ARTICLES ORIGINAUX OORSPRONKELIJKE ARTIKELS

ORIGINAL ARTICLES ARTICULOS ORIGINALES

Growth and Yield of Soybean (*Glycine max* (L.) Merr.) as Influenced by Combined Application of Cowdung and NPK Fertilizer in Ogoja, Southeastern Nigeria.

N. Ndaeyo*, N.S. Oguzor**, E.S. Utuk & S. O. Dan

Keywords: Soybean - Cowdung - NPK Fertilizer - Growth - Yield - Nigeria.

Summary

Field experiment was conducted in 1990 and 1991 sowing seasons at the University of Cross River State Teaching and Research Farm, Ogoja campus, Nigeria to evaluate the productivity of soybean under diverse soil fertility levels.
The findings suggest that combined use of Cowdung and NPK appears a better option.

Résumé

Croissance et production du soja (**Glycine max **(L.) Merr.), influencées par l'utilisation combinée de fumier de vache et de l'engrais NPK à Ogoja, au Sud-Est Nigeria

Deux essais de fertilisation ont été réalisés, en 1990 et 1991, à la ferme expérimentale de l'Université de l'Etat de Cross River, Campus d'Ogoja, Nigeria, pour évaluer la productivité du soja sous divers niveaux de fertilité du sol en utilisant du fumier de vache et un engrais NPK 15:15:15 selon un dispositif en blocs aléatoires complets. Les résultats obtenus mettent en évidence l'intérêt de combiner la fumure minérale avec l'application du fumier.

Introduction

The interest in production and utilization of soybean (*Glycine max* (L.) Merr.) in Nigeria has increased during the past decade. Presently, a wide gap exists between what is needed and what is currently produced.
Mamman (17) estimated that about 1.6 million metric tonnes are needed annually to satisfy domestic and industrial needs. With the high protein value of soybean and the development of assorted soybean products by the International Institute of Tropical Agriculture, Ibadan, Nigeria, farmers are likely to continue to be engaged in soybean production and utilization.

Although there is considerable potential for soybean production in southern Nigeria (20), there is a high variability in soybean grain yield ranging from 0.15 to 1.5 tonnes per hectare in farmers' fields (2). This has been attributed in part to continuous decline in soil fertility, essentially by deficiency in organic matter and/or of one or more essential nutrients (16). Also, the characteristic high rainfall of the zone usually give rise to leaching and erosion of mineralized and applied nutrients with poor crop yields as a consequence.

Maintenance of fertility under continuous land use is therefore a major problem because of increasing population pressure on the soil. Moreover, the existing approach of maintaining soil fertility or achieving high crop yield through land rotation practice is becoming unfeasible partly due to urbanization, industrialization and other factors competing for land. Presently, large quantities of cowdung are lying untapped in all abattoirs in the country. Again, fertilizer management technology for these soils has not been fully worked out. Therefore, a knowledge of efficient fertilization could be one of the panacea towards sustainable soybean production in agro-ecological zone.

There have been divergent views of the soybean response to fertilizer application. Reis et al. (23) observed no significant increase in yield of soybean due to nitrogen fertilization. Other workers (24) observed that nitrogen fertilizer application is only beneficial if applied when soybean nitrogen requirement is no longer being met by soil nitrogen reserves and biological symbiosis with nodule bacteria. Aristova (1) reported that side dressing of the soybean plant with nitrogen ferti-

* Corresponding author.
** Present address: Dean, School of Vocational Education, Federal College of Education (Tech.), P.M. B.11, Omoku, Rivers State, Nigeria.
Department of Agronomy, University of Uyo, Akwa Ibom State, Nigeria.
Received on 02.12.97 and accepted for publication on 27.08.98.

Table 1
Soil Physico-Chemical Characteristics of the Experimental Sites for the two years.

