanji Industrial Estate, Kharadpada
 Silvassa, Dadra Nagar Haveli
 Date of manufacturing. : Nov. 2006
 Date of expiry. : Oct. 2008
 Batch No. : SMW. 402
 Price of herbicide. : Rs 330/litre.
 Symptoms of poisoning : Irritant to skin, eyes and respiratory tract.
 Antidote : Symptomatic, in case of contact with skin and eye, wash with plenty of water. If swallowed, empty stomach by inducing vomiting. Get medical attention immediately
 Caution. : Harmful, if swallowed. Causes eye irritation. Avoid contact with eye, skin and clothes. Wash thoroughly with water after washing.

Exercise:

Write down the herbicide label information of phenoxyprop-p-ethyl which is available in the trade name of Whip super/Puma super.

① 5

Practical No - 6

Title: Computation of herbicide doses

Objective \Rightarrow To know the right dose or rate of application of herbicide

Exercises
Calculate the dose of amitraz when 1200ml Arogin 30EC sprayed in 1.5 ha area of rice.

Dose of herbicide (kg/ha)

$$\frac{\text{Quantity of Commercial kg} \times ai (\%)}{\text{Area (ha)} \times 100}$$

Given =

Quantity of Commercial product arogin = 1.2 kg

Active ingredient Content = 30%

area = 1.5 ha.

$$= \text{Dose of herbicide (kg/ha)} =$$

$$= \frac{1.2 \times 30}{1.5 \times 100}$$

dose of herbicide (kg/ha) = $\frac{36}{150}$

Dose of herbicide (kg/ha) = 0.24 kg
Cancellation \rightarrow

The dose of amibates to be applied into rice crop within 1200ml Aroge 30 EC sprayed in 1.5 ha. area will be 0.24 kg/ha.

~~Quantity of herbicide (kg/ha)~~

Quantity of commercial (kg/ha) = Area (ha) x 100

Quantity of commercial product = 1.5 ha x 100 = 150 kg/ha

Active ingredient content = 30%

1.5 ha = 1.5 ha

Dose of herbicide (kg/ha) =

$\frac{1.5 \times 30}{100}$

Practical - 6

Title: Computation of herbicide doses

Objective: To know the right dose or rate of application of herbicide.

Many a times, it has been observed that right herbicide is sprayed with right method at right time, but expected results of weed control could not be achieved. It may be due to improper rate or dose of herbicide application. Therefore, application of right dose with right herbicide with right method at right time is necessary to achieve the good results. Further, herbicides are available in different formulations and concentrations. Hence, application of same quantity of herbicide having different concentration is faulty approach. One can calculate the exact dose of herbicide with the following formula.

$$\text{Dose of herbicide (kg/ha)} = \frac{\text{Quantity of commercial product (kg) x a.i. ,\%}}{\text{Area (ha) x 100}}$$

Example:

Calculate the dose of Metolachlor when 1500 ml Dual having a.i. of 50% has applied in 0.75 ha area of soybean.

$$\text{Dose of herbicide (kg/ha)} = \frac{\text{Quantity of commercial product, kg x a.i.(}\%)}{\text{Area (ha) x 100}}$$

Given:

1. Quantity of commercial product (Dual) = 1.5 kg
2. Active ingredient content = 50%
3. Area = 0.75 ha

$$\text{Dose of herbicide (kg/ha)} = \frac{1.5 \text{ kg} \times 50}{0.75 \text{ ha} \times 100}$$

$$\text{Dose of herbicide (kg/ha)} = \frac{75 \text{ kg}}{75 \text{ ha}} = 1.0 \text{ kg/ha}$$

Dose of metolachlor = 1.0 kg/ha

Conclusion: The dose of application of metolachlor in soybean crop, when 1500 ml Dual 50EC is sprayed on 0.75 ha area, will be 1.0 kg/ha.

