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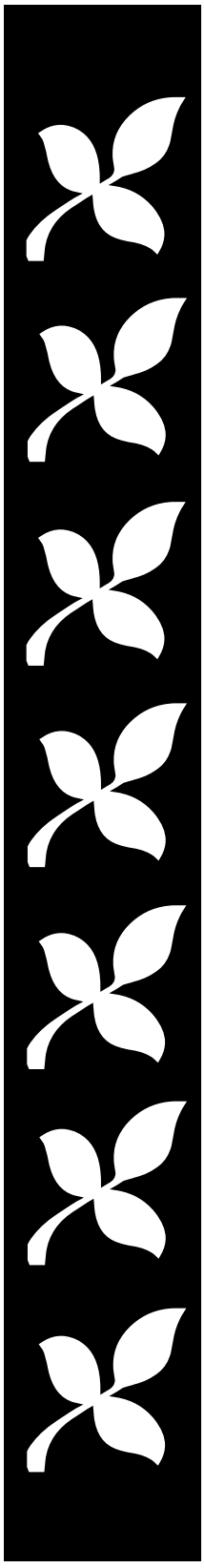

Soil & Crop Sciences

1999 High Plains Cotton Harvest-Aid Guide

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Harvest-aid chemicals are generally applied to hasten harvest of a mature crop, and to reduce potential preharvest losses of lint yield and fiber quality. Proper use of harvest aids will result in earlier harvest, preservation of fiber quality, and fewer seed quality reductions due to field exposure. Weathering losses in the High Plains can result in considerable reduction in dollar value of the crop, unless measures are undertaken to protect yield and quality potential. Results from an experiment conducted at Lubbock indicated that field weathering lint losses averaged about 3 percent per week the first week, and decreased to 0.5 percent per week after 12 weeks. Fiber length was significantly reduced by field weathering, and colorimeter readings of reflectance (or rd) were also detrimentally affected over time. Field weathering also reduced seed quality. When considering potential impacts of adverse weather conditions, many producers view harvest aid application as a means to reduce overall economic risk. An economic study of the above mentioned data indicated that highest cotton prices were obtained earlier in the harvest season. Total gross returns are generally higher earlier in the season, and by the last week of January, severe reductions can usually be expected. Timely applications of harvest aids and follow-up harvesting can potentially result in many benefits.

Proper harvest-aid material selection, tank mix partners and rates vary with environmental and crop conditions. What works best in one year is not necessarily the best for the next season. Efficacy of harvest-aid chemicals is always a concern. There are several factors that affect the performance or lack of performance of harvest-aid chemicals.

Some factors that increase the performance of harvest-aid chemicals include the following:

- **T** Warm, calm, sunny weather
- **T** Soil moisture relatively low but sufficient to maintain cotton plant in active growth condition without moisture stress
- **T** Soil nitrogen levels relatively low
- **T** Leaves active and uniformly expanded on plants
- **T** Little or no secondary growth evident on plants
- **T** Plants with a high percentage of open bolls that have reached "cutout" and shed some mature leaves

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Conversely, some of the factors which negatively affect harvest-aid chemical performance include:

- **T** Applications made under cool (below 60^{o} F), cloudy conditions
- **T** Prolonged periods of wet weather following treatment
- **T** Plants in vegetative growth state with low fruit set
- **T** Plants severely moisture stressed with tough, leathery leaves at time of treatment
- **T** High soil moisture and nitrogen levels which contribute to rank, dense foliage and delayed maturity
- **T** Plants exhibiting secondary growth (regrowth) following a "cutout" period
- **T** Improper calibration of application rates and poor spray coverage

CROP MATURITY DETERMINATION

Crop maturity determination is critical for a successful harvest-aid program. Premature crop termination has been shown to reduce lint yield, seed quality, micronaire, and fiber strength. Although some dry-weight transfer to developing lint has been noted with the use of some defoliants, desiccants generally abruptly terminate fiber and plant development. Harvest-aid chemicals cannot increase the rate of fiber development. Only additional good growing weather including open skies and adequate heat units combined with functional leaves can mature cotton bolls. Maturity can be determined by using a sharp knife to cut into the bolls. If the boll is watery or jelly-like on the inside, then it is immature and needs more heat units. If boll development is such that the knife cannot slice through the lint, then the boll is nearly mature. Close inspection of the seed will give further indication of boll maturity. If the seed coat is turning tan and the seed leaves (or cotyledons) are fully developed, the boll is mature.

