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Effects of Poultry Manure on Cotton Cultivation

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INTRODUCTION

Cotton is the engine of economic development in several countries. Cotton cultivation has brought about significant changes in national economies by creating means of subsistence for farmers and business through the organization of producers, trade, employment, transport, education, health (Traoré *et al.*, 2021; Soumaré *et al.*, 2020). However, the sustainability of cotton-based production systems is often debated because of their effects on soils and the negative impacts of chemicals used on the environment and human health (Soumaré *et al.*, 2020). Thus, support projects for the agro-ecological transition and the creation of departments in charge of the environment within cotton companies show the need and the desire to transform current production systems towards more ecological systems: reduction of the use of chemical inputs, promotion of agro-ecology and organic farming and diversification and use of organic products in conventional farming. Indeed, recent research shows that soils are degrading; one of the causes of which is the excessive use of chemical inputs. Excessive dependence on agro-chemicals is one of the main obstacles to the sustainable development of cotton (Traoré *et al.*, 2021). It has been observed that soils that have been repeatedly exploited for cotton cultivation for several decades using chemical inputs are characterized by a sharp drop in fertility and in most cases have turned acidic (Bacye *et al.*, 2019; Soremi *et al.*, 2017).

Degraded soils threaten productivity. Continuous use of chemical inputs further aggravates the crisis. Therefore, efforts are made with a view to ensure that nutrient management becomes effective and efficient using ecological inputs (Soremi *et al.*, 2017) so that soil health can be rejuvenated. It is in this perspective that the development of organic cotton appears as a sustainable alternative. Sustainable principles recommend fertilization of crops using organic manure and to practice biological control against diseases and insect pests. The contributions of poultry manure as an efficient alternative to chemical fertilizers in the cultivation of cotton are many-fold ranging from positive effects on yield, soil health and crop health.

EFFECT ON SOIL HEALTH

The use of poultry manure in crop production is recommended as it enhances the stability of soil structure; improves soil organic matter status, nutrients availability thereby resulting in high crop yields (Adeleye *et al.*, 2019). Poultry manure application improves soil physical properties, reduces soil bulk density, temperature and increases total porosity and soil moisture retention capacity. Poultry manure is an excellent agricultural input in general. Poultry manure was found to induce immediate positive effects on plants when applied in sufficient doses. Studies show that the combined supply of poultry manure with chemical fertilizers reduces nutrient losses and increases the efficiency of nitrogen (Jan, 2018). It is reported, for example in west part of Burkina Faso, poultry manure is an important fertilizer and constitutes about 35.72% of the production of organic manure which caters to the crop nutrient requirements in nearly 4.50% of the total cultivated areas (Gomgnimbou *et al.*, 2019).

Figure-1. Poultry

NUTRIENT SOURCE

Poultry manure is rich in nitrogen, phosphorus and potassium which constitute the major nutrients that are essential for crop growth including cotton. Broiler litter is not just a good source of N, P and K for cotton cultivation, but also supplies secondary and micro nutrients such as Fe, Cu, and Mn in full and Zn (Tewolde *et al.*, 2005). Incorporation of poultry litter into the surface soil enhances its retention capacity of nutrients and carbon sequestration over non incorporation, indicating losses of nutrients without incorporation (Adeli *et al.*, 2008). Application of litter at the higher rate exceeded cotton nutrient utilization as evidenced by increasing soil nitrate (NO_3) and accumulation of P, K, Cu, and Zn in the top 5 cm of the soil.

EFFECTS OF POULTRY MANURE ON SOIL pH

Soils turn acidic, largely due to previous production practices, specifically, due to application of nitrogen fertilizers (Sharry, 2019). Amelioration of soil acidity may be required to maximize profitability of cotton production in some conditions. Lime is commonly used as an amendment to remediate acidic soils.

Application of poultry manure for several years on a cotton farm maintains the soil pH in a stable manner (Reddy *et al.*, 2008). In fact, application of poultry manure increases the content of calcium hydroxide in soils to raise the pH. Farm experiments in Nigeria showed that poultry manure application increased soil pH from 6.1 to 7.17 when applied a rate of 10 t ha^{-1} (Soremi *et al.*, 2018).

Similar results were reported from experiments conducted in Burkina Faso using repeated application of poultry droppings (Gomgnimbou *et al.*, 2019) wherein an increase in the pH from 3.95 to 5.72 was recorded.

Table 1 **:** Some chemical properties of the poultry manure (Soremi et al., 2017).

