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WEED MANAGEMENT

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Effective weed management is one of the cornerstones of profitable cotton production. It requires detail, timeliness and good fortune to raise a clean crop of cotton. Mistakes are costly, second chances unlikely and rescue impossible. High tech solutions are in the wings. But for now, hard work is the key to clean, weed-free cotton. This newsletter reviews the current status of cotton weed control from a crop management perspective.

Strangers and Survivors

Once cotton comes up to a stand (hopefully), it seems it is the only thing not growing in the field. Insects, weeds and diseases are busy carving up the pie to see who gets the biggest piece. Much of this relates to cotton's position as stranger in a strange land. Planted early to extend the season, ill-equipped to capture sunlight and hamstrung by the cool or cold temperatures, the plants languish like sitting ducks.

Into this arena steps the enemy. Lean, mean weeds. Survivors every one. Some native, some exotic, but each a warrior. What distinguishes a plant as a weed? Are they merely plants out of place? Some people plant morning-glories for their flowers. Cowpeas make a tasty dish. Cattle love johnsongrass and kudzu.

Weeds are not simply undesirable plants. Weeds also are recognized by their competitive abilities. They don't need to be planted, cultivated or fertilized. They require no nurturing, just some space and the farmer's unfulfilled good intentions. Weeds possess certain inherent characteristics that enable them to establish themselves in disturbed ecosystems such as row crop fields. These include abundant seed production, rapid growth, vegetative reproduction in perennials and long life seed in soil. The outcome of competition between this foreigner, cotton, and these survivors is a foregone conclusion without some intervention. Cotton needs some help to succeed.

Competitive and Allelopathic Effects

Weeds compete with cotton for resources and time. Weeds may also affect cotton by releasing chemicals that inhibit growth and development. Allelopathy has not been studied in cotton systems to the extent it has in other systems, but is likely to occur with some weed species. This indirect chemical inhibition of cotton growth is of secondary importance compared to the consequences from direct competition.

Light

Cotton does not perform well in low light. Shade and cloudy weather are known to increase boll shed, delay maturity and reduce yield. Light is usually the factor for which there is the greatest competition. Tall growing weeds such as cocklebur, that create tremendous leaf area within and above the cotton canopy, are among the most competitive weeds. These weeds also restrict air movement and raise moisture levels in the canopy, stimulating boll rot and quality losses.

Water

Weeds also use water that could be used by cotton plants. In this regard, high plant populations (see April 1993 issue) and weeds are similar. Both draw on soil reserves without contributing to harvestable yield. However, weeds introduce another dimension that relates to their biological makeup; weeds can explore more of the soil profile, capturing a greater proportion of the available moisture. This attribute explains how some weeds are more competitive during periods of drought. Certain other weeds, such as pigweed and most grassy weeds, have more efficient photosynthetic machinery (C4 metabolism) that allows them to maintain higher growth rates during periods of limited water.

Nutrients

Competition between weeds and cotton is also expressed in their relative abilities to capture and utilize needed minerals. Weeds with extensive root systems can explore a greater volume of soil for nutrients. Weeds species that reproduce vegetatively or produce small seeds may have lower nutritional demands. Competition for nutrients can be lessened if soil fertility is kept high enough to also supply the cotton. Of course the approach may not be commercially advisable in the absence of other weed management practices.

Time

Weeds can compete with cotton by stealing time. The sum total of the other competitive effects reduce the effective season length available to produce the crop. Tall growing weeds that shade cotton delay development and boll loading. Competition for water and nutrients reduces the overall growth rate and predisposes the crop to premature cutout. All are different causes with the same expected effect — reduced yield.

Species Effects

Some weeds are more competitive with cotton than others. Common cocklebur and smooth pigweed have the greatest documented impact on cotton, partially due to their large size and extensive root system. Both grow faster than cotton, creating shade that reduces boll set. Management strategies must focus on these most competitive species to be economically effective.

