



ASSESSMENT OF SOME AGRONOMIC TRAITS OF COWPEA (*Vigna unguiculata* (L.) Walp.) FOR ADAPTATION IN THE WET SAVANNAH AGROECOLOGICAL IN NIGERIA

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Abstract

This study was conducted to propose an agricultural mitigation measure for hazard-prone individuals subsequent to and consequent to migration/relocation due to the effects of climate change, insurgency, and insecurity. The main objective is to prove the meaning of sustainability to the settlers. The break in the production and supply chain due to climate change and insecurity was also conceived as an objective in the study. Cowpea husbandry was identified as a crop that could be introduced with intercropping farming systems into the wet savanna ecology. Two locations (Ilorin and Iloffa) both in Kwara state, Nigeria, were selected as the experimental locations. Three cowpea varieties were tested for their adaptability to the ecological zone. Ex Borno and IT-04K-321-21460 recorded earlier flower initiation that took 60 to attain 50% flower initiation. The delay in flowering is an adaptation to excessive moisture during pod maturity. Ife Brown of cowpea was recorded to have the most susceptibility to naturally occurring nitrogen-fixing bacteria, thus yielding a significant ($p \leq 0.05$) highest nodule count of 47.63. The significant ($p \leq 0.05$) leaf area of 97.28 cm^2 recorded from cowpea is also an adaptation to control and manage assimilates efficiently between the source and sink. It was also observed that the heavy branching in Ife Brown (46.1) compensated for the small leaf area, as a result of which Ife Brown produced the significantly highest grain yield of 1173.4 kg/ha against the 1067.2 and 1067.2 kg/ha respectively, recorded for Ex Borno and IT-04K-321-2 1460. Based on the findings, Ife Brown was recommended for an intercropping farming system due to the fact that heavy branching is a good indication of adaptation to mixed cropping, especially under a taller canopy. Ife Brown was recommended for both. immigrant settlers from northern Nigeria and the native farmers of the wet savanna ecology.

Keywords: Climate change, insecurity, immigrants, cowpea, farming system, agronomic traits, intercropping system.

Introduction

Many natural and man-made disasters are responsible for human relocation through migration in Nigeria. Climate change has led to increased temperatures, erratic rainfall, and desertification, prompting rural-to-urban migration (Nenger et al. 2024). Climate change, as a consequence of global warming, is a major driving factor in environmental degradation, disrupting livelihoods and displacing communities (Rowlands and Eze, 2025). Empirically studied and showed that small-scale farmers in Nigeria's north perceive the impacts of climate change as determining the rate of human migration (Cristina & Emanuele, 2019).

The trending national insecurity (banditry, kidnapping, and general insurgency) was reported to negatively impact the cowpea production business. The insecurity has caused people's migration or relocation from northern to southern Nigeria, thus affecting not just the ordinary populace but a vast majority of cowpea and vegetable farmers (Ekpa et al., 2025; Mustapha et al., 2025; Amadasu et al., 2025; Amadasu et al., 2024)

The general insecurity has grossly crippled Nigeria's agricultural sector by disrupting transportation, forcing farm abandonment, and causing food scarcity. Attacks on rural communities and transit routes increase transport costs, reduce product availability in markets, and cause significant income losses for farmers. According to the displacement of over 200,000 individuals as reported by James (2024) has also resulted in the desertion of farmlands. Banditry has compelled numerous people to relocate. While the northern part of Nigeria remains a region of concern for insecurity, there is a disturbing disposition emerging in southern Nigeria, where insecurity is gradually encroaching. The migration of people is thus posing a new set of situations for the region, as well as a demand for a holistic approach to mitigate the emerging consequences. (Ajiboye et al., 2024; Alhaji, 2023; Alexander et al., 2022; Musa et al., 2026; Faruk, B. U., & Abdullahi, 2022).

