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Research article

Soil chemical properties and growth performance of white seed melon (*Cucumeropsis mannii* Naudin) influenced by combined soil amendments in Ile-Oluji, Nigeria

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Abstract: Field experiment was conducted to study the effects of crop residues in combination with NPK fertilizer (NPKF) on soil chemical properties and growth performance of white seed melon at Ile-Oluji, Ondo State Nigeria. The experiment involved applications of cocoa bean husk (CBH), cocoa pod husk (CPH), cocoa pod waste (CPW), kola pod husk (KPH), *Tithonia diversifolia* (weed much (WM) in combination with NPK 15:15:15 Fertilizer to produce twelve treatments at 4 t ha^{-1} CBH + 200 kg ha^{-1} NPKF, 4 t ha^{-1} CBH + 100 kg ha^{-1} NPKF, 4 t ha^{-1} CPH + 200 kg ha^{-1} NPKF, 4 t ha^{-1} CPH + 100 kg ha^{-1} NPKF, 4 t ha^{-1} CPW + 200 kg ha^{-1} NPKF, 4 t ha^{-1} CPW + 100 kg ha^{-1} NPKF, 4 t ha^{-1} KPH + 200 kg ha^{-1} NPKF, 4 t ha^{-1} KPH + 100 kg ha^{-1} NPKF, 2 t ha^{-1} WM + 200 kg ha^{-1} NPKF, 2 t ha^{-1} WM + 100 kg ha^{-1} NPKF, 300 kg ha^{-1} NPKF and control, all the amendments tested significantly improved soil chemical properties and growth performance of white seed melon relative to control. Three cocoa plants residues in combination with NPKF at reduced rates 4 t ha CBH + 200 kg ha^{-1} NPKF, 4 t ha^{-1} CPW + 200 kg ha^{-1} NPKF and 4 t ha^{-1} CPH + 200 kg ha^{-1} NPKF respectively significantly ($p < 0.05$) improved soil pH, organic matter (OM), available P, exchangeable k, Ca and Mg, Na, Fe, Al and ECEC among the amendments tested. All treatments increased number of leaf, branches and vine length of white seed melon compared to control. 4 t ha^{-1} CBH + 200 kg ha^{-1} NPKF, 4 t ha^{-1} CPW + 200 kg ha^{-1} NPKF, 4 t ha^{-1} CPH + 200 kg ha^{-1} NPKF, had highest value of crop branches.

Keywords: White seed melon, Crop residue, Combined amendments, Soil chemical properties, Growth performance.

INTRODUCTION

Soil fertility management is one of the major constraints affecting the quality and quantity of agricultural production in developing countries, particularly in Nigeria. Crop quality and quantity are largely dependent on the ability of soil to supply essential nutrient elements for plant growth without a toxic concentration (Boyd, 1996). Soils of the tropics varied widely in physical and chemical properties. In West Africa soils of rainforest are generally acidic and of low to medium inherent fertility. Crop varieties with the most high yielding potential cultivated on such soils without regular replenishment of nutrients either through organic or inorganic means are bound to experience low crop quality, yield or total failure due to nutrient loss through crop removal, leaching and erosion. The use of chemical fertilizers to return lost nutrients and achieve high crop yield is unsustainable due to its scarcity and high cost (Ojeniyi, 2000). Although inorganic fertilizers ensure quick availability of nutrients to crops but they have limited residual effect of the applied nutrients (Okigbo, 2000). In addition, inorganic fertilizer has not been helpful in intensive agriculture because it is often associated with a reduction in crop yield, soil acidity, nutrient imbalance and degradation of soil physical attributes. Other limitations include nutrients leaching, erosion and volatilization (Ojeniyi, 2000). Chemical fertilizers are said to have the following characteristics (Ellison, 2011); Water solubility of chemical fertilizers results in fast nutrient release. Death of Nitrogen fixing bacterium, the organism that plays a central role in refurbishing a maturing plants nitrogen demands is part of the results of chemical fertilizers with high acid content like sulphuric and hydrochloric acids which when successfully going through soil acidity. Nutrient supply through the application of organic fertilizers is also faced with some challenges. The maintenance of organic matter in soil is constraint by the high competing demands of organic and agricultural wastes. Organic fertilizers are known to be slow released nutrient sources. This clearly shows that nutrient immobilization may cause crops to experience initial nutrient deprivation before mineralization. They are also required in large quantities which may not be readily available to farmers (Agbede & Kalu, 1995; Okigbo, 2000; Adekiya *et al*., 2012). Combination of crop or plant residue with synthetic fertilizers is the sustainable means of avoiding problems emanating from sole use of organic and inorganic fertilizers. Organic fertilizer was reported to improve soil characteristics and obtain high crop yields in addition to inorganic fertilizer (Cezar, 2004). Akanbi *et al.*

