COTTON DEFOLIATION IN GEORGIA (2016)
UGA Extension Cotton Agronomist - Jared Whitaker, Ph.D.

Cotton harvest-aids are used primarily to facilitate machine harvest. Timely defoliation and harvest of cotton also reduces weathering-induced yield and fiber quality losses and decrease leaf trash and stain, which further reduce lint quality. Thus, a basic knowledge of crop development and maturity along with an understanding of the physiology of harvest-aids is necessary in making decisions concerning the effective application of these materials. Successful preparation of a cotton crop for harvest factors in the complexities of crop leaf senescence, boll maturation and the diversity of harvest-aid functions

Defoliation Timing:

Cotton defoliation is a sensitive process. For a successful harvest, defoliation must be carefully timed and carried out. Poor defoliation can lower fiber quality, while defoliating too early lowers yield and micronaire. Late defoliation increases the likelihood of boll rot and lint damage or loss due to weathering. Late defoliating also increases the possibility that defoliant activity will be inhibited by lower temperatures

Three ways to determine crop maturity and defoliation timing:

- 60 to 75% open bolls (only 60 for uniform crop)
- Sharp Knife – cotton strings when boll is cut
  - Seed are fully developed (brown coat & cotyledons)
- NACB – 4 or less (around 3 days per node)

There is often a relationship between percent open bolls in the canopy and the number of nodes between the uppermost first position cracked boll and uppermost first position harvestable boll (NACB). The chart below to the right shows predicted percent open bolls to NACB (60% = 4.1 NACB).

Relationship between NACB & % Open Bolls

(Bednarz et al. 2002)

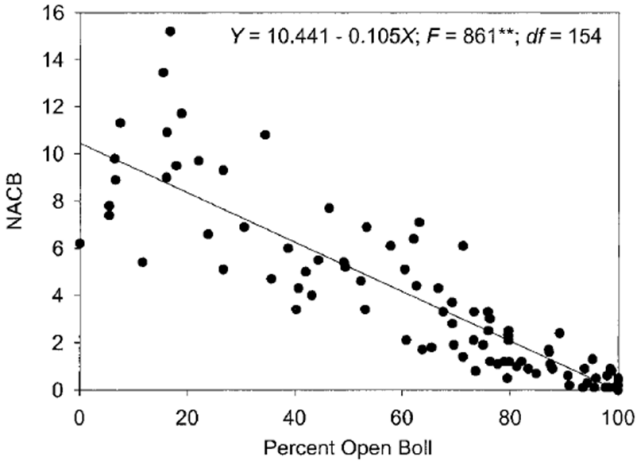

Fig. 1. Nodes from the uppermost first sympodial position cracked boll to the uppermost harvestable boll (NACB) vs. percent open boll in harvest timing studies conducted at the University of Georgia Coastal Plain Experiment Station in 1998, 1999, and 2000. **Denotes significance at the $P = 0.01$ level.

% Open Bolls	NACB
30	7.3
40	6.2
50	5.2
60	4.1
70	3.1
80	2.0
90	1.0
100	0

Harvest Aid Functions:

There are four basic functions of harvest aids when applied to cotton. Each process may or may not be required to prepare cotton harvest. An understanding is needed of these processes in order to properly determine products and rates to be chosen.

1. Removal of Mature Foliage
2. Removal of Juvenile Foliage
3. Boll Opening
4. Regrowth Suppression

The first two functions are considered to be involved with defoliation. Defoliation or leaf abscission is a natural plant process. The problem is this natural leaf drop does not occur simultaneously throughout the plant canopy, or in time to effectively facilitate mechanical harvest. Therefore, producers must manipulate the plant to drop its leaves in a relatively short period of time.

While the leaf abscission process is quite complex, it can be simplified as being governed by two major hormones within the plant, auxin and ethylene. Auxin is a growth-promoting hormone that stimulates leaf growth and development. Ethylene can be classified as a senescence or ripening hormone that causes leaf drop. Leaves fall from the plant once ethylene moves from the leaf blade to the base of the petiole and stimulates the formation of an abscission layer. The amount of auxin or ethylene present in the leaves of the cotton plant is related to leaf age. Younger leaves have a more elevated level of auxin, while older leaves have lower levels of auxin and higher levels of ethylene. This is why older leaves are more conditioned for defoliation than younger leaves. Furthermore, because of the hormone balance of younger leaves, low rates of harvest aids often have no effect, and higher rates may actually kill the leaf, leading to desiccation and leaf sticking. Eventually, almost all the leaves on a cotton plant age so they will abscise naturally. However, producers can manipulate these hormone levels so all the leaves abscise at the same time. When harvest-aids are applied ethylene levels artificially increase so the abscission process begins.

