COMPOSITION OF PLANT NUTRIENTS AND FRUIT YIELD OF WHITE SEED MELON (CUCUMEROPSIS MANNII NAUDIN) AT ILE-OLUJI, NIGERIA: AMELIORATIVE EFFECTS OF COMBINED SOIL AMENDMENTS

S. L. Adebisi[1]*, B. S. Ewulo[2] and M. Yahqub[3]
1 Department of Agricultural Technology, Federal Polytechnic, Ile-Oluji, Ondo State, Nigeria
2 Crop, Soil and Pest Management Department. Federal University of Technology, Akure, Nigeria
3 Samaru College of Agriculture, Division of Agricultural Colleges, Ahmadu Bello University, Zaria, Nigeria
*Corresponding Author: sunadebisi@fedpolel.edu.ng ; adebisisunday@gmail.com

ABSTRACT
At Ile-Oluji, Ondo State, Nigeria, a field experiment was carried out to examine the effects of crop wastes mixed with NPK fertilizer (NPKF) on the soil's characteristics, growth, fruit yield, and plant nutritional content of white seed melon. Three cocoa residues—cocoa bean husk (CBH), cocoa pod husk (CPH), and cocoa pod waste (CPW) and kola pod husk, and *Tithonia diversifolia* (Weed Mulch)—were applied in the experiment along with NPK 15:15:15, Fertilizer to produce twelve different fertilizer materials at 4 t/ha CBH + 200 kg/ha NPKF, 4 t/ha CBH + 100 kg/ha NPKF, 4 t/ha CPH + 200 kg/ha NPKF, 4 t/ha CPH + 100 kg/ha NPKF, 4 t/ha CPW + 200 kg/ha NPKF, 4 t/ha CPW + 100 kg/ha NPKF, 4 t/ha KPH + 200 kg/ha NPKF, 4 t/ha KPH + 100 kg/ha NPKF, 2 t/ha WM + 200 kg/ha NPKF, 2 t/ha WM + 100 kg/ha NPKF, 300 kg/ha NPKF, and control. Every treatment was duplicated four times in a randomized complete block design. The SPSS software (version 16) was used to do an analysis of variance (ANOVA) on the obtained data, and Duncan's multiple range test (DMRT) was used to compare the treatment means. In comparison to the control, all of the fertilizer materials evaluated showed a significant ($p < 0.05$) improvement in soil parameters 26 weeks after imposition, as well as in the growth, fruit yield, and plant nutritional composition of white seed melon. In comparison to other amendments, including the control, the three cocoa plant residues combined with NPKF at 4 t/ha CBH + 200 kg /ha NPKF, 4 t/ha CPW + 200 kg/ha NPKF, and 4 t/ha CPH + 200 kg/ha NPKF significantly ($p < 0.05$) enhanced soil pH, organic matter (OM), available P, exchangeable k, Ca, and Mg. These combinations are advised for the improvement of soil properties and the production of white seed melon.

Keywords: Plant nutritional content, fruit yield, combined soil amendments, white seed melon

INTRODUCTION
Soil's ability to supply essential nutrient elements for plant growth without toxic concentration is highly important and desirous of farmers purposely to feed the entire human population (Boyd, 1996). Unfortunately, the dream of producing adequate food by farmers to meet the nutritional demand of people could not be totally achieved as a result of the rapid depletion of soil fertility particularly, in tropical soils With careful soil management, soil properties, productive potentials and capability can be improved to support human beings and other living creatures, agro-industries and the economy of nations. The productive power of the soil which is determined by its physical properties, chemical properties, and organic matter and biotic content and activity has been proved ruinous by different soil management schemes adopted by the farmers currently. Chemical fertilizers are expensive and scarce, using them to replace lost nutrients and increase crop yields is not sustainable (Ojeniyi, 2000). Although, inorganic fertilizers guarantee the nutrients reach crops quickly, their impact on the nutrients that are applied is limited (Okigbo, 2000). Sustainable crop production should focus research on the development of adapted indigenous sustainable soil management techniques in order to boost effectiveness for enhanced productivity per unit area. Traditional nutrient supply through the use of organic material from both plants and animals as fertilizers is also faced with some challenges (Adebisi *et al.,* 2021). The strong competing needs of agricultural wastes and organic matter limit the ability of organic matter to remain in the soil. Fertilizers made of organic materials release nutrients for plant uptake relatively slowly. This demonstrates unequivocally that crop nutrient shortage prior to mineralization may occur as a result of nutrient immobilization. Large amounts of organic materials are also needed, and farmers might not have easy access to them (Agbede & Kalu, 1995; Okigbo, 2000; Adekiya *et al*., 2012). A sustainable way to prevent issues caused by using only organic and inorganic fertilizers is to combine crop or plant leftovers with synthetic fertilizers. In addition to inorganic fertilizer, organic fertilizer has been shown to enhance soil properties and increase crop yields (Cezar, 2004). Ojeniyi & Adeniyan (1999) and Akanbi *et al.* (2013) acknowledged the need to step up research into inexpensive, readily available, locally derived organic sources of plant nutrients.

