



Module No.

4

TEA RESEARCH Institute of Tanzania



The use of mulch to suppress weeds



Herbicide application

Training module on
**WEED CONTROL IN TEA
BUSHES**

July 2002

FOREWORD

This is the fourth of a series of Training Modules prepared by the Tea Research Institute of Tanzania (TRIT). The first was on Rehabilitation of abandoned Tea fields, the second on Fertilizer and manure, and the third on Tea plucking and Quality control. Weeds are the major constraint to tea production particularly in the early years of establishment. They compete with the Tea bushes for nutrients and water and can serve as alternate hosts of pest and diseases. This module is meant to assist farmers, extension workers, managers and researchers in their effort to address the weed problem. TRIT welcomes suggestions from users and readers of this module and other previous modules so that improvements can be made while updating them.

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INTRODUCTION

Weed is one of the main factors which reduces tea production. However weeds can be controlled effectively through proper management of the tea fields. It is a big problem to majority of smallholders and some estates.

This training module has been prepared to help farmers, managers and scientist in weed management in Tea fields. The main objectives of the training module are:

- To understand the meaning, characteristics and the effect of weeds in Tea production
- To identify types of weeds found in their tea fields and the appropriate control measures.
- To know how to protect ourselves, the society from herbicide poisoning

The module consist of 5 chapters which are Definition of terms used in weed control, Types of weeds and their characteristics, Weed control, Weed control in tea fields and prevention of herbicide poisoning.

The module has been designed to support participatory learning through group discussion, presentations by participants and plenary sessions.

DEFINITION OF TERMS USED IN WEED CONTROL.

Weeds

Are plants that grow out of place, the plants growing where they are not wanted.

Active ingredient

The active chemical in a formulation that do the actual work of immobilizing weeds, i.e. the part other than additives (e.g. wetters, stickers, emulsifiers) and inert ingredients.

Broad-leaved plant

These are the flowering plants other than grasses or sedges.

Contact herbicide

A herbicide that kills only those parts of a weed that come in direct contact. These herbicides are normally applied in large amounts to cover the foliage and they kill by direct action on the part of the weeds they come into contact. They are non selective e.g Paraquat (Gramoxone).

Caution

Contact herbicides must be directed at the weeds to avoid scorch on young plants.

Post-emergent treatment

Is the application of herbicide after crop emergence. Post emergence herbicides are herbicides which are applied after crop emergence.

Pre-emergence treatment

The application of a herbicide in bare soil before sowing or after sowing the crop but before it has emerged e.g Diuron, Simazine, Primagram. Pre emergence treatment are herbicides which are applied in bare soil before sowing or after sowing the crop but before it has emerged.

Pre-planting treatment

Application of a herbicide before sowing or planting.

Residual or persistent herbicide

These remain toxic to weeds for periods exceeding one or two months. Usually, they are sprayed onto the soil and are washed in where they remain until they are physically leached into the lower soil levels by the rain. Their chemical composition is in such a way that they are affected by heat and light.

Non residual/Non persistent herbicides

A chemical which is broken down quickly in the soil within a period of 2 weeks.

Spot treatment

Is the application of herbicides to individual weeds.

Surfactant

Surface active agent, i.e. a compound added to a herbicide to improve its mixing and/or wetting properties.

Systemic herbicide

A herbicide that moves inside the weeds after being absorbed.

Translocated herbicide

This is a systemic herbicide which is taken either Acropetally (i.e herbicides taken from the roots to leaves) or Basipetally (i.e. herbicide taken from the leaves to the roots).

These translocated herbicides are required only in a small amount and the use of Ultra Low Volume (ULV) is effective to active growing weeds in order to make full use of the herbicides. Examples of translocated herbicides are 2,4D, Dalapon, Glyphosate, Touchdown, Roundup etc.

Selective herbicide

These are herbicides that are effective against either grasses or broad-leaved weeds eg Dalapon (controls grasses) and 2,4-D (controls dicots).

Non selective Herbicide

Kills both monocots and dicots eg Paraquat (Gramoxone), Glyphosate.

Wetter

A surface that increases the wetting power of liquids.

Wettable powder

A powder which mixes with water to give a suspension.

INTRODUCTION TO WEEDS

Characteristic of weeds

Weeds have unique characteristics to enable them colonise large areas:

- They establish easily.
- Not easily eradicated.
- Capable of exploiting new habitat.
- Have efficient dispersal and reproduction mechanism.
- Undergo dormancy to suppress certain adverse conditions.
- Some can parasitise other plants.

Advantages of Weeds

- Food for humans and feed for livestock e.g. *Commelina spp*, *Bidens pilosa*, *Corchorus olitorius* (Mlenda), *Solanum nigrum*, *Sonchus olareacea* and *Amaranthus spp*.
- Act as soil cover/soil stabilizer which controls the land against wind, water and other sources of erosion. Land under fallow contain various vegetation (Weeds).
- Nutrient recycling: Nutrients are absorbed by deep rooted weeds species and brought into the leaves. The leaves then fall and decompose on top of the soil hence nutrients are brought into upper layers of the soil.
- Medicinal/ Aesthetic values e.g. *Ocimum canum* is used to chase away mosquitoes when burnt and to cure some minor fever, *Boerhavia spp* for relieving high blood pressure *Solanum incanum*, its roots are used to cure toothache, *Tephrosia vogelic* used to cure diamond black moth in Cabbages.
- They are source of nutrients e.g. *Clotolaria spp* (Marejea).
- Source of genetic material-They are used in conventional breeding programme to breed for pest and disease resistance and other environmental stress.
- Weeds contribute to biodiversity (Biological diversity); they are responsible for ecological balance (Balance of nature in ecosystem). They are source of food to some species and source of medicinal values.
- Serves as hosts of beneficial organisms, insects e.g. bees, butterflies and predators which are useful for biological control.
- Weeding provides employment.

Disadvantages of weeds

- They reduce crop production in terms of both quantity and quality due to competition for resources (Light, Nutrients, Water, Space).
- Reduce in farm operation efficiencies.
- Reduce water use efficiency i.e. water from rainfall, water source, irrigation water.
- Some weeds are poisonous to both human beings and animals e.g. *Solanum incanum*, *Euphorbia* spp.
- Weeds may serve as alternate host to a number of pests, diseases and rodents especially during off season.
- Parasitism e.g. *Striga* in Cereals and *Cuscuta* in pastures.
- Impaired visibility along roads.
- Fire hazard which occur around home areas where fire is used as a mean of weed control.
- Pollen from weed plants cause allergy to some people and animals.
- Weeding consumes time, up to 50% of total time for farm operation is spend on weeding.
- Thorny weeds are nuisance to workers.
- Increase incidence of blight.
- Grasses are potash robbers.
- Creeper weeds suppress crop exposure to light and make harvesting difficult.

