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Original Article

Efficacy of lemongrass (*Cymbopogon citratus* DC Stapf) and wild spikenard (*Hyptis suaveolens* L. Poit) compost on the productivity of cowpea (*Vigna unguiculata* L. Walp)

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ABSTRACT

This study compared the effects of composts from lemongrass (*Cymbopogon citratus*) (CCT), wild spikenard (*Hyptis suaveolens*) (HYS) and NPK fertilizers on the growth and yield performances of three varieties of cowpea (FUAMPEA1, FUAMPEA2 and SAMPEA14). A field experiment was designed using the Randomized Complete Block Design of 3 blocks, 3 varieties, 3 treatments, and 5 replications. Plant spread varied between 25.5cm and 114.2cm with an average of 18.5 pods per plant. Number of leaves was significantly higher in FUAMPEA2 (133.5) than other varieties. FUAMPEA1 produced more branches (9.3) than other varieties. Application of NPK fertilizer significantly improved the plant spread (142.4cm) and the number of branches (8.5). Meanwhile, both NPK and HYS had equal effect on leaf length with values of 13.7cm and 13.2cm respectively but they performed better than CCT. Leaf width improved significantly in NPK (6.15 cm) more than compost. The number of flowers remained unvaried among the three varieties whereas varieties differed significantly in all other yield parameters. Number of pods varied between 10.6 pods in SAMPEA14 to 23.2 pods in FUAMPEA2. The latter

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produced longer pods (13.1cm) and heavier seeds (39.67g/100 seeds) than other varieties. Treatments produced varied responses on all yield parameters ($p<0.05$). Application of NPK fertilizer significantly influenced the number of pods, flowers and seed weight whereas CCT and HYS had equal effects on these parameters. Pod sizes were significantly higher in CCT (12.54cm), followed by HYS (11.98cm) while NPK produced the shortest pods. Seed sizes were the same in the treatments ($p>0.05$). The use CCT and HYS composts are recommended to supplement NPK fertilizer as treatments were found to enhance pod and seed sizes only while HYS had positive effects on leaf sizes. They could serve as potential sources of making organic compost to improve soil and enhance productivity of cowpea.

Keywords: Cowpea, Cymbopogon, Hyptis, Organic compost, Productivity

INTRODUCTION

Cowpea (*Vigna unguiculata*) is an important tropical food legume for humans and especially for livestock in the dry savanna zone of the tropics. Cowpea is an important crop because it is a cheap source of protein for human and livestock nutrition. Cowpea forage (vines and leaves), fresh or as hay or silage is often used for fodder while attempts have been made using cowpea leaf meal for feeding pigs. The haulms, residues from seed production, contain about 45-65% stems and 35-50% leaves and sometimes roots (Anele et al., 2012; Omotayo and Chukwuka, 2019).

The increase in world population and climate change factors have created new concerns about the ability of the world to feed itself in a sustainable manner (Cassman et al., 2013). This is because the use of land for other purposes has resulted in the sharp degradation of agricultural natural resources particularly, the soil. In addition, the hot and humid tropical environment is characterized by rapid weathering of soils resulting in large areas of ultisols and oxisols (Udoh & Iren, 2016). The ultisols and oxisols regions have poor chemical properties and this adversely affects agriculture in these regions. The portability, high nutrient concentration, nutrient stability and high crop yield of inorganic fertilizers led to over-dependence on inorganic fertilizers as both a soil and crop improvement method (Udoh & Iren, 2016). However, inorganic fertilizers cannot correct excessive degradation of soils by a high rainfall climate. In addition, the high cost of inorganic fertilizers makes them unaffordable for poor farmers (Udoh & Iren, 2016). More so, the continuous use of chemical fertilizers has been reported to result in nutrient imbalance in the soil, hence the need for compost manures for crop production (Maheshbabu et al., 2018; Adeniyan et al., 2011). Besides, the first step in any farming practice in a tropical environment is the use of organic manure. This is because organic matter is an essential part of soil physical properties, aggregation and moisture-holding capacity. This provides a platform for good productivity. Therefore, a soil and crop improvement method that is able to preserve the satisfactory physical and chemical conditions of the soil should be employed (Golabi et al., 2014; Argaw, 2017).

