

Cotton Physiology

Today

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New Ways to Manage Weeds

Weeds, the bane of every farmer, just never seem to go away. Some, such as prairie sunflower, are tolerant of preplant-incorporated herbicides and have become an increasing problem (Figure 1). Fortunately, new technologies are now available that make controlling weeds a lot easier.

There are many advantages, some disadvantages, and new costs associated with adopting these tools. Here we discuss typical weed management programs for each of the four regions of the Cotton Belt and give some insights as to how these new products can best be used to complement existing practices.



Figure 1. Prairie sunflower.

W Keeling

Regional Perspectives – West (AZ, CA)

In Arizona, whether growers plant into pre-irrigated beds or plant shallow in dry soil and then irrigate, preplant-incorporated herbicides are used. They usually are applied to flat ground and incorporated by disking or using a field cultivator with S-tine sweeps followed by listing (bedding up). A dinitroaniline herbicide (Treflan, Prowl) is used alone or, when annual morning-glory is a problem, in combination with a broadleaf herbicide such as prometryn (Caparol,

Cotton-Pro). Occasionally injury from preplant applications of herbicides is observed (Figure 2).

Once the crop has emerged, cultivation and hand weeding are used to control weeds until cotton reaches the 6 to 8 inch stage, at which time the crop should be taller than the weeds. About one-third of the growers then apply non-selective, post-directed herbicides such as diuron (Karmex, Direx), prometryn (Caparol), or cyanazine (Bladex, CyPro).

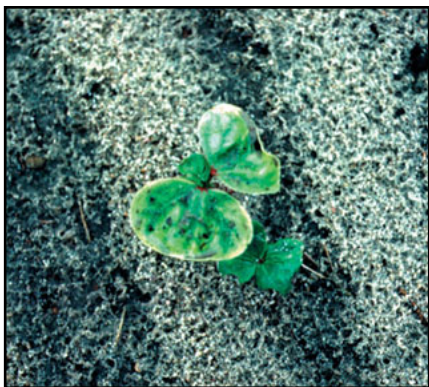
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The Cotton Physiology Education Program (CPEP) was created 9 years ago by a grant to the Cotton Foundation from BASF, makers of Pix®, the original plant regulator. CPEP's mission is to discover and communicate more profitable methods of producing cotton.

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S Brown

Figure 2. Cotton seedling injured by preemergence herbicide application.

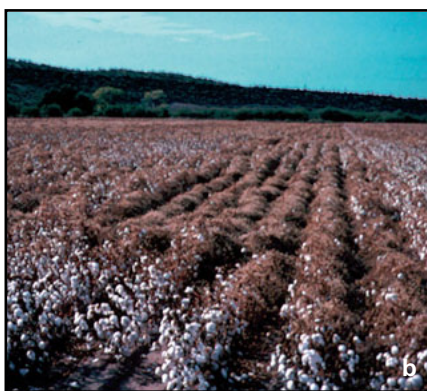
Sometimes these herbicides are combined with MSMA as burn-down postemergence treatments. These are the so-called ‘chemical hoe’ treatments for small weeds less than 2 inches in diameter. To avoid injury to the crop, these sprays must be directed at the base of the cotton plants.

Layby applications are made when the crop canopy reaches 20 to 24 inches in height — before equipment can no longer be driven through the field without damaging the plants. Some variations in this general weed control program exist.

In fields infested with nutsedge, norflurazon (Zorial) may be used preplant-incorporated for short-term suppression. If weed pressure is low, post-directed, broadleaf herbicide applications on 6 to 8 inch cotton may be eliminated. Selective postemergence grass herbicides include fluazifop (Fusilade), sethoxydim (Poast), and clethodim (Prism, Select). These herbicides are used to control weeds such as bermudagrass, johnsongrass and annual grass escapes.



a



b

WB McCloskey

Figure 3. Mid- (a) and late- (b) season infestations of morningglory.

In Arizona, annual morningglory (Figure 3) and perennial nutsedge species (Figure 4) are major weeds difficult to control with traditional practices.