Classification of weeds

Weeds classification is an important aspect and prerequisite in determination of management options of weed control.

Criteria used in weed classification are based on:

- Lifespan
- Morphology
- Growth Habit
- Habitat
- Degree of undesirability
- Scientific Nomenclature

For purpose of this training module, the classification will be based on Lifespan and Morphology.

LIFESPAN

This is based on the duration of the lifecycle of the given weed from germination to death.

i) Annuals

Complete their lifecycles within a year or in many cases within one season or one year.

Characteristics of annual weeds

- They grow fast i.e. during one season they will germinate, undergo vegetative growth, reproductive phase, shedding their seeds and then die. This is usually in the rain season.
- They produce large numbers of fruits and seeds which enable them to propagate more rapidly e.g. *Galinsoga parviflora*, *Bidens pilosa*.
- They reproduce only by seeds (Sexual reproduction).

ii) Bi-annuals

Complete their lifecycle within two season or two years.

In the 1st season/year –Vegetative growth phase- i.e Germinating and producing shoots

In the 2nd season/year-Reproductive growth phase-i.e Flowering, produce fruits and then die.

iii) Perennials

They can leave more than two year/season. There are 2 groups of perennial weeds.

a) Simple perennials

Normally reproduce by stem whenever the stems of these weeds are in contact with the soil they can develop roots at stem nodes and grow into independent plants.

b) Creeping perennials

They reproduce both sexually and asexually. They tend to reproduce more vegetatively (asexually) than sexually e.g *Cynodon dactylon* and *Digitaria scalarum*. Asexual reproduction depends on vegetative organs such as rhizomes, stolons, tubers and bulbs/bulbils. Most of these except stolons are usually below the ground. Reproduction is very fast because when weeding only the shoot system is cut therefore apical dominance is broken.

Characteristic of Perennials weeds

- Greater longevity of vegetative structures through various weather conditions (Both favourable and unfavourable).
- Most of them have deep roots which allow them to get access of water and nutrients. Their roots can grow up to 1 meter, and therefore difficult to remove all the roots neither by hand weeding nor by using implements.
- They have dual reproduction mechanism, if seeds fail to germinate still they can reproduce vegetatively.

- Tillering ability leads to the formation of new individual weeds which when cut above or below ground, they are able to multiply very fast and occupy all the area
- The presence of succulence stems allow the persistence of the weeds during dry seasons.

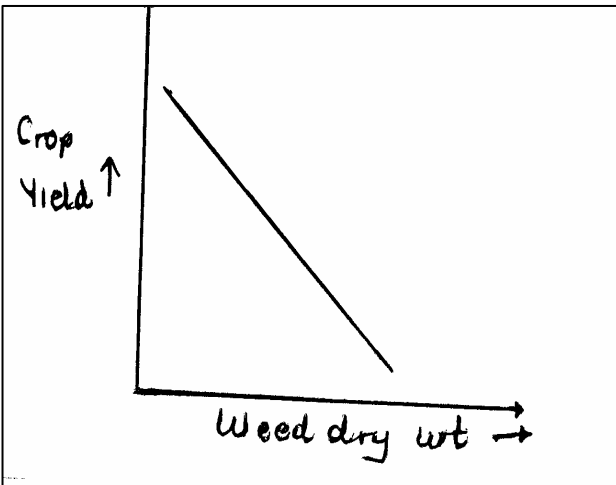
MORPHOLOGY

Monocots and Dicots

Characters	Monocots	Dicots
Roots	Fibrous root	Tap root
Stem	Unbranched without central pith	Branched with central pith
Bark	Firmly attached	Separable
Leaf	Sheathy leaf base	Petiolar or sessile
Venation	Parallel	Reticulate/Net
Flower parts	3 merous	4-5 merous
Seeds	Single cotyledon	Two cotyledon
Leaves	Narrow	Narrow or broad
Growing points	Just below the ground	At the apex

NOTE: Monocots are the most important weeds to control in young tea.

Weed weight and Crop yield



There is a negative linear relationship between weed dry weight and crop yield

As weed dry weight increase crop yield decrease. In general for every unit dry matter of weed produced, there will be similar reduction in crop yield.

However a crop has a certain genetic potential, weed management enable the crop to reach maximum genetic potential of production. Weed control cannot increase the crop yield beyond its genetic potential.

Fig 1: Crop yield Vs Weed dry weight

Weed density and crop yield

Relationship between crop yield and weed density is sigmoid. This applies for many weed spp in wide range of crops.

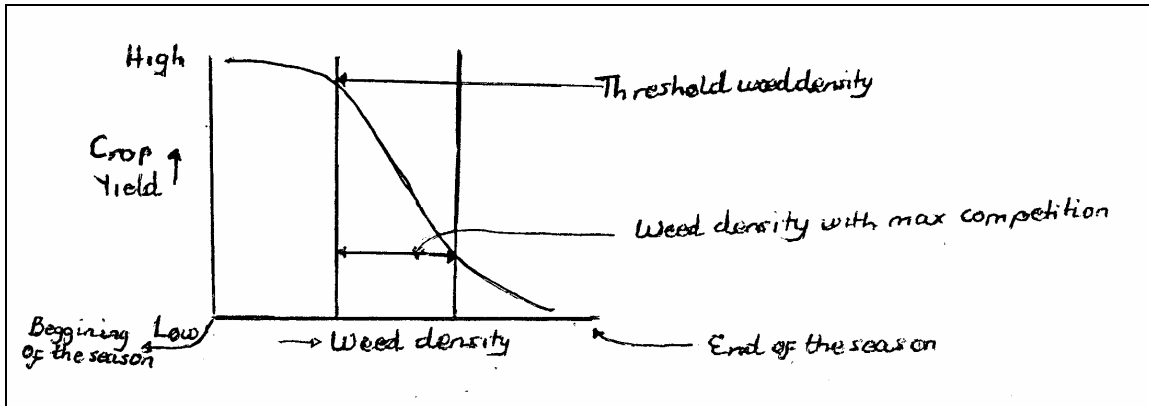


Fig 2: Crop yield Vs weed density

- A. Lag phase: Very low weed density with no influence on yield.
- B. Log phase: Very vigorous weed growth which result in drastic decrease in crop yield
- C. Stationery phase: Weed start to compete themselves for resources.

At the beginning of the season weed density is very low. If there is an ability of maintaining that density crop yield will be high.

Weed density could increase up to the point where any more increase in density will cause decrease in yield.

If weed density continues to increase they will reach a point where there will be competition among themselves in addition to the crop. Theoretically, there will be a point at which yield will be zero.

