Evaluation of Some Manure Types for the Growth and Yield of Watermelon in Southwestern Nigeria.

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ABSTRACT: Extensive use of inorganic fertilizes has been discovered to have depressing yield effects on watermelon. This study was carried out at the Teaching and Research Farm of the Federal University of Technology, Akure (7^{0}16'E, 5^{0}12'E) located in the rain forest vegetation zone of Nigeria to evaluate the performance of watermelon grown under sub-optimal rates of application of three different types of manure. The treatment imposed were poultry manure at the rates of 4 t/ha, 6 t/ha, 8 t/ha and 10 t/ha; organic manure at the rates of 4 t/ha, 6 t/ha, 8 t/ha and 10 t/ha; organomineral fertilizer at the rates of 2.5 t/ha, 3.0 t/ha, 3.5 t/ha and 4.0 t/ha; and a control plot where no fertilizer was applied. Crops establishment was in October 2008 to 'catch' remaining moisture before the exit of rains on the heavy soils of southwestern Nigeria. This was a deviation from the conventional growing of the crop in Nigeria, as its cultivation has been confined to the drier savanna region of the country where, it is believed that the crop will do best in terms of growth and yield. Excellent yields were obtained with all the manures at the varying rates with even the control plots, which recorded the lowest yield having as high as 22.7 t ha^{-1}. This is an indication that the crop will do well in this region even with no fertilizer application. All the manure types used increased the growth and yield of watermelon with increasing application rates. This also proposes that higher yields could be expected from the soils of southwestern Nigeria if the rates of application of these manures are increased.
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INTRODUCTION

Watermelon is one of the world most important vegetables, as the crop is reared both for its fruit and the vegetative parts (Schippers, 2000), which are highly nutritious.

While some works indicate that watermelons do not have a large fertilizer requirement and that the crop can be grown with little or no fertilizer after heavily fertilized crops or on fertile lands (Graham and Gratte, 2005), other authors have reported the crop to be a heavy feeder of nitrogen and therefore requires a liberal application of 200kg/ha, NPK fertilizer, which needs to be applied two weeks before sowing, and to be followed by an application of nitrogenous fertilizer at 5 weeks interval up to flowering (Rice et al., 1994 , Schippers, 2000). This requirement can be adequately met by using inorganic fertilizers as they are the most important sources of nitrogen. However, extensive use of inorganic fertilizer has a depressing effect on yield. This causes reduction in number of fruits, delays and reduces fruit setting, which subsequently delays ripening, and leads to heavy vegetative growth (Aliyu *et* al., 2003; John *et* al., 2004). Management of mineral fertilizers has also become increasingly critical in crop production from both economic and environmental standpoint. The use of mineral fertilizer by farmers is limited because of scarcity, high costs and basic disadvantages in apparent inability to substantially redress the physical fragility and chemical deterioration of the soil (Adeniyan and Ojeniyi, 2005). This necessitates research on the use of organic wastes that are cheap, readily available and environmentally friendly that can be used as fertilizers (Ayeni et al., 2010).

Recently, research attention in tropical countries has shifted to the utilization of agro industrial and organic wastes which can pose environmental hazards if not converted to agricultural and economic uses (Ayeni, 2010). These materials include waste derived from city refuse, animal wastes and other plant residues. Studies carried out in Nigeria and elsewhere confirm poultry manure as effective nutrient sources for increasing yield and nutrient status of crops such as maize, amaranth, sorghum and pepper (Adeniyan and Ojeniyi 2005; Babatola *et al.* 2002; Aliyu *et al.*, 1992). Adenawoola and Adejoro (2005) also found out that organic matter and soil nutrients increased with application rate of poultry manure and therefore affirmed that poultry manure contains organic matter, N, P, K, Ca and Mg which are released into the soil upon decomposition of the manure, and that depletion of soil organic matter under intensive cropping can be amended by proper addition of poultry manure into the soil. The recent interest in organomineral fertilizers arose from high cost and scarcity of inorganic fertilizers, the huge amount of organic fertilizers required for crop production, and handling problems (Makinde et al., 2010). John et al. (2004) has advocated an integral use of organic manure and inorganic fertilizers for the supply of adequate quantities of plant nutrient required to sustain maximum crop productivity and profitability while minimizing environmental impact from nutrient use. Organomineral fertilizer is a low input technology of improving the nutrient status of tropical soils for sustainable crop production. They combine the attributes of both organic and inorganic fertilizers (Ayeni, 2008). Studies by Adeoye *et al.*, (2008), Fagbola and Ogundipe (2007) and Ojeniyi *et al.*, (2009) recorded responses of maize and pepper to organomineral fertilizers and Makinde et al. (2010) recorded that the use of organomineral fertilizer enhanced better growth in *Amaranthus Cruentus.*

