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Ericoid fungal inoculation of blueberry under commercial production in South Africa

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ABSTRACT

Ericoid mycorrhizal (ERM) fungi are known to enhance growth of plants belonging to the Ericaceae family. However, the outcomes of root-fungal associations in this family are influenced by several factors such as soil nutrient status, climatic conditions, host variety and fungal partner. The aim of this study was (i) to determine whether symbiotic fungal structures form in roots of Misty (*Vaccinium corymbosum*) and Brightwell (*V. ashei*) blueberry varieties, following inoculation with *Leohumicola*, *Oidiodendron maius* and *Meliniomyces* fungal species, and (ii) evaluate inoculation effects on the growth of blueberry varieties. The study was conducted for 60 weeks under commercial production conditions at Amathole Berries, Sutterheim, South Africa. All three fungi were isolated from *Erica* plants growing naturally in Albany Centre of Endemism of South Africa. All ERM formed mycorrhizal structures characteristic of typical ericoid colonisation in the roots of both Misty and Brightwell. However, percentage colonisation was low. The highest colonisation percentage, 20.4%, was observed in Misty inoculated with *Oidiodendron maius*. Colonisation was significantly different compared to un-inoculated controls in the Misty variety. In both varieties inoculated with either *Leohumicola* or *Meliniomyces* did not improve ($p > 0.05$) shoot growth and biomass. All fungal species improved root biomass in Misty but not in Brightwell. This indicates that ERM inoculation may potentially benefit plant of Misty and that responses to ERM inoculation vary between blueberry varieties.

1. Introduction

Commercial blueberry (*Vaccinium* spp.) cultivation is a fast growing division of the horticulture industry in South Africa. According to Ryan Davies, the chairperson of South African Berry Producers' Association (SABPA), growers export three-quarters of the total produce. They find a ready market in Europe and the United Kingdom during the (September to mid-February) summer season (Personal communication), taking advantage of the off season market gap in the northern hemisphere. There is also potential for expanding to other market regions globally due to escalating demand (Meyer and Prinsloo, 2003).

Blueberries have variable uses which range from direct consumption as a fruit to pharmaceutical and cosmetic applications (Ghafar et al., 2010; Riihinen et al., 2008). They are rich in phenolic compounds such as anthocyanin pigments which give them the deep blue colour. The presence of chlorogenic acid, procyanidins and flavonoids phytochemicals enable blueberries to provide therapeutic health benefits to consumers (Smith, 2000). The benefits include antioxidant and anti-carcinogenic properties. In addition, they prevent cognitive decline during aging and diseases caused by the hepatitis C virus (Joseph et al., 2009; Koca and Karadeniz, 2009). Such benefits have resulted in increased blueberry consumption.

The genus *Vaccinium* belongs to the plant family Ericaceae. In nature ericoid mycorrhizal (ERM) fungi engage in symbiotic relationships with the Ericaceae. This enables the host root to access organic nutrients, a transfer facilitated through extracellular fungal enzyme activities secreted by the respective fungi (Cairney and Meharg, 2003). In a previous study Bizabani (2015) reported the ability of *Leohumicola*, *Oidiodendron maius* and *Meliniomyces* to utilize various organic and inorganic nutrient sources in culture. These characteristics are typical for ERM fungi (Midgley et al., 2006; Cairney et al., 2000; Chen et al., 1999). It has led to the suggestion that they potentially facilitate host nutrition in their natural ecological habitats. Growth benefits of ERM on *Vaccinium* grown in South Africa are unknown.

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The ERM status of fungi belonging to genus *Leohumicola*, *Oidiodendron* and *Meliniomyces* has previously been established with various Ericaceae hosts (Grunewaldt-Stöcker et al., 2013; Villarreal-Ruiz et al., 2012; Vega et al., 2009). *Leohumicola* species have been mostly identified from burnt ecosystems, commercial blueberry cultivation fields and ericaceous roots in the fynbos of South Africa (Nguyen and Seifert, 2008). Their ability to form ERM structures in ericaceous roots has been reported (Grunewaldt-Stöcker et al., 2013), but the functional roles are still vague. High isolation frequency of *Leohumicola* genus from *Erica* roots growing in the Albany Centre of Endemism (Bizabani, 2015), suggests they could have an important role in *Erica* growth and establishment. *Oidiodendron* spp. has widely been used to inoculate blueberry plants, and in addition to ERM structures it enhanced growth of

