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Evaluation of different alternative mixes for *amaranthus cruntus l.* production in abakaliki south east, Nigeria

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ABSTRACT

Suitability of alternative mixes for container vegetable production was studied in a Plant and Screen house of Faculty of Agriculture and Natural Resources Management, Ebonyi state University, Abakaliki. There were 5 growth media mixes and topsoil which included coconut husk mixed with pig dung, sawdust mixed with pig dung, burnt rice husk mixed with pig dung, fresh rice husk mixed with pig dung, burnt rice husk mixed with fresh rice husk mixed with sawdust mixed with coconut husk mixed with pig dung and native topsoil. The design used was a completely randomized design (CRD). The treatments were replicated four times to give a total of twenty-four experimental units. *Amaranthus cruntus L.* was used as a container vegetable to serve as a test crop. Data from both media mixes, topsoil chemical properties and agronomic yield of *Amaranthus cruntus L.* were analyzed using analysis of variance. Results showed that organic wastes based media mixes had superior chemical properties for vegetable production compared to native topsoil. Mixing each organic based media with pig dung significantly (P<0.05) improved their percent N,OC and pH contents relative to top soil. Percent N,OC and pH were 46, 46,91 and 15 % for sawdust mixed with pig dung, burnt rice husk mixed with unburnt rice husk mixed with sawdust mixed with coconut mixed with pig dung, coconut husk mixed with pig dung and sawdust mixed with pig dung when compared with control. There was generally significantly (P<0.05) better *Amaranthus cruntus L.* performance in organic based mixes when compared to topsoil. Coconut husk mixed with pig doing had superior significant (P< 0.05) effect on leaf number, number of branches, plant height, leaf area index and fresh shoot weight of *Amaranthus cruntus L.* in the study compared to topsoil and other media mixes. Coconut husk mixed with pig dung was higher by 23, 18, 15, 39, 37 and 14% than topsoil for leaf number, number of branches, plant height, leaf area index and fresh shoot weight of *Amaranthus cruntus L.* respectively. The media mixes and topsoil enhanced chemical properties and agronomic yield in the order of coconut husks mixed with pig dung > fresh rice husk mixed with pig dung > burnt rice husk with fresh rice husk mixed with coconut husk mixed with sawdust mixed with pig dung > burnt rice husk mixed with pig dung > sawdust mixed with pig dung > topsoil. It was concluded that growing *Amaranthus cruntus L.* in media mixes and particularly coconut husk mixed with pig dung could serve as suitable alternative to soil in container vegetable production in Abakaliki agro ecology.

Introduction

The soil serves as natural media that provides both physical and chemical environment for crop production (Ogbodo, 2012). The ultimate objective of soil is to provide water and nutrients to plant as well as permit gas exchanges to and from their roots and also mechanical support. This was corroborated by Bunt (1998) and Landis *et al.* (1990) who pointed out that soil media provides predictable starting point to establish the physical and chemical environment for plant growth, medium that physically supports the plants, possesses large pores that promote oxygen exchange for root respiration, small pores that hold water, mineral nutrients for plant growth and yield. Consequently, the necessity of using soil for crop production is therefore inevitable (Ogbodo, 2012).

With the emerging challenges involved in use of soil for crop production such as fertility constraints, population pressure leading to scarcity, convenience and technology drive to improve quality of produce (Micheal and Leith, 2009), it has become imperative to evaluate alternative media mixes to soil (Ogbodo 2012) for crop production. . Materials that have been used by most professionals include wood bark, vermiculite, perlite, coir, recycled forms of waste matter and compost from organic waste. These had often been used for soilless media culture mixes and were noted to be attractive since they were manipulated or even processed to produce a growing medium with superior physical and chemical properties to provide improved nutrients more than soil (Waru, 2010 and Ogbodo, 2012).

