

COTTON DEFOLIATION / HARVEST AID OPTIONS

Camp Hand and Stanley Culpepper, Extension Agronomy and Weed Science

COTTON

The following are basic guidelines for harvest aid application. Rates indicated are amount per acre. Specific rates should be adjusted according to temperature, humidity, day-length, plant leaf condition and maturity, expected weather, and desired effects such as defoliation, regrowth control, boll opening, and/or weed control. Defoliant should be applied in a minimum spray volume of 5 gal/A by air and 10–20 gal/A by ground.

Reduced performance issues are often related to low spray volume and poor canopy penetration. Fields should fit into one of the following categories based on temperature and harvest aid function. Preparing cotton for harvest is often difficult and is influenced by many factors, therefore the guidelines below should be considered as basic recommendations. Always observe label restrictions before using cotton harvest aids.

HARVEST-AID FUNCTION	HERBICIDE	BROADCAST RATE/ACRE (The rates below are given in the broadcast amount per acre unless otherwise noted)			REMARKS AND PRECAUTIONS
		EARLY-SEASON (highs 90°F plus, lows 70°F plus)	MID-SEASON (highs 80–89°F, lows 60–70°F)	LATE-SEASON* (highs below 80°F, lows below 60°F)	
Defoliation Only (combinations provide more consistent defoliation than a single product)	<i>carfentrazone ethyl</i> Aim 2.0EC	0.75–1 fl oz	0.75–1 fl oz	1 fl oz	Add non-ionic surfactant at 0.25% v/v during early-season and with 1 oz/A rate; add COC for 0.75 oz rate mid-season. The potential for leaf sticking is greater during periods of high temperatures.
	<i>carfentrazone ethyl</i> + <i>fluthiacet-methyl</i> Display 2.05EC	Up to 1 fl oz	Up to 1 fl oz	Up to 1 fl oz	Limited data, adhere to label restrictions, use precaution.
	<i>flumiclorac</i> Resource 0.86EC	4–6 fl oz	4–6 fl oz	4–6 fl oz	Add crop oil at 1–2 pt/A. Limited data, use precaution. The potential for leaf sticking is greater during periods of high temperatures. Label allows rate up to 8 fl oz.
	<i>fluthiacet-methyl</i> Blizzard 0.91EC	0.5–0.6 fl oz	0.5–0.6 fl oz	0.5–0.6 fl oz	Add crop oil at 1 pt/A. Limited data, use precaution.
	<i>pyraflufen ethyl</i> ET 0.208EC	1.5 fl oz	1.5 fl oz	1.5 fl oz	Add crop oil at 0.5% v/v early-season and increase rate to 1% in cooler conditions. The potential for leaf sticking is greater during periods of high temperatures. Label allows rate up to 2.75 oz/A.
	<i>sodium chlorate</i> Defol 5SL, others	3 lb ai	4 lb ai	4 lb ai	Apply to mature foliage only. Do not mix with products containing <i>tribufos</i> or <i>ethephon</i> . Label allows a maximum use rate of 6 lb ai.
	<i>tribufos</i> Folex 6EC, others	1–1.5 pt	1–1.5 pt	X	Reduce rate to 1.25 pt if above 94°F.
	<i>thidazuron</i> + <i>diuron</i> Ginstar 1.5EC, others	X	X	8–10 oz	Limited data are available.
	<i>tribufos</i> Folex 6EC + <i>paraquat</i> Gramoxone 3S, others	X	X	1.5 pt + 2–8 oz	May cause crop desiccation and damage to unopened bolls.

*Late-season defoliations may require a preconditioning treatment to be successful (see preconditioning section).

X = denotes product not suggested during those environmental conditions.