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Some species compete with cotton by lowering lint quality. For example, morningglory and grasses can significantly decrease cotton quality even if yield is not reduced. When bark from broadleaf weeds and grass cause a grade reduction, lint value may decrease by over 5 cents/pound.

Red vine and other climbing weeds cause yield losses through harvest interference. Vine density can be severe enough to limit picker efficiency or preclude harvest. Picker operators waste valuable time unwrapping vines from spindles and bars. Vines and other weeds that remain green after defoliation can contribute to green stains and subsequent price reduction.

Weed Density

Weed pressure is directly related to density. What morningglories or sicklepod lack in individual competitiveness, they more than offset in numbers. At low densities, additional weeds exert their competitive effects independently of one another. As weed density increases, weeds begin to compete with each other as well as cotton. However, at these high densities, substantial yield reductions already have occurred.

Species/ Density Interactions

Growers normally encounter many species and densities in fields, thereby increasing the complexity of control decisions. The diversity and density increases the breadth of the weed pressure. Each niche in the field environment is filled by a weed, leaving little room for cotton. The combined presence of the weed community can quickly overwhelm cotton while undermining any weed management strategy that relies on a single herbicide chemistry.

Duration

The duration of weed competition that can be economically tolerated depends on the weed species and density. Weed growth is favored when temperatures are cooler. Cotton is most susceptible to broadleaf weed pressure in early season when herbicide options are limited. Once the size differential between the weeds and cotton is lost, herbicide options are largely ineffective, forcing reliance on labor intensive practices. Cotton needs a head start to compete with weeds without sustaining a loss in yield. This weed-free time period has been determined to range between 4 weeks to get a jump on species like prickly side or velvet leaf to more than 8 weeks for morningglory.

Weeds also may harbor and support increased insect pressure while hampering control measures. Work in North Carolina has demonstrated a clear relationship between cocklebur infestations and European corn borer damage. Migration of plant bugs from border areas of fields has been associated with increased square abortion in several states.

Weed Management Tools

Weed management must be viewed within the larger context of crop management. All available tools can compliment each other and strengthen the overall system. When approached in this fashion, decisions are agronomically and environmentally sound.

Crop Competition

The first line of defense in weed control is: "Grow the crop, not the weed." Fashioning a strategy that keeps cotton healthy will strengthen its competitiveness. Cotton will not compete well with weeds (or any pest) if planted into unfavorable environmental conditions such as cool or wet soils. Over-application of soil-applied herbicides in pursuit of extra weed control can damage or kill cotton. Seedling diseases weaken plants and cause stand loss. Gaps in a stand provide an ideal site for weed invasion. Thrips can delay the formation and expansion of leaf area that is crucial for cotton to maintain a size advantage over emerging weeds. These additional crop stresses must be avoided to increase the competitive ability of the cotton.

Rotation

A largely under-used technology in many regions of the Cotton Belt is crop rotation. This practice incorporates complimentary crops into a system that maximizes sustainable profitability and crop health. Weeds are easier to manage in certain crops than others. Almost any broadleaf weed is easier to control in corn or sorghum than in cotton. Generally, weed control is easier in soybeans or peanuts than cotton. For example, morningglory or sicklepod can be handled quite effectively in corn and cocklebur is handled quite effectively in soybean.

Cultivation

Cold steel is a well-understood technology. Experienced growers know that cotton likes to be cultivated. Even with no weeds, improved oxygen supply to roots following cultivation maintains the vigor of the cotton crop.

Herbicides

The status of cotton herbicide technology is varied and evolving. A number of highly selective and effective soil-applied and post-emergence grass herbicides are available. Once cotton reaches 6" to 8" tall, a whole catalog of products can be used depending on the grower's specific needs. Recent advances in herbicide technology and biotechnology promise to revolutionize weed management strategies in the near future.

The Achilles heel in a cotton weed management program right now is the lack of an over-top broadleaf herbicide. The new technologies are targeted to reduce this limitation. A future newsletter will explore these technologies as they approach commercialization.

