

# **Section VII**

---

**New Mexico Pesticide Applicator Training  
Agricultural Pests and Agricultural Weeds**

## **Defoliant, Desiccants, and Growth Regulators**

---

**Written (1996) by  
Shane T. Ball**

**New Mexico State University Cooperative Extension Service**

---

# DEFOLIANTS, DESICCANTS, AND GROWTH REGULATORS

## TABLE OF CONTENTS

<b>I. Introduction</b> .....	1
<b>II. Defoliants</b> .....	1
A. What are they? .....	1
B. Which ones can we use? .....	2
C. Advantages and disadvantages .....	3
D. Other considerations .....	3
<b>III. Desiccants</b> .....	3
A. What are they? .....	3
B. Which ones can we use? .....	4
C. Advantages and disadvantages .....	4
D. Other considerations .....	5
<b>IV. Growth Regulators</b> .....	5
A. What are they? .....	5
B. Which ones can we use? .....	5
C. Advantages and disadvantages .....	6
D. Other considerations .....	6
<b>V. Conclusions</b> .....	6
A. Recent research efforts .....	6
B. Safe use and New Mexico law .....	7
<b>VI. Glossary</b> .....	8
<b>VII. References</b> .....	10

## I. Introduction

Defoliants, desiccants, and growth regulators that are used in agricultural production are known together as harvest-aid chemicals (Glover, 1988; Salisbury and Ross, 1978). These chemicals accelerate the preparation of the crops for mechanical harvest. Although at least 162 of these chemicals were labeled for agronomic crops in the United States in 1995, defoliants used in New Mexico are only commonly applied to cotton (American Society of Agronomy, 1984).

In the 1990s, 100 percent of the cotton crop in New Mexico has been mechanically harvested using spindle and strippen harvesters. Defoliants and desiccants are used to reduce and remove foliage from cotton prior to harvest (Cathey, 1986; Cathey and Thomas, 1986), while growth regulators are used for boll openers and to alter the vegetative and reproductive development of cotton. Additional reasons that producers have used these chemicals include

- Increase harvest efficiency,
- Erect lodged plants,
- Reduce trash and lint staining,
- Reduce cotton seed moisture and boll rot, and
- Lower insect population.

Thus, defoliants, desiccants, and growth regulators have an important role in harvest preparation of cotton grown in New Mexico (Western Regional Integrated Pest Management Project, 1984).

## II. Defoliants

### A. What are they?

Defoliants are chemicals or methods of treatment that cause only the leaves of a plant to fall off (abscise). Defoliants are applied to cotton in an attempt to improve mechanical harvest (Odom, 1991; Silvertooth, et. al., 1994). Currently, about 50 percent of the cotton grown in New Mexico is chemically defoliated each year. Sodium chlorates were among the first chemicals used as defoliants, and they are still extensively used in the cotton production areas (such as Helena 6#, Drexel Defol, and Tide Chlorate) of the Pecos and Mesilla valleys. Other highly effective defoliants include Def-6 and Folex (both organophosphorus compounds), as well as Harvest 5-F, Ginstar, and Quick Pick.

**B. Which ones can we use?**

Up-to-date information on defoliant selection, application, and proper use is given in Table 1.

