

LOW VOLUME HERBICIDES – ADJUVANTS AND THEIR USE IN HERBICIDES – MODE OF ACTION OF HERBICIDES – EFFECT OF SUB LETHAL DOSAGE

LOW VOLUME HERBICIDES

Herbicides play an important role in weed control on agricultural and non agricultural surfaces. They are mainly applied by sprayers (foliar application) that consist of a herbicide tank, a pressure generator, spray nozzles, pipes and connectors. Foliar application of herbicides entails spraying the leaves of target plants during the growing season with a low concentration of herbicide in a water carrier.

Among all possible weed control methods, the use of herbicides is principally associated with risks for human health and the environment. Because of this there is much discussion about the use of herbicides. Reduction in use of herbicides will reduce associated risks. It is expected that herbicide use can be much reduced when herbicides are applied according to best possible practices i.e. application of minimal doses of herbicide adjusted to weed, weather, herbicide and sprayer conditions.

Low volume herbicide application has many benefits. Besides its cost-effectiveness for the landowner, the low volume solution is also environmentally friendly. The spray can be applied with a hand-powered, backpack sprayer or larger, motorized sprayers.

This type of application method has numerous advantages:

1. With low volume foliar, only the targeted species are treated.
2. Low volume foliar application is also extremely low profile. No large trucks, no noisy spray devices, only professional employees with backpacks.
3. Low volume foliar also allows for a lower application cost due to the lower volume of mix being applied and is extremely effective due to the higher concentration of herbicide being applied to each individual plant.

HERBICIDE MIXTURES

It involves mixing of two or more herbicides used for effective and economical weed control.

Advantages of Mixture

1. A mixture will broaden the spectrum of herbicidal action and kill a variety of weeds
2. It may increase the effectiveness;
3. In a mixture one herbicide may prevent rapid degradation of the other and increase its efficacy
4. A mixture offers the possibility of reducing the dose of each of the herbicide necessary for weed control leading to low residue

Two types of mixtures

1. Tank mixtures made with the desired herbicides and rates before application eg., Anilophos + 2,4-D EE – rice
2. Ready mix – formulated by the manufacturer. Ready mix available in the world market eg., 2,4-D+Glyphosate, Paraquat+2,4,-D, Atrazine+metolachlor, paraquat+oxyfluorfen.

HERBICIDE ROTATION

The practice of following a systematic, rotational sequence of herbicide used in the same field to prevent or control formation of herbicide resistant weeds.

In a rotational programme a soil-applied or foliage applied herbicide or both are used in a sequence to take care of annual as well as perennial weeds. The choice of herbicide depends on the tolerance of crops to particular herbicides, type of weed spectrum, intensity of weed infestation, soil and climatic factors etc.,

The best rotational programme will aim at maximum cumulative cost benefit ratio and least residual problems and least build-up of tolerant weeds.

Advantages

- (i) Helps in preventing emergence of tolerant weed species (Herbicide is captured in vacuole and inactivated excluding the herbicide from site of action).
- (ii) Reduces the quantities of herbicide required for optimum weed control over the years.
- (iii) Provides most effective weed control for the duration of crop growth.
- (iv) Reduces the building up of herbicide residue problems.
- (v) It offers high cumulative cost-benefit ratio over the years

Weed survey and mapping may be done every year and if any shift in weed flora, appropriate changes in herbicide rotation should be made.

HERBICIDE TOLERANCE AND RESISTANCE

Herbicide Resistance: Naturally occurring inheritable ability of some weed biotypes within a population to survive a herbicide treatment that would, under conditions of use effectively control the weed population (Rubin, 1991)

- *Senecio vulgaris* resistance to triazine group of herbicide was noticed during 1970
- Worldwide 183 weeds have developed resistance to herbicides till 1997
- In India the most common example is *Philaris minor*
- The highest resistance in 61 weed species was recorded for atrazine
- USA alone found to have 49 herbicide resistant weeds, the highest in the world

Tolerance: The term tolerance refers to the partial resistance and presently the usage of the term is discouraged due to inconsistency in quantifying the degree of tolerance.

