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Evaluation of Different Agricultural Wastes as Fertilizer on Nursery Performance of Pawpaw (*Carica papaya* L.) and Soil Chemical Properties

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Abstract: This study evaluated different agricultural wastes as fertilizer on nursery performance of pawpaw *Carica papaya* L. and soil chemical properties. The experiment was conducted at the Teaching and Research Farm, Ekiti State University, Ado-Ekiti, Nigeria. Five agricultural wastes were used as organic fertilizers applied to pawpaw seedlings. The experimental design used was complete randomized design with three replicates. The following growth parameters were collected on weekly basis: Plant height, number of leaves per plant and leaf area. There was no significant differences in the effect of the different agricultural wastes applied as treatment on the pawpaw seedlings height, number of leaves per plant and leaf area. The soil chemical properties increased significantly after the study. The study confirms the appropriateness of the use of any of these agricultural waste at 2.5 ton ha^{-1} in raising pawpaw seedling since no significant different was observed in the growth parameters.

Key words: Pawpaw, agricultural wastes, fertilizer, seedlings, organic, Nigeria

INTRODUCTION

Pawpaw (*Carica papaya* L.) is the most economically fruit in the caricaceae family. The fruit is one of the most nutritional and cheapest fruits grown and consumed in Nigeria. It is widely consumed as it grown all the year round. However in an average, the fruit is increasingly becoming popular in the Nigeria diet but the production of this crop remains low and inadequate (Baiyewu and Amusa, 2005). Most of the pawpaw fruit consumed are grown in the wild but little are cultivated. The ripe fruit of papaya is usually eaten raw without its skin or seeds while the unripe green fruits can be eaten cooked, usually in curries or salads. According to Tietze (2002), mature green papaya contains more vitamin A than carrots, more vitamin C than oranges, abundant vitamin B factors and vitamin E. It also possesses antiseptic qualities and help to prevent abnormal proliferation of undesirable bacteria in the intestines (Ray, 1994). In some part of the world, papaya leaves are made into tea as treatment for malaria (Titanji *et al*., 2008). It can serves as raw materials for some industries and foreign exchange earning to the government. Pawpaw production can provide employment for small and large scale farmers and those who were involve in its marketing and processing.

Despite these numerous nutritional, medicinal and industrial benefits obtained from pawpaw, the output is still low in Nigeria. This is due to some problems such as low soil fertility, pests and diseases, poor harvesting and storage methods, climatic changes, etc. Inadequate supply of nutrients due to declining soil fertility is one of the major constraint to pawpaw production. The use of mineral fertilizers is constrained mainly by its high cost and risky returns (McGuiness, 1993). Majority of smallholder farmers in Nigeria are resource poor and cannot afford the high cost of mineral fertilizer. Mineral fertilizer use is risky for two reasons. First, yield and output prices can vary widely on a year to year basis so farmers fear that in any given year, their crop income will not be high enough to cover their fertilizer costs. Second, yield vary widely with climate changes: Rainfall is highly uncertain; in drought years, the crop response to fertilizers can be practically non-existent. Mineral fertilizer on the hand do not improve soil physical structure or enhance soil biological activities (McGuiness, 1993).

These challenges can best be met by the use of cheap but effective and sustainable soil conditioning organic fertilizer materials. Hence, this study seeks to explore the use of agricultural wastes as organic fertilizer for raising pawpaw seedlings. These agricultural wastes improve the soil physical, chemical and biological properties. The objectives of this study are to examine the effect of different agricultural wastes used as fertilizer on nursery performance of pawpaw and soil chemical properties.

MATERIALS AND METHODS

The study was carried out at the Teaching and Research Farm of Ekiti State University, Ado-Ekiti, Ekiti State. Ado-Ekiti lies between latitude 7°30' and 8°15' North of the equator and longitude 4°47' and 5°40' of the Greenwich Meridian (Adebayo, 1993). The experimental design used was complete randomized design with seven treatments and replicated 3 times. The treatments were: N.P.K 15:15:15 at 400 kg ha^{-1}, kola testa, cocoa pod ash, melon testa, cowpea pod, kola pod at 2.5 ton ha^{-1} and control (no fertilizer). The agricultural wastes used were sourced from local farms around Ado-Ekiti. The treatments were applied 3 weeks after planting. Polythene pots with drainage hole were filled with 20 kg of top soil. The seeds used for this study were extracted from pawpaw fruits obtained from the Crop Type Collection Centre of the Faculty of Agricultural Sciences, Ekiti State University, Ado-Ekiti. The seeds were planted immediately after extraction from the fruits into the polythene pots filled with top soil. Water was applied when necessary to enhance proper plant growth, weeds were hand pulled regularly to minimize competition with the developing seedlings.

