SOIL SCIENCE SOCIETY OF NIGERIA

UNIVERSITY OF AGRICULTURE MAKURDI

INNOVATION AND SERVICE

SOIL SCIENCE
SOCIETY OF NIGERIA (SSSN)

PROCEEDINGS

OF THE

43RD ANNUAL CONFERENCE, SOIL SCIENCE SOCIETY OF NIGERIA (SSSN)

FOOD BASKET 2019

Date: 15th - 19th July, 2019



Theme:

UNDERSTANDING NIGERIAN SOILS
FOR SUSTAINABLE FOOD AND NUTRITION SECURITY AND HEALTHY ENVIRONMENT

Host:
Department of Soil Science
University of Agriculture, Makurdi

EDITED BY:

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Published by the Soil Science Society of Nigeria (SSSN)

PROCEEDINGS OF THE 43RD ANNUAL CONFERENCE OF THE SOIL SCIENCE SOCIETY OF NIGERIA

THEME:

UNDERSTANDING NIGERIAN SOILS FOR SUSTAINABLE FOOD AND NUTRITION SECURITY AND HEALTHY ENVIRONMENT

DEPARTMENT OF SOIL SCIENCE, COLLEGE OF AGRONOMY, FEDERAL UNIVERSITY OF AGRICULTURE, MAKURDI, BENUE STATE – NIGERIA

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ISBN: 978-978958-981-5

CITATION

Jayeoba et al (editors). 2018. Understanding Nigerian Soils for Sustainable Food and Nutrition Security and Healthy Environment. Proceedings of the 43rd Annual Conference of the Soil Science Society of Nigeria held at the Department of Soil Science, College of Agronomy, Federal University of Agriculture, Makurdi, Benue State – Nigeria. 15th – 19th July, 2019.

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Publishers of the Nigerian Journal of Soil Science

Published in 2019

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FOREWORD

The 43rd Annual Conference of the Soil Science Society of Nigeria held on the 15th to 19th July, 2019 at the College of Agronomy Complex, Federal University of Agriculture, Makurdi with the theme: "Understanding Nigerian Soils for Sustainable Food and Nutrition Security and Healthy Environment". The choice of the theme was premised on the fact that Soil is a non-renewable resource and thus a sustained production of crops that would guarantee food and nutrition security while preserving and protecting the environment in Nigeria would require a clear understanding of the nature, dynamics and properties of these soils.

Papers were presented in the areas of Pedology, Soil survey and Climatology, Land use and Land Use Planning, Soil fertility and Plant nutrition, Fertilizer use and Management, Soil chemistry and Microbiology, Soil biology and Biochemistry, Biotechnology and Bioremediation studies, Soil physics, Soil and water management, Land degradation and Soil conservation.

The modern environmental movement that has evolved from a traditional emphasis on chemical reactions affecting plant growth to a focus on soil contaminant reactions was clearly demonstrated at this conference in terms of the number and quality of papers presented in this area. It was evident that the sources of these contaminants include fertilizers, pesticides, acid deposition, agricultural and industrial waste materials as well as oil spillage in the delta areas of Nigeria. Discussions on these contaminants and the soil chemical reactions that these contaminants undergo and how a knowledge of these reactions is critical in predicting their effect on the environment and quality of produce is well reported in this book of proceedings.

There were no field trips as a result of the prevailing security situation in the state. However, a presentation of the school laboratory project by the OCP Africa fertilizer company came in handy. This is a modern mobile Laboratory that conducts on site analysis of soil samples, instantly calibrates and provides field specific fertilizer recommendations. This ensures that fertilizers are applied at rates required by crop plants thus avoiding excesses that are bound to be applied when blanket recommendations are made with its attendant effect on the environment.

The papers presented at the conference which are published in this book of proceedings were painstakingly subjected to a peer review process. It is our hope that the information contained herein will be found helpful to environmentalists, Agriculturalists, policy makers, the academia and indeed a wide range of professionals.

Bemgba Anjembe Ph.D.
Chairman, Local Organizing Committee.
14th February, 2020.

