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Physicochemical Composition of Earthworm Cast in Federal College of Forestry, Jos, Nigeria.

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Abstract

Earthworm cast are an organic form of fertilizer produced from earthworms. The broad objective of this research work is to study the physicochemical composition of earthworm casts found in Federal College of Forestry, Jos. Ten transects of 200 metres was laid. Stratified sampling method on the basis of occurrence of fresh worm casts was used to select points for collection. Eight (8) samples of each type of cast were collected from different locations, the control (no cast but soil) was collected alongside at each of the locations making a total of thirty-two samples. Fifty (50g) grams of earthworm cast and soil samples within the plant rhizosphere (control) were collected. The samples were collected, properly labeled, air dried, sieved and taken to the laboratory for analysis. Descriptive statistics (mean, standard deviation and coefficient of variation among soil samples from different locations) and inferential (ANOVA) statistics was used to analyse data obtained, Duncan Multiple Range test was used to separate means and each soil property was compared using Pearson correlation coefficient at 1 and 5% significant levels. From the results, the two types of earthworm casts identified were; the mass and turret cast. Mass earthworm cast collected under many plant *species had a higher silt value which was significant; Bauhinia purpurea (7.00 ± 0.88), Bombax buonopozense (15.67±1.35), Auraucaria columnaris (13.00 ± 1.11), Delonix regia 1 (10.50 ± 0.75) and Jatropha curcas (13.00 ± 0.47). The clay content for the three components (mass, turret casts and control) were relatively the same with no significant difference ($p > 0.05$) while the value of sand was higher in the control with significant difference. Mass cast and turret cast had higher nitrate content, organic matter, potassium and phosphorous which was significant with the control ($p > 0.05$). Sulphur content was higher in the control with high significant difference ($p < 0.05$). Mass cast had the highest number of elements than the turret cast but there was no variation, hence both earthworm cast can be used simultaneously to enrich out soils when planting seedlings.*

***Keywords**: Biochemical, Earthworm cast, Composition, Physico-chemical, rhizosphere*

Introduction

Earthworms are considered as ecosystem engineers that play an important role in shaping soil structure and cycling nutrients (Blouin et al., 2013). Earthworms promote litter decomposition, nitrogen (N) mineralisation and water infiltration, as a result of their feeding and burrowing habits (Baker, 2017), and therefore deeply affect soil properties (Hättenschwiler and Gasser, 2005). They also play a crucial role in the provision of soil ecosystem services (Lavelle et al., 2016) Earthworm cast represent hot spot for carbon turnover and formulation of biochemical interface in soil (Alix et al., 2019). Earthworms excrete material that is referred to as earthworm casts. Earthworms eat a large amount of litter but only a small fraction of digested material (5-10%) is assimilated by the earthworms and the rest are excreted out in the form of earthworm cast which are rich in NPK, micronutrients and beneficial soil microbes (Bhawalkar and Bhawalkar, 1993; Bhat and Khambata, 1994). The humus-rich earthworm casting has been shown to play important role in soil fertility and productivity. The analyses of castings and their surrounding soils have shown that castings contain seven times more phosphorus, five times more nitrogen, eleven times more potassium and three times more exchangeable magnesium and one and one-half times more calcium (Delahaut and Koval, 2002). In addition, studies have shown that cast production by earthworms is an important activity that contribute greatly to soil fertility by stimulating natural activity of beneficial microorganisms, promoting the activity of enzymes and natural growth regulators and as such are beneficial to plants (Feller et al., 2003). Three major earthworm cast types are recognized in the Nigerian ecological zones, each of which is produced by different groups of earthworms. The granular (pellet) casts are produced by *Eudrilus* spp, *Agrotoreutus* spp, *Eutoreutus* spp. Turret (funnel shaped) casts are produced by *Hyperiodrilus africanus*, *Ephyriodrilus afroccidentalis* and the mass (mouldy) cast is produced by *Libyodrilus violaceus* and *Alma millsoni* (Segun, 1976). Since the various earthworms differ in their ducts and digestive activities, their characteristic cast types are expected to differ in organic and nutrient composition as well as their relative contribution to soil fertility. Earthworms are key organism in organic matter breakdown.