Exercise: Calculate the dose of anilofos when 1200 ml Arozin,30 EC sprayed in 1.5 ha area of rice.

Practical – 7

Title: Computation of an area with an available quantity of herbicide
Objective: To know how much area can be sprayed with an available quantity of herbicide.

It may happen that the farmer has some quantity of herbicide after spraying in the crop and he wants to use the same herbicide in new field of same crop. Under this situation, it will be helpful if he knows that how much area will be sprayed with the available herbicide. The area to be sprayed can be calculated with the help of following formula.

$$\text{Quantity of commercial product (Kg)} = \frac{\text{Area (ha) x dose of application (ai. kg/ha)}}{\text{a.i. content in product (\%)}} \times 100$$

$$\text{Area (ha) to be sprayed} = \frac{\text{Quantity of commercial product x ai (\%)}}{\text{Dose (ai kg/ha) x 100}}$$

Example: A farmer has MACHETE 50 EC . He has to spray butachlor @ 1.5 kg ai/ha as pre-emergence in rice. Calculate how much area will be sprayed with 1.5 litre of MACHETE 50 EC.

Given:

Commercial quantity of herbicide available = 1.5 l.MACHETE 50 EC.

Dose of application = 1.5 kg ai/ha.

Active ingredient in the herbicide = 50%

$$\text{Area (ha) to be sprayed} = \frac{\text{Quantity of commercial product x ai (\%)}}{\text{Rate, ai kg/ha x 100}}$$

$$\begin{aligned} \text{ha) to be sprayed} &= \frac{1.5 \text{ kg} \times 50}{1.5 \text{ ai kg/ha} \times 100} = \frac{75}{150} \\ &= 0.5 \text{ ha} \end{aligned} \quad \text{Area ($$

Answer:

Farmer can spray 0.5 ha area with 1.5 litre of MACHETE 50 EC when it is to be sprayed @ 1.5 kg ai/ha.

Exercise:

A farmer has 450 ml of TURGA SUPER 5 EC. He has to spray quizalofop @ 50 g ai /ha. Calculate the area to be sprayed with 450 ml of TURGA SUPER 5 EC.

practical No 7

Title Computation of an area available with an available quantity of herbicide.

objective =

To know how much area can be sprayed with an available quantity of herbicide.

Exercise ⇒

A farmer has 450 ml of TURCA Super 5 EC. He has to spray guazaflos @ 50 g ai/ha. Calculate the area to be sprayed with 450 ml of TURCA Super 5 EC.

= Area (ha.) to be sprayed =

$$\frac{\text{Quantity of commercial product} \times \text{ai}(\%)}{\text{Rate ai kg/ha} \times 100}$$

Given

Commercial quantity of herbicide available = 450 ml of TURCA Super 5 EC

Dose at application = 50 g ai/ha

= 0.050 kg ai/ha

active ingredient in the herbicide

= 5%

Area (ha) to be sprayed.

= $\frac{0.450 \times 5}{0.050 \times 100}$

= $\frac{2.25}{0.050 \times 100}$

= 0.45 ha

Calc conclusion

Farmer can spray 0.45 ha area with 450 ml TURNA super 5 EC when it to be sprayed at the rate of 50 g ai/ha.

Answer

Practical – 8

Title: Calculation of commercial quantity of herbicidal product

Objective: To know the exact quantity of commercial product of herbicide.