Herbicide Mode of Action (MOA)

Herbicides control weeds in a variety of ways. The visual symptom associated with a compound's activity is the sum of a series of physiological alterations within a susceptible plant. Some physiological processes are directly affected by the herbicide. Additional processes are altered as a consequence of this primary mode of action. Knowledge of a herbicide's MOA can explain why it is used in a particular fashion and offer clues as to why it sometimes doesn't perform as expected.

Federal Pesticide Record Keeping Requirements

Effective beginning May 10, 1993, "certified applicators" of restricted use pesticides must maintain certain records of their pesticide applications. Failure to maintain necessary records can subject individuals to fines. *See the April 9, 1993, issue of the Federal Register, page 19017.*

A "certified applicator" is any person certified by the Environmental Protection Agency or a State to use or supervise the use of restricted use pesticides. Producers who apply restricted use pesticides have, for a number of years, been required to become "certified" by, among other things, attending courses that teach pesticide safety. This recordkeeping requirement, then, applies to virtually all producers who use these chemicals on their farming operations.

Within 30 days after applying a restricted use pesticide, the certified applicator must record:

1. The **date of the application;**

2. The brand or product **name of the pesticide and its EPA registration number;**

3. The **total amount of the pesticide applied,** in quantities similar to label language, with each restricted use pesticide listed separately. This does not refer to the percent of active ingredient nor the quantity of water or other carrying agent;

4. The **location of the application.** The record should indicate the specific location of the application using either (1) the map—farm number—field identification system established by ASCS and SCS, (2) county, range, township, and section, (3) an identification system utilizing maps and or written descriptions which accurately identifies the location, or (4) the legal property description;

5. The **size of the area treated.** This refers to the entire area covered and should be reported as acres, linear feet, bushels, cubic feet, square feet, number of animals, etc. For special applications such as alternate middles, weed wicks or band applications, the size should still refer to the total area covered, i.e., the size of the entire field;

6. The **crop, commodity, stored product, or site** to which the pesticide was applied. The record must indicate whether the application was to a field of cotton, soybeans, corn, a storage bin of grain, or to livestock, etc. If the application was to trees, nursery stock, or fence row, etc., that information would need to be recorded; and

7. The **name and certification number (if applicable) of the certified applicator** who applied or supervised the application of the pesticide.

If the pesticide application is a "spot application," (a pesticide treatment directed at specific plants or areas which in total is less than one-tenth of an acre) the record need only include the date, brand or product name, EPA registration number, total amount applied and location, which would be designated as a "spot application". There must be a separate entry for each date pesticides are applied this way.

Records must be maintained for **2 years.** Commercial pesticide applicators must provide a copy of their application records to farmers for whom they apply pesticides within 30 days of the application.

Any person who violates these requirements shall be liable for a civil penalty of not more than $500 for the first offense and not less than $1,000 for each subsequent offense. If it is determined that a good faith effort to comply was made, the fine may be lowered.

If a particular State has pesticide record keeping requirements for certified applicators that are comparable to those for commercial applicators in that State, and the certified applicators maintain those records, those certified applicators do not have to comply with the separate federal requirement contained in this statute.

The records must be made available to authorized individuals who are acting on behalf of the Secretary of Agriculture or a State agency involved in overseeing compliance. Producers are advised to make the records available only after a request has been made and the individual has presented credentials indicating their authority. The producer should allow inspectors to copy records, but must always maintain the original. The records must also be made available to licensed health care professionals, if necessary, to provide medical treatment or first aid. There are safeguards to prevent further distribution of the records.

> **This is a new requirement in many states. Producers are urged to check with their local ASCS office or Extension Service to determine what records they must maintain.**

When complying with this requirement, producers should keep several points in mind:

1. Whatever system of determining the location of pesticide applications is used, the record should make it possible to accurately track pesticide applications. A good alternative is the ASCS farm/field numbering system.

2. List the certified applicator's name and number with each application if the certified applicator is not the same for all applications. If the same certified applicator is responsible for all applications, the applicator's name and number need not be listed repeatedly provided there is an obvious linkage on the record to the responsible certified applicator.

