Asian Journal of Agriculture and Rural Development

journal homepage: http://aessweb.com/journal-detail.php?id=5005

Response of Grain Weight of Maize to Variety, Organic Manure and Inorganic Fertilizer in Asaba Area of Delta State

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Abstract

This study was carried out in the Teaching and Research Farm of Delta State University, Asaba Campus from March 2008 to June 2010 to evaluate the response of grain weight of maize to variety, organic manure and inorganic fertilizer. The experiment was carried out in a Randomized Complete Block Design (RCBD) replicated three times in a factional layout. Four different rates of poultry manure, cattle dung and NPK 20:10:10 fertilizer were applied to three maize varieties sown at 75cm x 15cm and evaluated for the grain weight. The results obtained indicated that hybrid variety which produced yield of 2.1 tha^{-1} in 2008 and 2.3 tha^{-1} in 2009 was superior. The results of interaction showed that variety, manure type and rates of application were significantly ($p<0.05$) different in 2008 and 2009. Based on the findings of the study, it is recommended that (i) Hybrid maize variety, 9022-13, which was outstanding in grain weight be grown in the study area. Alternatively, farmers who prefer open-pollinated varieties could grow BR9922-DMRSF$_2$ or Agbor local variety for farmers who prefer local varieties in maize production. (ii) Farmers who prefer mineral fertilizers for increased grain weight of maize should apply 450$kgha^{-1}$ of NPK 20:10:10. (iii) Farmers who practice organic agriculture in Asaba agro-ecological zone should apply 30tha^{-1} of poultry manure to enhance maize yield.

Keywords: Grain weight of maize, variety, organic manure and fertilizer, Asaba area of Delta State

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Introduction

Maize (*Zea mays* L) is one of the major cereal crops grown in the humid tropics and Sub-Saharan Africa. It is a versatile crop and ranks third following wheat and rice in world production as reported by Food and Agriculture Organization (FAO, 2003). Maize crop is a key source of food and livelihood for millions of people in many countries of the world. It is produced extensively in Nigeria, where it is consumed roasted, baked, fried, pounded or fermented (Agbato, 2003). In advanced countries, it is an important source of many industrial products such as corn sugar, corn oil, corn flour, starch, syrup, brewer's grit and alcohol (Dutt, 2005). Corn oil is used for salad, soap-making and lubrication. Maize is a major component of livestock feed and it is palatable to poultry, cattle and pigs as it supplies them energy (Iken *et al.*, 2001). The stalk, leaves, grain and immature ears are cherished by different species of livestock (Dutt, 2005).

In spite of the increasing relevance and high demand for maize in Nigeria, yield across the country continues to decrease with an average of about 1 t/ha which is the lowest African yield recorded (Fayenisin, 1993).

The steady decline in maize yield can be attributed to:

1. Rapid reduction in soil fertility caused by intensive use of land and reduction of fallow period as reported by Directorate of Information and Publications of Agriculture.(DIPA, 2006).
2. Failure to identify and plant high yielding varieties most suited or adapted to each agro-ecological zone (Kim, 1997; Olakojo, et al.1998).
3. Use of inappropriate plant spacing which determines plant population and final yield (Zeidan *et al.*, 2006).
4. Negligence for soil amendment materials such as organic manure and inorganic fertilizers which improve soil condition and enhance crop yield.

Tolera *et al.* (1999) suggested that breeders should select maize varieties that combine high grain yield and desirable stover characteristics because of large differences that exist between cultivars. Odeleye and Odeleye (2001) reported that maize varieties differ in their growth characters, yield and its components, and therefore suggested that breeders must select most promising combiners in their breeding programmes. Sonetra *et al.* (2002) suggested that subsistence farmers should apply organic manure directly to the soil as a natural means of recycling nutrients in order to improve soil fertility and yield of crops. Manures and fertilizers are the life wire of improved technology contributing about 50 to 60% increase in productivity of food grains in many parts of the world, irrespective of soil and agro-ecological zone (DIPA, 2006). Reijnties *et al.* (1992) and Adepetu *et al.* (2005) remarked that the downward trend in food production should prompt farmers to amend the soil with different materials in order to enhance growth and yield of crops. Several organic materials such as cattle dung, poultry dropping, pig dung and refuse compost have been recommended to subsistence farmers in West Africa as soil amendments for increasing crop yield (Sobulo and Babalola, 1992; Ismail *et al.,* 1999; Olayinka, 1996 and Olayinka *et al.,* 1998). Enujeke (2013) recommended the application of 450kgha-1 of NPK 20: 10:10 or 30 tha-1 of poultry manure for increased grain yield of maize. The report further argued that poultry dropping and cattle dung increases root growth of maize and the crop extracts soil water more efficiently for increased grain yield.