Inorganic fertilizers in Nigeria are often not obtained at the right time and are at a high cost which is not affordable for smallholder farmers who are basically producing at a subsistence level. The country is endowed with large quantities of organic composts that could be used as alternative sources of nutrients in crop production. However, the appropriate application rates are still debatable and highly controversial because of the high variation in compost nutrient composition. A good number of researches have shown soils amended with animal manures and plant compost improved soil conditions and crop yields (Iren et al., 2011; John et al., 2013; Udoh et al., 2016; Khaliq et al., 2017). Ayeni and Adetunji (2010) reported that organic fertilizers positively impacted soil nutrients, soil structure, base saturation and bulk density. Composted manure is a good substrate for the growth of soil microorganisms and they positively affect the nutritional balance and the physical properties of soil (Maheshbabu et al., 2018). Soils treated with compost manures have been reported to significantly improve soil productivity and the yield of maize (John et al., 2013). Iren et al., (2011) reported that organic manures improved the sustained production of Waterleaf (*Talinum fruticosum*). The choice of *Cymbopogon citratus* and *Hyptis suaveolens* based compost is the ease of availability in the study area. The latter grow as weed plants with devastating effects on food crops. The cost of weed control due to the plant is high. Thus, this study offers an opportunity to convert weed plants into a usable form of compost, that may support the growth and yield of food crops. The aim of this study was to compare the effects of organic composts from *C. citratus* (CCT) and *H. suaveolens* (HYS) and NPK fertilizers on the growth and yield of cowpea varieties.

MATERIALS AND METHODS

Study Area

The experiment was conducted during the August to October cropping season at the Joseph Sarwuan Tarka University, Makurdi (JOSTUM), Benue State, Nigeria. Makurdi town lies between latitude 7°44' N and longitude 8°32' E covering an area of 820km^2 with an estimated population of 348,990 people (National Population Commission of Nigeria, 2011). The soil type in the location is Alfisols on Argillaceous sediments (Kwari et al., 1999). The vegetation type in Makurdi is the Guinea Savannah type.

Meteorological Data

Makurdi's rainfall ranges from 1290mm to 1585mm with an average temperature of 26°C (Nigerian Meteorological Agency, Headquarters, Tactical Air Command, Makurdi-Airport).

Physicochemical Data of Soil

The physicochemical properties of soil samples of the experimental sites as obtained from the Department of Soil Science, JOSTUM are presented. It is sandy loam made up of 77.6% sand, 13.2% silt and 9.2% clay. On the average, it has the following properties: 5.90 pH, 10.7g kg^{-1} organic carbon, 0.05% nitrogen, and 7.61mg kg^{-1} phosphorus.

Collection os Samples

Seeds of Cowpea (*V. unguiculata*) were obtained from the University (JOSTUM) Seed Technology Center. The seeds of the varieties of *V. unguiculata* cultivars collected were FUAMPEA1, FUAMPEA2 and SAMPEA14. *Cymbopogon citratus* and *H. suaveolens* were collected from the Northbank area of Makurdi metropolis, Benue State. Authentication was done by the Botany Department of the Joseph Sarwuan Tarka University, Makurdi, Benue State.

Field Preparation

The Botanical Garden of the above name institution was prepared. The research plot measured 15×20m and was cleared and divided into (3) three blocks of equal sizes. The tilling operation was done manually with hoe and a cutlass was used for clearing of bushes (Elawad & Hall, 2017). These blocks were prepared with a distance of 0.7m between ridges and the spacing of 1.02m between each plant.

