



# The Proper Use of Cotton Harvest-Aid Chemicals

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Preparing the crop for harvest is a season-long process. It begins with timely, uniform stand establishment, and includes adequate but not excessive nitrogen fertilization, development of adequate prebloom plant structure, high retention of early set fruit, avoidance of late irrigation, and other management practices that contribute to crop earliness and, finally, uniform cutout. Harvest-aid chemicals such as desiccants, defoliants and plant growth regulators are used in many areas to reduce the foliage and plant moisture that interfere with harvesting operations. Many factors influence the effectiveness of harvest-aid chemicals. One of the most important factors is plant maturity. Producers who understand cotton plant growth and the defoliation process will be more successful in deciding what harvest aids to use and when to apply them.



## Plant Growth and Development

Cotton defoliation/desiccation should be considered the final phase of cotton development. The maturity of the seed and fiber cannot be hastened through the use of harvest-aid chemicals. Only time and favorable growing conditions mature cotton. Harvest aids can only promote defoliation, more rapid boll opening and desiccation, and thus prepare the crop for timely harvest.

The cotton plant is a perennial shrub that can live for many years in a tropical environment. New leaves are critical to the cotton plant. During the first 14 days, leaves expand and nitrogen moves into them to produce proteins. Hormones and enzymes are very active and photosynthesis increases rapidly. Carbohydrate production peaks 16 to 18 days after leaves unfold. During this period leaves are very resistant to defoliation. Carbohydrates generated by leaves are directed to fiber development during boll filling.

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The active life of a leaf is very short. Photosynthesis gradually decreases after 30 days, and the leaf stops functioning after about 40 to 60 days. As leaves age, the plant is naturally conditioned for defoliation.

The cycle of growing new roots, leaves, stems, squares and bolls essentially stops when the carbohydrate demand by the fruit load equals or exceeds the energy produced by the plant. This condition is referred to as "cutout."



## Regrowth

Once bolls mature and begin to open, new growth may resume if moisture and nutrients are adequate. If cotton plants are actively growing at harvest time (i.e., producing new leaves and squares) defoliation will be difficult and subsequent regrowth is likely. Regrowth after defoliation is a major concern where cotton is stripped and where warm weather and late summer rains promote regrowth (especially in south and central Texas).

Regrowth is reduced by low nitrogen levels in plants, low soil moisture, and the physiological maturity of the plant. It is important to avoid late irrigation to reduce regrowth. Research shows that regrowth also can be inhibited by delaying defoliation with harvest-aid chemicals until 60 to 70 percent of bolls are open.



## Boll Opening

The purpose of the lint on cotton seed is to help spread the seed. That is why both fiber and seed complete their development at the same time. As the seed matures, a corky layer of cells forms between the boll and the stem. The corky layer prevents the movement of water from the plant into the boll, thereby hastening the drying process. Ethylene levels in the boll increase, which causes the cells between the carpels (segments of the boll

wall) to weaken and the boll wall and fiber to dry out. If defoliation allows sunlight to reach exposed bolls, their temperature increases 7 to 9 degrees F, which accelerates the drying process. As the carpels dry out and the cells that hold them together weaken, they separate and peel back. The cotton fiber dries and fluffs out. At this point the cotton fiber is at its peak quality and weight.



## Defoliation

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The plant synthesizes IAA (indole acetic acid) to maintain healthy, productive leaves, or ethylene to rid itself of injured, shaded or old leaves. Healthy, productive leaves produce IAA in large quantities, which prevents the abscission process. Abscisic acid and ethylene work in opposition to IAA to loosen and dissolve the cells on the leaf petiole where it attaches to the stem (the abscission zone). Some harvest aids (e.g., paraquat), if used at rates that are too high, may kill the stem and cells in the abscission zone so that the leaf cannot fall off. A hard freeze or diseases such as cotton root rot will kill the plant before any cell loosening can take place, so all the leaves remain “stuck.” The plant must be alive in order for defoliation to occur. Depending upon which hormones predominate, the leaf will remain or fall.

The same factors that restrict regrowth also enhance defoliation, or abscission. These include low plant nitrogen, low soil moisture, plant maturity, and application of harvest aids when 60 to 70 percent of bolls are open.



## Timing Harvest Aid Treatments

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Deciding when to apply harvest aids is a compromise between slowing or halting further development of green bolls and minimizing weathering of open bolls so that yield is maximized. If applied too early, the plant may not properly defoliate, fiber quality and yield may be reduced, reapplication may be necessary, and planting seed quality may be lowered. If applied too late, yield and quality may be reduced by weathering.

