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Evaluation of Rabbit Urine as Bio-fertilizer for the Growth and Yield of Cowpea (*Vigna unguiculata* (l.) walp)

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ABSTRACT

Rabbit urine, a bio-fertilizer can be used alone or in combination with inorganic fertilizer, organic or green manure to improve the growth and yield of crops. Trials were conducted at the Teaching and Research Farm of the Akwa Ibom State University, Obio Akpa campus, during the 2021 and 2022 second cropping seasons, to evaluate the effects of rabbit urine on the growth and yield of cowpea in the humid tropical region of South Eastern Nigeria. The experiment consisted of three varieties of cowpea (Sampea-7, Funam L2 and Ife brown), and five fertilizer application rates (0, NPK 200kg/ha, NPK 200kg/ha+250mls of rabbit urine (Ru), NPK 200kg/ha+500mls of Ru, NPK 200kg/ha+75mls of Ru) (designated as T1, T2, T3, T4 and T5 respectively). The experiment was a 3x5 factorial, laid out in a randomized complete block design, and replicated three times. Results indicated significant differences in growth and yield parameters. Among the cowpea varieties; Ife brown performed better than Funam L2 and Sampea-7; it produced the longest vines (28.96cm), the broadest leaves (2218cm2) and the highest grain yield (698.23kg/ha). The fertilizer rates also had significant positive effects on the growth and yield traits of cowpea; as the concentration of Ru in the mixture increased, growth and yield values also increased, with T5((NPK 200kg/ha +750mls of Ru) producing the best yield (708.89kg/ha). There were significant interaction effects between the cowpea varieties and fertilizer application rates; when T5(NPK 200kg/ha +750 mls of Ru.) was applied to Ife brown, it produced the highest number of seeds/pod (7.65), the highest number of pods/plant (19.81) and the highest dry grains yield (749.62kg/ha). Ife brown and NPK 200kg/ha + 750mls of Ru (T5) were therefore recommended to farmers in the study area.

Keywords: Rabbit urine, NPK fertilizer, Cowpea

1.0 Introduction

Cowpea is an annual grain legume grown mainly in semi-arid regions of the tropics. In Nigeria, it is the most important grain legume, valued for its protein-rich grains which are consumed in soup or as porridge and cakes (Ano & Agwu, 2005). When incorporated into the soil, it supplies nitrogen through atmospheric nitrogen fixation. The protein-rich vines and the leaves are fed to farm animals. Cowpea contributes to soil fertility improvement in the tropics, particularly in smallholder farming systems where little or no fertilizers are used (Akpan et al., 2022). Efforts have been made in recent times to integrate cowpea cultivation, especially the dwarf, short-duration varieties, into the farming systems of the forest zone of South Eastern Nigeria. The difficulties experienced in this regard, however, include the high incidence of pests and diseases, and the declining productivity of the tropical acid soils (Ekwere et al., 2019; Ibia et al., 1997). Onyebule et al. (2012) attributed the incidence of soil acidity in the humid tropics to the excessive loss of basic cations to leaching on account of high and intensive rainfall, and the application of acid-forming fertilizers. Acid soils are generally characterized by mineral deficiency, nutrient imbalance and aluminum toxicity (Ekwere et al., 2018; FAO, 2004). Trace elements such as magnesium required for good growth, nodulation and nitrogen fixation in cowpeas become unavailable at pH values above 7 (Kamprath, 1980). However, the introduction of cowpeas to the traditional farming systems of South Eastern Nigeria would, not only add nitrogen but greatly improve the organic matter contents of the soil and increase microbial activities (O'Sullinvan & Ernest, 2003).