Municipal wastes were reported to have reduced soil temperature, increased soil water, nutrient status and the yield of maize in temperate soils (Movahedi *et al.,* 2000). Cattle dung has been reported to contain 0.3 – 0.4 % N, 0.1 – 0.2 % P and 0.1 – 0.3 % K (Subedi and Gurung, 1991). According to Adekunle *et al.,* (2005) cattle dung applied at the rate of 10 t/ha to cowpea resulted to increased plant height, leaf area, pod number, pod weight as well as improved soil structure in a mixed farming system. Stefan (2003) indicated that fresh poultry dropping contain 70% water, 1.4% N, 1.1% P_2O_5 and 0.5% K_2O while dried poultry manure contains 13% water, 3.6% N, 3.5% P_2O_5 and 1.6% K_2O. Ayodele (1993) reported that inorganic fertilizer are known to influence the quantity and yield of maize. Iken and Anusa (2004) recommended an optimum plant population of 53,333 plants/ha for maximum yield of maize. Their report indicated that this is obtainable using a spacing of 75cm x 25cm at 1 plant per stand or 75cm x 50cm at 2 plants per stand. Azam *et al.,* (2007) reported that spacing of 75cm x 35cm resulted in increased grain yield of maize while 75cm x 15cm gave maximum cob weight. Similar report by Allessi and Power (2004) revealed that maize cob weight decreased with increased plant population.

At present, some farmers in Asaba area not only neglect the use of fertilizers or soil amendments but also sow any maize variety of their choice and these do not translate into expected high grain yield in the study area. Hence, there are no recommended standards taking into consideration the different combinations of such cultural practices as varietal selection, rates of appropriate organic manure and mineral fertilizer which interplay to influence yield and optimal performance of maize in Asaba area of Delta State. Against this background, the broad objective of this study, therefore, was to: identify variety of maize most suited or adapted to Asaba area, fertilizer types and rates for the variety.

The specific objectives were to:

(i) identify the best variety of maize for Asaba area

(ii) determine the effects of NPK (20:10:10) mineral fertilizer, poultry manure, cow dung on maize grain weight.

Materials and Methods

Site Description

The study was carried out in the Teaching and Research Farm of Delta State University, Asaba Campus from March to December 2008 and repeated between March and December, 2009. Asaba is located at latitude 06°14'N and longitude 06°49'N of the equator. It lies in the tropical rainforest zone dominated by mangrove, fresh water, swamps, humid forests and secondary vegetation (NEST, 1991). Its climate is influenced by the movement of the Inter-Tropical Discontinuity (ITD). The IDT is made up of two wind systems namely the moisture-laden South-West monsoon from the Atlantic Ocean and the dry cold North-East trade wind from the Sahara desert. The South-West Trade wind most significantly determine the climate condition of Asaba area of Delta State. Asaba is characterized by raining season between April and October, with annual mean-rainfall of 1500mm and 2000mm maximum. The distribution is bimodal with peak in July and September, coupled with a period of low precipitation in August. Mean temperature is 23.8°C with 37.3°C as maximum. Relative humidity is 77.2%, the mean monthly soil temperature at 100m depth is 20.3°C, while sunshine stands at 4.8 bars (Meteorological Office, Asaba, 2003).

Pre-planting Soil Analysis

Representative surface soils (0-20cm) were sampled with a tubular sampling auger. These soil samples were air-dried at room temperature for 5 days and crushed to pass through a 2mm mesh sieve. Sub-samples from the bulked soil sample were further grounded to pieces to pass through 100mm-mesh sieve for the determination of organic matter. The rest samples were then analyzed to determine the physical and chemical properties of the soil. The analysis was done at Delta State University, Asaba campus.

Analytical Procedure

Physical Properties

Particle Size Distribution: Particle size distribution was analyzed using the Bouyoucos hydrometer method in which 0.5 N Sodium hexameta-phosphate was used as dispersant (Landor, 1991).

Bulk density: The bulk density (Bd) was determined by Core-method.

Particle density: This was determined by pycometer or specific gravity bottle method as described by Bowles (1992).

Chemical Properties

Soil pH: This was determined in soil: water suspension (1:1) using glass electrode pH-meter as described by Mclean (1982).

Organic Carbon: This was determined using the wet oxidation method of Walkley and Black (Walkley and Black, 1945).

Total Nitrogen: This was determined using the modified KJeldah distillation method as described by Landor (1991).

