

Impact of Planting Date and Spacing on the Growth and Yield of Two Cowpea Varieties (SLIPEA 4 and Tented Beans) in the Lowland of Njala University, Kori Chiefdom, Southern Region

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DOI: <https://doi.org/10.70382/hujaesr.v11i1.043>

Keywords: Cowpea varieties, Planting date, Lowland agriculture, Spacing, Sierra Leone.

Abstract

A field experiment was conducted in 2024 at the School of Agriculture and Food Sciences, Njala University, Moyamba District, Southern Sierra Leone, to evaluate the effects of planting date and spacing on the growth and yield performance of two cowpea (*Vigna unguiculata* L.) varieties. The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. Each gross plot measured 15 m² (5 m × 3 m), and the total experimental area covered 532.5 m² (35.5 m × 15 m). Treatments consisted of three planting dates (early August, mid-August, and late August) and three spacing regimes (90 cm × 20 cm, 60 cm × 20 cm, and 30 cm × 20 cm). Results showed significant differences ($p < 0.05$) in growth and yield parameters in response to planting date and spacing. Early August planting recorded superior vegetative growth, including plant height (123.3 cm and 139.3 cm), number of branches per plant (7.8 and 12.31), stem girth (10.03 cm and 13.28 cm), number of leaves per plant (145.2 and 141.21), and leaf area (45.67 cm² and 49.90 cm²) at maturity and harvest. Among spacing, 90 cm × 20 cm produced the tallest plants (138.3 cm and 148.0 cm), highest number of branches (8.11 and 10.2), thickest stems (15.6 cm and 15.66 cm), highest leaf count (143.40 and 141.21), and largest leaf area (66.60 cm² and 49.90 cm²). Early August planting also produced the highest yield attributes: pods per plant (13.30), seeds per pod (6.17), 100-seed weight (20.33 g), dry pod weight per plot (499.67 g), dry seed weight per plot (387.00 g), plants harvested per plot (78.83), and seed yield (448.17

kg/ha). Similarly, 90 cm × 20 cm spacing recorded the highest pods per plant (10.89), seeds per pod (6.17), 100-seed weight (19.67 g), dry pod weight per plot (447.67 g), dry seed weight per plot (339.11 g), plants harvested per plot (88.11), and seed yield (439.67 kg/ha). Although both varieties adapted well, SLIEPA 4 consistently outperformed Tented Beans. Early August planting combined with 90 cm × 20 cm spacing was identified as the optimum practice under Njala conditions.

Introduction

Cowpea (*Vigna unguiculata*) is an essential legume crop in sub-Saharan Africa, contributing significantly to food security and the livelihoods of smallholder farmers and millions of people (FAO, 2019). Nigeria is one of the world's largest producers of cowpea with an average production of 2.92 million tons, followed by Niger with 1.10 million tons (FAO, 2012).

In Sierra Leone, cowpea is the second most important legume crop after groundnut (*Arachis hypogea*) (MAFFS *et al.*, 2005; Kallon *et al.*, 2010) and many local and improved varieties of the crop are cultivated across the country. The major cowpea producing areas in Sierra Leone are; Northern region (Kabala), Western area and Southern region; with Moyamba District (Southern Sierra Leone) producing the largest, compared with other regions in the country. However, cowpea yields are very low in the district probably due to poor management practices such lack of adopting the appropriate plant spacing and application of adequate amounts of fertilizers. Most of the soils in Sierra Leone are depleted and poor and lack the required mineral nutrients and therefore crops that are grown on the soil will perform poorly and produce low yield. To tackle this problem and increase legumes production in Sierra Leone, proper used of Varieties, spacing and correct time of planting should be adopted by local farmers. Grain yield of cowpea (*Vigna unguiculata* (L.) Walp) in West Africa has increased more than 2 times in the last 55 years; however, the 5-year average yield (0.57 t ha⁻¹) is still lower than the potential yield (2–3 t ha⁻¹) (Food and Agriculture Organization of the United Nations (FAO), 2022). Significant progress has been made by research institutes such as the International Institute of Tropical Agriculture (IITA), which have developed and released numerous improved varieties characterized by high grain yields, faster maturity, and combined with resistance to pests and diseases (Boateng *et al.*, 2019). However, challenges persist regarding the timely adoption of these improved cultivars, the application of the appropriate agronomic practices, and the poor marginal returns experienced by farmers in many parts of Africa (Worku *et al.*, 2018). Effective production systems, including the optimization of planting date and appropriate planting density, directly impact the yield of crops like cowpea (Nderi & Kamau, 2018).