Chemical analysis	Values 1990	1991
pH (1:1) H_2O	6.5	6.6
% Total N	0.5	0.5
Available P (ppm)	22.7	23.9
Exchangeable Cations ($cmol.kg^{-1}$)		
Calcium	2.8	3.1
Magnesium	2.0	2.4
Potassium	1.8	1.9
Sodium	0.2	0.3
Exchangeable acidity	0.6	0.5
C E C	7.4	8.1
Base Saturation (%)	87.4	88.5
Micro nutrients ($mg.kg^{-1}$)		
Magnesium	85.5	83.7
Iron	17.3	18.1
Copper	0.2	0.2
Zinc	6.1	7.1
Soil Particle analysis (%)		
Clay	10	11
Silt	3	4
Sand	87	85

lizer at the stage of bloom gave a yield increase per hectare over a five year period. A large positive linear response of soybean from moderate to high rates of phosphorus application on clay loam had been observed (15).

Grain yield and yield components had been reported to increase with potassium application even when soil fertility test levels were medium or high (7). Wakimoto (25) observed increased formation and development of root nodules and yield of up to ten percent when organic manure was combined with top dressing of inorganic fertilizer at flowering stage. The positive effects of combined application of organic manure and mineral fertilizers on soybean growth and yield had also been reported. The study reported here was undertaken to evaluate the interactive effects of combined organic and mineral fertilizer application on soybean productivity.

Material and methods

The experiment was conducted during the 1990 and 1991 cropping seasons at the University of Cross River State, Ogoja Campus (Latitude 06°40'N, Longitude 08°48'E, with an altitude of 117.38 metres above sea level). Teaching and Research Farm Ogoja lies within the derived savanna zone of Nigeria, with a mean annual rainfall of 151.97 mm, a mean annual sunshine of 6.42 hours per day while the mean relative humidity is 73.80 percent. The mean monthly atmospheric temperature is 27.46°C while the mean monthly earth temperature (at 30 cm depth) and mean evaporation rate are 30.74°C and 4.5 ml per day, respectively (18).

The soil, classified as an Alfisol, is well drained with sandy loam surfaces over a sandy clay loam sub-soil (8). The pre-treatment soil (0-15 cm depth) physico-chemical properties of the study sites are presented in Table 1. Soil pH was determined using the method described by IITA (12); available phosphorus by Bray No. 1 method (4) while flame photometry method was used to determine calcium, sodium and potassium. Magnesium was determined by atomic absorption spectrophotometry while organic matter was determined by multiplying the uncorrected value of organic carbon by a constant factor of 1.724 (21). Cation exchange capacity was obtained by the summation of the exchangeable cations and the exchangeable acidity. Exchangeable acidity and soil texture were determined using the methods described by Bouyoucos (3) and Jackson (13), respectively.

Experimental design

A randomised block design was used in the study and the entire experimental area was 24 x 21.6 m with four replications, each measuring 6.0 x 21.6 m while the plot size was 6.0 x 3.6 m. The replicate and plot alley ways were 2 m and 1 m, respectively. There were six fertilizer treatments, randomised in each of the replicates and consisted:

a. Zero application (control);
b. Cowdung (60 $t.ha^{-1}$) alone;
c. N: P: K (15: 15: 15) (200 $kg.ha^{-1}$) alone, (applied basally a day before sowing);
d. Cowdung (60 $t.ha^{-1}$) + NPK (15: 15: 15) 200 $kg.ha^{-1}$ (applied basally, a day before sowing);
e. Cowdung (60 $t.ha^{-1}$) + NPK (15: 15: 15) 200 $kg.ha^{-1}$ (applied at branching); and
f. Cowdung (60 $t.ha^{-1}$) + NPK (15: 15: 15) 200 $kg.ha^{-1}$ (applied at flower induction).

The cowdung was applied a month before planting and analyses of the cowdung revealed 0.50, 0.25 and 0.53 percent in 1990 and 0.67, 0.37 and 0.85 percent in 1991, respectively for N, P_2O_5 and K_20. The methods used for analyses of soil N, P and K mentioned above were also used for the cowdung analyses.

