



Effect of Cassava mill effluent on some soil chemical properties and the growth of fluted pumpkin (*Telfairia occidentalis* Hook F.)

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Abstract: In the trials, Cassava mill Effluent was used for fluted pumpkin (*Telfairia occidentalis*) cultivation in order to verify the influence of the effluent on the growth and some soil chemical properties. In this regard, a completely randomized and randomized complete block designs were used in the greenhouse and field trials respectively with 6 treatments replicated 3 times. In the greenhouse, the following rates of 0, 100, 200, 300, 400 and 500 ml per 5 kg topsoil were used while in the field trial, 0, 40000, 80000, 120000, 160000 and 200000 litres/ha were utilized. The rates used in the field were equivalent to those of greenhouse. In both trials, the cassava mill effluent was applied 2 weeks prior to transplanting the seedlings. Results indicated that the cassava mill effluent significantly ($P < 0.05$) increased soil pH, organic carbon, N, P, K, Ca, Mg, Na, Fe, Cu and Zn whereas the exchangeable acidity decreased significantly ($P < 0.05$) with corresponding increase in cassava mill effluent treatments. Except N and Na, which declined with corresponding increase in the cassava mill effluent treatments, an improved P, K, Mg, Ca, Fe, Cu and Zn components was achieved in cassava mill effluent polluted plants compared to control. The plant height, significantly ($P < 0.05$) decreased with increased cassava mill effluent treatment in the greenhouse trial while in the field trial, 120000 litres/ha was significantly ($P < 0.05$) higher than other treatments. In the greenhouse trial, significantly ($P < 0.05$) higher number of leaves was attained in 100 ml treatment compared to other treatments whereas in the field trial, the 120000 and 200000 litres/ha were significantly ($P < 0.05$) higher compared to other treatments

Keywords: Effluent, Fluted pumpkin, Growth, Pollution, Soil properties, Treatments

INTRODUCTION

Cassava (*Manihot esculentus* Crantz) is widely cultivated in the tropical and subtropical regions of the world and it produces starchy tuberous roots with more than 200 calories/day of food value (FAO, 2004). Cassava is a staple food of nearly one billion people in Africa, South America, Asia and Pacific (ANU, 2007). In Nigeria, the estimated cassava production is approximately over 34 million metric tons (FAO, 2004) and a lot of trade is associated with the processing of the tubers. The cassava tuber consists of peel and flesh with significant hydrocyanic acid which is hazardous to mankind and for use as human food, the peel is invariably removed and only the flesh is utilized (Olorunfemi *et al.*, 2008). Before consumption, by man the fleshy part of the tuber has to be severally detoxified. During the detoxification, a lot of effluent and solid wastes are generated and released into the environment. One of the major recipients of this effluent is the soil. The disposal of this cassava effluent is a source of concern to Environmentalists. Horsfall *et al.* (2006) and Isabirye *et al.* (2007) estimated that an average $2.62 \text{ m}^3 \text{ ton}^{-1}$ of solid residue and $3.68 \text{ m}^3 \text{ ton}^{-1}$ water residues are generated via cassava processing in Nigeria.

Ogboghodo *et al.* (2003) reported that soil treated with cassava mill effluent exhibited an increase in pH, P, K, Mg, Ca and Na. Akpan *et al.* (2011) also reported increased pH, N, organic carbon, exchangeable acidity and decreased Mg, K, P in soil treated with cassava mill effluent. It was recorded by Olorunfemi *et al.* (2008) that cassava mill effluent inhibited seed germination, the growth as well as chlorophyll content of maize and sorghum crops. Also, Olorunfemi *et al.* (2011) reported malformed root length, induced chromosome aberration in the root cell of onion plant seedlings assayed in cassava mill effluent while Ogboghodo *et al.* (2003) has recorded a decrease in maize height with increased volume of cassava mill effluent treatment.