It is generally accepted that soil biota benefit soil product but very little is known about the organism that lies in the soil and the functioning of the soil ecosystem. The recycling of nutrient is a critical ecosystem function that is essential to life on earth (Tunira et al., 2010). Use of inorganic fertilizer in farming and for growth of seedlings poses a big problem to the environment and microorganisms via surface runoff or leaching of soil to the aquatic ecosystems, the resultant water pollution poses demonstrated risks to aquatic ecosystems, human health and productive activities (UNEP, 2016). Hence, earthworm can be used as an alternative as they are known to be excellent ecosystem engineers (Blouin et al., 2013). They can be cultivated in plant nurseries, plantation etc., hence the need to compare the physicochemical elements becomes imperative. The broad objective of this research work is to study physicochemical composition of earthworm cast in Federal College of Forestry, Jos.

MATERIALS AND METHODS

Samples collection and Preparation

Ten transects of 200 metres was laid in the study site. Stratified sampling method on the basis of occurrence of fresh worm casts was used to select points for collection. Earthworm casts were collected at 8 points under different plant species which were also noted. Eight (8) samples of each type of cast type identified was collected from different locations, the control (no cast but soil) was collected alongside at each of the locations making a total of thirty-two samples. Fifty (50g) grams of earthworm cast and soil samples within the surface of the plant rhizosphere (0 -5 cm) known as the control, were collected and transferred into cellophane bags, tightly sealed with minimal air space, labelled properly and stored in a cool place to prevent breaking down of organic matter. Samples were air dried for 48 hours, and then sieved with 2 mm mesh to remove debris, gravel and other materials prior to analysis.

Soil Analysis

Particle size Analysis: Particle size analysis was determined according to the method of Bouyoucos (1962). 50 g of the soil sample was soaked overnight with 50 ml of cagon solution. The mixture was then transferred into a 1000 ml measuring cylinder and was made up to mark. The mixture was shaken and left for 40 secs. before dipping the hydrometer into it to determine the sandy content while the clay and silt was determined after 3 hours interval (for the mixture to settle down) through the same process. The temperatures were then recorded simultaneously. % sand, % clay and % silt was calculated.

Determination of pH (H2O) and pH ($CaCl_2$): The pH of soil samples was determined according to Ibitoye (2006) and hydrometer method described in Agbede and Ojeniyi (2009). 10 grams of air-dried samples were weighed into 100ml beaker (in duplicates), 20ml of distilled water was added to one beaker and 20ml of 0.01M $CaCl_2$ was added into another beaker. Each suspension was stirred several times over a 30 minutes interval with a glass rod, and the pH was measured by immersing the glass electrode (Horiba pH meter D- 51) well into the partly- settled suspension and the electrode deep enough into the clear solution on top of the suspension. Subsequently, the variations of the pH of the soil as a result of different treatments were measured.

Determination of Nitrogen: Nitrogen was determined according to Ibitoye (2006), using the Kjeldahl method where Kjeldahl digestion is usually performed by heating the sample with H_2SO_4 containing substances which promote oxidation of organic matter by increasing the boiling point of the acid (K_2SO_4 or Na_2SO_4) and Se or Cu which increases the rate of oxidation of organic matter. The process of digestion was followed by distillation and titration.

