



Unsprayed Pigeon Pea Refuge for Bollgard II[®] Cotton

GROWERS OF BOLLGARD II COTTON ARE REQUIRED TO PRACTISE PREVENTATIVE RESISTANCE MANAGEMENT.

The resistance management plan is based on two basic principles:

- (1) minimising the exposure of *Helicoverpa spp.* to the *Bacillus thuringiensis* (Bt) proteins and
- (2) providing a population of susceptible individuals that can mate with any resistant individuals and hence dilute any potential resistance.

HOW CAN WE GENERATE A POPULATION OF SUSCEPTIBLE MOTHS?

Each grower is required to grow a refuge crop that is capable of producing large numbers of *Helicoverpa spp.* moths that have not been exposed to selection with Bt. These will dominate the matings with any survivors from Bollgard II crops and thus help to maintain Bt resistance at low levels.

WHY CHOOSE UNSPRAYED PIGEON PEA?

When used as the refuge for Bollgard II cotton, unsprayed pigeon pea generates twice the number of susceptible moths as unsprayed cotton.

Pigeon pea must be planted at 5% of the Bollgard II area (refer to point 8 in the 'General conditions for pigeon pea refuges').

For example, for every 100 hectares of Bollgard II cotton a grower will need to plant 5 hectares of pigeon pea.

100 Hectares Bollgard II = 5 Hectares Pigeon Pea

GENERAL CONDITIONS FOR PIGEON PEA REFUGES:

1. Pigeon pea must be planted and managed so that the refuge is attractive to *Helicoverpa spp.* during the entire growing period of the Bollgard II cotton variety.
2. Pigeon pea should be planted within two weeks of planting the Bollgard II cotton, but should not be planted until soil temperatures reach 17°C.
3. If cultivation is required in the pigeon pea refuge, the Bollgard II cotton should also be cultivated at the same time.

4. Pigeon pea refuge must be planted within the farm unit growing the Bollgard II cotton.
5. All reasonable effort should be taken to plant the refuge either on one side of, or next to a Bollgard II cotton field.
6. All Bollgard II fields must be within 2 km of the nearest pigeon pea refuge.
7. If the Bollgard II variety planted is stacked with Roundup Ready cotton or Roundup Ready Flex, up to 200 metres of buffer between the refuge and the Bollgard II is allowed in order to prevent herbicide drift.
8. If sprayed cotton is planted on a farm unit all pigeon pea refuges must be at least 48 metres wide. If no sprayed cotton is planted on farm pigeon pea refuges must be at least 24 metres long and 24 metres wide.

CONTROL OF VOLUNTEER AND RATOON COTTON:

Volunteer and ratoon cotton, within back-to-back fields, may impose additional selection pressure on *Helicoverpa spp.* to develop resistance to the Bt proteins produced by Bollgard II cotton.

Ensure that any field in which pigeon pea is to be sown into is clean of volunteer or ratoon cotton prior to planting.

Pigeon pea refuges must be kept clean of volunteer and ratoon cotton for the entire growing period.



Helicoverpa spp. larvae could develop beyond the third instar on the pigeon pea refuge and transfer onto the volunteer Bollgard II cotton shown in this picture. This poses a high risk for resistance development.



SPRAY LIMITATIONS IN THE PIGEON PEA REFUGE:

1. No Bt sprays are allowed for the full season.
2. Food sprays cannot be used.
3. Trichogramma or any other biological control agent cannot be released.
4. Secondary pests can be controlled in the refuge as long as the product has no activity on *Helicoverpa* spp.

PIGEON PEA HARVEST OR CROP DESTRUCTION:

Harvest or crop destruction of aerial parts of the pigeon pea refuge can only occur after the Bollgard II cotton lint has been removed.

PUPAE DESTRUCTION IN PIGEON PEA REFUGES:

To ensure maximum emergence of late pupae from the pigeon pea refuge, soil disturbance in the refuge should not occur until after the pupae busting in the Bollgard II cotton is complete.

Ideally the pigeon pea refuge should be left uncultivated until the following spring.

Remember: the more susceptible moths that emerge from the refuge the more genetic dilution of resistant survivors can occur.

Direct drilling winter crops into pigeon pea refuge is allowed.

SIMPLE STEPS TO CREATING AN EFFECTIVE PIGEON PEA REFUGE:

Field selection:

1. Where possible, avoid planting pigeon pea into last year's cotton field.
2. Do not plant pigeon pea refuge into cotton stubble that has not been root cut effectively.
3. Where possible plant pigeon pea into well drained soils; waterlogging will kill pigeon peas.

Planting seed quality:

1. Always perform a germination test prior to sowing.
2. Adjust the sowing rate to ensure a plant stand equivalent to the Bollgard II cotton is achieved.
3. Don't forget to inoculate your seed to get the most benefit out of the legume rotation.
4. If saving your own seed from the previous pigeon pea crop, do not use glyphosate as a desiccate. If seed maturity is not complete the germination may be affected.

Weed management:

1. Apply a residual herbicide for long term weed control. Prometryn, Trifluralin and Sencor® are all registered.
2. Remember: don't let this year's refuge generate next year's weeds.



Barnyard grass is a strong competitor. The grass in this picture has not only reduced the vigour of the pigeon pea refuge, but will also increase waterlogging on the pigeon pea after the next irrigation.

Irrigation management:

1. Avoid watering up pigeon pea where possible. Waterlogging will burst seed.
2. At a minimum, pigeon pea should be irrigated with every second cotton crop watering.
3. Remember the pigeon pea must be attractive for the entire Bollgard II cotton growing period. After 120 days the expression of Cry1Ac reduces, effectively exposing Cry2Ab to higher selection pressure late season.



This pigeon pea crop received water with every second cotton irrigation. Excellent result!!

PIGEON PEA REFUGE FOR DRYLAND COTTON:

Irrigated pigeon pea can be used as a refuge for dryland cotton.

When using irrigated pigeon pea as the refuge the following ratio must be used;

100 Hectares Bollgard II = 5 Hectares Pigeon Pea

®Bollgard II, Roundup Ready and Roundup Ready Flex are registered trademarks of Monsanto Technology LLC

®Sencor is a Registered Trademark of Bayer