These regions (A, B and C) are very important in weed management. In the intergrated weed management the decision of weed control is determined by the knowledge of weed density.

WEED CONTROL

Methods of weed control

There are 4 methods of weed control which are Cultural, Biological, Chemical and Mechanical.

1) Cultural

Cultural practices such as mulching, raising cover crops, closer planting (High density spacing), higher pruning and tipping practices infilling, burning, flooding, crop rotation, fallowing are among the method used to control weeds.

2) Biological

Controlling weeds by using living organisms.

3) Mechanical

It involves:

- Weeding with tools and implements e.g. Cheel hoe and slashing
- Pulling by hand weeds which are closer to the plant (Manual weeding).

The dug up weeds and soil should be shaken before weeds are carried out of the field.

Caution

Be careful not to damage the plants and their feeder roots.

Disadvantages of mechanical weeding

- Accelerate soil erosion.
- Favours multiplication of grasses by vegetative propagation.
- Causes damage to surface roots and collar region.
- Bring up weed seed which were down the profile.
- Increase stress on labour availability.

Some of the mechanical methods of weeding such as the traditional hand weeding tend to be expensive due to low labour productivity. In most cases they increase total employment cost making this method of weeding uneconomic.

4) Chemical

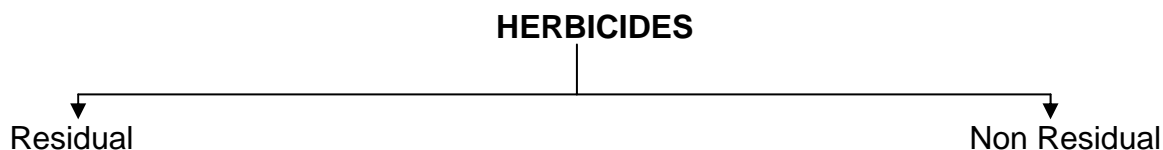
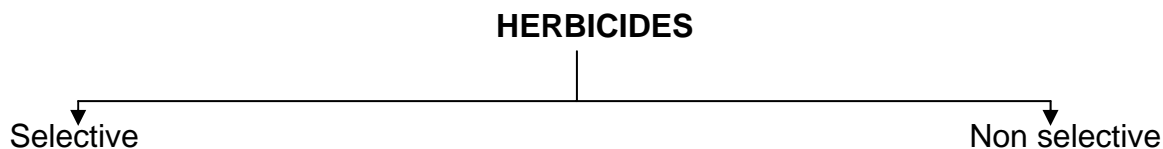
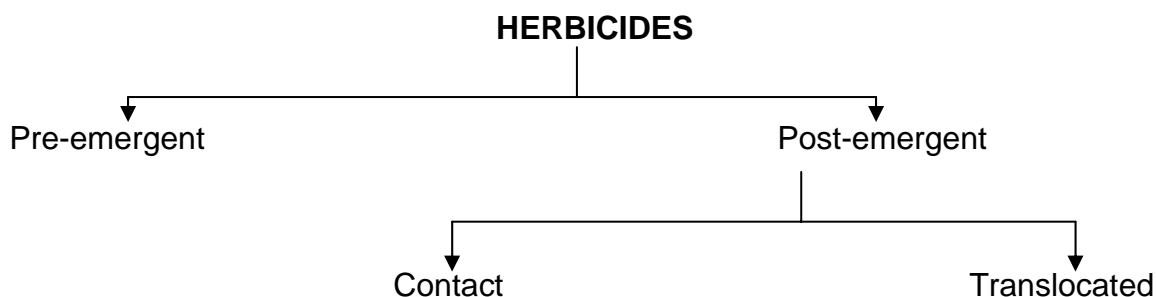
Herbicides: Any chemical which has phytotoxic properties to kill weeds.

Advantage

Does not interfere or damage the roots of tea plants.

Disadvantage

- Because of direct effect by contact or translocation (indirectly) via the soil, yields are not enhanced in the early establishment period and therefore use of herbicides is discouraged at this stage.
- Cost of chemicals and sprayers are very expensive.
- Need skilled labour for mixing and application conditions.
- Affect environment (Soil and Water pollution).



There are 4 main classification of herbicide based on:

- The total effect of the herbicide.
- The mode of toxicity of the herbicide.
- The length of time the herbicide will remain toxic in the environment.
- Herbicide application time in relation to the stage of growth of crops.

Category	Basis of Classification
Selective/non selective	Total effect of herbicide
Contact/translocated	Mode of toxic action
Residual/non residual	Length of time the herbicide will remain toxic
Pre-emergence/post emergent	Timing of application

Conditions for maximum effectiveness of herbicides:

- Recommended dosage rate should be used.
- Should hit the weeds when young and actively growing (10 cm high).
- They are effective for well established crops but for young crops herbicides can cause damage.
- Plan to spray when wind and weather condition are favourable to avoid drift for example residence of 30 minutes is required after spraying before rains for contact herbicide while for translocated herbicide, 2-3 hours are necessary.

Factors influencing choice of a herbicide**Frequency of application**

Time that elapse before next application. The longer the time it remain toxic, the suitable the herbicide.

Price of the chemicals

Chemicals with high herbicidal effect and less expensive are more preferred.

Formulation

The more concentrated chemicals would require low application quantities hence overhead costs are less.

Toxicity

Chemicals which cause environmental pollution are least preferred.

Mature Tea

Roundup is preferred in mature Tea while Gramoxone with shield in Young Tea

Spraying equipments

- Carrying buckets
- Measuring jar/ or syringe
- Sprayers

1) Water Tanks

Must be full of clean water to avoid:

- Sprayer blockage.
- Chemical inactivation e.g. Gramoxone becomes inactive when in contact with soil.

2) Mixing buckets

Can be of 20L. There is a need of using mixing buckets when you deal with a powdery herbicide

3) The carrying buckets

These are necessary for carrying water for the chemical mixtures for filling the sprayers.

4) The Knapsack sprayers

CP3 Knapsack sprayers and CP 15 Solo are commonly used.

For: GRAMOXONE: high volume jet nozzles are provided with the sprayer

For: ROUNDUP: Low volume nozzle is needed for economic use of the chemical.



Plate 1: CP 3 Knapsack Sprayer

WEED CONTROL IN TEA

In order to conduct a successful weed control in tea bushes (young or mature tea), one should analyse types and characteristic of weeds found in the field before design an effective method of weed control.

