Grower Summary

CP 106

Precolonisation of strawberry runners and tray plant with arbuscular mycorrhizal fungi to manage Verticillium wilt

Final 2017

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Project title:	Precolonisation of strawberry runners and tray plant with arbuscular mycorrhizal fungi to manage Verticillium wilt (AHDB Horticulture Studentship)
Project number:	CP 106
Project leader:	Prof Xiangming Xu, NIAB EMR
Report:	Final, Oct 2016
Previous report:	Annual report, Oct 2015
Key staff:	PhD student: Benjamin Langendorf
Location of project:	East Malling Research
Industry Representative:	Marion Regan, Hugh Lowe Farms Ltd
Date project commenced:	Oct 2013
Date project completed (or expected completion date):	Oct 2016

GROWER SUMMARY

Headline

1. Arbuscular mycorrhizal fungi (AMF) propagules can colonise strawberry roots when incorporated as a powder layer during the tipping or weaning process under misting conditions, irrespective of specific AMF strains or strawberry cultivars tested. AMF in colonised roots of tray plants can survive several months of cold storage at -2 °C.
2. However, a random mix of AMF inocula with compost in the commercial production of tipping plants resulted in a very low level of AMF colonisation. Thus, to incorporate AMF at this stage, we need to modify the commercial tipping process to ensure that AMF is present as a thin layer just below the surface of compost in each tray cell, increasing the likelihood of AMF colonisation of new roots during misting/weaning.
3. Pre-inoculation of strawberry tipping plants at the weaning stage with AMF does not necessarily improve plant growth during weaning and subsequent early growth before cold storage. Preconisation of plants with AMF did not reduce the wilt development in field conditions. AMF and PGPR (plant growth promoting rhizobacteria) could reduce development of red core (but not crown rot) but this effect is not consistent. We may conclude that using AMF and PGPR alone will not be able to increase the health of tray plants to reduce disease development significantly, especially when plants were either already infected or inoculated with a high dose of pathogen inoculum.
4. Combined with other on-going research, we conclude that using AMF in coir is likely to increase strawberry yield by 5%, particularly under reduced water or nutrient input.

Background

Verticillium wilt of strawberry caused by *Verticillium dahliae* was traditionally controlled in field soils through the use of soil fumigants to reduce quantities of the pathogen to levels which are not economically damaging to subsequent crops. With the gradual reduction in available soil fumigants over recent years, extensive effort has gone into finding alternative control methods including the incorporation of green manures that release volatile fungitoxic compounds (so-called biofumigation), which has shown promise as a component of a disease management strategy.

In a recent Defra Horticulture LINK project (HL0177, SF 77), the incorporation of lavender waste in soils prior to planting effectively reduced Verticillium wilt severity on strawberry. Three key terpenoids were identified as being responsible for the observed suppressive effect. In a subsequent TSB funded project led by East Malling Research (EMR), palletised lavender

waste and microencapsulated terpenoids are being assessed for their efficacy in controlling *V. dahliae.* However, it is almost certain that additional control measures will still be needed. Soil inhabiting arbuscular mycorrhizal fungi (AMF) have been shown to confer a number of benefits to their host plant including enhanced pathogen resistance, so there is merit in investigating this further to ascertain if it offers potential benefits to soil grown strawberry production. In a recently completed project (funded by Interreg), NIAB EMR researchers showed that AMF can increase strawberry yield by up to 10-15% in coir, particularly when plants were subjected either to reduced nutrients or reduced water input (Robinson Boyer et al. 2016).

This project, funded through the AHDB Horticulture studentship scheme, is investigating if pre-colonising strawberry plants with AMF leads to reduced incidence or severity of Verticillium wilt. During the project period, it has been decided, in consultation of the industry, that disease tolerance work should focus on *Phytophthora* instead of wilt because most strawberry production is now in substrate instead of soil.

We have carried out the following research work to investigate: (1) whether AMF could colonise tipping plants under weaning (humid misting) conditions, (2) whether there are interaction between AMF strains and strawberry cultivars in terms of AMF colonisation, (3) whether AMF in colonised roots of tray plants could survive a prolonged period of cold storage, (4) whether AMF colonisation could increase plant tolerance to wilt, (5) whether AMF colonisation could increase plant tolerance to *Phytophthora* diseases, and (6) whether we could establish an *in vitro* system to study the strawberry-AMF-pathogen interaction.