Although the ability of organic manures and organomineral fertilizers to compete favourably with chemical fertilizers have no doubt been established for an array of tropical crops, it is still highly imperative to test their efficacies in deep nitrogen feeder crops like watermelon. Watermelon has no production history in Southwestern Nigeria as its cultivation has been confined to the drier savanna region of the country (Anon, 2006), where, is hitherto believed that the crop will do best in terms of growth and yield. This study therefore intends to gain an insight into the overall performance of watermelon (in terms of growth and yield) as affected by the application of varying rates of organic and organomineral fertilizers in the heavier soils of southwestern Nigeria.

MATERIALS AND METHODS

Field Experiment

The study was conducted at the Teaching and Research Farm of the Federal University of Technology, Akure (7016'E, 5012'E) located in the rain forest vegetation zone of Nigeria. The land used had been under fallow for four years and prominently infested with *Chromolaena odorata*. Table 1 shows the nutrient status at 5cm soil depth at the experimental site before sowing watermelon.

The experiment was laid out in a randomized complete block design with three replications. The treatment imposed were poultry manure at the rates of 4 t/ha, 6 t/ha, 8 t/ha and 10 t/ha; organic manure at the rates of 4 t/ha, 6 t/ha, 8 t/ha and 10 t/ha; organomineral fertilizer at the rates of 2.5 t/ha, 3.0 t/ha, 3.5 t/ha and 4.0 t/ha; and a control plot where no fertilizer was applied (Organic manure is an organic formulation made up of some agro industrial wastes by the Ondo State Ministry of Agriculture). Crops establishment was in October 2008 to 'catch' remaining moisture before the exit of rains. Field preparation was by tractor after which seed beds, each measuring 4m X 4m were manually prepared. The treatments (manure types at varying rates) were incorporated into the soil prior to sowing of watermelon seeds. The seeds used were obtained from an early maturing cultivar of watermelon and were sown 2 seeds per hole at the spacing 1m x 1m, which was later thinned to 1 plant per stand.

Table 1: initial soil analysis of the experimental site

Parameters	Soil sample
pH (H2O	5.5
Organic Matter %	1.82
Total N %	0.15
Available P(mgkg^{-1})	10.8
Exchangable K(cmolkg^{-1})	0.42
Exchangable Ca(cmolkg^{-1})	2.0
Exchangable Mg(cmolkg^{-1})	1.4
Sand %	52.8
Silt %	16.0
Clay %	31.2

Plant and Soil Analysis

The moisture content was determined by the method described by Pearson (1976), while the micro-Kjeldhal method (AOAC, 1995) was used to determine crude protein, ash, fat, and crude fiber contents. Composite soil samples collected after land clearing at the experimental site was air-dried, ground and sieved using 2mm sieve mesh. They were chemically analysed as described by Tel (1984). Organic matter was determined by wet oxidation method through chronic acid digestion. Nitrogen was determined by microkjeldahl approach, P was extracted by Bray-P1 solution and determined using ammonium acetate, K was determined using flame photometer, and Ca and Mg by EDTA titration method. Soil pH in ratio 1:2 water suspension was determined using a glass electrode.

Data Collection and Analysis

Data collection was from the third week after planting and the experiment was terminated at the eighth week after planting when the fruits were adjudged ripe enough haven attained full market weight. Growth parameters collected were: number of leaves, number of branches and vine length; while the number of pods per hectare and pod weight in kilogram per hectare was taken as yield parameters.

