Lesson 21

Title of the Experiment: Weeds and Weed Management Methods
(Activity number of the GCE Advanced Level practical Guide - 34)

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Introduction

Weeds - Definition

There are numerous definitions;

- A plant considered undesirable, unattractive, or troublesome, especially one that grows where it is not wanted and often grows or spreads fast or takes the place of desired plants.
- Weed is a wild plant growing where it is not wanted and in competition with cultivated plants.

Characteristics of weeds

- Rapid population establishment, root growth and spreading
- Ability to colonize disturbed environments
- Can survive even under adverse conditions, ability to tolerate environmental stresses
- Germination and reproduction over a wide range of environmental conditions
- High reproductive capacity, prolific and have a very high reproductive capacity
- Short time of reproduction, flower earlier, produce seeds in profusion and mature ahead of the crop. Therefore, difficult to control and it may be even impossible to eradicate completely
- Seed dormancy, discontinuous germination, longevity of seed, viability of seeds remains intact, even if they are buried deep in the soil, long period of seed production, high seed output
- Seed characteristics - Ability to germinate and grow in many environments, rapid seedling growth, ability to produce seed in adverse conditions
- Presence of vegetative reproductive structures, many weeds are vegatatively propagated and spread rapidly all over the field even under adverse conditions, vigorous vegetative reproduction
- Adaptations for seed dispersion, seeds may have special structures like wings, spines, hooks, sticky hairs, etc. on account of which they can be easily disseminated over long distance
- Ability to compete well with crops, they being hardy, compete with the crop plants and deprive them of light, moisture and nutrients

Invasive Weeds

Some non-native plant species are considered to be very weedy in natural and or agricultural eco systems. Those non-native plants can grow vigorously and increase reproduction rates, and can have increased survival rates in the outside of their native habitat. This may be due, in part, to the loss of balance between them and the other plants within the habitat. Competitive ability by invasive weeds is determined by several plant characteristics. One of the most common traits of a weed species is its tendency to be an annual or biennial rather than a perennial; this allows the species a faster reproduction rate leading to a higher fecundity. Other characteristics that determine the “weediness” of an invasive species is the ability to colonize under extreme conditions (high sunlight, waterlogged or low soil moisture conditions *etc.*). Invasive plants that have capabilities of dealing with herbivory as well as plants that have allelopathic traits also tend to be better at out-competing surrounding plant species. Invasive weeds can effectively compete with

crop species, can lower yields, increase labor requirements and, ultimately, increase food costs for the consumer and perhaps alternation of habitat which may be not suitable for crops.

Alien invasive plants are a serious threat to native and agricultural ecosystems. They can compete with and displace native plants, animals (impact wildlife habitat), and other organisms that depend on them, alter ecosystem functions and cycles significantly (reduce plant and animal diversity), hybridize with native species, invade agricultural lands, impact the livestock industry (by lowering yield and quality of forage, interfering with grazing, poisoning animals, increasing costs of managing and producing livestock) and promote other invaders and reduce land values (deplete soil and water resources).

Background

Classification of Weeds

There are many ways on which weeds can be classified into groups for convenience of planning, interpreting and recording control measures against them. Classification of weeds is helpful for adopting weed management methods for particular group of weeds instead of against an individual weed species. It is always economical and practically feasible to manage the group of weeds as compared to manage the individual weed species. Therefore, weeds are usually classified based on the morphological similarity, growing duration - completion of the life cycle, growth conditions - requirements of soil, water, climatic condition ….. etc.

Classification of Weeds According to Life Cycle:

Weeds are classified according to the time required for the completion of their life cycle - life span - duration of the growth. Depending on their life cycle weeds can be classified as;

- **Annual Weeds:**
  They complete their life cycle within one year or one season - emerge from seed, set seed and die in less than 1 year.
- **Biennial Weeds:**
  They take at least two years or two seasons to complete their life cycle. They complete their vegetative growth in first year or season and produce flowers and seeds in the next year or season.
- **Perennial Weeds:**
  They continue or grow for more than two years or several years - survives from year to year (more than 2 years) and has some form of storage organ to sustain the plant; does not depend on seed production but produces rhizomes, stolons, tubers, etc. like vegetative propagation structures.

Classification of Weeds According to Morphology – Structure and Form

Specially, the leaf form is considered for this grouping. Nature of leaf blade has a relationship with the physiology of the leaf which is related to the application of weed management measures.

