

**EFFECT OF NITROGENOUS SOIL AMMENDMENTS ON SOIL
PHYSICO-CHEMICAL PROPERTIES AND PERFORMANCE OF
CASTORBEAN PLANT (*Ricinus communis*) IN RIVERS STATE, NIGERIA**

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ABSTRACT

The castor bean seed when cooked and fermented, is a staple food condiment in Nigeria, but its production is low in the humid rainforest zone of Southern Nigeria. A field experiment was conducted in the Rivers State University Teaching and Research Farm in Port Harcourt Nigeria, to evaluate the effect of various nitrogenous soil amendments on the growth and yield of castor bean plant (*Ricinus communis*). The treatments included 120kgNha⁻¹ equivalent of urea, NPK 20-10-10, poultry droppings, piggery dung and no amendment (control). These were replicated thrice and laid out in randomized complete block design. A Chinese improved variety of castor bean plant (Zibocastor No 5) was planted at a spacing of 1m x 1m within and between row, at a population of 5,000 seeds per hectare. Results showed that the various nitrogenous soil amendments significantly affected all growth and yield parameters measured, but germination was negatively affected. Piggery dung gave the best values of 52.6cm, 24.0, 85.0cm², 191.5, and 350gplant⁻¹ for plant height, number of leaves, leaf area, number of capsules and capsule weight respectively, when compared to the control with 24.5, 8.0, 40.0cm², 28.4, 153gplant⁻¹. Results of the physico-chemical properties of the soil showed significant increase in total nitrogen and available phosphorus, and a decrease in exchangeable calcium and magnesium with no significant changes in pH; following soil amendment and cropping. Amending the soil with piggery dung increased yield by 397.0% over the control.

Keywords: Castor bean, Soil, Nitrogenous amendments

1. INTRODUCTION

The castor bean plant (*Ricinus communisi*) is a specie of flowering plants in the spurge family: Euphorbiaceae (Weiss, 2000). Castor is indigenous to the southeastern Mediterranean basin, east African and India, but it is widespread throughout the tropical region (Orji and Eke 2018).

This crop is cultivated for its seeds, which contain up to 45% of fast-drying natural oil rich in ricinoleic acid used mainly in medicines and industry (Hussein et al., 2015). It is reported to be nutritious and high in protein, lipid and calcium contents (Obizoba and Atu, 1993). In Nigeria, castor bean oil is widely used to induce labour in pregnant women. When cooked and fermented, it is also used as a staple food condiment (ogiri) for soups and traditional dishes (Obizoba and Atu, 1993). This high yielding and short duration crop with its wide range of uses and global demand has become a cash crop in modern agriculture. Studies on its adaptability in different soils have been done in a number of countries (Orji and Eke 2018 and Mabuza and Mabuza 2019). Previous studies have also reported significant increase in growth and yield with addition of nitrogenous fertilizers. (Reddy and Matcha 2010; Mabuza and Mabuza 2019). In the humid rainforest region of Rivers State Nigeria, castor bean production is still low with little information on its production. The aim of this study was to evaluate the effect of various nitrogenous fertilizers on the performance of the castor bean plant and soil properties.

2. MATERIALS AND METHODS

The experiment was conducted at the Teaching and Research Farm of the Rivers State University of Science and Technology, Port Harcourt, with a mean annual rainfall ranging between 3000 and 4000 mm (Okonkwo, 2010) and average annual temperature of about 23⁰C.

The castor bean seed used for the experiment was a Chinese improved variety of castor bean called the Zibo Castor No5; a middle maturing hybrid variety bred by Zibo Academy of Agricultural Sciences (Chinese Hybrid Castor). The nitrogenous soil amendments used were Urea and NPK 20:10:10 which were procured from the Rivers State Agricultural Development Programme. Poultry droppings and piggery dung were obtained from the Teaching and Research Farm of the Rivers State University Nigeria.

