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Trellising Impact on Growth, Leaf Development, Yield and Yield Quality of Cucumber (*Cucumis sativus* L.) in the Sudan Savanna of Nigeria

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Abstract

This study evaluates the effect of trellising on cucumber growth, leaf expansion, and fruit yield under dry season conditions in the Sudan Savanna agro-ecological zone of Kebbi State, Nigeria. Trellised cucumber plants consistently showed improved vegetative growth, including taller vines, larger leaves, and greater leaf numbers compared to untrellised plants. Trellising also increased fruit number, size, and marketable yield while reducing non-marketable fruits. These findings highlight trellising as a critical agronomic practice to enhance cucumber productivity in this region.

Keywords: Cucumber, Trellising, Vegetative growth, Yield, Leaf development, Sudan Savanna

Introduction

Cucumber (*Cucumis sativus* L.) is one of the most important vegetable fruit crops cultivated globally for its edible fruit, which is highly valued in human diets. In Nigeria, cucumber has gained prominence as a popular vegetable with substantial nutritional and economic importance. Rich in vitamins, minerals, antioxidants, and water, cucumber

serves both as a fresh vegetable and as a raw material for processed products renowned for their hydrating and skin-soothing properties (Milan *et al.,* 2024). Cucumber is a warm- season crop. It is best grown with day-time temperatures at 77 to 84°F and night-time temperatures at 64 to 71°F. Plant growth is suppressed when temperatures are above 95°F. Extended high temperatures result in forming deformed cucumber fruit and shortening harvest window. Cucumber plants are sensitive to low temperatures. (Wenjing Guan, 2020) Light energy plays a critical role in cucumber growth and development, as in other horticultural crops. Radiation influences total leaf area, carbohydrate production, and ultimately crop productivity. Therefore, managing light exposure in relation to temperature is fundamental for achieving optimal growth (Hamedallah *et al*., 2022). Trellising, a technique involving the training and support of vining plants on vertical structures such as wooden or metal frames, enhances plant architecture and promotes upward vine growth. Trellising is a good way to efficiently use space in high tunnels, eliminating yellow ground spots that develop when fruit rests on the soil surface and can result in straighter fruit. Additionally, it encourages airflow throughout the planting, which is a good strategy to avoid/prevent some diseases (Elsa Sánchez et al., 2025). Trellised plants also tend to develop longer and wider leaves than untrellised plants, indicating enhanced leaf expansion and greater photosynthetic efficiency (Peter *et al*., 2024). Khan and Iqbal (2019) further reported that vertical training prolongs green leaf area retention due to reduced shading and improved air circulation, thereby delaying leaf senescence. Trellising also influences flower distribution along the vine. Additionally, fruit quality is enhanced when trailing crops such as cucumber are supported on trellises, as the system minimizes fruit-soil contact, reduces disease pressure, and improves harvest efficiency (Jadhav *et al*., 2023).
Substantial evidence shows that trellising increases cucumber productivity. Pradhan *et al*. (2021) reported significantly higher yields under staked systems. Peter *et al*. (2024)b also observed that non-trellised plants consistently produced lower marketable yields, with a higher proportion of defective or non-marketable fruits. This demonstrates the importance of trellising in improving fruit quality and reducing postharvest losses. In some studies, trellised plants produced up to 10,367 kg ha^{-1}, compared with 9,267 kg ha^{-1} under non-trellised

Statement of the Problem

Despite the significant contribution of cucumber to food security and the national economy, the production in Nigeria remains very low, particularly in the Sudan Savanna. Farmers are predominantly using improper agronomic practices that lead to low yields and economic losses. Example non-trellising method results in vine overcrowding and subsequent mold attacks due to high humidity, predisposing the crop to spoilage, flower abortion, fruit deformity, and the development of yellow bellies. It also leads to dirt accumulation, difficult harvests, deformed shapes, uneven ripening, cracks, and insect damage, resulting in non-marketable fruits this resulted high lost in the production and fruit scarcity which lead to high cost of the fruit in the market. The Sudan Savanna zone, characterized by moderate rainfall and high solar radiation, provides favorable conditions for cucumber cultivation. However,

low yields persist due to the continued use of traditional agronomic practices. It had become a necessary to find out the solution to the problem through using of scientific proven techniques such as trellising. The main purpose of the study is to increase the yield and yield quality of cucumber to ensure sustainable food security and increase cash flow to the farmer in the study area through using proper agronomic practices trellising specifically.

