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EFFECTS OF ABATTOIR EFFLUENT ON THE YIELD AND YIELD COMPONENTS OF MAIZE (*Zea mays*) IN FOREST-SAVANNA TRANSITIONAL ZONE OF EDO STATE, NIGERIA.

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ABSTRACT

Field experiment was carried out in the Forest–savanna Transition Zone of Ambrose Alli University, Ekpoma, Edo State, Nigeria to assess the effect of abattoir effluent on the yield and yield components of maize (*Zea mays*). The soil used for the experiment was analyzed for both its physical and chemical properties while the effluent used was also analyzed for its chemical properties before the experiment. The abattoir effluent had five levels (0, 2,025; 4,050 ;8,100 and 12,150 L/ha) fitted into Randomized Complete Block Design and replicated three times, maize variety Swan-1 was used as a test crop. Results obtained revealed that all the vegetative traits; plant height, number of leaves per plant, stem girth and total ear leaf area were significantly enhanced at 2 WAP while only stem girth was significantly enhanced at 6, 8, 10 and 12 WAP. Optimum maize grain yield of 6.8 t/ha was obtained from the application of 4,050 l/ha abattoir effluent.

INTRODUCTION

In Nigeria, inventory of industrial and urban wastes as compiled by Sridar (2006) showed that millions of tons of industrial, domestic and animal wastes are produced annually in the country and that these wastes can be utilized effectively for agriculture.

Abattoir effluent is an organic waste that originates from killing of animals, hides removal or deharing, paunch handling, rendering, trimming, processing and clean-up operations. The waste contain blood, grease, inorganic and organic solids, salt and chemicals added during processing operations (Mason, 1981). Some studies have shown that the application of organic wastes such as effluents, compost and sewage sludges to soils increase plant growth. However, excessive application of effluents to the soils may inhibit any benefit that could have been derived from such materials or induce undesirable soil damage as well as food-water pollution (Isirimah, 2002). Osaigbovo and Orhue (2006) stated that pharmaceutical effluent enhanced collar girth and leaf area while plant height as well as the number of leaves were depressed when compared to the control. They further indicated that high nutrient contents in the effluent did not reflect in the general growth of maize plant. Similar findings was earlier reported by Oghoghodo *et al.* (2003) using cassava mill effluent. Orhue *et al.* (2005) also reported positive growth response in maize after brewery effluent amendment of the soils while Cereti *et al*. (2004) observed that the beneficial effects of olive mill were highest when fermented repeatedly. However, Ayodele and Omotoso (2008) discovered that the respective single nutrients gave higher dry matter yields of maize than the control treatment in the greenhouse, with N and Mg as the best followed by K, Zn and P.

Adediran and Banjoko (1995) reported that the yield of maize varies from variety to variety, location to location and also depends on the availability of essential factors such as soil nutrient status and application of fertilizers. It was noted that the higher yields in the guinea savanna compared to forest zone was caused by higher solar radiation, photosynthetic rates and less incidence of diseases and insect attack that were characteristic of southern zone. Osemwota (2010) recommended 125 ml/kg soil of abattoir effluent for improving the fertility of soils and for optimum crop production. However, more studies are required even as literature is scanty. The aim of this study therefore, was to assess the effects of abattoir effluent on the vegetative traits, dry matter and grain yields of maize in the forest-savanna transitional zone of Edo state.

MATERIALS AND METHODS

Study area: The experiment was carried out in Teaching and Research Farm of Ambrose Alli University, Ekpoma, Edo State. Ekpoma is situated at about 85 km North of Benin City and South of Auchi in Edo State. It is located between latitude $6^0 41\,^1$N - $6^0 49\,^1$N and Longitude $6^0 00\,^1$E - $6^0 14\,^1$E. The study area is Rainforest/savanna Transition Zone which had been degraded to secondary forest as a result of shifting cultivation and left to fallow for about 10 years.

