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Cotton Stalk Management

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Although cotton stalks provide only small amounts of residue compared to grain crops, the management of that residue is critical for suppression of boll weevil, pink bollworm and protecting the soil from erosion. This issue of Cotton Physiology Today will discuss the various options in residue management and their effect on both insects, diseases and the soil.

Stalk Destruction

In most areas of the Cotton Belt, stalk destruction is an integral part of soil management between harvesting and the succeeding crop. In some of these areas the methods and timing of stalk destruction are regulated by state or local codes. Several factors encourage producers to start shredding immediately after harvesting.

• INSECT AND DISEASE CONTROL Besides management of boll weevil and pink bollworm, suppression of other pests also is enhanced by prompt crop destruction. Whiteflies and aphids build on regrowth, creating larger populations for the next crop. A number of important pathogens, such as root rot may overwinter in undestroyed cotton stalks.

• DEEP TILLAGE Where fall deep tillage is required to remove compaction, early stalk shredding allows a longer window for timing the tillage operations when soil moisture is optimum. When soil moisture is optimum, effective loosening of the soil profile occurs with minimum diesel consumption. If soils are wet when deep-tilled, further compaction occurs and soil loosening is reduced. If soils are too dry, large clods of compacted soil are unearthed requiring multiple tillage to pulverize and excessive consumption of diesel.

• SOIL EROSION Shredded cotton stalks on the soil surface provide some protection against water erosion. Anyone who has seeded a lawn is familiar with the erosion protection that small amounts of straw or other residue provide.

• STALK DECOMPOSITION Cutting up the residue allows microorganisms greater access to decompose the stalk which will reduce interference with the planting of the following crop. Research in Mississippi indicates that if shredded stalk pieces are no longer than 9 inches, maximum decomposition occurs along with minimal interference with cotton planting. Placing cotton residue on the surface (versus stalks still standing) will maintain a higher moisture content in the residue as water wicks from the soil surface. This practice also provides greater warmth for stalk decomposition from the sun's heat.

Boll Weevil Suppression

Following harvest, prompt destruction of cotton plants to aid in boll weevil suppression has been a recommended practice since this pest first invaded south Texas in the 1890's. This is especially true in the southern-most regions of the Cotton Belt where the plant is not killed by frost. In the early 1900's stalk destruction was difficult and relied on horse-drawn plows, or more "innovative" methods such as grazing or burning. However, from the beginning it was recognized that stalk destruction after harvest would reduce winter carry-over of adult boll weevils. By killing the boll weevil in the crop residue and depriving them of feeding and reproductive sites, entomologists reasoned fewer weevils would endure the winter to infest the following season's crop. Modern technology, unimagined in the early part of this century, has made this strategy that entomologists roughed out 85 years ago, possible. Additionally, mechanical harvesters and tractors provide the most cost effective component for both boll weevil and pink bollworm control: total compliance and promptness in the crop destruction.

Today, the first task for post-harvest boll weevil control is to shred stalks. Although the rotary cutter is more common, older work shows a slight advantage with the flail shredder for breaking open bolls and chopping up stalks. Both devices usually leave a residual of undestroyed bolls (up to 40% or more). Weevils in opened bolls often die from desiccation and predation (especially if fire ants are present). Those bolls that are not opened, if left on the soil surface during hot weather, will heat, killing the enclosed weevils. However, this effect does not occur if stalks are shredded during the cooler, fall or winter weather. Weevils surviving the shredding operation may overwinter in bolls still attached to plants, on the soil surface or buried by shallow plowing. If fields are plowed to control the weevil, deep plowing must be employed since numerous experiments (some conducted as early as 1907) have demonstrated the ability of the boll weevil to crawl through as much as 10 inches of topsoil.

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The second task after shredding the above ground portion of the stalk is to prevent the remaining stub from regrowing and producing squares on which boll weevils feed and lay eggs. The boll weevil is really misnamed, it should be called the square weevil since the square is its favorite food and egg laying site. When the stub or root is killed and does not regrow, the boll weevil is denied egg laying sites in squares and young bolls, those less than 12 days old. In addition, adult weevils feeding on squares or bolls for approximately 3 weeks commonly enter a state known as diapause, which allows them to survive the winter in a non-feeding, and often dormant, state. The destruction of cotton plants immediately after harvest removes from the weevil the resources needed for several overwintering tactics - reproduction, survival in dried bolls, and diapause - and is one of the one of the most potent means available to suppress the overwintering weevil population.

