CHAPTER 11
(NOTE: Does not include Transgenic Cotton)
Weed Management in Cotton

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Weed management is an important component of cotton production. Weeds reduce lint and seed yield by competing with cotton for water, nutrients, light, and space. Full-season competition causes the greatest yield reduction; therefore, weeds which germinate with or soon after cotton emergence cause the greatest losses. The weeds which germinate before or simultaneously with the crop are frequently capable of forming a leaf canopy over cotton. Later emerging weeds may interfere with cotton defoliation and harvest and may lower lint grade due to lint staining and to excessive foreign material. Additionally, weeds growing outside the immediate area may affect the crop indirectly by producing seed that are transferred into the fields and by serving as alternate hosts for insects and pathogens.

Effect of Weeds on Cotton

Weeds cause severe problems in cotton quantity and quality; or producers would not spend so much time, effort, and resources to manage them. Estimates are frequently presented which illustrate the cost of weeds to cotton production. This cost is commonly divided into "costs of control" and "direct losses in cotton due to weed competition"; however, the final estimated value is usually of their "combined costs". It is simple to calculate the cost of control by examining the receipts for purchased herbicides, custom application invoices, and/or prices quoted by a chemical dealer. It is, however, much more difficult to assess accurately the losses caused by weed competition.

Weed Competition

To understand weed competition with cotton, that complex issue will be reduced into three more easily discussed components. Those components include weed species, density of weeds, and duration of competition.

Within limits, cotton is capable of competing with weeds. When viable, vigorous seed are planted under favorable environmental conditions in a well prepared, weed-free seedbed, cotton can be very competitive with weeds. Producers should strive from a cultural standpoint to ensure uniform, healthy cotton stands. Cultural practices for cotton are covered in greater detail in other sections of this circular. They often are the difference between successful cotton harvests versus those plagued by weed competition, harvesting difficulties, yield losses, and grade reductions.

Weed Species

Weed species differ greatly in their ability to compete with cotton (Figure 11-1). The taller, more erect, broadleaf weeds are commonly the more competitive with cotton. Common cocklebur is usually considered the most competitive weed with most cultivated, summer row crops. However, devil's-claw which is common in Oklahoma is also a very competitive broadleaf weed with cotton, according to Oklahoma research. Generally, devil's-claw is not found in dense stands throughout a large cotton acreage, but yield reductions of 80 percent have been reported for this weed in Oklahoma and Texas. Other weeds, such as the morningglories and silverleaf nightshade, are also highly competitive and cause different degrees of cotton yield loss. Weeds like common purslane are not very competitive. As a rule, the grasses are not as competitive as the broadleaf weeds; however, when perennial grasses such as johnsongrass and bermudagrass are present in heavy infestations, cotton yield can be reduced to near zero. Scientific literature documents the competitive effects of many weeds on cotton yield. Some of the more common weeds in Oklahoma cotton are shown and discussed at the end of this chapter. (Photos 11-1 through 11-14).

Weed competition cannot be understood without examining the close relationship between weed

density and duration of competition. A high density of weeds combined with a long competition time will cause greater yield reductions. High densities for less time and low densities for longer periods will cause intermediate yield reductions; however, yield reduction may well be avoided if management tools are used to control weeds. The economic threshold of weed populations and weed density versus time of competition variables are not fully understood. More emphasis is being placed on this type of research to recommend more "cost effective" weed control programs.

Density of Weeds

The density of a weed infestation alters the competitiveness of that weed with the crop and affects lint and seed yield (Figure 11-1). Higher weed densities cause higher yield reductions. From the figure, devil's-claw causes the greatest yield reductions among the three species shown at all weed densities; therefore, it is the most competitive of these three weeds with cotton. Except in extreme cases, weed competition does not cause a complete bss of cotton yield. Cotton is competitive with weeds to some extent and it can usually obtain some water, nutrients, light, and space even in the presence of dense weed stands.

Figure 11-1. The response of cotton lint yield to full-season competition from increasing densities of three broadleaf weeds. This illustration is based on experimental data collected in Oklahoma.

Duration of Competition

The duration of competition (or length of time that weeds and crop grow together) is important as is when that competition occurs. Figure 11-2 shows a general graphic representation of the effect on cotton yield when the crop and weeds emerge and grow together for various periods of time. This curve represents the effects of weed competition from time from planting on cotton lint yield. Generally, weeds and cotton can coexist for 4 or 5 weeks before a noticeable loss in yield occurs. Large, fast growing weeds will cause a yield reduction sooner than small, slow growing ones. Likewise, high populations of weeds will cause yield reductions quicker than low populations. During the first 4 weeks of a growing season, the cotton and weeds are small; and their growth requirements are usually adequately supplied. As the plants get larger, competition increases rapidly...beginning at about 5 weeks and continuing for about 8 to 10 weeks. During this time, growth requirements are becoming more and more limited; the crop is unable to obtain sufficient growth requirements; and yield and quality reduction results.