Common weeds in Tea Fields

Common Name	Botanical name	Kiswahili	Kibena	Kisambaa
Red shank	<i>Polygonum persicaria</i>			
Wandering jew	<i>Commelina benghalensis</i>	Djadja	Likolowoga	Kongo
Button Weed	<i>Borreria stricta</i>			
Macdolnaldi	<i>Garinsoga parviflora</i>		Nyangeresa	
Sedges, Water grass	<i>Kylinga erecta</i>	Ndago	Ndago/Nyalusia	
Couch	<i>Digitaria scalarum</i>		Kidilu	
Black jack	<i>Bidens pilosa</i> (Vanivani)	Mashona nguo	Libangalala	Mbwembwe
Nut Sedges, Water grass	<i>Cyperus esculentus</i> , <i>Cyperus rotundus</i>	Ndago		
Couch grass	<i>Cynodon dactylon</i>	Ukoka	Linyang'wale	
Lantana, Tick berry	<i>Lantana camara</i>		Luhongole	
Oxalis	<i>Oxalis corniculata</i> , <i>Oxalis latifolia</i>		Kinyangw'ale	
Kikuyu grass	<i>Pennisetum clandestinum</i>			
Braken	<i>Pteridium aquilinum</i>			
Sodom apple	<i>Datura spp</i>	Ndura	Ndura	Tula
Sencio	<i>Senecio abyssinicus</i>			
Black night shed	<i>Solanum nigrum</i>	Mhaka	Mnavu	
Mexican marigold	<i>Tagetes minuta</i>			

Weed control in young tea

The large area of soil exposed to full sunlight together with the fragility of young plants make the control of weed in young plants more difficult than in mature tea. As conditions are favourable for weed growth, weed control in young tea must be an expensive operation compared to that of matured tea. **Either in young tea or mature tea weed should be controlled before they flower and set seeds.**

i) Weeding manually

It is our view that it is at all times best to control weeds in tea bushes by hand pulling. Even under an intensive programme of weed control by herbicides, some manual weed control will be required. Inevitably, when the use of herbicides is ad hoc or non existence (such as in many small holders plots), manual weed control takes on a very significant part in management, in particular while the tea is still young.

Weed growth will profuse in rainy season, particular where there is no mulch or only a partial covering of mulch. Thus frequent rounds of hand pulling of weeds will be required to meet the essential need to make sure the weeds do not start competing with the tea for nutrients and water. A circle around each plant of at least 40 centimeter diameter must be kept completely clear of weeds. As weeds are pulled out, they should be put into a sack and carried out of field. If left in the field some will strike roots and grow again.

The ground outside the circle around each plant should be covered with a nurse crop, such as oats. This crop, when both growing plants and the stems cut off and laid down, will reduce weed growth but some weeds will inevitably appear. These can be removed by hand along with weeds closer to the tea plants or it may be convenient to control them with herbicides.

Uncontrolled weed growth round the collar of young tea plants for only a short time can have a long term inhibiting effect on branching low on the main stem, which will cause problems when the time comes to prune for frame formation.

Hand pulling round of not less than 14 days is essential over the rain period in young tea where there is no mulch or where the mulch is thin. It is important to ensure that the weeding round is kept between 2 and 4 weeks in a cool dry season. The frequency of weeding can be reduced as the mulching regime become more intensive and experience will dictate the optimum weeding frequency.

Because weed grow slower in cool, dry season the weeding frequency can be reduced to monthly, but it is well to remember that in dry period the weeds are

competing with the tea for moisture and so steps should be taken to pull out weeds when soil moisture is low.

In all times manual weed control should be carried out when weeds are small, to ensure that they can be easily pulled out by hand and before the weeds start to compete with tea for nutrients and water. **A fundamental rule is to make sure weeds are pulled out before they flower.**

Recommended tasking procedures (This also applies to mature Tea)

2 ways

- a) Gang weeding
- b) Scheme weeding

Gang Weeding

A group of weeders are assigned sections of the field to be done each day. A supervisor ensures tasks assigned to individuals are accomplished within required time and standards.

Scheme Weeding

A weeder is allocated a set number of rows to be done each day. Also in this case supervision is important.

In both gang and scheme weeding any uncompleted task render the weeders concerned to be marked "T". The task will depend on:

- Length of the rows of tea
- Density of weeds
- Number of tea plants to be covered

ii) Weeding by using implement

Removing weeds by implement such as (cheel hoe, Jembe, fork Jembe etc) inevitably result in heavy damage to and loss of both tea plant and a nurse crop. Also weeding by using implements will disturb the soil hence bring up weed seeds which were below the ground level. So the use of any implement is discouraged except a small straight-pronged fork or trowel which can be used to loosen the roots. Cultivation should be carried out when weeds are small so that soil disturbance is minimal. Also weeding with hoes when there is covering of mulch will disturb the mulch and this result in its quicker decomposition.

When there is no mulch and planting has been done into land that has been ridged and boxed, then hoes will have to be used to repair the ridges and boxes after planting and again when the conservation measures have become inefficient after heavy rain. This repair work help to control weed growth.



iii) Mulching

We are of the opinion that even under the most extensive management system, keeping the soil under a cover of mulch for the first 2 years is a prerequisite that can no longer be ignored. Weed control at this stage is best achieved using mulch which should not be placed closer than 10 cm to the stem so that lateral growth is not hindered at the same time preventing stem infection. Mulch should be applied to a soil surface free of weeds. This can be achieved by using a light cultivation before mulching. The advantage of mulch are many and some of them are they

Plate 2: Mulch reduce weed growth

reduce weed seed germination by smothering them from light which is the important need for germination and there is no risk of building up chemicals with residual effect in the soil.



iv) By using herbicides

Using herbicides can control weeds in young tea.

Shielding the plants when spraying or the use of shield nozzles can prevent damage to tea plants. This can be done successfully in a number of ways:

- A piece of polythene sheet held by one man around each plant while another man is spraying.

Plate 3: A sprayer with shielded nozzles

- A tin (Debe) cut into halves to cover individual plants when spraying.
- A cone made from a stiff material which is easily dropped to cover individual plants can be used by one man while spraying as well. The cones made from a material of sufficient gauge and rigidity are simple and executive.
- Use of sprayers with shielded nozzles. It is widely used and more effective than those mentioned above.

When spraying any herbicide it is important to minimize drift to the young plants which are not protected. A flood jet at reduced pressure gives a coarser spray which is less easily carried by wind. Alternatively, a Dribble-bar attached to a pressure sprayer produces coarse drops and has been used successfully. Always avoid spraying under very windy conditions.

