IMPACT OF DIFFERENT MANURE ON THE GROWTH AND YIELD OF MAIZE IN SOUTHERN NIGERIA

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ABSTRACT

A field experiment was conduct at the Teaching and Research Farm, Akwa Ibom State University, Nigeria, to study the impact of different manures on the growth and yield of maize (Zea mays L). Three different manures were used to include: poultry droppings, pig dungs and goat droppings. It was replicated three times and was laid out in a Randomized Complete Block Design (RCBD). Data were collected on vegetative traits and yield component and statistically analyzed. The growth and yield attributes increased significantly with the application of poultry droppings. The control plot gives significantly lower means and maize that received 20 t/ha recorded the highest mean in all growth and yield parameter evaluated in the study. Applications of poultry manure significantly improve vegetative growth and yield attributes of maize plant and therefore recommended for adoption by resource-poor farmer can adopt the use of poultry droppings as substitute for inorganic fertilizer and ultimately improve yield in the study area.

Keywords: Organic fertilizers, Yields, Growth, Maize

INTRODUCTION

Agriculture in the sub-Saharan Africa is characterized by its poor productivity. Several factors related to soil fertility limits agricultural production (Ijah *et al.,* 2008). Low crop yields had been due to decline soil fertility as a result of impoverishment in manures and low reserves of nitrogen, phosphorus and some trace elements (Adedokun and Ataga, 2007). As such, some ventured into the use of inorganic fertilizer. Under intensive agriculture, the use of inorganic fertilizer has not been helpful because it is associated with soil acidity, nutrient imbalance and reduction in crop yield (Obi and Ebo, 1995). Manures have over time been used to improve soil fertility (Ijah *et al.,* 2008). The use of manure to meet the nutrient requirement of crop is an inevitable practice since manures generally improve the soil physical, chemical and biological properties along with conserving capacity of the moisture holding capacity of soil and this, resulting in enhanced crop productivity along with maintenance of the quality of crop produce (Malieswarappa *et al.,* 1999). Although manures contain plant nutrients in small qualities compared to inorganic fertilizers, the presence of growth promoting principle like enzymes and hormones, besides plant nutrient make them essential for improvement of soil fertility and productivity (Premsekhar and Rajashree, 2009). Improvement in the public health and environmental condition are also the strong reason for advocating the use of organic material (Abou El-Magd *et al.,* 2006).

In the present chemical input farming system, natural (use of organic amendment viz. green mature, poultry manure, farmyard manure etc.) can be considered to be a solution to many problems for different cropping system in different agro-ecological zones (Sharma and Mittra, 1991).

Fertilizer plays an important role in increasing yield of maize, and use of single and compound based fertilizer plays a vital role in increasing the yields of cereals (Bangroo *et al.,* 2012). Maize or corn (*Zea mays* L.) is one of the crop plants that provide food for humans, feed for animals and raw materials for industries. It is ranked third after wheat and rice in the world food grain production (Csathó, 2002). In spite of its nutritional and economic value its production has been hampered by low yield caused by several factors and chief among it is low soil fertility status. Nigeria soil has a high potential for crop production yield, levels obtained under farmers' condition are usually low due to poor soil management and conservation method. The type of problem is solved through the use of either inorganic or organic fertilizer. However, the use of inorganic fertilizer by resource poor farmers is limited by its untimely availability (Adedoyin, 1995), scarcity and cost (Gao *et al.,* 2023).

With the problem associated with inorganic fertilizers already being viewed, this project was carried out to evaluate the impact of different manure on the growth and yield performances of maize in southern Nigeria.

MATERIALS AND METHODS

Experimental Location: The research was carried out in Obio Akpa village, Oruk Anam LGA, Akwa Ibom State, Nigeria. Obio Akpa lies between latitudes 50171 and 70271 N and longitude 70271 and 70581 E of the Greenwich Meridian. Obio Akpa village is in the humid tropics, characterized with two seasons of dry that spanned from November to March and wet from March to November. The annual rainfall ranges from 4205.3 – 5381.2 mm with mean annual temperature range of 24 – 30^{0}C (Wikipedia, 2023).

Experimental Design and Treatment: A Randomized Complete Block Design (RCBD) with three replications was adopted. The experimental land was divided into three blocks of 12 x 2 m^2 (24 m^2) each with a distance of 0.50 m between each plots and each plot size was 2 x 2 m^2 (4 m^2) which produced a total number 15 plot. The manures were poultry, pig and goat manure. The manure was applied to the plot two week after planting (WAP) using ring method of application after being pulverized.