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		EARLY-SEASON (highs 90°F plus, lows 70°F plus)	MID-SEASON (highs 80–89°F, lows 60–70°F)	
Regrowth control and defoliation	<i>thidiazuron</i> Dropp 4SC, others	3.2 fl oz	3.2 fl oz	For maximum regrowth control. <i>Thidiazuron</i> is sensitive to wash-off when rain occurs within 24 hours and may be vulnerable through 12 hours after application. Addition of <i>tribufos</i> (4–8 oz) or <i>ammonium sulfate</i> (2 lb/A) enhances rain fastness.
	<i>thidiazuron</i> + <i>diuron</i> Ginstar 1.5EC, others	6.4–8 fl oz	6.4–8 fl oz	Limited data are available on these products. Regrowth control is minimal when these products are applied at rates below 6.4 fl oz.
	<i>thidiazuron</i> Dropp 4SC, others + ONE OF THE FOLLOWING:	1.6–2.5 fl oz +	2–2.5 fl oz +	Label allows rate to be increased to 3.2 fl oz.
	<i>carfentrazone ethyl</i> Aim 2.0EC	0.75 fl oz	0.75–1 fl oz	Add non-ionic surfactant at 0.25% v/v during early-season and with 1 oz/A rate; add COC for 0.75 oz rate mid-season. The potential for leaf sticking is greater during periods of high temperatures.
	<i>tribufos</i> Folex 6EC, others	4–16 fl oz	1 pt	These combinations may cause “leaf sticking” when temperatures exceed 94°F, when combined with spray adjuvants, or when calibration errors occur. Consider reducing higher rates of <i>tribufos</i> by 10–20% when temperatures exceed 94°F. Maximum use rate when mixed with Dropp is 24 fl oz/A.
	<i>carfentrazone ethyl</i> + <i>fluthiacet-methyl</i> Display 2.05EC	up to 1 fl oz	up to 1 fl oz	Limited data, adhere to label restrictions, use precaution.
	<i>flumiclorac</i> Resource 0.86EC	4–6 fl oz	4–6 fl oz	Add crop oil at 1 pt/A during early-season and 1–2 pt/A during mid-season. Limited data, use precaution. Label allows rate up to 8 fl oz.
	<i>fluthiacet-methyl</i> Blizzard 0.91EC	0.5–0.6 fl oz	0.5–0.6 fl oz	Add crop oil at 1 pt/A. Limited data, use precaution. The potential for leaf sticking is greater during periods of high temperatures.
	<i>pyraflufen ethyl</i> ET 0.208EC	1.5 fl oz	1.5 fl oz	Add 0.5% v/v crop oil during early-season and 1% during mid-season. Label allows rate up to 2.75 fl oz.

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		EARLY-SEASON (highs 90°F plus, lows 70°F plus)	MID-SEASON (highs 80–89°F, lows 60–70°F)	LATE-SEASON* (highs below 80°F, lows below 60°F)	
Boll Opening and Defoliation	<i>ethephon</i> Prep 6SC, others	2–2.67 pt	2–2.67 pt	2–2.67 pt	
	<i>ethephon</i> Prep 6SC, others + ONE OF THE FOLLOWING:	1.33–1.5 pt +	1.5–2 pt +	2–2.67 pt +	
	<i>Carfentrazone ethyl</i> Aim 2.0EC	0.75 fl oz	0.75–1 fl oz	1 fl oz	Add 0.25% v/v non-ionic surfactant at the 0.75 oz rate when conditions are warm/hot. Use crop oil 1% v/v when cooler.
	<i>carfentrazone ethyl</i> + <i>fluthiacet-methyl</i> Display 2.05EC	up to 1 fl oz	up to 1 fl oz	up to 1 fl oz	Limited data, adhere to label restrictions, use precaution.
	<i>flumiclorac</i> Resource 0.86EC	4–6 fl oz	4–6 fl oz	4–6 fl oz	Add 1–2 pt/A crop oil. Limited data, use precaution. Label allows rate up to 8 fl oz.
	<i>fluthiacet-methyl</i> Blizzard 0.91EC	0.5–0.6 fl oz	0.5–0.6 fl oz	0.5–0.6 fl oz	Add 1 pt/A crop oil. Limited data, use precaution.
	<i>pyraflufen ethyl</i> ET 0.208EC	1.5 fl oz	1.5 fl oz	1.5 fl oz	Add 0.5% v/v crop oil during early season and 1% during mid- and late-season. Label allows rate up to 2.75 fl oz.
	<i>tribufos</i> Folex 6EC, others	1–1.25 pt	1–1.25 pt	1–1.25 pt	
	<i>thidiazuron</i> Dropp 4SC, others	1.6 fl oz	1.6 fl oz	X	Label allows rate to be increased to 3.2 fl oz/A
	<i>thidiazuron</i> + <i>diuron</i> Ginstar 1.5EC, others	4–6 oz	6.4 fl oz	6.4 fl oz	Likelihood of “leaf sticking” is increased when applied at or above 5 oz in combinations of defoliant during early season conditions; rate of 4 oz suggested during periods of high temperatures.