MATERIALS AND METHODS
Experimental site, location
The study was carried out at the Federal Polytechnic Ile Oluji Teaching and Research Farm, which is situated at an altitude of 247 meters and in the Nigerian rainforest zone at latitude 7° 20′ N and longitude 4° 87′ E. The area experiences bimodal

rainfall, ranging from 1250 to 1460 mm, with an average yearly rainfall of 1367 mm and approximately 112 rainy days on average. The year-round average temperature ranges from 23 to 32 degrees Celsius, with few variations from the yearly mean of 27 degrees. The two warmest months, February and March, had mean temperatures of 28°C and 27°C, respectively. The average yearly radiation is approximately 130 kcal cm-3, and there are roughly 2000 hours of sunshine per year. The area lies in the upper forest zone, which was formerly home to lush tropical woods. Tropical humidity characterizes the area, with distinct wet and dry seasons. Its late March through October wet season begins, with a brief dry season in August.

Experimental design and treatments

Every treatment was duplicated four times in a randomized complete block design for the experiment. The entire space used was 1176 m^2 (24 m × 49 m). With an unused area of 1 meter within the plots and 2 metre between the blocks, each plot was 4 m by 3 m. In addition to 200 or 100 kg/ha NPK 15:15:15 fertilizer (NPKF) and 300 kg/ha NPKF and control (no amendment), the trial involved the application of 4 t/ha cocoa bean husk (CBH), cocoa pod husk (CPH), cocoa pod waste (CPW), Kola pod husk (KPH), and 2 t/ha *Tithonia diversifolia* (weed mulch (WM). Each hole was seeded with two white melon seeds, which were then thinned to one at a distance of one metre by one metre, for a total of twenty (20) plants per plot.

Chemical analysis of the soil of the experimental site

Prior to the experiment soil samples that were chosen at random from a depth of 0 to 20 cm were thoroughly mixed to create a composite, which was then subjected to physical and chemical analysis. As mentioned by Carter (1993), additional composite samples were taken during harvest on a plot basis and subjected to regular chemical analysis in a similar manner. Prior to making the conclusions, the soil samples were allowed to dry naturally and then sieved through a 2 mm sieve. Total N was determined by the micro-Kjeldahl digestion method (Bremner, 1996), available P was determined by Bray-1 extraction followed by molybdenum blue colorimetry (Frank, 1998), and soil organic matter was determined by the procedure of Walkley and Black using the dichromate wet oxidation method (Nelson & Sommers, 1996). Utilizing 1.0 N ammonium acetate, exchangeable K, Ca, and Mg were removed. After that, an EDTA titration procedure was used to estimate Ca and Mg, and a flame photometer was used to determine K (Hendershot & Lalande, 1993). The pH of the soil in a soil water (1:2) media was measured using a digital electronic pH meter. Particle size analysis was conducted using Bouyouco's hydrometer technique (Sheldrick & Wang, 1993).

Sources and chemical analysis of the organic amendments

Cocoa Products Limited, Ile-Oluji, Ondo State, Nigeria was the source of the cocoa bean husk. A nearby farm in Ile-Oluji provided the cocoa pod, kola pod, and weed mulch. Placenta, pulp, and dust from cocoa produce were gathered at Ile-Oluji's cocoa supply stores as cocoa waste. Wet digestion was used to process organic materials. P, K, Ca, and Mg were measured using the filtrate from the treated organic materials. The micro-Kjeldhal method was used to estimate the nitrogen content, and vanado molybdate colorimetry to determine P (IITA, 1979). A Perkin Elmer Atomic Absorption Spectrophotometer was used to measure the K, while a PFP-7 flame photometer was used to measure the Ca and Mg.

