

Principles of Weed Management ¹

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In any discussion of weed control, there must first be a definition of a weed. Many definitions have been used; however, for the purposes of this guide a weed is defined as: any plant that is a hazard, nuisance, or causes injury to man, his animals, or his desired crops.

It should be obvious from this definition that almost any plant can be a weed under certain circumstances. For example, corn and soybeans are crops and neither is generally considered a weed; however, if you are producing soybeans and corn is present in your field it could then be defined as a weed. Likewise, a small mixture of variety X soybeans in a field of variety Y soybeans is of little consequence if the beans are to be sold for oil; however, if you are attempting to produce certified variety Y soybeans then variety X is a serious weed problem.

Whether you live on the farm or in the city, weeds either directly or indirectly influence your everyday life. Weeds reduce yields, crop quality, and interfere with efficient harvest. These reductions are eventually passed to the consumer, either in increased

prices or in poor quality products. Weeds interfere with recreational activities in aquatic areas and in parks and playgrounds. Weeds, such as poison ivy and poison oak, cause misery to many people. Other weeds, such as ragweed can cause hayfever, resulting in discomfort and increased medical expenses.

It is estimated that current total losses to Florida agriculture due to weeds are approximately \$431 million dollars per year. It is also estimated that the current use of herbicides comprises more than 76% of the total pesticide sales in the United States. With this magnitude of agricultural losses and herbicide usage, weed control recommendations have been prepared to aid in more efficient and effective weed control. Since weed control consists of more than using herbicides, recommendations attempt to address other methods of weed control and how they may be combined with chemical weed control.

CLASSIFICATION OF WEEDS

Weeds may be classified as grasses, broadleaves, and sedges.

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Use herbicides safely. Read and follow directions on the manufacturer's label.

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They may further be classified by the length of their life cycle (annual, biennial, and perennial). The classification of weeds based on the length of their life cycle may not be obvious on visual inspection but will have a great impact on the selection and/or success of control procedures. The life cycle characteristic will become an automatic association as specific weeds and weed types are learned.

Grass Weeds

True grass weeds have hollow, rounded stems and nodes (joints) that are closed and hard. The leaf blades have parallel veins, are much longer than they are wide, and alternate on each side of the stem. Some examples are crabgrass, goosegrass, crowfootgrass, sandbur, annual bluegrass, torpedograss, and vaseygrass.

Broadleaf Weeds

Broadleaf weeds are a highly variable group of plants but most have showy flowers and net-like veins in their leaves. They are easy to separate from grasses due to their generally different leaf structure and habits of growth. Some examples of broadleaf weeds are cudweed, creeping charlie, henbit spurge, burning nettle, pennywort, creeping beggarweed, cocklebur, sicklepod, and Florida beggarweed.

Sedges

Sedges are an important group of "grass-like" weeds, but they are not true grasses. They are characterized by a solid, triangular-shaped stem with leaves extending in three directions and are usually referred to as nutgrass.

Annual sedges (often called water grass) are usually a minor problem and easier to control than the widespread and difficult to control perennial sedges.

There are two major perennial sedges. Yellow nutsedge is yellowish green in color and reproduces by seed, rhizomes, and tubers. The rhizomes radiate from the plant with a single bulb or tuber at the end which may produce new plants. Purple nutsedge is usually smaller in size than yellow nutsedge, has reddish purple seed heads, and produces a series of bulbs on radiating rhizomes called "tuber chains."

Annual Weeds

Annual weeds, as the name implies, complete their life cycle within one year. They germinate from seed, produce seed, and die in 12 months or less. They may be annual grasses, sedges, or broadleaved weeds. In addition, their life cycle may begin at different seasons of the year.

Summer annuals emerge in the spring and mature before winter. Weeds such as crabgrass and cocklebur are typical summer annuals. Similarly, winter annual weeds sprout from seed in the fall, and complete their life cycle before summer of the next calendar year. Wild radish, henbit, annual bluegrass, and chickweed are examples of winter annual weeds.

Biennial Weeds

Compared to annual weeds, biennial weeds are few in number. These weeds have a 2-year life cycle. They germinate from seed in the fall, develop large root systems and a compact cluster of leaves during the first year.

The second year they mature, produce seed, and die. Examples of biennial weeds are cudweed, Carolina false dandelion, wild carrot, and bull thistle.

Perennial Weeds

Weeds that live more than two years are perennials. They reproduce by vegetative parts such as tubers, bulbs, rhizomes (underground stems) or stolons (above-ground stems). Some also produce seed in addition to vegetative reproduction.

