Soil Physical Properties as Influence by Poultry and Cow dung from Different Housing and Stacking Types Following *Telfairia occidentalis* (Hook F.) Production

Abstract

Soil physical properties play significant function in the yield of crop produce. Sustaining food supply of the teeming population depends on the degree of preserving soil physical properties, therefore enhancing soil productivity. Experiments were conducted to establish the influence of poultry and cow dung from different housing and stacking types on physical properties of soil following *Telfairia occidentalis* production in 2017 and 2018. Amendments were applied in both years after which data were analyzed using Analysis of Variance. The experiment reveals that amendments statistically increased soil porosity, moisture content, hydraulic conductivity and therefore reduced bulk density above control in both years. It is concluded that for improved soil physical properties in the study area, bagged poultry manure in palm fronds house (PPB) at 5.4 tha^{-1} is recommended to farmers.

Keywords: *Contribution, Experiment, hydraulic, physical, properties*

Introduction

Soil physical properties are necessary to a developing plant (Abdisa, 2021). Soil stand as a storeroom for nutrients and water required for plant development (Almendro-Candel *et al*. 2018). Crop production capability is deeply influenced by the physical properties of soils (Adebola *et al*. 2017). Enhanced soil structure boost hydraulic conductivity, soil porosity, and moisture content thereby, reduces bulk density. These enhancements in soil superiority contribute to improved soil condition for crop growth and yield output. The physical properties of the soil are extremely vital in agricultural production and sustainable use of soil (Almendro-Candel *et al*. 2018). The quantity and rate of water, oxygen, and nutrient assimilation by plants rely on the capability of the roots to absorb nutrients from the soil solution as well as the ability of the soil to supply it to the roots (Almendro-Candel *et al*. 2018). A crop plant required a good and favorable soil conditions to give full potential yield. Soil offers habitats for living organisms and moisture and nutrients for the essential necessity of plant development. Soil is the center of production in agriculture (Akanbi *et al*. 2006).

The objectives of this research is to establish the effect of poultry manure and cow dung from different housing and stacking methods on some physical properties of post - harvest soil following *Telfairia occidentalis* production.

Materials and Methods

The research was conducted at the Organic Farm of the Federal University of Agriculture, Abeokuta (latitude 7° 13^{1} N and longitude 3° 28^{1} E). Poultry manure was obtained from Isekolowo farm, Egbeda, along Alabata road, Abeokuta whereas cow dung was obtained at the cattle unit of College of Animal Sciences farm, Federal University of Agriculture, Abeokuta. Manures were kept in three different housing types viz: Zinc house, Palm Fronds house and Open space.

Initial soil physical properties (porosity, hydraulic conductivity, bulk density and moisture content) were determined before amendments application. Thirteen (13) plots measuring 4 m x 2 m (8 m^2) were demarcated with inter and intra row spacing of 1 m and it was replicated three times given a total of thirty-nine (39) plots. Amendments applied were bagged poultry manure in Zinc House at 5.6 tha^{-1} (ZPB) and unbagged at 6.0 tha^{-1} (ZPU), bagged poultry manure in open space at 5.5 tha^{-1} (OPB) and unbagged at 6.8 tha^{-1} (OPU), bagged poultry manure in palm frond house at 5.4 tha^{-1} (PPB) and unbagged at 6.9 tha^{-1} (PPU), bagged cattle manure in Zinc House at 6.5 tha^{-1} (ZCB) and unbagged at 5.6 tha^{-1} (ZCU), bagged cattle manure in open space at 5.3 tha^{-1} (OCB) and unbagged at 5.9 tha^{-1} (OCU), bagged cattle manure in palm frond house at 5.1 tha^{-1} (PCB) and unbagged at 5.5 tha^{-1} (PCU), and control (i.e. no amendment). They were applied as guided by the native soil nitrogen and nitrogen requirement of *Telfairia occidentalis* (60 kg Nha^{-1}) (Akanbi *et al.*, 2006). At the end of the experiment, soil physical properties (porosity, hydraulic conductivity, bulk density and moisture content) were also determined.

The core method using a core sampler was used to determine Soil bulk density. Hydraulic conductivity was established using the Klute and Dirksen (1986) method. Total porosity was calculated from bulk density of the soil using: F = (1- Bd/Pd), Where F = porosity, Bd = bulk density (gcm^{-3}), Pd = particle density of the estimated soil at 2.65 gcm^{-3}, Moisture content was estimated by the gravimetric method using undisturbed soil cores (Blake and Hartge, 1986).

Data were analyzed by Analysis of Variance (ANOVA) using Statistical Analysis System Significant means were separated using Duncan's Multiple Range Test (DMRT) at 5 % level of probability.

Results:

Physical Properties of Soil used for the Research

The physical properties of the soil used for research shows that the soil was sandy loam (Table 1).

