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Preliminary evaluation of the Effects of organic materials and NPK fertilizer on the growth and yield of muskmelon (*Cucumis melo*)

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Abstract

The soils of the southern Guinea savannah zone of Nigeria are low in organic matter content due to constant bush burning which depletes the soil of valuable organic materials and the fallow period has been shortened due to increase in population and infrastructural development. However, organic residues abound in the zone, which can be utilized by farmers for soil fertility restoration. A field trial was conducted at the Teaching and Research Farm of the University of Ilorin, Ilorin, Nigeria during the 2015 cropping season to determine the effect of different organic manures and NPK fertilizer on the performance of muskmelon. The trial consisted of five treatments; control, poultry manure, cow dung, goat manure and NPK fertilizer. The organic materials were applied at the rate of 10 tha^{-1} while the NPK fertilizer was applied at 300 $kgha^{-1}$. The experiment was laid out in a randomized complete block design, replicated thrice. The result indicated that using NPK fertilizer recorded the highest growth and yield attributes which were similar to the poultry manure applied plots but significantly different ($p<0.05$) from the control plot. Although the NPK treatment outperformed the organic manures, it is expensive, not readily available and environmentally unfriendly. However, poultry and goat manures can be used for fertility restoration in the cultivation of muskmelon as the economic analysis indicated a slight difference (#0.04) in the return per investment by applying the NPK fertilizer and the poultry manure. The manures on the other hand, are cheap, readily available and leave no residues on the environment.

Introduction

Muskmelon (*Cucumis melo* L) which is a member of the Cucurbitaceae family is one of the most cultivated vegetable crops (Dilson, 2002) for its minerals, vitamins and high water content. The importance of the vegetable and its seeds in human diets include such health benefits as regulation of heartbeat, prevention of strokes, and reduction of the risks of kidney stone because of low-oxalate content. It is also rich in calcium that prevents osteoporosis, age related bone loss, and has sedative properties (Hazra and Som, 2015). They are good source of minerals (magnesium, phosphorus, zinc and copper) and vitamins (A, C and E). Studies have shown that eating muskmelon seeds help in expelling intestinal worms and improve digestion. In addition, due to its high water and dietary fibre contents, it relieves constipation and other digestive disorders when consumed regularly. The omega-3 fatty acids contained in the seeds are essential for fighting cardiovascular diseases (Mehra *et al.*, 2015).

A major constraint to availability and abundance of food to humanity in sub-Saharan Africa is low soil fertility with subsequent low yield because of degradation (Omotayo and Chukwuka, 2005) and traditional farmers in developing countries practice shifting cultivation with a long fallow period to support agricultural production (Kang and Wilson, 1987). However, with increasing population and infrastructural development, this practice is no longer sustainable. Although the use of organic manures such as farmyard and compost manure have been in use for millennia for the restoration of soil fertility (Sridhar and Adeoye, 2003) but they are not readily available, bulky and expensive to transport especially where farms are far from source. Inorganic fertilizer is reported to be water-soluble and can be leached by heavy rainfall and thus pollute river, streams, ponds and other water bodies. IITA (1992) had observed that soil fertility could be improved by the application of organic residues on the soil to increase its fertility. The use of farmyard manure is one of the ways of improving soil fertility and yield of crops (Lombin *et al.*, 1992). Eifediyi and Remison (2010) observed that farmyard manure had positive effects on the growth and yield attributes of cucumber in a rain forest and Guinea savannah transition zone of Nigeria. Enujeke *et al.* (2013) also reported that poultry manure is not only cheap and effective but essential for maintaining the soil physical conditions for plant

growth and yield as well as improve the soil physical properties by reducing soil temperature, bulk density and total porosity. Ojeniyi and Adegboyega (2003) reported that goat manure significantly increased growth and yield of vegetables, especially okra, amaranthus, celosia and cucumber in southwestern Nigeria. Organic manure helps to improve the physical condition of the soil and provide the required plant nutrients. It enhances cation exchange capacity and acts as a buffering agent against undesirable soil pH fluctuations (Akanni and Ojeniyi, 2008). The application of organic manure had been found to have economic advantage over the use of inorganic fertilizer. The objective of this study is to find out the effect of different organic materials and inorganic fertilizer on the performance of muskmelon.

