



August 1991, Volume 2, Number 9

Efficient Application of Harvest Aids

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Proper timing and material selection are only the first of several steps to preparing a field for harvest. Last year's newsletter, "Cotton Defoliation," discussed these two decisions in detail. This issue will focus on the technology to efficiently apply harvest-aids. Although much of this information also is valid for applications of other ag chemicals such as insecticides, harvest-aids require special care to insure good canopy penetration and minimal drift. Additionally, the visual evidence of drift from harvest aids is often more evident than drift from other ag chemicals.

Need for a Clean Defoliation

The motivation for cotton producers to obtain a clean defoliation has expanded over the years. Only 10% of the U.S. cotton crop was machine harvested in 1950, 50% by 1960 and by 1971 over 98% machine harvested. With spindle pickers a high percentage of open bolls and minimum leaf interference is needed for efficient harvesting and maintenance of lint and seed quality. Efficient stripper harvesting requires 100% open bolls, good defoliation and desiccation of plant material, including remaining leaves as well as burs, stem and stalks. Desiccants or a hard freeze are required to properly condition a crop for stripper harvest.

The widespread introduction of module builders in the 70's and 80's made the elimination of high moisture plant parts from picked or stripped cotton doubly important. It is imperative that the moisture content of moduled seedcotton be less than 12% to avoid heating and consequently, deterioration of yield as well as lint and seed quality. Green leaves are high in moisture (over 50%).

Delivering clean cotton to the gin increases returns to the producer with reduced lint losses and improved fiber quality. At the gin, lint cleaners are used to remove foreign matter from the cotton. Ten to 20 lbs of lint are lost in the gin lint-cleaning to remove trash. This lint ends up in the gin trash or bur pile behind the gin and its value is lost to the producer.

It is important to recognize that lint cleaners are proportional machines; they can only remove a portion of the trash and that for each stage of cleaning a portion of the trash is pulverized into fine particles that are difficult to remove, even at the mill. Trashy cotton not only requires multiple stages of lint cleaning to lower the trash content but also needs more heat during drying to reduce the moisture from the trash to allow efficient ginning. The combination of trashy cotton and clean cotton

causes a problem for the ginner. If the necessary equipment is employed to gin trashy cotton, the clean, dry cotton will be over heated and over cleaned. Multiple stages of lint cleaning and overheating increase the short fiber content of the bale. Hand classing for staple length does not indicate the severity of the damage to the fiber, but with HVI classing the damage will show up as shorter fiber and a lower uniformity index.

The grading system of the 1990's will examine the condition of our cotton with greater scrutiny. To maintain the fiber quality that was actually produced in the field requires timely harvest-aid application, allowing adequate time for the chemicals to work, harvesting under optimum conditions and limiting lint cleaning at the gin to 1 — at most 2 — lint cleaners.

Efficiency — Uniform Application

Each ag chemical applied to cotton has its own set of application requirements for optimum performance. This section will discuss leaf coverage, canopy coverage, canopy penetration, nozzle size and pressure as they relate to improving performance of harvest-aid chemicals.

Leaf Coverage

Defoliant and desiccants require that each leaf make contact with spray droplets. Fortunately, it is not required that the plant tissue be completely coated. For example, coverage of only the top side of a leaf or one side of a boll is sufficient to impart injury and to stimulate ethylene production. In fact, the risk of leaf stick or desiccation with the use of a defoliant is increased when the entire leaf is contacted with the spray.

Canopy Coverage

Defoliant and desiccant are not translocated in the plant. If a boll opener, defoliant or desiccant is applied, only the leaves and bolls that are contacted by the spray will be affected. The optimum coverage when applying harvest aids depends on the crop condition and intended goal. When an aerial application is used, coverage is controlled by gallonage, droplet size and spray adjuvants. For greater penetration into the lower canopy, high gallonage and large droplets are recommended. Adjuvants that reduce the surface tension (wetting agents) also decrease droplet size — an effect not desired under most harvest aid applications.