Collection of samples: Abattoir effluent (ABAE) was collected from a slaughter house along Benin-Auchi Express Road, Ekpoma. Maize seeds (Variety Swan-l) were collected from ADP, Benin–City while composite surface soil (0-15cm) samples were collected from Teaching and Research Farm of Ambrose Alli University, Ekpoma, Edo State.

Experimental Methods: A total of 15 plots cultivated with maize each measuring 2.25 m^2 were used for the study. Abattoir effluent was applied after land preparation at treatment rates of 0; 2, 025; 4, 050; 8,100 and 12,150 L/ha. Application of effluent was done by spreading the effluent uniformly on plot surfaces. Plots were left for 3 weeks before planting. These treatments were fitted into Randomized Complete Block Design and replicated three times. Maize seeds were sown at a spacing of 75 cm x 25 cm between and within rows. The seedlings were later thinned to one at two weeks after planting. There were twenty plants per plot and five plants per row. Growth parameters such as plant height, number of leaves, stem girth and leaf area were determined at 2, 4, 6, 8, 10 and 12 weeks after planting. At silking, two – three ear leaves were sampled from the middle rows for determination of the nutrient contents. The ear-leaves were oven dried at 70 ^{0}C for 48 hours and then weighed. Also at maturity, only the cobs in the middle rows were harvested to prevent cross feeding. At the end of the experiment, the maize cobs were harvested from each of the plots and weighed. The maize grains were shelled from the cobs and dried to 12 % moisture content and weighed in order to determine grain yield.

Soil sample collected was analyzed for its physical and chemical properties. The sample was first air dried at a room temperature, mixed and crushed gently with a wooden rolling pin to fine size particles. The sample was then passed through a 2 mm sieve and analyses were done using standard laboratory procedures. Soil pH was determined by a glass electrode pH method (IITA, 1979). Exchangeable cations were extracted with IN NH_4OAC at pH 7. Calcium and Magnesium were determined by titrimetric method (Jackson, 1982) while Na and K were read on flame photometer (Oshome, 1973). Exchangeable acidity ($H^+ + Al^{3+}$) was determined by titration method (Anderson and Ingram, 1993).

Table 1: Physico-Chemical Properties of the Soil Used for the Experiment before Application

Parameters	Value
pH	4.77
Organic carbon (g/kg)	12.32
Organic matter (g/kg)	21.24
Total Nitrogen (g/kg)	0.93
C:N	13.1
Available P (mg/kg)	60.72
Exchange cations (cmol/kg)	4.32
Exchangeable Mg	1.92
Exchangeable K	0.18
Exchangeable Na	0.40
Exchangeable acidity (cmol/kg)	
Hydrogen (H^+)	1.10
Aluminium (Al^{3+})	0.40
ECEC (cmol/kg)	8.32
Available micronutrients and heavy metals(mg/kg)	
Fe	3.26
Zn	31.60
Cu	1.59
Pb	0.09
Ni	0.48
Cr	4.36
Mn	0.98
Cd	0.99
Particle size (g/kg)	
Sand	908.00
Silt	66.00
Clay	26.00
Textural class	Sand

Effective Cation Exchange Capacity (ECEC) was determined by summation of exchangeable bases and exchangeable acidity. Micro-nutrients (Zn, Fe, Mn and Cu) and heavy metals (Pb, Cr, Ni and Cd) were determined using the method of Novosamsky *et al.* (1983). Particle size was determined by the hydrometer method (Bouy-oucos, 1981). Organic carbon was determined

Table 2: Chemical properties of the effluents used for the experiment.

Parameters	Abattoir Effluent (ABAE)
pH	7.60
Ava. P (mg/L)	112.00
Total N (mg/L)	0.56
Exchangeable cations (mg/L)	
Ca	947.00
Mg	317.00
K	250.00
Na	659.15
Available micro nutrients and heavy metals (Mg/L)	
Mn	338.55
Fe	215.50
Zn	96.65
Cu	28.11
Pb	1.10
Ni	2.98
Cr	2.35
Cd	0.08

Ava. P: Available P.