Prior to sowing, the top soil for the study was collected, air dried, crushed and packed in labeled air tight polythene bags for analysis. Immediately after the study, soil samples from each treatment were collected separately for determination of soil chemical properties. The analytical procedure used is as contained in the laboratory manual of the International Institute for Tropical Agriculture (Juo, 1979).

Data collected on weekly basis were plant height, number of leaves per plant and leaf area from 6-10 weeks after planting. These data were subjected to analysis of variance using Statistical Analysis System (SAS Institute, 1995) and mean separated with Duncan's Multiple Range Test at 5% probability.

RESULTS AND DISCUSSION

Table 1 shows the chemical properties of the top soil used before the commencement of the study. The soil pH was 6.22 indicating that the soil is slightly acidic while the soil organic matter is 2.10% which is <3.0% recommended for crop production in South West Nigeria (Agboola and Corey, 1973).

Nitrogen value was 0.11% which is <0.15% critical level recommended for crop production in South West Nigeria (Sobulo and Osiname, 1981). The value of exchangeable bases; Na, Ca, K and Mg were 0.54, 2.50, 1.20 and 0.93 Cmol kg^{-1}, respectively. Available phosphorus was 6.40 mg kg^{-1}.

Chemical analysis of agricultural wastes used as organic fertilizer for the study are presented in Table 2. Kola testa has the highest value of pH and cowpea pod has the lowest pH value. Cocoa pod ash has the highest value of carbon-nitrogen ratio, organic matter and nitrogen, respectively while melon testa has the highest value of available phosphorus and potassium. Organic matter, carbon-nitrogen ratio, nitrogen in %, available phosphorus in mg kg^{-1}, pH and Na, Ca, K, Mg in Cmol kg^{-1} content for each of the treatment are indicated in Table 2.

Table 3 shows the plant height of pawpaw seedlings at various weeks after treatment application. Plant height was unaffected by the treatment applied ($p>0.05$). At week 6, plant height values for the different treatments are as follows: Cowpea pod 15.01 cm, N.P.K. 15:15:15 15.01 cm, control 15.10 cm, melon testa 15.30 cm, kola testa 15.33 cm, cocoa pod ash 16.50 cm, kola pod 16.71 cm. Similar trend was displayed in week 7-9. At week 10, plant height ranged between 23.31-26.18 cm in control and kola pod, respectively.

Similarly, number of leaves was unaffected by different treatments applied ($p>0.05$). All the treatment

Table 1: The soil chemical properties of the soil before the study

Properties	Values
pH	6.22
OM (%)	2.10
OC (%)	0.71
N (%)	0.11
Available P (mg kg^{-1})	6.40
Na (Cmol kg^{-1})	0.54
Ca (Cmol kg^{-1})	2.50
K (Cmol kg^{-1})	1.20
Mg (Cmol kg^{-1})	0.93

Table 2: Chemical analysis of agricultural wastes used as fertilizer for the study

TRT	pH	C/N	OM	N	Available P mg kg^{-1}	K	Na	Mg	Ca
		----------%----------				----------(Cmol kg^{-1})----------			
Kola testa	7.20	18	0.47	0.04	11.12	2.03	1.10	0.04	1.33
Cocoa pod ash	7.10	29	2.00	1.20	10.00	2.47	2.23	1.20	2.63
Melon testa	7.06	25	0.98	1.00	15.61	3.42	1.66	0.76	2.01
Cowpea pod	6.68	14	0.91	0.70	12.04	3.10	2.60	1.53	2.64
Kola pod	7.00	20	1.70	0.90	5.80	2.23	2.28	2.02	0.63

applied and control have similar number of leaves per plant (Table 4). Table 5 presents the leaf area of pawpaw seedlings at various weeks after treatment application. The treatments has no significant effect ($p>0.05$) on the leaf area at various weeks after planting. The treatments and control resulted in similar leaf area per plant.

Table 3: Effect of different treatments applied on plant height of pawpaw seedlings

	Plant height (WAP)				
TRT	6	7	8	9	10
N.P.K. 15:15:15	15.01	17.30	19.21	21.80	23.62
Kola testa	15.33	17.39	20.50	23.11	25.68
Cocoa pod ashes	16.50	17.81	19.07	21.09	24.10
Melon testa	15.30	16.81	19.48	22.53	25.10
Cowpea pod	15.01	17.03	22.50	25.02	27.19
Kola pod	16.71	20.80	22.41	24.00	26.18
Control	15.10	15.59	17.88	18.07	23.31
LSD (0.05)	NS	NS	NS	NS	NS

Table 4: Effect of different treatments applied on number of leaves of pawpaw seedlings

	Number of leaves per plant (WAP)				
TRT	6	7	8	9	10
N.P.K. 15:15:15	5.40	7.61	9.220	11.80	13.93
Kola testa	7.00	8.61	10.61	14.79	16.60
Cocoa pod ash	8.09	9.61	11.59	13.08	15.20
Melon testa	6.43	8.60	10.00	12.13	14.19
Cowpea pod	7.71	8.20	9.610	13.39	16.60
Kola pod	8.40	10.0	11.00	16.10	17.61
Control	7.41	9.39	10.60	14.09	15.20
LSD (0.05)	NS	NS	NS	NS	NS