3. Compliance with the federal statute does not ensure compliance with state law. The federal requirements will allow a producer to continue applying the state system if the state system is comparable to the federal requirements. Producers in states that already require a certain amount of pesticide recordkeeping may not have to alter their recordkeeping system.

4. It would be advisable, where there are questions as to whether a particular pesticide is a "restricted use" pesticide, to err on the side of inclusiveness.

5. In developing a system of records, producers may consider incorporating the new Worker Protection Standards for Agricultural Pesticides into that system.

The charts on the next pages are examples of a type of recordkeeping system producers may want to use to comply with these recordkeeping requirements. Listed across the top of the table are the various pieces of information required by the regulations. Each individual pesticide application can be recorded down the left hand side of the table. USDA chose not to develop a standardized table, preferring to allow flexibility to individual producers. Other recordkeeping systems have been developed by private parties are available.

For copies of the final regulations and answers to questions on the pesticide recordkeeping requirements, producers may contact:

USDA—Agricultural Marketing Service
Pesticide Records Branch
8700 Centreville Road, Suite 200
Manassas, VA 22110
(703) 330-7826

This insert was developed by the National Cotton Council of America as a service to its members. Every effort has been made to ensure that the information contained in this document is accurate and as current as possible. However, individuals are advised to contact representatives of the U.S. Department of Agriculture for advice on complying with the pesticide recordkeeping requirements.

PESTICIDE APPLICATION RECORDS

Year ________ **Farm Number** _______

DATE	BRAND OR PRODUCT NAME	EPA REGISTRATION #	TOTAL AMOUNT APPLIED	LOCATION	SIZE OF AREA TREATED	CROP, COMMODITY, STORED PRODUCT, OR SITE	CERTIFIED APPLICATOR (Name & Number)	COMMERCIAL APPLICATOR (if applicable)

PESTICIDE RECORDS

Certifed Applicator Name: ____________________ **Certified Number:** _______________

DATE	BRAND OR PRODUCT NAME	EPA REGISTRATION #	TOTAL AMOUNT APPLIED	LOCATION	SIZE OF AREA TREATED	CROP, COMMODITY, STORED PRODUCT, OR SITE	COMMERCIAL APPLICATOR (if applicable)

Table 1 CHARACTERISTICS OF SELECTED COTTON HERBICIDES			
Herbicide	**Primary Uptake Site**	**Movement Within Plant**	**Primary Mode of Action(s)**
Arsenicals — MSMA, DSMA	leaves	toward growing points, limited	inhibit photosynthesis, free radicals
Ureas and Triazines — Cotoran, Bladex, Caparol, Karmex	roots and leaves	upward	inhibit photosynthesis, free radicals
Dinitroanilines (DNA)— Treflan, Prowl	coleoptile and roots	minor	disrupt cell division
Poast Plus, Fusilade, Select, Assure II, Bugle	leaves	toward growing points	prevent lipid formation (oils)
Zorial, Command	roots	upward	prevent formation of photosynthetic pigments (chlorophyll)
Diphenylethers — Goal, Cobra	leaves	minor	inhibit photosynthesis, free radicals
Gramoxone Extra	leaves	minor	free radicals
Glyphosate	leaves	toward growing points	prevent formation of aromatic (ring-shaped) Amino Acids
Dual	roots	upward	prevent lipid formation

Action Sites

Herbicides can act on several fundamental processes necessary for cellular integrity and ordered plant development. During photosynthesis, light energy is captured in chlorophyll molecules and converted to chemical energy in compounds that contain carbon. This multi-step capture and conversion of light energy is the action site of many herbicides. Different chemistries short-circuit various steps in the process.

Plants also manufacture fat-like compounds called lipids as components of membranes that enclose different parts of the cell. This separation of the cell into compartments allows for a wider variety of biochemical tasks to be completed simultaneously without disrupting the cell's overall functioning. When the manufacture of lipids is upset, the compartments are not maintained and the cell ceases to function. Cells must divide to continue to grow and develop. Several herbicides, including the dinitroanilines (yellow herbicides), disturb this process. Other herbicides, such as glyphosate, prevent the formation of an amino acid necessary for protein production.

