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Symbiotic Relationships and Effectiveness of Soybean Rhizobia in Soils of the Nigerian Savanna

Introduction

- Rhizobia are root bacteria that form symbiotic relationships with legumes including soybeans
- However, these symbiotic relationships can be significantly affected by population of indigenous rhizobia, their effectiveness and soil Total Nitrogen (Scharf and Wiebold, 2003)

objectives

- estimate the population and symbiotic effectiveness of indigenous rhizobia in soils of the Nigerian savanna in relation to agro-ecology.

- establish the relationship(s)between the symbiotic effectiveness of indigenous rhizobia population and the magnitude of response to inoculation in each soil

Methodology

Soil Sampling and Analysis

- Soils were sampled from 10 points per plot at the depth of 0-20cm using sterilized auger.
- Thereafter, 5g of subsamples were sieved through 0.5mm and refrigerated for Most Probable Number of indigenous rhizobia count according to the methods of Woomer, (1988)
- while 125g of sub sample were air-dried, crushed and sieved with a 2mm screen in preparation for physicochemical properties using standard methods outlined by ISRIC/FAO.(2002).

Treatment and Experimental Design

- **Most Probable Number Count (MPN) of Indigenous Rhizobia**

- The procedure was a factorial arrangement fitted to a Completely Randomized Design (CRD). Seeds of TGx 1448-2E were inoculated with tenfold serial dilution (10^{-1} – 10^{-6}) of each soil sample and replicated three times.

Need-to-Inoculate Experiment

- Soils sampled from thirty sites on farmer's field, collected in pots, were arranged in a green house located at National Cereal Research Institute, Badeggi, Niger State, Nigeria in the month of June, 2013.

- Treatments are 4 N sources as follows: (0kg N ha^{-1}, 100 kg N ha^{-1}, Biofix, Legumefix) and 30 sites across the Nigeria Savanna; 10 sites each from southern Guinea (Agwanga, Lapai, Garatu, Maikunkele, Keffi, Gwada, Paiko, Bwari, Sabon Gida and Kampani Mailamba) northern Guinea (Kagara, Tegina, Shika, Maigana, Soba, Tasha Ango, Rigachikun, Birnin Yaro, Birnin Gwari and Tasha Iyali) and sudan savanna (Bebeji, Karaye, Madobi, Tofa, Kura, Karefi, Bagwai, Chiromawa, Rano and Amawa) (Figure 1) fitted to Completely Randomized Design with 3 replicates.

Planting and Crop Management

Most Probable Number of Indigenous Rhizobia

- Coarse sand was severally washed and autoclaved at 121^{0}C for 20 minutes.
- Thereafter, 25 polybags, each containing 2 kg of sterilized sand were watered to field capacity with sandsman nutrient solution.
- Surface-sterilized seeds of TGX144 8-2E were then planted at the rate of four seeds per polypot and then thinned to 2 seedlings per polypot at one week after planting and before treatment application.
- Plants were constantly watered at a day interval with sandsman nutrient solution till harvested at 7 weeks after planting (WAP).

Data Collection

- dry weights of shoots were measured after oven-drying at 65^{0}C for 3 days while Percentage symbiotic effectiveness (%SE) was derived as follows:
- % SE = d-n/d+n X 100 ....eqn 1

  Where d-n and d+n are the dry weight of plants without N and plants with N respectively. Percentage Inoculation response (IR) was also derived as follows:
- % IR= d+I – (d-n) /d-n X 100 ....eqn 2

  where d+i and d-n are the dry weight of inoculated plants and plants without N respectively.

- **Statistical Analysis**
- Data generated from symbiotic effectiveness of indigenous rhizobia and response to inoculation with Legumefix and Biofix were analyzed using simple analytical tool that generated bar charts with error bars.

