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EVALUATION OF NUMBER OF SEEDS PER HOLE ON THE VEGETATIVE GROWTH PERFORMANCE OF MELON (*Citrullus colocynthis* L.) IN A FOREST SAVANNA TRANSITION ZONE OF EDO STATE

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ABSTRACT

This research examined how different numbers of seeds per planting hole affected the vegetative growth of *Citrullus colocynthis (Lanatus)* at the Teaching and Research Farm, Faculty of Agriculture, Ambrose Alli University, Ekpoma. The site lies in the forest-savanna transition zone of South-South Nigeria (6°08′N, 6°41′E). A randomized complete block design (RCBD) with three replications was used. Prior to planting, soil samples were collected from a 0–15 cm depth and analyzed for their chemical and physical properties. The study involved five treatments with 1 to 5 seeds planted per hole at a spacing of 1 m × 1 m. Vegetative growth indicators—including vine length, number of leaves, leaf area, stem girth, and number of branches per plant—were measured every three weeks. The data were analyzed using ANOVA, and treatment means were compared using the Least Significant Difference (LSD) method. The results showed that at 9 weeks after planting (WAP), plots with three seeds per hole produced the longest vines and the highest number of branches. Meanwhile, the highest number of leaves was recorded in plots with four seeds per hole. The thickest stems (2.89 cm) were observed in plots with either three or four seeds per hole. Additionally, the largest leaf area was found in the three-seed-per-hole treatment. Overall, the findings suggest that planting three seeds per hole results in the most favorable fruiting, which is essential for maximizing melon seed yield in similar agroecological environments.

Keywords: *Citrullus colocynthis*, Seed number per stand, Vegetative growth, Melon cultivation, Optimal planting density

INTRODUCTION

Melon (*Citrullus colocynthis*), commonly referred to as "egusi" in West Africa, is a culturally and nutritionally important member of the Cucurbitaceae family. Also known by names such as bitter apple, colocynth, and vine of Sodom, it is taxonomically related to *Citrullus lanatus* and has been classified under several synonymous scientific names Perez-Escobar *et al*. (2020). The Cucurbitaceae family includes over 800 species and is valued for its nutritional, medicinal, and economic contributions worldwide (Britannica, 2024; Xu *et al*. 2024). Among these, egusi melon stands out in tropical Africa, particularly in Nigeria, where it is widely cultivated for its protein- and oil-rich seeds, which are integral to local diets (Saeed *et al*. 2024; Ikeorgu *et al*. 2021).

In Nigeria's diverse agroecological zones, egusi melon thrives both in monoculture and intercropping systems with crops such as cassava, maize, and yam. It is especially suited to rainfed agriculture due to its ability to utilize residual soil moisture, making it valuable for smallholder farmers Adewale, (2019). Despite its growing relevance, egusi remains under-researched in terms of agronomic optimization, particularly at the early growth stage, which is essential for maximizing productivity.

Previous studies have established that plant density—whether through spacing or seed number per hole—significantly affects growth dynamics. Higher density can lead to competition for resources like water, light, and nutrients, thereby influencing vegetative parameters such as vine length, leaf number, and leaf area Okoh *et al.* (2021). For instance, research on watermelon and muskmelon suggests that while high density may increase total leaf area, it can also negatively affect individual plant vigor and yield components (Duarte *et al*. 2023 & Adlan *et al*. 2018). However, most existing studies prioritize final yield outcomes over early vegetative indicators, and few have examined these effects in field conditions across West African agroecological zones Olubi *et al*. (2023).

Despite egusi melon's importance in food systems and rural livelihoods, optimal planting practices, particularly seed number per hole, remain inadequately studied. This knowledge gap limits efforts to enhance early vegetative growth—a phase that significantly determines stand establishment, photosynthetic capacity, and ultimately yield potential.

Understanding the optimal seed number per planting hole can improve early crop vigor, reduce intra-species competition, and support better resource use efficiency. This is critical for smallholder farmers who rely on effective land use under variable environmental conditions. Optimizing early vegetative growth also lays the foundation for improved yield and quality, thus contributing to food security and economic sustainability in melon production.

This study aims to assess the vegetative response of *Citrullus lanatus* to different seed numbers per hole (ranging from one to four) under field conditions in a forest-savanna agroecological zone. Key vegetative traits such as vine length, plant height, leaf number, and leaf area will be evaluated to determine the planting density that best supports healthy early growth and maximized stand performance. The findings are expected to inform best agronomic practices for melon cultivation in similar agro climatic regions.