Data collected from the experiment were subjected to an analysis of variance and simple linear correlation and regression analysis between increasing application rate of the different types of manure used (X) and growth or yield parameters (Y) of the watermelon was performed with a scientific calculator (Casio *fx*-7400G PLUS POWER GRAPHIC Model).

RESULT AND DISCUSION

The soil at the project site was acidic, low in organic matter, N, K and Mg (Table 1). Exchangeable Ca was also marginal. The critical levels of pH and nutrient set for watermelon are pH 5.0 – 7.0, 70 – 110Kg N/ha, 30-55Kg K/ha and 30-50Kg P/ha (Yamaguchi, 1983). The critical levels of organic matter for crop production in Nigeria ecological zones were 3.0%, and the value of exchangeable Ca was 2.2 cmol/kg (Akinrinade and Obigbesan, 2000).

All the manures used at various levels increased vine lengths and leaf numbers of watermelon relative to the control. However, the highest values were recorded for these parameters in plots treated with organomineral fertilizers compared with poultry manure and organic manure treatments, with the control scoring the least. This could be due to enhancement of decomposition of the organic material and mineralization of nutrients especially N and P by the presence of mineral fertilizer in organomenerals. Makinde et al. (2010) observed similar increase in growth parameters of *Amaranthus cruentus* when both kola pod husk and city refuse plus cow dung were fortified with NPK fertilizer, and Ayeni *et* al. (2008) in the same vein detected similar increase in N and P when cocoa pod ash and poultry manure were respectively fortified with NPK fertilizer. The values recorded for all the growth parameters in the poultry manure treatments scored next and very close to those obtained in the organomeneral treatments. This is in line with the work of Adenawoola and Adejoro (2005) who found poultry manure to increase growth and yield of *Corchorus olitorius.*

All the three manures increased the growth parameters of watermelon with increasing rates of application. Regressing growth parameters (Y) against increasing rates of the manures show positive relationships with prediction equations shown in Table 3. This agrees with the findings of Ayeni et al. (2010) that plant height, number of leaves, leaf area as well as N, P and K were increased with increase in the level of poultry manure up to 30 t/ha.

Table 2. Effects of the different manures on the growth of watermelon

Type of manure	Application Rates (tha^{-1})	Vine length (cm)	Number of Leaves	Number of Branches
Organic Manure	4	66.4ab	17.2ab	1.8ab
	6	59.1ab	20.3ab	1.5ab
	8	66.6ab	23.1ab	1.5ab
	10	66.9ab	23.4ab	2.6a
Poultry Manure	4	59.9ab	17.4ab	1.3ab
	6	67.8ab	16.4ab	1.4ab
	8	68.9ab	20.1ab	1.3ab
	10	102.2a	27.0a	2.5a
Organomineral Fertilizer	2.5	65.7ab	16.1ab	1.4ab
	3.0	74.3ab	19.3ab	1.0ab
	3.5	78.5ab	24.1ab	2.0ab
	4.0	105.6a	27.3a	1.5ab
Control	0	48.6b	13.4b	1.3ab

Means in a column followed by the same letters are not significantly different by DMRT ($P<0.05$)

Table 3. Linear correlation and regression analysis between increasing rates of manure (X) and growth parameters of watermelon (Y) (n=4)

Manure type	Growth parameters	Correlation coefficient(r)	Regression equation
Organic manure	Vine length	0.31	$Y = 61.6 + 0.45X$
	Leaf number	0.95	$Y = 13.51 + 1.07X$
	Branch number	0.59	$Y = 1.01 + 0.12X$
Poultry manure	Vine length	0.88	$Y = 29.9 + 6.4X$
	Leaf number	0.88	$Y = 8.82 + 1.63X$
	Branch number	0.77	$Y = 0.4 + 0.18X$
Organomineral	Vine length	0.93	$Y = 0.49 + 24.78X$
	Leaf number	0.99	$Y = -3.26 + 7.68X$
	Branch number	0.41	$Y = 0.63 + 0.26X$