ACKNOWLEDGEMENTS

The Local Organizing Committee (LOC) of the 43rd Annual Conference of Soil Science Society of Nigeria (SSSN) wishes to express her profound appreciation to the Vice Chancellor, Federal University of Agriculture, Makurdi for providing venues and an enabling environment for the successful hosting of the conference. Apart from providing seed money as loan, his contributions towards provision of accommodation for the Leadership of our society is deeply appreciated.

His excellency, the executive Governor of Benue State Dr. Samuel Ioraer Ortom apart from supporting the LOC financially, was represented at the opening ceremony by his deputy. He graciously granted the Society a state banquet, personally decorated our President and presented him with an honorary citizenship of the state.
The notable contributions of OCP Africa, Indorama, IFDC, Value Seeds Nigeria Limited, Teryima Nigeria Limited and other bodies significantly contributed to the success of the conference.

The chairmen of technical sessions and rapporteurs contributed greatly to the success of the conference. We sincerely appreciate all reviewers of manuscripts presented at the conference. We are also thankful to the Management and Staff of ASOFAD Pinting Ltd. who worked tirelessly to ensure that our book of abstracts, programme of events, customized tags and certificates of attendance as well as the conference proceedings were delivered on time.

We are very highly indebted to the National Executive Committee of SSSN for their support and encouragement through this tasking period. The long conversations, arguments and constructive criticisms from the National President Prof. B. A. Raji largely improved the quality of our decisions and have tremendously contributed to our successful hosting of the 43rd Annual Conference.

Bemgba Anjembe Ph.D
Chairman, LOC
January, 2020

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SYMBIOTIC PROPERTIES OF RHIZOBIA STRAINS ISOLATED FROM SOILS OF BIRNIN-GWARI AND SHIKA IN KADUNA

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ABSTRACT
The experiment was carried out in the screen house of the Department of Soil Science and Land Management, Federal University of Technology, Minna. Prior to planting of four (4) seeds per pot, the pots were watered with calcium sulphate solution to field capacity. A week after planting, seedlings were thinned to two (2) plants followed by application of treatments as follows: Three (3) soybean varieties TGx1448-2E, TGx1835-10E and TGx1955-10E fertilized with –N, +N at the rate of 100kg N per pot, LF, Bg4, Bg5, Bg1-2, Bg1-4, Bg4-2, Sk1-4, Sk2-3, Sk2-5 and Sk6-3. Treatments were laid out in a factorial arrangement fitted to a completely randomized design and replicated 3 times. Nodulation and shoot biomass were assessed by counting and weighing while symbiotic effectiveness was derived from shoot biomass. Data obtained were subjected to ANOVA and means of treatments effect separated using Tukey studentized test. Result showed that interaction between varieties and N-sources significantly affected all the symbiotic properties. The highest nodule number of 23 nodules per plant was recorded when TGx1448-2E associated with isolate Bg5 while the heaviest shoot biomass and symbiotic effectiveness amongst isolate effect was obtained when TGx1835-10E associated with isolate Sk2-3. Cultivation of TGx1835-10E will therefore be most beneficial when supplied with 20kg N and inoculated with Sk2-3.

Keywords: Soybean, Rhizobia isolates, N-Sources, Nodulation

Introduction

Soybean, (Glycine max) formerly classified as *Glycine soja.* is an annual herbaceous plant in the Fabaceae (legume or bean family). Soybean has the ability to fix nitrogen from the atmosphere through root nodules formed in symbiotic association with Rhizobium bacteria on low-N soil (Harold *et al.,* 1992). The continuous depletion of nitrogen (N) from the soil by processes such as volatilization, leaching and, most importantly, removal of nitrogen-containing crop residues from the land results in the decline of soil N reserves in agricultural soils. Replenishment has depended largely on the addition of inorganic fertilizers which causes severe environmental pollution problem. Prolonged applications of large quantity of these N fertilizers are manifesting themselves in environmental degradation such as leaching of nitrates into the ground water and development of soil acidity (Ridley *et al.,* 2004). Biological nitrogen fixation (BNF) is the biological process by which the atmospheric nitrogen (N_2) is converted to ammonia by an enzyme called nitrogenase. It is the major source of the biosphere nitrogen and as such has an important ecological and agronomical role, accounting for 65 % of the nitrogen used in agriculture worldwide.

