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Creating Opportunities

Optimizing Commercial Nitrogen-Fixing Bacteria Rates on Nodulation and Growth of Bambara Groundnut (*Vigna subterrenia* (L.) Verdc.)

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Introduction

- Bambara groundnut is a legume originally grown in sub-Saharan Africa and parts of Asia (Bitire et al., 2022).
- Limpopo, Mpumalanga, Northwest, Gauteng, and KwaZulu-Natal (Nhamo et al., 2022).
- It is nutritious, drought-tolerant, crop rotation, promotes food security and improves soil (Ajayi et al., 2023).
- Forms a mutualistic relationship with rhizobia (Ajilogba *et al.*, 2022).
- Growth, development, and yield of legumes depend on the nitrogen-fixing bacteria (Bitire *et al.*, 2023).
- They help clean the soil by taking in harmful metals (Lawal, 2021).

Bambara groundnuts



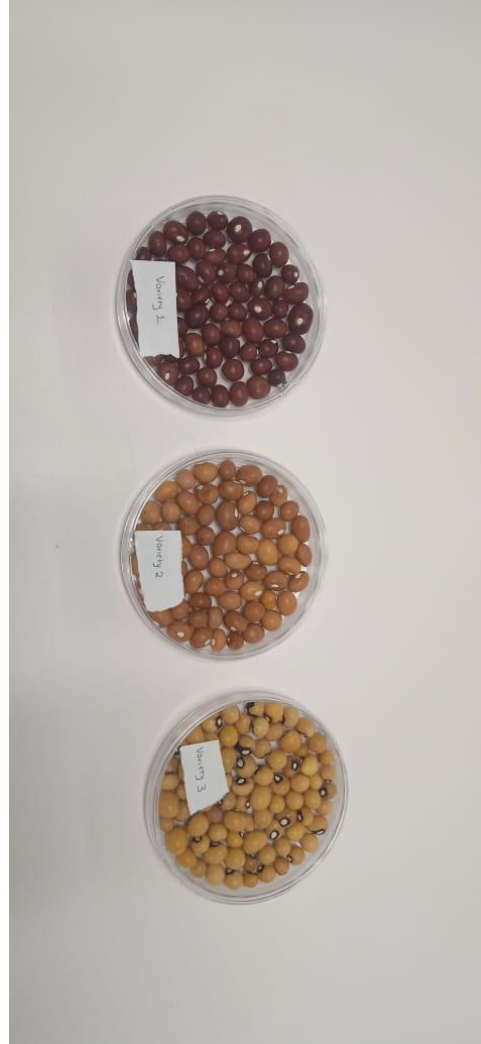
Figure 1: Bambara groundnut seeds
(Heuzé *et al.*, 2016).



Materials and methods

- **Location:** UMP farm Greenhouse (25°27'06.18"S, 30°58'5.21"E).
- **Design:** Randomized Complete Block Design (RCBD).
- **Treatments:** 2×3×5
 - ✓ 2 Inoculants: Bradyrhizobium japonicum (Bj), Rhizobium meliloti (Rm) and control
 - ✓ 3 Landraces: Red (L1), Brown (L2), brown with black colour (L3)
 - ✓ 5 bacterial application rates: 5×10^6 – 5×10^{10}
- **Replications:** 5

Landraces that were used



RESULTS and discussion (PLANT GROWTH VARIABLES)

The effect of *Bradyrhizobium japonicum* and *Rhizobium meliloti* on chlorophyll content (CC), number of leaves (NL), stem diameter (SD), fresh shoot mass (FSM), dry shoot mass (DSM), and fresh root mass (FRM) on Bambara groundnut bacteria.

