7

Weed Management in Vegetables

Weeds pose one of the most serious threats to vegetable production in the United States, causing millions of dollars in losses as a result of lower yields, poorer quality, and reduced efficiency and higher production costs (Table 7.1). In cultivated vegetable crops, weeds regularly appear, almost immediately after soil tillage and to a lesser extent throughout the remaining growing period. Each farm, as well as each crop area within a farm, may reveal unique

Table 7.1. Estimated Average Annual Losses of Vegetables in the United States due to Weeds[a]

Vegetable Crop	Losses from Potential Production		
	Reduction	Quantity	Value
	(%)	*(tons)*	*($1,000)*
Broccoli	13	60,900	22,403
Cabbage	10	97,300	13,629
Spinach	19	9,550	3,834
Carrots	12	86,600	14,415
Onions	9	275,000	40,102
Potatoes	7	1,400,000	105,980
Lettuce	8	569,350	91,512
Tomatoes	10	207,600	154,457
Green beans	10	22,100	10,165
Sweet corn	11	82,200	22,320
Cucumbers	12	44,200	17,395
Muskmelons	10	60,150	12,967
Watermelons	9	232,350	16,016
Total		3,147,300	525,195

[a]Source: Chandler, J. L., A. S. Hamill, and A. G. Thomas. 1984. *Crop Losses due to Weeds in Canada and the United States.* Weed Science Soc. Amer., Champaign, Illinois.

weed problems. In many less-developed countries more worker-hours are spent on weeding crops than any other cropping practice activity.

The successful management of weeds requires an integrated program that includes chemical and nonchemical methods. Some control methods entail the physical destruction of weeds. Other methods aim to establish a vigorous crop that competes effectively with weeds. The decision on which methods to use depends on the weed pressure, labor availability, environmental concerns, marketing opportunities, and the particular weed and crop species.

WEEDS

The first step of weed management in vegetable crops begins with an understanding of the growth habits and biology of weeds. Each grower must know or develop information on the specific weed problems likely to be encountered in a particular crop planting.

Weed Classifications

Weeds can be divided into three general groups: grasses, which include crabgrass, foxtails, barnyardgrass, and wild proso millet; sedges, such as yellow nutsedge; and broadleaf weeds, such as pigweed, purslane, and common milkweed (Table 7.2). In grasses and sedges, growth comes from a meristem located at or near the soil surface, while in broadleaf weeds, growth can be initiated from both apical and lateral meristems.

Weeds can also be grouped according to their life cycle: annual, biennial, or perennial. The most serious problem weeds for vegetables are generally the summer annuals such as barnyardgrass, giant foxtail, purslane, and common lambsquarter, which complete their life cycle during the summer. Winter annual weeds (e.g., wild mustard, chickweed), which complete their life cycle when most vegetables are not planted, are usually not a problem, except with fall-planted vegetables (e.g., cole crops) and perennial crops (e.g., asparagus). Annual weeds reproduce mainly by seeds, and the aim in their successful management is to prevent their seed production.

Biennial weeds, such as wild carrot and wild parsnip, have a two-year life cycle and are usually not a problem in annual vegetable crops. They occur primarily in reduced tillage or perennial crops and should be controlled in the first year as seedlings, before their seeds germinate the following spring.

Table 7.2. Common Weeds in Vegetable Crops

Broadleaves		
Annuals	**Biennials**	**Perennials**
Cocklebur	Common burdock	Canada thistle
Common lambsquarter	Evening primrose	Common milkweed
Common purslane	Wild carrot	Dandelion
Common ragweed	Wild parsnip	Field bindweed
Chickweed		Hemp dogbane
Galinsoga		Horsenettle
Giant ragweed		
Groundsel		
Jimsonweed		
Morning-glory		
Mustards		
Nightshade		
Pennycress		
Redroot pigweed		
Shepherds purse		
Smartweed		
Velvetleaf		