Gross Resistance: When a weed biotype exhibits resistant to two or more herbicides due to the presence of a single herbicide mechanism.

Multiple resistance: It is a situation where resistant plants possess two or more distinct resistant mechanisms to a single herbicide or groups of herbicides.

Basic principles of herbicide resistance

1. Time, dose and method of application of herbicide variation
2. Variation in phenotypes of a population
3. Genetic variation by mutation or activation of pre-existing genes

Conditions favourable for development of Herbicide resistance

- a. Repeated use of same herbicide or use of herbicide with same mode of action due to the practices of monoculture
- b. Areas where minimum/zero tillage is followed
- c. Fields where farmers rely on only herbicides for high degree/level of weed control including nurseries, orchards
- d. Non-crop situations like road sides, railway tracks etc. where herbicides are repeatedly used may be at higher doses than cropped situation

Resistance was exhibited in crop is due to

1. Herbicide metabolism by crops making them inactive
2. Absence of certain metabolic process in crops compared to weeds and thus tolerating the herbicides
3. Crops couple the herbicide molecule

ANTIDOTES

Chemicals which are used to inactivate the applied herbicides are called as antidotes. Eg. Paraquat spray can be inactivated by spraying 1% ferric chloride

SAFENERS / PROTECTANTS

Substances used for protecting crop plants, which are otherwise susceptible or less tolerant to some herbicides at doses required for good weed control.

eg., Naphthalic anhydride (NA) – 0.5g / kg of seed for rice to protect against molinate and alachlor

R – 27788 – soil application protects maize from alachlor and metolachlor

Mode of Action: Safeners enter the target plants and compete there with herbicide molecules for a binding site on some native enzyme.

ADJUVANTS

Adjuvants are chemicals employed to improve the herbicidal effects, sometimes making a difference between satisfactory and unsatisfactory weed control.

Mode of Action: Adjuvants aid the herbicide availability at the action site in plants. Some important kinds of adjuvants are

1. Surfactant (Surface active agents)

- (a) Aid in wetting the waxy leaf surface with aqueous herbicide sprays (wetting agents)
- (b) In spreading the hydrophilic herbicides uniformly over the foliage (spreaders)
- (c) In the penetration of herbicide into the target leaves and stems (penetrates)

A water drop is held as a ball on a waxy leaf surface. (Take water in a beaker, if you dip a leaf of *Cynodon dactylon* and pull it back, you can see the leaf without wetting. But if you add a drop of surfactant you can readily wet the foliage.). With the addition of surfactant, the water drop flattens down to wet the leaf surface and let the herbicide act properly.

2. Stabilizing agents

These include

(i) Emulsifiers: A substance which stabilizes (reduces the tendency to separate) a suspension of droplets of one liquid which otherwise would not mix with the first one. It substitutes for constant agitation of spray liquids during field operation.

Eg., ABS, Solvaid, 15-5-3, 15-5-9.

(ii) Dispersing agents: They stabilize suspensions. They keep fine particles of wettable powder in suspension in water even after initial vigorous agitation has been withdrawn. They act by increasing the hydration of fine particles of WP laden with the herbicides.

3. Coupling agents (Solvents and co-solvents)

Chemical that is used to solubilize a herbicide in a concentrated form; the resulting solution is soluble with water in all proportions. Eg., 2,4-D is insoluble in water, but it can be dissolved in polyethylene glycol to make it water soluble.

Common solvents: Benzene, acetone, petroleum ether, carbon tetrachloride

4. Humicants (Hygroscopic agents)

Humicants prevent rapid drying of herbicide sprays on the foliage, thus providing an extended opportunity of herbicide absorption Eg. glycerol.

