World Journal of Agricultural Sciences 3 (5): 642-652, 2007
ISSN 1817-3047

The Use of Compost Extract as Foliar Spray Nutrient Source and Botanical Insecticide in *Telfairia occidentalis*

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Abstract: The possibility of solving the transportation and application problems associated with the adoption of compost technology was explored by applying the manure extract from cassava peel and tithonia plant composts in form of foliar spray or liquid fertilizer as nutrient source and botanical insecticide. The equivalent quantity of cassava peel and tithonia plant composts required by the *Telfairia occidentalis* crop was immersed in appropriate volume of water for seven days to produce extracts. This was diluted into ratios 1:1; 1:2 and 1:3 to produce extracts of different nutrient concentrations. The general recommended NPK fertilizer for leafy vegetable crops was equally applied as soil incorporation and this along with non fertilized plants served as checks. Data collected include length of primary vine, number of secondary vines, leaf area, number of leaves, shoot yield, pest infestation and shoot nutritional contents. Data collected were averaged over the two trials before subjected to statistical analysis of variance and significant means compared using Duncan Multiple Range Test. Plants that received nutrients inform of foliar spray performed similarly with those that were fertilized with soil applied NPK fertilizers. The performance of plants with these two sets of nutrient sources were better than what was observed with the control non fertilized plants. Among the extracts, plants nourished with tithonia (a less lignified and high biodegradable plants) compost extracts performed better than those spray with cassava peel compost extracts. Irrespective of compost extract type, 1:2 dilution ratios of extracts, generally, out yielded other dilution ratios. The shoot nutritional contents of the T. occidentalis plants that received foliar spray were slightly higher than the ones which were fertilized with soil incorporated NPK fertilizer. Insect pests of the plant that received foliar spray of compost extracts were minimal compared with non fertilized plants and those that received soil incorporated NPK fertilizer. This suggests a dual role of this compost extract foliar sprays as source of nutrients and materials for controlling insect pests. The colour impacted by the extracts on the crop leaves disappeared between 2-3 weeks after application and this was found not to have significant effects on the yield, nutritional contents as well as consumer acceptability of the crop. Effort is on to characterize the nutritional active ingredient and insecticidal properties in the two compost extracts.

Key words: Indigenous vegetable · compost extracts, foliar spray · liquid fertilizer · nutritional quality · insect pest · *Telfairia occidentalis* · botanical

INTRODUCTION

Telfairia occidentalis Hook F. (fluted pumpkin) is one of the most important vegetables grown in Southern Nigeria. It is generally regarded as a leaf and seed vegetable. The leaves and young shoot are edible. The leaf has a high nutritional, medicinal and industrial values being rich in protein (29%), fat (18%) and minerals and

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vitamins (20%) [1, 2]. The oil in the seeds is non-drying and is useful in soap making and in cooking [3]. In the recent time, fluted pumpkin had gained medicinal recognition. It has been discovered to be blood purifiers [4] and could therefore be useful in maintenance of good health most especially among poor resource ruralities in developing countries. Despite the potential of this crop, its cultivation has not gained sufficient scientific recognition. One of its limitations is inadequate fertilizer application technology and poor pest control strategy. In order to get expected results from the use of agrochemicals, it has to be applied in correct form, with correct dosage and methods. The use of plant waste compost has been reported to be adequate for the production of Telfairia occidentalis. Akanbi *et al*. [5] reported significantly better performance of plants nourished with cassava and tithonia peel composts at a quantity equivalent to 60 kg N ha^{-1}.

Tithonia, commonly known as Mexican sunflower, is a shrub belonging to the family asteraceae. It is believed to originate from Mexico and it is now widely spread throughout the humid and subhumid tropics. Tithonia was probably introduced into Africa as an ornamental. It has been reported in Kenya [6], Nigeria [7], Rwanda [8] and Zimbabwe [9]. In addition, it is also known to occur in Cameroon, Uganda and Zambia. The reported uses of tithonia include fodder [10], poultry feed [11], fuelwood [12] and as compost [8, 12]. In addition, extract from tithonia plant parts reportedly protect crops from termites [13] and control other insects [14]. The green biomass of tithonia was previously recognized to be high in nutrients and effective as a nutrient source for lowland rice [15] and maize [6]. Recent work in Nigeria [5, 16] have similarly reported tithonia biomass or compost to be an effective nutrient source for okra, water melon and flutted pumpkin. The nutritive value of tithonia biomass can conceivably be influenced by plant part, age of tithonia, position of the leaf within the plant canopy, soil fertility and provenance. The form in which tithonia is added to the soil also influence its nutrient concentration. For instance, undecomposed tithonia litter on the soil surface under a tithonia canopy contained lower amount of essential nutrients compared to composted ones.

Cassava peels which are regarded in many areas in Nigeria as waste are rich in crude protein (5.29%) and fat (1.18%) [17]. It is usually burnt or used to feed livestock (most especially small ruminants) as source of protein and roughages [18]. However, not more than 10% of the cassava peels produced is utilized in feeding livestock. The remaining is commonly found in farm locations and processing sites as heap that are generally perceived as a nuisance. These materials, however, could be utilized more effectively and sustainablly through recycling rather than being destroyed through burning as commonly practiced by many and this causes air pollution.

Cassava peel like many organic waste materials is a potential sources of organic matter and plant nutrients. Management of cassava peel includes direct incorporation into the soil, feeding them to livestock, burning or processes them into a more stable organic fertilizer called compost [19]. Compost is a mixture of the remnants of degraded plant material and the by-products of the degrading organisms. It is produced through a process referred to as 'composting'. Preparing compost from cassava peel offers many advantages. It provides incentive for communities to recover locked nutrients in the peel, eliminate the problem of waste disposal and increases the manurial values of the materials [20-22]. In the recent past some studies have been conducted to elucidate the beneficial effects of adding crop residue compost into the soil. The practice improves soil physical, chemical and biological activities as well as improving crop yields and nutritional values [21-26]. This also maximizes the use of available organic resources on the farm and minimizing the use of costly purchased inorganic agro chemicals [26, 27].

