Direct Research Journal of Agriculture and Food Science

Vol. 12(3), Pp. 40-44, October 2024,

https://journals.directresearchpublisher.org/index.php/drjafs

Research Article
ISSN: 2354-4147

Performance of Watermelon (*Citrulus lanatus* Thumb) Intercrop with Plantain (*Musa paradisiaca* AAB) under Different Rates of Poultry Manure

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ABSTRACT

The experiment was conducted in the humid tropics of Southeastern Nigeria during the rainy season to evaluate the performance of Citrulus lanatus Thumb intercropped with Musa paradisiaca AAB under different poultry manure rates. The layout was a split - plot fitted into a Randomized Complete Block Design with four blocks and three replications. The spacing for each of the two C. lunatus varieties - Crimson sweet - V_1 and Sugar baby - V_2 that formed the main plot treatment was 2m x 2m with four seedlings per planting spot. The plantain spacing was 3.5m x 4.0m with the watermelon plants centralized between the plantain rows. The soil is ferallitic acid sand with a pH of 5.25, 0.09%N, 16.20ppm P and 0.53 cmol/100g of K. The sub-plot treatment consists of 0 ton/ha -T_1; 5.0 t/ha - T_2 and 7.5 t/ha - T_3 completely decomposed poultry manure. Except for days to 50% germination, all the yield and agronomic parameters evaluated were significantly (P≤0.05) affected by manure treatments. Maximum fresh fruit yield values for both V_1 and V_2 varieties of C. lanatus Thumb was obtained at 5.0 tons/ha poultry manure rate. The fresh fruit yield values for V_1 were 3.23, 9.50 and 9.00 tons/ha for T_1, T_2 and T_3, respectively. But for V_2 the corresponding fresh fruit yield values were 3.44, 8.70 and 8.15 t/ha, respectively. The Crimson sweet variety of watermelon at a poultry manure application rate of 5.0t/ha was therefore recommended for growers of watermelon under plantain/watermelon intercrop in the region.

Keywords: Watermelon, performance, manure rate, plantain /watermelon intercrop

Article information
Received 1 August 2024;
Accepted 29 September 2024;
Published 11 October 2024
https://doi.org/10.26765/DRJAFS84016435

Njoku,T.C., and Okorie, U. N. (2024). Performance of Watermelon (*Citrulus lanatus* Thumb) intercrops with Plantain (*Musa paradisiaca* AAB) under different rates of Poultry Manure. Direct Research Journal of Agriculture and Food Science. Vol. 12(3), Pp. 40-44.

INTRODUCTION

Intercropping is the system of growing more than one type of crop at the same time in a given area. It is a very important cropping system in the humid tropics, and a popular traditional practice in Nigeria which ensures the farmers against total loss of crop yield. The adoption of this system of farming has contributed a lot to the welfare of farmers in the region (Li *et al.*, 2013). Intercropping can enhance crop productivity and resource use efficiency while decreasing farming's environmental impact, controlling pests, ensuring against crop failure, improving soil quality and increasing income, making intercropping available approach for sustainable intensification especially in regions with impoverished soils and economies where measured benefits have been grates (Finch and Colliel, 2012; Rusinamhodzi *et al.*,2012). Moreover, due to high cost of inorganic fertilizers, farmers have to look for alternatives which include animal manure. Animal manure is said to be excellent for crop

production because of the organic matter content (Aguyoh et al., 2011). The use of poultry manure as an alternative to chemical fertilizer by rural farmers in southeastern Nigeria is increasingly becoming popular because of non-availability or high cost of conventional chemical fertilizer (Nyakatawa *et al.,* 2007). Chemical analysis of poultry manure showed that it contains the basic essential elements needed by crops in reasonable quantity more than some other organic manures and may thus form a good alternative to compound chemical fertilizer especially in south- eastern Nigeria (Duruigbo *et al.,* 2007). The superiority of poultry manure over other organic manure has been confirmed (Abdel, 2002, Hsich and Itus, 1993; Janadasa *et al.,* 1997).

Plantain can be grown with arable crops such as cocoyam and vegetables or fruits such as watermelon. Intercropping of plantain with tomato, eggplant or potato has been reported in the Andes region of South America (Aguyoh et al., 2011). In the rainforests of West Africa, intercropping is usually practiced by low income families to maximize the use of land and to provide extra food and cash (Lui et al., 2006; 2008). The benefits of intercropping plantain by resource poor farmers in Nigeria had also been reported by Simmond, (2000). Plantain cultivation is usually profitable for one or two years after which soil fertility declines, resulting in annual yields as low as 4-8 tons/ha compared with 30-50 tons/ha observed in backyard gardens in which the soils can sustain high yields over many years (Liu *et al.,* 2008).