Planting date is a key factor in the production of crops in semi-arid environment (Moatshe *et al.*, 2015). However, the length of growing crops has significantly decreased; the onset and cessation of growing crops have been October (onset) and March (cessation), respectively but this trend has shifted (Adelabu *et al.*, 2010). The crop yields are however, highly dependent on seasonal rainfall (Tsheko *et al.*, 2015), which is affected by the period of planting (Ezeaku *et al.*,

2015). Planting date is one of the most important cultural practices for the success of common bean production in Northern Iran, especially when the crop is sown in August. Early planting of common bean can enable the crop to set and fill grain before the onset of late-fall chilling. Early planting can also provide the potential for producing a larger crop canopy earlier in the growing season, which can better utilize solar radiation for photosynthesis (De Bruin *et al.*, 2010). Moreover, early planting can increase crop competitiveness against weeds, especially against late-emerging ones. However, very early planting of common bean exposes the germinating seeds to dry and warm conditions and, therefore, it has the potential to reduce stands and to cause uneven seedling emergence. Combining uneven seedling emergence and lower populations under these conditions may cause greater yield reductions. In contrast, late planting date causes the reproductive growth stage of the crop to face the fall chilling, which ultimately lowers yield.

The time of planting is important in determining the final seed yield and is a useful agronomic practice as observed in other leguminous crops such as cowpeas (Shiringani and Shimelis, 2011), bambara groundnut (Ngwako *et al.*, 2013) and faba bean (Thalji and Shalaldeh, 2006). Planting dates can also be used effectively to control several pests in cowpea (Ezeaku *et al.*, 2014) and corn rootworm damage in maize crop (Obopile *et al.*, 2012). Understanding the impact of planting date and Varieties on cowpea growth and yield is crucial for designing site-specific and climate-resilient farming systems (Ezeaku *et al.*, 2015). Moreover, optimizing cowpea production through proper Varieties selection and planting dates could contribute significantly to sustainable food production, poverty alleviation, and regional rural development (Ezeaku *et al.*, 2015; Ewansiha and Tofa, 2016; Kamara *et al.*, 2018). By addressing this knowledge gap, the objective of this study is to identify the most suitable planting date, spacing and Varieties combinations that can lead to enhanced crop performance, increased grain yield, and improved livelihoods for smallholder farmers. Furthermore, the findings will contribute to the scientific understanding of cowpea physiology and agronomy, enabling the development of tailored breeding programs and improved crop management practices for rainfed cowpea cultivation in the njala lowland and similar agroecological zones. Therefore, the technique can be a good cultural control method of pest and diseases among subsistence farmers with limited access to resources. However, no study has appraised sowing date, spacing and Varieties on the growth and yield of cowpea under Lowland field conditions in southern Sierra Leone.

Impact of Sowing Date and Spacing on Cowpea (*Vigna Unguiculata* (L.) Walp) Growth and Yield

Cowpea (*Vigna unguiculata*) is an essential legume crop in sub-Saharan Africa, contributing significantly to food security and the livelihoods of smallholder farmers and millions of people (FAO, 2019). *Vigna unguiculata* (L.Walp), commonly known as cowpea, is a significant component of cropping systems in regions characterized by pronounced climatic variability and low-to-medium rainfall and globally recognized as one of the third most important pulse crops that are widely cultivated across Africa, Southeast Asia and the Americas (Lum *et al.*, 2018). Its high protein content and its ability to fix atmospheric nitrogen make it a source of nutrition and

soil fertility improvement, and an essential component of sustainable agricultural systems (Adediran, 2019).