Three new, selective postemergence herbicides (Buctril, Roundup Ultra, and Staple) have been registered recently in Arizona. Buctril and Roundup Ultra can be used only on their complementary transgenic varieties — BXN from Stoneville Pedigreed Seed and Roundup Ready cotton from Delta and Pine Land, respectively. Staple can be used on all upland cotton varieties.



WB McCloskey

Figure 4. Bad purple nutsedge infestation.

These new chemicals can be applied over-the-top to small seedling cotton or post-directed on larger cotton which has more than four true leaves. One or two applications of these herbicides allow growers to control broadleaf weeds (pigweeds, Wright’s groundcherry, annual morningglories) in cotton from emergence until the cotton is over 8 inches high when traditional weed control practices can be used. Roundup Ultra also controls grass seedlings and suppresses nutsedge (Figure 5).

Use of Buctril, Roundup Ultra, and Staple requires that fields be scouted more frequently very early in the season (i.e. 2 weeks after planting). For them to be effective, it is important that these herbicides be applied to small, actively growing weeds. Water-stressed weeds will not be controlled. By planting time, spray rigs need to be calibrated and ready to go.

Usually herbicide applications should be made before the first cultivation following planting. Successful use of these herbicides can reduce or eliminate the expense of hand weeding.

Standard weed control strategies in California's San Joaquin Valley include combinations of crop rotation, cultivation, hand hoeing, and herbicide application. The most persistent weeds are tolerant of cotton herbicides. Rotation of cotton with crops like tomatoes, which use the same preplant-incorporated herbicides (i.e. a dinitroaniline like Treflan or Prowl) also has selected for herbicide-tolerant weeds.

Weeds tolerant of dinitroaniline herbicides include the most prevalent annuals, both black and hairy nightshades, the perennial silverleaf nightshade (Figure 6), groundcherry, tolgua-cha, annual buffalobur, and Chinese thornapple. These weeds are all members of the Solanaceae, the same family as tomato, pepper and eggplant.



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Figure 5. Nutsedge control in Roundup Ready cotton after two sequential applications of Roundup Ultra (a); untreated (b).

Additional perennial weeds that are problems include both yellow and purple nutsedge, field bindweed, bermudagrass, and johnsongrass. Annual morning-glory and velvetleaf are not controlled by dinitroaniline herbicides. Barnyardgrass and many other annual broadleaf weeds are controlled effectively by the dinitroanilines.



R Vargas

Figure 6. Severe nightshade infestation.

Preplant herbicides such as Treflan or Prowl are applied flat and double disced to incorporate. The field is then listed (bedded up). If listing is done in the fall, cultivation and/or residual herbicides (Bladex, Caparol, or Goal) are used to keep the fallow beds free of weeds until spring planting. If a residual herbicide is not used, either Gramoxone or Roundup is applied to control winter annuals.

Rolling cultivators or bed mulchers are used to cultivate and remove small weed seedlings or weeds killed by previous herbicide applications, just before the beds are planted.

Nightshade and nutsedge often emerge at the same time as cotton. Fields heavily infested with either of these weeds are sometimes treated with metam sodium (Vapam). Two to 3 weeks before planting, the fumigant is applied with spray blades that are pulled through the beds at planting depth. Control of nightshade and its relatives like Chinese thornapple has been excellent (Figure 7). Growth of nutsedge is suppressed for 20 to 30 days.

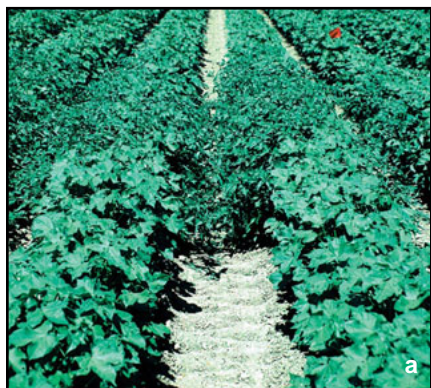


R Vargas

Figure 7. Control of Chinese thornapple with Vapam (right); untreated check (left).

Nightshade usually grows faster than cotton. Traditionally, hand hoeing, at costs of \$50 to 200 per acre, was one of the few options growers had for early season nightshade control. Unfortunately, post-directed sprays of residual herbicides often damage young cotton.

