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Nitrogen fixation potential with *Macroptilium* of native rhizobial populations in semi-arid Pernambuco, Brazil

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Introduction

Nitrogen (N) is one of nature´s most abundant elements, accounting for about 78% of the atmospheric gases, but mostly as the inert N_2 form. As such it is not directly available to plants, and is relatively scarce in most agroecosystems. Biological nitrogen fixation (BNF) through diazotrophic bacteria represents about 63% of the yearly N input in terrestrial ecosystems (Taiz and Zeiger 2004). Legumes, which form effective symbiosis with the diazotrophic group of bacteria commonly known as rhizobia, are an important source of available N. Tropical forage legumes can usually nodulate with a diverse population of rhizobia, and may make a significant contribution to nitrogen availability in pastures (Santos et al. 2005). Identification and isolation of symbiotically most efficient rhizobial strains would enhance the beneficial effects of legumes in pastures. This could be achieved by quantifying the BNF ability of strains from different regions, vegetation covers, cultivation systems and environmental conditions (Chagas Jr. et al. 2010). Native legumes, including several species of *Macroptilium*, are an important forage resource in the semi-arid northeast of Brazil, contributing to the quality of ruminant diets, but with unquantified BNF ability. This study evaluated nodulation efficiency of *Macroptilium lathyroides*, when inoculated with Litolic Neossols from 8 municipalities of the semi-arid Pernambuco State.

Methods

Soil samples from Litolic Neossols collected in 8 municipalities of Pernambuco State (Caetés, Santa Cruz, Petrolina, Floresta, Bom Jardim, Jataúba, Santa Cruz do Capibaribe and Tupanatinga) were evaluated, along with 2 uninoculated controls. Sterile plastic bottles were used as Leonard jars (Santos et al. 2009), containing an autoclaved 1:1 (v:v) sand:vermiculite mixture and Hoagland´s nutrient solution without N (Hoagland and Arnon 1950), except for a control with the full Hoagland solution. *M. lathyroides* seeds were scarified with concentrated sulphuric acid for 10 minutes, rinsed in potable water and allowed to germinate in germtest paper. After 10 days, 2 seedlings were transferred to each jar and inoculated with 2 g of the soil samples. Harvest was 50 days after transplanting and shoots, roots and nodules were separated; nodules were counted (NN) and preserved with silica gel for bacterial isolation. Shoot, root and nodule dry masses (SDM, RDM and NDM, respectively) and N concentration (NC) were determined according to AOAC (1990). Data were evaluated by ANOVA, and when significant, means were compared by the Scott-Knott test at 5% significance level using Sisvar 4.0 (Ferreira 2008). SDM, RDM, NN and NDM were transformed by square root.

Results

NNs for Santa Cruz do Capibaribe (SC Capibaribe), Jataúba and Tupanatinga were greater ($P<0.05$) than for the remaining municipalities (Table 1). NDMs from those 3 areas plus Bom Jardim and Floresta were greater ($P<0.05$) than for Caetés, Santa Cruz and Petrolina. While the highest SDM and RDM were found for plants receiving N (control with N), plants inoculated with soils from Bom Jardim, Floresta, Jataúba, Tupanatinga and SC Capibaribe had significantly ($P<0.05$) higher SDM and RDM than those inoculated with the remaining soils, plus the uninoculated plants. The direct relationship between nodule mass and plant growth suggests that there is also a direct correlation between nodule mass and BNF potential.

The absence of any difference in growth between plants inoculated with soils from Caetés, Santa Cruz and Petrolina and the control without N suggests that any

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Table 1. Nodule number (NN), nodule dry mass (NDM), shoot dry mass (SDM), root dry mass (RDM) and nitrogen concentration (NC) of *Macroptilium lathyroides* inoculated with soil from 8 municipalities in the semi-arid region of Pernambuco State, Brazil.

Municipality	NN	NDM (mg/plant)	SDM (mg/plant)	RDM (mg/plant)	NC (dag^2/kg)
Bom Jardim	6 b[1]	17 a	280 b	70 b	1.0 b
Caetés	0.6 b	1.0 b	27 c	10 c	---
Floresta	4.0 b	14 a	230 c	90 b	2.8 a
Jataúba	13.2 a	21 a	350 b	75 b	3.4 a
Petrolina	2.5 b	5 b	113 c	30 c	3.4 a
Santa Cruz	0.6 b	1 b	59 c	30 c	1.0 b
SC Capibaribe	19.2 a	24 a	410 b	96 b	3.3 a
Tupanatinga	14.2 a	32 a	560 b	120 b	3.1 a
Control without N	0	0	64 c	20 c	1.1 b
Control with N	0	0	1,880 a	420 a	3.1 a
CV	48.1	12.7	12.6	4.1	12.2

[1]Averages followed by the same letter in a column are not significantly different according to Tukey's test.
[2]dag = dekagram; 1 dag = 10 g.

native rhizobia in these soils have limited ability to fix atmospheric nitrogen in conjunction with *M. lathyroides*. This was reinforced by the absence of any differences in nitrogen concentration for uninoculated control plants and those inoculated with soil from Santa Cruz. The low N concentration in plants inoculated with soil from Bom Jardim raises issues about how much nitrogen was fixed in this treatment.

Conclusions

While all soils had rhizobial populations, there were marked differences in the ability of the native rhizobial strains to nodulate with *M. lathyroides* and fix atmospheric nitrogen. Native rhizobial populations from Floresta, Jataúba, Tupanatinga and Santa Cruz do Capibaribe and possibly Bom Jardim seemed quite effective in BNF ability with *M. lathyroides*. The amount of N retrieved in the plants varied considerably, highlighting the extreme variation in ability to fix atmospheric N.

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