

# Diagnosing Suspected Off-target Herbicide Damage to Cotton



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## Introduction

Off-target movement of agricultural chemicals, including pasture and right-of-way herbicides, can be detrimental to cotton production. While these herbicides are valuable tools for weed management, off-target damage to cotton often results in expensive fines and/or lawsuits, reduced yields, and bad publicity for the industry. Herbicide damage can lead to delayed harvests and reduced productivity for growers.

Following proper stewardship recommendations can reduce the impact of off-target herbicides in cotton (see UT Extension fact sheet W 291-A Preventing Off-target Herbicide Problems in Cotton Fields). However, these unfortunate events sometimes occur and diagnosing problems in the field is difficult. Many pasture herbicides mimic the plant hormone auxin, and symptoms can be quite similar. Images and descriptions in this publication are intended to highlight characteristic symptomatology of each of these broadleaf herbicides on cotton.



*A healthy crop of cotton. (Photo by Bob Hayes)*

## Procedures

Cotton plants were grown in a greenhouse and treated with simulated drift rates for aminocyclopyrachlor, aminopyralid, picloram, dicamba and 2,4-D (See table below). Products containing aminocyclopyrachlor are registered for non-cropland use, but are not yet registered for use in pastures. Plants were photographed over time to illustrate the development of symptoms.

The following are descriptions of commonly observed symptoms resulting from exposure to synthetic auxin herbicides:

**Curling** — Folding of edge of leaf margins.

**Epinasty** — Twisting, bending and/or elongation of stems and leaf petioles.

**Blistering** — Appearance of raised surfaces on leaf tissue.

**Chlorosis** — Yellowing or whitening of leaves resulting from loss of chlorophyll.

**Necrosis** — Browning of tissue resulting from cell death.

Common name	Chemical family	Trade names
aminocyclopyrachlor	Pyrimidine-carboxylic acid	Not yet registered for use in pastures and hay fields
aminopyralid	Pyridine-carboxylic acid	Milestone, ForeFront R&P, ForeFront HL, GrazonNext
picloram	Pyridine-carboxylic acid	Tordon, Surmount, Grazon P+D
2,4-D	Phenoxyacetic acid	Various names and mixtures
dicamba	Benzoic acid	Banvel, Clarity, Oracle, Rifle, Brash, Rangestar, Weedmaster

## Picloram

Plants exposed to picloram typically exhibit symptoms relatively soon, with leaf petioles drooping by three days after treatment. The upper stem is epinastic and newer leaves are folded downwards, nearly vertical. New leaf margins are curled downwards as well (Fig. 1). As early as five days after exposure, new leaves are blistered in appearance. By one week after treatment, most petioles are bent downwards, nearly vertical (Fig. 2). Most of the older leaves are curled downwards at the margins and the new leaves are bunched. By 10 days after exposure, leaves show signs of chlorosis (Fig. 3) and the newest buds are browning (Fig. 4). At higher rates, the stem is swollen and ruptured around two weeks after exposure (Fig. 5). By one month after exposure, nearly half the plant is necrotic (Fig. 6). Because picloram use rates are higher than aminocyclopyrachlor or aminopyralid, drift damage to cotton will often appear sooner and more pronounced.



**Fig. 1. Drooping of petioles and curling in new leaves.**



**Fig. 2. Severe petiole epinasty and curling of leaf margins.**



**Fig. 3. Early sign of chlorosis.**



**Fig. 4. Browning of new leaf buds.**



**Fig. 5. Swelling and rupturing of stem at base.**



**Fig. 6. Browning of leaves and abortion of meristem.**

## Aminocyclopyrachlor

Around three days after treatment, most petioles are drooping at or below horizontal. (Fig. 7). Leaves are also curled upwards slightly. By one week after exposure to aminocyclopyrachlor, leaf petioles have folded down even more and new leaves are yellow and have reduced lateral expansion (Fig. 8). At 10 days after exposure, plants exposed to high rates show signs of chlorosis and blistering near leaf margins (Fig. 9). Later, blistering and chlorosis become more apparent and young leaves are cupped upwards (Fig. 10) and plants have severely reduced apical growth (Fig. 11). By six weeks after exposure, younger leaves are brown and older leaves are highly chlorotic (Fig. 12). Abortion of the apical meristem and development of necrotic symptoms are slower than with picloram.



**Fig. 7. Petioles drooping.**



**Fig. 8. More severe petiole drooping and leaf curling.**



**Fig. 9. Early signs of chlorosis and blistering.**



**Fig. 10. Blistering and cupping of younger leaves.**



**Fig. 11. Reduced apical growth.**



**Fig. 12. Browning and chlorosis.**

## Aminopyralid

Symptoms from exposure to aminopyralid are similar to aminocyclopyrachlor and do not develop as rapidly as with picloram. Initially, petioles droop to horizontal around three days after treatment (Fig. 13). The main stem is bent and blisters appear near leaf margins around one week after exposure (Fig. 14). Later, petiole epinasty is more pronounced (Fig. 15) and new leaves are yellow, blistered and have reduced lateral expansion (Fig. 16). At low rates, older leaves are still upright, but younger leaves are yellow and blistered (Fig. 17). By six weeks after treatment, older leaves are yellow, younger leaves are browning near the margins, and the apical meristem is aborted (Fig. 18).



