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HIGHER COWPEA (*Vigna unguiculate L. Walp.*) PRODUCTION: USING SOIL TYPE SERIES AND IMPROVE CULTIVARS

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ABSTRACT: Study was conducted at Department of Soil Science Technology, Oyo State College of Agriculture and Technology, Igboora, during 2023 and 2024 cropping season to determine the influence of cultivars and different soil type on the growth and yield of cowpea (Vigna unguiculate). Four improved cowpea cultivars (JT89KQ 358-288, IT89KD-394 and IT97K-498-395 and IT97K-499-35) were obtained as a single batch from Agro-Permier store at Mokola Area, Ibadan, Oyo State, Nigeria, while the local cowpea cultivar (Danlla) was sourced from collaborated farmers at Ibarapa. Four improved cowpea cultivars and one local cultivar (Danlla) were cultivate on four different soil type series RSS1 (loamy sand), RSS2 (loamy fine sand), RSS3 (fine sand) and RSS4 (fine sand) on 6th of August 2023. The same experiment was repeated in the year 2024. The result showed that significant difference ($P<0.005$) existed among the improved varieties on growth characters measured. The percentage increase of grain yield of the improved cultivars JT89KQ 358-288, IT89KD-394 and IT97K-498-395 over local variety were 33.70%, 35.10% and 27.64% respectively. IT97K-499-35 and IT89KQ-288 cultivars performed best on RSS1 followed by RSS2 soil series. On the other hand, IT98KQ-288 performed optimally on RSS3 soil series. Based on the data from the study

JT89KQ-288 Cultivars is recommended to be planted on sand loam or fine loam soil series by farmers in derived savanna agro-ecological zone at which the study station represents.

Keywords: *Agro-ecological zone, Cultivar, Soil series, IT97K-498-395, cultivate*

Introduction

Cowpea (*Vigna unguiculata* L. Walp.) is one of the most important leguminous crops in the world, belonging to the family Fabaceae and subfamily Faboideae. It is believed to have originated in West and Southern Africa and is now widely distributed in East and Central Africa, India, Asia, and South and Central America. It is extensively cultivated in the lowlands and mid-altitude regions of Africa, particularly in the dry savanna. Cowpea is grown both as a sole crop and more often intercropped with cereals such as maize, sorghum, and millet. According to the Food and Agriculture Organization (FAO, 2017), global cowpea production is about 5.6 million metric tonnes, covering 12.6 million hectares. Africa produces 95.3% of the world's total cowpea output, followed by Asia (2.8%), the Americas (1.3%), and Europe (0.6%). The leading African producers are Nigeria, Niger, and Burkina Faso.

Among legumes, cowpea is one of the most widely grown, traded, and consumed (Philips & McWalters, 1991; Agbogidi, 2010), owing to its high nutritional value and role in human and livestock diets. It is a major staple in African and Asian diets, contributing significantly to protein intake for rural and urban households. Agbogidi (2010) describes cowpea as the "poor man's major source of protein." Cowpea grains contain high levels of protein, carbohydrates, vitamins, and fibre (Hall, 2012). Its amino acid profile complements that of cereals (Fashakin & Ojo, 1988; Fashakin & Fasanya, 1988). Minerals such as calcium and iron are more abundant in cowpea than in milk, while vitamin content—thiamine, riboflavin, and niacin—is comparable to lean meat and fish (Platt, 1962; Rachie, 1985; Achuba, 2006). Daily consumption of 100–135 g of dry beans has been shown to reduce serum cholesterol by up to 20%, lowering the risk of coronary heart disease by about 40% (Anderson, 1985; Ofuya, 1993).

Cowpea is consumed in various forms—as leafy vegetables, fresh pods, or dry grains. For resource-poor farmers who depend heavily on starchy staples such as millet, sorghum, maize, and cassava, cowpea offers an affordable protein source and potential to combat malnutrition (Ddungu et al., 2015). Like many legumes, cowpea forms a symbiotic relationship with *Rhizobium* bacteria present in tropical soils, enabling biological nitrogen fixation through the nitrogenase enzyme complex (Mulongoy, 1985). High phosphorus availability is essential for optimal nodule development (Barrett, 1980), while acidic, aluminium-rich soils and manganese toxicity can reduce nodulation (Applebaum, 1990). Cowpea contributes to soil fertility improvement, weed suppression, and sustainable cropping systems, thriving in poor soils with low nitrogen levels. Its deep root system, efficient water use, and early maturity confer drought tolerance (Gomez, 2004). However, it is sensitive to excessive moisture and poorly drained soils (Valenzuela & Smith, 2002). It can be grown under rainfed conditions or irrigated environments, including residual moisture in floodplains.

