Use of Macaúba-derived biochar as a carrier in *Rhizobium tropici* inoculant

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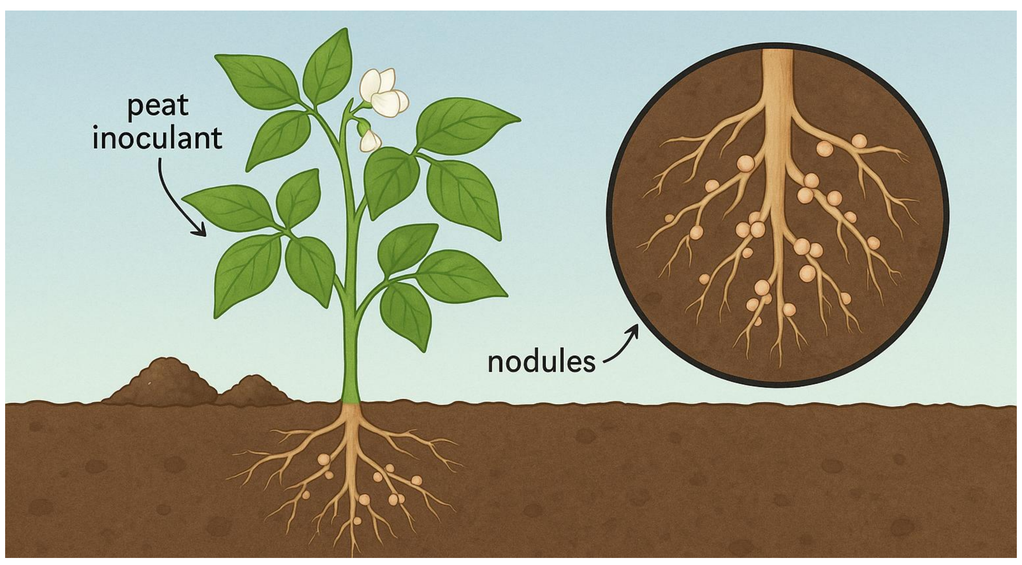
INTRODUCTION

Peat remains a commonly utilized carrier in the formulation of rhizobial inoculants, particularly for *Phaseolus vulgaris* (common bean) cultivation. Given that peat is a finite resource, there is a significant demand for sustainable alternatives. This study aimed to assess the potential of using Macaúba biochar as a carrier for *Rhizobium* tropici.



METHODS

Table 1: Treatments used on the experiments with inoculants presenting 180 and 15 days of shelf life, containing the strain SEMIA 4077 of *Rhizobium tropici*.

Treatments	Carrier	pH correction	Glycerol	Shelf life	CFU
Absolut control	-	-	-	-	-
Pni	Peat	yes	no	-	-
Bni	Biochar	no	no	-	-
Bni+Gl	Biochar	no	yes	-	-
Bni+HCl+Gl	Biochar	yes	yes	-	-
Pi-15	Peat	yes	no	15	$1,5x10^9$
Bi-15	Biochar	no	no	15	$9,1x10^9$
Bi+Gl-15	Biochar	no	yes	15	$5,2x10^9$
Bi+HCl+Gl-15	Biochar	yes	yes	15	$6,3x10^9$
Pi-180	Peat	yes	no	180	$8,2x10^8$
Bi-180	Biochar	no	no	180	$3,0x10^6$
Bi+Gl-180	Biochar	no	yes	180	$1,3x10^8$
Bi+HCl+Gl-180	Biochar	yes	yes	180	$3,0x10^8$

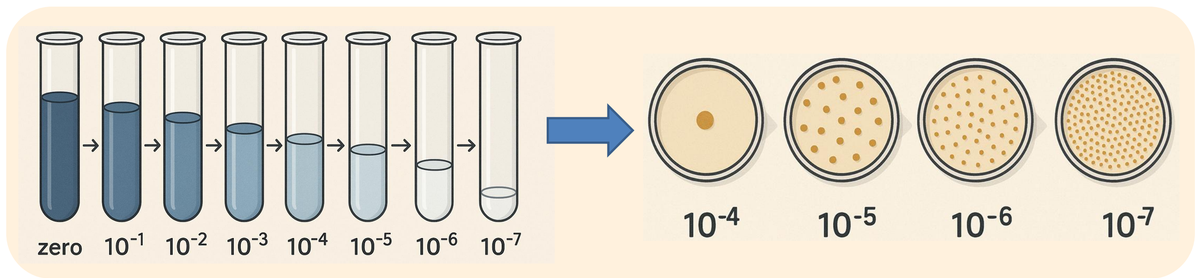


Figure 1: Serial dilution of inoculants and plating to determine the number of viable cells. Determination of colony forming units (CFU).