- **Narrow leaved weeds**
  Grasses (family Poaceae): Hollow stem, lingulate and alternate or opposite leaves with leaf sheath
  Sedges (family Cyperaceae): Angular and solid stem, no ligules and leaves in whorls around stem
- **Broad leaved weeds:**
  Broadleaf weeds are usually very easy to identify. They differ from grasses by their form and function. The physiological difference allows for the use of selective weed control methods to control broadleaf weeds without injury to the desirable grasses and inhabitants like earthworms.

This is the major group of weeds as all the other dicotyledon weeds grouped under this category except the narrow leaved weeds discussed earlier.

Classification of Weeds According to Habitat

- Terrestrial weeds: grow on land habitats
- Aquatic weeds: inhabit in water bodies or marshy lands and can be as submerged.

In addition to this several features such as, origin, ecological affinity, distribution, etc. are considered in weed classification.

Identification of Weeds

Identification involves both classification and nomenclature. The comparison of an unknown plant with an authenticated specimen and the determination of the similarity, decides that an unknown plant belongs to the same taxonomic rank (species, genus, family, etc.) as the known specimen. In practice plants identify by direct comparison of the specimens or by the use of diagnostic keys. Therefore, knowledge in diagnostic characters of the plants are very important in accurate identification of weeds.

Advantages and Disadvantages of Weeds

Advantages:

1. Weeds add organic matter and nutrients to the soil
2. Weeds prevent damage causes by wind, water and soil erosion
3. Some of the Weeds are used as fodder for animal - livestock
4. Some of the Weeds are used as leafy vegetables
5. Some of the Weeds have medicinal value
6. Some of the Weeds have Economic Importance, serves as ornamental and hedge plants, with nematicidal properties, as raw materials for industries

Disadvantages:

1. Reduction in crop yield
2. Increase in the cost of cultivation
3. Quality of field produce is reduced
4. Facilitate attacks of insect-pests & disease pathogens
5. Harmful to human beings and animals
6. Reduce value of the lands

Weed management methods:

For effective management of, weeds need to know the types of weed are dealing with, correct identification, impact of the weed and life cycle of the weed. Numerous control options have been developed to manage weeds, including legislation of prevention and spread, mechanical or physical control, cultural methods, biological methods, chemical methods and integrated weed management. Practice of these methods are more effective to prevent seed production and further spread, if they can be used before fruiting season of the weeds. Knowledge of seed characteristics, morphology, ontogeny, nature of competition and degree of association with crops are pre-requisites for suggesting efficient weed control measures. A successful weed management requires proper plant identification, selection of effective management methods and monitoring the effects over time. Weed control methods vary according to plant life cycles, infestation size, environmental parameters and management objectives.

Mechanical/physical weed control:

Mechanical control consists of methods that destroy or suppress weeds through physical disruption by use of farm equipment. The two mechanical control techniques most often used are tillage and

mowing. These techniques are more effective for the control of small infestations or weeds in the home gardens. Effective mechanical weed control requires compatibility among the crops, the soil and seedbed preparation technique and cultivation equipment.