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(2013) and Ojeniyi & Adeniyan (1999) recognized the need to intensify studies into locally sourced, cheap, adoptable organic sources of plant nutrients. Babadele & Ojeniyi (2013) found that plant variety such as those of siam weed and sawdust used alone or combined further with NPK fertilizer at a reduced rate supplied nutrients and improved yield. Organic amendments discharge their nourishing contents only when they break down through the intricate ecology of living creatures in the soil at that time they steadily discharge contents. All the components in the organic amendments are completely essential soil nutrients. The fact that the material is organic signifies that it is derived from a once-living plant, animal or a mix of both, which assures us that all components there are crucial to life. The organic amendment is relatively cheaper and it has all the carbon and vitality to conform to the demands of soil microbes. The above characteristic of organic and inorganic fertilizers which complements each other makes its combination a necessary component for crop production. While the importance of the mixture has been demonstrated (Onunka & Nwokocha, 2003). Mann's cucumeropsis (*Cucumeropsis mannii* Naudin) is one of the most important species of melon. It is an important quality crop. The large white seeds produced by the crop is called egusi-itoo. The seeds are processed into soups and oil products and are also eaten individually as a snack (National Research Council, 2006). The benefits of white seed melon are many but soil fertility is one of the most important factors limiting its production. It is a very high nutrient - demanding crop and it requires adequate nutrition for maximum performance (National Research Council, 2006). A complete fertilizer should be applied before the propagation of white seed melon with periodical application of nitrogenous fertilizer (National Research Council, 2006). The growing of *Cucumeropsis mannii* in savannahs with low fertility and organic matter was reported to be more challenging (National Research Council, 2006). The objective of this experiment was to determine the effect of combined amendments on soil properties and growth performance of white seed melon.

MATERIALS AND METHODS

The study was conducted during 2018 cropping season at the Teaching and Research Farm, Federal Polytechnic Ile Oluji, Ondo State located in the rainforest Zone of Nigeria on latitude 7° 20′ N and longitude 4° 87′ E and Altitude of 247 metres. The location has a bimodal rainfall of 1250 to 1460 mm with mean annual rainfall of 1367 mm and average number of rainy days of about 112 per annum. Temperature is almost uniform throughout the year 23-32 ^{o}C with little deviation from mean annual of 27°C. February and March are the hottest months with mean temperature of 28°C and 27°C, respectively. The mean annual radiation is about 130 kcal cm^{-3} with total sunshine hour is about 2000 hours $year^{-1}$. The location is found within the high forest zone where the rich tropical forests once thrived. The location has a tropical humid climate with distinct wet and dry seasons. Its wet season starts from late March to October while little dry season occurs in August.