How long must cotton be kept weed-free to assure maximum yield? Figure 11-3 shows a general graphic representation of the time that weed-free maintenance must be provided. Similar to Figure 11-2, weed size, growth status, and number will affect this representation. If cotton is kept weed-free for only the first 2 weeks of the season, very little yield will be realized. This minimum effort to manage weeds will result in minimum yield. If weed management practices keep the cotton weed-free for 4 weeks, yield begins to increase. Increasing the weed-free maintenance to 10 weeks results in dramatically increased cotton yield. When cotton is kept weed-free for 10 weeks or longer, its potential yield is at its maximum relative to weeds. Usually by that time of the season, weeds are unable to emerge and grow effectively under the crop canopy. This figure clearly indicates the importance of maintaining cotton as free of weeds as possible early in the season. This relationship may help a producer understand why a preplant or preemergence herbicide application results in higher cotton yields, even though the field becomes relatively weedy before harvest. Cotton is a slow-developing plant early in the season, and its canopy does not shade row middles quickly. For a faster growing crop like soybeans, the time required is usually less than 10 weeks.

Figures 11-2 and 11-3 clearly illustrate that maximum cotton yield is only obtained when weed competition occurs during the first 4 weeks (or less) of the growing season or when cotton is maintained weed-free for the first 10 weeks (or longer) of the season. Considering both figures, the crucial time to limit weed growth is from weeks 4 through 10. This situation poses a real challenge to the cotton producer because not many safe, long-residual herbicides control weeds for 10 weeks and because few herbicides can be applied over-the-top of the crop for broadleaf weed control after weed establishment. This scenario illustrates the need for a planned weed management program which includes several methods of weed control (e.g., cultural, chemical, mechanical, etc.). It also illustrates the importance of a preplant incorporated or preemergence herbicide program to control early germinating weeds.

Figure 11-2. A general graphic representation of the time that cotton and weeds can remain together and the lint yield reduction which could be expected if competition continues into the growing season.

Figure 11-3. A general graphic representation of the time required from cotton emergence to when weeds must be excluded from cotton for normal lint yield to be realized.

Major Weeds

Oklahoma cotton producers (as a whole) are trying to control approximately 25 weed species (Table 11-1). This list includes several very difficult-to-control weeds. More than one approach to manage such weeds must be used to minimize their effects on cotton production.

Weed Identification

The first and most critical step in achieving effective weed control is to correctly identify the weed species. Without proper identification, an ineffective control or management suggestion may be made. Many herbicides are weed specific, and they are too expensive to be used on weeds which they do not control. To assist the producer, photos and descriptions of many of the weeds in Table 11-1 are provided at the end of this chapter (Photos 11-1 through 11-14).

Methods of Weed Control

Weed management programs should utilize all reasonable methods to manage weeds economically. Involved may be the use of cultural, mechanical, nonmechanical, biological, legal, and chemical methods. More is required to solve weed problems than to simply list methods. One must analyze each component of his/her total cropping system and plan an integrated program to effectively and economically optimize weed management.

Crop Rotation

When one crop is planted on the same land year after year, one or more weed species will likely increase because they are adapted to the same

conditions as the crop. Repeated use of the same (or same family of) herbicide frequently favors those weeds that can tolerate them. For that reason morningglory, devil's-claw, silverleaf nightshade, common cocklebur, and yellow nutsedge have become major problems in many cotton fields. Herbicides applied year after year can also lead to the development of herbicide-resistant weeds. Increase of tolerant or resistant weed species can be prevented by rotating to crops which have different growth habits and require different cultural practices and herbicides. Good rotation crops with cotton in Oklahoma include those belonging to the grass family such as small grains and grain sorghum.

Prevention Methods

Preventive weed control is aimed at hindering weed spread by seed or vegetative propagules. This is especially helpful to suppress populations of perennial weeds such as the nightshades, field bindweed, and hogpotato that spread slowly, but persist indefinitely, once established. Prevention of seed production by such weeds may involve spraying or mowing fence rows and ditch banks. Another effective method is by roguing or spot spraying scattered plants before they produce seed. It is important to clean equipment so that seed and plant parts are not moved from field to field or from one part of a field to another in land preparation, planting, cultivation, and harvesting operations. Plant cotton seed that are not contaminated with weed seed, particularly of noxious weeds.

Land Preparation

Land preparation is not normally considered to be a primary weed control method, but it is important in beginning a weed control program. In Oklahoma cotton, soil incorporation of a herbicide is usually one of the secondary tillage operations prior to planting. Tillage controls weeds by burial or by disturbance of their rooting structures. Most annual weeds are easily controlled by tillage, and most perennial weeds are easily destroyed as seedlings. However, after perennial weeds develop rhizomes, stolons, or tubers, control becomes much more difficult. The method of tillage to improve weed control may be important with difficult-to-control weeds. Deep tillage to break rhizomes or stolons will decrease weed vigor and make chemical control more effective. Land preparation should be considered as part of a total weed control program.

Cultivation

Weed control and land preparation for irrigation are considered the primary reasons for cultivation. Cultivation soon after weed germination can effectively destroy them when small and before they seriously deplete soil moisture and nutrients. Larger weeds are more difficult to kill and require deeper cultivation which may in turn harm cotton roots and bring new weed seed near the soil surface to germinate. Cultivation, especially deep cultivation, should be minimized after squaring begins in cotton. Deep cultivation causes a rapid loss in soil moisture and can reduce yield. Shovels, knives, rotary hoes, and rolling cultivators slice off weeds, pull small weeds from the soil, and/or shatter the soil surface to expose weed roots which then die in the sun.

