healthy soils case study

mycorrhizal fungi

VAM

Mycorrhiza after long fallows: is it still there?

A mycorrhizal myth unearthed

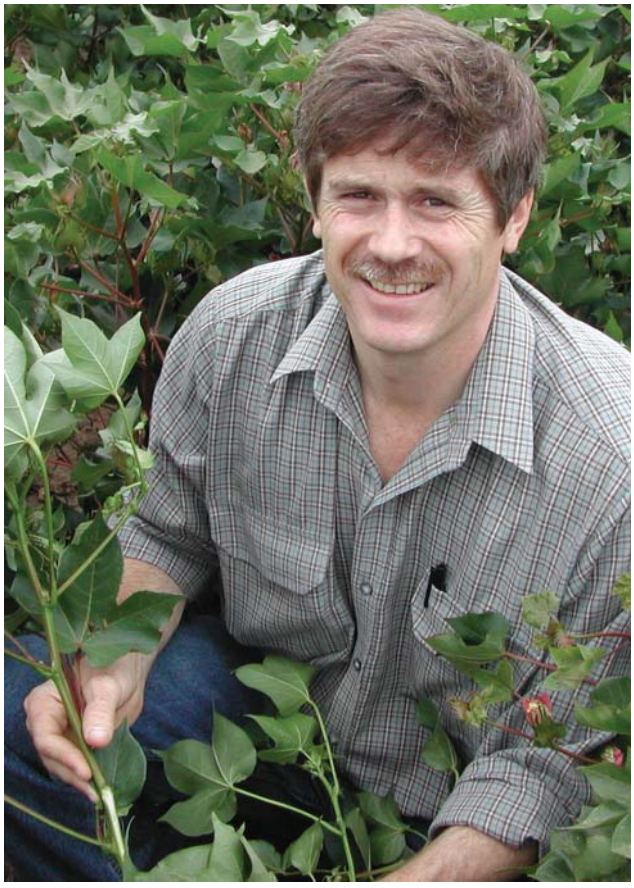
Management to help sustain mycorrhiza in your soil

- minimise soil disturbance during long fallows
- sow nurse crops such as wheat before a cotton crop
- use herbicides to control weeds and kill nurse crops instead of ploughing

Why act?

Most agriculturally important plants, including cotton, are colonised by soilborne fungi known as arbuscular mycorrhizal fungi (AMF) or otherwise known as vesicular arbuscular mycorrhizae (VAM). These fungi grow into the soil surrounding the roots, where they absorb 'immobile' elements such as phosphorus and zinc, which are transported to the roots and transferred to the plant. Generally, the improved nutrition of the plant outweighs the cost of supplying the fungi with sugars. In the field, cotton is highly dependent upon mycorrhiza for successful growth.

The mycorrhiza can only develop on living roots in the soil. If plants are absent for long periods the population of mycorrhizal fungi may decline and mycorrhizal development in subsequent crops may be reduced. This lack of mycorrhizal development, and consequent nutritional deficiencies (phosphorus and zinc), was reported to be the primary cause of long fallow disorder in many field crops. Soil disturbance also reduces mycorrhiza, as it breaks up the fungi.



"I can reassure growers that a long fallow, or a rotation with a non-mycorrhizal crop such as canola, won't cause any problems with VAM colonisation for your next cotton crop"

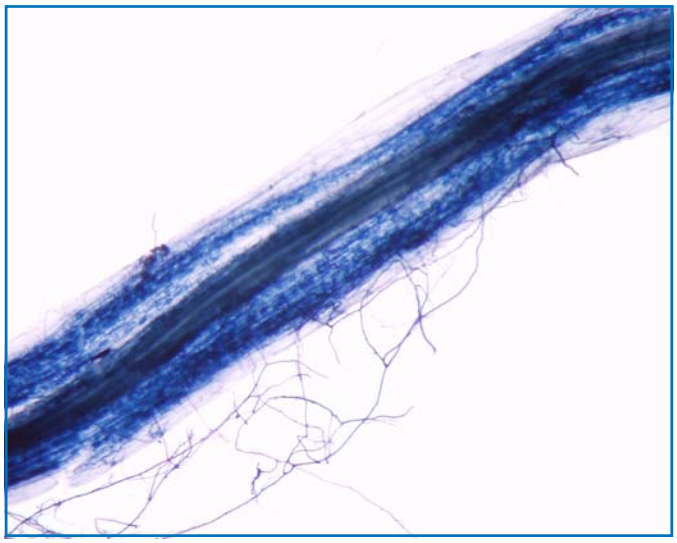
Dr David Nehl, Senior Research Scientist with the NSW Department of Primary Industries and the Cotton CRC

What is science saying?

Dr David Nehl, Senior Research Scientist with the NSW Department of Primary Industries, has investigated the survival of mycorrhizal fungi in three different farming systems across the cotton growing regions to confirm that long bare fallows and a rotation with canola (a non-mycorrhizal plant) do not decrease mycorrhizal development in subsequent cotton crops.