**Table 1. Suggestions for defoliants in New Mexico.**

Common Name	Trade Name	Suggested Rate/Care	Dilution	
			Ground	Water/Acre (g) Air
Sodium chlorates (with fire suppressant)	Helena 6# (Sodium chlorate)	2-3 qt	15-30	4-10
	Drexel Defol	1-1.5 gal	15-20	5
	Drexel Defol-6	2-3 pt	15-20	5
	Tide Chlorate	1-1.5 gal	20-30	4-7
	Riverside Chlorate	1-1.5 gal	10-20	5-10
<b>Comments:</b> Apply 7 days prior to harvest. Do not add insecticides or the chemicals unless specified on label. Do not graze treated areas or feed gin trash to livestock.				
Sodium cacodylate	Quick Pick	2-3 pt	5-10	15-25
<b>Comments:</b> Add 1/3 to 2/3 pt of non-ionic surfactant. Apply 7-10 days prior to harvest.				
S, SS (tributyl)	Def-6	1.5-2 pt	10-20	5-12
<b>Comments:</b> Requires 5-7 days minimum for leaf drop; (10-14 days may be required). Apply specified rates to give thorough coverage.				
Tributyl Phospho-triitolite	Folex	1.5-2 pt	10-20	5-12
<b>Comments:</b> Higher rates may be necessary. Certain phosphate insecticides can be mixed with Def or Folex for late season boll weevil control.				
Dimethipin	Harvard 5-F	6-8 fl oz + Crop oil concentrate	10-20	5+
<b>Comments:</b> Use 8 fl oz/acre plus crop oil concentrate for first application; use 6 oz plus oil applied 5-7 days later. Avoid spray drift.				
Thidiazuron	Ginstar	0.4-1	10-25	2-10
<b>Comments:</b> Apply when top harvestable boll is mature. Apply at least 5 days prior to harvest. It may be necessary to apply a standard desiccant or application of Ginstar.				

### C. Advantages and Disadvantages

The advantages and disadvantages of using defoliant are listed below.

#### Advantages

- \* Increases picker efficiency by reducing foliage.
- \* Reduces seed moisture percentage.
- \* Reduces boll rotting.
- \* Reduces pink bollworm and bollweevil populations.

#### Disadvantages

- \* Yield loss from improper application.
- \* Reduces fiber quality (for example, fiber staining from regrowth).
- \* Multiple applications may be needed.
- \* Increases cost of production.

### D. Other Considerations

The major limitation of using chemical defoliant has been their inconsistent responses in the field. The effectiveness of a selected defoliate depends on:

- \* Timing and rate of application (more than 60% bolls open);
- \* Environmental conditions (such as weather during and after application);
- \* Absorption, degradation, and translocation;
- \* Plant uniformity, affective coverage; and
- \* Use of surfactant and tank mixes.

## III. Desiccants

### A. What are they?

Desiccants are chemicals that rapidly kill the leaves, but generally the leaves stay attached to the plants (Hartman et. al, 1988). All desiccants are essentially contact herbicides.

Desiccants cause rapid loss of water from the leaves (i.e., a drying agent) and are primarily used with stripper harvesters of cotton. In addition, applications of desiccants are used to kill regrowth (e.q., sodium chlorates and Quick Pick). Formulations of paraquat are the most widely used desiccants applied to cotton in New Mexico. Another desiccant used is endothall (Accelerate), which is generally tank mixed with paraquat. Also, high rates of defoliant (such as sodium chlorate formulations and Def-6) applied at high temperatures have been used for desiccation of cotton.

### B. Which ones can we use?

The labeled desiccants for New Mexico, their application rates, and proper use are given in Table 2.

**Table 2. Suggestions for desiccants in New Mexico.**

Common Name	Trade Name	Suggested Rate/Acre	Dilution Water/Acre (g)	
			Ground	Air
Paraquat	Gramoxone Extra	3-24 oz	Min. 10	Min. 10
	Cyclone	4 oz - 2 pt	10-30	3-10
<p><b>Comments:</b> Apply when more than 80% of bolls are mature. Use a nonionic surfactant at 8-32 fl oz/100 gal mix. Most effective in western areas of the state. Apply 7-10 days before harvest. Do not pasture livestock in treated fields within 15 days after spraying. Livestock should be removed from treated areas 30 days before slaughter. <b>Warning:</b> Paraquat is extremely hazardous when ingested. Avoid spray drift.</p>				
Endothal and Paraquat CL	Accelerate and Paraquat r CL	1-2 pt  0.5-2 pt	10-30	3-10
<p><b>Comments:</b> Apply more than 3 days before harvest. Use nonionic surfactant at 1 pt/gal mix. Recommended for stripper harvested cotton. Use high rates with green and/or considerable growth.</p>				

r Restricted-use pesticide (Adapted from Oklahoma State Univ., 1995).

### C. Advantages and disadvantages

The advantages and disadvantages of using desiccants are listed below.

#### Advantages

- \* Harvest date can be scheduled.
- \* Increases stripper harvester efficiency.
- \* Reduces seed moisture.
- \* Kills some late-season weeds.