Table 3: Effects of abattoir effluent (ABAE) on mean vegetative traits of maize at 2 WAP in the field.

Treatment ABAE (L/ha)	Plant height (cm)	Number of leaves/Plant	Stem girth (cm)	Total Earleaf Area (cm^2)
0	28.92b	5.67b	0.53ab	184.10^{b}
2,025	26.65b	5.17b	0.49ab	180.50^{b}
4,050	27.68b	5.50b	0.53ab	177.60^{b}
8,100	33.28ab	5.67b	0.43b	226.85^{ab}
12,150	35.83a	6.33a	0.58a	293.05^{a}
LSD (P<0.05)	**6.71**	**0.64**	**0.14**	**91.20**

NS: Not Significant

Means within the same vertical column followed by the same letter(s) are not significantly different at 5% level.

Table 4: Effects of abattoir effluent (ABAE) on mean vegetative traits of maize at 4 WAP in the field.

Treatment ABAE (ml/kg)	Plant height (cm)	No of leaves/Plant	Stem Girth (cm)	Leaf Area (cm^2)
0	59.77	7.33	0.79	889.95
2,025	64.13	7.67	0.83	818.35
4,050	65.35	8.17	0.71	898.85
8,100	60.60	7.17	0.79	802.70
12,150	64.52	8.67	0.82	933.25
LSD (P<0.05)	**NS**	**NS**	**NS**	**NS**

NS: Not significant

Means within the same vertical column followed by the same letter(s) are not different at 5%level.

Table 5: Effects of abattoir effluent (ABAE) on mean vegetative traits of maize at 6 WAP in the field.

Treatment ABAE (L/ha)	Plant height (cm)	Number of Leaves/Plant	Stem girth (cm)	Total Earleaf Area (cm^2)
0	121.47	11.33	1.92ab	2,610.50
2,025	115.42	12.17	1.83ab	2,560.55
4,050	122.88	12.00	1.78b	2,872.10
8,100	141.13	13.00	2.37a	3,060.75
12,150	141.32	12.67	2.00ab	3,141.55
LSD (P<0.05)	**NS**	**NS**	**0.59**	**NS**

NS: Not significant

Means within the same vertical column followed by the same letter(s) are not significantly different at 5% level.

by Nelson and Sommers (1975) method. Total N and available P were determined according to method of Anderson and Ingram (1989). Abattoir effluent was analyzed for its chemical properties according to Rhoades (1982); Anderson and Ingram (1989).

RESULTS AND DISCUSSION

The physical and chemical properties of the soil before the application of effluent are shown in Table 1. The soil was acidic in nature which could be attributed to the nature of the parent material. Organic carbon and available phosphorus were high when compared with the criti-

Table 6: Effects of abattoir effluent (ABAE) on mean vegetative traits of maize at 8 WAP in the field.

Treatment ABAE(L/ha)	Plant height (cm)	Number of Leaves/Plant	Stem girth (cm)	Total Earleaf Area (cm^2)
0	160.17	12.83	1.73bc	2,841.80
2,025	178.57	12.67	1.72c	2,834.15
4,050	181.60	13.00	2.26ab	3,292.70
8,100	177.53	13.00	2.51a	3,356.45
12,150	181.97	13.33	2.34a	3,388.30
LSD (P<0.05)	**NS**	**NS**	**0.54**	**NS**

NS: Not significant

Means within the same vertical column followed by the same letter(s) are not significantly different at 5% level.

Table 7: Effects of abattoir effluent (ABAE) on mean vegetative traits of maize at 10 WAP in the field.