- **Mowing:**
  The optimum time for mowing annual species is in their flowering stage, before seed development. Mowing is a suppression measure that can prevent or decrease seed production. Mowing will not control weeds that have profuse basal branching. Shallow-rooted weeds can be destroyed by complete crown removal.
- **Hand-pulling and tillage:**
  The other mechanical methods are hand pulling, hoeing, bulldozing, digging and disking. The successes of various mechanical control methods depend on the life cycle of the target weed species. Hand pulling and digging are effective on annual and biennial species. Shallow tillage with a disk or sweep is effective for controlling annual species. Deep plowing (complete turnover of the top 25-30 cm of soil) disrupts underground root systems and buries seed from the surface to a depth too deep to germinate.
- **Use of Weeders or cultivators:**
  Cultivators are used for pre-plant weed control as well as incorporating residues and preparing a seed bed. Field cultivators are good for keeping fields free of weeds, or 'bare fallowing', until crops are planted. Weeders are good at uprooting very small weeds. They are most effective on small-areas and high-value crops. The weeder offers excellent in-row weed control, but must be used when weeds are small, therefore, timing is critical.
- **Prescribed Burning:**
  Some of the weed seeds can be destroyed by burning. The effectiveness of burning depends on the duration and intensity of heat produced, plus the maturity and location of the seeds. However, burning weeds over an extended area destroys valuable surface trash that would normally be returned to the soil through decay or cultivation.
- **Mulching:**
  The principle of mulching is to exclude light from the top parts of the weeds until the reserves of food supply in the roots are depleted, and let the weeds starve. Mulches include clean straw, hay or manure, tar paper, sawdust and black plastic. Cover crops are also considered as a live mulch which control weeds. In addition to physically suppressing of weeds, cover crops can also suppress weeds through chemical means, a process known as allelopathy.
- **Flooding:**
  For effective control by flooding, weeds must be submerged. Therefore, flooding is usually not an effective method to control weeds in dry regions and under poor land preparation. This method has been shown to be highly effective in controlling perennial weeds and may also suppress annual weeds by reducing the seed production. Flooding is used for weed control in rice, but it not effective to control aquatic weeds. Flooding to a depth of 10 cm prevents germination of most weed seeds and kills the majority of weed seedlings.
- **Solarization:**
  In solarization, soil is covered with a black plastic to trap the heat naturally generated by sun, increasing the soil temperatures to the levels that destroy plants, seeds, plant pathogens, and insects.

Cultural weed control methods:

Cultural weed control refers to any technique that involves maintaining field conditions such that weeds are less likely to become established and/or increase in number. Cultural weed control includes non-chemical crop management practices ranging from crop variety selection to land preparation to harvest and postharvest processing. Some common cultural weed control methods are given below:

- **Timing:**
  Weeds need to be controlled from planting until the crop canopy closes. Proper time, method and rate of sowing crop seeds also control weeds.
- **Land preparation and leveling:**
  Use land preparation to control growing weeds and to allow weed seeds to germinate. Kill newly emerging weeds by repeat tillage at adequate (~10-day) intervals.
- **Reduce weed entry into fields:**
  Prevent the introduction of weeds into fields by:
  1. Using clean good quality seed
  2. Keeping seedling nurseries free of weeds to ensure weeds are not planted with the seedlings
  3. Keeping irrigation channels and field bunds free of weeds to prevent weed seeds or vegetative parts entering the fields
  4. Using clean equipment to prevent field/crop contamination
  5. Rotating crops to break weed life cycles
- **Fallow management:**
  Fallow management includes killing weeds in fallow fields (e.g., use tillage) to prevent flowering, seed-set and the build-up of weed seeds in the soil.
- **Crop-weed competition:**
  Select a weed-competitive variety with early seedling vigor, and high tillering to suppress weeds. Transplanted crops tend to have fewer weeds and less yield loss than direct seeded crops. Transplant healthy, vigorous seedlings that can better compete with weeds in early stages. Maintain an adequate plant population (crop plant density/ spacing) that closes its canopy by maximum tillering to shade out weeds.
- **Kind, rate, time and method of fertilization application:**
  Appropriate rate and kind of fertilizer, time and method of fertilization application also manage weeds. Addition of N fertilizer just after weeding minimizes rice-weed competition for N, but application of N fertilizer into a rice field with weeds, increases weed growth. Broadcasting of fertilizer all over the field stimulates weed growth. Therefore, with localized placement around the crop plants, weeds in all over the field cannot make use of the fertilizers.
- **Water management:**
  Water management is one of the best control methods of weeds (Timing and method of irrigation). Many weeds cannot germinate or grow under flooded conditions (e.g. most grasses and some sedges). Maintain a 2 to 5 cm water level in the field to minimize weed emergence and lower weed pressure. If water is sufficient, fields can be continuously flooded from the time of transplanting to when crop canopy covers the soil completely. Good land leveling is critical to avoid high spots where weeds can become established.
- **Cultivation method**:
  Practice of crop rotation, intercropping, mixed cropping, crop diversification, trap crops and cover corps. The other cultural method include: Fallowing, Quality of Residual incorporation. Organic manure, avoiding overgrazing of pasture land, using well-adapted competitive forage species/competitive crop cultivars, and maintaining good soil fertility.

