Nitrogen fixation in white yam (*Dioscorea rotundata*) using naturally abundant ^{15}N

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Introduction

White yam (*Dioscorea rotundata*) is a tuber crop cultivated and utilized as a staple food in West Africa. However, little progress has been made in increasing supply by optimizing fertilization methods to improve yield. Several experiments conducted throughout the region suggesting the need to take a different approach to elucidate the nitrogen absorption mechanism and to apply it to cultivation. Here we report on the nitrogen absorption mechanism in white yam with a special focus on its nitrogen fixation ability using naturally abundant ^{15}N ($\delta^{15}N$).

Materials and Methods

- **Location**: The International Institute of Tropical Agriculture (IITA) in Ibadan, Nigeria.
- **Experimental design:** Randomized block design with three replication was used in the field without fertilizer application.
- **Plant materials**: Six white yam accessions and squash (*Cucurbita moschat*) as a reference of the percentage of plant N derived from atmospheric N_2 (%Ndfa) were collected at four months after planting in September 2018.
- **Data collection:** The %Ndfa was calculated based on $\delta^{15}N$ values. The amount of nitrogen in dry plant (g plant^{-1} DW) was calculated using the results of total nitrogen content (%) and %Ndfa.

$$\%Ndfa = \left(1 - \frac{\delta^{15}\mathrm{N}\ of\ white\ yam\ leaf}{\delta^{15}\mathrm{N}\ of squash\ leaf}\right) \times 100$$

Results and Discussions

- The nitrogen content of the soil used for this study was low (Table 1).
- The $\delta^{15}N$ of DrDRS074 and DrDRS020 leaves were lower than squash (Fig. 1).
- Based on the result of %Ndfa, it was estimated that appropriate 40% of the total nitrogen in DrDRS074 was derived from atmospheric nitrogen (Fig 2.).
- On the other hand, DrDRS074 plant showed high values for both the amount of total nitrogen and N derived nitrogen from atmospheric N_2 than DrDRS042 in low fertility soil without fertilization.
- It was suggested that the ability of white yam to fix atmospheric nitrogen; however, intraspecific variation must be also considered.
- To ascertain the nitrogen fixation ability of different white yam varieties, further research on the presence of symbiotic bacteria as well as the effect of nitrogen fixation on plant growth should be conducted.

Table 1 Soil characteristics of the experimental field in IITA analyzed before planting in 2018.

pH	EC (ms/m)	CEC (m.e)	TN (%)	TC (%)
6.3 (0.0)	1.8 (0.1)	0.9 (0.1)	0.07 (0.0)	0.61 (0.1)

( ): values represent the mean followed by s.e.

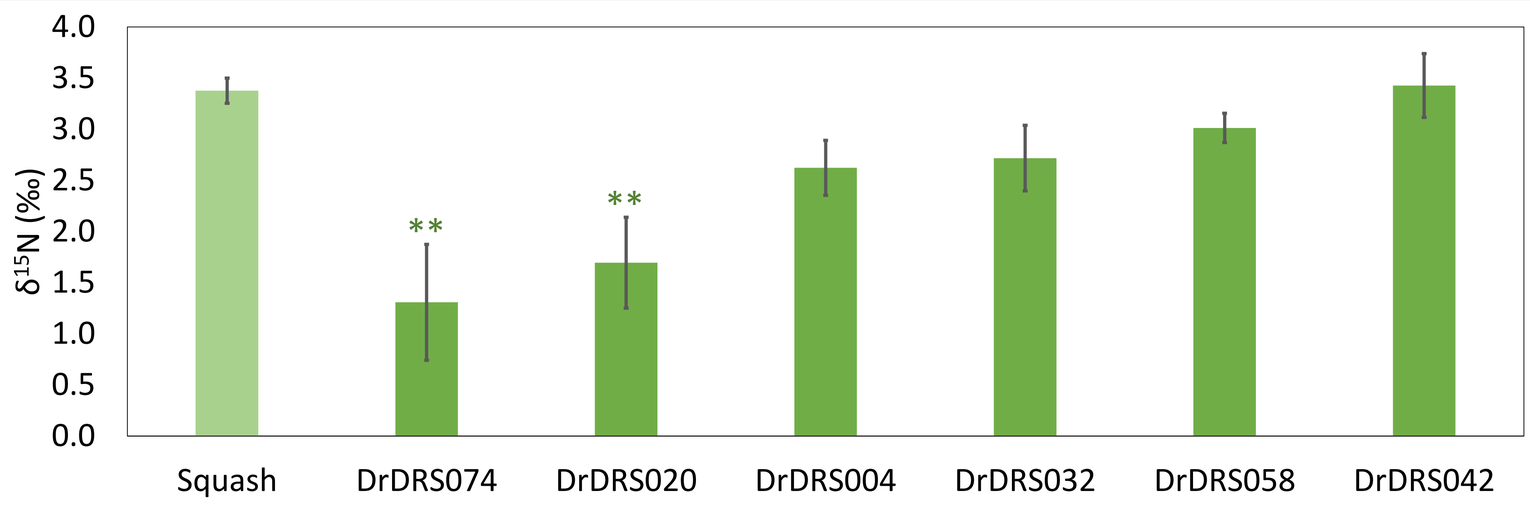

Fig. 1 Comparison the $\delta^{15}N$ of leaf in six white yam accessions with squash. ** indicates significant difference from references at 1% on the same sampling date according to the t-test. Vertical bars are standard errors of the mean.