Herbicides are available in various brands and formulations. Application of herbicide at lower dose/rate than recommended may not control weeds whereas, application at higher dose/rate than recommended may cause phyto-toxicity to crop and at the same time, may fail to give desired results. Further, continuous application of herbicide at lower dose/rate may develop tolerance in weeds and its higher dose/rate of application may cause the problem of pollution. It is, therefore, essential to apply the herbicide at correct dose/rate through available formulations. The quantity of commercial product of a herbicide at a specific dose/rate can be calculated by following formula.

$$\text{Quantity of commercial product required, Kg} = \frac{\text{Area(ha)} \times \text{Dose (ai, kg/ha)}}{\text{a.i. content in product, \%}} \times 100$$

$$\text{Quantity of commercial product required, g} = \frac{\text{Area(ha)} \times \text{Dose (ai, g/ha)}}{\text{a.i. content in product, \%}} \times 100$$

A = Area in ha.,

a.i. = Active ingredient content in the commercial product (%)

Example 1: Butachlor is to be applied @1.5 kg/ha. Butachlor is available as MACHETE 10 G in the market. Calculate the quantity of Machete 10G for 2000m² area.

Given :

$$\text{Area} = 2000 \text{ m}^2 = 0.2 \text{ ha}$$

$$\text{Dose} = 1.5 \text{ kg/ha.}$$

$$\text{Active ingredient content in commercial product} = 10 \%$$

Hence,

$$\begin{aligned} \text{Quantity of Machete 10G required (kg)} &= \frac{0.2 \text{ ha} \times 1.5 \text{ kg/ha}}{10} \times 100 \\ &= 0.30 \text{ kg} \end{aligned}$$

Answer:

In order to spray butachlor @1.5 kg/ha on 2000 m² area, the required quantity of MACHETE 10G will be 0.3 kg or 300 g.

Example 2: Ethoxysulfuron is to be sprayed in rice in an area of 4500 m² at 15 g/ha. It is available in market as SUNRICE 15 WDG. Calculate the quantity of SUNRICE to be required for aforesaid area.

Given :

Area = 4500m² = 0.45 ha

Dose = 15 g/ha.

Active ingredient available in commercial product = 15 %.

Hence,

$$\text{Quantity of commercial product required (g)} = \frac{\text{Area (ha)} \times \text{Dose (ai. g/ha)}}{\text{a.i. content in product (\%)}} \times 100$$

$$\begin{aligned} \text{Quantity of SURICE 15 WDG required (g)} &= \frac{0.45 \text{ ha} \times 15 \text{ g/ha}}{15} \times 100 \\ &= 45 \text{ g} \end{aligned}$$

Answer:

In order to spray ethoxysulfuron at 15 g/ha on 4500 m² area, the required quantity of SUNRICE 15 WDG will be 45 g

Exercise:

Chlorimuron ethyl + metsulfuron methyl is to be sprayed @ 4 gai/ha on 0.5 ha area of rice. It is available in market as ALMIX 20 WP. Calculate the quantity of ALIX 20 WP to be required for spraying in aforesaid area.

→ Quantity of ALMI x 20 WP required =

$$\frac{0.5 \times 4 \text{ g/ha} \times 100}{20} = 10 \text{ gm}$$

Conclusion

In order to spray chlorimuron ethyl + meflurofen methyl at 4 g/ha. on 0.5 ha. area, the required quantity of ALMI x 20 WP will be 10 gm.

Practical No = 2

Title = Calculation of commercial quantity
of herbicide product

Objective To know the exact quantity
of commercial product of herbicide

Exercise

Chlorimuron ethyl + metazulfuron
methyl is to be sprayed @ 4 ai/ha.
on 0.5 ha. area if it is available
in market as ALMI x 20 WP calculate the
quantity of ALMI x 20 WP to be
required area spraying in standard area.

Given area = 0.5 ha.

Dose = 4 g. ai/ha.

active ingredient available

in commercial product - 20%.

Quantity of commercial product sp
required (g) =

$\frac{\text{area (ha)} \times \text{Dose (ai g/ha)} \times 100}{\text{ai. Content in product (\%)}}$

Practical No = 99

Title Calculation of area sprayed in given time

Objective To know the area sprayed in specific time

Exercise ⇒

A farmer has Sulfosulfuron in wheat at the speed of 4 kmph through sprayer having four nozzles and swath at each nozzle is 0.50 m. Calculate how much area could cover in four hours.

