COURSE CODE:	**PCP 506**
COURSE TITLE:	**Weed Science and Control**
NUMBER OF UNITS:	**3 Units**
COURSE DURATION:	**Three hours per week**

COURSE DETAILS:

Course Coordinator:	**Dr. Adeyemi, Olusegun Raphael**
Email:	**segunadeyemi3@yahoo.co.uk**
Office Location:	**Room 147, COLPLANT**
Other Lecturers:	**Prof. Lagoke, S. T. O., Prof. Adigun J. A. and Dr. (Mrs) Olorunmaiye, P. M.**

COURSE CONTENT:

Weed definition, classification, and economic importance.Weed biology: reproduction, mechanism of weed seed dissemination, prolificity, survivability, persistence and colonisation. Seed viability, dormancy. Germination, adaptability to environment growth and feeding habits. Parasitic weeds.
Weed management: prevention, eradication and control. Methods of weed control: cultural, chemical, biological and integrated. Herbicides: classification, formulation, methods of application, dosage calculation, application equipment and their calibration for uniform and adequate delivery of herbicides, herbicide handling and disposal, assessment of herbicide performance. Weed control in crop and non-crop situations, cereals, legumes, vegetables, fibrers, root and tuber crops, landscape, road-side, estate, aquatic environment etc.
Practical : weed predictive index determination: weed seed types and population in soil bank, collection, classification and identification of weed types. Herbicide application, weed seed germination and weed control experiments. Calibration of sprayers ,classification of herbicides. Field application of herbicides. Movement of herbicides in soil.

COURSE REQUIREMENTS:

This is a compulsory course for all student in the College of Plant Science and Crop Production. In view of this, students are expected to participate in all the Course activities and practicals. A minimum attendance of 75% is required to be able to write the final examination.

READING LIST:

Akobudun I.O (1987) Weed Science in the Tropics. Principles and Practices. A Wiley-Interscience Publications. John Wiley & Sons. 521pp.

Akobudun I.O and Agyakwa C.W (1987). A Handbook of West African Weeds. International Institute of Tropical Agriculture. 521pp

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Labrada, R. Caseley, J.C and Parkey C. (1994). Weed Management for Development Countries. FAO Plant Production and Production. Paper 120

NACWC (1994): Weed Control Reccommendations for Nigeria Series No 3, Prepared by National Advisory Committee on Weed Control (NACWC). 111pp.

Stephens, R.S. (1982). Theory and Practice of Weed Control. Published in Collaboration with Royal Horticultural Society and the Horticultural Education Association 215pp (1994)

Steven R.R and Jodie S.H (1984). Weed Ecology: Implication for Vegetation Management A Publication. John Wiley and Sons. 265pp

LECTURE NOTES

Definition of Weeds

- **The definition of weed is predicated on human perception , desire and needs.**
- ***A weed is a plant which interferes with human activity or welfare.***
- ***It is also defined as plant growing in a place where it is not desired at a particular point in time.***

Origin and Evolution of weeds

- *In a stable (climax) vegetation, all plant species are equally naturally adapted.*

Weeds evolved (i) when the stable environment is disturbed through human activities.
*(ii) from e*cotypes that have evolved from wild colonizers in response to continuous habitat disturbances and selection pressures.
(iii) as a result of the products of hybridization between wild domestic races of crop plants.
Effects of Cropping Practices on biodiversity

Practices that Increase Biodiversity:

- Intercropping
- Crop Rotation
- Cover cropping
- Strip cropping

Practices that Decrease Biodiversity:

- Monocropping
- Tillage
- Herbicides use

Biodiversity leads to more stability for the ecosystem as a whole.

Characteristics of Weeds

- Harmful to humans, animal and crops
- Wild and Rank growth in an environment

- Exhibits persistency and resistant to eradication
- High reproductive capacity: large number of seeds, possess different types of propagules e.g. Seeds, tubers , rhizomes,stolons
- Seed Dormancy: could be innate, induced or enforced.
- Usually present in large populations..
- Could be regarded as being useless, unwanted and undesirable
- They exhibit spontaneous growth without being sown
- Some exhibit mimicry. (seed, vegetative and biochemical)
- Many weeds are aggressive and have rapid seedling growth

Economic Importance of Weeds
Detrimental effects:

- *Reduction in crop yield through:*

Physical Interaction (Allelospoly: competition for growth resources including water, light, nutrient, air, space.