A persistent herbicide sprayed over fields of young tea will prevent seedlings of many weeds from growing. Simazine is the only herbicide that can be considered in this respect, but it must be used in caution as young tea plants have on occasions be damaged by Simazine. Dalapon must not be used on Tea under 2 years old. The other herbicides, which can be considered in young tea under 2 years old, are fluozifopbutyl (Fusilade) and Oxyfluorfen (Goal 2E) and Gramoxone. Again in all cases precautions should be taken to protect the young plants when spraying the herbicides. **Care must be exercised if possible not to use herbicides in the first 2 years of establishment.**

It is essential to repeat weeding round, whatever method of control is employed, after a short interval so that weeds which have regrown are removed before they have a chance to seed or grow extensive root system which are left in the soil. The interval between rounds will vary, it may be as short as eight weeks and will depend on soil conditions, Weed flora, Climatic condition, Size/age of tea plants and weed population.

This must remain flexible and local management will need to exercise judgement continuously on this point. An inadequate number of weeding round at long intervals, whatever method is employed, is a complete wastage of money.

Weed control in mature tea

Weed control must be planned as a complete programme only by making use of all suitable methods and using these at the correct time will cause a continuous reduction in weeds hence the cost will fall as time goes on.

The use of either manual or chemical weed control is seldom satisfactory as the former method is likely to increase soil erosion while the use of selective herbicide may result in a build up of herbicide resistant weeds. It is desirable to have a properly trained weed control team of the estate, which can keep on top of any weed which occur. Weed control, therefore, generally requires an intergrated programme involving **mulching** as well as **manual, mechanical** and **chemical** method. Economic to the large extent determine the major emphasize.

As the tea plant grows and so covers the ground, its leaf canopy will play an increasingly important role in controlling weed growth. An additional advantage is an improved root environment under the covering provided by fallen leaves and pruning. Also the extended circles will assist in keeping weed growth down. However weeds will grow along the edges of the field in footpaths and vacant areas and unless watched, will become a problem after pruning.

It is impossible to set a hand weeding round for mature tea that will cover all the various situations. However, if the fundamental principle of not allowing the weeds to flower and set seeds is followed, the weed problem will be kept under control. Success with weed control depends on a weeding round based on the rate of weed growth, i.e. a 14 day weeding round during the main growing period extended to a longer round during the winter months. Setting a scheme programme where by each day a fixed area is weeded by hand, adjusting the frequency according to the time of the year, is one way of ensuring the weeds never seed and are kept under control.

It is imperative that the control programme should start during land preparatio, when perennial grasses and sedges (such as couch, spear grass, kikuyu, star grass and nut sedges) must be eradicated.

By using Herbicides

The soil, in particular the clay content, must be considered when using residual herbicides. Residual herbicides can be phytotoxic to tea if applied to very sandy soils. The instruction for use and application rates, given on the label, must be strictly complied with if the risk of damage is to be avoided.

If applied properly, herbicides can be great energy savers. The use of herbicides ensures that there is minimum disturbance to the soil. For contact herbicide, there is no risk of building up chemicals with residual effect in the soil.

The success of chemical control is very much dependent on application at the correct stage of weed growth. For example, a pre-emergent herbicide must be applied to weed-free soil, and weeds which grow later should be controlled on a regular basis by the use of a contact herbicide, pulling by hand or mechanical removal. Do not disturb the soil surface when using pre-emergent herbicides, particularly when they are not easily leached (e.g. Oxadiazon and Oxyfluorfen).

It is now established in many areas that there is considerable benefit from an annual application of a persistent herbicide. This largely prevents growth of weed from seed. However, there is no herbicide at present available which will control all weed species. The use of persistent herbicide does not give complete absence of weeds until the next application. Weeds which reappear must be dealt with in other ways. If this regrowth of weeds is not kept under control, the weed species which are unaffected by the persistent herbicide will take advantage of the lack of competition and cover the ground.

Weeds which appear after the application of persistent herbicide must be killed when they are small. This can be done in either of two ways: by hand weeding or by killing them with a contact or translocated herbicide. Presently, the persistent herbicide is less used in tea as new and more effective translocated herbicide

comes on the market. When control measures are due, the choice of method will depend upon the conditions prevailing at the time. Tea roots will be damaged, reducing the nutrient uptake of the bushes and making points where Armillaria or any other disease can enter.

Recommended Herbicides

The commonly used herbicides, their mode of action and other pertinent points are given below for easy reference.

Gramoxone (Paraquat)

- Gramoxone is a contact herbicide which kills all green vegetation to which it is applied.
- It leaves no soil residues and may therefore be used as frequently as required.
- Act on soft broad-leaf weeds.
- Used to suppress the weeds, but encourage growth of perennials therefore be alternated with another contact herbicide like Reglone.
- Gramoxone is highly toxic.
- Keep the spray off the green parts of crop plants
- Follow all safety precautions listed on the label.
- The use of clean water is essential for good results.

The recommended rate of Gramoxone depend on the following:

Types of weed growing in the field and weather conditions of the place. Example rainy days will dilute the herbicide, therefore use high dosage is recommended while on dry season use low dosage.

Recommended rate of Gramoxone is 1.5-3.0 litres per hectare, while mixing ratios are 1:300 to 1:400 i.e. 1 litre of Gramoxone to 300 litres of water as blanket spray, or 0.75L in 300L of water as spot spray.

Roundup (Glyphosate or Dalapon)

- Roundup is a non selective translocated herbicide with no residual soil activity.
- It is particularly useful for controlling tough perennial weed species that may have escaped other herbicide treatments.
- Roundup acts slowly but very effective, it kills nearly all weeds commonly found in tea except *Borreria princea* (Button weed is resistant to roundup therefore it has to be uprooted manually) provided application is done when growth is active.
- It requires 6 hours without precipitation to be rain fast.
- The use of rainwater is essential for good results.
- It is very expensive.

- Application can be by spray or by hand held 'weed-wiper', as complete foliar contact is not necessary because of its systemic action.
- Avoid contact with leaves and young branches. Best results will be obtained when roundup is used on its own in low volume, high concentration applications.
- However 2.5 kg of Sulphate of Ammonia in 100 litres of water can be added to improve control of weeds with a waxy leaf surface.

Ways to reduce the cost of roundup

There are 5 ways to reduce the cost of Roundup

- Roundup to be used during peak cropping season and when weeds are in active growth phase.
- Using a low volume nozzle which break the droplets into small size to increase the ability of herbicide to reach the weeds and kill them.
- Use of surfactants e.g. Agridex to reduce rain fastness, to extend contact periods and to reduce drift and evaporation. 0.5% of surfactant is recommended in a total spray volume.
- Roundup should be used in rotation with Gramoxone because Gramoxone is slightly cheaper than Roundup and tend to suppress broad-leaf weeds.
- Use of Contarolled Droplet Application (CDA) which is a motorized equipment, hence atomizer break the droplet size into 250 microns. Therefore 0.5L of roundup in 10 litres of water control weeds in a hectare.

Recommended rate

For annual weed is 2l/ha while for Perennial weeds 3l/ha when using low volume nozzle (1:500 is equivalent to 2L of roundup in 400L of water).