Sol

Given that -

speed = 4 kmph

→ No. of nozzle = 4

= swath at each nozzle = 0.50 m

∴ Total swath / width covered

$$= 0.50 \times 4 = 2.00 \text{ m}$$

time = 4 hours

Area Covered = $\frac{\text{height} \times \text{width} \times \text{time}}{\text{speed (km/h)} \times \text{swath (cm)} \times \text{time}}$

$$= \frac{4 \times 2 \times 4}{10} = \frac{32}{10}$$
$$= \underline{\underline{3.2 \text{ ha}}}$$

Conclusion

Area Covered by spraying

$$= \underline{\underline{3.2 \text{ ha}}}$$

Practical – 9

Title: Calculation of area sprayed in a given time

Objective: To know the area sprayed in the specific time.

Spraying of herbicide at proper dose is very important. Many a times, it happens that the farmer give instructions to the spray man and spray man complete spraying hurriedly which may result in either lower or higher dose than the recommended rate.

The area covered by the spraying can be calculated by noting the (i) speed of spraying, (ii) period of spraying, (iii) area of spraying

$$\text{Area covered, ha} = \frac{\text{Speed (km/hr)} \times \text{Swath (m)} \times \text{Time (h)}}{10}$$

Example: Butachlor was sprayed at a speed of 3 km/h through a sprayer having swath of 0.75m for four hours. Calculate the area covered by spraying.

Given:

Speed = 3 km/h

Swath = 0.75 m

Time = 4 hrs.

$$\text{Area covered, ha} = \frac{\text{Speed(km/h)} \times \text{Swath (m)} \times \text{Time (h)}}{10}$$

$$= \frac{3.0 \times 0.75 \times 4.0}{10}$$

$$= 0.9 \text{ ha}$$

Exercise:

A farmer has sprayed sulfosulfuron herbicide in wheat at a speed of 4 kmph through sprayer having four nozzles and swath of each nozzle is 0.50 m. Calculate how much area could cover in four hours.

Practical - 10

Title: Study of herbicide application equipments
Objective: To get acquainted with different herbicide application equipments.

Herbicides are used to kill weeds without or with minimum injury to crop. It can only be achieved through proper application of herbicide through proper herbicide equipment. The herbicide application may be ineffective or there may be damage to crop or nearby crop due to improper application of herbicide. Therefore, proper application of herbicide by proper equipment, technique and method is necessary to achieve the goal.

Herbicides are applied through sprayers, granular applicator and soil injector. There are types of sprayers (1) hand operated and (2) power driven.

Sprayers generally used in herbicide application are hydraulic knap sack sprayer, pneumatic or compressor sprayer, motorized pneumatic sprayer, foot sprayer, logarithmic sprayer, tractor mounted power driven sprayer and aerial sprayer.

Sprayer has six components. They are (1) tank, (2) agitator, (3) handle (4) cut off device (5) lance or boom and (6) nozzle.

Nozzles are important part of the sprayer as uniform distribution of spray is depends upon the type of nozzle used. The function of the nozzle is to break the pressurized spray liquid in to droplets for application on the target.

There are eight types of nozzle (1) flat fan ,(2) flood jet deflector (3) solid cone (4) hollow cone, (5) centrifugal, (6) low volume (7) triple action and (8) blast nozzle.

In herbicide application, mainly flat fan and flood jet nozzles are used.

Granular application of herbicide is generally made through hand operated granular applicator, machine operated and tractor mounted granular applicator.

Pre-plant incorporated herbicides are required to be incorporated to achieve good results. Such herbicides, after application, are incorporated or mixed well in the soil through implements like spring tooth harrow, rotary hoe, rolling cultivator, pulverizing disc harrow, spike harrow.

Exercise: Study herbicide equipments available in nearby area, draw their figures and name different parts and their functions.

