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RESCUING PRODUCTIVITY

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A wealth of management advice is available to assist producers who stay on production and development schedules. But what about those problem fields? Are they still manageable or do we accept our fate and focus our attention on avoiding these same problems next season? This newsletter will examine cotton that has fallen off the planned developmental track to assess what, if anything, can be done to rescue its productivity.

Favorable environmental conditions can make any management system excel. For example, some soils are easier to manage and more productive than others. Highly productive soils are frequently referred to as "ice cream" or simply "cotton" ground. Predictable water and plentiful moisture supports timely crop and yield development. Timely rainfall or irrigation allows producers or researchers to achieve the desirable, well-watered conditions. Clear days, followed by gentle late afternoon or evening showers, enable the crop to use this moisture status for optimum photosynthetic production and harvestable yield. Warmer-than-average temperatures during early and late season, coupled with moderate mid-bloom heat, are also ingredients found in production recipes for a good year. Minimal insect and weed pressure also make for easier management.

Chance alone dictates that one or more of these desirable conditions are sometimes met, even in the harshest production regions. In record breaking years like 1991 in the Mid-South or 1993 on the High Plains, several of these fortunate circumstances appeared simultaneously.

The reverse is also true. Environmental mishaps can and do surface in all production areas. In addition, management miscalculations are a reality, despite our best intentions. While plans should be implemented to limit the occurrence of these problems in future years, the pertinent question at mid-season when many of these problems are detected is: "What can be done now?"

There is no pat answer to this query. The possible responses to the problems vary with their causes, the available tools and the remaining time in the season. Decisions regarding rescue or salvage treatments should consider potential benefits versus costs. In some instances, the decision to avoid further inputs is warranted. These are vexing production decisions that require cold deliberation based on accurate portrayals of crop status and prospects, free from subjective wishes.

Before discussing specific production challenges and potential rescue operations, several overall considerations will be reviewed.

Developmental Timetables

Crop rescue procedures are frequently contemplated when boll loading is interrupted or proceeding slowly. While there may be several root causes for this delay, continual yield development is dependent on the initiation and/or development and maturation of additional fruiting forms. Additional yield requires additional harvestable bolls. At one extreme, plants may lack squares at any stage of development. This might result from a severe hail storm or extreme drought.

Squares produced early in the growing season require about 40 days from initiation in the bud to flower. This time requirement can be shortened by warmer, summer temperatures if renewed vegetative growth is vigorous. Also, some squares may remain in undamaged buds which will reduce the waiting period. Nonetheless, this delay can prove crippling if squares are absent or minimal when the problem surfaces. Producers hoping to recoup their losses may resort to unproven, novel rescue techniques. Unfortunately, there are no miracle products available that can shorten this lag period.

Boll maturation period also must be accounted for. Rate of boll development is sensitive to many variables including temperature. Maturation periods range from about 40 days to beyond 60 days. Attempts to restart or extend boll loading late in the season must contend with a lengthening boll maturation period during decreasing autumn temperatures.

Rescue operations will flounder, perhaps with dire economic consequences, if the remaining season is too short to meet these fixed developmental timetables.

Effective Bloom Period

Managers contemplating crop rescue as well as other more routine operations have a climatic landmark, called the end of the effective bloom period (EBP), to help guide their decisions and reduce their input costs. Meaningful boll loading ends either with cutout or the end of the EBP. Cutout is a plant driven landmark reached when the crop's carrying capacity has been reached. The EBP estimates the calendar days when white blooms have sufficient remaining season to become harvestable bolls prior to the arrival of inclement weather. The EBP starts with the first white bloom. Producers have some control over when this EBP clock starts ticking. Climate and other environmental forces signal its end (Table 1). Bolls produced after a given date in northern areas do not have sufficient time to mature prior to a killing frost. In other regions such as the Rio Grande and San Joaquin valleys, bolls that begin development too late are at increased risk of yield

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or quality damaging rains. In regions such as the lower deserts of the Southwest, increasing insect pressure also can signal the end of a realistic EBP, as can increasing insecticide resistance by the tobacco budworm in the Mid-South.