During the winter season, most survive in a dormant state, and many lose their above ground foliage and stems. With the beginning of spring, they regenerate from food reserves in their root systems. Torpedograss, nutsedge and various vines are members of this group of weeds. Florida betony is a perennial weed that, under a subtropical climate, initiates its growth in the fall, grows during the winter months and goes dormant during the heat of summer.

Perennial weeds may be further divided into groups based on the type of root system and reproductive process:

- Simple perennials reproduce by seeds but root pieces distributed by cultivation or other mechanical means may produce new plants. Florida betony, some trees, and shrubs are characteristic of this group;
- Bulbous perennials reproduce by seed and above- or below-ground bulbs. Yellow nutsedge and wild onions have their bulbs below ground while wild garlic has an above ground bulb;
- Creeping perennials produce seed but also produce rhizomes or stolons. Bermudagrass, torpedograss and purple nutsedge produce these specialized stems (rhizomes and stolons) that act as food storage organs and can initiate growth at each node (joint) along the stem.

Obviously, the perennial weeds are the most difficult to control because of their great reproductive potential and persistence.

In cultivated row crops, annual weeds such as crabgrass, goosegrass, cocklebur, and ragweed are the most prevalent. However, perennial weeds such as nutsedge, johnsongrass, and common bermudagrass may also be severe problems.

In pastures and rangeland, perennial weeds tend to dominate among the perennial forage crops. Weeds such as smutgrass, dog fennel, wax myrtle, and prickly pear are very competitive but would not survive in a cultivated, row crop situation. Similarly in fruit crops, where the desirable plants are also perennial, weeds such as guineagrass, vaseygrass, and milkweed vine are problems.

METHODS OF WEED CONTROL

There are several methods of weed control: mechanical control, crop competition, crop rotation, biological control, fire, and chemical control. Best weed control is usually achieved by a combination of two or more of these methods.

If effective weed control has been achieved, methods of prevention should be undertaken to keep weeds from reinfesting an area.

Mechanical Control

One type of mechanical control is burial. This method is most effective on annual weeds in which all the growing points can be buried. Burial is usually less effective on perennial weeds which have underground stems and roots and are capable of regrowth from these underground storage organs.

Another method of mechanical control is cultivation. The main objective in cultivation is to cut the root system of weeds and deep cultivation should usually be avoided due to damage to the crop roots. Deep cultivation may also bring more weed seed to the surface where they will germinate.

Most studies have shown that when weeds can be controlled without cultivation, there is no advantage to cultivating. In fact, there may be disadvantages such as drying out the soil surface, bringing weed seed to the surface, and disturbing the root system of the crop.

Mowing is another method of mechanical control. Mowing is usually most effective on tall growing annuals, and not as effective on short growing plants or perennials. The growth habit of the plant usually indicates how effective mowing will be.

Since grasses grow from basal meristems, mowing is not usually an effective method of controlling these weeds. Perennial weeds which regrow from underground storage organs require frequent and usually long term mowing for control. This is because the leaf area must be continually removed so that the underground plant parts are starved and not allowed to regenerate any carbohydrates for storage. Annual weeds are usually mowed to prevent seed production and to allow the crop a better competitive advantage.

Crop Competition

Crop competition is usually one of the cheapest and best methods of weed control; however, it is often one of the most overlooked methods.

Weeds compete with crops for space, light, moisture, nutrients, and carbon dioxide. Usually the plant which starts first and is growing under ideal conditions will have the competitive advantage. Factors such as planting date, row spacing, seeding rate, planting depth, soil moisture, soil fertility, and soil pH have an influence on the competitive advantage of the crop or weed.

Most of our crop plants have been developed under conditions which were as near optimum as possible for that crop; therefore, everything that can be done to simulate these conditions for the crop plants should be in its favor. Since weeds have not been developed by plant breeders for specific conditions, they are often more tolerant of a wide range in conditions. However, some forages have become weed problems which were selected for production purposes. Examples include hairy indigo and chufas or yellow nutsedge. These have both become major problems in agronomic crop production.

Usually only one crop species is planted; however, there are many weed species available to compete with this crop. For example, as soil pH becomes higher or lower than its optimum for the crop there is usually a weed species which is tolerant of that pH. This is also true for factors such as fertility, soil moisture, and depth of emergence.

Planting the crop at the optimum soil temperature, depth, soil moisture, soil fertility, and soil pH will allow it to emerge most rapidly, grow, and cover the row middles thus reducing much of the weed competition by shading.

Crop Rotation

If the same crop is planted in the same field year after year, there usually will be some weed or weeds which are tolerant and favored by the cultural practices and herbicides used on that crop.