Exchangeable Cations (EC) and Effective Cation Exchange Capacity (ECEC): Exchangeable cations were determined by extracting the cations with IN ammonium acetate (IN, NHOAC) as displacing solution, buffered at pH_7 as described by Brady and Weils (1999). The extract was then determined electrochemically using atomic absorption spectrophometry. The effective cation exchange capacity (ECEC) was calculated as the sum of exchangeable bases (Ca, Mg, K and Na) and exchangeable A1 and H expressed in cmo1/kg^{-1} of soil.

Exchangeable Acidity: This was determined by titration method as described by Juo (1981). The exchangeable H^+ and $A1^{++}$ were then expressed in cmo/kg^{-1} of soil

Available Phosphorus: This was determined by Bray No.1 method as described by Landor (1991).

Cation Exchangeable Capacity: This was determined by neutral NH_{4-} Acetate placement method using the procedure of Anderson and Ingram (1996).

Aim of the Experiment

The experiment was aimed at testing the response of three selected maize varieties to different rates of organic manure and inorganic fertilizer (NPK 20:10:10)

Experimental Design

The study was carried out in Randomized Complete Block Design (RCBD), replicated three times in a factorial layout. The factors were three sources of nutrients:- poultry manure (PM), cattle dung (CD), inorganic fertilizer (NPK 20:10:10). The different rates of PM were 0, 10, 20, 30t/ha, CD were 0, 10, 20, 30t/ha and NPK 20:10:10 were 0, 150, 300, 450kg/ha.

Agronomic Practices

Among the agronomic practices carried out were land preparation/plot layout, planting, application of treatments, weeding.

Land Preparation and Plot Layouts

The land was ploughed and harrowed using tractor. Three blocks (or replicates) consisting of 36 blocks each were layout, each block will measure 2.6m x 2.25m and was separated from one another with a space of 0.5m. Alley pathways of 1m separated one block from another, and the total number of plots laid out in the entire experiment was108.

Planting

Maize seeds were sown on the plots at the rate of 1 seed per hole at a depth of 2-3cm, using 75cm x 15cm spacing as indicated by the first experiment.

Procurement and Application of Organic Manure and NPK 20:10:10 Fertilizer

Well-decomposed cattle dung was collected from cattle pen area, while poultry droppings was obtained from the battery cage system of poultry management of Delta State University, Asaba Campus. These organic manure were analyzed to determine their nutrient contents. NPK 20:10:10 fertilizer was obtained from Delta Agricultural Procurement Agency (DAPA), Ibusa.These amendment materials were incorporated into the plots according to the treatment as suggested by Olanikan (2006).

Weeding: Weeding was done three times using hoe.

Data Collection: Fourteen middle stands were used as sample population for data collection. Data collected was grain weight of maize. The grain weight was measured using a weighing scale after harvesting and shelling at the end of the 16^{th} week.

Statistical Analysis: Data collected were subjected to analysis of variance (ANOVA) and means were separated with Duncan Multiple Range Test (DMRT) according to Wahua (1999).

Results

Soil Physico-chemical Properties of the Experimental Site:

The pre-physico-chemical properties of the experimental site is shown in Table 1. The result showed predominantly sand at the surface and this tends to decrease with depth of profile. Texturally, the soil of the experimental site is classified as sandy loam. The soil is acidic with pH of 6.2 in H_2O and 5.6 in CaCl. The organic matter content and total nitrogen were low with values of 1.22 gkg^{-1} and 0.113 gkg^{-1}. The available P was high with value of 26.5 $mgkg^{-1}$. The exchangeable cations (Ca, Mg, Na and K) were equally low in status with values of 2.6$cmolkg^{-1}$ for Ca^{2+} and 0.9 $cmolkg^{-1}$ for Mg^{2+}. The value obtained for Na^+ was 0.57 $cmolkg^{-1}$, which was moderate while that for K^+ was 0.08$cmolkg^{-1}$, which was low. The CEC was 4.15, while ECEC was 5.6$cmolkg^{-1}$, which were generally low. The exchangeable acidity was only trace for Al^{3+} and characteristically low for H^+ with a value of 1.4 $cmolkg^{-1}$.

Nutrient Content (%) of Organic Manure used in the Study

The nutrient content of organic manure (poultry manure and cattle dung) used in the study is shown in Table 2. The values of N, P and K in poultry manure were significantly ($P<0.05$) higher than their values in cattle dung. With respect to N, poultry manure had 1.6% against cattle dung which was 0.4%. Also, poultry manure had 0.6% P while cattle dung had 0.2% P. The value for K was 0.8% in poultry manure, while it was 0.3% in cattle dung.

