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Research Application Summary

Biological N_2 fixation of three *Acacia senegal* varieties in the drylands of Kenya using ^{15}N natural abundance method

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Abstract

A study is on-going in Kenya to identify *Acacia senegal* varieties with high symbiotic biological N_2 fixation capacity. *Balanites aegyptica*, a non-legume species, has been included for comparison. Variety *senegal* has so far shown the highest leaf biomass (9.9 t/ha) followed by variety *leiorhacis* and kavensis (5.9 and 3.1 t/ha, respectively). The nitrogen assimulation study is still being analysed.

Key words: *Acacia*, agro-forestry, Kenya, nitrogen fixation

Résumé

Une étude est en cours au Kenya pour identifier des variétés *Acacia senegal* ayant une capacité biologique symbiotique élevée de fixation de N2. *Balanites aegyptica*, une espèce de non-légumineuse, a été incluse pour la comparaison. La variété *senegal* a jusqu'ici montré la plus haute biomasse de feuille (9.9 t/ha) suivie des variétés *leiorhacis* et kavensis (5.9 et 3.1 t/ha, respectivement). L'étude d'assimilation d'azote est toujours en cours d'analyse.

Mots clés: *Acacia*, agroforesterie, Kenya, fixation de l'azote

Background

Acacia senegal is a drought-tolerant multipurpose tree species highly valued for gum arabic production and is increasingly being used in agroforestry and afforestation in the arid and semi-arid lands of Africa. Despite long history of utilization, there is very little quantitative information on the nitrogen (N_2) fixation potential of this species in its natural ecosystem. The species is also highly variable in growth form. Three varieties are currently recognized in Kenya; *A. senegal* variety *senegal* Schweinf, variety *kerensis* Schweinf and variety *leiorhachis* Brenan. Whilst the variation is desirable in terms of adaptability and potential for genetic improvement for various end uses, challenges in its management and sustainable utilization in Kenya include lack of proper knowledge on its potential to fix nitrogen, poor delimitation of the varieties and inconsistency in gum arabic production and quality. This study therefore aims at identifying *A. senegal* varieties with high symbiotic biological N_2 fixation capacity and high biomass accumulation for reforestation and agroforestry programmes within the drylands of Kenya. The study will provide data on the impact of *A. senegal* on nutrient cycling in agroforestry as well as provide estimates on the potential for carbon sequestration in agroforestry systems.

Literature Summary

Acacia senegal (L.) Willd. is a tree or shrub legume and widely distributed in dry savannas of Sub-Saharan Africa (Fagg and Allison, 2004). It is a drought resistant indigenous species and widely distributed in several parts of Kenya. The species is known for its exudate named "gum arabic", a water-soluble gum that is used internationally in processed food and medical products industries. *Acacia senegal* is highly suitable in agroforestry systems and particular in shifting cultivation (Gaafar *et al*., 2006). The ability to fix nitrogen and adaptive responses to moisture stress allow this species to produce a high biomass even under extremely dry environments (Gaafar *et al*., 2006).

Nitrogen is the nutrient that is most commonly deficient contributing to reduced agricultural yields throughout the world. Nitrogen- fixing species hence have larger effects on soils than other species and these effects include consistent increases in soil organic matter and carbon (Binkley, 2005). The nutrient status of the soil is therefore an important factor influencing symbiotic N_2 fixation (Kreibich *et al*., 2006).

The problems associated with estimating the proportion of nitrogen fixed by leguminous shrubs and trees in the field include difficult and time consuming methods (Spriggs *et al*., 2003). Because of these, the most promising technique to quantify trees and woody perennials N_2 fixation contribution to natural ecosystems is the ^{15}N natural abundance method (Boddey *et al*., 2000). This method requires no treatment, avoids soil disturbance and can be applied to existing experiments or to trees growing in plantations and forests (Boddey *et al*., 2000; Sylla *et al*., 2002). This could provide a solution to the problem of estimating nitrogen fixation in leguminous trees and shrubs as it uses non destructive sampling technique and provides an integrated measure of nitrogen fixed under field conditions (Spriggs *et al*., 2003).

Study Description

Ten trees were randomly selected from each variety population giving a total of 30 samples. Leaf samples were collected when the trees were bearing maximum foliage. Reference species, *Balanites aegyptica* was selected among the non-legume woody species occuring in the same area. The leaf samples were oven dried at 60^{0}C for 48 hrs and ground into fine powder ready for analysis. Plant leaf biomass (P) was assessed from diameter at breast height (dhb) according to the allometric equation where: P= k. dbh^a (Sylla *et al*., 2002), with k= 0.00873 and a= 2.1360 for leaf biomass and k= 0.05635 and a= 2.7248 for total biomass.Four of the ten trees studied were randomly selected and soil samples collected under the canopy of each tree. They were cored at 0, 1 and 2 metres distance from the trunk. Soils were sampled from within a 30 cm x 30 cm square at three depths of 0–25 cm, 25–50 cm and 50-75 cm. Occurrence of root nodules was checked in the collected soil.

Research Findings

Previous research is not available on the variation in leaf biomass of *A. senegal* varieties in their natural ecosystems in the study area. According to the allometric equation used by Sylla *et al*. (2002), variety *senegal* had the highest leaf biomass of 9.94 t/ha followed by variety *leiorhachis* and *kerensis* with 5.95 and 3.08 t/ha, respectively. There were no significant (P = 0.6833) differences among the three varieties. The ^{15}N natural abundance is currently being analyzed at the University of California, Davis. Soil samples are currently being analyzed at ICRAF, Kenya.

References

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