

Research Application Summary

**Effectiveness of *Rhizobium leguminosarum* strains nodulating hairy vetch, an introduced forage legume in the sandy soils of Zimbabwe**

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**Abstract**

Results from field experiments in Zimbabwe in 2009/10 - 2010/11 showed that nodulation of hairy vetch is erratic resulting in poor performance of the crop. The need to inoculate hairy vetch was therefore assessed using three (3) *Rhizobium leguminosarum* strains locally available in Zimbabwe's strain bank. Strains MAR1504, MAR 833, MAR 346 were evaluated for their N fixing effectiveness under common acidic soil conditions and when limed to pH 6.5 (CaCl<sub>2</sub> scale). In the greenhouse, strains MAR 833 and MAR 1504 produced the highest biomass (at least 50% more dry mass as compared to the control). The findings suggest that hairy vetch productivity hence its contribution to soil N may be improved.

Key words: Hairy vetch, nitrogen fixation, nodulation, *Rhizobium leguminosarum*, Zimbabwe

**Résumé**

Les résultats des expériences sur le terrain au Zimbabwe en 2009/10-2010/11 ont montré que la nodulation de la vesce velue est erratique entraînant une faible performance de la culture. La nécessité d'inoculation de la vesce velue a donc été évaluée en utilisant trois (3) souches de *Rhizobium leguminosarum* disponibles localement dans la banque de souches du Zimbabwe. Les souches MAR1504, MAR 833, MAR 346 ont été évaluées pour leur efficacité de fixation d'azote N sous les conditions communes des sols acides et quand elles sont chaulées au pH = 6,5 (échelle de CaCl<sub>2</sub>). Dans la serre, les souches MAR 833 et MAR 1504 ont produit la plus forte biomasse (au moins 50% de plus de biomasse sèche par rapport au témoin). Les résultats suggèrent que la productivité de la vesce velue, donc sa contribution à l'azote N dans le sol peut être améliorée.

Mots clés: Vesce velue, fixation de l'azote, nodulation, *Rhizobium leguminosarum*, Zimbabwe

## Background

In order to realise high hairy vetch biomass yields and hence increased soil fertility, it must be inoculated by an efficient rhizobium strain for N fixation. Many failures with vetch have been directly attributed to lack of inoculation (Henson and Schoth, 1955). Results from field experiments in Zimbabwe in 2009/10 - 2010/11 showed that nodulation of hairy vetch is erratic resulting in poor performance. The aim of this study was therefore, to assess the comparative efficaciousness of *Rhizobium leguminosarum* strains in the local strain bank at the Grasslands Research Station (GRS) on nodulation and N<sub>2</sub> fixation of hairy vetch on sandy soils. This study consisted of a greenhouse and field trial.

## Literature Summary

Hairy vetch is a temperate legume often suggested as a preferred legume cover crop to supply nitrogen and suppress weeds in a maize production system (Czapar, 2002). It is described as one of the best legumes in its ability to be productive in low soil fertility or acid soils (Dastikaite *et al.*, 2009). Lanyasunya *et al.* (2007) demonstrated that in a tropical climate (Kenya) hairy vetch can yield dry matter of up to 9.5 t ha<sup>-1</sup> and in Iran and Japan, sole hairy vetch can produce dry mass yields of up to 6.14 t ha<sup>-1</sup> (Soudabeh Shobeiri *et al.*, 2010) and 4.47 t ha<sup>-1</sup> (Anugroho and Kitou, 2011) respectively. The potential of hairy vetch for use in tropical areas like Zimbabwe is therefore high since it is drought tolerant and is adapted to sandy soils.