Biological control methods:

In nature, plant populations are controlled biologically by naturally occurring organisms. In agricultural ecosystems biological control agents can be purposely introduced and can reduce weed populations. Biological weed control refers to any technique that involves the use of natural enemies of weed plants to control the germination of weed seeds or the spread of established weeds. Therefore, biological control of weeds is the use of an agent, a complex of agents, or

biological processes to bring about weed suppression. Biological weed control involves using living organisms, such as arthropods (insects and mites), nematodes, bacteria, fungi, viruses or other organisms to reduce weed populations. Biological control has been used successfully as a practical and economically affordable weed control method in many situations. Bio-control is a self-regulating type of weed control. That is, as the weed host increases so does the insect population. As the weed population decreases due to the insect, the insect population also decreases. A balance is attained when the weed and insect populations are held at a low level.

Examples of biological weed control,

- *Cactoblastis* cactorum (Cactus moth) and *Montegnella opuntiorum* (fungal pathogen) were found very effective for controlling *Opuntia* (Katu Pathok)
- Weevils (*Neochetina eichhorniae* and *Neochetina bruchi) to* control *Eichhornia crassipes* (Japan Jabara)
- Weevil sp. (*Neohydromomus affinis*) used to control *Pistia stratiotes* (Diya Gowa)
- *Cyrtobagous salviniae* is a species of weevil used as an agent of biological pest control against *Salvinia molesta*

Legislation methods for weed control:

Prevention means stopping weeds from infesting an area. It advocates not permitting a weed alien to enter into an area which is not yet infested. Laws and regulations relating to weed control exist in many countries. **E**ffective enforcement of plant quarantine regulations ensure prevention, introductions, entry and spread of new plant species with weed potential. Their actions include strengthening border protection and quarantine services, focusing on imports, shipping containers, airfreight in horticulture, aquarium industries and other agri-businesses. Quarantine stations at harbors and airports are important for prevention of intercontinental movement of weeds. Improving awareness among people at all levels is required to reduce weed spread to new areas in the country after entry.

Legal measures in Sri Lanka to manage Invasive plants

Water Hyacinth Ordinance No. 04 of 1909 is the first legislation implemented with regard to invasive plants in Sri Lanka. The Fauna and Flora Protection Ordinance, No. 02 of 1937, Plant Protection Act No. 35 of 1999 and the Seed Act No. 22 of 2003 also make provisions for the sanitation of plants and regulate the introduction and spread of organisms harmful to the existing flora of the country.

Plant Protection services of the Department of Agriculture performed activities related to the introduction of bio-control agents for the two most serious aquatic weeds, *Salvinia molesta* and *Eichhornia crassipes*, and several awareness, training and capacity building programmes for the rural community in widely spread regions.

Weed law prevents dissemination by manual, physical or mechanical ways of weed species and invasive weeds in to the country. *eg*. Weed law exists, which declares *Parthenium hysterophorus* as an invasive weed in Sri Lanka. Weed Quarantine Law enforces isolation of an area where a serious weed has established and prevents further movement of the weed into a non-infested area.

Preventative measures for weed control

Preventative weed control refers to any control method that aims to prevent weeds from being established in agricultural fields. Examples of preventative weed control are using certified weed free seeds, cleaning farm equipment and vehicles before moving from one location to another, and screening irrigation water to prevent weed seeds from traveling along irrigation ditches and cut weed infested crops prior to weed seed production, field sanitation.

The preventive measures do not offer remedy over the already existing population, but they focus on the prevention of further introduction of weeds from different external sources/agents as well as perpetuation of weeds in the forth-coming years from the existing stands of weeds in crop fields. Therefore, an understanding of the mechanisms of reproduction and survival of weeds as well as the agents for their dispersal constitutes the basis and the success of preventive measure.

- **Pure and clean crop seeds and seed certification-** always use pure and clean crop seeds, which do not add seeds of the existing or new weed species to the soil seed bank
- **Well-decomposed farm yard manure (FYM)/compost -** well-decomposed/well-rotten and free from weed seeds. But, even a well-decomposed FYM may contain viable weed seeds undecayed, half-decayed or at various stages of decomposition
- **Clean irrigation channels and water or alternative irrigation method/system -** Irrigation water carries soil and weed seeds to a crop field. Therefore, irrigation water also needs to be cleaned or treated.
- **Clean farm bunds, roadsides, fences and other non-crop areas -** Weeds on farm bunds, paths/roads and fences should be controlled before they go for flowering to avoid weed perpetuation in the field.
- **Sand, soil from an infested area should not be transported and used to a clean or cultivated area.**
- **Weed control has to be exercised in the nursery -**While up-rooting crop seedlings, weed seedlings up-rooted may be removed before crop seedlings are taken to main field. In transplanted crops like vegetables, rice, this may be an important mechanism of spread of weeds.