When using ground rigs, greater control of canopy coverage can be obtained by directing the spray to different sections of the canopy with drop nozzles. Susceptibility of the leaves to shedding will determine where the spray should be targeted.

Leaves greater than 60 days old - located in the bottom of the plant, approximately 12 nodes from the terminal — often shed naturally prior to harvest-aid application. These older leaves senesce due to shade and recycling of their dry weight and nutrients to support boll development. On the other hand, younger fully-grown leaves that are in their prime (leaf age 20 to 40 days) often require higher rates of materials to obtain adequate defoliation or desiccation. Regrowth leaves that have not fully expanded, although highly resistant to defoliation, are highly sensitive to desiccation. To reduce leaf stick, avoid high rates of defoliant and desiccants, especially under hot weather or in combination with crop oil.

Another compounding feature is the leaf cuticle, the waxy layer on the outside of leaves that inhibits the penetration of water-based sprays. Leaves that expanded during hot, dry weather will retain a thick waxy cuticle, while leaves that expanded during cool, humid weather will have thinner and less waxy cuticles. Young, still expanding leaves have the thinnest cuticle and for this reason are highly vulnerable to desiccation with defoliants as the material gains rapid entry into the leaf. The faster the uptake and activity of a defoliant — the greater will be the potential for desiccation.

Canopy Penetration

High gallonage applications are the preferred method to achieve canopy penetration. Aerial harvest aid applications of 5 to 10 gallons per acre are preferred over the 2 to 5 gallons typical of insecticide applications. By ground, harvest aids should be applied in 10 to 20 gallons per acre. The top end of these gallonage recommendations should be used when spraying rank or tall cotton, where canopy penetration is most difficult to achieve.

Nozzle Size and Pressure

For any particular spray mix, droplet size is controlled by the nozzle orifice and pressure, and in aerial applications, by the nozzle orientation to the wind flow. When setting up a spray rig for harvest aid application, nozzle sizes should be selected such that the desired gallonage can be achieved at 30 to 40 psi. Increasing pressure to increase gallonage is not efficient, because pressure must be quadrupled to cause a doubling in gallonage. Additionally, excessive pressure will result in small droplets with increased drift and greater operating cost due to wear on pumps, nozzles and hoses.

Since harvest-aid applications are the last spray operation of the year, rigs are often sent to the field "as is". To get the most out of the dollars invested in harvest-aids, give the sprayer the "first of the year" maintenance check. Make sure nozzles match and are in good condition, that the pressure gage is accurate and plumbing sound. And above all, thoroughly clean the sprayer, using label recommended procedures. Good cleanup is especially important following use of Prep or Dropp to avoid corrosion or future crop injury.

Efficiency — Drift Reduction

Efficient application of ag chemicals requires not only proper coverage but also drift avoidance to minimize product loss and non-target injury. Most harvest-aids can cause injury to adjacent crop and sensitive plants such as trees and ornamentals.

Maximizing Product Efficiency (Drift Reduction)

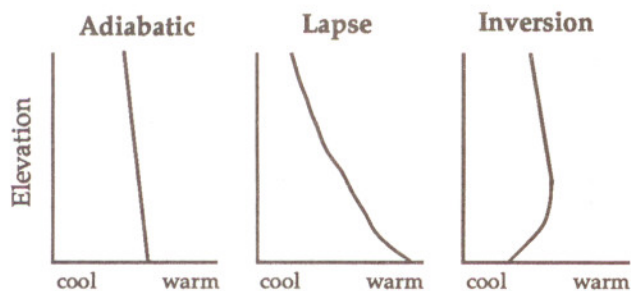
Movement of harvest-aids from the target area can occur as a vapor (volatilization) or as drift. Harvest-aids are not considered to be highly volatile unlike certain herbicides. Nevertheless, volatilization of a decomposition product after application of a phosphate defoliant can cause odor problems for nearby residences. The amount of odor in these defoliants has been significantly decreased in the last 10 years, but decomposition of the phosphate defoliant still occurs in the fields contributing to odor complaints. Hot, sunny weather following application aggravates odor problems.

