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Full Length Research

Response of *Glycine max*(Soya bean) to Different Levels of NPK Fertilizer and Soil Types.

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Despite the fact that most annual legumes (e. g. cowpea, soybean) are nitrogen fixing, their yields are still below expectation in some soils nowadays. This is not unconnected with the low/initials oil nutrient status of the sites/places of cultivation of those legumes, especially pertaining to their inability to meet the critical values required in those nutrients (pH, %N, % organic matter, available phosphorus, exchangeable bases, exchangeable acidity and effective cation exchange capacity) as result of continuous cropping/over cultivation. Thus, this study was conducted to determine the response of *Glycine max* (Soya bean) to four levels of NPK 15:15:15 fertilizer and four soil types for possible variations in yield. It was a 4x 4factorial experiment in completely randomized design which was replicated three (3) times. Germination / seedling emergence rates and percentages, apparent growth parameters (plant height, collar girth, number of leaves, number of branches) and yield indices (number of pods, number of seeds, weight of seeds) were assessed/ investigated. It was observed that senescence set-in /commenced at the 12th week after planting with yellowing of the leaves, browning of the pods and final cessation in growth. The study lasted for 14 weeks and loamy soil with 250kg ha^{-1} of NPK fertilizer had the highest mean values in growth and yield variables/parameters while the lowest mean values were recorded in sandy and clayey soils. The yield increased with increase in plant height and number of branches. Analysis of variance indicated significant differences (P< 0.05) in the growth and yield parameters. Plant height and number of branches were the two growth parameters or indices that determined the yield of this legume, these two parameters accounted for 63 – 89% of the variation in yield (R^2 = 0.063 – 0.089).

Keywords: *Glycine max*, soil types, NPK fertilizer, growth parameters, yield

INTRODUCTION

Soy bean (*Glycine max* L.Merril) is an economically important leguminous crop on a world wide scale and the most important legume in China (Gan*et. al.*, 2002). It is a legume that occupies greater position in world agriculture by virtue of its high protein content and ability to fix atmospheric nitrogen (Osodeke, 2001). It produces high quality oil which is highly digestible and high in saturated fatty acids that contains no cholesterol.

Unlike most oil seeds, soy bean especially the high yielding variety (SAMSOY-1) contains about 18% oil,38% protein and the extraction residue represents more than 40% of the utilization value of the plant (Mehmet, 2008). Soybean can be used when unprocessed or processed. It could be processed by roasting and fermentation. Preferably, the seeds should be processed to remove toxic proteins, haemaglutinins and anti-tripsin which must be destroyed or deactivated to make the beans palatable and digestible for human and animal consumption. *Glycine max* is one of the least expensive sources of protein when compared to eggs, beef, fish, milk and cowpeas. Many nutritious products can be derived from full fat or deflated seeds and these

Table 1: Experimental Plot lay - out

Fertilizer Level	Soil Types a_0	a_1	a_2	a_3
b_0	a_0 b_0	a_1 b_0	a_2 b_0	a_3 b_0
b_1	a_0 b_1	a_1 b_1	a_2 b_1	a_3 b_1
b_2	a_0 b_2	a_1 b_2	a_2 b_2	a_3 b_2
b_3	a_0 b_3	a_1 b_3	a_2 b_3	a_3 b_3

(**Note:** a $_0$= river sand, a_1 = sandy soil, a_2 = clayey soil, a_3 = loamy soil while b0, b1, b2 and b3 are NPK Fertilizer levels at 0, 150, 200and 250kg ha^{-1} respectively,The above 16 treatment combinations were replicated 3 times: making 48 treatment combinations).

products include flours, flakes, snacks, soy sauce, soybean curd and component of some beverages (FAO, 1992).

Soybean belongs to the family Fabaceae, an annual herb propagated by seed and could attain a height of 1.8 – 2m. It is capable of utilizing both soil nitrogen and atmospheric nitrogen through symbiotic nitrogen fixation (Harper, 1974; Milic*et.al.*, 2002). In order to improve yield, the use of nitrogenous fertilizers had been given due recognition and there is inadequacy of information regarding soybean fertilizer requirements in the humid tropical areas of Southern Nigeria (Osodeke, 2001). Most tropical soils are highly weathered leached, some of which are typical ultisols that are characterized by low levels of organic matter and nitrogen content of about 0.3 – 0.6% and 0.03 – 0.05% respectively (Adepetu, *et. al*., 1979; D' Hoore, 1994).

