Soya bean *Bradyrhizobium* persistence or an inoculation paradox?

The case of Mooigelegen Farm, east of Ermelo

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About 88% of the over 19 321 known species of the plant family *Fabaceae* (legumes) form a symbiotic association with a group of soil microbes known as rhizobia (Chaulagain and Frugoli, 2021). The association leads to the formation of specialised structures, namely nodules on the roots of legumes.

Inside the nodules, the rhizobia convert atmospheric nitrogen (N_2), usually unavailable to plants, into a usable form of nitrogen (N), namely ammonia (NH_3). The NH_3 is then converted to amino acids and amides within the nodules, after which it is transported in the xylem sap to other parts of the legume plant. This important interaction between the legumes and the rhizobia that results in converting N gas into a usable form of plant-available N is termed biological N fixation (BNF).

Using this process, it is estimated that 50 to 60 million tons of N are fixed annually by the symbiotic interaction between rhizobia, 250 million hectares of pulse and oilseed crops, and 220 million hectares of pasture legumes globally (Farquharson *et al.*, 2022).

Photo 1A) Soya bean roots uprooted from Mooigelegen Farm showing several prominent nodules formed mainly on the root crown regions (photo: Jantjie Randell). B) The same plants on the field on which the nodules in Photo 1A are shown (photo: Jantjie Randell). C) Dr Ahmed Hassen and Prudence Mtsweni of the ARC-BNF unit are pictured with Jantjie Randell at one of the fields planted to maize. D) Dr Abe Shegro Gerrano of ARC-VIMP (left) and Dr Ahmed Hassen collect soil samples from the maize rhizosphere.

Exploring rhizobia inoculation

According to an early study by Van Rensburg *et al.* (1976) the indigenous soil rhizobia, which specifically nodulate and fix N in soya bean, are absent in many African soils, including South Africa. It is therefore essential to inoculate soya bean plants with the appropriate type of rhizobia, *Bradyrhizobium japonicum* (*B. japonicum*), in the form of liquid or powdered inoculants.

Inoculation with rhizobia is also required when a legume is grown in a particular soil for the first time or after a break of several years. This is because compatible, effective rhizobia will not be present in such circumstances and therefore inoculation with a high concentration of rhizobia is required (Farquharson *et al.*, 2022).

In December 2021, a team of research scientists from the Agricultural Research Council Plant Health and Protection (ARC-PHP), as well as the ARC-Vegetables, Industrial and Medicinal Plants (ARC-VIMP) visited Jantjie Randell, a soya bean producer at Mooigelegen Farm in Lothair, east of Ermelo, for a survey and soil sampling as part of an existing soya bean inoculants research project funded by the National Research Foundation (NRF).

Randell has been growing soya bean and other crops such as maize for several years. He used to treat his soya bean plants with *Bradyrhizobium* inoculants every second year, using mainly seed treatment and sometimes liquid application of different commercially available products of *B. japonicum* strains in furrows. However, he stopped inoculating his soya bean