Another direct and indirect MOA is the formation of free radicals. These highly reactive oxygen-containing compounds steal electrons from many necessary cellular components. They work like tiny monkey wrenches thrown into the biological gears. Not only do they stop the mechanisms, they destroy the gears.

These are examples of several possible modes of action identified for cotton herbicides. Other herbicide classes may have other modes of actions. The ultimate consequence of all MOA is the destruction of cellular order.

Table 1 summarizes some of the identified characteristics of cotton herbicides. Herbicide application strategies are guided by the mechanism of plant uptake, its movement within the plant and the primary action site(s) of biochemical and physiological MOA.

Herbicides that prevent or disturb photosynthesis include MSMA, DSMA, Cotoran, Bladex, Caparol, Cobra and Gramoxone Extra. Lipid formation is disrupted by Poast Plus, Fusilade, Select, Assure II, Bugle and Dual. Chlorophyll pigment formation is prevented by Command and Zorial. Glyphosate (Roundup) prevents the formation of aromatic (ring-shaped) amino acids. Free radicals are partially responsible for the havoc raised by many of these herbicide classes.

Uptake and Translocation

Herbicide uptake sites and movement within plants (translocation) are inherent characteristics of herbicides that may or may not compliment each other. Materials that are translocated toward the growing points simplify application strategies. Those that move within the transpiration stream (upward) are commonly soil-applied or used on small weeds where excellent foliar contact is assured. Contact herbicides do not move within the plant and must be applied to insure thorough plant coverage.

These uptake/translocation characteristics explain why DNA herbicides are soil-applied so germinating weed and grass seeds can contact the herbicides. Alternately, compounds that inhibit photosynthesis are excellent candidates for foliar treatment, but may also work well when soil applied depending on sites of uptake.

Knowledge of herbicide characteristics can suggest why treatments sometimes do not perform as predicted. Uptake site characteristics of pre-emergent herbicides such as fluometuron (e.g. Cotoran), may explain poor performance if rain is insufficient to move material into the root zone uptake site. Poor DNA performance may also result from uptake site characteristics. Grass shoot (coleoptile) and root absorption of the DNA is critical for control. When herbicides are incorporated too deeply, the concentration in the weed seed germination zone (top ½ to 1 inch) decreases, sometimes allowing escape.

Herbicides that move toward growing points such as Poast Plus and Fusilade are used to control perennial grasses that have extensive root systems. However, if the plant is not actively moving nutrients and carbohydrates to these zones, the herbicide may not reach all the growing points, resulting in unsatisfactory control. For example, cultivation may disturb the plant enough to shock its system and temporarily stop growth. This can also occur if the weed is growing slowly while under drought or cold stress. Moisture stress can also thicken the leaf cuticle of weeds reducing foliar absorption of herbicides.

Stewardship

Weed management has progressed with the development and evolution of herbicide technology. The tools now available to producers have increased their capabilities. New advances promise to further enhance weed control options, strengthening the production system. Instead of relying on preventative treatments, growers may be able to move toward responsive, prescription weed management. Uncertainties about expected weed pressure will diminish and growers can reduce their dependence on "insurance" applications. In the hands of a thoughtful manager, increased agronomic capabilities complement their environmental stewardship. Knowledge of available alternatives allows the producer to choose the right tool for the right job.

Wrap-Up

Skills developed in weed management carry over to cotton management. Deliberate and conscientious attention to detail produces a workable and flexible strategy. Weeds will win if given half a chance. The manager's challenge is to make sure they don't get it.

Weed Control Reference Available

The Cotton Foundation has recently published a comprehensive guide to weed management entitled Weeds of Cotton: Characterization and Control. Topics covered in this reference book include weed biology, herbicide chemistry and application technology, and future trends in management. Producers, consultants and allied professionals will find the book a valuable source of information. Copies can be obtained by contacting Janice McRae of the Cotton Foundation at (901) 274-9030.

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