MATERIALS AND METHODS

Site description

The field trial was carried out at the Teaching and Research Farm of the University of Ilorin, Ilorin (latitude 8° 49'North 4° 49' East, 306 above sea level), southern Guinea savanna zone of Nigeria. The study comprised of five treatments, the control, cow dung, goat manure, poultry manure and NPK fertilizer. The design of the experiment was a randomized complete block replicated three times. The size of each plot was 3.0 x 4.0 m with a 1-meter alley between plots and between replicates. The different manures were incorporated into the soil two weeks before seeds were sown at a spacing of 1.0 m x 1.0 m between plants. N P K 20:10:10 fertilizer was applied at 3 weeks after planting using the side band placement method. Insect pests were controlled by using karate at the rate of 2 litres per hectare at biweekly intervals and weeds were controlled by using traditional hoe weeding at 3, 5 and 7 weeks after planting.

Top soil (0 - 30cm) samples were collected in a 4 x 5 m^2 grid, bulked and a composite sample collected for physical and chemical characterization on the experimental site prior to planting and application of the organic manures and at the end of the experiment. Soil pH was measured (in soil: water ratio of 1:2) using a glass electrode, total nitrogen (N) content was determined by micro-Kjeldahl method (Bremner, 1996). Available phosphorus was determined following Bray No 1 method (Kuo, 1996), organic carbon was determined according to Walkley Black method (Nelson and Sommers, 1982); exchangeable bases (calcium (Ca), magnesium (Mg), potassium (K) and sodium (Na)) were extracted with 1N ammonium acetate. Calcium and Mg in the extract were analyzed using Atomic Absorption Spectrophotometer (AAS) whereas K and Na were determined by flame photometry.

Data collection and analysis

Data were collected on vine length and number of leaves from five tagged plants from the net plot at 4, 6, 8 and 10 weeks after planting (WAP). Vine length were measured from the base of the plant to the terminal point by using a measuring tape and number of leaves and fruits per plant were determined by physical counting while the fresh fruit weight per plant were assessed using weighing balance. Weight of fruits per hectare was extrapolated from the weight of fruits per plant.

The data collected were subjected to analysis of variance (ANOVA) and significantly, different treatment means were separated by using the Least Significant Difference (LSD) at 5% level of (Steel and Torrie, 1980).

RESULTS

The result of the soil analysis presented in (Table 1). The data indicated that the soil of the experimental site was slightly acidic before and after the trial and low to very low in most of the parameters analyzed. Results presented in Table 2 showed that at 4 and 6 WAP, poultry manure produced the longest vines while at 8 and 10 WAP, NPK produced the longest vines which were significantly ($p<0.05$) different from the control. It was observed that the treatment with poultry manure produced the highest number of leaves at 4 and 6 , whereas the highest number of leaves were produced by the NPK treated plots at 8 and 10 weeks after planting (WAP) which were significantly different ($p<0.05$) from the control. The number of fruits per pant, weight of fruits per plant, weight of fruits per plot and per hectare was as presented in Table 3. The results indicated that the NPK treated plots outperformed the other treatments significantly ($p<0.05$) in the yield characters that were evaluated. The result of the economic analysis of muskmelon as affected by NPK fertilizer and different organic materials presented in Table 4. The data indicated that the highest return per investment was recorded in the NPK treated plots, which was closely followed by the poultry manure treated plots. However, the difference was very small (four kobo).