Soybean grown in many African soils is characterized by low levels of biological nitrogen fixation (BNF) which often cannot support high soybean yields without addition of inorganic N fertilizers, and these inorganic N fertilizers leads to severe pollution problems. Nitrogenous fertilizers are also subject to losses due to denitrification leading to release of N_2 and NO_2 gases, volatilization of ammonia, run-off and leaching which can contaminate surface and underground water. A common approach to improve symbiotic nitrogen fixation and legume productivity has been the reliance on superior or very effective exotic rhizobia strains as inoculants. This approach has failed to achieve the desired responses in a lot of environment (Brockwell *et al.*, 2005). Although generally low, soil nitrogen availability can fluctuate greatly in both space and time due to factors such as precipitation, temperature, wind, soil type, and pH. Therefore, the preferred form in which N is taken up depends on plant adaptation to soil conditions.

The use of strains adapted to environmental conditions can contribute to enhance biological nitrogen fixation (BNF) effect upon yield of soybean and the nitrogen status of the soil. The effect of biological nitrogen fixation (BNF) depends on the survival of rhizobial strain under different soil conditions; it was reported by O'Hara *et al.* (2002) that the abundance of diversity in the soil populations of rhizobia provides a large resource of natural germplasm to screen for desired characteristics present in the natural pool. This requires rigorous screening for efficient rhizobial strains with adaptation to different soil conditions (Zaharan, 1999). To achieve this, indigenous rhizobial strains need to be characterized under different conditions in the laboratory and then later tested in the field for their effectiveness. Inorganic N fertilizer such as urea and ammonium nitrate are expensive input in agriculture compared to the use of inoculants. The cost of a bag of urea is about 7,500 naira, for a hectare a farmer will require four (4) bags costing approximately 30,000 naira. But a sachet of rhizobium inoculants is about 1,800 naira which can be used to inoculate 100kg seeds/ha. The use of inoculants will save a farmer 28,200 naira/ha. Hence the importance of inoculation cannot be ignored. Evidently, legumes will remain the backbone of farming system in farmers residing in poor areas due to their capacity to fix nitrogen. Research efforts should be directed in assessing the optimum combinations between inoculants and inorganic fertilizers that will offer immediate economic returns to the resource poor farmers who cannot afford the full package of inorganic fertilizers. The objectives of this study were to evaluate the nodulation and growth traits of three promiscuous soybean varieties and evaluate the symbiotic properties of rhizobia isolates associated with soybean varieties.

Materials and Method

Experimental site and description

The experiment was carried out in a screen house of the Department of Soil Science, Federal University of Technology, Minna at southern Guinea savanna zone of Nigeria. The coordinate of Federal University of Technology Minna lies at longitude (6^0 31' E) and latitude (9^0 41' N). The climate of Minna is sub-humid with mean annual rainfall of Minna of about 1300 mm; the rainy season begins at most times in April and persists till October (Ojanuga, 2006). The average annual temperature is 27.5^{0}C.

Soil physical Characteristics and Microbiological Properties

The soils where the isolates were gotten from are slightly acidic to moderately acidic. This is a common feature of savanna soils (Jones and wild, 1975). The indigenous isolates include Bg1-2, Bg1-4, Bg4, Bg4-2, Bg5, Sk1-4, Sk2-3, Sk2-5 and Sk6-3.

Legume fix (LF) contain rhizobium strain 532C. It is a damp peat formulation manufactured by legume Network, UK. The effect of the above stated properties on the experiment is negligible since the experiment was conducted in a controlled environment ideal for rhizobium growth.

Sand washing, Autoclaving and Pot filling

The sand used for planting was collected from a river side and washed thoroughly for several times. The essence of washing the sand thoroughly was to remove other soil particles and soluble nutrients present in the sand. Thereafter the sand was sterilized to kill all microbes with the help of an autoclaving machine at a temperature of 121^{0}C for 20 minutes. Sterilized Poly-pots were filled with the sterilized sand and served as the growth medium.