Determination of Soil Organic matter (Organic Carbon): Carbon is the chief element of organic matter that is readily measured quantitatively; hence estimates of organic matter were based on organic carbon which was determined by using Walkley -Black wet oxidation procedure and digestion method as described by Anderson and Ingram (1989). About 1 g of soil sample was placed into a block digester tube (sample weight) and added 5 ml of potassium dichromate solution and 7.5 ml of concentrated H_2SO_4. The tube was placed in a pre- heated block at 145-155^oC for 30 minutes, then removed and allowed to cool. The digest was quantitatively transferred into a 100ml conical flask and then added 0.3 ml of O- phenanthrene-ferrous complex (ferroin) indicator solution, then stirred and mixed properly using magnetic stirrer. The digest was titrated with ferrous ammonium sulphate solution with end point indicating a change from greenish to brown colouration. The organic carbon content was calculated and expressed in percentage.

Determination of Soil Nitrate, Phosphorous, Potassium and Sulpur: The phenoldisulphonic acid colorimetric method by Ibitoye (2006) was used to determine the percentage nitrate of the samples. Atomic absorption spectrophotometer was used to determine the P and S (AOAC, 1995; Aladesida et al., 2014). The exchangeable potassium (K+) was extracted with HCl solution and their levels determined by flame photometry (Vogelmann et al., 2010).

STATISTICAL ANALYSIS

Data was inputed into Microsoft excel and analysed using the Statistical Package for the Social Science (SPSS) version 17.0. Results obtained from all samples were subjected to descriptive statistics (mean, standard deviation and coefficient of variation among soil samples from different locations) and inferential (ANOVA) statistics w calculated to aid in providing explanations and assessing dispersion of the variables. Measure of Dispersion tells us about the variation of the data set. $P<0.05$ was considered to indicate statistical significance. Means were separated using Duncan's Multiple Range Test. Each soil property was compared using Pearson correlation coefficient at 1 and 5% significant levels.

RESULTS

Table 1 shows the physical properties of the earthworm cast and control. Mass earthworm cast collected under many plant species had a higher silt value which was significant; *Bauhinia purpurea*, *Bombax buonopozense*, *Auraucaria columnaris* and *Mangifera indica*. The clay content for the three components (mass, turret casts and control) were relatively the same with no significant difference while the value of sand was higher in the control with significant difference in *Bauhinia buonopozense*, *Auraucaria columnaris*, *Delonix regia* and *Jathropha curcas.*

Table 1: Mean particle size of different earthworm cast around plant species (Physical properties)

Particle Size	Earthworm Cast	PLANT SPECIES							
		B. purpurea	*B. buonopozense*	*Thuja plicata*	*H. columnaris*	*D. regia* (Site 1)	*M. indica*	*D. regia* (Site 2)	*J. curcas*
Silt (%)	Control	1.00^{b}	4.00^{c}	8.50^{ab}	10.50^{b}	6.00^{b}	6.50^{b}	4.50^{b}	5.50^{c}
	Mass	7.00^{a}	15.67^{a}	8.00^{b}	13.00^{a}	2.50^{c}	10.50^{a}	9.50^{a}	11.00^{b}
	Turret	3.00^{b}	10.00^{b}	10.00^{a}	9.00^{b}	10.50^{a}	10.00^{a}	11.00^{a}	13.00^{a}
	S.E	**0.88**	**1.35**	**0.50**	**1.11**	**0.75**	**0.82**	**1.20**	**0.47**
Clay (%)	Control	24.00^{a}	21.67^{a}	22.00^{a}	21.00^{a}	21.00^{a}	21.50^{a}	20.50^{a}	21.00^{a}
	Mass	22.00^{a}	21.50^{a}	22.00^{a}	22.00^{a}	21.50^{a}	21.50^{a}	20.50^{a}	22.00^{a}
	Turret	21.33^{a}	22.00^{a}	22.00^{a}	22.00^{a}	21.50^{a}	21.00^{a}	22.00^{a}	22.00^{a}
	S.E	**1.54**	**1.18**	**0.82**	**1.83**	**1.25**	**0.75**	**0.82**	**0.91**
Sand (%)	Control	75.00^{a}	73.67^{a}	69.50^{a}	68.50^{a}	65.00^{a}	72.00^{a}	75.00^{a}	73.50^{a}
	Mass	71.00^{a}	62.50^{b}	68.00^{a}	65.00^{b}	68.00^{a}	68.00^{a}	70.00^{b}	67.00^{b}
	Turret	74.33^{a}	67.00^{b}	68.00^{a}	69.00^{a}	68.00^{a}	69.00^{a}	68.00^{b}	65.00^{b}
	S.E	**1.68**	**1.41**	**0.82**	**0.96**	**1.19**	**1.67**	**1.11**	**0.65**