Cultural details

Two different sites were used for the two years studies but the sites were within the same vicinity. The cowdung was spread uniformly with a spade to cover all the plots except that of the control (zero application) and the purely mineral fertilizer treatments, and subsequently incorporated into the soil (at 25 cm soil depth) using a tractor (Model Steyr 8075) drawn plough and harrow. The basal NPK fertilizer application was broadcasted, while the subsequent applications for the other treatments, that is, at branching and flower induction, were by banding method. In the first year, sowing was done in April and in March in the second year. The soybean, cultivar TGX 923/E (medium maturing and day sensitive) was sown manually at a spacing of 45 cm (between rows) and 15 cm (within row). Three seeds were sown per hill at a 3 cm depth but later thinned to two giving 296,296 stands per hectare. Weeding was done manually from the third week after sowing (WAS). Pest control was carried out with the insecticide, nuvacron 40 ScW (monocrotophos - organophosphate), applied at the rate of 2.5 ml to 1 litre of water using Knapsack sprayer.

Table 2
Effects of cowdung and NPK (15: 15: 15) on emergence and height of Soybean.

	1990					1991				
Treatment	Emergence %	Height (cm) 20 DAS*	40	60	80	Emergence %	Height (cm) 20 DAS*	40	60	80
Zero application (control)	96.3a	8.2b	25.3c	28.3c	32.7c	93.8a	10.1b	23.6c	34.2d	35.3d
Cowdung (60t/ha)	94.8a	17.2a	32.1a	53.9a	70.9a	95.2a	12.2a	30.6a	50.1b	50.3b
NPK (200 kg/ha) (Basal)	95.2a	18.2a	28.0b	47.8b	58.9b	94.7a	11.5ab	27.2b	41.5c	42.1c
Cowdung (60t/ha) + NPK (200 kg/ha) (Basal)	95.2a	18.6a	29.0b	52.7a	69.3a	93.8a	13.9a	27.0b	60.2a	61.1a
Cowdung (60t/ha) + NPK (200 kg/ha) (at branching)	97.1a	18.6a	32.6a	45.6b	71.3a	94.3a	10.6b	31.2a	51.2b	51.7b
Cowdung (60t/ha) + NPK (200 kg/ha) (at flowering)	96.8a	18.7a	34.0a	48.0b	72.4a	95.2a	11.3ab	29.7a	47.2b	48.2b

Means within a column followed by the same letter are not significantly ($P<0.05$) different according to Duncan's Multiple Range Test (DMRT)
* DAS = Days after sowing.

Measurements and data analyses

The following measurements were made: Emergence count, height, drymatter accumulation and nodule formation (determined from an area of 1 m^2 at 100% flowering). Yield and yield components were assessed by harvesting all pods and recovering all grains after shelling and then their weights determined using top load balance (with basin - like top and calibrated in kg). Data collected were subjected to analysis of variance and mean that showed significant differences were seperated using Duncan Multiple Range Tests (10). Cost of production and economic returns were determined using Benefit-Cost analysis in order to determine the benefit that could accrue to soybean production given the cost of production. A discount factor of 15% (current interest rate) as cited by (9) was used to obtain discounted Benefit-Cost ratio.

Results and discussion

Emergence and height : The effects of cowdung and NPK fertilizer application on soybean emergence and height are presented in Table 2. Soybean emergence showed no significant differences in both years while height differed significantly ($P<0.05$) among treatments. In the first year, cowdung + NPK treatment applied at flowering had the tallest plants at 20 (18.7 cm), 40 (34.0 cm) and 80 (72.4 cm) days after sowing (DAS) while cowdung alone (53.9 cm) recorded the tallest at 60 DAS. These represent 128, 25.6, 121.4 and 90.5 percent increase in growth above the control treatment that consistently showed the shortest soybean plants. In the second year, plants that received cowdung alone, cowdung + NPK applied at branching and cowdung + NPK applied basally were significantly taller at 20 (12.1 cm), 40 (31.2 cm), 60 (60.2 cm) and 80 (61.1 cm) DAS, respectively while control treatment remained consistently lower. The mean soybean height for the two years at 80 DAS revealed that growth was best under cowdung + NPK applied basally and the worst from control treatment.