The effects of the three manures on the yield of watermelon also followed the same trend as the growth parameters. The regression of the number of pods and tones of watermelon per hectare against rates of manure application in table (3) indicate a perfect positive correlation. Organomineral fertilizer was also found as having the highest figures, followed by poultry manure while the control scored the least. This supports the works of many authors who have discovered the merits of combining organic and mineral fertilizers – as organomineral fertilizers. Kang and Balasubramanian (1990) suppoted by Babatola et al. (2002) on leafy vegetable suggested that high and sustained yield could be obtained with judicious and balanced NPK fertilizer combined with organic source of plant nutrients. Ipinmoroti et al. (2002) also indicated that quick mineralization of inorganic component and the slow nutrient release of the organic constituents of organominerals must have sustained the continous better performance of *A. cruentus* than their separate applications.

Table 4. Linear correlation and regression analysis between increasing rates of manure (X) and yield of watermelon in tones per hectare (Y) (n=4)

Manure type	Correlation coefficient (r)	Regression equation
Organic manure	0.95	Y = 22.59 + 1.18X
Poultry manure	0.80	Y = 21.28 + 1.29X
Organomineral	0.69	Y = 19.35 + 4.6X

Table 5: Effect of the different manures on the yield of watermelon

Type of manure	Application rates (tha^{-1})	Number of Fruits/ha	Average fruit weight (tha^{-1})
Organic manure	4	28,333abc	26.4cd
	6	24,167bc	30.7abcd
	8	29,167abc	32.7abc
	10	31,667ab	33.6abc
Poultry manure	4	23,333bc	28.1bcd
	6	25,833abc	25.5cd
	8	31,667ab	33.5abc
	10	33,333a	34.0abc
Organomineral fertilizer	2.5	30,000ab	33.6abc
	3.0	25,833abc	28.6bcd
	3.5	33,333a	36.3ab
	4.0	33,333a	38.7a
Control	0	20,833c	22.7d

Means in a column followed by the same letters are not significantly different by DMRT ($P<0.05$)

The lack of significant differences recorded in the values of the yield component of watermelon within the varying rates of application and among the different manures as shown in Tables (4,5) confirms the findings of Graham and Gratte (2005) that watermelons grow well on acid and alkaline soils and that watermelons can be grown anywhere in Western Australia but need a long warm to hot growing season. They however suggest lime application to soil with a pH below 5. The land has been left for some time to fallow under *Chromolaena odorata*, a popular weed that has given excellent soil nutrient rejuvenation both in fallow and as compost (Nawaz and Sansamma, 2004). Application of the manures, especially organominerals is therefore believed to have contributed to the release of the nutrient held in organic liters.

All the rates of manure application in this study appear sub-optimal relative to recommendations by some authors. For instance, Adenawoola and Adejoro (2005) found poultry manure at the previous application rates of 30 to 50 t/ha to give higher biomass, marketable and edible yields of *C. olitorius* compared to applications of 10 and 20 t/ha, and then went further to recommend the rate of 40 t/ha as best for the crop in southwestern Nigeria. Ayeni et al. (2010) also recommended the rate of 30 t/ha poultry manure to achieve optimum yield and N, P, K and Ca content of tomato plant. However, contrary to the expected culmination of these sub-optimum rates of application to low yields, the yield range of between 22.8 – 38.7 t/ha obtained from this study proved excellent when juxtaposed with certain other findings. Messiaen (1992) suggested a yield range of 10 to 20 t/ha while the yield proposed for growers by Graham and Grate (2005) is between 10 and 50 t/ha. This is in line with the findings of Graham and Gratte, 2005 that watermelons do not have a large fertilizer requirement and that the crop can be grown with little or no fertilizer after heavily fertilized crops or on fertile lands. They recommended further that heavy soils are preferred, as fertilizer costs are reduced as watermelons grown on a heavy soil following a good clover pasture may not benefit from top dressing.