When determining boll maturity of adjacent fruit, one can consider the following. When moving up the plant from a first position boll that has just cracked to a first position closed boll on the next fruiting branch, about 60 additional heat units (DD60s) are required to obtain similar boll maturity. If moving out from a first position boll to a second position boll on the same fruiting branch, about 120 heat units will be required to reach the same level of maturity. A total of about 800-850 heat units are required to produce normal size and quality bolls. However, bolls obtaining fewer heat units may still make productive lint of lower micronaire that may contribute to final yield.

Nodes above cracked boll (NACB) is a recently developed tool that can be used to time harvest aid application (Figure 1). A Beltwide cotton harvest aid project was conducted over multiple sites and years by Kerby, Supak, Banks, and Snipes. It was determined that if the uppermost first position-cracked boll is within three nodes of the uppermost harvestable first position boll then no lint weight will be lost if a defoliant-type harvest aid is applied at that time (Figures 1 and 2). However, if the uppermost harvestable first position boll is four or more nodes above the uppermost first position cracked boll, then potential for some lint loss exists. The lint loss potential increases as the NACB increases. Micronaire reduction generally follows a similar pattern when using the nodes above cracked boll criterion. When applying defoliant type materials, some dry weight transfer occurs which allows marginally mature bolls to finish development. If applying desiccants, more bolls must be mature in order to reduce the risk of fiber weight loss or reduction of micronaire, thus two to three NACB would be a better target.

Figure 1. Determining nodes above cracked boll.

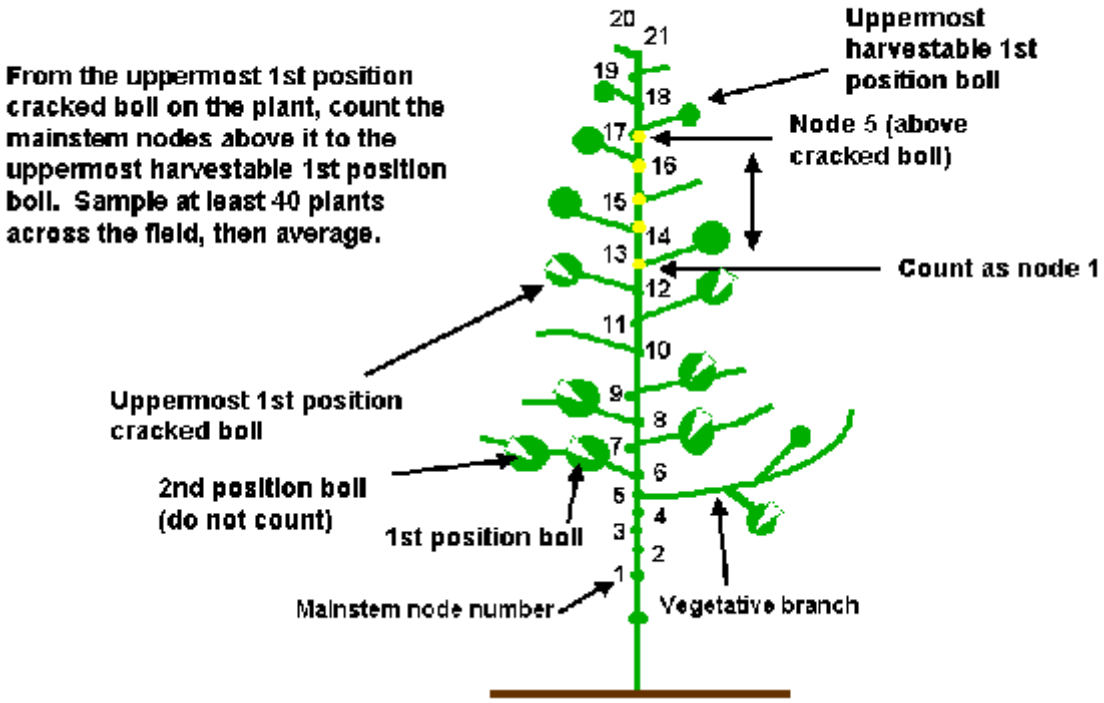
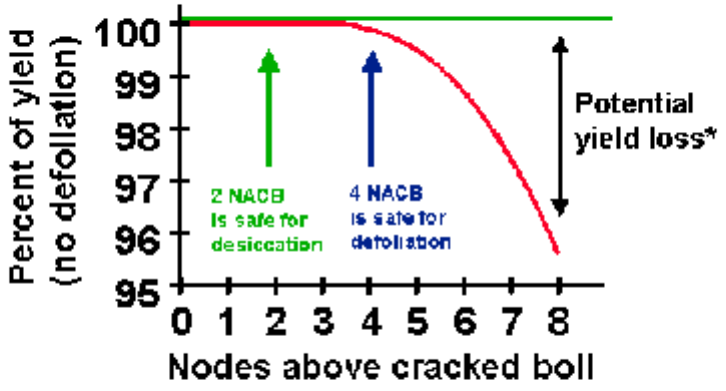


