

## Cotton Growth Regulators

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**Table 6.1 - Plant Growth Regulation**

Objective	Chemical rate per acre	Product per acre	Remarks and Precautions
Plant growth regulation	Mepiquat chloride 0.35 lb or Mepiquat chloride + <i>Bacillus Cereus</i> or Kinetin 0.35 lb or Mepiquat pentaborate 0.82 lb	Pix, Mepex, 4.0-8.0 oz or Pix Plus, Mepex Ginout 4.0-8.0 oz or Pentia 4.0-8.0 oz	Although plant growth regulator applications can be an important part of an overall cotton management program, they can result in reduced yields if applied while plants are undergoing stressful (especially moisture) conditions. Before applying plant growth regulators, variety, soil type, fertility, irrigation potential, and field history must be taken into consideration.

**Note:** Maximum of 48 oz of Mepiquat chloride may be applied/A/growing season.

### Timing Suggestions – the Modified Early Bloom Technique

The modified early bloom strategy involves the use of height to node ratios and the measurement of the most recently expanded internode length. The most recently expanded internode is measured by counting down the plant from the highest mainstem leaf (> quarter size) to the fourth leaf. Examine the internode above and below the fourth leaf and measure the larger of the two. This is a good indicator of the plant vigor over that past week or so. Long internodes will range between 2.5 to 3 inches while short internodes will be below 2.0 inches. The tables below are provided to aid in determining Pix application decisions using the modified early bloom strategy.

**Table 6.2 - 10 to 14 Days after First Square**

	Plant height		
	< 17 in	17 - 20 in	> 20 in
Height to node ratio > 1.85 in	4 oz	6 oz	8 oz
Internode <sup>1</sup> > 2.5 in	4 oz	6 oz	8 oz

Do not apply if soil moisture is poor.

<sup>1</sup>Most recently expanded internode (see measurement description above).

**Table 6.3 - Early Bloom – Use this Chart if Prior Pix Has Been Applied**

	Plant height			
	< 24 in	24 - 27 in	27 - 30 in	> 30 in
Internode <sup>1</sup> > 2.5 in	6 oz	6 oz	9 oz	12 oz

Do not apply if soil moisture is poor.

Do not apply if nodes above the highest first position white bloom < 7.

<sup>1</sup>Most recently expanded internode (see measurement description above).

## 6-2 Plant Regulators: Cotton Growth Regulators

**Table 6.4 - Early Bloom – Use this Chart if No Prior Pix Has Been Applied**

	Plant height			
	< 24 in	24 - 27 in	27 - 30 in	> 30 in
Internode <sup>1</sup> > 2.5 in	8 oz	8 oz	12 oz	16 oz

Do not apply if soil moisture is poor.

Do not apply if nodes above the highest first position white bloom < 7.

<sup>1</sup>Most recently expanded internode (see measurement description above).

**Table 6.5 - 10 to 14 Days after Early Bloom**

	Pix applied at early bloom	
	> 8 oz	0 - 8 oz
Internode <sup>1</sup> > 2.5 in	0 oz	0 oz
Internode 2.5 - 3.5 in	8 oz	12 oz
Internode > 3.5 in	12 oz	16 oz

Do not apply if soil moisture is poor.

Do not apply if nodes above the highest first position white bloom < 5.5.

<sup>1</sup>Most recently expanded internode (see measurement description above).

## Cotton Harvest Aids

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**Table 6.6 - Cotton Harvest Aids**