## Study Description

*Greenhouse experiment:* A greenhouse experiment was run using potted field soil from June 2011 up to 80 days after planting (DAP). Soil for pots was collected from a depth of 10-15cm at the Grasslands Research Station (GRS) and sieved through a 5mm mesh screen to remove stones and twigs. Half of the soils were limed and allowed to equilibrate for 7 days to bring the pH to 6.5. Each pot received 4 kg of unsterilised soil and 21 mg kg<sup>-1</sup> soil of phosphorus (P). The various bacterial strains were applied as liquid inoculants to their respective pots at planting and a further application added at two weeks after germinating. The strains used were MAR 833 (Sydney, Australia 391/SU, 1993), MAR 346 (Pretoria, South Africa, 1993) and MAR 1504 (nifTAL, Hawaii 638/TAL, 1993). Pots receiving no inoculant had the equivalent volume applied as distilled water. The experiment was arranged as a completely randomised blocked design (CRBD) with treatments replicated 4 times. Three (3) strains were tested with a negative control in limed and acidic soil to give eight (8) treatments: i) MAR 833, ii) MAR 1504, iii) MAR 346, iv) No Rhizobium, v) MAR 833 + lime, vi) MAR

1504 + lime, vii) MAR 346 + lime, and viii) No Rhizobium + lime.

*Field experiment:* Hairy vetch was planted in 5 m x 5 m plots in the 2011 – 2012 season spaced at 0.1 m x 0.3 m. Basal fertiliser was broadcasted within each plot at planting as single super phosphate (SSP) at a rate of 200 kg/ha (19% P<sub>2</sub>O<sub>5</sub>). *Rhizobium* inoculant was applied as a slurry to the seeds at planting. The experimental design was a Randomised Complete block design (RCBD) with 4 treatments (MAR833, MAR 1504, MAR 346 and a Control) replicated 4 times. The strains used in the study were

## Research Application

Inoculating hairy vetch significantly improved its biomass production (Table 1 and Table 2) and hence its possible contribution to soil fertility. Results from the greenhouse experiment have shown that strains MAR 833 and MAR1504 produced significantly higher biomass than MAR 346 and the control. An analysis of N contents in the shoots and roots revealed that the inoculated pots had significantly higher N contents compared to the uninoculated control. No nodulation was observed in the uninoculated pots when plants were sampled at 80 DAP (Table 2) indicating the need to inoculate hairy vetch because local soils might lack the right strain to effectively nodulate and fix nitrogen. The field experiment is still running and therefore biomass and N content results are not available.

**Table 1. Biomass production of hairy vetch inoculated with various *Rhizobium leguminosarum* strains in an acidic and limed sandy soil in the green house.**

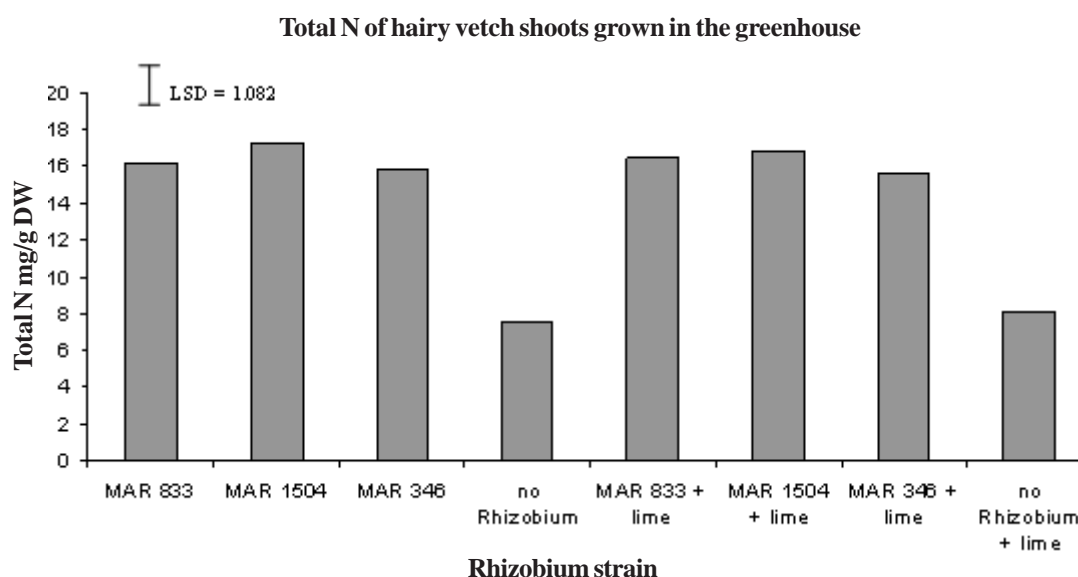
Treatment	Above ground Dry mass (g)	Root dry mass (g)
MAR 833	10.34 <sup>a</sup>	3.74 <sup>d</sup>
MAR 1504	9.96 <sup>a</sup>	4.49 <sup>d</sup>
MAR 346	6.69 <sup>b</sup>	3.73 <sup>d</sup>
-Rhizobium	4.09 <sup>c</sup>	3.53 <sup>d</sup>
MAR 833 + Lime	9.31 <sup>a</sup>	4.38 <sup>d</sup>
MAR 1504 + Lime	9.95 <sup>a</sup>	3.85 <sup>d</sup>
MAR 346 + lime	7.20 <sup>b, c</sup>	3.66 <sup>d</sup>
-Rhizobium + lime	5.32 <sup>c</sup>	3.40 <sup>d</sup>