Figure 2. Potential yield loss based on NACB method.



* when desiccating, add 2 to value for NACB to determine the effect on yield (desiccation at 2 NACB=percent of yield at 4 NACB for defoliation)

Kerby, Bupak, Banks, and Snipes

HARVEST-AID CHEMICAL TYPES

Harvest aids are basically classed in three categories – desiccants, defoliants, and boll openers. Desiccants (Cyclone and various tank-mixes) dry the plant down by causing the cells to rupture and lose cellular contents and water due to leakage. The old "rule of thumb" is that desiccants are normally applied when approximately 80 percent of the productive bolls are open, or at 2-3 nodes above cracked boll. However, if sufficient numbers of bolls are mature, then these materials may be applied to somewhat lower percent open boll fields. Applications of Cyclone made in the late afternoon prior to a bright, sunny, day appear to enhance the effectiveness of desiccation and tends to increase regrowth control.

Defoliants (Ginstar, Folex/Def, Harvade, Dropp, sodium chlorates, Cyclone at low rates, and other products) result in initiation of an abscission layer at the base of the leaf petiole where it attaches to the stem. The natural abscission layer formation process is enhanced by the defoliant, which results in leaf drop. In order to obtain maximum leaf drop, defoliants require fairly healthy and active leaves which still properly function and are not drought stressed or tough and leathery. Warm air temperatures generally enhance activity. The commonly used rule of thumb is that defoliants can be safely applied when 50-60 percent of the bolls are open and the remaining bolls are of sufficient maturity to obtain desired yield. Although a boll opening response is generally obtained as a result of defoliation, green unopened bolls can still remain a problem. Many times a follow-up application of Cyclone or a killing freeze is necessary to allow stripping of the crop.

Boll openers (Prep and other generic products such as Ethephon 6, SuperBoll, Boll'd) and boll openers-defoliants (such as Finish 6 and CottonQuik) are based on ethephon chemistry. These materials affect natural plant processes associated with boll opening, but do not increase the rate of boll or fiber maturation. Once inside the plant, ethephon is converted to ethylene, a plant hormone which increases the rate of abscission layer formation. These materials result in significant defoliation responses at high rates, but generally are applied at lower rates to obtain boll opening. Defoliant chemicals can be tank mixed with normal use rates of ethephon products to enhance defoliation. The response to ethephon is generally driven by temperatures. Under warmer conditions, reduced rates of ethephon may be used compared to cooler temperature regimes where higher rates are required to obtain similar plant responses. Recently, ethephon-based product labels have stated that there should be "sufficient mature unopened bolls present to produce desired crop." Mature bolls are defined as "too hard to be dented when squeezed between the thumb and fingers, too hard to be sliced with a sharp knife, and when the seedcoat becomes light brown in color." Follow-up applications of Cyclone are generally required to sufficiently condition the crop for stripper harvest. Applications of boll opening products when bolls lack adequate maturity will result in reduced lint yield and micronaire. Results from several High Plains studies indicate that reductions occurred when applications were made at 25 percent open bolls, but did not at 50 percent open bolls. Lint yields were reduced at least 10 percent, and micronaire was decrease by about 5 percent.

