CottonInfo

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May 2014

Managing Bt resistance

Crop destruction & pupae busting

As another harvest finishes up, it's timely to think about the importance of crop destruction and pupae busting in managing resistance risk in Bt cotton.

These end of season resistance management tactics are key components of the Bollgard II resistance management plan (RMP). The success of the Bollgard II RMP in managing resistance is due to the implementation of these tactics, along with the other key components of the RMP such as the use of mandatory refuges.

Post harvest crop destruction reduces resistance risk by limiting the season length, therefor limiting the amount of time *Helicoverpa* spp. are exposed to the Bt toxins.

Increased length of exposure to the Bt toxins can result from regrowth on plants left in the field post harvest, or from regrowth on ratoon plants that were not destroyed properly providing a source of Bt toxins in the environment outside of the cotton growing season. Resistance research shows that limiting season length is an effective tactic in extending the time until resistance develops, or the 'time to failure'.

A requirement of the Bollgard II RMP is that crop residues are destroyed as soon as practical after picking. This usually involves mulching and root cutting, followed by cultivation to fully destroy the plant root system.

Luke Sampson, Monsanto Regional Business Manager for Bourke, Macquarie and Southern NSW, shares some **tips for effective crop destruction**:

- **Root-cutting is highly recommended** to prevent re-growth of ratoon cotton and improve soil disturbance in the plant line. Check your machinery setup to ensure the roots are being cut below the cotyledon level and recheck often, especially when starting new fields.
- **Early incorporation aids in the breakdown of any residual seed cotton**, which helps in reducing volunteer numbers the following summer.

Not only are ratoon and volunteer plants a Bt resistance risk but they also act as an overwintering host for pests and disease including silverleaf whitefly, cotton aphids, mites, mealybugs and cotton bunchy top disease. Soil borne diseases such as black root rot, Fusarium and verticillium wilt build up where ratoons are present in the field.

Best Practice

Pupae busting helps manage resistance risk in a different way to crop destruction, by reducing the amount of potentially resistant individuals in the population. The strategy works by targeting the dormancy phase in the *Helicoverpa* lifecycle when the pupae enter into diapause.

Diapause is a dormancy strategy used by *Helicoverpa* to survive the winter months in temperate regions when host plants are scarce and temperatures are generally too low to allow successful development. As autumn approaches in temperate regions daylength decreases and temperatures begin to cool, triggering mature *Helicoverpa* larvae to enter a diapause phase in the soil.

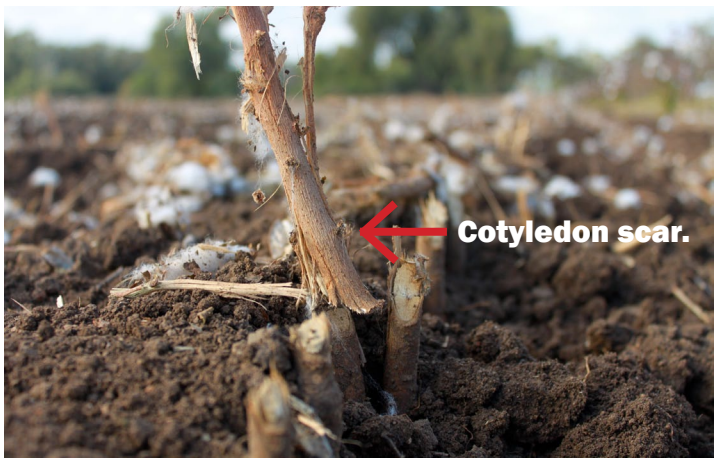
Cultivation of the soil between seasons, during the dormancy phase, is an effective way of preventing any moths that may have developed resistance in the previous year from contributing to the population in the following year. In the early 1990's CSIRO researchers led by Gary Fitt showed that single operations reduced pupal survival by up to 90 percent, depending on timing and the method used.

Although it is known that few larvae will survive in Bollgard II crops, those that do are more likely to be resistant and so are precisely the ones that should be targeted to prevent them emerging and contributing resistant genes to the population the following spring. So while the numbers of pupae killed may seem small, the proportions of resistant individuals could be high, meaning that taking this group out of the overall population can have a big impact on the frequency of resistance.

Pupae busting can be described as our 'last line of defence' at the end of the season to remove any potentially resistant individuals. The Bollgard II RMP states that pupae busting of all Bollgard II crops in NSW and Southern QLD should occur within 4 weeks of harvest and must be completed by 31 July. Soil disturbance must occur to a depth of 10cm across the whole soil surface. Soil disturbance of the unsprayed refuge associated with Bollgard II crops should not occur until all the pupae busting in the Bollgard II has been completed.

There are a variety of implements that can be used to achieve soil disturbance of 10cm. The method chosen will depend on a range of factors including soil moisture and farming rotation (eg. whether the field is going back into cotton, fallow or a winter crop). Effective pupae busting can also aid crop destruction in the reduction of ratoon and volunteer cotton plants the following season.

Pictured: Regrowth cotton



Pictured: A root cut operation. Note the cotton stalk is cut below the cotyledon level.

The following table shows some general guidelines of the adequacy of typical cultivation equipment for effective pupae busting (source MACHINEpak):

Generally satisfactory	**Inadequate alone** (more than one of these options may be required)	**Unsatisfactory**
chisel, disc or blade plough	centre busting	stalk pull (wet)
stalk pull and go – devils or lillistons plus alabamas	stalk pull (dry), rake and burn	phoenix harrows
cultivators with wide sweeps	go-devils	drag harrows
planters with cultivating tines	stubble mulchers	direct drill planters

Luke Sampson shares his **top tips for effective pupae busting:**

- **Work with your Technology Service Provider** (TSP) to ensure your pupae busting operation is effective from the start.
- **Regularly check the level of soil disturbance achieved**, particularly when moving into new fields or variable soil types.
- **Unsprayed refuge areas do not need pupae busting.**
- **Achieving effective pupae busting can be more difficult in dry conditions.** Again, work with your TSP to ensure soil disturbance is adequate. This may help prevent having to perform multiple passes.

In all areas of resistance mitigation, it is the 'collective approach' of all growers in the industry that has the biggest impact.

Macquarie grower Anthony McAlary, "Milawa," points out that by not committing to resistance management on your own farm, you are having an impact on your neighbours farm, and the farms of others in your valley and the industry.

"Resistance management should be a priority for everyone, and doing a good pupae busting job or controlling volunteers is something that we, as growers, have a fair amount of control over."

Anthony thinks its important to remember that while nobody's perfect, if everyone does the best job they can then it has a positive impact on resistance management for the industry overall.

With Monsanto currently working to introduce a third generation Bt technology, it is important to ensure that future RMPs are as robust as possible in managing resistance, whilst still being practical and achievable for growers.

The industry is investing in a number of research projects to ensure that the development of new RMPs for this and other potential Bt technologies in the future can be well informed by locally relevant science. It is not expected that Bollgard III will provide a 'silver bullet' for Helicoverpa control and as such resistance management will be just as important as it has been in protecting the longevity of the technology.

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