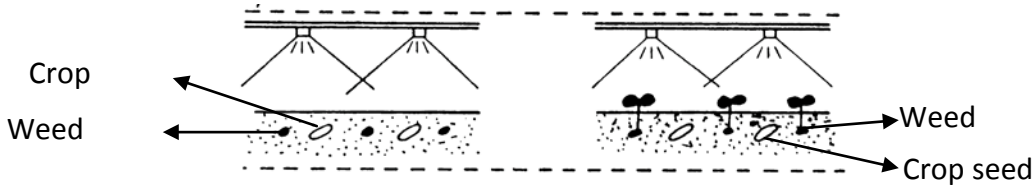
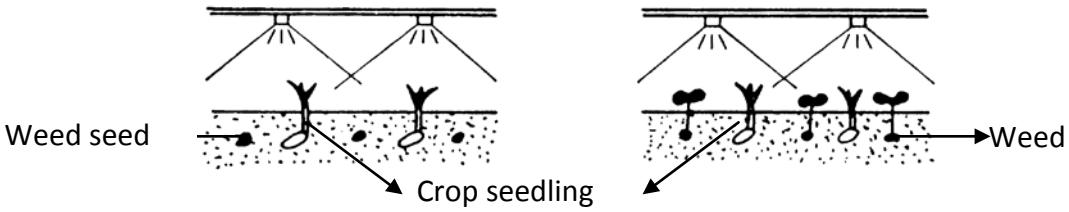
Application of herbicides before a crop or weed has emerged. In case of annual crops application is done after the sowing of the crop but before the emergence of weeds and this is referred as pre-emergence to the crop while in the case perennial crops it can be said as pre-emergence to weeds. For example soil application by spraying of atrazine on 3rd DAT to sugarcane can be termed as pre-emergence to cane crop while soil application by spraying the same immediately after a rain to control a new flush of weeds in a inter-cultivated orchard can be specified as pre-emergence to weed. Eg. Atrazine, Pendimethalin, Butachlor, Thiobencarb, Pretilachlor



iii) Post – emergence

Herbicide application after the emergence of crop or weed is referred as post-emergence application. When the weeds grow before the crop plants have emerged through the soil and are killed with a herbicide then it is called as early post-emergence. For example spraying 2,4-D Na salt to control parasitic weed striga in sugarcane is called as post-emergence while spraying of paraquat to control emerged weeds after 10-15 days after planting potato can be called as early post-emergence. Eg. Glyphosate, Paraquat, 2,4-D Na Salt.



iv) Early post emergence: Another application of herbicide in the slow growing crops like potato, sugarcane, 2-3 week after sowing is classified as early post emergence.

5) Based on molecular structure

a. Inorganic compounds
b. Organic compounds

FORMULATIONS

Herbicides in their natural state may be solid, liquid, volatile, non-volatile, soluble or insoluble. Hence these have to be made in forms suitable and safe for their field use. An herbicide formulation is prepared by the manufacturer by blending the active ingredient with substances like solvents, inert carriers, surfactants, stickers, stabilizers etc

Objectives in herbicide formulations are;

- ❖ Ease of handling
- ❖ High controlled activity on the target plants

Need for preparing herbicide formulation

- ❖ To have a product with physical properties suitable for use in a variety of types of application equipment and conditions.
- ❖ To prepare a product which is effective and economically feasible to use
- ❖ To prepare a product which is suitable for storage under local conditions?

Types of formulation

I. Emulsifiable concentrates (EC): A concentrated herbicide formulation containing organic solvent and adjuvants to facilitate emulsification with water eg., Butachlor

ii. Wettable powders (WP): A herbicide is absorbed by an inert carrier together with an added surface acting agent. The material is finely ground so that it may form a suspension when agitated with a required volume of water eg., Atrazine

iii. Granules (G): The inert material (carrier) is given a granular shape and the herbicide (active ingredient) is mixed with sand, clay, vermiculite, finely ground plant parts (ground corn cobs) as carrier material. eg. Alachlor granules.

iv. Water soluble concentrates (WSC): eg. paraquat

METHODS OF APPLICATION

1. Spraying
2. Broadcasting

Factors influencing the methods of application are

a. Weed-crop situation
b. Type of herbicides
c. Mode of action and selectivity
d. Environmental factors
e. Cost and convenience of application

Depending on the target site, the herbicides are classified in to

a. Soil applied herbicides
b. Foliage applied or foliar herbicides

Different methods by which these herbicides are applied is tabulated below

	Soil application		Foliar application
a.	Surface	i.	Blanket spray
b.	Sub surface	ii.	Directed spray
c.	Band	iii.	Protected spray
d.	Fumigation	iv.	Spot treatment
e.	Herbigation		

Soil appication of herbicides

a. Surface application

Soil active herbicides are applied uniformly on the surface of the soil either by spraying or by broadcasting. The applied herbicides are either left undisturbed or incorporated in to the soil. Incorporation is done to prevent the volatilization and photo-decomposition of the herbicides.