Rabbit urine is widely accepted as liquid manure and bio-pesticide (Arowogbola et al., 2022; Indabo & Abubakar, 2022). It is rich in nitrogen because the major food preference of rabbits is forage and as they drink little water, their urine is highly concentrated and rich in nutrients such as nitrogen (2.36%), phosphorous (2.11%) and potassium (3.56%) (Atia et al., 2005). A rabbit can produce 100mls of urine at a time. Its urine contains high proportions of ammonia and other nitrogenous gases which are by-products of protein digestion. It is non-toxic, environmentally friendly, and can be cheaply sourced from rabbit farmers in every community in sufficient volumes (Arowogbola et al., 2022). Rabbit urine, therefore, may be a suitable alternative to chemical fertilizers, especially in homestead gardens, since it poses minimal risks to the ecosystem and requires no further treatments before application (Indabo & Abubakar, 2022).

This study was conducted to evaluate the effects of rabbit urine application as a bio-fertilizer on the growth and yield of cowpeas grown on intensely cultivated ultisols of South Eastern Nigeria.

2.0 Materials and Methods

The experiment was conducted at the Teaching and Research Farm of the Faculty of Agriculture, Akwa Ibom State University, Obio Akpa Campus, between September, 2021 and December, 2022. Obio Akpa is located between Latitude 4°31′N and 5°31′N, Longitude 8°30′E and 8°00′E, in the tropical rain forest zone of South Eastern Nigeria. It records annual rainfall of about 2500 mm, usually with a short break in August (August break) that may last two weeks. The temperature range is between 23.5°C – 30.7°C. The Relative humidity is about 79% (SLUS-AK, 1989). The experiment was a 3x5 factorial, laid out in a randomized complete block design. It consisted of three varieties of cowpea (Sampea-7, Funam L2 and Ife brown), and five fertilizer application rates; T1, T2, T3, T4 andT5 representing (0, NPK 200kg/ha, NPK 200kg/ha+250mls of rabbit urine (Ru), NPK 200kg/ha+500mls of Ru, NPK 200kg/ha+750mls of Ru) respectively. The rabbit urine was obtained from the Rabbitry Unit of the Department of Animal Science, Akwa Ibom State University. It was collected with the aid of a corrugated iron plate placed under the mesh floor of the two-tier hutches, and the urine was directed through a trough and collected in plastic buckets. The buckets were emptied every morning, and the contents were filtered and stored in air-tight plastic containers until needed. All the fertilizer materials were applied basally, two weeks before sowing the cowpea seeds. Each experimental unit measured 2.0 x 3.0m and was separated by paths measuring 1.0m wide, while the replicates were separated by alleys measuring 1.5m wide. The total experimental area was 504m^2 (36 x 14m). The seeds were sown at 25 x 75cm (two seeds per hole). It was later thinned to one seedling per stand, to give a plant population of 53,333 plants ha^{-1}. Weeding was carried out at 3 and 7 weeks after sowing (WAS). Five stands of cowpeas from the inner rows were randomly selected from each experimental unit and tagged for data collection. Data were collected on the following parameters; vine length, number of vines plant^{-1}, leaf area., number of pods plant^{-1}, number of seeds pod^{-1}, weight of 100 seeds and dry grain yield (kg/ha). Data collected were subjected to analysis of variance using IBM SPSS statistic software, version 23. Treatment means were separated using the least significant difference (LSD) at 5% probability.

2.1 Soil analysis

Soil samples (0-15 cm) were collected, air-dried, sieved and subjected to analysis. Particle size distribution was determined by the Bouyoucos hydrometer method (Bouyoucos, G. J., 1962). Soil pH was measured electronically in 1:1.5 soil-water suspension (Mclean, 1982). Soil organic matter was determined by the Walkley-Black wet oxidation method (Black, 1965). Phosphorous was determined by the Bray P-1 method (Olsen &Sommers, 1982). Exchangeable cations (K, Ca. and Mg) were extracted in 1M NH4OAC at pH 7. K and Na were determined on the Flame spectrometer, while Ca and Mg were determined on the Atomic absorption spectrophotometer. Effective cation exchange capacity (ECEC) was obtained by the summation of the exchangeable bases and the exchangeable acidity (Udoh et al., 2009).