Means on the same column with the same superscript do not differ significantly from each other (P = 0.05). **Where: SE = Standard error**

Table 2 shows that pH (H_2O) and pH ($CaCl_2$) had no significant difference but mass cast (for *Delonix regia* and *Mangifera indica*) and turret cast (*Bauhinia purperea*, *Bombax buonopozense, Thuja plicata* and *Auraucaria columnaris*) had higher nitrate content which was significant with the control. The same pattern was followed for potassium content. phosphorous for samples collected around mass cast (*B. buonopozence, A. columnaris, D. regia* site 1 and 2) and control (*B. purpurea*, *Thuja plicata*, *M. indica* and *J. curcas*) were higher with variation. Sulphur content was higher in the control with high significant difference especially in *A. columnaris* and *Jathropha curcas*. Organic matter content was highest in mass and turret cast samples collected around all plant species with very high variation with the control which was very low. Turret cast had the highest amount of nitrogen for all samples with no significant difference with the mass cast but with great variation with the control.

Table 2: Mean biochemical elements of different earthworm cast around plant species

Biochemical Element	Earthworm Cast	PLANT SPECIES							
		B. purpurea	*B. buonopozence*	*Thuja plicata*	*iii. columnaris*	*D. regia* (Site 1)	*M. indica*	*D. regia* (Site 2)	*J. curcas*
pH(H_2O)	Control	6.80[a]	6.50[a]	6.20[a]	6.60[a]	6.20[a]	6.24[a]	6.40[a]	6.34[a]
	Mass	6.70[a]	6.10[a]	6.01[a]	6.50[a]	6.20[a]	6.06[a]	6.20[a]	6.11[a]
	Turret	6.70[a]	6.06[a]	6.14[a]	6.50[a]	6.20[a]	6.20[a]	6.09[a]	6.12[a]
	S.E	**1.04**	**1.00**	**0.61**	**0.58**	**0.58**	**0.47**	**0.85**	**0.65**
pH($CaCl_2$)	Control	5.87[a]	5.44[a]	5.50[a]	5.36[a]	5.46[a]	5.39[a]	5.52[a]	5.42[a]
	Mass	5.66[a]	5.55[a]	5.47[a]	5.92[a]	5.51[a]	5.49[a]	5.54[a]	5.33[a]
	Turret	5.63[a]	5.30[a]	5.36[a]	5.71[a]	5.40[a]	5.43[a]	5.37[a]	5.32[a]
	S.E	**0.54**	**1.11**	**1.05**	**0.76**	**0.89**	**0.51**	**0.79**	**0.59**
NO_3(ppm)	Control	63.00[b]	88.00[a]	91.00[c]	6.60[b]	120.00[c]	100.00[c]	93.00[b]	95.00[b]
	Mass	91.00[a]	120.00[a]	160.00[b]	130.00[a]	200.00[a]	140.00[a]	160.00[a]	120.00[a]
	Turret	93.00[a]	130.00[a]	180.00[a]	140.00[a]	160.00[b]	120.00[b]	160.00[a]	120.00[a]
	S.E	**7.53**	**11.91**	**4.75**	**4.73**	**4.71**	**4.71**	**5.15**	**5.02**
K^+(ppm)	Control	160.00[c]	900[b]	600[b]	5.70[c]	2200[a]	500[b]	250.00[b]	170.00[c]
	Mass	440.00[b]	1200[a]	1600[a]	1200[a]	2200[a]	1700[a]	720.00[a]	360.00[b]
	Turret	520.00[a]	1100[a]	1500[ab]	1000[b]	1300[b]	1600[a]	780.00[a]	480.00[a]
	S.E	**12.02**	**57.74**	**262.47**	**3.37**	**33.67**	**150.00**	**39.02**	**7.45**