Grasses and Sedges	
Annuals	**Perennials**
Barnyardgrass	Johnsongrass
Fall panicum	Quackgrass
Foxtails	Wild garlic
Goosegrass	Yellow nutsedge
Crabgrass	
Shattercane	
Wild proso millet	

Perennial weeds, such as Canada thistle, field bindweed, johnsongrass, and yellow nutsedge, live more than two years and remain in fields until they are killed. Although they usually start from germinating seeds, many perennial weeds propagate and spread largely by asexual means (rhizomes, stolons, or tubers), making them difficult to control. Some perennial weeds may lose their leaves, while the stems of others may die back to the ground each winter. Managing perennial weeds requires a combination of mechanical and chemical methods, but even then their control may be difficult. It is usually best just not to use fields with perennial weed problems.

Weed Competition

Vegetables and weeds have the same basic requirements for growth and development. Weeds compete effectively with vegetables for water, nutrients,

sunlight, carbon dioxide, and space. They usually dominate because of their more aggressive growth habit (Figure 7.1). The period from emergence until approximately four weeks later is a critical time for competition, especially for small-seeded crops like carrots and lettuce. Weeds can also harbor insects and disease. Carrots may be attacked by the carrot weevil, which uses wild carrots as an alternate host. Onion thrips can live in ragweeds and wild mustards.

Some weeds affect vegetable growth by releasing toxic or growth-inhibiting substances into the soil. This is known as *allelopathy* and is a form of weed competition. For example, leachates from common lambsquarter can significantly reduce the growth of tomatoes. For about 90 weed species, some type of allelopathic potential has been reported.

Figure 7.1. Weeds, such as pigweed, growing in the row with cabbage can cause significant reductions in crop yield and quality.

In addition to yield reductions, poorer-quality crops are produced where weeds are present. Muskmelons grown where weeds are present are smaller and remain green longer than those produced in weed-free plots. Due to competition for water, blossom end-rot in tomatoes is more severe in fields infested with nightshade than in weed-free fields. A negative effect on vegetable quality can also occur from physical damage due to weeds or contamination of the harvested crop with weed seeds or parts. This is particularly troublesome for mechanically harvested crops used for processing. Increased expense in harvesting because of heavy weed populations can cause substan-

tially higher production costs. Very often, vegetables faced with serious uncontrolled weed infestations are not harvested.

MECHANICAL AND CULTURAL CONTROL

Vegetable growers today must rely on sound, well-established mechanical and cultural practices for a good part of their weed control. In the past, the tendency was for growers to do less cultivating and to depend more on herbicides for weed control. This has changed, and today nonchemical weed management methods are of increasing importance due to public and industry concern with pesticides impacting the environment by leaching into groundwater sources, as well as from residues on food.

In addition, many older herbicides are no longer available. There are also many weed problems in vegetable crop production that cannnot be effectively solved with available chemicals. For these reasons, weed management should include nonchemical practices to combat and reduce weed problems. The modern vegetable grower should use chemical weed killers where practical and only as a supplement to good cultural and mechanical practices.

Plowing and Rotary Hoeing

Thorough working of the land prior to seeding or planting will kill many small weeds that have just germinated. Primary tillage operations prior to planting are particularly effective against perennial weeds. Moldboard plowing will destroy emerged annual weeds. Rotary hoeing is used with large-seeded vegetable crops such as sweet corn, beans, and peas and should be done after the weeds germinate but before they emerge. Once the crop germinates or transplants have been established, row cultivation is the most effective mechanical method in controlling weeds.

Cultivating

Cultivation, or intertillage of crops, is a very old agricultural practice that is used primarily to control weeds that emerge between rows of crops (Figure 7.2). It is most effective when weeds are breaking through the surface, since at this time weeds are not well established and merely breaking the soil surface will destroy them.

Figure 7.2. Cultivation is used to control weeds that grow between the rows of snap beans.