Table 1: Physico-chemical Properties of Experimental Site

Soil Property		Value	Interpretation
Particle Size Distribution (%)			
	Coarse sand	38	
	Fine sand	41	
	Silt	9	
	Clay	12	
	Texture	_____	Sandy loam
Ph	H_2O	6.2	Acidic
	CaCl	5.6	Acidic
Organic	Carbon gkg^{-1}	0.71	
Organic	Matter gkg^{-1}	1.22	Very low
Total	Nitrogen gkg^{-1}	0.113	Low
Available	P (ppm)	26.5	
Exchangeable bases ($cmol/kg^{-1}$)			
	Na^+	0.57	Moderate
	K^+	0.08	Very low

	Ca^{2+}	2.60	Low
	Mg^{2+}	0.90	Low
Cation Exchange Capacity		4.15	
Exchangeable acidity (cmol/kg^{-1})			
	Al^{3+}	Trace	
	H^{+}	1.4	
Effective cation Exchangeable capacity (Cmol/kg^{-1})		5.6	

Table 2: Nutrient (%) of Organic Manure Used in the Study

	Nutrient Content (%)		
Parameter	N	P	K
PM	1.6_a	0.6_a	0.8_a
CD	0.4_b	0.2_b	0.3_b

Legend: PM = Poultry Manure, CD = Cattle Dung, N = Nitrogen, P = Phosphorus

Effects of Variety, Organic Manure and Inorganic Fertilizer on Grain Weight of Maize

The responses of grain weight to variety, organic manure and inorganic fertilizer is shown in Table 3. Hybrid variety (9022-13) had higher grain weight of 2.10t/ha in 2008 and 2.30 t/ha in 2009, followed by open-pollinated variety BR9922-DMRSRF$_2$ with 1.80 t/ha in 2008 and 1.91 t/ha in 2009, while Agbor local variety had the lowest grain weight of 1.20 t/ha in 2008 and 1.43 t/ha in 2009. The order of superiority in terms of highest cob weight was 9022-13 > BR 9922-DMRSRF$_2$ > Agbor local. Plants that received inorganic fertilizer NPK 20:10:10 were superior in weight (2.30 t/ha in 2008 and 2.20 t/ha in 2009), followed by plants that received poultry manure (1.50 t/ha in 2009 and 1.73 t/ha in 2009), while plants that received cattle dung had the lowest weight. Increased application of manure or fertilizer resulted in increased gain weight. Among the varieties, plants that received NPK 20:10:10 fertilizer at the rate of 450kg/ha were superior with values of 3.10t/ha in 2008 and 2.76 t/ha in 2009, while unfertilized plants were inferior with values of 0.80 t/ha in 2008 and 1.27 t/ha in 2009. The effects of interaction (Table 4) indicated that variety, manure type, rate of application, variety * manure type, variety * rate were significantly (P<0.05) different and affected the changes in grain weight of maize, while manure type * rate, variety * manure type * rate were not significantly (P>0.05) different and did not affect changes in grain weight of maize in 2008 and 2009.

Table 3: Effects of Variety, Organic Manure and Inorganic Fertilizer on Grain Weight and Number of Grains per Cob of Maize in 2008 and 2009

		Grain weight (tha^{-1})	
	2008	**2009**	Mean
Variety			
9022 – 13	2.10_a	2.30_a	2.20_a
BR9922-DMRSF$_2$	1.80_b	1.91_b	1.85_b
Agbor Local	1.20_c	1.43_c	1.31_c
Nutrient Source			
PM	1.50_b	1.73_b	1.61_b
CD	1.30_c	1.70_b	1.50_c
IF	2.30_a	2.20_a	2.25_a
Rates of application (tons or kg/ha)			
manure (tha^{-1}) 0	0.80_g	1.27_d	1.03_e
10	1.10_f	1.52_c	1.31_d
20	1.80_e	1.98_b	1.89_c
30	2.10_c	2.19_b	2.14_c
IF ($kgha^{-1}$) 150	2.00_d	2.06_b	2.03_c
300	2.80_b	2.57_a	2.68_b
450	3.10_a	2.76_a	2.93_a

Means with the same letter(s) under the same column are not significantly different ($P \leq 0.05$) using Duncan Multiple Range test (DMRT).