Experimental design and treatments

The experiment was arranged in a randomized complete block with each treatment replicated four times. The area used was 24 m × 49 m (1176 m^2) in total. Each plot measured 4 m × 3 m with discard of 1 m within the plots and 2 m between the block. The trial involved application of 4 t ha^{-1} cocoa bean husk (CBH); cocoa pod husk (CPH); cocoa pod waste (CPW); Kola pod husk (KPH) and 2 t ha^{-1} *Tithonia diversifolia* (weed mulch (WM) plus 200 or 100 kg ha^{-1} NPK 15:15:15 fertilizer (NPKF) and 300 kg ha^{-1} NPKF and control (no amendment). Two seeds of white seeds melon were planted per hole and later thinned to one at a spacing of 1 m × 1 m with a total of twenty (20) plants per plot. Before the commencement of the experiment, soil samples randomly collected from 0-20 cm depth were thoroughly mixed to form a composite which was later analyzed for physical and chemical properties. At the harvest, another set of composite samples were collected per plot basis and similarly analyzed for routine chemical analysis as described by Carter (1993). The soil samples were air-dried and sieved using a 2 mm sieve before making the determinations. Soil organic matter was determined by the procedure of Walkley and Black using the dichromate wet oxidation method (Nelson & Sommers, 1996), total N was determined by micro-Kjeldahl digestion method (Bremner, 1996), available P was determined by Bray-1 extraction followed by molybdenum blue colorimetry (Frank *et al*., 1998). Exchangeable K, Ca and Mg were extracted using 1.0 N ammonium acetate. Thereafter, K was determined using a flame photometer and Ca and Mg were determined by EDTA titration method (Hendershot & Lalande, 1993). The digital electronic pH meter was used to determine soil pH in soil water (1:2) medium. Bouyoucos hydrometer method was used for particle size analysis (Sheldrick & Wang, 1993).

Data collection and statistical analysis

Five plants of white seed melon were randomly selected from each plot across the four blocks for growth determination. The parameters assessed included the number of leaves, number of branches and vine length. The data collected were subjected to analysis of variance (ANOVA) using the SPSS package (version 16) and treatment means were compared using the Duncan's multiple range test (DMRT).

RESULTS

Pre-Planting Soil properties

Soil properties of the experimental site before planting is presented in table 1. The result revealed that the soil at the location was sandy loam, acidic, low in N, available P, exchangeable K and OM in accordance with the rating of Akinrinde & Obigbesan (2000). Therefore, the results revealed that additional soil conditioner would be needed before the soil could effectively produce a crop.

Table 1. Pre-Planting Soil properties.

Property	Values
Sand (%)	73.9
Silt (%)	14.7
Clay (%)	11.4
Textural Class	Sandy loam
pH (H_20)	5.83
Organic Matter (%)	2.36
Total N (gkg^{-1})	0.20
Available P ($mgkg^{-1}$)	15.14
Exchangeable K ($cmolkg^{-1}$)	0.17
Exchangeable Ca ($cmolkg^{-1}$)	2.61
Exchangeable Mg ($cmolkg^{-1}$)	1.24
Na ($cmolkg^{-1}$)	0.58
H ($cmolkg^{-1}$)	1.29
Al ($cmolkg^{-1}$)	0.81
ECEC	6.7
BS (%)	59.31

Note: BS = Base saturation.

Data on effects of combined application of amendments on number of leaf of white seed melon are shown in table 2. Number of leaf at 4, 12, 20, and 28 weeks after treatment application (WATA) ranged from (7.2-13.1), (47.67-68.11), (133.27-174.71) and (210.47-274.57) respectively. All the amendments tested significantly improved the number of leaf of white seed melon relative to the control. The highest number of leaf (13.13) was obtained for plant treated with 4 t ha^{-1} CBH + 200 kg ha^{-1} NPKF and it was closely followed by the plant treated with 4 t ha^{-1} CPW + 200 kg ha^{-1} NPKF. Plants treated with 4 t ha^{-1} CBH + 200 kg ha^{-1} NPKF, 4 t ha^{-1} CPW + 200 kg ha^{-1} NPKF, 4 t ha^{-1} CPW + 100 kg ha^{-1} NPKF, and 4 t ha^{-1} KPH + 200 kg ha^{-1} NPKF were not significantly different from one another at ($P < 0.05$) at 4 WATA. Highest values of number of leaf (68.11, 174.77 and 274.57) were obtained for 300 kg ha^{-1} NPKF at 12 and 20 WATA and 4 t ha^{-1} CPW + 200 kg ha^{-1} NPKF at 28 WATA. The number of leaf recorded for 300 kg ha^{-1} NPKF was not significantly different from the plant treated with 4 t ha^{-1} CBH + 200 kg ha^{-1} NPKF and 4 t ha^{-1} CPW + 200 kg ha^{-1} NPKF at 12 WATA. The number of leaf at 20 WATA showed those plant residues in combination with either 100 or 200 kg ha^{-1} NPKF were not significantly higher than one another. Plot treated with 2 t ha^{-1} WM + 100 kg ha^{-1} NPKF was significantly higher than the number of leaf obtained for the control. The value obtained on the number of leaf at 28 WATA revealed that plant treated with 4 t ha^{-1} CPW + 200 kg ha^{-1} NPKF and 300 kg ha^{-1} NPKF were statistically similar and showed no significant difference from each other at ($P < 0.05$).

