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Effects of cultural practices on mineral compositions of cassava peel compost and its effects on the performance of cabbage (*Brassica Oleracea* L.)

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ABSTRACT
Objective: To assess the mineral compositions of cassava peel compost, and to determine its effects on the head yield of *Brassica oleracea*.
Methodology and Results: Cassava peel compost was prepared and subjected to three turning rates, i.e. at 7, 14 and 21 days intervals and three watering regimes of 7, 14 and 21 days intervals. On the field, cabbage was subjected to nine compost treatment combinations laid out in a factorial experiment and fitted into a randomized complete block design with three replicates. Temperature during composting, and the growth and yield attributes of cabbage were assessed. The temperature in the compost increased as the composting days increased up to 40 days, then declined thereafter. The temperatures during composting were significantly affected by turning and watering regimes, with the highest recorded from 14 days turning and watering regimes. The mineral elements available in the cassava peel compost were significantly influenced by turning and watering regimes with the highest values obtained from compost under 14 days turning and 21 days watering rates. Compost with 7 days turning by 7 days watering regimes had the least values. Plant height, number of leaves, and shoot and head yields varied significantly with treatments, with the highest values being for plants treated with compost from 14 days turning by 21 days watering regimes.
Conclusion and application of findings: The results show that 14 days turning by 21 days watering regimes would be the best management practice for compost preparation. These cultural practices improved the mineral composition of compost as well as the head yield of cabbage.

Key words: Cassava peel, compost, turning rate, watering rate, cabbage, head yield.

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INTRODUCTION

The Food and Agriculture organization (FAO, 1988) has identified cabbage as one of the top twenty vegetables and an important source of food globally. Many countries have incorporated cabbage as part of their national cuisine. Cabbage is an excellent source of vitamins C and K, and also contains many phytonutrients such as Indole-3-carbinole (13C) (Fowke *et al.*, 2003) which prevents breast cancer in women. Apolipoprotein and glucosinolates which eliminate harmful compounds from the body (Cohen *et al.*, 2000) are other constituents. Organically grown crucifers contain higher level of phytonutrients than conventionally grown vegetables (FAO, 2000).

Heading cabbage varieties such as green, white red and Savoy that are more adapted to the cooler regions of Northern Europe can also be grown at higher elevations in Nigeria if suitable varieties are selected (Attfield, 1968). Good performance has been reported in places like Jos Plateau which is reputed to have the highest cabbage production in Africa (Harry, 1968). The preferred variety is green cabbage e.g. Golden acre, Cabbage Gloria, Pride of the market and hundred weight. Cabbage can be grown both in the northern and southern parts of Nigeria, though some reports indicate good growth and head yield performance of Chinese cabbage F_1 varieties in southwestern Nigeria (Fagbayide & Adelakun, 1996; Fagbayide & Olaniyi, 2007). However, cabbage production in Nigeria encountered a setback in that temperature does not favor seed production. Cool temperature conditions of about 10°C continuously for five to six weeks that is required for cabbage plants to flower (Toru, 1981) is the major constraint to seed production in Nigeria.

Organic crop production involves the use of plant and animal materials/wastes such as farmyard manure, green manure or compost as a fertilizer. Composting is an aerobic process in which microorganisms convert mixed organic substrate into carbon dioxide, water, minerals and stabilized organic matter under controlled conditions. The key requirements are moisture and aeration levels creating temperatures that are conducive to the microorganisms involved in the composting processes (Chen *et al*., 1993).

Compost can comprise of waste organic materials, e.g. grasses, weeds, crop trimmings, kitchen waste and other residues. These are stimulated into a state of decomposition by the addition of water and manure (Akanbi *et al*., 2004). The chemical composition depends on the materials used for the compost mixture (Ngeze, 1998), which would in the end affect the growth and yield of crops or vegetables that are treated with these composts. Compost can supply both major and minor nutrients to plants in the required amount, thus providing an alternative to the use of convectional fertilizers which may affect the nutritional composition of crop plants and pollute soil and water (Akanbi *et al*., 2005). Compost binds soil particles together forming soil aggregates, increases soil CEC, releases nutrients in slow form and maintains soil fertility for a long period of time.

