Endophytic fungi add to plant defences

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Plants have a battery of physical and chemical defences that enable them to be resistant to herbivores and pathogens. Least understood and probably most effective are the induced compounds that act systemically within the plant[1].

The induced resistance may be long- or short-lived. Some compounds appear to be highly specific, while others have a broad capacity to decrease colonisation by viral, bacterial and fungal invaders[1]. At the same time, apparently benign fungi, known as endophytes, can be isolated from healthy tissues of most plants (Figure 1)[2].

Endophytes appear to re-colonise plants from germination through to senescence. Deterrence has been found and well characterised in the specific association between the grass endophyte *Neotyphodium* and the pasture grasses *Lolium* and *Festuca*[3]. We are interested in determining if the less specific endophytic fungi might be aiding the host plant in some way.

We have focused on examining whether endophytic fungi interact with pests and pathogens, using cotton and wheat as our model plants respectively. Cotton is subject to severe damage by larvae of the Lepidopteran *Heliothis armigera.* The insects eat leaves and burrow into bolls damaging the lint of cotton. Wheat is subject to attack by various rust fungi and the culturable *Pyrenophora tritici-repentis.*

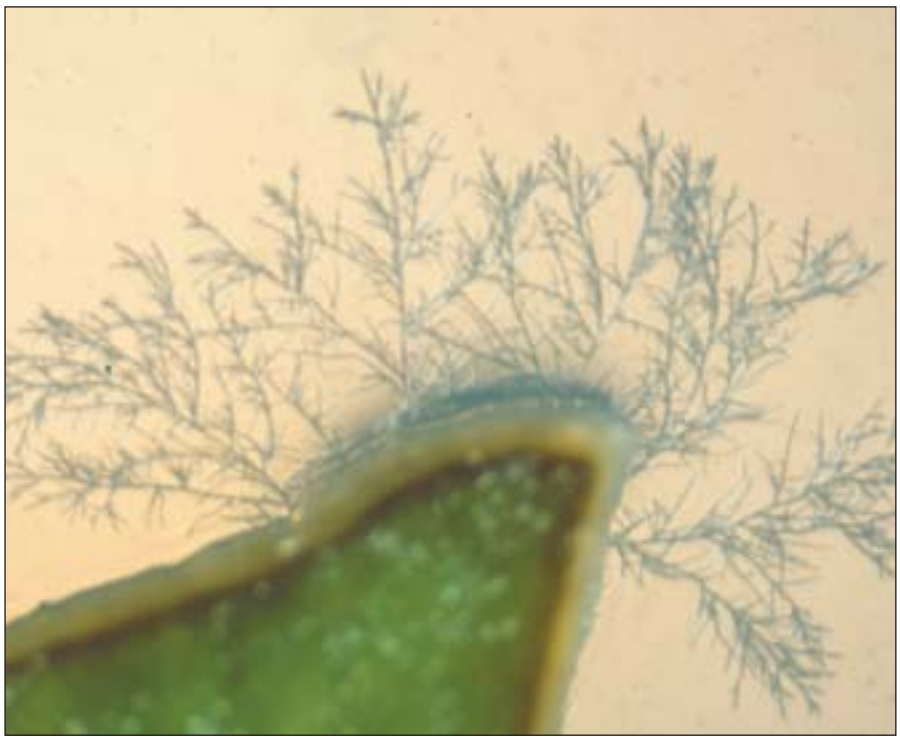
More than 15 apparently different fungi were isolated from cotton over one growing season from three locations in northern NSW and southern Qld. After potential pathogens were excluded, one type of fungus, tentatively identified in the genus *Phomopsis,* was found to be common and widespread[4]. *Phomopsis* and three other endophytic fungi were grown on agar. The cultures were washed with methanol and the washings filtered.

The larvae of *Heliothis* can be maintained on an artificial diet, enabling examination of the effect of the various washings after incorporation in the diet. Larvae fed on a diet containing cell-free washings from Phomopsis cultures were smaller. The reduction was variable and methanol itself reduced growth of the larvae[4].

Subsequent experiments showed that the effect was due to antifeedant rather than toxic or antinutritive effects. This conclusion was supported in feeding choice experiments, in which larvae preferred uninoculated leaves from the same or different plants to leaves inoculated with Phomopsis[4]. However, the data are confounded by the induction of an insect deterrent due to the way we segmented leaves [Creighton & McGee unpublished].

Induction of a host response was also observed in wheat co-inoculated with rust fungi and endophytes including *Chaetomium*[5]. In these experiments, the presence of the endophytic fungus in leaves or its cell-free washing on the leaf reduced the number and size of pustules of the rust fungus. The induction of resistance was maintained for up to 15 days. Resistance could also be induced if the washings and pathogen were spatially separated.

Figure 1. An unknown endophytic fungus emerging from a surface sterilised segment of *Banksia integrifolia* (photo by D Macarthur).



In subsequent experiments, we found that *Chaetomium* excretes several metabolites that inhibit the growth of the wheat pathogen *P. tritici-repentis* on agar. Some of these compounds are large, indicating that they may be proteinaceous, while others are quite small [Istifadah & McGee unpublished]. While these compounds remain to be identified, their presence in extracts indicate that *Chaetomium* may have a direct effect on some pathogens of wheat, in addition to inducing host resistance.

Plant pathogens and pests are showing increased resistance to pesticides. Use of pesticides is becoming increasingly unpopular because of the perceived risks of toxicity to humans. The controlled use of populations of endophytic fungi offers one alternative approach to reducing pests and pathogens. Management of natural populations of endophytic fungi will be difficult. Not only are the populations diverse, but their structure changes over time [6] and the mechanisms of interaction with both host and pest or pathogen appear to be complex. However, the data reported above encourage us to continue seeking alternatives to pesticides for the control of pests and pathogens.

References

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