MATERIALS AND METHODS

Description of Experimental Site

The study was conducted at the Teaching and Research Farm, Faculty of Agriculture, Ambrose Alli University, Ekpoma (in above sea level; Latitude 6'41' North, Longitude 6'8' East), in the forest-savanna transition agro-ecological zone of South-South Nigeria.

Soil Analysis
Soil samples were collected at a depth of 0-15 cm before planting. The samples were taken to the Nigerian Institute for Oil Research (NIFOR) Benin City for routine laboratory analysis of the physical and chemical properties .

Method
The land used for the experiment was manually-cleared and the debris packed out of the site. The experimental design was a randomized complete block design (RCBD) with five treatments. The five treatments are l seed/hole, 2 seeds /hole, 3 seeds/hole, 4 seeds/hole and 5 seeds/hole. The crop was sown at a spacing of 1x1 m apart. The entire experimental area covered 25x23 m. The area was divided into three blocks and each block was further divided into five experimental units making a total of 15 experimental units. Each unit measured 5m x 3m, that is a total area of 15 m^2. Three plants at the middle row of every experimental unit were selected for data collection. Data collection was done at three week intervals, that is, at 3, 6 and 9 weeks after planting (WAP).

Data Collection
Data were collected on the following parameters:

i. Vine length: A meter ruler was used to measure the length of the vine from the base of the crop to the terminal bud.

ii. Leaves per vine: The total number of leaves was obtained by visual counting on the s sample plants, and average value recorded.

iii. Branches per vine: This was done by counting and recording the value, as above.

iv. Leaf area: The leaf area was determined by multiplying the length and breadth of the widest portion off the leaf and the product multiplied by a constant 0.67 according to Hui-chin *et al* (2010)
LA =0.67 (LL X LW) = 0.67 LW.

v. Stem girth: This was determined by placing a twine or thread around the stem and spread it on a meter ruler to determine its circumference.

Statistical analysis
All data collected were subjected to analysis of variance (ANOVA) and the significant differences among the treatment means were compared using the Least Significant Difference (LSD) test at 0.05 level of probability.

RESULTS AND DISCUSSION
The soil analysis revealed a slightly acidic pH (6.70), which is within the optimal range for melon cultivation. Nutrient levels of available phosphorus (23.7 mg/kg), potassium (2.65 cmol/kg), calcium (10.56 cmol/kg), and magnesium (1.84 cmol/kg) were sufficient to support early vegetative development. However, the soil's organic carbon (1.60 g/kg) and total nitrogen (0.121 g/kg) were below established critical thresholds of 2.6 g/kg and 0.15 g/kg, respectively.

Table 1: Physico-chemical properties of soil sample at the experimental site before planting

Properties	Values
Ph	6.70
Available Phosphorus (mg/kg)	23.71
Exchangeable Cation (cmol/kg	15.96
Organic Carbon (g/kg)	1.60
Nitrogen (g/kg)	0.121
Magnesium (cmol/kg)	1.84
Sodium (cmol/kg)	0.71
Potassium (cmol/kg)	2.65
Calcium (cmol/kg)	10.56
Aluminium (cmol/kg	___
Clay (%)	5.1
Silt (%)	3.0
Sand (%)	91.9
Textural class	Sand

Source: Field Experimental Research 2024

Effect of number of seeds per stand on vine length (cm) of Melon.
There was a significant difference in vine length at 3 and 6 WAP but no significant (P > 0.05) difference was observed at 9 WAP. The length ranged from 19.39 - 23.89 cm at 3WAP, to 27.56 – 38.72 cm at 6 WAP, and 44.78 - 55.83 cm at 9 WAP.

Table 2: Effect of number of seeds per stand on vine length (cm) of Melon

Treatments	Weeks After Planting		
	3	6	9
1 seed/hole	20.05b	38.72a	51.55
2 seeds/hole	19.39c	29.11d	44.38
3 seeds/hole	20.11b	27.56e	55.83
4 seeds/hole	23.89a	30.89c	52.39
5 seeds/hole	23.72a	33.33b	50.72
L.S.D (0.05)	0.37	0.69	N.S

NS = Not Significant at P = 0.05. LSD- Least significant difference
Source: Field Experimental Research 2024

Effect of number of seeds per stand on branches per plant of Melon

In Table 3, branches per plant at 3 WAP ranged from 0.89 - 1.33. Significant ($P<0.05$) differences were not recorded among the treatments. At 6 WAP, although there was no significant difference, the number of branches ranged from 1.89 - 2.78 per plant while at 9 WAP, the number of branches ranged from 4.78 - 6.44 per plant.