Defoliation Only, Field Cutout	Defoliation with Regrowth Anticipated	Defoliation and Boll Opening	Defoliation and Boll Opening with Regrowth Anticipated	Temperatures		
				<sup>1</sup> Low $\geq 70^\circ$ High $\geq 85^\circ$	<sup>2</sup> Low $60^\circ$ - $70^\circ$ High $75^\circ$ - $85^\circ$	<sup>3</sup> Low $<60^\circ$ High $<75^\circ$
				Rate per Acre		
Def 6/Folex 6EC				1.5 pt	1.5-2.0 pt	2.0-3.0 pt
Harvade 5F + COC <sup>4</sup>				0.5 pt +1.0 pt	0.5 pt +1.0 pt	0.5 pt +1.0 pt
Finish 6SC				1.33 pt	2.0 pt	2.67 pt
FirstPick				2.0 qt	2.0 qt	3.0 qt
	thidiazuron 50WP <sup>5</sup>			0.125-0.2 lb	0.15-0.2 lb	—
	Def 6/Folex 6EC + thidiazuron 50WP <sup>5</sup>			1.0 pt -1.5 pt + 0.1-0.15 lb	1.0 pt -1.5 pt + 0.1-0.15 lb	2.0 pt + 0.1-0.15 lb
	Harvade 5F + COC <sup>4</sup> + thidiazuron 50WP <sup>5</sup>			0.5 pt +1.0 pt + 0.1lb	0.5 pt +1.0 pt + 0.1-0.15 lb	0.5 pt +1.0 pt + 0.1-0.15 lb
	Finish 6SC + thidiazuron 50WP <sup>5</sup>			1.33 pt + 0.1lb	2.0 pt + 0.1lb	2.67 pt + 0.1-0.15 lb
	FirstPick + thidiazuron 50WP <sup>5</sup>			2.0 qt + 0.1lb	2.0 qt + 0.1lb	3.0 qt + 0.1-0.15 lb
	Def 6/Folex 6EC + ethephon 6EC <sup>6</sup>			1.33 pt -1.5 pt + 1.33 pt	1.5 pt -2.0 pt + 1.5 pt	1.5 pt -2.0 pt + 1.5-2.0 pt
	Harvade 5F + COC <sup>4</sup> + Def 6/Folex 6EC + ethephon 6EC <sup>6</sup>			0.5 pt +1.0 pt + 4.0 oz + 1.33 pt	0.5 pt +1.0 pt + 6.0 oz + 1.5 pt	0.5 pt +1.0 pt + 8.0 oz + 2.0 pt
	Harvade 5F + COC <sup>4</sup> + ethephon 6EC <sup>6</sup>			0.5 pt +1.0 pt + 1.33 pt	0.5 pt +1.0 pt + 1.5 pt	0.5 pt +1.0 pt + 1.5-2.0 pt
	FirstPick			2.0 qt	2.0 qt	3.0 qt
	FirstPick + Def 6/Folex 6EC			2.0 qt + 8.0 oz (rank growth)	2.0 qt + 8.0 oz (rank growth)	3.0 qt + 8.0 oz (rank growth)
	thidiazuron 50WP <sup>5</sup> + ethephon 6EC <sup>6</sup>			0.1-0.15 lb + 1.33 pt	0.125-1.5 lb + 1.5 pt	— —
	Finish 6SC			1.33 pt	2.0 pt	2.67 pt
	Finish 6SC + Def 6/Folex 6EC			1.33 pt + 8.0 oz (rank growth)	2.0 pt + 8.0 oz (rank growth)	2.67 pt + 8.0 oz (rank growth)
	Def 6/Folex 6EC + thidiazuron 50WP <sup>5</sup> + ethephon 6EC <sup>6</sup>			4.0-8.0 oz + 0.1-0.125 lb + 1.33 pt	4.0-8.0 oz + 0.125-0.15 lb + 1.5 pt	4.0-8.0 oz + 0.15-0.2 lb + 1.5-2.0 pt
	thidiazuron 50WP <sup>5</sup> + ethephon 6EC <sup>6</sup>			0.1-0.15 lb + 1.33 pt	0.125-0.15 lb + 1.5 pt	— —
	FirstPick + thidiazuron 50WP <sup>5</sup>			2.0 qt + 0.1 lb	2.0 qt + 0.1 lb	3.0 qt + 0.1-0.15 lb
	Finish 6SC + thidiazuron 50WP <sup>5</sup>			1.33 pt + 0.1lb	2.0 pt + 0.1lb	2.67 pt + 0.1-0.15 lb
	Harvade 5F + COC <sup>4</sup> + thidiazuron 50WP <sup>5</sup> + ethephon 6EC <sup>6</sup>			0.5 pt +1.0 pt + 0.1 lb + 1.33 pt	0.5 pt +1.0 pt + 0.1-0.15 lb + 1.5 pt	0.5 pt +1.0 pt + 0.1-0.15 lb + 2.0 pt

<sup>1,2,3</sup>See following page.

<sup>4</sup>COC = crop oil concentrate.

<sup>5</sup>The active ingredient thidiazuron is available as the trade name Dropp 50WP and FreeFall 50WP.

<sup>6</sup>The active ingredient ethephon is available as 6EC formulations as a number of trade name products such as Prep, Ethephon, Super Boll, etc.