Frequent cultivations will be needed when conditions are favorable for the germination of weed seeds, such as after a rain or after the application of irrigation water. If cultivated when too wet, most classes of soils, except sands and loose peats and mucks, will bake on drying. If allowed to dry, the surface will have already become baked and hard and will not crumble when broken up. The best time to cultivate after a rain or after the application of water is when the soil is dry enough to crumble, but not so dry as to break into lumps.

Shallow cultivation is preferable to deep cultivation to minimize damage to crop roots. Some vegetable growers in the past practiced deep cultivation when the plants were small, with the idea that breaking of the roots near the surface would result in greater development of the crop roots. Experimental evidence indicated that this was a mistake and that destroying the surface roots did not make the roots go deeper. On the contrary, deep cultivation might bring a fresh supply of weed seeds to the surface where they could germinate.

Cultivation close to the crop row can be very destructive, causing significant root damage and uprooting of plants. Where high plant populations are grown for single-harvest cropping, rows may be too close for tillage, and weeds normally must be controlled with herbicides.

Hand weeding and hoeing may be used to supplement other weed control practices, and are most effective in the row where weeds are close to the crop

plants. To avoid damaging shallow roots, hoeing should remove weeds at the soil surface. Hand weeding and hoeing are labor-intensive and costly, and for most commercial vegetable production, they are practiced as little as possible.

Cultivating Effects on Soil Moisture and Temperature

Other benefits of cultivation include conservation of moisture and lower soil temperatures through the formation and maintenance of a soil mulch. By destroying weeds, cultivation usually results in moisture conservation. The formation of a soil mulch prevents or decreases surface runoff and slows the movement of water to the soil surface where it evaporates. Working the soil surface also increases aeration, which promotes biological and other chemical changes in the root environment.

However, under certain conditions, cultivation can also result in moisture loss. In general, when the soil is cultivated soon after a rain of 0.5 inch or less, moisture is likely to be lost because evaporation is hastened by exposing more surfaces to the drying action of air. Moisture may also be lost if cultivation is done when a mulch is already present. The mulch is deepened, and moist soil from below is brought to the surface where moisture is lost by evaporation.

It is often believed that cultivation increases the absorption and retention of heat. This is because heat is used in the evaporation of water. If this was the only factor involved, working the soil would raise the temperature when it resulted in conserving soil moisture and would lower the temperature when cultivation increased the loss of moisture. In fact, many studies have shown that during the growing season, cultivation reduces the soil temperature. The compactness of the surface of an uncultivated soil most likely accounts for its higher temperature, since a compact surface layer is a better heat conductor than a loose, dry layer.

Cultivation for the purpose of conserving moisture or reducing soil temperatures does not always increase yields. Destruction of roots by improper cultivation may more than offset the benefits from either conserving moisture or lowering soil temperatures. In general, the effects of cultivation on soil moisture and temperature are probably small and normally of little practical significance. Except for the purpose of controlling weeds, there is generally no justification for cultivating vegetable crops at regular intervals. Not only is unnecessary cultivation an added expense, but very often it is also injurious.

Cultivating Implements and Tools

Vegetables are cultivated by all types of equipment that are used for cultivating other intertilled crops. Special garden tractors and hand cultivators are also used in certain situations. Hand cultivators of the wheel-type hoe are used mainly for cultivating small growing crops produced intensively and for home gardens. Tractor cultivators range in size from the small garden tractor to the large four-wheel–drive farm tractor. Generally, the heaviest tractors are not well suited for cultivating most vegetables. Some of the medium-sized farm tractors are satisfactory for cultivating potatoes, cabbage, tomatoes, and other crops grown in rows far enough apart to give ample space for wheels.

Various types of attachments are used on cultivators. The sweep and the blade are efficient in controlling weeds between the crop rows and are less destructive to roots than the shovel and teeth attachments. Rotary hoe attachments are excellent for cultivating within the row over the plants when they are small.

