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Performance of Mungbeans (*Vigna radiata* (L) Willczek) in Soil Amended with Oil Palm Bunch Ash and Poultry Manure in Humid Tropical Environment of South Eastern Nigeria

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Authors' contributions

This work was carried out in collaboration among all authors. Author AEU designed the study, performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript. Author EBE managed the analyses of the study. Author IAI managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Aim: A study was conducted to evaluate supplementary effects of oil palm bunch ash (OPBA) and poultry manure (PM) on the growth and yield performance of mungbeans.
Study Design: The study used a 3 x 3 factorial experiment laid out in randomized complete block design with three replications.
Place and Duration of Study: The experiment was carried out at the University of Calabar Teaching and Research farm, Calabar, Nigeria during the 2014 and 2015 cropping seasons respectively
Methodology: Mung bean variety NM 92 was planted in a well prepared field to evaluate its

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response to PM and OPBA applications. The treatments included three levels of OPBA (0, 5 and 10 t ha^{-1}) and three levels of PM (0, 5 and 10 t ha^{-1}. PM was cured and applied two weeks before planting while the OPBA was applied at planting. Plant growth data including plant height, number of leaves, number of branches and leaf area were measured at 2,4, 6 weeks after planting whereas the yield data including days to fifty percent flowering, number of pods, pod length , pod and seed yield were recorded

Results: The highest agronomic parameters as well as yield attributing characters and yield were obtained when 10 t ha^{-1} OPBA or 10 t ha^{-1} of PM were applied. Each of the levels of applications significantly decreased the number of days to 50% flowering. The highest seed yields of 0.77 t ha^{-1} in 2014 and 0.82 t ha^{-1} in 2015 were obtained with the applications of 5 t ha^{-1} OPBA + 10 t ha^{-1} PM and 10 t ha^{-1} OPBA + 10 t ha^{-1} PM, respectively.

Conclusion: The best agronomic, yield attributing characters and yield of mungbeans were obtained when 10 t ha^{-1} OPBA or 10 t ha^{-1} of PM were applied. Also the combined application of 5 t ha^{-1} OPBA + 10 t ha^{-1} PM or 10 t ha^{-1} OPBA + 10 t ha^{-1} PM gave significantly higher increment in yield. Hence, from our study, it was found that both organic matter sources may be used to obtain higher yields in mungbeans.

Keywords: Mungbeans; oil palm bunch ash; poultry manure; growth; yield; organic manure.

1. INTRODUCTION

Mungbean (*Vigna radiata* (L) Willczek) is an age-long and widely used legume in the Family Fabaceae. It is a low input, quick growing and short duration legume which is adaptable to marginal conditions and therefore fits into different cropping systems apart from being an excellent source of easily digestible protein. Previous studies show that the Rainforest agro-ecologocal zone of South Eastern Nigeria is suitable for mungbean cultivation [1,2]. However, the soils are inherently low in plant nutrients and mycorrhizae capable of nitrogen fixation for legume production [3]. Thus the need for supplementation with organic or inorganic fertilizers arises if economic yields are the target.

Application of mineral fertilizers is expensive and not easily affordable by local farmers [4], apart from the attendant injurious hazards to the soil and crops [5]. The main option for the subsistence farmers is the use of organic manure which can easily be sourced from the abundant farm by-products. The use of inorganic manure such as poultry droppings, goat manure and wood ash has been found to complement organic fertilizers as such manures improve crop yield and soil health [3,6,7]. The use of wood ash alone or in combination with poultry manure, in promoting organic farming or in enhancing soil fertility, has profound implications in agricultural production, as well as the socio-economic status of rural livelihood in the developing world [8].

