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EFFECTS OF SELECTED FUNGICIDES ON VESICULAR- ARBUSCULAR MYCORRHIZAL SYMBIOSIS

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SUMMARY

Nampiah Sukarno. 1994. **Effects of selected fungicides on vesicular-arbuscular mycorrhizal symbiosis**. Ph D thesis, Department of Soil Science, The University of Adelaide, Australia.

The application of fungicides to increase crop yields may lead to detrimental effects on plants and their vesicular-arbuscular (VA) mycorrhizal fungi. The effects of the systemic fungicides Aliette, Benlate and Ridomil on the symbiosis between onion (*Allium cepa* L.) and the VA mycorrhizal fungus *Glomus* sp. "City Beach" (WUM 16) were studied in terms of plant and fungal growth and phosphorus (P) uptake. Growth and mycorrhizal infection were assessed by conventional methods, supplemented by vital staining and image analysis. The efficiency of symbiosis was assessed using P uptake per unit length of root (inflow), P uptake per unit length of living external hyphae in the soil, and transfer of P from the fungus to the host plant per unit area of interface.

In this thesis the following aspects are reported:

1. Development of a satisfactory method for measurement of living external hyphae in the soil. The vital stain fluorescein diacetate (FDA) produced a good contrast against the dark background and this was selected for future work.
2. Suitable non-mycorrhizal control plants were established in order to avoid confounding effects of P deficiency and fungicide application in non-mycorrhizal plants. Although this proved difficult to achieve, the most closely "matched" non-mycorrhizal plants were produced by addition of $15 \mu\text{g P g}^{-1}$ soil.
3. The effect of systemic fungicides on non-mycorrhizal plants was assessed. Benlate had no effect on onion plants whereas Aliette and Ridomil markedly

reduced growth, particularly of roots. Benlate had no effect on shoot P concentration. Ridomil had no effect on shoot P concentration at early harvests, but later shoot P concentration increased. In plants treated with Aliette the shoot P concentration and content were significantly increased despite the reduction in plant growth. This led to the Experiments reported in section 5 below.

4. Two experiments were conducted under growth room conditions to determine the effects of the three fungicides on onion plants associated with *Glomus* sp. "City Beach" (WUM 16). All three fungicides had negative effects on growth of the mycorrhizal fungus both in soil and in the root.

Benlate appeared to act directly on the fungus, reducing percentage infection markedly, together with intensity of infection (number of arbuscules, intercellular hyphae and vesicles), area of interface and development of external hyphae in the soil. P inflow and P transfer across the living interface were reduced. The rate of P uptake per cm living external hyphae was not affected but, as development of external hyphae was reduced, the contribution of the fungus to P uptake was limited.

Aliette and Ridomil were found to act both on the plant and the fungus. Aliette reduced mycorrhizal colonization and development of external hyphae in the soil. The intensity and characteristics of infection per unit length of root were not affected but, as this fungicide reduced root growth, the area of interface per plant was lower. The reduction in length of external hyphae and in area of interface on a per plant basis and negative effect of Aliette on plant growth led to stunted growth of mycorrhizal plants following Aliette application. Mycorrhizal plants recovered after 13 weeks but non-mycorrhizal plants remained stunted. Aliette increased P concentration and content as observed in non-mycorrhizal plants. This led to the experiments reported in section 5 .

Ridomil reduced mycorrhizal colonization, intensity and characteristics of infection, area of interface between plant and fungus and length of external hyphae in the soil. P inflow per cm root and P uptake per cm living external hyphae were reduced but not significantly. There was no effect on the rate of P transfer across the interface, but shoot P concentration and content were reduced.

5. The effects of Aliette on growth of both non-mycorrhizal and mycorrhizal plants was investigated in greater detail. The effects of aluminium (applied as aluminium chloride) and phosphonate (applied as dimethyl phosphonate), degradation products of Aliette, were compared with Aliette itself. Aluminium chloride alone had no effects on the growth of either non-mycorrhizal or mycorrhizal plants at the pH of the soil used. Dimethyl phosphonate and Aliette markedly reduced plant growth, especially root growth. The effects of Aliette were more severe than those of dimethyl phosphonate.

NMR spectroscopy was used to determine the relative concentration of phosphonate and phosphate. Both non-mycorrhizal and mycorrhizal plants took up phosphonate as well as phosphate following Aliette or dimethyl phosphonate application. The relative concentration of the two compounds in the plant tissue correlated with the reduction of plant growth. The results suggest that phosphonate is converted to phosphate by plant and fungus. The recovery from initial stunted growth of mycorrhizal plants appears to be due to ^{the} mycorrhizal fungus being more efficient in converting phosphonate to phosphate than non-mycorrhizal plants. Other mechanisms are also discussed.