Herbicides

Most herbicides are selective...meaning that they control some weed species, but not others. In fact, the object of using herbicides is to control the undesirable plants (weeds) and leave the desirable plants (crops) undamaged. Because different weeds are controlled by different herbicides, it is crucial to match the herbicide with the weed species in the field to be treated.

Herbicides can be classified in a number of ways, i.e., chemistry, use, time of application, plant response, residual activity, potential environmental hazards and others. This manual describes the herbicides used for weed control in cotton by their use and time of application.

General Use of Herbicides

Soil-applied, residual herbicides are absorbed from the soil by weed seedlings as they germinate, killing the seedlings before or soon after emergence. Preplant or preemergence herbicides available for use in cotton are effective against most annual grasses and many annual broadleaf weeds. However, they often do not adequately control annuals that germinate deep

in the soil such as morninglories, common cocklebur, or devil's-claw. Most soil-applied, residual herbicides do not control established perennial weeds. These herbicides are effective because they kill susceptible weeds early in the season before they can deplete moisture and nutrients from the soil. (Examples: Treflan or Trilin, Prowl, Caparol or Cotton-Pro, Cotoran or Meturon, Karmex or Direx, Lasso, Command, Dual, and Zorial)

Contact herbicides are used to kill small weeds present at the time of application. Many do not have sufficient residual activity to kill later germinating weeds. Most contact herbicides are used at planting to destroy small weeds that germinated since the last tillage. Some herbicides used in preemergence applications (if mixed with a surfactant or crop oil) have contact action on small weeds. Some herbicides can be used in postemergence directed applications where the spray is directed onto small weeds, but only to the lower stem of cotton plants. (Examples: MSMA, DSMA, Cobra, and Gramoxone Extra)

Foliar-applied herbicides are absorbed through plant leaves and then translocated to roots and growing points. They are generally the most effective herbicides for control of perennial weeds and those annual weeds that germinate deep in the soil. Some of these herbicides can be applied over-the-top of the crop; however, some can injure cotton. Some can be used as special treatments to control perennial weeds if a shield, hood, or other special equipment is used to exclude the chemical from cotton. Weeds should be growing vigorously and in the correct growth stage for optimum control with this type of herbicide. Treating weeds under stress usually results in poor weed kill. Additives, such as surfactants or oils, may enhance the penetration of plant tissue. These additives can improve weed control, but they may also increase cotton injury. The herbicide label will provide a guide for the additives to use with a particular herbicide. (Examples: over-the-top -- Poast Plus, Fusilade, Select, and Bugle; selectively applied -- Roundup; directed -- Caparol or Cotton-Pro, Bladex, Cotoran or Meturon, Karmex or Direx, Goal, and Cobra)

Time of Herbicide Application

Preplant herbicides are applied before planting cotton, but are not necessarily incorporated. If stale seedbeds or reduced tillage practices are used for cotton, this type of herbicide application is very important. If only annual weeds are targeted, a herbicide with good preemergence and residual activity is required. Application can be made in late winter or very early spring to control annual weeds as they emerge in the spring. Some herbicides used for this purpose have good postemergence activity on small weeds if an oil or surfactant is added. If larger weeds are present, a foliar-active or contact herbicide can be added to provide better overall control. For example, to control horseweed in a reduced tillage system, usually a tank mixture of herbicides is necessary. (Examples: residual -- Caparol or Cotton-Pro, Karmex or Direx, Bladex, and Cotoran or Meturon; nonresidual -- Roundup and Gramoxone Extra)

Preplant incorporated herbicides are important for most cotton weed control programs because they are very effective for annual grass control and are economical to use. Herbicide labels specify the tools that should be used for incorporation and how to most effectively use them. The herbicide must be thoroughly mixed with the soil surface to a specified depth for a particular herbicide. (Examples: Treflan or Trilin, Command, and Prowl)

Preemergence herbicides can be used in some situations instead of preplant incorporated herbicides or as a second herbicide. Band application is often practiced for the second herbicide if applied preemergence. The herbicide is applied in a band over the cotton row, and cultivation is used to control weeds in the row middles. Rainfall is necessary after application before a preemergence herbicide actively kills weeds. Generally, these herbicides are used to control weeds that are resistant to the PPI herbicides. Application of soil-applied herbicides is complicated in fields with variation in soil texture because rates must be adjusted for that environmental factor. If a field has sandy spots and herbicide rate cannot be adjusted, a certain amount of crop injury may occur in the sandy soil to obtain acceptable weed control in the nonsandy parts of the field. (Examples: Caparol or Cotton-Pro, Dual, Lasso, Karmex or Direx, Cotoran or Meturon, Command, Zorial, and Bladex)