However, with the registration of Staple in 1996, growers now have another effective means of combating nightshade (Figure 8). When Staple is applied early season to cotton (just emerging up to the 3 or 4 leaf stage), this over-the-top herbicide gives 95 to 100% control of nightshade at the 3 or 4 leaf stage. Costly hand hoeing can be reduced. Because Staple persists in the soil, rotation-crop restrictions apply to a number of crops.



R Vargas

Figure 8. Nightshade in untreated plot (a); 100% controlled with Staple (b).

Before a layby herbicide (Bladex, Goal, Treflan) is applied, cultivation is used to supplement preplant herbicide applications and to develop furrows for irrigation. Post-emergence grass herbicides (Fusilade, Poast, Prism) are used when annual grasses such as barnyardgrass or perennials such as johnsongrass are present (Figure 9). Roundup, applied with a hooded sprayer, has been used to successfully control field bindweed.



R Vargas

Figure 9. Johnsongrass infesting cotton (a); after application of Prism (b).

Weed-Seeker sprayer technology has been used for nutsedge control. This sprayer only sprays herbicide when it “sees” or senses the green chlorophyll of weeds in the furrows (Figure 10). When this technology is combined with a hooded sprayer, Roundup can be sprayed to control nutsedge and other emerged weeds. A big advantage is the savings of herbicides because it only sprays when weeds are present.



R. Vargas

Figure 10. Weed-seeker sprayer, fitted with hood, applying Roundup only to green weeds.

At the final cultivation, a layby herbicide is often applied as the cotton canopy closes over the furrow. This application prevents the growth of nightshade, annual morningglories and ground cherry when it is no longer possible to cultivate.

Breeders are developing Acala cotton varieties with tolerance to Roundup and Buctril. However, because of the variety testing and release program conducted by the San Joaquin Valley Cotton Board, these new technologies will not be available to growers until 2000.

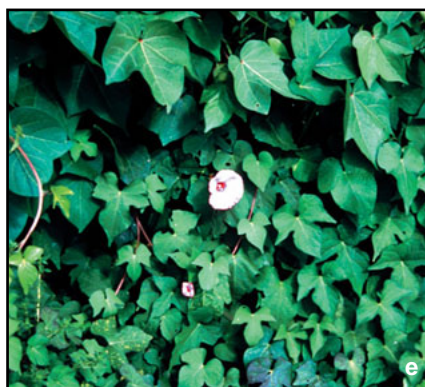
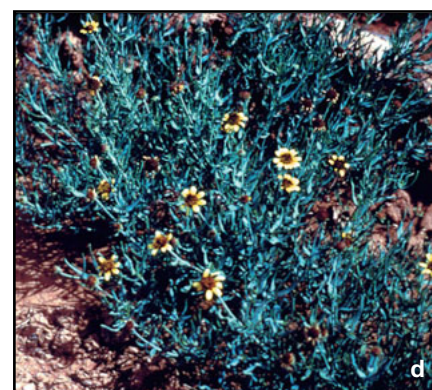
Regional Perspectives – Southwest (NM, OK, TX)

Although weed pressure throughout the growing season is not as intense in the semi-arid Southwest as it is in areas with higher rainfall, weeds compete with cotton for limited soil moisture, nutrients, and light. The end result is reduced yields and quality.

Common weed problems include pigweed (Palmer amaranth), Russian thistle (tumbleweed), devil's claw, and perennials like silverleaf nightshade (whiteweed), Texas blueweed, and woollyleaf bursage. Weeds that are becoming a problem are yellow and purple nutsedge, morningglory, lanceleaf sage, cocklebur, prairie sunflower (Figure 1), black nightshade, and venice mallow. Several of these weeds are shown in Figure 11.

In the Southwest, preplant-incorporated dinitroaniline herbicides (Treflan, Prowl) are used on 85 to 90% of the cotton acreage to control pigweed, Russian thistle, kochia, and annual grasses. Preemergence herbicide treatments (Caparol, Karmex, Cotoran, or Dual) are applied at planting to control broadleaf annuals and yellow nutsedge, which are not affected by the preplant herbicides.