Chemical interaction (Allelopathy)

- *Reduction in crop quality through*

- direct contamination of cultivated crops e.g rice and maize grain are contaminated by wild rice
(*Oryza longistaminata*) and itchgrass (*Rottboellia cochinchinensis*) respectively.;
- contamination of forage, silage or pasture crop .by *Cyperus. rotundus* seeds ,
- reduction in Sugarcane juice quality by the presence of *Imperata cylindrica*.
- Contamination of cotton lint by dried weed fragments
- Damage of underground tuber of yam and cassava through piercing of Spear grass rhizomes

- Interference with field operations (harvest,pesticide application,etc.)
- *Some are poisonous to grazing animals* e.g.*Amaranthus spinosus* contains high level of nitrate and *Halogeton glomeratus* contain high oxalate content, it can kill livestock when eaten in dry season.
- Some are harmful to grazing animals e.g. *Amaranthus spinosus, Acanthospermum hispidus*
- increase cost of production; high cost of labour and equipment during harvesting.
- Presence of weeds can impede water flow in irrigation canals
- Weeds present in lakes and reservoirs can increase loss of water by evapotranspiration
- Reduction in quality of pasture land; it reduces the carrying capacity of grazing lands and pastures through their physical presence and weediness
- Reduction in quality of animal products; it affects the palatability of pastures, hay, silage etc. protein content in alfalfa wild garlic (Alliums spp) when eaten by cattle spoils the meat and the milk.
- Serve as alternate hosts for many plant diseases and animal pests e.g. insects, rodents, birds. *Cyperus rotundus* serve as alternate to nematodes and athropods
- Impose limitation to the farm size of a farmer

- Can serve as sources of fire hazards

Beneficial Effects :

- Reduce erosion problem through the production of protective cover
- Help in nutrient recycling through decay of vegetative part.
- Food/vegetables for humans e.g. leaves of *Talinum triangulare,* and tubers of *Colocasia esculentus* .
- Serve as hosts and nectar for beneficial insects
- Beautification of the landscape e.g. *Cynodon dactylon*
- Feed for livestock and wildlife and aquatic organisms in form of hay, silage and forage / pasture, fruit seeds and branches and whole plant.
- source of pesticides e.g. *Chrysanthemum cinerariifolium*
- Source of genetic material for useful traits in crop improvement.
- Medicinal use e.g neem (*Azadirachta indica), Ageratum conyzoides*
- Some serve as trap crop for parasitic weeds.
- Habitat for wildlife and plant species hence biodiversity conservation.
- Major role in carbon recycling through carbon sequestration. Field of exposed soil always suffers a net loss in organic matter and releases carbon dioxide, while a field covered with crops and/or weeds takes up carbon dioxide. This concept of carbon sequestration is an added advantage of sustainable and organic farming.

Classification of Weeds

Weeds can be classified based on

(1) **Life cycle or history (Ontogeny) : Annual, Ephemeral, Perennial and Biennials weeds**

(2) **Habitat**: (a) *Upland (terrestial*) weeds or dry land weeds (**Agrestal /**Weeds of arable or cultivated crops, and **Ruderal weeds** /weeds of disturbed non- cropped area such as rubbish heaps, landfills, paths, roads, compost heaps

(b) ***Aquatic weeds*** (**Submerged aquatic, Floating aquatic, Emergent aquatic weeds**

(3) **Growth habit**: Free living (autotrophic) weeds

ii Parasitic plants(*Root parasitic weed*s or *obligate parasite, Stem parasitic weeds , Hemi parasitic weeds, Total parasites*

(4) **Degree of undesirability**: ease and difficuly in controlling weeds.

(5) **Morphology** : a.Form e.g. Woody Stem e.g *Azadirachta indica,*

ii. Semi Woody weeds- e.g *Chromolaena odorata, Sida acuta.*

Iii Herbaceous weeds*: e.g Ageratum conyzoides, Talinum triangulare,*

b. Leaf Type : narrow leaf: grass like(ii) Broad leaf weeds (Dicotyledons):, Sedges; e.g. *Cyperus rotundus, C. esculentus, Mariscus alternifolius*

(6) **Scientific classification (Binomial nomenclature):** based on their taxonomy (family,, genera and specific epithet)

(7) **Ecological affinities** : dryland weeds, gardenland weeds and wetland weeds

(8) **Origin:** native or introduced.

Weed Ecology

- **Ecology** is the study of the relationship of plants and animals to their physical and biological environment. Physical environment like light, heat solar radiation, moisture, wind, oxygen, carbon dioxide, nutrient soil, water and atmosphere. Biological environment includes organism of the same kind as well as other plants and animals

- **Weed ecology** is generally about the growth characteristics (ii) adaptation (iii) survival mechanism of weed that enables them to exploit environmental resources and successfully colonize new habitat often at the expense of other neighboring plants

- **A habitat** is a dwelling place or a kind of environment occupied by the individuals of a species. Habitat may imply places like rubbish dump, farm land or other sites occupied by weeds.

- **Niche**: it is the condition in a location under which a species can live successfully. Within the habitat, organisms occupy different niches. A niche is the functional role of a species in a community—that is, its occupation, or how it earns its living. For example, the scarlet tanager lives in a deciduous forest habitat. Its niche, in part, is gleaning insects from the canopy foliage. The more a community is stratified, the more finely the habitat is divided into additional niches

WEED-CROP ECOSYSTEM

Ecosystem is the energy driven complex system in which the living organisms interact with themselves and the environment.