Pink Bollworm Suppression

Like most pests, the pink bollworm starts out in relatively low abundance with the spring generations. As the season progresses, each succeeding generation can hatch greater and greater numbers, until at the end of the growing season massive populations infest untreated cotton. Natural mortality over the winter decreases the pest numbers until the spring emergence starts the cycle all over again. With no controls, the spring emergence increases each year and eventually produces disaster. By eliminating the last 1 or 2 generations, the number surviving the winter are substantially reduced. The success of the pink bollworm in surviving the winter depends upon a physiological change in the larvae that allow a greater range of exposure without death. This diapause is related to the time of year. Early destruction of the food supply before diapause restricts survival through the winter. This phenomena is the basis for the use of early crop termination and stalk destruction as a method to suppress the pink bollworm.

Early crop termination and destruction has 3 benefits: the last generations of pink bollworm are curtailed by the lack of bolls for egg lay, the increased severity/duration of the overwintering mortality and the reduction in diapause pink bollworm. Pink bollworm initiates larval diapause when the day length drops to a certain period (usually 13 hours or less). The absence of cotton bolls or blooms during this late summer period will significantly reduce the incidence of pink bollworm diapause and thus effectively suppress the overwintering population.

For effective control of pink bollworm-infested fields following an early harvest, plants should be promptly shredded and killed to prevent continual production of food. Like the boll weevil, the pink bollworm relies on live cotton plants for 99% of its food. A fall or early winter post-harvest irrigation further contributes to overwinter-mortality of pink bollworm.

Stalk Incorporation

The prime justification for incorporation of shredded stalks is to insure that the plant is killed and does not regrow. In areas where fall temperatures are cold enough to kill the plant and curtail regrowth, producers prefer to leave the residue on the surface where it can protect the soil from erosion caused by winter rains.

Regrowth

Regrowth occurs when the supply of warm weather, soil moisture and nutrients extend beyond the boll's demand for carbohydrates. Plants that enter cutout cease boll retention. As the last bolls near maturation, their demand for nutrients and carbohydrates plummets, thus allowing the support of new shoot and root growth. The new shoot growth can consist of both fruiting branches (if the mainstem continues to grow) or vegetative branches (if buds break dormancy). In the irrigated West, soil water limits growth; therefore extensive regrowth occurs only where excess water was applied late in the season. In the Mid-South and Southeast, where moisture is usually ample late in the season, available soil nitrogen promotes regrowth. In the Texas High Plains temperature is usually the factor that limits regrowth. All 4 conditions must be met for regrowth to occur: mature bolls, water, nitrogen and warm temperature.

Regrowth provides an ideal food source for other insect pests, besides boll weevils and pink bollworms. For example, the young tender leaves support cotton aphid and sweet potato whitefly overwintering populations.

Organic Matter Decomposition

Soils are composed of both minerals and organic compounds. The soil minerals weather and breakdown over centuries, resulting in small particles such as clays and silts. The organic content of the soil, for the most part, originated as plant material, including that consumed by animals. Plant material in the form of leaves, stalks and roots break down rapidly to individual organic molecules and then on to carbon dioxide and water. This breakdown is especially fast in warm soil where the activity of soil microorganisms speeds up. The dark rich color of North Iowa soils is due to the slow decomposition during the cold, fall-winter months and the resulting buildup of partially decomposed organic matter. Cotton is grown in areas of greater overall temperatures. Thus cotton residue is decomposed rapidly, creating nearly mineral soils in parts of California, Arizona and Texas.

The changes in soil organic matter of concern to farmers are the annual and long term organic content which affect not only tilth and related costs of tillage but also the population dynamics of insects and disease pests.

Incorporation of cotton residues into the soil nearly always insures rapid decomposition. Although the buried plant material is generally cooler than material left on the surface, the moisture content will be higher thus insuring an increased rate of decomposition. Leaving residue on the soil surface insulates it from the soil microorganisms and reduces the moisture content thus slowing decomposition. The following diagram demonstrates that the most rapid stalk decomposition occurs when residue is placed 4 inches deep.