The objectives of this study are: to determine the response of *Glycine max* to different soil types and three levels of NPK 15:15:15 fertilizer in terms of growth rate and yield, to pave way for reasonable recommendation with regard to the best soil type and the correct level of NPK fertilizer to the farmers in the study area, to convince people around the study area that soya bean can be productively produced/cultivated even without Single Superphosphate fertilizer (SSP) and enable people know more about the useful products obtainable from this crop (soybean).

MATERIALS AND METHOD

This study was carried out at the Field Research Site of the Department of Plant Science and Biotechnology, Adekunle Ajasin University, Akungba Akoko, Ondo State, Western Nigeria (Lat.7^0 28^1N and Long. 5^0 44^1 E). The altitude is about 423 above sea level and this location experiences two seasons (rainy and dry seasons).The materials used include soybean seeds, NPK 15:15:15 fertilizer, plastic pots (perforated at the base and were procured from a nearby town (Ikare) while the soil types were .collected from the University site//premises/ environment in AkungbaAkoko (the soil types: river sand, sandy, clayey and loamy soils were identified / confirmed before use). Pre – planting soil analysis was carried out prior to the commencement of the experiment. In order to achieve this, the four soil samples were taken for laboratory analysis (after random collection of samples of each soil type from five spots/sub locations in its major location, bulking, air drying and grinding to pass through 2mm sieve). The physicochemical properties were determined by employing some methods: Particle size analysis was done by using hydrometer method (Day, 1965) and separated into sand, silt, clay and there-after expressed in %, pH in water (1:1) by pH meter, % organic matter/carbon by potassium (Table 1)

dichromate method of Walkey and Black (1974), total nitrogen by Kjdeldal method (Jackson, 1962), available phosphorus by Bray and Kurtz (1945), exchangeable bases (Na and K) determined with flame photometer, estimation of Ca and Mg by means of atomic absorption spectrophotometer, extraction of exchangeable acidity (E.A.) by means of 1N KCL and effective cation exchange capacity (ECEC) by summation method (Kamprath, 1984) of exchangeable bases/ cations (Ca, Mg, K, Na) plus exchangeable acidity. The experiment was a 4 x 4 factorial experiment in completely randomized design consisting of three (3) replicates(each replicate consisted of 16 treatment combinations, the experimental plot lay-out is in Table 1 above).

The seeds were planted in the plastic pots (filled with 2.6kg of all the soil types) at 2 cm soil depth. The plastic pots were perforated at the bottom to prevent water logging and river sand due to its extremely low nutrient status was employed as control (a_0) which was without fertilizer application (a_0 b_0).Three seeds were planted per pot and later thinned to one. This experiment was conducted during the rainy season, regular weeding was

Table 2: Pre-planting soil sample analysis (results) of the four soil types (used as growth media)

Parameters	Loamy soil	Clayey soil	Sandy soil	River sand
pH	6.37	5.20	7.65	7.30
O. M. (%)	1.24	0.44	0.63	0.16
TN (%)	0.26	0,18	0.15	0.14
P (ppm)	13.88	9.35	4.57	2.54
Ca	4.53	3.10	2.24	1,22
Mg	4.11	3.42	3.00	0.80
K	1..26	1.13	1.01	0.40
Na	0.61	0.54	0.44	0.24
E. A.	1.58	1.46	0.78	0 40
ECEC	12.09	9.65	7.47	3.06
Sand (%)	61.00	33.44	70.06	86.04
Silt (%)	18.80	15.52	18.03	9.06
Clay (%)	20.20	51.04	11'91	5.90
Textural class	Loam	Clay	Sand	River sand

Note: The exchangeable bases/cations(Ca, Mg, K, Na), exchangeable acidity (E. A. i. e.Al^{3+}, H^{+}) and effective cation exchange capacity (ECEC) are in cMol/kg of oven dry soil.

ensured and whenever the need arose watering was done. The thinning of the seedlings was done after the first week and the seedling emergence (germination) rates / percentages were calculated. Between 1st and 14th day after planting (DAP), fertilizer application was yet to commence, therefore the mean germination rate of seeds in a_o = 9.5, a_1 = 7.8, a_2 = 6.8, a_3 = 5.0 (DAP) and germination percentages of seeds in a_o = 58.34, a_1 = 63.89, a_2 = 77.79 and a_3 = 94.45 (%).