Percentage base saturation was calculated as follows:

$$\text{Percentage base saturation} = \frac{Exchangeable\ bases}{ECEC} X \frac{100}{1}$$

Equation *2.1*

3.0 Results and Discussion

Results of the soil physical and chemical analysis at the commencement of the experiment (Table 3.2) showed that the soil was acidic (pH 5.10). The Organic matter contents of the soil were 0.86%, nitrogen-0.13 cmolkg^{-1} and potassium-0.137 cmolkg^{-1}. Results also indicated that the nutrient levels were generally low compared to the recommended values for soils in the ecological zone. Results further showed that the cowpea varieties indicated significant differences in vine production (Table 3.3); Ife brown produced the longest vines (28.96 cm) in 2021 and in 2022 Ife brown and Funam L2 were among the highest (24.40 and 23.8cm), while Sampea-7 produced the shortest vines (25.57cm in 2021 and 20.33cm in 2022). The fertilizer materials had significant positive effects on the vine length of cowpea; the vine length increased as the concentration of rabbit urine in the mixture increased. The longest vines (29.36 cm) were, however, produced in 2021 when NPK 200kg/ha was added to 750mls of Ru (T5). This was closely followed by 28.16cm long vines produced at NPK 200kg/ha+500mls of Ru (T4). The shortest vines (24.97cm) were however produced on the control plots which received no fertilizer treatments. The trend was similar in 2021 except that comparatively shorter vines were produced that year. There were significant interactive effects of the fertilizer materials and cowpea varieties on the vine length of cowpea (Table 3.4); the longest vines (31.22 cm) were produced in 2021 when fertilizer NPK 200kg/ha + 750mls of Ru (T5) were applied to Ife brown. This, however, was not significantly different from 29.87cm long vines produced by the same variety when NPK200kg/ha was combined with 500mls of rabbit urine (i.e.$Var^3 + T^4$).

The shortest vines (22.99 cm) were produced on Sampea- 7 that received no fertilizer. In 2022, the longest vines (25.77cm and 25.43cm) were however produced on Ife brown at NPK 200 kg/ha + 500mls of Ru ($Var^3 + T^4$) and NPK200 kg/ha + 700mls of Ru. There were significant differences among the cowpea varieties in yield and yield attributes (Table 3.5). Ife brown consistently produced the best results; It had the highest number of seeds /pod (6 in 2021, and 7 in 2022), the highest number of pods per plant (18 in 2021 and 2022), and the highest grain yield (698.23 kg/ha in 2021, and 627.27 kg/ha in 2022). Sampea-7 was the least productive among the three cultivars on all the growth and yield parameters considered in the experiment.

The fertilizer application rates had significant effects on the yield and yield attributes of cowpea; NPK 200 kg/ha + 750mls of Ru consistently produced the best results; It produced the highest number of seeds/pod (5.90 in 2021 and 7.30 in 2022) and the highest dry grain yield (708.89 kg/ha in 2021, and 645.79 kg/ha in 2022). There were significant interaction effects of the fertilizer materials and the cowpea varieties on the yield and yield attributes of cowpea (Table 3.6). When NPK 200kg/ha + 750 mls of Ru was applied to Ife brown, it produced the highest number of seeds/pod (7.22) in 2021 while in 2022 NPK 200kg/ha + 750 mls of Ru and NPK 200kg/ha + 500 mls of Ru were the highest. In 2022, the highest dry grain yields (698.28 kg/ha) were also produced on Ife brown when treated with NPK 200 kg/ha + 750 mls of Ru. In 2021 however, the highest number of pods/plant (18.38, and 18.06) were produced on Ife brown when treated with NPK 200kg/ha+ 500mls of Ru and NPK 200kg/ha + 750 mls of Ru. NPK 200kg/ha + 500 mls of Ru fertilizer application rate also produced the highest dry grain yields (873.70kg/ha).