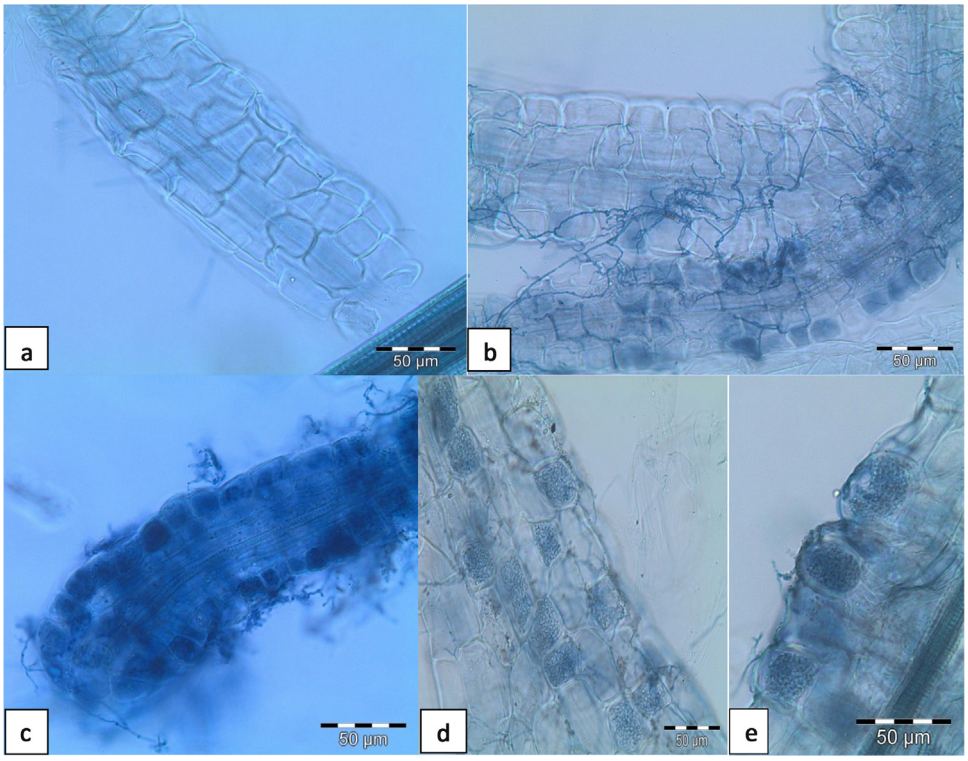

Fig. 1. Colonisation of Misty variety 60 weeks after inoculation showing (a) no colonisation (b) Intercellular hyphae in un-inoculated control. Ericoid mycorrhiza structures in plants inoculated with (c) *Leohumicola* (Chem038) (d) *Oidiodendron maius* (CafRU082b) (e) *Meliniomyces* (ECRU075).

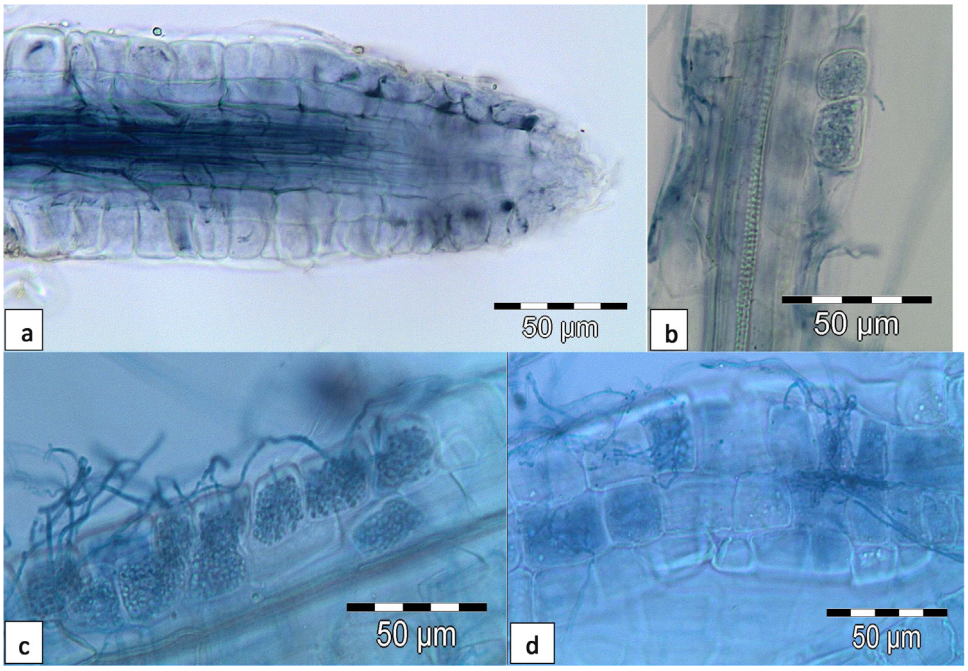

Fig. 2. Colonisation of Brightwell variety 60 weeks after inoculation (a) no colonisation in un-inoculated control. Ericoid mycorrhizal structures in plants inoculated with (b) *Leohumicola* (Chem038), (c) *Oidiodendron maius* (CafRU082b) (d) *Meliniomyces* (ECRU075).