There are several techniques for determining when to begin applying harvest aids. Using a combination of methods will improve timing.



## Determining the Percent of Open Bolls

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Most harvest-aid chemical labels recommend that the products be applied when the crop attains a certain percentage of open bolls, generally 50 to 70 percent. Cotton with rank growth should have at least 80 percent of the bolls open to reduce regrowth. If there was a “skip” in the fruit set on the plant, using the percent open bolls method may not fully evaluate the maturity of the remaining green bolls compared to the mature bolls.



## Evaluating Seed and Fiber Maturity

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Seed development also is a good indicator of boll maturity. Cutting across mature bolls with a sharp knife will split seed so their maturity can be evaluated. The seed coats of mature seed will be tan to brown in color. There will not be any clear “jelly” in mature seed. The cotyledonary leaves will be completely formed and the embryo will be dry. Mature fiber rolled between the thumb and forefinger will feel moist but not watery.



## Nodes Above Cracked Boll

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The location of the uppermost harvestable green boll in relation to the uppermost first position cracked boll also can be used to assess crop maturity and time harvest aid applications. This technique, known as Nodes Above Cracked Boll (NACB), takes into account the relationship between the age (and consequently the maturity) of bolls at adjacent fruiting branches. A 3-year study in Texas, Oklahoma and California showed that by using the NACB concept, a producer could determine the optimum timing for harvest aids. A cracked boll is defined as one where white lint is visible, but is not sufficiently fluffed to be efficiently harvested with a spindle picker. It is more than a “smiling” boll (with just a slight crack in the boll wall where lint can be seen) and less than an open boll. When using this technique a producer must count nodes above the uppermost cracked boll and not bolls above cracked bolls to determine the age of bolls above the cracked boll. A cracked boll is used as a reference point because it denotes the uppermost boll that has attained 100 percent of its yield and quality potential.

Percent Reduction in Yield from Defoliation	
Nodes above cracked bolls	Percent weight loss
3	1.3
4	7.9
5	14.6
6	21.3
7	28.0
8	34.7

In addition to weight loss, micronaire is strongly affected by early defoliation. The earlier the defoliation, the lower the micronaire. Harvest aids should be sprayed when there are no more than three to four nodes with harvestable bolls above the uppermost cracked boll.

Careful field evaluations using a combination of methods to evaluate plant and boll maturity will contribute to the proper timing of harvest aids.

## Making Harvest Aids Work

Many factors are involved in obtaining good results from a defoliant or desiccant. Good results are obtained when applications are made under the following conditions:

- warm, calm, sunny weather
- low soil moisture but sufficient to maintain plant activity without drought stress
- low soil and plant nitrogen levels
- few new or active leaves
- mature, cutout plants that have at least 70 percent open bolls

Poor results often are attributed to the following conditions:

- cool (below 60 degrees F), cloudy weather
- prolonged wet periods following treatment
- plants in a vegetative growth state with low fruit set
- plant severely drought stressed with tough, leathery leaves
- high levels of soil nitrogen and moisture

- plants showing new growth following cutout
- improper sprayer calibration and poor spray coverage
- incorrect choice of harvest-aid products



## Types of Harvest Aids

Defoliants can be broken down into different categories depending upon their modes of action. Some products are considered “enhancers” or “synergists.” Accelerate<sup>®</sup> or Quick Pick<sup>®</sup>, for example, are used to speed up the action of other harvest aids. Products that include sodium chlorate, DEF<sup>®</sup>, Folex<sup>®</sup> and Cyclone<sup>®</sup> at low rates injure the leaf and stimulate the abscission process. Hormone defoliants such as Dropp<sup>®</sup>, Ginstar<sup>®</sup> and Harvade<sup>®</sup> defoliate plants and reduce regrowth but do not affect bolls directly. Ethephon products such as Prep<sup>®</sup> at higher rates will cause some defoliation, but work best in combination with true defoliants. Ethephon causes increased ethylene production and hastens boll opening.

Desiccants, such as paraquat, kill plant tissue and cause a rapid loss of water from the foliage. They prepare the crop for stripper harvest. Plants are usually killed so rapidly that defoliation cannot take place, hence the leaves frequently remain attached. In high-yielding cotton, defoliants are usually used to remove leaves and then a desiccant is applied to speed up the drying of stems and remaining leaves.



## Summary

The producer’s goal should be to have physiologically mature plants at harvest. Careful evaluation of plant maturity and an understanding of how harvest aids affect the plant will enable a producer to make the best decisions for each field.

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