## 6-4 Plant Regulators: *Cotton Harvest Aids*

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### <sup>1</sup>Low $\geq 70^{\circ}\text{F}$ , High $\geq 85^{\circ}\text{F}$

- a. With drought-stressed cotton, regrowth is likely where boll load is low to moderate and late season rainfall occurs.
- b. Regrowth suppression with thidiazuron (Dropp 50WP/FreeFall 50WP) increases with increasing rates. The activity of Dropp 50WP/FreeFall 50 WP is temperature sensitive and declines as temperature declines.
- c. With drought stress and high temperatures ( $\geq 85^{\circ}\text{F}$ ), three way mixes and high rates of Def 6/Folex 6EC and Harvade have a tendency to rapidly desiccate and “stick” cotton leaves.
- d. Ethephon rates may be increased to 2.0 pt/A to accelerate boll opening.

### <sup>2</sup>Low $60^{\circ}\text{--}70^{\circ}\text{F}$ , High $75^{\circ}\text{--}85^{\circ}\text{F}$

- a. With drought-stressed cotton, regrowth is likely where boll load is low to moderate and late season rainfall occurs.
- b. Regrowth suppression with thidiazuron (Dropp 50WP/FreeFall 50WP) increases with increasing rates. The activity of Dropp 50WP/FreeFall 50 WP is temperature sensitive and declines as temperature declines.
- c. Ethephon rates may be increased to 2.0 pt/A to accelerate boll opening.

### <sup>3</sup>Low $< 60^{\circ}\text{F}$ , High $< 75^{\circ}\text{F}$

- a. With cool conditions (highs  $< 75^{\circ}\text{F}$ , lows  $< 60^{\circ}\text{F}$ ), it is advisable to delay defoliation treatments until warmer conditions return. Harvest aid treatments are much less effective at cool temperatures.
- b. Use of thidiazuron (Dropp 50WP/FreeFall 50 WP) alone (without a tank-mix partner) when nighttime temperatures are expected to fall below  $60^{\circ}\text{F}$  can result in less than desirable defoliation and/or regrowth inhibition. The use of adjuvants such as petroleum-based crop oil or penetrating oils approved for use on growing crops has been shown to improve performance during low nighttime temperatures ( $60^{\circ}\text{--}65^{\circ}\text{F}$ ).

**Note:** For more detailed descriptions of situational defoliation, please refer to *Defoliating Cotton under Adverse Conditions: Drought-stress, Cool Temperatures, and Rank Growth*, VCE publication, 427-208.

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## **Defoliation Materials**

**Def 6, 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. The 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 pound per acre WP or 1.6 fl. ounces per 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 65°F 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 ounces per acre of Def or Folex will shorten the 24-hour required 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 ounces per acre and growers are cautioned not to exceed 8 ounces with this product until more information is available from Virginia. Growers are cautioned that rates in excess of 10 ounces have shown a tendency to desiccate leaves. The label does not allow mixing with 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 pint per acre of crop oil is required by the federal label and is needed for acceptable defoliation. Harvade needs a six-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 to 12 ounces per acre delivers the equivalent of 0.125 to 0.15 pounds. Dropp/Freefall and 6.4 to 7.7 ounces per acre Harvade. If morningglory desiccation is desired, additional Harvade can be added. Crop-oil concentrate at 0.5 to 1.0 pints per acre should be added to Leafless for acceptable activity.

**Aim, ET, Blizzard, and Resource:** These products have different active ingredients (carfentrazone, pyraflufen, fluthiacet, and flumiclorac, respectively) but similar modes of action. They are all contact herbicidal defoliants that do not appear to be extremely temperature sensitive. Research indicates they can cause excessive desiccation at high rates under warm condition where rank, juvenile growth is not present. They perform best in well-cutout cotton and can be beneficial when used as a second application. They provide regrowth control but have no residual activity and are good morningglory desiccants. These products can be mixed with most other defoliants/boll openers. See labels for adjuvant requirements and use restrictions.

**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 the 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.

## 6-6 Plant Regulators: *Cotton Harvest Aids*

**FirstPick:** FirstPick weighs 12.45 pounds per gallon and contains 2.28 pounds of ethephon (Prep) and 7.30 pounds of a synergist (AMADS). Like Finish, it is an excellent boll opener. Acceptable defoliation with FirstPick typically occurs within 7 days in well-cutout cotton containing mature leaves. FirstPick 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 defoliant 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.

### ***Boll-opening Materials***

Although some boll openers are used to enhance the activity of defoliant, they are typically 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 to 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, FirstPick, Finish (ethephon):** With adequate spray coverage, ethephon products expedite natural boll opening. While ethephon can enhance defoliation, tank mixing with defoliation products (Def, Folex, Dropp, Freefall, Ginstar, ET, Blizzard, and/or Aim) is necessary for acceptable defoliation and/or regrowth control. Allow at least 7 days 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. FirstPick 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 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 defoliant 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% open and the remaining 10% are 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.