Treatment ABAE (L/ha)	Plant height (cm)	Number of Leaves/Plant	Stem girth (cm)	Total Earleaf Area (cm^2)
0	156.72	12.00	1.79ab	2,788.25
2,025	176.57	11.67	1.64b	2,729.55
4,050	174.30	12.50	2.03ab	3,354.35
8,100	174.13	12.17	1.97ab	3,266.75
12,150	183.70	12.00	2.13a	3,363.85
LSD (P<0.05)	**NS**	**NS**	**0.41**	**NS**

NS: Not Significant

Means within the same vertical column followed by the same letter(s) are not significantly different at 5% level.

cal levels of 10 g/kg and 15 mg/kg respectively given by Agboola and Ayodele (1987), Adeoye and Agboola (1985). Total nitrogen content in the soil was low when compared with the critical level of 1.5 g/kg given by Sobulo and Osiname (1981). Exchangeable calcium in the soil was above the critical level of 3.8 cmol/kg given by Agboola and Ayodele (1987). Exchangeable magnesium was adequate when compared with the critical level of 1.92 cmol/kg given by Agboola and Ayodele (1987). Exchangeable potassium was low when compared with the critical level of 0.2 cmol/kg given by Agboola and Ayodele (1987). The value of ECEC was also low. The soil was sandy which could be related to the parent material. Akamigbo and Asadu (1983) asserted that soil texture is related to the parent material. The chemical properties of the abat-

Table 8: Effects of abattoir effluent (ABAE) on mean vegetative traits of maize at 12 WAP in the field

Treatment ABAE (L/ha)	Plant height(cm)	Number of leaves/plant	Stem girth (cm)	Total Earleaf Area (cm^2)
0	157.42	11.67	1.75ab	2,468.00
2,025	176.98	10.17	1.63b	2,639.55
4,050	173.95	11.50	1.94ab	3,002.10
8,100	172.97	11.33	2.02ab	2,726.90
12,150	184.43	11.50	2.08a	2,868.95
LSD (P<0.05)	**NS**	**NS**	**0.41**	**NS**

NS: Not significant

Means within the same vertical column followed by the same letter(s) are not significantly different at 5% level.

Table 9: Effects of abattoir effluent (ABAE) on mean earleaf dry matter and Grain yields of maize in the field.

Treatment ABAE (L/ha)	Earleaf Dry Matter Yield (kg/ha)	Grain Yield (tons/ha)
0	6.31	5.48^{ab}
2,025	5.16	4.28^{b}
4,050	7.03	6.82^{a}
8,100	s6.66	6.49^{ab}
12,150	7.06	6.69^{a}
LSD (P<0.05)	**NS**	**2.53**

NS: Not Significant

Means within the same vertical column followed by the same letter(s) are not significantly different at 5% level.

tior effluent used are shown in Table 2.The effluent was slightly alkaline in nature.The heavy metals concentrations in the soil were within the permissible ranges, given by the European Community Regulation (Lacatusu et al., 2011) (Table 2).

Abattoir effluent (ABAE) significantly affected all the agronomic traits at 2 WAP (Table 3). The application of 12,150 L/ha abattoir effluent significantly increased plant height to 35.83 cm, number of leaves to 6.33 per plant , stem girth to 0.58 cm and total earleaf area to 293.05 cm^2, respectively when compared to 28.92cm obtained from the control. This finding is similar to Orhue *et al.* (2005b); Nwoko and Ogunyemi , (2010). At 4 WAP, abattoir effluent had no significant effect on the vegetative traits determined (Table 4). This finding is contrary to Osaigbovo and Orhue, (2006).

At 6 WAP, abattoir effluent had significant influence on stem girth alone (Table 5). The highest stem girth of 2.37 cm was obtained from the application of 8,100 L/ha abattoir effluent.

The effects of abattoir effluent on vegetative traits of maize at 8 WAP are shown in Table 6. Abattoir effluent had no significant influence on the above growth parameters at 8 WAP except stem girth where the highest stem girth was recorded at the application of 8,100 and 12,150 L/ha.