Rotation

Vegetables are commonly grown in rotation with field crops such as corn, soybeans, and wheat. By rotating fields among different families of crops, growers can sometimes avoid problems with weeds since a wider spectrum of herbicides is generally available for use in agronomic crops than with vegetables. Weed problems that cannot be controlled in vegetable crops may be curbed with herbicides applied to field crops in the rotation. Rotation is often used in vegetables to prevent the buildup of common weeds, such as purslane. Cover crops such as barley, rye, sorghum, and alfalfa are especially competitive with weed species and can be either rotated with vegetables or used as fall cover crops.

When planning a rotation system between vegetables and field crops, growers should consider the potential threat of herbicide carry-over. Herbicide persistence, which is required to provide season-long weed control in field crops, can lead to injury in subsequent crops, since many vegetables exhibit extreme sensitivity to many commonly used herbicides. Environmental factors such as low temperatures, dry soils, and high soil pH all decrease microbial degradation of herbicides and increase the likelihood of herbicide carry-over. Problems with herbicide carry-over can usually be avoided through careful selection of herbicides and crop rotations. Bioassays and labo-

ratory residue analyses are common practices used by growers to identify and prevent potential carry-over problems.

Mulching

Properly applied organic and synthetic mulches can be useful in managing weeds. Fine-grained organic mulches applied 1 to 2 inches deep prevent light penetration to germinating weed seeds and reduce weed growth. Organic materials must be free of weed seeds and other noxious pest organisms. Unfortunately, most organic materials are difficult to apply over large areas and are best suited for specialized situations and the home garden.

Black and opaque synthetic plastic films are easy to apply by machine and will prevent weed growth. They are most useful to control weeds in warm-season crops, such as tomatoes, peppers, muskmelons, and watermelons, due to their added ability to increase soil temperatures (see Chapter 8). Clear plastic materials do not control weeds and must be used in combinations with selective herbicides to avoid weed problems. In practice, most mulches, whether organic or synthetic, control only annual weeds and are largely ineffective against perennial weeds.

Other Nonchemical Strategies

A general rule in weed management is not to plant vegetable crops on land with a history of weed problems, especially perennial weeds. In fields where weed problems may exist, growers should select competitive crops such as peas, potatoes, and cabbage and avoid poorly competitive vegetables such as onions and carrots. Growers should use cultivars adapted to their area.

Balanced fertility and effective insect and disease management will provide for vigorous, healthy crops that are more competitive against weeds. In combination with proper row spacings and plant densities, well-grown crops will provide an effective canopy cover that will shade out late emerging weeds.

CHEMICAL CONTROL

Although in many instances mechanical and cultural practices may be sufficient for weed control, they are generally time-consuming and require a large expenditure of both mechanical and human energy. Perennial weeds are usually difficult to control with nonchemical measures but can often be effec-

tively suppressed with herbicides. Along fence rows and irrigation ditches, where cultivation is not feasible, herbicides can be successfully applied. Weedy areas, formerly not recommended for vegetable crops, may be used with the proper application of herbicides.

For certain crops, such as snap beans, weeds between the rows can be controlled by cultivation, while weeds within the row are controlled with herbicides. In other cases (green peas), the rows are too close together for mechanical control and herbicides must be used.

Herbicides

The age of modern chemical weed control began in 1944 with the introduction of the auxin-type synthetic plant growth regulator 2,4-D (2,4-dichlorophenoxyacetic acid). Today, chemical weed suppression is still the primary method of weed control in commercial vegetable production.

Herbicides can be classified as either selective or nonselective. Selective herbicides will kill a specific group of weeds and not harm other plants. Certain herbicides control only grasses, while others control only broadleaf weeds. For example, 2,4-D when used on sweet corn will kill broadleaf weeds such as carpetweed, dandelion, and wild mustard but will not harm grasses, including the crop. Nonselective materials, such as paraquat, will kill all or most types of vegetation. The vast majority of herbicides used on vegetable crops are selective in nature.