Decomposition Rate is Altered by Placement

Surface	slowest - too dry
2 Inches deep	slow - too dry
4 Inches deep	fast - optimum temp, water and oxygen
6 Inches deep	slow - too cold and low oxygen

Where rapid decomposition of cotton stalks is necessary — such as planting a small seeded vegetable or removing the food source from pests — incorporating finely shredded stalks is beneficial. Where organic matter is limited — leaving the residue on the surface as along as possible will maintain more soil organic matter and protect the surface from erosion, crusting, ponding and puddling. High organic matter soil surfaces are much less prone to sealing and subsequent ponding of rain water.

Surface Residue

Erosion control is a mandated component of the 1990 Farm Bill. Farms in highly erodible areas must complete soil conservation plans by 1991 and fully implement them by 1995. The cotton stalks from a 1 bale per acre field will result in approximately 0.5 tons of residue and cover approximately 30% of the soil surface. Leaving this residue on the soil surface protects the soil by increasing water infiltration and reducing soil loss to erosion.

Residue protects the soil pores that allow rapid entry of water into the soil. The micro and macro channels within the soil, created by natural processes such as decaying roots, worms, etc., are destroyed by tillage. These channels, especially the macro-pores, are responsible for the major water entry into ponded soil. When the surface soil is tilled, not only are those macro-pores destroyed but the loss of organic matter on the surface leaves it vulnerable to surface sealing and ponding. During this year's wet Mid-South spring, reduced-tillage cotton fields were planted before conventional-till fields, due to more rapid infiltration of water into the soil and the improved strength and traction in untilled fields. These factors allowed earlier entry of cotton planters.

Surface residue also minimizes soil crusting which can become a serious problem for cotton emergence. If the residue is finely chopped or partially decomposed, planting into the residue can be accomplished with minimal changes in planter design. The crust prevention is thought to be related to the total organic material in the surface covering soil. This beneficial effect minimizes the stress on emerging seedlings and can reduce their vulnerability to seedling disease.

Effect of Residue Management on Cotton Diseases

Sanitation by incorporating plant residue to speed the rapid decomposition of diseased leaves and stems is a general recommendation of plant pathologists. While this is appropriate for crops with leaf and stem diseases, cotton is invaded predominately by root pathogens. The organisms that cause seedling diseases and wilt diseases infest cotton's roots and produce only limited growth in the stem and leaves. Incorporation appears to be of no general benefit to controlling these diseases. However, where leaf or boll diseases severely infest cotton, it is a good recommendation to incorporate the residue to speed decomposition and minimize exposure of next year's crop to the pathogen. Deep tillage to a depth of 2 to 3 feet, in combination with dry summer fallow has been recommended for control of Texas Root Rot.

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WRAP-UP

Cotton stalks after harvest are both a nuisance and a resource for farmers. Unfortunately, no single recipe can be proposed. However there are 2 important practices that have Belt wide application:
1) early and complete shredding of the stalk; and
2) killing the stub or root. Early shredding is important for boll weevil, pink bollworm, diseases, soil erosion, water runoff and soil tilth. Killing the stub is important for suppression of pests. Given these 2 as requirements, field conditions determine whether to leave the residue on the surface or bury it. Where pink bollworm is a problem, tillage to bury the residue may be required. Where the boll weevil is a problem fine shredding and exposing the shredded material to solar radiation heating may be indicated. Where erosion or water runoff is a major problem coarse shredding and thatching of the residue into the soil surface is beneficial. With low organic soils a slow decomposition of the residue is beneficial for maintaining a higher organic content. Where stalks decompose slowly fine shredding and burial at an optimum depth may be required to minimize interference with planting. Where leaf or boll disease is a problem, fine shredding and burial are important.

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Cotton Physiology Today: Edited by Kater Hake

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Quality of the U.S. Cotton Crop

Interpretation provided by National Cotton Council, Cotton Incorporated and USDA-Extension Service (Kater Hake, Jess Barr, Doug Herber, Bill Mayfield and Preston Sasser).

The strength of the U.S. cotton crop classed to date is, on average, significantly higher than previous crops. Every classing office has reported improved strength over the 1990 classings. We can only speculate on possible causes for this increased strength.