Postemergence herbicides are generally used to destroy weeds that are not controlled by (or escape control from) soil-applied herbicides. Time of application relative to weed species, crop growth, and weed growth is critical in determining which herbicide to use and how to apply it. Options may depend on which weed is present. Some of the postemergence herbicides can be applied over-the-top of cotton at a

certain growth stage; others cannot. Some weeds are susceptible only to those herbicides that cannot be applied over-the-top on cotton. Control of such weeds will require directed spray equipment. When perennial weeds such as johnsongrass, yellow nutsedge, bermudagrass, horsenettle, silverleaf nightshade, or field bindweed are present, foliar-applied herbicides which translocate to the root system are necessary. Poast Plus and Fusilade can be applied safely over-the-top of cotton for johnsongrass and bermudagrass control. However, herbicides which control perennial broadleaf weeds will also injure cotton if the herbicide comes into contact with the crop; therefore, selective application methods must be used. Spot-treatment applications can be used, but the crop will be killed or severely injured where the weeds are treated. (Examples: annual weeds -- Gramoxone Extra, Caparol or Cotton-Pro, Bladex, Cotoran or Meturon, Karmex or Direx, Goal, Poast Plus, and Fusilade; perennial weeds -- Roundup, Poast Plus, Select, and Fusilade)

Special Methods of Herbicide Application

A **directed sprayer** is designed to apply herbicide below the crop leaves for control of shorter weeds within the row. Height and angle of the nozzle are very important in such operations. Normally, some type of ground-contact device, either a gauge wheel or sled, is used to keep the spray pattern at a uniform height above the soil surface. A directed sprayer unit can be used alone or attached to a cultivator to enable spraying and cultivation to be accomplished simultaneously. It is highly important to follow the herbicide manufacturer's instructions as to size of cotton plant and timing of application. (Examples: Gramoxone Extra, Caparol or Cotton-Pro, Bladex, Cobra, Cotoran or Meturon, Goal, MSMA, and DSMA)

Shielded sprayers are of two basic types. One type shields the crop while herbicides are applied over-the-top, and the other shields the spray nozzle so the herbicide cannot contact the crop. Shielded sprayers should be tested to ensure that nozzle pressure and volume per acre are adequate. These sprayers should <u>not</u> be operated at a high pressure (>35 psi) due to atomization of spray particles and danger of herbicide drift. (Example: Roundup)

When weeds are considerably taller than the crop, a **herbicide wiper** will selectively apply the herbicide to the weeds. Herbicides used on weed wipers should be effective with low volume rates in a more concentrated solution. In some situations, traveling the field in both directions is required to allow a sufficient volume of chemical to be applied. (Example: Roundup)

Factors Affecting Herbicide Performance

Many factors affect the performance of a herbicide. Recognizing those factors can greatly affect the ability to choose the right herbicide and to apply it so as to obtain optimum effectiveness. Those factors are individually discussed below. However, no one factor acts alone. They are interrelated, and several may be acting at one time.

Herbicide Formulation

Many components other than the active chemical go into the formulation of a herbicide. Adjuvants, surfactants, stickers, or emulsifiers may be added to improve application and/or the killing properties of a formulation. Some formulations are easier to use than others, but may cost more. Often, you have a choice of formulation. The label will describe those additives, if any, which should be included in the spray tank.

Herbicide Rates

Many herbicide failures can be traced to the use of too little chemical to control the target weeds. On the other hand, many examples of crop injury from herbicides can be traced to overdosage. Herbicide labels include recommended rates for each soil type, weed size, or weed species. Follow those recommendations closely for best herbicide performance.

Plant Species

A given plant species may or may not be injured by a specific herbicide depending on its genetic

makeup, physiological condition, germination time, and many other factors. Often, one plant species will be controlled by a given herbicide and another similar species will not be controlled at all. Identification of the species to be controlled is crucial before choosing a herbicide.

Cotton and Weed Seed Size

Seed size is important because planting small or low quality crop seed results in a slow developing, weak plant. Weak cotton seedlings are more susceptible to seedling disease and herbicide injury than are strong seedlings developed from larger seed.

Seed size of weeds may influence their control with a preemergence herbicide. Large seed that germinate deep in the soil, such as common cocklebur, may produce plants that can grow through herbicide treatments because the plant roots are not exposed to herbicide-treated soil. Many preemergence herbicides are selective because of the difference in weed versus crop seed size. Small-seeded weeds, such as pigweed and crabgrass, germinate near the soil surface where the herbicide has been activated by rainfall.

Plant Age

Plant age often influences weed resistance to a particular herbicide, especially with postemergence treatments. Many postemergence herbicides that destroy small plants have little effect on the same species of plant when larger. In general, young plants are more susceptible to postemergence herbicides. However, a few cases are known when the ideal time to spray is in a later developmental stage. Sufficient leaf area to absorb herbicides is necessary for many perennial weeds. Some plants are more susceptible to certain herbicides in early reproductive stages. Determine when the weed to be controlled is most susceptible to available herbicides before selecting a postemergence weed control program. Case in point: Roundup and Fusilade are applied to the same perennial weed species at very different times to obtain effective control.

Weed Growth Rate

The growth rate of a weed can have a pronounced effect on whether that plant will be killed by a given herbicide. Plants that grow rapidly are usually more susceptible to herbicides than are plants growing slowly. For maximum herbicide effectiveness, the best time to spray plants is when they are actively growing. Other factors such as soil temperature and moisture may indirectly affect herbicide performance by directly affecting the growth rate of the weeds.