The experiment lasted for 14 weeks, the growth parameters considered were plant height, collar girth, number of leaves, number of branches while the yield parameters were number of pods, number of seeds and weight of dry seeds kg/ha.Data collected from the above mentioned growth and yield parameters were subjected to statistical analysis of variance (ANOVA).

RESULTS AND DISCUSSION

It was observed from the analyzed soil samples (from different soil types) that the pH values ranged between 5.20 and 7.65 with clayey soil having the lowest value (5.20) which could still enable the crop perform well but better level of performance could be achieved when the nutrient status is augmented (Adeoye and Agboola, 1985; Akanbi*et. al*., 2010; Olaniyi and Ojetayo, 2010) as shown in Table3. The loamy soil had the highest % organic matter (O.M.) and river sand had the least which were 1.24 and 0.16 respectively. In terms of the total nitrogen and available phosphorus, the loam recorded the highest values which subsequently affected the growth and yield of this legume ((Table 2).

Seedlings' emergence took place at the 4th day after planting (DAP) in loamy soil (in two of its replicates) with overall mean germination / seedlings' emergence rate of 5 DAP. Those of river sand, sandy and clayey soils were 9.4, 7.8 and 6.4 DAP respectively. The highest mean germination percentage was also observed in loamy soil (94.4%) while those of river sand, sandy and clayey soils were 67%, 56% and 78% respectively at 14 DAP. The above variations or differences could be attributed to the nature of the different soil types used especially in terms of compactness and water retaining capacity. Though river sand and sandy soil are less compacted

but germination did not occur before or at 5 DAP like that of loamy soil probably due to their lower water retention which did not pave way (allow) for proper water imbibition that normally proceeds germination. It was however observed that the mode of germination in all the treatment combinations was the same, that is, the germination occurred in trickles (not at the time) and also proved the viability of the seeds (Nwoboshi, 1982; Kareem, 2003).The highest mean value of plant height, leaf count (number of leaves), collar girth and number of branches were obtained from *Glycine max* planted (sown) in loamy soil at 250kg ha^{-1} of NPK 15:15. This was followed by *Glycine max* plants in river sand (control) while the least values were got from those soya bean plants in sandy and clayey soils. For instance, the highest mean plant height (42cm) was obtained in a_3 b_3 (soya bean plants in loamy soil with fertilizer application rate at 250kg ha^{-1}) at the end of the 12th week after

Table 3: Germination rates and percentages, mean apparent growth (12WAG) and yield (14WAG) parameters of soya bean (*Glycine max Linn.*)

TC	*GR*	*G %*	*P H*	*C G*	*NL*	*N B*	*N P*	*N S*	*WS(tha^{-1})*
a_ob_o	9	66.67	30.80	3.43	59.67	13.00	59	127	1.11
a_1b_o	6	55.56	25.80	2.60	48.33	12.30	48	79	0.61
a_2b_o	7	88.89	26.03	2.23	39.67	10.00	34	65	0.35
a_3b_o	4	100	31.40	3.40	61.00	15.67	55	128	1.32
a_o b_1	10	55.56	33.27	3.57	56.67	11.33	71	140	1.50
a_1 b_1	9	66.67	19.53	2.01	20.33	6.67	38	80	0.63
a_2 b_1	7	77.79	17.70	2.00	21.00	6.33	40	79	0.62
a_3 b_1	6	88.89	19.97	2.30	30.67	10.33	50	100	0.84
a_o b_2	10	55.56	18.57	2.00	28.10	8.67	33	57	0,29
a_1 b_2	9	66.67	14.02	2.05	18.00	5.43	22	63	0.33
a_2 b_2	7	66.67	14.80	2.04	16.00	4.80	33	74	0.60
a_3 b_2	4	100	39.07	4.27	85.67	19.67	94	221	1.78
a_o b_3	9	55.56	22.7	2.40	34.33	8.33	38	129	1.27
a_1 b_3	7	66.67	18.10	2.08	26.00	7.35	35	89	0.71
a_2 b_3	6	77.79	19.47	2.00	28.00	7.66	30	67	0.39
a_3 b_3	6	88.89	42.00	4.87	81.00	26.00	105	290	2.73
Mean	7.25	73.62	24.58	2.70	40.90	10.85	49.06	112	0.94
S	1.92	15.15	8.24	0.88	21.46	43.38	196.25	447	0.65
CV	0.26	0.21	0.34	0.33	0.53	4.00	4.00	3.99	0.69

