Weed control

Overview and objectives

Weeds and people have been intimately associated for centuries. Even before people started cultivating crops, hunters and gatherers selected some plants for food and fiber and rejected others – the weeds – that were of no use to them.

There is no definite record of when weed control (as we know it) was first practiced. Probably, soon after people started cultivating desired plants, they found it necessary to remove unwanted vegetation from the fields. Since then, humans have struggled against weeds.

The content in this reference guide will assist you to:

- describe direct and indirect methods of controlling weeds in wetland rice.
- name two requirements for effective use of herbicides in controlling rice weeds.
- classify herbicides based on time of application, mode of action, and selectivity, and give examples of each.
- identify and discuss commonly used herbicide formulations in wetland
- rice weed control, and give examples of each.

Weed Control Requisites

Weed identification

Some weeds closely resemble rice plants, particularly at the seedling stage.
Identification of weed species is very important in hand weeding. It is also needed for choosing the most appropriate herbicide to use.

Determining the proper time to remove weeds

Knowing when to control the weed is another important requisite in weed control. Often, early weeding is essential; weeds are easier to control during the early growth stages, and have not yet caused considerable damage to the crop. When weeding is delayed, then more time must be spent weeding and the potential for damage to the crop increases.

Controlling Weeds - Indirect Method

Land preparation

Land preparation is frequently overlooked as a method of weed control. Typically, two tillage operations are required to achieve a weed-free seedbed:

1. **Plowing** - Incorporates weeds into soil, often to a depth of 10 to 15 cm.

2. **Harrowing** - Early harrowing destroys weeds and encourages weed seeds to germinate. Later harrowing destroys weeds that have germinated since the previous harrowing. Greater numbers of harrowing reduce seed stocks in the soil and, consequently, reduces weed infestations.

Preventative weed control

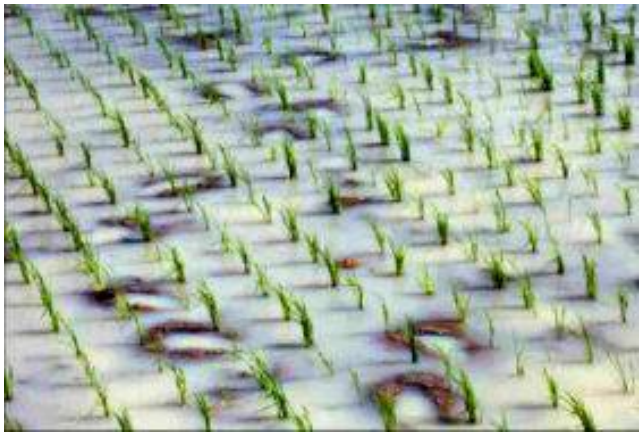
It is easier to prevent the introduction or germination of weeds than to control them after they are already established. Seven possible methods of preventive weed control exist:

1. Use “clean” seeds that have no weed seeds in them.
2. Keep the rice seedling nursery free of weeds and make sure weeds are not transplanted with seedlings.
3. Keep bunds and irrigation canals free of weeds.
4. Keep tools and machinery clean so that seeds are not transported from field to field.
5. Keep livestock out of rice fields.
6. Prevent weeds in the area from producing seeds.
7. Prevent entry of water-carried vegetative propagules of weeds that are perennial.

Water management

Water management has always been an effective and very important method of controlling weeds in rice. Many weeds cannot germinate under flooded conditions. Proper leveling of paddies results in even distribution of water during early flooding, which is essential to effective herbicide application.

In general, weed densities decrease as water depth increases. Even as little as 1 to 2 cm of water reduces weed densities. Continuous flooding usually results in abundant aquatic species but can be useful for controlling grasses and some sedges. Few weeds occur when a field is flooded to a depth of 15 cm.



Flooding is effective only when the area is submerged from time of planting until the crop forms a continuous canopy. If the water level drops within this period, then conditions become favorable for seed germination or regrowth of some weed species.