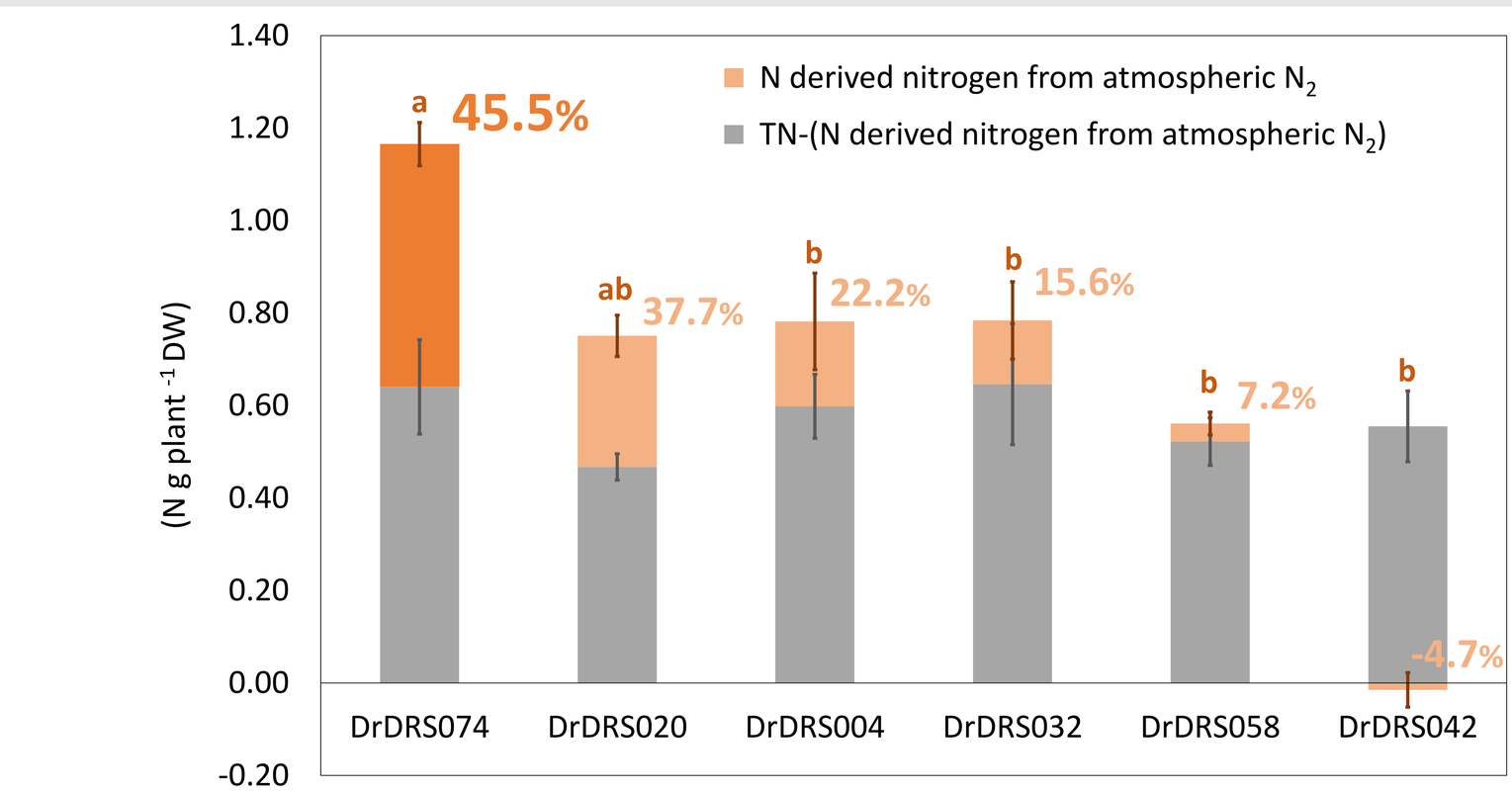

Fig. 2 Comparison between amount of nitrogen in the N derived from atmospheric N_2, and N amount by subtracting the N derived from atmospheric N_2 from total N of white yam leaf calculated in 2018. Vertical bars are standard errors of the mean. Means with the same letter at data in N2 derived N are not significantly different at $P < 0.05$ according to Tukey's multiple comparison-test. The TN-(N derived nitrogen from atmospheric N_2) values of six white yam cultivars showed no significant difference.

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