The fluted pumpkin is commonly cultivated and consumed in Nigeria because of its nutritive value. This leafy and fruit vegetable growth is always boosted with farmyard manure and where available, an inorganic fertilizers such as N P K are used. The Cassava mill effluent is commonly available in Nigeria especially in Southern part of the country. Therefore, the purpose of this study was to determine the influence of Cassava mill effluent on some soil chemical properties and growth of fluted pumpkin (*Telfairia occidentalis*).

MATERIALS AND METHODS

The greenhouse and field trials were conducted at the experimental site of the Faculty of Agriculture, University of Benin, Benin City which lies between longitude 5° 38' 52'E and latitude 6° 24' 20.9'N.. The rainy season is between April and September with a peak at June while the dry season is between October and March. The average relative humidity and temperature is 70 % and 27°C respectively.

Greenhouse trial: The topsoil collected from a depth of 0-15 cm at a plot left fallow for about 5 years was air-dried and sieved to remove debris. Thereafter, 5 kg sieved soil was filled into the polythene bags. Each polythene bag was placed on a saucer to prevent inter replicate contamination. The trial was laid out in completely randomized design and replicated 3 times. Six levels of cassava mill effluent namely 0, 100, 200, 300, 400 and 500 ml per 5 kg soil were applied to the polythene 2 weeks before transplanting one seedling per pot to allow for the cassava effluent mineralization and equilibration. Three pots per treatment were used. Therefore, each replicate had 18 pots while the entire greenhouse trial had 54 polythene bags. The greenhouse trial lasted for 56 days. Thereafter, data on the height and number of leaves were taken. After data collection, the plants were carefully uprooted, the shoot carefully separated from the root, oven-dried at 78°C for 48 hours to a constant weight used in determining the nutrient content of the plant.

Field trial: The field trial which was organised in a randomized complete block design with 3 replicates occupied an area measuring 12 m × 10 m. Each replicate had 6 beds and each bed with a dimension of 2 m × 2 m represented a treatment. The replicates were separated from one another by 1 m alley while the beds were separated from one another by 50 cm alley. The moistened beds were treated with the following rates of cassava mill effluent: 0, 40000, 80000, 120000, 160000 and 200000 litres /ha. These rates were equivalent to those of greenhouse trial. The applied cassava mill effluent was thoroughly mixed with the soil and left for 2 weeks before transplanting 4 seedlings per bed at a spacing of 90 cm × 90 cm. This field trial also lasted for 56 days. The data collected were similar to that of greenhouse trial.

Effluent and soil analysis: The Cassava mill effluent was analysed prior to application while the soil used was analysed before and after the trials. The cassava mill effluent pH was read directly by glass electrode pH meter while the soil pH was determined at a soil to water ratio of 1: 1 using a glass electrode pH meter. The N, P, K, Mg, Ca, Na, Fe Zn and Cu content of the cassava mill effluent were determined by methods of Ademoroti (1996) whereas the sand, silt, clay, organic carbon, N, P, K, Mg, Ca, Na Ea, Fe, Cu and Zn components of the soil were determined by methods of Udo *et al.* (2009).

Plant analysis: The oven-dried plant materials were

ground and then digested with a mixture of concentrated HNO₃, H₂SO₄ and HClO₄ acids (IITA, 1979). The Na, K, Ca, Fe, Cu and Zn were read by UNICAM 969 Atomic Absorption Spectrophotometer. Udo *et al.* (2009) method was used for P determination while the micro-Kjeldhal method of Jackson (1962) was adopted for N determination. The data obtained were analysed by Genstat statistical version 6. 1. 234 (Payne, 2002). Mean separation was carried out by Duncan multiple range test at 5 % level of probability.

RESULTS AND DISCUSSION

Properties of Cassava mill effluent used: Table 1 shows the properties of the cassava mill effluent used. The cassava mill effluent has a foul odour and unattractive sight. It is acidic and contains both suspended and dissolved particles, N, P, K, Mg, Ca, Na, Fe, Cu, and Zn.