Nottigde et al. [9] and Mbah and Nkpaji [10] demonstrated that in the absence of any other source of supplementary fertilizer, wood ash alone can produce significant effects on plant growth and yield of many crops. Bougnon et al. [11] and Rodriguez et al. [12] also observed that wood ash significantly increased the effective cation exchange capacity and base saturation, as well as decreased the concentration of exchangeable aluminum. Wood ash has been confirmed to be a good source of K, P, Mg, Ca and micronutrients [13,14]. Application of wood ash to young maize plants significantly increased the maize grain yield [7] Such an increase in maize grain yield with the application of wood ash was earlier reported by Iremiren [15] to be consistent with the amount of P added in the soil. Other studies have also shown that wood ash also has liming effect on the soil [16,17,18]. Liming neutralizes the soil pH and makes plant nutrients more easily absorbable by plants.

Poultry manure has been extensively used for crop production. The use of PM as soil amendment to sustain adequate crop yield has been found effective on many crops in South Western Nigeria [19]. Its use for crop production might be a better substitute for chemical fertilizer [20]. The positive yield response from chicken manure treatment is attributed to increased nitrogen nutrition as indicated by increased N concentration in plant tissues [21,22]. PM improves soil organic matter, total N, available P, exchangeable Mg, Ca, and K and lowers exchangeable acidity as well as increases nutrient uptake, crop growth and yield. It as well ensures the stability of soil structure by reduction of bulk density [19]. PM generally has higher N concentration and lower C: N ratio resulting in a quick release of N to plants [23]. Approximately 30 – 50% of N becomes available to plants following application of PM [24].

In spite of the fact that wood ash or poultry manure have been reported to positively affect crop yield, Amujityegbe et al. [25] and, Adekayode and Olujugba [18] pointed out that wood ash in combination with other organic or inorganic manure may give better soil fertility improvement for higher increases in crop production. This research was therefore undertaken with the objective of assessing the optimum rates of wood ash, poultry manure and wood ash/poultry manure combinations for enhanced yield of mungbeans in the Tropical Rainforest agro-ecology of South Eastern Nigeria.

2. MATERIALS AND METHODS

2.1 Site Information

The experiment was carried out at the University of Calabar Teaching and Research farm. Calabar is located in the humid tropical rainforest zone of Nigeria between latitude $4^0 58^{'}$N and longitude $8^0 21^{'}$E of the equator. The annual temperature, rainfall and relative humidity ranges are 24.5-26.8°C, 2748-3738 mm/annum and 77-83% respectively [26].

2.2 Experimental Design and Treatments

The study used a 3 x 3 factorial experiment laid out in a randomized complete block design (RCBD) with three replications. The experiment consisted of a factorial combination with three levels of oil palm bunch ash (OPBA) (0, 5 and 10 t ha^{-1}) and three levels of PM (PM) (0, 5 and 10 t ha^{-1}). There was a total of nine treatment combinations which were replicated thrice to give a total of twenty seven treatments.

2.3 Land Preparation/ Field Layout

The site was manually prepared. Each experimental plot measured 2.5 x 2.5 m (6.25m^2) and separated from each other by an alleyway of 0.5 m wide, while the replicates were separated from each other by a path of 1 m wide. The total plot size used for the experiment was 10 x 27 m (270 m^2).

2.4 Source of Experimental Materials

Mungbean variety NM 92 was collected from the College of Crop and Soil Sciences, Michael Okpara University of Agriculture, Umudike, Umuahia in Abia State, Nigeria. Poultry manure was sourced from the Broiler unit of University of Calabar Teaching and Research Farm in Calabar, while the empty oil palm bunches were collected from an oil palm in Akpabuyo Local Government Area of Cross River State. The empty oil palm bunches were packed in heaps and burnt to obtain the ash.

2.5 Analysis of Soil, Poultry Manure and Oil Palm Bunch ash

The soil was sampled randomly from 0 -15 cm depth at the study site and bulked, air-dried, sieved through a 2mm mesh. A sub-sample was taken to determine the physical and chemical properties of the soil of the site using suitable laboratory analytical procedures as outlined by IITA [27]. Poultry manure and OPBA were analyzed for nutrient content including N, P, K, Ca, organic carbon, Cu and C/N ratio prior to application.