One mitigation measure worthy of adoption to forestall the vices of climate change and the associated issues is to make provision for means of life sustainability for both the immigrants and the new host community. The present study identifies that the immigrants will need jobs and, of course, food. Enhanced agricultural productivity was thus identified as appropriate. Cowpea cultivation was considered to be very relevant based on its nutritional value, which has been extensively reported, especially its value as a food source for humans and animals (Abebe and Alemayehu 2022; Affrifah 2022). The crop (cowpea varieties) has been effectively produced on a large scale throughout tropical environments (Omoigui et al., 2023). Its adaptability makes the species a good subject for enhancing food security in climatically challenged areas since it is drought-tolerant. Cowpea can grow in all soils and can be intercropped with other crops (Abiodun et al., 2020)

Overcoming these challenges, Nigeria would be able not only to increase the production of cowpea but also to improve food security and facilitate the sustainability of agricultural production among the population (Adewale et al., 2023).

One major production limitation that is yet to be sufficiently addressed is the relationship between cowpea farming and the nutrient composition of the soils in the tropics (Hartemink 2006; Trap et al., 2024).

Native farmers have long identified that the efficiency of biological nitrogen fixation can be relied on. Based on this awareness, cowpeas without mineral fertilizer augmentation have been produced on poor soil where the vast majority of arable crops have failed. It is, however, relevant to emphasize that a complex of soil chemical conditions must favorably coincide to achieve an optimum cowpea yield if the efficiency of biological nitrogen fixation is to be dependent upon (Adewale et al., 2023).

A choice of appropriate agronomic practices, seed technology, and the interaction of the two with the environment is required to favor nodulation/gall formation and the resulting nitrogen fixation. Ogunwande (2024) stated that cowpea production technology is beyond limitations from climate, soil nutrients, and agronomic practices. The introduction and adoption of newly developed farming technology as a mitigation measure to global warming, according to Aluko et al. (2016) were also identified as challenges that were further reported as a problem in the production and supply chain.

The overall consequence of human migration and relocation calls for an investigation into farming strategies with the objective of accommodating immigrant farmers in the farming system of southern Nigeria. To achieve this objective, an attempt was made in the present study to determine and introduce cowpea varieties that would best adapt to the ecology of the wet savannah zone of Nigeria. The study also considers the choice of variety that would facilitate the incorporation of the intercropping farming system of cowpea in the wet savanna zone of Nigeria.

Materials and Methods

Description of the experimental site

Location 1: Iloffa, Oke Ero, Kwara State, Nigeria (Coordinates: 5° 8' 32" E, 8.09343, 5.14233) Climate: Tropical wet savanna. Iloffa's soil demonstrates great agricultural potential with a composition of 72% sand, 12% clay, and 16% silt. Its pH of 5.45 falls in an ideal range for many crops. While macro-nutrient levels are modest (N: 32, P: 38, K: 0.17 PPM), the organic carbon content is 0.84, enhanced by a high base saturation of 6.60, which supports nutrient retention. Location 2: Ilorin is the state capital of Kwara in Western Nigeria. (Coordinates: Latitude: 8° 29' 47.90" N, Longitude: 4° 32' 31.70" E) Ilorin soil is characterized by 75% sand, 15% clay, and 10% silt. Its slightly acidic pH of 5.2 is suitable for many crops. Macro-nutrient levels include N: 28, P: 26, and K: 0.15 PPM, with a healthy base saturation of 5.1 cmol/kg. Olaniran (2002); & Ajani and Adeniyi (2017)

The wet savannah zone of Kwara State experiences up to 101.45 millimeters (3.99 inches) of rainfall in 148.38 days annually. While the monthly mean temperature ranges from 22 °C during nighttime to 33 °C The average monthly temperature ranges from 22 °C during nighttime to 33 °C during the day (NIMET 2023).

Land preparation and cultural practices

Bush clearing began during the August break of the 2022 cropping season. We manually removed weeds and shrubs with a cutlass and cleared away rubble obstructing the farmland, preparing it for a productive growing season. The demarcation of plots was methodically carried out, creating perfect 4m x 2m sizes. Utilizing hoes, we expertly turned the soil into ideal friable seed beds. This careful preparation resulted in the establishment of 27 well-defined plots, ready for successful cultivation.