Weed- crop ecosystem involves weed-crop interaction as well as the nature and the function of that ecosystem. This will assist in understanding the impact of crop production and husbandry on the shifts in weed flora, for instance the persistent of weed in given weed- crop ecosystem.

Persistence and survival mechanism of weeds

Weed persistence is a measure of the adaptive potential of weeds that enables them to survive in disturbed environment such as i. Crop land ii. Recreational site iii. Irrigation canal and iv. Pastures

- **Survival mechanisms or adaptive features of annual weeds** include: i. Production of large quantities of seeds ii. Seed dormancy and iii. Periodicity of seed germination and short life span.

- **Survival mechanisms of perennial weeds** include: i. Deep rooting ii. Dormancy iii. characteristics of buds on rhizome iv. Other modified stems and v. Fragmentation of parts

Types of perennating and vegetative structures in perennial weeds:

1. Rhizome – underground, horizontal stem (quackgrass, swamp smartweed)
2. Stolon – aboveground, horizontal stem (bermudagrass)
3. Tuber – swollen stem tissue (yellow nutsedge)
4. Bulb – stem with shortened internodes and fleshy modified leaves (wild garlic)
5. offset
6. bulbils
7. corm
8. runners
9. suckers

Storage organs may act as 'perennating organs‘ These are used by plants to survive adverse periods in the plant's life-cycle (e.g.conditons caused by cold, excessive heat, lack of light or drought). During these periods, parts of the plant die and then when conditions become favourable again, re-growth occurs from buds in the perennating organs. For example geophytes growing in woodland under deciduous trees back to underground storage organs during summer when tree leaf cover restricts light and water is less available.

Crop mimicry

Crop mimicry is an example of the extent to which weeds have adapted themselves to survive in that frequently disturbed site.

Crop mimicry is defined as the phenomenon whereby weeds develop morphological and biochemical close resemblance to some phases in the life history of a crop as to be mistaken for the crop and thus evade eradication

Types of crop mimicry

*Vegetative mimicry:*A situation where close similarity in appearance occurs between weeds and crops at seedling and vegetative stages .e.g. wild rice (O*ryza longistaminata)* in cultivated rice ; wild sorghum (*Sorghum halepense)* in cultivated sorghum, wild sugarcane (*Saccharum spontaneum)* in sugarcane.

*Seed mimicry:*This is a situation whereby the similarities between weeds and crops is observed in seed, weight, size and appearance. e.g. similarity in seed size between seeds of upland rice and those of itch grass (*Rottboellia cochinchinensis).*
*Biochemical mimicry:*This is a situation in which a weed develops resistance to a herbicide that has been used previously for selective control in a given crop.

Factors affecting weed persistence

- Weed persistence can be affected by:
- Climate e.g light, temperature, water, and wind
- Soil (edaphic)
- Biotic factors e.g. plants and animals

WEED-CROP INTERACTION

- When plants grow close to each other, they interact in various in ways.

- ***Interference:*** It is the detrimental effects of one species on another resulting from their interactions with each other. When plants are far apart they have no effect on each other. Interaction generally involves competition and amensalism**.**

- ***Commensalism:*** This is the relationship between unrelated organism (different species) in which one derives food or benefit from the association while the other remains unaffected.

Competition (**allelospoly)**: It is the relationship between two plants (weed/crop, crop/crop, weed/weed) in which the supply of a growth factor falls below their combined demand for normal growth and development. The growth factor competed for include water, nutrients, light, space and air/gasses (oxygen, carbon dioxide

Types of competition

- Above-ground (Aerial) competition : Takes place in the leaves and the growth factors involve are light and carbon dioxide.

- Below-ground(Subterranean) competition: Takes place mainly in the roots while the growth factors involve are water, nutrients and oxygen.

The perceived consequence of competition with crop is reduction in the economic yield of affected crop plants.

Forms of competition:
Intraspecific competition: competition for growth factors among individuals of a plant species
Interspecific competition: competition for growth factors between two different plant species i.e crop/weed, weed/weed,or crop/crop

Critical Period of Weed competition/interference:
This is the minimum period of time during which the crop must be free of weeds in order to prevent loss in yield .
it represents the overlap of two separate components (a) the length of time weeds can remain in a crop before interference begins
(b) the length of time that weed emergence must be prevented so that subsequent weed growth does not reduce crop yield.

Factors affecting weed-crop competition
Weed factors

- Competitiveness of weed species

- Weed density and weight
- Onset and duration of weed-crop association
- Growth factors

Crop factors

- Type of crop and seeding rate
- Spatial arrangement of crops
- Plant architecture
- Growth factors availability
- Cropping patterns
- Crop type (C3 or C4 plants)
- Crop variety (tolerance, resistance, aggressiveness)

Environmental factors

- Climatic factors e.g. rainfall, temperature, wind, light etc
- Tillage
- Ground water management
- Soil (Edaphic)

Amensalism (**Allelopathy**)

Allelopathy is the production of chemical(s) or exudates by living and decaying plant species which interfere with the germination, growth or development of another plant species or microorganism sharing the same habitat.

