New rhizobia to improve the nodulation and production of faba bean and lentil on acid soils

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As the area sown to faba bean and lentil expands, crops are being grown in areas where soil acidity (pH less than 5.0, measured in 0.01M calcium chloride) is limiting crop nodulation and performance. Beans in the high rainfall areas of western Victoria and south-east South Australia (SA) and lentils on well drained acid soils in parts of SA and southern NSW are known to be affected. It is likely to become an issue in other areas, if soil pH continues to decline.

The nodulation of faba bean, lentil, pea and vetch by *Rhizobium leguminosarum* bv. *viciae* (*Rlv*) is sensitive to soil acidity. Below pH_{Ca} 5.0, proliferation of the rhizobia around plant germination, steps in the nodulation process and persistence of the rhizobia in the soil are detrimentally affected. Since strains of rhizobia can vary in their acidity tolerance, work is being undertaken to determine if there are strains with greater acidity tolerance than WSM1455, the current Group F inoculant strain for bean and lentil.

Strains of *Rlv*, including some sourced from acidic soils, were selected for further assessment, based on their ability to nodulate seedlings growing in hydroponic solutions maintained at pH 4.2.

Promising *Rlv* strains (SRDI-969, SRDI-970 and WSM-4643) have now been tested at up to 19 field locations (mainly in SA and Vic., covering a range of hosts and soil types) to examine their effect on nodulation, crop biomass production, N_2-fixation and grain yield. Included are two studies of soil colonisation by the rhizobia. The ability of the strains to survive on seed post inoculation has also been examined.

Pulse crop performance on acid soils was consistently improved by rhizobia strain SRDI-969, compared to WSM1455. Site means for nodulation, legume dry matter, N_2-fixation and grain yield were increased on average by +56, +15, +24 and +14 percentage units respectively. The same measures were increased by approximately +30, +7, +6 and +5 percentage units, by strains SRDI-970 and WSM-4643. Regardless of the rhizobia strain used, nodulation was reduced to negligible levels at pH 4.2, indicating the requirement for liming to increase soil pH above that level.

In acid soil colonisation studies, strains WSM-4643 and SRDI-969 were more persistent and increased nodulation compared to WSM1455. However, soil colonisation by the rhizobia was

still limited, indicating that re-inoculation will be needed each time the crop is grown and that there may still be opportunity for further strain improvement.

Survival of the rhizobia strains on seed stored in the laboratory (lentil and bean) varied. In this regard, SRDI-970 survived at highest number. WSM-1455 and SRDI-969 survived at lower but similar number. WSM-4643 survived least well, which may explain reduced nodulation by the strain in some field trials.

Although WSM-1455 has consistently been out-performed, none of the alternative strains performed best across all measures. In terms of crop impact, SRDI-969 has performed best so far, with further evaluation underway in 2019. Pending the outcome of current trials, the replacement of WSM-1455 is planned for 2021.