Compost improves the yield and performance of a crop and it is most appropriate in vegetable production. There are reports on the effects of organic manure on the growth and yield of cabbage (Fageria *et al*., 1991; William *et al*., 1991). Although overall head yield was not significant, higher head weights were recorded with 30t/ha manure and 15t/ha manure x 60kg /ha NPK fertilizer (Fagbayide & Adelakun, 1996). Takayuki (1980) and Fujiida (1973) reported that nitrogen and phosphorus are absorbed in large quantities during the first half of the growth period and increases during the second half. The highest head yield of 31.5 $t.ha^{-1}$ was obtained from AVRDC hybrid # 58 supplied with 60 kg.N ha^{-1} as basal and 30 kg.N ha^{-1} dressed at two and three weeks after transplanting.

Despite the numerous advantages of compost to farming, farmers face problems of determining the ideal or suitable cultural practices that enhance the quality of composts. The objectives of this project were to determine the effects of turning and watering regimes on the chemical compositions of cassava peel compost, as well as determining the effects of the compost on the performance of cabbage.

MATERIALS AND METHODS

Experimental site: The experiments were conducted at the Teaching and Research Farm of Faculty of Agricultural Sciences, Ladoke Akintola University of Technology, Ogbomoso, within the guinea savannah agro-ecological zone of Nigeria. Ogbomoso is located at 8°10'N and 4°10'E and the climate is cold and dry from November to March and then warm and moist from April to October. The maximum and minimum temperature is 33 and 28°C, respectively. The humidity of this area is high (about 74%) all year round except in January when a dry wind blows from the north. Annual rainfall is over 1000mm (Olaniyi, 1997). The soil is well drained tropical soil and sandy loam in texture. The vegetation is composed of weed species like *Chromolaena odorata, Tithonia sp.* and *Aspilia americana,* among others.

Compost preparation and assay: The materials used for the compost were dried cassava peel (20 kg), well cured poultry manure (10 kg), woodash (2 kg), soil (5 kg) and 5 litres of water. These were air dried, pounded and sieved to remove large particles, then arranged in two layers and spread evenly in a plastic compost preparation drum. Woodash, loam soil and water were added to reduce pH, reduce loss of volatile nitrogen and moisten and aid the decomposition processes. The initial properties of the cassava peel were determined to be N (1.60%), P (0.16%), K (1.14%), Ca (0.88%), Mg (31.37 mg/kg), Zn (32.29 mg/kg) and Cu (39.22 mg/kg) while poultry manure contains 6.24% N, 0.25% P, 0.82% K, 0.07% Ca, 25.49 mg/kg Mg, 33.32 mg/kg Zn, and 31.38 mg/kg Cu (Akanbi *et al*., 2004).

In order to determine the effect of cultural practices on the compost, the composting materials were subjected to different turning and watering rates each at 7, 14 and 21 days intervals. These resulted into nine treatment combinations, arranged in a complete randomized block design, each with three replicates.

To determine the nutrient element contents, the cassava peel composts were bulked, air-dried and ground to pass through a 2mm x 2mm sieve. Available phosphorus and total nitrogen were determined separately by Technicon A All method (Technicon, 1975) while exchangeable Ca, Mg, K, Fe, Zn, S and Mn were quantified using an atomic absorption spectrophotometer (IITA, 1982).

Effect of compost on cabbage growth: Seeds of cabbage variety Gloria F_1 (*Brassica oleracea*) were obtained from the Seed company, Kano, Nigeria and planted in seed boxes filled with topsoil collected from Gmelina plantation. The seeds were sown on the 18th of May 2007 and seedling emergence noted 5 days after sowing. Standard management practices in the nursery included weeding, watering, mulching and disease and pest control.

Nine raised beds representing nine compost treatments in three replicates were made and the treatments were randomly assigned to beds within each block to fit into a randomized complete block design. The seedlings were transplanted on to the field at four weeks after sowing (4 WAS). During transplanting, care was taken to prevent damage to the young seedlings and the seedling watered. The compost prepared was used as organic fertilizer and applied to the soil at transplanting using drilling method with 2.5 $t.ha^{-1}$ of compost from each treatment evenly distributed to their respective plots. Weeding was done manually at 3 weeks intervals and insect pests controlled by applying neem extract at the rate of 2 ml per litre of water applied at 2 weeks intervals.