Based on the percentage of nitrogen in the nitrogenous fertilizers, the treatments consisted of 120kgNha⁻¹ equivalent of Urea, NPK 20:10:10, piggery dung, poultry droppings and then a control with no nitrogenous amendment. The treatments were replicated thrice and laid out in a randomized complete block design (RCBD). The plots were manually cleared and ridged; to provide for a good soil tilth. The castor bean seeds were planted one seed per hole at a depth of 3cm into the soil and at a spacing of 1m x 1m within and between rows. This gave a total plant population of 5,000 seeds per hectare. Between ridges was 2m spacing. Missing stands were supplied at 2 weeks after planting (WAP). Plots were kept weed free by hoeing and handpicking at 2,4 and 6WAP. The various sources of nitrogenous fertilizers were applied wholly at 2WAP; using the band placement method at a 20cm radius from the plant.

Surface soil samples (0-15cm depth) were collected randomly from the experimental site before treatment application and from the various plots after harvest. The soil samples were air-dried

and sieved with a 2mm mesh size sieve and subjected to routine analysis as described by Page *et al.* (1982). Organic matter was determined by the wet dichromate oxidation method (Nelson and Sommers, 1982), total nitrogen by the micro kjeldahl method, (Bremner and Mulvaney,1982), available Phosphorus by Bray-1 extraction followed by molybdenum blue-colorimetry, exchangeable cations (calcium, magnesium and potassium) were extracted with ammonium acetate (Thomas, 1982).

The following growth and yield parameters were estimated from 50% of the stands planted on each plot: percentage germination of seeds, plant height and number of leaves, leaf area and yield (number and weight of capsules). Data collected were subjected to analysis of variance for an RCBD and means were separated using the Least Significant Difference.

3. RESULTS AND DISCUSSION

3.1 Effect of Nitrogenous Amendments on Soil Properties

The physico-chemical properties of the test soil before treatment application is as shown on Table 1. The sandy loam soil is acidic and low in organic matter content, and exchangeable cations. These conditions are typical of the Ultisols of Southern Nigeria; given their acid parent material (Lal, 1986).

Table1: Properties of The Soil of The Experimental Site Before Treatment Application

Property	Value
pH (H ₂ O)	5.20
Organic Carbon (%)	0.97
Organic matter (%)	1.67
Total Nitrogen (%)	0.21
Exchangeable acidity (cmolkg ⁻¹)	1.52
Exchangeable cations (cmolkg ⁻¹)	
✓ Ca ²⁺	13.20
✓ Mg ²⁺	1.30
Available P (mgkg ⁻¹)	27.25
% sand	73.3
% Silt	4.0

%Clay	22.7
Texture	Sandy loam

The soil properties as affected by the nitrogenous amendments is as shown on Table 2. Particle size distribution and texture were not affected by the amendments. This is not unexpected as the percentage of sand, silt and clay fractions of soil, are not likely to be affected by addition of fertilizers within a short period of time.

Soil pH was generally not affected by the various treatments. Exchangeable acidity was observed to be significantly lower in soils amended with inorganic sources of nitrogen; which includes urea and NPK 20-10-10 with values ranging between 1.22 to 1.42 cmolkg^{-1} when compared with soils treated with the organic sources including poultry manure and piggery dung which has the same values with the untreated soil of 1.54 cmolkg^{-1} . Calcium and magnesium contents of the soils were also not affected by the various nitrogenous amendments; except for the soil treated with the piggery dung where calcium content was significantly reduced to 8.8 cmolkg^{-1} when compared with the control of 12.2 cmolkg^{-1} .

Organic matter contents were significantly lower in urea treated soils when compared with all the other treatments. The generally low organic matter contents across all the treatments may have been as a result of the very low carbon:nitrogen (C/N) ratio ranging between 1.3 to 5.6; even with the amendments.

The total percentage nitrogen contents were significantly increased in all the amended soils; with urea amended soils having a percentage nitrogen content of 0.84% when compared with the unamended soil of 0.28%. Urea being a single nitrogen fertilizer with a high percentage of nitrogen content may have contributed to this trend. Available phosphorus was significantly enhanced by the nitrogenous amendments; particularly with the NPK 20-10-10 fertilizer and the piggery dung. The available P values were 43.85 and 35.08 mgkg^{-1} for NPK 20-10-10 and piggery dung respectively, when compared with the control of 29.81 mgkg^{-1} .

