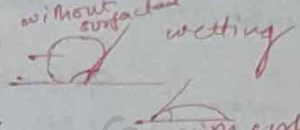
Concept of Adjuvant, Surfactant, Herbicide formulation & their use :-

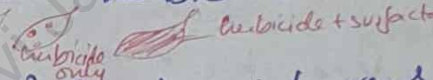
Adjuvant :- It is an additive that is intended to improve the effectiveness of herbicide.

- There are chemicals to improve herbicidal effect, sometimes making a difference b/w satisfactory or unsatisfactory weed control.
- mode of action - Adjuvant aids the herbicide availability at action site in plants.



eg - 1) Surfactant (surface active agents).

- a) wetting agents - aid in wetting the waxy leaf surface with aqueous herbicide spray
- b) Spreaders - In spreading hydrophilic herbicide uniformly all over the foliage



- c) Penetrates - In penetration of herbicide into target leaves & stems.

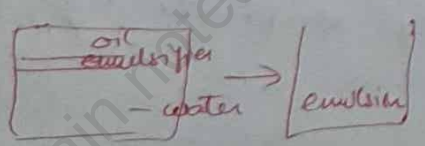
→ Take a water in beaker, if you dip a leaf of Cynodon dactylon & pull it back, you see leaf without wetting. But if you add a drop of surfactant you can readily wet a foliage. With addition of ~~tot~~ surfactant, the H_2O drop flattens down to wet the leaf surface & herbicide acts properly.

2) Stabilizing agent :-

Emulsifiers

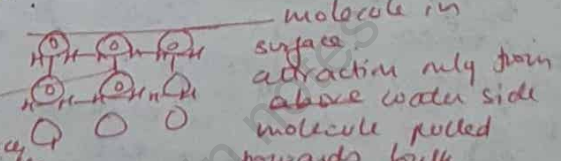
substance which reduce tendency to separate), ~~a sub~~ stabilize a suspension of droplet of one liq which otherwise would not mix with first one.

eg - ABS, Solvaid, etc.



Dispersing agent

- They stabilize suspensions.
- They keep fine particles of wettable powder in suspension in water even after vigorous agitation has been withdrawn.



3) Coupling agents (Solvents & co-solvents).
- eg - 2,4-D is insoluble in H_2O, but can be dissolved in polyethylene glycol to make water soluble
- Chemical that is used to solubalize a herbicide in a concentrated form, resulting solution is soluble in H_2O in all proportions.
- Common solvents → Benzene, acetone, CCl_4 etc

4) Humicants (Hygroscopic agents) :-
- Humicants prevent rapid drying of herbicide sprays on the foliage, thus providing a extended opportunity of herbicide absorption.
- eg - glycol.

5) Deposit builders (Sticker or filming agents) :-
- Chemicals added to herbicide concentrates to hold the toxicant in intimate contact with plant sauce
- They reduce washing off of the toxicant from treated foliage by rain
- eg - several petroleum oils, Du pont spreader sticker.

6) Compatibility agents :-
- Used to mix fertilizer & pesticides in spray liquids
- compatibility agents allow simultaneous application of two or more ingredients.
  eg - Compex, ammonium sulphate.

7) Activators (Synergists) :- chemicals having cooperative action with herbicides.
- The resultant phytotoxicity is more than the effect of two working independently
  eg - ~~2,4-D phytotoxicity~~, Urea & amm. chloride to enhance 2,4-D phytotoxicity.

8) Drift control agents - material used in liq. spray tank mixtures to reduce physical drift & improve the deposition of pesticide sprays.
  eg - 2,4-D on cotton. solution is to spray herbicide liq in large droplets.

Herbicide formulations

Herbicides $\xrightarrow{\text{natural state}}$ solid, liquid, volatile or non-volatile, soluble or insoluble.

- These cannot be applied in original form.
- These have to be made into suitable & safe forms for field use. Such forms are called herbicide formulations.
- Herbicide formulations are diluted by use in water or oils before application in target area.
- Dry granules of herbicide formulations are applied either as such or diluted with dry sand.
- Manufacturer prepare herbicide formulation by blending toxicant (active ingredient) with substances like solvents, surfactants, stickers, stabilizers, antifoaming agents, etc.

objectives of formulating herbicides are to ensure —
① care of handling ② high controlled activity in target plants

Herbicide formulation is in the form of:—

① Emulsifiable concentrate (EC)
② Water Soluble concentrate (SC)
③ Floable fluid (FL)
④ gels (GL)
④ granules (GR)
⑤ dry floables (DF).
⑥ Wettable powders (WP)
⑧ others - capsules, wax bars, aerosols, etc.

* Herbicides not use in dust forms for fear of mis drift hazards.

Sprayable concentrates :- in form of (1) soluble concentrate, (2) EC (3) WP (4) DF.

Water as carrier of these herbicide concentrates form solutions, emulsions or suspension. These are designated collectively as sprayable concentrates.