Other harvest aid products include various formulations of sodium cacodylate/cacodylic acid mixtures, Accelerate (endothall), and Roundup. Cacodylate/cacodylic acid mixes (QuickPick and others) are added as tank mixes with other defoliants or desiccants. Accelerate is sometimes tank mixed with Cyclone to enhance desiccation. Roundup Ultra can be applied as a harvest aid material to conventional cotton specifically to target weed problems and/or to reduce regrowth potential. Outstanding control of silverleaf nightshade (or whiteweed) can be observed in the following season with application of 1-2 quarts per acre of Roundup Ultra when weeds are in the green-berry stage. Control of severe weed infestations may be increased by the higher rate. Research has shown that reductions in weed populations of up to 97 percent can be obtained from such an application. Applications made in September should target cotton that is 50-80 percent open. After October 1, cotton can be treated when 30 percent of the bolls are open. Regrowth in Roundup Ready cotton varieties will not be controlled by Roundup Ultra application. Roundup Ultra also should not be applied to fields grown for seed production since viability and/or vigor of seed will likely be reduced.

APPLICATION CONSIDERATIONS

In general, the yield and condition of the cotton should determine the type of harvest aid material chosen. If the leaves are beginning to shed and have reddish to purple pigmentation present, they will be easier to drop off the plant without detrimental "leaf stick." "Sticking" occurs when the leaves do not drop and are frozen on the plant. The natural abscission layer forming process at the base of the leaf petiole was abruptly halted by physiological stress such as a freeze or desiccant application. Some cotton varieties do not readily form abscission layers even on older leaves and may not defoliate properly. If the leaves "stick," then lint quality can be reduced due to increased leaf content in the fiber. Drought-stressed leaves generally have a much thicker waxy cuticle on the surface. This can considerably affect harvest-aid performance.

Cotton secondary growth (or "regrowth") sometimes occurs after the plants have "cutout" or stopped blooming due to drought stress or physiological maturity. If warm temperatures and rainfall is then received, the cotton plant growth cycle can start again, and one can find secondary growth in the terminal and on many of the other nodes on the plant. Plants with unopened bolls or young, developing bolls are less likely to produce secondary growth, although application made at this stage can result in reduced lint quality and yield. Secondary growth is difficult to control since young foliage does not form abscission layers or shed as older leaves do and is generally hard to kill using harvest aids that are currently labeled.
Proper spray volume and coverage are also critical to the success of a harvest-aid program. Be sure to calibrate the sprayer to deliver the correct volume and nozzle pressure to ensure adequate distribution and foliage penetration. **Read and follow the label directions for use of the product.** The harvest-aid label contains information based on many years of testing and results. Avoid applying on windy days to reduce the hazard of spray drift to nontarget vegetation. Some harvest-aid materials are very toxic when ingested, and should be properly handled and stored, especially around small children and pets.

CHEMICAL SELECTION DECISIONS

For lower yielding cotton (generally less than 400 lb per acre lint yield) desiccants such as Cyclone are generally recommended. If the plants are large and have a lot of leaves remaining, sequential applications of low rates of desiccants are sometimes use to promote defoliation and reduce leaf sticking. Use of desiccants should be discouraged when seedling wheat is in close proximity to targeted cotton fields. Drift from desiccants can cause severe damage to developing small grains plants grown for cover or harvest.