The potential of soil less media is measured by the level of air and water the media can hold, how well the media holds the nutrient or their availability to the plants. According to Castillo (2004), the use of the soilless media and their controlled

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concentrations of plant nutrients can be applied to the various crops, various environments, stage of plant growth while keeping harmful plant elements such as Mn, B, Zn, Cu and Pb under control. Unlike soil, media mixes are usually free of contamination from disease pests and weeds.

It is hoped that use of both fresh or burnt rice husk, saw dust or coconut husk each mixed with pig dung as soilless media could be relatively cheap, inexpensive and besides environmentally friendly. In Abakaliki area, large quantities of these materials are produced from rice, wood and coconut processing and lay waste constituting environmental nuisance or sometimes as fire pollution when they are burnt. The use of these materials as media for vegetable production could serve as environmentally friendly means of their disposal. The objective of this study was to formulate and evaluate these media mixes as suitable alternatives to soil for container vegetable production.

Materials and Methods

Study Area

This experiment was carried out at Plant and Screening House of Faculty of Agriculture and Natural Resources Management, Ebonyi State University, Abakaliki. The area is located by latitude 06^o4^1N and longitude 08^o65^1 E. The annual rain fall ranges from 1700 mm to 2000 mm with a mean of 1800 mm. Rainfall pattern in the area is bimodal and is spread from April - July and September - November. There is a break in August commonly called “August break”. The mean minimum and maximum temperatures are 27^oC and 31^oC, respectively. Relative humidity during dry weather is low (60%) and high approximately 80% during rainy season (ODNRI, 1989). The area is characterized by growth of primarily derived vegetation made up of herbs, shrubs and grasses with medium to short vegetations.

Treatments and Their Preparation of Media Materials

The treatments were:

1. Topsoil
2. Coconut husk + Pig dung
3. Burnt rice husk + Pig dung
4. Fresh rice husk + Pig dung.
5. Saw dust + Pig dung
6. Coconut husk + burnt rice husk + fresh rice husk + saw dust + pig dung.

The coconut husks were crushed to smaller sizes. Then, the saw dust, burnt rice husk, fresh rice husk and crushed coconut husks were pre incubated before using it for the experiment. The process involved mixing the materials with water up to 70% moisture content and compositing the media in a bag for 56 days. The materials were turned weekly and moisture maintained at 70% throughout compositing period. There were 6 treatments replicated 4 times to give a total of 24 experimental units. The experiment was arranged in completely Randomized Design form. Then 6 kg of the pre-incubated sawdust, burnt rice husk, fresh rice husk, coconut husk, a mixture of the four media and 2 kg of top soil were weighed into containers measuring 50 x 50 cm each. Each medium was mixed with 1.5 kg of dry pig dung respectively as appropriate and weighed into the respective containers of same dimensions. The containers were laid out in rows at the distance of 0.5 m and 0.5 m between rows.

Cultural Practices

Amaranthus cruntus L. seeds were sourced from Ministry of Agriculture, Ebonyi State, Nigeria. The seeds were raised in nursery for 14 days after which they were transplanted. The media mixes were allowed to equilibrate for two weeks before the transplanting of *Amaranthus cruntus L.* seedlings into the containers. The planting distance was 20 by 10 cm to give a total of 500, 000 *Amaranthus* plants per hectare. The containers were watered daily while weeding was done once a week till harvest. The *Amarathus cruntus L* .plants were harvested at 31 days after transplanting by hand cutting manually on weekly basis. Number of branches and leaves per plant were determined by counting. The plants were pulled with hand at the end of harvest, the roots washed and root length measured with metric rule. Leaf area index (LAI) determination was by measuring the length and width of leaf and using a conversion factor of 0.95. Fresh shoot weight was determined by weighing in weight balance. Plant height was measured with ruler.

Sample collection

Four core samples were collected from each container randomly at 0-20 cm depth and later composited and used to determine chemical properties of the media and topsoil.