All cotton harvest-aids can be classified into two modes of action, herbicidal and hormonal. Herbicidal harvest-aids injure the leaf, stimulating the production of ethylene. Hormonal harvest-aids increase the ethylene concentration in the leaves without causing any injury. Product selection and application rates should be adjusted to match environmental conditions as they change during the harvest season in order to reduce occurrence of leaf desiccation.

Types of Defoliants:

1. Herbicidal defoliants
   - Tribufos (Folex)
     - Injures leaf below cuticle, causing stress which stimulates ethylene production

     P.P.O. INHIBITBITING HERBICIDES
     - Destructs cell membranes, causing ethylene production
   - Carfentrazone (Aim), Pyrafluefen ethyl (ET), Flumiclorac (Resource), Flutiacet-methyl (Blizzard)

2. Hormonal defoliants
   - Ethephon (Prep, etc.)
     - Increases production of ethylene, leading to leaf drop
     - Accelerated boll opening
       - Finish 6 Pro – ethephon + cyclanilide
       - FirstPick – ethephon + urea sulfate
   - Thidiazuron (Dropp, Freefall, etc.)
     - Enhances production of ethylene and inhibits auxin transport
     - Inhibits regrowth
       - Ginstar – thidiazuron + diuron

PERFORMANCE RATING OF HARVEST AIDS BY FUNCTION

COMMON NAME (BRAND NAME)	FUNCTION			
	Removal of Mature Foliage	Removal of Juvenile Foliage	Boll Opening	Regrowth Suppression
Ethephon (Prep, numerous brands)	F-G	F	E	P
Ethephon + Cyclanilide (Finish)	G-E	F-G	E	F
Thidiazuron (Dropp, FreeFall, TDZ)	G-E	G	P	G-E
Thidiazuron + Diuron (Ginstar, Adios, Cutout)	G-E	G-E	P	G-E
Tribufos (Def, Folex)	G-E	P-F	P	P
PPO Inhibitors (Aim, ET, Resource, Blizzard)	G	F	P	P

Applications:

Most harvest aid materials do not translocate or move very far within the plant. Therefore, application coverage is important. To ensure adequate foliar coverage use the proper spray pressure, ground speed and nozzle size in order to apply the desired spray volume in accordance of label instructions.

WATER VOLUME CAN SIGNIFICANTLY IMPACT OVERALL PERFORMANCE, THE MORE WATER THE BETTER (SHOOT FOR 15 GPA)

Be sure to consider harvest when making defoliant applications and treat enough acres to anticipate harvesting the crop 10 to 14 days after application. Leaf drop should start in about four days and be complete in about 10 days.

Rainfall occurring after applications can affect defoliant activity. Be sure to consider weather forecasts when making applications and pay attention to rain-free periods of particular products. Thidiazuron is of particular concern, since it requires a 24 hour rain-free period.

See the two tables below from the "2014 Mid-South Cotton Defoliant Guide" written by Darrin M. Dodds, Daniel B. Reynolds, L. Thomas Barber, and Tyson. B. Raper for use details and activity of selected defoliants and desiccants. http://www.mississippi-crops.com/wp-content/uploads/2014/09/2014-Cotton-Defoliation-Guide_Final.pdf

Table 2. Use pattern and expected activity for defoliants and desiccants.

Harvest Aid[1]	Labeled Broadcast Rate/Acre	Max. Use per Season	Rainfree Period (hours)[2]	Pre-Harvest Interval (Days)	Estimated min. temp.	Mature leaves	Juvenile growth	Re-growth prevention	Boll opening
Thidiazuron® SC	1.6-6.4 oz	9.6 oz	24	5	65 F	Excellent	Excellent	Excellent	None
Ginstar®	6.4-16 oz	16 oz	12	5	60 F	Excellent	Excellent	Excellent	None
Folex® 6	16-24 oz	24 oz	1	7	60 F	Excellent	Fair	Poor	None
Aim®	0.5-1.6 oz	3.2 oz	8	7	55 F	Excellent	Excellent	Poor	None
Display	1.0 oz	2 oz	8	7	55 F	Excellent	Excellent	Poor	None
ET®	1.5-2.75 oz	5.5 oz	1	7	55 F	Excellent	Excellent	Poor	None
Sharpen™	2.0 oz	2.0 oz	1	5	55 F	Excellent	Excellent	Poor	None
Ethephon	21-42 oz	42 oz	6	7	60 F	Fair	Poor	Poor	Excellent
Finish® 6 Pro	21-42 oz	42 oz	6	7	60 F	Excellent	Poor	Fair	Excellent
Glyphosate[3]	11-44 oz	44 oz	4	7	55 F	Fair	Fair	Excellent	None
Desiccants									
Paraquat	3.1-32	32	30 min.	3	55 F	Fair	Excellent	Poor	Fair
Sodium Chlorate	4.5 # ai	N/A	24	7	55 F	Fair	Fair	Poor	None

