I.J.A.B.R, VOL. 3(3) 2013: 412-417 ISSN 2250 – 3560

INTERNATIONAL JOURNAL OF ADVANCED BIOLOGICAL RESEARCH

ECONOMIC EVALUATION OF MAIZE GRAIN YIELD PRODUCED WITH LIQUID ORGANIC 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 (Nigeria) from August to December in 2005 and repeated between March and July, 2006 to conduct an economic evaluation of maize grain yield produced with different rates and methods of application of liquid organic fertilizer. The study was conducted using split plot fitted into randomized complete block design with three replicates. The dilution rate of liquid organic fertilizer was 60 mls of the product to 15 litres of water. This was applied to maize foliage, topsoil, foliage and topsoil at the rates of 5 1/ha, 10 l/ha, 15 l/ha, 18 l/ha, 20 l/ha and 25 l /ha. The results obtained indicated that plants which received fertilizer on topsoil were superior in grain weight than other plants. Based on the findings of the study, it is recommended that liquid organic fertilizer application rate of 15 l/ha which produced dry grain yield of 5.0 t/ha from topsoil in 2005 with estimated revenue of ₦ 199,362, and grain yield of 5.4 t/ha from topsoil in 2006 with estimated revenue of ₦ 214, 362 be applied to maize plant for increased grain yield, high market value, high estimated revenue and optimum benefit cost ratio.

KEYWORDS: Economic evaluation, maize grain yield, liquid organic fertilizer, Asaba Delta State, Nigeria.

INTRODUCTION

Following wheat and rice, maize (*Zea mays*) ranks third most important cercal crop which has added great value to the lives of both man animals (F.A.O, 2002). It is consumed fried, boiled, roasted or fermented in Nigeria (Agbato, 2003). In developed countries, various industrial products are obtained from maize, including, syrup, corn sugar, corn oil, corn flour, starch and alcohol (Ihekoronye and Ngoddy, 1985) Maize constitutes a major part of livestock feed, and it is cherished by different species of animals such as cattle, poultry, pigs, sheep and goats (Rouanet, 1992*)*

Despite the numerous uses and high demand for maize in Nigeria, continuous cropping and declining soil fertility have continuously depressed yield obtained in farmers' field on yearly basis (Ojeniyi, 2000). This necessitates research into avenues for improving crop productivity through the use of such soil amendments as liquid organic fertilizers, organic manure or inorganic fertilizer. Organic manure harbours reptiles, possesses unpleasant odour, mineralizes slowly over long period of time, and are too bulky to be transported over long distance, especially where large hectarage of cropland is to be applied. Saber (1998) reported that inorganic fertilizers are not only costly and inaccessible to resource poor farmers, but lead to adverse environment, agricultural and health consequences. Liquid organic fertilizers are environmentally friendly fertilizers formulated from botanical extracts into liquid, readily absorbed soluble state that promotes healthy plant growth and development because they are fortified with nutrients (Danbara and Green Planet, 2003).Some advocates of organic farming believe that food produced with liquid organic fertilizers is safer, more acceptable in some markets, and more nutritious than food produced from conventional farming (Schupan, 1974, Bockman *et al*., 1990)

Powerplant™ liquid organic fertilizer is highly suitable for growth and development of maize, rice, yam, cassava, potato and oil palm (Danbara and Green Planet, 2003).This study was carried out to assess the response of maize to liquid organic fertilizer. The specific objectives were to:

i. determine the best method of applying liquid organic fertilizer to maize.
ii. determine the best rate of liquid organic fertilizer for increased grain yield, high market value, high estimated revenue and optimum benefit cost ratio.

MATERIALS AND METHODS

Site description

The study was carried out in the Teaching and Research Farm of Delta State University, Asaba Campus from August to December, 2005 and repeated between March and July, 2006. 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 ITD 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 determines the climate condition of Asaba area of Delta State. Asaba is characterized by raining season between April and October, with annual mean-rainfall of 1500 mm and 2000 mm 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^{o}C with 37.3^{o}C as maximum. Relative humidity is 77.2 %, the mean monthly soil temperature at 100m depth is 20.3 ^{o}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 (Landon, 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 K. Jeldah distillation method as described by Landon (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 Landon (1991).

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

Seed procurement and viability test

Hybrid maize seed (Oba Super 2) was obtained from Premier seed and viability test was carried out.