Microencapsulated formulation (ME) or Capsule suspension (CS) :—

- There are small particles consisting of herbicides core surrounded by barrier layer, made of polymer shell
- Also called capsule suspension because these capsules are suspended in a liquid medium
- It reduces the amount of solvent needed.

Mode of action of herbicides & Selectivity

- Mode of action refers to sequence of events from absorption into plant to plant death.
- It influences how the herbicide is applied.

eg – 1) Contact herbicide disrupt cell membrane such as Paraquat / Aciflurorfen
3) Seedling growth inhibitor → Treflan, Alachlor.

To be effective herbicide must be → 1) adequately contact plants, 2) absorbed by plants (3) move within plants to site of action (4) without being deactivated (4) reach toxic levels at site of action).

1) Growth regulator herbicide :- 2,4-D, MCPP, Dicamba.
• foliar applied, • systemic & translocate in xylem & phloem.
• mimic auxins • cause abnormal growth of plant

2) Inhibitors of amino acid synthesis :- glyphosate, halosulfuron, sulfometuron
• foliar & soil applied • translocate in phloem
• inhibit enzyme which produce amino acid
• once protein production stops, growth stops. • stunting & lack of protein

3) Cell membrane disruptors :- Oxyfluorfen, lactofen, aciflurorfen.
• foliar & soil applied • enter stem, roots, • limited in movement once they enter plant • membrane damage due to lipid peroxidation • necrosis of leaves & stem.

4) Lipid biosynthesis inhibitors :- Diclofop, fluazifop
• foliar & soil applied • moves to xylem & phloem • inhibits production of lipid
• lipid necessary for growth of plant • stunting & death of tissue.

5) Pigment inhibitors :- fluridone, norflurazon, amitrol.
• Soil applied • xylem & phloem • inhibit caroteniod leaving chlorophyll unprotected from photoxidation. • bleached appearance of foliage.

6) Growth inhibitors of shoot :- Thiocarbamate, EPTC.
• soil applied, volatile • xylem, • enter through roots • stunting & distortion of seedling leaves

7) Cell division disruptor :- Pendamethalin, DCPA.
• soil applied • limited movement in soil • absorbed through roots & shoots • enter through leaves, stems, • do not move within plant once absorbed. • limit cell division / mitosis • stunting & swollen root tips

8) Inhibitors of photosynthesis :- Atrazine, Simazine
• soil applied • xylem • block electron transport system in photosynthesis.
• destroy chlorophyll • & necrosis.

9) Glutamine synthesis inhibitor :- gluphosinate

10) Acetolactate synthase inhibitor (ALS) :- Triazolopyrimidine

Bioherbicides

Bioherbicides - biologically based control agent for weeds.
↳ derived from microbes such as fungi, bacteria, virus, protozoa, phytotoxic plant residues, extracts or ~~simple~~ single compounds derived from other plant species.
→ Bioherbicide & bio-pesticides ~~refer~~ as naturals.
→ Bioherbicides utilize naturally occuring enemies rather than chemicals (man made)
→ applied as aerial sprays, cut & paste application, powder applied to soil

History of bioherbicides

- Mycoherbicide research to control agricultural & environmental weeds began in 1940s.
- eg - In 1963, Chinese mars - produced a different fungus Colletotrichum gloeosporioides sp. cuscutae. for parasitic weed dodder (Cuscuta) → Lubao ~~bar~~ mycoherbicide

Benefits of herbicides over other herbicides:-

- occurs naturally in areas
- less harmful
- eco-friendly
- more selectide in their mode of action. so risk of damage to other plant is reduced.
- less toxic to people & animal.
- weed control
- sustainability
- cost effective.
- produce abundant & durable inoculum in culture
- genetically stable
- detrimental effect on non-target plants.

Some commercial mycoherbicides in use abroad:-

Product	Content	weed controlled
1) Luboa-2	Collectotrichum gloesporioides spp. Cuscuta.	~~Cuscuta~~ Cuscuta.
2) ~~Luboa~~ Bipolaris	A suspension of fungal spore of bipolaris sorghicola.	Jhansgrass (Sorghum halpense)
3) De-Vine	- liq. suspension of fungal spores Phytophthora palmivora - causes root rot in weed.	Strangler vine in citrus orchid

Dissemination / Dispersal

It is a silent unseen unidirectional & multidirectional travelling of weed seeds from one place to another is called dissemination / dispersal.

→ Therefore weeds are described as silent traveller

→ agents → wind, water, animals, humans and effective adaptation to new environment.

→ Once a seed has successfully dispersed to an area it starts colonization with it seeds produced & spreads gradually.

Mechanism of dissemination :- It has ecological basis

→ Vegetative propagule of weed
rhizome, stock, tuber etc

Autochory

- dispersion exercised by weed plants themselves for dissemination of seeds.
- Several special structures eg- comose, pappus, baloon, wing, persistent style, etc. present in weeds are adaptations for autochory in weed plants which help them float & move from one place to another by action of several outside agent.