The absence of significant differences in soybean emergence among all treatments could be ascribed to the availability of adequate soil moisture at the time of sowing. Optimum rain fell during the sowing periods thereby guaranteeing adequate moisture for seedling emergence. Grande and Borrero (11) observed no significant difference in emergence among treatments when there was optimum soil moisture. Generally, the differences observed in soybean height could be attributed to the complementary role of cowdung and NPK fertilizer. Musa (19) observed that the application of cowdung and mineral fertilizer together provided the crop with a readily available source of nitrogen from the mineral fertilizer at crop establishment, and the early growth stages supplemented by a slow release of nitrogen from the cowdung during the later stages of growth.

Nodule formation and drymatter accumulation

In both years, application of cowdung + NPK (applied basally) gave more nodules (Table 3); while control treatment had the least. Soybean dry matter accumulation was significantly higher in cowdung + N.P.K. applied at branching than other treatments throughout the first year, showing 150, 128.6, 52 and 35.1% over control treatment at 20, 40, 60 and 80 DAS, respectively. In the second year, cowdung + NPK applied basally had higher dry matter accumulation at 20 and 40 DAS. However, at 60 and 80 DAS, the trend reverted to cowdung + NPK (applied at branching) but the control treatment remained consistently lower. The mean value of dry matter accumulation for the two years at 80 DAS revealed that soybean accumulated most of its dry matter when cowdung + NPK was applied at branching.

Table 3
Effects of cowdung and NPK (15: 15: 15) on nodule formation and dry matter accumulation of Soybean.

	1990					1991				
	Nodule** No	DAS* 20 (Dry matter accumulation t/ha)	40	60	80	Nodule** No	DAS* 20 (Dry matter accumulation t/ha)	40	60	80
Zero application (control)	22.9e	0.04c	1.4d	2.5b	3.7b	24.3e	0.03c	1.2d	1.7c	2.0c
Cowdung (60 t/ha)	53.0b	0.06b	1.9c	2.7b	4.0a	60.0b	0.08ab	1.4c	2.9b	2.3c
NPK (200 kg/ha) (basal)	36.2d	0.07b	2.1b	3.3a	3.4b	39.6d	0.08ab	1.4c	2.4b	2.7c
Cowdung (60 t/ha) + NPK (200 kg/ha) (basal)	69.3a	0.07b	2.2b	3.3a	3.7b	79.0a	0.11a	1.7a	2.9b	4.6a
Cowdung (60 t/ha) + NPK (200 kg/ha) (at branching)	47.8c	0.10a	3.2a	3.8a	5.0a	56.7c	0.07b	1.5b	3.4a	4.6a
Cowdung (60 t/ha) + NPK (200 kg/ha) (at flowering)	53.6b	0.07b	2.0c	3.4a	3.5b	64.2b	0.08ab	1.5b	3.4a	3.4b

Means within a column followed by the same letter are not significantly (P<0.05) different according to DMRT
* DAS = Days after sowing. ** Determined at 100% flowering.

The presence of nodules on the soybean roots confirmed the presence of indigenous *Rhizobium* in the soil capable of inducing nodulation in soybean. This confirms the observation (22) that many tropical soils contain strains of *Rhozobia* that can nodulate soybean and cowpea. The increase observed in the number of nodules in all the treatments that received cowdung over those of the NPK and the control treatments could be ascribed to the availability of substrate from the cowdung for increased microbial activities and the supply of macro- and micro-nutrients thereafter. Wakimoto (25) had earlier observed increased formation and development of root nodules and yield of up to 10% when organic manure was combined with top dressing of inorganic fertilizer even at flowering stage. The higher dry matter accumulation noted in soybean plants that received cowdung and NPK applied basally and at branching could be linked with the presence of nitrogen in particular and other nutrients that ensured optimum vegetative growth. Similar observation had also been reported (5).