Seeds were sown at a rate of three seeds per hill, with thinning carried out seven days after sowing. A spacing of 50 cm by 20 cm was adopted to achieve a total of 105 plants per hectare. To achieve formidable pest control, tobacco leaf extract was applied using nicotine, d-limonene, pyridine, and indole with a knapsack sprayer. Three applications were performed: first at 50% blooming, second at 100% blooming, and third at the pod maturity stage. Weeds were manually removed using hoes at the 3rd and 6th weeks after sowing to reduce competition. This weeding process also helped further incorporate the manure into the soil and facilitated earthing up around the base of the plants, which were initially planted on flat ground.

Experimental design and treatment allocation

A complete randomized block design was used. Each treatment was replicated three times. The *plot consisted of three cowpea varieties: (i) IT-04K-321-2 1460 (ii) Ife Brown, and (iii) Ex Borno*. Data collection on days to 50% flowering was determined by daily observations conducted to ascertain when 50% of the cowpea plants in each plot would initiate flower formation. The number of branches (i.e., branching) was enumerated by sampling a of fifteen plants from which the counting was done. At six weeks after sowing, manually count and record the number of main branches that originated from the main stem. Nodule count was achieved using frames measuring 50 cm by 50 cm placed on each plot; any 15 plants that fit within the frame were uprooted for nodule counting. The roots of the uprooted cowpea plants were rinsed in water, and the nodules attached to the roots were counted using a hand lens to aid clarity. Leaf area was determined using the methodology described by Pati et al. (2021). The grain yield (kg^{-ha}) was determined by hand picking/manually harvesting pods when they began to turn brown and dry. The harvested pods were then sun-dried for five days until they started to shatter. Threshing was performed by beating the bags containing the pods with a stick. This was followed by winnowing to separate the chaff from the grains. The weight of the grains was measured using an electronic weighing machine.

Data Analysis

The collected information was statistically analyzed using Analysis of Variance (ANOVA) at a 95% confidence interval. Treatment means for variables that were significantly different at $P \geq 0.05$ were separated using the least significant difference (LSD) method. Pearson correlation analysis was used to establish the relationships that exist among the agronomic data.

Results

Days to 50% Flowering

The number of days taken to attain 50% flowering in cowpea was significantly ($p \leq 0.05$) reduced by varieties (Table 1). The three means are different from one another at location A; at location B, the ranking was slightly inconsistent with the results from location A. At location B, IT-04K-321-2 1460 and Ex-borno recorded no significant ($p \leq 0.05$) difference in the number of days to 50% flowering at the two locations. The bi-location ranking was 60.74, 57.23 and 57.24 respectively, for IT-04K-321-2 1460, Ex-Borno, and Ife Brown. This result is consistent with Egbe (2010), Agele & Agbi (2013), Agele et al. (2018), and Ndenkyanti et al. (2022).

The responses were attributed to various adaptations to weather, specifically photoperiod and Photoperiod Sensitivity Genes. Cowpea is a short-day plant, meaning its flowering is delayed by longer day lengths. Sensitive varieties flower later in extended daylight, while photoperiod-insensitive (day-neutral) varieties flower earlier, regardless of day length. This sensitivity trait is often partially dominant. The result is consistent with Mohammed et al. (2025), Kamara et al. (2025), Dorvlo et al. (2022).

Variations in flowering time among cowpea varieties, according to Adetayo et al. (2023) are mainly influenced by complex genetic factors involving multiple genes, a concept known as quantitative inheritance. Hamadou et al. (2025) supported that a cowpea variety flowers earlier or later than another due to the specific combination and interaction of these multiple genetic factors, which allows for adaptation to different environments and cropping seasons. Varieties possess different alleles that make them sensitive or insensitive to the length of the day (Olufajo 2012)

The timing of flowering—whether early or late—is crucial for assessing crop adaptation in varietal trials, especially when introducing plants to a new environment. In the case of the present study, the number of days taken to attain 50 % flowering being longer in Ife Brown could be an advantage in the wet savannah. The pod maturity and drying will not coincide with the period of heavy rainfall. Early flowering can be detrimental if heavy rains occur during this time, which Ishiyaku et al. (2005) explained to be capable of resulting to flower abortion due to disease complexes.