Land preparations and plots layout- The land was cleared using cutlass, tillage was done using plough and harrow. Plots were laid out according to the treatments.

Experimental design

The experiment was carried out using Split plot fitted into Randomized Complete Block Design (RCBD) replicated three times. The main plots were occupied by the methods of application, while the subplots were allotted the different levels of liquid organic fertilizer. The main plot treatment and subplot treatments are listed below.

Methods of application of liquid organic fertilizer

(1) Foliar application
(2) Topsoil application
(3) Foliar + Topsoil application

Subplot- Rate of liquid organic fertilizer application (l/ha)

(1) 5
(2) 10
(3) 15
(4)18 control (Danbara and Green Planet International, 2003)
(5) 20
(6) 25

Dilution rate – liquid organic fertilizer was diluted at the ratio of 60 ml of product to 15 litres of water (1 ml of liquid organic fertilizer to 250 ml of water)

Planting – sixty stands of maize were sown per-subplot measuring 7.88 m^{2} at spacing of 75 cm X 25 cm, giving a plant population of 5.33 plants/m^{2}

Application of liquid organic fertilizer: Liquid organic fertilizer was applied to maize foliage, topsoil, foliage and topsoil at three weeks and six weeks after solving using land sprayer.

Weeding: weeding was done three times using hoe.

Date sampling and collection.

Twenty-six middle stands were used as sample population. After harvesting and shelling, dry weight of seeds was measured using a weighing scale.

Statistical analysis – Data collected were subjected to analysis of variance using SAS (2010) and means were separated using Duncan Multiple Range Test.

RESULTS

Physico-chemical properties of the experimental site

The phvsico-chemical properties of the study area are shown in Table 1. The soil was predominantly sandy. The surface had more sand than the subsurface. Texturally, the experimental site was classified as sandy clay. The soil is generally acidic with a pH of 5.7. The organic matter and total nitrogen content were low with values of 0.12 gkg' and 0.O5 gk g^{-1}, respectively. The available P was equally low with a value of 9.3 mg kg. The exchangeable cations were low in status with values of 1.86 cmol kg for Ca and 1.42 cmol kg' for Mg. The values obtained for K (0.07 cmol kg') and ECEC (8.45 cmol kg') were low. This could be attributed to low activity clay of the study area while the low values obtained with respect to Organic C, total Nitrogen and P were as a result of erosion that is predominant in the area and subsequent leaching of the nutrient beyond the root zone.

TABLE 1: Physico-chemical properties of the experimental site

Soil properties	Value
Particles size distribution (%)	
Sand	66.3
Silt	26.3
Clay	7.4
Textural class sandy clay	
Soil pH (H_20)	5.7
Org. C (g Kg^{-1})	0.05
Total N (gkg^{-1})	0.12
Available P ($mgkg^{-1}$ soil)	9.3
Exchangeable cations (cmol kg^{-1})	
Ca	1.86
Mg	1.42
K	0.07
Na	0.12
ECEC (cmol kg^{-1})	8.45
Base saturation (%)	41.1

Legend: % = Percentage, H_20 = Water, Org. C = Organic carbon, gkg^{-1} = gram per kilogram, N = Nitrogen, P = Phosphorus, mgkg-1 =Milligram per kilogram, cmol kg^{-1} = centimole per kilogram,Ca = Calcium, Mg = Magnesium, K = Potassium, Na = Sodium, ECEC = Exchangeable Cation Exchange Capacity.

TABLE 2. Market value and estimated revenue from maize grain yield of various rates of application of liquid organic fertilizer in 2005.