For cotton yielding in excess of one bale per acre, other materials can be used and the higher costs more easily justified. Tank mixes of Harvade, sodium chlorate, and 1 pint per acre crop oil concentrate (COC) have performed well in medium yielding cotton and have good desiccation activity on morningglories. Ethephon-based materials result in an increased rate of boll opening and defoliation that generally reaches a maximum within 14 days. Tank mixes of ethephon and defoliants (Folex/Def or Ginstar) are effective in higher yielding cotton to open bolls and drop leaves. Warm temperatures (80^{o} F) are normally required to obtain the maximum boll opening response, although higher rates of ethephon are still effective under cooler temperature conditions. Finish (4 lb ethephon per gallon formulation) has been replaced with Finish 6 (6 lb ethephon per gallon) in the 1999 season. Finish 6 has 51.4 percent active ingredient (a.i) ethephon with a proprietary synergist cyclanilide (6.4 percent a.i.). Cyclanilide is reported to be an effective inhibitor of auxin transport and binding which should result in increased abscission activity. In order to obtain desirable levels of defoliation with Finish and Finish 6, tank mixes of low rates of defoliants are many times required. A FIFRA Section 2(ee) label is available for Finish 6 in 1999 which recommends that a 1 pint per acre rate of Finish 6 should be tank mixed with low rates of defoliant products such as Folex, Def, Dropp, Accelerate, or Ginstar. This rate is not recommended for rank cotton. Cotton Quik is another ethephon-based material (18.3 percent a.i.) which has a synergist identified as AMADS (58.6 percent a.i.). Sixteen to 21 oz per acre of ethephon (equivalent to 0.75-1 lb per acre a.i.) when tank mixed with low rates (3-5 oz per acre) of Ginstar result in good defoliation, boll opening response and in many instances good regrowth control. Ginstar is a good defoliant that is also one of the most effective materials for controlling regrowth, and works

over a fairly wide range of environmental conditions. Tank mixes of ethephon and Ginstar are fairly expensive, and can be used for boll opening and defoliation of cotton with high yield potential.

When boll openers and defoliants are used, a follow-up application of a desiccant such as Cyclone is often required to sufficiently condition the cotton for stripper harvest in the High Plains region. Although this adds more expense to the overall harvest-aid program, it is sometimes necessary in order to complete the season-long earliness investment the producer has made.

LATE SEASON INSECT MANAGEMENT AND REDUCTION OF STICKY COTTON POTENTIAL

In recent years, boll weevils have become a major problem in some areas in the High Plains. Reduction of late season squares which are used as a food source for boll weevils entering diapause can be accomplished by timely termination of the crop. Addition of 0.5 lb per acre methyl parathion or 0.25 lb per acre of azinphosmethyl (Guthion) to harvest aid mixes can be beneficial to reduce diapausing boll weevil numbers. A potential for fire hazard exists if the above insecticides are tank mixed with chlorate-type defoliants, and such mixes should be avoided.

Sticky cotton problems plagued the High Plains a few years ago, and mills were reluctant to purchase contaminated bales. During fiber laydown at the mill, one contaminated bale can affect as many as 25 to 50 other bales, resulting in increased maintenance and cleaning costs, more down time, and considerable financial losses for the mill. This problem results in a backlash by the mills, reducing the marketability of High Plains cotton. Lack of commercial testing equipment for determining "sticky" bales results in boycotting of the region's cotton by most mills. High Plains producers have come a long way in improving the reputation of the region's cotton due to the introduction of higher strength, longer staple varieties. Sticky cotton concerns are still with us and in order to preserve the hard-earned reputation of good quality, measures should be taken by producers to reduce the potential of the problem. Late season aphid buildups and resultant honeydew-derived sticky cotton can and should be reduced by insecticide applications and timely chemical termination of the crop. Refer to the section on crop maturity determination for more information. Dryland producers should consider using low-cost desiccants such as Cyclone on fields that experienced premature cutout due to drought. Short plants with low yield potential and 80 percent open bolls (or when two to three unopened first position bolls are above the uppermost first position cracked boll - also called nodes above cracked boll) can usually be terminated using 8-16 oz per acre of Cyclone. Producers of irrigated cotton should carefully watch the maturity of their crop. When an adequate percentage of mature bolls is reached, defoliants and boll openers should be applied. Timely termination of irrigated fields will greatly reduce the leaf area necessary for aphids to feed and produce honeydew, thus reducing the potential for sticky cotton problems in harvested lint.