Consequently, cowpea is a promising food and forage species in typical tropical lowland climates, contributing significantly to food security in arid and semi-arid regions (Augustine, 2018). Young leaves, green pods, and green seeds are used as vegetables, and dry seeds are used in various food preparations (Tahir *et al.*, 2024). A critical agronomic role of cowpea is the restoration of soil fertility within cropping systems, which is achieved through the plant's capacity for biological nitrogen fixation via symbiotic association with rhizobia bacteria in its root nodules. Nitrogen fixation significantly improves soil properties and contributes to the sustainability of cropping systems, particularly in smallholder settings where fertilizer use is limited (Sichilima *et al.*, 2018, Xu *et al.*, 2025).

In Sierra Leone, cowpea is the second most important legume crop after groundnut (*Arachis hypogea*) (MAFFS *et al.*, 2005; Kallon *et al.*, 2010) and many local and improved varieties of the crop are cultivated across the country. Although cowpea can be grown throughout Sierra Leone, studies have indicated that Moyamba District (Southern Sierra Leone) is the largest cowpea producing district in the country. However, cowpea yields are very low in the district probably due to poor management practices such lack of adopting the appropriate plant spacing and application of adequate amounts of fertilizers Furthermore, the choice of cowpea Varieties and planting date significantly influences crop growth, development, and ultimately, grain yield (Kamara *et al.*, 2018; Ewansiha and Tofa, 2016). Therefore, understanding the interactions between planting date Spacing and Varieties to cowpea growth and yield is critical for enhancing crop productivity and ensuring food security in the region (Ewansiha and Tofa, 2016).

Description of Study area

The field experiment was conducted in 2024 at Njala university experimental farm site of the School of Agriculture and Food Sciences, Njala University Njala Campus, Moyamba District, Southern province Sierra Leone. School of Agriculture and Food Sciences is located on an elevation of 54 m above sea level on latitude 8°6N and longitude 12°6W of the equator. The mean annual rainfall total was 3015 mm. The heaviest rainfall occurs between July and September when the maximum of 23 to 27days per months falls. The dry season started from November to end of April. However, there was an intermittent rainfall pattern from April to end of October with intervals of about 3-5 days between rainfall ends another. The temperature was generally high with an average range of 24.6°C-32.0°C. However, temperature varies in diurnal and seasonal patterns with maximum in March, April and minimum in July and August. Sunshine was about, but it varied with the amount of cloudiness. The average sunshine hour was between 6-9 h per day during the dry season and only about 3-4 h per day during the raining season.

Experimental Design

A field experiment was arranged in a Randomized Complete Block Design (RCBD), replicated three times. The gross plot size was 15 m² (5m x 3m) and the total experimental area was 532.5m²

(35.5 m x 15 m). The path between any two replications was one meter (1m) and the path between any two plots was 0.5 m. the different planting date observed were Early-August, Mid-August and Late-August with three different spacing of 90 cm x 20 cm, 60 cm x 20 cm and 30 cm x 20 cm respectively. SLIPEA 4 and tented beans was investigated in this trial. This Varieties is an improved line introduced by Sierra Leone Agricultural Research institute (SLARi) several years ago. It is well adapted to the environmental conditions in Sierra Leone.

Growth Data Collection

Data on growth parameters was collected focusing on the following parameters; plant height, stem girth, branch number and leaf area.

- **Plant height (cm)** was collected by measuring the distance from soil surface to the tip of the main stem.
- **Number of stem branches:** The number of stem branches was measured by counting the total number of stem branches produced per sample plant.
- **Stem Girth (cm).** These was measured using a Vernier caliper. Direct measurement at 5 cm above soil level.
- **Leaf Area (cm²).** The leaf area was measured by calculating the Length x Breadth x constant using the Formula: $LA = L \times W \times k$ ($k=0.75$).

