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Contributions of Different Litter Levels on Birds' Performance, Quality of Poultry Droppings on Soil Nutrients and Percent Seed Emergence of Cowpea (*Vigna ungiuculata*) in Acid Sand

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Abstract This study investigated the effects of different litter levels on the performance of broiler birds, and soil nutrient quality amended with poultry dropping. Also the effect on germination of cowpea (Vigna ungiuculata) seeds was taken into consideration. A total of 96 Top Notch broiler breeds and litter were used as treatments; T_1 as 2.5kg of wood shavings, T_2 as 2.0kg, T_3 as 1.5kg and T_4 as control (without litter). Each of the treatments was replicated three times on a floor space of 1.44 m^2 and 8 broiler birds assigned in a pen. Routine management procedure and vaccination schedules were maintained throughout the experimental period. Parameters studied included the body weight, feed intake and faecal droppings. Data obtained showed significant ($p < 0.05$) different between faecal droppings of T_1 and T_4. Accordingly, broilers in T_1 indicated about 12 % appreciable body weight, 34, 23 and 60 % increased in feed intake for T_1, T_2 and T_3 respectively and quantity faecal droppings. However, in T_4, broilers exhibited reduced body weight, low feed intake (anorexia) and decreased faecal droppings, in addition to stress, poor health and low performance. Negative correlations existed between litter levels and feed intake ($r = -0.727$). Effects of litter levels on seedlings emergence of cowpea (Vigna unguculata) seeds suggested that treatments T_1, T_2 and un-amended soils were found to be effective for the growth of cowpea.

Keywords Birds, Cowpea, Germination, Litter levels, Poultry droppings, Soil nutrient

1. Introduction

Broiler birds have been sources of quality protein supplies and other nutrients needed for growth and development in man [1,2]. They are also potential means of income generation and employment whether in a small and large-scale production productions [3]. Besides, other considerations for broiler production border on their short generation intervals, faster growth rate, lower age at maturity, high meat yield at slaughter and absence of cultural barriers or taboos to consumption [4, 5]. According to Wattanachant [6], broilers are also rated and appreciated for their low cholesterol level, abundance of minerals and vitamins than red meat.

As an efficient management practice, Oluyemi and Roberts [7] reported that the choice and adoption of litter can optimize birds performance and cost of production. According to Ritz *et al* [8], litters are bedding materials spread on the floor of the broiler pens to absorb birds droppings. In the same view, Fanimo [9] also reported on the importance of litters as they provide insulation from cold and protective cushion between the birds and the floor. Several studies on litters as absorbents for faecal droppings and spilled water from drinkers had been cited by Algers and Severberg [10]. Although in the earlier study on litters, Austic and Nesheim [11] suggested that an effective litter material must be readily available, absorbent, lightweight and non-toxic. Whereas David [12] noted that where high temperature and humidity prevail, litter has been known to favour the proliferation of pathogens and parasites. He also concluded that the effect of different litter materials is dependent on the physic-chemical characteristics of the materials, much the same way that geographic locations determine the types of litter selected for broiler production. Broiler birds can be managed under extensive, semi-intensive and intensive systems but in this experiment, they are reared in the deep litter system where the use of litter is applicable. It is the most common method of raising broilers and the droppings are good source of organic fertilizer on degraded soil.

Soil is often degraded due to constant use and there is need

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to replenish either by the use of organic matter or chemical fertilizer [13]. Due to increase in Nigerian population shifting cultivation method of farming is no longer sustainable, hence chemical fertilizers often produce plants products quickly and in large quantities. But over time, they become less and less effective and eventually leave the soil arid with some xenobiotic chemicals and the soil depleted of essential nutrients [14]. Consequently, attention is now shifting towards organic manures as soil amendment for crop production on soils [15]. Soil therefore acts as a long-term sink for nutrients and heavy metals which have residence times ranging from hundreds to thousands of years, depending on the element (s) and properties of the soil. The effects on soil nutrients quality on the germination of cowpea bean were used as a model in this study, since seeds are well protected against various stresses which soon after imbibitions and subsequent vegetative developmental processes become stress-sensitive in general.

In the present study, the effects of different litter levels on the physiological parameters of birds and the quality of poultry droppings on soil productivity and percent germination of cowpea seeds were assessed.

2. Materials and Methods

2.1. Experimental Sites

The research was conducted at the poultry unit of the Teaching and Research Farm, of the Faculty of Agriculture, University of Uyo, Nigeria. The area lies between latitudes 4^0 52^1 and 5^0 3^1N and longitudes 7^0 51^1 and 8^0 20^1 E and latitude 65 m from the sea level. The area is divided into two distinct seasons, the wet and dry seasons. The wet or rainy season begins from April and lasts till October. It is characterized by heavy rainfall of about 2500-4000 mm per annum [16].