Table 2. Effects of combined amendments on number of leaf of white seed melon (*Cucumeropsis mannii* Naudin) at 4, 12, 20 and 28 WATA at Ile-Oluji.

Treatments	Weeks After Treatment Application (WATA)			
	4	12	20	28
Control	7.2e	47.67e	133.27c	210.47h
300 kg ha^{-1} NPKF	12.90ab	68.10a	174.77a	274.0ab
4 t ha^{-1} CBH + 200 kg ha^{-1} NPKF	13.13ab	63.71abc	174.2a	272.33abcd
4 t ha^{-1} CBH + 100 kg ha^{-1} NPKF	11.87cd	67.42cd	164.67ab	267.8cde
4 t ha^{-1} CPH + 200 kg ha^{-1} NPKF	12.03cd	65.02bcd	167.2ab	268.17cde
4 t ha^{-1} CPH + 100 kg ha^{-1} NPKF	11.44d	62.13d	160.47ab	264.37efg
4 t ha^{-1} CPW + 200 kg ha^{-1} NPKF	13.07ab	67.34abcd	171.2a	274.57a
4 t ha^{-1} CPW + 100 kg ha^{-1} NPKF	12.53abc	64.12bcd	166.8ab	267.64def
4 t ha^{-1} KPH + 200 kg ha^{-1} NPKF	12.47abc	61.93bcd	166.37ab	268.83cde
4 t ha^{-1} KPH + 100 kg ha^{-1} NPKF	12.03cd	58.49d	161.6ab	262.7fg
2 t ha^{-1} WM + 200 kg ha^{-1} NPKF	11.97cd	61.84d	166.43ab	267.47def
2 t ha^{-1} WM +100 kg ha^{-1} NPKF	11.3d	58.03d	141.21b	261.37g

Note: NPKF= NPK 15:15:15 fertilizer; CBH= Cocoa Bean Husk; CPH= Cocoa Pod Husk; CPW= Cocoa Pod Waste; KPH= Kola Pod Husk; WM= Weed Mulch. Means with the same letters are not significantly different (*P*<0.05) from other.

The result on the effect of soil amendment on number of branches of white seed melon is shown in table 3. The number of branches ranged from (1.57-1.83), (3.07-5.50), (5.67-10.33) and (10.04-12.07) at 4, 12, 20 and 28 WATA respectively. Highest value of number of branches of white seed melon was obtained for plant treated with 300 kg ha^{-1} NPKF, 4 t ha^{-1} CPW + 200 kg ha^{-1} NPKF, 4 t ha^{-1} CPW + 200 kg ha^{-1} NPKF and 4 t ha^{-1} CBH + 200 kg ha^{-1} NPKF and 4 t ha^{-1} CBH + 200 kg ha^{-1} NPKF, 4 t ha^{-1} CPH + 200 kg ha^{-1} NPKF and 4 t ha^{-1} CPW + 200 kg ha^{-1} NPKF at 4, 12, 20 and 28 WATA respectively. Value on the number of branches of white seed melon recorded for 300 kg ha^{-1} NPKF was not significantly different from plant treated with other soil amendments at 4 and 12 WATA. Significant difference was only observed at 20 and 28 WATA compared with 300 kg ha^{-1} NPKF, 4 t ha^{-1} KPH and 2 t ha^{-1} WM plus 100 or 200 kg ha^{-1} NPKF and that of control.

Table 3. Effects of combined amendments on number of branches of white seed melon (*Cucumeropsis mannii* Naudin) at 4, 12, 20 and 28 WATA at Ile-Oluji.