HARVESTING CONSIDERATIONS

Harvest aid applications should be timed such that harvestable cotton fields coincide with harvesting capacity of strippers and other equipment. If harvest is initiated too early or delayed too long, bark potential is increased. Generally, a one to two week “curing out” period is necessary after desiccant application. Harvest as soon as possible after plants are sufficiently conditioned for harvest, but be aware that harvesting too quickly after harvest-aid application may result in barky grades and/or other quality discounts. Avoid long-term weathering of stalks when possible. Brittle stalks contribute to high stick content, which results in increased bark potential. Strippers should be adjusted to reduce foreign matter. When necessary, readjust the stripper when moving from field to field or as conditions change.

USDA-ARS researchers at Lubbock have determined that use of 5 brush/1 bat or 3 brush/2 brush-bats/1 bat configurations will generally reduce foreign matter content (particularly sticks) in seedcotton, compared to 3 brush/3 bat configurations (Figure 3). It is best to time stripper rolls brush-to-bat with such patterns. Widen spacings between stripper rolls as far apart as acceptable seedcotton loss permits. Wider spacings can considerably reduce stick content of stripped cotton, thus reducing potential for bark problems (Figure 4). When plants become brittle late in the season, reducing paddle length by 0.75 to 1 inch on brush-roll headers can reduce stick content as much as 40 percent. If shortened paddles are used, stripper rolls should be timed brush-to-brush.

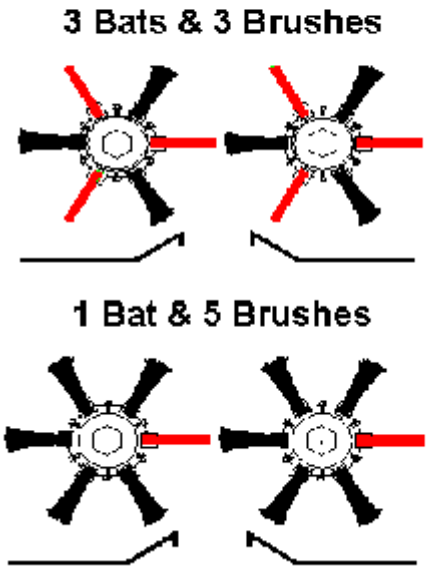
Whenever the strippers are adjusted for the field specific conditions, remember that some tagging may be acceptable, especially if the amount of foreign material can be reduced by less aggressive stripping. Yield losses can be estimated by measuring 10 feet behind your harvester and collecting the seedcotton. If there is an average of 2.5 seeds per foot behind one row of the harvester unit, then about 4-5 lbs of lint per acre harvest loss is expected. This number is for 40-inch row machines. For 30-inch rows, the number for the same loss is about 1.9 seeds per foot of row.

When harvesting begins and cotton is stored in modules, moisture content of the stripped material must be less than 12 percent. This will ensure that there will be no heating in the module, and that lint staining due to green plant material will be minimized. Cotton is ready to strip when leaves are dry and bolls easily snap off plants. No surface moisture or water droplets (such as dew) should be present.

PREVENTION OF LINT CONTAMINATION

Contaminants are a significant problem during subsequent lint processing by mills and care should be taken to reduce contamination potential. Various materials that are picked up by strippers and carried through the ginning process can end up in the bale of cotton, and ultimately impact the quality of yarn and fabric products. During fiber laydown at the mill, one contaminated bale could affect as many as 25 to 50 other bales, resulting in considerable financial losses. Liability issues may soon become a reality. Since cotton is a natural fiber with considerable fiber property variability, mills and other users do not need additional “challenges” when the bale arrives. Major types of contaminants include plastic, rubber, grease and oil, apparel or other fabrics, and other materials. Pieces of plastic from ditch liners or irrigation tubing (polypipe) can be gathered with the cotton during harvesting and become a source of contamination. Trash from adjacent urban or farmstead areas (plastic bags, sacks, etc.) can also be picked up during the stripper harvesting process. Pieces of old inner tubes or tires can also be a source of contamination. Grease can be derived from poor handling of grease guns, cartridges, etc., which should be avoided. Hydraulic fluid leaks, and other similar problems can contribute to fiber impurities. Grease rags have been noted as another source of contamination. Make sure these do not get mixed into the moduled cotton. Do not use acrylic or permanent paints for marking modules or bales. A Cotton Incorporated licensed sprayable product called Brand-A-Bale is the preferred choice. Module covers are also potential contamination sources. Do not use hay baling twine for module cover tie downs. It is important to use a 100 percent cotton rope, without running it through the module. Module tarps should also be made of cotton. If plastic covers are used, watch the ends closely and repair when frayed or worn.