Compost Preparation

The procedures outlined in Golabi et al. (2014) was used in preparing the compost. This was done in the Botanical Garden of the above-named institution. Fresh leaf samples were placed in the pit, kept moist and covered with a layer of cowdung organic manure. A dry grass layer was added to retain moisture, heat and nutrients. Composting lasted for 30 days (Cahyono et al., 2020) from 1st June to 30th June, 2024. The experiment lasted for 91 days from June 30th (seed sowing) to October 2nd, 2024 (harvest time).

Experiment Design Structure

A field experiment was designed using the Randomized Complete Block Design of 3 blocks, 3 varieties (FUAMPEA1, FUAMPEA2 and SAMPEA14), 3 treatments, and 5 replications. The treatments were composts from *C. citratus* (CCT) and *H. suaveolens* (HYS) while NPK fertilizer (20:10:10 brand) served as positive control (Elawad & Hall, 2017). Treatments were applied as a single dose of 25t ha^{-1} in a row, for both composts and fertilizer, 7 days before planting (Cahyono et al., 2020).

Data Collection and Evaluation

Growth parameters measured were: plant height (cm), stem girth, leaf breadth, number of leaves, and number of branches. Plant vigor using Likert scale 0-5. Standard descriptors were used in the evaluation of the following yield parameters: number of flowers, number of pods, pod length, seed weight, seed length and seed width. Measurements were taken using a ruler and digital weighing balance (Elawad & Hall, 2017).

Statistical Analysis

Data collected were analyzed using descriptive statistics and multivariate statistical tools test for determination of significant differences among the three cowpea cultivars. Genstat Statistical software was used for the analysis. Mean separation was done using least significant difference (LSD) at 95% confidence interval (p<0.05).

RESULTS

Plant Description

Table 1 describes the growth and yield parameters of the cowpea varieties. The mean plant height was 12.5cm and ranged from 5cm to a maximum of 28cm for FUAMPEA 1. The mean leaf length was 11.3cm ranging from 7-18cm. Plant spread was between 25.5cm and 114.2cm with a mean of 85.7cm. Average number of branches was 9.3 ranging from 3-18 branches. Pods recorded average value of 18.5 per plant ranging from 4 to 50 pods. Minimum and maximum pod sizes were 2.5cm and 20.5cm respectively with an average pod size of 18.6cm. Seeds weighed 103.2g per 100 seeds on the average while seed length was an average of 0.7cm.

Table 1. Descriptive statistics of cowpea characters

Character	Minimum	Maximum	Mean±SE
Plant height (cm)	5.0	28.0	12.5±3.25
Leaf length (cm)	7.0	18.0	11.3±2.11
Plant spread (cm)	25.5	114.2	85.7±4.51
Number of branches	3.0	18.0	9.3±1.19
Number of pods	4.0	50.0	18.5±2.18
Pods length (cm)	2.5	20.5	18.6±2.08
Weight of seed/100 seeds (g)	5.8	120.6	103.2±6.33
Seed length (cm)	0.5	1.0	0.7±0.02

Varietal and Treatment Effects on Growth Parameters

Analysis of variance of the two factors evaluated on growth parameters is shown in the appendix. Varieties differed significantly (p<0.05) in the number of leaves and branches. The three treatments (NPK, CCT and HYS) significantly affected plant spread, number of branches and leaf sizes (p<0.05). The interaction of treatments and varieties was significant in plant height, plant spread, number of branches and leaf sizes (p<0.05). Table 2 shows the effect of variety factor on the growth performance of cowpea. Number of leaves was significantly higher for FUAMPEA2 (133.5) than other varieties. FUAMPEA1 produced more branches (9.3) with longer (10.51cm) and wider (5.21cm) leaves than other varieties. Table 3 gives the effects of treatments on the growth performance of cowpea. All treatments produced the same responses on plant height and number of leaves as the observed differences among them were insignificant (p>0.05). Application of NPK fertilizer significantly improved the plant spread (142.4cm) and the number of branches (8.5). Meanwhile, both NPK and HYS had equal effect on leaf length with values of 13.7cm and 13.2cm respectively but they performed better than CCT. Leaf width improved significantly in NPK (6.15cm) more than compost.

