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PRELIMINARY STUDIES ON FOUR NITROGEN
FIXING TREES IN SENEGAL

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ABSTRACT

Because of the destruction of forests for agricultural needs, there is a continuous degradation of soils. To reforest these soils, it is necessary to use trees that can thrive in wayed soils. Fortunately such trees exist and they are mainly Nitrogen Fixing Trees (NFT). Four species of NFT were studied: *Prosopis africana*, *Prosopis juliflora*, *Albizia lebbek*, and *Leucaena leucocephala*. *Prosopis africana* and *Albizia lebbek* were well nodulated in South Senegal soils whereas *Prosopis juliflora* and *Leucaena leucocephala* were not nodulated in this area. *Rhizobium* strains were isolated from the NFT species and their host spectrum determined. Nitrogen fixation was estimated in the laboratory by measuring the shoot and nodules dry weight and, shoot total N content. The four NFT species studied fell into two categories: (a) NFT for which nitrogen fixation could significantly be increased by inoculation with the strains we had isolated (i.e. *Prosopis africana* and *Albizia lebbek*). *Rhizobium* strains Al₁₀ and Pa₁ were most effective strains on these two NFT species. (b) NFT for which nitrogen fixation could not significantly be increased by inoculation with our strains (i.e. *Prosopis juliflora* and *Leucaena leucocephala*). The reason of this failure is probably that strains native to Senegalese soils were not effective on these two NFT species.

INTRODUCTION

The first objective was to study the nodulation of four Nitrogen Fixing Trees (NFT), *Prosopis africana*, *Prosopis juliflora*, *Albizia lebbek* and *Leucaena leucocephala* then to isolate *Rhizobium* strains from those NFT and finally to estimate nitrogen fixation in the laboratory.

MATERIALS AND METHODS

For isolating *Rhizobium* strains from the five different soils studied (Table 1), germinated seeds of the four species were planted in plastic pouches 24 x 11 cm filled with the different soils. The seeds had been sterilized by immersion in concentrated sulphuric acid (Table 2), a treatment which was necessary to allow the germination (chemical scarification).

Et al. de: Biological nitrogen fixation in Africa. Proceedings of the first conference of the African Association for Biological Nitrogen Fixation (1982)

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Table 1. Characteristics of five South Senegalese soils.

Soils	Clay %	Fine Loam %	Coarse Loam %	Fine Sand %	Coarse Sand %	Organic matter %	pH KCl
Diouloulou	6,9	6,3	1,6	52,2	32,7	1,3	4,0
Djibelor	9,1	6,8	3,5	43,4	36,5	1,3	4,5
Bayottes	11,8	5,3	3,3	52,0	27,3	1,8	4,3
Dabo	10,2	6,3	4,8	29,8	47,3	1,5	4,8
Botou	13,1	17,5	9,3	31,9	27,4	1,3	4,9

Soils	CZ	NA	P ₂ O ₅ assimilable
Diouloulou	7,4	0,50	0,012
Djibelot	7,4	0,50	0,017
Bayottes	10,7	0,60	0,010
Dabo	8,9	0,50	0,012
Botou	7,4	0,53	0,010

Table 2: Sterilization of the seeds and germination test.

Species	Duration of ster- ilization (mn)	Duration of imme- diate in- cubation (mn)	Duration of seeds germina- tion (H)		Percentage of germination
			on agar	on sand	
<i>P. africana</i>	120	120	48	72	40 to 60
<i>P. juliflora</i>	15	60	24	48	90 to 95
<i>A. lebeck</i>	60	60	24	48	90 to 95
<i>L. leucocephala</i>	30	60	24	48	80 to 100

The experiment was conducted with three seedlings per pouch for the four NFT and fifteen replicates per treatment. Rhizobia were isolated from the nodules that appeared after 35 days. Isolates were then plated in petri dishes containing the routine YEMA medium (Vincent, 1970).

Infection plant tests were carried out in Gibson tube (Gibson 1963) containing agar Jensen medium (Jensen, 1942). Seedlings were inoculated with a 7-day-old culture of the isolated *Rhizobium* strains and the ORS 911 and Cb 756 as reference

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Rhizobium strains. Nitrogen fixation was estimated by difference between the total N content of non-, inoculated and inoculated plants. In addition, oven dry weights of nodules and shoots were determined.

RESULTS

1. Nodulation of the NFT: *Prosopis african* and *Albisia lebbeek* nodulated in all soils used but the number of nodules was highest in Dabosoil. *P. juliflora* and *L. leucocephala* did not nodulate in any of the soils (Table 3).

2. Isolation of *Rhizobium* strains and study of their host range: Ten strains were isolated, all of them from *P. africana* and *A. lebbeek*. These strains indifferently nodulated *P. africana* and *A. lebbeek* and most of them were effective on both hosts. Only two of these strains (Pa1 from *P. africana* and Al₄ from *A. lebbeek*) were able to effectively nodulate *L. leucocephala*. None of the ten strains isolated was able to nodulate *P. juliflora*.

