The effects of legumes on arbuscular mychorrhizal colonisation and phosphorus uptake on wheat

A thesis submitted to The University of Adelaide in fulfilment of the requirements for the degree of Master of Agricultural Science

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Grateful to God, the Almighty

Dedicated to my beloved Father

Andi Mappelawa

you are always in my memory and my heart

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ABSTRACT

A number of studies have shown that biomass and P uptake in cereals following legumes are higher than in cereals following cereals. The positive effect of legumes on the following wheat may be due to the growth of legumes prior to wheat and/or due to nutrients released during decomposition of legume residue that are used by the subsequent wheat. The aim of this study is to assess the effects of legumes and/or their residues on AM colonisation, P uptake and the growth of the following wheat.

A series of short experiments were carried out to assess the relationship between P addition, P availability, P uptake and AM colonisation of wheat in a soil with low P availability under conditions in which N was not limiting. Young and mature faba bean shoots (FYS, FMS) and mature chickpea shoots (CP) were added to the soil at different rates. Other treatments included addition of inorganic P at different rates. As expected, inorganic P addition increased growth and P uptake, but decreased AM colonisation. AM colonisation was not correlated with available P in the soil amended with residues, whereas there was significant negative correlation between available P and AM colonisation within the treatments with inorganic P. FMS and CP addition not only decreased wheat growth and P uptake but also AM colonisation despite low P availability in the soil. It is concluded that addition of some legume residues cannot be explained solely by soil P availability.

The aim of the first experiment with legume pre-crops was to identify the effect of legumes as a pre-crop and their residues on AM colonisation and P uptake by the following wheat. Four pre-crops (chickpea, faba bean, white lupin and wheat) were grown for 10 weeks in the loamy sand. Before planting wheat as the following crop, several treatments were imposed: (1) both roots and shoots of the pre-crop were removed completely; (2) only roots (0.04 % w/w) were added back into the soil to determine; (3) only shoot residues(0.24% w/w) mixed with soil; (4) a mixture of shoot and root residues (0.24% shoots + 0.04 % w/w roots) was added. Wheat growth and P uptake were greatest in the previously unplanted soil. Among the legume pre-crops, only white lupin increased the growth and P uptake but decreased AM colonisation of the following wheat compared with wheat as a pre-crop.

The aim of last study was to investigate the effect of legume pre-crop and soil water content during the fallow period on P uptake and AM colonisation by the following wheat. The experimental design was similar as in the study described above but there was fallow period of one month. During the fallow there were two treatments: (1) soil moisture was maintained at 70% water-holding capacity, and (2) allowed to dry and maintained dry until wheat sowing and rewet to 70% water-holding capacity. Dry weight was generally similar with previous study while N and P concentrations of faba bean and white lupin were higher in this study. If compared with previous experiment without fallow time, this experiment showed a surprising results for N concentrations were about 50% lower in constant moisture treatment, while in drying-rewetting treatment resulted similar value with previous experiment.

DECLARATION

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LIST OF PUBLICATIONS

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