Data gathering and statistical evaluation

To determine growth and yield, five white seed melon plants were randomly chosen from each of the four plots. The number of leaves, branches, fruits, fruit length, fruit girth, and fruit weight were among the factors that were evaluated. The SPSS software (version 16) was used to do an analysis of variance (ANOVA) on the obtained data, and Duncan's multiple range test (DMRT) was used to compare the treatment means.

RESULTS

Soil properties of the experimental site prior to planting

The soil properties of the experimental site prior to amendment application and planting are shown in Table 1. The results showed that the soil's textural class was sandy loam; it was also found to be acidic, low in N, available P, exchangeable K, and OM when compared to the rating of Akinrinde & Obigbesan (2000). Since the soil's capacity to supply essential elements needed for plant growth is a prerequisite for crop production, results indicated that additional soil conditioner and amendment would be required before the soil could produce a crop.

Table 1: Physical and chemical properties of soil of the experimental sites prior to planting

Soil Properties	Values
pH (H_2O)	5.83
OM (g /kg)	2.36
N (g /kg)	0.20
P (mg/kg)	15.14
K (cmol/kg)	0.17
Ca (cmol/kg)	2.61
Mg (cmol/kg)	1.24
Sand (g/kg)	739
Silt (g/kg)	147
Clay (g/kg)	114
Textural Class	Sandy Loam

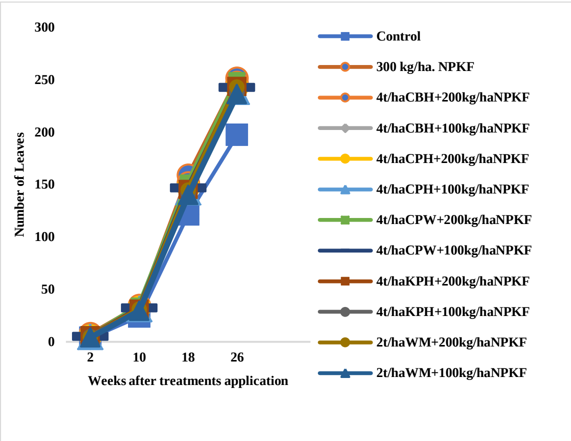

Figure 1: Effects of combined application of NPKF with CBH, CPH, CPW, KPH and WM on number of leaves of white Seed melon at Ile-Oluji

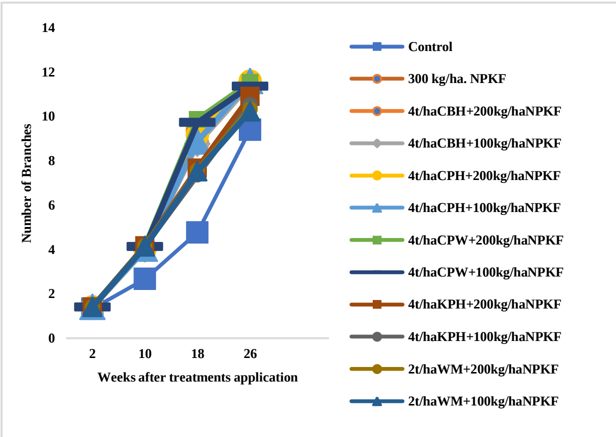

Figure 2: Effects of combined application of NPKF with CBH, CPH, CPW, KPH and WM on number of branches of white seed melon at Ile-Oluji

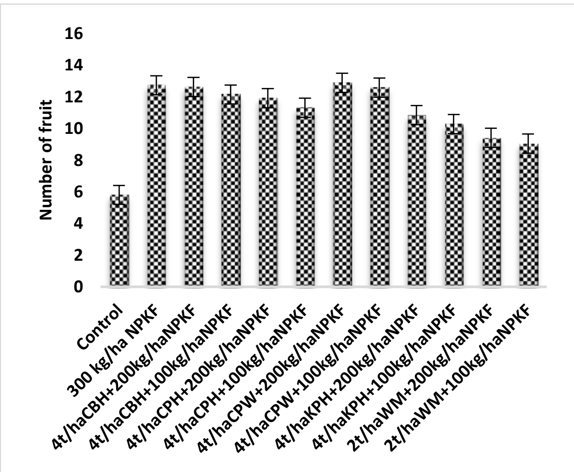

Figure 3: Effects of combined application of NPKF with CBH, CPH, CPH, CPW, CPW, KPH and WM on number of fruits of white seed melon at Ile-Oluji

