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IFDC

Soil Resources Management, Global Climate Change and Food Security

Proceedings of the

35th ANNUAL CONFERENCE

of the

Soil Science Society of Nigeria

MARCH 7 – 11, 2011

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Edited By

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FEDERAL UNIVERSITY OF TECHNOLOGY,
Minna, Niger State, Nigeria.

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"MINNA 2011"

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FOREWORD

The 35th Annual Conference of the Soil Science Society of Nigeria (SSSN) was held at the Fede University of Technology (FUT), Minna, Niger State, Nigeria, from 7th – 11th March, 2011. The theme the Conference was " Soil Resources Management, Global Climate Change and Food Security". T Conference was attended by over four hundred (400) registered participant, comprising of eminent S Scientists from within and outside Nigeria, including, Prof. S. Norcliff, Chairman of Budget and Finan International Union of Soil Science (IUSS). Ninety-six (96) papers were presented and after they we peer reviewed, eleven (11) papers were selected for publication in Journal and fifty-one (51) a published in this book of Proceedings.

In recent times, there has been growing societal concern about the deleterious impact of clima change in the achievement of food security in the developing countries. The increasing demand f food is leading to environmental degradation, thereby exacerbating factors such as increasing carbo dioxide concentration in the atmosphere, in part, responsible for climate change. This is furthe undermining the food systems upon which food security is based. Soils represent an importar terrestrial stock of carbon in the form of soil organic matter and contain approximately two to three time as much as terrestrial vegetation and atmosphere respectively. Thus, the dynamics of soil organi carbon as affected by agroecosystem, to a large extent, affects the carbon dioxide concentration in the atmosphere, as well as global climate change. The theme of the Conference is therefore apt and timely in order to discuss soil management strategies to reduce carbon dioxide concentration in the atmosphere, through increasing terrestrial stock of carbon as well as improving soil fertility.

The sub themes on which papers were presented, addressed the various areas of soil science that wi not only help to manage the soil to mitigate the impact of climate change, but improve the fertility of th soil for optimum and sustainable productivity. These sub themes were:

- Integrated Nutrient Management and Food Security.
- Biological Interactions in the Soil and Food Security.
- Organic Agriculture and Climate Change.
- Soil Genesis, Classification and Land Evaluation.
- Land Use Systems and Climate Change.
- Tillage and Soil Conservation for Enhanced Food Security.
- Irrigation Management, Climate Change and Food Security.
- Environmental Management and Climate Change.
- Socio-economic Implications of Climate Change on Soil Resources Management.

Agricultural activities are partly responsible for changing the world's climate and giving rise to othe environmental changes, including carbon and nitrogen cycling. The achievement of food security Millennium Development Goals (MDGs), Poverty/Hunger Alleviation, Environmental Protection and New Partnership for Africa Development (NEPAD) sectoral priorities of Agriculture and Environment remains a major challenge for Nigeria. Thus, coming up with this theme, at this time, was not only propitious, but afforded eminent soil scientists from both within and outside the country, to collectively discuss their experiences, findings and proffer soil management strategies to mitigate the negative effects of climate change on food security and the environment. This edition of our Conference proceedings, therefore contain very valuable information for the attainment of food security, thereby alleviating poverty and hunger, and on environmental protection for sustainable biological productivity and environmental quality. I, therefore recommend the publication, for the use of environmental management experts, scientists, policy makers, industrialists and business investors.

Dr. M.K.A. Adeboye
18th January, 2012

ACKNOWLEDGEMENTS

The Editors wish to express their profound gratitude and appreciation to the Vice-Chancellor, Federal University of Technology (FUT), Minna, Prof. M.S. Audu, for accepting to host the 35th Annual Conference of the Soil Science Society of Nigeria (SSSN) and approving the use of the various facilities of the University, for the successful hosting of the Conference. The University administration provided accommodation and transportation for SSSN officials and invited guests, in addition to a sumptuous cocktail party. We are particularly grateful to the Deputy Vice-Chancellor (Administration), Prof. M.A.T. Suleiman, for his assistance in raising fund for the Conference. Our profound appreciation also goes to the Dean, School of Agriculture and Agricultural Technology, Prof. K.M. Baba, who was the host Dean, for his contributions towards the successful hosting of the Conference.