#### Disadvantages

- \* Reduces quality and yield when improperly applied.
- \* Delayed harvest can result in stalk deterioration.
- \* Toxic residues can build up if tank mixed with 2,4-D.
- \* Increase production costs.

### D. Other considerations

The major limitation of using desiccants is improper timing of application. For example, if a desiccant is applied when 80% of the bolls are open (too early) significant yield reductions have been observed. Desiccants should be applied when about 95% of the bolls are open. Also, it should be noted that mixing paraquat and sodium chlorate has been found to be increase the amount of desiccation.

## IV. Growth Regulators

### A. What are they?

Growth regulators are natural or synthetic plant hormones that when applied to plants have been found to influence growth responses (Guinn, 1986). The natural growth regulators include auxin, abscisic acid, cytokinin, ethylene, and gibberellin. Applications of growth regulators have been used to induce germination, abscission, dormancy, stomatal closure, growth inhibition, and other plant responses (Oosterhuis et. al., 1995); Waibel, 1991). Specifically, the growth regulators commonly used in cotton in New Mexico are Pix and Prep (Glover, 1992). Pix is commonly used to increase boll retention and stimulate early maturity. Prep is used as a boll-opening chemical (the only synthetic ripening chemical used in the United States).

### B. Which ones do we use?

The labeled plant growth regulators for New Mexico, their application rates, and proper use are given in Table 3.

**Table 3. Suggestions for growth regulators in New Mexico**

Common Name	Trade Name	Suggested Rate/Acre	Dilution Water/Acre (g)	
			Ground	Air
Mepiquat -	Pix	0.13-0.5 pt	>10	>3
<p>Comments: Apply when plants are in early bloom stage and about 24 inches tall. Plant heights can range from 20-28 inches tall as long as the cotton less than 8 days past early bloom. Up to 4 low-rate applications is optional, allowing discontinuing the applications if stresses occur.</p> <p>Pix should not be applied if plants are under severe stress (from weather factors; mite, insect or nematode damage; diseases; and/or herbicide injury). If drought stress occurs when Pix is applied, or after a full rate (0.5 to 1 pt) is applied, results won't be optimal.</p>				
Ethephon	Prep (6 lb AI Per gal)	For boll opening	15-50 gal	2-5
		for pre-	15-50 gal	2-5

conditioning  
 .7 - 1.4 pt

15-50 gal      2-5

**Comments:** Apply when 50-60% or more bolls are open. To prepare crop for defoliation, treat with Prep 4-14 (+) days before defoliation treatment. Prep can be mixed with Def, Fofex, Dropp, Harvade, Methyl Parathion, Guthion and Malathion. Some premature drop of immature bolls may be associated with application. Do not apply Prep if rain is expected in the next 8 hours. Temperatures 65°F or lower after treatment will delay boll opening.

† Restricted-use pesticide.

### C. Advantages and disadvantages

The advantages and disadvantages of using growth regulators are listed below.

#### Advantages

- \* Earlier harvest dates.
- \* Increases once-over harvesting.
- \* Improves defoliation and reduces trash.
- \* Reduces pink bollworm populations.

#### Disadvantages

- \* Erratic crop responses.
- \* Yield reduction when Pix is applied under stress conditions.
- \* Rate and timing interactions (for example, sensitivity to low temperatures).
- \* Increased production costs.

### D. Other considerations

The major limitation of using growth regulators is their inconsistent response in field applications. The degree of success depends on the concentration, timing, and environmental conditions at time of application.

## V. Conclusions

### A. Recent research efforts

Defoliation research on Pima and Upland cotton continues to evaluate the effectiveness of using different defoliates (such as sodium chlorate, Ginstar, Starfire, Dropp, Def, and their combinations). Generally, no significant differences in yield were found between the untreated checks and defoliation treatments (Nelson et al., 1994). These results show that the effectiveness of defoliate applications varies between years, location, and even within fields.



Growth regulator research on Pima and Upland cotton continues to determine optimal application guidelines (with more than 20 years of research to date) and new products (such as PGRIV, Glyphosate, and Atomik). Although additional research is needed, the use of current and new growth regulators may be useful for controlling growth (Clark and Carpenter, 1994; Locke et.al., 1995). However, results so far have yet to show consistent and significant increases in cotton yields.

