Unsprayed pigeon pea refuge agronomy

Establishing and growing an attractive, refuge is a critical, mandatory component in the Resistance Management Plan for Bollgard II. The aim of a refuge is to generate significant numbers of *Helicoverpa* spp. moths which have not been exposed to selection pressure from either of the Bt proteins. Attractive, fully irrigated, unsprayed pigeon pea will, on average, produce twice as many moths as the same area of unsprayed cotton. As well as producing high numbers of moths, it is also crucial that the timing of production of moths from refuges matches that of Bollgard ll cotton crops.

The following information is intended to assist growers establish and maintain effective pigeon pea refuges. It is not part of the Resistance Management Plan (RMP) and growers should also refer to the RMP for guidance on refuge requirements.

While pigeon pea is a hardy, deep-rooted crop typically grown in dryland situations, it is not currently offered as a dryland refuge option because establishment and timing and duration of flowering can be problematic. Research is exploring the use of pigeon pea within a dryland environment as a refuge option.

Planting

Field selection

Pigeon pea can be grown on a wide range of soils, however is very susceptible to waterlogging, so select fields with good surface and internal drainage. Avoid areas where water tends to back up after irrigation and/or heavy rainfall.

The presence of Bollgard II volunteers/ratoons cannot be tolerated in refuge crop areas. This will diminish the value of the refuge and may impose additional selection pressure to *Helicoverpa* species. All refuges should preferably be planted into a fallow or rotation fields that have not been planted to cotton in the previous season so as to avoid the likelihood of ratoon or volunteer cotton in refuges. Avoid fields where Bollgard II was the most recent crop and there is a high risk of ratoon cotton (ie there were difficulties with crop destruction).

Refuges should be planted on one side of, or next to, a Bollgard ll field. Sprayed crops and unsprayed refuges that are planted in adjacent fields must be separated by sufficient distance to minimise the likelihood of insecticide drift onto the unsprayed refuge. To minimise the possibility of herbicide drift, pigeon pea refuges should be separated from herbicide tolerant Bollgard ll cotton crops by a sufficient distance to minimise drift but not more than 2km from the Bollgard ll cotton.

Nitrogen fixation by legumes such as pigeon pea is optimal in soils with very low residual soil N. Field selection should take this into consideration.

As with many other legumes, pigeon pea has been shown to have allelopathic properties which may inhibit the growth and performance of the following season's crop. This should be taken into account if large fields are planted.

Timing

Pigeon pea requires a minimum soil temperature of 17°C and rising (similar to mungbeans and soybeans). Depending on location, this will normally occur in October-November. Pigeon pea is a photoperiod sensitive plant, and there is a wide range of flowering times among varieties. Therefore, choice of variety and sowing date will strongly affect when it flowers.

Variety

Quest is currently the only variety available for refuge purposes. There is on going research to identify improved varieties, particularly for Northern cotton growing areas.

Given the usual planting time for cotton refuges, Quest takes 65 to 80 days to flower. With the right conditions it will continue to flower for a long period. To ensure Quest is attractive to *Helicoverpa* spp. during the same period of time that cotton is attractive (flowering), refuges should be planted within the two week period prior to planting Bollgard II, or if not possible, completed within 3 weeks of the first day of sowing Bollgard II*.

*See RMP for details.

Row spacing

As pigeon pea is only available for use as a fully irrigated refuge option in the RMP, the maximum row spacing is 1.0 metre.

Larvae in pigeon pea refuge. (Photo: Johnelle Rogan)

Where cotton is grown on a row spacing narrower than 1.0 metre, the row spacing for pigeon pea should match that of the cotton for which it is a refuge.

Seeding rates

To maintain attractiveness, it is important to comply to the required plant stand of not less than 4 plants per square metre. Higher plant populations tend to produce plants with thinner stalks, making crop residues easier to handle. Evenly spaced, lower plant populations can still be attractive and tend to produce larger plants that flower for longer and can cope better with water stress.

Seed germination percentages can vary greatly (<30% to >80%). Growers are advised to have a current germination test for either purchased or farm-saved seed. The proportion of hard seed can also influence the number of plants established, often above expectations.

Seed size is normally in the range of 6,000–10,000 seeds/kg. Generally a sowing rate of 25–40 kg/ha is used, but allowances must be made for planting conditions and seed quality.

Seed bed preparation and planting

Ensure seedbed preparation is reasonable to avoid replants. Reasonable preparation is described as that in which seed is sown to a depth of no more than 5cm. Levelling of any seed trenches created during planting is important, particularly when residual herbicides have been used and/or the field is to be watered up. The use of press wheels with light pressure has been shown to improve emergence.

Pre-irrigation

Pre-irrigation and planting into moisture is generally recommended over watering up. Some growers choosing to water up the refuge with the rest of the field, then replant into this moisture if a replant is required.

Inoculum and fertiliser

Pigeon pea requires inoculation with Group J inoculant. To ensure efficacy of inoculant, follow all label requirements and directions regarding storage, handling and application. Nodulation will be limited in high nitrogen soils. A well-grown crop of pigeon pea can add up to 38kg/ha of nitrogen. However grown in soils with moderate to high background nitrogen, pigeon pea can leave the soil depleted of nitrogen. Pigeon pea is much more sensitive to phosphorus deficiency than cotton. In soils with long cropping histories where soil P may be depleted, pigeon pea is likely to respond to addition of phosphorus and zinc. Like cotton, pigeon pea is highly VAM dependent and in long fallow situations, it may even be more responsive to P and Zn.