Foliar feeding is an effective method for correcting soil deficiencies and overcoming the soils inability to transfer nutrients to the plant. Tests have shown that foliar feeding can be 8 to 10 times more effective than soil feeding and up to 90 percent of a foliar fed nutrient solution can be found in the smallest root of a plant within 60 minutes of application. Foliar fertilizers have been used on many crops for at least 40 years. In recent years, foliar application of essential nutrients has increased and has been used to improve the quality and increase yields of muskmelon [28, 29], maize [30-32], soybean [30, 33] and peanuts [34]. The ability of a crop variety to absorb large amount of nutrients and convert them into plant biomass on highly enriched soils, where less efficient cultivars reach a yield plateau, has been described as the 'effectual response' to fertilizer application. In this approach to plant nutrition, the emphasis is placed solely on plant uptake from the soil. One of the most immediate, obvious effects of applying mineral nutrients, especially nitrogen, to the soil is an increase in leaf area. It has been argued that this is agronomically the most important result of fertilizer application because an increase in leaf area results in more radiation intercepted by the crop. The above mentioned studies have shown that foliar fertilization is a potential alternative to soil application for increasing foliar area. In another studies, application of fertilizer as foliar spray improved crop proximate and nutritional contents. In bread wheat, the use of foliar urea was reported to increase the protein content of the grain and this may provide the quality benefits of N fertilization and simultaneously reduce risks of nitrate leaching and denitirification [35-37].

Foliar spays of fertilizer could also be used to manipulate leaf duration, dry matter accumulation and net photosynthetic rate in plants. For instance, Chauhan *et al*. [38] reported significant increase in leaf retention and yield of pigeonpea exposed to foliar spray at maturity of concentrated urea. In their study, concentrated urea spray on a mature pigeonpea crop assisted not only in increasing the amount of leaf litter but also increasing nitrogen concentration in its defoliated leaves compared to a situation where the nutrients where supplied through soil incorporation.

Plant insect pests continued to play a major limiting role in agricultural production, particularly in intensively managed crops. Concerns about food safety, environmental quality and pesticide resistance have dictated the need for alternative pest management techniques. Data from many researches indicated that foliar sprays of fertilizers can induce systemic protection against foliar insect pests in various crops such as cucumber, maize, rose and apple [39]. In very many of the reports, crops that received its nutrients in form of foliar application produced higher yield with superior qualities. This implies the possibility of this form of nutrients application in performing dual roles of supplying adequate nutrients to the crop and at the same time induces plant protection against insect pests.

The possibility of using tithonia extract as nutrient source and insecticidal materials was first suggested in the report of Adoyo *et al*. [13]. In the research work, extract of tithonia compost was applied as foliar spray to control insect pests of okra and soybean. It was observed that the extract was not only as effective as the use of conventional insecticide (karate) but the plants treated with tithonia compost extract have better growth and yield. Although application of fertilizer as foliar spray is common to control micro nutrient deficiency in plants, extracts from high nutrient content plant biomass like that of tithonia could also offer advantage of making the nutrient available to plants faster than through other any known methods. Despite research efforts on the use of plant wastes as source of nutrients to crop, their potential as liquid compost fertilizer materials or their extract as source of nutrients and insecticides through foliar spray have not been fully exploited in Nigeria. The present research was therefore carried out to assess: (i) the possibility of supplying crop nutrient through crop waste compost as extract and (ii) the potential of crop waste extracts as insecticidal materials. The impact of the colour or patches of compost extracts (left on the crop shoot) in relation to crop nutritional value was also reported.

MATERIALS AND METHODS

This experiment was conducted at the Teaching and Research Farm, Ladoke Akintola University of Technology, Ogbomoso, Nigeria in 2006 with the objective of assessing the potential of plant compost extracts as foliar spray or liquid fertilizer for production of vegetable crops. The analytical result of the soil use for the experiment show that it is sandy loam in texture and contained pH 6.3 and organic carbon 0.17%. The soil N (g kg^{-1}), P (mg kg^{-1}) and K (cmol kg^{-1}) were 0.38, 7.97 and 0.25, respectively. The region has a hot humid tropical climate and receives 1,080 mm rainfall annually. A major part of the rain is received during April-October.

Cassava peel and tithonia plant were composted separately with poultry manure (in ratio 3:1 dry weight) [40] in each case. The materials were allowed to decompose for a period of eight weeks. Samples of poultry manure, cassava peel, tithonia plant and matured compost were subjected to chemical analysis. At maturity the composts were air dry and subjected to chemical analysis to determine the nutrient composition. The equivalent quantity of cassava peel (CP) and tithonia plant (TP) composts required by the *Telfairia occidentalis* [5] crop was immersed in water in ratio 1:3 for seven days to produce extracts. This was further diluted into ratio 1:1; 1:2 and 1:3 to produce extracts of different nutrient concentrations. The recommended dose of N (60 kg ha^{-1}) (as NPK soil incorporated) for fluted pumpkin in Nigeria [41] and non nutrient treatment served as check. The rate of CP and TP composts used were based on their N equivalent and applied on dry weight. The equivalent quantity of CP and TP composts used were 4.5 and 3.0 t ha^{-1}, respectively and this is equivalent to materials that would have supplied 60 kg N ha^{-1} to the crop during the current growing season. In all there were eight treatments viz:

