It's all phenoxy!

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Herbicide damage has become increasingly common in cotton crops over the past couple of seasons, with 2,4–D the more commonly suspected culprit. There are a number of steps to managing this damage, but central to these is recognising the range of herbicides which can cause damage, the type of damage caused, and the potential impact of this damage to a cotton crop. This knowledge can also lead to the best outcome, which is avoiding herbicide damage in the future.

One of the reasons we are seeing so much herbicide damage on cotton is that, unfortunately, cotton is easily damaged by many of the herbicides which can be commonly used in the farming system. In fact, most of the herbicides used on grain crops and fallows can damage cotton. The two most widely used herbicides in fallows are glyphosate and 2,4–D. Roundup Ready Flex cotton can easily tolerate drift rates of glyphosate, but all currently available lines of cotton are very sensitive to 2,4–D, and easily damaged by 2,4–D.

2,4–D is a member of the phenoxy group of herbicides. It is a synthetic auxin, or plant hormone, meaning it is a synthetic chemical which causes a similar response in the plant to endogenous auxin (indoleacetic acid), one of the plant hormones which stimulates plant growth.

At very low concentrations, 2,4–D increases the rate of plant growth and has no negative effect on the plant. But at higher concentrations, it causes new growth to be distorted, and at higher concentrations again, it causes plant growth to accelerate out of control, killing the plant. At still higher concentrations, 2,4–D inhibits plant growth, again killing the plant.

Most cotton growers and consultants are now all too familiar with the typical symptoms of 2,4–D damage on cotton, with a proliferation of highly distorted new leaves, as shown in Photo 1. Still, there are a number of points to remember about 2,4–D damage.

- Low rates of 2,4–D cause no visual symptoms of damage to exposed leaves. At high rates, 2,4–D will cause some bending and twisting of the petioles, giving the crop a wilted appearance. This effect disappears within two days of exposure, after which some petiole reddening may be apparent.
- More typically, symptoms of damage are only seen as new leaves expand. So the first symptoms of 2,4–D exposure are generally not observed before two to three weeks after exposure, depending on the growth rate of the crop.
- The severity of the symptoms is related to the level of exposure. Severe symptoms, such as in Photo 1, are caused by exposure to a high rate of 2,4–D – in this case 160 ml 2,4–D amine 500 per hectare – 10 per cent of a typical field application rate. Lower rates cause less severe symptoms
- 2,4–D affects the growing points of the plant (the meristematic areas). Successive new leaves produced on a damaged stem show symptoms of damage for a number of nodes above the initial damage and the effect only diminishes slowly over time (damaged leaves never recover). This does not indicate repeated exposure.

Photo 1: A cotton crop showing typical symptoms of 2,4–D damage.

Photo 2: A collage of cotton plants showing typical symptoms of phenoxy damage. Starting at the top left and going clockwise, the damage was caused by: 2,4–D, dicamba, Tordon 242, Grazon DS, Tordon 75D and MCPA.

- If young plants are damaged before the laterals are initiated, the laterals will probably not be damaged and the plant should continue to grow and set fruit on these lateral branches. The long-term impact of exposure to low rates of 2,4–D on young plants can be minimal.
- 2,4–D is the most widely used member of the phenoxy group of herbicides, but there are a number of other auxin-type herbicides, all of which cause similar damage symptoms.

THE OTHER AUXIN-TYPE (GROUP I) HERBICIDES

A quick search of a pesticide data base reveals 10 other auxin-type herbicides (all Group I), any of which might be used near cotton. All of these herbicides can cause similar damage to cotton and all cause similar symptoms of damage.

One of the displays at the 2009 Cotton Trade Show was a set of cotton plants damaged by different auxin-type herbicides. The one consistent observation of participants to the show was that none could positively identify a particular herbicide from the damage symptoms on the plants. At lower rates, it is impossible to separate the auxin-type herbicides from their damage symptoms (Photo 2).

A cotton crop showing typical symptoms of phenoxy damage may not have been damaged by 2,4–D coming from miles away, but from Starane applied to the channel, or Grazon applied to the fal-

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low next door, or any of the other auxin-type herbicides. Drift from any of these herbicides can be equally damaging to cotton, and you probably can't pick them apart!