Treatments	Weeks After Treatment Application (WATA)			
	4	12	20	28
Control	1.57e	3.07b	5.67e	10.04c
300 kg ha^{-1} NPKF	1.93a	5.47a	10.27a	11.87a
4 t ha^{-1} CBH + 200 kg ha^{-1} NPKF	1.83abc	5.40a	10.33a	12.00a
4 t ha^{-1} CBH + 100 kg ha^{-1} NPKF	1.80abc	5.40a	10.27a	11.93a
4 t ha^{-1} CPH + 200 kg ha^{-1} NPKF	1.82abc	5.43a	10.20a	12.07a
4 t ha^{-1} CPH + 100 kg ha^{-1} NPKF	1.80abc	5.43a	10.20a	12.03a
4 t ha^{-1} CPW + 200 kg ha^{-1} NPKF	1.82abc	5.50a	10.33a	12.07a
4 t ha^{-1} CPW + 100 kg ha^{-1} NPKF	1.80abc	5.47a	10.27a	11.93a
4 t ha^{-1} KPH + 200 kg ha^{-1} NPKF	1.81abc	5.13a	8.63c	11.00b
4 t ha^{-1} KPH + 100 kg ha^{-1} NPKF	1.80abc	5.17a	8.23d	11.03b
2 t ha^{-1} WM + 200 kg ha^{-1} NPKF	1.80abc	4.93a	8.43d	11.00b
2 t ha^{-1} WM +100 kg ha^{-1} NPKF	1.63de	4.87a	7.73d	10.87b

Note: NPKF= NPK 15:15:15 fertilizer; CBH= Cocoa Bean Husk; CPH= Cocoa Pod Husk; CPW= Cocoa Pod Waste; KPH= Kola Pod Husk; WM= Weed Mulch. Means with the same letters are not significantly different (P<0.05) from other.

The results on effects of amendments on vine length of white seed melon are shown in table 4. All the amendments tested significantly improved the vine length of white seed melon relative to the control. Vine length of melon ranged from (14.96-19.40), (15.67-253.00), (228.83-623.87) and (287.20-844.3) at 4, 12, 20 and 28 WATA respectively. Value of vine length of white seed melon recorded revealed that all soil amendments were not significantly different (P < 0.05) from one another but significantly higher than the control at 4 WATA. The highest value of vine length was obtained for plant amended with 4 t ha^{-1} NPKF at 12 WATA and 300 kg ha^{-1} NPKF at 20 and 28 WATA but there was no significant difference compared with 4 t/ha CBH, CPH and CPW plus 200 or 100 kg ha^{-1} NPKF.

Table 4. Effects of combined amendments on vine length of white seed melon (*Cucumeropsis mannii* Naudin) at 4, 12, 20 and 28 WATA at Ile-Oluji.

Treatments	Weeks After Treatment Application (WATA)			
	4	12	20	28
Control	14.96b	156.67f	228.83f	287.20d
300 kg ha^{-1} NPKF	19.40a	252.60a	623.87ab	844.30a
4 t ha^{-1} CBH + 200 kg ha^{-1} NPKF	19.33a	244.30ab	605.20ab	814.23abc
4 t ha^{-1} CBH + 100 kg ha^{-1} NPKF	18.96a	233.63abc	575.17abcd	793.37abc
4 t ha^{-1} CPH + 200 kg ha^{-1} NPKF	19.00a	239.70abc	599.07ab	812.33abc
4 t ha^{-1} CPH + 100 kg ha^{-1} NPKF	18.73a	227.07abcd	5.7853abcd	791.83abc
4 t ha^{-1} CPW + 200 kg ha^{-1} NPKF	19.33a	253.00a	620.00ab	8.4173a
4 t ha^{-1} CPW + 100 kg ha^{-1} NPKF	19.20a	237.97abc	613.67ab	819.33abc
4 t ha^{-1} KPH + 200 kg ha^{-1} NPKF	18.70a	214.43cde	5.7140bcde	806.73abc
4 t ha^{-1} KPH + 100 kg ha^{-1} NPKF	18.50a	206.63de	5.4943cde	796.77abc
2 t ha^{-1} WM + 200 kg ha^{-1} NPKF	17.56a	205.10de	546.63cde	779.80bc
2 t ha^{-1} WM +100 kg ha^{-1} NPKF	18.73a	199.30e	526.50e	768.10c

Note: NPKF= NPK 15:15:15 fertilizer; CBH= Cocoa Bean Husk; CPH= Cocoa Pod Husk; CPW= Cocoa Pod Waste; KPH= Kola Pod Husk; WM= Weed Mulch. Means with the same letters are not significantly different (P<0.05) from other.