Irrigated winter crop rotation

Cotton was sown in a field at the Australian Cotton Research Institute (ACRI), Narrabri after: bare fallow, no cultivation; bare fallow with cultivation; wheat; chickpea; linseed or canola. The winter crops were sown immediately after the previous cotton crop then harvested and the fields were left bare until cotton was sown the following year. In both years, colonisation of cotton by mycorrhizal fungi was no lower after long bare fallow than with any of the other crops (Table 1).



A stained sample of arbuscular mycorrhizal fungi that has colonised a root

Table 1. Mycorrhizal colonisation and growth of cotton after bare fallow for 18 months or rotation with winter crops. (Source: Nehl et al., 2004)

	1992–93 cotton crop		1994–95 cotton crop	
Previous crop	AM root (%)	Shoot mass (g/plant)	AM root (%)	Shoot mass (g/plant)
18 months BF uncultivated	30	1.6	49	0.74
18 months BF cultivated	38	1.6	40	0.67
Wheat	36	1.8	38	0.74
Chickpea	25	1.5	36	0.67
Linseed	31	1.7	39	0.63
Canola	30	1.3	35	0.68

AM = arbuscular mycorrhizal; BF = bare fallow

Table 2. Mycorrhizal colonisation of cotton after bare fallow for 18 months or rotation with winter and summer cereals in a non-irrigated farming-system. (Source: Nehl et al., 2004)

	Arbuscular mycorrhizal root (%)		
Treatment	1994–95	1996–97	1998–99
Bare fallow	65	71	56
Sorghum	62	54	68
Wheat*	64	55	55

* Barley used as the 1993 winter crop

Table 3. Mycorrhizal (VAM) colonisation of roots of cotton and linseed after very long fallows at Bourke. (Source: Nehl et al., 2004)

	Field 45/46	Field 75
Fallow length	28 months	35 months
Effective sowing date*	24 March	30 March
Sampling time	42 days	36 days
Linseed VAM (%)	29 ± 3.1	37 ± 2.5
Cotton VAM (%)	28 ± 1.6	35 ± 1.2

* Seed was sown in both fields on 19 March into dry soil and then irrigated at the dates indicated

Rain-fed farming systems

Cotton was sown every two years on a commercial farm near Warra, Queensland, with no irrigation and the following rotations between cotton crops: bare fallow; summer sorghum; winter wheat or barley (sown straight after cotton). In comparison to rotation with winter or summer cereals, colonisation of cotton by mycorrhiza was not reduced by long bare fallows (Table 2). There were no significant differences in mycorrhizal colonisation over time in any of the rotations, including bare fallow.

Very long fallows

With the current drought, some cotton fields have experienced bare fallows of two years or more and there is a concern that the mycorrhizal fungi will not survive such long periods. Strips of linseed and cotton were sown in March 2004 in two fields at Bourke where very long bare fallows have occurred (Table 3).

The length of time that the mycorrhizal fungi have survived in these fields without any host plants is an indication that, even in long bare fallows, mycorrhizal fungi are still present in adequate population size to support the colonisation for the next cotton crop.

Research at the Bourke site, seen in these pictures, investigated the impact long fallows have on the presence of mycorrhizal fungi, or VAM

Michael Dummigon and David Nehl collect samples on the field trail at Bourke in the 2005–06 season

Cotton crop at Bourke in the 2005–06 season after four years of bare fallow on the left and back to back cotton on the right

Acotton crop at the Bourke site after a long fallow

The popular belief that bare fallows of 17 to 18 months reduce mycorrhizal development in cotton is misconceived. Mycorrhizal colonisation was not reduced by long bare fallows in any of the farming systems, nor by rotation with a non-mycorrhizal crop (canola). In most farm trials the levels of mycorrhizal colonisation were consistent with those normally observed in cotton. At some sites the development of mycorrhizal colonisation can be slower than elsewhere in the same field but other soil factors are involved.

The Solution

Mycorrhizal colonisation of cotton can develop very rapidly from small numbers of mycorrhiza. While the population of mycorrhiza may decline somewhat during bare fallows the remaining population is clearly adequate for cotton. The mycorrhiza in the soils used to grow cotton in Australia are undoubtedly indigenous populations that have evolved to cope with long periods of drought. Periods of very long bare fallow with wetting and drying cycles but no rotation crops or weed growth may lead to inadequate mycorrhizal development in cotton; however, such periods are unlikely to occur under the current cotton farming systems in Australia.

Dr David Nehl's research has confirmed that – contrary to previously held views – long bare fallows such as this one, or a rotation with canola (a non-mycorrhizal plant) do not decrease mycorrhizal development in subsequent cotton crops

Acknowledgement:

Dr David Nehl, Senior Research Scientist with the NSW Department of Primary Industries, for his dedication to plant pathology research.

Source

D.B. Nehl, S.J. Allen, A.H. Mondal and P.A. Lonergan. (2004). Do long fallows decrease mycorrhizas in cotton? Proceedings of 12th Australian Cotton Conference, Broadbeach

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