Branching

Branching in cowpea (Table1) was significantly ($p \leq 0.05$) increased by cowpea varieties from the two locations (A and B). The trend was consistent between the two locations. The mean for the bi-location branches was rated as 8.4, 8.72 and 10.39 respectively, for Ife Brown, Ex-Borno, and IT-04K-321-2 1460. The present result is consistent with Mohamed et al. (2025); Alhassan and Shaltut (2025); Isaac et al. (2018); Amina and Belel (2025).

The primary reason for the differences in cowpea growth is genetic variability among various cultivars and varieties. Research consistently shows the existence of differences in the number of branches per plant across several genotypes, even when grown under the same conditions. This implies that they inherently differ in growth, which ranges between erect, semi-erect, prostrate (trailing), and climbing

types. Prostrate or spreading varieties tend to produce more branches that cover a larger ground area; this is in contrast to erect types. Shakeel Ahmed et al. (2023)

Greater branching typically results in more leaves, which increases the leaf area and enhances photosynthetic capacity. This may account for the superior grain yield recorded from Ife Brown, which has the highest branching. According to the explanation of Banso et al. (2024), this improved branching, in turn, supports the production of more flowers, a higher number of pods per plant, and ultimately leads to a greater overall grain yield.

Cowpea varieties that have a strong branching ability show greater resilience to stresses such as drought. This is because they can effectively explore soil moisture with their extensive root systems, allowing them to maintain growth during challenging conditions. As a result, these branched varieties are a valuable asset in various agricultural systems, including intercropping and rainfed environments (Bawa and Shaltut, 2025).

Leaf Area

The leaf area of cowpea (Table1) varied significantly ($P \leq 0.05$) among the varieties. All three means were significantly different from one another at both locations. However, there were inconsistencies between the locations. Ife Brown recorded the highest leaf area overall. In contrast, the variety IIT-04K-321-2 1460 had the smallest leaf area at location La, while Ife Brown exhibited the least branching at location LB. The mean values at both locations were 106.46 for Ex-Borno, 97.28 for Ife Brown, and 89.47 for IIT-04K-321-2 1460, respectively Agbogidi and Egho (2012); Peter et al. (2022); Shakeel et al (2023); The leaf area of cowpea (*Vigna unguiculata* L. Walp) is hereditary and also influenced by environmental factors. The adaptations result in variations in leaf shape among varieties. Research shows that the total leaf area correlates with the number of leaves, which is determined by the number of nodes and branches Kana et al., (2021) During water stress, some varieties adopt drought tolerance strategies, either maintaining larger leaf areas for photosynthesis or reducing leaf area to conserve water (Hatfield, & Dol (2019)). Additionally, Patil et al. (2018) reported that the differential ability to absorb nutrients like nitrogen (N) and phosphorus (P) varies among varieties, thus influencing leaf size and expansion.

An ideal leaf area ensures resources are not over-invested in leaf production, as leaves are vital for capturing sunlight for photosynthesis. While adequate leaf area is necessary for light absorption, excessive leaf growth can cause self-shading, reducing the efficiency of lower leaves, which consume valuable resources through respiration, as reported by Leigh et al. (2017); Wang et al. (2019); Afiukwa (2017). The main goal is to maximize the net assimilation rate—the net gain of dry matter for the entire crop canopy. A leaf area that is too large can lead to increased respiration, negating the benefits of photosynthesis and ultimately reducing biomass and yield (Tewodros Ayalew, 2022). The foregoing may be the reason why Ex-Borno, despite having the highest leaf area, did not produce the highest grain yield, while, in contrast, Ife Brown, with the least leaf area, produced a superior grain yield. This large leaf area and low grain yield in Ex-Borno and IIT-04K-321-2 1460 may be a consequence of excessive leaf

area creating a dense canopy with high humidity and poor air circulation, raising the risk of biotic stress. The optimal leaf area index varies by crop species, cultivar, climate, and management practices; it is thus important to choose varieties with the optimum leaf area for specific intercropping farming systems.