Note: a_o = river sand, a_1 = sandy soil, a_2 = clayey soil, a_3 = Loamy soil while b_o = 0 kgha^{-1}, b_1 = 150 kgha^{-1}, b_2 = 200 kgha^{-1}, b_3 = 250 kgha^{-1}of NPK 15:15:15 fertilizer applied,DAP = Day After Planting, WAG = Week After Germination (WeekAfter Seedlings' emergence), TC= treatment combination, GR=germination rate (in days), G%=germination percentage, PH=plant height (in cm), CG=collar girth (in cm), NL=number of leaves, NB=number of branches, NP=number of pods, NS=number of seeds, WS= weight of dry seeds, S = standard deviation, CV = coefficient of variation.Each of the values (figures) is a mean (average value) from three (3) replicates.

Germination (12WAG). The second value next to a_3b_3 was a_ob_3 (Table 3) and the least value was a_1 b_3 (18.10cm). The trend was not reasonably different with regard to the remaining apparent growth parameters. Unexpectedly, the values obtained from the apparent growth and yield parameters of the control experiment (aobo, *Glycine max* planted in river sand at 0 kgha^{-1}) were higher than some of the treatment combinations with varying levels of fertilizer application with the exemption of $a_3$bo, aob$_1$, a_3b_2, aob$_3$, and a_3b_3(Table 3).

Very importantly, data collection on the apparent growth parameters stopped at 12 WAG due to retardation in the growth of the *Glycine max* plants (being an annual crop). Senescence started/commenced/set-in at the end of the 12th week after germination, thus there was no increase in plant height, collar girth, number of leaves and number of branches. The yellowing/drying of the leaves, stem and pods commenced at the end of the 12 WAG. Harvesting of the mature/dry pods from all the treatment combinations started immediately the leaves turned yellow and thepods turned brown/began opening so as to prevent them from splitting /opening reasonably which could have resulted to loss of the dry seeds.

Significant differences existed among the apparent growth parameters in all the treatment combinations at 5% probability level (P< 0.05). Also, the same level of significance was recorded with regard to the yield parameters. The treatment combination $a_3b_3$had the highest yield of 2.73t/ha(Table 3) possibly due to the fact that it was the treatment combinationwith the highest level of NPK fertilizer application in addition to its initial nutrient status (the highest, beingloam) the same trend was observed by Kareem (2015$_b$) in respect of eggplant (*Solanummelongena*) under different growth media and levels of fertilizer application. Positive correlation was also observed between plant height and number of leaves, number of branches and number of leaves, number of pods and number of branches, number of seeds and weight of seeds. Essentially, plant height and number of branches were the two growth parameters or indices that determined the yieldof this crop (soya bean), these two parameters accounted for 63 – 89% of the variation in yield [i. e. coefficient of determination (R^2) = 0.63 – 0.89].

CONCLUSION

Glycine max could be fairly produced in Akungba Western Nigeria by employing soil types ranging from sandy to clayey and loamy soils, but reasonable and

sustainable production can be best achieved on loamy soil with NPK 15:15:15 fertilizer at the rate of 250kg ha^{-1}. It is interesting to note that the 'control experiment' which was (river sand: a_ob_o) performed better thansome of the soya bean plants in sandy /clayey soilsand a treatment combination with loam (Table2) and NPK fertilizer despite the factthat nitrogen fixation activities of the soya bean plant took place in all the soil types.This calls for further investigation with regard to variation in the rates of nitrogen fixation in soil types by the nitrifying bacteria (*Nitrobacter*and*Nitrosomonas*) in the root nodules of this plant (*Glycine max*). If it were a crop that belongs to the 'Graminine family' like maize (*Zea mays*) the lowest yield could have been recorded in the 'control' (a_ob_o), more so when the soil employed for the control was river sand, without fertilizer application and of extremely low nutrient status. Also, owing to continuous cropping which had caused serious degradation in soil fertility in the study area and its environs, it is not feasible to achieve high/optimum yield without fertilizer application despite its (soybean} nitrogen fixing ability.