2.2. Birds' Management

A total of 96 Top Notch day old chicks weighing 40 g were obtained from an accredited farm. These chicks were brooded and managed for 4 weeks under deep litter system using wood shavings. Adequate quantity of weighted pelletized vital starter mash and drinking water were provided adlibitum and the needed warmth was supplied from electricity. The birds were also administered with appropriate medications which included newcastle vaccines, lasota, coccidiostats and word expellers. At 5^{th} week, the birds were transferred from brooding house to finisher pens where weight pelletized vital finisher mash, sufficient drinking water and other management practices were maintained till the experiment was terminated at 8^{th} week.

The poultry experiment had 4 treatments and with three replicates each. Treatments were different litter levels, with the following combination: 2.5kg litter of wood shavings for T_1 were labeled as T_1R_1, T_1R_2, T_1R_3; 2.0kg litter (T_2) were T_2R_1, T_2R_2, T_2R_3, T_2R_4; 1.5kg litter (T_3) as T_3R_1, T_3R_2, T_3R_3, T_3R_4 and T_4 without litter (control).

2.3. Determination of Physico- chemical Properties of Soil and Dropping

Particle-size distribution was determined by hydrometer method [17]. Soil pH was measured in distilled water (1:2.5) with the use of glass electrode pH meter. Available phosphorus was determined using bicarbonate extraction, with acid reductant. The exchangeable cations (Calcium, Ca; Magnesium, Mg; Potassium, K; and Sodium, Na) in the soil and dropping were determined by first extracting with 1M NH_4 OAc (ammonium acetate) solution [18]. Organic Carbon (OC) was determined by loss-on-ignition [19]. Nitrogen was determined in form of ammonium (NH_4-N) and nitrate (NO_3-N) by absorbance measurement as described by Nelson [20]. Heavy metals were determined by the perchloric acid digestion method. Two grammes of air-dried soil which had been passed through a 2 mm sieve were weighed into a 150 ml beaker. This was added 20 ml of concentrated HNO_3, followed by 15 ml of $HClO_4$ after it was allowed to stand for one hour. The mixture was then digested on a hot plate till it turned white. The residue was dissolved in dilute HCl and then filtered. The filtrate was used for the determination of Zn, Cu and Pb by atomic absorption spectrophotometry. Consideration was taken of the dilution factor in concentration calculations.

2.4. Green House Study

Surface soil was collected at a location near the Department of Forestry Teaching and Research Arboretum. The soils were air dried, crushed and sieved through a 2-mm sieve. Sub samples were taken for analysis of some soil parameters i.e. pH, organic C, electrical conductivity (EC_{25}) water holding capacity (WHC), and moisture content were determined using the methods described by Gupta [21]. The soil was filled into poly pots (2 kg / pot) and was amended with 200 g of poultry droppings of different litter levels (2.5, 2.0, 1.5, 0 kg / 1.44 m^2). Control was run side by side without any poultry manure amendment. All the tests and control were run in triplicates. In order to determine the effects of different litter levels in poultry manure on germination, cowpea (*Vigna unguiculata*) seeds were immersed in deionized water to eliminate the exogenous contamination. These seeds were embedded 1.0 cm deep in soil pots (2 kg) amended with different concentration of litter in poultry droppings and seedlings emergence rate was determined.

2.5. Statistical Analysis

Laboratory and field data collected from the treatment sets were subjected statistical analyses of multivariate statistical techniques, ANOVA and Bivariate spearman correlation analysis (separately performed for birds' physiological and soil parameters) using SPSS for Windows (release Ver. 17. Inc. Chicago). Means were subjected to Duncan Multiple Range Test (DMRT). A significant difference among the parameters was concluded when the probability has a difference by 0.05.

3. Results and Discussion

3.1. Effects of Different Litter Levels on Birds' Performance

Results of Table 1 showed significant difference ($p < 0.05$) among the parameters; Bodyweight, Feed Intake and Droppings from broilers raised at different litter levels. Bodyweight varied significantly across the treatments $p<0.05$ through weeks 5, 6, 7, and 8. Value for week 8 (1.72kg) under T_1 was higher than those of other treatments whereas T_2 at week 5 had shown significant increase (2.11kg) in body weight than other treatments T_1, T_2, T_3 and T_4. This result of litter quality on bodyweight gain and broiler performance is in agreement with the results reported by Ritz et al., that litter quantity and quality management could increase feed intake of broilers and body weight as they grow older. From the view point of cost effectiveness, birds receiving treatments T_2 and T_3 are best for table between weeks 6 and 7, because beyond this period, there is likelihood of weight reduction.

Besides, broilers in T_1 (2.5 kg), T_2 (2.0kg) and T_3 (1.5 kg) through weeks 5,6,7 and might not expend their metabolic energy to counteract cold from the floor but broilers in T_4 (0.0 kg) without litter might have utilized their metabolic energy towards heat production for warmth instead of growth, thus the observed low bodyweights.