Practical- 11

Title: Calibration of spray equipment

Objective: To know the exact quantity of herbicidal solution required to be sprayed in known area through the particular sprayer.

Herbicide application at right dose is important to achieve targeted weed management. Herbicide spray is made through different sprayers. The quantity of carrier i.e. water required may be varied from type of sprayer as well as the walking speed of a person engaged in spraying. It is therefore, essential to calibrate the spraying equipment for application of required quantity of herbicidal solution for proper weed management. The best way to calibrate the spray equipment is to spray the water on the specific area and measure the quantity of volume of water spray delivered and speed of operator.

Procedure:

- Select the sprayer which is to be calibrated.
- Check that sprayer is working properly.
- Remove water or solution, if any, present in the tank of the sprayer.
- Pour the known quantity of water (l) in the tank of sprayer (V1)
- Marked the area to be sprayed
- Start spraying at normal speed
- Note the speed of spray (km/hr)
- Record the length of spray (L) in metre
- Record the swath of spray (S) in metre
- Remove and measure the quantity of carrier or water (l) remained unsprayed in the sprayer (V2)

Area of spray, $m^2 = \text{Length of spray}(L), m \times \text{Swath of spray}(S), m$

Quantity of carrier or water sprayed = $V1 - V2$

Quantity required to spray one hectare area (litre) = $\frac{\text{Volume of water sprayed (l)}}{\text{Area of spray (m}^2\text{)}} \times 10000$

Quantity required to spray one hectare area (l) = $\frac{(V1 - V2) \times 10000}{(L \times S)}$

Example:

In the tank of a sprayer 2.50 litres of water is poured and sprayed in 80 metre long area at a speed of 4 kmph. The swath of spray was 0.5 metre. Water remained in the spray tank after spraying was 0.5 litres. Calculate the quantity of water required to be sprayed over a hectare area.

Given:

1. Quantity of water poured in spray tank before spraying (V1) = 2.50 litre
2. Quantity of water remained in the spray tank (V2) = 0.5 litre
3. Quantity of water used for spray (V1 - V2) = 2.50 - 0.50 = 2.0 litre
4. Length of spray (L) = 80 m
5. Swath of spray (S) = 0.50 m
6. Speed of spray = 4 kmph

$$\begin{aligned}
 \text{Quantity required to spray one hectare area, l} &= \frac{(V1 - V2) \times 10000 \text{ m}^2}{(L \times S)} \\
 &= \frac{(2.50 - 0.50) \times 10000 \text{ m}^2}{(80.0 \text{ m} \times 0.5 \text{ m})} \\
 &= \frac{2.0 \text{ l} \times 10000 \text{ m}^2}{40 \text{ m}^2} \\
 &= 500 \text{ litres}
 \end{aligned}$$

Hence, to spray an area of one hectare at a speed of 4 kmph with sprayer having swath of 0.5m, the required quantity of water will be 500 litres.

Exercise:

Sprayer having 2.0 litres of solution was sprayed on 100 m length with swath of 0.75 m at a speed of 6 kmph. There was 0.75 litre of solution remained unsprayed in spray tank. Calculate the quantity of water (carrier) to be required to spray one hectare area.

$$\frac{(V_1 - V_2) \times 2}{7.5} = 1.25 \text{ lt}$$

$$\text{Swath spray} = 0.75 \text{ m}$$

$$\text{Speed} = 6 \text{ kmph}$$

Quantity required to spray one
here. area =

$$\frac{V_1 - V_2 \times 10000 \text{ m}^2}{L \times 5}$$

$$\frac{2 - 0.75 \times 10000}{100 \times 0.75}$$

$$\frac{1.25 \times 10000}{7.5}$$

$$= \frac{12500}{7.5}$$

$$\Rightarrow \boxed{166.66 \text{ liter}}$$

Practical NO = 011

Title - Calculation of area sprayed in given time equipment

Objective \Rightarrow To know the area sprayed in specific time.