Allochory

- mechanism of weed seeds solely by extraneous factor agents like human, wind, animal, water, crop seeds, FYM, compost, org. matter, etc.

Mammilochory - dispersal by humans, cattles, mammals, & other livestock or wind animals.

ornithochory - by birds.

myrmecochory - by ants.

other factors - sewage, sludge, agri implements, feed fodder, etc.

- Autochory inherent in legume seeds.
- Pappus - modification of persistent calyx into hairs eg - Dandelion seeds dispersed by this manner.
- Comose - seeds covered with special hairs partially or fully. eg - Calotropis.
- Baloon - modified papery calyx encloses fruit loosely with entrapped air eg - Cherry
- Persistent style - eg - Anemone spp. fruits are hairy.
- Wings - seeds & fruits have one or more appendage that act as wing. eg - Big leaf maple.

Weed Control

(1) Preventive method

2 dimensions

1) Time – prevent infestation prior to weed germination.
2) Space – prevent spread to new areas.

4 measures

a) Crop management practices –
- proper crop rotation
- better irrigation practices
- high plant population
- proper placement of fertilizer
- use of vigorous & fast growing varieties

b) Use of weed free crops – procedure :–
- cleaning & testing
- separating crop seeds by separators
- clean agri equipments
- well decomposed weed free FYM

c) Seed Certification

e) Weed Laws – There is no weed law in India except Karnataka which declared Parthenium as noxious weed.

(2) Curative method

→ (1) Eradication
1) destroy species at initial stage of introduction before it produces propagules
2) degenerating buried dormant but viable seeds by fumigation, flooding, heating & other methods

→ (2) Control
1) Cultural
2) Biological
3) Chemical

(2) Control :–

(1) Cultural method :–

(1) Mechanical / Physical method –
- hand weeding in 15-20 days interval
- dredging – remove weeds along with their roots & rhizome.
- Chaining – floating of weeds removed by chaining
- other → tillage, mulching, clipping, chilling, burning etc.

(2) Cropping / ecological method –
- crop rotation
- clean cultivation
- suitable time & method of planting
- summer fallowing
- bushing cultivation.

(3) Biological method :–
- by employing crop plants, parasites, predators, pathogens, parasitoids.

(i) Cropping & competition.

Insects – 1st attempt to control weeds by insects in 1920 to control Lantana camara by beetles.

water hyacinth by Rhizoctonia blight.

Limitations of biological control
- weeds must by highly specialized
- insect will thrive a new environment.

(3) Chemical control :–

earliest attempt to control weeds by herbicides in 1937 in Punjab for controlling Carthamus oxycantha by sodium arsenite

max. herbicide use in tea & coffee

Reproduction in Weeds

① Sexual :- fusion of gametes by (a) conjugation (b) fertilization
→ majority by seed formation through fertilization → Monoecious
→ which bear both male & female flowers on different → Dioecious individuals. eg- Canada thistle.
→ Seed production prolific (more) in → annual & biennial → sorghum halepense (Johnson grass) 1000's seeds/plant/year
limited → (perennial) eg- Cyperus & Cynodon (40-170 seeds/plant)

→ Commelina spp. place its seeds directly inside soil since it produce aerial & underground flowers & seeds.

② Asexual :- • without union of gametes.
• each reproductive cell is simply cut off from parent plant & grow as new individual. by fission or spore formation.
• sexual conjugation is limited to weed algae, horse tails and ferns.

③ Vegetative Reproduction :- portion of mother plant either stem or root gets detached & becomes new individual
→ It is primary source of perennial weeds.
2 advantages :- 1) purity of parental stock is maintained.
2) quick multiplication.

There modifications in form of rhizome, suckers, runners, root stocks tubers, bulbs, bulbils, stems & roots -

1) Rhizome & root stocks - horizontally growing underground modified shoot. bearing nodes, internodes, buds, leaves.
eg- Cynodon dactylon → use rhizome under the ground
runners & stolons above the ground.

These rhizome grow vertically downward called as Root stock eg- Johnson grass (Sorghum halepense)

Runners :- Aerial shoots coming from axils of lower leaves called runners.
eg- Bermuda grass.

③ Stolons, Suckers & offsets :- runner instead of trailing on soil surface rises in form of an arch before hitting the soil called as stolon. eg - Rose -

Suckers - trail little below the soil surface. eg - Hawkweed.

offset - Runners of floating weeds called offset
eg - water hyacinth, water lettuce (Pistia cancoolata).

④ Tubers - swollen ends of rhizome & suckers are tubers.
eg - Cyperus rotundus.

⑤ Bulbs - crown region of plant is compressed in a shape of disc. eg - Allium cepa.

⑥ Stems & Roots - eg - Cuscuta arvensis, Opuntia dilenii (dodder)