T1	Soil incorporated NPK
T2	Tithonia compost extract in 1:1 extract to water
T3	Tithonia compost extract in 1:2 extract to water
T4	Tithonia compost extract in 1: 3 extract to water
T5	Cassava peel Compost extract 1: 1 extract to water
T6	Cassava peel Compost extract 1: 2 extract to water
T7	Cassava peel Compost extract 1: 3 extract to water
T8	Control (no nutrient in any form)

The experiment was conducted using 4×3 m (12 m^2) plots. The plots had 1m gaps and there were 2m alleys between replicates. Each plant was placed at distance of 1×1 m to each other to ensure adequate spacing for the crop. The experiment was a Randomized Complete Block Design with three replicates. Matured pods of fluted pumpkin were split and seeds extracted. The seeds were sown in containers and seedlings raised and transplanted 28 days after sowing (DAS). The seedlings were transplanted with inter-and intra-row spacing of 1 m each. This is equivalent to 10,000 plant h^{-1}. The compost extract treatments were applied as f oliar spray while the NPK treatment was as soil incorporated. All the treatments were applied in two equal splits at 2 and 8 weeks after transplanting (WAT) the crop. The crop was staked using 1.5 m long bamboo pole at 5 WAT. Hoe weeding and other cultural practices were carried out as at when required [3].

Growth parameters assessed at 12 WAT were length of primary vines, number of secondary vines, number of leaves per plant, leaf area and shoot dry matter. Shoot yield and nutritional contents were also determined at. Cumulative shoot yield was obtained by adding together shoot from the five harvests and expressed on hectare basis. Samples were taken from 1st shoot harvest, washed and, cut into pieces, dried (80°C for 48 h), ground and processed for nutritional content analysis. Proximate compositions for nutrients were determined using A.O.A.C. [42] method. Total shoot tissue N was determined by a semi micro-kjeldahl procedure [43, 44]. Shoot protein was calculated from the Kjeldahl nitrogen using the conversion factor 6.25. Lipid was estimated by exhaustively extracting a known weight of sample with petroleum ether (BP 60°C) using a Tecator Soxhlet apparatus. Fibre content was estimated from the loss in weight of the crucible and its content on ignition. Mineral elements were estimated using the A.O.A.C. [42] method. The atomic absorption spectrometer was used to determine Fe. Phosphorus (P) was determined using the colorimetric molybdenum-blue procedure [45].

Assessment of insect pest types and their population densities as well as corresponding damage were done. Insect pest types were assessed by observing and counting different types of insects on the plants at different growth stages. The insect pest infestation were visually rated base on a scale of 1-6, where 1 = no insect pest to 6 = >10 of a given insect per plant [46]. The infestations were assessed fortnightly for 8 weeks starting 2 weeks after treatment application, on 4 plants randomly chosen per plot.

In order to determine the consumer acceptability of the sprayed shoot, rating scale of 1-5 was used to assess the marketable shoot at the point of harvest. In the rating scale, 1 represent badly coloured shoot and 5 for non coloured fresh shoot.

Statistical analysis of data collected was carried out using standard analysis of variance [47]. The significance of the treatment was determined using the F-test. To determine the significance of the difference between the means of the treatments, Duncan Multiple Range Test (DMRT) was computed at the 5% probability level.

RESULTS AND DISCUSSION

There was a significant effect of different fertilizer extracts on growth parameters and shoot yield ($p<0.05$) (Fig. 1). Plants fertilized with soil incorporated NPK fertilizer had longest primary vines (231.0 cm) and number of secondary vines, which were significantly greater than only cassava peel compost extract and control non-fertilized treatments. The vine length and number of primary vines of soil incorporated NPK and tithonia extract nourished plants were not significantly different. In case of number of leaves, leaf area and dry matter yield, soil incorporated NPK treatment consistently gave the highest values. In all these parameters, the order of increase in value were soil incorporated NPK>tithonia extract>cassava peel extract>control.

Dilution ratio also had significant effect ($p<0.05$) on all the growth parameters considered (Fig. 2). In all, dilution ratio 1: 2 (1 part of extract by 2 volume of water) consistently outperformed other treatments. The length of primary vine, number of secondary vines and number of