Soil Texture

A crucial section on most herbicide labels gives the herbicide rate relative to soil texture. A sandy soil has fewer clay particles for adsorption of the herbicide. Thus, the chemical can move more readily through a sandy soil to harm cotton roots when heavy rain occurs. Not all colloids adsorb herbicides at the same rate. Clay is more effective than silt which is more effective than sand. Usually, a lower rate of herbicide is required for good weed control on sandy soils than on clays. On the other hand, it is also much easier to use too much herbicide and thus harm crop plants on course-textured soils than on those with a high clay content. Know the soil type before deciding what rate of herbicide to use.

Organic Matter

Another soil characteristic that affects herbicide action is organic-matter content. Organic matter will adsorb herbicides much the same as clay particles. Soil organic matter can inactivate certain types of herbicides. Some herbicides are effective only on high organic soils; whereas, others may be the opposite. Thus, organic-matter content of the soil can affect herbicide rate as recommended on some labels.

Herbicide Persistence

Some herbicides are short-lived in the soil while others persist for a long time. In some cases, a herbicide is wanted that will be gone in a few weeks because a crop susceptible to that chemical will be planted next. On the other hand, for continuous cotton, a herbicide would be desirable that controls weeds throughout the summer and where crop rotation would not be a problem the next season.

Application Factors

Spray coverage is important in the application of herbicides. Selective placement may involve a preemergence herbicide that will only be on or near the soil surface. The crops germinate deeper in the soil and are not affected, but the weed seed germinate in the soil containing the herbicide and are killed.

Another form of selective placement is incorporation of the herbicide into the top 1 to 2 inches of soil and planting the crop seed at the bottom of that incorporated layer. If the herbicide is thoroughly mixed with the top layer of soil, weeds germinating in that volume of soil should be killed.

Herbicides are often directed so as to avoid contact with the crop, but to be applied to the weeds. Shielded and directed-spray methods are used for this purpose. Most herbicide labels have directions on such application for maximum effectiveness.

Good Equipment and Proper Calibration

Good spray equipment is important for the proper application of a herbicide. A properly operating, well calibrated sprayer includes the correct size nozzle for the amount of water distributed by the sprayer and uses the same size nozzle across the boom. A good pressure gauge, careful sprayer calibration, proper spacing of nozzles, and travel speed are also essential ingredients for the correct application of herbicides. For granular applications, the equipment must also be calibrated. OSU Fact Sheets are available which provide information on sprayers, nozzle selection, and calibration.

Some herbicides are sold only as wettable powders. They are as useful as liquids or other formulations if properly applied. However, the wettable powders must be kept in suspension during application. Poor agitation in the spray tank can cause unequal herbicide distribution resulting in poor weed control in some areas and crop injury in others. It is wasteful to buy good herbicide and then use poor equipment to apply it.

Placement of a herbicide relative to the crop is often just as important as the coverage obtained. For example, in band application the droplets are sprayed in a band over the row. This requires a different nozzle from the one used for broadcast applications. For directed spraying, use yet another nozzle to direct the spray at the base of the plants, but not onto the leaves of the crop.

Incorporation of Herbicides

"Incorporation" is a term used to describe the mixing of a herbicide with soil. The depth, method, and time of incorporation are important. Considerable research has been conducted in Oklahoma to study the effects of those factors on herbicide performance. In general, if the soil has a high clay content, a finishing disk will do a good job of incorporation. On sandier soils, other tools may do better because of depth control.

Herbicides should be mixed properly with the soil when incorporating. The tool must be pulled at a speed that moves soil. The proper depth of incorporation for maximum effectiveness varies with different herbicides. Some preemergence herbicides can be lightly incorporated to a depth of 1 to 1.5 inches, but should not be incorporated deeper because of dilution in the soil and poor weed control. Other herbicides should be incorporated 2 to 3 inches deep.

Ideally, cottonseed should be planted in the bottom one-half inch to 1 inch of the incorporated soil layer. The depth of incorporation must be considered relative to the depth of planting and germination of the crop's seed.

Time of incorporation depends on the volatility of the herbicide and the speed of its chemical break down. Some herbicides, such as Treflan and Prowl, do not break down when the soil temperatures are low. Such herbicides can be incorporated 6 to 8 weeks before planting and still give good performance. On the other hand, herbicides that only last 6 to 8 weeks should not be incorporated until a week or so of planting. The volatile herbicides should be incorporated immediately after application; others need not be incorporated as quickly.

Rainfall

Rainfall following the application of a preemergence herbicide is critical to activate them. The incorporated and postemergence herbicides do not depend as much on rainfall, but it is still important for the best performance of those chemicals. Many water-soluble herbicides will leach if heavy rainfall

occurs, especially on sandy soils. Approximately one-half to 1 inch of rainfall after application is ideal for a preemergence herbicide.

Timing of rainfall greatly influences herbicide performance. If the soil is moist and rainfall does not occur within 7 to 10 days after application, weeds may start growing. Rain may fall later and activate the herbicides, thereby killing weeds which germinated after the rain. However, weeds that germinated before the rain will still grow if not removed. A rolling cultivator, rotary hoe, or other tool have proven useful in lightly incorporating the herbicides while simultaneously removing this first crop of weeds. Many herbicide failures occur in Oklahoma because this is not practiced.

Temperature

Within limits, higher temperatures contribute to more rapid plant growth. A rapidly growing plant will usually be killed quicker by a postemergence herbicide than will a slowly growing one.