Table 2: Soil Properties as Affected by Nitrogenous soil amendments after harvest

Properties	← Treatments →				
	Urea	Poultry Droppings	Piggery Dung	NPK 20:10:10	Control
pH (H ₂ O)	5.70	5.10	5.50	5.10	5.40
Organic Carbon (%)	1.05	1.66	1.56	1.60	1.56
Organic matter (%)	1.81	2.86	2.69	2.76	2.69
Total Nitrogen (%)	0.84	0.56	0.28	0.56	0.28
C/N Ratio	1.3	3.0	5.6	2.9	5.6
Exchangeable acidity (cmolkg ⁻¹)	1.42	1.54	1.54	1.22	1.54
Exchangeable cations (cmolkg ⁻¹)					
Ca ²⁺	12.7	12.4	8.8	13.1	12.2
Mg ²⁺	1.10	1.60	1.00	0.40	0.70
Available P (mgkg ⁻¹)	29.81	29.81	35.08	43.85	29.81
% sand	83.2	87.2	85.2	83.2	87.2
% Silt	8.0	4.0	4.0	4.0	4.0
% Clay	8.8	8.8	1.08	12.8	8.8
Texture	Sandy loam	Sandy loam	Sandy loam	Sandy loam	Sandy loam

3.2 Effect of Nitrogenous Amendments on Growth and Yield of Castor Bean

Germination for all treatments was observed to be between 6 to 10 days after planting (Fig. 1). The soil amendments negatively affected germination, with only the control having 100% germination, and all the others 70%. This may have been due to the acidic nature of the soil amendments used.

There were significant differences among treatments with respect to plant heights, at both the 6 and 8 weeks after planting (WAP). Plant height at 8WAP was in the order 52.6 > 39.7 > 37.3 > 24.5 > 17.4 cm for piggery dung, poultry droppings, NPK 20-10-10, control and urea

respectively (Fig.2). Results showed that only urea amended soils depressed plant heights. There are similar findings on the effect of urea on plant parameters (Makinde et. al., 2011, Amin 2011, Hozhbryn 2013).