Weed suppression through plant competition

Crop and weed plants compete with each other for resources such as light and nutrients. Good crop husbandry favors the crop over the weed.

The following four crop production practices can be used to favor the crop over the weed and suppress weed production and growth under certain conditions:

1. **Planting method -** transplanting is primarily done for good weed control. Planting seedlings gives the crop a 14- to 21-day growth advantage over the weeds, and allows continuous flooding at greater depths. Plus, with rice in neat rows, hand weeding, or the use of mechanical weeders, is much simpler.

2. **Cultivars -** cultivars may differ in how competitive they are against weeds. Cultivars with greater seedling vigor, greater leaf area development, greater early height growth rates, and greater tillering ability are probably most competitive.

3. **Plant density -** the closer the plants are sown, the more competitive they are against weeds. Greater plant densities may allow the crop canopy to close sooner, reducing weed germination and growth.

4. **Time of fertilizer application -** weeds also require nutrients, and application of nitrogen and phosphorous stimulates weed growth. In unweeded plots, weed growth increases as nitrogen level increases, resulting in yield reductions.

Fertilizers should be applied when they are most beneficial to the crop, not when they would increase weed competition. Early to mid-season application of nitrogen often benefits the rice crop, but if weeds are present, then weed competition may also increase. Therefore, weeds should be controlled before nitrogen application.

Controlling Weeds - Direct Method

Hand weeding

Hand weeding is most useful on annual weeds and certain perennial weeds that usually do not regenerate from underground parts. It is a practical method of removing weeds within rows and hills where a cultivating implement cannot be used, but requires more labor than other direct weed control methods.

Hand weeding of young weeds at the two-leaf to three-leaf growth stages is extremely difficult. Therefore, hand weeding is generally delayed until weeds are large enough to be grasped easily.

Mechanical weeding

Mechanical weeding is another direct method of weed control. For all mechanical methods, straight-row planting is essential. Mechanized interrow cultivation is less effective than hand weeding because weeds in crop rows are not removed. Competition from those weeds can be harmful.

Herbicide application

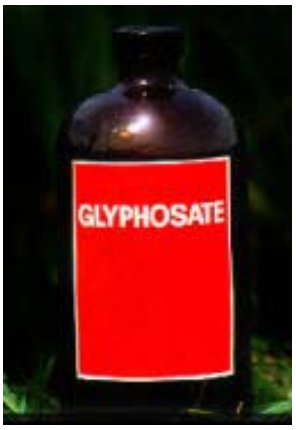
Herbicides are chemicals that kill certain plants or inhibit their growth. Herbicides are a supplement to other methods of weed control, not a replacement. It is especially important to maximize control gotten from indirect methods in order to reduce the need for herbicide use.

Three Classifications of Herbicide

Time of application

Based on time of application, herbicides are classified as:

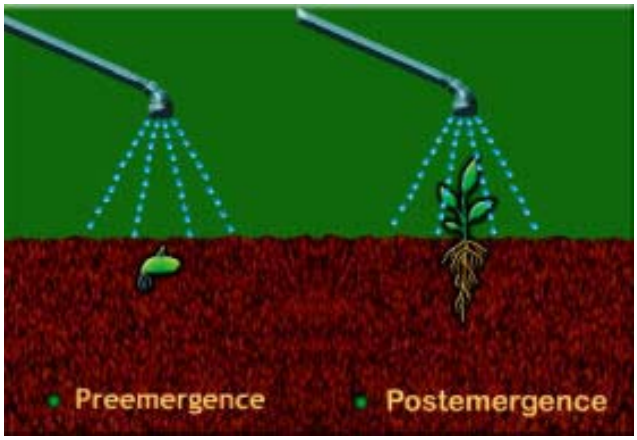
1. **Preplant** - preplant herbicides are applied before the crop is planted. This term is often abbreviated as PP in herbicide literature. They are usually used to kill weeds that have germinated before planting or were left from fallowing. *Glyphosate* is an example of a preplant herbicide.