Table 3: Effect of number of seeds per stand on branches per plant of Melon

Treatments	Weeks After Planting		
	3	6	9
1 seed/hole	0.89	2.33	4.78
2 seeds/hole	0.89	2.22	5.33
3 seeds/hole	1.33	2.78	6.44
4 seeds/hole	1.33	2.00	6.33
5 seeds/hole	1.22	1.89	5.56
L.S.D (0.05)	N.S	N.S	N.S

NS = Not Significant at P = 0.05 Source: Field Experimental Research 2024

Effect of number of seeds per stand on the leaves per plant of Melon

In Table 4, leaves per plant at 3 WAP ranged from 5.78 - 7.22 with no significant difference. At 6 WAP, leaves per plant ranged from 8.11 - 11.89 with observed significant differences recorded among the treatments while at 9 WAP, leaves per plant ranged from 33.89 - 48.66, significant difference was also observed.

Table 4: Effect of number of seeds per stand on the leaves per plant of Melon

Treatments	Weeks After Planting		
	3	6	9
1 seed/hole	6.45	8.11e	43.67b
2 seeds/hole	6.22	9.11d	44.22b
3 seeds/hole	5.78	11.89a	43.67b
4 seeds/hole	7.22	10.89c	48.66a
5 seeds/hole	7.00	11.44b	33.89c
L.S.D (0.05)	N.S	0.02	0.83

NS = Not Significant at P = 0.05
Source: Field Experimental Research 2024

Effect of number of seeds per stand on stem girth (cm) of Melon

In Table 5, the stem girth at 3 WAP ranged from 1.33 - 1.56 cm with no significant difference. At 6 WNAP, the stem girth ranged from 1.83 - 2.06 cm also without any significant difference while at 9 WAP, the stem girth ranged from 2.1 1 - 2.89 cm with observable significant differences.

Table 5: Effect of number of seeds per stand on stem girth (cm) of Melon

Treatments	Weeks After Planting		
	3	6	9
1 seed/hole	1.33	1.83	2.11
2 seeds/hole	1.33	1.95	2.22
3 seeds/hole	1.33	1.83	2.89
4 seeds/hole	1.44	1.99	2.89
5 seeds/hole	1.56	2.06	2.56
L.S.D (0.05)	N.S	N.S	0.07

NS = Not Significant at P = 0.05
Source: Field Experimental Research 2024

Effect of number of seeds per stand on leaf area per plant (cm^2) of Melon

In Table 6, the leaf area at 3 WAP, ranged from 39.22 - 56.84 cm² with no significant difference. At 6 WAP, the leaf area ranged from 50.55 - 70.00 cm² with no observed significant difference while at 9 WAP, the leaf area ranged from 226.39 -247.68 cm² without any difference among the treatments.

Table 6: Effect of number of seeds per stand on leaf area per plant (cm^2) of Melon

Treatments	Weeks After Planting		
	3	6	9
1 seed/hole	56.84	70.83	234.50
2 seeds/hole	43.70	52.03	226.39
3 seeds/hole	39.22	50.55	247.01
4 seeds/hole	53.45	74.00	247.01
5 seeds/hole	51.98	63.80	235.8
L.S.D (0.05)	N.S	N.S	N.S

NS = Not Significant at P = 0.05.
Source: Field Experimental Research 2024

Discussion

This study provides important insights into the influence of varying seed numbers per hole on the early vegetative growth performance of *Citrullus lanatus* under field conditions in a forest-savanna agro ecological zone.

The soil analysis revealed a slightly acidic pH (6.70), which is within the optimal range for melon cultivation. Nutrient levels of available phosphorus (23.7 mg/kg), potassium (2.65 cmolc/kg), calcium (10.56 cmolc/kg), and magnesium (1.84 cmolc/kg) were sufficient to support early vegetative development. However, the soil's organic carbon (1.60 g/kg) and total nitrogen (0.121 g/kg) were below established critical thresholds of 2.6 g/kg and 0.15 g/kg, respectively (Parvej, 2024; Patrick *et al*. 2021), potentially restricting biomass accumulation. The sandy loam texture, dominated by sand (91.9%), while beneficial for drainage, may further limit nutrient retention, thereby intensifying the effects of intra-specific competition, especially in denser planting arrangements.

Vine length varied across growth stages and appeared sensitive to seed density. At 3 weeks after planting (WAP), the longest vines were observed in plots sown with four seeds per hole, likely due to light competition triggering elongation—a well-documented plant adaptation in dense stands (Novák *et al*. 2023). However, by 6 WAP, the advantage shifted to single-seed plots, likely due to reduced resource competition and better nutrient availability per plant. At 9 WAP, the longest vines occurred in plots with three seeds per hole, suggesting that moderate competition may promote upward growth without significantly limiting access to essential resources. This trend aligns with findings by Okoh *et al*. (2021), who reported that moderate intra-hill competition can enhance certain growth traits without negatively affecting overall plant performance.

