

S. Tobita · O. Ito · R. Matsunaga · T.P. Rao  
T.J. Rego · C. Johansen · T. Yoneyama**Field evaluation of nitrogen fixation and use of nitrogen fertilizer by sorghum/pigeonpea intercropping on an Alfisol in the Indian semi-arid tropics**

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**Abstract** A field experiment was conducted to obtain the N balance sheet for sole crops and intercrops of sorghum [*Sorghum bicolor* (L.) Moench] and pigeonpeas [*Cajanus cajan* (L.) Millsp.]. Intercropping gave a significant advantage over sole cropping in terms of dry matter production and grain yield, as calculated on the basis of the land equivalent ratio and area-time equivalent ratio. The N fertilizer use efficiency and atmospheric N<sub>2</sub> fixation by pigeonpea were estimated using <sup>15</sup>N-labeling and natural abundance methods. The N fertilizer use efficiency of sorghum was unaltered by the cropping system, while that of the pigeonpea was greatly reduced by intercropping. Although intercropping increased the fractional contribution of fixed N to the pigeonpeas, no significant difference was observed between the cropping systems in total symbiotically fixed N. There was no evidence of a significant transfer of N from the pigeonpea to the sorghum. This study showed that use of soil N and fertilizer N by pigeonpeas was almost the same as that by sorghum in sole cropping, indicating the potential competence of pigeonpeas to exploit soil N. However, when N was exhausted by a companion crop in intercropping, the pigeonpea crop increased its dependency on atmospheric N<sub>2</sub> fixation. We conclude that knowledge of how N from different sources is shared by companion crops is a prerequisite to establishing strategies to increase N use, and consequently land productivity, in intercropping systems.

**Key words** Fertilizer use efficiency · Intercropping · Natural <sup>15</sup>N abundance · Nitrogen fixation · Pigeonpea · Sorghum

**Introduction**

Cereal/legume intercropping has been practised traditionally throughout the developing countries of the tropics, especially in the semi-arid regions. Intercropping has the potential to achieve a higher grain yield and greater land use efficiency per unit area than sole cropping, through efficient use of resources, such as light, water, and nutrients (Willey 1979). Improvement of soil fertility due to N amendment by legumes has been considered a major advantage of cereal/legume intercropping. Although many papers have reported a yield advantage with cereal/legume intercropping systems (Eaglesham et al. 1981; Bandyopadhyay and De 1986; Elmore and Jackobs 1986; Patra et al. 1986; Danso et al. 1987; Papastylianou 1988; van Kessel and Roskoski 1988; Papastylianou and Danso 1991), few have dealt with the N economy within the system. N budgets in intercropping systems seem to be strongly affected by crop combinations, soil available-N levels, and other environmental factors.

The intercropping combination of early-maturing sorghum and late-maturing pigeonpeas is widely practised by farmers in India. Intensive studies have mainly focused on the agronomic performance of the cropping system, revealing that the intercropped pigeonpea suffers considerable competition for light because of the vigorous growth of the sorghum (Willey et al. 1981). However, relatively less information is available on the underground competition for resources in intercropping systems.

In the present studies, we examined the intercropping effects of the N economy of the component crops, i.e., N<sub>2</sub> fixation by the pigeonpea and uptakes of fertilizer and soil N by both crops. Four levels of fertilizer N application were used because the critical N level, at which competition between the companion crops for N uptake

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