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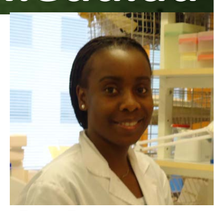

Species diversity and symbiotic efficiency of soybean nodulating rhizobia in previously inoculated Zimbabwean fields

Mazvita Chiduwa[1,2], Julie Ardley[1], John Howieson[1], Graham O'Hara[1] Ravi Tiwari[1]

[1]Murdoch University, 90 South Sreet, Perth WA 6150, Australia,

[2]Soil Productivity Research Laboratory, P. Bag 3757, Marondera, Zimbabwe

INTRODUCTION

Soybean is a pillar crop in the agriculture driven Zimbabwean economy. Benefits derive from Biological Nitrogen Fixation (BNF) with their microbial symbiotic partners, rhizobia. This removes the need for costly and potentially environmentally damaging nitrogenous fertilizer.

Research has indicated that there are limited soybean nodulating rhizobia in Zimbabwean soils (Fig 1). Inoculation with sufficient numbers of effective strains is essential to realize sustainable crop yields. Therefore, elite exotic rhizobial strains have been used to inoculate soybean in Zimbabwe. However, they may be poorly adapted to local climatic and edaphic conditions or poorly competitive against background indigenous rhizobia.

Fig 1: Typical impoverished smallholder farmers fields, showing a) contrast between inoculated and uninoculated soybean crop b) showing mature inoculated crop

In order to maximise soybean yields, the effects of agro-ecology and farm management styles on persistence and performance of introduced strains must be understood. In addition, as bacterial horizontal gene transfer can affect symbiotic effectiveness, the interactions of introduced strains with local rhizobia populations needs to be studied.

SAMPLING AND METHODS

1. Soils inoculated five years prior to the commencement of this study were sampled using two methods:
   - Rhizobia were isolated from trap host soybean plants grown under glasshouse conditions in soils collected from research farm fields
   - Rhizobia were isolated from nodules collected directly from soybean growing in smallholder farmers' fields.
2. Recovered isolates were identified to species level using partial gene sequences
3. Isolates were evaluated for symbiotic efficiency by dry weight accumulation under glasshouse conditions
4. Representative isolates were evaluated for legume host range under glasshouse conditions

RESULTS

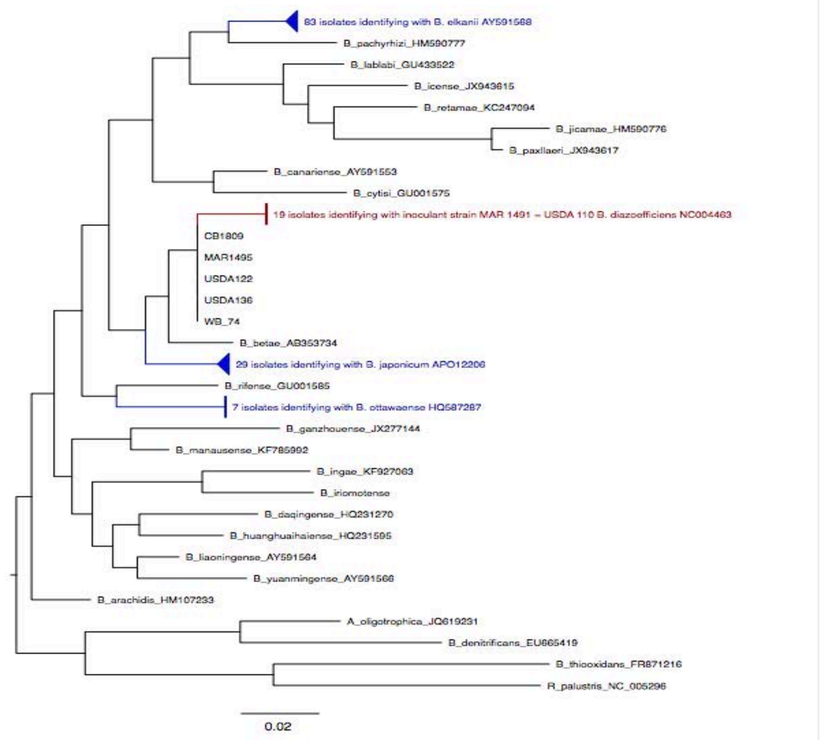

Fig. 2: Phylogeny of rhizobia recovered in this study

- A total of 217 isolates were recovered
- 138 isolates authenticated as root nodulating rhizobia
- All authenticated strains are slow-growers
- recA gene sequencing revealed 4 species of *Bradyrhizobium* (Fig. 2)