Drift results in the major loss of harvest aids. Traditional spray equipment relies on nozzles and pressure to break up a liquid stream into individual droplets. Unfortunately, the distribution of droplet sizes is very wide with these traditional systems, resulting in some of the droplets being less than 100 microns in diameter (same size as a human hair). Droplets this size or smaller fall very slowly. For example, a 50 micron droplet reaches a maximum fall velocity of 3 inches per second, while a 200 micron droplet would fall 30 inches during that same second. Small droplets also can be produced from larger droplets from evaporation and when nozzles are sprayed into the wind, such as aerial applications with nozzles oriented forwards or down. Small droplets can be minimized with large nozzles, relatively low pressure (20 -30 psi), and the use of anti-drift agents.

Weather and Drift

In addition to droplet size, weather factors can contribute to chemical movement from the field. The potential effects of wind are obvious but temperature and relative humidity also can affect chemical loss. Aircraft normally apply ag chemicals when the wind speed is between 2 to 10 miles per hour. At wind speeds above 10 miles per hour, small droplets can move considerable distance before they contact the ground. That same 50 micron droplet falling at 3 inches per second could be blown one-sixth of a mile before it hits the ground.

Very low wind speeds, below 2 mph, also can contribute to drift if small droplets are released during a temperature inversion. The neutral temperature gradient for dry air increases 5.4° F for every 1000 feet of elevation gain. This neutral condition is called adiabatic and results from the greater temperature of air under a greater pressure, such as occurs at lower elevations. This neutral condition is not common, especially during the day, when the air near the surface is warmed due to contact with sun-heated soil, creating an unstable condition called lapse. Under lapse conditions, the super-heated surface air rises and cooler air sinks causing turbulence and thereby the lifting and suspension of small droplets into the air.



Although lapse conditions keep some small particles from settling, lapse and adiabatic conditions are considered favorable for aerial applications. It is the third type of temperature gradient, called an **inversion**, that contributes the most to off-target movement of chemicals. During an inversion, the air near the ground is cooler than air above. Inversions generally occur at night and the early or late hours of the day. They result from:

- Intrusion of cool air flowing in from lakes, forcing warm air upward.
- Radiant cooling of the ground during the night. The night sky is very cold, and soil or plants radiate energy losing heat, especially when the night sky is clear and dry.
- Evaporative cooling from irrigated fields can create a strong localized inversion all day long due to evaporation and transpiration of water into a dry atmosphere. In the irrigated west, when driving by a recently irrigated alfalfa field, the cool air one feels is forming an inversion.

Inversions contribute to off target movement of ag chemicals by trapping pockets of chemical-laden air resulting from the release of small droplets. Under inversion conditions, the warm air above keeps the cooler air trapped below, until a side wind blows the contaminated air laterally off-target. Smoke is by far the simplest indicator of local field conditions and inversions, although many states prohibit burning for this purpose.

Humidity also affects the efficiency of harvest aid applications. As the air heats up during the day, it can hold more water and thus the relative humidity drops. This dry air causes evaporation of water from spray droplets. Water-based spray droplets will shrink more than twice as fast at 30% Relative Humidity (RH) versus 70% RH. Consequently, small droplets rapidly become even smaller, reducing canopy penetration and increasing drift potential.

Time of Day

Two weather factors favor early morning applications of harvest aids: the generally lower wind speeds and moister air in the morning. In addition, application of harvest aids to a warming canopy also may enhance uptake and activity, compared with late afternoon applications to plants that are beginning to cool off. On the other hand, inversions and heavy dew are also more prevalent in the morning. Harvest-aids and other ag chemicals can be lost due to runoff when applied to leaves with a heavy dew.

Adjuvants

The term adjuvants refers to all materials mixed with an ag chemical that are not effective by themselves. Most ag chemicals are formulated with their own adjuvants because the choice of adjuvants is critical to mixing and absorption. In fact, the formulation of ag chemicals is one of the most complex components of the industry. Adjuvants used with defoliant include:

- Viscoelastic agents, thickeners or drift retardants that thicken the spray solution, keeping droplet size large, thereby minimizing drift. These large molecules restrict droplet breakup. If used to excess or improperly they can result in poor coverage.
- Wetting agents decrease the surface tension of water, promoting smaller droplets and greater spread of droplets across the leaf surface. The use of wetting agents is typically recommended with the use of desiccants.
- Crop oils increase the speed with which harvest aids penetrate the cuticle and also reduce the surface tension of water. They are often used when treating cotton with drought-hardened leaves or under dry conditions.