*Late-season defoliations may require a preconditioning treatment to be successful (see preconditioning section).

X = denotes product not suggested during those environmental conditions.

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		EARLY-SEASON (highs 90°F plus, lows 70°F plus)	MID-SEASON (highs 80–89°F, lows 60–70°F)	LATE-SEASON* (highs below 80°F, lows below 60°F)	
Boll Opening and Defoliation (continued)	<i>ethephon</i> + <i>urea sulfate</i> FirstPick 2.28SC + ONE OF THE FOLLOWING:	1.75–2 qt	2 qt	X	Likelihood of leaf sticking is increased during periods of high temperatures.
	<i>carfentrazone ethyl</i> Aim 2.0EC	0.75 fl oz	0.75–1 fl oz	X	
	<i>carfentrazone ethyl</i> + <i>fluthiacet-methyl</i> Display 2.05EC	up to 1 fl oz	up to 1 fl oz	X	Limited data, adhere to label restrictions, use precaution.
	<i>flumiclorac</i> Resource 0.86EC	4–6 fl oz	4–6 fl oz	X	Add 1–2 pt/A crop oil. Limited data, use precaution. Label allows rate up to 8 fl oz.
	<i>fluthiacet-methyl</i> Blizzard 0.91EC	0.5–0.6 fl oz	0.5–0.6 fl oz	X	Add 1 pt/A crop oil. Limited data, use precaution.
	<i>pyraflufen ethyl</i> ET 0.208EC	1.5 fl oz	1.5 fl oz	X	Add 0.5% v/v crop oil during early season and 1% during mid- and late-season. Label allows rate up to 2.75 fl oz.
	<i>tribufos</i> Folex 6EC, others	4–6 fl oz	6–8 fl oz	X	FirstPick label allows one to increase Folex rate up to 12 oz/A but be careful to avoid leaf sticking.
	<i>thidiazuron</i> Dropp 4SC, others	1.6 fl oz	1.6 fl oz	X	Label allows rate to be increased up to 3.2 fl oz/A.
	<i>thidiazuron</i> + <i>diuron</i> Ginstar 1.5EC, others	4–6 fl oz	5–6 fl oz	X	Likelihood of “leaf sticking” is increased when applied at or above 5 oz in combinations of defoliant during early season conditions; rate of 4 oz suggested during periods of high temperatures.