Yield and yield components

In both years, no significant differences were observed in the weight of 1000 seeds determined. However, soybean pod number per plant was significantly higher under cowdung + NPK applied at branching (Table 4) in both years. Number of seeds per plant and grain yield were significantly higher under cowdung + NPK applied basally with 144.9 and 2.1 $t.ha^{-1}$, respectively in the first year and 98 and 1.8 $t.ha^{-1}$ in the second year. Control treatment remained consistently lower for the two parameters in both years with 235.4 and 162.5 percent reductions, respectively in the first year and 191.7 and 157.1 percent reduction in second year compared to cowdung + NPK applied basally.

Table 4
Effects of cowdung and NPK (15: 15: 15) on Soybean grain yield and yield components.

	1990				1991			
Treatment	Pod No. ($Plant^{-1}$)	Seed No. ($Plant^{-1}$)	Wt. of 1000 seeds g	grain yield $t.ha^{-1}$	Pod No. ($Plant^{-1}$)	Seed No. ($Plant^{-1}$)	Wt. of 1000 seeds g	grain yield $t.ha^{-1}$
Zero application (control)	20.3c	43.2d	114.6a	0.8c	17.8d	33.6d	104.4a	0.7c
Cowdung (60 t/ha)	86.4a	132.9b	133.3a	2.0a	45.0a	94.2a	131.1a	1.7a
NPK (200 kg/ha) (Basal)	53.1b	69.2c	129.9a	0.9b	23.7c	48.5c	128.8a	0.8c
Cowdung (60 t/ha) + NPK (200 kg/ha) (Basal)	85.1a	144.9a	137.7a	2.1a	44.2a	98.0a	131.0a	1.8a
Cowdung (60 t/ha) + NPK (200 kg/ha) (at branching)	88.9a	132.0b	132.2a	1.9a	45.4a	91.8a	129.9a	1.4b
Cowdung (60 t/ha) +NPK (200 kg/ha) (at flowering)	83.8a	142.4a	131.1a	1.9a	38.8b	81.9b	131.0a	1.4b

Means within a column followed by the same letter are not significantly (P<0.05) different according to DMRT.

Table 5
Cost of production and economic return to management (N.ha^{-1}) as influenced by combined application of cowding and NPK Fertilizer.

	Treatment											
	ZA[+]		CD[+]		NPK[+]		CD+NPKBa[+]		CD+NPKBr[+]		CD+NPKFi[+]	
Farm Operation	1990	1991	1990	1991	1990	1991	1990	1991	1990	1991	1990	1991
(A) Production Cost (N.ha^{-1})												
(1) Land Preparation	430	500	430	500	430	500	430	500	430	500	430	500
(2) Fertilizer	-	-	-	-	400	400	400	400	400	400	400	400
(3) Cowdung	-	-	80	100	-	-	80	100	80	100	80	100
(4) Seeds	120	125	120	125	120	125	120	125	120	125	120	125
(5) Insecticide	110	140	110	140	110	140	110	140	110	140	110	140
(6) Labour[a]	1982	2108	1982	2108	1982	2108	1982	2108	1982	2108	1982	2108
Total cost of Production (TC)	2642	2873	2722	2973	3042	3272	3122	3373	3122	3373	3122	3373
(B) Yield (t.ha^{-1})	0.8	0.7	2.0	1.7	0.9	0.8	2.1	1.8	1.9	1.4	1.9	1.4
(C) Gross Revenue (GR)b	4800	4200	12000	10200	5400	4800	12600	10800	11400	8400	11400	8400
(D) Return to Management (GRT)	2158	1327	9278	7227	2358	1527	9478	7427	8278	6292	8278	5027
Benefit/cost ratio	1.8	1.5	4.4	3.4	1.8	1.5	4.0	3.2	3.7	2.5	3.7	2.5