2.6 Planting and maintenance

Poultry manure and OPBA were incorporated into the soil two weeks before planting, which was done on 20th September, in both years. Two mungbean seeds were planted per hole at the spacing of 20 cm x 20 cm and at the depth of 2 cm. Seeds germinated three days after planting with peak germination at the 5th and 6th day and were later thinned to one to achieve a plant population of 250,000 plants per hectare.

2.7 Data Collection

Five plants from the middle rows of each plot were sampled for crop growth and yield attributes. Agronomic parameters measured were the plant height, number of leaves, leaf area at 3, 5 and 7 weeks after planting (WAP), number of branches at 5 and 7 WAP, days to 50 % flowering, number of pods $plant^{-1}$, length of pods, number of seeds pod^{-1}, pod yield (t ha^{-1}), 100-seed weight (g) and seed yield (t ha^{-1}).

2.8 Statistical Analysis

Two-way Analysis of Variance (ANOVA) was performed on data and treatment means compared using Fisher's least significant difference (FLSD) at a probability level of 5% [28].

3. RESULTS

The soil analysis indicated that the soil had low N and K content with pH in the slightly to strongly acidic range. Therefore, it was justifiable to ameliorate the acidity using OPBA as a liming material and PM to improve the fertility status of the soil. The PM is rich in N, P, K, and a good amount of copper, besides having a low C: N ratio which will ensure rapid mineralization to release the available nutrients.

Oil palm bunch ash (OPBA) and PM had significant effects on plant height of mungbeans in both years (Table 2). During this period, each successive increment in the rate of OPBA from 0 to10 t ha^{-1} resulted in corresponding significant (P≤) increments in plant height at all sampling periods except 7 WAP in 2014 when plant height was not significant (P>0.05). However, Mung bean plants in control plots that received no OPBA were significantly (P≤) shorter compared to those that received OPBA in 2014 and 2015. Similarly PM applied at 10 t ha^{-1} produced the tallest plants at all sampling periods which were significantly (P≤) taller than plants in plots that received 5 t ha^{-1} in both years. Plants which were not treated with PM (in control plots) were the shortest compared to those that received any level of PM application.

There was no significant (P>0.05) interaction effect of OPBA and PM on plant height at 3 WAP in both years and at 5 WAP in 2014. At 5 WAP in 2015, application of 5 t ha^{-1} OPBA x 10 t ha^{-1} PM and 10 t ha^{-1} each of OPBA x PM resulted in statistically similar plant heights which were significantly (P<0.05) taller than plants from other treatment combinations with the shortest plants occurring on plots receiving 0 t ha^{-1} each of OPBA and PM (Table 2). At 7 WAP in 2014, 5 t ha^{-1} OPBA x 10 t ha^{-1} PM produced the tallest plants but these were not significantly taller when compared to the plants fertilized with 0 t ha^{-1} OPBA X 10 t ha^{-1} PM, 10 t ha^{-1} each of OPBA and PM, 5 t ha^{-1} each of OPBA and PM and 5 t ha^{-1} OPBA x 10 t ha^{-1} PM, respectively.

In 2015, application of 10 t ha^{-1} each of OPBA and PM resulted in the tallest plants but which were not significantly different compared to those that were fertilized with 5 t ha^{-1} OPBA x 10 t ha^{-1} PM, 0 tha^{-1} OPBA X 10 t ha^{-1} PM, 5 t ha^{-1} each of OPBA and PM and 5 t ha^{-1} OPBA x 10 t ha^{-1} PM, respectively (Table 2).

Oil palm bunch ash had significant effects on number of leaves at all sampling periods in both years except at 3 WAP in 2014 and 5 WAP in 2015 respectively (Table 2). OPBA had similar trend of increase in the number of leaves at 5 and 7 WAP in 2014 as well as at 3 and 7 WAP in 2015. Across this periods, application of 10 t ha^{-1} OPBA resulted in significantly higher number of leaves when compared to 5 t ha^{-1} OPBA which in turn produced significantly higher number of leaves to plants in plots that were treated with 0 t ha^{-1} OPBA (control plot) The 10 t ha^{-1} PM rate resulted in significantly higher number of leaves than the 5 t ha^{-1} PM which was in turn superior to plants from plots that were treated with 0 t ha^{-1} PM (control plot). However, enhancement of increase in number of leaves as a result of OPBA x PM interaction in all periods were not significant (P>0.05).