Laboratory methods

Total N was determined by semi macro kjeldahl method (Bremner and Mulvancy, 1982). Available P was determined by Brav -2 method as outlined in Olsen (Page *et al.*, 1982). Organic carbon and carbon content determination was by Walkley and Black (Nelson and Sommers *et al*., 1982) method. pH was determined in soil/water suspension ratio of 1:2.5. The exchangeable bases of Na, K, Ca and Mg were extracted using IN NH_4OAC (Thomas, 1982). Exchangeable K and Na were read using flame photometer. Cation exchange capacity was calculated by summation method. C.N ratio was determined by dividing the value of carbon by that of nitrogen.

Data Analysis

Data collected from this study were analyzed using SAS by the method of Genstat (2004).

Results and Discussion

Nutrient Concentration of Media Mixes And Topsoil

The nutrient concentration of media mixes and topsoil is shown in Table 1. The percentage carbon (%C) of the different media mixes was generally higher when compared with that of the topsoil. Percent carbon of sawdust mixed with pig dung was 94 and 77% higher relative to topsoil and coconut husk mixed with pig dung. The percent carbon of sawdust mixed with pig dung was also slightly higher than those of other media mixes. However, percent nitrogen (%N) was higher in topsoil and lower in media mixes except in burnt rice husk mixed with pig dung. The percent nitrogen in burnt rice husk mixed with pig dung was higher by 76 and 45% when compared with sawdust mixed pig dung and burnt rice husk+ fresh rice husk+ saw dusk+ cocoanut husk mixed with pig dung. The concentration of carbon and nitrogen in the media mixes and topsoil was reflected in their C.N ratio. Topsoil had lowest C. N ratio and it generally increased in media mixes with saw dust mixed with pig dung giving highest C.N ratio.

High carbon content of mixes affected its efficient conversion and this therefore encouraged immobilization of nitrogen into microbial tissues. According to Biswas and Mukherjee (2008), higher C.N ratio leads to loss of carbon and immobilization of nitrogen. Mbah (2004) reported inverse relationship between C.N ratio and amount of nitrogen mineralized from organic materials. The percentage organic carbon of media mixes was generally higher compared with that of the topsoil. Percent organic carbon was higher in burnt rice husk mixed with pig dung than those of other media mixes. The %OC was respectively higher by 93, 76, 26 and 73% relative to topsoil, coconut husk mixed pig dung, sawdust mixed with pig dung and burnt rice husk+ fresh rice husk+ coconut husk + sawdust mixed with pig dung. The percent organic matter followed the trends as observed in percent organic carbon with all the media mixes having higher organic matter content than the top soil organic carbon content (Table 1). The percentage organic carbon and organic matter according to the ratings of Enwezor *et al*. (1981) and Landon (1991) were very high in media mixes compared to topsoil percent nitrogen. However, percent nitrogen was low (Asadu and Nweke, 1999) in media mixes. Available phosphorus was high in topsoil (Landon, 1991) with those of media mixes being generally very low. This could be attributed to high carbon content of the media mixes which influenced immobilization of nitrogen and probably phosphorus. The pH of the topsoil and media mixes ranged from slightly acidic to neutral except that of coconut husk mixed with pig dung. The exchangeable cations were generally higher in the topsoil and low in media mixes with calcium and magnesium dominating the exchange complex of both topsoil and media mixes. Cation exchange capacity of topsoil was higher than those of media mixes. This is due to low exchangeable cations in media mixes compared with those of topsoil. The capacity of a medium to fix and release nutrients to growing crops is dependent upon available exchangeable cations.