During composting, the temperature was recorded at 10 days interval while plant growth parameters were assessed at two week intervals. The data collected were plant height, number of leaves (by counting of unfolded leaves), and the shoot (unwrapped leaves and stems) and head weight assessed at harvest.

All data collected were subjected to analysis of variance using SAS-GLM (SAS, 1989) procedure and means separated where applicable using the Least Significant Difference at 5 % probability level.

RESULTS AND DISCUSSION

The compost prepared from dried cassava peels and cured poultry manure was significantly improved by the effects of turning and watering regimes (Table 1). Turning after 14 days combined with watering after 21 days resulted in the highest mineral nutrient contents, while the shorter 7 days turning by 7 days watering regimes had the least values.

During composting the temperature rose steadily with time up to 60 days, then declined slightly (Table 2). The change in temperature is due to activities of microorganisms as composting progresses. As the microorganisms feed, they release enzymes into the composting mixture thereby causing decomposition and consequently accelerating a rise in temperatures within the mixture (Ngeze, 1998; Akanbi *et al*., 2004). The results showed that the composting process would be optimal when various materials of different decomposition rates are combined and well mixed. If the organic materials, air, moisture, and temperature combinations are optimized, the micro-organisms are able to function optimally and yield high quality compost (Ngeze, 1998).

Nickel *et al*. (2005) reported that a good composting process passes through three consecutive stages. These are (1) heating phase (fermentation) when the compost heap starts to heat up considerably (60-70°C) as a result of the breaking down of the complex and tough fibrous materials of the organic matter; (2) a cooling down phase involving decomposition without much heat generation and the slow dropping of temperature (50-30°C); and (3) maturation phase at the end of decomposition, when the temperature drops to soil temperature (15-25°C), depending on the climate. Ngeze (1998) recommended at least 60°C as an ideal temperature for a compost heap aim of getting good quality compost manure. The temperatures obtained in this study at different composting stages are slightly lower than those recommended by Nickel *et al*. (2005) and Ngeze (1998) for composting. This may be due to the cooler climatic conditions during the composting period.

Table 1: Mean temperature of cassava peel compost as affected by turning and watering regimes.

Turning rate (days)	Watering rate (days)	Temperature (°C)									
		10	20	30	40	50	60	70	80	90	100
7	7	27	40	40	39	39.7	41	38.5	39	38.9	34.2
7	14	26	40	41	38.8	40	40.8	37	40	39.2	36.2
7	21	25	39	40	37.4	37.8	41.5	39	39.4	39.3	38.5
14	7	28	41	39	37	37	40	38.6	39	41	36.3
14	14	30	41	41.6	40.5	41.5	41.3	41	41.9	40.3	39.5
14	21	30	38	40	38.5	36	39.3	39	40	39.9	37.5
21	7	31	39	38	40.1	38.5	38.5	38	38.7	39.3	38.1
21	14	31	40	40.5	38.9	39.5	38.3	37.5	39	40.5	35.9
21	21	29	41	28.5	39.1	39.2	39	36.5	39	40.5	38.1
LSD (0.05)											
TR		1.04	ns	3.4	ns	Ns	0.65	0.71	ns	ns	0.31
WR		ns	ns	3.4	0.5	Ns	ns	ns	ns	ns	0.31
TR x WR		ns	ns	11.6	ns	ns	ns	ns	ns	ns	0.096

TR=turning rate ; WR=Watering rate

Table 2: Chemical composition of matured compost.