[1] Addition of spray adjuvants may enhance defoliation during cold temperatures or when leaves are tough from drought-stressed conditions. However, adjuvants may increase leaf desiccation during the early season when temperatures are warm.

[2] Expected rainfree periods are estimates only and may or may not be exact. Other conditions, including temperature, moisture and crop status, will play a role in product performance.

[3] Non-glyphosate tolerant (Roundup Ready Flex®; Glytol®/Liberty Link™) varieties only.

There are a many things to consider when making defoliant decisions. One of which relates to label restrictions for planting small grains following applications. Be sure to check particular labels for information if planning to plant small grains after cotton harvest. See the table on the right for selected products.

Table 1. Label restrictions for planting small grains following harvest aid application in cotton.

Harvest Aid	Small Grain Re-Crop Interval
Thidiazuron®	14 days
Ginstar®	1 month
Folex® 6	None
Aim®	None
Display™	None
ET®	None
Sharpen®	None
Glyphosate	None
Finish® 6 Pro	1 month
Ethephon	1 month
Paraquat	None
Sodium Chlorate	None

Comments on Additives:

Refer to manufacturer's recommendations. Consider potential negative effects with increased leaf desiccation. Hot temperatures can increase potential for leaf desiccation and possible fiber quality deductions. Unless a label requirement, USE AT OWN RISK.

Specific Recommendations:

For particular defoliant tank-mixture recommendations visit the UGA Pest Management Handbook (pages 226 – 235) at http://www.ent.uga.edu/pest-management/Commercial-Cotton.pdf

In the UGA cotton defoliant section of the handbook, recommendations are broken up two different ways. First, a separate section is available for each "season" or relative range of temperatures. This is done to account for effectiveness of products related to temperature. Another way the recommendations are organized relates to harvest aid functions needed to get the crop ready. For more information on these recommendations and how to incorporate them into your operation, please contact your local UGA Cooperative Extension office.

Although there a lot of tank-mixture options for cotton defoliation, one mixture utilizes three products and has become one of the most common and effective treatments in Georgia. This "three-way" mix contains ethephon to open bolls, tribufos to remove mature foliage, and thidiazuron to remove juvenile tissue and prevent regrowth. The table on the right contains rates for each product based on seasonal temperature.

"Three-way" Defoliation Mixtures

Season (Temperatures)	Ethephon (Prep)	Thidiazuron (Dropp)	Tribufos (Folex)
Early Season (highs >90, lows >70)	21 to 24 oz (1.33 to 1.5 pt)	1.6 to 2.5 oz	6 to 12 oz
Mid-Season (highs 80<89, lows 60<70)	24 to 32 oz (1.5 to 2.0 pt)	2 to 2.3 oz	8 to 12 oz
Late-Season (highs <80, lows <60)	32 – 42 oz (2.0 to 2.67 pt)	---	16 to 20 oz

Ethephon = rates increase with cooler temps, less effective, need more boll opening
Thidiazuron = rates increase with cooler temps, less activity,
increase rate with more regrowth, more green
< activity when low is less than 65 F for 3 days
Tribufos = increase rate with cooler temps, too high can desiccate, need more later

In cases where weeds are present at harvest, some cotton defoliants are products that have herbicidal activity on particular pests. See the table below from the UGA Pest Management Handbook for specific recommendations.