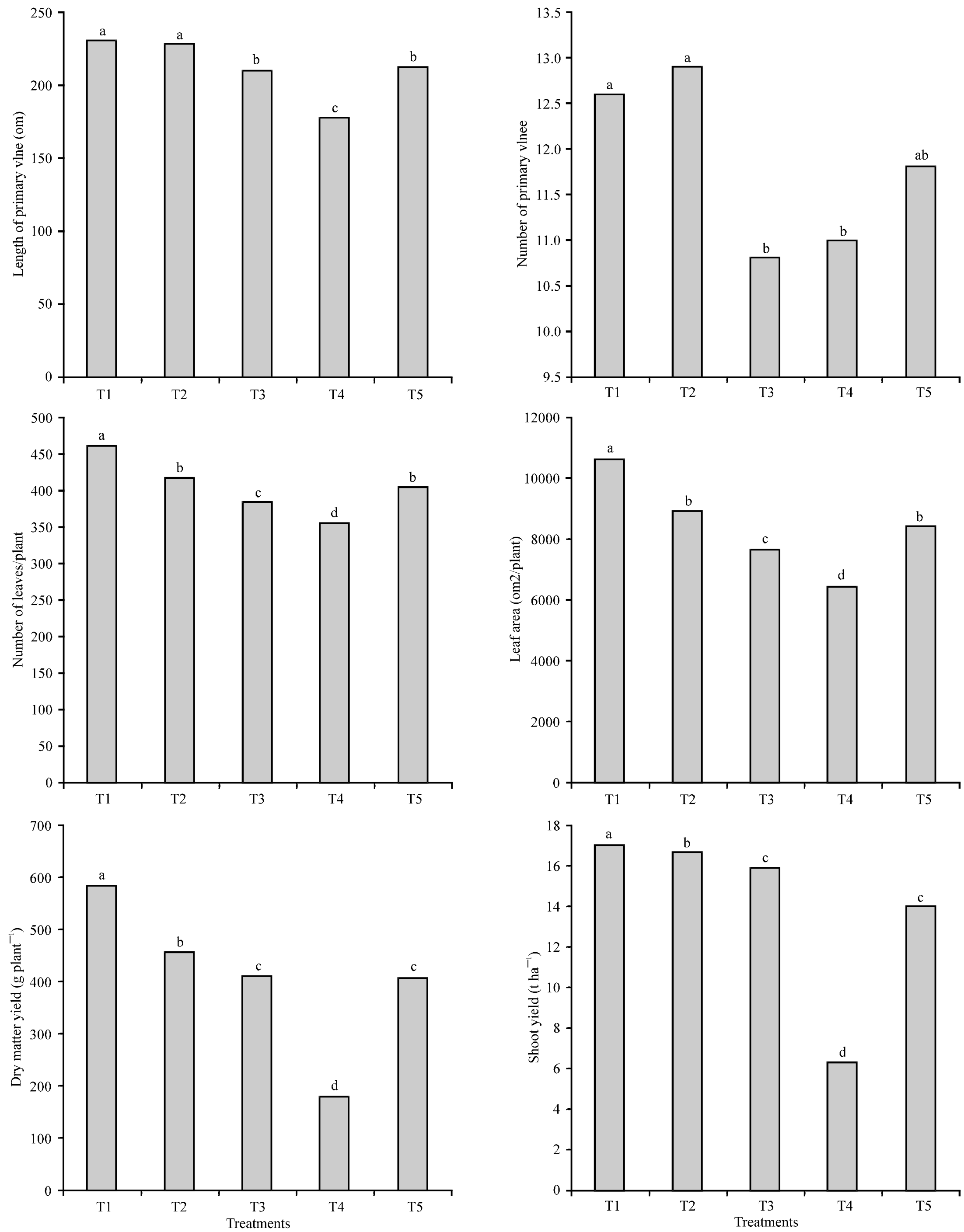

Fig. 1: Effects of different fertilizer extracts on growth parameters and shoot yield of Fluted pumpkin. T1 = Soil incorporated NPK; T2 = Tithonia compost extract; T3 = Cassava peel Compost extract; T4 = Control (no nutrient) and T5 = Mean value. Bars with the same letters are not significantly different using DMRT

leaves of plants nourished with 1: 2 compost extract were 25, 38 and 23%, respectively significantly higher than that of 1: 1 and 21, 22 and 17% higher than dilution ratio 1: 3 treatments.

The shoot yield of *T. occidentalis* was significantly affected by extract types as well as their dilution ratio (Table 1 and 2). The shoot yield of soil incorporated NPK treatment (18.96 t ha^{-1}) was 16, 31 and 54% higher than

Table 1: Interactive effects of extract types and their dilution ratio on the growth and shoot yield of Telfairia occidentalis

Treatments	Length of primary vine	Number of secondary vines	Number of leaves/plant	Leaf area/ plant (cm^2)	Dry matter yield (g/plant)	Shoot yield (t ha^{-1})
Soil NPK*	231.0b	12.6b	460.0b	10622.7b	582.0b	18.9c
TC Extract ratio 1:1	195.3c	11.2c		7423.0d	295.0f	14.7f
TC Extract ratio 1:2	263.7a	14.6a	486.0a	10845.7a	672.7a	20.9a
TC Extract ratio 1:3	225.0b	12.8b	399.0c	8484.3c	402.3d	19.9b
CPC Extract ratio 1:1	181.3b	9.4d	341.0e	7379.7e	291.3f	15.5e
CPC Extract ratio 1:2	228.0b	12.9b	460.0b	8497.0c	561.7c	20.0b
CPC Extract ratio 1:3	220.0b	10.2cd	348.0e	6996.7f	381.0e	17.4d
Control (no nutrient)	177.6d	11.0c	354.0de	6420.7g	180.3g	7.04g
Mean	211.6	11.8	403.5	8396.4	407.6	15.54

Means followed by the same letter along column are not significantly different using DMRT, *Soil incorporated NPK; TC = Tithonia Compost and CPC = Cassava Peel Compost

Table 2: Interactive effects of compost extracts on population density of major foliage insect pests of *T.* occidentalis[a,b]

Treatments	Leaf beetle	Red pumpkin beetle	Cotton leaf roller	Grass-hopper	Cut worms	Infestation ratin per plant[c]	Consumer acceptability[d]
Soil NPK[e]	14ab	5a	17a	5c	4ab	5a	2bc
TC Extract ratio 1:1	12c	3c	8b	7b	3b	4b	2b
TC Extract ratio 1:2	8d	7a	5c	4c	4ab	3c	4a
TC Extract ratio 1:3	13b	7a	5c	5c	7a	3c	3a
CPC Extract ratio 1:1	14ab	3c	8b	9a	3b	2c	4a
CPC Extract ratio 1:2	9c	3c	5c	7b	2b	2c	4a
CPC Extract ratio 1:3	9c	4b	5c	8b	4ab	3c	2b
Control (no nutrient)	16a	8a	16a	9a	4ab	6a	1c
Mean	11.9	5	8.6	6.8	3.9	3.5	2.8