Table 1: Physical and chemical composition of the soil before and after cropping

	Soil pH	Organic C %	Organic matter %	Total N mg kg^{-1}	Available P. mg kg^{-1}	K mg kg^{-1}	Ca cmol kg^{-1}	Mg cmol kg^{-1}
Before	5.63	0.91	1.57	0.04	3.80	0.72	4.50	1.68
After	5.71	0.32	0.55	0.02	2.70	0.68	4.30	1.27

Table 2: Effects of fertilizer on the vine length (cm) and number of leaves of muskmelon at 4, 6, 8 and 10 weeks after planting

Treatments	Vine length				No of leaves			
	Weeks after planting							
	4	6	8	10	4	6	8	10
Control	11.00	40.57	106.98	113.20	6.25	14.08	15.42	18.00
NPK	15.65	51.70	114.15	140.00	8.71	17.00	21.00	23.00
Poultry manure	15.73	62.01	112.00	139.55	9.83	17.42	19.00	22.00
Cow dung	13.83	44.05	109.99	119.07	8.55	16.23	19.00	21.67
Goat dung	12.37	42.35	112.45	116.85	6.67	17.00	18.00	20.33
$LSD_{(0.05)}$	0.334	4.659	0.479	1.173	1.426	1.408	1.910	2.160

Table 3: Effects of fertilizer on yield components of muskmelon

Treatments	No of fruits per plant	Weight of fruits per plant (g)	Weight of fruits per plot (g)	Weight of fruits per ha (kg)
Control	1.77	69.41	123.23	410.78
NPK	7.51	145.32	1090.25	3634.17
Poultry manure	5.32	113.01	601.61	2005.35
Cow dung	4.32	112.14	484.75	1615.82
Goat manure	5.20	111.47	580.38	1934.61
$LSD_{(0.05)}$	0.653	0.935	1.424	4.744

Table 4: Economic Analysis of the yield of muskmelon

Treatments	Total revenue (a) N	Total expenditure (b) N	Gross margin c=a-b N	Return/ investment d =c/b
Control	82,156	41000	41156	1.0
NPK	726,834	83,000	643834	7.75
Poultry manure	401070	46,000	355070	7.71
Cow dung	323,164	46,000	277164	6.01
Goat manure	386,922	46,000	340922	7.41

Discussion

Although the NPK fertilizer treated plot had the highest growth at later stages of muskmelon`s growth and superior yield attributes, the manures also had positive effects on the crop`s growth and yield components. The higher growth attributes experienced in the organic manure treated plots at the early growth stages could be attributed to the improvement in soil physical and chemical conditions suitable for plant growth. This is consistent with the reports of Lombin *et al.* (1992) and Mangila *et al.* (2007) who posited that organic manures are essential for establishing and maintaining the optimum soil physical condition for plant growth. This is also in line with the findings of Agbede *et al.*(2008) and Ewulo *et al.*(2008) who reported that organic manures are not only cheap and effective source of nitrogen for sustainable crop production, but improves soil physical properties by reducing temperature, bulk density, and increasing soil porosity. The organic manure applied to the soil must have increased the amount of organic matter content of the soil and this in turn improved the soil chemical properties thus enhancing the nutrients availability in the soil making it available for plant growth. This observation is in agreement with studies made by Agboola and Fayemi (1972) that maintaining the levels of organic matter in tropical soil requires application of manure over a period. Aliyu (1997) asserted that poultry manure application significantly increased plant height, leaf area index and fruit length of pepper.

The highest vine length observed by poultry manure also seemed to be due to maximum release of nutrient to the plant especially nitrogen, phosphorus, potassium and calcium. This implies that poultry manure increased plant height since more nutrients required for growth would be released to the soil. Large amount of nitrogen and calcium in poultry manure may be a factor to high growth rate. Because low nitrogen content will lead to poor green colouration of the plant which in turn will reduce the rate of photosynthetic activities, and this may adversely influence the number of branches and vine length of the crop. This is in conformity with the findings of Akinyosoye (1985) who observed that low nitrogen supply reduced stem extension with pale leaf colouration, which becomes darker immediately after nitrogen is increased. The maximum supply of available phosphorus and