Sandman nutrient preparation and basal application

The nutrient solution was prepared according to sandman's procedure as follows;

micronutrient solution was prepared by dissolving $CuSO_4.5H_2O$ (0.157 g), $ZnSO_4.7H_2O$ (0.44 g), $MnSO_4.7H_2O$ (3.076 g), $(NH_4)_6Mo_7O_{24}.4H_2O$ (0.02 g) and H_3BO_3 (2.26 g) in 1000 ml of distilled water. Stock solution of iron was prepared by dissolving 5 g each of $FeSO_4.7H_2O$ and citric acid in 1000 ml of distilled water. Calcium solution was obtained by dissolving KNO_3 (0.2 g) and $CaSO_4$ (2.5 g) in 1000 ml of distilled water which 200 ml was added to the sand before sowing. The irrigating medium was therefore be obtained by dissolving KCl (0.149 g), $MgSO_4.H_2O$ (0.493 g), K_2HPO_4 (0.348 g), 5 ml of micronutrient solution into 1000 ml of distilled water.

Seed sterilization and planting

Soybean seeds from institute for agricultural research (IAR) were surface sterilized to get rid of contamination, especially with Rhizobium. This was done by rinsing the seeds in a sterile beaker containing 5 % Hypochlorite solution for some time to get rid the seeds of waxy material and trapped air. The hypochlorite solution was drained and the seeds were completely rinsed with six changes of distilled water .The poly pots filled with sand was watered to field capacity before planting. Four seeds were planted per pot and then later thinned to two plants per pot at one week after planting. The plants were irrigated frequently depending on the moisture content of the soil with the prepared sandman solution.

Yeast Mannitol Broth preparation and inoculation

Native rhizobia strain isolated from soils obtained from Birnin gwari and Shika in Kaduna state was cultured on Yeast Mannitol Broth (YMB) in slant bottles. The YMB media contain 5.0 g yeast, 0.25 g K_2HPO_4, 0.1 g $MgSO_4.7H_2O$, 0.05 g NaCl, 0.5 g Yeast Extract,0.5 g $CaCO_3$ in 500 ml of distilled water. The broth cultures was placed on a rotary shaker at 100 rev/min and allowed to grow for 5 days at 28°C. After thorough mixing, the solution was serially distributed to the base of the plants using a syringe at 5ml per plant.

Harvesting and tissue sampling

7 weeks after sowing, plants were harvested. The plants were removed carefully from the pots and the nodules were collected and counted. The plant shoot and nodules were also assessed based on their dry weight obtained. by oven drying them at a temperature of 65°C for 3 days. Also the percentage symbiotic effectiveness was derived using the formulae

Percentage symbiotic effectiveness (%SE) $=\frac{d-n}{d+n} \times 100$

Where d-n is dry weight of inoculated plants, while d+n is the dry weight of plants with N supply.

Experimental Treatment and Design

Three soybean varieties (TGx1448-2E, TGx1835-10E and TGx1955-10E) was assigned treatment with 10 rhizobia isolates (LF, Bg4, Bg5, Bg1-2, Bg1-4, Bg4-2, Sk1-4, Sk2-3, Sk2-5, Sk6-3) and two controls (control with nitrogen, N+ and without nitrogen, N-). All treatments were laid out in a factorial arrangement fitted into a completely randomized design and replicated 3 times.

Statistical Analysis

All the data obtained was subjected to analysis of variance (ANOVA) at 5% level of significant difference. The treatments mean was separated using Tukey studentized test.

Result and Discussion

Effect of N-Source on Shoot biomass, Nodulation and Symbiotic Effectiveness of Soybeans Varieties