Herbicides can also be categorized by their chemical structure (e.g., triazines, dinitroanilines, acetanilides) and mode of action (i.e., photosynthesis inhibitors, meristematic inhibitors, amino acid synthesis inhibitors). After they are applied, herbicides are translocated from the point of absorption to their specific site of action. This may be in the roots or in above-ground parts of the plant. Contact herbicides, such as paraquat, normally are applied to the foliage and will kill all vegetative matter they contact. A knowledge of herbicide mode of action is important for proper selection of materials and application methods to develop an effective and safe chemical weed control program.

For most vegetable crops, there are usually several choices of herbicides available, depending on crop species, soil type, climate, and weed species. Growers must make their choice based on their specific situation. Identifying the weeds present and knowing the weed history of the site will allow the grower to select the herbicide that will give the best results. In some cases, there may be very few, sometimes only a single herbicide, to treat a crop.

Some herbicides have very specialized use and may be limited to one crop. These limit grower flexibility in crop rotation, since herbicide residue from one crop may carry over and damage the following crop.

When selecting a herbicide the grower must also consider potential environmental hazards. Information on environmental hazards is contained on the herbicide label.

Herbicide Application

Herbicides used to control weeds in vegetable crops can be applied as (1) preplant, (2) preemergent, and (3) postemergent treatments. Preplant herbicides are applied before the crop is planted. In preplant-incorporated (PPI), the herbicide is applied before the crop is planted and worked into the soil to place it in the root zone of germinating weed seeds. Preemergent herbicides (PRE) are applied to the soil surface after the crop is planted but before the emergence of either the weed or crop seedlings, or both. Postemergent treatments are applied after the emergence of the crop plant.

Most vegetable herbicides are applied PPI or PRE (Table 7.3). The advantage of PPI herbicides is that they are in contact with soil moisture and usually do not require immediate rain or irrigation for activation, while PRE herbicides usually need a small amount of moisture to kill weeds. PPI application is used with volatile herbicides to prevent their escape to the atmosphere. Postemergent herbicides generally have foliar action, and their effectiveness (penetration and action) is usually greater when both the temperature and the relative humidity are high (Table 7.4).

Herbicides may be applied in a number of different ways. Broadcast treatments are uniform applications to an entire area (Figure 7.3). Foliar treatments are applied directly to leaves. Band treatment is the application of herbicide to a narrow strip, most often directly over the crop, with mechanical weed control methods used in the aisles. Directed sprays are applied to a particular portion of the plant and are used most often when the crop is susceptible to the herbicide.

Some herbicides can be effectively applied either as granules or as sprays. In general, sprays provide more precise placement and better distribution, as well as the best weed control. Herbicides are usually applied to vegetable crops with ground applicators, although in some specific instances, fixed-wing or helicopter aircraft may be used.

Table 7.3. Relative Effectiveness of Preplant-incorporated (PPI) and Preemergent (PRE) Herbicides on Various Weeds[a]