Cool conditions after planting can cause herbicide injury to cotton more often than warm temperatures. The crop is growing slowly and takes up too much herbicide before the roots can extend from the treated zone.

With extremely high temperatures, herbicides may volatilize more rapidly and leave the treated area. Some contact and postemergence herbicides may cause more cotton injury at high temperatures. Temperatures above 90 F are generally considered above optimum for herbicide spraying.

Wind

Wind affects herbicide performance because it influences drift and evaporation of herbicides. It may also influence proper herbicide placement.

Relative Humidity

Relative humidity affects herbicide performance because of volatilization from the soil. With postemergence herbicides, relative humidity reduces the herbicide taken up by the plant before the droplets evaporate from the leaves.

Planning a Weed Control Program

An effective, economical weed management program involves scouting cotton fields to determine which weeds are present, then designing a control program using the best combination of cultural, mechanical, nonmechanical, biological, and chemical control methods to maintain weed populations at or below economic threshold levels. Herbicides used will change as new chemicals become available and as weed populations shift. Refer to the most recent "Cotton Weed Control" Fact Sheet or Current Report for information on specific herbicides and other tools available. This publication can be obtained at the nearest county extension office.

Alphabetical Listing and Brief Description of Herbicides Used

Approximately 25 herbicides are labeled for some use in cotton. The following brief descriptions are not intended to replace the labels for each, but rather are brief statements of how each herbicide might be used in a cotton production system. Carefully read and follow all label directions for herbicide use.

Assure II (quizalofop) is a selective herbicide used for postemergence over-the-top control of annual and perennial grasses. Consult the label for rates and suggested weed sizes. Use caution when including Assure II in tank mixtures, reduced grass control is often noticed. For optimum results, it is suggested that Assure II not be included in tank mixtures.

Buctril (bromoxynil) can be used over-the-top of BXN cotton for the control of broadleaf weeds. Application of the herbicide can only be made to transgenic BXN cotton which has been genetically modified for crop tolerance to over-the-top applications of Buctril. Treatment of other cotton varieties will result in severe crop injury.

Caparol or **Cotton-Pro** (prometryn) can be used preplant in a reduced tillage system, preemergence, and postemergence directed. Its spectrum of activity is similar to Bladex. Caparol should not be used preemergence on coarse-textured soils or on soils with a high pH. A tank mixture with MSMA will broaden the spectrum of control when applied as a postemergence directed spray.

Cobra (lactofen) can be used in cotton as a broad spectrum, contact herbicide for postemergence directed control of broadleaf weeds. Apply Cobra as a postemergence directed spray following a preplant incorporated and/or preemergence herbicide(s) for early-season control of grasses and broadleaf weeds. Use Cobra as a postemergence directed spray when cotton has reached a minimum height of 6 inches and when a height difference of 3 to 5 inches has been established between the lower leaves of cotton and the tops of the broadleaf weeds. Cobra may also be used as a layby application when cotton has reached a height of 12 inches.

Command (clomazone) may be applied as a preemergent banded or a soil-incorporated broadcast treatment in conventional or conservation tillage systems for the control of annual grasses and broadleaf weeds in cotton. Do not apply unless either disulfoton or phorate organophosphate insecticide is applied in-furrow with the seed at planting time (at a rate of 0.75 pound per acre or higher of active ingredient). Failure to do so can result in crop phytotoxicity and/or stand reduction. Take special precautions to avoid off-site movement of spray drift or vapor. Check label for specific spray tip and pressure requirements to avoid drift problems.

Cotoran or **Meturon** (fluometuron) can be used preplant in a reduced tillage system, preemergence, postemergence over-the-top, and postemergence directed. Its spectrum of activity is similar to Bladex and Caparol. Cotoran should not be used on sandy soils. Cotoran can be applied over-the-top of cotton, but the preferred method of postemergence use is directed with a surfactant. A tank mixture with MSMA will broaden the spectrum of control.

Cyclone (paraquat) is a herbicide which can also be used as a harvest aid for boll opening and defoliation. It will also desiccate green weeds. Consult the Cyclone label for tank mixing with other chemicals for improved boll opening and defoliation.

DSMA (disodium methanearsonate) is very similar to MSMA, but may cause slightly less burn to the crop and weeds. Usage is described under MSMA below. Several different trade names exist for DSMA.

Dual II (metolachlor) is a soil-applied herbicide effective for annual grass control and is fair to good for control of yellow nutsedge. Cotton tolerance is somewhat marginal; therefore, Dual should not be used in sandy soils or where cotton is planted in a furrow. Dual is generally used preemergence, but shallow incorporation may improve yellow nutsedge control. Early postemergence applications are also approved for cotton up to 6 inches tall, but this treatment will not control weeds which have already emerged at the time of application.

Fusilade DX (fluazifop-butyl) is a selective herbicide that can be used postemergence in cotton to control annual and perennial grasses. Two applications are usually required for control of perennials. Time application to the size of weeds as indicated on the label for the most successful control.

Fusion (prepackage mixture of fluazifop + fenoxaprop) is a selective postemergence over-the-top herbicide for control of annual and perennial grasses. This herbicide will not control broadleaf weeds or sedges. Always add a nonionic surfactant or crop oil concentrate according to the label. Tank mixtures of Fusion with other postemergence herbicides may result in reduced grass control.

