Synergistic effects of poultry and goat manures on the growth and yield of groundnut (*Arachis hypogaea* l.) in humid Ultisol

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Abstract

A field experiment was conducted from June to October 2019 to examine the synergy between poultry and goat manure on the performance and yield of groundnut on humid Ultisol in South-Eastern rainforest of Nigeria. The study utilized a 3 x 3 factorial disposition, laid out in randomized complete block design (RCBD) and replicated three times. Treatments consisted of goat and poultry manure, applied at three levels of 0, 5 and 10 t/ha. Data were collected on plant height, number of leaves, number of days to 50 % flowering, number of pods/plant, number of filled pods/plant, number of empty pods/plant, shelling percentage, 100-seed weight (g), pod yield/ha, and seed yield/ha. Goat manure applied at 5 and 10 t ha^{-1} significantly ($p \leq 0.05$) increased plant height, number of leaves, number of pods, shelling percentage, pod and seed yield. Poultry manure only significantly ($p \leq 0.05$) affected the number of pods and shelling percentage with increase in rates applied up to 10 t ha^{-1}, while significant interactions were only observed for plant height and number of leaves, number of pods and shelling percentage. At 10 t ha^{-1}, goat manure gave significantly ($p \leq 0.05$) higher number of leaves (50.70). The interaction of poultry manure and goat manure at 10 t ha^{-1} gave the tallest groundnut plants (25.33cm). Interaction of 10 t ha^{-1} of poultry and goat manure gave the tallest plants, highest number of pods (17.50) and shelling percentage (41.50 %) for groundnuts. The 10 t ha^{-1}goat manure in combination with zero poultry manure recorded the highest number of leaves in the study. The application of 5 t ha^{-1} of goat manure is hereby recommended for groundnut production in the study area.

Keywords: Synergy, goat manure, poultry manure, organic manure

Introduction

Groundnut (*Arachis hypogaea* L.) a member of the Family Fabaceae is one of the important leguminous crops due to the high nutritive value of its seeds, rich in protein and edible fats (Ajeigbe *et al*., 2014). It also contains other vital nutrients such as calcium potassium, phosphorus, magnesium and Vitamin E. The green leafy organs contain More than 10 % protein which makes to it good for use as fodder for livestock. Groundnut, is the sixth most important Oil seed Crop in the world. It is cultivated through-out the tropics and subtropics. Leading world producers of groundnut include: China, India, Nigeria, USA and Senegal. Nigeria ranks third among the major producer (FAOSTAT 2022), it plays an extremely important agronomic role in the traditional farming systems as a Nitrogen fixer in crop rotations. Commercial production of groundnut is concentrated in Northern Nigeria (Garba *et al*., 2002) but gradually gaining popularity as a cash crop for peasant households in the Southern parts of Nigeria.

Despite the economic potentials of the crop, the full production potentials in Nigeria have not been realized. Yields obtained by farmers are very low especially in intensive cropping systems due to imbalance in the use of fertilizer and continuous cropping which have led to severe nutrient deficiencies (Mahmood *et al.*, 1999, Onyia *et al*., 2012 and Enujeke, 2013). Due to population explosion and consequent high demand for groundnuts, the use of external inputs in the form of organic manure, has become imminent to condition the soil for harnessing full crop potential. According Ramakrishna *et al*. (2017), nutrient management in organically grown groundnut is possible through different organic manures without reduction in grain yield. Improvement in environmental conditions and public health are important reasons for advocating increased use of organic materials (Ojeniyi, 2000). Organic matter incorporation down the soil profile improves drainage and air pores via the activities of soil organisms. Organic manure (poultry, goat and farm yard manure etc.) release nutrients slowly, steadily and activate soil microbial biomass (Ayuso *et al*., 1996; Belay *et al.*, 2001). Organic manure sustains cropping systems through nutrient recycling and improvement of soil physical attributes (El-Shakweer *et al*., 1998). It also enhances chemical and biological properties of soil and nutrient availability (Brady and Weil, 1999). Poultry manure is a good source of N, P and K and also contains Ca, Mg, S and some micronutrients (Mullins *et al*., 2002). Bakayoko *et al.* (2009) also reported that Poultry manure had the greatest content of organic C, N, P, K, Ca and Lowest C: N ratio. According to Ibrahim *et al*. (2014), poultry manure is a relatively cheaper source of both macro nutrients (N, P, K, Ca, Mg, S) and micronutrients (Cu, Fe, Mn, B) and can increase soil organic Carbon (Wamba *et al*., 2012). Organic production could sustain the fertility of soils, boost ecosystems services and the health of people, relying mostly on locally adapted improved ecological processes and cycles and natural biodiversity rather than synthetic inputs and Genetically Modified seeds.