#### **B. Safe use and New Mexico law**

The suggested uses of defoliant, desiccant, and growth regulators in New Mexico are based on the manufacturer's label (Clean Crop, 1995; Crop Protection Reference, 1995; Riverside, 1994). Application rates and the intervals from application to harvest are based on EPA's tolerances for residues of these chemicals. The use of trade names does not indicate an endorsement for, or discrimination against other products by the Cooperative Extension Service of New Mexico State University. We do not claim that this list is complete. Please use all agricultural chemicals safely, and read and follow all label directions. Wear protective clothing when mixing and applying defoliant, desiccant, and growth regulators.

## VI. Glossary

**Abscisic acid** - A plant hormone involved in abscission, dormancy, stomatal closure, growth inhibition, and other plant responses.

**Abscission zone** - A layer of thin-walled cells extending across the base of a petiole or peduncle, whose breakdown separates the leaf or fruit from the stem causing the leaf or fruit to drop.

**Auxins** - A class of plant growth regulators chemically and functionally related to the natural hormone indoleacetic acid (IAA).

**Cultivar** - A cultivated variety. Denotes certain cultivated plants that are clearly distinguishable from others by any characteristic.

**Cutout** - A period of reduced growth and square production following a fruiting cycle.

**Cytokinins** - A group of plant growth hormones important in the regulation of nucleic acid and protein metabolism and in cell division, organ initiation, and delaying senescence.

**Defoliant** - A chemical or method of treatment that causes only the leaves of a plant to fall off or abscise.

**Defoliation** - Application of a chemical or cultural practice to make leaves fall from a plant prematurely. Removing the leaves (tops) from a plant by cutting or grazing.

**Dehiscence** - Opening or splitting along definite morphological lines. Usually refers to pods, capsules, siliques, or anthers at maturity opening to permit discharge of their contents.

**Desiccant** - A chemical that rapidly kills the leaves of a plant, but they stay attached to the plant (i.e., a drying agent).

**Desiccation** - Rapid loss of water from the foliage following the application of a chemical such as paraquat.

**Ethylene** - A gaseous growth hormone ( $C_2H_4$ ) regulating various aspects of vegetative growth, fruit ripening, abscission of plant parts, and the senescence of flowers.

**Green pick harvest** - machine harvest of cotton without the use of harvest-aid chemicals.

**Gibberellic acid** - One of the gibberellins. Abbr.: GA<sub>3</sub>.

**Gibberellins hormones** - Stimulate new growth and influence shoot formation in plant tissue culture material. Abbr.: GA

**Growth regulator** - A synthetic or natural compound that, in low concentrations, controls growth responses in plants.

**Growth retardant** - A chemical that selectively interferes with normal hormonal promotion of plant growth, but without appreciable toxic effects.

**Harvest aid chemicals** - Accelerate the preparation of the crop for mechanical harvest. These chemicals include boll openers (and/or growth regulators), defoliates, and desiccants.

**Hormone** - A natural chemical that exerts strong controlling effects on growth, development, or metabolism at very low concentrations, and usually at sites other than the site of synthesis. Synonym in plants is phytohormone.

**IAA** - Indoleacetic acid; a natural hormone (plant growth regulator).

**Phytohormone** - Plant hormone.

**Pima cotton** - *Gossypium barbadense* L.

**Senescence** - Developmental stage during which deterioration occurs leading to the end of functional life of an organism or organ.

**2,4-Dichlorophenoxyacetic acid (2,4-D)** - A selective auxin-type herbicide that kills broad-leaved plants but not grasses.

**Trademark** - A legally registered identifying device, numeral, letter, word, or combination of these used to designate a product as originating with or owned by a specific company or firm and legally reserved for the exclusive use of the trademark holder.

**Upland cotton** - *Gossypium hirsutum* L.

**Vegetative** - Referring to asexual (stem, leaf, root) development in plants in contrast to sexual (flower, seed) development.