Eg. Fluchoralin – Left undisturbed under irrigated condition

- Incorporated under rainfed condition

b. Subsurface application

It is the application of herbicides in a concentrated band, about 7-10 cm below the soil surface for controlling perennial weeds. For this special type of nozzle is introduced below the soil under the cover of a sweep hood.

Eg. Carbamate herbicides to control *Cyperus rotundus*

Nitralin herbicides to control Convolvulus arvensis

c. Band application

Application to a restricted band along the crop rows leaving an untreated band in the inter-rows. Later inter-rows are cultivated to remove the weeds. Saving in cost is possible here. For example when a 30 cm wide band of a herbicide applied over a croprows that were spaced 90 cm apart, then two-third cost is saved.

d. Fumigation

Application of volatile chemicals in to confined spaces or in to the soil to produce gas that will destroy weed seeds is called fumigation. Herbicides used for fumigation are called as fumigants. These are good for killing perennial weeds and as well for eliminating weed seeds.

Eg. Methyl bromide, Metham

f. Herbigation

It is the application of herbicides with irigation water both by surface and sprinkler systems. In India farmers apply fluchloralin for chillies and tomato, while in western countries application of EPTC with sprinkler irrigation water is very common in Lucerne.

Foliar application

i. Blanket spray

It is the uniform application of herbicides to standing crops without considering the location of the crop. Only highly selective herbicides are used here. Eg. Spraying 2,4-Ethyl Ester to rice three weeks after transplanting

ii. Directed spray

It is the application of herbicides on weeds in between rows of crops by directing the spray only on weeds avoiding the crop. This could be possible by use of protective shield or hood. For example, spraying glyphosate in between rows of tapioca using hood to control *Cyperus rotundus*.

iii. Protected spray

It is a method of applying non-selective herbicides on weeds by covering the crops which are wide spaced with polyethylene covers etc. This is expensive and laborious. However, farmers are using this technique for spraying glyphosate to control weeds in jasmine, cassava, banana.

iv. Spot treatment

It is usually done on small areas having serious weed infestation to kill it and to prevent its spread. Rope wick applicator and Herbicide glove are useful here.

Crop	Herbicide	Dose (kg ai/ha)	Trade name and formulation	Time of application
1. Rice	Butachlor	1.25	Machete 50% EC Delchlor 50% EC	Pre-emergence
	Thiobencarb	1.25	Thunder 50% EC Saturn 50% EC	Pre-emergence
	Anilophos	0.40	Arozin 30% EC Aniloguard 30% EC	Pre-emergence
	Fluchloralin	0.90	Basalin 45% EC	Pre-emergence
	Pendimethalin	0.90	Stomp 30% EC	Pre-emergence
	2,4-D Na salt Pretilachlor+S	1.00	Fernoxone 80% SS Sofit	Post-emergence Pre-emergence
2. Rice (Upland	Thiobencarb	1.25	Saturn 50% EC	Pre-emergence

direct sown)				(8 DAS)
	Pretilachlor	0.45	Refit 50% EC	Pre-emergence
3. Sorghum	Atrazine	0.25	Atrataf 50% WDP	Pre-emergence
4. Ragi (Transplanted)	Butachlor	1.25	Machete 50% EC	Pre-emergence
	Pendimethalin	0.75	Stomp 30% EC	Pre-emergence
5. Maize	Atrazine	0.25	Atrataf 50% WDP	Pre-emergence
6. Cumbu	Atrazine	0.25	Atrataf 50% WDP	Pre-emergence
7. Cotton	Metolachlor	1.00	Dual 50% EC	Pre-emergence
	Fluchloralin	1.00	Basalin 45% EC	Pre-emergence
	Pendimethalin	1.00	Stomp 30% EC	Pre-emergence
	Diuron	0.40	Karmex 50% WP	Pre-emergence
8. Groundnut	Metolachlor	1.00	Dual 50% EC	Pre-emergence
	Fluchloralin	0.90	Basalin 45% EC	Pre-emergence
9. Sunflower	Fluchloralin	0.90	Basalin 45% EC	Pre-emergence
	Pendimethalin	0.90	Stomp 30% EC	Pre-emergence
10.Vegetables	Fluchloralin	1.00	Basalin 45% EC	Pre-emergence
	Pendimethalin	1.00	Stomp 30% EC	Pre-emergence
11. Sugarcane	Atrazine	1.00	Atrataf 50% WDP	Pre-emergence
12. Pulses	Fluchloralin	0.70	Basalin 45% EC	Pre-emergence
	Pendimethalin	0.60	Stomp 30% EC	Pre-emergence
13. Wheat	Isoproturon	0.60	Arelon 75% WP	Pre-emergence
Cropping Systems				
1. Sorghum + Cowpea	Pendimethalin	0.90	Stomp 30% EC	Pre-emergence
2. Sugarcane + Pulses	Thiobencarb	1.25	Saturn 50% EC	Pre-emergence
3. Maize + Soybean	Pendimethalin	1.00	Stomp 30% EC	Pre-emergence
	Alachlor	2.00	Lasso 50% EC	Pre-emergence