Table 2. Effect of varieties on the growth performance of cowpea

Varieties	Plant Height (cm)	Plant Spread (cm)	Number of Leaves	Number of Branches	Leaf Length (cm)	Leaf Width (cm)
FUAMPEA1	12.5^{a}	85.7^{a}	88.5^{b}	9.35^{ab}	10.51^{a}	5.21^{a}
FUAMPEA2	11.6^{a}	83.9^{a}	133.5^{a}	6.51^{a}	9.96^{a}	4.96^{a}
SAMPEA14	10.9^{a}	84.1^{a}	93.4^{b}	6.27^{a}	10.15^{a}	4.99^{a}
LSD (0.05)	3.15	11.58	12.58	2.21	0.95	2.15

Means with different superscripts are significantly different at $p \leq 0.05$

Table 3. Effect of treatments on growth parameters of cowpea

Treatment	Plant Height(cm)	Plant Spread (cm)	Number of Leaves	Number of Branches	Leave Length (cm)	Leave Width (cm)
NPK	15.24^{a}	142.38^{a}	96.18^{a}	8.52^{a}	13.65^{a}	6.15^{a}
CCT	12.11^{a}	85.77^{c}	95.91^{a}	6.58^{a}	10.22^{b}	4.55^{b}
HYS	13.55^{a}	108.2^{b}	95.93^{a}	5.98^{ab}	13.18^{a}	4.61^{b}
LSD (0.05)	16.15	19.18	1.53	1.64	0.81	1.51

Means with different superscripts are significantly different at $p \leq 0.05$
NPK = Inorganic fertilizer; CCT=*C. citratus;* HYS=*H. suaveolens*

Varietal and Treatment Effects on Yield Parameters

Analysis of variance of the two factors evaluated on yield parameters is given in the appendix. The varieties varied significantly in all yield parameters ($p<0.05$) except the number of flowers produced. The three treatments (NPK, CCT and HYS) showed significant differences ($p<0.05$) on all yield parameters ($p<0.05$). The interaction of treatments and varieties gave significant effects only on the number of flowers, pod length and seed weight ($p<0.05$). Table 4 shows the effect of variety factor on the yield performance of cowpea. Only the number of flowers remained unvaried among the three varieties whereas they differed significantly in other yield parameters. The number of pods varied between 10.6 pods in SAMPEA14 to 23.2 pods in FUAMPEA2. The latter (FUAMPEA2) produced longer pods (13.1cm), heavier seeds (39.67g) and wider seeds than other two varieties. However, seeds were longest in FUAMPEA1 (0.81cm). Table 5 gives the effects of treatments on the yield performance of cowpea. Treatments produced the varied responses on all yield parameters ($p<0.05$). Application of NPK fertilizer significantly influenced the number of pods (21.4 pods), number of flowers (11.2) and seed weight (42.6g) whereas both CCT and HYS composts had equal effects on these parameters. Pod sizes were significantly higher with CCT compost (12.54cm), followed by HYS compost (11.98cm) while NPK produced the shortest pods. Seed sizes were the same in the treatments ($p>0.05$).