5. Deposit builders (Stickers or filming agents)

Chemicals added to herbicide concentrates to hold the toxicant in intimate contact with the plant surface. They also reduce washing off of the toxicant from the treated foliage by rain. Eg., Several petroleum oils, Du pont spreader sticker, Citowett.

6. Compatibility agents

Used to intimately mix fertilizers and pesticides in spray liquids Eg. Complex

7. Activators (Synergists)

These are the chemicals having cooperative action with herbicides. The resultant phytotoxicity is more than the effect of the two working independently.

Eg., Paraffinic oils, Ammonium thiocyanate, Urea and Ammonium chloride to enhance 2,4 -D phytotoxicity

8. Drift control agents

Herbicide spray drifts may pose serious hazards to non-target plants. Eg., 2,4-D on cotton. Solution is to spray herbicide liquids in large droplets.

Thickening agents eg., (Decagin, Sodium alginate)

MANAGEMENT OF HERBICIDE RESIDUES IN SOIL

An ideal soil applied herbicide should persist long-enough to give an acceptable period of weed control but not so long that soil residues after crop harvest limit the nature of subsequent crops which can be grown. Various management techniques have been developed which can help to minimise the residue hazards in soil.

A. Use of Optimum dose of herbicide

Hazards from residues of herbicides can be minimised by the application of chemicals at the lowest dosage by which the desired weed control is achieved. Besides, applying herbicides in bands rather as broadcast will reduce the total amount of herbicide to be applied. This will be practicable in line sown crops or crops raised along ridges, such as cotton, sugarcane, sorghum, maize etc.

B. Application of farm yard manure

Farmyard manure application is an effective method to mitigate the residual toxicity of herbicides. The herbicide molecules get adsorbed in their colloidal fraction and make them unavailable for crops and weeds. Besides, FYM enhances the microbial activity, which in turn degrades the herbicide at a faster rate.

C. Ploughing/cultivating the Land

Ploughing with disc plough or intercultivators reduces the herbicide toxicity, as the applied herbicide is mixed to a large volume of soil and gets diluted. In case of deep ploughing the herbicide layer is inverted and buried in deeper layers and thereby the residual toxicity got reduced

D. Crop rotation

Ragi – Cotton – Sorghum is the common crop rotation under irrigated field conditions of Coimbatore district. Fluchloralin 0.9 kg or butachlor 0.75 kg/ha + Hand weeding at 35 DAT for ragi + sunflower (border crop), pendimethalin 1.0 kg/ha + hand weeding on 35 DAS for cotton

intercropped with onion and two manual weeding at 15 and 35 DAS for sorghum inter cropped with cowpea is the recommended weed control practice. The above weed management schedule did not show any residual effect in the cropping system because the herbicides are changed for every crop.

E. Use of non phyto-toxic oil

Atrazine residual hazard could be reduced by mixing non phyto-toxic oil which would also enhance the weed killing potency

F. Use of activated carbon

Activated carbon has a high adsorptive capacity because of its tremendous surface area which vary from 600 - 1200 m²/g. Incorporation of 50 kg/ha of activated charcoal inactivated completely chlorsulfuron applied at 1.25 and 2.50 kg/ha and did not affect the yield of maize compared to untreated control. Application of charcoal at 5.0 kg/ha along the seed line reduced the residual toxicity of atrazine in soybean crop.

G. Use of safeners and antidotes

A new development in herbicide usage is the use of safeners and antidotes in order to protect the crop plant from possible damage by a herbicide. This means that it may be possible to use certain herbicides on crops that would normally be affected by herbicide. NA (1,8-naphthalic anhydride) has been used as a seed dressing on rice to protect the crop against molinate and alachlor. Another herbicide safener cyometrinil is used along with metolachlor in grain sorghum and other crop species.

H. Leaching the soil

Leaching the herbicide by frequent irrigation is possible especially in case of water soluble herbicides. In this case, the herbicides are leached down to lower layers i.e. beyond the reach of the crop roots.