Exercise \Rightarrow

Sprayer having 2.0 l of solution was sprayed on 100 m length with swath at 0.75 lit of seed remained unsprayed in spray tank. Calculate the quantity of water required to spray one hectare area.

Sol \Rightarrow Quantity of water poured in spray tank before spraying (V)
 $V = 2.0$

Quantity of water remained in the spray tank $V_2 = 0.75$ l

Quantity of water used for spray \Rightarrow

Practical - 12

Title: Demonstration of methods of herbicide application

Objective: To know and acquaint different methods of herbicide application.

Herbicides are applied as broadcast application, blanket application, band application, directed spray, protected spray, lay by application, soil injection and spot treatment for small areas.

Exercise 1:

Prepare the herbicide spray solution; apply in the recommended crop with different nozzles as blanket application, band application, and spot treatment.

Exercise 2:

Get the known quantity of granulated herbicide and broadcast them on calculated area as per recommended dose and time.

Exercise 3:

Prepare the herbicide spray solution, apply on the soil and immediately incorporate it into the soil with the help of spring tooth harrow, rotary hoe, rolling cultivator, pulverizing disc harrow or spike harrow.

Note the following observations:

1. Date of application of herbicides
2. Dose of application of herbicide
3. Time of application of herbicide
4. Type of nozzle used
5. Area covered
6. Time required
7. Quantity of water required
8. Quantity of herbicide required and
9. Weeds controlled.

Practical - 13

Title: Preparation of list of commonly available herbicides

Objective: To know available herbicides in the local market.

Herbicide manufacturer register their product with Pesticide Registration Board, Govt. of India. All the registered herbicides may not be available in a particular locality. Availability is mainly depend upon the crops grown, feasibility of herbicide sale, marketing network of company and local market. Same herbicide is manufactured by different companies with different formulations, % of active ingredients and names. It is, therefore, necessary to collect all the information of commercial available herbicide in the locality so that farmers can be advocated with available herbicide.

The information can be collected through detailed survey of herbicide dealers of local market.

Procedure:

Visit each and every dealer of herbicide and collect the information available and prepare the list as per following format.

List of herbicides available in the local market on the basis of survey.

Sl. No.	Common name of herbicide	Trade name of herbicide	Active ingredient, %	Formulation	Name and address of Manufacturer
1	Butachlor	Machete	50	E.C.	Monsanto
2					
3					
4					
5					

The list of herbicides registered in India is as follows.

SI No.	Name of herbicide	Formulation registered
1	2,4-D	a) 2,4-D Sodium salt as Tech a.i.80% min. b) 2,4-D Amine salt 58% SL, 22.5% SL c) 2,4-D Ethyl Ester 38% EC, 4.5% G, 20% WP
2	Alachlor	50% EC, 10% G
3	Anilofos	30% EC, 18% EC

4	Butachlor	50% EC, 5% G
5	Chlorimuron-ethyl	25% WP
6	Cinmethalin	10% EC
7	Clomazone	50% EC
8	Cyhalofop-butyl	10% EC
9	Diclofop-methyl	28% EC
10	Diuron	80% WP
11	Ethoxysulfuron	10% EC, 15% WDG
12	Fenoxaprop-p-ethyl	10% EC, 9.3% EC
13	Fluchloralin	45% EC
14	Glufosinate Ammonium	13.5% SL
15	Glyphosate	41% SL, 20.2% SL, 5% SL
16	Imazethapyr	10% EC,
17	Isoproturon	50% WP, 75% WP, 50% Flow
18	Linuron	50% WP
19	Methabenzthiazuron	70% WP
20	Methyl bromide	99% L, 98% L
21	Methyl chlorophenoxy acetic acid	40% SL or 40% AS
22	Metsulfuron methyl	20% WD
23	Metolachlor	50% EC
24	Metoxuron	80% WP
25	Metribuzin	70% WP
26	Oxdiazon	25% EC
27	Oxadiargyl	80% WP, 6% EC
28	Oxyfluorfen	23.5% EC, 0.35% G
29	Paraquat dichloride	24% SL
30	Pendimethalin	30% EC, 5% G
31	Pretilachlor	50% EC, 30.7w/w EC
32	Propanil	35% EC
33	Quizalofop ethyl	5% EC
34	Sulfosulfuron	75% WG