Values in the same column with similar letters are not significantly different.

**Table 2. Nodulation of hairy vetch in the field at the Grasslands Research Station (GRS) in Marondera sampled at 80 days after planting (DAP).**

Treatment	Number of nodules */plant	Nodule dry mass */plant	Plant dry mass * (g)
MAR 833	24 <sup>a</sup>	0.1758 <sup>a</sup>	9.52 <sup>a</sup>
MAR 346	22 <sup>a</sup>	0.1292 <sup>b</sup>	3.79 <sup>b</sup>
MAR 1504	15 <sup>b</sup>	0.1575 <sup>a</sup>	8.86 <sup>a</sup>
No Rhizobium	0 <sup>c</sup>	0 <sup>c</sup>	0.77 <sup>c</sup>
LSD	3.579	0.02937	0.836
% CV	14.6	15.9	9.1

\*Data are averages of 5 plants sampled from each treatment plot; Values in the same column with similar letters are not significantly different.



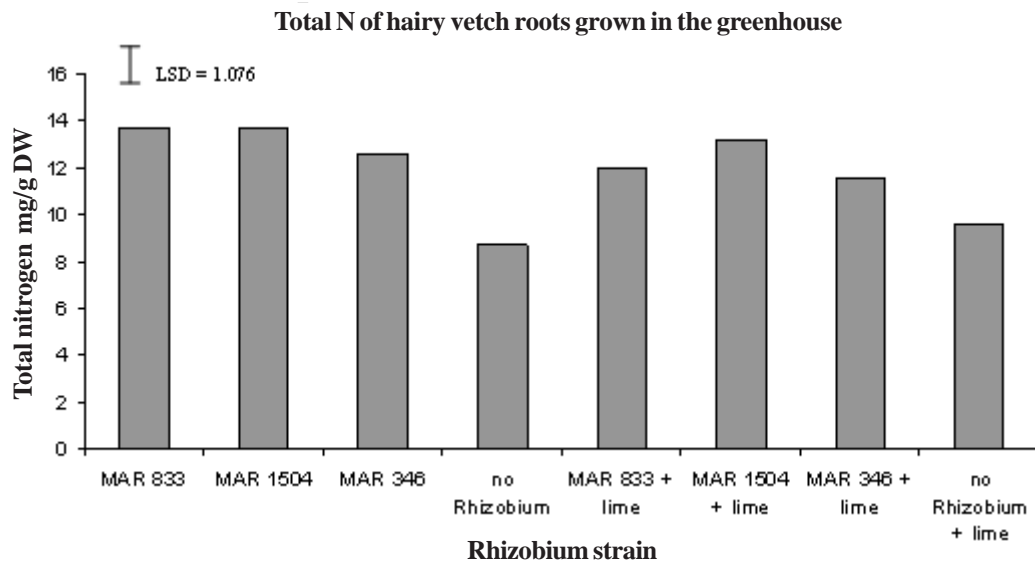
**Figure 1. Nitrogen contents of hairy vetch shoots harvested from potted field soil at 80 days after planting. The vertical bar shows the Least Significant Difference (LSD) ( $P < 0.05$ ).**

**Acknowledgement**

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**Figure 2.** Nitrogen contents of hairy vetch roots harvested from potted field soil at 80 days after planting. The vertical bar shows the Least Significant Difference (LSD) ( $P < 0.05$ ).

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