Fusilade

- Fusilade is a post-emergence herbicide which is translocated systematically downwards through the foliage to the weed roots.
- It controls all grasses and Fusilade affects no broadleaf plant, other than star bur, so contact with tea is not a problem.
- Fusilade is rain fast within 1-2 hours.
- It may not be compatible with other chemicals and should therefore be used on its own.

Dual and Gardomil

- These are soil acting pre emergent herbicides which must be applied in weed free soil. Application should be to moist soil followed by irrigation or rain within 7-10 days to take the residual herbicide into the soil.
- They have quite good activity on small weeds that have recently germinated.
- They are very safe on tea at the recommended rates even when applied to the foliage.

Ronstar and Goal

- They are soil acting pre-emergent herbicides with some contact actions on young weeds.
- As they do not leach into the soil, they are very safe on sandy soils.
- They give good control of most broad-leaved weeds but not of blackjacks (*Bidens pilosa*) and Mexican marigold (*Tagetes minuta*).
- They have some post emergent activity and can be applied up to the two and three leaf stage. Do not apply to foliage of young tea plants.

Metribuzin

- This is a pre emergent herbicide with some contact action on young weeds.
- Metribuzin has a good residual action on a wide spectrum of broadleaved weeds and some annual grasses.
- Apply just after transplanting.
- Requires rain or irrigation for activation.

Dowpon

- This is a translocated herbicide and is specific for the control of grasses and in particular perennials such as couch (*Cynodon dactylon*), Star grass (*e.nlemfuensis*) and other related species, Kikuyu (*Penisetum elandestinum*) and spear grass (*Imperata cylindrical*).
- It is only effective when the grass is growing.
- Good wetting is essential so the addition of a wetting agent is recommended.
- One application of Dowpon will not give complete control of perennial grasses and a further application should be made to regrowth.
- Dowpon is often followed by Gramoxone 10-14 days later.
- Dowpon is not recommended in tea under 4 years old.

MSMA

- MSMA, a contact herbicide, can be used for control of grasses.
- Usually a double application is necessary and the best results are obtained when application is done in hot sunny conditions.
- There is no soil persistence and it requires between 12 to 24 hours before it is rain fast.

Weed control for specific situations

Perennial grasses (e.g. Couch, kikuyu, and paspalam spp)

These plants should be eradicated before planting by the use of mechanical methods. At the end of rainy season, when little moisture is left in the soil, mow and burn the grass; deep ploughing should follow within two days of burning operation. This can be followed by addition cultivation, trying to kill the grass by desiccation. As temperatures start to rise in spring, a recommended herbicide can be used on any regrowth.

Chemical control alone can be effective but is costly if not properly managed. The recommended alternatives are:

-Roundup should be applied at 3-6l/ha (for Kikuyu 2-4 l/ha), if wetter is added reduce rates (see label).

-Fusilade at rates depending on weed control species (See label).

-Down pon at 5.5 kg/ha on vigorous growing grass in sufficient water to wet the foliar completely without runoff. Repeat this dosage when grass start to regrow. Following this treatment, spot spray of any other regrowth with 1 kg of Dowpon product in 100 litres of water will improve control. The addition of a wetter is advised. The second addition of application of Dowpon can be replaced by 1.5l/ha of Gramoxone 10-14 days after the initial application of Dowpon.

Whichever of the above programme is used, it must be repeated, normally as spot spraying, as required. Dowpon is not recommended for use in tea lands after planting. If there is a dense stand of these grasses, therefore, the grower is advised to use roundup, but odd, small patches can be treated with Dowpon, preferably with the follow-up of Paraquat as mentioned above which reduces the total amount of Dowpon applied.

Nasongole or Speargrass (*Imperata cylindrical*)

Roundup at 6.0l/ha followed by spot spraying has proved to be successful. Details of its application should be discussed with the local representative.

Nutsedges (*Cyperus spp*)

The two nutsedge which infest tea are yellow nutsedge (*Cyperus esculentus*) and purple nutsedge (*Cyperus rotundus*). Yellow nutsedge can be controlled by application of Dual as recommended on the label but it should be noted that the herbicide must be applied before the nutsedge emerges. Post emergent control of yellow nutsedge can be achieved by using Round up at 4-6 l/ha.

Purple nutsedge is a more serious weed problem and is now appearing in some tea plantations. Dual does not control it. It can be controlled by sequential use of Roundup at 4-6 l/ha, alternated with tank- mixes of Gramoxone and wetting agent with a suitable residual herbicide, but on dense stands this will be extremely expensive. However eradication of purple nutsedge is economically feasible when population is low. Early identification is therefore vital.

Annual grasses and Broadleaved weeds

Mulching is recommended to control majority of weed in the first 3 years.

Residual herbicide e.g. Ronstar can be used in newly transplanted areas. Gramoxone must be used with care during the first 3 years because of its detrimental effect on young green stem. Hand pulling, light cultivation or herbicide can be incorporated into the weed control programme during this period. After the third season the tea has canopied and a hard wood branching framework has been formed, weed control is usually based on Gramoxone, Round up and hand pulling. Alternatively, a residual herbicide not possessing foliar activity, e.g.

Ronstar, Goal, Dual or Gardomil mixed with Gramoxone (a contact herbicide) may be used. The rates of these herbicides should be adjusted according to the weed spectrum and soil type.

Weed free areas

Mulch can be applied to weed free areas, preferably after applying a suitable residual herbicide. Alternatively, pre emergent herbicides may be used to maintain the area weed free, such as Ronstar, Goal, Dual and Gardomil, or mixtures of these herbicides at rates suitable for the soil type or potential weed spectrum.

Vacancies

Planting with Guatemala grass for 1 to 3 years should rehabilitate these areas. This will help to keep weeds under control, protect the soil from erosion and improve the soil for infilling.

Verges, Contour ridges and waterways

Regular slashing or mowing to prevent seeding and the use of contact herbicide to prevent weeds encroaching on the tea land is integral part of a weed control programme. Gramoxone and Roundup can be very effective here, but avoid using a soil active herbicide on Canal verges, from where it may be transferred through an irrigation system onto the crop zone with possible harmful effects.

Weed Identification

Weed identification booklets are available and growers are advised to make use of these. Correct weed identification will greatly assist in the choice of herbicides.

PREVENTION OF HERBICIDE POISONING

Chapter

5

Introduction

All herbicides are potentially poisonous to human, animals and the environment. The word potential is emphasized, because by and large if a fairly straight forward set of precautions are followed at all stages in their use, the chances of poisoning may be reduced to a minimum.