Post-directed treatments for broadleaf weeds are not commonly used, but over-the-top grass herbicides are applied for the control of johnsongrass, bermudagrass and escapes of annual grasses.



W Keeling & P Baumann

Figure 11. Common weeds of the Southwest include a) pigweed, “Palmer amaranth,” b) devil’s claw, c) silverleaf nightshade, d) Texas blueweed, e) sharppod morningglory, and f) cocklebur.

Fall treatments of Roundup and Banvel are widely used for perennial weed control. Spot spray treatments with Roundup are applied in-season for silverleaf nightshade and other weed escapes. Cultivation is used for in-season weed control.

In the irrigated cotton grown in the Brazos river bottom, careful vigilance is required to spot the first emergence of sharppod

morningglory, a difficult-to-control pest (Figure 11 e). Preplant and preemergence herbicides have been used traditionally to combat this and other troublesome weeds. If weeds escape these measures, timely post-directed herbicide applications, in conjunction with cultivation, help provide control.

In the dryland farming of the Blacklands, weed pressure is not as intense. Use of post-directed sprays has not been common. Broadleaf weeds that escape preplant or pre-emergence herbicide applications are controlled by cultivation or spot sprays of herbicides.

In South Texas, weeds grow well 12 months of the year. A successful weed control program uses a year-round approach. Off-season, winter treatments include cultivation, burn-down, and/or residual chemical treatments (i.e. Bladex, Caparol, Prowl, or Treflan).

These treatments are usually followed with a standard pre-emergence treatment. This program provides adequate in-season control of most annual species. Although hooded sprayers are gaining favor, in-season directed spraying is normally not attempted because high winds are typically present in the critical spring treatment period. Escapes are removed by spot treatment or hand weeding.

For several years, producers used Command preemergence to control tough weeds like Texas croton, cocklebur, prairie sunflower, and lanceleaf sage. The potential for off-target drift limited the use of this technology, however. Application of Command also required that an organophosphate soil insecticide be used as a safening agent at planting.

Staple, the newly-registered, over-the-top, broadleaf herbicide, gives growers new options. Staple applied postemergence controls pigweed escapes,

morningglory, lanceleaf sage, and other broadleaf annuals. However, because of the severe drought experienced in much of South Texas in 1996, Staple received a mixed review. For most effective action, Staple needs to be applied to small, actively growing weeds. Its potential will be greater in years with more rainfall.

Transgenic cottons (BXN and Roundup Ready) will be available to producers in 1997 and will be particularly useful where growers practice minimum tillage, or where they have tough-to-control species. Roundup Ultra applied early postemergence to Roundup Ready cotton in research plots showed excellent control (Figure 12).



Figure 12. Untreated (a); Roundup Ultra applied early postemergence to Roundup Ready cotton (b).

P Baumann

Buctril applied to BXN cotton controls many tough broadleaf annuals such as cocklebur, devil's claw, and morningglory (Figure 13). When used at higher rates, it can suppress perennial weeds.



W Keeling

Figure 13. Control of weeds with Buctril applied postemergence to BXN cotton.

Research to date indicates that Roundup and Buctril should be integrated into a complete weed management system that includes use of soil-applied herbicides. Because products used to treat transgenic cotton will have few, or no, restrictions as to which crops can follow, their use will open up new crop rotation possibilities.

Regional Perspectives – Mid-South (AR, LA, MO, MS, TN)

Cotton weed management in the Mid-South region begins with tillage (chiseling, discing, and/or bedding) or preplant herbicides to control vegetation before planting. Roundup or Gramoxone Extra alone, or in combination with oxyfluorfen (Goal), cyanazine (Bladex, CyPro), or prometryn (Caparol, Cotton Pro), is applied in minimum and no-tillage fields (Figure 14). Cyanazine, prometryn, and oxyfluorfen provide residual soil activity to reduce reinfestation. In no-till, Prowl or Dual are surface-applied in combination with pre-emergence herbicides (Cotoran, Command, Meturon, Zorial, etc.) for broadleaf weed control. Gramoxone Extra is used if weeds have emerged.