Table 4: Effects of Interaction of Variety, Manure and Inorganic Fertilizer on Grain Weight of Maize in 2008 and 2009

Variety	**Nutrient Source**	**Rate**	**Grain weight (tha^{-1})**	**Grain weight (tha^{-1})**
9022-13	PM	0	1.0	1.2
		10	1.5	1.7
		20	2.4	2.4
		30	2.6	3.0
		Mean	**1.9**	**2.1**
	CD	0	0.6	0.8
		10	1.4	1.6
		20	2.2	2.5
		30	2.4	2.7
		Mean	**1.7**	**1.9**
	IF	0	1.5	1.4
		150	2.5	2.4
		300	3.2	3.8
		450	3.7	3.9
		Mean	**2.7**	**2.9**
BR9922-DMRSRF$_2$	PM	0	0.8	1.3
		10	1.3	1.6
		20	1.9	2.1
		30	2.2	2.0

		Mean	**1.6**	**1.8**
	CD	0	0.4	1.3
		10	1.0	1.5
		20	1.8	2.0
		30	2.3	2.3
		Mean	**1.4**	**1.8**
	IF	0	1.3	1.4
		150	2.1	2.4
		300	0.7	3.8
		450	3.4	3.9
		Mean	**1.9**	**2.9**
Agbor Local	PM	0	0.6	1.1
		10	0.8	1.3
		20	0.4	1.4
		30	1.7	1.6
		Mean	**1.1**	**1.4**
	CD	0	0.5	1.3
		10	0.7	1.4
		20	1.0	1.5
		30	1.6	1.6
		Mean	**1.0**	**1.5**
	IF	0	0.7	1.3
		150	1.5	1.4
		300	2.0	1.5
		450	2.2	1.7
		Mean	**1.2**	**1.5**
Variety			*	*
Manure type			*	*
Rate			*	*
Variety x manure type			*	Ns
Variety x rate			*	*
Manure type x rate			Ns	Ns
Variety x manure type x rate			Ns	Ns

Legend: * = significant at 0.05 level of probability, Ns = not significant

Discussion

Soil Physico-chemical Properties of the Experimental Site

The sandy loam texture of the experimental site may be attributed to the Parent Material (PM) from which the soil was formed and the climate of the area. The soil might be formed from sandstone and quartz parent materials. These impart sandy texture to the soils. The high sand content of the soil could be attributed to high content of quartz in the material (Brady and Weils, 1999). The weak acid nature of the soil of the area may be traced to the marked leaching of exchangeable bases resulting from the high rainfall associated with the environment and the dissociation of strong and functional group in the organic matter. This is in harmony with the findings of Esu (2001).

The low organic matter status of the experimental site could be attributed to the rapid decomposition of organic matter due to high solar radiation and moisture, this favours optimum microbial activities in the soil, It could also be attributed to the annual seasonal bush burning which tend to deplete organic matter accumulation in the soil (Landor, 199l).

The low level of total nitrogen could be due to high temperature. It could also be attributed to leaching of' nitrate by torrential rainfall prevalent in the environment (Olatunji *et al.*, 2007). The high level of' Phosphorus may be attributed to either of these reasons: (i) history of land use and cultural practices associated with the land use (that is, cropping of crops that do not take much P nutrient from the soil and the application of P organic fertilizers (Nnaji *et al.*, 2002 and Nnaji, 2008). (ii) The parent material from which the soil was formed may be rich in P minerals (Brady and Weils, 1999). (iii) The soil may not be highly acidic as to cause high level of fixation (Brady and Weils, 1999, Isirimah *et al.*, 2003 and Omokri *et al.*, 2007). The low values of exchangeable cations may be attributed to the leaching of bases from the solum due to high rainfall characteristics of the area. The low action exchange capacity could be attributed to the PM from which the soil was formed, and low organic matter (OM) content of the soil. The PM from which the soil was formed may be poor in basic nutrients. FMANR (1990) noted that soils of the study area was dominated by Fe oxide and Kaolinites. These clay minerals are low in basic cations (Brady and Weils, 1999). The exchangeable acidity was low possibly because of the cultural practices associated with the land use (that is, previous use of amendments to improve soil condition and enhance crop yield. The results, generally, are in harmony with the findings of Osaretin *et al.* (2006), Olatunji *et al.* (2007) and the results of soil fertility evaluation in the region. It is also consistent with the findings of Nnaji *et al.* (2002) and Nnaji, (2008) which reported that the history of land use and cultural practices affect soil conditions and crop productivity.

Nutrient Content (% dry matter) of Organic Manure used in the Study

The values of N, P and K were higher in poultry manure than in cattle dung used in the study possibly because poultry manure, especially those produced in deep litter or battery cage house, have more concentrated nutrient content compared with other types of animal manure. This is similar to the findings of Sharpley and Smith (1995), Lombin *et al.*, (1991), and Brady and Weils (1999) who reported that among the different sources of organic manure which have been used in crop production, poultry manure was found to be the most concentrated in terms of nutrient content. It is also in harmony with the findings of Subedi and Gerung (1991) and D1PA (2006) who reported that poultry manure has higher levels of N. P and K than cattle dung. It is also consistent with the findings if Ibeawuchi *et al.*, (2007) who reported higher levels of N. P and K in plots treated with poultry manure than in plots treated with other nutrient sources.