The result of the effect of the different manures and rates of application on the proximate composition of watermelon is presented in Table (6). Organomineral application at 2.5 t/ha gave the lowest moisture content of 62.30% while the highest percentage of moisture was found in the control. This is an indication that all the manure used released some nutrients to the soil, which were in turn taken up by the crop. The highest percentage of protein was also recorded in plots to which organominerals were applied at the rate of 3.5 t/ha and lowest in the poultry manure treated plots. This suggests that N mineralization and subsequent availability for root uptake is highest in organomineral treated plots. As mentioned earlier, Ipinmoroti et al. (2002) noted that quick mineralization of inorganic component and the slow nutrient release of the organic constituents of organominerals must have sustained the continous better performance of *A. cruentus* than their separate applications. Despite the fact that organic manures especially poultry manure contain high percentages of nitrogen and phosphorus (Yayock and Awonubi, 1988), only one-fifth to half of the nutrient supplied by poultry manure are recovered by the first crops following application. Much of the remaining is held in humus-like compounds subject to very slow decomposition. In this form, the elements are released very slowly, rates of 2.4% per annum being common (Brady, 1987).

Table 6: Effect of the different manures on the moisture content and nutrient composition of watermelon

Type of manure	Application Rates (tha^{-1})	Moisture Content (%)	Protein (%)	Crude Fibre (%)	Ash (%)	Fat (%)	Carbohy-drate (%)
Organic Manure	4	65.7	1.6	1.5	4.0	2.4	24.7
	6	65.3	1.4	1.3	5.2	2.4	24.5
	8	68.4	1.8	1.1	4.8	2.4	20.5
	10	66.9	1.4	1.2	5.2	1.3	24.1
Poultry Manure	4	65.3	1.3	1.5	4.1	2.3	25.4
	6	75.3	1.4	1.3	4.1	3.4	14.5
	8	67.5	1.0	1.7	5.2	1.3	24.3
	10	65.4	1.1	1.3	5.0	2.4	24.9
Organomineral Fertilizer	2.5	62.3	2.1	1.9	5.3	3.4	23.6
	3.0	64.2	2.1	1.7	5.8	2.4	23.8
	3.5	65.0	2.2	2.0	5.0	2.5	23.5
	4.0	68.3	1.8	2.1	5.9	1.3	20.8
Control	0	74.3	1.2	0.5	4.1	1.4	17.6

CONCLUSSION

Excellent yields of watermelon were obtained with all the manure types at the varying rates with even the control plots, which recorded the lowest yield having as high as 22.7 t ha^{-1}. This is an indication that the crop will do well in this region even with no fertilizer applications. All the manure type used increased the growth and yield of watermelon with increasing application rates. This also proposes that higher yields could be expected from the soils of southwestern Nigeria if the rates of applications of these manures are increased.

REFERENCES

1. Adenawoola, A.R. and Adejoro, S.A. Residual effects of poultry manure and NPK fertilizer residues on soil nutrient and performance of Jute (*Corchorus olitorius* L.). Nigerian journal of soil science, 2005: Vol. 15: 133 -135.
2. Adeniyan, O.N and Ojeniyi, S.O. Effect of poultry manure, N.P.K 15:15:15 andcombination of the reduced levels on maize growth and soil chemical properties. Nigerian Journal of Soil Science, 2005: 15, 34-41.
3. Adeoye, G.O., Sridhar, M.K.C., Adeoluwa, O.O., Oyekunle, M., Makinde, E.A. and Olowoake, A.A. Comparative evaluation oforganomineral fertilizer and mineral fertilizer on yield and quality of maize. *Nigerian Journal of Soil science,* 2008: 18: 132 – 137.
4. Akinrinade, E.A and Obigbesan, G.O. Evaluation of the fertility status of selected soils for crop

production in five ecological zones of Nigeria. Proceedings 25th Annual Conference of Soil Science Society of Nigeria, Ibadan, 2000: Pp 279 – 288