HARVEST AID WEED MANAGEMENT

PRODUCT COMMON NAME	BROADCAST RATE/ ACRE	REMARKS AND PRECAUTIONS *The rates below are given in the broadcast amount per acre unless otherwise noted.*
carfentrazone Aim EC	1 oz.	Add 1% v/v crop oil. Effective on morningglory, coffee senna, and tropical spiderwort.
carfentrazone + fluthiacet-methyl Display	up-1 oz.	Limited data, adhere to label restrictions, use precaution.
glyphosate (numerous brands)	1.2-2 pt.	Use in combination with Def/Folex, dimethipen (Harvade) and/or ethephon. Glyphosate provides fair regrowth suppression of cotton. However, glyphosate WILL NOT provide regrowth suppression when applied to RF cotton. See specific labels for product rates.
paraquat Gramoxone Max, Firestorm, or Parazone	1-4 oz.	Use in combinations with standard defoliation applications. May cause crop desiccation and damage to unopened bolls.
Gramoxone Inteon	3-5 oz.	
pyraflufen ethyl ET	1.5 oz.	Add 0.5% v/v crop oil when temperatures are above 90°F. Add 1% v/v crop oil when temperatures are 89°F or below. Effective on morningglory.
Follow-up Treatments Desiccants paraquat or sodium chlorate	See "Desiccants for Cotton Harvest Preparation" next page.	

Finalizing Cotton Irrigation Management for the Season

Dr. Wesley M. Porter, Extension Precision Ag and Irrigation Specialist

In most places we had an excessively wet early to mid-season. This caused problems with root development as there was either ample water or saturated conditions. Our soils have a low water holding capacity (approximately 1.0 in/ft).

In the last week or so the rainfall has tapered off, the temperatures have dropped slightly, but so has the humidity. Most of our cotton is around peak bloom or moving into open boll. Lower humidity means higher evapotranspiration rates. The crop requires more water moving through the plant.

Don't forget that due to the excessive rainfall during the beginning of the season, the crop didn't develop an extensive rooting system. This means that the crop does not have access to an ample amount of soil moisture. We are seeing the "deeper" roots deplete the deep moisture rapidly across the state.

We may see crops wilting faster than normal due to shallower roots and lack of access to deeper moisture. Don't confuse heat and moisture stress. Heat stress only exhibits during the hottest parts of the day, it goes away in the evening and early morning.

If you are in peak bloom don't lose your deep moisture, but at the same time a lot of the shallower moisture is still holding, so don't trigger irrigations too quickly. Keep a close track at how far along the crop is, which week of bloom, estimated water requirement, effective rainfall, etc…

As you start to see bolls opening in the field check the soil moisture, review how long it has been since there was irrigation applied or rainfall received on the field. If you have sub-soil moisture, you are probably sufficient to make it to defoliation. Check the future forecast; currently we are only scheduled for sporadic thundershowers in the next week or so. If you feel like the soil is relatively dry and doesn't have enough moisture to finish the crop, a final irrigation may be needed.

Keep an eye on the humidity; more humid conditions are conducive to boll rot and hard lock. The recent drop in humidity makes it a little easier to add a final irrigation to the crop. Again proceed with caution and only add it if you feel it is absolutely necessary. **The recommendation for irrigation termination is 10% open bolls. This is around 2-3 open bolls.**

Cotton Irrigation Schedule				
Growth Stage	**DAP**	**Weeks after Planting**	**Inches/Week**	**Inches/Day**
Emergence	1 - 7	1	0.04	0.01
Emergence to First Square	8 - 14	2	0.18	0.03
	15 - 21	3	0.29	0.04
	22 - 28	4	0.41	0.06
	29 - 35	5	0.56	0.08
First Square to First Flower	36 - 42	6	0.71	0.10
	43 - 49	7	0.85	0.12
	50 - 56	8	1.08	0.15
First Flower to First Open Boll	57 - 63	9	1.28	0.18
	64 - 70	10	1.47	0.21
	71 - 77	11	1.52	0.22
	78 - 84	12	1.43	0.20
	85 - 91	13	1.42	0.20
	92 - 98	14	1.33	0.19
	99 - 105	15	1.16	0.17
	106 - 112	16	0.88	0.13
	113 - 119	17	0.69	0.10
First open boll to >60% Open Bolls	120 - 126	18	0.51	0.07
	127 - 133	19	0.35	0.05
	134 - 140	20	0.22	0.03
	141 - 147	21	0.12	0.02
	148 - 154	22	0.05	0.01
	155 - 161	23	0.02	0.00
Harvest	162 - 168	24	0.00	0.00
	169 - 175	25	0.00	0.00

Manage Plastic Contaminants to Protect Price
By Dr. Don Shurley
August 24, 2018

Contamination from plastics is a hot-button topic in the U.S. cotton industry right now. It should be. It's a serious problem. Major culprits include plastic wrap from round modules, shopping bags from stores and plastic used as ground cover in the production of previous crops in that field.