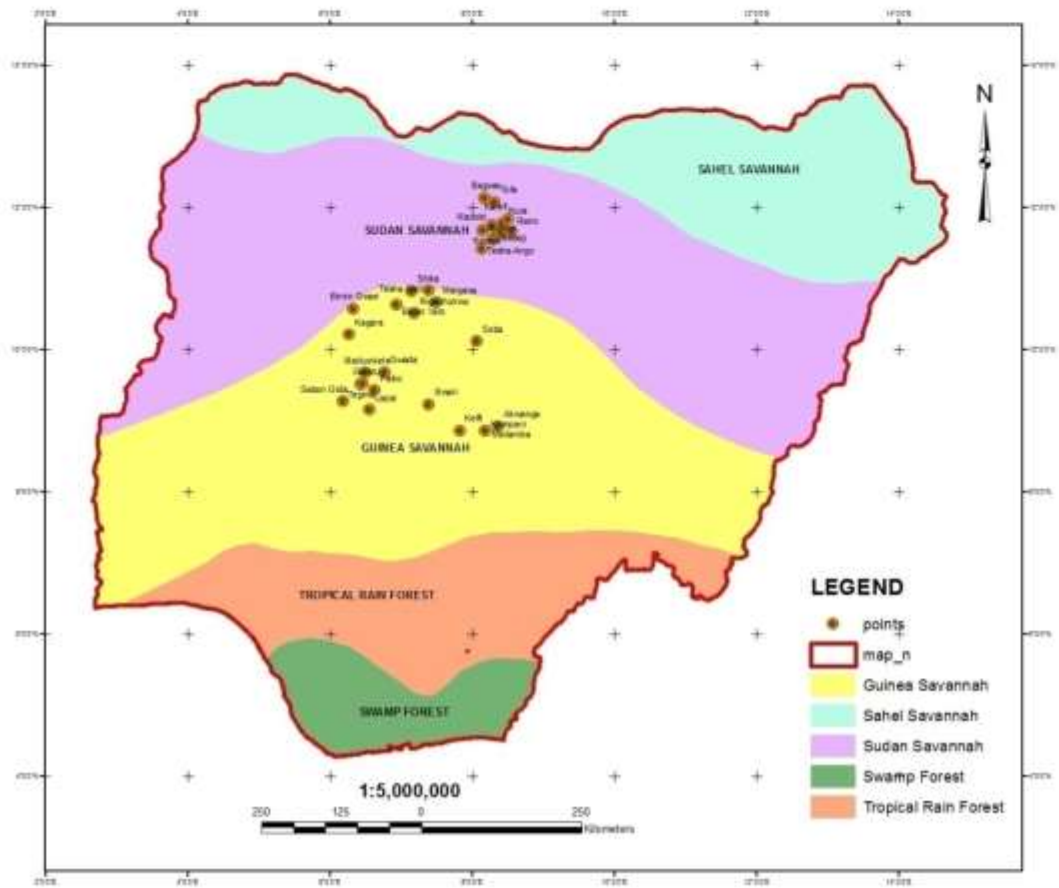

Fig1: Map of Nigeria showing study area of locations

Table 1: Indigenous rhizobia counts(MPN) and Total N of soils of the Southern Guinea Savanna

Soil characteristic	Akwanga	Lapai	Garatu	Maikunkele	Keffi	Gwada	Paiko	Bwari	Sabon Gida	Kampani Mailamba
MPN count trapped by TGx1448-2E	1.6 x 10^5	1.1 x 10^6	1.1 x 10^6	1.1 x 10^6	9 x 10^2	3.6 x 10^5	1.1 x 10^6	1.1 x 10^6	1.1 x 10^6	1.1 x 10^6
Soil Total N (g Kg-1)	0.25	0.14	0.17	0.03	0.22	0.25	0.13	0.10	0.24	0.17

Table 2: Indigenous rhizobia counts (MPN) and Total N of soils of the Northern Guinea Savanna

Soil characteristic	Kagara	Tegina	Shika	Maigana	Soba	Tasha Ango	Rigachikun	Birnin Yaro	Birnin Gwari	Tasha Iyali
MPN count trapped by TGx1448-2E	1.1×10^5	1.1×10^5	2.1×10^5	1.1×10^6	2.1×10^3	3.6×10^5	2.1×10^3	1.1×10^6	1.1×10^6	3.6×10^2
Soil Total N (g Kg-1)	0.18	0.24	0.18	0.22	0.27	0.20	0.28	0.17	0.18	0.15

Table 3: Indigenous rhizobia counts (MPN) and Total N of soils of the Sudan Savanna

Soil characteristic	Bebeji	Karaye	Madobi	Tofa	Kura	Karefi	Chiromawa	Rano	Amawa	Bagwai
MPN count trapped by TGx1448-2E	1.1×10^6	1.1×10^6	2.1×10^2	1.1×10^6	2.1×10^2	9.3×10^2	1.1×10^5	1.1×10^6	1.1×10^5	1.6×10^5
Soil Total N (g Kg^{-1})	0.29	0.17	0.25	0.14	0.20	0.29	0.21	0.21	0.18	0.28