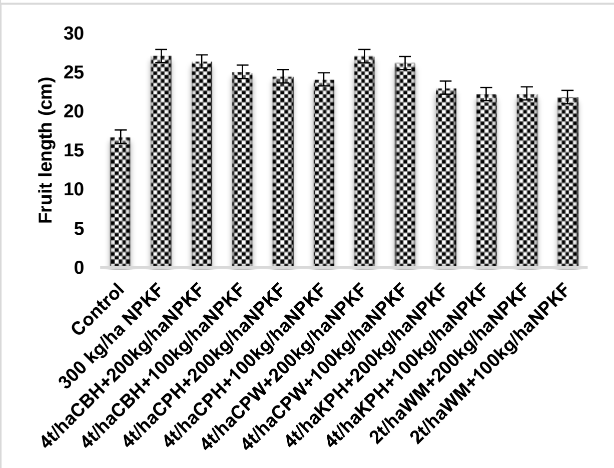

Figure 4: Effects of combined application of NPKF with CBH, KPH and WM on fruit length of white seed melon at Ile-Oluji

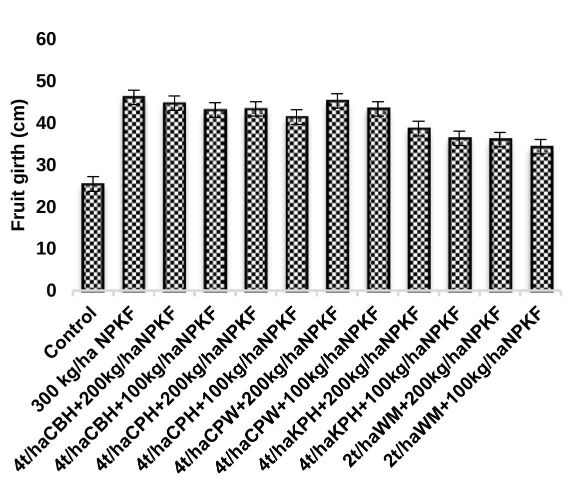

Figure 5: Effects of combined application of NPKF with CBH, CPH, CPH, CPW, CPW, KPH and WM on fruit girth of white seed melon at Ile-Oluji

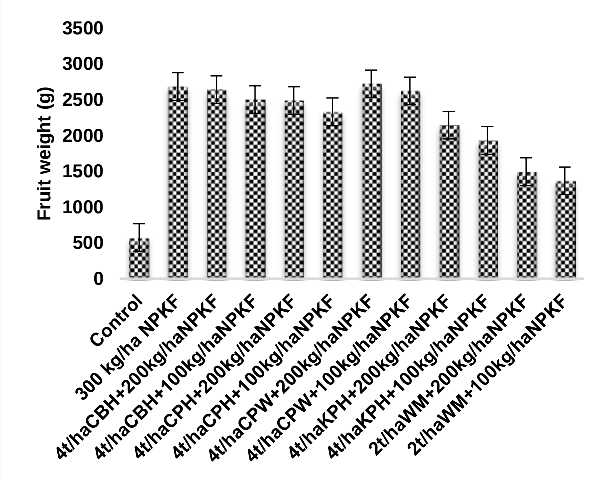

Figure 6: Effects of combined application of NPKF with CBH, KPH and WM on fruit weight of white seed melon at Ile-Oluji

Table 2: Effects of combined amendments on selected soil chemical properties at twenty-six weeks after treatments imposition for the production of white seed melon (*Cucumeropsis mannii*) at Ile-Oluji