Effects of Variety, Organic Manure and Inorganic Fertilizer on Grain Weight of Maize

The superiority of hybrid variety 9022-13 over other varieties could be attributed to the yield advantage of hybrid varieties over other varieties. This is similar to the findings of Kim (1997) and Olakojo *et al.* (1998) who reported that hybrid varieties of maize have yield advantage of 25% and 50% over the best open pollinated varieties in Nigeria. It also agrees with the report of Obi (1999) that hybrid maize varieties possess such specials qualities as high yield, disease resistance, uniformity of flowering and ear placement, as well as ease of harvesting using combined harvester. The higher grain weight obtained from plants that received NPK 20:10:10 fertilizer over other plants may be attributed to its faster rate of mineralization and release of nutrients for plants' use. This is similar to the findings of Abiola and Aiyelaagbe (2005) who reported that inorganic fertilizer performed better than organic manure because inorganic fertilizer made their minerals easily available for plants' use. It is also similar to the findings of Akintoye and Olufolaji (2005) that made such reports on the growth and yield of cayene pepper. Higher rate of application of manure or inorganic fertilizer resulted in higher cob weight of maize possibly because of increased availability of nutrient elements in the soil. This is similar to the findings of Olarewaju and Showemimo (2003); Aliyu and Olarewaju (1996) who reported that the number of fruits, fruits yield and size increased as the nitrogen and phosphorus fertilizer levels increased in the soil pepper. Plants that received poultry manure had higher grain weight than plants that received cattle dung. This supports the report of Lombin *et al.* (1991) which rated poultry manure best among the different source of organic manure because its nutrient content are more concentrated and supplied in readily absorbable form.

Conclusion and Recommendations

The study was carried out to evaluate the response of grain weight of maize to variety, organic manure and inorganic fertilizer in Asaba area of Delta State. It was a factorial experiment carried out in a Randomized Complete Block Design (RCBD) with three replicate. The result showed that hybrid variety 922-13 was superior in grain weight of maize and was therefore recommended to be grown in the study area. Also, it was recommended that 450 kgh^{a-1} of NPK 20:10:10 which resulted in higher grain weight be adopted by farmers who prefer mineral fertilizers in maize production.

References

Abiola I. O. and Aiyelaagbe I. O. (2005). Comparative investigation on the influence of organic and inorganic fertilizers on the growth of *Passifola edulis var (flavicarpa). In Horstson Abstracts 2005 23rd Annual conference on September 16-22 at* Port Harcourt River State. 37.

Adepetu, I. O., Akirinade, O. E. and Azeaz, J. O. (2005). Influence of combined application of cattle manure and NPK fertilizer on soil chemical properties, growth and yield of Okra *(Abelmoschus esculentum)* in Alfisol. *Proceedings of the 29th Annual*

Conference of the Soil Science Society of Nigeria, December 6-10, 2004, University of Agriculture, Abeokuta, Nigeria. Pp. 143-146.

Agbato, S. O. (2003). Principles and Practices of crop production. Odumatt press publisher, Oyo, pp. 57-62.

Akintoye, H. A. and Olufolaji, A. O. (2005). Effect of different levels of organic mineral fertilizer on the growth and yield of Cayenne pepper grown in South Western Nigeria. In HORSTON Abstracts 2005 of 23rd Annual conference held on September 16-22 at Rivers State p. 35.

Aliyu, L. and Olarewaju, J. D. (1996). Response of pepper *(Capsicum annum L)* to fertilizers: growth, yield and yield components as affected by nitrogen and phosphorus levels. *In proceedings of 14th HORTSON conference, Ago-Iwoye, 1-4 April, 1996* pp 5, 82-87

Allessi, J. and Power, J. F. (2004). Effect of plant population, row spacing and relative maturity on dry land corn in the Northern plans. *Agronomy Journal*, 66(2): 316-319.

Anderson, J. M. and Ingram, J. S. (1996). A hand book of Methods of Analysis CAB International Pp. 38.

Ayodele, O. J. (1993). Further yield responses of tomatoes *(Lycopersicum esculentum)* to fertilizer application *Research Bulletin* No. 16. national Horticultural Research Institute, Ibadan, Nigeria.

Azam, S., Ali, M., Amin, M., Bibi, S. and Arif, M. (2007). Effect of plant population on maize hybrids. *Journal of Agricultural and Biological Science*, 2(1): 104 – 111.

Bowles, J. E. (1992). Engineering properties of soils and their management. 4th (ed). McGraw Hill Publishers, Boston, U.S.A. p 241.

