

MANAGING DISEASE WITH ROTATIONS

David Nehl¹ and Stephen Allen²
Australian Cotton Cooperative Research Centre
NSW Agriculture, Narrabri¹
Cotton Seed Distributors, Wee Waa²

Rotations are important to plant disease because they affect the survival and reproduction of plant pathogens and the biology and quality of soil. Plant disease is one of several factors to consider when choosing a rotation sequence for cotton.

Seedling disease

Seedling disease is caused by fungi in the soil, particularly *Rhizoctonia* and *Pythium*. Cotton seedlings are infected during germination and before and after emergence. *Rhizoctonia* occurs in all soils and multiplies on crop residues; particularly residues with a high carbon to nitrogen ratio, such as in legumes (including woolly pod vetch). While cool wet conditions have a large impact on the severity of seedling disease, there is scope to minimise the carry over of *Rhizoctonia* on crop residues. Early incorporation of residues from cotton and legumes reduces carryover of *Rhizoctonia*. Incorporation of a crop of woolly pod vetch only one week before sowing cotton resulted in a dramatic increase in seedling mortality, which was reversed in the presence of fungicides that are active against *Rhizoctonia* (Figure 1). Rotation with cereals is likely to decrease *Rhizoctonia* in cotton because the strains of *Rhizoctonia* that attack winter cereals are different to those that attack cotton. In crusting soils, cereal cover crops and/or standing stubble may improve emergence and establishment of cotton (current research is examining the effect of cover crops on seedling diseases).

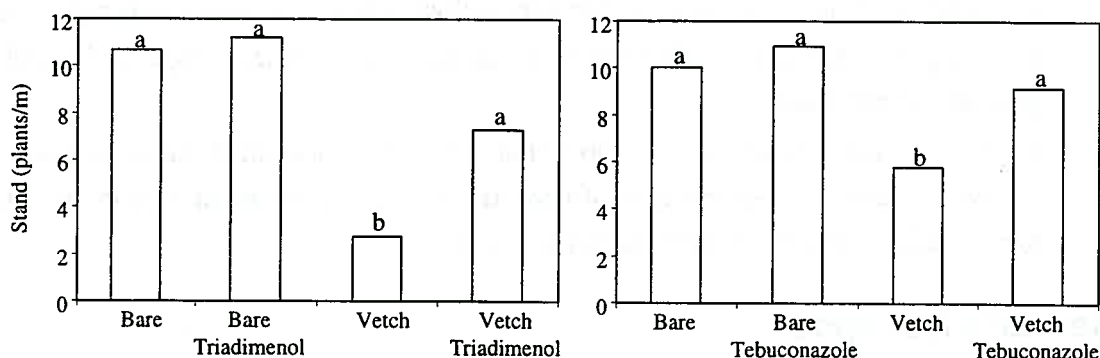


Figure 1. Reduced plant stand in cotton sown one week after incorporation of woolly pod vetch at Narrabri, 1998. The fungicides triadimenol and tebuconazole are active against *Rhizoctonia*. Bars with the same letter are not significantly different ($p < 0.001$).

Black root rot

Black root rot is widespread in NSW and QLD. The fungus that causes black root rot (*Thielaviopsis*) does not grow on crop residues and survives as long-lived spores in the soil. Each crop of infected cotton deposits more spores in the soil and the severity of black root rot increases according to the number of cotton crops, irrespective of rotations.

- Woolly pod vetch, mustard and canola can have a 'biofumigation' (toxic) effect on the black root rot fungus when grown as 'green manures'. To minimise the risk of increasing Rhizoctonia, biofumigation crops must be incorporated at least four weeks before cotton.
- Rotation with cereals delays, but does not prevent, the build-up of black root rot. The population of the black root rot fungus will be reduced substantially by three consecutive years with non-host crops (e.g. cereals, canola).
- Rotation with legumes (except woolly pod vetch) may increase black root rot.