a, Labour cost are for panting, weeding, fertilizer application, harvesting and shelling.
b, Yield X unit price of N6000 t^{-1}. N/B US$ 1=N22.00 and prevailing market prices were used.
+, represents: Zero application, cowdung alone, NPK alone applied basally, cowdung + NPK applied basaly, cowdung + NPK applied at branching, and cowdung + NPK applied at flower induction, respectively. N/B All production variables are expressed in N.ha^{-1}.

The significant differences exhibited in the number of pods and seeds per plant, and grain yield are perhaps due to variations in the source and sink capabilities of the soybean plants as dictated by the environments created by the diverse fertilizer treatments applied. Chiezey (5) had also reported similar findings.

Costs of production and economic returns to management

The cost of production and economic returns to management are shown in Table 5. In both years the highest cost of production was observed under all the treatments that received both cowdung and NPK fertilizer while the least was from the control treatment. These show 15.4 and 14.8 percent increase over the control for the 1990 and 1991 cropping years, respectively. The use of both cowdung and NPK fertilizer applied basally gave the highest economic return indicating 339.2 and 459.7 percent increase over the control for both years, respectively. However, the highest Benefit-Cost ratios (4.4 and 3.4) were observed where cowdung alone was used.

The higher cost of production indicated in treatments that received both cowdung and NPK over the control and those that received either cowdung or NPK fertilizer alone is due to the extra cost of acquiring, the organic fertilizer (cowdung) and the mineral fertilizer (NPK). These collectively accounted for 15.4 percent and 14.8 percent of the total cost of production in 1990 and 1991, respectively. The high costs were however compensated for by higher economic returns to management under these treatments. The use of cowdung alone gave the highest benefit-cost ratio, indicating that farmers can equally rely on it for profitable soybean production. Though the cowdung alone had the highest Benefit-Cost ratios (4.4 and 3.4), the cowdung + NPK fertilizer applied basally showed superior economic returns with 2.2 and 2.8 percent increase in 1990 and 1991, respectively over the use of cowdung alone. This suggests that the extra cost of production notwithstanding, it may be more economical to combine cowdung with NPK fertilizer (applied basally) for increased soybean grain yield and farm profits. De Haan (6) had earlier made similar observations.

Conclusion

This study suggests that the supply of nutrients at early stages of growth through mineral fertilizer (NPK) and during reproductive stages through organic manure (cowdung) could enhance soybean performance and increase farm profit. The combined use of cowdung and NPK (applied basally) is therefore recommended for this agro-ecological zone.

Literature

1. Aristova L.O., 1980. Effect of nitrogen fertilizer application on Soybean under irrigation. J. of Oil crops. 3: 46-47.
2. Baten M.A., 1991. Effects of NPK Fertilization on Soybean Production in Southwestern Nigeria. Ph.D. Thesis, University of Ibadan, Nigeria. 200 pp.
3. Bouyoucos G.H., 1951. A recalibration of the hydrometer method for making mechanical analysis of soils. Agronomy Journal, 43: 434-438.
4. Bray R.H. & Kurtz L.T., 1945. Determination of total organic and available forms of phosphorus in soils. Soil Science, 59: 39-45.

5. Chiezey U.F., 1993. Performance of Soybean (*Glycine max* (L): Merrill.) Cultivar + 'Samsoy - 2' as affected by Rate and Time of Nitrogen Fertilizer. Tropical Oilseeds Journal **1** (2): 19-31.

6. De Haan S., 1977. Humus, its formation, its relation with the mineral part of the soil, and its significance for soil productivity. In: Soil organic matter studies (symposium, 1977), Vol. **1**, 21-30. International Atomic Energy Agency. Vienna: IAEA.