Means followed by the same letter along column are not significantly different using DMRT, *Soil incorporated NPK; TC = Tithonia Compost and CPC = Cassava Peel Compost, [a]Values in the table represent insect population per plant, [b]Data pooled for two trials and assessment was over 8 weeks

[c]Insect infestation rating per plant 1 = no insect, 2 = 2-4, 3 = 5-6, 4 = 7-8, 5 = 9-10 and 6 =>10 insects/plant, [d]Consumer acceptability ratin 1 = badly damaged shoots, 2 = fairly, 3 = little and 4 = no damaged shoots

that of tithonia extract, cassava peel extract and control, respectively. Irrespective of extract type, dilution ratio 1:2 produced the highest shoot yield (16.74 t ha^{-1}), which was significantly greater than all other dilution ratios. The lowest shoot yield was recorded with the lowest dilution ratio of 1 : 1 (Fig. 2 and Table 2). The interactive effects of extract types and dilution ratio on growth parameters and shoot yield are presented on Table 2. For all the parameters, the best values were obtained with plants that received dilution 1 : 2 of tithonia compost extract.

Application of adequate quantity of fertilizer to crop in usable form is highly needed to obtain high quality plant products. Our study clearly demonstrated that application of plant waste composts in form of liquid or foliar fertilizer had a significantly different effect on the crop growth and nutritional values.

Growth parameters of the treated *T. occidentalis* plants showed that the different types of extracts resulted in significantly different responses. Some of the growth parameters even with recommended soil incorporated NPK were also different among the treatments. It was evident that the growth parameters among the different extracts were different from those with NPK and control. This could be related to ease with which each treatment makes nutrients available for plant use. The non-significant different in the performance of plants treated with NPK and that of tithonia could be attributed to higher nutrient contents of tithonia over other compost types used in this study. A similar observation was also reported by Akanbi *et al.* [5] on *T. occidentalis* nourished with different soil incorporated plant waste composts.

The proximate analysis and elemental composition of shoot of *T. occidentalis* differed significantly among the different treatments ($p>0.05$). Effects of compost extracts and their dilution ratios on the crude protein, crude fibre,

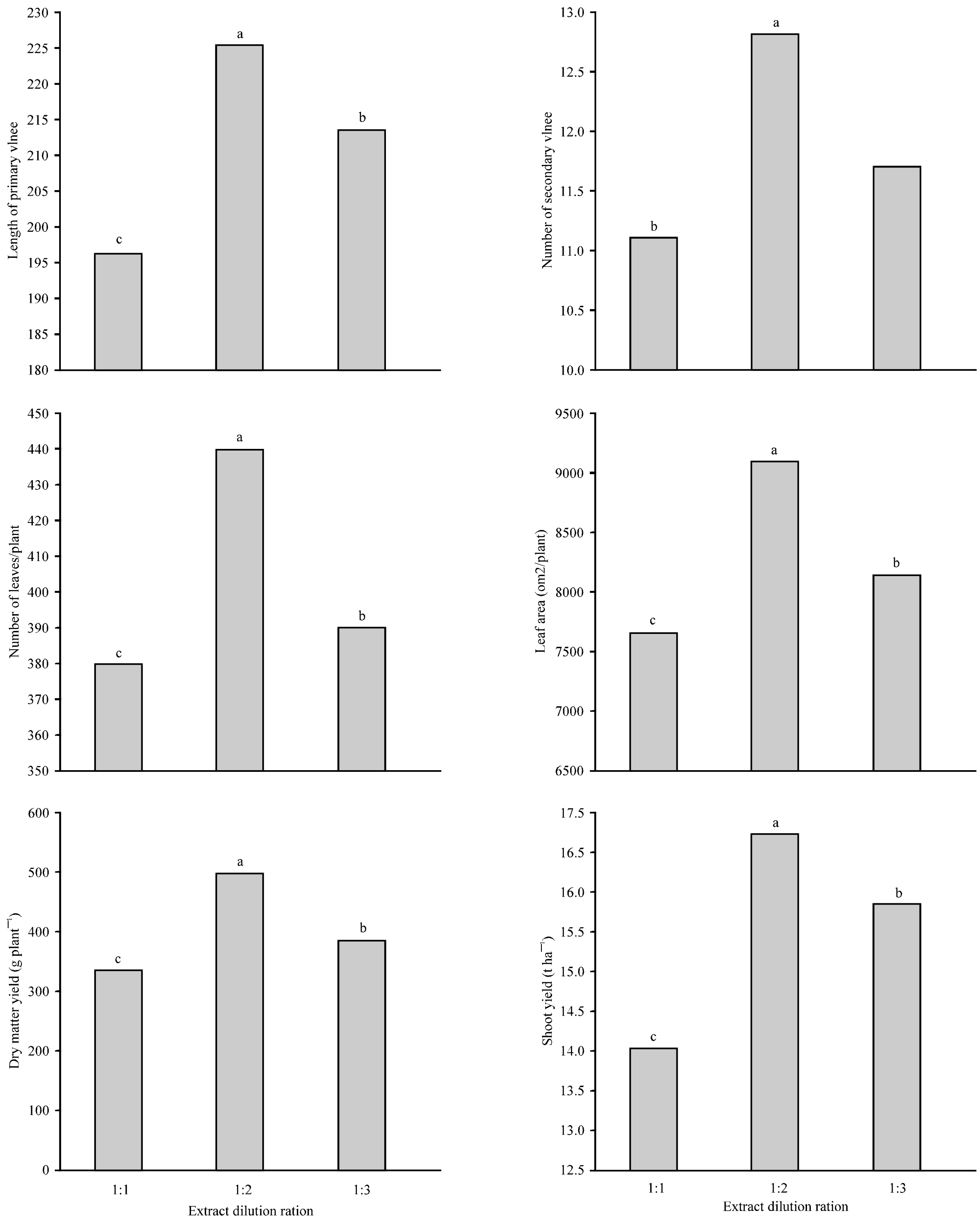

Fig. 2: Effects of fertilizer extracts dilution ratio on growth parameters and shoot yield of Fluted pumpkin. Bars with the same letters are not significantly different using DMRT