Goal (oxyfluorfen) can be used postemergence in directed applications after cotton has reached a minimum height of 6 inches, but this herbicide should not be applied over-the-top. It can be tank mixed with certain formulations of Bladex, Karmex, or MSMA.

Gramoxone Extra (paraquat) can be applied preplant or postemergence to the cotton, but postemergence to the weed for burn-down. If cotton has emerged, do not use or severe injury will result. Gramoxone Extra can be tank mixed with several residual herbicides for longer weed control - consult the label.

Karmex or **Direx** (diuron) was one of the first preemergence herbicides approved for use in cotton. It can be used in directed postemergence applications. It is similar to Caparol and Cotoran.

Lasso (alachlor) is a soil-applied herbicide that is very similar to Dual. Use it only on medium- and fine-textured soils, and, use it according to label directions as cotton tolerance is marginal.

MSMA (monosodium methanearsonate) is effective for control of grasses and cocklebur. It works primarily by contact action and is used in cotton as a directed spray application. Excellent performance in mixtures has been observed.

Poast Plus (sethoxydim) herbicide is an improved formulation for broad spectrum postemergence control of annual and perennial grasses. Poast Plus does not control sedges or broadleaf weeds. Apply to actively growing grasses when at the proper growth stage. Always add Dash spray adjuvant or a nonphytotoxic oil concentrate. Never apply Poast Plus to grass under stress because unsatisfactory control will likely result.

Prowl (pendimethalin) is a dinitroaniline herbicide used in preplant incorporated applications in cotton. It is good to excellent for control of annual grasses and fair to good for several small-seeded broadleaf weeds.

Roundup Ultra (glyphosate) is an excellent foliar-applied herbicide for control of annual and perennial weeds, but it is not generally selective. It can be used to kill weeds prior to planting; however, Roundup Ultra does not have residual activity in the soil and must be applied to plant foliage to be effective. It can also be used in selective application equipment such as a ropewick or shielded sprayer, that places the herbicide solution on the weeds, but not on the cotton. A recent change has been the development of Roundup Ready cotton cultivars. These cultivars are tolerant to over-the-top Roundup Ultra applications. These applications can be made over-the-top of cotton up to the fifth leaf. After the fifth leaf, the Roundup Ultra must be applied as a postemergence directed spray to avoid crop injury and delayed maturity.

Select (clethodim) is a selective postemergence herbicide for control of annual and perennial grasses. Apply it to actively growing grasses not stressed by insufficient moisture or by cold temperatures. Always use a crop oil concentrate, and check the label for proper rates and weed heights.

Staple (pyrithiobac) is a new, selective, over-the-top postemergence herbicide. It is most effective for the control of small, seeding broadleaf weeds. A nonionic surfactant or crop oil concentrate should be added according to label directions. Please read the label for rotational crop restrictions. Special cotton varieties are not required when using Staple.

Starfire (paraquat) is a herbicide which can be used as a harvest aid. See also Cyclone.

Treflan or **Trilin** (trifluralin) is a dinitroaniline herbicide similar to Prowl. It controls seedling grasses better than broadleaf weeds and should be thoroughly incorporated into the top 2 to 3 inches of soil soon after application.

Zorial (norflurazon) is a good soil-applied herbicide to help control problem weeds such as prickly sida, purslane, and spurges. Rates adequate to control a broad spectrum of weeds can result in cotton injury on many Oklahoma soils. Therefore, in order to avoid crop injury from Zorial you can use a lower rate of Zorial in a tank mixture with another approved herbicide. Another effective way to reduce injury from Zorial is apply one-half the rate PPI and the other half of the rate Preemergence. Using Zorial in this manner will result in reducing the rate at any one application timing yet provide a sufficient rate to achieve weed control. If used preplant incorporated, follow the label instructions for controlling depth of incorporation to prevent cotton injury.

Table 11-1. Common weeds in Oklahoma cotton.

Broadleaf		
Annual		Perennial
buffalobur	pigweeds	field bindweed*
common cocklebur	palmer	hogpotato
common purslane*	redroot	horsenettle
devil's-claw	smooth	silverleaf
eclipta* tumble	nightshade	
hophornbeam	prickly sida	
copperleaf	(teaweed)	
lambsquarters	puncturevine	
leafflower*	(goathead)*	
morningglory*	spotted spurge	
tropic croton		

Grass		Sedge
Annual	Perennial	Perennial
barnyardgrass	bermudagrass*	yellow nutsedge
large crabgrass	johnsongrass	
Texas panicum		

*Prostrate growth habit. Others are erect.

Photo 11-1. Yellow nutsedge (*Cyperus esculentus*) is a very difficult-to-control perennial. Its plants are grass-like with fibrous root systems. The stem is triangular in cross-section; and the leaves are slender, smooth, and taper to a sharp point. Seed heads are golden-brown or golden-green; the seed will usually not germinate. Each plant can produce underground many smooth, round tubers which are the primary means of spread. This weed is well adapted to all parts of Oklahoma whether soils are clay or sandy and whether fields are dryland or irrigated.

Photo 11-2. Texas panicum (*Panicum texanum*) is one of the more difficult-to-control annual grasses. Its leaves are broad, and both upper and lower leaf surfaces have a soft velvet-like surface because of dense plant hairs. The seed head is a rather compact panicle with only slightly spreading branches. The football-shaped seed are relatively large for a grass, and they are light to dark brown in color.