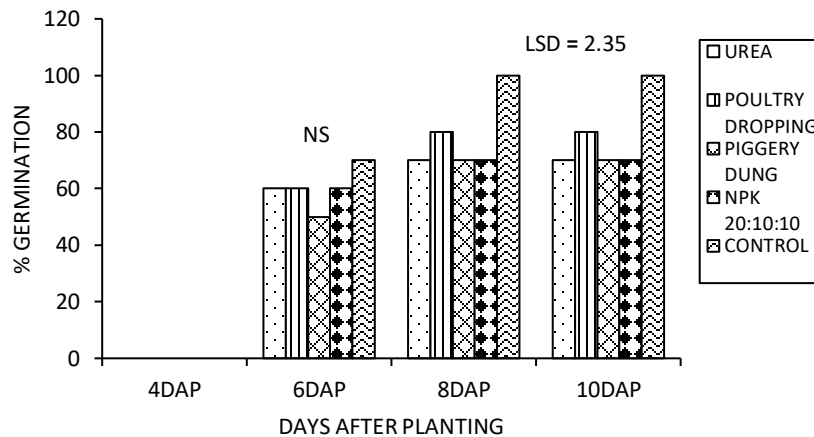


Fig. 1: Effect Of Various Nitrogen Sources On Percentage Germination

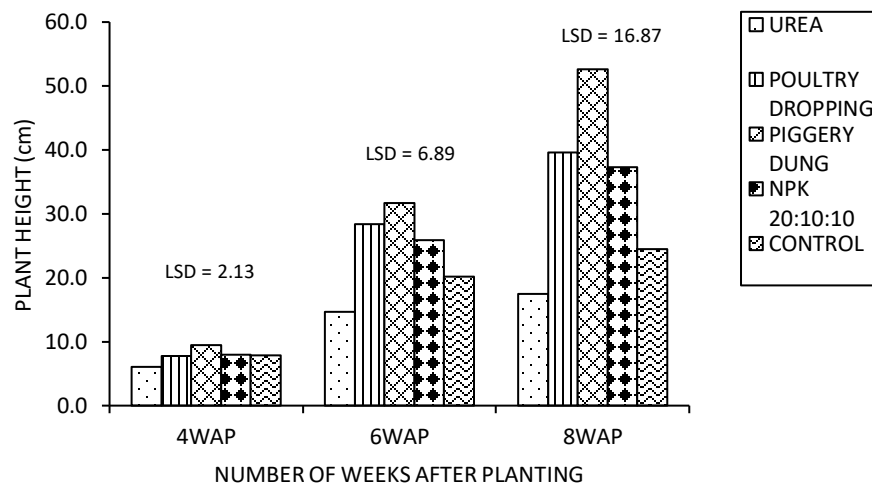


Fig. 2: Effect Of Various Nitrogen Sources On Plant Height

The trend was the same with number of leaves (Fig. 3) and leaf area (Fig. 4). Urea appears to harm seeds and seedlings and may be better used before seed or transplanting or after the plant grows larger. This is in addition, to the fact that it tends to lower soil pH and therefore affect

other nutrient availability. Piggery dung amended soils had number of leaves (15.7) and leaf area (296.7cm²) values significantly higher than the control, with 8.0 and 162.7cm² for number of leaves and leaf area respectively.