Treatments	pH (H_2O)	OM (%)	N (%)	P (mg/kg)	K (cmol/kg)
Control	5.01e	1.87g	0.18j	8.27e	0.38k
300 kg/ha NPKF	5.34d	2.16f	0.94a	26.48a	0.82f
4 t/ha CBH + 200 kg/ha NPKF	6.41a	4.69a	0.92c	24.01a	0.91a
4 t/ha CBH + 100 kg/ha NPKF	6.24b	4.63a	0.89d	22.51ab	0.87c
4 t/ha CPH + 200 kg/ha NPKF	6.43a	4.67a	0.92c	24.03a	0.90b
4 t/ha CPH + 100 kg/ha NPKF	6.41a	4.62a	0.86e	22.47ab	0.85e
4 t/ha CPW + 200 kg/ha NPKF	6.39a	4.38c	0.93b	24.01a	0.91a
4 t/ha CPW + 100 kg/ha NPKF	6.22b	4.29d	0.86e	22.52ab	0.86d
4 t/ha KPH + 200 kg/ha NPKF	6.25b	4.46b	0.71f	21.27ab	0.81g
4 t/ha KPH + 100 kg/ha NPKF	6.05c	4.45b	0.68g	21.11ab	0.74i
2 t/ha WM + 200 kg/ha NPKF	6.02c	3.11e	0.67h	19.27c	0.77h
2 t/ha WM + 100 kg/ha NPKF	6.02c	3.02e	0.65i	17.03d	0.61j

NPKF = NPK fertilizer, CBH = cocoa bean husk, CPH = cocoa pod husk, CPW = cocoa pod waste, KPH = kola pod husk and WM = weed mulch: means with the same letters are not significantly different ($P < 0.05$) from other.

Table 3: Effects of combined amendments on nutrient composition of white seed melon at maturity (*Cucumeropsis mannii*) at Ile-Oluji

Treatments	Plant nutrient composition				
	N (%)	P (%)	K (%)	Ca (%)	Mg (%)
Control	0.19g	0.10k	0.23i	0.43h	0.23j
300 kg/ha NPKF	1.71b	0.43a	1.61a	0.59g	0.32i
4 t/ha CBH + 200 kg/ha NPKF	1.91a	0.41b	1.63a	1.10a	1.01b
4 t/ha CBH + 100 kg/ha NPKF	1.21c	0.36e	1.42c	1.10a	0.82g
4 t/ha CPH + 200 kg/ha NPKF	1.64b	0.39c	1.24e	1.08b	1.11a
4 t/ha CPH + 100 kg/ha NPKF	1.31c	0.32f	1.11g	0.98c	0.92d
4 t/ha CPW + 200 kg/ha NPKF	1.62b	0.39c	1.48b	1.10a	0.99c
4 t/ha CPW + 100 kg/ha NPKF	1.41bc	0.22i	1.11g	0.98c	0.93d
4 t/ha KPH + 200 kg/ha NPKF	1.46bc	0.37d	1.42c	1.11a	0.93d
4 t/ha KPH + 100 kg/ha NPKF	0.86de	0.31g	1.32d	0.94d	0.88e
2 t/ha WM + 200 kg/ha NPKF	0.94d	0.23h	1.21f	0.72e	0.86f
2 t/ha WM + 100 kg/ha NPKF	0.48f	0.21j	0.72h	0.60f	0.62h

NPKF = NPK fertilizer, CBH = cocoa bean husk, CPH = cocoa pod husk, CPW = cocoa pod waste, KPH = kola pod husk and WM = weed mulch: means with the same letters are not significantly different ($P < 0.05$) from other.

Combined Effects of NPKF with CBH, CPH, CPW, KPH and WM on Growth Components of white seed melon at Ile-Oluji

The result of the effects of combined application of NPKF with CBH CPH, CPW, KPH and WM on the number of leaves of white melon at Ile-Oluji is presented in Figure 1. When fertilizer ingredients were applied, compared to the control, there were more leaves at 2, 10, 18, and 26 WATA. In terms of the quantity of white seed melon leaves, plants treated with 300 kg/ha NPK fertilizer did not differ substantially from those treated with 4 t/ha CBH + 200 kg/ha NPKF, 4 t/ha CPW + 200 kg/ha NPKF, and 4 t/ha CPH + 200 kg/ha NPKF, but they did differ significantly when compared to other fertilizer materials. Out of all the fertilizer materials, the plant treated with 2 t/ha WM + 100 kg/ha NPKF produced the fewest leaves, however it had a considerably higher number than the control ($p < 0.05$).