Figure 3. Configuration of bats and brushes.



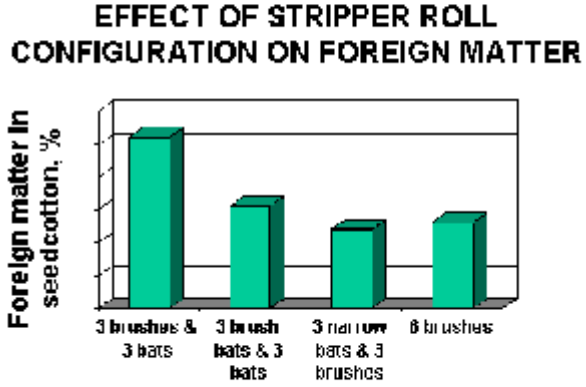


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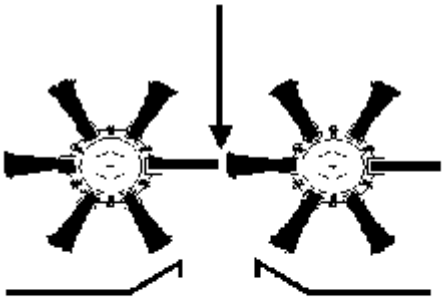
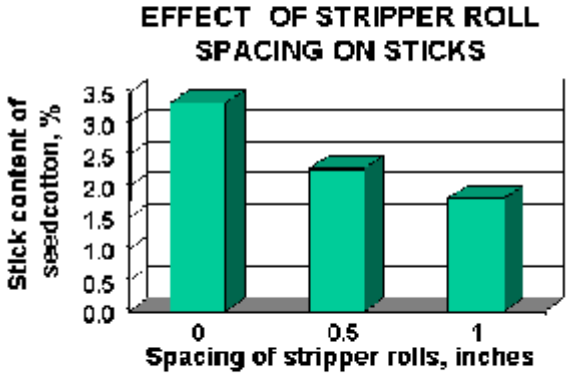
Figure 4. Spacing of stripper rolls.





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1999 HIGH PLAINS COTTON HARVEST-AID DECISION TABLE

(NOT ALL TREATMENTS ARE EQUALLY EFFECTIVE - RATES LISTED ARE PER ACRE)