Herbicide	Barnyard Grass	Crabgrass	Fall Panicum	Foxtails	Goosegrass	Yellow Nutsedge	Annual Morning Glory	Galinsoga	Jimsonweed	Lambsquarter	Nightshade	Pigweed	Purslane	Ragweed	Smartweed	Velvetleaf
Alachlor (PRE)	G[b]	G	G	G	G	F	N	G	P	F	G	G	G	P	P	N
Atrazine (PRE)	G	G	P	F	G	F	FG	G	G	G	G	G	G	G	G	F
Benefin (PPI)	G	G	G	G	G	P	P	P	P	F	P	G	P	P	P	P
Bensulide (PPI)	G	G	G	G	G	N	N	N	N	F	N	F	F	N	N	N
Clomazone (PPI)	G	G	G	G	G	N	F	P	F	G	P	P	G	G	G	G
Cyanazine (PRE)	G	G	F	G	G	N	G	G	G	G	G	G	G	G	G	F
Cycloate (PPI)	G	G	G	G	G	F	N	F	N	F	P	G	F	P	P	P
DCPA (PRE)	G	G	G	G	G	N	N	N	P	G	N	F	G	N	N	N
Diuron (PRE)	G	F	F	G	G	P	G	G	G	G	G	G	G	G	G	G
EPTC (PPI)	G	G	G	G	G	F	P	P	N	F	FP	G	G	P	P	F
Ethalfluralin (PRE)	G	G	G	G	G	N	N	F	N	F	F	G	G	P	P	N
Imazethapyr (PRE)	P	P	P	G	P	P	P	G	F	F	G	G	G	P	G	F
Linuron (PRE)	F	F	F	F	F	N	P	G	F	G	F	G	G	G	G	G
Metolachlor (PPI,PRE)	G	G	G	G	G	F	N	G	P	F	G	G	G	P	P	N
Metribuzin (PRE)	F	F	F	FG	F	N	N	G	F	G	N	G	G	G	G	G
Napropamide (PPI)	G	G	G	G	G	N	N	P	N	F	N	G	G	N	P	N
Naptalam (PRE)	P	P	P	P	P	N	F	F	F	G	P	G	F	F	F	F
Norflurazon (PRE)	G	G	G	G	G	F	N	G	N	F	F	F	F	G	F	F
Oxyfluorfen (PRE)	P	F	F	P	P	N	F	G	FG	G	G	G	G	G	G	F
Pebulate (PPI)	G	G	G	G	G	P	N	F	N	F	N	F	P	P	P	N
Pendimethalin (PPI)	G	G	G	G	G	N	N	N	N	G	P	G	G	P	P	P
Pronamide (PRE)	F	F	P	F	F	P	P	P	P	F	P	P	G	F	F	P
Surflan (PRE)	G	G	G	G	G	N	F	N	N	G	P	G	G	P	P	P
Terbacil (PRE)	G	G	G	FG	G	P	FG	G	G	G	G	FG	G	G	G	G
Trifluralin (PPI)	G	G	G	G	G	N	F	N	N	G	P	G	G	P	P	P

[a] Source: Foster, R., D. Egel, E. Maynard, R. Weinzierl, M. Babadoost, H. Taber, L. W. Jett, and B. Hutchinson. (eds.). 2000. *Midwest Vegetable Production Guide for Commercial Growers*. Purdue Univ. Coop. Ext. Ser. ID-56.

[b] G (good), FG (fair to good), F (fair), FP (fair to poor), P (poor), N (none).

Table 7.4. Relative Effectiveness of Postemergent Herbicides on Various Weeds[a]

Herbicide	Barnyard Grass	Crabgrass	Fall Panicum	Foxtails	Goosegrass	Yellow Nutsedge	Annual Morning Glory	Galinsoga	Jimsonweed	Lambsquarter	Nightshade	Pigweed	Purslane	Ragweed	Smartweed	Velvetleaf
Atrazine	G[b]	G	F	FG	G	G	FG	G	G	G	G	G	G	G	G	G
Ametryn	G	G	G	G	G	F	G	G	G	G	F	G	F	G	G	G
Bentazon	N	N	N	N	N	G	F	G	G	F	P	P	FG	F	G	G
Bromoxynil	N	N	N	N	N	N	G	N	G	G	G	F	P	G	G	G
Clethodim	G	G	G	G	G	N	N	N	N	N	N	N	N	N	N	N
Clopyralid	N	N	N	N	N	N	N	N	G	G	N	G	N	G	F	N
Cyanazine	G	F	P	G	G	N	F	G	P	G	G	F	G	G	G	P
Dimethenamid	G	G	G	G	G	G	P	P	P	F	G	G	N	F	N	N
Fluazifop-butyl	G	G	G	G	G	N	N	N	N	N	N	N	N	N	N	N
Glyphosate	G	G	G	G	G	F	G	G	G	G	G	G	G	G	G	G
Imazethapyr	F	F	F	G	F	F	F	P	G	F	G	G	P	F	F	F
Linuron	F	F	F	F	F	N	G	G	F	G	G	G	G	G	G	G
Metribuzin	F	F	F	F	F	N	FG	G	F	G	P	G	G	G	G	G
Nicosulfuron	G	P	G	G	G	P	G	P	G	PF	P	G	P	P	G	P
Oxyfluorfen	P	P	P	P	P	N	F	G	G	F	G	F	G	G	F	F
Paraquat	G	G	G	G	G	F	G	G	G	G	F	G	F	G	G	G
Phenmedipham	N	N	N	N	N	N	F	G	F	G	F	P	G	G	G	F
Quizalofop	G	G	G	G	G	N	N	N	N	N	N	N	N	N	N	N
Sethoxydim	G	FG	G	G	G	N	N	N	N	N	N	N	N	N	N	N
2,4-D	N	N	N	N	N	N	G	G	F	G	G	G	P	G	P	F