Table 3.1: Nutrient composition of Rabbit urine

Nutrient	Values
pH	8.50
Nitrogen (%)	2.36
Phosphorous(%)	2.11
Potassium (%)	3.56
Sulphur (%)	1.26
Calcium (%)	3.55

Table 3.2: Soil physical and chemical properties (0-15cm) at planting

Soil properties	Mean values
Sand (%)	82.14
Silt (%)	4.11
Clay (%)	13.75
Soil pH	5.10
Organic matter (%)	0.86
Nitrogen (%)	0.13
Phosphorous ($mgkg^{-1}$)	52.26
Calcium($cmolkg^{-1}$)	4.53
Magnesium ($cmolkg^{-1}$)	0.85
Potassium ($cmolkg^{-1}$)	0.137
Sodium ($cmolkg^{-1}$)	0.006
Aluminum ($cmolkg^{-1}$)	0.32
Base saturation (%)	84.73

Table 3.3: Effects of NPK fertilizer and rabbit urine mixture on shoot emergence and growth attributes of cowpea

	2021					2022				
Treatment	**Emergence (%)**	**Vine length (cm)**		**Number of vines**	**Leaf area (cm)**	**Emergence (%)**	**Vine length (cm^2)**		**Number of vines**	**Leaf area(cm)**
Cowpea varieties		**6WAS**	**8WAS**	**8WAS**	**8WAS**		**6WAS**	**8WAS**	**8WAS**	**8WAS**
Var^1	90.53	20.65	25.57	10.76	2110	92.45	17.62	20.33	10.76	2201
Var^2	92.93	21.29	27.01	10.97	2210	90.60	18.99	23.80	10.97	2218
Var^3	90.73	22.17	28.96	11.44	2218	92.27	19.10	24.40	11.44	2272
$LSD_{0.05}$	1.81	0.46	0.73	0.29	NS	1.63	0.41	0.65	0.29	NS
Rabbit Urine +										
NPK Fertilizer										
T^1	90.78	19.86	24.97	10.72	1184	90.44	17.86	21.00	10.72	954
T^2	91.22	20.89	26.27	11.06	1186	91.11	18.12	21.96	11.06	962
T^3	90.67	21.68	27.15	10.96	1190	92.56	18.68	23.14	10.96	956
T^4	91.22	21.95	28.16	11.07	1483	90.78	19.05	23.66	11.07	1144
T^5	93.11	22.48	29.36	11.46	1705	94.00	19.13	24.43	11.46	1196
$LSD_{0.05}$	1.88	1.33	0.69	0.30	448	1.60	0.46	0.89	0.30	136

Key: Var.[1] = Sampea-7, Var.[2] = Funam L_2, Var.[3]= Ife brown, T^1 = Control , T^2 = NPK 200kg/ha T^3 = NPK 200kg/ha + 250mls of Ru, T^4 = NPK 200kg/ha + 500mls of Ru, T^5 = NPK 200kg/ha + 750mls of Ru. Ru = Rabbit urine., WAS=weeks after sowing.

Table 3.4: Interactive effects of NPK fertilizer and rabbit urine mixture on emergence and vine length of cowpea

	2021					2022				
Treatments	**Emergence (%)**	**Vine length (cm) 6WAS**	**8WAS**	**Nos. of vines**	**Leaf area (cm^2)**	**Emergence (%)**	**Vine length (cm) 6WAS**	**8WAS**	**Nos. of vines**	**Leaf area (cm^2)**
$Var^1 + T^1$	93.00	18.93	22.99	10.89	1564	91.67	17.34	19.02	10.54	1667
$Var^1 + T^2$	87.00	20.21	24.14	11.10	1728	91.14	16.69	19.75	11.73	1833
$Var^1 + T^3$	91.67	21.14	25.56	10.05	1953	92.61	18.45	20.78	12.56	1998
$Var^1 + T^4$	87.00	21.05	26.77	10.40	2151	94.00	17.96	20.67	12.52	2136
$Var^1 + T^5$	94.00	21.90	28.13	11.35	2149	92.33	17.64	21.40	12.96	2186
$Var^2 + T^1$	92.32	19.65	25.30	10.34	1684	87.45	18.17	21.26	11.94	1194
$Var^2 + T^2$	95.00	20.99	26.18	10.90	2092	91.32	18.84	23.00	12.75	1733
$Var^2 + T^3$	92.00	21.33	26.93	10.98	2116	90.06	19.07	24.38	12.87	1745
$Var^2 + T^4$	94.33	22.04	27.82	11.20	2166	89.14	19.13	24.53	13.15	1957
$Var^2 + T^5$	91.00	22.41	28.76	11.41	2175	94.23	19.76	25.86	13.36	2149
$Var^3 + T^1$	87.00	20.99	26.62	10.93	1485	92.67	18.08	22.71	12.46	1370
$Var^3 + T^2$	91.67	21.45	28.18	11.19	1843	90.33	18.85	23.12	12.72	1582
$Var^3 + T^3$	88.31	22.58	28.91	1184	1919	94,00	18.52	24.25	13.28	1626
$Var^3 + T^4$	92.23	22.75	29.87	11.62	2177	89.01	20.06	25.77	13.08	1839
$Var^3 + T^5$	94.35	23.08	31.22	11.61	2194	95.33	20.01	25.43	13.66	2257
$LSD_{0.05}$	1.72	0.24	0.32	0.27	443	1.62	0.34	0.37	0.33	136