Turning rate (days)	Watering rate (days)	%				mg/kg				
		N	P	K	Ca	Mg	Fe	Zn	S	Mn
7	7	1.00	0.34	1.02	1.92	0.21	0.27	111	0.79	162.50
7	14	1.40	0.42	1.51	3.19	0.28	0.26	137	0.82	226.00
7	21	8.60	0.35	1.40	2.34	0.20	0.21	134	0.92	170.50
14	7	3.50	0.53	1.61	4.70	0.28	0.30	154	1.02	250.00
14	14	2.20	0.51	1.72	3.20	0.28	0.26	153	0.96	232.50
14	21	9.30	0.45	1.72	6.95	0.24	0.28	120	1.16	260.00
21	7	0.53	0.38	0.81	1.76	0.21	0.27	92	0.71	175.00
21	14	5.91	0.35	1.24	2.90	0.28	0.28	101	0.86	201.00
21	21	0.72	0.41	1.67	5.01	0.25	0.27	159	0.80	231.00
LSD (0 =.05)										
TR		2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1
WR		2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1
TR x WR		4.41	4.41	4.41	4.41	4.41	4.41	4.41	4.41	4.41

TR=Turning rate; WR=Watering rate

The turning and watering rates, and their interactive effects significantly affected the chemical compositions of the matured compost (Table 3). The quality of compost increased with increasing watering interval up to 21 days and as the turning interval increased up to 14 days. The highest N, K, Ca, S and Mn contents were obtained from matured compost under 14 days turning by 21 days watering regimes treatment, while the least values were recorded from 7 days turning by 7 days watering regimes. Although the highest values of P, Mg, Fe and Zn contents were obtained from 14 days turning by 7 day watering regimes, there was no significant different between 14 day turning by 7 day watering regimes and 14 days turning by 21 days watering regimes.

Except for Mg, the mineral element contents of the matured compost were higher than what was obtained from raw cassava peel (Akanbi *et al*., 2006). This shows that composting of organic materials into compost helps to improve their chemical compositions. These results also reveal that cultural practices especially turning and watering regimes are important factors to consider when composting.

Table 3: The mean plant height (cm) of cabbage as affected by compost application.

Turning rate (days)	Watering rate (days)	Weeks after Transplanting				
		2	4	6	8	10
7	7	7.0	13.0	16.0	22.7	20.25
7	14	8.0	13.0	19.0	24.0	25.0
7	21	7.0	12.0	19.0	29.5	31.2
14	7	6.0	15.0	23.0	28.0	29.0
14	14	7.0	13.0	22.2	30.4	32.1
14	21	9.0	14.0	23.5	36.6	38.2
21	7	8.0	16.0	24.6	29.8	33.4
21	14	10.0	16.0	24.25	34.6	36.3
21	21	7.0	14.0	14.8	32.9	34.5
LSD (0.05)						
TR		0.37	0.71	0.77	0.5	0.57
WR		0.37	0.71	0.77	0.5	0.57
TR x WR		0.14	0.5	0.59	0.25	0.32

TR=Turning rate; WR=Watering rate

All cabbage plants exhibited uniform morphotype and shortened non-branching stem that is terminated in the production of leaf rosette as from 6 WATP (IBRGR, 1990; Fagbayide & Olaniyi 1999). The plant height increased as the plant aged (Table 4) and it was significantly affected by different turning and watering regimes, and their interactive effects as from the 2nd to the 10th week after transplanting. The highest value was obtained at 14 days turning by 21 days watering regimes while the least value was obtained from 7 days turning by 7days watering rates. All cabbage plants had a similar growth pattern, with an initial slow growth, then a steady or constant growth as observed from 2 to 10 WATP. This is due to reduced soil moisture content during the early August period (Opena *et al*., 1988; Olaniyi & Fagbayide, 1999).

The number of leaves increased as the plant aged. The numbers of leaves were significantly affected by the application of compost with the highest value obtained from 14 days turning by 21 days watering regimes treatment. The least number of leaves was obtained from 21 days turning by 7 days watering regimes at 2 to 10 weeks after transplanting.

Table 4: Number of cabbage leaves as affected by application of compost.