We are grateful to the Chairmen and members of the various sub-committees of the Local Organizing Committee (LOC), for their hard work, dedication and commitment, that made the hosting of the Conference possible and successful.

The Editors thank both staff and students of the School of Agriculture and Agricultural Technology, FUT, Minna, for their support and sacrifice, right from the beginning of preparations to the end of the Conference.

The Conference was held with donations from various individuals and Corporate organizations, already listed in this book, without which our ability to host the Conference would have been doubtful. Let us acknowledge here, our special donors:
Prof. Sheikh Abdallah (former Honorable Minister of Agriculture and Rural Development).
International Fertilizer Development Center (IFDC).
We appreciate all your financial contributions.
The Editors express their thanks to the Chairmen of the Plenary and Technical Sessions, Prof. V.O. Chude, Prof. I.E. Esu, Prof. O.O. Agbede, Prof. S.O. Ojeniyi, Prof. P. Nnabude and Prof. J.O. Ogunwole, who saw to the smooth running of the Sessions.

Finally, the Editors are sincerely appreciative of the unflinching support of the National Executive of the SSSN in the articulation of the Conference Theme and Sub-themes and for their moral and logistics support. We particularly express our profound gratitude to the President and Fellow of the SSSN, Prof. V.O. Chude, for his untiring, selfless and persistent encouragement, right from the day we got the hosting right, to the end of the Conference and the production of this Book of Proceedings.
God bless you all.

Editors
18th January, 2012.

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RESPONSE OF SOYBEAN VARIETIES TO RHIZOBIUM INOCULATION ON AN ALFISOL IN MINNA, SOUTHERN GUINEA SAVANNA ZONE OF NIGERIA

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ABSTRACT

Growth, nodulation and yield response of soybean to rhizobium inoculation was evaluated in a field experiment at the experimental farm of the Federal University of Technology, Minna during the 2010 rainy season. Treatments consisted of five varieties of soybean, TGX1448-2E, TGX1951-2E, TXG1945-3F, TXG1835-10F and a local check, either uninoculated or inoculated with 'legume fix'. The experimental layout was 2x5 factorial experiment arranged in a randomized complete block design with three replicates. The results revealed a significant ($p<0.05$) inoculation x variety effect on grain yield, nodule dry weight, days to 50% flowering and podding. For inoculated plots, TGX 1448-2E had the highest nodule dry weight, of 0.31g plant^{-1} followed by TGX 1945-3F, TGX 1951-3F, local variety and TGX 1835-10F in that sequence. With the exception of TGX 1835-10F, inoculation increased nodule weight of all the varieties. Among the inculcated treatments, TGX 1448-2E produced the largest grain yields followed by TGX1951-3F, while the yield produced by TGX1835-10F was the smallest. The same trend was observed among the uninoculated treatments, except that the local variety had the second best yield. On the average, inoculated variety of TGX1951-3F, TGX 1945-1F and TGX 1835-10F had the second best flowering dates than the local variety and TGX1448-2E in that order. The uninoculated treatments exhibited the same trend except that the local variety flowered later than others. Similarly, inoculated plots of the local variety poddded later than those of TGX1448-2E, TGX1835-10F, TGX1945-1F and TGX1951-3F in that sequence. A similar pattern was observed for the uninoculated plots, except that TGX 1448-2E podded earlier than TGX 1951-3F.

Key words: Alfisol, inoculation, Rhizobium, soybean, variety.

INTRODUCTION

Soybean is a relatively new crop. Its production and utilization has expanded approximately 10-fold in Nigeria over the past 10-15 years (Sanginga, 2003). It is mainly for maintaining soil fertility of our agricultural soils which are often constrained in their ability to sustain productive farming systems due to factors associated with low fertility, sodicity, salinity and extremes of acidity and alkalinity. These same attributes can also have a negative impact on the Soybean-Rhizobium symbiotic relationship reducing the ability of indigenous rhizobia to form nodules with optimal N_2- fixing capacity, hence impeding the continued success of soybean in Nigerian agricultural systems. The IITA breeding programme since 1977 has been using the principle of soybean selection for promiscuity (ie the ability to nodulate with a wide range of indigenous rhizobia so that the crop could be grown by farmers without rhizobial inoculation(Kueneman *et al.,*1984). Results of laboratory evaluations of early rhizobial collection from Nigeria from 1979 to 1984 (Rao *et al.,* 1985; Sinclair and Eaglesham, 1990; La Favre *et al.,* 1991) showed that local strains nodulating promiscuous soybeans comprise approximately only 10% of the total soil rhizobial population which were ineffective on US soybeans. The presence therefore of indigenous bradyrhizobia populations does not necessarily ensure tha adequate nodulation and N_2 fixation will occur in the various promiscuous soybean lines This still leaves us wondering whether indigenous rhizobia adequately meet the yiel potentials of these promiscuous soybean varieties.