Key: $Var.^1$ = Sampea-7, $Var.^2$ = Funam L_2 , $Var.^3$= Ife brown, T^1 = Control , T^2 = NPK 200kg/ha T^3 = NPK 200kg/ha + 250mls of Ru, T^4 = NPK 200kg/ha + 500mls of Ru, T^5 = NPK 200kg/ha + 750mls of Ru. Ru = Rabbit urine, WAS=weeks after sowing.

Table 3.5: Effects of NPK fertilizer and rabbit urine mixture on yield and yield attributes of cowpea

	2021				2022			
Treatment	**Nos. of seeds/pod**	**Nos. of pods/plant**	**Weight of 100 seeds (g)**	**Dry grain yield (kg/ha)**	**Nos. of seeds/pod**	**Nos. of pods/plant**	**Weight of 100 seeds (g)**	**Dry grain yield (kg/ha)**
Cowpea varieties								
Var^1	4.21	14.25	69.52	545.41	5.86	17.66	64.83	532.97
Var^2	4.62	16.57	67.61	550.19	6.32	16.92	65.28	598.89
Var^3	6.02	17.72	70.96	698.23	6.69	18.20	65.32	627.27
$LSD_{0.05}$	0.37	0.80	1.38	42.36	0.36	0.66	1.97	23.54
Rabbit Urine + NPK Fertilizer								
T^1	4.20	15.20	67.21	502.78	5.52	15.82	61.01	535.79
T^2	4.35	16.03	67.77	553.90	5.87	16.69	62.72	554.84
T^3	4.97	15.98	69.29	586.97	6.20	17.76	64.16	586.72
T^4	5.33	16.54	69.93	637.18	6.56	18.36	67.97	608.75
T^5	5.90	17.16	72.60	708.89	7.30	19.33	70.52	645.79
$LSD_{0.05}$	0.14	1.00	1.29	43.52	0.28	0.43	1.28	24.03

Key: $Var.^1$ = Sampea-7, $Var.^2$ = Funam L_2, $Var.^3$ = Ife brown, T^1 = Control , T^2 = NPK 200kg/ha , T^3 = NPK 200kg/ha + 250mls of Ru, T^4 = NPK 200kg/ha + 500mls of Ru, T^5 = NPK 200kg/ha + 750mls of Ru. Ru = Rabbit urine

Table 3.6: Interactive effects of NPK fertilizer and rabbit urine mixture on yield and yield attributes of cowpea