2. **Preemergence** - preemergence herbicides are applied after the crop has been planted but before weeds emerge. Preemergence herbicides are usually applied to the soil surface. This term is often abbreviated as PRE in literature on herbicides. They are used to prevent establishment of weeds right after planting. They must not be toxic to the crop. *Butachlor* is an example of a preemergence herbicide.


3. **Postemergence** - are applied after weeds have emerged. The term is often abbreviated POST in the herbicide literature. Postemergence herbicides are used to control weeds that have established in the crop. They should not be toxic to the crop and usually must contact the weed foliage to be effective. An example of a postemergence herbicide is *2,4-D*.

The terms preemergence (PRE) and postemergence (POST) are sometimes used to denote time of application of herbicides to both the crop and the weeds. To avoid confusion, state the stage of development of both the crop and the weeds.



NOTE: Timing of herbicide treatments may depend on the chemical nature of the herbicide and its persistence, crop species and tolerance, characteristics of weed species, cultural practices, and climatic and soil conditions.

Mode of action

Based on mode of action, herbicides are classified into two categories:

Contact - Contact herbicides are applied to foliage and other above-ground parts of a plant. They kill plant tissues at or very close to the application site. An example of a contact herbicide is *propanil*.

Translocated - Translocated herbicides are absorbed by the roots or above-ground parts of a plant. Within the plant, the herbicides then move to and kill tissues that may be remote from the point of application but where herbicide action occurs

Some herbicides are active only when applied to the leaves; others are active when absorbed by both leaves and roots. Examples of translocated herbicides are *2,4-D* and *cyhalofop butyl*.

Selectivity

Selectivity is how narrowly or widely an herbicide is effective on plants and falls into two categories:

1. **Selective** - A herbicide that kills or stunts some plant species with little or no injury to others, especially the crop, is selective. Examples of selective herbicides used in rice production are *butachlor*, *thiobencarb*, *propanil*, and *2,4-D**.These herbicides do not kill rice and are therefore safe to use. However, they might injure rice in some conditions.

2. **Nonselective** - A herbicide that kills all plant species, or shows no selectivity, is nonselective. An example of a nonselective herbicide is *glyphosate*. *Glyphosate* will kill all plants in a field, including rice. Therefore nonselective herbicides are used as preplant (PP) herbicides.

NOTE: At recommended doses, a herbicide may be selective when used with a particular crop. However, if higher doses are used or if the herbicide is applied at the wrong time, it can damage or even kill the crop. The same herbicide may be selective or nonselective, depending on the rate and time of application.

Herbicide Formulation

Herbicide formulation

Herbicides are frequently insoluble in water. Usually applied at low rates, they must be combined with a carrier that is a liquid or solid. Combination with a carrier makes application easier, increases effectiveness, and ensures even distribution of herbicides.

Herbicides are usually available in three formulations:

- water-soluble salts
- emulsifiable concentrates
- granules

Water soluble salts

Salts of some organic herbicides are soluble in water and are referred to as water-soluble salts. They are sold as solids or as aqueous concentrates. Examples of water-soluble herbicides are sodium and amine salts of 2,4-D. These herbicides, when dissolved in water, require minimum stirring before they are sprayed.

Emulsifiable concentrates

Emulsifiable concentrates are concentrated liquid formulations in which the water insoluble herbicide is dissolved in a suitable solvent. Oil is commonly used as an organic solvent. When oil is added to water, the mixture usually forms emulsions of the oil-in-water type. Herbicide molecules are not dissolved in water, but occur as the dispersed phase in the liquid.

Examples of emulsifiable concentrates are *butachlor* and ester formulations of *2,4-D*. Constant agitation during spraying is required to keep the spray solution uniformly mixed.

Granules

In granular formulations, the herbicide is mixed with an inert ingredient (a carrier) such as marble chips or clay. Granules vary in shape and size, and are broadcast over the flooded field. The herbicide is then released gradually into the water.

Two examples of granular herbicides used in rice are *butachlor* and *2,4-D*.These formulations do not require special spraying equipment, if care is taken to distribute

than uniformly across the field. Blowers may be a useful mechanical delivery option for herbicides.