Turning rate (days)	Watering rate (days)	Weeks after Transplanting				
		2	4	6	8	10
7	7	7	8	9	10	11
7	14	7	9	10	12	11
7	21	6	9	10	12	11
14	7	7	9	10	12	10
14	14	7	9	10	12	11
14	21	8	10	11	13	14
21	7	7	10	9	8	12
21	14	8	10	11	12	13
21	21	6	10	11	9	12
LSD (0.05)						
TR		ns	ns	0.53	ns	ns
WR		0.67	0.73	0.53	0.93	0.87
TR x WR		ns	ns	0.28	ns	ns

TR=Turning rate; WR=Watering rate

The growth of leaves is genetically controlled (Olaniyi & Fagbayide, 1999) but it can be affected by the nutrient contents in the compost especially N and P supply (Toru, 1981). Inadequate supply of these elements during growth restricts the number of leaves in the head. The non-heading leaves improved head formation by photosynthesis to the inner leaves as well as providing shade to the head (Fagbayide& Olaniyi, 2007; Toru, 1981).

Composts from different turning and watering regimes produced cabbage heads of varying weights (Table 5). The highest head weight was produced by plants treated with compost from 14 days turning by 21 days watering regimes. The least was recorded in 21 days turning by 14 days watering regimes. It is generally believed that cabbage produce high shoot yield and low head yield in the tropics (Olaniyi & Fagbayide, 1999). This is attributed to high temperature, sunlight intensity and low moisture supply during the growth period which leads to leaf production at the expense of head formation (Messiaen, 1992). However, the head yield obtained from our study was contrary to this finding, being slightly higher than the shoot yield. This might be due to the heat tolerant trait of the F_1 hybrid cabbage variety used (Fagbayide & Olaniyi, 2007) and possibly the influence of applied compost in improving head yield as compared to shoot yield. Moreover, the hybrid cabbage variety used in this study is genetically adaptable to the tropical climate existing in guinea savanna zone of southwestern Nigeria (Opena & Lo, 1981).

Table 5: Yield of cabbage as affected by the compost application.

Turning rate (days)	Watering rate (days)	Shoot yield per plant (g)	Head yield per plant (g)	Total head yield ($t.ha^{-1}$)
7	7	391.42	542.0	36.3
7	14	383.18	536.0	35.9
7	21	289.26	478.0	32.0
14	7	231.43	358.13	23.9
14	14	199.47	381.0	25.5
14	21	205.67	578.0	38.7
21	7	183.5	343.1	22.99
21	14	176.68	231.7	15.5
21	21	329.58	498.0	33.4
LSD (0.05)				
TR		0.68	0.73	0.53
WR		0.68	0.73	0.53
TR x WR		0.46	0.53	0.28

This study revealed that application of organic fertilizer in form of compost can significantly improve vegetable production. The conditions that yield the best cassava peel compost are 14 days turning by 21 day watering rates. Farmers should be advised to practice these measures to produce their own compost which would be cheaper than inorganic fertilizers but equally or even more effective.

REFERENCES

Akanbi WB, Olabode OS, Olaniyi JO, Ojo AO, 2004. Introduction to tropical crops. Raflink computers, Eleyele, Ibadan, Nigeria. Pp. 17-52.

Akanbi WB, Akande MO, Adeniran JA, 2005.Suitability of composted maize straw and mineral nitrogen fertilizer for tomato production. Journal of Vegetable Science 11 (1): 57-65.

Akanbi WB, Adeboye CO, Togun AO, Ogunrinde JO, Adeyeye SA, 2006. Growth, herbage and seed yield and quality of *Telfaria occidentalis* as influenced by cassava peel compost and mineral fertilizer. Journal of Bioresource Technology (In press).

Attfield HD, 1968. Vegetable gardening in western Nigeria. Ministry of Agriculture and Natural Resources. Ibadan, Nigeria. Pg 42-45.

Chen Y, Ahmed O, Inbar U, 1993. Chemical and Spectroscopial analysis of organic matter transformation during composting in relation to compost maturity. In HAJ Hotitink and HM Keener (Eds.) Science and engineering of composting. Pp 550-600.

Cohen JH. and Kristal AR, 2000. Fruit and vegetable intakes and prostate cancer risk. J. Nath cancer Inst. 2000 Jan. 5, 92(1): 61-8. PMID: 15210.

Fageria NK, Bhoro DP, Kale PN, Patil JD, 1991.Growth and mineral nutrition of field crops. Marcel Darcer Inc. New York. Pp.476.