Yield Data Collection

- **Number of Pods per Plant.** The number of pods per plant was measure by collecting the total pods harvested/number of plant sample. These was done using the formula below;

$$\text{Number of pods per plant} = \frac{\text{Total pods harvested}}{\text{Number of plant sample}}$$

- **Number of Seeds per Pod:** The number of seeds per pod was determined by counting the total number of seeds obtained from a known number of sampled pods and then the average were calculated. Mathematically,

$$\text{Number of seeds per pods} = \frac{\text{Total number of seed counted}}{\text{Total number of Pods sample}}$$

- **100-Seed Weight (g);** Weight of 100 randomly selected seeds was weight using a sensitive balance.
- **Dry Pod Weight (g) per Plot:** The dried pods from each net plot were weighed using a sensitive digital balance.
- **Dry Seed weight (g) per plot:** The dried pods from each plot are manually or mechanically threshed to separate the seeds.
- **Dry Seed Weight (g) per Plot=**Total weight of clean, dried seeds obtained from the net plot was weighed.
- **Seed Yield (kg/ha) per Plot:** Seed yield per hectare was calculated by converting the dry seed weight obtained from the net plot area to hectare basis.

Formula:

$$\text{Seed Yield (kg/ha)} = \frac{\text{Dry seed weight per plot (kg)}}{\text{Net plot area (m}^2\text{)}} \times 10,000$$

Data Analysis

All data collected were subjected two-way analysis of variance (ANOVA) using the STATISTICA software version 12 (Stat Soft Inc., Tulsa, OK, USA) and means were separated using the DUNCAN MULTIPLE RANGE TEST (DMRT) at 0.05 level of significant.

Growth Performance at Maturity Stage

Analysis of variance revealed a statistically significant difference ($p < 0.05$) in the growth parameters of the two cowpea genotypes (SLIPEA 4 and Tented Beans) under different sowing dates and spacing at maturity in the Njala lowland. The results indicate that both cowpea genotypes planted in early August recorded superior growth performance, including taller plant height (123.3 cm), higher number of branches (7.8), thicker stem diameter (10.03 cm), greater number of leaves per plant (145.2), and broader leaf area (45.67 cm²) at the maturity stage. Furthermore, a significant effect of spacing was also observed, with the 90 cm × 20 cm spacing producing taller plants (138.3 cm), higher number of branches (8.11), thicker stems (15.6 cm), increased leaf count (143.40), and broader leaf area (66.60 cm²), respectively. Although both genotypes exhibited adaptive responses to variations in sowing date and spacing, SLIPEA 4 showed significantly superior growth performance. This genotype recorded taller plant height (112.4 cm), more branches (8.11), thicker stems (12.2 cm), higher leaf count (142.2), and broader leaf area (56.89 cm²) compared to Tented Beans.

Table 1: Effect of sowing date and spacing on the growth of two cowpea genotype at maturity stage

Treatment	Plant Height (cm) at Maturity	Branch number at maturity	Stem girth (Mm) at maturity	Number of Leaves at maturity	Leaf Area (cm ²) at maturity
Planting date					
Early-August	123.3	7.8	10.03	145.2	33.23
Mid-August	119.3	7.8	7.08	139.2	45.67
Late-August	110.9	7.6	9.02	138.50	32.2
Planting Spacing					
90 x 20	138.3	8.11	15.6	143.4	66.60
60 x 20	98.21	8.10	8.90	121.1	45.09
30 x 20	58.12	6.07	7.12	98.6	40.90
Cowpea Varieties					
SLIPEA 4	112.4	8.11	12.2	142.2	56.89
Tented Beans	89.01	7.01	7.09	98.80	46.8
F-Statistics					
Planting Date	9.02***	ns	Ns	6.90***	14.58***
Plant Spacing	11.23***	ns	Ns	6.80***	15.90***
Cowpea Varieties	14.67***	ns	Ns	11.78**	16.09***
Planting date*Varieties	4.673***	ns	Ns	5.410**	6.77***
Genotype					

