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THE IMPACT OF NITROGEN ON MAIZE PRODUCTIVITY USING POULTRY MANURE IN RURAL LIBERIA: A CASE STUDY IN GRAND KRU COUNTY

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Abstract— this review focuses on optimizing nitrogen application in a crucial way from organic source for maximizing Zea mays productivities and ensuring efficient use of nitrogen resources to protect the environment and water bodies.

The application of nitrogen related sources; for instance, farm yard manure (FYM) like PM can influence yield of maize and also affect the height of plant, numbers of row per crop, number of grains per row, yield grain and harvest index significantly. Increase in nitrogen application can increase the soil productivity and crop nutrient use efficiency and it plays critical role in photosynthesis and other biological processes in maize. Positive impact on maize productivity is attributed to its influence on plant growth, grain yield and nitrogen use efficiency. However, little or no research has been conducted on the nitrogen impact on maize productivity and the efficient use of nitrogen sources in crop production in Liberia.

Keywords: Maize, Nitrogen, poultry manure, organic fertilizers, productivity

I. INTRODUCTION

Maize (*Zea mays* L) is a very essential cereal crop and it provides staple food to the human, and serves as feed for animals in the poultry industries. Maize has its origin from Central America and Mexico and it belongs to the Poaceae tribe and the Poaceae family with over 32,000 genes. Maize is highly consumed and as a staple food in the United States (USDA, 2022). According to the United States Department of Agriculture in 2023 ranking for maize production, America is the world largest producing country of maize with 382,654,000 metric tons followed by China 277,000,000, Brazil 129,000,000, India 34,300,000 and Liberia with the least production rate of 24,406 metric tons. United States Department of Agriculture in 2022 also showed that South Africa is the largest maize producing country in Africa, producing 414,735 tons. Liberia statistics have shown that

Nimba County produce 46% of the Country total corn production, Lofa 34% and Bong 9%, Grand Kru 0.7% and others 10.3% constituting the total of total production maize (USDA: GoL. MoA, 2022).

Maize cereal also serves as nutritional food source for infant. It is a comparatively a short duration crop that can be cultivated twice a year, both during the dry and rainy season. Maize grain contained approximately 72% starch, 10% oil, 8.5% fiber, 3% sugar and 1.7% ashes. Maize is a multifunctional plant in diet for most farm families, animals and poultry feed and its use for a diverse purposes in the industry as well as starch, dextrose, syrup, and cornflakes (Gul et al, 2021).

Liberian farmers use the grain and silage of maize for animals feed and sweet corn and grain maize are also used for human consumption. Different varieties of maize are produced in the agro ecological zones in Liberia and maize is consumption as a standard dish. However, due to limited production, Liberia had to import an estimated 15,500mt of maize grain in 2015, mainly from neighboring Guinea and Cote D'Ivoire (FAO/WFP.2015.Crop and food Security assessment). Many Liberian farmers are small producers using the traditional methods of production (moa.govt, Liberia maize production, 2022). In Liberia, maize is one of the standard dishes consumed by farmers and families. It is used as feed for poultry and is produced in a variety of agro ecological zones in Liberia. However, there is no much research conducted on the method and agronomical practices of its production which cause limited production (FAO/WFP.2015.Crop and food Security assessment).

The soil in Liberia is mostly Oxisol and Udisols constituting 47% arable land with very acidic pH ranging from 3-5 which make available plant nutrients in the deficient and make the cultivation very difficult (Pan et al.2019). Despite the substantial use of fertilizer application by Liberian farmers, crop yield is not increasingly corresponding and it reflects low or poor fertilizer use efficiency (FUE).

Poultry manure (PM) contained the average of 3.03%N: 2.63% P₂O₅ and 1.4% K₂O nutrient content and it's an excellent organic fertilizer. PM improves soil structure,

nutrient content, water retention of the soil and soil moisture holding capacity (Deksissa et al. 2018). The application of PM readily supplies Phosphorus to plant then other organic manure sources (Garg and Bahla 2008). Currently, there is an increasing demand of farm yard manure to reduce the effect of chemical fertilizer in the soil and the environment and PM is recommended as substitute for chemical fertilizer due to its importance to supply NPK in a reasonable quantity. The increase of nitrogen application can lead to accumulation in maize plant to heat unit for the tasseling, silking and physiological maturity of the crop and increase the plant ears, leaf area, height and biomass of the yield. However, decrease in N will result to decrease in the following as well (Amanullah et al. 2009). Research also shown that cultivating maize at high density with 50% higher N rate or the ratio of 180kg/ha then the optimum growing rate of 120kg/ha in a 4-5 will increase the leaf area and plant high; the biological yield and maize crop production will also increase (Amanullah et al. 2009). The uninterrupted application of synthesis fertilizer reduce the farmer's income and require a large amount energy and the possible solution is the use of PM during an organic farming (Prabu et al. 2003). Lemaire et al. (1997) showed in their research that under appropriate condition, nitrogen is the greatest element in the increase of maize yield. The growth of maize plant and grain yield can be influenced by the availability of nitrogen and can be control by the proper application of nitrogen source. The application of nitrogen on maize can increase the rate of germination and improve crop elongation and yield (Keskin et al. 2005; Siddiqui et al. 2006).