Data on soil chemical properties after harvest of white seed melon are shown in tables 5, 6 and 7. All soil amendments imposed significantly improved soil chemical properties relative to the control. Data obtained on soil pH (H_20), OM, N, P, K, Ca, Mg, Na, H^+, Al, ECEC and BS ranged from, (5.06-6.57), (1.85-4.76%), (0.20-0.93%), (7.88-25.92%), (0.41-0.91 cmol kg^{-1}), (1.42-1.73 cmol kg^{-1}), (0.37-0.79 cmol kg^{-1}), (0.69-0.75 cmol kg^{-1}), (1.51-1.97 cmol kg^{-}

[1]), (0.41-0.75 cmol kg^{-1}), (5.356.29 cmol kg^{-1}) and (50.44-64.92%). Highest value of soil pH (H_20) was obtained for the plot treated with 4 t ha^{-1} CPH + 200 kg ha^{-1} NPKF and it was significantly higher than the pH value recorded for other soil amendments. Least value of soil pH was recorded for the control and it was significantly lower than all the soil amendments imposed tables 5 and 6.

Table 5. Effects of combined amendments on soil pH, OM, N and P at Ile-Oluji.

Treatments	pH (H_20)	OM (%)	N (%)	P (%)
Control	5.06k	1.85j	0.20l	7.88k
300 kg ha^{-1} NPKF	5.41o	2.14i	0.89c	25.92a
4 t ha^{-1} CBH + 200 kg ha^{-1} NPKF	6.52c	4.76a	0.90b	20.07h
4 t ha^{-1} CBH + 100 kg ha^{-1} NPKF	6.32f	4.76a	0.90b	23.69c
4 t ha^{-1} CPH + 200 kg ha^{-1} NPKF	6.57a	4.74b	0.93a	24.31b
4 t ha^{-1} CPH + 100 kg ha^{-1} NPKF	6.53b	4.71b	0.84d	22.61f
4 t ha^{-1} CPW + 200 kg ha^{-1} NPKF	6.52c	4.39d	0.83e	23.12c
4 t ha^{-1} CPW + 100 kg ha^{-1} NPKF	6.34e	4.38e	0.76f	21.65g
4 t ha^{-1} KPH + 200 kg $^{-1}$ha^{-1} NPKF	6.06g	4.34f	0.68i	22.81e
4 t ha^{-1} KPH + 100 kg ha^{-1} NPKF	6.37d	4.34f	0.76f	22.86d
2 t ha^{-1} WM + 200 kg ha^{-1} NPKF	6.03h	3.21g	0.61j	19.85i
2 t ha^{-1} WM +100 kg ha^{-1} NPKF	6.04i	2.97h	0.62k	17.63j

Note: NPKF= NPK 15:15:15 fertilizer; CBH= Cocoa Bean Husk; CPH= Cocoa Pod Husk; CPW= Cocoa Pod Waste; KPH= Kola Pod Husk; WM= Weed Mulch. Means with the same letters are not significantly different (*P*<0.05) from other.

Table 6. Effects of combined amendments on soil K, Ca, Mg and Na at Ile-Oluji.