Chemical weed control methods:
Chemical weed control refers to any technique that involves the application of a chemical (herbicide) to weeds or soil to control the germination or growth of the weed species. Use of several herbicides is popular for weed control in crop lands, because herbicide application can provide the most effective and time-efficient method of managing weeds. It is important to understand both the benefits and disadvantages associated with chemical weed control before selecting the appropriate control method. However, herbicidal applications are usually cost-effective. Common examples of chemicals used to control weeds in forages are 2,4-DB; EPTC; Bromoxynil; Paraquat and Glyphosate. Chemical herbicides control weeds either by speeding up, stopping, or changing the weed's normal growth patterns. This affects the weed by drying out the leaves or stems, or by making it drop its leaves.

A **non-selective** herbicide kills or damages all plant life in a treated area (e.g., Roundup).
A **selective** herbicide will kill weeds in a germinating or growing crop without harming the crop beyond the point of recovery (e.g., 2,4-D is used to control broadleaved weeds).

New trends in weed management
Researchers around the globe are working to refine and expand the weed management tools that serve as alternatives to synthetic herbicides. These strategies include new mechanical technologies, the use of bio-control approaches (such as natural plant products and soil bacteria), plant breeding to enhance crop competitiveness with weeds, improved models to predict weed populations, and further development of production systems designed to limit weed competition.

By using crops with increased competitive ability and enhanced weed suppressive qualities farmers will have yet another advantage over weeds. Crop qualities that promote crop competitiveness include early, rapid establishment in less favorable conditions, crop structures that limit weed

access to light and nutrients (such as increased ground cover by vegetative portions) and increased plant hardiness.

Researchers are investigating the various agents of weed control available in nature: phytochemicals produced by plants that suppress the growth of other plants (allelopathy), organic herbicides and bio- herbicides, soil bacteria that inhibit seedling growth, and insects that prey upon weed seeds. Deleterious rhizobacteria (DRB) and other soil microbes can suppress weed species. DRB are specific rhizobacteria (bacteria that naturally occur in association with crop and weed root systems) that reduce or prevent plant growth. Investigators are currently working to identify DRB that inhibit specific weed species, to study the effects of cropping systems on DRB populations, and to develop procedures by which DRB can be isolated and applied as a biological weed control agent.

Integrated weed management approaches

Successful management of weeds will require the development of a long-term strategic plan incorporating prevention programs, education materials and activities, and economical and sustainable multi-year integrated approaches that improve degraded land, enhance the utility of the ecosystem, and prevent reinvasion or encroachment by other weed species.

Most often a single method is not effective to achieve sustainable control of a range weed. Integrated weed management (IWM) is the control of weeds through a long-term management approach using combinations of several weed management techniques and multiple strategies such as: mechanical, cultural, biological, and chemical control techniques (Figure 1). Any integrated weed management plan or strategy should focus on the most economical and effective control of the weeds and environmentally sound. A long-term integrated weed management plan, that considers all available management control techniques or tools to control weeds, can be developed for a particular area.

Integrated weed management involves use of several techniques to manage weed populations in a manner that is economically viable. It reduce the chance that weed species will adapt to the control techniques. E.g. if a herbicide is used over a long period of time, a weed species can build up a resistance to the chemical.

A sustainable approach to successfully managing the resource must include the following processes:

- managing the resource to **prevent** weeds from invading
- proper **identification and knowledge** of invasive weed species
- **inventory, mapping and monitoring** of weed populations and damage
- making **control decisions** based on knowledge of potential damage, cost of control method and environmental impact of the weed and control decision
- using control strategies that may include a **combination of methods** to reduce the weed population to an acceptable level
- **evaluating** the effectiveness and effects of management decisions