Figure 2: Greenhouse experiment with different *Rhizobium tropici* inoculants.

Determination of: Number of nodules (NN – n° plant^{-1}), Nodule dry weight (NDW - mg plant^{-1}), Root volume (RV – cm^3 plant^{-1}), Root dry weight (RDW – g plant^{-1}), and Shoot dry weight (SDW - g plant^{-1}).

RESULTS

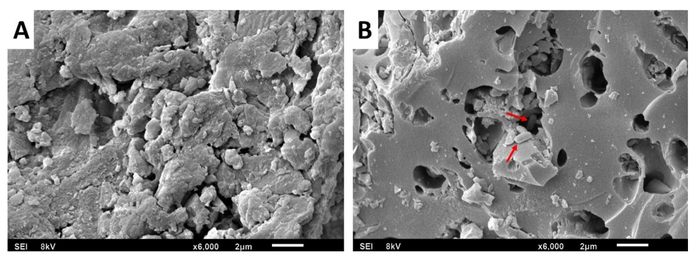


Figure 2: Scanning electron micrographs of peat (A) and biochar (B). Red arrows indicate the presence of the SEMIA 4077 strain of *Rhizobium tropici* adhering to the surface and within the pore of the biochar.

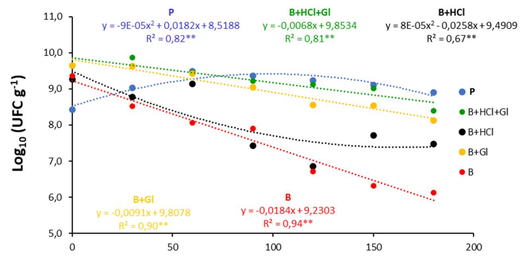


Figure 3: Regression analysis for the colony forming unit (CFU) of *Rhizobium tropici* strain SEMIA 4077 during the 180-day shelf-life test.

Figure 3: Common bean plants inoculated with the strain SEMIA 4077 of *Rhizobium tropici* in different carriers stored for 15 days (A) and for 180 days (B).

Table 2: Effect of different biochar and peat-based treatments carrying the strain SEMIA 4077 of *Rhizobium tropici* on the number of nodules (NN – n° plant^{-1}), nodule dry weight (NDW - mg plant^{-1}), root volume (RV – cm^3 plant^{-1}), root dry weight (RDW – g plant^{-1}) and shoot dry weight (SDW - g plant^{-1}) of common bean.

Treatments	NN	NDW	RV	RDW	SDW
Absolute control	0.0 c	0 c	8.8 d	0.53 c	1.65 b
Pni	0.0 c	0 c	12.9 cd	0.76 abc	2.07 ab
Bni	0.0 c	0 c	11.9 cd	0.65 bc	1.54 b
Bni+HCl	0.0 c	0 c	11.5 cd	0.70 bc	2.11 ab
Bni+HCl+Gl	0.0 c	0 c	12.0 cd	0.41 c	2.72 ab
Pi-15	19.1 b	18 bc	11.3 cd	0.74 abc	2.20 ab
Bi-15	74.0 ab	66 ab	20.0 abc	1.20 ab	3.07 a
Bi+Gl-15	126.3 a	87 a	27.8 a	1.42 a	3.58 a
Bi+HCl-15	48.8 ab	39 abc	14.4 cd	0.92 abc	3.09 ab
Pi-180	47.6 ab	36 abc	25.0 ab	1.05 abc	2.90 ab
Bi-180	40.8 ab	30 abc	13.0 cd	1.17 ab	2.76 ab
Bi+HCl-180	33.4 b	21 abc	15.6 bcd	1.06 abc	2.82 ab
Bi+HCl+Gl-180	32.4 b	34 abc	15.0 cd	0.96 abc	2.84 ab

CONCLUSIONS

- Macaúba biochar inoculants (B+HCl+Gl and B+Gl) show similar shelf life to peat-based inoculant;
- The number of nodules and nodule dry weight are similar with macaúba biochar and peat inoculants with shelf life of 180 days (Bi-180 and Pi-180);
- The root volume is similar with macaúba biochar and peat inoculants (Bi+HCl-180 andPi-180);
- The root and shoot dry weights are similar with macaúba biochar and peat inoculants with shelf life of 180 days (Bi-180, Bi+HCl-180, Bi-HCl+Gl-180 and Pi-180);
- Macaúba biochar can be used in microbial inoculant formulation as an ecological alternative to peat, which is a non-renewable and scarce resource.

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