Table 4.1 shows the main effect of N-source on symbiotic properties. Mineral N, N+ and control without Nitrogen, N- produced no nodules. Averagely isolate Bg5 was observed to produce the highest nodule number of 15 nodules, while isolate Bg4-2, Bg1-4 and Sk6-3 produced nodule number that is not significantly different from the nodule number produced by isolate Bg5. The least number of nodules was produced by isolate LF and Sk2-5 with 4 nodules. The heaviest nodule weight was observed with plants inoculated with Bg5 while plants inoculated with Bg1-4 and Sk6-3 produced nodule weight that is not significantly different from those produced by isolate Bg5. Plants treated with nitrogen only (N+) was observed to produce the highest shoot biomass while plants inoculated with isolates Sk2-3, Bg1-4, Sk6-3 and Bg5 produced high shoot biomass, but not as those produced with mineral N treatment (N+) only. Plants inoculated with isolate Sk2-3 was observed to produce the highest symbiotic effectiveness (SE) of 64.67% while plant inoculated with isolate Bg1-2 produced the least symbiotic effectiveness (SE) of 44.56%.

Soybean varieties had no significant difference but variety TGx1448-2E was observed to induce the highest percentage symbiotic effectiveness, while TGx1835-10E induced the highest nodule number and shoot biomass.

Table 4.1: Effect of N-Source on shoot Biomass, Nodulation and symbiotic effectiveness on soybean varieties.

Treatments	Nodule Number	Nodule dry weight (g plant^{-1})	Shoot dry weight (g plant^{-1})	Symbiotic Effectiveness (%)
Varieties (V)				
TGx 1448 – 2 E	5.44^{a}	0.06^{a}	2.13^{a}	48.47^{a}
TGx 1955 – 10E	5.94^{a}	0.10^{a}	2.03^{a}	40.06^{a}
TGx 1835 – 10E	6.72^{a}	0.09^{a}	2.13^{a}	47.47^{a}
SE^{+}-	0.96	0.01	0.06	1.89
Nitrogen source (N)				
–N	0^{c}	0.00^{b}	1.76^{cd}	0.00^{c}
+N	0^{c}	0.00^{b}	3.66^{a}	0.00^{c}
LF	4^{bc}	0.06^{ab}	1.81^{cd}	49.44^{ab}
Bg5	15^{a}	0.17^{a}	2.02^{bcd}	56.22^{ab}
Bg4-2	9^{ab}	0.10^{ab}	1.77^{cd}	49.22^{ab}
Bg 4	5^{bc}	0.09^{ab}	1.99^{bcd}	55.44^{ab}
Bg1-2	5^{bc}	0.10^{ab}	1.60^{d}	44.56^{b}
Bg1-4	9^{abc}	0.14^{a}	2.20^{bc}	60.22^{ab}
Sk 6-3	9^{abc}	0.13^{a}	2.07^{bcd}	57.44^{ab}
Sk 2-5	4^{bc}	0.08^{ab}	1.88^{bcd}	52.11^{ab}
Sk 2-3	6^{bc}	0.06^{ab}	2.42^{b}	64.67^{a}
Sk 1-4	7^{abc}	0.08^{ab}	1.99^{bcd}	54.67^{ab}
SE ±	1.91	0.03	0.12	3.78
Interaction V X N	*	*	*	*

***p < 0.05 significant**
Means with different letter(s) indicated in the columns are significantly different (p <0.05).

Table 4.2: Interaction between inoculation and soybean varieties on nodule number per plant

	Variety		
	TGx1448 – 2E	TGx1955 – 10E	TGx1835 – 10E
Nitrogen source (N)			
–N	0^{m}	0^{m}	0^{n}
+N	0^{m}	0^{m}	0^{n}
LF	4^{i-l}	6.33^{hi}	2.67^{j-m}
Bg5	23^{a}	12^{def}	9^{fg}
Bg4-2	10^{fg}	4^{ijk}	$15^{b.d}$
Bg 4	3^{j-m}	8^{gh}	5^{ij}
Bg1-2	4^{ijk}	4^{ijk}	5^{ij}
Bg1-4	5^{ij}	16^{b}	5^{hij}
Sk 6-3	11^{ef}	0^{m}	15^{bc}
Sk 2-5	0^{m}	5^{hij}	8^{gh}
Sk 2-3	5^{hij}	2^{klm}	10^{fg}
Sk 1-4	1^{lm}	13^{cde}	6^{hi}
SE±		3.30	

$^*p < 0.05$ significant

Means with different letter(s) indicated in the columns are significantly different ($p < 0.05$).