Land Preparation: The land had *Sida acuta, Impereta cylnidrica,* Siamweeds and some other common weeds growing on it. The land had been under continuous cultivation for the past four years without application of either inorganic or organic fertilizers. The land was cleared, stumps manually removed and thereafter ploughed and harrowed mechanically in order to obtain a clean fine tilt soil.

Treatment of Maize Seed: The seeds of maize were treated by soaking in water for 24 hours in other to break the seed dormancy, before cultivation.

Crop Establishment and Management: Two seeds of improved maize seed downy middle resistance early streak resistance yellow (DMR-ESR-Y) obtained from National Center for Genetic Resource and Biotechnology (NACGRAB) Ibadan, Oyo State, Nigeria was planted per hole at a spacing of 50 x 50 cm^2 at a depth of 3 to 5 cm; which was later thinned to one healthy plant per stand. Immediately after planting Atrazine mixed with Paraquat was applied as pre-emergence weed control and when necessary rouging was carried out to eliminate emerging weeds.

Soil Analysis: Prior to the commencement and at the end of the experiment, top soil samples of 20 - 30 cm deep were collected randomly from five spots using soil auger from the experimental plot and mixed together to form a composite sample. It was air dried, sieved with a 2 mm mesh-size sieve and taken to the laboratory to determine the soils physicochemical properties using standard laboratory procedures (Okalebo *et al.,* 2002).

Data Collection: Five plants were randomly tagged from two middle rows in each plot for sampling and data collection on the vegetative growth and yields assessment. The following data on vegetative growth (number of leaves, leaf area, stem girth and plant height) and yield attributes (number of grains per cobs, cob circumference, grain weight and husk weight) were collected at crop maturity and harvest.

Statistical Analysis: Data collected from the experimental field were subjected to analysis of variance (ANOVA) using Statistical Package for Social Science (SPSS, 2011). Significant treatment means were separated using Duncan Multiple Range Test (DMRT) at 5% probability level.

RESULTS AND DISCUSSION

Physiochemical Properties of Soil: The physiochemical properties of the soil at the experimental field before cropping showed that the soil textural classification was sandy loam, slightly acidic in nature with pH value of 5.49 and low in fertility as indicated by the low content of organic carbon, organic matter, total nitrogen, available phosphorus and exchangeable cations (Table 1). Soils with low levels of nutrients need to be boosted with soil amendments input in form of inorganic or organic fertilizer in order to improve them for crop production. Crops planted on the low fertility and acidic soils are expected to benefit from application of manure (Table 2). Low soil nutrient of the experimental site was probably as a result of high proportion of sand content of the soil, which implies that basic cations would be leached more easily as texture determines the degree of retention or ease of leaching of basic cations (Wapa and Oyetola, 2014) and the low NPK levels observed in the soil can be attributed to continuous cropping and increased land use intensity.

At crop maturity, application of different manure slightly increased the soil pH value and total nitrogen ranges from 5.58 to 5.87 and 0.12 – 0.28 respectively. Percentage organic carbon, Ca and Mg was significantly increased in soil amended with manure compared with control plot and the highest recorded from plots supplied with poultry droppings, while available P, Na and K was drastically and slightly decreased across the different manure application respectively (Table 1). The marginal increase observed in the soil pH level indicates the buffering capacity of manure in reducing soil acidity. This finding however did not agree with the findings of Adekiya and Agbede (2009) and Sanni (2016), who observed that soil pH tended to reduce with a rise in the amount of poultry and cow manure application, suggesting that poultry and cow manure led to increased acidity in the soil.

The increases in soil organic carbon, Ca and Mg observed at crop maturity from plots incorporated with different manure may be as a result of the slow rate in which their nutrients are released into the soil (Olowoake and Adeoye, 2013) or may be due to the increased in the amount of nitrogen present in the different manure applied which improved microbial activity that led to enhanced production and mineralization of organic matter from natural (native) source in soil (Sanni, 2016). The higher organic carbon content in the plot treated with manure relative to other treated plots agreed with findings of Mahmoud *et al.* (2009) on the increase in organic matter as a result of addition of rice straw compost. While the low P and K levels and marginal increase of K observed at crop maturity may be as a result of NPK uptake for the growth and development of the plant.

Effect of Different Manures on Vegetative Growth of Maize: The response of maize to the different manures on the vegetative growth (plant height, number of leaves, leaves area and stem girth) indicated that the response of plant in terms of vegetative growth followed the same trend whereby the lowest values were recorded for control plants and higher values for fertilized plants in line with the type of manure applied (Table 3). This result suggests that nutrient availability, especially NPK, determines plant vegetative growth and development (Adebayo *et al.,* 2012).