Brady, C. and Weils, R. R. (1999). Nature and properties of Soil Twelfth Edition, Prentice Hall, New Delhi, pp. 74 –114.

Day, R. R. (1965). Particle fraction and particle size analysis. In C.A. Black (ed). Methods of soil Analysis. Part 1. American Society iof Agronomy, A.S.A. Monography 9: 545-567.

DIPA (2006). Handbook of Agriculture: facts and figures for farmers, students and all interested in farming. Directorate of Information and Publications of Agriculture. Indian Council of Agricultural Research, New Delhi, p. 435.

Dutt, S. (2005). A Handbook of Agriculture. ABD Publishers, India, pp. 116-118.

Enujeke E. C. (2013). Effects of Variety and Fertilizers on Number of Grains/Cob of Maize in Asaba Area of Delta State. *Asian Journal of Agriculture and Rural Development*, 3(4): 215-225

Esu, I. E. (2001). Pedological characterization of soils of Alluvial complex of Nigeria. Ibadan. *Pedological handbook* 171-190

FAO (2003). Fertilizer and the future. *IFA/FAO Agriculture Conference on Global food security and the role of Sustainability Fertilization.* Rome, Italy. 16th-20th March, 2003, pp 1-2.

Fayenisin, O. (1993). Search for Improved maize varieties for farmers in Nigeria. *3rd National Workshop of Maize Centre. NASPP, Ibadan December, 6th - 10th 1976.*

Hamayun, M. (2003). Effect of spacing and weed free periods on the productivity of

Maize (*Zea mays L.*). *Pakistan Journal of Weed Science Research,* 9(3&4): 179-184.

Ibeawuchi, I. I., Opara, F. A., Tom, C. T. and Obiefuna, J. C. (2007). Graded replacement of inorganic with organic manure for sustainable maize production in Owerri Imo State, Nigeria. *Life Science Journal,* 4(2): 82-87.

Iken, J. E. and Anusa, A. (2004). Maize Research and Production in Nigeria. *African Journal of Biotechnology,* 3(6): 302-307.

Iken, J. E., Anusa, A. and Obaloju, V. O. (2001). Nutrient Composition and Weight Evaluation of some Newly Developed maize Varieties in Nigeria. *Journal of Food Technology,* 7: 25-28.

Isirimah, N. O., Dickson, A. A. and Igwe C. (2003). Introductory soil Chemistry and Biology for Agriculture and Biotechnology. Asia International Publishers Limited, Port-Harcourt, Nigeria, pp. 103

Ismail, A. S., El-Schaay, A. S., Salehu, S. A., and Abdel-Wahab, A. F. (1999). Effect of application of mineral and organic amendment of nodulation of cowpea growth and certain chemical properties of calcareous soil. *Ann. Agric. Sci.* (Special Ed) pp. 23-39.

Kim, S. K. (1997). Achievement, challenges and future direction of hybrid maize research and product in B. Badu-Apraku, Akoroda M.O., Oedraw M. and Quin F. M. (eds). *Proceedings of Required Maize Workshop May 99-june 2, 1995. IITA Cotonou,* Benin Republic.

Landor, J. R. (1991). Brooker tropical soil manual. A handbook for soil survey in the tropics and subtropics. Longman Group. England. 106-144.

Lombin, L. G., Adeputu, J. A. and Ayetade, K. A. (1991). Complementary use of organic manures and inorganic fertilizers in arable crop production. *Proceeding of National organic fertilizer seminar held in October 20th -22nd at University of Ibadan,* Ibadan. Pp 146 -162.

Mclean, E. O. (1982). Aluminium. In C.A. Black, (ed) Methods of soil analysis part 2. American Society of Agronomy, ASA Monograph 9: Pp 978-998.

Meteorological Office Asaba (2003). Weather Characteristics of Delta State of Nigeria. Unpublished Vol. 2 p 2-21.

Movahedi, S.A. R. and Cook, H. F. (2000). Influence of municipal compost on temperature, water, nutrient status and the yield of maize. In a Temperate Soil. *Soil use and Management,* 16(3): 215-221.

Murphy, S. D., Yakubu Y., Weise, S. F. and Swanton, C. J. (1996). Effects of planting patterns and intra-row cultivation on competition between corn (*Zea mays*) and late emerging weeds. *Weed Science,* 44: 864-870.

Nest-Nigerian Environment Study Action Team (1991). Nigerian threatened environment: A National Profile, p 288.

Nnaji, G. U. (2008). Fertility status of some soils in Isoko South Local Government Area of Delta State. *Proceedings of the Annual Conference of the Agricultural Society of Nigeria* held n Ebonyi State University, Abakiliki Pp 515-519.