ether extract, P and Fe contents are presented in Fig. 3. The crude proteins, crude fibre and ether extract were all significantly affected by the applied treatments. Crude protein was highest in soil incorporated NPK, followed by 2: 1 diluted cassava peel compost extract and the least in tithonia compost extract 1 : 1. Crude fibre varied among the different applied treatments. The crude fibre was highest in control but least in titonia based extract. The

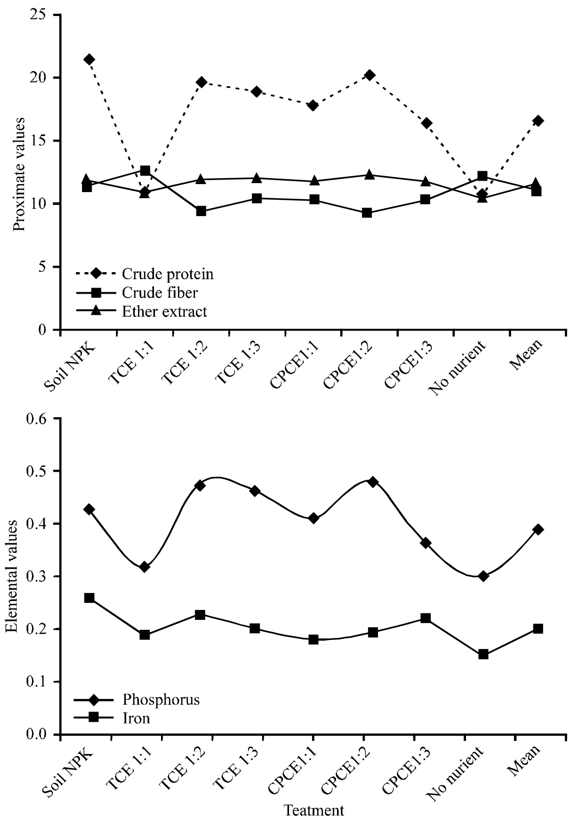

Fig. 3: Effect of applied treatments on (a) the proximate analysis and (b) elemental composition of shoot of Telfairia occidentalis, TCE = Tithonia Compost Extract; CPCE = Cassava Peel Compost Extract

highest % ether extract was obtained in 1: 2 diluted cassava peel compost extract. This was closely followed and insignificant from what was obtained with soil incorporated NPK, 1 : 2 and 1 : 3 diluted tithonia extracts.

Applied treatments had significant effect on plant shoot tissue P and Fe contents. Generally, plants that were fertilized with compost extracts had higher P content than those of NPK and non-fertilized control treatments. The variations in P content among different dilution ratios of tithonia compost extracts (CV = 1.94%) were somewhat higher than those of cassava peel extracts (CV = 1.47%). This was more evident when compared with the soil NPK and control treatments.

The variability of plant shoot Fe content in response to applied nutrients was significant ($p<0.05$; Fig. 3). The highest Fe tissue content (0.26mg/100 g) was recorded with plants fertilized with soil incorporated NPK. This was however, similar to 0.23 and 0.22 mg/100 g obtained with 1:2 diluted tithonia compost extract and 1 : 3 diluted cassava peel compost extract, respectively. In our study we found that applied treatments had a significant effect on the crop proximate, P and Fe elemental composition. Fasina *et al*. [3] reported that varying concentration and mode of application of fertilizer nutrient source significantly changed the crop tissue nutritional values. That the shoot crude protein is highest in soil incorporated NPK and 1 : 2 diluted extract is an indication that the ease with which plants absorb fertilizer nutrients has effect on the nutrient absorption, assimilation and metabolism.

The effects of compost extracts and their concentrations on insect pest types, pollution density and degree of infestation are given in Table 2. Significant differences were observed among the compost extracts and among the extract ratios for population density of each insect types. The five majour insect pests identified on flutted pumpkin were: leaf beetle (*Lagria villous* T.), red pumpkin beetle (*Aularophora* spp.), cotton leaf roller (*Sylepta derogate* F.), cut worms (*Noctuidae spp.*) and green grasshopper (*Zonocerus veriagatus*). The number of leaf beetle varied from 16 in no spray plants to 11 in plants sprayed with TC extract at ratio 1 : 2. In case of red pumpkin beetles and cotton leaf roller, non sprayed plants had the highest population, followed by plant sprayed with TC extract while CPC extract sprayed plants had the least. The number of cut worms and grasshopper per plant differed significantly. Grasshopper population ranged from 9 in no sprayed plants to 4 in plants treated with ratio 1:2 of TC extracts. On the average, the population of leaf beetles was the highest and this was 165, 223, 80 and 105% higher than that of red pumpkin beetle, cotton leaf roller, cut worms and grasshopper respectively. Among the tested treatments, insect pest population was lowest among CPC extracts followed by those of TC extracts and highest among non sprayed ones.

