N relationship in a legume nonlegume association grown in an intercropping system

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Abstract. Sorghum grown in a mixture with legumes viz. groundnut, mungbean and cowpeas took up more N than sorghum grown as sole crop. In a mixture with mungbean the total N uptake by sorghum was 8.65 g m⁻², while with sole sorghum it was 6.79 g m⁻². The per cent N derived from fertilizer (% Ndff) was highest with sole sorghum and the lowest when grown in mixture with legumes. It is possible that sorghum derived part of the N from the soil pool enriched by concurrently grown legumes in the mixture.

In many developing countries peasant farmers have adopted mixed cropping based on a cereal and leguminous crop. Several workers have examined and advocated mixed cropping [3, 4, 13, 14, 17]. The suggested benefits of a legume and non-legume association are the increased growth of roots and shoots, better root stratification and utilization of soil nutrients, and nitrogen fixation by the legume which allows the legume to become independent of soil nitrogen and making some nitrogen available to the associated non-legume [2, 5]. The main benefit is the increase in soil nitrogen available to the non-legume either through soluble root exudates [9, 10] or through the decay of nodules [16]. Legumes grown in shade can exude a considerable amount of fixed nitrogen [1]. Although a number of pot experiments have been carried out since the 1930’s with legume/non-legume associations data from field conditions are meagre. However, several workers [11, 12, 15] have reported that the yield advantage of mixed crops in the semi-arid and sub-humid tropics results in below-ground interactions, mainly the transfer of nitrogen in the rhizosphere from the legume to the non-legume.

The present field experiment was conducted with the following objectives: (i) to monitor the proportion of N taken up by the sorghum plants from the fertilizer and from the soil by using ¹⁵N as a tracer, and (ii) to evaluate the possible nitrogen contribution from a legume to the associated sorghum crop.

Materials and methods
A field experiment was carried out in the summer-rainy season (July to November) of 1982 at the Indian Agricultural Research Institute, New Delhi
(28°40'N; 77°12'E and altitude 228 m above msl). The weather was hot and dry during this period and received sub-optimal rainfall, 281.8 mm as against normal of 480 mm for Delhi. The soil was a well drained sandy loam, neutral in reaction (pH 7.3), deficient in nitrogen (0.04% total N) and phosphorus (9.6 available P kg ha⁻¹) adequate in potash (149 kg available K ha⁻¹).

The experiment was conducted in a randomised block design with four replications and four treatments as follows: (1) Sole sorghum, (2) Sorghum and groundnut, (3) Sorghum and mung, (4) Sorghum and cowpeas. Fertilizers at the rate of 40 kg N, 17 kg P and 16 kg K ha⁻¹ were applied to each plot measuring 11 x 3 m. This was done by drilling superphosphate and muriate of potash below each seed row and broadcasting urea over the entire plot except a micro-plot measuring 1 m x 1.2 m in the centre of each plot where ¹⁵N labelled urea (1% atom excess) weighing 10.44 g was used. After broadcasting urea was raked in. At 30 days after sowing (DAS) another 10.44 g of labelled urea (40 kg N ha⁻¹) was top-dressed uniformly over the entire plot followed by hand raking.

Plant population in micro-plots was constant for all the treatments and maintained at 2 x 10⁵ plants ha⁻¹. Sorghum rows were placed 30 cm apart in sole crop situation while two sorghum rows were placed 30 cm apart and two such pairs were separated by 90 cm where two legume rows were accommodated in the intervening space bounded by paired sorghum rows. In sole crop situation the intra-row spacing was 16.6 cm while in intercropped situation it was 8.33 cm. Legume population m⁻² was maintained as per recommendation for each crop.

Plant samples for dry matter determination were taken from the micro-plots at 30 DAS from an area of 0.3 x 0.6 m and at final harvest from 0.6 x 1.2 m area.

N determination was made by the micro-Kjeldahl method. The determination of ¹⁵N abundance was done in an Emission Spectrometer (Model: Jassco N 150, Japan Spectroscopic Co. Ltd., Tokyo) with recording systems that give peaks for ²⁸N, ²⁹N and ³⁰N in the gas sample.

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% \text{¹⁵N abundance was calculated from } \frac{100}{2R + 1},
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Where \( R = \frac{²⁸N}{²⁹N} \)

To calculate % ¹⁵N atom excess 0.365 was deducted from % ¹⁵N abundance in the sample.

Method of calculation

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% \text{Ndff (per cent N derived from fertilizer)} = \frac{\% \text{¹⁵N atom excess in sample}}{\% \text{¹⁵N atom excess in fertilizer}} \times 100
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