Precaution

It is imperative to make sure that all persons who have any herbicide responsibilities are fully conversant with the precautions that must be taken at all times and the danger of pesticide misuse.

In the stores

- Keep insecticides, acaricides, fungicides and herbicides well apart in the stores.
- Locate stores far away from water supplies and food stores.
- Always keep stores dry and locked and never allow access to children and irresponsible persons.
- Herbicides must be stored in their original containers. If other containers are used make sure they are properly labeled.
- Never decant herbicide into soft drink or beer bottles, or into containers that are associated with food.
- Pesticides should not be stored for periods longer than their shelf life (expiry date).
- In case of spillage, use soil or ash to soak up spilled liquids and burry the contaminated soil in a deep hole away from water supplies. Wash down any surfaces and equipment and always wear protective clothing during the clean up process.
- Never re-use herbicide containers for other products, in particular food and/or soft drink.
- Dispose off containers in a deep hole away from streams and water supplies and making sure they are all damaged to avoid the chance of the container being recycled in the market. Plastic containers should be destroyed and burnt.

The store should be:

- Secure-with access only by those responsible, e.g, store keeper.
- Tidy.

- Dry.
- Sufficiently ventilated.
- Adequately illuminated.
- Of adequate size.
- Situated away from any foodstuffs or water supply.
- Provided with protective clothing for personnel issuing concentrates i.e., goggles, gloves, face mask, apron.
- Close to washing facilities.
- Provided with washing materials (i.e., soap, towel, etc).
- Within reach of nearest fire extinguisher equipment.
- Labeled as 'chemical store' on or near the exterior part of the door

The chemicals should be:

- Carefully recorded in standard bin cards.
- Stored in well marked separate section.
- Stored as recommended on the label.
- Stored only in the quantities needed.
- Kept in original containers which are undamaged -not transferred to unlabeled containers.
- Returned to stores department or written off if slow moving.
- Immediately mopped up if spilled. Materials used for mopping should be disposed of by incineration or deep buried in the soil.

Before application

- Identify the weed and/or damage correctly.
- Only use a herbicide if it is essential.
- Seek advice on the proper method of control. If several pesticides are recommended, choose the least toxic to mammals, if possible the least persistent.
- Take only sufficient herbicides for the days' application from the store to the site of application. Do not transfer herbicides into other containers, especially beer and soft drink bottles and also all concerned with application must understand the recommendations and be fully trained on how to apply herbicide.
- Read the label and follow the instruction to the letter. A label contains all the information necessary for effective and safe use of pesticide. Understand well the instruction before starting to use the herbicide.
- Select your spraying equipment and see that it is in good working order.
- Calibrate your sprayer using clean water.
- Make sure you have appropriate protective clothing.
- Warn neighbours of your spray programme, especially if they have apiaries.

At the time of measuring and mixing

- Make sure measuring instructions are fully understood.
- Wear protective clothing and do not measure or mix herbicides in a confined space.
- Keep a container of clean water, towel and soap for washing in case of herbicide spillage.
- Use a suitable container (glass cylinder, cups, glass syringe etc) to accurately measure the right amount of herbicide. Avoid spillage of pesticides on operator's skin. Wash immediately if this occurs.
- Never deep your arms or hands into liquid while mixing, or using your hand as a scoop, but if it is necessary wear plastic gloves.
- Do not mix or pre-dilute more than is required.
- Spray tank should be partly filled with water before the concentrate or the pre-diluted mixture is added and the tank should be filled carefully. Shake well to mix thoroughly.
- Keep the containers of concentrates closed when not in use.
- Never leave herbicide un attended.
- After use, wash thoroughly the measuring cups, syringes and other containers with plenty of soapy water.
- Do not contaminate waterways, dams and streams while washing.
- If it is necessary to take concentrates to the field, transport with care and make sure all containers are clearly marked.
- Make sure herbicides are mixed in the correct quantities
- Avoid inhalation of chemicals, dust or fumes.
- Follow the recommended liquid formulations on the label.

During application

- Make sure operators have been trained properly, are well supervised and safety precautions observed.
- Insist in the use of protective clothing and programme to spray during cooler hours of the day as protective clothing can be very uncomfortable in hot weather.
- Have clean water, towel and soap available for washing.
- Keep a container for drinking water clearly marked **DRINKING WATER ONLY** in a safe place and away from herbicide.
- Never allow children or pregnant women to apply or be exposed to herbicides.
- Do not allow smoking, eating or drinking while spraying and make sure all operators wash their hands and faces before drinking, eating or smoking.
- Always spray down wind and avoid drift onto yourself, other people and the crop being protected.
- Never clean a blocked nozzle by sucking or blowing with your mouth.
- Avoid contamination of waterways, other crops, buildings etc while spraying

- Operators should have regular medicinal check-ups when carbamate or organophosphate herbicides are being used continuously.

After application

- Wash spraying equipment thoroughly with plenty of soapy water.
- After spraying immediately return chemicals and other equipments to the store.
- Operators should wash themselves, as well as all their protective clothing, thoroughly after spraying.
- Avoid working in freshly treated areas for at least 24 hours.

The degree of protection that should be given by the use of protective clothing will be related to the potential toxicity and formulation of the pesticide being used.

Read the label carefully and use the recommended protective clothing.

To adequately protect the spray men from all pesticides, the following protective clothing should be kept on stock.

- Rubber gloves.
- Rubber boots.
- Long sleeved overall which must be worn outside boots and gloves.
- Face shield or mask.
- Apron and plucking cap which also facilitates walking through tea and protect the spray man from contamination.
- Breather or respirator or a double layer of clean cloth.



Plate 4: A spray man with full set of protective gears

Always make sure that the protective gear is in good condition. Worn out protective clothing gives little or no protection at all.

REFERENCES

TEA PLANTERS HANDBOOK

Tea research foundation of Kenya
4th Edition

TEA

CULTIVATION TO CONSUPTION

Edited by K.C.Willson and M.N.Clifford
First Edition 1992

TEA RESEARCH FOUNDATION OF CENTRAL AFRICA

Edited by W.J.Grice
April 1990

PRACTICALS

1. Weed Identification.
2. Cleaning and storage of sprayers.
3. Storage of herbicides
4. Measuring and mixing herbicides.
5. Different kinds of protective gears and their use.
6. Preparing the sprayer before use.
7. Herbicide application by using sprayers.

WEED CONTROL IN TEA BUSHES

DATE

VENUE

DURATION: 2 DAYS.

COURSE TITLE: Weed control in Tea bushes.

COURSE OBJECTIVES

At the end of the session participants will be able to:

- Understand the meaning, characteristics & economic importance of weeds.
- Identify kinds of weeds found in their tea fields and suitable methods of control.
- Understand prevention of herbicide poisoning.