Insect pest infestation was higher in plants not sprayed with any of the extracts than in the treated ones. This suggests the need to control these pests in *T. occidentalis.* Population of each insect pest depends on the applied extracts. For instance, leaf beetle is less with CPC extract. This is I line with report of Karungi *et al.* [46] that insect pest resistant depends to certain extent on the concentration and type of botanical used. Table 2 also indicates the significant differences of applied treatments on insect pest infestation and consumer acceptability in *T. occidentalis.* Irrespective of extract ratios, the best insect control was achieved with spraying of CPC extracts. Consumer acceptability of plant shoots varied from poorly accepted (with shoot badly damaged) to highly (with non damaged shoot) accepted levels. This invariably has effects on the economic value (data not presented) of the crop.

CONCLUSIONS

Compost fertilizers are used in many crops throughout the world. Our study clearly demonstrated that instead of in bulky heavy form, compost could be formulated into liquid form (of higher nutrient contents). This reduces quantity required per unit area of land, makes handling and application easier and improved the chances of adoption of composting technology by the peasant farmers in Nigeria.

ACKNOWLEDGEMENTS

Appreciation is extended to Dr. J.A. Adediran; Deputy Director, IAR and T; Ibadan for making available parts of materials used in this study.

REFERENCES

1. Tindal, H.D., 1986. Vegetables in the Tropics: Macmillan Education Ltd. Houndmills, Hampshire, pp: 533.
2. Badifu, G.I.O. and A.O. Ogunsua, 1991. Chemical composition of kernels from some species of cucurbitacea grown in Nigeria. Plant Food Human Nutr., 41: 35-44.
3. Fashina, A.S., K.A. Olatunji and K.O. Alasiri, 2002. Effect of different plant populations and poultry manure on the yield of Ugu (*Telfairia occidentalis*) in Lagos State, Nigeria. In: Proceedings of the Annual Conference of Horticultural Society of Nigeria (HORTSON), 14-17th May 2002; NIHORT, Ibadan, Nigeria.
4. Aletor, O., A.A. Oshodi and K Ipinmoroti, 2002. Chemical composition of common leafy vegetables and functional properties of their leaf protein concentrates.
5. Akanbi, W.B., C.O. Adebooye, A.O. Togun, J.O. Ogunrinde and S.A. Adeyeye, 2006. Growth, herbage and seed yield and quality of *telfairia occidentalis* as influenced by cassava peel compost and mineral fertilizer. J. Bioresource Tecnology, (In Press).
6. Niang, A., B. Amadalo, S. Gathumbi and C.O. Obonyo, 1996. Maize yield response to green manure application from seleceted shrubs and tree species in western Kenya: a preliminary assessment. In: Mugah J.O., (Ed.). Proceedings of the First Kenya Agroforestry Conference on people and Institutional Participation in Agroforestry for sustainable Development, Kenya Forestry Research institute (KEFRI), Muguga, Kenya, pp: 350-358.
7. Ayeni, A.O., D.T. Lordbanjou and B.A. Majek, 1997. *Tithonia diversifolia* (Mexican sunflower in south-western Nigeria: occurrence and growth habit. Weed Research (Oxford), 37: 443-449.
8. Drechsel, P. and B. Reck, 1998. Composted shrub-pruning and other organic manures for small holder farming systems in southern Rwanda. Agroforestry Systems, 39: 1-12.
9. Jiri, O. and S.R. Waddington, 1998. Leaf prunings from two species of tithonia raise maize grain yield in Zimbabwe, but take a lot of labor! Newsletter of Soil Fert Net. Harare, Zimbabwe. Target, 16: 4-5.
10. Anette, M., 1996. Evaluation of indigenous fodder trees and shrubs in different agro-ecological zones of western Kenya.Diplomarbeit Institut furnPflanzenbau und pflanzezuchtung Universitat fur Bodenkultur, Vienna, Austria.
11. Odunsi, A.A., G.O. Farinu and J.O. Akinola, 1996. Influence of dietary wild sunflower (*Tithonia diversifolia* hemls. A. Gray) leaf meal on layers performance and egg quality. Nig. J. Anim. Prod., 23: 28-32.
12. Ng'inja, J.O., A. Niang, C. Palm and P. Lauriks, 1998. Traditional hedges in western Kenya typology, composition, distribution, uses, productivity and tenure. Pilot Project ReportNo 8. Regional Agroforestry Research Centre, Masseno, Kenya.
13. Adoyo, F., J.B. Mukalama and M. Enyola, 1997. Using tithonia concoction for termite control in Busia Districts, Kenya. ILEAI Newsletter, 13: 24-25.
14. Dutta, P., R.P. Chaudhuri and R.P. Sharma, 1993. Insect feeding deterrents from Tithonia diversifolia (Hemsl) Gray. J. Environ. Biol., 14: 27-33.
15. Nagarajah, S. and B.M. Nizar, 1982. Wild sunflower as a green manure for rice in the mid-country west zone. Trop. Agric., 138: 69-78.
17. Oyenuga, V.A., 1968. Nigeria's food and feeding stuffs: their chemistry and nutritive value. 3rd Edn. University of Ibadan Press, pp: 15-22.