Optimal growth occurs at temperatures between 28–30 °C and annual rainfall of 500–1,200 mm (Duke, 1981). It is cultivated from the dry savannas to the Sahel, with some varieties tolerating rainfall as low as 300 mm annually (Boukar et al., 2018). Global cowpea production averages 6.99 million tonnes from 12.31 million hectares (FAOSTAT, 2016). In sub-Saharan Africa, farmer yields often range from 50–600 kg/ha, far below the potential yield of over 2,000 kg/ha (Boukar et al., 2018). Low productivity is linked to unimproved varieties, inadequate inputs, drought, and poor agronomic practices (Lydia et al., 2022). Additional constraints include biotic factors such has insect pests, fungal, viral, and bacterial diseases, parasitic weeds, and lack of quality seed. Abiotic factors like low soil fertility, drought, high temperatures, and salinity (Haggag, 2015).

Noteworthy, drought and high temperatures are critical climate change-related stresses impacting cowpea yields (Olajide & Ilori, 2017). Although drought-tolerant, cowpea can experience yield losses of 20–50% under severe water deficit, depending on timing and duration (Bailey, 1990). Water stress reduces leaf area index, chlorophyll content, pod number, and grain yield. Adaptive strategies include shifting planting dates, adopting drought-tolerant or early-maturing varieties, and adjusting cropping systems (Owugu et al., 2018). Plant breeding programs now prioritize drought tolerance and water-use efficiency (Huynh et al., 2016; Horn et al., 2015). The crop's growth period varies between 90–240 days depending on variety and climate (Carvalho, 2017). Well-watered cowpea can yield over 1,000 kg/ha (Bastos, 2011), while Ghanaian farmers report average yields of 1.25 t/ha under field conditions (Larweh, 2019). In semi-arid regions, erratic rainfall patterns at the start and end of the growing season cause significant stress (Olajide & Ilori, 2017). Drought reduces turgor pressure and cell expansion, threatening both food security and rural livelihoods (Oladipo, 2008).

MATERIALS AND METHODS

Study Site

The experiment was carried out during the main cropping seasons (July–November) of 2023–2024 at the Teaching and Research Farm, Oyo State College of Agriculture and Technology, Igboora, Oyo State, Nigeria. Igboora lies within Ibarapa Central Local Government Area of Oyo State, located between 7°15′–7°33′ N and 3°36′–3°57′ E. The area experiences distinct wet and dry seasons. The average annual rainfall is approximately 1,278 mm, with sunshine hours ranging from about 24 hours per month in August to 7 hours per month in February. Based on prevailing climate and soil characteristics, three vegetation zones are identifiable in the area: forest, savanna, and derived savanna. The forest zone, characterized by high relative humidity, supports the cultivation of tree crops such as cocoa and citrus, as well as arable crops including cowpea, maize, millet, cassava, and yam. Igboora is situated in the derived savanna agro-ecological zone of Nigeria, where rainfall is generally adequate for about seven months (mid-March to September), followed by a dry period lasting from October to May. In recent years, rainfall distribution has become increasingly variable due to the effects of global warming. The average temperature in the area ranges from 15°C to 38°C, providing a favorable climate for a variety of crops, including cowpea.

Screen House Procedure and Soil Analysis

Four different soil series types, four improved cowpea varieties and one local variety were used.

Source of Planting Material

The four improved cultivars were purchased as a single batch from Agro Premier Store at Mokola, Ibadan, Oyo State, Nigeria. While the local cultivar (Danlla and IAR-48) were sourced from collaborated farmers in Ibarapa.