Nitrogen and phosphorus are unarguably, among the limiting nutrients for cereals and food legume metabolism, promoting cell division and enlargement (Shehu *et al*., 2010). They are also associated with high photosynthetic activities, vigorous growth, and dark green leaves (Mukhtar *et al*., 2014). Application of poultry manure decreased the absorption capacity and increased the soluble P and phosphorus absorption for enhanced groundnut yield (Reddy and Reddi, 1995). Waldrip *et al.* (2011) also reported that poultry manure promoted the transformation and mineralization of less labile inorganic and organic phosphorus into a labile -phosphorus in the rhizosphere which resulted in higher root phosphorus concentration and higher p-uptake by plants. More-so phosphorus is associated with increased root density and proliferation which aid in extensive exploration and supply of nutrients and water to the growing plants resulting in an increased growth and yield (Maiti and Jana, 1985). Application of 12 t/ha poultry manure was found to increase seed weight, number of pods per plant, 1000-grain weight, pod yield as well as grain yield in bambara groundnut (Wamba *et al*., 2012). In another study, Ibrahim *et al*. (2014) found that higher rates of poultry manure application resulted in increase in vegetative characters such as plant height, canopy, and number of branches while reduced rate of application led to corresponding reduction in days to 50 % flowering in groundnuts. Also, Mukhtar *et al*. (2014) found that application of poultry manure increased the number of pods, pod weight, pod yield, haulm yield as well as pod yield of groundnut. Similarly, Uko *et al*. (2016) stated that poultry manure applied at 15 t/ha produced higher number of pods per plant which culminated in higher yields as a result of vigorous foliar growth, increased meristematic and physiological activities in the plant resulting in higher production of assimilates used in formation of pods. Odiete *et al*. (1999) and Ojeniyi and Adegboyeaga (2003) had found that goat manure significantly improved growth and yield of okra, amaranthus, celosia and maize in southwest Nigeria. In southeast Nigeria, Samuel *et al*. (2003) found that goat manure increased soil pH, N and yield of plantain. According to Uwah and Eyo (2014), the application of GM significantly ($P \leq 0.05$) increased soil pH, organic matter (OM) content, total N, available P, exchangeable K, Ca, Mg and the cation exchange capacity (CEC) status of the soil. Soil exchangeable acidity (EA) was reduced from 1.76 to 0.64 cmol kg^{-1} at 20 t ha^{-1} GM rate.

Combined application of poultry and goat manure increased microbial activity in the soil and increased organic matter production resulting in increased availability of nutrients such as N, P, and K which enhanced the yield of the crop (Ojeniyi *et al*., 2010). Wamba *et al*., (2012) reported that PM applied at 15 t/ha more significantly enhanced the growth and yield attributes of groundnut. Also, Mbatha *et al*. (2021) found that Poultry and goat manure application led to increased levels of Ca, Mg, K, P, and micronutrients in sesame. The increase in nutrient concentrations in *sesame* plants treated with manure over the control suggests that poultry and goat manures are useful in the improvement of crop nutrient content. Furthermore, application of 12 t/ha PM was found to increase seed weight, number of pods per plant, 1000-grain weight, pod yield as well as grain yield in bambara groundnut (Wamba *et al*., 2012).