Table 1: Physical Properties of Soil used for the Experiment

Soil Properties	2017	2018
Bulk Density (g cm^{-3})	1.29	1.25
Hydraulic Conductivity (cm sec^{-1})	0.01	0.01
Total Porosity	0.51	0.53
Moisture Content	15.8	15.8
Sand (g kg^{-1})	806	811
Clay (g kg^{-1})	123	146
Silt (g kg^{-1})	71	43
Textural Class	Sandy Loam	Sandy Loam

Effect of Poultry and Cow dung from Different Housing System and Stacking methods on Post Planting Soil Bulk Density and Porosity in 2017 and 2018

In year 2017 (Table 2), it was observed that control (unamended) plots had highest post planting soil bulk density although, not statistically ($P \leq 0.05$) higher than the post planting soil bulk density of plots amended with OPU at 6.8 tha^{-1}, OCB at 5.3 tha^{-1}, OCU at 5.9 tha^{-1} and PCB at 5.1 tha^{-1} but was statistically ($P \leq 0.05$) higher than the post planting soil bulk density of every other plots. However, in year 2018, the same trend was observed as control (unamended) plot had highest Post planting soil bulk density.

The porosity of Post planting soil of plots amended with poultry manure bagged in palm fronds house (PPB) at 5.4 tha^{-1} was observed to be highest in year 2017. Meanwhile, in year 2018, plots amended with PPB at 5.4 tha^{-1} was also observed to have highest post planting soil porosity which was not statistically ($P \leq 0.05$) higher than the Post planting soil porosity of plots amended with PCU at 5.5 tha^{-1} and ZPB at 5.6 tha^{-1} but was statistically ($P \leq 0.05$) higher than the post planting soil porosity of all other plots (Table 2).

Table 2: Effect of Poultry Manure and Cow dung from Different Housing Systems and Stacking methods on Post planting Soil Bulk Density and Porosity in 2017 and 2018

Amendments (tha^{-1})	Bulk Density ($g\ cm^3$)		Porosity (%)	
	2017	2018	2017	2018
ZPB at 5.6	1.16ef	1.15efg	56.33a	56.67ab
ZPU at 6.0	1.32bcd	1.30bcd	50.33bc	50.67cd
ZCB at 6.5	1.27de	1.25cde	52.00b	52.67bc
ZCU at 5.6	1.32bcd	1.28cd	50.00bcd	51.67c
OPB at 5.5	1.29cd	1.23def	51.33b	52.00c
OPU at 6.8	1.42ab	1.40ab	46.33de	47.00d
OCB at 5.3	1.39abc	1.36abc	47.33cde	48.67cd
OCU at 5.9	1.37abcd	1.34abc	48.33bcde	49.33cd
PPB at 5.4	1.07f	1.09g	59.67a	58.67a
PPU at 6.9	1.32bcd	1.26cde	50.33bc	52.67bc
PCB at 5.1	1.35abcd	1.30bcd	49.00bcde	50.67cd
PCU at 5.5	1.17ef	1.14fg	56.33a	57.00a
Control	1.45a	1.41a	45.33e	47.00d
LSD (0.05)	**0.11**	**1.10**	**3.96**	**4.14**

Means with the same letter(s) in a column are not statistically different at $P \leq 0.05$

KEY:

ZPB:	Poultry Manure Bagged in Zinc House	**ZPU:**	Poultry Manure Unbagged in Zinc House
ZCB:	Cowdung Bagged in Zinc House	**ZCU:**	Cowdung Unbagged in Zinc House
OPB:	Poultry Manure Bagged in Open Space	**OPU:**	Poultry Manure Unbagged in Open Space
OCB:	Cowdung Bagged in Open Space	**OCU:**	Cowdung Unbagged in Open Space
PPB:	Poultry Manure Bagged in Palm Fronds House	**PPU:**	Poultry Manure Unbagged in Palm Fronds House
PCB:	Cowdung Bagged in Palm Fronds House	**PCU:**	Cowdung Unbagged in Palm Fronds House

Effect of Poultry Manure and Cow dung from Different Housing System and Stacking methods on Post Planting Soil Saturated Hydraulic Conductivity and Gravimetric Moisture Content in 2017 and 2018

It was observed in year 2017 (Table 3) that, Post planting soil saturated hydraulic conductivity of plots amended with poultry manure bagged in palm fronds house (PPB) at 5.4 tha^{-1} was highest (16.37 cm hr^{-1}) while control (unamended) plot had the least Post planting soil saturated hydraulic conductivity (10.50 cm hr^{-1}). Also, in year 2018, plot amended with PPB at 5.4 tha^{-1} had highest post planting soil saturated hydraulic conductivity although, not statistically ($P \leq 0.05$) higher than the post planting soil saturated hydraulic conductivity of plots amended with PCU at 5.5 tha^{-1} and PPU at 6.9 tha^{-1} but was statistically ($P \leq 0.05$) higher than the post planting soil saturated hydraulic conductivity of all other plots.