By rotating to other crops, many of the cultural practices and herbicide programs are changed. This often will reduce the population of specific weeds which were tolerant in the previous crop. Rotating grasses and broadleaf crops is most effective due to effective herbicide rotations.

Biological Control

Biological weed control as a practical tool has not been utilized to a great extent in controlling weeds. There have been certain instances of successful biological control programs, but these have been infrequent. Insects, disease, and nematodes naturally suppress growth of certain plants and this is a continual process in the field. One area which should be recognized is how the use of fungicides, nematicides, and insecticides influences weed populations. If a plant is naturally suppressed by one of these organisms, it could become a weed if that organism is controlled. Many attempts have been made to successfully use biological control agents for weeds; however, none have proven successful. A better approach could be the utilization of integrated weed management (IWM). IWM encompasses many control practices while ensuring sustainable crop production.

Fire

Fire is an old method of weed control and in certain instances can be used to selectively favor certain species over others. Controlled burning can be useful to remove weeds from ditch banks, roadsides, and other waste areas.

Fire has been used for many years to favor the growth of pine seedlings over hardwoods. Special equipment for flaming is available. Fire is usually more effective on annual weeds than on perennial weeds and usually does not kill weed seed in the soil.

Chemical Control

Time of Application

Chemical control can be administered preplant, preemergence, and postemergence.

Preplant

Preplant refers to applications made before the crop is planted. In most cases at the present time, these materials are incorporated into the soil and are called preplant incorporated treatments.

The great advantage of these incorporated treatments is that the herbicide is placed in the zone where weed seed germinate and is not dependent on rainfall to move the herbicide into this zone.

This treatment adds to the cost of incorporation and requires that the crop be tolerant of the herbicide since they will be in contact. Examples of such herbicides are trifluralin, pendimethalin, and ethalfluralin.

Preemergence

Preemergence treatments usually refer to applications made after the crop is planted but before it emerges. However, strictly speaking, preemergence may apply to other situations. It may be preemergence to the crop, preemergence to the weeds, or preemergence to both crop and weed.

These preemergence applications are usually applied to the soil surface and require rainfall or irrigation to move the herbicide into the soil. If the herbicide is not moved into the soil where the weed seed are located, it will not be effective. If left on the soil surface, these herbicides are often lost due to photodecomposition and vaporization.

Postemergence

Postemergence treatments are applied following emergence; however, as with preemergence, it should be specified as to postemergence to the crop or weed. If the crop has emerged but no weeds are present, the application is postemergence to the crop but preemergence to the weeds and would be applied to the soil surface. If the crop has emerged and the weeds have emerged, the applications is postemergence to both weed and crop and would be applied to the foliage of the weeds.

Area of Application

Chemical application may involve broadcast, band, directed, or spot treatment.

Broadcast Applications

As the name implies, broadcast applications cover the entire area. These treatments, while requiring the largest amount of chemical and highest cost per acre, usually result in best weed control.

Band Applications

Band applications usually refer to treating a narrow strip directly over the row. This reduces the amount of chemical required and therefore the cost per acre. With this type of application, the area between the rows is not treated and usually will require cultivation or chemical treatment later in the season.

Directed Applications

Directed applications are applied to a particular area or part of the plant. These applications are usually directed to the base of the crop plant and away from the leaves. The ability to use directed sprays usually depends on a height differential between the crop and the weed. If the crop is taller than the weeds, drop nozzles can be used to direct the spray treatment over the weeds but below the leaves of the crop.

Directed sprays are very useful in late season control of weeds and usually follow a preplant or preemergence application. In many cases, preplant or preemergence applications do not persist long enough to control late germinating weed seed or may not be used on certain soil types. In such cases, directed sprays are used to obtain effective control and improve harvest efficiency.

Spot Treatments

Spot treatments are used for weeds which are localized in certain areas but are not widespread over the entire area. When only isolated areas of weeds are present, this is the cheapest and best method to control and prevent their spread to other areas.

Herbicides

General herbicides may be classified in several ways depending on where and how they are applied and their action in or on the plant. Herbicides may be either foliage applied or soil applied. They consist of contact or systemic materials that are translocated throughout the plant.

Herbicides may also be selective or non-selective. Some herbicides may be effective either foliage applied or soil applied. Whether a

herbicide is selective or non-selective may depend on several factors, such as the crop or weed present, time of application, and rate of application. Genetic engineering has resulted in transgenic crop varieties that are resistant to control by certain herbicides, while the conventional varieties are sensitive to the same herbicide.

For example, paraquat would usually be described as a foliage applied, contact, non-selective herbicide, while atrazine would usually be described as a soil applied, translocated, selective herbicide.