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		EARLY-SEASON (highs 90°F plus, lows 70°F plus)	MID-SEASON (highs 80–89°F, lows 60–70°F)	LATE-SEASON* (highs below 80°F, lows below 60°F)	
Boll Opening and Defoliation (continued)	<i>ethephon</i> + <i>cyclanilide</i> Finish 6 PRO + ONE OF THE FOLLOWING:	1.33–1.5 pt	1.33–1.5 pt	1.75–2 pt	
	<i>carfentrazone ethyl</i> Aim 2.0EC	0.75 fl oz	0.75–1 fl oz	1 fl oz	Add 0.25% v/v non-ionic surfactant at the 0.75 oz rate when conditions are warm/hot. Use crop oil 1% v/v when cooler.
	<i>carfentrazone ethyl</i> + <i>fluthiacet-methyl</i> Display 2.05EC	up to 1 fl oz	up to 1 fl oz	up to 1 fl oz	Limited data, adhere to label restrictions, use precaution.
	<i>flumiclorac</i> Resource 0.86EC	4–6 fl oz	4–6 fl oz	4–6 fl oz	Add 1–2 pt/A crop oil. Limited data, use precaution. Label allows rate up to 8 fl oz.
	<i>fluthiacet-methyl</i> Blizzard 0.91EC	0.5–0.6 fl oz	0.5–0.6 fl oz	0.5–0.6 fl oz	Add 1 pt/A crop oil. Limited data, use precaution.
	<i>pyraflufen ethyl</i> ET 0.208EC	1.5 fl oz	1.5 fl oz	1.5 fl oz	Add 0.5% v/v crop oil during early season and 1% during mid- and late-season. Label allows rate up to 2.75 fl oz.
	<i>tribufos</i> Folex 6EC, others	4–6 fl oz	6–8 fl oz	8–12 fl oz	
	<i>thidiazuron</i> Dropp 4SC, others	1.6 fl oz	1.6 fl oz	X	
	<i>thidiazuron</i> + <i>diuron</i> Ginstar 1.5EC, others	4–6 fl oz	5 fl oz	6 fl oz	Likelihood of “leaf sticking” is increased when applied at or above 5 oz in combinations of defoliant during early season conditions; rate of 4 oz suggested during periods of high temperatures.

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X = denotes product not suggested during those environmental conditions.

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		EARLY-SEASON (highs 90°F plus, lows 70°F plus)	MID-SEASON (highs 80–89°F, lows 60–70°F)	
Boll Opening, Regrowth Control, and Defoliation	<i>ethephon</i> Prep 6SC, others + ONE OF THE FOLLOWING:	1.33–1.5 pt +	1.5–2 pt +	Limited data are available for some products. <i>Thidiazuron</i> rate may be increased to 3.2 fl oz. Regrowth control is minimal when <i>thidiazuron</i> + <i>diuron</i> is applied at rates below 6.4 fl oz.
	<i>thidiazuron</i> Dropp 4SC, others	2–2.5 fl oz	2–2.5 fl oz	
	<i>thidiazuron</i> + <i>diuron</i> Ginstar 1.5EC, others	6.4 fl oz	6.4–8 fl oz	
	<i>ethephon</i> Prep 6SC, others + <i>thidiazuron</i> Dropp 4SC, others + ONE OF THE FOLLOWING:	1.33–1.5 pt + 2–2.5 fl oz +	1.5–2 pt + 2–2.5 fl oz +	<i>Thidiazuron</i> rate may be increased to 3.2 fl oz
	<i>carfentrazone ethyl</i> Aim 2.0EC	0.75 fl oz	0.75–1 fl oz	Add non-ionic surfactant at 0.25% v/v during early-season and with 1 oz/A rate; add COC for 0.75 oz rate mid-season. The potential for leaf sticking is greater during periods of high temperatures.
	<i>tribufos</i> Folex 6EC, others	6–12 fl oz	8–12 fl oz	
	<i>carfentrazone ethyl</i> + <i>fluthiacet-methyl</i> Display 2.05EC	up to 1 fl oz	up to 1 fl oz	Limited data, adhere to label restrictions, use precaution.
	<i>flumiclorac</i> Resource 0.86EC	4 fl oz	4 fl oz	Add crop oil at 1–2 pt/A; lower rate under hot conditions. Limited data, use precaution. Label allows rate up to 8 fl oz.
	<i>fluthiacet-methyl</i> Blizzard 0.91EC	0.5–0.6 fl oz	0.5–0.6 fl oz	Add crop oil at 1 pt/A. Limited data, use precaution.
<i>pyraflufen ethyl</i> ET 0.208EC	1.5 fl oz	1.5 fl oz	Add 0.5% v/v crop oil during early-season and 1% during mid-season. Label allows rate up to 2.75 fl oz.	