The common auxin-type herbicides are listed in Table 1, together with a common trade name. Most of these herbicides are sold under a wide variety of trade names and any herbicide containing one of these active ingredients can cause the same damage to cotton, regardless of the formulation. Many of the actives are also commonly sold in mixtures.

Damage from an auxin-type herbicide may come from a number of sources and the damage will be the same, regardless of the source. The most common sources are:

- Drift from an application to another target;
- Using a contaminated spray rig or mixing trailer;
- Residue in the soil from an application to a fallow;
- Accidental contamination from the wrong drum; and,
- Contamination of the pesticide.

The last two sources of contamination are rare, but there have been instances of self-inflicted damage due to grabbing the wrong drum in haste, and of traces of phenoxy contamination in product coming out of a pesticide production plant where several different pesticides were produced by the same plant.

TABLE 1: Commonly used auxin-type herbicides

Active ingredient	Common trade name*
2,4–D	2,4–D amine, 2,4–D ester
2,4–DB	Buttress
Aminopralid	Mixtures in Hotshot, Grazon Extra
Clopyralid	Lontrel
Dicamba	Kamba, Dicamba
Dichlorprop**	Corasil
Fluroxypyr	Starane
MCPA	MCPA, LVE MCPA
Mecoprop	In combination in some lawn products
Picloram	Tordon, in combination in Grazon
Triclopyr	Garlon, in combination in Grazon

*Most of these herbicides are sold under a wide variety of trade names and may also be included in combination with other active ingredients.
**A plant growth regulator used on oranges and mandarins.

Photo 3: A cotton crop at Pilliga showing symptoms of heavy damage from phenoxy herbicide. Photo taken January 19, 2009.

2,4–D residues in the soil have historically been more problematic in cotton in dry times, as the rate of 2,4–D breakdown is much slower in a dry soil. Cotton should not be planted for at least 10–21 days following a 2,4–D application to a damp soil (the time depends on the application rate), and this plant-back period does not start till at least 15 mm of rain has fallen on a dry soil. Adequate plant-back periods must be allowed for with any of these herbicides.

More common again is damage from using a contaminated spray rig. Decontaminating a rig which has been used to apply an auxin-type herbicide is very difficult, due to the sensitivity of cotton to trace amounts of these herbicides. Cotton growers should be particularly cautious if they are not using their normal rig, unless they can be certain that the rig has been thoroughly cleaned. Equal care must be taken when employing an aerial or ground contractor's rig.

THE DRIFT PROBLEM

Phenoxy-type damage has been most commonly due to pesticide drift. So are these herbicides equally susceptible to drift?

Pesticide drift comes about in one of two ways:

- Volatility; and,
- Physical drift.

There is a wide range in volatility within this group, with the older formulations of 2,4–D ester the most volatile. This means that even when these formulations of 2,4–D ester were applied to a weed target under ideal conditions, some of the 2,4–D could later be released from the target site and could drift for long distances before settling on a new target, which in some instances was a cotton crop. These formulations of 2,4–D ester have been removed from the market. Volatility should not be a significant problem with the remaining phenoxy herbicides, provided they are applied under suitable conditions

But all herbicides formulations are prone to physical drift, as drift is not primarily a function of herbicide chemistry, but a function of droplet size, temperature and wind movement. Using, for example, a 2,4–D amine formulation such as Surpass or an alternate product, such as Starane, does not stop the herbicide from drifting. Any of the auxin-type herbicides can drift and all can seriously damage cotton crops.

There are a number of factors which need to be addressed to reduce the risk of herbicide drift. These include:

- Spraying under suitable wind, humidity and temperature conditions;
- Using large droplets (with a minimal number of fine droplets);
- Ensuring the appropriate release height;
- Ensuring the location of any sensitive crops is clearly identified; and,
- Ensuring an adequate buffer between the application site and sensitive crops.

Always remember that native vegetation, some trees and home gardens can be very sensitive to herbicide drift.

More information on herbicide application can be found in SPRAYpak and in the latest version of the Cotton Pest Management Guide.