Data on the Table 1 also indicated that the feed consumed by birds in T_2 and T_3 were 1.19 and 1.11 kg respectively at week 8 and were not significantly ($p > 0.05$), whereas the mean feed intake for birds in treatments T_1 and T_4 varied significantly ($p < 0.05$) (1.33 kg and 0.97 kg). This same trend in Feed intake was observed across other treatments in weeks preceding week 8 and this could be attributed to comfort and convenience provided from litter while birds in T_4 without litter suffered discomfort and body injuries that adversely affected their feed intake. Birds performance can be optimized through appropriate choice and adoption of litter management that has lent credence to the above development.

In week 8, significant difference ($p < 0.05$) occurred in values obtained for droppings in T_1 (2.5kg) and T_4 (0.0 kg) but values 13.60 and 13.79 for T_2 (2.0 kg) and T_3 (1.5 kg) did not differ significantly ($p>0.05$). Other weeks preceding week 8 also experienced similar trend across their treatments whereby T_1 showed higher values while lower values were recorded for T_4. Significant values for T_1 and T_4 presented in Table 1 has corroborated in the report of Algers and Sverberg that litters absorb faecal droppings in a manner that reduce contact between birds and droppings.

From Table 2, correlation analysis revealed negative correlation between the treatments, feed intake and dropping while positive correction between dropping and feed intake were also observed. This implies that litters in poultry pens enhance feed consumption and vice visa. On the other hand, it also confirmed that increase in feed intake gave rise to the increase in the quantity of dropping.

Table 1. Effect of different litter levels on body weight, feed intake and droppings on broilers at 5 to 8 weeks

Parameters*	Weeks	T_1 (2.5kg)	T_2 (2.0kg)	T_3 (1.5kg)	T_4 (0.0kg)
Body weight (kg)	5	0.77^c	2.11^a	1.45^b	0.55^c
	6	1.05^b	1.89^a	1.75^b	1.01^b
	7	1.37^a	0.94^c	1.79^a	1.24^{bc}
	8	1.72^a	1.29^b	1.10^b	1.56^a
Feed Intake (g)	5	1.00^b	0.84^a	0.96^a	0.78^{ab}
	6	1.06^a	1.04^a	1.99^a	0.77^a
	7	1.02^b	0.98^b	1.20^b	0.76^a
	8	1.33^a	1.19^b	1.11^b	0.97^b
Droppings (kg)	5	13.42^c	12.25^a	13.33^a	9.50^a
	6	14.30^a	14.16^b	13.89^b	10.00^a
	7	16.60^b	13.54^b	13.60^b	10.20^b
	8	16.71^a	13.60^b	13.79^b	10.32^c

* Means with the same superscript along the column within a parameter are not significantly different at $p>0.05$

Table 2. Correlation analysis to show relationship among treatment in feed intake, bodyweight and droppings

	Litter level	Feed Intake	Body Weight	Dropping
Litter level	1			
Feed Intake	-0.250**	1		
Body Weight	0.052	-0.015	1	
Dropping	-0.727**	0.287	0.012	1

** Correlation is significant at the 0.01 level (2 tailed)

3.2. Influence of Litter Levels on Quality of Poultry Droppings as It Affects Soil Nutrients

Table 3. Some chemical properties and heavy metals of the poultry manure used in the study

	2.5 T_1	2 T_2	1.5 T_3	0 T_4	soil Check
pH	-	-	-	-	5.1
EC ($uScm^{-1}$)	-	-	-	-	178.5
WHC %	-	-	-	-	23.0
MC %	-	-	-	-	2.13
Exchangeable cations $*^H$					
Mg	1.65c	1.53d	1.95b	2.95a	1.33e
Ca	1.38d	1.34d	6.32a	4.33b	3.6c
K	0.9b	0.63c	0.21d	2.18a	0.17d
N	2.17b	0.15d	1.53c	3.49a	0.12d
P	0.19d	0.16d	1.12c	1.68b	12.8a
OC	26.32c	26.8c	40.53b	50.54a	4.61d
Heavy metals ($mg\ kg^{-1}$)					
Zn	5.63b	5.16c	5.55b	9.47a	4.51d
Cu	5.09bc	5.82b	5.16b	7.26a	2.76d
Pb	0.22c	0.32b	0.43b	0.95a	0.15c

* = nutrients measured in % for poultry droppings and
H = nutrient elements measured in $mg\ kg^{-1}$ for soil