				2021				2022
Treatments	**Nos. of seeds/pod**	**Nos. of pods/plant**	**Weight of 100 seeds(g)**	**Dry grain yield (kg/ha)**	**Nos. of seeds/pod**	**Nos. of pods/plant**	**Weight of 100 seeds(g)**	**Dry grain yield (kg/ha)**
$Var^1 + T^1$	3.62	13.60	68.44	467.95	4.78	15.79	60.61	465.30
$Var^1 + T^2$	3.54	14,15	68.12	499.88	5.45	16.87	62.27	504.91
$Var^1 + T^3$	4.13	14.03	69.59	531.91	5.88	17.81	63.02	522.47
$Var^1 + T^4$	4.70	14.55	70.35	597.28	6.11	18.32	68.40	583.68
$Var^1 + T^5$	5.04	14.93	71.09	630.01	7.06	19.50	70.34	588.49
$Var^2 + T^1$	3.94	15.41	65.28	484.67	5.57	15.68	62.11	558.42
$Var^2 + T^2$	4.25	16.24	66.43	532.21	5.83	16.03	62.45	571.51
$Var^2 + T^3$	4.58	16.02	66.82	546.46	6.40	16.59	64.82	600.15
$Var^2 + T^4$	4.87	16.69	68.21	564.63	6.63	17.61	68.45	613.79
$Var^2 + T^5$	5.44	18.49	71.29	622.97	7.18	18.68	70.09	650.59
$Var^3 + T^1$	5.03	16.59	67.91	555.71	6.22	16.00	60.31	583.65
$Var^3 + T^2$	5.25	17.71	68.77	629.60	6.32	17.18	63.43	588.09
$Var^3 + T^3$	6.19	17.88	71.45	682.53	6.34	18.87	64.65	637.53
$Var^3 + T^4$	6.41	18.38	71.23	873.70	6.94	19.18	67.08	628.79
$Var^3 + T^5$	7.22	18.06	75.42	749.62	7.65	19.81	71.14	698.28
$LSD_{0.05}$	0.28	0.36	0.38	30.81	1.44	0.42	1.25	30.21

Key: $Var.^1$ = Sampea-7, $Var.^2$ = Funam L_2, $Var.^3$= Ife brown, T^1 = Control , T^2 = NPK 200kg/ha T^3 = NPK 200kg/ha + 250mls of Ru, T^4 = NPK 200kg/ha + 500mls of Ru, T^5 = NPK 200kg/ha + 750mls of Ru. Ru = Rabbit urine.

The low levels of organic matter and total nitrogen recorded in the experimental site show that the soil fertility status was low, and highly acidic as reported by (Efretuei et al., 2023; Ekwere & Efretuei, 2021; Ibia et al., 1997). Umoh et al. (2023) stated that the coastal soils of southeastern Nigeria are poorly buffered, and rapidly lose fertility on intense cultivation. The planting of cover crops such as cowpea and melon are acceptable soil remediation measures, besides being weed and erosion control measures. Cowpea is capable of improving soil fertility by fixing atmospheric nitrogen through its root nodules. Its foliage also protects the soil from direct sunshine and raindrops, thus preventing erosion and encouraging microbial activities (Ekwere et al., 2013). Rabbit urine is an efficient and effective liquid fertilizer that can either be used alone or in combination with organic and/or inorganic fertilizers (Arowogbola et al., 2022). It is reputed to contain high levels of nitrogen (2.36%). Nitrogen is a characteristic constituent element of protein and hence the protoplasm of all living cells. It promotes cell division and enhances the accumulation of dry matter in leaves and other vegetative parts of the plant. The results of this experiment indicated that rabbit urine had significant beneficial effects on all the growth and yield parameters of cowpeas. This result agrees with Indabo and Abubakar (2022) who found significant improvement in the morphological and yield parameters of tomatoes due to treatments containing rabbit urine. Similarly, Okoro-Robinson et al. (2013) reported a significant increase in all the growth and reproductive components of *Telfairiaoccidentalis* due to the application of nitrogen fertilizer. Results on yield and growth parameters suggest there are no differences in the application of NPK 200kg/ha + 500mls of Ru (T4) and NPK200kg/ha + 750mls of Ru (T5).

4.0 Conclusion and Recommendation

In this experiment, there were positive beneficial effects of rabbit urine on the growth and grain yield of cowpea. The grain yield of cowpeas increased significantly with an increase in the rate of rabbit urine application. The best yields however were obtained when Ife brown was treated with NPK 200kg/ha + 750mls Rabbit urine. This application mixture is recommended to farmers in the study area.

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