REFERENCES

Adepetu AA, Obi O, Aduayi EA (1979). Changes in soil fertility under continuous cultivation and fertilization in South Western Nigeria. Nigerian Journal of Agric. Sc.1 (!): 15-20

Adeoye OA, Agboola AA (1985). Critical level of soil plant available PKZMCandMn on maizeleaf content in sedimentary soils of S/W Nigeria. Fert. Res., 6: 60-70

Akanbi WB, Togun AO, Adediran JA, Ilupeju EAO (2010). Growth, dry matter and fruit yields of okro under organic and inorganic sources of nutrients . American-Eurasian Journal of Sustainable Agriculture 4 (1: 1-13)

Bray RH, Kurtz LT (1945). Determination of total nitrogen and available phosphorus. Journal of Soil Science 59: 39-45.

Day PR (1965). Particle fractionalization and particle size analysis.. In C. A. Black (Ed.). Method of soil analysis. Argon American Monograph Society. Argon Madison Wis. Pp545-567.

D'Hoore JL (1964). Soil Map of Africa. Joint Project IICommunications in Technical Cooperation in Africa, Lagos PP 1 -8.

FAO (1992). Technology of Production of Edible Flours and Protein from Soya beans.FAO Agricultural Service Bulletin No. 97.

Gan Y, Porsrhimus E, Keulen H, Peter JC (2002). Effects of NitrogenMgt. On Growth, N_2 Fixation and Yield of Soya beans. Nutrient Cycling Agrocyst62: 163 – 174.

Harper JE (1974). Soil and Symbiotic Requirements for Optimum Soya bean Production. Crop Science. 14: 255 – 260.

Jackson ML (1962). Soil chemical analysis. Prentice Hall New York, pp 4-8.

Kamprath EJ (1984). Fertility management of low activity clayey soils. In: SMSS 1986. Technical Monograph No. 14. Proceedings of a Symposium on low activity clay soils. Las Vegas 1984. Pp 91-106.

Kareem IA, Garba UA, Fasehun FE (2003). Possibility of Propagating *Aframomummelegueta*K. Schum from its Rhizomes for Increased Production. Journal of Leage of Researchers in Nigeria (JOLORN). 4 (1): 135 – 143.

Kareem IA, Obiaga PC, Owa OJ, Okonkwo MC, Nwadike N, Sani YR (2005a). Propagation of *Albizialebbeck*Benth from Cuttings as an Alternative to Production from Seeds.Nigeria Journal of Botany. BOSON PP 106 – 110.

Kareem IA, Adepetu AA, Olowolafe EA (2014). Rattle Tree *(Albizialebbeck*Benth)

Effects on potato (*Solanumtuberosum* Linn.) Productivity on the Jos Plateau,Nigeria. Field

andVegetable Crops Research Journal 51 (2): 116-126

Kareem IA (2015a). Soil chemical properties as influenced by *Albizialebbeck*Benth (rattle tree) under agri-silvicultural system (alley cropping) with *Solanumtuberosum* Lin. (potato). Donnish Journal of Horticulture and Forestry (UK) 1(1): 1-11

Mehmet OZ (2008). Nitrogen rate and plant population effects of yield componentsSoya bean. African Journal of Biotechnology 7 (24): 4464 – 4470.

Milic V, Nastagsija M, Milica H (2003). Interrelationship of nitrogen fixation potential and soya bean yield and vegetable crops. 36: 133 – 139.

Nwoboshi LC (1982).Tropical Silviculture. Principles and Techniques. Ibadan University Press Ltd. 333pp.

Olaniyi JO, Ojetayo AE (2010). The effect of organomineral and inorganic fertilizers on the growth, fruit yield and quality of pepper (*Capsicum frutescence*).Journal of Animal & Plant Science. Vol. 8, Issue 3: 1070-1076

Osedeke UE (2001). Yield performance, N_2 fixation and fertilizer requirements of soya bean in some soils of the forest Zone of South Eastern Nigeria. Ph.D Dissertation. Dept. of Soil Sc. and Agro – Climatology. Michael OkparaOkpara University of Agric., Umudike – Nigeria.

Walkey A, Black LF (1974). an examination of Degtjarref method for determining soil organic matter and a proposed modification of the chromic acid titration. Soil Sc. 37: 29-38.