The soil collected was dark brown, porous with small aggregates, organic C 4.61%, pH 5.1, EC_{25} 178.5 micro Siemens cm^{-1}, water holding capacity (WHC) 23% and moisture content of 2.13%. Exchangeable cations were significantly higher in T4, but exponentially decreased with the level of litter inclusion (Table 3). The mineral element originated from soil and poultry droppings dissolved in water for plant roots' absorption but those required in small quantity for optimum performance are regarded as traced elements. The concentration of these metals can however be increased to become potential pollutants if heavy metals containing in agronomic activities are introduced into the environment [22]. Concern over the presence of heavy metals in an environment arises from the fact that they cannot be broken down into non toxic forms. Thus once aquatic ecosystems are contaminated by heavy metals; they remain a potential threat for many years. The results obtained are presented in Table 3. Clearly indicated that the two treatments (Litter and non-litter droppings) exhibited different concentrations of heavy metals. It is evident that litter inclusion in dropping had high degree of variation of heavy metals level.

3.3. Seed Emergence of *Vigna unguiculata* in Poultry Dropping Amended Soil

As shown in Fig. 1, delayed germination of the *Vigna unguiculata* in soil amended with treatment 4 resulted from the relative toxicity of heavy metal concentration. Kelly *et al*., [23] observed that seed germination was gradually delayed in the presence of increasing concentration of traced elements. Seed emergence results obtained after 10, 15, and 20 days of planting revealed that at lower concentration of heavy metal, little or no harm is done to seed viability but at higher concentration, germination was retarded (Fig. 1). Order of toxicity of these heavy metals was found to be $T_4 > T_3 > T_2 > T_1 \geq$ un-amended soil (check).

Those seeds emerged in litter's free dropping (T_4) showed resistance through their delayed germination. Consequences of the presence of toxic metals and organic binding effect lead to delay in germination of seeds that in turn will affect the crop yield. If plant tissues accumulate these heavy metals then it can ultimately affect the human health in the form of poisoning (Lead poisoning). Applications of T_4 in the soil leads to the decreased value of this soil above 80 % with reference to its productivity and ultimately affect the human health.

4. Conclusions

Litter quantity and quality are essential, management factors in broiler production as applicable to deep litter system. This is due to its several advantages that enhance feed intake, body weight gain and minimal faecal droppings, all which also promote growth, good health and performance among broilers as compared with those broilers that were raised without litter.

Heavy metal contamination of soil via litter's free droppings (poultry manure) application can induce serious problem to the soil, cropping, vegetation and in turn human health. Heavy metal accumulation by plant tissues and its presence in soil persistently is not healthy for the soil environment. So poultry manure containing 2.5 Kg per 1.44 m^2 floor space (T_1) is most preferred and is recommended because its amendment in soil derived from acid sand parent material is not toxic to plant.

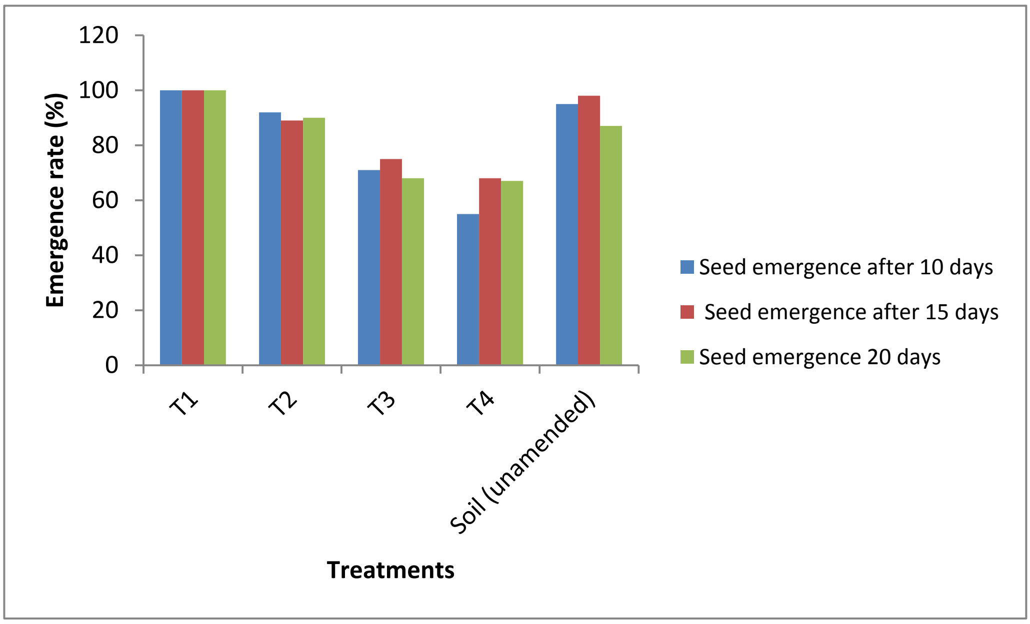

Figure 1. Percent cowpea seed emergence after 10, 15 and 20 days planted in poultry dropping amended soils

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