Table 5: Effect of different treatments applied on the leaf area of pawpaw seedlings

	Leaf area (WAP)				
TRT	6	7	8	9	10
N.P.K. 15:15:15	31.90	32.70	34.81	38.41	40.50
Kola testa	21.41	35.03	47.42	59.23	65.00
Cocoa pod ash	39.11	44.00	46.30	49.63	52.30
Melon testa	20.56	34.00	35.00	46.08	56.80
Cowpea pod	30.04	34.30	38.00	38.96	39.66
Kola pod	43.60	46.50	50.23	54.36	60.00
Control	21.32	25.00	30.01	36.61	51.23
LSD (0.05)	NS	NS	NS	NS	NS

NS = Not Significant; WAP = Weeks After Planting

Table 6 presents the soil chemical composition of the soil after the study. The result shows no significant difference in %N, pH, Ca, K and Na. N.P.K. 15:15:15, cocoa pod ash, melon testa and control are not significantly different from each other in the percentage of organic carbon. Cowpea pod has the highest value for organic carbon (1.30) and kola testa (0.39) has the lowest value.

N.P.K. 15:15:15 has the lowest value for pH (7.13) and kola pod has the highest value (7.9). Melon testa has the highest value for available P, Ca and Na with 3.08, 3.41 and 0.58, respectively.

The result of this study revealed that there were no significant difference in the treatment effect, both the organic and inorganic fertilizer have the same effect on the pawpaw seedlings height, number of leaves per plant and leaf area. The chemical composition of organic fertilizer was responsible for the increase in soil chemical composition under different treatment compared to control where no fertilizer was added. This observation agreed with the research of Swift and Anderson (1993) who reported that organic manure supplied nutrient including micronutrient which is absent in inorganic fertilizer (N.P.K. 15:15:15).

Although, the N.P.K fertilizer (inorganic) increase the plant height, number of leaves per plant, leaf area and also reduced soil pH, the reduction in soil pH might be as a result of sorption of ammonium ion on the soil surface. Barber (1962) reported that large application of inorganic fertilizer continuously might influence the cation concentration in the soil solution on the exchange phase, thereby affecting their equilibrium, selecting an effective diffusion co-efficient. These challenges can best be met by the use of cheap but effective and sustainable soil conditioning organic fertilizer materials.

These organic fertilizers are cheap and available at all local levels. Unlike inorganic fertilizers, these organic fertilizers improve the soil physical, chemical and biological properties.

Table 6: Effect of different treatments applied on chemical properties of the soil after the study

		N	OC	OM	Available	Ca	Mg	K	Na
TRT	pH	----------%----------			P	----------(Cmol kg^{-1})----------			
N.P.K. 15:15:15	7.13	0.90	0.82^{ab}	1.10^{a}	1.97^{a}	2.79	1.89^{a}	0.39	0.56
Kola testa	7.90	0.57	0.39^{b}	0.65^{ab}	1.90^{b}	2.61	0.92^{abc}	0.51	0.51
Cocoa pod ash	7.37	0.77	0.90^{ab}	0.80^{ab}	2.41^{ab}	2.85	1.10^{a}	0.80	0.56
Melon testa	7.51	0.68	0.68^{ab}	0.60^{ab}	3.08^{a}	3.41	0.74	0.54	0.58
Cowpea pod	7.50	0.42	1.30^{a}	1.07^{ab}	1.59^{b}	3.38	1.08	0.54	0.40
Kola pod	7.40	0.66	0.59^{b}	0.88^{ab}	1.90^{b}	2.60	0.97	0.57	0.57
Control	7.37	0.24	0.68^{ab}	0.86^{ab}	1.46^{b}	2.57	0.76^{bc}	0.55	0.54
LSD (0.05)	NS	NS	-	-	-	NS	-	NS	NS

NS = Not Significant; Treatment means within each column followed by the same letter are not significantly different at $p<0.05$ according to DMRT

CONCLUSION

The result of this study show no significant difference in the effect of the agricultural waste used as fertilizer on the pawpaw seedling height, number of leaves per plant and leaf area. This study confirm the appropriateness use of agricultural wastes (Kola testa, cocoa pod ash, melon testa, cowpea pod and kola pod) as fertilizer for optimum production of pawpaw seedlings as this enhances the rapid growth and produced vigorous growing seedling for transplanting. Agricultural waste application as fertilizer also increase soil chemical properties.

RECOMMENDATIONS

It is recommended that local as well as commercial farmers should make use of agricultural waste to boost pawpaw production. This will reduce farmers expenditure on mineral fertilizers and also increase the soil fertility.

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