Each production region has a different EBP determined by their unique climatic characteristics. Any calculated end of the EBP is an estimate for an average year. Season-to-season variations may delay or speed its arrival in any specific year. This variation may lure hopeful growers into an overly optimistic attitude. One rare year of harvested bolls from Labor Day blooms can overshadow a more realistic EBP conclusion two weeks earlier.

Producers in regions without predictable killing frosts are at the greatest risk of over-estimating the EBP. Predictions of future insect pressure or rain events are met with deserved skepticism. While continued yield development may be possible in regions with long frost-free periods, economic returns on the additional investment in money, time and energy may not be justified.

Table 1

End of Effective Bloom Period

State	*Date*
Alabama	
South	Sept. 1
North	Aug. 15
Arizona	Aug. 15-Sept. 1 (depending on elevation)
Arkansas	
Northeast (N. I-40)	Aug. 10-15 (preferred statewide Aug 1-10)
Southeast	Aug. 15-20
California	Aug. 15-20
Georgia (Coastal Plain)	Sept. 1-10
Louisiana	Aug. 5 (preferred – can go to Aug. 25)
Mississippi	Aug. 1 (preferred – can go to Aug. 25)
Missouri	Aug. 5
New Mexico	Aug. 15
North Carolina	Aug. 15-20
Oklahoma	Sept. 1-6
South Carolina	Sept. 1-5
Tennessee	Aug. 15-20
Texas	
Central	July 5-15
South	June 10-July 5
Rio Grande Valley	June 1-20
High Plains	Aug. 15-Sept. 1
Rolling Plains	Aug. 20-Sept. 5

Phantom Bolls

Bolls initiated after the end of the EBP should be viewed as phantoms. Producers without an accurate measure of the end of the EBP may wait on these phantoms while sacrificing the real yield and quality of the lint produced earlier. Tie brightly-colored surveyor's tape around the main stalk at nodes with first position white blooms near the end of the EBP. Bolls produced lower on the stalk (therefore earlier) have some likelihood of reaching maturity. Those produced later are poor candidates for harvest.

A variety of environmental or management mishaps can derail development and challenge producers to consider rescue operations. Several are highlighted below.

Drought

The timing and duration of drought will differentially impact crop development and potential rescue operations. The onset of mid-season drought has a minor effect on overall plant vegetative structure. Final plant height, node development and total fruiting sites are largely determined prior to bloom. Drought that begins during bloom reduces overall boll set for the duration of the water stress. However, continued yield development is possible if squares remain when the drought is relieved.

Mid-season drought is more common in rainfed production on sandy soils. The onset of greater water use demands approaching or exceeding 3/10 inch per day, coupled with unreliable rainfall and scanty soil moisture reserves, limits boll loading and yield in large areas of the Southeast. Management approaches to counter this limitation include reduced plant population which increases individual plant's vegetative vigor and node and square development. This strategy helps delay the onset and consequences of drought.

On the other hand, early season drought has a dramatic impact on overall plant structure and the likelihood of yield revival if and when the drought abates. Leaf area development, node number and potential fruiting sites are reduced by prebloom drought, increasing the threat of premature cutout.

"Bumble Bee" crops with less than 10 nodes and one boll per plant are vivid reminders of how early season drought can strangle yield prospects.

When early season drought is followed by mid-season rains, growers may test the feasibility of developing a later and larger second boll load. The success of this strategy depends primarily on the available EBP. Premature cutout may be accompanied by wholesale square shed. Also, older pre-existing squares that remain on the plant when the drought is relieved may be destined to shed due to the earlier stress or the plant shifting resources back to vegetative growth.