35	Thiobencarb (Benthiocarb)	50% EC, 10% G
36	Triallate	50% EC
37	Trifluralin	48% EC

Approved formulations of herbicidal mixture

SI No.	Herbicide combination	a.i & Formulation
1	Anilofos + 2,4-D	24% + 32% EC
2	Metsulfuron methyl + Chlorimuron ethyl	10% + 10% WP
3	Metsulfuron methyl + Idosulfuron methyl sodium	3% + 0.6% WG
4	Imazethapyr + Pendimethalin	2% + 30% EC

Practical – 14

Title: Assessment of herbicide toxicity on crop

Objective: To study the herbicide toxicity on crops.

The herbicide toxicity of pre as well as post emergence herbicides on crop can be visualized through various symptoms. Pre-emergence herbicide may reduce germination and growth of crop or produce deformity in crop plants. Post emergence herbicides mainly show symptoms on standing crop and first symptom visualize on leaves as these herbicides are absorbed by leaves.

Toxicity of herbicides is generally measures through bioassay, a method to assess biological response of herbicide on a living plant species referred as indicator or test species. Bioassay is simple to carry out and does not require costly sophisticated instrument/ equipments. It is important as it determines phytotoxic activity of herbicide molecule and determines phytotoxic residue in substrate or soil.

In bioassay, test species are grown in herbicide treated soil or in solution of herbicide extracted quantitatively from soil or plant tissue and the response is compared with that shown by same species grown in untreated soil or extract having known concentration of same herbicide molecule. Biological response is commonly measured by whole plant method and sometimes even by taking into accounts only the effect on shoot or root growth. The response is measures either by qualitatively by using visual rating or quantitatively by using the green or dry matter of shoots. Green weights are preferable to dry weights as the dead and necrotic plants may have the same dry weight as green healthy ones.

In bioassay, first the dose or rate response is established through the known concentration of a herbicides. The plant response in soil having unknown herbicide concentration (Herbicide residue) is compared with curve of known concentration of herbicide and the quantity is determined.

The phytotoxicity of post emergence herbicide is mainly observed on the foliage of crop or species grown. In order to measure the herbicide toxicity, the herbicide molecule is sprayed at various concentrations under controlled condition and symptoms of herbicide are recorded and the crop grown under natural condition is compared with controlled condition. Here generally visual rating of phytotoxicity of herbicide measured. The visual rating is on 1 – 9 scale as suggested by the European Weed Research Council as given in Table 1. Similarly, as per Central Insecticide Board (CIB), phytotoxicity symptoms are recorded in 1 – 10scale (Table2).

Table 1: The European Weed Research Council Rating System

Rating	Crop response (% crop injury)		Verbal description
	From	To	
1	0	-	No injury
2	1.0	3.5	Very slight discoloration
3	3.5	7.0	More severe but not lasting
4	7.0	12.5	Moderate and more lasting
5	12.5	20.0	Medium and lasting
6	20.0	30	Heavy
7	30.0	50.0	Very heavy
8	50.0	90.0	Nearly destroyed
9	100	-	Complete death

Table 2: The Central Board of Insecticide grading system

Grade	Per cent damaged leaves	Grade	Per cent damaged leaves
1	0 - 10	6	51 - 60
2	11 - 20	7	61 - 70
3	21 - 30	8	71 - 80
4	31 - 40	9	81 - 90
5	41 - 50	10	91 - 100

Indicator or test species: The indicator or test species used in the bioassay are the species which are very sensitive enough to detect the very small amount of herbicide in the soil or substrate. Further, it must show gradual increase in susceptibility to increased concentrations of herbicide. There must be vigorous and rapid growth habit of test plant under laboratory condition during bioassay. The most commonly used indicator plants or test species are cucumber, oat, barnyard grass, tomato, barley, sorghum, crab grass, yellow foxtail.