Table 4. Effect of varieties on the yield performance of cowpea

Accession	Number of pods	Number of Flowers	Pod Length (cm)	Weight of Seed (g)	Seed length (cm)	Seed width (cm)
FUAMPEA1	11.78^{b}	8.80^{a}	9.06^{b}	31.76^{b}	0.81^{ab}	0.45^{b}
FUAMPEA2	23.22^{a}	8.88^{a}	13.11^{a}	39.67^{a}	0.77^{a}	0.53^{a}
SAMPEA14	10.55^{b}	8.27^{a}	8.00^{b}	31.76^{b}	0.73^{a}	0.33^{c}
LSD (0.05)	2.34	2.79	0.56	19.34	0.14	0.13

Means with different superscripts are significantly different at $p \leq 0.05$

Table 5. Effect of treatments on the yield performance of cowpea

Treatment	Number of pods	Number of Flowers	Pod Length (cm)	Weight of Seed (g)	Seed length (cm)	Seed width (cm)
NPK	21.41^{a}	11.2^{a}	8.57^{b}	42.5^{a}	0.84^{a}	0.52^{a}
CCT	10.58^{b}	7.28^{b}	12.54^{a}	30.1^{b}	0.83^{a}	0.54^{a}
HYS	12.11^{b}	8.15^{b}	11.98^{ab}	29.8^{b}	0.83^{a}	0.52^{a}
LSD (0.05)	1.81	2.16	0.43	14.98	0.10	0.11

Means with different superscripts are significantly different at $p \leq 0.05$
NPK=Inorganic fertilizer; CCT=*C. citratus*; HYS=*H. suaveolens*

DISCUSSION

Plants demonstrated excellent performances under field conditions in growth and yield characteristics. This implies a highly productive and vigorous field trial that is well adapted to the prevailing environmental conditions (biotic and abiotic). This is because environmental stresses can affect the productivity and overall performances of legumes, thereby restricting carbon fixation and vigour (Kovacs et al., 2022). A vigorous growth would undoubtedly result in higher biomass accumulation and ultimately carbon storage (Mitani-Ueno & Ma, 2020). The above observation could be an indication of high ecological adaptation and tolerance to the biotic and abiotic environment including the climatic and edaphic related factors as suggested in other studies (Yashvir & Rex, 2018; Nair et al., 2019).

Varietal and treatments effects were recorded in some growth parameters. FUAMPEA2 produced the highest number of leaves while FUAMPEA1 produced the highest number of branches with large leaf sizes. Kovacs et al. (2022) earlier reported varietal differences in cowpea as they positively influenced vegetative structures and it was attributed to genetic factors or the interplay of genes and environment. According to Oladosu et al. (2017), it is necessary to conduct a G × E (genotype by environment) interaction analysis to validate stable and superior plants before releasing a commercially improved variety. The present study found no significant differences among the varieties with respect to their height, spread and leaf sizes. This is an indication that these varieties were not improved for growth characters, although it was found that the interaction of treatments and varieties was significant in plant height, plant spread, number of branches and leaf sizes.

The three treatments (NPK, CCT and HYS) showed equal effects on plant height and number of leaves. Hence, the compost may be equally useful as NPK fertilizer to improve the vegetative growth of cowpea. Application of NPK fertilizer significantly improved plant spread, number of branches and leaf sizes while HYS was found to improve only the leaf length. Similar findings were reported in maize, wheat and soybean grown with inorganic soil amendments and improved leaf chlorophyll, nitrogen uptake and biomass was found as a result of improved shoot and root development (Galindo et al., 2021).

Varietal and treatments effects were recorded for all yield parameters except flowering. FUAMPEA2 was the best in number, sizes and weight of pods as well as in seed width while FUAMPEA1 was noted for its long seeds. This may be due to the current plant breeding work and varietal development. FUAMPEA2 was developed and improved for yield and striga resistance. Improved varieties of cowpea were developed and released from this institution. The present work has supported other reports on the unique agronomic qualities of these varieties including yield performances (Olasan et al., 2023). Pod characteristics, in terms of number of pods per plant, pod sizes, pod weight and number of seeds, are excellent attributes that may attract the attention of growers and breeders. This work further supports other reports where the two selected FUAMPEA varieties were recommended as an improvement to other local varieties in yield attributes (Omoigui et al., 2017). Application of NPK fertilizer significantly influenced the number of pods, number of flowers and seed weight. This effect might be attributed to the ability of NPK fertilizer to supply the needed nutrients in physiological and biochemical processes in plants (Maheshbabu et al., 2018; Thorne et al., 2021).

