



Managing Bt resistance

Crop destruction & pupae busting

End of season resistance management tactics are key components of the Bollgard 3 resistance management plan (RMP). The success of the Bollgard 3 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.

The Bollgard 3 RMP offers more flexibility in end of season management for growers. Mandatory pupae busting is no longer required in every field but is now an operation targeted at those fields most at risk of having overwintering pupae. This is determined as fields defoliated later than March 31 in Victoria, NSW and Southern Qld.

Effective crop destruction in early fields with no requirement for pupae busting now becomes an important consideration in a Bollgard 3 cropping system.

Under the Bollgard 3 RMP, all crops must be destroyed by cultivation, root cutting or herbicides so that they do not continue to act as hosts for *Helicoverpa*.

The intent of this statement in the RMP is that crop destruction should occur to prevent any further regrowth. Previously, all fields would have been pupae busted. This operation assisted crop destruction by further helping to remove any plants following a mulch or root cut operation.

Removing pupae busting from the system puts more emphasis on achieving effective crop destruction post harvest.

Post harvest crop destruction works to reduce resistance risk by limiting the amount of time *Helicoverpa* are exposed to the toxins contained in Bt cotton outside of the cotton growing season. Resistance research shows that limiting season length is an effective tactic in extending the time until resistance develops.



Pictured: Helicoverpa pupae in soil

Not only are ratoon plants a resistance risk but they also act as an overwintering host for pests and disease including silverleaf whitefly, cotton aphids, mites, mealybug 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. In other crops and subsequent cotton crops, ratoon cotton is considered a weed and can affect yield through plant competition.

Ratoon cotton is best managed post harvest with an effective root cutting and mulching operation after picking. A follow up pupae busting operation or cultivation will further assist with ratoon destruction if required.



Ratoon cotton is very difficult to control with herbicides, especially in other broadleaf crops. Ratoon cotton plants have a very small leaf area compared to a large root system.

In practical terms, it is rarely possible to get ratoon plants to take up enough chemical through their leaves to kill the roots. Even above-label rates of herbicide are very unlikely to be effective on ratoon cotton.

Heavy cultivation can be effective in destroying ratoon cotton, however this may not be a preferred option in a dryland system, or if the ratoons are within a rotation crop.

The simplest and most cost effective way of controlling ratoon cotton is to prevent it occurring in the first place.

Pupae busting works 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 1990s, 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.

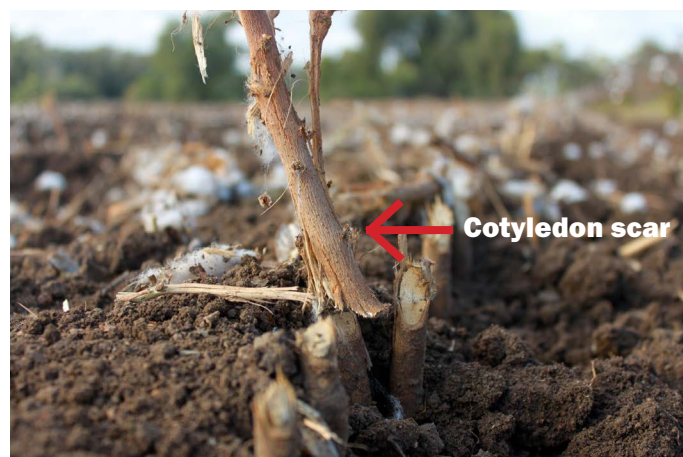
Although it is known that few larvae will survive in Bollgard 3 crops, those that do are more likely to be resistant and so are precisely the ones that should be targeted to prevent them emerging and contributing resistant genes to the population the following spring.

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.



Pictured: Regrowth cotton



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

The Bollgard 3 RMP states that pupae busting of Bollgard 3 crops (if required) in Victoria, NSW and Southern QLD should occur within 4 weeks of harvest and must be completed by 31 July for all valleys except for regions including the Lachlan, Murrumbidgee, Menindee and Murray Valleys and Victoria where pupae busting must be complete by August 31. Soil disturbance must occur to a depth of 10cm to a distance of 30cm both sides of the plant line.

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.

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 of ‘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 it’s 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 and helps protect the efficacy of the technology for the future.

For more information, contact:

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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