Branch development followed a similar pattern. The three-seed-per-hole treatment consistently produced the highest number of branches across all time intervals (3, 6, and 9 WAP). This suggests that moderate seed density achieves an effective balance between resource sharing and competition, supporting lateral vegetative growth. In contrast, plots with five seeds per hole showed a reduction in branch number, likely due to excessive competition for limited nutrients. Similar trends were observed by Duarte *et al.* (2023) in muskmelon, where higher plant densities led to reduced vegetative vigor and branching.

Leaf production was also influenced by seed density but varied by growth stage. At 3 WAP, the highest leaf counts were recorded in plots with four seeds per hole, potentially due to early competition stimulating leaf proliferation. By 6 WAP, plots with three seeds per hole produced the most leaves, indicating that moderate density favored sustained leaf development. At 9 WAP, four-seed plots again had the highest leaf counts, possibly due to increased canopy expansion. However, excessive crowding may eventually reduce light penetration and photosynthetic efficiency, a concern previously highlighted by Adlan *et al*. (2018).

Stem girth increased over time, peaking at 9 WAP in plots with three and four seeds per hole. Although five-seed plots showed high stem girth at earlier stages, this effect diminished later—possibly due to nutrient exhaustion. These findings suggest that initial morphological advantages from higher density may not be sustained without adequate nutrient input. This observation is consistent with (Marcos-Perez, *et al.* 2023), who reported that overpopulation within planting units can initially stimulate growth but ultimately reduce individual plant vigor.

Leaf area exhibited a distinct pattern compared to other traits. At 3 and 6 WAP, single-seed plots had the highest leaf area, likely reflecting minimal competition for light and nutrients. However, at 9 WAP, plots with three and four seeds per hole recorded the highest leaf area values, suggesting that collective canopy mass can compensate for individual limitations in less competitive stages provided that nutrient conditions are not severely limiting.

Collectively, these findings underscore the importance of optimizing seed number per hole to balance intra-plant competition with resource availability. The three-seed-per-hole treatment provided the most consistent and favorable results across multiple vegetative parameters, including vine length, branch number, and leaf area by 9 WAP. These results confirm and expand upon previous research (Okoh *et al*. 2021; Duarte *et al*. 2023), indicating that moderate planting densities can enhance vegetative vigor in melon without incurring the detrimental effects of overcrowding. Moreover, the observed outcomes emphasize the need to consider soil fertility, especially nitrogen and organic matter content, when selecting appropriate seeding strategies for melon cultivation in sandy loam soils.

CONCLUSION

This study has demonstrated that the number of seeds planted per hole significantly influences the vegetative growth performance of *Citrullus colocynthis* (Lanatus) under the forest-savanna agro -ecological conditions of South-South Nigeria. Among the five seeding treatments evaluated, planting three seeds per hole consistently led to superior vegetative traits, including the longest vine length, greatest number of branches, and largest leaf area at 9 weeks after planting. Although four seeds per hole yielded the highest number of leaves and comparable stem girth, the three-seed-per-hole treatment offered a more balanced and optimal growth profile across all measured parameters. These results indicate that moderate plant density achieved through three seeds per hill supports better resource utilization, resulting in improved vegetative development. Therefore, for farmers and researchers aiming to optimize melon growth and eventual seed yield in similar agro-ecological zones, planting three seeds per hole is recommended as the most effective practice. Further studies could explore the effects of this seeding rate on flowering, fruit development, and final yield to build a more comprehensive agronomic recommendation.

RECOMMENDATION

Based on the findings of this study, it is recommended that melon (*Citrullus colocynthis* (*Lanatus*)) be planted at a rate of three seeds per hill when cultivated under forest-savanna agro-ecological conditions similar to those in Ekpoma, South-South Nigeria. This seeding rate provided the most favorable vegetative growth characteristics, which are critical for supporting healthy crop development and achieving high seed yield.

Farmers are advised to maintain a spacing of 1 m × 1 m between planting holes and to monitor growth stages closely, especially around 9 weeks after planting when vegetative performance peaks. Researchers and extension agents may also consider promoting this practice in melon production training and outreach programs. Additionally, further research is recommended to assess the impact of this planting density on fruiting, seed yield, and overall economic return to confirm its effectiveness throughout the crop's full growth cycle.

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