Photo 11-3. Tall pigweeds. Palmer amaranth (*Amaranthus palmeri*) is the most common of about five tall, erect-growing pigweeds found in western Oklahoma. Its flowers are small, round, green and borne in dense more-or-less unbranched spikes. This species is unusual in that its male and female flowers are borne on separate plants. Although not particularly difficult to control, pigweeds are present in almost every cotton field. After emergence, pigweeds are much more difficult to control with chemicals; however, an early cultivation can be very effective. A pigweed plant is capable of producing nearly 100,000 tiny, black seed each year, so it is easy to understand how huge weed populations can build up rapidly.

Photo 11-4. Tumble pigweed (*Amaranthus albus*) is a short, almost bush-like pigweed. Its control is very similar to that of the taller species. Its round growth habit has sometimes misled people into calling it a "tumbleweed". Russian thistle (*Salsola iberica*) and kochia (*Kochia scoparia*) are more commonly referred to as tumbleweeds.
very difficult to selectively control in cotton; it is found over almost the entire U.S.

Photo 11-5. Field bindweed (*Convolvulus arvensis*) is a deep-rooted, perennial vine without tendrils. This plant readily propagates from seed or root sections. Field bindweed has large white or white with vertical bands of pink flowers and oblong to triangular leaves. This weed is very difficult to selectively control in cotton; it is found over almost the entire U.S.

Photo 11-6. Entireleaf morningglory (*Ipomoea hederacea* var. *integrinscula*) is one of about five annual morningglory species common in Oklahoma. It is considered by some authorities to be among the most difficult-to-control morningglories. Its dull black seed can remain viable in the soil for over 10 years; therefore, control efforts must be applied for many years to effectively manage this weed. Ivyleaf morningglory (*Ipomoea hederacea*) is very similar, except for its three-lobed leaf shape; it is usually found in mixtures with populations of entireleaf morningglory.

Photo 11-7. Common purslane (*Portulaca oleracea*) is a fleshy, flat-growing annual with yellow flowers at the tips of its stems. It is widely distributed in Oklahoma, but it is not considered to be very competitive with cotton. It is easily controlled.

Photo 11-8. Devil's-claw (*Proboscidea louisianica*) is a weed very competitive with Oklahoma cotton. The weed occurs statewide; it usually does not densely infest a field, but rather is in scattered stands. Its foliage is foul smelling and densely covered with glandular hairs. Its fruit split at maturity forming two large, curved, woody claws. Preemergence treatments provide fair control, but a follow up treatment (usually hoeing) is often needed. If allowed to remain for the entire growing season, this weed can cause severe harvesting difficulties as well as cotton lint yield reductions.

Photo 11-9. Silverleaf nightshade (*Solanum elaeagnifolium*) and **horsenettle** (*Solanum carolinense*) are deep-rooted, perennial weeds from the nightshade family and often occur together. They have large flowers that range in color from white to blue-violet; their sepals (at the base of the petals) have no spines; and their leaves are not deeply divided. Silverleaf nightshade leaves are silvery gray-green with numerous velvety hairs whereas horsenettle leaves are green and not velvety. Silverleaf nightshade is considered by many cotton producers to be their most serious weed. Seed of both weeds are viable, but their greatest spread probably occurs from root propagation.

Photo 11-10. Buffalobur (*Solanum rostratum*) is an annual weed with large, bright yellow flowers. The sepals (at the base of the petals) are densely covered with stout spines. Leaves are deeply divided into narrow lobes. This weed occurs over much of Oklahoma, especially on drouthy soils. Buffalobur can be controlled with preemergence herbicides, but it is very difficult to control after emergence. It is especially difficult to control after flowering.

Photo 11-11. Prickly sida (*Sida spinosa*) is an annual weed which in dense stands can cause substantial yield loss. Its leaves have few plant hairs. Its flowers are yellow on short stalks. It is a member of the same plant family as cotton and can emerge throughout the growing season which causes its control to be difficult.

Photo 11-12. Hogpotato (*Hoffmanseggia glauca*) is a perennial legume native to the southwestern U.S. This weed is not widespread in the state, but it appears as irregularly shaped patches in some fields. Almost a complete crop loss occurs when cotton is planted in a hogpotato-infested area. The weed can propagate from both seed and small tubers; however, the tubers appear to be the more important means of survival and propagation. The tubers are as deep as 3 feet in the soil which makes cultural control impractical. Soil sterilants are the only known method for control.

Photo 11-13. Eclipta (*Eclipta prostrata* or *E. alba*) is an annual, prostrate weed with toothed edges on its oblong leaves, roughly hairy leaves, and white flowers borne in heads. It appears to be spreading rapidly into cotton-growing areas of the state. The only herbicides which effectively control this weed cannot be safely used on cotton.

Photo 11-14. Hophornbeam copperleaf (*Acalypha ostryifolia*) is an annual weed in the spurge family. Its light green, sharply serrated leaves aid in identifying this plant. Its flowers are borne at the tips of its stems; the male flowers are surrounded by bracts with several lobes. This weed emerges throughout the growing season which makes its control difficult.