The results of applying NPKF in combination with CBH, CPH, CPW, KPH, and WM to the number of branches of white seed melon at Ile-Oluji are displayed in Figure 2. It was discovered that applying the fertilizer materials increased the quantity of white seed melon branches in comparison to the control. The average branch count for 4 t/ha CBH + 200 kg/ha NPKF, 4 t/ha CPW + 200 kg/ha NPKF, and 4 t/ha CPH + 200 kg/ha NPKF did not differ significantly ($p < 0.05$) from the plot that received 300 kg/ha of NPK fertilizer amendment.

Combined Effects of NPKF with CBH, CPH, CPW, KPH and WM on yield components of white seed melon at Ile-Oluji

Figure 3 illustrates the impact of NPKF in combination with CBH, CPH, CPW, KPH, and WM on the quantity of fruits produced by white seed melons. When NPK fertilizer was added to all the amendments at 200 kg/ha and 100 kg/ha rates, the average number of fruits produced was higher and showed a significant difference from the control. The values for KPH + 200 kg/ha and KPH + 100 kg/ha were considerably ($p < 0.05$) higher than WM + 200 kg/ha and WM + 100 kg/ha, as were the values for 4 t/ha CBH + 200 kg/ha NPKF, 4 t/ha CPW + 200 kg/ha NPKF, and 4 t/ha CPW + 100 kg/ha NPKF.

Figure 4 depicts how the combined application of various fertilizer ingredients with NPKF affects the white seed melon's fruit length. When compared to the control, the combined fertilizers greatly increased the length of the fruit. In comparison to CBH + 100 kg/ha, CPH + 200 kg/ha, and CPH + 100 kg/ha, which recorded a substantial ($p < 0.05$) increase in fruit length. The values obtained from CBH + 200 kg/ha, CPW + 200 kg/ha, and CPW + 100 kg/ha were significantly ($p < 0.05$) higher but not significantly different from one another.

The effects of combined amendments on fruit girth are presented in Figure 5. All the amendments increased the fruit girth of white seed melon irrespective of combination rates compared to the control. Plots treated with CPW + 200 kg/ha and CPH + 200 kg/ha paired with NPKF showed a significant ($p < 0.05$) increase in the mean value of fruit girth. While there was no significant difference between the values observed for CPH + 200 kg/ha and CPW + 200 kg/ha, there was a substantial increase in fruit girth when compared to other treatments.

The effect of combined application of cocoa and plant residues with NPKF on the fruit weight of white seed melon is shown in Figure 6. All the fertilizer materials in combination with NPKF significantly ($p < 0.05$) improved the fruit weight of white seed melon relative to control. Plants treated with CPH + 200 kg/ha, CBH + 200 kg/ha, CPW + 100 kg/ha, CBH + 100 kg/ha and CPH + 100 kg/ha were not significantly ($p < 0.05$) different from one another but showed significant ($p < 0.05$) weight increase over others.

Effects of combined amendments on soil chemical properties at 26 WATA

The effect of combined organic soil amendments on soil properties at 26 weeks after treatment imposition is shown in Table 2. The pH values obtained for soils were generally increased by combined amendments irrespective of sources and rates. The soil pH values ranged from 5.06 - 6.66. Significant ($p < 0.05$) increases in pH values were observed in all the plots treated with the combination of plant residues with NPKF. The addition of soil amendments was found to have improved soil pH values significantly ($p < 0.05$). The least soil pH value was observed in the control plot and soil treated with 300 kg NPKF.

The OM values ranged from 1.85 – 4.93 g/kg. The addition of combined amendments significantly improved soil OM relative to the control and 300 kg/ha NPKF. Among the combined soil amendments tested, 2 t/ha WM + 100 kg/ha NPK had the least values of OM (3.45 and 2.97 %) but was significantly ($p < 0.05$) higher than the soil treated with 300 kg/ha NPKF and the control.

The soil N values ranged from (0.20 – 0.89 %). The least value of soil N was recorded for the control and it was significantly lower than the values of N obtained for all the soil amendments. The highest value of soil N was recorded for soil treated with 300 kg/ha NPKF followed by 4 t/ha CBH + 200 kg/ha NPKF and 4 t/ha CPH + 200 kg/ha NPKF. All the amendments significantly improved soil N irrespective of nutrient sources and rates.