	Treatment	Maize grain yield (t/ha)	Market value of grains (₦)	Cost of LOF used (₦)	Estimated revenue (₦)	Benefit cost ratio
	Rates of LOF (l/ha)					
Foliar	5	2.8	140, 000	3,546	136, 454	39:1
	10	3.5	175, 000	7,092	167, 908	24:1
	15	4.2	210, 000	10,638	199, 362	19:1
	18	3.2	160, 000	12,765	147, 235	12:1
	20	3.9	195, 000	14, 184	180, 816	13:1
	25	3.8	190, 000	17, 730	172, 270	10:1
	Mean	3.5	175, 000	109, 925	116, 299	10:1
Topsoil	5	3.4	170, 000	3,546	166, 454	50:1
	10	3.5	175, 000	7,092	167, 908	24:1
	15	5.0	250, 000	10, 638	239, 362	23:1
	18	4.2	210, 000	12, 765	197, 235	16:1
	20	3.6	180, 000	14, 184	165, 816	12:1
	25	4.0	200, 000	17, 730	182, 270	10:1
	Mean	3.9	195, 000	109, 925	186, 508	23:1
Foliar + Topsoil	5	3.6	180, 000	3,546	176, 454	50:1
	10	3.4	170, 000	7,092	162, 908	23:1
	15	4.4	220, 000	10, 638	209, 362	20:1
	18	2.8	140, 000	12, 765	127, 235	10:1
	20	3.1	155, 000	14, 184	153, 816	11:1
	25	3.2	160, 000	17, 730	142, 270	8:1
	Mean	3.4	107, 833	109, 925	162, 008	20:1

Legend: + Market value of grains (₦) = ₦ 50, 000/ton
+ Cost of LOF (₦) = ₦ 1, 000/litre

Market value and estimated revenue from maize grain yield of various methods and rates of application of liquid organic fertilizer

The market value and estimated revenue from maize grain yield of various methods and rates of application of liquid organic fertilizer is shown in Table 2. In 2005, (Table 2) plants that received liquid organic fertilizer application rate of 15 l/ha had the highest grain yield (5.0 t/ha on topsoil, 4.4 t/ha on Foliar +topsoil, 4.2 t/ha on Foliar. Plants that received 5 l/ha had the lowest grain yield of 2.8 t/ha on foliar and 3.4 t/ha on topsoil, while plants that received fertilizer rate of 18 l/ha on Foliar + topsoil had the lowest grain yield of 2.8 t/ha. With respect to market value of grains in 2005, plants produced with liquid organic fertilizer application rate of 15 l/ha had the highest market value (₦250,000 from the topsoil dressed plants, ₦ 210,00 from Foliar dressed plants, and ₦220,000 from Foliar + topsoil dressed plants. Plant that received 5 l/ha of fertilizer had lowest market value of ₦140,000 from foliar dressing and N170,000 from the topsoil dressing. Plants dressed with 18 l/ha of fertilizer on Foliar + topsoil had ₦140, 000 (an equivalent value with those that received 5 l/ha on foliar)

The estimated revenue from plants that received 15 l/ha of liquid organic fertilizer was highest with all the methods and rates of application (foliar ₦199, 362, topsoil ₦239, 362, foliar + topsoil ₦209, 362).The lowest estimated revenue in 2005 were ₦136, 454 from 5 l/ha on Foliar, ₦166, 454 from 5 l/ha on topsoil and ₦127, 235 from 18 l/ha on foliar + topsoil. Though the benefit cost ratio of 5 l/ha was highest in all the methods, application rate of 15 l/ha had optimum value of 19:1 from foliar, 23:1 from topsoil and 20:1 from foliar + topsoil.

In 2006 (Table 3), the trend in superiority of grain yield of plants that received 15 l/ha by various methods, with their market values and estimated revenue did not change. Application rate of 15 l/ha had the highest grain yield of 5.4 t/ha from topsoil, with market value of ₦270, 000 and estimated revenue of ₦259, 362. This was followed by foliar + Topsoil method with grain yields of 4.7 t/ha, with market value of ₦235, 000 and estimated revenue of ₦224, 362. Foliar method application rate of 15 l/ha had grain yield of 4.5 t/ha, with market value of ₦225, 000 and estimated revenue of ₦214, 362. All the methods and rates of application compared, plants that received 18 l/ha and 20 l/ha of liquid organic fertilizer on foliar + Topsoil had the lowest market values of grains (₦160, 000 each), and lowest estimated revenue (₦147, 235 and ₦145, 816, respectively). The benefit cost ratio of using 15 l/ha application rate was also optimum in 2006, with values of 20:1 from foliar method, 24:1 from Topsoil, and 21:1 from foliar + topsoil.

TABLE 3. Market value and estimated revenue from maize grain yield of various rates of application of liquid organic fertilizer in 2006.