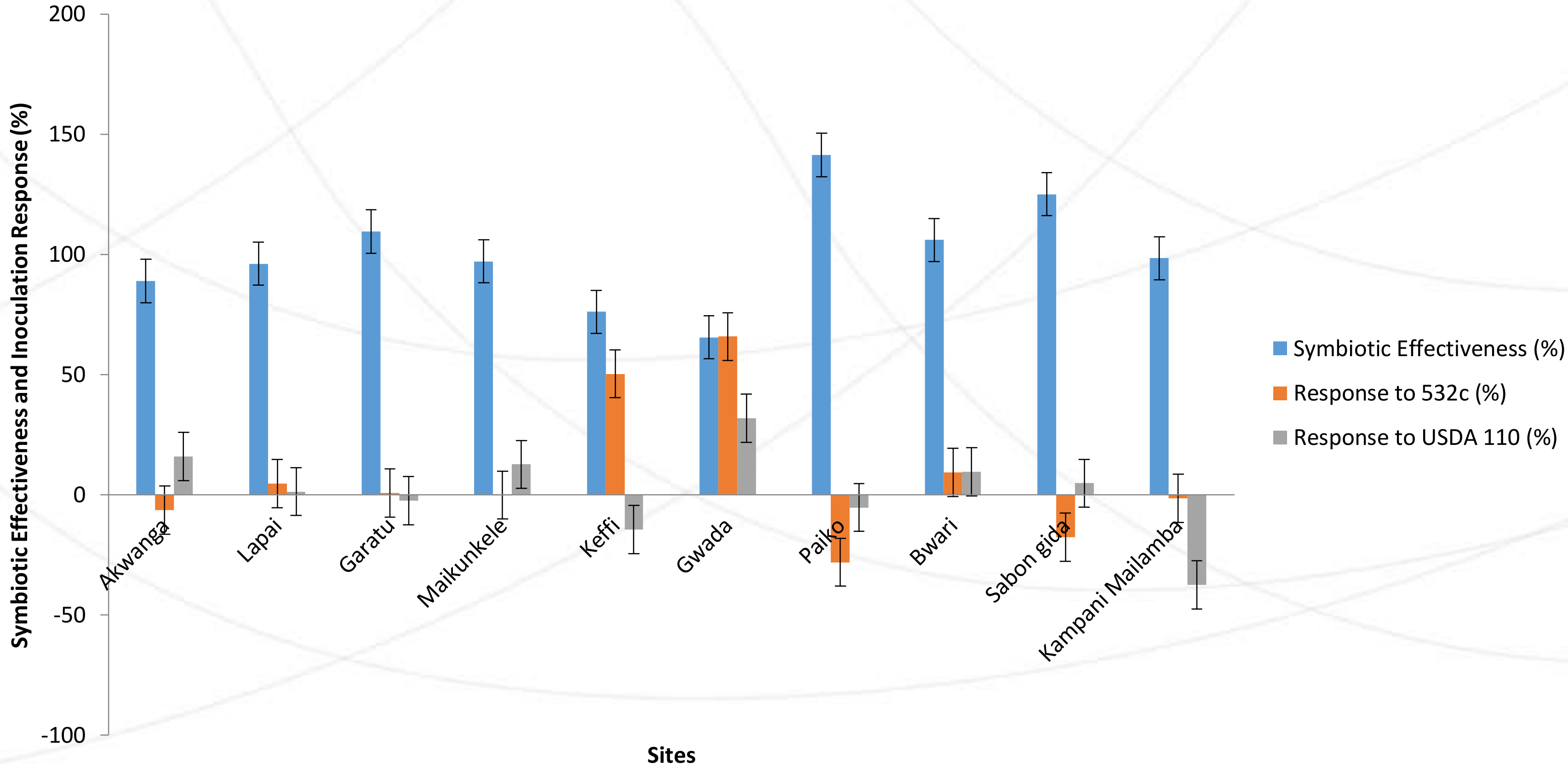

Figure. 2: Symbiotic effectiveness and inoculation Response of Soybean across Sites in the Southern Guinea savanna