5. Aliyu, L., Karikari, S.K. and Ahmed, M.K. Yield and yield components of egg Plant (*Solanum nigro* L.) as affected by date of transplanting, intra row spacing and nitrogen fertilization. Journal of Agricultural Science and Technology, 1992: 2 (1): 7 -12
6. Anons, A. Nasarawa state Agricultural Development Programme, Annual Crop Area and Yield Survey (CAYS), Lafia, Nasarawa state, 2006
7. AOAC. Official method of analysis of the association of official analytical chemist, 1995
8. Ayeni, L.S. Integration of cocoa pod ash, poultry manure and NPK 20:10:10 fertilizer for soil fertility management – Incubation study. Continental Journal of Agronomy, Nigeria, 2008: 2:25 – 30.
9. Ayeni, L.S., Adetunji, M.T., Ojeniyi, S. O., Ewulo, B.S. and adeyemo, A.J. Comparative and cumulative effects of cocoa pod husk ash and poultry manure on soil and nutrient content and yield of maize. American-Eurasian Journal of sustainable Agriculture, 2008: 2(1): 92 - 97
10. Ayeni, L.S. Effect of combined cocoa pod ash and NPK fertilizer on Soil Properties, nutrient uptake and yield of Maize. Journal of American Science, 2010: 6(3): 79 – 84
11. Babatola, L.A., Adebayo, O.B. and Lawal, O.I. Effects of different rates of poultry manure and NPK on performance of *Celosia argentia. Proceeding of Horticultural Society of Nigeria, Ibadan.* 14-19, May 2002: pp. 54-56.
12. Fagbola, O and Ogungbe, P.N. Growth and yield response of some maize cultivars to organomineral fertilizer application in simulated degraded soil under greenhouse condition. Nigerian journal of soil science, 2007: 7: 87 – 93.
13. Graham, M and Gratte, H. Farmnote : Australia Department of Agriculture, 2005: No 75/94.
14. Ipinmoroti,R.R. and Adeoye, G.C. Effect of organic and NPK fertilizers on tea (Camellia sinesis) performance on a humid lowland ecological area of South western Nigeria. *Proceedings of Horticultural society of Nigeria Confrence*, Ibadan, Nigeria, 2002: Pp.69-74.
15. John, L.W., Jamer, D.B., Samuel, L.T and Waner, L.W. Soil fertility and fertilizer: an introduction to nutrient management. Pearson Education. India, 2004: 106-153pp
16. Kang and Balasubramaniam, V. Long term fertilizer trial on Alfisols in West Africa In: *Transactions of XIV International Soil science Society* (ISSS) Congress, Kyoto Japan, 1990: 350pp.
17. Makinde, E.A., Ayeni, L.S. and Ojeniyi, S.O. Morphological Characteristics of *Amaranthus cruentus* L. as influenced by Kola Pod Husk, organomineral and NPK Fertilizers in Southwestern Nigeria. New York Science Journal, 2010: 3(5): 130 – 134.
18. Messiaen, C.M. The Tropical Vegetable Garden, CTA Macmillan, 1986: pp221 – 222.
19. Nawaz, M. and Sansamma, G. (2004). Eupatorium (*Chromolaena odorata* (L.) King and Robinson) biomass as a source of organic manure in okra cultivation. *Journal of Tropical Agriculture,* 1983: *42 (1-2): 33-34*
20. Ojeniyi, S.O; Ezekiel, P.O., Asawalam,D.O., Awo, A.O., Odedina, S.A and Odedina, J.N. Root growth and NPK status of cassava as influences by oil palm bunch ash. African journal of biotechnology, 2009: Vol8 (18), pp 4407 – 4412.
21. Pearson, D. The chemical analysis of food. Seventh edition. ChurchHill Livingstone, New York, 1976: 575pp
22. Rice, R.P., Rice L. W. and Tindall, H.O. Fruits and vegetables production in warm climates. Machmillian Publications, 1994: 245 – 285pp
23. Schippers, R.R. African Indigenous Vegetables. An overview of the species. Chatthan, UK., N.R/ACO. EU, 2000: pp 56-60.
24. Tel, D. A. *Soil and Plant Analysis.* Department of Land Resources Science. University of Guelph, Ontario, Canada, 1984.
25. Yamaguchi, M. World vegetables: Principles, production and nutritive values. Van Nostrand Reinhold, New York, 1983: 415 pp.

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