Pre-trial soil properties: The pre-trial soil properties of both trials are shown in Table 2. The soil was acidic with low nutrient components. The organic carbon, N,

Table 1. Properties of the Cassava mill effluent used.

Parameters	Value
pH	5.07
N	0.19
P	0.18
K	0.58
Mg	0.82
Ca	1.48
Na	1.20
Fe	2.00
Cu	1.83
Zn	1.07
Total dissolved solids	766
Total suspended solids	789

Table 2. Physico-chemical properties of the soils used in the trials.

Properties	Greenhouse value	Field value
pH	5.50	5.40
Organic carbon (g/kg)	2.25	2.07
N (g/kg)	0.95	0.82
P (mg/kg)	1.50	1.32
K (cmol/kg)	0.11	0.12
Mg (cmol/kg)	0.12	0.14
Ca (cmol/kg)	0.10	0.12
Na (cmol/kg)	0.08	0.10
Fe (mg/kg)	1.20	1.15
Cu (mg/kg)	0.06	0.05
Zn (mg/kg)	0.76	0.56
Sand (g/kg)	849	850
Silt (g/kg)	37	35
Clay (g/kg)	114	115

Table 3. Post-trial chemical properties of the soils used as influenced by Cassava mill effluent.

Treatment	pH 1 : 1 (Soil:water)	Org carbon (gkg ⁻¹)	N (gkg ⁻¹)	P (mgkg ⁻¹)	K (cmolkg ⁻¹)	Mg (cmolkg ⁻¹)	Ca (cmolkg ⁻¹)	Na (cmolkg ⁻¹)	Ea (cmolkg ⁻¹)	Fe (mgkg ⁻¹)	Zn (mgkg ⁻¹)	Cu (mgkg ⁻¹)
Greenhouse Trial												
ml/5kg soil												
0	5.50d	0.70d	0.80c	0.56e	0.87e	0.24d	0.80c	0.05b	1.05a	2.06d	1.59d	3.01b
100	6.50c	1.00c	1.00bc	1.08d	1.00d	0.35cd	0.90c	0.08b	1.00a	2.56c	1.92c	3.06b
200	6.60bc	1.20b	1.20bc	1.41c	1.10d	0.40c	1.53b	0.13b	0.80b	2.60c	2.00c	3.10b
300	6.70abc	1.32b	1.20bc	1.45c	1.50c	0.48bc	2.00a	0.18b	0.50b	3.02b	2.10bc	3.21a
400	6.80ab	1.35b	1.50ab	2.00b	2.02b	0.60b	2.10a	0.20b	0.21c	3.11ab	2.30ab	3.25a
500	6.90a	2.58a	1.87a	2.23a	3.00a	1.10a	2.32a	0.70a	0.12c	2.27a	2.42a	3.25a
Field Trial												
Litres/ha												
0	5.70b	1.08d	0.87c	0.23e	0.09c	0.22e	0.84c	0.04b	1.08a	2.04f	2.20c	3.04d
40,000	6.60a	2.20c	1.00c	0.69d	0.09c	0.45d	0.89c	0.05b	1.07a	2.72e	2.20c	3.07d
80,000	6.60a	2.20c	1.00c	1.21c	0.10c	0.53d	1.90b	0.09b	0.17b	2.83d	2.45b	3.20c
120,000	6.67a	2.40bc	1.55b	1.53bc	0.10c	1.22c	1.90b	0.10b	0.16b	2.90c	2.52b	3.24c
160,000	6.67a	2.56ab	1.65b	1.85ab	0.35b	1.40b	2.33a	0.35a	0.14b	3.02b	2.90a	3.50b
200,000	6.87a	2.67a	2.50a	2.04a	2.00a	1.58a	2.55a	0.39a	0.11b	3.11a	3.01a	4.02a

Mean values with same letter(s) in the column are not significantly different from one another at 5% level of probability

Table 4. Effect of Cassava mill effluent on the nutrient content of fluted pumpkin.