Treatments	K (cmol kg^{-1})	Ca (cmol kg^{-1})	Mg (cmol kg^{-1})	Na (cmol kg^{-1})
Control	0.41l	1.42j	0.37l	0.69e
300 kg ha^{-1} NPKF	0.86d	1.68b	0.46k	0.67g
4 t ha^{-1} CBH + 200 kg ha^{-1} NPKF	0.88c	1.64e	0.79a	0.75a
4 t ha^{-1} CBH + 100 kg ha^{-1} NPKF	0.90b	1.45i	0.75d	0.72c
4 t ha^{-1} CPH + 200 kg ha^{-1} NPKF	0.91a	1.53h	0.79a	0.68f
4 t ha^{-1} CPH + 100 kg ha^{-1} NPKF	0.83e	1.45a	0.77c	0.73b
4 t ha^{-1} CPW + 200 kg ha^{-1} NPKF	0.72h	1.67d	0.74e	0.68f
4 t ha^{-1} CPW + 100 kg ha^{-1} NPKF	0.69l	1.64e	0.73i	0.69e
4 t ha^{-1} KPH + 200 kg ha^{-1} NPKF	0.76f	1.73a	0.77c	0.70d
4 t ha^{-1} KPH + 100 kg ha^{-1} NPKF	0.65j	1.69c	0.71i	0.68f
2 t ha^{-1} WM + 200 kg ha^{-1} NPKF	0.75g	1.62f	0.78b	0.64h
2 t ha^{-1} WM +100 kg ha^{-1} NPKF	0.56k	1.54g	0.69j	0.63i

Note: NPKF= NPK 15:15:15 fertilizer; CBH= Cocoa Bean Husk; CPH= Cocoa Pod Husk; CPW= Cocoa Pod Waste; KPH= Kola Pod Husk; WM= Weed Mulch. Means with the same letters are not significantly different (*P*<0.05) from other.

The result on the effect of soil amendments on soil OM revealed that the highest value of OM was recorded for the plot amended with 4 t ha^{-1} CBH + 200 or 100 kg ha^{-1} NPKF and it showed a significant difference compared with plot treated with other soil amendments. The least value of soil organic matter was recorded for the control and it was significantly lower than other soil amendments at ($P < 0.05$) (tables 5 and 6). Values on soil N revealed that (0.93, 0.90 and 0.89 %) N were obtained for 4 t ha^{-1} CPH and CBH plus 200 kg ha^{-1} NPKF and 300 kg ha^{-1} NPKF respectively and they were significantly different from one another and other amendments imposed. The least value of N was recorded for the control. The highest value of soil p was obtained for the plot treated with 300 kg ha^{-1} NPKF and it was significantly different from the P values recorded for other soil amendments used during the experiment. The control also recorded the least value of P which was lower significantly compared with other soil amendments. The result of soil exchangeable properties (K, Ca, Mg, Na, H and Al) revealed that the highest value of soil K was recorded for 4 t ha^{-1} CPH + 200 kg ha^{-1} NPKF and it showed a significant difference when compared with other soil amendments tested. The value of soil Ca was significantly different compared with other soil amendments. Soil pH, OM, N and P as affected by amendments are presented in table 4. All the amendments tested significantly ($p < 0.05$) increased soil pH, OM, N and P concentration relative to control after harvest. The concentration of soil pH, OM, N and P were significantly increased by 4 t ha^{-1} CBH + 200 kg ha^{-1} NPKF relative to other amendments while the least values of soil pH, OM, N and P (6.09, 3.45, 0.68 and 18.29) were respectively recorded for 2 t ha^{-1} WM + 100 kg ha^{-1} NPKF.

Effects of amendments on soil exchangeable properties are presented in tables 6 and 7. All the amendments tested significantly improved soil K, Ca, Mg, Na, ECEC and BS relative to control after harvest. Among the fertilizer treatments, the highest K, Ca, Mg, Na, ECEC and BS (0.97, 1.76, 0.88, 0.80, 6.70 and 65.82) were respectively obtained for soil treated with 4 t ha^{-1} CBH + 200 kg ha^{-1} NPKF and were significantly ($p < 0.05$) higher than the values recorded for other amendments.

Table 7. Effects of combined amendments on soil H+, Al, ECEC and BS at Ile-Oluji.