- Producers planted more of their acreage to high-strength varieties in response to the increased emphasis on strength, both in the CCC loan schedule (see table) and by the mills. Regions of the Cotton Belt that historically have planted varieties with expected strength readings of 22 to 24 planted more of the acreage to high-strength varieties.

Strength	cents/lb
18 and below	Ineligible
19	-2.5
20	-2.0
21	-1.5
22	-1.0
23	-0.5
24 and 25	Base
26	+0.15
27	+1.0
28	+1.5
29	+2.0
30	+2.5
31 and above	+3.0

- Many regions of the Cotton Belt experienced excellent boll retention at the first position on the fruiting branch. Work by Tom Kerby and George Ruppenicker indicates that first position bolls — the ones closest to the main stem — have the highest quality (higher maturity, strength and length).
- Due to the shortness of the 1991 growing season, many parts of the Cotton Belt set their crop over a short time in the bottom- and mid-crop zone. The research mentioned above demonstrated that bolls set high in the plant usually have inferior length and strength than bolls set either in the premium middle-crop or good quality bottom-crop.
- The U.S. crop is forecast to be the second highest yielding crop on record. This is despite the shortened growing season across the Belt. A Mississippi producer reported that one field produced 1100 lbs of lint/A in 143 days from planting till harvest. The lint produced with the limited days truly has been phenomenal. High-yielding fields tend to produce high-strength cotton. The non-stress cultural practices that promote top yields also promote superior quality.

Interpretive Summary

Cotton harvesting has just started in **Arizona** and southern **California**. Although only a few bales have been classed in the Phoenix classing office, this region is starting out with significantly stronger and longer cotton than in the previous 2 years. Micronaire is starting out closer to the new premium range of 37 to 42, the range that receives a 15-point premium when cotton is put in the loan.

Cotton harvest is finishing in the southern parts of **Texas,** served by the Harlingen and Corpus Christi classing offices. These areas have already produced 845,000 bales, a 40% increase over 1990. The next southern classing area, Waco, has just recently started. All three of these areas show a phenomenal increase in strength over the last 2 years, increasing on average 1 g/tex per year. These areas dramatically increased their acreage planted to high-strength varieties. For example in the Waco area, where the change is most dramatic, 39% of their acreage was planted to DPL90 and HS46, 2 very-high-strength varieties. Variety is clearly the dominant factor determining strength. Other quality factors from the South Texas areas are similar to the preceding 2 years, with the exception of a slight increase in length in both Corpus Christi and Waco. These 2 areas traditionally have been staple length 33 and 34. In 1991 both areas are averaging staple 34 to 35.

The **Louisiana** crop, classed in Rayville, is starting the season with a high grade crop; 92% of the crop has classed 41 or better and 55% has classed 31 or better. This is substantially above last year's classing — for the same time period and season average. Staple continues to be average and strength has increased over last year. Micronaire is starting out significantly higher, than the average of the last 2 year.

The **Missouri** Bootheel along with the N.E. Arkansas crop is classed in Hayti. Many fields in this area were planted earlier than the rest of the Mid-South. As a result over 96,098 bales have been classed to date. Quality has been superior to the 1990 and 1989 crop in all respects except micronaire. The early harvested fields in this area have averaged 47 micronaire, similar to other classing areas in the Mid-South.

The **Mississippi** crop, classed in Greenwood, is starting out with a strength of 27.5 g/tex, 3 g/tex stronger than last year's crop. In addition to higher strength varieties planted in this state, growing conditions generally have been favorable and early yields are encouraging. Indications are that the Mid-South crop will be both stronger and longer than either of the 2 previous years, and yields could be surprisingly good for such a late start.

The Tennessee crop, classed in Memphis, is starting out with a high percentage, 87, of its crop classed as 41 or better. This classing office shows the greatest improvement in strength over last year. Strength-to-date averages 27.7 g/tex. Length and uniformity (an indicator of fiber length uniformity) also are up over the last 2 crop years. Micronaire has been extremely high, with over 46% of the bales in the discount range of 50 and above. The early-planted crop in this area suffered from drought. Water stress generally increases micronaire and earliness of harvest (see Cotton Physiology Today, Sept. 1990, "Causes of High and Low Micronaire"). In addition, early maturing bolls develop under warmer temperatures which leads to higher micronaire.