Table 1: Physiochemical properties of soil before planting and at crop maturity

Chemical	Constituents	Pre-cropping	Post-cropping	5 t/ha – 10 t/ha	15 t/ha – 20 t/ha
pH (H_2O)	5.49	5.64	5.58	5.76	5.87
Organic carbon (%)	0.54	0.82	1.43	2.09	3.11
Total nitrogen (%)	0.08	0.12	0.22	0.28	0.26
Available P (mg/kg)	9.18	4.91	3.82	4.32	4.81
Na (cmol/kg^{-1})	0.93	0.38	0.70	0.77	0.73
Ca (cmol/kg^{-1})	0.42	1.10	1.53	1.81	1.83
K (cmol/kg^{-1})	0.96	0.24	0.18	0.23	0.27
Mg (cmol/kg^{-1})	0.20	0.50	1.04	2.64	2.97
Physical					
Sand (%)	47.00	64.80	70.50	72.40	71.90
Silt (%)	44.00	8.00	15.70	15.00	12.40
Clay (%)	9.00	27.20	13.80	12.60	15.70
Textural class			Sandy loam		

Table 2: Chemical analysis of the manure used

Parameters	Poultry manure	Pig manure	Goat manure
N (g/kg)	30.20	16.90	15.60
P (g/kg)	10.60	6.30	6.90
K(g/kg)	10.30	7.60	7.30
Ca (g/kg)	37.20	31.60	21.20
Mg(g/kg)	17.30	19.20	11.70
Ma (g/kg)	2.10	1.60	1.10
Fe (mg/kg)	650.90	650.70	614.60
Zn (mg/kg)	75.40	81.20	54.80
Cu (mg/kg)	32.70	27.30	29.10
Mn (mg/kg)	217.90	260.30	321.90

Table 3: Effect of different manures on vegetative growth parameters of maize

Treatments	Plant height (cm)	Number of leaves	Leaves area (cm^2)	Stem girth (cm)
Control	102.25 ± 11.01^a	13.07 ± 0.56^a	313.62 ± 0.81^b	22.13 ± 0.86^a
Pig droppings	114.69 ± 14.81^b	13.42 ± 0.36^{ab}	379.91 ± 0.33^c	22.94 ± 0.67^{ab}
Goat droppings	118.15 ± 18.81^c	13.93 ± 0.86^b	381.14 ± 0.71^d	23.43 ± 0.97^b
Poultry droppings	214.27 ± 12.81^d	14.27 ± 12.81^c	119.03 ± 0.91^a	24.35 ± 0.56^d

$^{a-d}$*Means on the same column with different letter superscript are significantly different (p<0.05)*

The consistent poor performance of control plots (non-fertilized) and those with low level of manure revealed that when nutrients are available in adequate amounts, plant tends to grow at their optimum potential. These improvements in growth parameters with respect to poultry manure applied agreed with the findings of Aminifard *et al.* (2010).

Leaf area is a crucial growth parameter determining the capacity of plant to trap solar energy for photosynthesis and has marked effect on growth and yield of plant. The influence of manures on leaf area remained significant under different manures; maximum leaf area (381.14 ± 0.71 cm^2) was recorded for goat droppings application which was statistically higher ($p<0.05$) than poultry droppings (119.03 ± 0.91 cm^2), pig droppings (379.91 ± 0.33 cm^2) and the control (313.62 ± 0.81 cm^2). Nitrogen (N) is one of the main plant nutrients affecting plant growth and yield (Tafteh and Sepaskhah, 2012) and leaf area increase with increase in N level (Valentinuz and Tollenaar, 2006). Increased leaf area in soil amended with organic fertilizer could probably be attributed to N availability which promoted leaf area during vegetative development and also helped to maintain functional leaf area during the growth period (Mojeremane *et al.,* 2015).

Stem diameter was significantly influenced ($p<0.05$) by different manure application. Application of poultry manure (24.35 ± 0.56 cm) gave the highest response, which was followed by application of goat droppings (23.43 ± 0.97 cm), while the control treatment (22.13 ± 0.86 cm) gave the least stem diameter. Manures have been said to improve soil fertility by activating soil microbial biomass, which in turn leads to development in corps (Eleduma *et al.,* 2020) and this may have been responsible for the observed increase in stem diameter resulting from nutrient application. Stem diameter have positive implication on lodging, particularly during fruiting; the thicker the stem, the less likely the plant would lodge as a result of fruit carriage or other lodge inducing factors, such as wind (Kashiwagi *et al*., 2008).