Foliage Applied Herbicides

Foliage applied herbicides may be applied to leaves, stems, or shoots of plants. Herbicides that kill only those parts of the plants which the spray touches are contact herbicides.

Translocated or systemic herbicides may be taken into the plant and moved throughout the plant to site of action. For example, if a drop of paraquat were applied to the leaf tip of a young tomato plant then only that leaf tip would be killed; however, if a drop of 2,4-D were applied to the leaf tip of a young tomato plant then other areas of the plant would express symptoms due to translocation of the 2,4-D throughout the plant.

For systemic herbicides to be effective, they must enter the plant that is to be controlled. Entrance may be influenced by factors, such as the shape or orientation of the leaf, roughness of the leaf surface, pubescence on the leaves, presence of wax, or the formulation of the herbicide. For example, it is difficult to obtain good coverage of plants with narrow upright leaves such as wild onion since the herbicide bounces or runs off, while plants with prostrate leaves such as wild radish are much easier to cover.

The presence of pubescence (hairs) on the leaf may result in a herbicide not reaching the leaf surface but remaining suspended on the hairs. In such cases, the addition of a surfactant may be useful in reducing the surface tension of the water droplet and allowing it to spread through the hairs onto the leaf surface where it may be absorbed.

On waxy leaf surfaces, the formulation of the herbicide may be important. For example, the amine formulations of phenoxy herbicides are not highly soluble in wax and are not as effective on plants with waxy leaves as the ester formulations which are soluble in wax.

Contact herbicides are more effective on annual weeds but are not usually effective on perennials. Translocated herbicides may be effective on annuals or perennials.

Soil Applied Herbicides

Soil applied herbicides primarily enter plants through the root system. Factors such as tolerance of the crop or weed to the herbicide, depth of weed and crop seed, amount of sand, silt, clay and organic matter of the soil, amount and time of rainfall, and temperature are a few factors which may influence effectiveness.

One example of tolerance is with atrazine. When atrazine is applied to a field of corn it may enter both the corn and the weeds; however, corn has the ability to detoxify atrazine. This results in selective weed control.

Although soil applied herbicides must be moved into the soil to be effective, the amount of movement in the soil can be used to achieve selectivity. For example, if the problem weeds are in the upper 1 inch of soil and the crop seed can be planted 2 inches, a herbicide which does not move rapidly in the soil or incorporation to a depth of 1 inch can be used, thus resulting in the crop seed remaining below the zone of herbicide.

Persistence of herbicides is extremely important in the duration of weed control. It is also important in determining what crop can be planted later in the season or the next growing season(s). The persistence of herbicides applied to the soil may be influenced by numerous factors such as microbial decomposition, chemical decomposition, adsorption, leaching, volatilization and photodecomposition.

Soil type is extremely important in herbicide selection and activity. Soluble herbicides applied to sandy soils may be rapidly leached out of the zone

containing weed seed and into the zone of germination or roots of the crop resulting in poor weed control and damage to the crop. In fine textured soils or organic soils, herbicides may be so tightly adsorbed that they are not available for weed control or they may be released so slowly that they are not in a concentration great enough to kill the weeds. This lack of release may also increase the persistence of herbicides into the following crop in fine textured or organic soils.

Herbicides which specify incorporation into the soil may do so to improve the contact of the herbicides with the seed and to minimize the loss of the herbicides by volatilization and photodecomposition. Some herbicides, if not incorporated soon after application, may be lost from the soil surface.

One of the major factors influencing herbicide persistence in the soil is microorganisms. These organisms may use the organic herbicides as a source of carbon for their food supply. The specific herbicide, microorganism present, temperature, water, oxygen, and mineral nutrients are all important in the persistence.

Generally, the fast degradation of herbicides is achieved in warm, moist, well-aerated, fertile soils at pH ranges favorable to crop growth. The greatest persistence of herbicides may be expected if the soil is cool, dry, poorly aerated, and generally unfavorable to the growth of the microorganisms.

Prevention

If effective weed control has been achieved using the previously discussed methods, one further step should be considered. This is preventing weeds from reinfesting the area.

Knowledge of how weeds enter the field is important. Weed seed may be distributed in crop seed, hay, straw, by wind, water, animals, machinery, and other ways.

Fence rows and ditch banks are often neglected when controlling weeds in crops. Seed produced in these areas may move into the field and although it is difficult to prevent weed seed from blowing into the

field or being carried by birds, or water, if they can be stopped from producing seed in these areas it will reduce the possibility of reinfestation.

The use of certified, registered, and foundation seed, or clean planting material cannot be over emphasized in preventing weeds from infesting fields. It is also important to clean equipment before entering fields or when moving from one field to another.