Treatment	N (mgkg ⁻¹)	P (mgkg ⁻¹)	K (mgkg ⁻¹)	Mg (mgkg ⁻¹)	Ca (mgkg ⁻¹)	Na (mgkg ⁻¹)	Fe (mgkg ⁻¹)	Zn (mgkg ⁻¹)	Cu (mgkg ⁻¹)
Greenhouse trial									
ml/5kg soil									
0	2.93a	0.93d	0.70b	0.20b	0.10e	0.20a	0.10d	0.08e	0.04d
100	2.90a	0.93d	0.80b	0.23b	0.60d	0.12b	0.50c	1.30d	0.10c
200	2.50a	1.50c	0.90b	0.20b	0.80b	0.12b	2.10b	2.20c	0.37c
300	1.33b	1.48c	0.80b	0.30a	0.70c	0.10b	2.30b	2.40b	1.20b
400	0.87bc	2.10b	0.87b	0.20b	0.70c	0.11b	5.50a	3.67a	1.60ab
500	0.60c	2.50a	2.10a	0.10c	0.90a	0.10b	5.70a	3.70a	1.90a
Field trial									
Litres/ha									
0	3.02a	0.50e	0.60c	0.10c	0.80a	0.18a	0.30c	0.08c	0.01d
40,000	2.87a	0.62d	0.80b	0.19b	0.80a	0.15b	0.80b	1.20b	0.07c
80,000	1.45b	1.00c	0.60c	0.30a	1.00a	0.12c	0.90ab	1.50b	0.10c
120,000	1.00c	1.20bc	0.60c	0.10c	0.93a	0.09cd	1.00ab	2.00a	0.97b
160,000	0.80d	1.50b	0.80b	0.10c	0.93a	0.08d	1.00ab	2.20a	0.97b
200,000	0.51e	2.50a	1.00a	0.10c	1.00a	0.09cd	1.13a	2.70a	2.00a

Mean values with same letter(s) in the column are not significantly different from one another at 5% level of probability

Table 5. Influence of Cassava mill effluent on plant height and number of leaves of fluted pumpkin.

Treatment	Plant height (cm)	Number of leaves
Greenhouse trial		
ml/5 kg soil		
0	101.33a	29.33c
100	99.67a	34.67a
200	94.34b	32.67b
300	50.67c	33.00b
400	50.33c	29.00c
500	47.33c	23.33d
Field Trial		
Litres/ha		
0	103.80c	57.30d
40,000	108.70bc	62.00cd
80,000	105.00c	67.00bc
120,000	127.20a	76.00a
160,000	111.00bc	64.00cd
200,000	119.20ab	74.00ab

Mean values with same letter(s) in the column are not significantly different from one another at 5% level of probability

P, K, Mg, Ca, and Cu for example were below the critical values of 20-30 mgkg⁻¹ (Enwezor *et al.*, 1989), 1.5-2.0 gkg⁻¹ (Sobulo and Osiname, 1981), 10-16 mgkg⁻¹ (Adeoye and Agboola, 1985), 0.16-0.25 cmolk⁻¹ (Akinrinde and Obigbesan, 2000), 0.2-0.4 cmolk⁻¹ (Adeoye and Agboola, 1985) and 2.50 cmolk⁻¹ (Akinrinde and Obigbesan, 2000) and 2-250 mgkg⁻¹ (Alloway, 1995) respectively. The Zn and Fe were below the normal range of 1-90 mgkg⁻¹ (Alloway, 1995) and 2.50 mgkg⁻¹ (Rhue and Kidder, 1983) respectively.