	Treatment	Maize grain yield (t/ha)	Market value of grains (₦)	Cost of LOF used (₦)	Estimated revenue (₦)	Benefit cost ratio
	Rates of LOF (l/ha)					
Foliar	5	3.3	165, 000	3,546	161, 454	46:1
	10	3.6	180, 000	7,092	172,908	24:1
	15	4.5	225,000	10,638	214,362	20:1
	18	3.3	165,000	12,765	152,235	12:1
	20	3.9	195,000	14, 184	180,816	13:1
	25	3.8	190,000	17, 730	172,270	10:1
	Mean	3.7	185,000	109, 925	175,674	21:1
Topsoil	5	3.8	190,000	3,546	186,454	53:1
	10	3.7	1895,000	7,092	177,908	25:1
	15	5.4	270,000	10, 638	259,362	24:1
	18	4.4	220,000	12, 765	207,235	16:1
	20	3.8	190,000	14, 184	171,816	12:1
	25	4.3	215,000	17, 730	197,270	11:1
	Mean	4.2	210,000	109, 925	200,008	24:1
Foliar + Topsoil	5	3.6	180,000	3,546	176,454	50:1
	10	3.5	175,000	7,092	167,908	24:1
	15	4.7	235,000	10, 638	224,362	21:1
	18	3.2	160,000	12, 765	147,235	12:1
	20	3.2	160,000	14, 184	145,816	10:1
	25	3.3	165,000	17, 730	147,270	8:1
	Mean	3.6	179,167	109, 925	168,174	21:1

Legend: + Market value of grains (₦) = ₦ 50, 000/ton
+ Cost of LOF (₦) = ₦ 1, 000/litre

DISCUSSION

Physico-chemical properties of experimental site

The sandy 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 acidic 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 favors 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 (Landon, 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 (Brady and Weils, 1999). 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 took much P nutrient from the soil and non application of P organic fertilizers (Nnaji, *et al*., 2002). (ii) The parent material from which the soil was formed may not be too 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). 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 cation 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 were dominated by Fe oxide and Kaolinites. These clay minerals are low in basic cations (Brady and Weils, 1999). The results, generally, are in harmony with the findings of Nnaji *et al*. (2002) which reported that the history of land use and cultural practices affect soil conditions and crop productivity.

Market value and estimate revenue from grain yield of various rates and methods of application of liquid organic fertilizer

Plants that received liquid organic fertilizer on topsoil out-yielded other plants, had higher market value, higher estimated revenue and optimum benefit cost ratio possibly because the fertilizer promoted microbial activities, enhanced nutrient uptake by plants, stimulated growth, and improve yield of maize. This is similar to the findings of Mekki *et al*. (1999), Panwar *et al*. (2000), Ghosh and Mohiuddin (2000) who reported that liquid organic fertilizer applied on topsoil promoted microbial activities, enhanced nutrient uptake by plants, stimulated growth and yield of the receiving plants. It is also consistent with the reports of Hedge (1999), and Ojeniyi (2000) that liquid organic fertilizers preserve the topsoil, encourage health population of beneficial insects that keep destructive organisms under control, and lead to increase crop productivity

Plant that received liquid organic fertilizer application rate of 15 l/ha out-yielded other plants, had higher market value, higher estimated revenue and optimum benefit cost ratio possibly because that rate was more compatible or appropriate to maize, and to Asaba agro-ecological condition. This is consistent with the findings of Danbara and Green Planet International (2003) who reported that liquid organic fertilizers are environmentally friendly, and so recommended distinct dilution rate based on Agro-ecological condition of the area.

CONCLUSION AND RECOMMENDATION

The study was carried out to conduct an economic evaluation of maize grain yield produced with different rates of liquid organic fertilizer. Four parameters were assessed to achieve the objectives of the study: dry grain weight, market value of maize, estimated revenue from dry grain yield of various methods and rates of liquid organic fertilizer, and benefit cost ratio of applying the different rates. From the result of the study it was noted that:

1) Soil applied fertilizers enhanced maize yield better than fertilizers applied by other methods
2) Higher grain yield was obtained at 15 l/ha than at other rates of application.
3) Market value and estimated revenue from plants that received 15 l/ha of fertilizer were highest
4) Application rate of 15 l/ha liquid organic fertilizer had optimum benefit cost ratio.

Based on the findings of the study, it was recommended that liquid organic fertilizer be applied on topsoil at the rate of 15 l/ha in Asaba Area of Delta State for increased grain yield, high market value, high estimated revenue and optimum benefit cost ratio.

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