Plants grown with poultry manure (214.27 ± 12.81 cm) were significantly taller ($p<0.05$) than plant produced with the other manures (pig manure - 114.69 ± 14.81 cm and goat manure - 118.15 ± 18.81 cm) and control plant (102.25 ± 11.01 cm). The increase in height of maize plants with application of poultry droppings suggests that the type of manure applied affects nutrients availability for uptake by plants which promoted vigorous plant growth through efficient photosynthesis (Sadur *et al.,* 2010).

The highest number of plant leaves in the present study was recorded in plants grown with poultry organic fertilizer (14.27 ± 12.81) which was significantly higher ($p<0.05$) than the control (13.07 ± 0.56) and other plants grown with other organic fertilizers (pig manure - 13.42 ± 0.36 and goat manure - 13.93 ± 0.86). The application of manure to the soil lead to improved soil fertility and soil structure, increased soil organic matter and enhanced microbial activity (Sadur *et al.,* 2010) and the nutrients released from manure thus support and enhanced rapid root development (Abou El-Magd *et al.,* 2005) which lead to enhanced leaf growth.

Effect of Different Manures Application on Yield Attributes of Maize: A non-significant treatment effect was revealed from mean value showed in Table 4 for number of harvested cob per plant, cob diameter and husk weight. However, maize plants grown with poultry droppings had superior treatment mean numbers of cobs. Meanwhile, the treatment mean obtained for number of grains per cobs, cob length and grain weight increased in an ascending order with poultry droppings having the highest mean value which was significant different ($p<0.05$) from mean value obtained from other applications and control plots recorded the lowest mean treatment value. Pig manure did not differ significantly ($p>0.05$) compared to control treatment. The higher yield attributes obtained from the application of poultry manure was in agreement with the studies of Ogar and Asiegbu (2005), Aujla *et al.* (2007) and Zainub *et al.* (2021). This may be attributed to the stimulating effect of poultry manure that supplies the plant with nutrients required for better yield (Abdelrazzag, 2002). According to Udounang *et al.* (2023), application of poultry droppings increases the growth and yield of cocoyam intercropped with maize and melon.

The application of poultry manure increased the maize growth, which might have been due to the balance availability of nutrients to the plants that resulted in a favourable soil environment. These favourable conditions increased the nutrient availability and water holding capacity of the soil resulting in enhanced growth and yield (Rashid *et al.,* 2013).

Conclusion: The study clearly indicated that manure significantly improved the performances of maize and soil fertility proportional with the application of poultry droppings giving the best performances. Therefore, it is recommended that resource-poor farmers in the study area should utilize poultry droppings for sustainable cultivation and optimum yield of maize in the study area as the manure contribute to the improvement of the low fertility status of the soil.

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Table 4: Effect of different manure application on mean yield attributes of maize

Treatments	Number of cobs	Number of gains per cob	Cob length (cm)
Control	5.33 ± 0.64[a]	400.32 ± 1.50[a]	15.05 ± 0.89[a]
Pig droppings	5.67 ± 0.32[b]	447.40 ± 1.51[b]	15.69 ± 0.80[b]
Goat droppings	5.67 ± 0.32[ab]	473.49 ± 1.36[bc]	16.61 ± 0.34[c]
Poultry droppings	6.07 ± 0.74[c]	516.83 ± 1.35[ad]	17.38 ± 0.02[d]
	Cob diameter (cm)	**Grain weight (Kg)**	**Husk weight (Kg)**
Control	3.49 ± 0.60[a]	1.13 ± 1.03[a]	0.11 ± 0.50[a]
Pig droppings	3.66 ± 0.50[b]	1.54 ± 1.41[b]	0.15 ± 0.60[b]
Goat droppings	3.94 ± 1.03[c]	1.70 ± 1.66[c]	0.20 ± 1.03[c]
Poultry droppings	4.18c ± 0.29[c]	2.04 ± 2.37[d]	0.21 ± 0.29[d]

[a-d]Means on the same column with different letter superscript are significantly different (p<0.05)

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REFERENCES

ABDELRAZZAG, A. (2002). Effect of chicken manure, sheep manure and inorganic fertilizer on yield and nutrients uptake by onion. *Pakistan Journal of Biological Sciences*, 5(3): 266 – 268.