Effect of media mixes and topsoil on chemical properties

Table 2 shows effect of media mixes and topsoil on chemical properties. The sawdust mixed with pig dung and fresh rice husk + burnt rice husk + coconut husk + sawdust mixed with pig dung had significantly (P<0.05) higher percent nitrogen (%N) than that of topsoil and the other media mixes. Similarly, the media mixes had higher %N when compared with that of the topsoil. The fresh rice husk mixed with pig dung and burnt rice husk mixed with pig dung were 31 and 25% higher in %N than that of topsoil. The lower %N of topsoil after planting could be attributed to exploitation by crop for photosynthetic processes. However, high %N in media mixes following cropping suggests that more nutrients were yielded upon mineralization by the media mixes more than in topsoil. Furthermore, the percent organic carbon (%OC) of the media mixes was significantly (P<0.05) higher than that of topsoil. The %OC of coconut husk mixed with pig dung, sawdust mixed with pig dung and fresh rice husk mixed with pig dung was significantly (P<0.05) higher compared with those of burnt rice husk mixed with pig dung and fresh rice husk + burnt rice husk + coconut husk + saw dust mixed with pig dung. High %OC content in coconut husk mixed with pig dung after cropping could be attributed to release of more organic carbon in the media mix more than other media mixes and topsoil. Conversely, available phosphorus of topsoil was significantly (P<0.05) higher than those of media mixes. Again, the available P of coconut husk mixed with pig dung significantly (P<0.05) increased relative to those of other media mixes. High available P of the media mixes after cropping could be an indication of under utilization of the nutrients by crops. This could be possible since vegetable crops need more nitrogen than other nutrients in order to produce succulent leafy parts. The pH of media and topsoil slightly varied from slightly acidic to alkaline but with those of coconut husk and fresh rice husk each mixed with pig dung being significantly (P<0.05) higher than those of other media mixes.

Exchangeable calcium (Ca) of topsoil was significantly (P<0.05) higher when compared with those of media mixes.

However, except for fresh rice husk mixed with pig dung exchangeable Ca of saw dust mixed with pig dung significantly (P<0.05) increased relative to other media mixes. Exchangeable magnesium followed the same trend as observed in calcium with that of topsoil being significantly (p<0.05) higher than those of other media mixes. Saw dust mixed with pig dung had significantly (P<0.05) higher magnesium than those of other media mixes. Potassium (K) was significantly (P<0.05) higher in the topsoil than those of media mixes. However, coconut husk, saw dust and fresh rice husk respectively mixed with pig dung had their K significantly (P<0.05) higher than those of burnt rice husk mixed with pig dung, fresh rice husk + cocoanut husk + burnt rice husk + sawdust mixed with pig dung. Topsoil had its sodium (Na) significantly (P<0.05) higher than those of saw dust and fresh rice husk each mixed with pig dung. Similarly, coconut husk mixed with pig dung had its Na significantly (P<0.05) higher than those of sawdust and fresh rice husk each mixed with pig dung. Generally, exchangeable cations were higher and also dominated exchange complex of soil than media mixes. The result of cation exchange capacity is a reflection of exchangeable cations (Table2). Nevertheless, cation exchange capacity (cec) of topsoil was significantly (P<0.05) higher than those of media mixes. When sawdust was mixed with pig dung, CEC was significantly (P<0.05) higher than those of other media mixes, respectively.

Generally, organic media mixed with pig dung had higher percent N and OC than topsoil. The levels of these nutrients were considered to be high in media mixes and according to the rating of Landon (1991) are moderately high. Available P was high in topsoil

High available P in native topsoil is expected since it is envisaged to have better structure, texture, aeration, moisture, pH, and C:N ratio all of which encouraged microbial activities. Bazai and Achakzai (2006) and Achakzai *et al*., (2011) corroborated this findings in lettuce grown in waste water of quetta. Available P was very high in topsoil (Enwezor *et al*., 1982) in comparison to media mixes. Mixing organic wastes with pig dung only brought about slight changes in pH of media mixes and that of topsoil. High pH was instrumental to releasing of exchangeable cations in the exchange complex of media and which promoted their microbial decomposition.