The number of branches was significantly (P≤) influenced by OPBA application at all sampling periods in 2014 and 2015 for leaf area (Table 3). Each successive increment in the rate of OPBA from 0 to 10 t ha^{-1} gave corresponding significant (P≤) increments in number of branches at all sampling periods. Increments in leaf area were significant except at 3 WAP in both years and the trend of increment was same as that of the number of branches (Table 3). Application of PM also significantly influenced the number of branches and leaf area at all sampling periods in 2014 and 2015. Each incremental rate of PM resulted in higher leaf area and was highest for plants that received 10 t ha^{-1} PM (Table 3). There was no significant interaction of OPBA and PM on the number of branches in both years, whereas significant interaction of OPBA and PM on leaf area expansion were obtained at 5 WAP in 2014 only and at 5 and 7 WAP in 2015 (Table 3). At 5 WAP in 2014, Mung bean fertilized with 10 t ha^{-1} each of OPBA and PM had the largest leaf area but this was not significantly larger when compared to those fertilized with 5 t ha^{-1} OPBA and 10 t ha^{-1} PM, 5 t ha^{-1} each of OPBA and PM, 0 t ha^{-1} OPBA and 10 t ha^{-1} PM. Plants in the control plots that did not receive any OPBA and PM treatments had the least leaf area compared to the plants in fertilized plots. In 2015, at 5 WAP, Mung beans fertilized with 10 t ha^{-1} each of OPBA and PM had significantly larger leaf areas when compared with other treatment combinations whereas at 7 WAP, no significant differences existed between plants that were fertilized with 10 t ha^{-1} OPBA x 10 t ha^{-1} PM a, 5 t ha^{-1} each of OPBA and PM, 5 t ha^{-1} OPBA and 10 t ha^{-1} PM respectively. However, plants in the control plots that did not receive any OPBA and PM treatments had the least leaf area compared to the plants in fertilized plots.

OPBA application did not significantly influence the number of days to 50% flowering whereas PM significantly increased the number of days to 50% flowering in both years (Table 4). As PM rates increased from 0 to 10 t ha^{-1} in both years' plants took a longer number of days to attain 50% flowering. Also, there was no significant interaction effect of OPBA x PM on 50% flowering. Application of OPBA significantly increased the number of pod plant^{-1} in 2015 only and PM had significant effect in both years (Table 4). The increment in number of pods in 2015 for OPBA and in both years for PM followed the same trend. Every successive increment in the rate of OPBA and PM from 0 to10 t ha^{-1} increased the number of pods plant^{-1}. The length of pods and number of seeds pod^{-1} in both years were significantly increased by both OPBA and PM treatments (Table 4). Application of 5 and 10 t ha^{-1} OPBA did not differ significantly in terms of their respective lengths of pods and number of seeds pod^{-1}. However, these were significantly longer when compared to length of pod and number of seeds pod^{-1} with zero application. PM at 10 t ha^{-1} had significantly longer pods when compared 5 and 0 tha^{-1} PM respectively (Table 4). In both years application of 5 and 10 t ha^{-1} PM did not differ significantly in terms of their respective number of seeds pod^{-1} but these respective rates of PM had significantly more seeds pod^{-1} relative to 0 t ha^{-1}.