Bacteria	CC	NL	SD	FSM	DSM	FRM
Control	338.573 ^a	335.53 ^a	466.9720 ^a	333.2747 ^a	333.1100 ^a	333.2747 ^a
<i>Bradyrhizobium japonicum</i>	404.668 ^{ab}	402.21 ^{ab}	493.8135 ^a	413.3180 ^a	413.0756 ^a	413.3180 ^a
<i>Rhizobium meliloti</i>	630.429 ^b	627.53 ^b	706.5023 ^a	612.9500 ^a	612.8032 ^a	612.9500 ^a
F-value	4.999	4.931	4.152	4.002	4.001	5.771
P-value	0.008	0.008	0.035	0.017	0.020	0.004

PLANT GROWTH VARIABLES

The effects of nitrogen fixing bacteria application rates on plant height (PH), chlorophyll content (CC), number of leaves (NL), stem diameter (SD), fresh shoot mass (FSM), number of runners (NR), length of longest runner (LLR), dry shoot mass (DSM) and fresh root mass (FRM) of Bambara groundnut

Application rate	PH	CC	NL	SD	FSM	NR	LLR	DSM	FRM
5×10^6	504.030 ^{ab}	538.310 ^{ab}	535.17 ^{ab}	533.7883 ^a	466.6177 ^a	499.57 ^{ab}	499.557 ^{ab}	466.3463 ^a	633.2023 ^{ab}
5×10^7	767.803 ^a	702.120 ^b	700.27 ^b	799.4437 ^a	732.7477 ^a	765.90 ^b	765.900 ^b	732.6550 ^a	732.8297 ^b
5×10^8	403.457 ^a	336.707 ^a	335.47 ^a	467.1600 ^a	399.8457 ^a	399.63 ^a	399.673 ^a	399.6993 ^a	400.0810 ^{ab}
5×10^9	470.207 ^{ab}	371.887 ^{ab}	368.93 ^{ab}	500.5343 ^a	400.0147 ^a	466.20 ^{ab}	466.200 ^{ab}	399.7767 ^a	367.0520 ^a
5×10^{10}	669.130 ^{ab}	638.720 ^{ab}	634.53 ^{ab}	699.8630 ^a	566.4443 ^a	666.03 ^{ab}	666.067 ^{ab}	566.2197 ^a	633.1967 ^{ab}
F-value	2.939	3.338	3.281	2.664	2.452	2.925	2.925	2.451	3.317
P-value	0.023	0.012	0.013	0.035	0.049	0.023	0.023	0.049	0.012

RESULTS (NODULATION VARIABLES)

The effect of landraces on nodule positioning (NP), nodule number (NN), active nodule (AN), non-active nodule (NAN), and color and abundance of Bambara groundnut

Landraces	NP	NN	AN	NAN	Colour and abundance
Red	980.85 ^b	980.93 ^b	980.84 ^b	980.93 ^b	980.89 ^a
Brown	835.91 ^a	837.35 ^a	836.31 ^a	836.56 ^a	835.91 ^a
Brown with black colour	872.11 ^{ab}	874.18 ^{ab}	872.56 ^{ab}	873.44 ^{ab}	872.13 ^{ab}
F-value	3.490	3.491	3.486	3.497	3.493
P-value	0.033	0.033	0.033	0.033	0.033

NODULATION VARIABLES (CONTINUED)

The effect of nodulation variables, including plant growth vigor (PGV) and total score (TS), on bacteria

Bacteria	PGV	TS
Control	334.60 ^a	600.47 ^a
<i>Bradyrhizobium japonicum</i>	401.17 ^a	627.72 ^a
<i>Rhizobium meliloti</i>	613.80 ^a	813.16 ^a
F-value	4.387	3.736
P-value	0.014	0.026

The effect of plant growth vigor (PGV) on the application rate

Application rate	PGV
5×10^6	467.70 ^{ab}
5×10^7	700.07 ^b
5×10^8	334.70 ^a
5×10^9	401.17 ^{ab}
5×10^{10}	633.80 ^{ab}
F-value	3.033
P-value	0.019

Conclusions and recommendations

Although BJ had the most crops, RM has showed to have more nodules and high plant vigor. This therefore leads to a conclusion that RM had more impact on both the parameters than BJ. The most effective and most suitable application rate was therefore observed to be 5×10^7 , and in terms of landrace, red has shown to be more effective. This has led to the conclusion and recommendation of the 5×10^7 *rhizobium melilot* (RM) with the red landrace.



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Thank you for your attention!

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