Post-trial soil properties: The differences in soil pH between the polluted and unpolluted soils in both trials were significant (Table 3). The applied Cassava mill effluent caused a significant rise in the soil pH which tended towards neutral status. This increase in soil pH may definitely influence nutrient availability to plants. Similar increases in soil pH have earlier been reported by Ogboghodo *et al.* (2003) and Akpan *et al.* (2011). The organic carbon significantly increased with increased cassava mill effluent treatments in the trials (Table 3). The significant increase in organic carbon may be attributed to the decomposition of both dissolved and suspended particles. The increase in organic carbon has earlier been recorded by Orhue and Uzu (2011) in soils treated with Cassava mill effluent. The total N obtained in the trials increased with increased cassava mill effluent application (Table 3). The decomposition of the dissolved and suspended particles may be responsible for the increased N. This result further confirmed earlier result of Akpan *et al.* (2011). The available P also significantly increased with increased cassava mill effluent application (Table 3). This report is similar to earlier results of Ogboghodo *et al.* (2003) and Orhue and Uzu (2011) who reported a significant

increase in available P in soils treated with Cassava mill effluent compared to unpolluted soils. The values of exchangeable Ca, Mg, K and Na at the end of the trials indicated that there were significant differences among the treatments including the control (Table 3). Indeed, the Ca, Mg, K and Na significantly increased with increased cassava mill effluent treatments. The increase in Ca, Mg and Na may have accounted for the rise in soil pH. However, the Exchangeable acidity (Ea) in the trials was significantly higher in the control than those treated with cassava mill effluent. The Ea decreased with increased effluent treatments. In both trials, the Fe, Cu and Zn also significantly increased with increased cassava mill effluent (Table 3).

Influence of Cassava mill effluent on the nutrient content of fluted pumpkin: The influence of cassava mill effluent on the nutrient content of the fluted pumpkin is shown in table 4. The N content of the plant decreased significantly with increased cassava mill effluent treatments (Table 4) whereas the 500 ml and 200000 litres/ha in greenhouse and field trials respectively were significantly higher than other treatments in P and K components of the plant. This decrease in N content of the plant may be attributed to presence of immobilize soil N which although is not easily lost from the soil by leaching, volatilization, de-nitrification, it is not taken up by roots and micro-organisms as earlier reported by Foth (1990). Significantly higher Mg content of the plant was achieved by 300 ml treatment in the greenhouse and 120000 litres/ha in the field trial compared to other treatments while the control treatment in both trials was significantly higher ($P < 0.05$) than other treatments in Na component of the plant. Significantly higher Fe, Cu and Zn components of the plant were achieved in the cassava mill effluent treated plants in both trials compared to control. In the case of Ca, the 0, 100 and 500 ml treatments were significantly higher than other treatments in the greenhouse trial whereas in the field trial all the treatments were not significantly different from one another.

Effect of Cassava mill effluent on height and number of leaves of fluted pumpkin: Table 5 shows the influence of Cassava mill effluent on the height and number of leaves of the plant. In the greenhouse trial, plant height significantly decreased with increasing Cassava mill effluent treatments whereas in the field, the 120000 litres/ha treatment was significantly higher than other treatments including control. Significantly higher number of leaves were obtained in 100 ml treatment in the greenhouse and 120000 and 200000 litres/ha in the field trials compared to other treatments.

Conclusion

The results revealed that Cassava mill effluent increased the soil pH, organic carbon, N, P, K, Mg, Ca, Na, Fe, Cu and Zn components of the soil while the exchangeable acidity was depressed with increased Cassava mill

effluent application. The increased soil pH indicated that Cassava mill effluent could be used as a source of liming in acid soils. With the exception of N and Na, there was an improvement in the P, K, Mg, Ca, Fe. Cu and Zn content of the plants treated with cassava mill effluent compared to control. The height of fluted pumpkin significantly decreased with increased cassava mill effluent treatment in the greenhouse trial whereas in the field trial, the 120000 and 200000 litres/ha were significantly higher ($P < 0.05$) than other treatments. In the case of number of leaves, the 100 ml treatment was significantly higher than other treatment in the greenhouse trial while the 120000 and 200000 litres /ha significantly dominated other treatments in the field trial. From the on-going result therefore it is suggested that Cassava mill effluent should be tried over the years in the cultivation of fluted pumpkin to ascertain the fertilizer potential.

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