There are two types of allelopathy:(***True and Functional***)

True allelopathy involves the release into the environment compounds that are toxic in the form they are produced. *Functional allelpathy* involves the release into the environment substances that are toxic as a result of transformation by microorganism.

Allelochemical complex commonly encountered in plants include:

coumaric acid, terpenoids, - syringic acid, butyric acid, flavonoids, phenolic compounds.

Examples of allelopathic plants:

1. Black walnut (*Juglans nigra*)
2. *Gmelina arborea*
3. *Sorghum bicolor*
4. Casuarina
5. *Lantana camara*
6. *Imperata cylindrica* is allelopathic on tomato, cucumber, maize rice, glnut, olera, cowpea, pepper.
7. *Cyperus esculentus*– is allelopathic on rice, maize
8. *C. rotundus* – is allelopathic on barley.

Parasitism

- ***Parasitism:*** It is a relationship between organisms in which one lives as a parasite in or on another organism.
- ***Parasitic* weeds** are plants that grow on living tissues of other plants and derive part or all of their food, water and mineral needs from the plant they grow on (host plants)

Hemi parasite (*Semi parasite*) is a plant which is only partially parasitic, possessing its own chlorophyll (green colour) and photosynthetic ability (may be facultative or obligate). E.g *Striga hermonthica*

Holo parasite – a plant which is totally parasitic, lacking chlorophyll thus unable to synthesize organic carbon. E.g *Orobanche spp*

Obligate parasite – a plant which cannot establish and develop without a host

Facultative parasite – a plant which can grow independently but which normally behaves as a parasite to obtain some of its nutrition.

- ***Predation***: It is the capture and consumption of organisms by other organisms to sustain life.
- **Mutualism**: It is an advantageous relationship between two organisms of different species that benefits both of them. It is obligatory and the partners are mutually dependent. Both partners are stimulated when the interaction is on. Example is the case between fungus and algae. The fungus protects the algae while the algae provide carbohydrate for the fungus.
- **Neutralism:** This is the situation where plant exerts no influence on one another.
- **Protocooperation:** This is a condition whereby two plants interact and affect each other reciprocally. Both organisms are stimulated by the association but unaffected by its absence.

Weed Biology

- Definition: Weed biology is the study of the science of physical life of weeds. It is also defined as the study of the establishment, growth and reproduction of weeds as well as environmental influences on these processes.
- Weed identification
- Periodicity of weed emergence
- Dormancy characteristics

Distribution of weeds

Global distribution of weeds divides weeds into three climatic regions as follows:

- Tropical weeds
- Sub-tropical weeds
- Temperate weeds.

Temperature is the most important factor of climate which governs the global distribution of weeds.

Local distribution of weeds

Factors affecting distribution of weeds:

- Land use
- Soil characteristics
- Cropping practices
- Frequency of weeding

Terrestrial weeds:

- are weeds that grow on land and consist of
- 69% are broadleaves, 23% grasses, 6% sedges and 2% ferns.

Aquatic weeds:

- are those that grow on water or are submerged in water.
- 60% account for grasses, 30% for broadleaves and 10% for ferns.

REPRODUCTION IN WEEDS

Four processes are involved in weed reproduction:

- Seed production
- Seed dissemination (Dispersal)
- Seed germination
- Vegetative propagation

Roles of seed in a weed's life cycle

- Survivability and adaptability to environment
- Perpetuation of species
- Dispersability
- Food Storage
- Protection during adverse conditions that are favourable for germination (dormancy)

Seed Rain

- This is a periodic weed seed supply whereby weed seeds are shed by mature weeds and added to the population of weed seeds in or on the soil.

Factors that affect the quantity of weed seeds in the seed rain include:

- Damage by animals
- Damage by adverse weather conditions

Fate of weed seeds shed on the soil

- Such seeds can move unto the soil profile :
  - Cracks and fissures in the soil
  - Cultivation
  - Harvesting of root and tuber crops
- Transportation by water.
- Such seeds can remain dormant for years and germinate during land preparation.
- May be killed by heat during burning or mulching
- May be killed by pre-emergence herbicide
- May germinate (if not-dormant) and seedling killed by adverse weather condition; herbicides (post and pre-emergence) mechanical and hoe weeding.

- The weeds seedlings that escape these actions and grow into maturity and produce mature seeds add to the seed rain.

Seed Bank

- This is the reservoir of seed in the soil . It consists of seeds produced on a given area plus weed seeds that have migrated to the area as a result of the actions of agents of seed dissemination/dispersal.

- Distribution of weed seeds in a soil profile is affected by: Tillage practices and action of natural forces

- Top 10cm of soil contains higher seed density than the lower soil depth.

SEED DISPERSAL (Dissemination)

- Weed seeds are dispersed in time and space

- Weed seeds dispersal in time means the capacity of many weed seeds to remain dormant for a period of time.