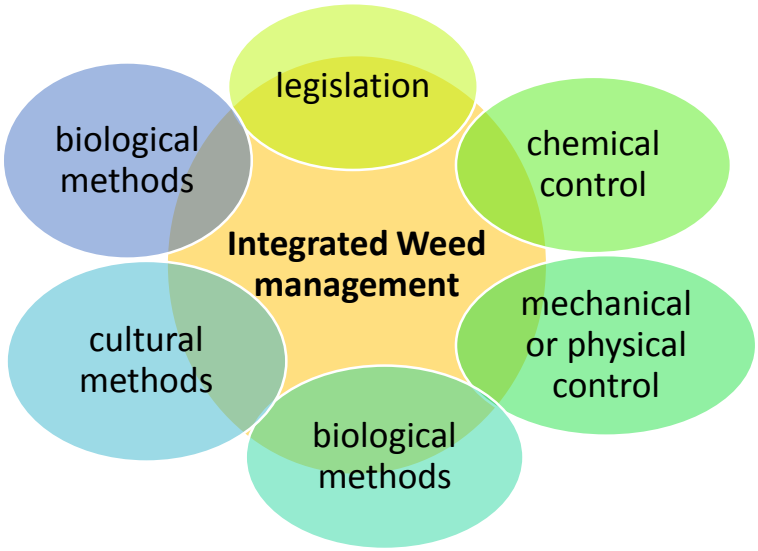

Figure 1: Approaches in integrated weed management

Critical period for weed control:
Weed competition does not occur during the entire cropping period. Control of weeds in the critical period of competition is important. Usually it commences around 2 weeks of seeding and may continue up to 5-8 weeks. Hence, thresholds are critical parts of any integrated weed management program reduce economic yield losses.

Economic thresholds (ET), in which the density of a weed has reached a point at which a management intervention is economically justified (Figure 2). An economic injury level (EIL) is the lowest population density of a pest that will cause economic damage.

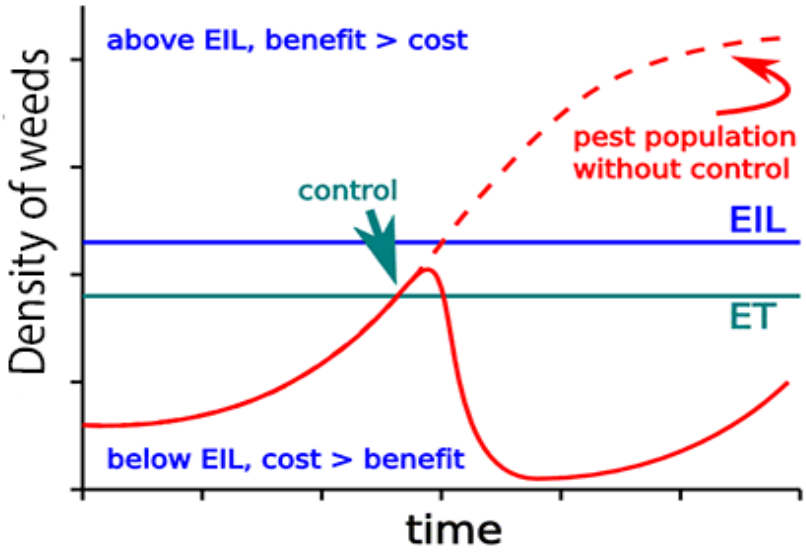

Figure 2: Identification of Economic thresholds economic injury level for weed management

(Source: http://www.extension.org/pages/19915/insect-pest-management:-differences-between-conventional-and-organic-farming-systems#.VZoDjEavbik)

Learning Outcomes

After completion of this laboratory session you should be able to

i. develop skills in classification and identification of weeds
ii. demonstrate knowledge in selecting suitable methods, benefits and risks and modern trends in weed management

Materials and Methodology

Identification of Weeds

Materials

Collection of Samples

Garden scissor/ secateurs / Knife/ Fork, Polythene bags/ containers, Note book
Pencil, Labels/tags

Preparation of Specimens

News papers, Methylated spirit, Corrugated boards, Blotters, Plant press, Plant Drier, Mounting Sheets, Binder gum/glue