Combined application of OPBA x PM significantly affected the length of pod and number of seeds pod^{-1} in both years (Table 4). In 2014 and 2015, OPBA x PM at 5 x 10 t ha^{-1}, 5 x 5 t ha^{-1}, 10 x 10 tha^{-1}, and 0 x 10 t ha^{-1} were statistically similar in their respective effects on length of pods but were significantly higher when compared to each of the other treatment combinations. Also OPBA x PM at 5 x 5 t ha^{-1}, 10 x 10 tha^{-1}, 10 x 5 tha^{-1}, 5 x 10 t ha^{-1}, and 0 x 10 t ha^{-1} were statistically similar in their respective effects on number of seeds pod^{-1} whereas in 2014 whereas in 2015, application of OPBA x PM at 10 x 10 tha^{-1} had the highest number of seeds pod^{-1} but not significantly higher when compared to that produced when OPBA x PM at 10 x 5 tha^{-1}, 5 x 10 t ha^{-1}, 5 x 5 t ha^{-1} and 0 x 10 t ha^{-1} were applied, respectively.

Table 1. Physical and chemical properties of soil at the experimental site, poultry manure and oil palm bunch ash

	Soil		Poultry manure		Oil palm bunch ash	
	2014	2015	2014	2015	2014	2015
pH (H_2O)	5.4	5.80				
%Organic carbon (g kg-^{1})	0.82	0.85	31.42	31.54	1.08	1.06
Total Nitrogen (g kg-^{1})	0.07	0.11	3.85	3.89	0.15	0.13
Available P (mg kg-^{1})	28.37	24.75	1.69	1.57	1.28	1.33
Exchangeable K (Cmol/ kg-^{1})	0.08	0.09	0.62	0.68	2.75	2.73
Exchangeable Ca (Cmol/ kg-^{1})	5.0	5.50	2.20	2.34	2.80	2.77
Exchangeable Mg (Cmol/ kg-^{1})	0.8	0.82	0.84	0.79	0.96	0.98
Exchangeable Na (Cmol/ kg-^{1})	0.06	0.05	0.42	0.45	1.29	1.27
Exchangeable acidity (Cmol/ kg-^{1})	1.60	1.70	-	-	-	-
ECEC	5.94	6.64	-	-	-	-
Base saturation (BS)%	79.0		-	-	-	-
Sand (%)	82.6	83.40	-	-	-	-
Silt (%)	10.0	9.60	-	-	-	-
Clay (%)	7.4	8.0	-	-	-	-
Textural class	Loamy sand	Loamy sand	-	-	-	-
Copper (mg/ kg-^{1})			12.8	12.5	16.6	15.3
C:N ratio			1:8.0	1:8.1	1:7.2	1: 7.0

Table 2. Effects of oil palm bunch ash (OPBA) and poultry manure (PM) on plant height and number of leaves of Mung bean at 3, 5 and 7 weeks after planting (WAP) in 2014 and 2015

Treatment	Plant height						Number of leaves					
	3WAP		5WAP		7WAP		3 WAP		5 WAP		7 WAP	
	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015
OPBA (tha^{-1})												
0	0.58	0.62	11.13	11.79	21.37	20.74	2.06	2.11	4.02	4.69	6.10	5.51
5	0.70	0.66	14.04	14.25	24.85	25.87	2.22	2.56	4.96	5.33	7.47	8.85
10	0.72	0.74	15.24	16.23	25.31	28.18	2.26	2.74	5.18	6.01	8.60	10.41
LSD (0.05)	0.02	0.01	0.86	0.59	NS	1.50	NS	0.09	0.24	NS	0.64	0.68
PM (tha^{-1})												
0	0.60	0.62	8.91	9.75	14.99	15.90	1.81	1.96	3.56	3.73	5.14	5.91
5	0.69	0.68	12.89	12.93	23.69	24.43	2.06	2.33	4.84	5.58	7.47	8.78
10	0.73	0.73	15.24	19.59	32.86	34.46	2.67	3.22	5.76	6.72	9.56	10.07
LSD (0.05)	0.02	0.01	0.86	0.59	2.77	1.50	0.16	0.09	0.24	0.36	0.64	0.68
Interaction (OPBA x PM in tha^{-1})												
0 OPBA x 0 PM	0.50	0.56	6.08	7.19	11.28	12.33	1.50	1.54	2.73	2.84	3.83	4.08
0 OPBA x 5 PM	0.60	0.63	10.88	10.84	18.86	18.66	1.93	2.11	4.20	4.67	5.40	5.78
0 OPBA x 10 PM	0.65	0.67	16.42	17.34	33.97	31.24	2.73	2.67	5.13	6.56	9.07	6.67
5 OPBA x 0 PM	0.62	0.61	8.58	9.31	14.37	15.55	1.87	2.11	3.53	3.56	4.87	5.67
5 OPBA x 5 PM	0.73	0.67	13.79	13.05	26.39	27.77	2.07	2.33	5.27	5.78	8.33	10.00
5 OPBA x 10 PM	0.77	0.71	19.74	20.39	33.79	34.30	2.73	3.22	6.07	6.67	9.20	10.89
10 OPBA x 0 PM	0.67	0.68	12.08	12.75	19.31	19.83	2.07	2.22	4.40	4.78	6.73	8.00
10 OPBA x 5 PM	0.74	0.73	14.01	14.89	25.82	26.87	2.17	2.55	5.07	6.31	8.67	10.56
10 OPBA x 10 PM	0.76	0.82	19.64	21.05	30.81	37.84	2.53	3.45	6.07	6.93	10.40	12.67
LSD (0.05)	NS	NS	NS	1.78	11.28	12.33	NS	NS	NS	NS	NS	NS