- Seed dispersal in space refers to the physical movement of seeds from one place to another

Dispersal in time

- weeds show periodicity in germination whereby the weed seeds have the tendency to have germination flushes at certain times in the growing season

- some weed species have one germination while others have more than one germination

- All weed species will show peak germination between March and June

- So most broadleaf weeds are predominate in the early season while grasses are more serious in the late (dry) season due to the low soil moisture, high soil temperature, land use patterns and cropping practices

Dispersal in Space

- The quantity of weed seeds falling on a unit area of land is affected by:

  (i) Height and distance of the source of seed
  (ii) The concentration at the seed source

- Dispersability of the seed (seed, size, presence of pappus), bouyancy in water and other morphological and anatomical features that may facilitate transportation to far distances.

Activities of the dispersing agents.

Agents of weed seed dispersal

Natural agents for weed seed dispersal are:

- Water - through surface run-off, drainage, streams and irrigation water.

- Wind e.g. seeds of Asteraceae family

- Animals - clinging to animal fur, feathers or eaten by animals or birds and passing out of their droppings without loss of viability

- Humans - clinging to clothing, as impurities in crop seeds and clinging to muddy tillage implement or harvesters.

- The farther the distance from the source (e.g. wind dispersed seeds) the lower the density of dispersed seeds.

Regardless of the agents of dispersal, distribution of seeds in space is uneven.

Seed Germination

- Germination is the resumption of vegetative growth by a seed resulting in theproduction of seedling.

Process of Germination:

- Inception of rapid metabolic activities within the seed.
- Appearance of radicle and its emergence.
- Radicle emergence is the evidence that germination has begun.
- The best indicator of seed germination is the emergence of plumule (broadleaf plants) or the coleoptiles (monocots).

STAGES OF SEED GERMINATION

- **Germination**- It involves water inbibition and all the biochemical and physiological processes that culminate in the emergence of radicle and plumule.
- **Underground Elongation**: Elongation of radicle and plumule takes place at the expense of food stored in the endosperm.
- **Emergence**- The aerial parts of the seedlings emerge above ground.
- Seedling emergence could be Hypogeal (Cotyledons remain below the soil surface), or Epigeal (Cotyledons are forced above ground by elongation of the epicotyl.
- **Independent growth**- Process starts with the onset of photosynthetic activity by the seedling plant.

SAFE SITE

- A site that provides favourable conditions for the weed seed to germinate is called a SAFE SITE. This site provides the following:
- Stimuli required for the breaking of dormancy
- Conditions required for the germination process to proceed.
- The resources (water, and oxygen) which are consumed in the course of germination etc.

Factors Affecting Weed Seed Germination

- **Temperature**: It is specific for a given non-dormant weed species.
- **Soil moisture**: Adequate moisture at the safe site.
- **Alternative wetting and drying of soil:** relates to the removal of inhibitory substances associated with seed dormancy e.g *Digitaria* and *Striga species* germinate better when subjected to such changes in soil moisture.
- **Depth of seed burial**: Tillage affects depth of weed seed burial. Seedlings of small seeded weeds (< 2mm) cannot germinate from soil depth > 5cm
- **Disturbance of the soil surface**
- **Aeration**

- **Light**:
- **Soil nutrient level**

Dormancy characteristics of weed seeds

- Dormancy is the situation whereby the viable seeds, spores or buds fail to germinate under conditions of moisture, temperature and oxygen favourable for vegetative growth.
- Seed dormancy is a survival mechanism.
- Buds of rhizomes, stolons and other specialized stems also exhibit dormancy.

Types of dormancy

- Innate dormancy
- Induced dormancy
- Enforced dormancy

VEGETATIVE PROPAGATION
Types of Vegetative Organs

- Stolons or Runners
- Rhizomes
- Tubers
- Bulbs
- Bulbils
- Stems

Advantages and Disadvantages of vegetative propagation
Advantages:

- Uniformity
- High yield
- Fast establishment

Disadvantages:

- Limited adaptable qualities
- Few individuals are produced from vegetative organs.

regenerated vegetative plants cannot survive continuous soil disturbance of the environment

WEED MANAGEMENT

Weed Management refers to how weeds are manipulated so that do not interfere with the growth, development and economic yield of crops and animals. It encompasses all aspects of weed control, prevention and modification in the crop habitat that interfere with weed ability to adapt to its environment.

Weed control: Refers to those actions that seek to restrict the spread of weeds and destroy or reduce their population in a given location. The effectiveness of weed control is affected by

i Type of crop grown
ii Timing of weeding operation
iii Nature of the weed problem
iv Methods of weed control available to the farmer

v Type of weeds to be controlled
vi Cost of the operation
vii Available labour or cash resources
viii Environmental condition before during and after the time of operation.

Weed prevention: This refers to the exclusion of a particular weed problem from the system that has not experienced that weed problem. It involves those measures necessary to prevent the introduction of new weed species into a given geographical area as well as the multiplication and spread of existing weed species.

It includes the following:

- *Fallowing*
- *Preventing weeds from setting seeds*
- *Use of clean crop seed for planting*
- *Use of clean machinery*
- *Controlling the movement of livestock*
- *Quarantine laws services*

Weed eradication:

This involves complete removal of all weeds and their propagules from a habitat.