Financial decisions to preserve and protect this second crop with additional inputs should be scrutinized carefully in light of the EBP remaining. When renewed terminal growth has produced visible new squares, rational assessments of the prospect of yield resuscitation can be made. Pinhead squares (2mm diameter) precede bloom by about 20 days. The end of the effective squaring period (ESP) can be calculated by subtracting 20 days from the dates given in Table 1. If this translates into bloom prior to the end of EBP, some additional yield may be salvaged.

Nutrient Deficiency – Nitrogen

The ability to rescue a cotton crop from a nutrient deficiency depends on the specific nutrient's role in plant development, the degree of deficiency and the timing of detection. Nitrogen is recognized as the nutrient with the widest physiological role and the most likely to limit productivity. This helps explain grower tendency to over-

fertilize nitrogen. Nonetheless, deficiencies surface due to the nutrient's mobility and unforeseen environmental influences.

Unfortunately, damaging developmental consequences frequently precede visible symptoms of deficiency. This arises, in part, due to the dramatic increase in nitrogen utilization that coincides with the onset of boll loading. Prebloom plant utilization of nitrogen is less than ⅓ of the seasonal total. Consequently, prebloom plant structure including square numbers are less sensitive to a developing deficiency. Growers may not detect visible deficiency symptoms until boll loading commences.

This creates a predicament of rising demands coupled with dwindling supplies. The deepening deficit puts producers in a squeeze play where response must be swift to avoid crippling square shed. Repeated foliar sprays may be required to salvage yield. Diagnostic tissue (petiole) testing has helped reduce the danger of yield-limiting nitrogen shortfalls. If significant square shed leads to premature cutout, the feasibility of adding nitrogen to restart the crop must be evaluated in light of the EBP.

Potassium

Reported potassium deficiencies are becoming widespread. The recent increased attention to potassium results from new evidence linking potassium deficiency to rapid boll loading during a time of less active root growth. In this sense, potassium deficiency does not constitute a rescue situation due to its association with unanticipated higher yields. Nonetheless, additional yield and improved fiber quality from foliar potassium sprays has been reported. Growers contemplating foliar potassium sprays are advised to establish the need for additional potassium through tissue tests prior to treatment. If a need is verified, prompt foliar treatment is necessary to avoid significant leaf tissue death and defoliation. Contact your local extension service for additional information on foliar potassium sprays.

Micronutrients

Boron is applied as a foliar spray in many production areas as an insurance treatment. Documented boron deficiencies can have drastic consequences on boll development. Drought conditions can reduce release of this nutrient, especially boron released from soil organic matter breakdown. Boron usually is considered as part of an intensive cotton management program, along with nitrogen, potassium and irrigation. However, boron should not be overlooked in salvage crops because its key role in the plant is the utilization of nitrogen in protein formation for plant cell growth.

Insect Control

Early season insects such as thrips and cutworms can affect stand and rate of growth. Experience has shown that materials applied to soil at planting time best protect against thrips. Stand reductions, whether resulting from diseases, insects, hail or weather, should be assessed to determine if corrective action is necessary. Producers should take into account surviving plant stand, replanting considerations (growing season remaining, cost, seed, alternative crops, herbicide(s) used, etc.) and extent of plant damage. When stand failure is widespread or terminal damage is extensive, replanting may be the appropriate rescue operation.

Plant bugs can efficiently remove early, match head-sized squares. Depending upon the number of squares removed, yield may or may not be affected. However, the effective blooming period (EBP) may be delayed resulting in the boll load set higher on the plant. Also, late-season cultural activities such as insect control, fertility, irrigation and defoliation need to be adjusted to the expected delays in maturity.

Boll weevils present challenging rescue operations. In the spring, adult weevils emerge from over-wintering sites and usually proceed to the closest and oldest cotton. Most growers know where these "hot spots" on their farm are. Pinhead square treatments take most of the weevils out. Salvage or rescue operations begin when boll weevil reproduction (egg laying) becomes established in a field. Controls then must be timed to eliminate adults when they emerge from squares on the ground some 10 to 14 days later. Since newly-emerged female weevils feed for 3 days before laying eggs, controls applied at three to five day intervals are needed to prevent egg laying by this generation of weevils and to break the weevil's reproductive cycle.

