

# Spot the difference? Mycorrhiza in GM and non-GM cotton

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**G**ood growth in cotton plants is highly dependent on the establishment of a special relationship known as a mycorrhizal symbiosis. Mycorrhizas are highly evolved associations between soil fungi and plant roots and symbiosis means they are living together.

This mycorrhizal symbiosis forms when fungi in the soil colonise the roots of plants and both the plant and the fungus gain from the association. Many crops depend on mycorrhizal symbiosis and this is especially true for cotton (see photo, right) because the fungus is the primary means by which it obtains important elements, such as phosphorus, from the soil.

The phosphorus is transferred to the plant via arbuscules — microscopic, fungal structures that develop inside individual cells of the plant root (see photo below). Fungal threads grow into the soil surrounding the roots to absorb elements such as phosphorus and zinc. In effect, the fungi increase the volume of soil from which the root system can extract these elements. In return for the phosphorus, the plant provides the fungus with sugars produced by photosynthesis, which enables the fungus to grow.

Over the past few years there have been rumours that GM cotton is not mycor-



**Spot the difference:** when mycorrhizal fungi in field soil were eliminated by fumigation (left), growth at six weeks after sowing was dramatically decreased in comparison to the adjacent unfumigated soil (right) (grid denotes 10 cm squares).

rhizal. Because we were investigating the interactions of GM and non-GM cotton on soil microbiota, of which mycorrhiza are a component, we decided to investigate these claims.

During field trials in the 2003–04 and

2004–05 seasons, we sampled shoots and roots of GM and non-GM cotton. The shoots were assessed for dry weight comparisons, while the roots were recovered, blanched, stained with a fungal-specific dye and assessed for mycorrhizal colonisation by scoring for the presence of arbuscules. The assessments were initiated after planting and conducted early in the season, coinciding with the period when rapid colonisation of roots occurs.

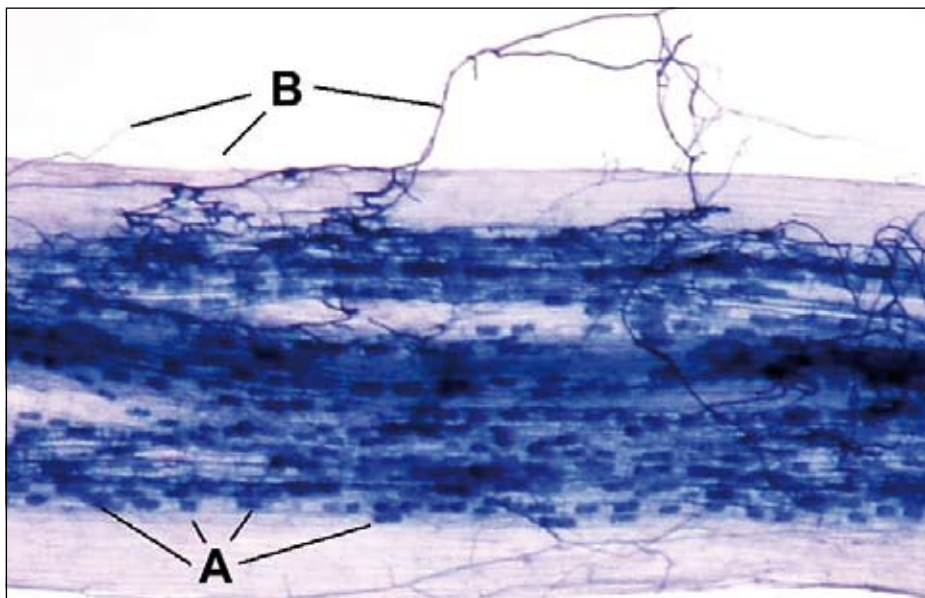
What we saw clearly indicated that both GM and non-GM cotton were mycorrhizal. Rather than take our word for it, why not see if you can ‘spot the difference’!!

## The 2003–04 season

The following graphs (Figure 1) are of the percentage of arbuscules scored for four samples of each variety recovered over time for both GM and non-GM cotton. Are there any clear cut differences between the plots?