There is presently scarcity of information on the response of watermelon intercropped with plantains to different levels of poultry manure, especially in the humid tropics of Southeastern Nigeria. Farmers vulnerability in production in most rural communities in Nigeria, especially in Southeastern Nigeria due to erosion, flood, draught, soil acidification, Fulani herdsmen attacks, etc. has in recent years been aggravated. Intercropping offers unique opportunities for reconciling the objectives of mitigation and adaptation to climate change with rapid demographic and land use pressures (conversion of forest lands into cities and industrialization activities) where traditional fallows are reduced below the minimum threshold required for the system to sustain itself. It was on this basis that this study was therefore initiated to evaluate the response of watermelon (*C. lunantus)* intercropped with plantain *(M. paradisiaca ABB)* to different rates of poultry manure and to estimate the quantity of poultry manure required to obtain optimum growth and yield performance of watermelon under plantain/water melon intercrop.

MATERIALS AND METHODS

Experimental conditions

The experiment was carried out in the Faculty of Agriculture Research farm of Imo State University. It is located in South East, agroecological zone of Nigeria. It lies between latitude 05°, 30′N, and longitude 07°24′E, altitude 91.0m above sea level and located in the humid tropical rainforest zone of West Africa. The area has an average rainfall of 2,500mm, 75% relative humidity and 27°C temperature respectively (NIMET, 2021).There are two main seasons, namely the rainy season and the dry season. The rainy season starts in March and lasts till October with a pronounced 10-14 days break around August, while the dry season lasts from December through February. Land clearing and other activities were carried out manually.

Soil sampling and analysis

Soil samples were randomly collected from the experimental site at the depth of 0-15cm using soil auger before tillage operation. A composite sample of the soil was obtained, air dried and passed through a 2mm diameter sieve.

The sample was subjected to laboratory analysis for the determination of physical and chemical properties of soil. Particle size was determined using Bouyoucous method while the glass electrode, pH meter was used to determine the soil pH (Rhoades, 2002). Organic carbon was determined by Walkley and Black procedure using the weight oxidation method (Nelson and Summers, 1996). Total Nitrogen was by the distillation method (Bremner, 1996). Exchangeable basis were determined by flame photometry method as described by AOAC (2010).

Nursery and field establishment

The plantain suckers were first planted in nursery before field planting. They were disinfected with a mixture of 5 g of Benlate and 3 mls of Ultracide which was diluted in 4 liters of water. The suckers were transplanted after 2 months in the nursery. The levels of poultry manure used were as follows:

T0 (control)	=	0.0 tons/ha
T1	=	5.0 tons/ha
T2	=	7.5 tons/ha

The poultry manure was dry and completely decomposed and applied as a single dose. Plantain suckers were planted in holes measuring 45 cm x 45 cm x45 cm. In making these holes, the top soil was separated from the sub-soil and then mixed thoroughly with poultry manure. It was allowed to stay for three days before planting. The plant spacing was 3.5 m x 4 m with a planting depth of 40 cm. Data were collected on Plant height, Leaf area, Number of leaves per plant, fresh fruit weight and fruit dry matter yield. Watermelon was spaced 2 m x 2 m with a

planting depth of 3 cm. The seeds were treated with 3.0 g of Benlate, dissolved in 5 mls of water. They were first planted in a seed tray. Germinated seedlings were transplanted to the fields after 3 weeks. The levels of poultry manure were:

T0 (control)	=	0.0 tons/ha
T1	=	5.0 tons/ha
T2	=	7.5 tons/ha

The poultry manure was also completely decomposed and applied as a single dose treatment. Six seeds per hole were sown at the depth of 3 cm and thinned down after two weeks, leaving 4 seedlings per planting spot. Weeds were controlled manually using hoe.

Experimental design, data collection and analysis

The experiment was set up in a Randomized Complete Block Design (RCBD). The plot was divided into four each block contains twelve plantain stands and thirteen watermelon spots. There are four blocks with three replications per treatment. Data collected on watermelon crop includes: Number of leaves per plant, number of days to 50% emergence, vine length, percentage germination, number of days to 50% flowering, fruit weight per plant, fruit yield per hectare and shoot dry matter yield. Data were subjected to analysis using analysis of variance and means separation was done using Duncan's Multiple Range Test (Statgraphic model version 16.0).