TARGET GROUP

Managers, Assistant managers, supervisors and farmers.

NUMBER OF PARTICIPANTS

Approximately 20 per each training session.

COURSE DELIVERY

1 ½ days will be spend on indoors workshop while ½ day spend on practical session. The course will emphasize learning by doing i.e. most of the concepts and methods will be communicated through practical exercise based on field visit.

COURSE METHODOLOGY

Participatory approach will be used. Trainers will encourage trainees to participate in different ways like plenary sessions, group discussion, cards etc. The approach is not a type of open ended quiz game with the tutor as the sole member of the panel, rather all course participants are expected to contribute towards a solution.

TRAINING MATERIALS

WHO	MATERIALS
For each trainee	Pen, Pencil, Rubber, Ruler, My clear bag, Calculator, Notebook
For trainers	Flipchart (3 rolls), Flipchart stand (1), Transparencies (1 box), Overhead projector (1), Marker pens (3 boxes), Masking tapes (3), PowerPoint machine (1)
For practicals	Aprons (10), Un weeded tea field (1), Sacks (10), Sprayers (10), Rubber gloves (10), Rubber boots (10), Long sleeved overall (10), Measuring container (2), Face shield/Mask (10), Herbicides

TIMETABLE

TIME	DAY 1	DAY 2
8:00-8:30	INTRODUCTION	RECAP
8:30-9:00	PROGRAMME&METHODOLOGY	FIELD WORK
9:00-10:00	EXPECTATION & FEARS	FIELD WORK
10:00-10:30	TEA BREAK	TEA BREAK
10:30-11:30	DEFINITION OF TERMS	FIELD WORK
11:30-12:30	INTRODUCTION (WEEDS)	FIELD WORK
12:30-1:30	LUNCH	LUNCH
1:30-2:30	WEED CONTROL	EXERCISE
2:30-3:30	WEED CONTROL IN TEA	ACTION PLAN
3:30-4:30	PREVENTION OF HERB POISONING	EVALUATION
4:30-5:00		CLOSING

SESSION PLAN

SESSION 1

WHAT	WHY	HOW
Introduction	To know each other	Pair wise introduction
Course Programme & Methodology	Trainees to understand the programme and methodology to be used	Plenary
Expectation & Fears	Participants to construct their expectation & fears to help trainers to concentrate on topics mostly needed	Cards
Definition of terms	To have a common understanding of terms used in weeding	Plenary, Buzz groups
Introduction (Weeds)	Trainees to understand weeds, their characteristics & importance	Plenary, Question & Answers, Group work
Weed control	Trainees to know different methods of weed control and their conditions	Plenary, Question & Answers, Group work
Weed control in Tea	Trainees to know different ways of weed control used in tea bushes	Plenary, Question & Answers, Group work
Prevention of herbicide poisoning	Trainees to have a basic knowledge on the use, handling and storage of herbicides	Plenary, Question & Answers, Group work

SESSION 2

WHAT	WHY	HOW
Recap	Revision	Each trainee
Field work	Trainees to learn by doing	Everyone to learn by doing
Exercise	One way of course evaluation i.e. if trainees understood the theme	Group
Action plan	Trainees to construct their action plan which will be followed up	Each trainee/Group
Course evaluation	Trainees to evaluate the course for the trainers to improve on their future training	Each trainee/Group

EXERCISE

A. Circle the correct answer

- 1) A weed is
 - a) Any plant which is not edible
 - b) A plant which grows where is not needed
 - c) Both a and b are true
 - d) None of the above

- 2) The frequency of weed control on tea bushes depend on all named factors except
 - a) Weather condition
 - b) Soil condition
 - c) Age of tea plant
 - d) Terrain

B. Write T for True statements and F for False statements

- Biological weed control involves pulling by hand weeds that are close to the tea plants._____
- Manual weeding tends to be less expensive because wages and overheads are low than the cost of herbicides._____
- One advantage of chemical weed control is, it does not interfere or damage the roots of tea plants._____
- Care must be exercised not to use herbicides in the first year of establishment._____
- Translocated herbicides are taken into the plant in 2 ways which are ACROPETALLY and BASIPETALLY._____
- Roundup is a non selective contact herbicide with no residual soil activity._____
- Neither in mature tea nor in young tea weeds should be controlled before they flower and set seeds._____
- Gramoxone acts on soft broad leaf weeds and is highly toxic._____

C. Fill in the space given

Define

3) Translocated herbicide

.....
.....

4) Post emergent treatment

.....
.....

5) Spot treatment

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.....

6) Residual/Persistent herbicide

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.....

7) Mention 5 characteristic of weeds

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8) Differentiate between monocots and dicots weed

	Monocots	Dicots

D. Answer in a given piece of paper

- 9) Mention botanical name or common name or tribal name of weeds found in your area and recommend suitable control method?
- 10) What steps will you take to control weeds in mature tea?
- 11) Mention 5 points on how the herbicide store should look like?
- 12) What are the weaknesses of your current weed control system?

ACTION PLAN

Name:..... Organisation.....

Title.....

ACTION	EXPECTED RESULTS	COLLABORATORS	BY WHEN

Trainees should fill in 2 copies of their Action plans in groups or individually. One copy will be returned to the trainer while the other will help him / her in implementation.

COURSE EVALUATION

Your frank assessment is needed in order to improve future training.

Please circle:

1-Very Good

2-Good

3-Average

4-Bad

5-Very bad

1) Course objectives were:

1. Very relevant
2. Relevant in parts only
3. Not quite sure
4. Not at all relevant

2) Did the training course meets its objectives?

1. Yes
2. Yes in some but not all
3. Not quite sure
4. Not at all

3) Did the trainers meet your expectations?

1. Yes
2. Yes in some but not all
3. Not quite sure
4. Not at all

4) Level of understanding

	Rank				
*****	*****				
Definition of terms	1	2	3	4	5
Introduction (Weeds)	1	2	3	4	5
Weed control	1	2	3	4	5
Weed control in Tea	1	2	3	4	5
Prevention of herbicide poisoning	1	2	3	4	5
*****	*****				

5) Aspects of the programme

	Rank				
Plenary	1	2	3	4	5
Buzz groups	1	2	3	4	5
Group Discussions	1	2	3	4	5
Training Aids	1	2	3	4	5
Handout materials	1	2	3	4	5

Please tick:

6) What is your view on the subjects/Topics discussed?

Too advance Too elementary

7) What was your feeling about the pace of the course?

Too fast Too slow

8) What are your views on the volume of trainers' voice?

Very clear Not clear

9) Were there any subject which

You felt it could have been omitted, if so which?

.....

You felt could have been included

.....

10) Do you have any comments/suggestions for future improvements?

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