## So how did you go?

The plots are very similar and all show some level of colonisation in most of the samples. There was a difference at the



**Staining of mycorrhizal cotton roots reveals masses of fungal arbuscules (A) and the external fungal filaments (B) that grow into the surrounding soil**

...48 ▷

second sampling time between the graphs with the open symbols and the filled ones because this trial, planted on October 10, was accidentally sprayed with Roundup shortly after emergence.

By the time of the second sampling all the non-RR varieties were dead and this was reflected in the colonisation of material sampled on October 31. As a result, the entire trial was disked out and replanted the same day into a drier soil profile. Mycorrhizal colonisation assessments were continued and, despite what was considered low levels of colonisation, we showed that:

- Mycorrhizal fungi colonised both GM and non-GM cotton;
- There was no statistical difference between varieties in levels of colonisation; and,
- Shoot dry weights were similar for all varieties and indicated good growth.

**The 2004-05 season**

This trial was monitored into January 2005. Shoot weight again indicated good plant growth without any differences among varieties, GM or otherwise. But what of the mycorrhizal colonisation? Well let's play spot the difference again.

The graphs in Figure 2 are for Sicot 189, Sicot 189RR, Sicot 289B and Sicot 289BRR. Are there any differences between them?

Without the legend, it is impossible to identify the varieties as there is no difference between them. This is because this trial, too, showed colonisation of both GM and non-GM cotton and no difference in the levels of colonisation between the two. Additionally, colonisation in this experiment was better than in the previous season and followed what was considered a more normal pattern, reaching very high levels (60 to 90 per cent).

There may have been several reasons for this better colonisation including a

difference in propagules within the field, better environmental conditions (such as moisture and temperature) and the fact that the crop was not replanted. Whatever the reason, it provided yet further evidence that GM cotton is mycorrhizal.

**Take home messages**

- Mycorrhizal fungi are an important part of the cotton production system and are essential for the plant to satisfy its requirements for certain nutrients, especially P and Zn.
- Over two seasons, assessment of field grown GM and non-GM cotton varieties indicated that GM cotton is mycorrhizal.
- GM cotton is just as mycorrhizal as non-GM cotton.