Methodology

- **Collection and Preparation of Specimens**
  Specimen should be representative of the population - a twig with leaves, flowers and fruits or entire plant if possible
  Field data recording is important for accurate identification. Field notebook information: i) field number, ii) vernacular name of plant (if known), iii) locality, iv) altitude, v) habitat, vi) description - observations not apparent from the specimens, especially color, abundance, odor, height of plant, etc., vii) date and viii) Name of the collector
- **Fixing**
  Specimens should be collected into polythene bags/ containers. To cease the growth of the plant material specimens are needed to be fixed. For the fixing, sprinkle Methylated spirits into the polythene bags/ containers and keep for 2-3 days
- **Pressing and Drying (Herbarium specimens)**
  The Herbarium technique is the standard method for preserving plants.
  1. Prune the specimen as necessary to obtain scientifically accurate, specimen
  2. Tag the specimen with the collection number
  3. Place between sheets of newspaper in a plant press. Some leaves up and others down. Large stems bent
  4. Place blotters under and over the sheet
  5. Do the same with the corrugated cardboard
  6. Repeat these steps for each specimen
  7. Loosely fasten the press and place in a plant press
  8. Keep for 2-3 days, open the press and rearrange as necessary daily. It may be necessary to change the newspaper and/or blotters. It is critical to dry specimens quickly to prevent decomposition, prevent mold growth, and maintain color
- **Mounting**
  Mount specimen on herbarium sheet (11.5 cm × 16.5 cm, acid free) with white glue. A label for each specimen should be prepared stating the field data. Herbarium specimens last for years (assuming they are properly housed and kept dry and pest free).

Figure 3: Herbarium Specimen

Procedure

- Observe and list the diagnostic characters of given specimens
- Make suitable illustrations
- Prepare herbarium specimens
- Identify the given specimens of common weeds

Weed management

Materials

Common Agricultural Tools
Agricultural beds

Procedure

- Study and compare advantages and disadvantages of various weed control methods
- Prepare a list of invasive weeds in Sri Lanka.
- Collect information and write a report on new trends in weed management, eg. crop breeding for weedicide resistance
- Identify appropriate mechanical or cultural weed management methods to control weeds in the vegetable beds in your school garden. (Define criteria to select appropriate method: crop yield/no of weed seedlings before and after control *etc.*).
  Find vegetable growing beds with following treatments
  Method 1 – Control (Without weed control)
  Method 2 – Mechanical weed control
  Method 3 – Cultural weed control
  Possible information to be collect are given in Table 1.
- Collect and study information on ordinances/ acts available in Sri Lanka for weed management.

Readings/Observations

Identification of Weeds
Records of the Morphological Characteristics of given specimens

Datasheet:
No. 1 ……

Plant form …….. Duration ……..

Habitat …… Leaf arrangement ……

Leaf type …….. Leaf margin ……

Leaf shape …… Fruit type ……

Flower characteristics ……
……

Other characteristics ……
……

Weed management

Prepare comparison tables for advantages and disadvantages of each weed management methods

Eg. Advantages and disadvantages of mechanical weed management methods

Advantages	**Disadvantages**
Aerates soil, breaks soil crust, stimulates crop growth	May damage soil structure
Reduces pollution - no soil chemical pollution, no health hazards	provides only short-term control
Effective, especially on small weeds and in small fields or adverse environmental effects	Extremely tedious and time consuming More expensive than herbicides Timing is critical
Practical and efficient method of removing weeds within rows or hills of crop (rice) where weeds cannot be controlled by other means	It is not practical to use on large scale cropping area
May reduce the need for herbicides	It is difficult to distinguish weed seedlings from (crop) rice seedlings at early stage of growth and uprooting or damaging crop cannot be avoided. This occurs particularly in direct-seeded rice/with random seed broadcasting
Equipment/tools are readily available	Improper use of tillage implements can damage the crop
	Cannot be used effectively when the soil is too dry or too wet
	Inability to control weeds growing close to crop plants
	Less effective than herbicides

Comparison of effectiveness of mechanical and cultural weed control methods.

Method 1 – Control (Without weed control)
Method 2 – Mechanical weed control
Method 3 – Cultural weed control

Table 1: Data sheet for information on weed management

Parameter	Method 1	Method 2	Method 3
Frequency of occurrence (percentage of weed cover) of weeds one month after crop growing			
Frequency of occurrence of weeds at flowering stage of the crop growing			
Crop yield			
Number of weed species			
Any other appropriate characteristics ……. …….			

Compare your results and determine appropriate weed control method

……

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Recommended Readings

Bridson, D and Leonard F (1998) The Herbarium Handbook, 3rd ed. Royal Botanic Gardens, Kew, Great Britain

Zimdahl R L (2013) Fundamentals of Weed Science, Academic Press