Eradication is difficult to achieve in crop production and uneconomical. However in situations where weed problem becomes so overwhelming, eradiation may be desirable in long term goal. E.g. *Striga asiatical, S. hermonthica*.

Eradication may be considered if

i other weed control method s are ineffective
ii Weeds have many buried seeds that can not be controlled by convectional pratice
iii The infested field is small
iv Benefits from eradication outweigh those of the alternate methods for copping with weeds.

Methods of weed control

i Cultural
ii Biological
iii Chemical
iv Integrated

CULTURAL WEED MANAGEMENT

Cultural weed management is defined as any practice or effort adopted by the farmer in crop production which minimizes weed interference problem but such methods are not necessarily directed or aimed at weed control

Cultural weed methods include:

Hand weeding

Mechanical weeding (animal-drawn weeders & machine-power weeder.

- Mulching
- Crop Rotation
- Tillage
- Burning
- Flooding
- Sowing/planting time and crop spatial management
- Crop genotype choice
- Cover crop (used as Living mulches)

- Intercropping
- Fertilization

BIOLOGICAL WEED MANAGEMENT

- Biological weed management refers to the use of biological agent – pest, predators, pathogen and parasites to control weeds.
- It involves the control or suppression of weeds through the action of one or more organisms by natural means, or by manipulation of the weeds, organism or environment. It involves:
- ***Control of weeds with vertebrates & invertebrates (Macrobial weed control)***
- ***Use of micro organism such as plant pathogen (Microbial weed control)***
- ***Live mulch:***Live mulch is the crop production system in which a food crop in planted directly in the living cover of an established cover without destruction of the fallow (cover crop vegetation).

Perennial legumes such as *Psophocarpus palustris* have been evaluated and found suitable as live mulch.

- ***Allelopathy:*** Allelopathy is the production of chemical(s) or exudates by living and decaying plant species which interfere with the germination, growth or development of another plant species or microorganism sharing the same habitat.

Examples of allelopathic plants:

1. Black walnut (*Juglans nigra*)
2. *Gmelina arborea*
3. *Sorghum bicolor*
4. Casuarina
5. *Lantana camara*
6. *Imperata cylindrica* is allelopathic on tomato, cucumber, maize rice, ground nut, cowpea, pepper.
7. *Cyperus esculentus*– is allelopathic on rice, maize
8. *C. rotundus* – is allelopathic on barley

Plant canopy: Major effect of plant canopy is to shade the understorey plants and limit their ability to synthesize carbohydrates.

A competitive crop should be able to establish complete ground cover.

Some low grow crops which can provide early ground cover and shade out weeds when intercropped with other crops are egusi melon (*Colocynthis citrillus*) and sweat potato

CHEMICAL WEED CONTROL

Chemicals that are used for killing weeds or suppress the plant growth are called herbicides. The practice of killing the undersirable vegetation (that is weeds) with herbicide is called chemical weed control.

History of herbicides/chemical weed control

- The use of chemical weed control started with inorganic copper salts e.g $CuSO_4$ for broadleaf weed control in cereals in Europe in 1896.

- Other inorganic salts that were tested between 1900-1930 included nitrates and borates.

- In 1912, sulphuric acid (H_2SO_4) was used for selective weed control in onions and cereals. In 1932, the first organic herbicide, Dinitro-ortho Cresol (DNOC) was introduced.

- In the 1950s triazine was introduced. In 1974, Glyphosate , (frequently sold under brand name Roundup) for non-selective weed control was introduced.

- Agriculture witnessed tremendous changes through the production of organic herbicides, which came at a time when field workers were reducing, high cost labour

and productive cost of production. Thus, farmers in advance countries almost depended on herbicide because it met their production challenges in agriculture and relatively ignored other methods of weed control.

There are various factors that made chemical weed control popular than manual and mechanical weeding.

- Less drudgery in chemical control than in cultural method of weed control.
- Preemergence application of herbicides protects crops from the adverse effects of early weed competition
- Field labour demand is lower than in manual and mechanical control.
- Faster than manual and cultural weed control
- More effective against perennial weeds than other methods of weed control.
- Less likely to be adversely affected by erratic weather condition than other methods of weeding.

Limitations of chemical weeds control

- Weeds become resistant due to prolonged and constant use of a given herbicide .
- Sudden dry spell may cause failure of preemergence herbicides
- Crop injury as a result of poor sprayer calibration or wrong dosage calculation, faulty equipment or failure to follow label directions
- there could be side effect on the applicator
- Special skills are needed for effective herbicide use.
- Herbicide use is limited under multiple cropping
- Chemical weed control require special equipment which may not be useful for other operations on the farm.