In conventional planting, emerged weeds are destroyed by tillage with a bed conditioner or field cultivator. Dinitroaniline herbicides (Prowl, Treflan) are incorporated at the same time the field is tilled. Preemergence herbicides (Cotoran/Meturon, Command, and Zorial) are usually banded on less than one-half the row width. Almost all the acreage is treated with Cotoran/Meturon.



W Keeling

Figure 14. Conservation tillage with terminated wheat crop.

Command is primarily used to improve control of velvetleaf, morningglories, prickly sida and spurred anoda. The insecticides Di-Syston or Thimet are needed as safeners at planting to protect the cotton from Command injury. Zorial is one of the most effective treatments for prickly sida and nutsedge.

Whims of the weather can further complicate weed control in this region. Excessive rainfall after planting may remove herbicides from the effective zone in the soil. If this happens, weeds escape. On the other hand, sometimes not enough rain falls to activate preemergence herbicides. Again, weeds escape. Cool growing conditions promote the growth of some weeds like johnsongrass, velvetleaf and common cocklebur. At cool temperatures, these weeds grow faster than cotton. Weeds taller than cotton are not easy to control with post-directed herbicides.

Selective over-the-top herbicides (Poast, Fusilade, Assure, Fusion, Select) replaced DSMA for johnsongrass control. DSMA is still being used for post control of broadleaf weed escapes, especially common cocklebur. However, arsenical-resistant common cocklebur is widespread throughout the region.

In 1996, Staple applied post-emergence on small, actively growing broadleaf weeds was an effective new means of control — even of cocklebur. In addition to cocklebur, morningglory, pigweed, and hemp sesbania all succumbed. Growers have been satisfied with Staple's performance when it is used with a sound pre-emergence program and timely post-directed sprays.

Prickly sida, spotted spurge, velvetleaf, and sicklepod (Figure 15) are all better controlled by pre- rather than postemergence applications of Staple. Take the weed history of a field into account when deciding whether to use Staple in a preemergence application. A maximum of 2.4 oz/A can be applied during a season.



S Brown

Figure 15. Heavy sicklepod pressure in cotton.

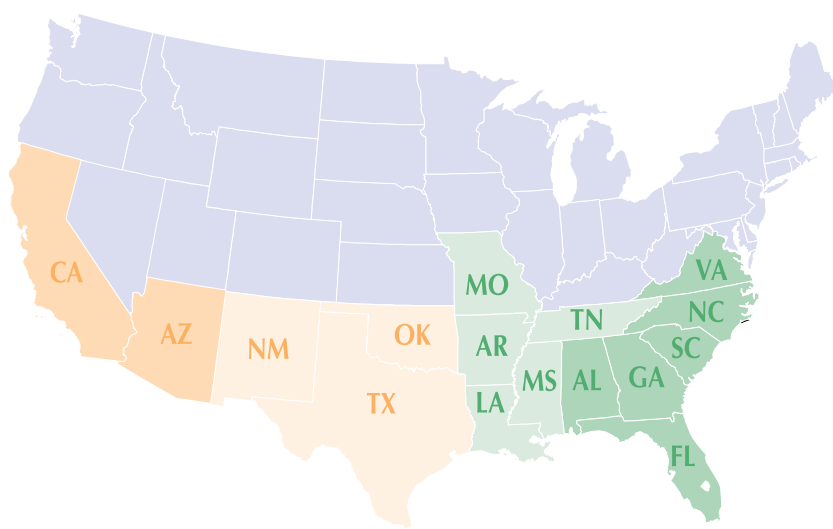
Genetically-engineered BXN cotton, resistant to Buctril herbicide, will be another tool available to growers in 1997. Buctril applied to BXN 47 is particularly effective on common cocklebur and morningglory. Growers no longer have to push preemergence herbicides to the point where some cotton injury occurs in order to control these two weeds. However, Buctril must be applied only to BXN cotton. It very effectively kills conventional varieties. Buctril is best used as one component of a well-planned total weed management program which includes appropriate preemergence and post-directed herbicides.

Roundup Ready cotton will be commercially available for the first time in 1997. For the North Delta, Paymaster varieties PM1215RR, PM 1220RR, and PM 1244RR, along with Deltapine 5415RR, are similar to their backcross parent with the same numerical designation. These varieties tolerate Roundup Ultra postemergence overtop through the four-leaf stage. After that, application should be directed to the base of the plant. Application can also be made overtop once the crop reaches 20% open bolls. Roundup rates should be selected according to weed species and size tables on the label.