High quality fiber is one reason foreign mills have beat a path to our door in recent years. As an industry, anything that impacts the demand and market share for our cotton – especially overseas – needs to be resolved. The industry is being vigilant in addressing this problem. Groups have visited foreign mills to observe and discuss the problem. Also, the National Cotton Council will soon roll out an intensive educational effort.

Beginning with this year's 2018 crop, the USDA-AMS Cotton Program is implementing new extraneous matter codes, 71 and 72, for plastic – "71" means type 7, level 1 (light), and "72" means type 7, level 2 (heavy). Producers will begin to see these new 71 and 72 codes on their bale analysis classing reports if plastic is detected in the sample.

Extraneous Matter			
Code	Description	Code	Description
01	Prep Level 1	41	Oil Level 1
02	Prep Level 2	42	Oil Level 2
11	Bark Level 1	51	Spindle Twist Level 1
12	Bark Level 2	52	Spindle Twist Level 2
21	Grass Level 1	61	Other Level 1
22	Grass Level 2	62	Other Level 2
31	Seed Coat Fragments Level 1	71	* Plastic Level 1
32	Seed Coat Fragments Level 2	72	* Plastic Level 2

* Unlike plant-based extraneous matter such as bark, grass or seed coat fragments, plastic extraneous matter is generally not uniformly distributed throughout a plastic-contaminated bale. Therefore, a sample from a plastic-contaminated bale submitted for classification may or may not have plastic extraneous matter present.

For 2018 loan value purposes, FSA will treat plastic as "Other" (codes 61 and 62). Discounts for plastic are severe. The loan value discount for level 1 is 460 points, or 4.6 cents/lb – about $23 per bale. The cash/spot market discount for a level 1 is currently mostly 375 to 550 points or, again, roughly $23 per bale.

Prior to this year, any bale sample found to contain plastic was coded as "Other" – a 61 or 62 (see the table above). "Other" could also be anything else not otherwise in the above table. But, now that plastic

will have its own code, such a bale may be discounted even more severely. Further, such a bale could be rejected from the market place entirely.

The severity of the plastics problem is not understated. Therefore, an issue for the industry is this – it appears that classing data does not reflect what we feel is the true severity of the problem. If bale sampling and classing were detecting any plastic to a great extent, classing data would show it. If classing doesn't detect the problem (if there's plastic in the bale), then coming up with new classing codes wouldn't necessarily be a solution except to say that if plastic is detected, it will now be coded and better known as such.

Let's look back three years at both Texas and Georgia classing data as examples. Prior to 2018, if plastic was found in the sample, it was coded as a 61 or 62 and included in the "Other" category. In 2015, 2016, and 2017, if I take the total bales classed that contained extraneous matter of any sort and then subtracted everything but the "Other" category, then by definition the number of remaining samples classed must be the ones with any other type of contamination – plastic plus anything else not accounted for.

Estimated Crop Classed, Found With Plastics and Other Extraneous Matter[1]

	Texas			Georgia	
	% Crop	# Samples		% Crop	# Samples
2015	*	127		*	2
2016	*	284		0.22	4,700
2017	*	1,736		*	266

* less than .05 percent or not reported to avoid disclosure of an individual gin.

1/ Total bales with any type extraneous matter, minus bark, grass, prep, seed coat fragments, oil, and spindle twist. Thus the remainder shown here would be anything else including plastic.

SOURCE: USDA-AMS, Cotton and Tobacco Program, *Annual Quality* report, Table 21.

The numbers in this table would then be the maximum possible number of bales that, when sampled, were found to contain plastic. I am told that in some years, samples actually containing plastic were considerably less than this.

For Texas, 2017 was the Hurricane Harvey year and a big jump in 61's and 62's, but still less than .05%. In Georgia for 2016, 4,700 running bales or .22% classed 61 or 62, but it's believed most of this number was actually due to whitefly damage.

Unlike plant-based extraneous matter, plastic is generally not uniformly distributed in the bale. There may be plastic in the bale, but not in the sample. The plastic may not be realized until that bale gets run in the mill. THIS is the problem. If bales with plastic keep showing up, the mill may avoid that gin or origin all together.

Since classing may not necessarily catch the problem even with the new coding, the only real solution is that producers and gins must be vigilant to adopt practices to keep plastic out.