Exercise:

1. Spray the 2,4-D at 0.05, 0.10, 0.20, 0.30, 0.50, 0.75, 1.00, 1.50, 2.00, 2.50 kg/ha on different plots.
2. Keep one plot unsprayed i.e. no 2,4-D application(Control).
3. Take the soil sample from another plot where 2,4-D was sprayed.
4. Sow the tomato seed in sprayed, control and from field sprayed with 2,4-D at various concentrations.
5. Observe toxicity symptoms of 2,4-D on tomato i.e. on shoot and root portion; dry as well as green matter of tomato, deformity if any.
6. Workout the phytotoxicity of 2,4-D qualitatively and quantitatively.

Practical - 15

Title: Biology of *Echinochloa*

Objective: To study the life cycle of *Echinochloa*.

Material required:

Fresh matured seed of *Echinochloa*, Petri dishes, Filter paper, germinator, earthen pots, soil.

Procedure:

Step I

- Collect the fresh matured seeds of *Echinochloa*.
- Wash Petri dishes and dry them in the oven.
- Put double layer of filter paper in the Petri dishes. Moist the filter paper and remove air trapped, if any.
- Put 50 seeds in one Petri dish in such a way that there is no over lapping of seeds.
- Prepare such four to five Petri dishes and put them in the germinator at 30°C.
- Record the germination periodically by counting germinated seeds of *Echinochloa*. up to 14 days.
- Calculate the germination percentage at 14 days.
- Repeat the process at every month to find out the dormancy in seeds of *Echinochloa*, if any.

Step II

- Collect the representative sample soil from the field.
- Sieve the soil and remove the seed of *Echinochloa*, if any.
- Fill the earthen pot with soil.
- Dibble ten seeds per pot at about 1 to 1.5 cm deep in such a way that they are sufficient away from each other and as far as at equidistance.
- Water the pot and allow the seed to germinate.
- Water the pot whenever necessary.
- Record the germination up to 14 days., In case all the seeds germinate, allow only 2 -3 representative seedling for further growth studies and remove remaining seedlings.

Record the following observations of the representative seedlings of *Echinochloa*.

1. Days require to germinate the Echinochloa seeds, Initiation of tillering, maximum tillering, flowering, seed setting and maturity.
2. Plant height at appearance of first tiller (Initiation of tillering), flowering, seed setting and at maturity.
3. Number of tillers/plant, leaves /plant, internodes/mother shoot, and dry matter/plant at an interval of 10 days interval.
4. Number of grains/panicle, Number of seeds/plant, test weight, seed yield and straw yield/plant.

Practical- 16

Title: Calculation of economics of weed management practices

Objective: To study the economics of different weed management practices.

Procedure:

In order to calculate the economics of different weed management practices, following observations need to be recorded under each treatment.

1. Area of crop.
2. Number of labourers required for each weeding.
3. Number of labourers required for herbicide spraying, in case of herbicide treatment.
4. Time required for weeding/spraying.
5. Yield of crop.

Exercise:

Grow the crop (rice/ soybean/ wheat/sunflower) on given plot. Note down the (i) number of labourers required for various operations starting from field preparation to threshing and winnowing (ii) time required to complete each operation (iii) quantity of herbicide required, and (iv) cost of herbicide (v)Yield of crop and (vi) Market price of crop (seed and straw). Calculate on the basis of data, total cost of cultivation, gross income, net income and income per rupee invested i.e. benefit:cost ratio and accordingly draw conclusion of more remunerative weed management practice/treatment.