Procedure and Experimental Design

In the middle of July, six (6) large blocks dimension of 100cm x 100cm were ploughed thrice within 6 weeks and harrowed after two weeks at the six different sites soil was prepared by ridging at 0.7m spacing between ridges. The experimental layout was established using tape, pegs, cutlass, and rope. Within each ridge unit, a block measuring 24 m × 28 m was prepared. Four subunits, each measuring 17 m × 11 m, were demarcated within the block to serve as replicates for the randomized complete block design (RCBD), consisting of eight treatments (4 cultivars × 4 soil series). Individual treatment plots measured 6 m × 6 m, with a 1 m alley on all sides to minimize border effects between plots.

During the main cropping season in August, three seeds of each cowpea variety were sown by hand at a spacing of 0.75 m × 0.40 m. Thinning was conducted 10 days after emergence, leaving two plants per stand, equivalent to a planting density of 66,666 plants ha^{-1}. Weeding was carried out manually using hoes at regular intervals. Insect pests were controlled by spraying Karate 2.5 EC at two weeks after seedling emergence, followed by subsequent applications at 10-day intervals. Fertilization involved applying 20 kg N ha^{-1} and 30 kg P_2O_5 ha^{-1} to all plots in 2023, and again at the onset of the 2024 rainy season before the second planting. The experiment was conducted in two series 2023 – 2024: 2023 – 2024 based on a complete block design, four (4) replicates. Treatments consisted of a factorial combination of 4 improved cowpea varieties, 1 local cowpea varieties and 4 soil series. Growth parameters measured were plant height, branches per plant, pods per plant, seeds per plant, grain yield, and straw yield.

Pod and Yield related Parameters

Dry Grain Yield (kg ha^{-1}): One hundred (100) seeds from each treatment were weighed using a **Haus Model triple-beam balance,** and the weights were extrapolated to yield per hectare.

Number of Pods per Plant: This was determined following the method of **Egho (2009). A 1 m length** of a cowpea row was marked with stakes, and all pods and plants within the marked section were counted. The average number of pods per plant was calculated as:

$$\frac{\text{Number of Pods}}{\text{Number of Plants}} = \text{Number of pods per plant}$$

Harvesting and Processing: At physiological maturity (65–70 days after planting), pods were hand-harvested, sun-dried for **one week,** shelled, and winnowed. The dry grain yield from each plot was then weighed and recorded.

Pod load: Pod load was visually assessed in the field using a 1–9 rating scale, following the procedure of Egho (2009), where 1 indicates very low pod load and 9 indicates very high pod load.

Statistical Analysis

Data collected were subjected to Analysis of Variance (ANOVA), and significant means were separated using Duncan's Multiple Range Test (SAS, 2005). For the Randomized Complete Block Design (RCBD), significant differences among treatment means were further analyzed using Least Significant Difference (LSD) values, as described by Gomez and Gomez (1984). Regression and correlation analyses were also conducted to determine the relationships between nutrient levels and yields.

Results and Discussion

Soil Physical and Chemical Properties

The initial pre-planting soil properties of the study area are presented in Table 1. The analysis revealed that the soils (RSS1, RSS2, RSS3, RSS4, RSS5, and RSS6) were marginally fertile, being low in nitrogen content, organic matter, available phosphorus, exchangeable bases, and exchangeable cations, according to the ratings of the Federal Ministry of Agriculture and Natural Resources (FMANR, 1990). This indicates poor nutrient status and low fertility, suggesting that the use of organic manure would be beneficial. The pH values of 6.10 and 6.21 show that the soils were slightly acidic, likely due to the high rainfall in the area, which promotes nutrient leaching. The low organic matter and total nitrogen levels can be attributed to soil erosion, leaching, and bush burning, all common in the region. Similarly, the low exchangeable cation content reflects nutrient depletion. The relatively higher base saturation suggests a generally low fertility status, possibly resulting from prolonged intensive cropping without replenishing lost nutrients through fertilizer application.

