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Cotton Harvest Aid Selection and Application Timing

Joel C. Faircloth, Extension Cotton/Peanut Specialist, Tidewater Agricultural Research and Extension Center
Jason Sanders, Research Associate, Eastern Shore Agricultural Research and Extension Center
Henry Wilson, Professor, Weed Science, Eastern Shore Agricultural Research and Extension Center

Since defoliation is considered an "art and a science," selecting harvest aids can be among the toughest, but most critical decisions a cotton producer will make all year. There is no one encompassing prescription. Producers have to assess their current situations and environmental conditions and adjust from there. Boll maturity should be an important part of the decision. Once the leaves are removed the bolls will come close to, or cease, maturation altogether. The goal of defoliation is to have the leaves die and drop from the plant. To do this, the harvest aid must not kill the leaf immediately, but keep it alive long enough to form an abscission zone. If the leaf desiccates too rapidly, the leaves will stick to the plant, possibly resulting in grade reductions.

Advantages associated with harvest aid applications prior to cotton harvest include: increased harvester efficiency, reduction in leaf and trash content in harvested lint, and quicker drying of dew. These advantages can include increasing picking hours, retarding boll rot, straightening lodged plants, maintaining or improving certain fiber quality characteristics, and stimulating boll opening (increasing earliness). If weeds are present when defoliants are applied, the weed control afforded by defoliants with desiccating activity can increase harvest efficiency.

Factors that influence defoliation include environmental and crop conditions, crop maturity, and harvest scheduling. Harvest scheduling is especially important in Virginia where most cotton producers also have a valuable peanut crop to harvest. Due to changes in the weather and the crop, the appropriate harvest aid materials and rates are subject to rapid change.

Defoliants should be applied in the late afternoon or morning when the wind is calm and humidity is high. In general, defoliants work best when nighttime temperatures are above 60º to 65ºF. Most defoliants are not mobile in the plant and therefore full coverage is essential.

Defoliation Timing

Properly timing defoliation involves balancing the value of potential increases in yield with the value of changes in fiber quality. Early defoliation can be critical in maximizing yield. Delaying defoliation increases the risks of yield loss due to damaging early frosts and late season inclement weather, both of which are possible in the Virginia cotton-growing region. However, delaying defoliation allows immature bolls to develop, thus enhancing yields. Defoliation timing also impacts various cotton quality characteristics. Defoliating too late or early can negatively impact fiber quality, including micronaire and staple.

Percent Open Boll

Numerous methods have been tested for timing defoliation. Percent open boll is one of the methods, and the traditional recommendation for harvest aid application has been 60 percent open boll in most areas. Research in North Carolina has demonstrated most varieties can be defoliated between 40 percent to 60

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percent open boll without adversely affecting yield or micronaire. This method, focusing on the opened portion of the crop, has a couple of disadvantages. One is that this method does not account for fruiting gaps, and the second is the time it takes to perform this measurement. Percent open boll can be measured by marking a section of row (e.g., 10 feet) and counting the number of total bolls within that row distance. Then, the open bolls are counted. The number of open bolls divided by the total bolls times 100 is the percent open boll for that area. Keep in mind, that number only represents the area measured and may not be representative of the entire field. Also, the bolls counted should only include harvestable bolls. Bolls where anthesis (flowering) took place prior to August 15 should be considered harvestable in a typical year. As defoliation nears, questionable bolls can be tested with the sharp knife technique to determine harvest potential. If the boll is very difficult to cut in cross sections, seed coats are brown to black, and no jelly is present within the seed walls, the boll is at a point where harvest aid application will not negatively impact yield potential.

Nodes above Cracked Boll

Nodes above cracked boll (NACB) is a method of timing defoliation whereby only plants containing a first-position cracked boll are utilized. Beginning with the node (branch) above the sympodial (fruiting) branch containing the highest first position cracked boll, nodes are counted upward **to the node containing the highest harvestable boll** (see above). The number of nodes traversed equals the NACB. Research has demonstrated that an optimal time to apply harvest aids relative to changes in yield and micronaire is when the crop reaches NACB ≤ 3. This method, in contrast to the percent open boll method, focuses on the unopened portion of the crop. One advantage of this method is that it takes less time than percent open boll. Like all methods of defoliation timing, measurements need to be taken in numerous areas of the field to accurately represent overall condition.

Harvest Timing

Harvest timing is also an important part of managing for yield and fiber quality. As cotton harvest is delayed, open bolls can be exposed to adverse weather conditions. Researchers have demonstrated that rainfall during the harvest period can cause significant yield losses and fiber quality discounts.

In years with rapid plant development, regrowth is an issue and it is important to spread out defoliation and harvest. Unless the intention is to come back with a second application to control regrowth, it is important to apply a chemical that controls regrowth, defoliating only what can can be picked in 10 to 14 days.