The compost performed best only in pod sizes where CCT produced the longest pods followed by HYS. These composts equaled NPK in seed size performances. This may be due to the action of compost manure in the soil. It shows that compost manures were readily available and in the best form for easy absorption by the plant roots, hence there was a boost in the yield and quality of the plant. The obtained result is in concordance with the findings of Adeniyan et al. (2011), who compared the different organic manures and NPK fertilizer for improvement of soil chemical properties and dry matter yield of maize in two different soils. It was earlier stated that organic matter is an essential part of soil physical properties, aggregation and moisture-holding capacity that provides a platform for good productivity (Golabi et al., 2014). Moreover, organic composts are rich in organic matter and are a good substrate for the growth of soil microorganisms and they positively affect nutritional balance and the physical properties of soil (Maheshbabu et al., 2018). The present work is in agreement with other reports that recommended the use of organic materials as soil amendments for increasing crop yield include cow dung, poultry dropping, pig dung and refuse composts (Adeniyan et al., 2011; Olayinka et al., 2018). The continuous use of chemical fertilizers has been reported to result in nutrient imbalance in the soil, hence the need for organic compost for crop production (Maheshbabu et al., 2018).

CONCLUSION

Application of NPK fertilizer significantly improved plant spread, number of branches, leaf sizes, number of pods, number of flowers and seed weight while HYS was found to improve only the leaf length. The compost performed best in pod sizes where CCT produced the longest pods followed by HYS. These composts equaled NPK in seed size performances. FUAMPEA2 was the best in yield parameters.

The use of CCT (*Cymbopogon citratus*) and HYS (*Hyptis suaveolen*) composts are recommended to supplement NPK fertilizer as the composts were found to enhance pod and seed sizes of cowpea while HYS had a positive effect on leaf size.

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AUTHOR CONTRIBUTIONS

OJO and CUA; conceptualized and designed the work. NAN and INA carried out field and laboratory practical together with data collection. OJO analyzed the data and wrote the manuscript. LOO proofread the work.

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AVAILABILITY OF DATA AND MATERIALS

The data that support these findings are available from the corresponding authors upon reasonable request.

ETHICAL CONSIDERATIONS

This article did not include human subjects or animal studies.

COMPETING INTEREST

The authors declare no competing interest.

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APPENDIX

Analysis of variance showing the effect of two factors on growth of cowpea

Source	Plant Height (cm)	Plant Spread (cm)	Number of Leaves	Number of Branches	Leave Length (cm)	Leave Width (cm)
Variety	28.20 ns	1722.2 ns	8422.8*	10.20*	1.73 ns	0.44 ns
Treatment	15.01	13314. *	683.4	14.30*	35.31*	9.53*
Variety*treatment	30.17*	1682.1*	9744.1 ns	12.33*	8.75 *	2.38*
Error	14.13	603.1	803.1	4.15	4.41	0.91

Legend: ns=not significant; * =significant difference exists at $p \leq 0.05$

Analysis of variance showing the effect of two factors on yield of cowpea

Source	Number of pods	Number of Flowers	Pod Length (cm)	Weight of Seed (g)	Seed length (cm)	Seed width (cm)
Rep	40.81	1.84	13.71	238.4	0.08	0.08
Variety	273.2*	43.42 ns	46.51*	511.2*	0.39*	0.06*
Treatment	478.3*	79.87**	55.37*	1624.1*	0.15*	0.05*
Var*Trt	258.5 ns	50.25*	38.22*	1710.2*	0.28 ns	0.02 ns
Error	155.8	5.91	9.41	397.5	0.25	0.03

Legend: ns=not significant; * =significant difference exists at $p \leq 0.05$