At 10 WAP, abattoir effluent also had significant influence on stem girth alone. The highest stem girth of 2.13 cm was obtained from the application of 12,150 L/ha abattoir effluent. This value was significantly different from what was obtained from the application of 2,025 L/ha abattoir effluent but not significantly different from that obtained from other treatments (Table 7). The highest stem girth of 2.08 cm was obtained from the application of the highest level of abattoir effluent at 12 WAP (Table 8). Similar observation was obtained at 10 WAP.

Effects of abattoir effluent on mean earleaf dry matter and grain yields of maize are shown in Table 9. There was no significant response of earleaf dry matter yield to different levels of ABAE application. The highest earleaf dry matter yield of 7.06 kg/ha was obtained from the application of 12,150 L/ha ABAE. This finding is similar to that of Nwoko and Ogunyemi (2010). There was a significant response of maize grain yield to different levels of ABAE application. The highest grain yield of 6.82 tons/ha was obtained from the application of 4,050 L/ha ABAE. This finding was in agreement with what was earlier reported by Osemwota *et al.* (2012), Kogbe and Adeniran (2003).

CONCLUSION

ABAE had significantly influence all the vegetative traits (plant height, number of leaves per plant, stem girth and leaf area) at 2 WAP but at 6 WAP to 12 WAP, the effluent only had positive and significant effect on only stem girth. Though, the effluent had no significant effect on dry matter yield, the highest dry matter yield of 7.06 kg/ha was obtained from the highest level of application of 12,150. However, abattoir effluent had a significant effect on the grain yield of maize with the application of 80 x 10^3 resulting in the yield of 6.82 t/ha. Nonetheless, it is expected that more studies be carried out to determine/assess the effects of abattoir effluent on soil fertility for crop production.

REFERENCES

Adediran, J.A. and Banjoko, V. A. (1995). Response of maize to N. P. and K fertilizers in the Savanna zone of Nigeria. *Communication in Soil Science and Plant Analysis* 26:593-606.

Adeoye, G.O. and Agboola, A.A. (1985). Critical levels for soil pH, available P, K, Zn and Mn and maize earleaf content of P, Cu and Mn in sedimentary soils of South- western Nigeria. *Fertilizer Research* 6: 65-71

Agboola, A.A. and Ayodele, O.J. (1987). Soil test calibration for upland rice in Southwestern Nigeria. *Fertilizer Research* 14. 227-234.

Akamigbo, F.O.R. and Asadu, C.I.A. (1983). Influence of Parent material in soil of South-western Nigeria. *East Africa Agriculture and Forest Journal* 44:525-534.

Anderson, J.M. and Ingram, P. (1989). *Topical Soil Biology and Fertility: A Handbook of Methods of Analysis.* CAB International. Walling-Ford, UK. Pp 38-39.

Anderson, J.M. and Ingram, J.S.I. (1993). *Tropical Soil Biology and fertility: A Handbook of methods.* CAB International. Walling-Ford, UK. p 35 2nd edition.

Ayodele, O. J and Omotoso, S.O. (2008). Nutrient management for maize production in soils of Savannah zone of South – western Nigeria. *International Journal of Soil Science,* 3:20-27.

Bouyoucos, G. J. (1981). Soil particle Size Analysis In: Okalebo, J.R., Gauthua, K.W. and Woomer P.L. (eds). *Laboratory Methods of Soil and Plant Analysis: A working manual* 2nd ed. pp 22-24.

Cereti, C.F., Rossini, F., Federici, F., Quaratino, D., Vassilev, N. and Fenice, M. (2004). Reuse of microbially treated olive mill waste water as fertilizer for wheat (*Triticum durum* Desf.) *Bioresource Technology* 91:135-140.

IITA. (1979). *Selected Methods for Soil and Plant Analysis.* Manual Series No. 1. International Institute of Tropical Agriculture, Ibadan, Nigeria pp 38-43.