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HARVEST-AID FUNCTION	HERBICIDE	BROADCAST RATE/ACRE (The rates below are given in the broadcast amount per acre unless otherwise noted)		REMARKS AND PRECAUTIONS
		EARLY-SEASON (highs 90°F plus, lows 70°F plus)	MID-SEASON (highs 80–89°F, lows 60–70°F)	
Boll Opening, Regrowth Control, and Defoliation (continued)	<i>ethephon + urea sulfate</i> FirstPick 2.28SC OR <i>ethephon + cyclanilide</i> Finish 6 PRO +	1.75–2 qt OR 0.33–1.5 pt +	2 qt OR 1.5–2 pt +	Likelihood of “leaf sticking” is increased when temperatures exceed 94°F.
	ONE OF THE FOLLOWING: <i>thidiazuron</i> Dropp 4SC, others	1.6–2 fl oz	2–2.5 fl oz	
	<i>thidiazuron + diuron</i> Ginstar 1.5EC, others	6.4 fl oz	6.4–8 fl oz	Limited data are available with some of these products. Regrowth control is minimal when these products are applied at rates below 6.4 oz.

PRECONDITIONING

Fields with a dense canopy of foliage and significant numbers of green bolls may require two applications. The goal is to remove much of the foliage with an initial application, exposing un-open bolls to sunlight and improving air circulation within the canopy. The follow-up application should be made 7–10 days later when sufficient leaf drop has occurred to allow spray coverage with boll opening products containing ethephon. However, premature preconditioning or defoliation may increase the risk of halting development of younger or immature bolls, rendering them unharvestable.

TREATMENT	HERBICIDE	BROADCAST RATE/ACRE	REMARKS AND PRECAUTIONS (The rates below are given in the broadcast amount per acre unless otherwise noted)
Initial Preconditioning Treatment	<i>carfentrazone-ethyl</i> Aim 2.0EC	1 fl oz	Add 1% v/v crop oil.
	<i>carfentrazone-ethyl + fluthiacet-methyl</i> Display 2.05EC	up to 1 fl oz	Limited data, adhere to label restrictions, use precaution.
	<i>ethephon</i> Prep 6SC, others	0.67–1.33 pt	
	<i>flumiclorac</i> Resource 0.86EC	4 fl oz	Add 1–2 pt crop oil. Label allows rate up to 8 fl oz.
	<i>fluthiacet-methyl</i> Blizzard 0.91EC	0.5–0.6 fl oz	Add 1 pt crop oil.
	<i>pyraflufen ethyl</i> ET 0.208EC	0.3–0.75 fl 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.
	<i>tribufos</i> Def/Folex 6EC	0.5–1.25 pt	
Follow-up Treatments	Should include products containing ethephon with harvest aid mixtures listed in the previous table.		

HARVEST AID WEED MANAGEMENT

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HERBICIDE	BROADCAST RATE/ ACRE	REMARKS AND PRECAUTIONS (The rates below are given in the broadcast amount per acre unless otherwise noted.)
<i>carfentrazone-ethyl</i> Aim 2.0EC	1 fl oz	Add 1% v/v crop oil. Effective on morningglory, coffee senna, and tropical spiderwort.
<i>carfentrazone-ethyl + fluthiacet-methyl</i> Display 2.05EC	up to 1 fl oz	Limited data, adhere to label restrictions, use precaution.
<i>glyphosate</i> Roundup Powermax 3 5.88S, others	up to 2.5 pts	Use in combination with defoliant.
<i>paraquat</i> Gramoxone 3S, others Gramoxone Inteon 2S	1–4 fl oz 3–5 fl oz	Use in combinations with standard defoliation applications. May cause crop desiccation and damage to unopened bolls.
<i>pyraflufen ethyl</i> ET 0.208EC	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. Label allows rate to be increased to 2.75 fl oz/A.
Follow-up Treatments Desiccants <i>paraquat</i> or <i>sodium chlorate</i>	See Desiccants for Cotton Harvest Preparation (below).	