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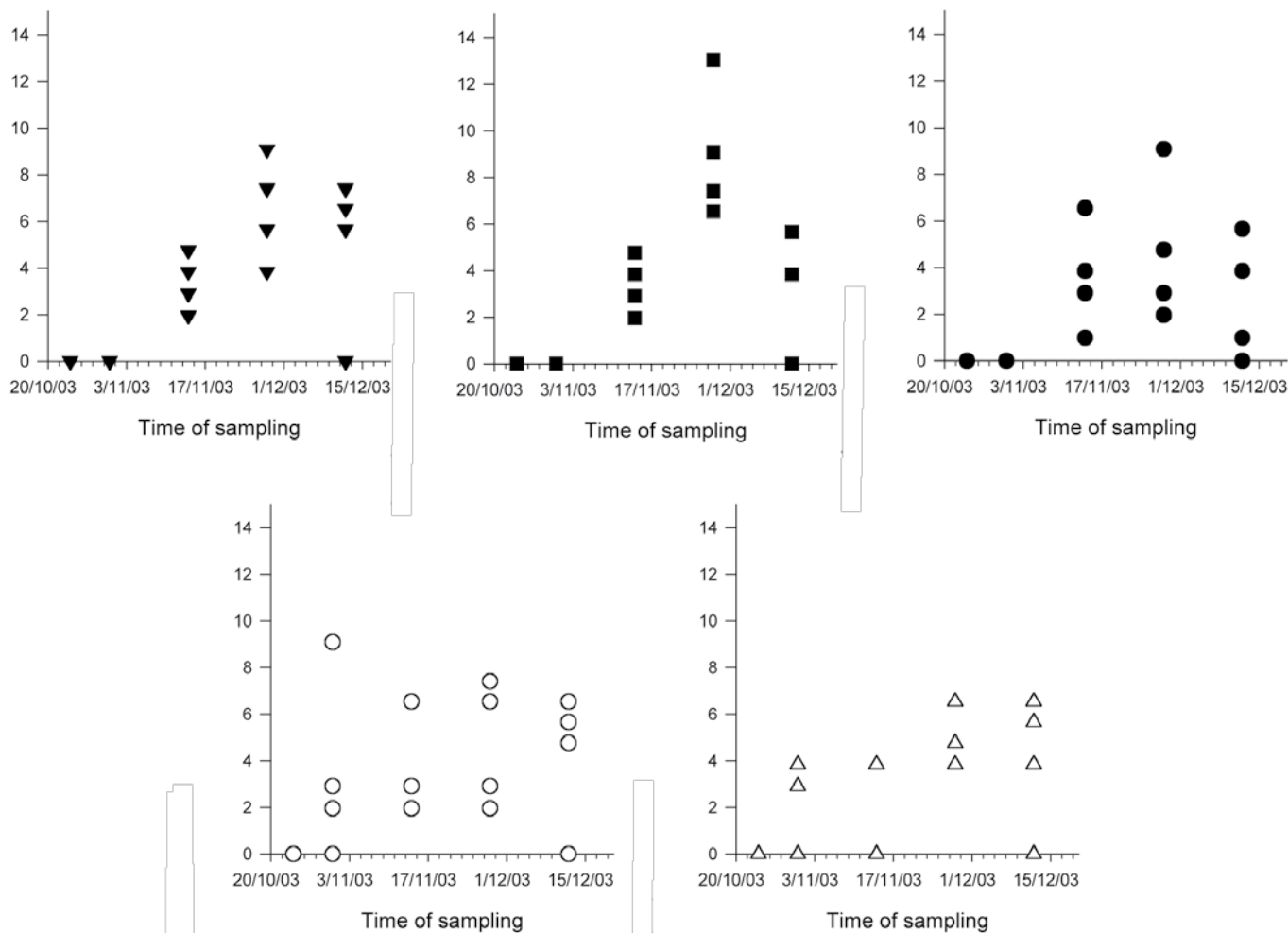
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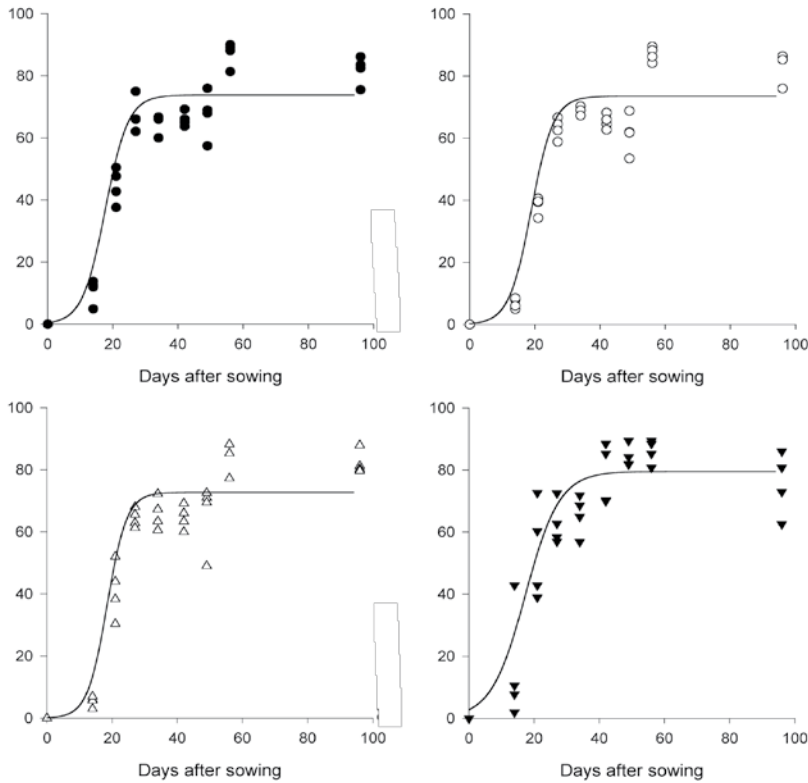
<sup>3</sup>Cotton Catchment Communities CRC



**FIGURE 1: 2003-04 plots of mycorrhizal colonisation as a percentage of arbuscules in roots of Sicot 189 (●), Sicot 189RR (○), Sicot 289i (■), Sicot 289B (▼) and Sicot 289BRR (△) recovered on given dates**



**FIGURE 2: 2004-05 plots of mycorrhizal colonisation as a percentage of arbuscules in cotton roots during 14 weeks after sowing (8 October 2004) in Sicot 189 (●), Sicot 189RR (○), Sicot 289B (▼) and Sicot 289BRR (△)**



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