Available P content was significantly improved by the soil amendments irrespective of sources and rates of nutrients compared to the control. The soil available P ranged from (7.88 – 25.92 mg/kg). The highest value of available P was observed in the soil treated with 300 kg/ha NPKF and it was significantly ($p < 0.05$) higher than the values of available P obtained for other soil amendments. The values of soil exchangeable K revealed that all the amendments significantly increased soil K content relative to the control. Values of exchangeable K (0.97, 0.94 and 0.92 mg/kg) were respectively recorded for soil treated with 4 t/ha CBH + 200 kg/ha NPKF, 4 t/ha CPH + 200 kg/ha NPKF and 300 kg/ha NPKF and they were not significantly different from one another but showed a significant increase compared with other soil amendments. The least exchangeable K was obtained for the control.

Effects combined amendments on plant nutrient composition of white seed melon at maturity

The nutrient composition of the white seed melon plant was affected by combined soil amendments as shown in Table 3. The plant N content after harvest was significantly ($P < 0.05$) higher in all the plants treated with combined amendments relative to the control. The values of N content ranged from 0.19 to 1.91 %. Among the plants treated with combined amendments, 2 t/ha WM + 200 or 100 t/ha NPKF had the least content of plant N although, it was significantly higher than the control.

The various fertilizer types imposed during the experiments irrespective of sources or rates significantly ($p < 0.05$) increased plant P relative to the control. The highest and least values (0.43 and 0.10 %) of P were obtained for 300 kg/ha NPKF and the control respectively, 4 t/ha WM and 2 t/ha WM + 100 kg/ha NPK produced lower values of plant P.

The plant K content ranged from 0.23 to 1.92 %. Plants treated with 6 t/ha CBH + 200 kg/ha NPKF had the highest 1.82 % value of plant K but it was not different from 300 kg/ha NPKF while the control had the least value of K.

Combined amendments produced similar effects on plant Ca composition of white seed melon. The Ca composition of white seed melon increased from 0.43 to 1.11 %. The values of Ca were highest for the plants treated with 6 t/ha CBH and 6 t/ha CPW in combination with 200 kg/ha NPKF.

DISCUSSION

Tropical soils are fragile and it requires careful management to prevent further degradation of its properties. The use of sole organic or inorganic fertilizer is not sustainable enough due to the delay being experienced in nutrient release and loss through volatilization and erosion respectively. Combined soil amendments involving the application of organic and inorganic fertilizer is suitable for sustainable crop production on a continuous basis due to its ability to release nutrients consistently for crop use without experiencing initial starvation (Adebisi *et al.*, 2020). The increase in the number of leaves and branches of white seed melon as observed in this research could be attributed to the availability of required nutrients through the application of the fertilizer materials that enhanced more production of leaves and branches which improved the yield. The outcomes of this study are consistent with those of (Adebisi *et al.*, 2021), who found that the growth components of white seed melon were improved when specific plant residues were combined with synthetic fertilizer. Yield increase, improved soil chemical properties and plant nutrient content observed from this research were due to the consistent release of nutrients by the combined amendment without starvation. This may not be possible with the use of sole organic or inorganic fertilizer. This is in line with studies by Adepetu *et al.* (1997) and Vanauwe *et al.* (2004), which found that using a combination of inorganic and organic fertilizers is appropriate for managing soil nutrients in a sustainable manner.

CONCLUSION

Application of plant or crop residues in combination with 200 kg/ha NPKF as a soil amendment is found suitable through this research. Plant growth, yield, plant nutrient composition and soil chemical properties were improved by the fertilizer materials. The fertilizer material is highly useful for soil improvement and the production of crops as observed in white seed melon production.

REFERENCES

Adebisi, S., Adekiya, A. O. & Ojeniyi, S. O. (2016). Study into tillage-mulch package for production of sweet potato (Ipomoea batatas L.) effect on soil properties and yield. *Scientia Agriculturae*. 15 (2), 361-366

Adebisi, S. L., Agbona, A. I. & Akande, G. M. (2020). Residual effects of combined soil amendments on soil chemical properties and growth performance of white seed melon (*Cucumeropsis mannii*) at Kabba Nigeria. *Int'l Journal of Agric. And Rural Dev. 23(2), 5176-5183*

Adebisi, S. L. Yahqub, M. & Akande, G. M. (2021). Soil chemical properties and growth performance of white seed melon *(Cucumeropsis mannii* Naudin) influenced by combined soil amendments in Ile-Oluji, Nigeria. *Plants and Environment* 3(1): 1-7

Adekiya, A. O., Ojeniyi, S. O. & Agbede, M. T. (2012). Poultry manure effects on soil properties, leaf nutrient status, growth and yield of cocoyam in a tropical Alfisol. *Nigerian Journal of Soil Science*, 22(2): 30-39.