Table 1: Characteristics of Different Soil Type Used for the Experiments

Soil Type	Soil Texture	pH	Total N(%)	O.C (%)	O.M (gKg^{-1})	ECEC (mol/kg)	Available P(Kg/ha)	Avialble K(Kg/ha)	Base Saturation (%)
RSS 1	Loamy sand	6.10	0.08	0.91	2.70	0.15	12.00	130	76.10
RSS 2	Fine sand	6.20	0.06	0.80	2.50	0.12	7.20	142	73.30
RSS 3	Find sand	6.21	0.05	0.70	2.50	0.17	3.00	125	70.00
RSS 4	Fine sand	6.21	0.05	0.71	2.50	0.18	2.40	142	68.40

Note: O.C = Organic Carbon; O.M = Organic Matter; ECEC = Effective Cation Exchange Capacity

The Growth and Yield of JT89KQ-288 Cultivars under Moderate Water Stress

The performance of improved cultivar (JT89KQ-288) planted on plot with loamy sand (RSS1) texture of 65.50 and 72.20% and lower silt texture of 7.40 and 8.30%

significantly ($p<0.05$) improved the length of the branches per plant from 8.35 to 9.00, pods per plant from 20.00 to 25.56; seed per plant, 8.80 to 10.25; grain yield, from 310.50 to 452.48 per hectare; straw yield was increased from 6.52 to 7.46 per hectare while the plant height of the local varieties (Danila) was higher over improve varieties (Table 2).

Data collected on crop yield and growth were consistent with the findings of previous studies, which reported that particle size distribution, pH, and exchange acidity significantly influence plant growth, productivity, and yield during the cropping season (Bado et al., 2004; Ossom & Rhykerd, 2007). In the present study, the local variety (Danila) exhibited greater plant height compared to the JT89KQ-288 cultivar. However, the JT89KQ-288 cultivar recorded significantly higher values for branches per plant, pods per plant, seeds per pod, grain yield per hectare, and straw yield per hectare than the local variety. However, straw yield which was significantly higher with local variety, might be due to more vegetable growth. The increase in seed yield due to improved variety (JT89KQ-288) was 29.91% over local variety. Variation in growth and yield of JT89KQ-288 was also observed due to soil type. Maximum seed and straw yield was recorded in RSS1 soil series followed by RSS2 soil series in both years (Table 2). The higher yield in RSS soil series was probably due to better soil fertility status. Soil fertility that has to do with soil water, nutrient, pH (soil reaction) and soil health in adequate amount/quantity.

Table 2: The Growth and Yield of JT89KQ-288 Cultivars under Moderate Water Stress

Treatment	Plant Height(cm)	Braches Plant^{-1}	Pods Plant^{-1}	Seeds Pod^{-1}	Grain Yield (qha^{-1})			Straw Yield (qha^{-1})		
					2023	2024	Mean	2023	2024	Mean
Varieties										
Local IIa-48	41.10	8.35	20.00	8.80	310.50	318.13	314.15	8.15	6.76	7.46
JT89KQ-288	35.00	9.00	25.56	10.28	452.48	469.36	460.92	7.65	5.39	6.52
LSD	3.02	2.47	3.28	1.21	0.70	0.90	0.80	1.37	1.14	1.26

(5%)										
<u>SOIL TYPE:</u>										
RSS 1	35.25	9.50	52.36	14.65	472.40	473.12	472.76	9.40	6.70	7.30
RSS 2	36.10	9.00	39.32	14.38	463.10	446.36	454.73	8.12	5.82	7.66
RSS 3	35.46	6.33	44.36	8.91	398.40	413.14	405.77	7.90	5.38	6.75
RSS 4	33.20	4.74	27.57	7.79	365.24	328.31	346.78	7.20	4.85	6.03
LSD 5%	5.90	0.80	1.37	2.32	4.13	2.15	3.14	5.10	0.28	2.69
Mean	35.00	7.32	40.90	11.43	424.79	415.23	420.01	8.16	5.69	6.93
%	14.84	12.34	100.00	29.91	36.81	30.52	33.70	6.67	5.57	6.12

Improved varieties of cowpea were shorter in height as compared to local variety, but branches plant^{-1}, Pods Plant^{-1} and Seed Pod^{-1} were higher in IT89KD-394 resulting in higher seed yield by 47.86% over local variety (Table 3). However, the straw yield was higher in local variety. The higher seed yield and yield attributes of improved variety IT89KD-394 were probably due to its genetic characteristics. On the contrary the vegetative growth was more in local variety resulting in higher straw yield. Among soil series, the IT89KD-391 production performance was maximum in RSS 1 series which was significantly higher over RSS 2, RSS 3 and RSS 4 soil series in the year 2003 and 2004.