In some cases, picking without defoliating may be an option. If cotton is completely cutout and has dropped leaves naturally (possibly older, tough leaves remaining), cotton harvested with care may not require defoliation to eliminate leaf trash and prevent excess staining. If the decision is made to not defoliate, avoid picking too early or late in the day as this may result in excessive moisture. Producers are strongly urged to harvest an adequate sample to evaluate effects on ginning efficiency prior to performing this on a large scale.

Product Selection - General

As mentioned, the objectives of harvest aid applications include defoliation, inhibition of regrowth, boll opening, and weed desiccation. There are few stand-alone products that can accomplish all the objectives and tank-mix combinations typically are required. Harvest aid compounds either have herbicidal or hormonal activity. Herbicidal compounds (Aim, Def, Folex, Harvade, ET) injure the plant, reducing auxin levels and stimulating ethylene production. Ethylene is a hormone that causes the leaf to form an abscission layer and ultimately drop from the plant. If herbicidal defoliants kill the leaf before the abscission zone is formed, leaves are likely to "stick." Dropp, Freefall, Finish, Cottonquick, and Prep are examples of hormonal defoliants. Through several methods, they promote synthesis of ethylene in the plant.

Defoliation Materials

Please note, discussion of products herein is meant for educational purposes and certain products are not endorsed by Virginia Cooperative Extention. For recommendations, please consult the *Virginia Cotton Production Guide*, Virginia Cooperative Extension publication 424-200.

Def, Folex: These phosphate-based compounds have been a standard defoliant for many years and provide good defoliation of older more mature leaves in well cutout cotton. These products provide minimal regrowth inhibition and are typically mixed with other products (e.g. ethephon-Prep, Super Boll, etc.). They are similar

in efficacy and will perform well over a wide range of environmental conditions. However, the high end of the labeled rate performs best in cool conditions. Leaf drop is fast and they only require a rain-free period of two hours. Activity of these compounds improves with increased cutout of the crop. The addition of surfactants or crop oils can increase activity under adverse conditions. The pungent odor of these products may be a consideration in populated areas.

Dropp 50 WP and SC, Freefall 50 WP, etc. (thidiazuron): Dropp and Freefall defoliate mature leaves, have excellent activity on juvenile leaves, and suppress or delay regrowth. A minimum of 0.1 lb/acre WP or 1.6 fl. oz/acre is needed for 10 to 14 days of regrowth inhibition. Higher rates will result in longer periods of regrowth inhibition. Thidiazuron alone is usually equal to or better than other defoliants in drought stressed situations where leaves have thick cuticles. Dropp and Freefall are somewhat slower acting than other defoliants and their activity is temperature dependent. Temperatures less than 65ºF will reduce activity: however, the addition of crop oil concentrate, or a phosphate type defoliant will help the activity of thidiazuron under cooler conditions. The addition of 2 to 4 oz/acre of Def or Folex will shorten the required 24-hour rain-free period. The label provides specific tank clean out procedures when using thidiazuron containing materials to avoid premature defoliation when the sprayer is used the following year. When thidiazuron is tank mixed with a phosphate defoliant or insecticide, the label recommends a surfactant to aid in tank clean out. When using the WP formulation, thorough rinsing is critical.

Ginstar: Ginstar is a premix emulsifiable concentrate of thidiazuron (active ingredient in Dropp and Freefall) and diuron. Ginstar has been found to be more active under cool conditions than most thidiazuron containing materials. Ginstar is a strong inhibitor of terminal regrowth. It is more likely to cause unwanted desiccation and sticking of cotton leaves than thidiazuron alone. Tank mixing and higher rates increase the potential for leaf sticking. Labeled rates are 6.4 to 16 oz/acre and growers are cautioned not to exceed 8 oz with this product until more information is available from Virginia. Growers are cautioned that rates in excess of 10 oz have shown a tendency to desiccate leaves. The label does not allow mixing of phosphate type defoliants (Def, Folex). However, ethephon containing materials (Prep, SuperBoll, Finish, CottonQuik, etc.) can be tank mixed at low rates for enhanced defoliation. The use of adjuvants with Ginstar is not recommended. Pay close attention to rotational restrictions on the label. Research in Virginia with this product is limited. Pay attention to label for Virginia, some other state labels differ greatly. Pay close attention to rotational restrictions on the label.

Harvade (dimethipin): Harvade is an herbicidal type defoliant that provides effective defoliation of mature leaves but minimal inhibition of terminal regrowth. It has little activity on emerged juvenile growth. Harvade is less temperature-sensitive than phosphate defoliants and is reported to have better activity at lower temperatures. In combinations with ethephon, it has demonstrated the ability to desiccate morningglory and prickly sida. The addition of 1 pt/acre of crop oil is required by the federal label and is needed for acceptable defoliation. Harvade needs a 6-hour rain-free period following application. Pay attention to precaution statements on label.