Herbicide classification

Herbicides are classified based on the following:

- Based on time of application (when applied)
- Based on point of application (where applied)
- Based on Herbicide movements in plants (how they move in plants) (Site of primary action)
- Based on type of plants killed (Selectivity)
- Based on chemical structure (Chemistry)
- Based on Physiological action

INTEGRATED WEED MANAGEMENT

Integrated weed management (IWM) refers to the system of combining 2 or more weed management systems at low input level to keep weed interference in a given cropping system below economic threshold level. It combines 2 or more weed management systems at low inputs to obtain a level of weed suppression superior to that ordinarily obtained when one weed management system is used.

IWM may involve combinations of cultural plus chemical, cultural plus biological, cultural plus preventive, biological plus chemical or combinations of three or more of these systems.

- ***Factors that made IWM desirable.***
- Inability of any one method of weed control to completely solve the weed problem
- tendency of weeds to adapt to a given cropping system and thus escape control
- ability of weeds to develop resistance to a frequently used herbicide
- tendency of certain cropping systems to favour the dominance of specific weeds
- Seasonal fluctuation in labour availability
- Reduction in environmental degradation/hazards

HERBICIDES

Herbicide use in weed control has been the most important in world agriculture because it destroys weeds on a large scale either before or at emergence of crop without disturbing the crop or soil and farmers don't depend heavily on human labour. Weed killers consist of inorganic, organic, and biological herbicides. ***Types of Inorganic herbicides***

- Ammonium sulfate
- Ammonium thiocyanate
- Sodium borate
- Sulfuric acid
- Sodium chlorate

Types of organic herbicides

Over 200 organic herbicides are in use in the world agriculture today. Some of the herbicides are either selective or non- selective while some are also contact or systemic in their actions.

i. **Oil**: the petroleum oils used in agriculture consists of phytotoxic and phytobland (non-phytotoxic) oils.

Phytotoxic oils: kill plant by solubilizing cell walls, thus causing cells to disintegrate. Phytotoxic oils can be selective or non selective. They have high content of unsaturated fatty acids. Example of selective phytotoxic oils include: diesel oils, while non-selective phytotoxic oils include Stoddard solvent.

Phytobland / Non pyhtotoxic oils: these are light non herbicidal oils which are added to herbicide to enhance their activity. They are used both as toxicant and adjuvants. Examples of nonphytotoxic oils include sun 11 or corn oils.

ii. Organic arsenicals or methane arsonate herbicides eg. Cacodylic acid, MSMA, DSMA.

iii Aliphatic acids e.g TCA, Dalapon

iv. Nitrophenols or substituted Phenol herbicides e.g dinoseb, DNOC and PCP

v.Phenoxycarboxylic acid derivative

(a) Phenoxyaceticacid herbicide; 2,4-D, MCPA.

(b) Phenoxypropionic acid herbicide; dichlorprop, mecopropane, fenoprop.

(c) Phenoxybutyric acid herbicide; 2,4-DB, MCPB.

(d) Phenoxy-Phenoxypropionic acid; dichlofop-methyl

vi. Amide derivatives

a. α-Chloroacetamide herbicides; acetochlor, alachlor,CDA A (callidochlor), butachlor, diphenamid metolachlor, propachlor.
b. Carboxyanilide herbicides; propanil

vii. Benzonitriles; Bromoxynil, dichlobenil and ioxynil.
viii. Carbamic acid derivates (carbamates)

a. Carbanilic acid derivatives; asalam, chlorpropham.
b. Thiocarbamate herbicides; butylate, EPTC, molinate, thiobencarb.
c. Dithiocarbamate herbicides; CDEC, metham

ix. Dinitroaniline herbicide; Benefin, (benfluralin), dinitramine, pendimethalin, trifluralin, isopropalin.
x. Diphenyl ethers: acifluorfen, bifenox, lactofen, oxyfluofen.
xi. Substituted benzoic acids e.g chloramben, dicamba, DCPA
xii. Symmetrical triazines:

a. Chlorodiamino-s-triazine: atrazine, cyanazine, propazine, simazine
b. Methoxydiamino-s-triazine: atraton ana prometon
c. Methythiomino-s-triazines: ametryn, prometryne and terbutryn

xiii. Triazinones: e.g. hezazinone, metribuzin
ix. Substituted ureas e.g chlorbromuron,chloroxuron, diuron, linuron, metobromuron, monuron
x. Sulfonylurea herbicides: chlorsulfuron, sulfometuron-methyl, classic, lindax
xi. Uracils herbicides: e.g bromacil and terbacil
xii. Miscellaneous herbicides:

- Amitrole
- Bentazone
- Bipyridilium herbicides e.g difenzoquat, diquat and paraquat
- Cinethylin
- Fosamine
- Glufosinate- ammonium
- Glyphosate
- The imidazolinone herbicides

e.g. Buthidazole, Imazaquin, arsenal, Imazapyr

- The picolinic acid derivatives: Picloram, Triclopyr
- Oxadiazon
- Sethoxydim (Akobundu, 1987)

Effectiveness of herbicide can be modified by: environment, stage of maturity of target plant, type of plant, plant part sprayed, how herbicide moves within the plant, concentration of herbicides, method of application and tissue of application.
Herbicides are named in three major ways:

- **Common name**
- **Trade name**
- **Chemical name of the active ingredient (chemical formulae)**
- **Structural formulae (Chemical Structure)**

DEFINITION OF TERMS

ADJUVANTS: This is any substance in herbicide formulation or added to spray tank or improve herbicide activities or application characteristics.