Commonly Used Herbicides for Wetland Rice in the Tropics

Commonly used herbicides for wetland rice in the tropics

The following table is a list of commonly used herbicides for wetland rice in the tropics. Each of these herbicides are discussed in further detail in the following pages of this section.

These herbicides have given consistent results in countries with different climates and different soils. They should be tested in specific areas before recommendations are made.

HERBICIDE FORMULATION	RATE kg a.i./ha	APPLICATION	ACTION	ACTION	
		PRE-EMERGENCE	POST-EMERGENCE	CONTACT	SYSTEMIC
1. 2, 4-D EC	0.4-0.8		X		X
Granules	0.8	X			X
2. Butacholor EC	1	X			X
Granules	1	X			X
3. Thiobencarb EC	1.5	X			X
Granules	1.5	X			X
4. Propanil EC	3-4		X	X	

2,4-D

Commercial formulations of 2,4-D include water-soluble salts, emulsifiable concentrates or esters, and granules. Salt and ester formulations of 2, 4-D are postemergence (POST), translocated, and selective herbicides that control many sedges and broadleaf weeds. They usually do not control grasses. Application rates of these herbicides vary from 0.4 kg a.i./ha to 0.8 kg a.i./ha.

2,4-D granules act as preemergence (PRE), translocated, and selective herbicides for dry-seeded and transplanted rice. Four days after transplanting, the granular formulations are applied at 0.8 kg a.i./ha. They control grasses, sedges, and broadleaved weeds.

NOTE: In wet-seeded rice, 2,4-D should not be used as a preemergence (PRE) herbicide.

Butachlor

Butachlor, a preemergence (PRE), translocated, and selective herbicide, is effective against many annual grasses, sedges, and broadleaved weeds. Best results are obtained when butachlor is applied at 1 kg a.i./ha to 2 kg a.i./ha.

In transplanted rice, the granular form of butachlor is applied three to five days after transplanting (DAT).In wet-seeded rice, the emulsifiable form of butachlor should be applied three days before seeding (DBS).

Propanil

Another common rice herbicide is propanil. It is a postemergence (POST), contact, and selective herbicide that controls many annual grasses. To be effective, the weed foliage must absorb propanil. Starting from the day of spraying, a paddy must be drained for about one week to expose weeds to the herbicide and ensure a contact.

The rate of application of propanil ranges from 3 kg a.i./ha to 4 kg a.i./ha. The herbicide is applied 10 to 20 DAT, or 10 to 20 days after sowing pregerminated seeds. To avoid crop damage, propanil should not be applied within two weeks after applying carbamates and organophosphate insecticides.

Glossary

Contact herbicide – an herbicide that kills plant tissue at or very close to the site.

Emulsifiable concentrate – a concentrated solution of a herbicide and an emulsifying agent in an organic solvent, which forms an emulsion when added to water.

Granular herbicide – a type of formulation for dry application consisting of granules, which act as a carrier for the herbicide.

Handweeding – Removal of weeds by hands or by the use of sickle (or syhte).

Herbicide – a chemical used for killing or inhibiting the growth of certain plants.

Mechanical weeding – removing weeds with the use of a mechanized interrow cultivator.

Nonselective herbicide – an herbicide that kills all vegetation with which it comes into contact.

Preemergence herbicide – an herbicide applied after the crop has been planted but before the weeds emerge, or before the crop and weeds emerge. Sometimes abbreviated as PRE.

Preplant herbicide – an herbicide applied before the crop is planted. Sometimes abbreviated as PP.

Postemergence herbicide – an herbicide applied after the crop and/or weeds have emerged from the soil. Sometimes abbreviated as POST.

Selective herbicide – an herbicide that kills or stunts some plant species but causes little or no injury to some others.

Translocated herbicide – an herbicide that kills plant tissues when absorbed by the leaves or roots and then translocated within the plant system to tissues remote from the application point.

Water-soluble herbicide – a type of formulation of inorganic herbicides and the salts of some organic herbicides that are soluble in water.