**Fig. 13. Petioles drooping and young leaves curling upwards.**



**Fig. 14. Blistering near leaf margins.**



**Fig. 15. Severe petiole epinasty.**



**Fig. 16. Blistering and yellowing of young leaves.**



**Fig. 17. Upright petioles and blistered young leaves with low rate.**



**Fig. 18. Meristem abortion and leaf chlorosis.**

## 2,4-D

Symptoms begin to appear sooner with 2,4-D than with aminocyclopyrachlor, aminopyralid, and picloram. By two days after exposure, leaf petioles are horizontal and the upper stem is bent (Fig. 19). By four days, petioles are twisting and new leaves are curled downwards at the margins (Fig. 20). Later, red to dark brown patches begin to appear on the stem and petioles (Fig. 21). Lower rates cause new leaves to cup upwards and blister at two weeks after exposure (Fig. 22). At one month after exposure, new leaves have parallel venation and lobes have been reduced to finger-like projections (Fig. 23). These young leaves are bent where the base of the leaf meets the petiole and resemble a piece of worn leather. Chlorosis, strapping and reddening of petioles are more severe at six weeks after exposure (Fig. 24).



**Fig. 21. Reddening of stem and petioles.**



**Fig. 22. Upward cupping and swelling of new leaves with low rate.**



**Fig. 19. Petioles drooping and stem bending.**



**Fig. 23. Parallel venation and strapping.**



**Fig. 20. Petioles twisting and young leaves curled at margins.**



**Fig. 24. Chlorosis in older leaves and strapping in younger leaves.**

## Dicamba

Overall, symptoms develop quickly in plants exposed to dicamba. Generally, petiole twisting is more severe in plants treated with dicamba than with 2,4-D. By two days after treatment, leaf petioles are curved and youngest leaves are curled (Fig. 25). Around one week after treatment, newer leaves are beginning to yellow and blister along the leaf veins (Fig. 26). By 10 days after exposure, petioles are curved severely and often resemble an “S” shape (Fig. 27). Later, the newest buds are brown (Fig. 28) and the base of the stem has ruptured (Fig. 29). By one month after exposure, older leaves are highly chlorotic and the meristem has been aborted (Fig. 30).



**Fig. 27. Severe curvature of petioles.**



**Fig. 28. Browning of newest buds.**



**Fig. 25. Petiole curving and leaf curling.**



**Fig. 26. Blisters developing along leaf veins.**



**Fig. 29. Swelling and rupturing of stem at base.**



**Fig. 30. Chlorosis and abortion of apical meristem.**

## Conclusions

Although diagnosing herbicide injury in the field is difficult, several steps can be taken to determine possible causes. First, always record the date, time, location and description of observed symptoms. Photographs of injury can help document symptom development, especially since the appearance of plants can change over a short period of time. Try to rule out other causes of plant stress, such as weather, soils, insects or misapplied fertilizer. Off-target movement of herbicides will cause multiple plants over a large area to exhibit similar symptoms. Pay particular attention to leaf margins, new growth and the main stem, as these areas can offer several clues for herbicide damage. Common symptoms and herbicides that can cause them are listed in the table at right.

Symptom	Herbicides
Elongated leaves with leathery appearance	2,4-D
Red or brown patches on stem and petioles	2,4-D
S-shaped petiole	Dicamba
Severe downward bending of petioles (nearly vertical)	Dicamba and picloram
Rupturing of stem at base	Aminocyclopyrachlor, aminopyralid, picloram, dicamba
Blistering along leaf veins	Dicamba
Blistering along leaf margins	Aminocyclopyrachlor, aminopyralid, picloram, 2,4-D

If herbicide injury is suspected, it can be difficult to determine if the herbicide was placed there by tank-contamination, drift, carryover in manure, or movement well after application due to volatility. Research is important to narrow down the source of contamination. Therefore, determine when symptoms first appeared, what the previous crop was and what herbicides were applied in the previous three seasons, what sprayer was used, whether manure was used, and if there was an application of pesticides soon before the symptoms appeared.

Looking for patterns in fields can also narrow down the source of contamination. If the majority of plants are injured, then a change in the intensity of symptoms in the field may indicate from which direction the herbicide came. Vapor drift can travel several miles, though, making the direction of origin difficult to determine.

Herbicide residue testing is expensive, especially if the herbicide or family of herbicides is unknown. Being able to narrow the list of possible herbicides can significantly lower the cost of residue testing. One important thing to remember is that picloram, aminopyralid and dicamba are often sprayed in combination with 2,4-D. Even though pasture herbicides damage cotton in similar ways, the descriptions listed in this publication can help to verify the source of injury.

## References

Munk, Daniel, Kurt Hembree, Kassim Al-Khatib, Bob Hutmacher, Doug Munier, and Steve Wright. Synthetic Auxin Herbicide Injury in Cotton. University of California Cooperative Extension. UCCE Cotton Production Guidelines. <http://cottoninfo.ucdavis.edu/>

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<http://ag.tennessee.edu>

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