Effect of interaction between N-source and variety on nodule number per plant

The table 4.2 shows the interaction between N-source and variety on nodule number. No nodules was recorded for both +N and –N. Soybean Variety TGx1448-2E produced the highest nodule number of 23 nodules when inoculated with isolate Bg5, TGx1448-2E also produced the least nodule number of 1 nodule when inoculated with isolate SK1-4. Isolates Sk2-5 and Sk6-3 did not nodulate with TGx1448-2E and TGx1955-10E respectively.

For variety TGx1955-10E, inoculation with Bg1-4 produced the highest number of nodules. Soybeans variety TGx1835-10E when inoculated with Sk6-3 gave the highest nodule number amongst the remaining isolates treated with TGx1835-10E. Soybeans variety TGx1835-10E when inoculated with LF produced the poorest nodule number of 3 nodules amongst other isolate in association with variety TGx1835-10E.

Effect of interaction between N-source and variety on nodule weight (g plant $^{-1}$)

Table 4.3 shows the interaction between N-source and variety on nodule number. The highest nodule weight of 0.26 g plant^{-1} was observed in TGx1835-10E when inoculated with isolate Sk6-3, Soybean variety TGx1955-10E produced nodule weight of 0.24g plant^{-1} when inoculated with Bg1-4 which makes it closest to those observed with TGx1835-10E and isolate Sk6-3. Soybean variety TGx1448-2E when inoculated with isolate Bg5 produced nodule weight of 0.21 g plant^{-1} close to 0.269 g plant^{-1}.

Isolate Bg1-2 when inoculated with TGx1955-10E produced heavier nodule weight than TGx1448-2E and TGx1835-10E. This trend was observed in isolate LF, Sk1-4, Sk2-5, and Bg1-4.

Table 4.3 Interaction between inoculation and soybean varieties on nodule dry weight (g plant⁻¹)

	Variety		
Nitrogen source (N)	TGx1448 – 2E	TGx1955 – 10E	TGx1835 – 10E
–N	0.00^{l}	0.00^{l}	0.00^{l}
+N	0.00^{l}	0.00^{l}	0.00^{l}
LF	0.06^{ij}	0.10^{fgh}	0.02^{kl}
Bg5	0.21^{b}	0.16^{c}	0.14^{cde}
Bg4-2	0.10^{fgh}	0.05^{ijk}	0.16^{c}
Bg 4	0.03^{jkl}	0.12^{dgf}	0.11^{efg}
Bg1-2	0.07^{hi}	0.14^{cde}	0.08^{ghi}
Bg1-4	0.10^{fgh}	0.24^{ab}	0.07^{hi}
Sk 6-3	0.10^{fgh}	0.02^{kl}	0.26^{a}
Sk 2-5	0.00^{l}	0.15^{cd}	0.10^{fgh}
Sk 2-3	0.05^{ijk}	0.03^{jkl}	0.11^{efg}
Sk 1-4	0.02^{kl}	0.14^{cde}	0.08^{ghi}
SE±	0.045		

Means with different letter(s) indicated in the columns are significantly different ($p < 0.05$).

Effect of interaction between N-source and variety on shoot Biomass (g plant⁻¹)

Table 4.4 shows the interaction between N-source and varieties on shoot biomass. Soybean variety TGx1955-10E was observed to induce the highest shoot biomass of (3.90g plant⁻¹) when treated with urea (+N) followed by the shoot biomass of TGx1835-10E and TGx1448-2E with 3.61g plant⁻¹ and 3.46g plant⁻¹ respectively. Treatment with urea (+N) produced the best result regardless of the variety.TGx1835-10E when treated with isolate Sk2-3 was observed to give 2.79 g plant⁻¹ close to the highest and TGx1955-10E produced shoot biomass of 2.52g plant⁻¹. TGX1955-10E was observed to produce the least shoot biomass when treated with isolate Bg4-2.