**Winter desiccation** - The death of leaves or plants by drying during winter dormancy.

**VII: References**

- American Society of Agronomy. 1984. Cotton. R. J. Koehh, and C. F. Lewis (ed.). American Society of Agronomy, Agronomy Series No. 24.
- Cathey, G. W. 1986. Physiology of defoliation in cotton production. pp. 143-154. In J. R. Mauney and J. McD Steward (ed.) Cotton Physiology. No. 1. The Cotton Foundation, Memphis, TN.
- Cathey, G. W., and R. O. Thomas. 1986. Use of plant growth regulators for crop modification pp. 137-142. In J. R. Mauney and J. McD Steward (ed.). Cotton Physiology. No. 1. The Cotton Foundation, Memphis, TN.
- Clark, L. J. and E. W. Carpenter. 1994. Plant growth regulation studies at the Safford Agricultural Center, 1993. Cotton, A College of Agriculture Report, The University of Arizona, Tucson, AZ. Series p-94:143-150.
- Clean Crop. 1995. Specimen label and material safety data sheet reference book. Tri-State Chemical, United Agri Products, Greeley, CO.
- Crop Production Reference. 1995. 11th (ed.). Chemical and Pharmaceutical Press, New York, NY.
- Glover, C. R. 1992. Pix and Prep use in cotton. New Mexico State University, Cooperative Extension Service. Guide A-213.
- Glover, C. R. 1988. Harvest-aid chemicals for cotton in New Mexico. New Mexico State University, Cooperative Extension Service.
- Guinn, Gene. 1986. Hormonal relations during reproduction. pp. 113-136. In J. R. Mauney, and J. McD Stewart (ed.) Cotton Physiology. No. 1. The Cotton Foundation, Memphis, TN.
- Hartman, H. T., A. M. Kofranek, V. E. Rubatzky, and W. J. Flocker. 1988. 2nd. (ed.). Plant Science: Growth, Development, and Utilization of Cultivated Plants. Prentice-Hall, Englewood Cliffs, NJ.
- Locke, D., J. A. Landivar, D. Mosely, 1995. The effects of rate and timing of glyphosate applications on defoliation efficiency, regrowth inhibition, lint yield, from quality and seed quality. pp 1088-1090. In D. A. Richter and J. Armour (eds.). Proc. Beltwide Cotton Production Res. Conf., San Antonio, TX, Jan. 4-7, 1995. National Cotton Council of America, Memphis, TN.

- Nelson, J. M., F. S. Nakayama, H. M. Flint, R. L. Garcia, and C. L. Hart. 1994. Methanol treatments on Pima and Upland cotton. Cotton, A College of Agriculture Report, The University of Arizona, Tucson, AZ. Series p-94:138-142.
- Odom, P. 1991. Defoliation. Section VII. In Arizona Department of Agriculture Environmental Services (ed.). Arizona study guide for agricultural pest control advisors. University of Arizona, Tucson, AZ.
- Oklahoma State University. 1995. Cotton production and pest management in Oklahoma. Oklahoma State University, Cooperative Extension Service, Circular E-883.
- Oosterhuis, D. M., L. D. James, and B. R. Bondada, 1995. Research on plant growth regulators in cotton, summary of 1994 results. pp 1077-1079. In D. A. Richter, and J. Armour (ed.). Proc. Beltwide Cotton Production Res. Conf., San Antonio, TX, Jan. 4-7, 1995. National Cotton Council of America, Memphis, TN.
- Riverside. 1994. Product Labels and MSDS. Terra International, Sioux City, IA.
- Salisbury, F. B., and C. W. Ross. 1978. Plant Physiology. 2nd (ed.). Wadsworth Publishing Company, Belmont, CA.
- Silvertooth, J. C., S. W. Stedman, R. E. Cluff, and E. R. Norton. 1994. Cotton Defoliation Evaluations, 1993. Cotton, A College of Agriculture Report, The University of Arizona, Tucson, AZ. Series p-94:49-56.
- Waibel, G. 1991. Plant Growth Regulations. Section VII. In Arizona Department of Agriculture (ed.). Arizona study guide for agricultural pest control advisors. University of Arizona, Tucson, AZ.
- Western Regional Integrated Pest Management Project. 1984. Integrated Pest Management for Cotton in the Western Region of the United States. University, of California, Publication No. 3305.