Interestingly ORS 911 (isolated from *Acacia farnesiana*) was able to nodulate *L. leucocephala* (Table 4). The effectiveness of the strains was determined only with *P. africana* and *A. lebbeek* and the best strains were Al₁₀ and Pa₁ (Fig. 1, 2 and 3).

CONCLUSION

The preliminary investigations of the four species of NFT showed that these species fell into two inoculation groups according to the *Rhizobium* that nodulated them: the first group included *Prosopis african* and *Albisia lebbeek* which nodulated readily with *Rhizobium* strains distributed in the five Senegalese soils studied (which are probably ubiquitous strains). Some of the *Rhizobium* strains were fast growing while others were slow growing. There was no relation between the efficiency of these strains and their growth rate. The second group included *Prosopis juliflora* and *Leucaena leucocephala* did not nodulate with the native *Rhizobium*

Table 3: Nodulation of four NFT in five Senegalese soils

NFT Species	SOILS									
	DIOULOULOU		DJ IBELOR		BAYOTTES		DABO		BOTOU	
	A*	B**	A	B	A	B	A	B	A	B
<i>P. africana</i>	8 (15)	3.12	10 (15)	1.10	14 (15)	2.21	15 (15)	4.00	12 (15)	3.40
<i>P. juliflora</i>	0 (15)	0.00	0 (15)	0.00	0 (15)	0.00	0 (15)	0.00	0 (15)	0.00
<i>A. vesicaria</i>	12 (15)	1.75	10 (15)	1.30	12 (15)	3.33	15 (15)	4.60	12 (15)	3.08
<i>L. leucocephala</i>	0 (15)	0.00	0 (15)	0.00	0 (15)	0.00	0 (15)	0.00	0 (15)	0.00

*A- Plants nodulated; **B- Nodules per plant; (): Number of plants tested.

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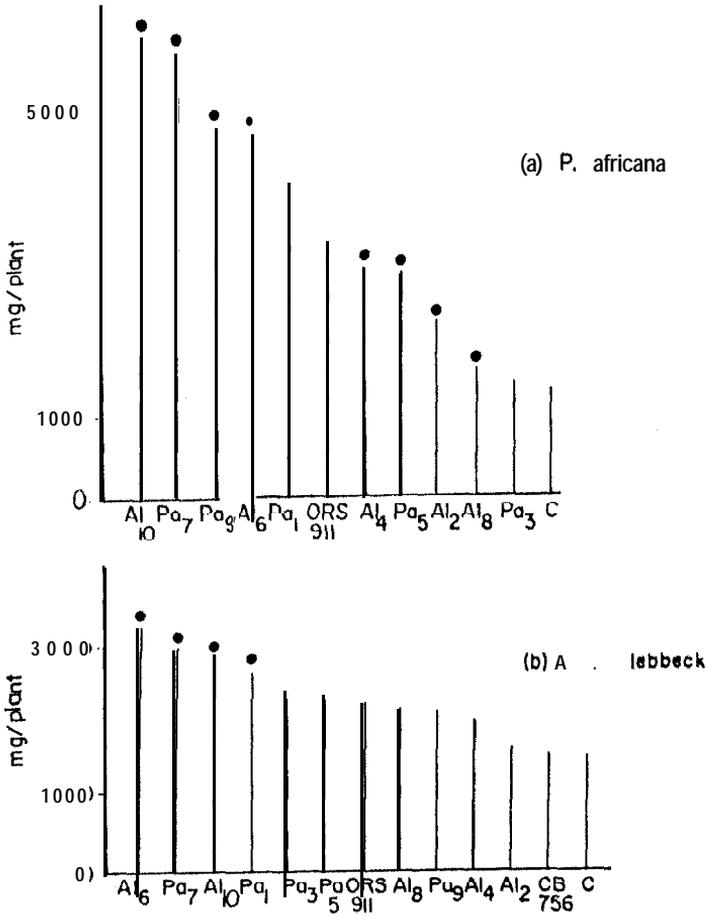


Figure 1. Shoot dry weight (● = these treatments were significantly higher than C i.e. control).