[a]Source: Foster, R., D. Egel, E. Maynard, R. Weinzierl, M. Babaadoost, H. Taber, L. W. Jett, and B. Hutchinson. (eds.). 2000. *Midwest Vegetable Production Guide for Commercial Growers*. Purdue Univ. Coop. Ext. Ser. ID-56.

[b]G (good), FG (fair to good), F (fair), P (poor), PF (poor to fair), N (none).

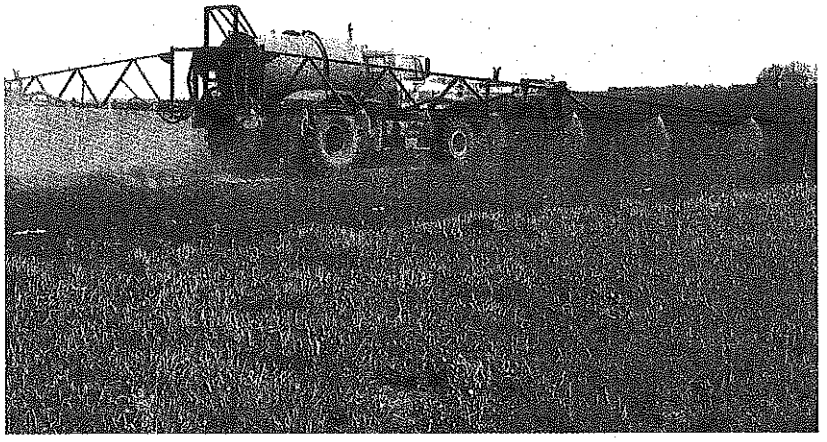

Figure 7.3. Broadcast application with a boom sprayer is commonly used with preemergent and preplant-incorporated herbicides.

Considerations in Herbicide Effectiveness

The effectiveness of a herbicide often depends on the care exercised in following the directions for its use. The rate and timeliness of application, soil type, cultural practices, weather conditions, type of crop, and weed species should be considered. Rates are usually lower on sandy or low organic matter content soils, and higher on heavier or organic soils. Soil pH can markedly influence herbicide performance, and many herbicides may not work well in acid soils. Herbicides to be incorporated should not be applied to rough, cloddy soils, because the herbicides will likely be distributed unevenly as the clods break up. A well-prepared seedbed provides the best conditions for herbicide performance.

Herbicide combinations may be used in lieu of single herbicide applications to increase the control spectrum on some hard-to-control weed species. It is important that labels and instructions indicate the approval of the specific mixture being used. When an unfamiliar chemical is used, a small test trial plot should be treated before the herbicide is extensively applied.

Proper timing of application relative to weed and crop growth is important to control weeds and to avoid crop injury. Weeds are controlled easier as seedlings than in later growth stages. Also, crop species are usually more tolerant to herbicides as they mature.

Herbicides are generally not recommended for the home garden because of the wide variety of crops at different stages of development in a relatively small area. The use of any material and method depends upon registration of the herbicides by federal and state agencies. A herbicide should not be used unless the label states that it is cleared for the intended purpose. Due to the constant introduction of new chemicals and materials, and to changes in herbicide labels, no specific herbicide recommendations are included here. For the most up-to-date information on herbicides, growers should contact their state extension specialists.

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