Nodulation

Nodulation (Table 1) was significantly ($P \leq 0.05$) increased by cowpea varieties. All the 3 means are significantly different from one another at locations A and B. The trend was similar at the two locations: the mean nodulation was rated as 46.1, 44.74 and 39.75 respectively, for Ife Brown, Ex Borno, and IT-04K-321-2 1460. The result from the present study is supported by Ndungu et al. (2018), Hatfield and Dold (2019), Ndukwe et al. (2016), Kim (2025), and Ayisi (2000).

Records have it that inherent differences in nodulation exist among diverse cowpea varieties. According to Oladejo et al. 2025, nodulation efficiency is basically dictated by the genetic variations (genotype) of the host plant, the specific rhizobial strains available in the soil environment, and the genotype by environment interaction, which was also reported by was also reported by Prathima et al. (2024) as key players in the phenomenon. The hereditary composition of the cowpea variety thus plays a fundamental role in its ability to nodulate effectively. Nodulation efficiency of cowpea (varieties) can thus be described as hereditary, as a result of which the nodule characteristics, such as size and number, are dependent on the genetic composition.

Nitrogen-fixing bacteria, such as *Bradyrhizobium* and *Rhizobium* species, according to Becker et al. (2023) are host-specific. They establish symbiotic relationships with specific cowpea varieties. The effectiveness of this symbiotic association is strongly regulated by the compatibility of the specific cowpea genetic constitution/genotype and the precise strain of bacteria it interacts with. Saba et al. (2021) explained that nodulation is not only dependent on the root architecture of individuals; root length also results to deeper taproots and wider root angles. This root morphology and environmental influences may have varying capacities for nodulation and nutrient uptake, which may also eventually influence the overall nodule-forming activities, as reported by Dukare et al. (2017); Harshani & Fernando (2021); Mekonnen et al. (2022); Mohammed et al. (2022).

The physiological factors of auto-regulation of nodulation (AON) are systemic processes that involve leaf tissue sensing early nodulation events to control the total number of nodules formed, thus preventing "supernodulation" that could drain plant resources. Further explanations by Parasar (2025); Oliveira et al. (2025) indicate that cowpea, based on variety, shows significant variability in nodulation, nitrogen fixation, and nutrient uptake. The variation, according to this study, is to a great extent influenced by the composition of the individual root exudates. The exudates, according to Jaiswa et al. (2021) act as signaling molecules to attract beneficial rhizobia. Studies show that these exudates, including flavonoids and organic acids, play a crucial role in forming specific symbiotic relationships. The result is a pointer to the fact that Ife Brown is a more efficient variety in fixing N biologically.

Grain Yield (kg/ha)

Grain yield of cowpea (Table 1) was significantly ($p \leq 0.05$) increased by the variety. The trend was consistent at the two locations. The mean grain yield for the bi-location was rated as 1173.4, 1067.2, and 981.4 kg/ha, respectively, for Ife Brown, Ex Borno, and IIT-04K-321-2 1460. This result is consistent with Mofokeng (2020), Odedina (2014), Ndenkyanti (2022), Peter (2022). Varietal differences in grain yield are a is hereditary and also dictated by prevailing environmental factors. Genetic traits, according to Hari et al. (2020): Ligarreto–Moreno & Pimentel–Ladino (2022), determine a variety's inherent yield potential and its ability to respond to environmental stimuli. According to Feng (2024)) different cultivars respond variably to environmental conditions such as drought, low soil fertility, and sowing density, which is further explained by peculiar genetic traits, such as grain dimension and the number of grains per pod, along with the entire plant architecture and canopy structure, facilitating the attainable yield.

Cowpea varieties are either developed or improved for specific maturity periods ranging from early to medium or late maturing. These explain the adaptation and survival under varying prevailing atmospheres. According to Mofokeng et al. (2020), the alignment between the genetic cycle of a variety and the prevailing growing period can significantly affect final yield. Breeders also select for resistance or tolerance to biotic stresses, such as pests and diseases, as well as abiotic stresses, including drought, heat, and poor soil nutritional status. Genetic factors, according to Adediran et al. (2018), Odedina et al. (2014), and Peter et al. (2022). Thus, bestow diverse levels of survival adaptations. The resistance and tolerance to these stresses enhance crop performance under diverse environmental conditions and consequently dictate yield performance.