Growth Performance at Harvesting Stage

The results further showed a statistically significant difference ($p < 0.05$) in the growth parameters of the two cowpea varieties (SLIPEA 4 and Tented Beans) under different sowing dates and spacing at the harvesting stage in the Njala lowland. With respect to planting date, both cowpea varieties planted in early August recorded superior growth, including taller plant height (139.3 cm), higher number of branches (12.31), thicker stems (13.28 cm), greater number of leaves per plant (141.21), and larger leaf area (49.90 cm²). This was followed by plants established in late August, which recorded the second tallest plant height (119.3 cm), branch number (9.31), thickest stem (9.28 cm), and leaf count (138.51). Significant differences were also observed among the planting spacing, with the 90 cm × 20 cm spacing producing taller plants (148.0 cm), more branches (10.2), thicker stems (15.66 cm), higher leaf count (141.21), and larger leaf area (49.90 cm²). Among the two varieties, SLIPEA 4 consistently exhibited superior growth performance, recording taller plant height (122.01 cm), higher branch number (11.31), thicker stems (14.02 cm), greater leaf count (144.02), and broader leaf area (58.08 cm²).

Table 2: Effect of sowing date and spacing on the growth of two cowpea varieties at harvesting

Treatment	Plant Height (cm) at Harvesting	Branch number at harvesting	Stem girth (cm) at harvesting	Number of Leaves at harvesting	Leaf Area (cm ²) at harvesting
Planting date					
Early-August	139.3	12.31	13.28	141.21	49.90
Mid-August	123.3	10.21	10.43	126.2	34.44
Late-August	110.9	8.21	9.21	138.51	38.80
Planting Spacing					
90 x 20	148.0	10.2	15.66	143.44	68.09
60 x 20	99.23	9.80	9.20	121.10	46.88
30 x 20	68.02	8.29	8.22	99.06	46.60
Cowpea Varieties					
SLIPEA 4	122.01	11.31	14.02	144.02	58.08
Tented Beans.	99.21	8.19	9.19	99.90	48.08
F-Statistics					
Planting Date	9.02***	ns	Ns	6.90***	5.60***
Plant Spacing	12.03***	ns	8.70*	7.60***	8.90***
Varieties	9.90***	Ns	6.70*	10.09**	12.89***
Planting date*Varieties	6.77***	7.89**	7.90**	6.90***	8.90***
Genotype					

Note: Values are presented as mean ± standard deviation, NS indicates non-significant difference, *** indicates p -value < 0.001, ** indicates p -value < 0.05

Yield Performance

Analysis of variance showed a statistically significant difference ($p < 0.05$) in all yield parameters of the two cowpea varieties (SLIPEA 4 and Tented Beans) under different sowing dates and spacing in the Njala lowland. Overall, the results indicated consistent yield responses across

planting dates, spacing, and varieties evaluated in the study. With respect to planting date, cowpea varieties planted in early August produced superior yields, recording higher number of pods per plant (13.30), number of seeds per pod (6.17), 100-seed weight (20.33 g), dry pod weight per plot (499.67 g), dry seed weight per plot (387.00 g), number of plants harvested per plot (78.83), and seed yield (448.17 kg/ha). Similarly, planting spacing significantly influenced yield performance, with the 90 cm × 20 cm spacing producing the highest yield attributes, including pods per plant (10.89), seeds per pod (6.17), 100-seed weight (19.67 g), dry pod weight per plot (447.67 g), dry seed weight per plot (339.11 g), number of plants harvested per plot (88.11), and seed yield (439.67 kg/ha). Significant varietal differences were also observed. SLIPEA 4 exhibited superior yield performance over Tented Beans, recording higher pods per plant (16.90), greater number of seeds per pod (14.68), 100-seed weight (14.68 g), dry pod weight per plot (244.24 g), dry seed weight per plot (189.09 g), number of plants harvested (68.08), and seed yield (314.40 kg/ha).