Means with NS at the bottom of the column are not significant at 5 % probability level

Table 3. Effects of oil palm bunch ash (OPBA) and poultry manure (PM) on number of branches and leaf area of Mung bean at 3, 5 and 7 weeks after planting (WAP) in 2014 and 2015

Treatment	Number of branches						Leaf area					
	3WAP		5WAP		7WAP		3WAP		5WAP		7WAP	
	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015
OPBA (t ha^{-1})												
0	1.26	1.56	1.57	1.89	2.20	2.42	2.69	2.06	10.67	18.97	19.29	25.92
5	1.52	1.99	2.12	2.33	2.62	2.68	3.34	2.22	12.61	27.13	22.97	38.74
10	1.79	2.20	2.52	2.60	2.96	3.13	3.19	2.18	13.49	30.40	25.53	43.51
LSD (0.05)	0.20	0.13	0.20	0.11	0.13	0.08	NS	NS	1.00	1.08	1.95	3.04
PM (t ha^{-1})												
0	1.00	1.50	1.48	1.78	2.03	2.23	2.40	1.81	8.83	13.86	16.77	22.99
5	1.33	1.94	2.12	2.38	2.64	2.78	3.06	1.98	12.99	25.01	23.35	36.76
10	2.23	2.30	2.61	2.67	3.10	3.22	3.77	2.67	14.94	37.64	27.68	48.45
LSD (0.05)	0.20	0.13	0.20	0.11	0.13	0.08	0.35	0.16	1.00	1.08	1.95	3.04
Interaction (OPBA x PM in (t ha^{-1}))												
0 OPBA x 0 PM	1.00	1.33	1.17	1.50	1.83	2.00	2.10	1.50	6.36	8.06	14.06	12.12
0 OPBA x 5 PM	1.00	1.50	1.33	1.83	2.17	2.44	2.63	1.93	11.53	17.49	17.27	24.58
0 OPBA x 10 PM	1.77	1.83	2.20	2.33	2.60	2.82	3.33	2.73	14.12	31.36	26.55	41.07
5 OPBA x 0 PM	1.00	1.50	1.33	1.83	2.00	2.13	2.50	1.87	8.63	16.21	16.55	29.55
5 OPBA x 5 PM	1.33	2.00	2.43	2.50	2.77	2.78	3.00	2.07	14.26	27.08	24.32	38.57
5 OPBA x 10 PM	2.23	2.47	2.60	2.67	3.10	3.13	4.53	2.73	14.93	38.09	28.06	48.09
10 OPBA x 0 PM	1.00	1.67	1.93	2.00	2.27	2.56	2.60	2.07	11.51	17.30	19.70	27.30
10 OPBA x 5 PM	1.67	2.33	2.60	2.80	3.00	3.11	3.53	1.93	13.19	30.46	28.46	47.13
10 OPBA x 10 PM	2.70	2.60	3.03	3.00	3.60	3.71	3.43	2.53	15.77	43.45	28.44	56.12
LSD (0.05)	NS	NS	NS	NS	NS	NS	NS	NS	2.98	NS	NS	9.14