Soil degradation resulting from intensive cultivation and excessive use of synthetic fertilizers has unequivocally placed a tedious task on agronomists. Although, studies evaluating the production of crops under varying poultry manure rates are common, there is paucity of information on the productivity of groundnut involving combined rates of poultry and goat manure. This work therefore seeks to evaluate the synergistic effects of poultry and goat manure on the growth and yield of groundnut.

Materials and Methods

Field experiment was carried out from June-October, 2019 at the Faculty of Agriculture Teaching and Research Farm, University of Calabar (latitude 4.5 and 5.2 North and longitudes 8.0" to 8.3 East). The weather conditions are as defined by Nigeria Meteorological Agency (NIMET, 2012). Soil samples were collected randomly with auger at 0-15cm depth from the experimental site. The samples were bulked, air dried, sieved; and a composite sample taken and analysed for physical and chemical properties according to the method of Anderson and Ingram (1996). Samples of goat and poultry manure sourced from the University of Calabar livestock farm were also subjected to analysis to determine their nutrient composition. Goat manure pellets were crushed mechanically into powder. Site was cleared manually on 28th May, 2019, followed by mapping and pegging. The plots were tilled manually with spade. The experimental plot size was 2.0 m x 2.0 m (4.0 m with 1.0 m path separating the blocks and 0.5 m paths separating each plot within blocks. The gross plot was 22 m x 8 m. The plot was levelled to a fine tilled flat, and beds raised to evade running water. Poultry and goat manure were incorporated into the tilled plots on the 12th of June before sowing.

The experiment was dispersed as a 3 x 3 factorial experiment laid out in randomized complete block design (RCBD) and replicated three times. Treatments consisted of goat manure and poultry manure, applied at three levels of 0, 5 and 10 t/ha, each corresponding to 0, 2 and 4 kg of manure respectively per plot. The groundnut (*Arachis hypogaea* L.) variety RMP-12 was obtained from the Agricultural Development Programme seed store in Taraba State. Seeds were sown on the 26th of June, 2019, at a 2 cm depth. Two to three seeds were sown per hole at 40 cm x 25 cm spacing. The seedlings were later thinned to one plant/stand after germination, giving a plant population of 100,000 stands/ha. Manual weeding by hand - hoeing and pulling was done at 2 and 6 weeks after planting. During weeding, the base of the plants was earthed-up to protect developing pegs and provide loose medium for easy penetration and pods enlargement.

Data was collected from the four middle rows of groundnut stands in net plots for plant height, number of leaves, number of days to 50 % flowering, number of pods/plant, number of filled pods/plant, number of empty pods/plant, the shelling percentage, 100-seed weight (g), pod yield/ha, and seed yield/ha. Data was subjected to analysis of variance (ANOVA) and significant treatment means compared by Fisher's Least Significant Difference at P≤0.05 (Gomez and Gomez, 1984).

Results and discussion

The physico-chemical analysis of soil and the chemical composition of the manures used for the study are presented in Table 1. The physical properties of the soil at the study area classified the soil as sandy clay loam. With a pH of 5.2, which is moderately acidic, the pH of poultry (7.65) and goat manure (7.89) may tend to offset the pH towards a more favourable position for groundnut production. The soil native N of 0.12 was at the critical value for soils in the study area. The base saturation of 85.4 % implies that the soil is capable of supplying cations to the plants. The effects of goat manure (GM) and poultry (PM) on growth of groundnuts at 8 weeks after planting are presented in Table 2. From the results, goat manure had no significant effects (p>0.05) on the number of branches and number of days to 50% flowering. However, plant height and number of leaves increased with successive increases in goat manure rates applied (p≤0.05). At 10 t ha^{-1} GM application, plant height and number of leaves were significantly higher (p≤0.05) than what was observed of these variables at 5 t ha^{-1} which was in turn significantly higher than the occurrence at control (10 > 5 > 0 t ha^{-1}). Poultry manure had non-significant effects (p>0.05) on the phenology of groundnut in the study. The effects of interaction were significant for plant height and number of leaves only (Table 2). During the period under consideration, combination of poultry and goat manure at 10 t ha^{-1} each resulted in the tallest plants (25.33), which were significantly taller (p≤0.05) than groundnut plants when poultry manure at zero t ha^{-1} interacted with 10 t ha^{-1} of goat manure (22.16). These were in turn significantly higher (p≤0.05) than plant height at interaction between zero and 5 t ha^{-1} poultry and zero goat manure, which resulted in the shortest groundnut plants (19.23 and 19.57) cm respectively. As for number of leaves, PM_0GM_{10} gave the highest number of leaves (54.40) followed by $PM_{10}GM_{10}$ and PM_5GM_5 (50.70 and 50.60) respectively. The lowest record of number of leaves occurred with the interactions of zero PM and GM (40.20).