Growers considering Roundup Ready cotton may be able to eliminate some preemergence herbicides which are now applied to the soil at planting. However, if these at-planting herbicides are eliminated, careful management

will be required to assure the proper timing of the Roundup Ultra application to control early-emerging weeds. What other course of action can be taken if a prolonged rainy period prevents timely application of Roundup and no preemergence products have been used?

Some residual herbicide at planting, or as a post-directed spray, may be beneficial. Grower agreements, an \$8 per acre technology charge, and seed premiums must be included in totaling costs of the Roundup Ready program. Budgets suggest that the total program costs are equal to or below that currently being spent.



Regional Perspectives – Southeast (AL, FL, GA, NC, SC, VA)

In the Southeast, growers use an herbicide application program similar to the following:

- 1) preplant incorporated application of a dinitroaniline herbicide (Treflan, Prowl);

- 2) preemergence applications of fluometuron (Cotoran, Meturon) alone or in combination with other products such as Zorial or, more recently, Command;

- 3) early postemergence-directed applications of fluometuron plus MSMA (sometimes just MSMA);

- 4) one, or possibly two, directed applications of cyanazine (Bladex or Cy-Pro) plus MSMA to finish out the season;

- 5) over-the-top applications of graminicides (Poast Plus, Fusilade, Select, Fusion and Assure) to control escaped grasses (annuals, bermudagrass or johnsongrass).

Conventional tillage systems typically include a couple of mechanical cultivations (Figure 16) which are often accompanied by post-directed herbicide treatments. Use of hooded sprayers has increased in the past half dozen years in both conventional

and conservation tillage (Figure 17). Gramoxone Extra or Roundup are commonly used alone, or in combination with diuron (Karmex, Direx) or cyanazine (Bladex). The combinations increase the types of weeds affected.



S Brown

Figure 17. Hooded sprayer with post-directed nozzles.

Zorial can be included for sicklepod, tropic croton, prickly sida and sometimes nutsedge control. Results are generally better when it is applied preplant-incorporated or at least half of the Zorial is preplant-incorporated. Zorial alone will not give adequate control of heavy infestations of nutsedge. Directed applications containing MSMA are needed to complete the job.

A preemergence spray including Command effectively stops Pennsylvania smartweed. It also improves effectiveness on prickly sida, spurred anoda, velvetleaf, tropic croton, cocklebur, ragweed, jimsonweed, lambsquarters and sicklepod.

Growers used all the Staple they could acquire in 1996. Satisfaction varied greatly. Growers who applied Staple in a timely fashion, when weeds are actively growing and of the right size, and followed up with a directed application, such as Bladex plus MSMA, were quite pleased. Without question, Staple works well on pigweed that escapes residual treatments. It also has good to excellent foliar activity on many other broadleaf weeds including morningglories, coffee senna, wild poinsettia (Figure 18), and citron.



S Brown

Figure 18. Wild poinsettia, one broadleaf weed targeted by Staple.



S Brown

Figure 16. Early (a) and later (b) season cultivations are effective components of weed control programs in the Southeast.

Although post applications of Staple are erratic on sicklepod, research in the southern extremes of the Coastal Plain indicates that the addition of low rates (2/3 to 1 pt/A) of MSMA to Staple improves control. Early over-the-top applications of MSMA or Staple with MSMA pose minimal risks. These early applications must be made to small weeds and cotton of one or two true leaves.

In some states, DuPont has applied for an over-the-top label for the Staple/MSMA combination with reduced rates of MSMA. The Staple label was recently expanded to allow pre-emergence applications in combination with fluometuron. Much better sicklepod control is achieved when Staple is applied preemergence.

In 1995, BXN cotton, transgenic cotton with immunity to the post-emergence herbicide, Buctril, was introduced on limited acreage. Although broadleaf weed control was superb, the variety BXN 58 did not stand up to August heat. Yields were as much as 30% lower than those of other varieties. However, this year's research trials showed high yields and good weed control in BXN 47, a new transgenic developed from the recurrent parent, Stoneville 474. In 1997, limited quantities of BXN 47 will be available for growers to add to their arsenal of weed control strategies.