The evidence of Okereke and Eaglesham, 1993; Olufajo and Adu, 1993; Sanginga *e al.* (1996) suggests that inoculation response are possible. Sanginga *et al.* (1996 indicated that when less than 10 rhizobia cells g of soil^{-1} were present there was the nee to inoculate. However, in this research, since we did not determine the need to inoculat prior to field investigation, we assumed that given an indigenous rhizobia population of 5 10^3 cell g^{-1} soil and elite strain population of 5 x 10^8 cell g^{-1} of peat, we needed to apply 5 of peat per kg of seed to ensure response to inoculation of five soybean varieties name TGX 1448-2E, TGX 1951-3F, TGX 1945-1F, TGX 1835-10F and a local check. A fie experiment was carried out in Minna, the southern Guinea savanna zone of Nigeria. Th aim was to evaluate their response to inoculation with 'legume fix' in order to recommen varieties with highest nodulation and yield potentials for farmers' use.

MATERIALS AND METHODS

Study Area

The research was carried out on the farm of School of Agriculture and Agricultu Technology, Federal University of Technology permanent site situated at kilometer sixte

(16km), along Minna-Bida Road, from the month of July to November 2010. Minna lies within the Southern Guinea Savanna of Nigeria (Lat 9° 49'N and long 6° 30'E).

Soil Sampling and Analysis

Prior to planting, soil samples were collected randomly at 0-20cm soil depth from 20 points on the field, with soil auger. A total of 20 soil samples were collected and air dried. The samples were lightly crushed and sieved with a 2mm and 0.5mm sieve to remove stones and plant debris and then mixed to obtain a composite sample. Sub samples were taken there after for determination of physico-chemical properties by standard methods as follows: soil particle size distribution was determined by the hydrometer method (Bouyoucous, 1962). pH was measured by using a pH meter in both water and 0.01 M $CaCh_2$ solution (soil solution ratio 1 :2:5) (Roswell, 1994). Total nitrogen was estimated by the kjedhal method (Bremner and Mulvaney, 1982) and organic carbon in the soil by dichromate oxidation and titrating with ferrous ammonium sulphate (Walkley,, 1947). Available P was determined colorimetrically after Bray-I extraction. Exchangeable bases was extracted with neutral IN NH_40Ac. Total Na^+ and K^+ were measured by using a flame photometer, Ca^{2+} and Mg^+ by Na-EDTA titration (Agbenin, 1995). Exchangeable acidity was extracted within KCl.

Treatments and experimental design

The total land area of 22.5m by 22.0m i.e. 0.0495 hectares was cleared, harrowed and ridged. The land was divided into six blocks i.e. two blocks representing one replicate. Each block was further divided into plots of size 4.5m by 3m. The spacing between blocks was 1m while spacing between replicates was 2m. The treatments were five soybean varieties namely TGX 1448-2E, TGX 1951-3F, TGX 1945-1F, TGX 1835- 10F and local variety either inoculated or inoculated with legume fix. The ten treatments of the experiment were arranged in a randomized complete block design.

Planting and crop management

The uninoculated soybeans were planted on 21st of July, 2010, while the inoculated variety was planted on the 22nd of July, 2010 so as to prevent contamination of the uninoculated blocks with the inoculants. Prior to planting of the inoculated plots, inoculant was prepared as follows: 5g of legume fix inoculants that was mixed with 30mls 20% sugar solution to make a slurry, was applied to I kg of seeds which was sown immediately at the rate of 3 seeds per hole at intra and inter row spacing of 5cm by 75cm. The sugar served as an energy source for the rhizobium and also improved adhesion of inoculants to treated seeds. A basal urea fertilizer was applied to all the plots in bands one week after planting (WAP) at the rate of 20 kgN ha^{-1} to give the starter N effect. Plants were thinned to two plants per stand at 2 WAP. Two manual weeding were done at 2 and 6 WAP. Due to the clayey nature of soil; drainage channels were constructed to drain the soil where rain fell uncontrollably (rainfall data not available).