Phosphorous (mg/kg)	Control	0.40^{a}	0.30^{b}	0.95^{a}	0.07^{b}	0.45^{b}	0.75^{a}	0.16^{b}	0.63^{a}
	Mass	0.12^{b}	0.42^{a}	0.27^{b}	0.53^{a}	0.70^{a}	0.05^{c}	0.60^{a}	0.23^{c}
	Turret	0.13^{b}	0.14^{c}	0.22^{c}	0.05^{b}	0.26^{c}	0.43^{b}	0.50^{b}	0.49^{b}
	S.E	**0.03**	**0.03**	**0.01**	**0.01**	**0.04**	**0.01**	**0.07**	**0.01**
Sulphur (mg/kg)	Control	1.50^{a}	1.74^{a}	8.96^{a}	96.00^{a}	1.43^{a}	1.58^{a}	1.28^{a}	140.00^{a}
	Mass	1.50^{a}	1.58^{a}	1.71^{a}	1.67^{b}	1.62^{a}	1.65^{a}	1.55^{a}	1.63^{b}
	Turret	1.66^{a}	1.25^{a}	1.63^{a}	1.71^{b}	1.44^{a}	1.65^{a}	1.57^{a}	1.61^{b}
	S.E	**0.58**	**0.75**	**4.78**	**1.27**	**0.31**	**0.28**	**0.18**	**1.67**
Organic Matter (%)	Control	0.05^{b}	0.10^{c}	0.11^{c}	0.08^{b}	0.11^{b}	0.07^{b}	0.01^{b}	1.04^{a}
	Mass	0.05^{b}	0.16^{b}	0.17^{a}	0.08^{b}	0.17^{a}	0.16^{a}	0.14^{a}	0.16^{b}
	Turret	0.16^{a}	0.18^{a}	0.13^{b}	0.14^{a}	0.17^{a}	0.15^{a}	0.14^{a}	0.18^{b}
	S.E	**0.01**	**0.01**	**0.01**	**0.01**	**0.01**	**0.01**	**0.01**	**0.01**
Nitrogen (mg/kg)	Control	20.60^{a}	19.89^{b}	20.57^{b}	21.70^{a}	27.12^{c}	22.60^{b}	21.02^{b}	21.47^{b}
	Mass	20.60^{a}	27.12^{a}	36.16^{a}	29.38^{a}	45.20^{a}	31.64^{a}	36.16^{a}	27.12^{a}
	Turret	21.02^{a}	29.38^{a}	40.68^{a}	31.64^{a}	36.12^{b}	31.64^{a}	36.16^{a}	27.12^{b}
	S.E	**0.95**	**1.11**	**4.29**	**3.02**	**1.01**	**1.13**	**1.82**	**0.75**

Table 3 below shows a significant correlation ($p > 0.05$) for the control sample (clay and sulphur) and organic matter ($p > 0.01$). Mass turret samples have a significant correlation for organic matter ($p > 0.05$). Turret samples had a positive correlation for sulphur, sand ($p > 0.05$) and silt ($p > 0.01$).