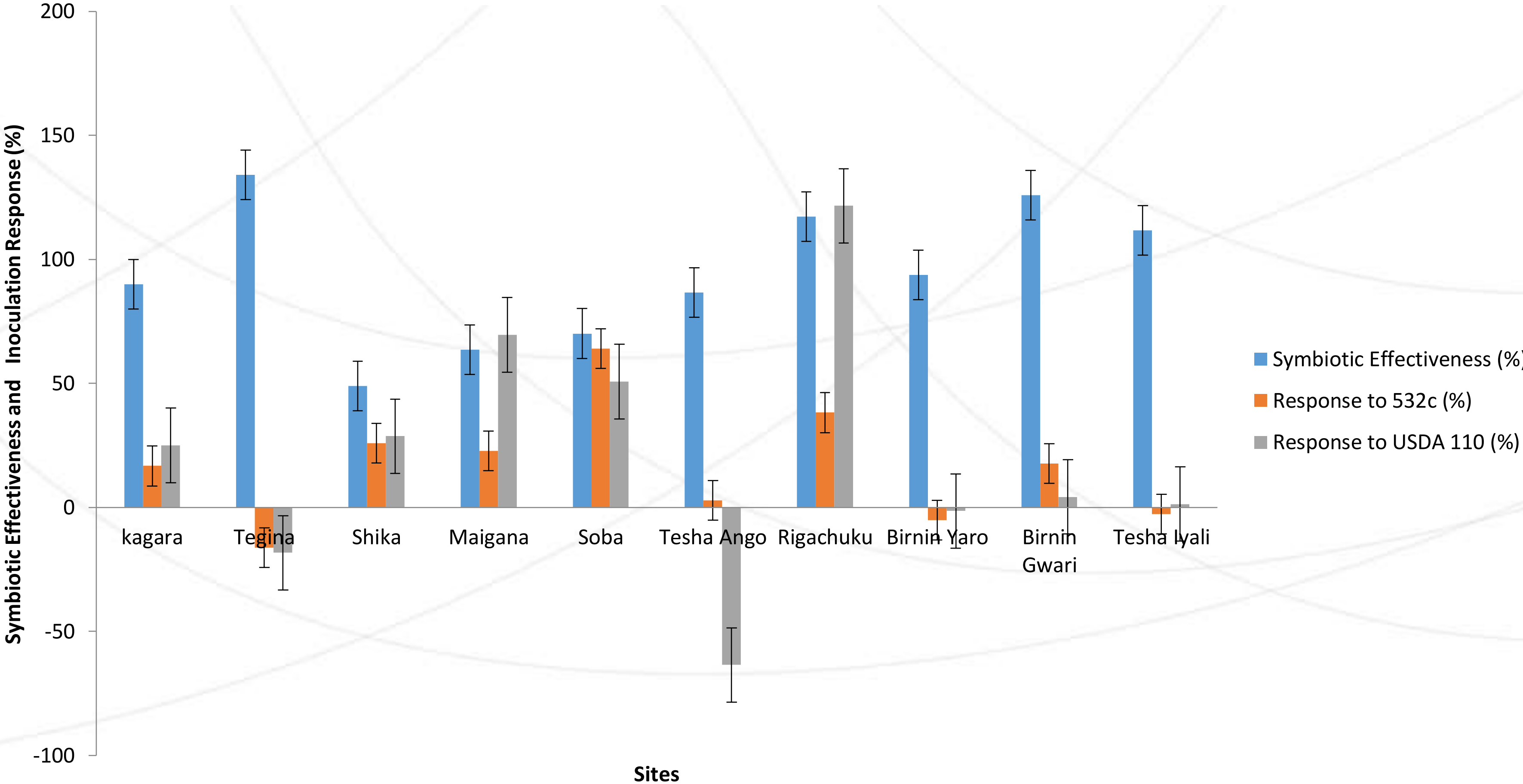

Figure 3: Symbiotic effectiveness and inoculation response of soybean across sites in the northern Guinea savanna