Isirimah, N.O. (2002). *Understanding the nature, properties and sources of waste for quality environment.* Tom and Harry Publish Ltd. Port-Harcourt pp 14-172.

Jackson, M.L. (1982). *Soil Chemical Analysis*. Prentice Hall. New York pp 263-268.

Kogbe, J.O.S. and Adediran, J.A. (2003). Influence of nitrogen, phosphorus and potassium application on the yield of maize in the Savannah zone of Nigeria. *Africa Journal of Biotechnology* 2(10):345-349.

Lacatusu, R., Lundu, M. and Teodorescu, S. (2011). Heavy metals abundance in the soil of the *Pantelinum Branseti* area: Fe, Mn, Ni, Pb and Zn. *Present Environment Sustainable Development* 5 (2) : 55-65.

Manson, C.F. (1991). *Biology of Fresh water Pollution*. 2nd edition, Longman scientific and Technical. John Wiley and Sons, incopoted, New York. P. 351.

Nelson, D.W. and Sommers, I. E. (1975). A Rapid and Accurate Method for estimating organic carbon. In: *Soil Proceedings of the Indian Academy of Science* 84: 456-462.

Novosamsky, I., Houba, V.J.G., Eck Van R. and Vark Van, W. (1983). Novel digestion techniques for multi-element plant analysis. *Communication in Soil and Plant Analysis* 14: 239-249.

Nwoko, C.O. and Ogunyemi, S. (2010). Evaluation of palm oil mill effluent to maize (*Zea mays.* L) crop: yields/ tissue nutrient content and residual soil chemical properties. *Ausrialian Journal of Crop Science* 4 (1):16-22.

Ogboghodo, I.A., Iruaga, F.K., Osemwota, I.O. and Chokor, J.U. (2004). An Assessmentof the Effects of crude oil pollution on soil properties, germination and growth of maize (*Zea mays* L.) using two crude types forcados Light and Escravos Light. *Environmental Monitoring and Assessment* 96: 143-152.

Orhue, E.R., Osaigbovo, A.U. and Osahon, O. (2005). Rubber Effluent effects on some Chemical properties and Growth of *Dialium guineese* seedlings: *Journal of Sustainable Agricultural Environment* 7:69-82.

Orhue, E.R., Osaigbovo, A.U. and Nwoko, D.E. (2005b). Growth of maize (*Zea mays* L) and Changes in some chemical properties of an ultisol amended with brewery effluent. *African Journal of Biotechnology* 4(9): 973-978.

Osaigbovo, A.U. and Orhue, E.I. (2006). Influence of pharmaceutical effluent on some soil chemical properties and early growth of Maize (*Zea mays* L). *African Journal of Biotechnology* 5(12): 1612-1617.

Osemwota, I.O. (2010). Effect of abattoir effluent on the physical and chemical properties of soils. *Environmental Monitoring Assessment* 167: 399-404.

Osemwota, I.O., Isitekhale, H.H.E. and Bakare, A. (2012). Effects of abattoir effluent and sawdust on yield and yield components of maize. *Nigerian Journal of Soil Science*22: 50-51.

Oshome, J.F. (1973). Determination of P,K, Ca and Mg-Solution, FAFRO. *Methods of soil Analysis Chemistry Division, Mugaga* p 7.

Sobulo, R.A. and Osiname, A.O. (1981). Soils and fertilizer use in Western Nigeria. University of Ife Institute of Agriculture and Training. *Research Bulletin* 11 pp 193-203.

Sridar, M.K.C. (2006). Solid waste management in the twenty first century in Nigeria. In: *Proceedings of the Fourth Annual Conference of Senate on the Nigerian Environment, organized at Portharcourt by Senate Committee on Environment and Ecology,* National Assembly, July 5-7 (pp. 1-11). Abuja.