Mycorrhizas

A mycorrhiza (also known as VAM) occurs when the roots of plants form a partnership with 'beneficial' fungi in the soil. The plant 'feeds' the fungi with sugars and, in return, the mycorrhizal fungi supply the plant with nutrients from the soil. Cotton is highly dependent on mycorrhizal fungi for uptake of P and Zn. A lack of mycorrhiza development can slow the growth of cotton seedlings. Cropping sequences are important to mycorrhizal fungi because they can only survive and reproduce on living plants. In most seasons, cotton can compensate for a slight delay in the development of mycorrhizas.

- Mycorrhizal development in cotton will be adequate after rotation with cereals or legumes in either summer or winter.
- After a single season with either bare fallow or rotation with a non-mycorrhizal crop (e.g. canola), there will usually be adequate mycorrhizal fungi in the soil for normal cotton growth.
- Topsoil removal (especially more than 40 cm) or more than one season of bare fallow can result in a severe lack of mycorrhiza; a cereal or green manure crop may restore sufficient mycorrhizal fungi for cotton.

Alternaria leaf spot

Alternaria leaf spot is ubiquitous in Australian cotton but seldom severe. The fungus, *Alternaria macrospora*, survives on cotton residues on the soil surface. Alternaria leaf spot at the pre-flowering stage is unlikely to cause later problems. Alternaria leaf spot affects mature cotton when stressed (e.g. premature senescence).

- Carryover of *Alternaria* is reduced by incorporation of cotton residues between consecutive cotton crops or by rotation with cereals.

Verticillium wilt

Verticillium wilt is widespread in much of NSW and southern QLD. *Verticillium* survives in infested cotton trash but does not multiply in crop residues. Verticillium wilt increases with the use of susceptible varieties of cotton. Weeds such as Noogoora burr and bladder ketmia are alternative hosts and, if allowed to proliferate during rotations, may increase the population of *Verticillium*.

- Rotation with cereals may decrease Verticillium wilt.

Fusarium wilt

Fusarium wilt is caused by the soilborne fungus *Fusarium oxysporum* f.sp. *vasinfectum*. The disease occurs widely in southern QLD and northwest NSW and is spreading in many other areas. *F. oxysporum vasinfectum* survives in infested cotton trash and may also multiply on residues from other crops. Hence, rotation with any crop has the potential to increase the severity of Fusarium wilt. Recent research has shown that vetch and mustard increased Fusarium wilt substantially when grown as biofumigation crops in a field with the disease (Table 1). The result was similar in a duplicate experiment using canola as a green manure crop (data not presented).

Table 1. Increased Fusarium wilt in cotton sown six weeks after incorporation of woolly pod vetch and Indian mustard in a field near Boggabilla in the 2001-02 season.

	Bare	Vetch	Mustard	
Initial plant stand (plants/m, 18 DAS)	7.9a	7.5a	5.8b	$p \leq 0.001$
Plants surviving to late-season (%)	60a	36b	46b	$p \leq 0.014$
Plants with little or no disease all season (%)	13.5a	1.7b	1.8b	$p \leq 0.001$

Values in rows with the same letter are not significantly different by pairwise comparison of means at the stated probability level. (DAS = days after sowing)

In a field experiment near Boggabri, *Fusarium* wilt was less severe when cotton stalks were mulched and then left on the soil surface for one month before incorporation, in comparison to incorporation immediately after mulching. This effect could be due to either (i) drying of the stalks on the soil surface or (ii) more-rapid growth of *Fusarium* when stalks are incorporated while still fresh.

- Do not grow green-manure or biofumigation crops in fields where *Fusarium* wilt occurs.
- Retain cotton residues on the soil surface for as long as possible before incorporation.
- Best bet option for infested parts of fields: sow cereal into standing cotton, pull and mulch cotton stalks and leave on surface, harvest cereal and burn stubble.

Acknowledgments

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