CROP CONDITION	DRY TEMPERATURES GREATER THAN 80º (0-3 DAYS AFTER TREATMENT)	DRY TEMPERATURES LESS THAN 80º (0-3 DAYS AFTER TREATMENT)	WET TEMPERATURES LESS THAN 75º (0-3 DAYS AFTER TREATMENT)
HEIGHT: Short 12-14 inches **YIELD:** up to 400 lb/acre	Cyclone 8-16 oz[1]	Cyclone 8-16 oz[1]	Cyclone 8-16 oz[1]
	Cyclone 4-8 oz FB* Cyclone up to 48 oz total[2]	Cyclone 8-12 oz FB Cyclone up to 48 oz total[2]	Cyclone 8-12 oz FB Cyclone up to 48 oz total[2]
	Cyclone 6-10 oz + defoliant/desiccant[3]	Cyclone 8-12 oz + defoliant/desiccant[3]	Cyclone 10-24 oz + defoliant/desiccant[3]
	Ginstar 6-8 oz banded	Ginstar 8 oz banded	Ginstar 8-10 oz banded
HEIGHT: Medium 15-24 inches **YIELD:** 500+ lb/acre	**FOR TREATMENTS LISTED BELOW, A SEQUENTIAL APPLICATION OF CYCLONE 10-14 DAYS AFTER INITIAL TREATMENT WILL LIKELY BE NECESSARY TO SUFFICIENTLY CONDITION CROP**		
	Cyclone 6-10 oz + defoliant/desiccant[3]	Cyclone 8-12 oz + defoliant/desiccant[3]	Cyclone 10-24 oz + defoliant/desiccant[3]
	Cyclone 4-8 oz FB Cyclone up to 48 oz[2]	Cyclone 6-8 oz FB Cyclone up to 48 oz[2]	--
	Ginstar 8 oz	Prep 16-21 oz[4] + Ginstar 8 oz	Prep 21 oz[4] + Ginstar 8 oz
	Harvade 8 oz + 1 pt COC + sodium chlorate 77 oz[5] FB Cyclone	Harvade 8 oz + 1 pt COC + sodium chlorate 77 oz[5] FB Cyclone	Harvade 8 oz + 1 pt COC + sodium chlorate 77 oz[5] FB Cyclone
	Prep 16-21 oz[4] + Folex/Def 8-16 oz	Prep 16-21 oz[4] + Folex/Def 16 oz	Prep 21 oz[4] + Folex/Def 16 oz
	Finish 6 16 oz + defoliant (Folex/Def 8 oz or Ginstar 3-5 oz)	Finish 6 21-32 oz (defoliant may be required)	Finish 6 21-42 oz (defoliant may be required)
	CottonQuik 3 pts + Ginstar 3 oz	CottonQuik 3-4 pts + Ginstar 5 oz	CottonQuik 4 pts + Ginstar 6-8 oz
HEIGHT: Greater than 24 inches **YIELD:** 800+ lb/acre	Prep 21 oz + Folex/Def 8-16 oz	Prep 21 oz + Folex/Def 16 oz	Prep 21-28 oz[4] + Folex/Def 16 oz
	Finish 6 16-21 oz + defoliant (Folex/Def 8 oz or Ginstar 3-5 oz)	Finish 6 21-32 oz + defoliant (Folex/Def 8-10 oz or Ginstar 4-6 oz)	Finish 6 32-42 oz[4] + defoliant (Folex/Def 8-10 oz or Ginstar 6-8 oz)
	CottonQuik 3-4pts + Ginstar 3-5 oz	CottonQuik 4-5 pts + Ginstar 6-8 oz	CottonQuik 6-7pts + Ginstar 6-8 oz
	Harvade 8 oz + 1 pt COC + sodium chlorate 77 oz[5] FB Cyclone	Harvade 8 oz + 1 pt COC + sodium chlorate 77 oz[5] FB Cyclone	Harvade 8 oz + 1 pt COC + sodium chlorate 77 oz[5] FB Cyclone
	Ginstar 8 oz	Prep 21 oz + Ginstar 8 oz	Prep 21 oz + Ginstar 8-12 oz
LATE MATURING	**CONDITIONING TREATMENT ONLY** (Apply after daily heat units drop below 5, but 7 days before average first killing freeze date)		
	Cyclone 4-8 oz	Cyclone 6-12 oz	Cyclone 10-16 oz
	Prep 21-24 oz	Prep 21-32 oz	Prep 32-42 oz
	Prep 21-24 oz + Folex/Def 8 oz or + Ginstar 8 oz	Prep 21-32 oz + Folex/Def 8 oz or + Ginstar 8 oz	Prep 21-32 oz + Folex/Def 16 oz or + Ginstar 8-16 oz

* - FB = Followed by

[1] - Use on cotton with natural leaf shed. High rates can cause green, healthy leaves to stick. Always use a non-ionic surfactant when applying Cyclone. [2] - No more than 48 oz total of Cyclone may be applied (in up to 3 multiple applications) in one season based on the Texas Special Local Need label. The need for and rate of Cyclone in a second application will depend upon green leaves remaining. Use higher rates if regrowth is excessive.

[3] - Successful tankmix partners with **Cyclone include Accelerate, sodium chlorate, Folex/Def, and QuickPick**. [4] - **Ethephon-based material (such as Finish 6, CottonQuik, Prep, SuperBoll, Boll'd, Ethephon 6)** activity is determined by rate and temperature. At lower temperatures, boll opening response can be enhanced by increasing rate. [5] - Always use crop oil concentrate with this combination and follow with Cyclone 7-10 days later.