Data Collection and Statistical Analysis

The yield data was taken at harvest. Plant height, shoot biomass, leaf number and nodulation were taken at 50% podding. The statistical package, Statistical Analysis System Version 2.2 for window copyright by SAS inc. (2000) was used to determine treatment effect at 5% level of significance. The least significant difference (LSD 5%) was determined in order to compare significant treatment effects. Duncan multiple range tests was used to separate means. Correlation analysis was done to correlate growth and yield parameters.

Table 1 Some physico-chemical properties of the soil at the experimental farm prior to planting of soybean

Parameters	Values
Sand (%)	75.88
Silt (%)	0.70
Clay (%)	23.42
Textural class	Sand clay loam
pH in $CaCl_2$	6.41
pH in H_2O (1:2.5)	6.91
Available P (mgkg^{-1})	9.00
Total Nitrogen (g kg^{-1})	0.28
Organic C (g kg^{-1})	6.5
Exchangeable cations (cmol kg^{-1})	
Mg^{2+}	1.00
Ca^{2+}	3.10
K^+	0.48
Na^+	0.29
Exchangeable acidity (cmol kg^{-1})	
$AL^{3+} + H^+$	1.38
ECEC	6.25

Table 2 Growth Nodulation and Yield Parameters of soybean varieties as affected by inoculation treatment

atment	No of leaves	plant height (cm)	Shoot biomass (g plt^{-1})	nodules weight (g plt^{-1})	No of pods	Dry weight of pods	Yield (kg ha^{-1})	50%F	50%P
culation									
culated	62^{a}	58^{a}	12.60^{a}	0.24^{a}	34^{a}	5.18^{a}	962.0^{a}	50^{a}	64^{a}
noculated	62^{a}	48^{a}	11.08^{a}	0.19^{b}	16^{b}	1.49^{b}	669.6^{b}	48^{b}	64^{a}
iety									
X 1448 – 2E	49^{a}	52^{a}	9.329^{a}	0.22^{a}	16^{a}	2.00^{a}	1313.60^{a}	51^{a}	61^{a}
X 1951-3F	67^{a}	55^{a}	13.40^{a}	0.19^{ab}	29^{a}	3.89^{a}	938.3^{ab}	47^{c}	61^{a}
X 1945-1F	72^{a}	54^{a}	15.32^{a}	0.19^{ab}	35^{a}	4.07^{a}	667.90^{bc}	48^{b}	63^{c}
X 1835 – 10F	54^{a}	55^{a}	12.51^{a}	0.14^{b}	30^{a}	4.41^{a}	323.50^{c}	48^{b}	65^{d}
al variety	69^{a}	51^{a}	8.58^{a}	0.16^{ab}	17^{a}	2.27^{a}	835.80a^{bc}	51^{a}	61^{a}
raction vxI	NS	NS	NS	*	NS	NS	*	*	*

Ns: not significantly different *** significantly different**

Means with the same letters indicated in columns are not significantly different (P< 0.05).

RESULTS AND DISCUSSION

Soil texture, Reaction and Exchangeable Bases

The results of the physical and chemical properties of the soil at 0 – 20cm depth are shown in Table 1. The soil was classified as sandy clay loam, slightly acidic in water and $CaCl_2$ respectively and also low in organic carbon and available P. A low total N content or < 0.28g kg^{-1} justifies the reason for screening soybean varieties for better adaptation to low soil N content.