calcium in poultry manure may also be a reason for the optimum development of the number of branches and vine length. Togun and Akanbi (2002) who reported that high level of available phosphorus throughout the root zone is essential for rapid development and good utilization of water and other nutrients by the plants. Organic manure and inorganic fertilizer performed well on the vine length of muskmelon showing no significant difference but treatment with poultry manure had the higher vine length than other treatments possibly because poultry manure improved moisture availability which enhanced the release of more nutrient elements for increased vine growth. This is consistent with the findings and reports of Adekiya and Ojeniyi (2002), and Ewulo *et al* (2008) which attributed increased growth of crops to the release of more nutrient elements through the conservation of moisture that has been made possible by the manure. It is also in agreement with the report of John *et al.*(2004) who indicated that poultry manure released essential elements, which promoted high photosynthetic activities that enhanced growth and yield of watermelon.

The control plot could not support growth of the plants because the nutrient content of the soil was insufficient to support growth of muskmelon, probably because the nutrient content of the soil was below the critical level, which leads to the poor performance of the crop (Hamma *et al.*, 2012) thereby making the plants to produce shorter vine length. Cattle manure also supplied appreciable nutrients that could support appropriate nutrition and growth of muskmelon. Therefore, ability of the plants to photosynthesis has led to an increase in growth and development of the crop resulting in the production of longer vine length. Highest fruit weight, number of fruits per plant and number of fruits per hectare were obtained from NPK treated plot due to quick release of the nutrients present in the inorganic fertilizer which was closely followed by the poultry manure treated plots. Shafeek *et al.*(2015) had reported that using different levels of NPK increased the yield and yield components of cantaloupe in Egypt. Improved the soil conditions for proper crop establishment and released adequate nutrient elements for yield enhancement. This is in consonance with the reports of Aliyu (2000), Adekiya and Ojeniyi (2002), Mangila *et al.* (2008) and Agbede *et al.*(2008) which indicated that application of poultry manure increases crop yield. The increase in the total yield resulting from application of poultry droppings may be attributed to the presence of readily available ammonia and nitrate (Gross *et al.*, 2008) and to its property, which enhances soil aggregation, soil aeration, water-holding capacity and providing good environmental conditions for the root system of broccoli plants. The availability of soil nutrients and favorable soil condition in poultry droppings treatments resulted in healthy plants with large vegetative growth, which lead to higher number of fruits per plants and weight per hectare. The highest yield was obtained in organic treatment due to availability of readily available nutrient in high quantity. The lowest yield in control is due to the insufficient supply of plant nitrogen resulting in reduction of plant productivity (Lawlor and Cornic, 2002). Response of weight of fruits per plant and weight of fruits per hectare to applied NPK fertilizer may be an indication that the nutrients taken up by the plant was well utilized in cell multiplication, amino acid synthesis and energy formation which increased the rate at which photosynthetic activities occur. The products of photosynthesis were then translocated to the sinks (fruits and growing buds).This was in consonance with the findings of Lawal (2000) who reported significant response of cucumber fruit weight per plant and total yield to applied inorganic fertilizer.

The economic analysis indicated that the difference between the NPK fertilized plot , the poultry manure and the goat manure treated plots on return per investment was very small. However, many researchers had earlier reported on the negative effects of applying NPK fertilizer to include pollution of the environment, high cost and scarcity when needed. Moreover, the continuous use of NPK fertilizer without adequate liming can result in drastic reduction in yield.

Conclusion

Although the NPK fertilizer treated plots produced superior growth and yield attributes, it is beyond the reach of resource poor farmers in the southern Guinea savannah zone. From the result of the study, the use of poultry and goat manures can serve as an alternative in the cultivation of muskmelon due to its positive effects on growth and yield components. These organic materials are cheap, readily available, environmental friendly and have no negative effects on the soil properties. Therefore, farmers are advised to use organic materials, which are readily available in the zone.

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