Treatments	H+ (cmol kg^{-1})	Al (cmol kg^{-1})	ECEC (cmol kg^{-1})	BS (%)
Control	1.97a	0.75a	5.52j	50.44l
300 kg ha^{-1} NPKF	1.82b	0.71b	6.20b	59.19k
4 t ha^{-1} CBH + 200 kg ha^{-1} NPKF	1.77c	0.46d	6.29a	64.55c
4 t ha^{-1} CBH + 100 kg ha^{-1} NPKF	1.72f	0.44e	5.98e	63.88g
4 t ha^{-1} CPH + 200 kg ha^{-1} NPKF	1.74d	0.46d	6.10c	63.77h
4 t ha^{-1} CPH + 100 kg ha^{-1} NPKF	1.72f	0.46d	5.96f	63.42i
4 t ha^{-1} CPW + 200 kg ha^{-1} NPKF	1.73e	0.46d	6.00d	63.33j
4 t ha^{-1} CPW + 100 kg ha^{-1} NPKF	1.66h	0.41g	5.82h	64.43d
4 t ha^{-1} KPH + 200 kg ha^{-1} NPKF	1.67g	0.47c	6.10c	64.92a
4 t ha^{-1} KPH + 100 kg ha^{-1} NPKF	1.64i	0.44e	5.81i	64.20e
2 t ha^{-1} WM + 200 kg ha^{-1} NPKF	1.62j	0.44e	5.83g	64.67b
2 t ha^{-1} WM +100 kg ha^{-1} NPKF	1.51k	0.42f	5.35k	63.93f

Note: NPKF= NPK 15:15:15 fertilizer; CBH= Cocoa Bean Husk; CPH= Cocoa Pod Husk; CPW= Cocoa Pod Waste; KPH= Kola Pod Husk; WM= Weed Mulch. Means with the same letters are not significantly different (*P*<0.05) from other.

DISCUSSION

Optimum yield could not be obtained from the sole application of organic manures due to the slow release of nutrients. The use of organic and inorganic fertilizers has been advocated for sustainable soil productivity under intensive and continuous cultivation in southwest Nigeria (Adepetu *et al.*, 1997), sustainable nutrient management on smallholder farms can be achieved by a combination of mineral fertilizers and organic soil amendments (Vanauwe *et al.*, 2004). From this study, the contribution of amendments to soil fertility has clearly shown through increased availability of plant nutrients for its growth and development (Brady & Weil, 2007; Adeoluwa *et al.*, 2010). A combination of organic and inorganic sources of nutrients led to optimal pH of about 6.0-7.0 which is recommended for nutrient availability and suitable for most tropical field and arable crops. It could be seen that a combination of 4 t ha^{-1} CBH + 200 kg ha^{-1} NPKF, 4 t ha^{-1} CBH + 100 kg ha^{-1} NPKF and 4 t ha^{-1} CBH + 200 kg ha^{-1} NPKF gave highest value of soil N, P and K which are the nutrients most often limiting to tropical crops and deficient tropical soils (especially N and P). The improved soil chemical properties should have enhanced nutrients uptake by melon. The better attributes of the combination of nutrient sources are further confirmed by the relatively high soil organic matter contents and in the cases of 4 t ha^{-1} CBH plus any of 200 or 100 kg ha^{-1} NPKF. The integrated soil fertility management (ISFM) approach supports that there are positive interrelations and complementarities of organic and mineral nutrient sources to support sustained soil fertility and crop productivity. The trend in the values of soil chemical properties indicated that higher values of soil organic matter were more favourable to soil quality hence melon performance. The result of the experiment also showed that soil amendments improved soil fertility and increased growth components of white seed melon relative to control. This is consistent with the findings of Liu & Stutzel (2004) and Adeoluwa *et al.* (2010). The result is also in agreement with that of Prasad & Singh (2000) who reported that soils treated with soil amendments increased number of leaves and other growth components compared with untreated soil.

CONCLUSION

Combination of selected plant residues with synthetic fertilizer (NPK 15:15:15) showed improving effects on soil chemical properties and growth components of white seed melon compared with the control. Combination of 4 t ha^{-1} CBH + 200 kg ha^{-1} NPKF, 4 t ha^{-1} CPW + 200 kg ha^{-1} NPKF and 4 t ha^{-1} CPH + 200 kg ha^{-1} NPKF gave highest value of soil N, P, K, Ca, Mg, ECEC and BS respectively compared to others. The overall results revealed that a combination of plant residues with NPKF particularly 4 t ha^{-1} CBH + 200 kg ha^{-1} NPKF can be used for improving soil with profitable production of white seed melon in the study area.

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