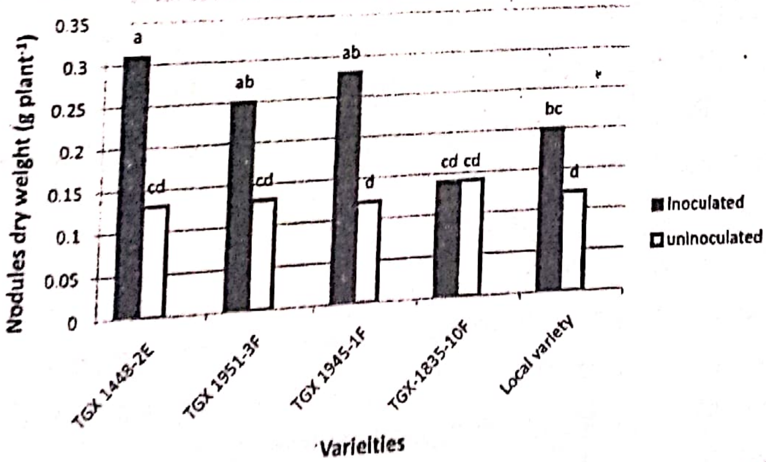

Fig. 1 **Nodule Dry Weight (g plant^{-1}) of soybean varieties as affected by inoculation treatments. Bars of the same nodule dry weight with different letters are significantly different (P<0.05).**

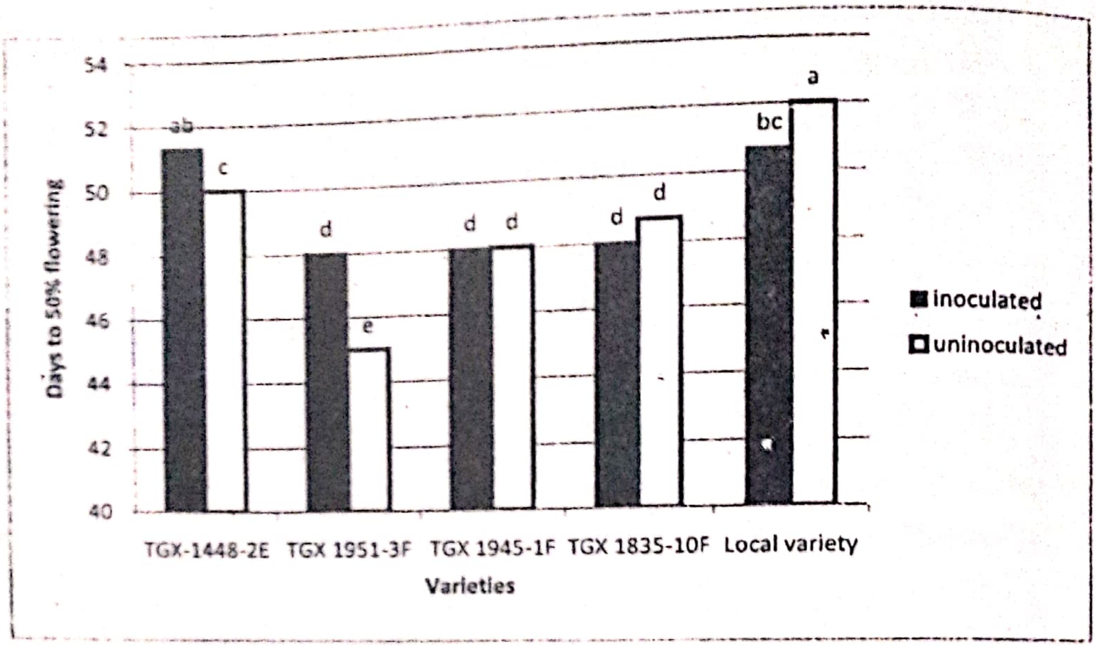

Fig. 2 **Days to 50% flowering of soybean varieties as affected by inoculation treatments.**

Bars of the same days to 50% flowering with different letters are significantly different (P<0.05).