Table 3: The growth and yield of IT89KQ-394 under Moderate Water Stress (25% Fc)

Treatment	Plant Height(cm)	Braches Plant^{-1}	Pods Plant^{-1}	Seeds Plant^{-1}	Grain Yield (qha^{-1})			Straw Yield (qha^{-1})		
					2023	2024	mean	2023	2024	Mean
<u>Varieties</u>										
Local	51.05	9.25	36.20	7.00	312.67	319.27	315.97	8.20	7.90	8.05

119-48										
IT89KD-391	42.05	12.30	43.10	7.25	453.14	465.80	459.47	7.80	7.10	7.45
LSD (5%)	0.67	0.96	1.20	3.14	4.37	4.86	4.62	0.47	0.83	0.65
SOIL TYPE:										
RSS 1	44.05	10.98	50.85	13.20	473.16	475.06	474.11	10.05	6.85	12.45
RSS 2	42.02	10.60	45.20	10.20	466.37	467.48	466.93	8.25	6.80	7.53
RSS 3	38.01	10.50	40.10	9.35	397.46	398.96	398.21	7.85	5.75	6.08
RSS 4	38.05	10.45	38.20	8.65	364.49	372.05	368.27	6.35	5.90	6.13
LSD (5%)	6.92	0.834	15.08	1.08	4.05	3.63	3.84	0.22	2.05	1.13
Mean	40.53	10.63	43.59	10.35	425.37	428.39	426.88	8.13	6.33	7.23
%	20.60	14.92	20.41	47.86	36.04	34.18	35.10	9.15	19.94	14.55

Variation in Plant growth and yield parameter of IT97K-498-395 varieties were observed. It was found that plant height was higher in the local variety but branching and number of pods were more in IT97K-498-395. The seed yield was increased by 16.67% (Table 4) due to adoption of improved varieties of IT97K-498-395 was better in RSS2, RSS3 soil compared to RSS4 soil series.

Table 4: The growth and yield of IT97KQ-498-395 under Moderate Water Stress (25% Fc)

Treatment	Plant Height(cm)	Braches Plant^{-1}	Pods Plant^{-1}	Seeds Plant^{-1}	Grain Yield (%ha^{-1})			Straw Yield (%ha^{-1})		
					2023	2024	Mean	2023	2024	Mean
Varieties										
Local 119-48	42.70	6.30	30.10	7.20	330.41	331.24	330.83	6.65	5.80	6.23
IT97K-498-35	40.30	7.10	36.40	8.05	458.42`	468.41	463.42	6.31	5.82	6.07
LSD (5%)	2.67	2.50	3.70	3.72	1.78	2.02	1.90	0.24	0.61	0.43

SOIL TYPE:										
RSS 1	41.30	8.20	42.30	9.50	471.90	472.87	472.39	6.80	5.80	6.30
RSS 2	39.10	8.00	50.00	7.25	462.34	441.38	451.86	6.75	5.75	6.25
RSS 3	39.00	7.80	45.35	7.10	396.11	298.02	397.07	6.50	5.50	6.00
RSS 4	38.60	7.70	42.30	0.14	367.36	368.15	367.76	6.25	5.35	5.80
LSD (5%)	4.00	2.100	1.73	0.58	2.76	1.84	2.30	0.25	1.11	0.68
Mean	39.50	7.93	44.99	6.00	424.43	420.11	422.27	6.58	5.60	6.09
%	74.94	25.80	49.47	16.67	28.45	26.83	27.64	1.13	3.45	2.29

Observations from this study indicate a significant interaction between soil series and cowpea varieties. This was evident from the high grain yield recorded in the cowpea cultivar **JT89KQ-288** grown on soil series **RSS1,** compared to the lower yields obtained from the same variety on RSS2, RSS3, and RSS4. Significant differences at the 5% probability level were observed among all cowpea varieties studied, with **JT89KQ-288** consistently outperforming the other varieties in all measured growth and yield parameters (Tables 2, 3, and 4). These four improved cowpea cultivars had appreciable accumulation of grain yield when compared to local varieties. The pooled data revealed that, of all soil series considered, grain and straw yield were highest in all RSS1.

Conclusion

The combined effects of soil properties significantly enhanced the performance of improved cowpea varieties in terms of growth parameters and yield, compared with the local varieties. Therefore, sandy loam (RSS1) and silt (RSS2) were recommended for higher cowpea production in the studied agro-ecological growing environment condition.

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