Chemical control of caterpillar pests like **bollworms, budworms and beet armyworms** is triggered when eggs and small larvae exceed thresholds. Effective management is the key because rescue treatments are largely ineffective and quite costly. Good scouting, well- timed applications and effective products are important because susceptibility to insecticides is reduced dramatically as worm size increases. For this reason, controls are timed against eggs and small (3 to 5 day old) larvae. Moths are very mobile, so moths that lay eggs in your field may have come from that field, your neighbors field or a corn field in the next state. A close watch on light trap captures and pheromone traps can indicate moth flight activity in the general area and bollworm:budworm ratios and warn of insect activity in the field. Moths from traps also can be used to monitor resistance levels to pyrethroids and other products.

Salvage or rescue operations for aphids and whiteflies in cotton require different approaches. For the last several years, **aphid** populations in the Southeast and Mid-South have been decimated in late July by a fungus pathogen, *Neozygites fresenii*. The operative here is for producers to patiently withstand rather high populations and wait for the fungus to do its job. Rescue chemical treatments are risky because of reproductive capacity of aphids, high populations and widespread resistance. Most entomologists suggest cultural practices and maximizing use of predators and parasites to manage aphid populations.

We learned early on with **whitefly** that it is much easier to manage whitefly to avoid population explosions rather than to rescue the field with chemical treatments. Texas's Lower Rio Grande Valley, Arizona and California have developed community-wide, multiple crop guidelines that have been quite effective. New chemical products have greatly improved the successes of mid-season attempts to bring populations back under control.

Weeds

Salvage herbicide applications are required when inclement weather follows earlier inadequate activation of soil-applied herbicides. Escaped weeds such as cocklebur can rapidly out-pace early season cotton growth. In this situation, with the present limited catalog of available herbicides, some over-the-top application may be the answer. While growers recognize that delayed development and reduced yield may result from an over-the-top spray, the alternative prospect of unhindered cocklebur growth is even less appetizing. Over-the-top sprays that are considered unavoidable should be applied when cotton is actively growing and before pinhead square.

When application problems allow later emerging weeds to escape control, rescue prospects are less certain. The commercialization of new herbicide options promises to brighten this outlook. When weeds like morningglory threaten to climb to the top of the cotton canopy, there are currently no painless options. There are no effective salvage broadleaf weed control treatments for cotton that has developed its full canopy.

Hail Damage

Assessing the recoverability of hail-damaged cotton is extremely difficult. The stage of development, degree of damage and remaining EBP must be considered. While some formulas have been derived to aid in this assessment, yield prospects made immediately after hail damage are unreliable. If a sufficient boll/square load remains on the plant, new or existing leaf area will also be needed to support the growing fruit. Better estimates of square damage and developmental delays can be obtained if an assessment is delayed for several days. Consideration should be given to irrigated cotton which can revive and sustain growth more predictably than dryland cotton after hail damage.

Wrap Up

As the word rescue suggests, these operations are efforts taken in an emergency. It is difficult to arrive at effective strategies when coping with these marginal situations. The success of any rescue attempt is uncertain. However, knowing the risks enables you to make informed decisions and offer some measure of control over the situation.

For additional reading on mid-season management topics, refer to the following issues of *Cotton Physiology Today*:

- High Temperature Effects on Cotton, July 1990, Vol. 1, #10
- Plant Water Relations, July 1992, Vol. 3, #7
- Cotton Irrigation Scheduling, August 1992, Vol. 3, #8

To obtain copies of these issues, call or write the National Cotton Council, PO Box 12285, Memphis, TN 38182-0285, phone: 901-274-9030.

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