Growth, nodulation and yield parameters

Table 2 shows the growth response of soybean varieties to inoculation. Averagely, TGX1448-2E produced the heaviest nodule (dry wgt), followed by TGX1951-3F or TGX 1945-1F, local variety and TGX1835-10F in that sequence suggesting that variation exist in nodulation across varieties tested. Soybean variety TGX1835-10F that had the same nodule weight with or without inoculation implied that the indigenous rhizobia strains were as infective as the elite strains. Otherwise, the poor response to inoculation may be as a result of the dominance of indigenous strains of rhizobium at its nodules (Ge and Xu, 1982). This is also signifying that the soil population density of indigenous bradyrhizobium is a major factor determining competition for nodule occupancy and response to inoculation. Although use of massive inoculation rates can overcome competition from indigenous strains, such a delivery system is not yet practical or economical considering the high cost of producing rhizobium inoculants. It is therefore advised to determine the need to inoculate prior to field inoculation in order to establish the population of the indigenous strains in the soil and the elite strains in the inoculants. In this experiment, based on the assumption that the indigenous rhizobia population was $5x10^{3\ g-1}$ soil and the population of elite strains in the peat inoculants was 5x 108 cells g-1 of peat , we applied

5g peat kg-1 of seed to ensure nodule dominance of the elite strains(Weaver and Frederick, 1982).The highest nodule dry weight of 0.31g plant[1] recorded by TGX144-2E when inoculated (fig 1) implied that the nodules were probably effective since it translated to higher yield (Fig.4). This may also suggest a level of host-strain compatibility. Consistent with this finding is the report of Cregan and Keyser (1989) who maintained that effective symbiosis is depending on genetic determinants in both plant and bacteria.

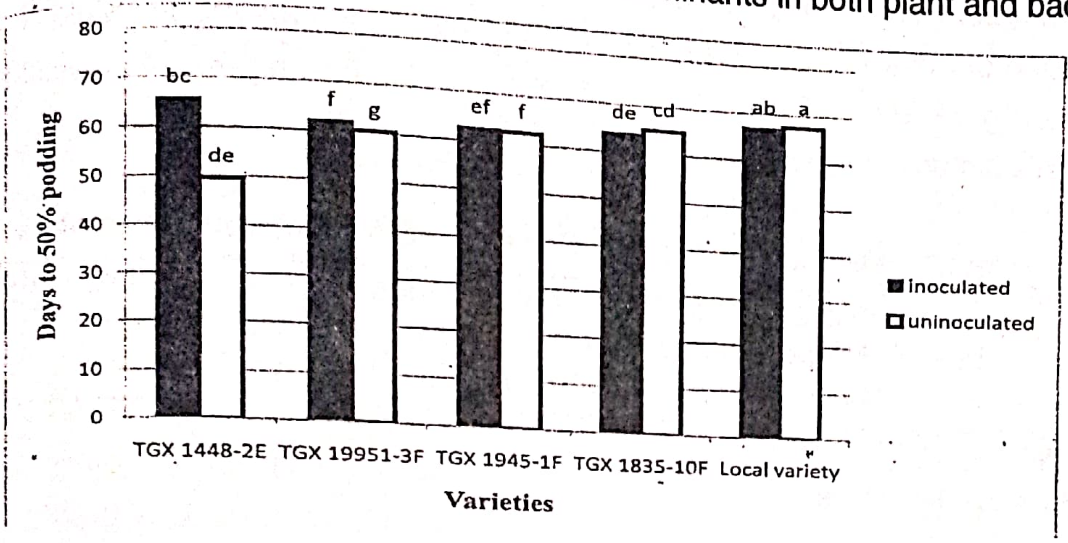

Fig. 3 **Days to 50% podding of soybean varieties as affected by inoculation treatments.**

Bars of the same days to 50% podding with different letters are significantly different (P<0.05).