ABOU EL-MAGD, M. M., EL-BASSIONY, A. M. and FAWZY, Z. F. (2006). Effect of organic manure with or without chemical fertilizers on growth, yield and quality of some varieties of Broccoli plants. *Journal of Applied Sciences Research,* 2(10): 791 – 798.

ABOU EL-MAGD, M. M., HODA, M. A. and FAWZY, Z. F. (2005). Relationships, growth, yield of Broccoli with increasing N, P or K ratio in a mixture of NPK fertilizers. *Annals of Agricultural Science*, 43: 791 – 805.

ADEBAYO, A. G., AKINTOYE, H. A., AINA, O. O., OLATUNJI, M. T. and SHOKALU, A. O. (2012). Assessment of organic amendments on growth and flower yield of sunflower (*Helianthus annus*). *Libyan Agricultural Research Centre Journal International*, 3(1): 24 – 29.

ADEDOKUN, O. M. and ATAGA, A. E. (2007). Effects of amendments and bioaugmentation of soil polluted with crude oil, automotive gasoline oil, and spent engine oil on the growth of cowpea (*Vigna ungiculata* L. Walp). *Scientific Research and Essays*, 2(5): 147 – 149.

ADEDOYIN, S. F. (1995). An assessment of the linkage in the delivery of technologies on rehabilitation and management of soil in Ogun State, Nigeria. Pages 19 – 26. *In: 3rd All African Soil Science Conference,* University of Ibadan. Ibadan.

ADEKIYA, A. O. and AGBEDE, T. M. (2009). Growth and yield of tomato (*Lycopersicon esculentum* Mill) as influenced by poultry manure and NPK fertilizer. *Emirates Journal of Food and Agriculture*, 21(1): 10 – 20.

AMINIFARD, M. H., AROIEE, H., FATEMI, H., AMERI, A. and KARIMPOUR, S. (2010). Responses of eggplant (*Solanum melongena* L.) to different rates of nitrogen under field conditions. *Journal of Central European Agriculture,* 11(4): 453 – 458.

AUJLA, M. S., THIND, H. S. and BUTTAR, G. S. (2007). Fruit yield and water use efficiency of eggplant (*Solanum melongena* L.) as influenced by different quantities of nitrogen and water applied through drip and furrow irrigation. *Scientia Horticulturae*, 112(2): 142 – 148.

BANGROO, S. A., MUSHTAQ, W. A., TAHIR, A., MALIK, M. A., KIRMANI, N. A., SOFI, J. A. and FAISULUR, R. (2012). Potassium adsorption characteristics of soils under long term maize-legume cropping sequence. *African Journal of Agricultural Research*, 7(48): 6502 – 6507.

CSATHÓ, P. (2002). The residual effect of K fertilization in a Hungarian corn monoculture long-term field trial, 1990–1999. *Communications in Soil Science and Plant Analysis*, 33: 3105 – 3119.

ELEDUMA, A. F., ADERIBIGBE, A. T. B. and OBABIRE, S. O. (2020). Effect of cattle manure on the performances of maize (*Zea mays* L) grown in forest-savannah transition zone Southwest Nigeria. *International Journal of Agricultural Science and Food Technology*, 6(1): 110 – 114.

GAO, F., LI, H., MU, X., GAO, H., ZHANG, Y., LI, R., CAO, K. and YE, L. (2023). Effects of organic fertilizer application on tomato yield and quality: a meta-analysis. *Applied Sciences*, 13(4): 2184. https://doi.org/10.3390/app13042184

IJAH, U. J. J., SAFIYAN, U. H. and ABIOYE, O. P. (2008). Comparative study of biodegradation of crude oil in soil amended with chicken droppings and NPK fertilizer. *Science World Journal*, 3(2): 63 – 67.

KASHIWAGI, T., TOGAWA, E., HIROTSU, N. and ISHIMARU, K. (2008). Improvement of lodging resistance with QTLs for stem diameter in rice (*Oryza sativa* L.). *Theoretical and Applied Genetics*, 117: 749 – 757.

MAHMOUD, E., IBRAHIM, M., ROBIN, P., AKKAL-CORFINI, N. and EL-SAKA, M. (2009). Rice straw composting and its effect on soil properties. *Compost Science and Utilization*, 17(3): 146 – 150.

MALIESWARAPPA, H. P., NANSAPPA, H. V. and HEDGE, M, R. (1999). Influence of planting material, plant population and organic manure on yield of East India Galangal and on soil physiochemical and biological properties. *Journal of Spices and Aromatic Crops*, 8(1): 35 – 40.