Another transgenic, Roundup Ready cotton with foliar tolerance to Roundup, will be available in limited supply in 1997. Over-the-top applications of Roundup cause no visible injury such as stunting, yellowing, or leaf crinkling. However, over-the-top applications of Roundup after square initiation have resulted in occasional fruit loss and yield reduction. This unpredictable response is believed to be associated with pollen sterilization. Because of the potential for fruit loss, the Roundup Ultra label for Roundup Ready cotton permits over-the-top applications up through the fourth leaf stage and post-directed sprays thereafter.

Applications of Roundup to stressed weeds are not effective. Other weeds presenting a challenge are those more than a few inches in height and troublesome weeds such as Florida pusley, yellow and purple nutsedge, volunteer peanuts, and possibly morningglories.

How is the Roundup Ready technology best used? Growers committed to using Roundup Ready cotton will need to eliminate something from their standard weed control program in order to offset the technology costs. One possibility debated by weed scientists is not using the standard preemergence herbicides. In order to eliminate them, early post-Roundup applications must clear the field of weeds as effectively as the pre- and early post-emergence herbicide treatments.

Rarely will a single post treatment deliver season-long weed control. Follow-up applications are routine. In the Southeast, the standard, directed application of cyanazine plus MSMA, or a similar treatment, is logical because it should be more effective on nutsedge and morningglories and it also provides residual weed control.



S Brown

Figure 19. Misapplication of dinitroaniline herbicide results in strip of escaped grass.

With or without Roundup Ready technology, the economy and effectiveness of the incorporated dinitroaniline herbicides make them irreplaceable. Like any other herbicide, they must be applied correctly to be effective (Figure 19). For many of the small-seeded broadleaf and annual grass weeds which these products eliminate, postemergence treatments are far less effective. Treflan and Prowl deliver remarkably consistent weed control for just a few dollars per acre. More studies of the Roundup Ready cultivars are needed to better determine their yield potential.

Conclusions

Using these valuable new technologies is but one part of an integrated weed management system. Determining which tools to use and how best to apply them is the challenge presented to growers everywhere. Insights gained from answering these questions may help in deciding the best management options for your field.

1) What is your normal weed inventory? Which products are labeled for controlling them? Answers to these two questions should help you decide if you need to keep pre-plant and pre-emergence programs in place.

2) Is your application equipment up to the task? For example, will you be able to successfully post-direct a mid-season Roundup Ultra application or ensure complete coverage with

an application of Buctril?

3) Will postemergence products alone handle your weed problems? Some early season weather patterns can keep equipment out of the field. Would such an event interfere with the crucial timeliness of an application?

4) What are your crop rotation plans?

5) Can you use these new technologies to cut costs and increase yields?

New weeds and developing herbicide-resistant weeds are likely to occur if producers rely solely on any single herbicide. As new herbicide-tolerant cotton varieties become available, weed management systems will continue to change and evolve.

On the Horizon

Technological advances in precision, or site-specific, farming will change weed management in cotton in several ways.

Equipment that “sees” and sprays weeds as it moves through the field will reduce herbicide costs while more effectively controlling weeds (Figure 10). Quick-hitch precision guidance systems combined with in-row cultivation tools will remove broadleaf weeds in the seed line without using chemicals (Figure 20). Sensors that “see” the crop row, rather than physically touch it with antennae, promise to make these systems even better.

Many weeds, especially perennials, are not evenly distributed throughout the field. By using global positioning systems (GPS), growers will be able to



WB McCloskey

Figure 20. Antennae of precision ag cultivator (A) sense cotton stems and keep cultivator centered on crop row. Spring-hoes uproot weeds and leave cotton unscathed (B).

map weed infestations and soil textures in their fields and download these data to GPS computer-controlled sprayers that will apply herbicides to only those locations requiring treatment. Rates of soil-applied herbicides will be adjusted to reflect different soil textures appearing in a field.

Mention of a specific product does not imply endorsement of it over any other product.