II. WORLD MAIZE PRODUCTION STATISTIC

No	Country	Production (metric ton)
1	America	382, 654,000
2	China	24,406
3	Brazil	129,000,000
4	India	34,300,000
5	Liberia	24,406

USADA, 2022

Local Maize Production (Liberia)

No.	County	Production (%)
1	Nimba	46
2	Lofa	34
3	Bong	9
4	Grand Kru	0.7
5	Others	10.3

Gol.MOA, 2022

III. EXPERIMENT AND RESULT

Problem Affecting Maize Production in Liberia

Liberia has Oxisol and Utisols soil within the humid agro-ecological zone, making the soil physical property good for plant growth but with a low nutrient content and poor chemical fertility and low nutrient retention (FAO/WFP/GOL.MOA.2015). The low quality of the soil productivity is a constituent factor limiting the production of maize. Poultry manure is an organic source of fertilizer and it improves soil quality and productivity and does not require a high level education of farmers for application. In 2010 and 2011, LISGIS report indicates that 117,120 persons are raising poultry making Poultry manure readily available and affordable for farmers.

Nutrient Requirement

Maize is grown for it commercial and nutritional purpose, whether for grain or feed, maize have had a high nutrient demand; especially Nitrogen (N), Phosphorus (P) and Potassium (K) while the demand for micro nutrients varies on soil types. Aluminum toxicity affect plant growth, leading to stunted growth and impairment of plant growth and the application of PM during maize production provide the average of 3.03%N, 2.63%P₂O₅ and 1.4%K₂O. Poultry manure (PM) contained the average of 3.03%N: 2.63% P₂O₅ and 1.4% K₂O nutrient content and it's an excellent organic fertilizer. PM improves soil structure, nutrient content, water retention of the soil and soil moisture holding capacity (Deksissa et al. 2008). The application of PM readily supplies Phosphorus to plant then other organic manure sources (Garg and Bahla 2008).

Nitrogen Maize Relation

Nitrogen has so many functions in the soil and plant metabolism. Nitrogen also plays a key role in different metabolic pathways in the plant. It constitutes molecules such as ATP, NADH, NADAH, storage proteins, nucleic acids and enzymes (Harper, 1994). Other research also showed that nitrogen application affects maize development and productivity and corn silage and grain quality is affected (Basi et al. 2011). The rate at which nitrogen is applied can influenced can increase the number of ears of plant, weight of plant and mass of the seed.

Nitrogen in the Soil

Nitrogen in the soil is in the form of ammonium (NH₄⁺ and nitrate NO₃⁻) and is a major driver of changes in the soil pH and predominantly, Poultry manure are Uric and Urea and provide 60 -70% nitrogen in the soil. Depending on the way the manure is prepared, stored and treated can affect the amount of ammonia provided to cropland around 50 to 90% (Alexander,M. 1977).



Key Recommendation to Help Enhance Farmers Productivity

- 1. Adaptation to local soil needs:** For Liberia's acidic soils, organic nitrogen sources like poultry ca help buffer the pH levels while enhancing soil structure, moisture retention, and improving microbial activity. This is particularly crucial in nutrients poor Oxisols and Ultisols soil commonly found in Liberia.
- 2. Provision of Subsidies and Training:** To improve farmers productivities, government need to subsidize farmers with incentives and also provide training programs for maize farmers. Subsidies will reduce input cost for seeds, fertilizers and technology allowing farmers to adopt better practices and mechanization which increases efficiency and yield. To empower farmers, they need training in adopting modern techniques in resources management, diesel control and climate adaptability, further improving crop quality and resilience.
- 3. Use of Poultry Manure as an Organic Fertilizer:** Over use of synthetic fertilizers can lower farmers income and denigrate soil health. Poultry manure is highly effective due to its nutrients content, particularly about in nitrogen (3.03%), phosphorus (2.63% P₂O₅) and potassium (1.4% K₂O). transitioning to organic options such as poultry manure to reduce the environmental impacts while providing essential nutrients to crop

The Commercial uses of Maize

The cultivated of maize can be dated back to the 1990s in Liberia for its grain purposes and one of the most productive crop species for with a global average yield of more than four (4) tonnes per hectare (moa.govt, Liberia maize production, 2022).

Maize products are directly consumed as food at various development stages ranging baby corn as vegetables to mature corn as grain and are widely use in Liberia for it feed importance in the poultry industry. Maize has a worldwide economics value and can serve as a source of starch and food ingredient in its native form or chemically modified. Maize starch can be fermented into alcohol and ethanol. The paper industry is also the biggest nonfood user of maize starch; oil and protein are often of commercial value as byproducts of starch.

IV.CONCLUSION

The application of nitrogen in the field affects not only the soil but yield of the crop under cultivation and crop growth and yield of maize is highly influence by nitrogen and it is very essential to explore its impact on yield of maize production and in Liberia, maize yield potential has not been judiciously exploited because of many factors and the supply of nutrient inappropriately is the major factor.

Series of research reviewed have many gaps that need to be investigated, there is no or little research conducted on maize

production and the impact of nitrogen on maize yield in Liberia and absolutely no research have been conducted on nitrogen impact on maize yield in the state of Liberia, particularly in Grand Kru county which makes it more important and pressing need for this research. Various researches also show a positive result on various growth parameters and yield of maize using nitrogen but did not considered the source of the element.

Therefore, it is critical to study the optimizing of nitrogen application in a crucial way from organic source for maximizing maize yield and ensuring efficient use of nitrogen resources to protect the environment, water bodies and sustainable use of the soil.

This research will explore the impact of nitrogen on maize productivity considering the geographical location of Grand Kru in terms of the soil quality and potential hydrogen concentration (pH) and all other growth parameters and grain factor.

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