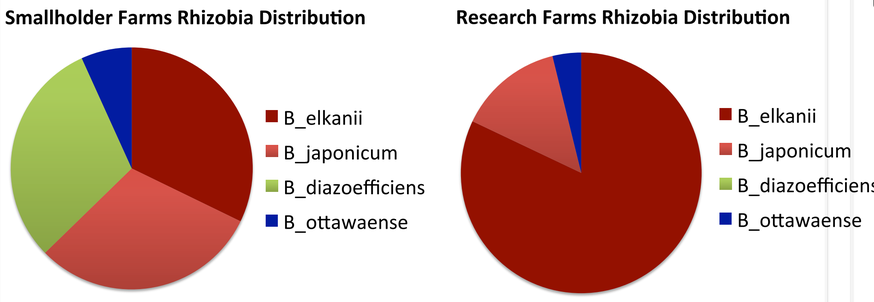

Fig 3: Species distribution of rhizobia recovered from two contrasting farm management systems.

- Of the 5% MAR 1491 inoculant strain-like isolates, none were recovered from research farms.
- Rhizobial diversity is richer in the smallholder farmers' fields (Fig. 3).

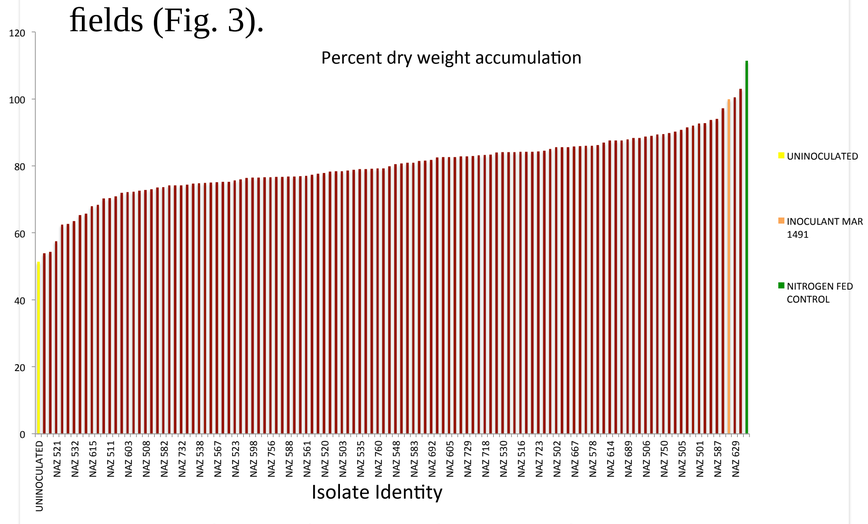

Fig 4: percent dry weight accumulation in relation to recommended inoculant strain *B. diazoefficiens* MAR 1491 = USDA 110

- Only two strains, NAZ 710 (*B. japonicum*) and NAZ 629 (*B. diazoefficiens*) exceed nitrogen fixation capacity of the recommended inoculant strain under glasshouse conditions (Fig. 4).

Results

- In the host range investigation, all tested strains nodulated *Acacia ligulata* (acacia), *Cajanus cajan* (pigeon pea), *Vigna angularis* (adzuki bean) and *Vigna unguiculata* (cowpea). No isolates nodulated *Lupinus angustifolium* (lupin), *Pisum sativum* (garden pea), *Vicia faba* (broad bean) or *Arachis hypogea* (peanut).

	NAZ 505	NAZ 519	NAZ 641	NAZ 661
Species identity	B. japonicum	B. ottawaense	B. diazoefficiens	B. elkanii
Mung bean *V. radiata*	No nodulation	Effective nodules	Ineffective nodules	No nodulation
Crotalaria *C. juncea*	No nodulation	Effective nodules	No nodulation	Effective nodules
Common bean *P. vulgaris*	No nodulation	Ineffectve nodules	No nodulation	Ineffective nodules

Table 1: Host range of isolates representative of species diversity

- Nodulation patterns of three host legumes (Crotalaria juncea, Phaseolus vulgaris and Vigna radiata) were markers for distinguishing the different rhizobial species (Table 1).

RESEARCH DIRECTION

Guided by current results, future work will:

- identify inoculant strain candidates through further symbiosis tests across a wider range of soybean varieties.
- assess the top performers for genetic stability with respect to symbiosis genes.
- scan the indigenous rhizobia for symbiosis genes obtained by horizontal gene transfer.

References

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