RESULTS AND DISCUSSION

Physico-chemical properties of the experimental site:

The physico-chemical properties of the soil where the plantain/watermelon intercrop were grown are presented in (Table 1). The results of the soil analysis showed that the soil was sandy loam. The pH was 5.25 which indicated that the soil was slightly acidic. The result showed that the total nitrogen content and organic carbon content of the experimental soil were low. The soil had a total exchangeable acidity of 0.60cmol/100g soil. The organic carbon content was 2.15 with 1.01% organic matter level. The total nitrogen was 0.09% and available phosphorus of 16.20ppm with percentage base saturation of 27.00% (Table 1).

Watermelon growth and yield attributes

The effect of different levels of poultry manure on the growth and yield attributes of watermelon intercrop with plantain are shown in (Table 2). The number of days taken for the germination of the seeds were not significantly ($P \leq 0.05$) affected by the treatments. Mean number of days for germination ranges from 6.83 to 7.80 days. The mean number of leaves per plant at 6 weeks after planting (WAP) ranges from 3.52 to 22.28 and was significantly ($P \leq 0.05$) affected by poultry manure treatment. The least mean number of leaves per plant (3.52 leaves) was gotten from 0 ton/ha x crimson sweet (V_2) at 6WAP. Poultry manure rate of 7.5t/ha x crimson sweet at 6WAP gave the highest mean leaf number per plant of 22.28, and this was significantly ($P \leq 0.05$) different from the (control) and 5 t/ha poultry manure rate. 0 t/ha x crimson sweet and sugar baby which had the mean values of 3.52 and 7.13 respectively were not significantly ($P \leq 0.05$) different (Table 2). Also, the vine length of watermelon intercropped with plantain were significantly ($P \leq 0.05$) different at 5t/ha and 7.5t/ha of poultry manure application rates. The longest vine length of 72.63 and 75.46cm obtained at 5t/ha and 7.5t/ha poultry manure rates (PMR) were significantly ($P \leq 0.05$) different from 57.21 cm vine length with 0t/ha for both varieties of watermelon. Poultry manure application significantly ($P \leq 0.05$) reduced the number of days to 50% flowering when compared to the control which was 31 days for V_1 and 32.3 days for V_2. The number of days to 50% flowering obtained at 5ton/ha and 7.5ton/ha poultry manure application rates were 30.33 and 30.67 days, respectively for both varieties and they were statistically ($P<0.05$) the same (Table 2).

The 0 ton/ha poultry manure rate gave a significantly ($P \leq 0.05$) higher number of days to 50% flowering of 32.33days for variety 2 (sugar baby) and 31.00 days for variety 1 (crimson sweet) (Table 2). Poultry manure application increased the mean number of flowers per plant at 50% flowering significantly ($P \leq 0.05$), different from the control irrespective of the variety. Application of poultry manure at the rate of 5ton/ha however, gave statistically ($P \leq 0.05$) the same mean number of flowers per plant at 50% flowering with 7.5ton/ha poultry manure rate application for Sugar baby (V_2) (Table 2). The mean number of flowers per plant at 50% flowering in plantain/watermelon intercrop, were 3.00, 5.33 and 7.33 for 0ton/ha, 5ton/ha, 7.5ton/ha respectively for crimson sweet (V_1) and these were all significantly ($P \leq 0.05$) different (Table 2). Application of 7.5ton/ha and 5.0ton/ha poultry manure rates gave mean fruit weight per plant of 8.94kg and 8.70kg, respectively, for sugar baby and these were not significantly ($P \leq 0.05$) different. However, they were significantly ($P \leq 0.05$) different from the control (0ton/ha) which produced much smaller mean fruit weights per plant of 3.15kg and 3.34kg for V_1 and V_2, respectively, (Table 2). There were significant ($P \leq 0.05$) variations in the mean fresh fruit yield of watermelon in plantain/ watermelon intercrop applied with different levels of poultry manure. The mean fresh fruit yield ranges from 3.23 to 9.50 t/ha. The fresh fruit yield of 9.50

Table 1: Selected soil physical and chemical properties of the experimental site.

Soil parameter	Values
pH (H_2O)	5.25
Sand (%)	90.24
Clay (%)	5.76
Silt (%)	4.00
Organic Carbon	2.15
Organic matter (%)	1.01
Nitrogen (%)	0.09
Phosphorus (ppm)	16.20
Potassium (cmol/100g soil)	0.53
Calcium (cmol/100g soil)	0.18
Magnesium (cmol/100 g soil)	0.07
Sodium (cmol/100 g soil)	0.03
Exchangeable acid (cmol/100 g soil)	0.60
Percentage base saturation (%)	27.00
Texture	Sandy loam

Source: Field Result

Table 2: Effect of different poultry manure rates on the growth and yield parameters of watermelon (*Citrulus lanatus Thumb*) under plantain /watermelon intercrop.