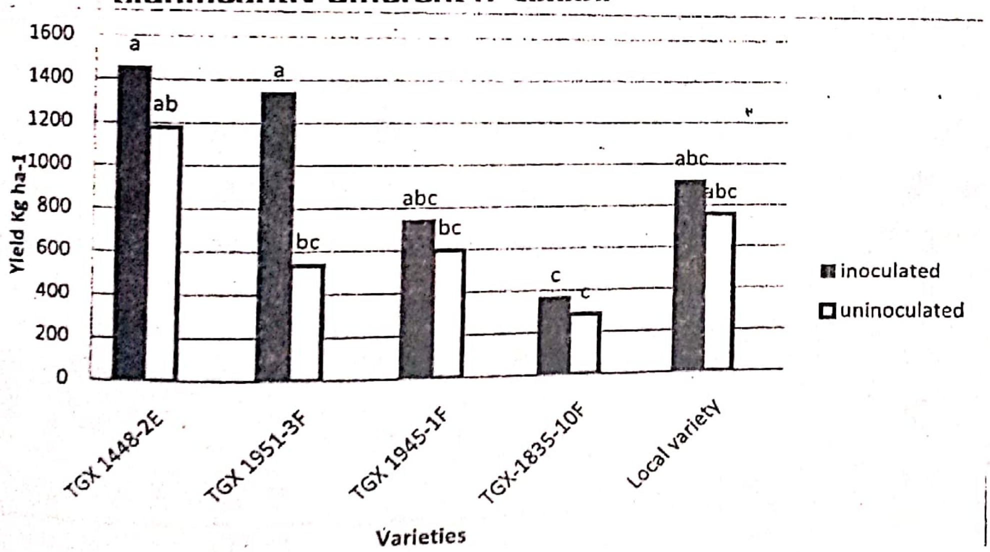

Fig. 4 **Yield kg ha^{-1} of soybean varieties as affected by inoculation treatments.**

Bars of the same yield kg ha^{-1} with different letters are significantly different (P<0.05).

On the average, the inoculated plots of Local variety, and TGX1835-3F flowered and podded earlier than those of their uninoculated counter parts (figs.2 & 3) implying that their N-use were efficiently enhanced by the introduction of the elite strains. This translated to better yields (fig 4). Consistent with the report of Ali *et al.* 2001, our results have shown that legume fix significantly affected the seed yield of soybean varieties (fig4). The high yield of 1314 kg he^{-1} recorded by TGX1448-2E is close to the yield of 1500 kg ha^{-1} reported by Jensen and Hauggard – Nelson (2003). This represents a yield increase of 11% above the uninoculated counterpart.

Table 3 Correlation between the Pairs of Growth and Nodulation Parameters

	No of Leaves	Plant Height (cm)	Shoot biomass (g/plt^{-1})	nodules wt. (gplt^{-1})	Pods No. (plt^{-1})	pod wt. (gplt^{-1})	Yield (kg ha^{-1})	F50	P50
No of leaves									
Plant Height (cm)	0.21								
Shoot biomass (g/plant)	0.66*	0.32							
nodules wt. (gplt^{-1})	0.06	0.13	0.14						
Pods No. (plt^{-1})	0.25	0.15	0.54**	0.12					
pod wt. (gplt^{-1})	0.22	0.39	0.56**	0.22	0.06				
Yield (kg ha^{-1})	0.23	-0.08	0.23	0.13	0.32	0.06			
F50	-0.09	-0.09	0.04	-0.24	0.17	-0.23	-0.28	0.25	
P50	-0.05	-0.01	-0.27	-0.06	-0.20	-0.22	-0.00	0.89	

$p > 0.05$ not significant *$P < 0.05$ significant **$P < 0.001$ P50 days to 50% pod
F50 days to 50% flowering

Correlation between the pairs of growth and nodulation parameters is shown in Table 3. The positive correlation of plant height and shoot biomass with nodule dry weight shows that the above ground weights increased in favour of the sink; in this case, the nodules. Plant height had a negative correlation with yield and days to 50% flowering and podding probably because the vegetative development of the varieties was at the expense of reproductive growth. Conversely, the positive and significant correlation between short biomass and podding suggests that the vegetative plants produced heavier pods which probably translated to higher yield as revealed by the positive correlation between yield and shoot biomass. Days to 50% flowering and days to 50% podding were positively correlated with nodulation indicating that plants that flowered and podded earlier had larger nodules because they allowed more time for assimilate partitioning and translocation to the nodules.

Conclusion

Generally, the positive correlation of nodulation with yield implied that the nodulated plants probably produced more and heavier seeds. The significant improvement in yield due to inoculation of TGX1448-2E, TGX1951-3F and TGX1945-1F with legume fix was observed in the study. These varieties also showed superior nodulation as a result inoculation and should be the focus for further studies. It is however important to establish the need for inoculation using appropriate methods to know the population of indigenous rhizobia strains in the soil prior to inoculation with elite strains. This will be the key to the development of a comprehensive soil survey across the soybean growing sites of Minna so as to provide a critical analysis of the background rhizobia population. This might save us from too many generalizations that may result to the abuse of rhizobium inoculants.

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