Check the product label or consult with extension personnel or product representatives for advice regarding use of adjuvants.

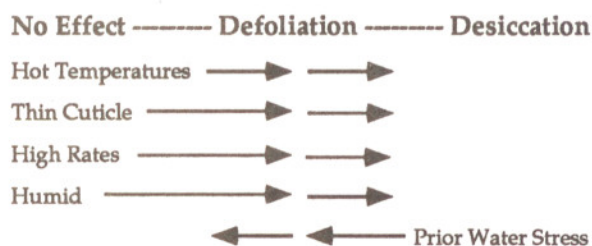
Air versus Ground Applications

The following conditions make air or ground application more appropriate.

| Air | Ground |
|-------------------|----------------|
| Tall Cotton | Short Cotton |
| Narrow Rows | Wide Rows |
| Lodged or Leaning | Upright Plants |
| Loose Lint | Stormproof |
| Wet Soil | Dry Soil |

Defoliant Applications

Defoliants act by wounding the leaf. The intensity of the wounding stimulation from harvest aids determines whether a particular application results in no effect, leaf drop or desiccation. The following diagram charts the factors that influence the response from a harvest aid.



For example, under warm, humid conditions, chemicals are taken into the leaf rapidly and activated rapidly. The result is an intense wounding stimulation, shifting away from the no effect side toward defoliation and possibly on to desiccation. Likewise, high

rates of one product result in an intense wound stimulation.

Multiple applications and combinations of materials allow a protracted wound stimulation with less intensity that often results in better defoliation with less desiccation. Combinations that include a hormone defoliant such as Prep or Dropp appear to produce a strong defoliation stimulation with less chance of desiccation. Multiple applications are especially beneficial when defoliating rank or lodged cotton. Harvest aids are not systemic; each leaf or boll must be contacted with the spray. Under dense foliage conditions, speed of activity is critical because significant leaf drop should occur prior to the second application. Under these conditions, the first application may need to be an expensive, fast-acting combination, applied at high gallonage, to avoid excessive harvest delay.

Desiccant Applications

Desiccants are harsh herbicides that rapidly kill and dry plant tissues. Plant injury is so sudden and severe that leaves and immature green bolls are "frozen" in place before ethylene synthesis occurs. In addition to leaves and burs, desiccants also accelerate drying of fruiting limbs and stems. All these components must be dry (8-12%) for efficient stripper harvesting and module storage.

Defoliation and boll opening prior to the application of desiccants improves their effectiveness in drying stems and any remaining leaves. Good coverage is essential and the use of proper chemical rates, wetting agents, and high gallonage spray solutions is advocated. Because of their modes of action (desiccation on contact), the efficacy of desiccants is not as strongly influenced by temperature and humidity. Nevertheless, these materials are generally most effective when applied during warm, dry, sunny weather. The activity of paraquat is especially improved by sunny weather.

Allowing sufficient time for desiccants to "do their job" is important for harvesting clean, dry cotton. Typically, harvest should be delayed until 7 to 14 days following treatment with high rates of desiccants. When low rates are used, the pre-harvest interval may be 15 to 20 days. Harvesting within 3 to 5 days after desiccant treatment (or a hard freeze) can result in excessive bark. A good rule of thumb is to wait until the bur snaps cleanly from the fruiting branch. If pulling on the boll results in tearing the branch from the stem, the field is still too "green" to harvest. If the field passes that test, bite down on the seed; if the seed cracks, the cotton is dry enough to strip.

Read and Follow the Label

Consult the label and use it as the basis of all product recommendations. Many harvest-aid labels have changed for the 1991 season. Take the time before the season starts, to read the label.

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