Table 3 reflects the effects of GM and PM on yield aspects of groundnuts at 8 weeks after planting. The effects of goat manure were significant (p≤0.05) among number of pods, the shelling percentage, pod and seed yield t ha^{-1} only. Other yield variables were not significantly affected by the application of goat manure. The highest number of pods per plant (17.21), were recorded from plants treated with goat manure at 5 t ha^{-1}, statistically similar (p>0.05) to number of pods at 10 t ha^{-1} but significantly higher than number of pods at the control (0 t ha^{-1} GM). Shelling percentage at 5 and 0 t ha^{-1} were statistically similar (26.84 and 27.60 %) which were significantly lower ($p \leq 0.05$) than shelling percentage at 10 t ha^{-1} (34.55 %). Pod yield (4.19 t ha^{-1}) and seed yield (2.57 t ha^{-1}) were significantly higher ($p \leq 0.05$) at the 10 t ha^{-1} than that recorded from control but statistically similar to yields at 5 t ha^{-1} of goat manure.

Effects of poultry manure were significant only for number of pods, number of filled pods and shelling percentage. Other yield variables were not significantly affected by the application of poultry manure. The number of pods from 10 t ha^{-1} PM was significantly higher ($p \leq 0.05$) than number of pods at 5 t ha^{-1} PM and 0 t ha^{-1} PM respectively. Increase in rates of poultry manure from 0 – 10 t ha^{-1} resulted in significant increases in number of pods per plant and the shelling percentage. The interactions between goat manure and poultry manure were however not significant ($p>0.05$).

The combination of poultry and goat manure at the highest rates at 10 t ha^{-1}each, may have resulted in improved soil chemical conditions, paving way for the supply of essential nutrients such as P and N, crucial for improved plant performance in a general sense. This has been similarly reported by Mbatha *et al*. (2021) that combined application of goat and poultry manure increased the nutrient content in *Sesame*. An increased nutrient profile could translate to improved growth in plants and perhaps yield, all other factors being equal. According to Attarde (2012) the application of organic fertilizers significantly increased the growth and yield variables of okra, which was due to the high level of increased soil nutrients made available for the crop. In the same way, an enhanced nutrient profile could easily translate into a bumper harvest. Folorunso (1999) also reported positive effects on yield and nutrient contents of Amaranths and okra from the application of organic fertilizer as compared with the performance from the untreated control plots.

As an individual or single treatment, goat manure had a significant effect on the pod and seed yields but not poultry manure. Due to its physical appearance and pellety nature, goat manure appeared to have a longer lasting effect of nutrient release on the groundnut plants than poultry manure. The positive interaction effects are indicative of the great synergy that existed between poultry manure and goat manure, which presented a more enhanced growth situation from treated plots.

Conclusion

The synergy of goat and poultry manure had beneficial effects on the pod and seed yields of groundnut in the study. Plant height and number of leaves were also positively influenced by co-application of poultry and goat manure as were number of pods per plant and the shelling percentage. The single application of goat manure alone at the 5 and 10 t ha^{-1} recorded the highest yields of groundnut. However interaction of 10 t ha^{-1} of poultry and goat manure gave the tallest plants, highest number of pods (17.50) and shelling percentage (41.50 %) for groundnuts in the study. The 10 t ha^{-1} GM in combination with zero poultry manure recorded the highest number of leaves in the study. The application of 5 t ha^{-1} of goat manure is hereby recommended for groundnut production in the study area.

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