MOJEREMANE, W., MOTLADI, M., MATHOWA, T. and LEGWAILA, G. M. (2015). Effect of different application rates of organic fertilizer on growth, development and yield of rape (*Brassica napus* L.). *International Journal of Innovative Research in Science, Engineering and Technology*, 4(12): 11680 – 11688.

OBI, M. E. and EBO, P. O. (1995). The effects of organic and inorganic amendments on soil physical properties and maize production in a severely degraded sandy soil in southern Nigeria. *Bioresource Technology*, 51(2-3): 117 – 123.

OGAR, E. A. and ASIEGBU, J. E. (2005). Effects of fertilizer rates and cutting frequency on the marketable vegetable and pod yields in fluted pumpkin in southeastern Nigeria. *Agro-Science*, 4(1): 66 – 69.

OKALEBO, J. R., GATHUA, K. W. and WOOMER, P. L. (2002). *Laboratory Methods of Soil and Water Analysis: A Working Manual.* Tropical Soil Biology and Fertility Programme, Nairobi, Kenya.

OLOWOAKE, A. A. and ADEOYE, G. O. (2013). Influence of differently composted organic residues on the yield of maize and its residual effects on the fertility of an Alfisol in Ibadan, Nigeria. *International Journal of Agriculture, Environment and Biotechnology*, 6(1): 79 – 84.

PREMSEKHAR, M. and RAJASHREE, V. (2009). Influence of organic manures on growth, yield and quality of okra. *American-Eurasian Journal of Sustainable Agriculture*, 3(1): 6 – 8.

RASHID, Z., RASHID, M., INAMULLAH, S., RASOOL, S. and BAHAR, F. A. (2013). Effect of different levels of farmyard manure and nitrogen on the yield and nitrogen uptake by stevia (*Stevia rebaudiana* Bertoni). *African Journal of Agricultural Research*, 8(29): 3941 – 3945.

SADUR, R., KHALIL, S. K., FIDA, M., ABDUR, R., KHAN, A. Z., SALJOKI, A. R., MUHAMMAD, Z. and KHALIL, I. H. (2010). Phenology, leaf area index and grain yield of rainfed wheat influenced by organic and inorganic fertilizer. *Pakistan Journal of Botany*, 42(5): 3671 – 3685.

SANNI, K. O. (2016). Effect of compost, cow dung and NPK 15-15-15 fertilizer on growth and yield performance of Amaranth (*Amaranthus hybridus*). *International Journal of Advances in Scientific Research*, 2(3): 76 – 82.

SHARMA, A. R. and MITTRA, B. N. (1991). Effect of different rates of application of organic and nitrogen fertilizers in a rice-based cropping system. *The Journal of Agricultural Science*, 117(3): 313 – 318.

SPSS (2011). *SPSS Statistics Base 17.0 User's Guide.* SPSS Incorporated, Chicago, Illinois, USA. https://www.sussex.ac.uk/its/pdfs/SPSS_Statistics_Base_Users_Guide_17.0.pdf

TAFTEH, A. and SEPASKHAH, A. R. (2012). Yield and nitrogen leaching in maize field under different nitrogen rates and partial root drying irrigation. *International Journal of Plant Production*, 6(1): 93 – 113.

UDOUNANG, P. I., ESSIEN, O. A., UMOH, F. O., IJAH, C. J. and AKPAINYANG, F. E. (2023). Evaluation of growth and yield of cocoyam on varying rates of organic manure in a cocoyam based-intercropping system. *American Journal of Life Sciences*, 11(3): 50 – 55.

VALENTINUZ, O. R. and TOLLENAAR, M. (2006). Effect of genotype, nitrogen, plant density, and row spacing on the area-per-leaf profile in maize. *Agronomy Journal*, 98(1): 94 – 99.

WAPA, J. M. and OYETOLA, S. O. (2014). Combining effects of nitrogen fertilizer and different organic manures on major chemical properties of typic ustipsament in north-east Nigeria. *American International Journal of Biology*, 2(2): 27 – 45.

WIKIPEDIA (2023). *Akwa Ibom State*. https://en.wikipedia.org/wiki/AkwaIbomState Accessed July 23, 2023.

ZAINUB, B., AYUB, G., SIDDIQUE, S., ZEB, S. and JAMIL, E. (2021). Response of Brinjal (*Solanum melongena* L.) cultivars to nitrogen levels. *Pure and Applied Biology (PAB)*, 5 (1): 134 – 141.