7. Eharat M.P., Whighan D.K. & Voss R.D., 1986. Soybean response to tillage and N, P and K fertilization. Agron. 76: 947-950.

8. FDALAR (Federal Department of Agriculture Land Resources), 1990. Soil Map of Nigeria.

9. FOS (Federal Office of Statistics), 1991. Annual Abstract of Statistics, Federal office of Statistics, Lagos, Nigeria, p.35.

10. Gomez K.A. & Gomez A.A., 1984. Statistical procedures for agricultural research. New York, USA, John Wiley and Sons. 680 p.

11. Grande M.J. & Borrero A., 1979. Effects of planting dates on soybean development and production under irrigation in southern Spain. In: W.H. Judy and J.A. Jacobs (Ed.) Irrigated soybean production in Arid and Semi Arid Regions. Intsoy series. No. **20**: 129-134.

12. International Institute of Tropical Agriculture (IITA), 1979. Selected methods for soil and plant analysis. IITA Manual, Series No. 1, IITA, Ibadan, Nigeria, 86 pp.

13. Jackson M.L., 1958. Soil Chemical Analysis. Englewood Cliffs, New York, Prentice Hall, Inc., 498 pp.

14. Jackson M.L., 1962. Soil Chemical Analysis. 2nd ed. Prentice-Hall, Englewood Cliffs, New York. 326-338.

15. Johnson J., 1975. Understanding Soybean Solutions. Aust. J. Agr. 27: 6-31.

16. Maduakor H.O., 1991. Efficient fertilizer use for increased crop production: The humid Nigeria experience. Fertilizer Research 29: 65-79.

17. Mamman I., 1990. Soybean in Nigerian Agriculture. Paper Delivered by the Honourable Minister of Agriculture and Natural Resources, 3rd Annual Conference of the Nigerian soybean Association, Badeggi. March 26-29, 1990.

18. Meteorological Department, 1991. Weather data Records 1990 and 1991. Meteorological Unit, Ogoja L.G.G.A. Ogoja, Nigeria. 10 pp.

19. Musa M.M., 1975. A method for conservation of Cattle Manure. FAO Soils Bulletin 27: 89-96.

20. Mutsaers H.J.W., 1991. Opportunities for Second Cropping in Southwestern Nigeria. RCMD Research Monograph no. 4, IITA, Ibadan, Nigeria, 28 pp.

21. Odu C.T.I., Babalola O., Udo E.J., Ogunkunle A.O., Bakare T.A. & Adeoye G.O., 1986. Laboratory Mannual for Agronomic Studies in Soil, Plant and Microbiology. Department of Agronomy, University of Ibadan, Ibadan, Nigeria, 83 pp.

22. Pulver E.L., Brochman F. & Wein H.C., 1982. Nodulation of soybean cultivated with *Rhizobium spp.* and their response to inoculation with *Rhizobibium japanicum*. J. crop Sc. vol. **22**, pp. 1065-1070.

23. Reis M.S., Sediyama C.S. & Sediyama T., 1977. Application of Nitrogen fertilizer inoculation and application of fritted trace elements to soybean crops. Rev. ceres **24** (132): 163-169.

24. Riger A.I. & Grebenior I., 1980. Effectiveness of Fertilizer application on the soybean crop in Krasnodor region. Bull. of oil crops. Vo. **1**, pp. 43-45.

25. Wakimoto K., 1989. The joint effect of Nitrogen fertilizer and organic matter application on soyabean yields in warm region of Japan. Jr.Q.J. **22** (4): 268-276.

N. Ndaeyo: Nigerian. Lecturer in Agronomy Department of this University of Uyo.
N.S. Oguzor: Nigerian. Ph.D., Lecturer in Agronomy Department of this University of Uyo.
E.S. Utuk: Nigerian. Research Student in Agronomy Department of this University of Uyo.
S.O. Dan: Nigerian. Research Student in Agronomy Department of this University of Uyo.