Table 3: Correlation between physical and biochemical composition of earthworm cast in Federal College of Forestry, Jos

Earthworm Cast		Silt (%)	Clay (%)	Sand (%)	pH (H_2O)	pH ($CaCl_2$)	NO_3 (ppm)	K+ (ppm)	P (mg/kg)	Sulphur(mg/kg)	Organic matter (%)	Nitrogen (mg/kg)
Sample (Control)	Pearson Correlation	0.230	-0.425*	0.001	-0.107	-0.067	0.322	-0.192	0.067	0.452*	0.545**	0.230
	Sig. (2-tailed)	0.280	0.038	0.996	0.618	0.754	0.125	0.369	0.757	0.027	0.006	0.280
Sample (Mass)	Pearson Correlation	-0.039	-0.105	0.118	-0.091	-0.075	0.346	0.055	0.141	0.022	0.460*	0.308

	Sig. (2-tailed)	0.855	0.624	0.584	0.671	0.729	0.098	0.797	0.512	0.920	0.024	0.143
Sample (Turret)	Pearson Correlation	0.678**	0.017	-0.504*	-0.103	-0.042	0.175	-0.019	0.512*	0.050	0.038	0.241
	Sig. (2-tailed)	0.000	0.936	0.012	0.633	0.846	0.413	0.929	0.010	0.815	0.860	0.257

DISCUSSION

From the results, the two types of earthworm casts identified in the study site are; the mass and turret cast. The mass earthworm cast collected under many plant species had a higher silt value which was significant. The clay content for the three components (mass, turret casts and control) were relatively the same with no significant difference while the value of sand was higher in the control with significant difference. Mass earthworm cast collected under all plant species had a relatively lower sand content compared to turret cast. Results also shows that pH (H_2O) and pH ($CaCl_2$) had no significant difference for all samples collected but mass and turret cast had higher nitrate content which was significant with the control. The same pattern was followed for potassium content where Turret and Mass cast had higher composition than the control; the variation was significant. This agrees with studies by Cortez et al. (2000) who reported that earthworms are known to be important regulators of major soil processes and functions such as soil structure, organic matter decomposition, nutrient cycling, microbial decomposition and activity, and plant production. He also reported that the presence of earthworms whatever the ecological category, increased the quantity of inorganic N in the soil. Earthworms can impact plant growth by promoting N-availability (Li et al., 2002; Ortiz-Ceballos et al., 2007). The formation and production of N_2O in soils is determined by microbial processes: nitrification, denitrification, and nitrifier denitrification (Wrage et al., 2001). The same pattern was followed for potassium content where Turret and Mass cast had higher composition than the control, the variation was significant. Cast samples collected around *Thuja plicata* had the highest potassium content while samples collected around *Bauhinia purperea* had the highest nitrate content. This agrees with findings by Khare (2004) who stated that *Bauhinia purpurea* L. belongs to the family

Leguminosae (Caesalpinioideae) and a good nitrogen fixing plant. Organic matter content was highest in mass and turret cast samples collected around all plant species with very high variation with the control which was very low. Turret cast had the highest amount of nitrogen for all samples with no significant difference with the mass cast but with great variation with the control. This was also reported by that through interactions of earthworms with the microbial community and by processing Organic matter, earthworms can increase the system flux of CO_2 (gaseous C loss). These same interactions, coupled with earthworm excretion, can also lead to increased availability of N. Earth worm cast are usually found to have greater exchangeable K, calcium (Ca), and magnesium (Mg) contents than bulk soil (Edwards et al., 2014). This was also confirmed by Teng et al. (2012) who examined the physical, chemical and biological properties of casts produced by endogeic species in clay soil incubated in the dark for two weeks. The findings suggested improved nutrient content in Earth Cast as compared. This was shown by higher content of macronutrients (N, Ca) in mean difference effect of Earthworm cast. This is probably due to the intimate mixing of OM (organic matter) through the earthworm gut which can further enhance mineralization and humification processes (Blanchart et al., 1999). Improved Calcium (Ca) content in earth worm was probably due to the presence of an active calciferous gland in earthworms that actively secretes mucus rich in calcium carbonates into the esophagus (Drake et al., 2007). This leads to the elimination of excess Ca ions via casting activity, and greatly increases Ca availability in soil.