Adepetu, J. A., Aduayi, E. A. & Alofe, C. O. (1997). Preliminary survey of the fertility status of soil in Ondo state under traditional cultivation. *Ife Journal of Agriculture*, 1: 134-149.

Agbede, O. O. & Kalu, B. A. (1995). Constraints of small-scale farmers in increasing crop yields, farm size and fertilizer supply.

Nigeria Journal of Soil Science, 11:139-152.

Akanbi, O. S., Famaye, A. O., Ojeniyi, S. O., Nduka, B. A., Taiwo, N., Olasupo, F. O., Azeez, O. M., Edibo, G. O. & Gbemisola, D. O. (2013). Growth response of Cashew seedlings to applied organic fertilizer of animal and plant origin on degraded soil in Ibadan,
Southwest Nigeria. *International Research Journal of Agricultural Science and Soil Science*, 3(3): 93-98.

Akinrinde, E. A. & Obigbesan, G. O. (2000). Evaluation of the fertility status of selected soils for crop production in five ecological zones of Nigeria. In: Proceedings of the 26th Annual Conference of *Soil Science Society of Nigeria*, Ibadan, Nigeria, pp. 279-288.

Boyd, E. (1996). *Soil Fertility*, Second Edition by Publisher: CRC Press.

Bremner, J. M. (1996). Nitrogen-total. In: Sparks D.L. (Ed.) Methods of Soil Analysis. Part 3. Chemical Methods. 2nd Ed. SSSA Book Series No. 5, ASA and SSSA, Madison, WI, USA. pp. 1085-1121.

Carter, M. R. (1993). Soil sampling and methods of analysis. Canadian Society of Soil Science, Lewis Publishers London, pp. 823.

Cezar, P. M. (2004). Organic Fertilizer in Rice: Myths and facts. A public education series of the Asia Rice Foundation.

Frank, K., Beegle, D. & Denning, J. (1998). Phosphorus. In: Brown J. R. (Ed.) Recommended Chemical Soil Test Procedures for the North Central Region, North Central Regional Research Publication No. 221 (revised). Missouri Agric. Exp. Stn., Columbia, MO, pp. 21-26.

Hendershot, W. H. & Lalande, H. (1993). Ion exchange and exchangeable cations. In: Carter M.R. (Ed.) Soil Sampling and Methods of Analysis. Canadian Society of Soil Science, Lewi Publishers, London, pp. 167-176.

Nelson, D. W. & Sommers, L. E. (1996). Total carbon, organic carbon and organic matter. In: Sparks D.L. (Ed.) Methods of Soil Analysis. Part 3, 2nd Ed. SSSA Book Series No. 5, SSSA, Madison, WI., USA, pp. 961-1010.

Ojeniyi, S. O. & Adeniyan, N. O. (1999). Effect of poultry manure and NPK fertilizer on soil fertility, nutrient contents and yield of maize at Akure South West Nigeria in: Management of the soil resources of Nigeria for sustainable agricultural production in the 21st century. In: Proceedings of the 25th Annual Conference of the *Soil Science Society of Nigeria (SSSN)*, Benin City, Nigeria, pp. 185-191.

Ojeniyi, S. O. (2000). Effect of goat manure on soil nutrients and okra yield in a rainforest area of Nigeria. *Applied Tropical Agriculture*, 5: 20-23.

Okigbo, I. (2000). Application of organic and inorganic fertilizers and the response of maize crop. *Nigerian Journal of Soil Science*,18(2): 22.

Sheldrick, B. H. & Wang, C. (1993). Particle-size distribution. In: Carter M.R. (Ed.) Soil Sampling and Methods of Analysis. *Canadian Society of Soil Science*, Lewis Publishers, Ann Arbor MI, pp. 495-511.

Vanauwe, B., Diels, J., Sanginga, N. & Merckx, R. (2004). *Integrated Plant Nutrient Management in Sub-saharan Africa*: From Concept to Practice. CABI Publishing. Oxon, U. K., pp. 352