Application of amendments statistically ($P \leq 0.05$) influenced post planting soil moisture content above the control in year 2017. Moreover, in year 2018, application of amendments also

statistically ($P \leq 0.05$) influenced post planting soil moisture content above the control (unamended) plot.

Table 3: Effect of Poultry Manure and Cow dung from Different Housing Systems and Stacking methods on Post planting Soil Saturated Hydraulic Conductivity and Gravimetric Water Content in 2017 and 2018

Amendments (tha^{-1})	Saturated Hydraulic Conductivity ($cm\,hr^{-1}$)		Gravimetric Moisture Content (%)	
	2017	2018	2017	2018
ZPB at 5.6	14.20bcd	14.57bcd	18.53ab	19.03ab
ZPU at 6.0	13.17bcd	13.67bcd	17.77bcde	18.30bcd
ZCB at 6.5	13.13bcd	13.57bcd	17.77cdef	18.00cde
ZCU at 5.6	13.67bcd	14.03bcd	18.20abcd	18.67abc
OPB at 5.5	12.90cd	13.37cd	17.20def	17.73def
OPU at 6.8	12.37de	13.17cd	16.90ef	17.23ef
OCB at 5.3	12.33de	12.93de	16.57f	16.97f
OCU at 5.9	12.60cd	13.17cd	16.97ef	17.47def
PPB at 5.4	16.37a	16.67a	19.00a	19.37a
PPU at 6.9	14.53abc	14.97abc	18.40abc	19.00ab
PCB at 5.1	14.03bcd	14.33bcd	18.23abc	18.73abc
PCU at 5.5	14.93ab	15.27ab	18.63ab	19.00ab
Control	10.50e	11.10e	14.27g	15.20g
LSD (0.05)	**1.98**	**1.87**	**1.01**	**0.88**

Means with the same letter(s) in a column are not statistically different at $P \leq 0.05$

KEY:

ZPB:	Poultry Manure Bagged in Zinc House	**ZPU:**	Poultry Manure Unbagged in Zinc House
ZCB:	Cowdung Bagged in Zinc House	**ZCU:**	Cowdung Unbagged in Zinc House
OPB:	Poultry Manure Bagged in Open Space	**OPU:**	Poultry Manure Unbagged in Open Space
OCB:	Cowdung Bagged in Open Space	**OCU:**	Cowdung Unbagged in Open Space
PPB:	Poultry Manure Bagged in Palm Fronds House	**PPU:**	Poultry Manure Unbagged in Palm Fronds House
PCB:	Cowdung Bagged in Palm Fronds House	**PCU:**	Cowdung Unbagged in Palm Fronds House

Discussion

The post planting soil physical properties were observed to be improved by the application of amendments (Carmeis *et al.* 2016). Soil physical properties contribute to water and nutrient activities, soil temperature, aeration, nutrient cycling, and root growth which affect yield of crops (Blanco-Canqui *et al.* 2013 and Sainju, *et al.* 2022). Soil provides the necessary nutrients, oxygen, water and root support that the plants need to develop and thrive (FAO 2015). Physical properties of soil affect fertility status of the soil thereby enhancing water movement through soil, root penetration, and waterlogging (Priori, 2021). When soil physical properties is improved, it increases soil porosity and improve nutrient and water recycling, water availability,

and biodiversity while decreases water and wind erosion (Alaoui *et al*., 2011). These improvements in soil quality lead to improved soil conditions for crop growth and yields.

The highest bulk density observed on control plot indicated that post planting soil of unamended (control) plots were more compacted which in turn lead to reduced saturated hydraulic conductivity, moisture content and porosity. This corresponds with the findings of Inyang *et al*. (2012) who asserted that agricultural soils amended with animal manure tends to reduces bulk density and improves soil porosity (Akanbi *et al*. 2006). Also, results of Escobar *et al*. (2008) discovered that addition of organic materials had direct effect on soil physical characteristics. All amended plots had higher saturated hydraulic conductivity, moisture content, porosity and reduced bulk density which showed that amendments help to improve physical properties of soil such that it helps to ease root penetration, erosion resistance, good moisture content, water holding capacity and also aid aeration for enhanced food safety, wellness and as such improve livelihoods. This reconfirms the discovery of Adebola *et al*. (2017) who asserted that organic manures help to improve soil physical properties. Indeed, soil physical properties is linked to food quality and quantity. Plots amended with organic manure from different housing and stacking methods revealed that poultry manure bagged in palm fronds house (PPB) at 5.4 tha^{-1} contributed positively to soil productivity.

Conclusion

The experiment revealed that amendments significantly increased soil porosity, moisture content, hydraulic conductivity and therefore reduced bulk density above control in both years with application of poultry manure bagged in palm fronds house (PPB) at 5.4 tha^{-1} being the best. Based on the findings of this experiment, poultry manure bagged in palm fronds house (PPB) at 5.4 tha^{-1} is therefore recommended to farmers for improved soil quality.

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