18. Tewe, O.O., 1975. Implication of the cyanogenic glucoside fraction of cassava in the growth and reproduction of rats and pigs. Ph.D. Thesis, Department of Animal Science, University of Ibadan, Nigeria, pp: 189.
19. Rogers, D.J. and M. Milner, 1983. Amino acid profile of manioc: Leaf protein in relation to nutritive values. Econ. Bot., 17: 211-216.
20. Edward, D.R. and T.C. Daniel, 1992. A review of poultry manure. Bioresource Technol., 41: 91-102.
22. Ashutosh, S., M.R. Raja and C. Rina, 2006. Effects of four diffrenet doses or organic manures in the production of *Ceriodaphnia cornuta*. Bioresource Technol., 47: 1036-1040.
23. Manna, M.C., T.K. Ganguly and B.N. Ghosy, 1999. Evaluation of compost maturity and mineral enrichment Quality through simple chemical parameters. J. Ind. Soc. Soil Sci., 48: 781-786.
24. Akanbi, W.B. and A.O. Togun, 2002. Productivity and Influence of maize stover compost on Growth, Yield and Nutrient Uptake of Amaranth. Sci. Hortic., 93: 1-8.
25. Maharishnan, K., A. Sambasira and K. Bhanu, 2004. Effects of organic sources of plant nutrients in conjuction with chemical fertilizer on growth, yield and quality of rice. Research on Crops, 5: 159-161.
26. Ghosh, P.K., K.K. Ajay, M.C. Manna, K.G. Mandal, A.K. Mistra and K.M. Hati, 2004. Comparative effectiveness of cattle manure, poultry manure, phosphocompost and fertilizer-NPK on three cropping systems in Ventisols of semi-arid tropics. II. Dry matter yield, nodulation, chlorophyll content and enzyme activity. Bioresource Technol., 95: 85-93.
27. Manral, H.S and S.C. Saxena, 2003. Plant growth, yield attributes and grain yield of soybean as affected by the application of inorganic and organic sources of nutrients. Bioresource Technol., 92: 110-118.
28. Giskin, M. and H. Nerson, 1984. Foliar nutrition of muskmelon: I: Application to seedlings greenhouse experiments. J. Plant Nutr., 7: 1329-1339.
29. Nerson, H., M. Giskin and M. Edelstein, 1985. Foliar nutrition of muskmelon: II. Field experiments. Commun. Soil Sci. Plant Anal., 16: 1165-1177.
30. Barel, D. and C.A. Black, 1979. Foliar application of P. II. Yield responses of corn and soybeas sprayed with various condensed phosphates and P-N compounds in greenhouse and field experiments. Agron. J., 71: 21-24.
31. Giskin, M., A.T. Santos and J.D. Etchevers, 1984. Decreasing fertilizer inputs by use of foliar application of essential nutrients. Proceedings, Intl. Symp. Plant Nutrition, Montpellier, France, 1: 239-242.
32. Giskin, M. and Y. Efron, 1986. Planting date and Foliar fertilization of corn grown for silage and grain under limited moisture. Agron. J., 78: 426-429.
33. Garcia, L.R. and J.J. Hanway, 1976. Foliar fertilization of soybeans during the seed-filling period. Agron. J., 68: 653-657.
34. Malakondalah, N. and G. Rajeswararao, 1980. Effects of foliar application of phosphorus on chlorophyll content, Hill reaction, photophosphorylation and $^{14}CO_2$ fixation under stress in peanut plants. Photosynthesis, 14: 17-21.
35. Gooding, M.J and W.P. Davies, 1992. Foliar Urea fertilization of cereals: A Review. Fert. Res., 32: 209-222.
36. Readman, R.J., P.S. Kettlewell and C.P. Beckwith, 1997. Application of N as urea solution: N recovery and N use efficiency. Aspects Appl. Biol., 50: 125-132.
37. Abad, A., J. LIoveras and A. Michelena, 2004. Nitrogen fertilization and foliar urea effects on urum wheat yield and quality and on residual soil nitrate in irrigated Mediterranean onditions. Field Crops Res., 87: 257-269.
21. Adediran, J.A., N. De Baets, P.N.S. Mnkeni, L. Kiekens, N.Y.O. Muyima and A. Thys, 2003. Organic waste Materilas for soil fertility improvement in the Border Region of the Eastern Cape, South Africa. Biol. Agric. Hortic., 20: 283-300.
38. Chauham, Y.S., A. Apphum, V.K. Singh and B.S. Dwivedi, 2004. Foliar sprays of concentrated urea at maturity of pigeonpea to induce defoliation and increase its residual benefit to wheat. Field Crops Res., 89: 17-25.
39. Reuveni, R. and M. Reuveni, 1998. Foliar fertilizer therapy-a concept in integrated Pest management. Crop Protection, 17: 111-118.
40. Akanbi, W.B., 2002. Growth, Nutrient uptake and Yield of maize and okra as influenced by compost and Nitrogen fertilizer under different cropping systems. Ph.D. Thesis, University of Ibadan, Nigeria, pp: 228.
41. Federal Ministry of Agriculture, Water Resources and Rural Development (FPDD), 1990. Literature Review on Soil Fertility Investigations in Nigeria, pp: 49-58. Food Chem., 78: 63-68.

42. A.O.A.C., 1984. Official Method of Analysis (12th Edn.). Washington Dc. Asociation of Official Analytical Chemists.
43. Bremner, J.M., 1965. Total Nitrogen. In: C.A. Black (Ed.). Methods of soil analysis. Part 2. Amer. Soc. Agron. Madison, Wis., pp: 1149-1178.
44. Ulger, A.C., H. Ibrikci, B. Cakir and N. Guzel, 1997. Influence of Nitrogen Rates and Row Spacing on Corn Yield, Protein content and other plant Parameters. J. Plant Nutr., 20: 1697-1709.
45. Murphy, J. and J.P. Riley, 1962. A modified single solution method for the determination of phosphate in natural waters. Anal. Chem. Acta, 27: 31-36.
46. Karungi, J., E. Adipala, S. Kyamanywa, M.W. Ogenga-Latigo, N. Oyobo and L.E.N. Jackai, 2000. Pest management in cowpea. Part 2. Integrating Planting time, plant density and insecticide application for management of cowpea field insect pests in eastern Uganda. Crop Prot., 19: 237-245.
47. Gomez, A.K. and A.A. Gomez, 1984. Statistical Procedures for Agricultural Research. 2nd Edn. John Wiley and Sons New York, pp: 680.