Fagbayide JA. and Adelakun OK, 1996. Preliminary evaluation of the growth and yield of heading cabbage (*Brassica oleracea*) in the southwestern Nigeria. 10th Horticultural Society of Nigeria (HOTSON) Conference Pp. 169-172.

Fagbayide JA. and Olaniyi JO, 2007. Growth and yield of Cabbage in the savanna zone of southwestern Nigeria. European Journal of Scientific Research 16 (4): 510 - 514.

FAO, 2000. Statistical database. Food and Agricultural Organization of the United Nations, Rome, Italy.

FAO, 1988. Traditional food plants. Food and Agricultural Organizations of the United Nations, Rome, Italy.

Fowke JH, Chung FL, Jin FC, Cheng TR, Shu XO, Gao YT, Zheng W, 2003. Urinary isothiocyanate level, brassica, and breast cancer. Cancer Res. Jul 15: 63 (14): 3980-6.

Fujiida K, 1973. Chinese cabbage (In Japanese). In: R. Akitani (ed.) Handbook of vegetable. Horticulture. Yokendo, Tokyo.

Heo HJ. and Chang VL, 2006. Phenolic phytochemicals in cabbage inhibit amyloid beta protein induced neurotoxicity. Food science and Technology 39(4): 331-337.

Harry DA, 1968. Vegetable gardening in Nigeria. Ministry of Agriculture and Natural Resources, Ibadan,Nigeria. Pp.42-45.

IBPGR (International Board for plant Genetic Resources), 1990. Descriptors for Brassica and Raphanus. European Communities, Rome. 51 Pp.

IITA, 1982. Automated and semi-automated methods of soil and plant analysis manual, No. 7. Pp 4-15.

Inckel M, Smet PD, Termette T, Veldkamp T, 2005. The preparation and use of compost. Agromisa Foundation, Wageningen, the Netherlands.

Irvine FR, 1979. Western African Crops Oxford University press, London:

Kato I, 1967. Head formation phenomenon In (Japanese) In: I Sugiyama (ed) Development physiology and cultural techniques in vegetable crops. Seibunde-shinkosha Taakyo Pp. 63-104.

Messiaen CM, 1992. The tropical vegetable garden: Principles for improvements and increased production, with application to the main vegetable types. CTA Macmillan.

Ngeze PB, 1998.Learn how to make and use compost manure in farming. Stantex Publisher, Westland, Nairobi, Kenya.

Olaniyi JO, 1997. Evaluation of eight F_1 Hybrid Cabbage (*Brassica oleracea* L.) varieties in the savanna zone of southwestern Nigeria.

Master of Science Thesis in Agronomy, University of Ibadan, Ibadan, Nigeria.68 Pp.

Olaniyi JO. and Fagbayide JA, 1999. Performance of eight F_1 Hybrid Cabbage (*Brassica oleracea* L.) varieties in the savanna zone of Nigeria. Agriculture BiotechnologyEnvironment 1(2): 4-10.

Opena RT. and Lo SH, 1981. Breeding for heat tolerance in heading Chinese cabbage, NS Talekan and TD Griggs (eds) Chinese cabbage AVEDC, Shanhua, Taiwan. Pp 431-442.

Opena RT, Kuo CG, Yoon JY, 1998. Breeding and seed production of Chinese cabbage in the Tropics and subtropics. Asian veg. Res. and Dept., Shanhua, Taiwan, R.O.C Pp. 2-61.

SAS (Statistic Analysis System) Institutious Inc, 1989. SAS User's Guide SAS Institutes/STAT User's Guide, Version 6, 4th ed., Vol. 2. Cary, NC, USA.

Takayuki Y, 1980. Management of summer Chinese cabbage in Taiwan. In Chinese cabbage (Proceedings of the first International Symposium, AVRDC). Pp. 55

Technicon Instrument Corporation, 1975. Industrial method No. 155 - 71W. Tarry Town, New York.

Toru K, 1981. The physiological mechanism of heading Chinese cabbage. AVRDC. Taiwan Pp. 181-195.

William CN, Uzo JO, Peregrine WTH, 1991.Vegetable production in the tropics. Longman Scientific Technical Group, U.K.Pp.179.