



Refuge Options for Dryland 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.

REFUGE OPTIONS FOR DRYLAND BOLLGARD II COTTON:

Dryland Bollgard II cotton growers have three refuge options:

1. Dryland unsprayed cotton planted at 10% of the area and of the same configuration as Bollgard II.
2. Irrigated unsprayed pigeon pea at 5% of the area.
3. Dryland sprayed cotton at 100% of the area and of the same configuration as the Bollgard II cotton.

Cotton refuge acts as a host for other *Lepidoptera spp* such as Rough Bollworm.

Growers who choose to use Roundup Ready Flex[®] cotton and Roundup Ready[®] cotton varieties as the refuge have the added benefit of being able to control in crop weeds with Roundup Ready[®] herbicide.

GENERAL CONDITIONS FOR REFUGES:

1. The refuge must be planted within the farm unit growing the Bollgard II cotton.
2. All Bollgard II fields must be within 2 km of the nearest refuge.
3. All reasonable effort should be taken to plant the refuge either on one side of, or next to, a Bollgard II cotton field.
4. Avoid glyphosate drift onto non glyphosate tolerant refuges all season.

SPECIFIC IRRIGATED PIGEON PEA REFUGE CONDITIONS:

1. Irrigated pigeon pea must be planted within two weeks of the Bollgard II crop.
2. They must be managed to ensure several cycles of flowering throughout the cotton season.
3. They cannot be treated for any reason with any products that control *Helicoverpa spp.*



SPECIFIC SPRAYED COTTON REFUGE CONDITIONS:

1. All dryland refuges must be the same configuration as the Bollgard II.
2. Sprayed cotton must be planted within two weeks of the Bollgard II crop.
3. Can be conventionally managed for *Helicoverpa* spp. and other pests.
4. No product containing *Bacillus thuringiensis* (Bt) proteins can be applied at any stage.

CONTROL OF VOLUNTEER AND RATOON COTTON:

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

Ensure that the refuge area of the field is clean of volunteer or ratoon cotton prior to planting.

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

WHEN SOWING, DO NOT OVERLAP BOLLGARD II COTTON AND UNSPRAYED COTTON REFUGE

This picture illustrates an unacceptable level of overlap between the Bollgard II and the unsprayed cotton refuge. Helicoverpa spp. larvae could develop beyond the third instar on the refuge and transfer onto the Bollgard II cotton shown in this picture. This poses a high risk for resistance development



PIGEON PEA CROP DESTRUCTION AND HARVEST:

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

UNSPRAYED OR SPRAYED COTTON DEFOLIATION AND HARVEST:

Defoliation of the unsprayed or sprayed cotton refuge cannot commence until defoliation of the Bollgard II cotton has commenced.

PUPAE DESTRUCTION IN DRYLAND COTTON REFUGES:

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

Ideally the unsprayed 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 refuge is allowed.

SIMPLE STEPS TO CREATING AN EFFECTIVE DRYLAND COTTON REFUGE:

Field Selection:

1. Ensure the field history of the unsprayed cotton refuge and the Bollgard II fields are similar.

Planting seed quality:

1. When using pigeon pea always perform a germination test prior to sowing (refer to pigeon pea biotech topic).
2. Adjust the sowing rate to ensure a plant stand equivalent to the Bollgard II cotton is achieved.

Sowing:

1. Do not overlap the Bollgard II cotton and the refuge areas.
2. Avoid planting refuges along tree lines.
3. Unsprayed cotton refuges must be planted into the same conditions as the Bollgard II crop.

Weed management:

1. If using cotton as the refuge choose a conventional Roundup Ready Flex cotton variety as the refuge, to improve your weed control options.
2. Remember: don't let this year's refuge generate next year's weeds.
3. Poor weed control will lead to an ineffective refuge. Refuges are a critical component of the Bollgard II Resistance Management Plan.

UNSPRAYED COTTON REFUGES CANNOT BE USED AS ROADWAYS FOR THE BOLLGARD II COTTON.

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