WHEN HERBICIDE DAMAGE OCCURS

When herbicide damage does occur, the first step in managing the damage is to identify the likely product involved. There is now a growing bank of information on the Cotton CRC's website to assist with this task.

This information can be accessed through the Herbicide Damage Guide in WEEDpak, the COTTONpaks CD and on the Cotton CRC website at: www.cotton-crc.org.au/content/Industry/Tools/Herbicide_Damage_Identification.aspx

Herbicide damage symptom images on the website include:

- 2,4–D amine*;
- 2,4–D + picloram (Tordon 75D);
- Atrazine;
- Dicamba*;
- Fluroxypyr (Starane)*;

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- Glufosinate (Liberty)*;
- Glyphosate*;
- Glyphosate + 2,4–D*;
- MCPA*;
- MCPA + picloram (Tordon 242);
- Paraquat + diquat (Spray.Seed)*;
- Simazine; and'
- Triclopyr + picloram (Grazon DS).

ASSESSING THE IMPACT

The next step is to assess the likely long-term impact of the damage. This is a function of:

- The herbicide;
- The exposure rate;
- The crop growth stage; and,
- The crop's potential.

Information on the impact of known rates of some of these herbicides at various crop stages is also shown on the website (those herbicides followed by an '*' in the previous list). These information sheets show the development of the damage symptoms over time and give information on the herbicide's impact on plant growth, flowering, fruit development and retention, final crop maturity and yield.

Growers can compare these data to the damage symptoms on their crops and assess the likely impact of these herbicides to their crops. Every crop and every season is different, so these data can only be used as a general guide, but they give some idea of the likely consequences of herbicide damage to a crop. Closely monitoring boll retention following herbicide exposure should give the best guide to the crop's actual rate of recovery.

HOW TO RESPOND?

Once an assessment of the likely impact of the damage is made, the next step is to determine an appropriate response.

Generally speaking, crops can grow out of early season damage with minimal losses, although any damage will cause some delay in crop maturity and/or loss of yield. Similarly, late season damage may take the cream off the top of the crop, but still leave a harvestable crop.

Crops seem to be most sensitive to damage at around eight to 12 nodes of crop development, after the lateral branches have been initiated. Crops which suffer heavy damage at this stage are likely to be slow to recover, with long delays in crop maturity and may suffer heavy yield losses.

After the damage is assessed, the best course of action can then be determined. In a season when water is at a premium, for example, it may be best to terminate a badly damaged crop and put these resources into other crops with more potential.

In other seasons, it might be justified to persist with a moderately damaged crop, which is likely to have delayed maturity and may have reduced yield, depending how the season ends. In a long season, a moderately damaged crop may still achieve a good yield, although picking may be delayed till June or even July to allow the crop time to recover.

Last season I monitored a cotton crop at Pilliga which appeared to have been damaged by multiple low rates of exposure to phenoxy herbicide (Photo 3). This crop was less severely damaged than some neighbouring cotton crops which had no retained bolls in mid-January and were terminated.

The crop was at 17 nodes on January 19 and had 30 bolls per metre, but with no fruit retained on the top half of the crop. The crop was treated normally and continued to develop, in spite of the damage.

The result was:

- The crop wasn't harvested till early June;
- It required two extra white fly sprays;
- It required extra irrigation; but,
- Still yielded around nine bales per hectare.

A similar result was achieved on a property with an extensive area of phenoxy damaged cotton in Central Qld, where picking was delayed till July, but a reasonable yield was still achieved, although lint moisture was a major problem at picking.

But these results would not have been achieved in a shorter/cooler autumn, and would not have been achieved on more severely damaged crops. The Herbicide Damage Guide in WEEDpak recorded a maximum 88 per cent yield loss from a cotton crop exposed to 2,4–D drift at the 12 node growth stage, even though picking was delayed till July!

Similarly, some growers have achieved very poor yields even after an extended season which required significant additional inputs. A June or July pick may also have serious implications for lint quality, insect management and planting a rotation crop.

For more information on herbicide damage and crop response, see the Cotton CRC website at: www.cottoncrc.org.au/content/Industry/Tools/Herbicide_Damage_Identification.aspx

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