Means with NS at the bottom of the column are not significant at 5 % probability level

Table 4. Effects of oil palm bunch ash (OPBA) and Poultry manure (PM) on the yield attributes of Mung bean in 2014 and 2015

Treatment	Days to 50% flowering		Number of pods plant^{-1}		Length of pods (cm)		Number of seeds per plant		Pod yield (t ha^{-1})		100-seed weight (g)		seed yield (t ha^{-1})	
	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015
OPBA (t ha^{-1})														
0	38.67	39.11	6.78	7.48	7.48	7.53	9.44	9.84	0.69	0.70	4.21	4.05	0.57	0.62
5	38.89	37.56	8.00	9.26	7.95	8.09	11.11	11.59	0.80	0.76	4.20	4.04	0.62	0.66
10	39.67	37.56	9.44	11.26	7.95	8.24	11.44	11.84	0.84	0.85	4.17	4.07	0.72	0.74
LSD (0.05)	NS	NS	NS	1.05	0.23	0.22	0.73	0.46	0.01	0.02	NS	NS	0.06	0.11
PM (t ha^{-1})														
0	37.78	36.89	5.67	5.93	7.22	7.37	9.00	9.24	0.69	0.70	4.13	4.02	0.57	0.59
5	39.00	38.22	8.33	9.74	7.92	8.05	11.22	11.66	0.80	0.77	4.13	4.09	0.65	0.60
10	40.44	39.11	10.22	12.33	8.25	8.43	11.78	12.38	0.84	0.84	4.31	4.05	0.71	0.71
LSD (0.05)	0.45	0.52	0.86	1.05	0.23	0.22	0.73	0.46	0.01	0.02	NS	0.03	0.05	0.10
Interaction (OPBA x PM in (t ha^{-1}))														
0 x 0	37.33	36.67	4.00	3.67	7.03	7.17	7.33	7.63	0.23	0.46	1.40	4.03	0.50	0.56
0 x 5	38.67	37.67	6.33	7.00	7.24	7.25	9.33	10.00	1.93	2.19	3.07	4.10	0.60	0.63
0 x 10	40.00	38.33	10.00	11.78	8.17	8.15	11.67	11.89	3.61	3.90	4.72	4.02	0.65	0.67
5 x 0	37.00	37.00	5.00	5.55	7.29	7.39	9.33	9.97	0.23	0.46	1.38	4.01	0.62	0.61
5 x 5	38.67	38.67	9.00	9.67	8.23	8.37	12.33	12.33	1.93	2.19	3.04	4.04	0.73	0.67
5 x 10	41.00	41.00	10.00	12.56	8.35	8.49	11.67	12.48	3.61	3.89	4.77	4.07	0.77	0.71
10 x 0	39.00	36.33	8.00	8.56	7.34	7.54	10.33	10.11	0.08	0.23	0.47	4.01	0.67	0.68
10 x 5	39.67	37.33	9.67	12.56	8.28	8.52	12.00	12.64	0.64	1.37	1.02	4.13	0.74	0.73
10 x 10	40.33	39.00	10.67	12.67	8.23	8.66	12.00	12.78	1.20	2.50	1.57	4.06	0.76	0.82
LSD (0.05)	NS	NS	NS	NS	0.69	0.68	2.21	1.40	0.23	0.46	NS	NS	NS	NS

Means with NS at the bottom of the column are not significant at 5 % probability level

OPBA and PM applications significantly influenced pod yield in t ha^{-1} in both years (Table 4). Each successive increment in the rate of OPBA and PM from 0 to10 t ha^{-1} produced a corresponding increase in the pod yield. OPBA did not significantly increase 100 seed weight in both years but PM significantly enhanced 100 seed weight only in 2015. Application of 10 t ha^{-1} PM significantly increased 100 seed weight above other rates of application. Respective OPBA and PM applications significantly influenced seed yield in t ha^{-1} in both years (Table 4). Incremental rates of OPBA and PM as single application resulted in incremental pods yields. That is application of 10 tha^{-1} OPBA or PM resulted in significantly ($P<0.05$) higher seed yield of mungbean relative 5 and 0 tha^{-1} respectively.