Effect of media mixes and topsoil on agronomic yield of *Amaranthus cruntus L.*

Effect of medial mixes and topsoil (Table 3) on agronomic yield of *Amaranthus cruntus L.* showed that significantly (P<0.05) higher leaf number was obtained in coconut husk mixed with pig dung and fresh rice husk media mixed with pig dung, respectively compared with topsoil, sawdust mixed with pig dung and burnt rice husk + fresh rice husk + coconut husk+ saw dust media mixed with pig dung, Saw dust mixed with pig dung and burnt rice husk+ fresh rice husk+ saw dust + coconut husk mixed with pig dung depressed leaf numbers but in saw dust mixed with pig dung, it accounted for 92% reduction in number of leaves per plant when compared to that of topsoil. The different media mixes except saw dust mixed with pig dung produced slightly more number of branches but comparable to that of topsoil. The number of branches obtained in coconut husk mixed with pig dung and fresh rice husk mixed with pig dung were 18 and 12% each higher than those of topsoil, burnt rice husk mixed with pig dung and burnt rice husk + fresh rice husk + coconut husk + saw dust mixed with pig dung, respectively. Plant height, although higher in coconut husk mixed with pig dung and fresh rice husk mixed with pig dung did not significantly (P<0.05) vary from topsoil, saw dust mixed with pig dung, burnt rice husk mixed with pig dung and burnt rice husk+ fresh rice husk+ coconut husk+ saw dust media mixed with pig dung. Plant height in both top soil and organic based media mixed with pig dung is comparable.

Table 1. Initial properties of soil and Nutrient Composition of media

Treatment	%C	%N	C:N	%OC	%OM	Pmgkg-1	pH $_{H2O}$	Ca	Mg	K	Na	CEC
Control	2.32	0.82	3	2. 5	4. 3	25. 1	6.8	5.40	4.0	0.31	0.22	9.9
Ch + PD	8.51	0.56	15	8. 5	14.7	0. 18	8.0	0.42	1.6	0.10	0.10	2.2
SD + PD	36.3	0.20	182	26.3	45.3	0. 19	7.4	0.66	1.9	0.02	0.08	2.7
Urhd + PD	34.3	0.71	48	34.2	59.0	0. 22	6.7	0.42	2.5	0.05	0.08	3.1
Brhd + PD	35.4	0.84	42	35.4	61.0	0. 51	7.3	o.72	1.0	0.03	0.24	2.0
Urhd + brhd	32.3	0.46	70	9. 5	16.4	0. 19	6.8	0.51	1.3	0.03	0.22	2.1
+sd+Ch+PD												

PD- pig dung, Urhd- unburnt rice husk, Brhd-burnt rice husk dust, sd – sawdust, Ch- coconut husk

Table 2. Effect of different media and soil on chemical properties of soil

						Cmolkg-1			
Treatment	N%	%0C	Pmgkg-1	$pH_{H2}o$	Ca	Mg	k	Na	CEC
Control	0.68	2.21	59.69	6.2	6.20	3.6	0.46	0.27	10.55
Ch + PD	0.70	23.32	0.49	6.2	0.46	1.2	0.05	0.24	1.95
Sd +PD	1.26	11.21	0.29	7.3	1.08	1.8	0.09	0.10	3.07
Urhd+PD	0.98	17.72	0.24	6.8	0.72	1.0	0.06	0.11	1.89
Brhd+PD	0.94	7.54	0.26	6.5	0.36	1.1	0.03	0.21	1.70
Urhd+Brhd+Sd+PD	1.26	8.40	0.24	6.4	0.42	1.2	0.03	0.20	1.85
FLsd (0.05)	0.06	1.42	0.11	0.2	0.39	0.2	0.01	0.12	0.45

PD=pig dung, Urhd- Unburnt rice dust, Brhd-Burnt rice hust dusk, sd-sawdust, NS-non significant, ch – coconut husk

Table 3. Effect of different media and soil on agronomic yield of Amaranthus

Treatment	**No of leaf/plant**	**No of Branches/plant**	**Plant length (cm)**	**Root length (cm)**	**LAI**	**Fresh Weight short (g)**
Control	113	23	71.57	16.80	9.60	12.0
Ch +PD	147	28	84.05	27.60	15.34	14.0
Sd + PD	59	19	55.40	13.80	8.67	8. 0
Urhd+ PD	136	26	78.47	18.60	9.32	12.0
Brhd + PD	124	23	65.55	24.00	9.57	8. 0
Brhd+Sd+Urhd + Ch + PD	104	23	58.97	19.40	14.83	9. 0
Flsd (0.05)	20.4	NS	NS	3.48	NS	NS