Manure levels (tons/ha)	Variety	NL (6WAP)	VL (cm) (6WAP)	DFF	DFG (%)	NF/P	FY (t/ha)	DMFY (t/ha)
	v_1	7.13^c	57.21^b	31.00^a	7.80	3.00^c	3.23^b	0.36^b
0 tons/ha	v_2	3.52^c	57.21^b	32.33^b	7.33	3.33^c	3.44^b	0.36^b
	v_1	19.42^b	72.63^a	30.33^c	6.83	5.33^b	9.50^a	1.40^a
5 tons/ha	v_2	16.17^b	72.63^a	30.33^c	7.67	6.33^a	8.70^a	1.41^a
	v_1	22.28^a	75.46^a	30.67^c	7.00	7.33^a	9.00^a	1.41^a
7.5 tons/ha	v_2	19.12^b	75.46^a	30.67^c	7.33	7.33^a	8.15^a	1.39^a

*Means within a column without a common letter differ significantly (P≤0.05)
NL = Number of leaves, VL = Vine length; DFF = Days to fifty percent flowering, DFG = Days to fifty percent germination, NF/P = Number of flowers/ plant at 50% flowering, FFY = Fruit fresh yield, DMFY = Dry matter fruit yield. V_1 = Crimson sweet variety, V_2 = Sugar baby variety.

t/ha obtained from 5.0 t/ha manure rates was statistically (P≤0.05) similar to 9.00 t/ha obtained using 7.5 t/ha poultry manure, but significantly (P≤0.05) different from the control with mean yield values of 3.23 t/ha and 3.44 t/ha for Crimson sweet and Sugar baby varieties, respectively. The nitrogen level at 7.5ton/ha manure rate may have been above the optimum level. This also agrees with the report of John et al. (2004) who reported that extensive use of poultry manure causes depression of fruit yield, delays and reduces fruit setting, which subsequently delays ripening and leads to heavy vegetative growth. It was observed that plants receiving 7.5ton/ha poultry manure rate, had greater incidence of pre-maturity fruit drop. This is in agreement with Yang (2008) that excess nitrogen has been associated with reduced fruit yield in watermelon due to toxicity (Aguyoh et al., 2011).

Effect of poultry manure levels on mean dry matter fruit yields of watermelon (*Citrulus lanatus Thumb*) in plantain /watermelon intercrop

There were significant (P≤0.05) variations in the mean dry matter fruit yields of watermelon and this varied from 0.36 t/ha in the control to 1.41t/ha in 7.5ton/ha manure treated plots (Table 2). Watermelon crops treated with 7.5t/ha poultry manure had the highest mean fruit dry matter yield of 1.41t/ha which was however not significantly (P≤0.05) different from 5t/ha manure treated crops (Table 2). This suggests that 7.5ton/ha poultry manure rate may be too high. This finding is in line with the reports of several workers on the use of organic manure (Asiegbu and Dike, 1993; Onwubiko *et al.*, 2009). The results as stated above indicated that poultry manure had significant (P≤0.05) effect on all the growth and yield parameters measured except days to 50% germination. This may be so because, poultry manure may have decomposed and added the essential nutrients such as nitrogen, phosphorus, potassium, etc to the soil thereby enhancing greater vegetative growth and yield of watermelon. This agrees with the findings of John *et al., (2004)* who reported that adequate supply of nitrogen is associated with high photosynthesis activity, vigorous vegetative growth and a dark green colour of watermelon leaves. They also observed that the supply of animal manure increased optimum yield of watermelon. This finding is in conformity with the results obtained by Dauda *et al.* (2005) who reported that poultry manure rate of

5.0t/ha to 8.5t/ha produced the number of fruits and weight of fruits per ha statistically ($P \leq 0.05$) higher than 3.3t/ha and 0t/ha and hence improve watermelon yield and production. They also noted that watermelon yield increased because poultry manure supplies nutrients which enhanced vigorous growth and increased fruit yield.

Conclusion and Recommendation

In the savanna area of Nigeria, watermelon production plays an important role in farming systems due to conducive soil and environmental conditions. In southeastern Nigeria, however, excessive rainfall and soil acidity reduces the normal performance of watermelon. The dry matter fruit yield obtained from plantain/watermelon intercrop is relatively high using 5 t/ha poultry manure. 5.0 t/ha of poultry manure also gave the best results in terms of fresh fruit yield per plant; Interplanting of plantains with watermelon using 5.0 t/ha poultry manure rate with crimson sweet variety is therefore recommended in the study area and other locations with similar soil and climatic conditions. This will also be a useful strategy in reducing weeding cost and soil erosion. More research is however required in this area, especially as it concerns plantain fruit yields in the plantain /watermelon intercrop.

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