Combining both OPBA and PM did not have significant ($P>0.05$) effects 100 seed weight and seed yield. The percentage yield increase at 10 and 5 tha^{-}1 OPBA was 17.14 and 2.86%, respectively, over the untreated mungbean. In 2015, yield increased at 10 and 5 tha^{-}1 OPBA over the control was 16.22 and 10.81%, respectively.

4. DISCUSSION

The highest rates of applied organic matter; 10 t ha^{-1} each for OPBA and PM applied respectively increased vegetative parameters significantly better compared to 5 t ha^{-1} applications and the control plots where no fertilizer treatment was given. Such increased vegetative growth with application of OM has been demonstrated repeatedly in a number of studies [9,11,12]. Recent work by Ayeni [29] indicated that application of OM not only supply plant nutrients for enhanced vegetative growth but also improved the soil physical structure, nutrient retention, aeration, soil moisture capacity and water infiltration. Increased vegetative growth as observed in our study may be attributed to enhanced nutrient availability and improved soil properties as indicated by Ayeni [29]. Oil palm bunch ash (OPBA) apart from supplying a good amount of K also contains organic matter and varying amount of nutrients such as N, P, Mg, and Ca [17,30,31,32,33]. These nutrients made available, particularly N, must have been responsible for the enhanced leaf area development with the resultant enhancement of radiation use efficiency and increased dry matter accumulation. Leaf expansion promoted by N availability [34] and Vos et al. [35] had earlier observed that radiation interception is reduced under low soil N.

Yield and yield attributing characters in this study were also observed to be positively influenced by the maximum rates of applied OM used. Application of OM in our study might have favoured not only vegetative growth but also physiological and yield attributing characters, such as number of seeds/plant, 100-seed weight, seed yield and a reduction in number of days to 50% flowering. Also, application OPBA leads to reduction in soil acidity which enhanced cation availability in the soil. The net effect of this is enhancement in nutrient supply and thus significant increase in the growth and yield of crops. These are in line with the observation of Ojeniyi et al. [36]; Odedina et al. [32] Adjei-Nsiah and Obeng [37]. Amujityegbe et al. [25] and Adekayode and Olujugba [18] recommended the use of wood ash in combination with other organic or inorganic manure for better soil fertility improvement and increased in crop production. On acidic soils [16,17,18] recommended the application of OM including oil palm bunch ash and poultry manure as a standard practice by subsistence farmers to ameliorate the soil acidity for increased crop production.

Though not significant, the combined application of OPBA and PM showed synergistic or complementary effects on the yield of Mung beans in each of the years. However, from our study, it was found that both OM sources may be used alone to obtain higher yields in mungbeans. The no significant interaction effect does not agree with the suggestion by Amujityegbe et al. [25] and, Adekayode and Olujugba [18] that wood ash in combination with other organic manure gives better soil fertility improvement for higher increases in crop production. For the Rain Forest agro-ecology of Nigeria, oil palm bunch ash or poultry manure may be used alone for the production of mungbeans.

4. CONCLUSION

Oil palm bunch ash (OPBA) and poultry manure (PM) had significant effects on both vegetative growth and yield attributes of mungbeans in both years. The highest rates of treatment application (10 t ha^{-1} each for OPBA and PM) increased vegetative parameters significantly compared to no application (OM) or 5 t ha^{-1} of OM fertilizer sources in both years. Application of OM in this study favoured both vegetative growth and yield attributing characters, such as number of seeds/plant, 100-seed weight, seed yield and a reduction in number of days to 50% flowering. The combined application of OPBA and PM showed synergistic or complementary effects on the yield of Mung beans in each of the years.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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