Summary

The work has demonstrated that arbuscular mycorrhizal fungi (AMF) can colonise *in-vitro* produced plantlets in vermiculite and runner-tip produced plants in a peat/perlite based substrate irrespective of AMF strains/species and strawberry cultivars tested. The high moisture conditions during weaning/tipping did not prevent AMF from colonising roots. AMF can survive inside colonised strawberry roots during cold storage at -2°C for several months. Therefore, AMF inoculated during the weaning stage of micro-propagated plants or runner tips can result in a high success rate of mycorrhizal colonisation, independent of plant material size and/or the strawberry cultivar. Commercial AMF inocula may be applied during strawberry tipping without reducing the mycorrhiza viability during subsequent cold storage of pre-colonised plants.

However, pre-inoculation of strawberry transplants with AMF does not necessarily translate to improved plant growth during weaning and subsequent growth prior to cold storage. All AMF

species tested on the tissue culture produced plants of the genotype EM1996 increased the crown diameter of the plantlets, but this increase was only significant with the AMF *Rhizophagus irregularis*. For the runner tip produced plants, the effects of AMF inoculation on crown diameter varied greatly with specific combinations of AMF and cultivars. However, the differences between different AMF treatments were very small and hence are not likely to have any commercial consequences in terms of the yield potential.

The incidence of wilt in potted experiments was very low, despite the fact we used field soil with a moderate level of wilt inoculum. A large field trial showed that AMF pre-inoculation did not improve plant growth after transplantation in soils and did not reduce the incidence of wilt. This result indicates that pre-colonisation of plants with AMF did not offer sufficient advantage over colonisation of plants by resident AMF inoculum in the soils.

Joint inoculation of plants with AMF and PGPR appeared to slow down development of red core rot symptoms. However, these treatments did not affect development of crown rot. This is probably not surprising given the fact we wounded plants before inoculation of a large dose of pathogen inoculum. Thus, improved tolerance offered by AMF and PGPR is not likely to be strong enough to cope with such a high infection pressure. Indeed this finding agrees with the current consensus that AMF/PGPR will only be able to improve plans tolerance against a low to moderate level of disease pressure. Thus, we conclude that use of AMF and PGPR alone will not be able to reduce disease sufficiently when disease pressure exceeds low level.

Use of AMF and PGPR led to increased yield of ca. 5-10% in coir, agreeing with recent studies at NIAB EMR. This is especially the case when strawberry plants were subjected to reduced fertigation regime. Thus combining results from several studies at NIAB EMR, we conclude that use of AMF will on balance lead to increased fruit yield in the range of 5-10% when plants are under reduced fertigation regimes in coir. This increased yield potential may be the main reason for growers to consider using AMF in practice.

In a commercial strawberry nursery, random mix of AMF inocula with compost in the commercial production of tipping plants resulted in a very low level of AMF colonisation (3%), compared to > 60% when a thin layer of AMF was placed just below the surface of compost. Thus, to incorporate AMF at the tipping/weaning stage, we need to modify the commercial production procedure such that a thin layer of AMF is placed below the surface of compost in each cell. It will greatly increase the likelihood of AMF colonisation of new roots during misting/weaning.

Financial Benefits

This is a PhD research project, focusing more on the research aspect. Thus, it does not directly impact on growers' practice. However, this research does suggest that arbuscular mycorrhizal

fungi (AMF) can colonise plants during the tipping/weaning process, and can increase strawberry yield in coir, especially when growers adopt regulated fertigation scheme to save water and nutrient.

- The best estimate of yield increase due to AMF is ca. 5%.

However, the precise financial benefit will depend on the cost of AMF, how plants are to be pre-colonised with AMF and the extent of reduction in fertigation.

However, it should be stressed that pre-colonisation of plants with AMF will not likely result in any noticeable reduction in the level of diseases.

Action Points

- Growers should consider using arbuscular mycorrhizal fungi (AMF) in coir production if they are planning to reduce water or nutrient input.
- Large growers should consider conducting their own trials to assess the benefit of using AMF, particularly in relation to water and nutrient input.
- NIAB EMR will be more than happy to assist growers in trialling AMF.
- Currently, there is an on-going Innovate UK project relating to the use of AMF in substrate strawberry, which may greatly influence the commercial future of AMF in substrate strawberry production. This project will finish in October 2017.