TABLE 22: Herbicides available for use in pigeon pea (registered or permit number Per13758)

Active Ingredient	Mode of Action	Concentration and formulation	Application rate of product	Comment
Prometryn*	C	500 g/L	Apply up to 4.5 L/ha	Apply up to the maximum rate pre planting and incorporate, or as a post emergent directed spray towards the base of established plants (Per13758)
		900 g/kg	Apply up to 2.5 kg/ha	
Trifluralin	D	480 g/L*	Apply up to 2.3 L/ha	Apply up to the maximum rate pre planting and incorporate. Rate dependent on soil type, refer to label or Per13758
		500 g/L	Apply up to 1.6 L/ha	
		530 g/L	Apply up to 1.5 L/ha	
		600 g/L	Apply up to 1.35 L/ha	
Butroxydim *	A	250 g/L	Apply 180 g/ha	Apply the specified rate as a post emergence spray over the top of the pigeon pea crops. (Per13758)
Fluazifop-p*	A	212 g/L	Apply 1 L/ha	
		128 g/L	Apply 1.6 L/ha	
Haloxyfop*	A	130 g/L	Apply 0.6 L/ha	
Haloxyfop*	A	520 g/L	Apply 0.150 L/ha	
Sethoxydim*		186 g/L	Apply 1 L/ha	Apply specified rate as a post emergence spray over the top of the pigeon pea crops. (Per13758)
Clethodim*	A	240 g/L	0.250–0.375 L/ha (2–3 leaf stage)	Always apply with D-C-trate at 2 L/100 L or Hasten or Kwickin at 1 L/100 L or Uptake at 500 mL/100L spray volume. The lower doses will provide effective control if applied under ideal conditions to weed that are smaller, actively growing and free from temperature or water stress. (Per13758)
Quizalofop*	A	99.5 g/L	0.25–1 L/ha (dependent on growth stage and species of weed)	Refer to permit for growth stages of species and critical comments. (Per13758)
Flumetsulam	B	800 g/kg	25–50 g/ha + wetter	Post plant, pre emergent. Minimum spray volume 150 L water.
Diquat	L	200 g/L	2–3 L/ha	Harvest aid
Diquat/paraquat	L	135 g/L + 115 g/L	0.8–2.4 L/ha	Apply pre-sowing, in minimum 50–100 L water
Pendimethalin	D	330 g/L	2.5–3 L/ha	Incorporate into the soil within 24 hours of application. Use higher rate on heavy textured soils or those high in organic matter. May be applied by aerial or ground spraying. In Macquarie Valley area, only apply by air when ground is too wet for ground application.
		435 g/L	1.9–2.3 L/ha	
		440 g/L	1.9–2.25 L/ha	
		455 g/L	1.8–2.2 L/ha	
		475 g/L	1.74–2.11 L/ha	
Metribuzin	C	480 g/L	750 mL/ha	Furrow irrigated: apply after furrowing out, within 2 weeks before sowing and incorporate. For post-emergence: apply to actively growing seedling stage weeds provided crop plants have at least 2 trifoliate leaves. Do not spray if rain is likely to fall within several hours. Overhead irrigated: apply pre emergence then irrigate.
		700 g/kg	470 g/ha	
		750 g/kg	470 gha	

*Use of these products is under permit (Per13758).
NOTE: Only apply to pigeon pea crops that are to be destroyed at the end of the season or to be harvested for seed for refuge replanting only. No crop product or crop residue is to be fed to livestock. Refer to all labels and permit conditions. Please go to www.apvma.gov.au to check allowable usages.

Weed management

Pigeon pea grows slowly, particularly when planted into low soil temperatures. Therefore will be a poor competitor with weeds. While there are a number of herbicides available for use under permit, as seen in Table 22, inter-row cultivation can be a useful tactic. However cultivation can inadvertently kill (the Bt-susceptible) Helicoverpa pupae present in the soil at the time. For this reason it is a requirement that once Bollgard ll cotton begins to flower the corresponding refuge should not be cultivated. The presence of Bollgard ll volunteers/ratoon cotton in any refuge will diminish the value of the refuge and must be removed as soon as possible.

Irrigation

Pigeon pea is extremely sensitive to waterlogging, and flood irrigation is generally not ideal for this crop. However it is the most common form of irrigation and growers need to be manage this carefully, for example, it is advisable to delay irrigating if heavy rain is predicted. Practices such as watering every second row, can be useful in supplying water to the crop, while reducing the risk of waterlogging by leaving room in the soil profile to make use of rainfall.

While pigeon pea generally requires less irrigation water than cotton, it is important to ensure crops do not become water stressed as this will impact on attractiveness. Flowering will be delayed under periods of extreme moisture stress and this situation appears to be one of the biggest problems facing an efficient refuge system. If there is moisture present, pigeon pea will respond very quickly with attractive regrowth after insect attack.

Destruction and harvest of pigeon pea refuge crops

Harvest or destruction of aerial parts of a pigeon pea refuge should only be carried out after Bollgard ll lint removal has been completed. In NSW and Southern Qld, soil disturbance should only occur after Bollgard II cotton fields have been pupae busted, (to ensure maximum emergence of pupae from refuges), and preferably be left uncultivated until the following October to enable the emergence of overwintering pupae. In Central Queensland soil disturbance of refuge crops can only occur 2 weeks after final defoliation of the Bollgard ll cotton. Growers in Central Queensland using pigeon pea for trap crop purposes should refer to the late summer pigeon pea trap crop requirements of the RMP for full details.

The pigeon pea refuge can be harvested with the aim of recouping refuge planting seed for the following season. No crop product or crop residue is to be fed to livestock. To ensure viability for planting, focus on preserving quality. Harvest at 13.0% grain moisture for optimum seed quality. Rotary harvesters with low drum speeds (350-400 rpm) give best results. Crop dessication may be required.