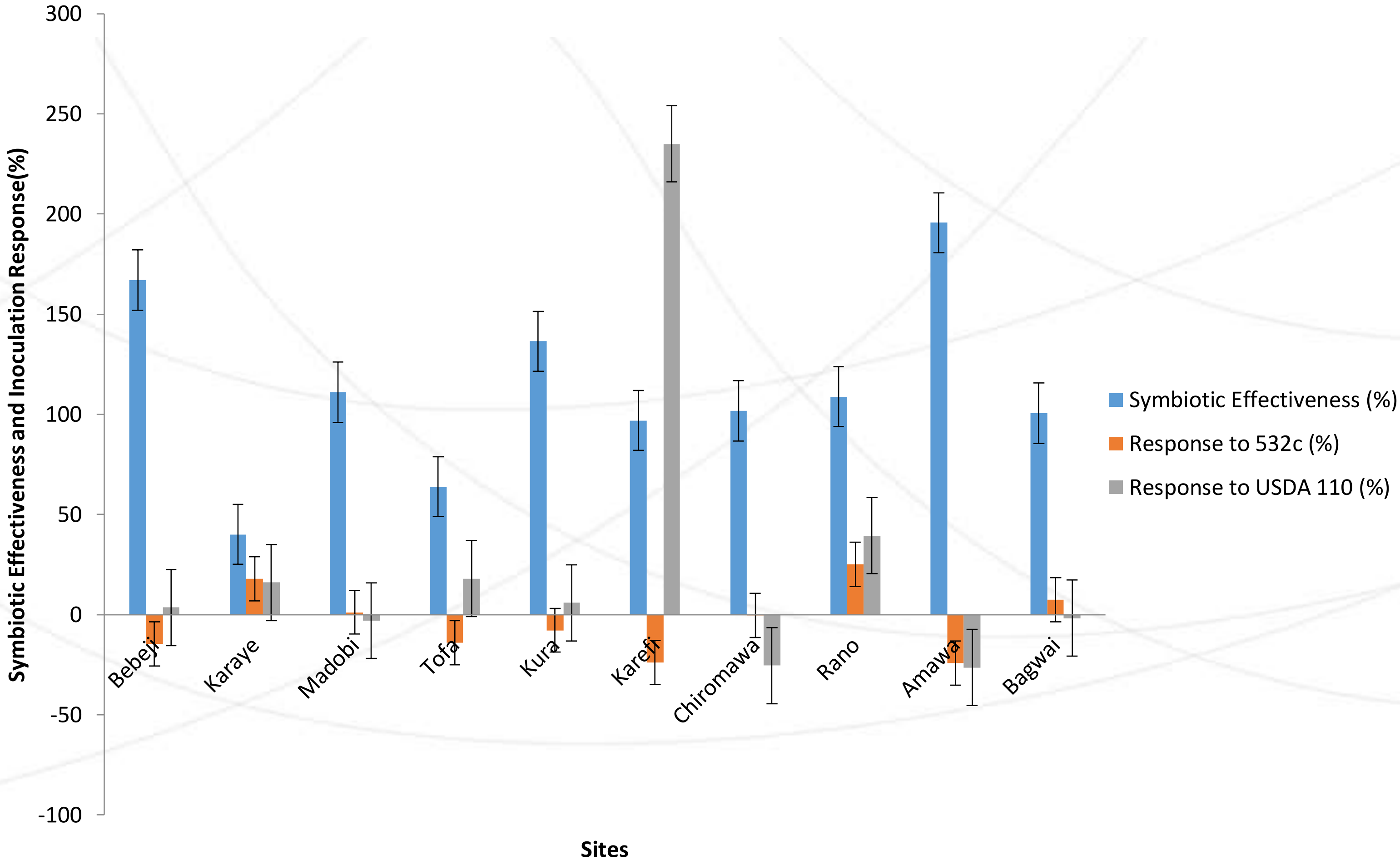

Figure 4: Symbiotic effectiveness and inoculation response of soybean across sites in the Sudan savanna

Discussion

- In the southern Guinea savanna, indigenous rhizobial count averaged 822,090 cells g^{-1} (Table 1) and Symbiotic effectiveness of indigenous rhizobia ranged from 69% - 123% (Figure 2).
- That explains why 50% of the soils responded positively to USDA110 (Biofix inoculant) while 20% responded positively to 532c (Legumefix inoculant) (Figure 2).

- In the northern Guinea Savanna, indigenous rhizobial count averaged 409,456 cells g^{-1} (Table 2) and Symbiotic effectiveness of indigenous rhizobia ranged from < 50% to >120% (Figure 3).
- No wonder soybeans grown on 60% of the locations responded to USDA110 (Biofix) and 532c (Legumefix inoculant) respectively (Figure 3).
- In the Sudan Savanna, indigenous rhizobial populations (478,135 cells g^{-1})(Table 3) and their symbiotic effectiveness < 50% to >180% (Figure 4) were averagely higher than those obtained in the Northern Guinea Savanna (Table 2 and Figure 3). Consequently, 50% of the locations responded to Biofix while 30% responded to Legumefix (Figure 4).

Conclusions and Recommendations

- In conclusion, average population of indigenous rhizobia, their symbiotic effectiveness and response to the inoculants were highest in the southern Guinea savanna, sudan savanna and northern Guinea savanna respectively.

- It is therefore recommended that the use of these elite inoculants (Biofix and Legumefix) be restricted to Northern guinea savanna while the potentials of indigenous rhizobia native to southern Guinea and sudan savanna be explored in local production of rhizobium inoculants.

Thank you for your attention