Estimation of early biological nitrogen fixation capacities of some improved fallow tree/shrub species

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Nitrogen is one of the limiting nutrients in most tropical soils, which leads to low crop yields if artificial amendments are not made. Trees and shrubs such as *Sesbania sesban* (L) Merill, *Crotalaria grahamiana* Wight & Arn, *Tephrosia candida vogelii* Hook f. *and Gliricidia sepium* (Jacq.) Steud. have been recommended for integration into farmlands with annual crops in order to replenish the much needed nitrogen nutrient [3]. The value of leguminous trees/shrubs components in agroforestry systems lies in their ability to fix atmospheric nitrogen, so reducing the use of inorganic fertilizer N and enhancing soil fertility [1].

In order to evaluate these legume trees/shrubs for their potentials to fix atmospheric nitrogen, two greenhouse experiments were conducted at the Moi University, Eldoret, Kenya. The first experiment compared different species whether inoculated or un-inoculated with known effective *Rhizobium* bacteria. The second experiment compared different provenances of *S. sesban* when all were inoculated with same known effective rhizobial strain. The ^{15}N isotope dilution method [2] was used to determine percent N derived from the atmospheric (%Ndfa) in both experiments .

In the species trial while using *Tithonia diversifolia* (Hemsley) A. Gray as the reference plant, inoculated *S. sesban*, *C. grahamiana*, *T. candida* and *G. sepium* derived 81.3, 75.0, 63.1, and 51.6 % N from the atmosphere respectively. Significantly low %Ndfa values were detected in un-inoculated treatments except for *Crotalaria*, which fixed significantly higher value without inoculation (Figure 1). Since the soil used was not sterilized there could have been effective indigenous rhizobial strains for *Crotalaria*, which were lacking for other species. Through inoculation the N-yield in the above ground biomass of *Sesbania sesban* was doubled (Table 1).

In the second experiment where both *T.diversifolia* and *Eucalyptus grandis* were used as reference plants, Muguga provenance had a %Ndfa value of 65.6, while Ukwala provenance, which had the highest value, derived 70.7% of its total N from the atmosphere. There were no significant differences ($p<0.05$) in %Ndfa observed between the different *S. sesban* provenances in their BNF potentials. But pair wise comparison of the different reference plant used revealed significant differences. Quantifications of %Ndfa using *Tithonia* as the reference plant gave significantly ($p<0.0$) higher values than calculations using *E. grandis* (Table 2).

Maximising biological nitrogen fixation by legumes can significantly increase crop yields in N depleted soils of the tropics as well as reducing the need for inorganic nitrogen fertilizer, which are usually costly for small-scale farmers.

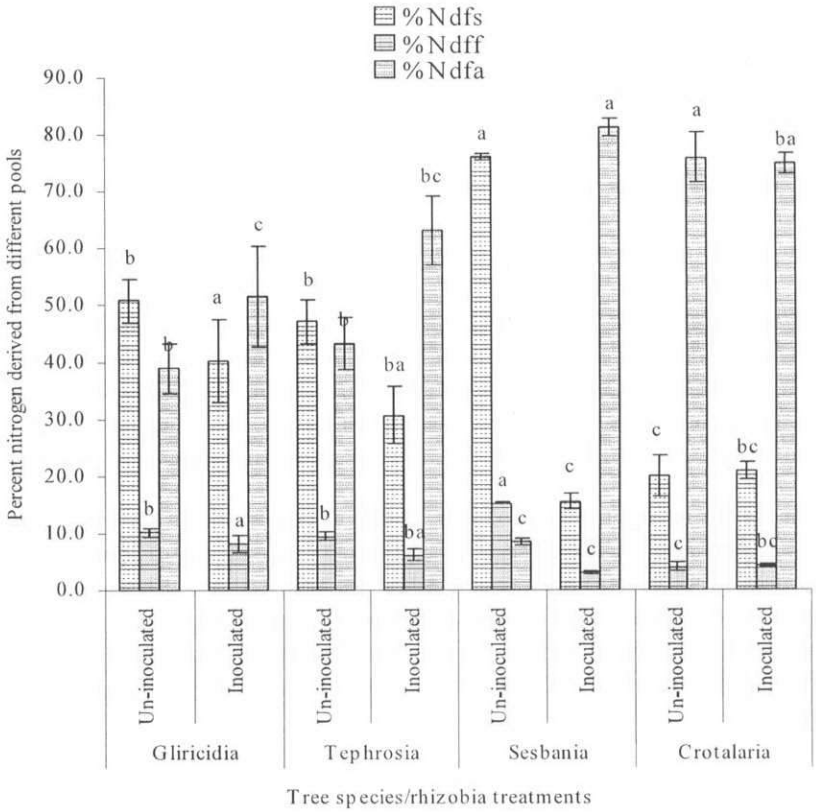

Figure 1. Percent nitrogen derived from different pools as influenced by species and rhizobial treatments. The comparisons are per the effects of inoculum treatment on a particular N-pool.

Table 1. Percent total nitrogen and nitrogen yields (mg/pot) in plant parts given as a mean of three replicates.

Species	Un-inoculated				Inoculated			
	%N roots	%N shoots	N-yield roots	N-yield shoots	%N roots	%N shoots	N-yield roots	N-yield shoots
Gliricidia	2.020$^{b\#}$	2.843^{ba}	13.47^{c}	34.53	2.567^{b}	3.180^{b}a	15.04^{b}	45.52^{c}
Tephrosia	3.017^{a}	2.030^{b}	23.37^{bc}	50.51	2.857^{b}	2.497^{b}	25.57^{b}	71.65b^{c}
Sesbania	2.437^{ba}	1.917^{b}	35.69^{ba}	97.69	3.477^{b}a	3.207^{ba}	70.39^{a}	195.89^{a}
Crotalaria	3.257^{a}	3.463^{a}	53.63^{a}	139.95	3.300^{a}	3.363^{a}	65.31^{a}	150.40^{ba}
SED	0.181	0.249	5.00	18.01	0.143	0.136	7.81	20.50

Means follows by the same latter are not significantly different at $p<0.05$ (Student LSD test)

Table 2. Mean percent total nitrogen, ^{15}N atom excess, N derived from different pools and total N-yields.

Origin	N (%)	$^{15}N_{excess}$ (%)	Ndff (%)	Ndfs(E) (%)	Ndfa(E) (%)	Ndfs(T) (%)	Ndfa(T) (%)	Total N-yield (g/pot)
Kibwezi	2.520	0.3536	3.56	26.80	69.64	25.82	70.62	0.3724
Muguga	2.756	0.4006	4.02	30.36	65.64	29.20	66.76	0.3476
Shinyalu	2.572	0.3528	3.54	26.76	69.72	25.76	70.68	0.3998
Ukwala	2.470	0.3532	3.56	26.78	69.66	25.76	70.70	0.3864
SED	0.191	0.0548	0.56	4.15	4.71	4.01	4.56	0.0294

Ndff-Nitrogen derived from fertiliser, Ndfs(E)-Nitrogen derived from soil using *Eucalyptus* as reference, Ndfs(T)-Nitrogen derived from soil using *Tithonia* as the reference crop, Ndfa(E)-Nitrogen derived from the atmosphere using *Eucalyptus* as the reference crop, Ndfa(T)-Nitrogen derived from the atmosphere using *Tithonia* as the reference crop.

References

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