PD- Pig dung, Urhd-unburnt rice dust, brhd- Burnt rice dust, Sd-Saw dust, Ns- Not significant, Ch-coconut husk

The coconut husk and burnt rice husk media each mixed with pig dung had significanthy ($p<0.05$) longer root length compared to topsoil, saw dust mixed with pig dung, fresh rice husk mixed with pig dung and burnt rice husk+ saw dust+ coconut husk + fresh rice husk media mixed with pig dung. Even though, coconut husk mixed with pig dung and burnt rice husk+ fresh rice husk+ coconut husk+ saw dust mixed with pig dung had larger leaf areas, they are comparable to those of topsoil, saw dust, burnt rice husk and fresh rice husk each mixed with pig dung. Coconut husk mixed with pig dung had heavier weight of *Amaranthus cruntus L.* than those of topsoil and the other media based organic materials mixed with pig dung. *Amaranthus cruntus L* was 14, 57, 14, 57 and 36% heavier when compared to those of topsoil, saw dust mixed with pig dung, fresh rice husk mixed with pig dung, burnt rice husk mixed with pig dung and burnt rice husk+ fresh rice husk + coconut husk+ saw dust mixed with pig dung, respectively.

Agronomic yield of *Amaranthus cruntus L.* was generally enhanced in coconut husk mixed with pig dung when compared with those of top soil and other organic based media mixed with pig dung. The phenomenal growth and yield performance of *Amaranthus cruntus L.* in coconut husk media mixed with pig dung could be attributed to in the first place more available organic carbon and phosphorus in the mix (Table2) and generally available nutrients to plants. Therefore, the superior performance of *Amaranthus cruntus L.* in coconut husk based media mixed with pig dung derives from better aggregation, provision of air, retention of water and gaseous exchange due to better texture. This observation is corroborated by ogbodo (2012) that different media mixes exhibited variations in their properties and lettuce yield. Low agronomic yield of *Amaranthus cruntus L.*in saw dust based media mixed with pig dung suggests low utilization of available nutrients by crops. There could have been inhibition and inefficient reaction to elicit and encourage maximization of nutrients by the crops. According to ogbodo (2012), it is not just enough to add plant nutrient into soil less mix because certain materials could react with added plant nutrients so that the nutrients become unavailable to the plants. Significant agronomic yield in organic materials based mixe is an indication of beneficial effect of microbial decomposition. Castillo (2004) reported that compositing increased beneficial micro organisms, a situation that encouraged microbial decomposition of residues and the release of nutrients in the final stage.

Conclusion

The result from this study show that organic based media could be used as alternatives to *Amaranrthus* vegetable production and produce comparable yields. Using burnt rice husk, fresh rice husk, saw dust and coconut husk or their mixes mixed with pig dung, respectively increased percent N, OC and pH of the media. Consequently, agronomic yield of *Amaranthus cruntus L.* was higher in media mixes more than in topsoil. Conversely, exchangeable cations were profoundly high in native topsoil compared to media mixes. Conclusively, the general performance of the media mixes in enhancement of chemical properties and agronomic yield of *Amaranthus cruntus L.* is arranged as follows coconut husk + pig dusk > fresh rice husk +pig dung > burnt rice husk + fresh rice husk + coconut husk+ sawdust + pig dung> burnt rice husk + pig dung > saw dust+ pig dung> top soil. The practice of using organic material based media for container vegetable production affords the opportunity for safe disposal of these wastes in environmentally sound manner that has become nuisance in our society. Above all, farmers could also practice vegetable production in the comfort of their immediate environment thereby limiting outdoor farming activities.

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