Leafless: Leafless is a combination of the active ingredients in Dropp/Freefall (thidiazuron) and Harvade (dimethipin). It combines effective defoliation of mature leaves (dimethipin) with regrowth inhibition and removal of juvenile growth (thidiazuron). Limited research is available for this product in Virginia. The recommended rate of 10-12 ounces per acre delivers the equivalent of 0.125 to 0.15 lb Dropp/Freefall and 6.4 to 7.7 oz/acre Harvade. If morningglory desiccation is desired, additional Harvade can be added. Crop oil concentrate at 0.5 to 1.0 pt/acre should be added to Leafless for acceptable activity.

Aim: Aim is an herbicidal defoliant that has similar activity to ET, Def/Folex, and Harvade. While it is not extremely temperature sensitive, research indicates it can cause excessive desiccation under warm conditions and where rank juvenile growth is present. Aim has been found to be very good as a second shot application. It will remove regrowth but provides no regrowth inhibition. It performs best in well-cutout cotton, and/or cool conditions. Aim is good as a morningglory dessicant. Aim can be tank-mixed with most defoliants, and the addition of 1 percent v/v crop oil is required by the label. Some research with Aim/Dropp tank mixes has indicated regrowth inhibition from Dropp may be slightly reduced.

ET: ET is an herbicidal defoliant that has activity similar to Aim, Def/Folex, and Harvade. Little research from Virginia is currently available regarding ET as

a defoliant. Research in other states has demonstrated that this product is very similar to Aim and chould be used similarly. The ET label allows tank mixing with all other defoliants, although tank mixes with Ginstar are not recommended.

Finish: Finish contains the active ingredient in Prep (ethephon) and a synergist (cyclanilide) that aids in defoliation. Finish tends to open bolls more rapidly than Prep alone and thus shortens time to harvest. It is less temperature sensitive than most products. In situations where regrowth or added defoliation is needed, thidiazuron (Dropp, Freefall, etc) and/or Def/Folex should be added to the tank.

CottonQuik: CottonQuik weighs 12.45 lb/gallon and contains 2.28 lb of ethephon (Prep) and 7.30 lb of a synergist (AMADS). Like Finish, it is an excellent boll opener. Acceptable defoliation with CottonQuik typically occurs within 7 days in well cutout cotton containing mature leaves. Cottonquik also provides limited control of terminal regrowth. Where thick regrowth is a concern, add thidiazuron (Dropp, Prepp, etc.). Def/Folex may be added to enhance defoliation of juvenile or rank growth. Thorough rinsing of the tank is recommended following application.

Roundup (glyphosate, many formulations): Glyphosate can be applied as a harvest aid material. Tank mixed with defoliants or ethephon, it provides regrowth inhibition in conventional (non-Roundup Ready) cotton. It also provides excellent control of perennial grasses. Check specific product labels for registrations as a harvest aid.

sodium chlorate: Sodium chlorate is most effective in defoliating mature leaves although it is not good at removing juvenile growth and provides no regrowth inhibition. However, sodium chlorate may be the best defoliant choice when temperatures are below 55ºF. Application should not be made before cotton has 85 percent or greater open bolls. At higher rates, sodium chlorate tends to stick cotton leaves to the plant. It is not safe to tank-mix sodium chlorate with other defoliants, oils, surfactants, or insecticides due to the potential for formation of toxic fumes. Limited research exists on this product in Virginia.

Boll Opening Materials

Although some boll openers are used to enhance the activity of defoliants, they typically are used to hasten the maturity of boll opening. Boll openers are meant to open mature bolls and can alter micronaire and fiber length if applied too early. They are not systemic, making thorough coverage essential. Boll openers are most beneficial for cotton that needs to be picked between 7 and 14 days following application. The active ingredient in Prep, ethephon, is also found as a premix in several products but is below the boll opening rate. Check labels to make sure the boll opening rate is applied, if this is the objective.

Ethephon 6, Prep, Super Boll, CottonQuik, Finish (ethephon): With adequate spray coverage, ethephon products expedite natural boll opening. While ethephon can enhance defoliation, tank mixing with products (Def, Folex, Dropp, Freefall, Ginstar, ET and/or Aim) is necessary for acceptable defoliation and/or regrowth control. At least 7 days should be allowed following application before harvest for optimum boll opening effect. If cotton is not picked for more than 14 days following application, there is likely no advantage to ethephon use. CottonQuik and Finish are combinations of ethephon and a synergist to increase defoliation and speed boll opening over ethephon alone. Bolls that are not mature at the time of application have little chance of opening in 14 days regardless of ethephon use. Do not mix with sodium chlorate due to the potential for toxic fume formation.

Gramoxone Max, Gramoxone Extra, and Starfire (paraquat): Paraquat can enhance defoliation of juvenile growth when applied in combination with other defoliants although it will not inhibit regrowth. It can stimulate boll opening. High rates may result in excessive desiccation and “freezing” of closed bolls. It also can be used as a spot treatment for weed desiccation. It should not be applied at weed desiccation rates before cotton is at least 90 percent open and the remaining 10 percent is mature. It is necessary to pick within 7 days following paraquat application to avoid bark contamination. Consult label for use rates and pay close attention to precautions.

Reviewed by David Holshouser, Extension specialist, Tidewater Agricultural Research and Extension Center