DESICCANTS FOR COTTON HARVEST PREPARATION

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DESICCANT	FORMULATION (lb ai/gal)	BROADCAST RATE/ ACRE (amount of formulation)	SPRAY VOLUME (gal/A)		REMARKS AND PRECAUTIONS (The rates below are given in the broadcast amount per acre unless otherwise noted.)
			GROUND	AIR	
<i>paraquat</i>					For addition to defoliant mixtures in cotton at least 85% open. Improves activity in colder, late-season conditions. May cause crop desiccation and damage to unopened bolls.
Firestorm	3	5.4 fl oz	10–20	5	
Gramoxone Inteon	2	3–5 fl oz	10–20	5	
Gramoxone Max	3	1–4 fl oz	10–20	5	
Parazone	3	5.4 fl oz	10–20	5	
<i>paraquat</i>					For desiccation of weeds and cotton regrowth after defoliation. Add surfactant at 1–2 qt/100 gal of spray solution. Be prepared to harvest in a timely manner (3 to 5 days ideally) to minimize bark problems. May cause crop desiccation and damage to unopened bolls.
Gramoxone Max	3	5.5 oz–1.5 pt	10–20	5	
Firestorm	3	0.7–1.3 pts	10–20	5	
Parazone	3	0.7–1.3 pts	10–20	5	
Gramoxone Inteon	2	1–2 pt	10–20	5	
<i>sodium chlorate</i>	4–6	3–6 lb ai	10–20	5–10	

PERFORMANCE RATING OF HARVEST AIDS BY FUNCTION

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CHEMICAL NAME	FUNCTION				
	REMOVAL OF MATURE FOLIAGE	REMOVAL OF JUVENILE FOLIAGE	BOLL OPENING	REGROWTH SUPPRESSION	WEED DESICCATION
<i>ethephon</i> (Numerous brands)	F–G	F	E	P	P
<i>ethephon + urea sulfate</i> First Pick	G	G	E+	P	F
<i>ethephon + cyclanilide</i> Finish 6 Pro	G–E	F–G	E+	F	P
<i>paraquat</i> Gramoxone Max, Gramoxone Inteon, Parazone, Firestorm	F	F	P–F	P	G
<i>PPO inhibitors</i> Aim, ET, Resource, Blizzard	G	F	P	P	F
<i>sodium chlorate</i>	F	P	P	P	F–G
<i>thidiazuron</i> (Numerous brands)	G–E	G	P	G–E	P
<i>thidiazuron + diuron</i> (Numerous brands)	G–E	G	P	G–E	P
<i>tribufos</i> Def/Folex	G–E	P–F	P	P	P

P—Poor, F—Fair, G—Good, E—Excellent

UGA “THREE-WAY” DEFOLIATION MIXTURE RECOMMENDATIONS BY TEMPERATURE

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SEASON (TEMPERATURES)	ETHEPHON (PREP 6SC)	THIDIAZURON (DROPP 4SC)	TRIBUFOS (FOLEX 6EC)
	BROADCAST RATE/ACRE		
Early Season (highs >90° F, lows >70° F)	21–24 fl oz	1.6–3.2 fl oz	6–12 fl oz
Mid-Season (highs 80–89° F, lows 60–70° F)	24–32 fl oz	2–2.3 fl oz	8–12 fl oz
Late-Season (highs <80° F, lows <60° F)	32–42 fl oz	X	16–20 fl oz

Ethephon—Higher rates necessary with cooler temperatures to increase boll opening.

Thidiazuron—Increase rates for greater regrowth potential, less activity when lows are less than 65°F for 3 days.

Tribufos—Higher rates necessary for cooler temperatures, however too high can desiccate.

X = denotes product not suggested during these environmental conditions.