The superior grain yield of Ife Brown in the present experiment may be attributed to the stability of the genotype. This could mean that the variety possesses a steady and broadly adapted status that enables it to perform consistently well across various environments (Bocianowski et al., 2024; Olanrewaju et al. 2024; Ligarreto–Moreno & Pimentel–Ladino (2022): On the other hand, it is possible that Ex Borno and IIT-04K-321-2 1460 were specifically adapted genotypes tailored to certain specific conditions, performing exceptionally well only in those environments. It is important to note that the stability and adaptability of these genotypes cannot be entirely separated from human management decisions. Factors such as seed sowing rate or spacing (Bawa and Habib, 2025), sowing date, and pesticide or fertilizer application rates are crucial components of the environment that interact with genetic stability. The results indicated that breeding programs can exploit sufficient variability among genotypes.

Conclusion

Immigrant farmers from northern Nigeria can grow cowpeas in the wet savannah ecological zone. Crop husbandry can be done under an intercropping farming system, which they are originally familiar with. Although cowpea varieties (genotypes) differ in their inherent yield potential, The field agronomic performance and biological yield are determined by the interaction of the environment and the genotype

(i.e., E x G). A major advantage of the various agronomic characteristics is the delay in flower initiation by Ife Brown. The knowledge of flower maturity can be explored to choose a sowing date that would support a pod maturity (ripening and drying) stage not to fall within a period of heavy rainfall. The high nodulation in Ife Brown is an indication that the variety is the most susceptible to the naturally occurring soil inhabiting nitrogen fixing bacteria.

The high number of branches recorded in Ife Brown cowpea is an advantage in intercropping systems, particularly when paired in an intercrop with taller crops like maize or millet. Branching enables the cowpea to better occupy available space, intercept light, and maintain productivity under the shaded, competitive conditions typical of intercropping. High branching could mean a better adaptation to produce more flowers and pods compared with low-branching varieties when established in an intercropping farming system with maize. A highly branched cowpea will enhance improved ground cover, which can assist in weed suppression in an intercropped field. The inherent capacity for high branching recorded from Ife Brown remains a key trait for adaptation to ecology and farming systems.

Recommendation

Ife Brown cowpea varieties (genotypes) that have recorded high and stable yield performance can thus be recommended to both immigrant and native host farmers to boost the productivity of cowpea in the wet savanna zone of Nigeria. The adoption of the seed technology and farming system will also provide the settlers with a means of livelihood.

Table 1: Agronomic Traits of Cowpea (*Vigna unguiculata* (L.) Walp.) tested under Wet Savannah agroecology in Nigeria.

Days to 50% flowering Branching Leaf Area (Cm²) Nodulation Grain Yield (kg/ha)

	A	B	Mean	A	B	Mean	A	B	Mean	A	B	Mean	A	B	Mean
Variety															
IT-04K-321-21460	54.5c	59.97b	57.24	8.99c	7.80c	8.40	87.41c	92.33b	89.87	38.93c	40.56c	39.75	977.7c	984.7c	981.4
Ex Borno	56.2b	58.25b	57.23	9.30b	8.13b	8.72	103.70a	109.22a	106.46	43.70b	45.78b	44.74	1063.2b	1072.4b	1067.2
Ife Brown	58.4a	63.09a	60.74	10.97a	9.80a	10.39	93.97b	100.42c	97.28	44.56a	47.63a	46.1	1171.6a	1175.1a	1173.4
SE±	0.21	1.15		0.36	0.36		0.89	0.30		0.31	0.04		0.03	3.60	
LSD (P≤ 0.05)	0.46	2.3		0.72	0.72		1.79	0.61		0.62	0.07		0.06	7.23	

Key: Location A = Iloffa, Location B=Ilorin, SE= Standard Error, LSD= Least Significant Difference

Values sharing the same alphabets are not significantly different from one another at an LSD of $p \leq 0.05$.

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