Nnaji, G. U., Asadu and Mbagwu, J. S. C. (2002). Evaluation of the physico-Chemical properties of soils under selected agricultural land utilization types. *Journal of Tropical*

Agriculture, Food, Environment and Extension, 3: 27-33.

Obi, I. (1999). Maize: Its Agronomy, Diseases, pests and Food values. Optimal Computer Solution Limited Enugu pp. 106-108.

Odeleye F. O. and Odeleye, M. O. (2001). Evaluation of morphological and agronomic characteristics of two exolic and two adapted varieties of tomato *(Lycopersicom esculentum)* in South West Nigeria. *Proceedings of the 19th Annual Conference of HORTSON.(1):140-145.*

Olakojo, S. A., Ogundodede, B. A. and Kogbe, J. O. S. (1998). Evaluation of Maize *(Zea mays)* Top crosses in a Rainforest Location. *Biose res. Comm*. 11(2): 141-146.

Olanikan, P. C. (2006). Organic manures as Soil Amendment in Eroded Tropical Soil of South Western Nigeria. In Soil and Nutrition. *Journal of Tropical Soils,* 5:11-18.

Olarewaju, J. U. and Showemimo, F. A. (2003). Response of pepper to nitrogen and phosphorus fertilization in Northern Nigeria. *In Proceedings of the 21st Annual conference of the Horticultural Society of Nigeria* 2003. November 10-13th pp. 28-30.

Olatunji, C. A., Ighodo, and Igiri, J. N. (2007). Soil survey report of the Niger Delta. Federal Government Action of the Niger Delta 158.

Olayinka, A. (1996). Carbon Mineralization from Poultry Manure Straw Sawdust amended alfisol. *Ife Journal of Agriculture* 1 and 2, (18): 26-36.

Olayinka, A., Adentunyi, A. and Adebayo, A. (1998). Effect of organic amendment on nodulation and nitrogen fixation of cowpea. *Journal of Plant Nutrition*, 21(11): 2455-2464.

Omokri, J. I., Nnaji, G.U. and Uyovbisere, E. O. (2007). Assessment of the physical properties of Orogodo basin and the surrounding soils in in Agbor, Delta State. Proceedings of the 31st Conference of Soil Science Society of Nigeria held on the 13th – 17th November, 2006 at Ahmadu Bello University, Zaria, Nigeria Pp 358-362.

Osaretin, A. U., Jedeki, F. C. and Odingo, F. M. (2006). Fertility status and classification of some tropical soil cateria. *Tropical soils,* 31(24): 38-52.

Reijnties, C., Hoverkork, B. and Water-Bayer, A (1992). An introduction to Low External-Input and Sustainable Agriculture. John Wiley and Sons. London. p. 340.

Sharpley, A. N. and Smith, S. J. (1995). Nitrogen and phosphorus forms in soil receiving manure. *Soil Science,* 159: 253-258.

Sobulo, R. A. and Babalola (1992). Improved organic fertilizer and soil condition. In Toward Efficiency Fertilizer use in Nigeria. Federal Ministry of Agriculture, Water Resources and Rural Development. Lagos pp. 90-110.

Sonetra, S., Borin, K. and Preston, T. R. (2002). Waste water from rubber processing as fertilizer for water spinach and forage cassava. http.www.utafoundation.org/utacanbod/msc99thes/sonintro.htm.

Stefan, T. (2003). Organic Agriculture: Sustainability market policies. CAB Organization for Economic Co-operation and Development p. 95.

Subedi, K. D. and Gurung, G. (1991). Soil fertilizer thrust towards sustainable agriculture: experience of Lumile Regional Agricultural Research centre. *In: Soil Fertility and Erosion Issues in the Middle Mountains of Nepal* pp. 81-82 IDRC, Otawa, Canada.

Sukanya, T. S., Nanjappa, H. V. and Ramachandrappa, B. K. (1998). Growth parameters and yield of babycorn as influenced by varieties and spacing. *Mysore Journal of Agricultural Science*, 32(4): 264-268.

Tolera, A., Berg, T. and Sundstol, F. (1999). The effect of variety on maize grain and crop residue yield and nutritive value of the Stover. *Journal of Animal feed Science and Technology*, 79(3): 165-177.

Wahua, T. A. T. (1999). Applied statistics for scientific studies. Afrika-Link Books, Nigeria, pp. 250 -287.

Walkely, A. and Black, I. A. (1945). An Examination of Detrigrareff methods for determining soil organic matter and proposed modification of the chronic and titration methods. *Soil Science*, 37: 29-38.