Parameter	Value	Parameter	Value
Nitrogen	23.6g kg^{-1}	Iron	70 g kg^{-1}
Phosphorus	14.9 g kg^{-1}	Sulphur	5.7 g kg^{-1}
Potassium	14.2 g kg^{-1}	Zinc	53.50 mg kg^{-1}
Calcium	4.3 g kg^{-1}	Organic carbon	128.4 g kg^{-1}
Magnesium	1.8 g kg^{-1}	C/N	5.44

Cotton crop is relatively tolerant to changes in pH above or below 7.0 to an extent. However, the best yields are obtained when the soil pH is between 5.5 and 7.5. Consequently, it is recommended to avoid cultivating cotton in acidic soils with pH less than 5.5.

Work from Georgia by showed that. In studies conducted in Georgia, when soil pH was increased through lime application, cotton yield like other crops increased significantly (Gascho and Parker, 2001; Sharry, 2019).

In addition, the soil pH has an influence on cotton lint yield and fibre properties. Generally, lint quality is best when pH is greater than 6.0.

EFFECTS ON EXCHANGEABLE CALCIUM, POTASSIUM AND MAGNESIUM

Poultry droppings improve the cation exchange capacity of soils and constitute a good amendment (Bambara, 2017, Gomgnimbou *et al.*, 2019). Poultry manure is a good source of nutrients and exchangeable cations. It has been estimated that 1 ton of dry droppings contains 30.5 kg of nitrogen and 20 kg of potassium. Studies showed that poultry droppings at a dose of 10 t/ha improved the exchangeable Ca in soils to reach a value of 3.90 cmol/kg with higher concentrations of Ca, K and Mg compared to the control (Soremi *et al.*, 2017). It also, improves soil organic matter, total N, available P, and exchangeable Mg, Ca and K. Application of poultry manure also increased nutrient uptake, growth and yields significantly. Residual effects of poultry manure, and combined application of reduced quantities of poultry manure and NPK fertilizer gave higher soil organic matter, N, P, K, Ca, Mg and micro-elements contents compared to application of 300 kg/ha NPK 15-15-15 fertilizer (Adeniyan and Ojeniyi, 2003).

IMPACT ON NEMATODES

Studies showed that chicken droppings had a negative effect on the population density of the lance nematode *Hoplolaimus columbus*, that damages cotton plants (Koenning *et al.*, 2003). However, for a better control, 13t to 21t/ha of poultry manure was recommended to be applied in mid-season. Poultry litter application in cotton farm was found to reduce the effect of the root knot nematode *Meloidogyne incognita* (Riegel and Noe, 2000). *Meloidogyne incognita* reduces plant dry weight, root weight, leaf area, boll number, and boll dry weight (Lu *et al.*, 2014). Poultry manure not only contributes to reduction in nematode populations, but also helps in better crop growth of cotton by supplying essential nutrients and micronutrients.

EFFECT ON SOIL FUNGI

Studies conducted in China showed that application of poultry manure resulted in an increase of fungal populations (Huang *et al.*, 2006; Pratt and Tewolde, 2009). Poultry manure when used alone is not known to have any deleterious effects on soil fungi populations. Observations show that when poultry manure is used as a fertilizer for commercial cotton production, soil fungal population levels may increase over time due to enhanced soil fertility and better plant growth.

EFFECTS ON COTTON PRODUCTIVITY

Cotton yield was found to be positively correlated with manure application rate up to a maximum application of 13.4 t/ha; beyond this dose, the correlation becomes negative (Koenning *et al.*, 2003).

When poultry manure is applied, about 75% of N and almost 100% of P and K contained in poultry droppings are available to plants during the year of their application (Islam *et*

al., 2014). Other studies have shown more beneficial effects when poultry manure application is associated with chemical fertilizers in cotton cultivation. Studies using poultry manure as fertilizer showed an increase in yields of cotton and maize compared to application of mineral fertilizers such as Nitrogen (N), Phosphorus (P) and Potassium (K). However, the effects on yields were more pronounced when poultry droppings were combined with chemical fertilizers (Gomgnimbou *et al.*, 2019; Reddy *et al.*, 2007).

Integrated nutrient management studies show that if poultry manure is applied in a proportion where 30 to 40% of nitrogen is provided by the manure and the rest comes from urea it was possible to produce around 3.48 tons of seed-cotton per hectare compared to 3.5 tons when the nitrogen requirement was supplied by urea alone (Islam *et al.*, 2014).

Studies showed that composting fresh poultry litter (FPL) to make composted poultry litter (CPL) did not improve its impact on cotton growth or yield (Reddy *et al.*, 2007) as per observations wherein FPL produced the highest mean lint yield over a five-year period (1492 kg ha-1) compared with CPL (1392 kg ha-1) and urea (1391 kg ha-1).

CONCLUSION

Poultry manure can enrich soil health by improving structure, remediating acidity, providing macro and micronutrients, improving carbon sequestration, and increasing productivity of cotton and other crops. Its use in cotton cultivation can effectively replace or supplement mineral fertilizers. Poultry manure helps to control harmful nematodes, such as *Meloidogyne incognita* but improves soil fungal populations.

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