A CARRIER is a substance (gas, liquid or solid) used to dilute or suspend a herbicide during its application..

SURFACTANTS: this is a material which improves the emulsifying, dispersing, spreading, wetting or other surface modifying properties of liquid.

EMULSIFYING AGENTS (EMULSIFIERS)

These are chemicals that improve the suspension of particles of one liquid in another liquid. They are also referred to as emulsifiers.

WETTING AGENTS

Wetting agents are surface active agents that reduce the interfacial tension as well as improving the contact between a liquid and surface on which it is applied.

STICKERS: These are spreaders which also reduce the surface tension of other liquid and decrease the possibility of aqueous solution to form discreet droplets.

DETERGENTS: They are cleansing chemicals used mainly for cleaning equipment/sprayers.

HERBICIDE FORMULATION

This is a process by which pure chemicals (e.g.) the active ingredient of a herbicide is prepared and made available for use in a form that will improve handling, storage, application, efficacy and safety.

In order to produce a good commercial herbicide, the formulation chemist must try to maintain a good chemical additives such as emulsifiers, wetting agents and inert materials to make a new herbicide formulation.

Reasons why herbicides are formulated:

- To reduce the concentration of the active ingredient through dilution in appropriate solvent.
- To make the pure chemical available in a form that will permit uniform distribution of target.
- To reduce the level of contamination and hazard during handling and application.
- To improve the efficacy of the herbicide through slow release of the active ingredient.
- Better protection from degradation.
- Greater uptake by the weed.
- To reduce cost of weed control with that particular herbicide. For example, the choice of wettable powder over emulsifable concentrate and vice-versa may be, based to a large extent on which of the formulation is easy to produce and market

Types of herbicide formulation

- **Water soluble (WSC, SL)**
- **Emulsifiable concentrate (EC)**
- **Wettable powder (WP)**
- **Flowable formulation (FW, F)**
- **Granular Formulations (G)**
- **Water Dispersible Granules (EDG, SG, DG)**
- **Salts**
- **Pellets**

- **Microencapsulation**

WEED CONTROL IN CROPPED AND NONCROPPED LANDS

Name of crop	Hand weeding (WAP)	Herbicide application	Rate of application (kg a.i./ha)	Time of application
CEREAL CROPS				
Maize (*Zea mays)*	2-3 and 5-7	1.atrazine + alachlor 2.atrazine + metolachlor 3.atrazine + pendimethalin	3.0 3.0 2.0+2.0	PE PE PE

Name of crop	Hand weeding (WAP)	Herbicide application	Rate of application (kg a.i./ha)	Time of application

Cowpea (*Vigna unguiculata)*	2-3 and 6-8	pendimethalin + imazaquin metolachlor + imazaquin trifluralin	1.5+0.2 1.25+0.2 1.0-1.5	PE PE PE

Leguminous crops

Name of crop	Hand weeding (WAP)	Herbicide application	Rate of application (kg a.i./ha)	
Cowpea (*Vigna unguiculata)*	2-3 and 6-8	pendimethalin + imazaquin metolachlor + imazaquin trifluralin	1.5+0.2 1.25+0.2 1.0-1.5	

Vegetable crops

Name of crop	Hand weeding (WAP)	Herbicide application	Rate of application (kg a.i./ha)	
Tomato *(Lycopersicum esculentum)*	2-3 and 6-8	Metribuzin Diphenamide Napropamide	0.25 - 0.35 4.0 – 5.0 1.0 – 2.0	

Root and Tuber crops

Name of crop	Hand weeding (WAP)	Herbicide application	Rate of application (kg a.i./ha)	
Cassava *(Manihot esculentus*	3, 8 and 12	atrazine + pendimethalin atrazine + metolachlor (Primextra)	3.0 3.0	

AQUATIC WEEDS

Name of weed	Herbicide	Rate (kg ai)
Most weeds	fluoridone	0.6 – 4.5

Water hyacinth	**diquat**	**0.5 – 0.7**
Salvinia spp.	**Diquat** **2.2,4-D**	**0.9 – 1.8** **3.6 (apply to surface)**

WEED CONTROL IN LANDSCAPE

- **Weed control options in landscape include:**
- **hand weeding**
- **Cultivation**
- **mowing**
- **Mulching**
- **Use of herbicides e.g. glyphosate, oxadiazinon (Ronsta) and oxyfluorfen (Goal).**

ROADSIDE AND ESTATE WEED CONTROL

- **Strip of vegetation by the road side and around buildings constitutes roadside weeds.**
- **Such weeds should be controlled at less cost.**
- **Regular hand weeding will control most weeds.**

use of non - selective post emergence herbicides (e.g. glyphosate or amitrole) will give a satisfactory weed control.