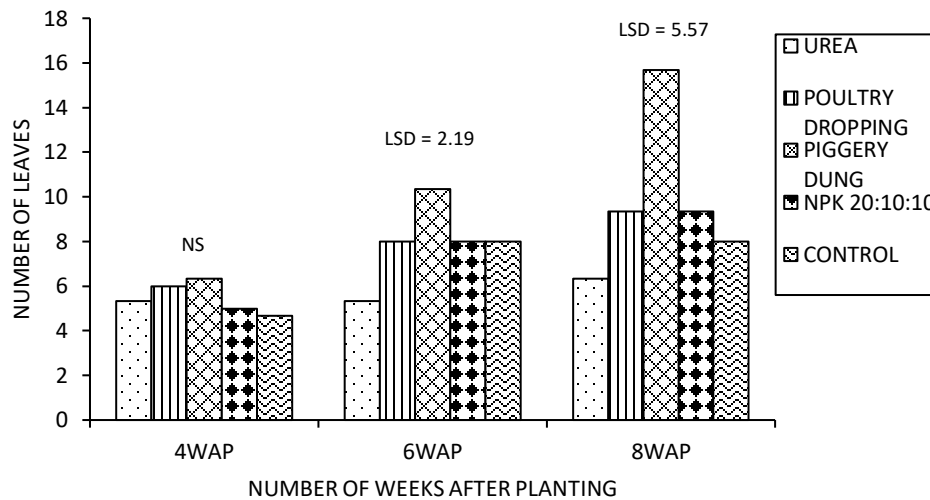


Fig. 3: Effect Of Various Nitrogen Sources on Number Of Leaves

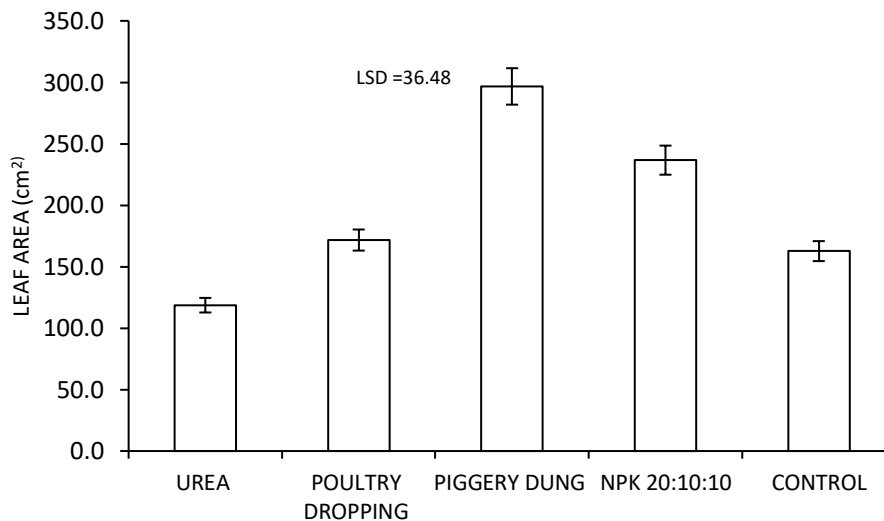


Fig. 4: Effect Of Various Nitrogen Sources On Leaf Area

Piggery dung and NPK 20-10-10 significantly increased both number of capsules and weight of capsules per plant, when compared with the control (Figs. 5 and 6). The number of capsules was in the order: 96.3 > 88.3 > 40.0 > 19.0 > 18.0 capsules per plant for NPK 20-10-10, piggery dung, control, poultry droppings and urea respectively. For the capsule weights, it was in the order 141.0 > 78.9 > 28.4 > 12.8 > 11.5 gplant⁻¹ for piggery dung, NPK 20-10-10, control, poultry droppings and urea respectively. This may be as a result of the higher available phosphorus contents in these when compared with the other treatments. Phosphorus is an essential nutrient element for grain filling in plants. It is also reported in previous works that piggery dung contains more available phosphorus than poultry droppings (Buckley and Markortff, 2004).

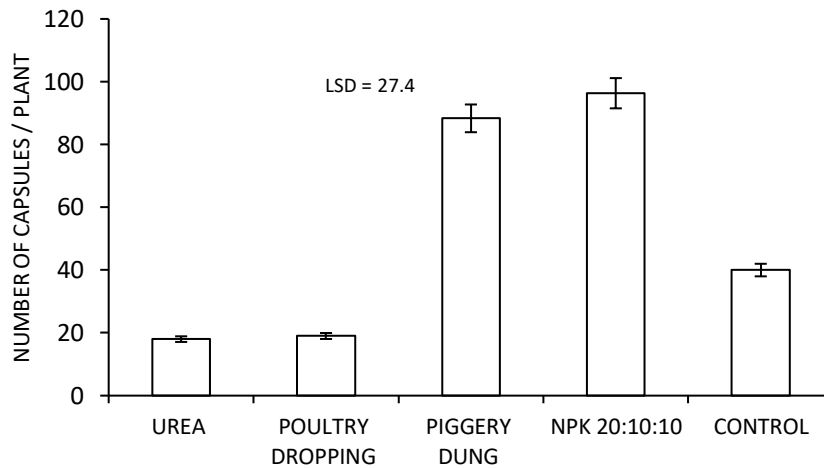


Fig. 5: Effect Of Various Nitrogen Sources On Number Of Capsules Per Plant

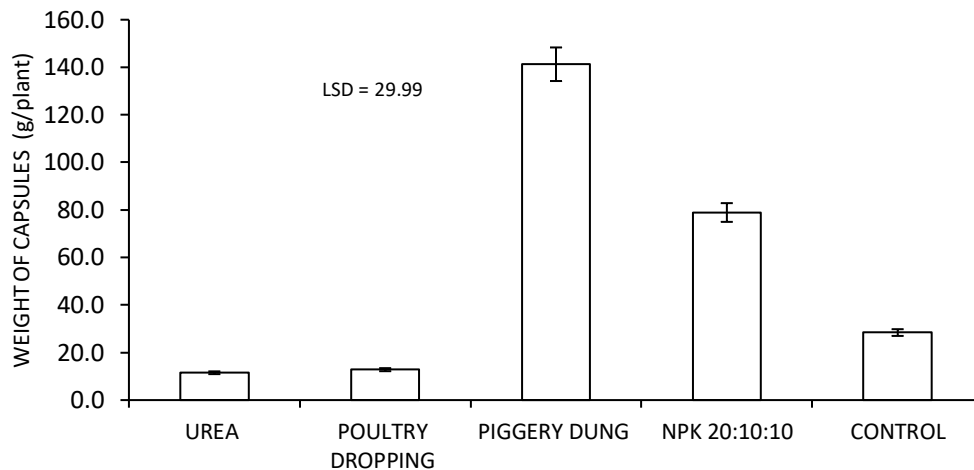


Fig. 6: EFFECT OF VARIOUS NITROGEN SOURCES ON WEIGHT OF CAPSULES (G/Plant)

4. CONCLUSION

The findings of this work show that amending the soil with materials that will supply copious available nitrogen and phosphorus, like the piggery dung and NPK 20-10-10, will increase the yield of castor bean plant by over 100%. However, given that the piggery dung, in addition to higher yields, is more soil environmental friendly when compared with NPK 20-10-10 it is recommended for better castor bean production.

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