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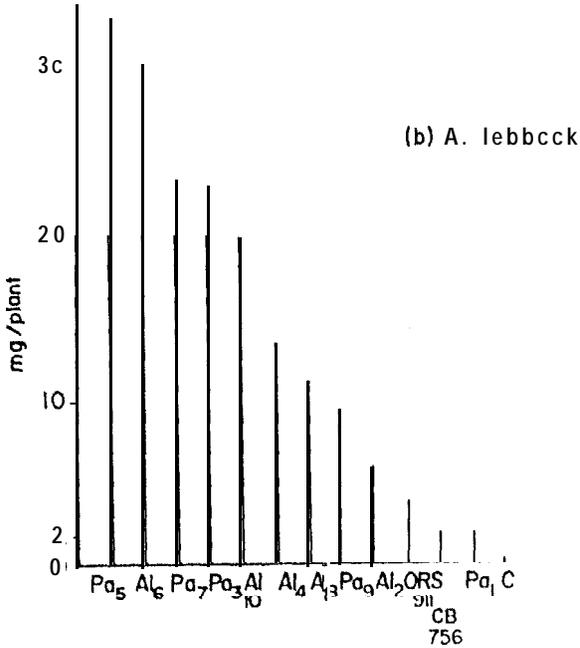
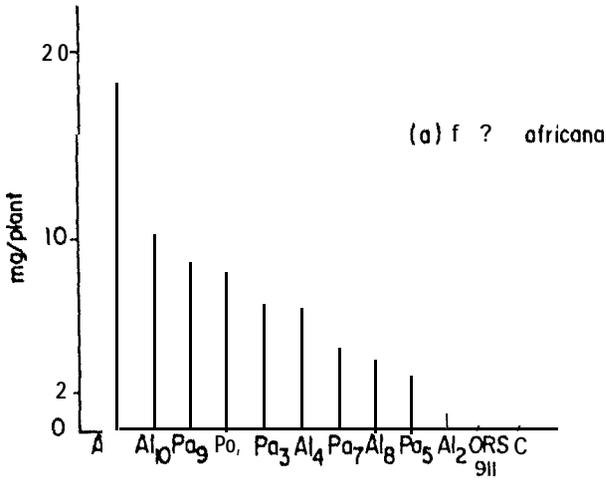


Figure 2. Nodule dry weight

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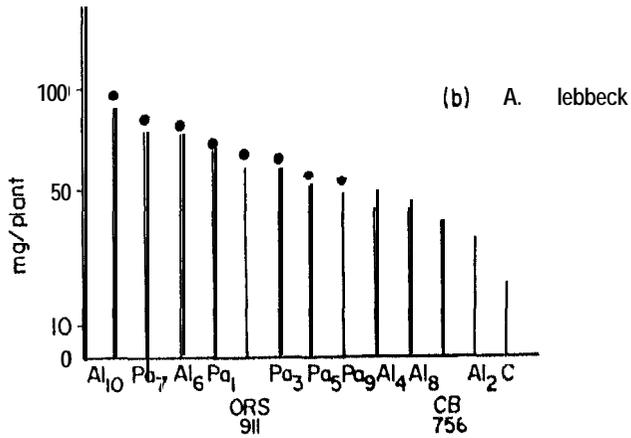
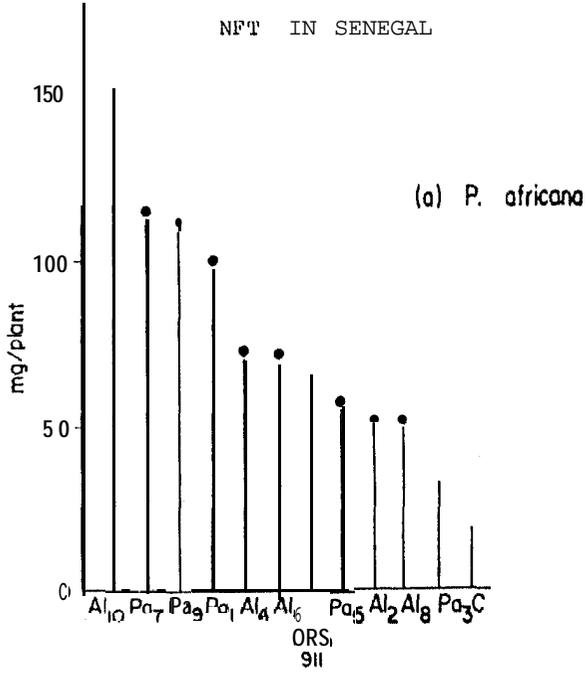


Figure 3. Total N content (● = as in Fig. 1)

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strains from these soils which suggests that *Rhizobium* requirements of *P. juliflora* and *L. leucocephala* are more specific than those of the first group. It appears necessary to initiate investigation in that field.

Table 4. Host spectrum of ten *Rhizobium* strains isolated from *P. africana* and *A. lebbek*.

Strains	Growth rate	<i>Prosopis africana</i>	<i>Albizia lebbek</i>	<i>Acacia leucocephala</i>	<i>Prosopis juliflora</i>
Pa ₁	fast	E	E	E	n.i.
Pa ₃	fast	e	E	e	II.i.
PS ₅	slow	E	E	n.i.	n.i.
Pa ₇	slow	E	E	n.i.	n.i.
Pa ₉	slow	E	E	n.i.	n.i.
A1 ₂	fast	E	e	e	e
A1 ₄	fast	E	E	E	n.i.
A1 ₆	slow	E	E	n.i.	n.i.
A1 ₈	slow	E	E	n.i.	e
A1 ₈	fast	E	E	n.i.	n.i.
ORS ¹⁰ ₉₁₁	fast	E	E	E	e
CB756	slow	*	c	n.i.	n.i.

E = effective; e = ineffective; n.i. = non-infective
 * = Plants of this treatment were contaminated.

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