Both Carolinas class their bales in Florence, SC. This crop is starting out as a clean, high-grade crop with normal length and superior strength. Early bales have a strength averaging 28.1 g/tex, continuing the progress toward improved strength that is occurring all across the U.S.

Only a limited number of bales have been classed at the **Alabama** (Birmingham), **Georgia** (Macon) and **Arkansas** (Dumas) classing offices, and it is too early to determine how these crops are developing.

Special insert to Cotton Physiology Today. Data provided by USDA-AMS Cotton Division.

U.S. Cotton Classing for the period — August 1 through September 26, 1991

		Bales Classed	%31 or better	%41 or better	Staple 32nd	Micronaire	Strength g/tex	Uniformity	Trash Area
Phoenix	1991 to date	**12,087**	**86**	**96**	**36.3**	**43**	**27.5**	**81.7**	**0.18**
ARIZONA	1990	818,000	59	75	35.3	43	26.2	80.7	0.19
	1989	545,000	69	87	35.3	45	26.5	80.4	0.12
Harlingen	1991 to date	**341,893**	**35**	**79**	**34.5**	**43**	**25.7**	**81.5**	**0.39**
TEXAS	1990	323,000	52	85	34.8	46	25.3	82.4	0.26
	1989	165,000	31	74	34.1	45	24	81.3	0.26
Corpus C.	1991 to date	**503,175**	**46**	**71**	**34.4**	**44**	**26.2**	**81.7**	**0.35**
TEXAS	1990	282,000	41	70	33.5	45	24.4	81.2	0.26
	1989	173,000	63	86	32.7	45	23.4	80.9	0.24
Waco	1991 to date	**177,153**	**24**	**54**	**34.9**	**44**	**26.2**	**81.6**	**0.54**
TEXAS	1990	363,000	32	63	33.7	45	24.0	81.0	0.32
	1989	355,000	42	73	34.0	40	24.0	80.6	0.29
Rayville	1991 to date	**67,940**	**55**	**92**	**35.4**	**45**	**27.4**	**81.8**	**0.43**
LOUISIANA	1990	1,190,000	20	64	35.1	41	25.3	79.9	0.36
	1989	886,000	36	81	35.0	41	27.0	81.0	0.36
Dumas	1991 to date	**7,137**	**46**	**81**	**36.6**	**45**	**27.5**	**82.4**	**0.48**
ARKANSAS	1990	460,000	21	77	35.3	41	24.8	80.2	0.32
	1989	511,000	27	73	35.8	42	26.8	80.8	0.39
Hayti	1991 to date	**96,098**	**51**	**90**	**35.8**	**47**	**26.1**	**81.9**	**0.46**
MISSOURI	1990	672,000	16	75	35.3	40	25.2	80.4	0.40
	1989	552,000	21	80	35.3	44	26.1	81.7	0.39
Greenwood	1991 to date	**81,285**	**48**	**92**	**36.0**	**46**	**27.5**	**82.1**	**0.34**
MISSISSIPPI	1990	1,604,000	17	65	35.3	41	24.6	80.2	0.37
	1989	1,358,000	20	74	35.4	40	26.4	80.9	0.42
Memphis	1991 to date	**35,881**	**49**	**87**	**35.6**	**49**	**27.7**	**82.2**	**0.46**
TENNESSEE	1990	880,000	21	63	34.6	41	24.7	80.3	0.30
	1989	651,000	25	65	35.0	46	25.9	82.0	0.36
Birmingham	1991 to date	**18,111**	**54**	**82**	**34.0**	**46**	**25.9**	**81.8**	**0.29**
ALABAMA	1990	393,000	26	65	34.3	40	25.2	79.9	0.28
	1989	379,000	21	71	35.1	42	26.9	81.0	0.36
Macon	1991 to date	**8,854**	**38**	**77**	**35.4**	**44**	**27.0**	**82.0**	**0.34**
GEORGIA	1990	399,000	22	69	34.7	44	26.9	80.8	0.27
	1989	336,000	5	66	35.2	41	27.1	80.9	0.40
Florence	1991 to date	**32,342**	**30**	**85**	**35.6**	**46**	**28.1**	**82.3**	**0.36**
CAROLINA'S	1990	414,000	16	64	35.3	45	26.5	81.3	0.43
	1989	292,000	7	63	35.6	39	26.2	80.9	0.40