Sand content of the control collected around *Bauhinia purpurea* and *Delonix regia* was highest with no variation with other samples collected. Earthworm cast and control had no variation in pH (H_2O and $CaCl_2$), but there was variation in nitrate, phosphorous, organic matter and nitrogen. *Delonix regia* had the highest and *A. columnaris* had the least nitrate content. This finding is in line with findings by Ajagbe et al. (2020) who discovered that *Delonix regia* root (DSR) contained calcium, phosphorus, potassium, zinc, magnesium, sodium, copper, iron, cobalt and selenium. The non-cast sample (control) had more sand content while the silt was higher in the two cast samples. Similar results have also been reported from many parts of the world (Blanchart *et al*., 1993; Hulugalle and Ezumah, 1991). Various mechanisms to explain the characteristic of cast material have been postulated and have been extensively documented (Marinissen and Dexter, 1990). The information presented above strongly suggests that the earth-worm gut plays an important role in modifying the physico-chemical properties of the cast soil. There was a significant correlation ($p > 0.05$) for the control sample (clay and sulphur) and organic matter. Mass turret samples have a significant correlation for organic matter ($p > 0.05$). Turret samples had a positive correlation for sulphur, sand and silt. The negative correlations that occur between the spatial distributions of soil ecosystem engineers of different species producing separate cast types have been often interpreted as a result of competition (Jimenez *et al*., 2001; Decaëns *et al*., 2006; Jimenez *et al*., 2012). Alternatively, this distribution patterns may be considered as the consequence of a micro successional process.

pH of cast samples was not significant with non-cast samples, pH of samples was observed to be slightly alkaline, between 6.0 to 7.0 for all samples. However, Owa et al. (2003) identified a pH range of 5.0-7.4 for earthworm distribution and abundance in soils. According to these authors, soils within this pH range support earthworm survival and in those outside these range earthworms were rarely found. The implications of this to the present result would be that as the soil passes through the earthworm gut the pH is altered by enzymatic activity or and microbial activity in the earthworm gut. Earthworms are very sensitive to soil pH. Abundance, distribution and species composition of earthworms are affected by soil pH. According to Edwards and Bohlen (1996) a neutral soil pH is preferred by most species of the earthworms, but pH of 5.0 to 8.0 can be tolerated by them which is in line with this study. Low or high pH is generally unfavorable for many species of earthworms and increase or decrease in soil pH may cause decline in earthworm count. Significant correlation between worm cast production and adjacent soil chemical properties was not observed except for phosphorus. Potassium and phosphorus levels were also found to be significantly higher in casts compared to the surrounding soil. Earthworm casts are richer in soluble inorganic phosphate as well as exchangeable phosphorus. Higher phosphatase activity in worm casts than in uningested soil also increases the mineralization of organic phosphorus (Mansell et al., 1981).

CONCLUSION

Two earthworm cast were found in FCFJ; mass and turret cast which were observed to have the highest biochemical content (Nitrogen, phosphorous, organic matter, sulphur, potassium) with significant variation with the control.

The mass cast had the highest number of elements than the turret cast but there was no variation, hence both earthworm cast can be used simultaneously. The control (no cast) was only observed to have high sand content with low amount of silt and clay which makes it less fertile. Samples collected from plant species vary in their composition of the nutrient but was not significant, although *Delonix regia*, *Jathropha curcas*, *Mangifera indica*, *Bombax buonoposenze* had higher composition of nutrients.

Mass Casts with Turret Cast had higher amount of all biochemical element which was significant compared to soils with no cast (control) and will be very useful to be used in agricultural farms and plant nurseries as alternatives to soils with inorganic fertilizers.

RECOMMENDATIONS

Indebt study on earthworm species across Plateau state and different vegetation zones should be encouraged as they play a vital role. Earthworms should be cultivated in farmlands to replace inorganic fertilizers that pose great problem to the ecosystems.

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