Table 3: Effect of sowing date and spacing on the yield of two cowpea varieties

Treatment	Number of Pods Per Plant	Number of Seeds Per Pod	100-Seeds Weight (g)	Dry Pod Weight (g) Per Plot	Dry Seeds Weight (g) Per Plot	Number of Plants Harvested Per Plot	Seeds Yield (kg/ha) Per Plot
Planting Date							
Early-August	13.30	6.17	20.33	499.67	387.00	78.83	488.17
Mid-August	11.73	5.60	19.50	486.17	358.83	66.66	475.00
Late-August	10.53	5.90	20.00	525.17	338.50	63.50	428.83
Planting Spacing							
90 cm x 20 cm	10.89	9.44	19.67	447.89	339.11	88.11	439.67
60 cm x 20 cm	9.82	6.33	14.22	159.44	310.44	75.89	261.67
30 cm x 20 cm	8.90	5.45	11.90	104.80	220.12	68.80	189.90
Cowpea Varieties							
SLIPEA 4	16.90	8.68	14.68	244.24	189.09	68.08	314.40
Tented Beans.	10.09	4.68	12.24	168.90	120.80	44.40	221.23
F-Statistics							
Planting date	11.652**	ns	ns	10.809**	0.838***	1449.115***	4.032***
Plant spacing	16.971**	ns	ns	138.493***	13.364***	0.154***	1.25***
Varieties	5.531*	ns	ns	5.763***	0.474***	3.500***	4.409***
Planting date*	5.412**	ns	ns	12.201***	4.440***	4.501***	7.901***
Spacing*							
Varieties							

Discussion

The field experiment assessed the influence of planting date, spacing and Varieties on cowpea growth and yield. The results revealed significant differences among the planting dates and varieties in terms of these growth attributes. Early planting resulted to taller plant height, highest branches produced, thicker stems, higher number of leaves plant⁻¹ and broader leaf area at both maturity and harvesting stage, indicating better growth and photosynthetic capacity.

These findings are in line with the results reported by Ezeaku *et al.*, (2015) and Kamara *et al.*, (2018), where early planting positively affected plant height and leaf area index in legume crops. Kyei-Boahen *et al.*, (2017) also reported similar positive effects of early planting on crop performance. Similarly, cowpea planted using 90 cm x 20 cm resulted in to taller plant height, highest branches produced, thicker stems, higher number of leaves plant⁻¹ and broader leaf area. Regarding Varieties, significant variations were observed in all growth and yield parameters among the cowpea varieties. Varieties SLIPEA 4 consistently outperformed other varieties, showing the highest values for plant height, number of branches, number of leaves, pod weight, seed weight, and grain yield. This suggests that SLIPEA 4 possesses desirable genetic traits and adaptability to the local environment, contributing to its superior performance (Boukar *et al.*, 2016). Similar findings were reported by Ewansiha and Tofa, (2016), where certain cowpea varieties exhibited superior growth attributes and yield components in similar agroecological zones. Also, SLIPEA 4 high yield potential can be attributed to genetic traits that promote efficient photosynthesis, better assimilate partitioning to pods and seeds, and superior nutrient utilization. It is a promising choice for farmers seeking maximum grain yield potential in the given agro-climatic conditions (Ankrumah and Yahaya, 2015). Overall, the study concludes that early August planting combined with 90 cm x 20 cm spacing and the use of SLIPEA 4 genotype is the most suitable production strategy for optimizing cowpea growth and yield in the Njala lowland of Southern Sierra Leone. These findings provide practical recommendations for farmers seeking to maximize cowpea productivity in similar agro-ecological zones while promoting climate change adaption strategies in the study environment and Sierra Leone.

Conclusion

In conclusion, the study demonstrated that, both planting date and Varieties significantly influence cowpea growth and yield in the lowland environment of Njala University, Sierra Leone. Early planting (Early-August) generally leads to superior growth and yield, while certain cowpea varieties, particularly SLIPEA 4, exhibited excellent adaptability and potential for higher productivity. The findings emphasize the need for farmers to consider proper timing and appropriate Varieties selection for optimal cowpea production in the study area. Therefore, Farmers in the within Southern region and Sierra Leone at large are encouraged to consider planting cowpea in Early-August specifically using plant spacing of 90 cm x 20 cm to capitalize on the favourable growing conditions during critical growth stages. The adoption of high-performing varieties, such as SLIPEA 4, is recommended for cultivation due to its superior performance in terms of higher grain yields and overall crop productivity. Further research and on-farm trials should be conducted to assess the performance of other cowpea varieties and planting dates using other spacing in different agro-climatic regions to optimize productivity. Proper crop management practices, including adequate nutrient supply and pest control, should be employed to maximize cowpea yield potential in the study environments.

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