Table4.4 Interaction between inoculation and soybean varieties on Shoot Biomass (g plant⁻¹)

	Variety		
Nitrogen source (N)	TGx1448 – 2E	TGx1955 – 10E	TGx1835 – 10E
–N	1.81^{g-k}	1.77^{g-l}	1.69^{j-n}
+N	3.46^{b}	3.90^{a}	3.61^{b}
LF	1.72^{i-n}	1.76^{h-m}	1.95^{g}
Bg5	2.43^{de}	1.69^{j-m}	1.95^{g}
Bg4-2	2.16^{f}	1.20^{p}	1.95^{g}
Bg 4	2.51^{d}	1.58^{mno}	1.89^{ghi}
Bg1-2	1.49^{o}	1.55^{no}	1.76^{h-m}
Bg1-4	2.22^{f}	2.50^{d}	1.88^{ghi}
Sk 6-3	2.29^{ef}	1.62^{l-o}	2.29^{ef}
Sk 2-5	1.92^{gh}	1.86^{g-j}	1.86^{g-j}
Sk 2-3	1.94^{gh}	2.52^{d}	2.79^{c}
Sk 1-4	1.64^{k-o}	2.42^{de}	1.90^{ghi}
SE±	0.213		

Means with different letter(s) indicated in the columns are significantly different ($p < 0.05$).

Effect of interaction between N source and variety on percentage symbiotic effectiveness of rhizobia isolate.

Table 4.5 shows the interaction between N-source and varieties on percentage effectiveness. Inoculation between soybean variety TGx1835-10E and isolate SK2-3 was observed to produce the highest symbiotic effectiveness (SE) of 79%, while inoculation of soybean variety TGx1955-10E with isolate Bg4-2 was observed to produce the lowest symbiotic effectiveness (SE) of 30.67%. Soybean variety TGx1448-2E produced percentage symbiotic effectiveness close to highest as observed with inoculation between TGx1835-10E and isolate SK2-3 to give 79%, TGx1448-2E with isolate Bg4 produced percentage SE of 72.67% while isolate Bg5 produced percentage SE of 70.67%.

Table 4.5: Interaction between inoculation and soybean varieties on Percentage Symbiotic effectiveness.

	Variety		
	TGx1448 – 2E	TGx1955 – 10E	TGx1835 – 10E
Nitrogen source (N)			
–N	0.00^{m}	0.00^{m}	0.00^{m}
+N	0.00^{m}	0.00^{m}	0.00^{m}
LF	49.67^{f-i}	45.00^{ijk}	53.67^{ef}
Bg5	70.67^{bc}	43.67^{jk}	54.33^{ef}
Bg4-2	62.33^{d}	30.67^{l}	54.33^{ef}
Bg 4	72.67^{b}	40.67^{k}	53.00^{efg}
Bg1-2	43.00^{jk}	39.67^{k}	51.00^{e-h}
Bg1-4	64.00^{d}	64.33^{d}	52.33^{e-h}
Sk 6-3	66.33^{cd}	41.67^{k}	64.33^{d}
Sk 2-5	55.67^{e}	47.67^{g-j}	53.00^{efg}
Sk 2-3	50.00^{f-i}	65.00^{d}	79.00^{a}
Sk 1-4	47.33^{hij}	62.33^{d}	54.33^{ef}
SE±	6.543		

Means with different letter(s) indicated in the columns are significantly different ($p < 0.05$).

Conclusion

From the study a high nodule number does not always indicate effectiveness. Result obtained showed that isolate Bg4-2 with a high nodule number gave a low shoot biomass. Isolates Sk2-5 and Sk6-3 did not nodulate with TGx1448-2E and TGx1955-10E respectively. TGx1835-10E nodulated better with rhizobial isolates than the other two varieties.

Interaction between rhizobia isolate Sk2-3 and soybean variety TGx1835-10E produced the highest symbiotic effectiveness while interaction between isolate Bg4-2 and TGx1955-10E induced the lowest percentage SE.

Recommendation

This study has demonstrated clearly that inoculation of TGx1835-10E should be encouraged especially with isolate Sk2-3. On the other hand, TGx1448-2E should be inoculated with Isolates Bg4, and Bg5. Isolates Sk2-5 and Sk6-3 did not nodulate with TGx1448-2E and TGx1955-10E respectively. These two associations should not be used in soybean inoculation program

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