Aim and Objectives of the Study:

The aim of this study was to evaluate the growth, yield and yield quality of cucumber as influenced by trellising practice in Sudan Savanna of Kebbi State, Nigeria. The specific objectives were to:

1. Determine the effect of trellising on vegetative growth of cucumber.
2. Examine the effect of trellising on yield performance of cucumber.
3. Evaluate the impact of trellising on yield qualities of cucumber in the study area

Research questions

1. What are the response of cucumber on growth and yield as influenced by various intra-row spacing in Sudan savanna of Nigeria?
2. What are the effect of trellising to growth and yield of cucumber plant in Sudan savanna of Nigeria?
3. What are the significant impact of trellising on yield quality of cucumber in Sudan savanna of Nigeria

Hypothesis

To answer the research question the following null hypothesis had been formulated

1. There was no significant effect of trellising on vegetative growth of cucumber in Sudan savanna of Nigeria
2. There was no significant influence of trellising on yield performance of cucumber in Sudan savanna of Nigeria
3. There was no significant effect of trellising on yield quality of cucumber in Sudan savanna of Nigeria

Experimental Design and Treatments

Two field trials were conducted during the 2023/2024 and 2024/2025 dry seasons at the Fadama Teaching and Research Farm of Abdullahi Fodio University of Science and Technology, located in Jega, within the Sudan Savanna ecological zone of Kebbi State (lat. 12°12.99' N; long. 4°21.90' E; 197m above sea level). The treatments consisted of two training methods (trellised and non-trellised). The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. Each treatment was replicated three times. The cucumber variety used was Poinsett 76, commonly adapted to the Sudan Savanna environment.

Cultural Practices

Land preparation involved plowing, harrowing, and ridging at 0.75 m apart. Seeds was sown directly in furrows. Trellising was installed immediately after planting using bamboo poles and nylon ropes, with horizontal wires positioned at 0.75m intervals up to 1.8 m height. Surface Irrigation system was carried out twice per week using tube well and pumping machine. Weeding and pest control was done manually and hand picking was done occasionally to keep plant free from weed. Vegetative growth and yield parameters were collected and subjected to the analysis of variance (ANOVA) using the DMRT at a 5% level of significance. Treatment means were separated where significant differences occurred.

Plant height:

The result (Table 1) showed that there was significant effect of trellising on vegetative growth of cucumber. Trellised cucumber plants consistently exhibited taller vines, then untrellising plant. this may be due to the sunlight penetration. Similar finding with (Muhammad *et al*., 2023) who stated that trellised plant significantly produced longer vine then untrellised cucumber.

Table1: Effect of trellising on plant height of cucumber during 2023/2024 and 2024/2025 dry seasons and combined data at Jega Sudan Savanna of Kebbi State

	Plant height (m)								
	3 WAS			6 WAS			9 WAS		
Trellising	**2023**	**2024**	**Combined**	**2023**	**2024**	**Combined**	**2023**	**2024**	**Combined**
Trellised	9.49	12.05^{a}	10.77	30.62^{a}	30.45^{a}	30.535^{a}	43.71^{a}	36.76^{a}	40.24^{a}
Un-trellised	9.83	8.94^{b}	9.39	26.55^{b}	23.22^{b}	24.88^{b}	36.86^{b}	32.82^{a}	34.84^{b}
SE±	2.266	3.295	3.444	6.944	7.655	7.41	4.390	8.725	7.854
Interaction									
S x T	NS	NS	NS	NS	NS	NS	NS	NS	NS

Means followed by the same letter(s) within a column in each treatment are not significantly different at 5% using DMRT.*= Significant at 5%, NS= not significant. WAS= Weeks after sowing

Number of branches

The result (Table 2) revealed that there was significant effect of trellising on vegetative growth of cucumber. Trellised plant produced more branches than un-trellised plants, indicating enhanced vegetative growth through improved light interception and reduced shading (Muhammad *et al*., 2023; Ansa and Garjila, 2019).

Table 2: Effect of trellising on cucumber number of branches during 2023-2025 dry seasons and combined data at Jega Sudan Savanna of Kebbi State.

	Number of branches		
Trellising	**2023/2024**	**2024/2025**	**Combined**
Trellised	0.2^{a}	1.00	0.60
Non-trellised	0.17^{b}	0.97	0.57
SE ±	0.058	0.116	0.095
Interaction			
S x T	NS	NS	NS

Means followed by the same letter(s) within a column in each treatment are not significantly different at 5% using DMRT. *= Significant at 5%, NS= not significant. WAP= Weeks after planting

Number of leaves

The result (Table 3) showed that there was significant effect of trellising on vegetative growth of cucumber. Higher numbers of leaves recorded on trellised cucumber due to the less competition. This study supported the Ansa and Garjila. (2019) work who found that trellised cucumber significantly produced more number of leaves then untrellised plant..

Table 3: Effect of trellising on number of leaves per plant of cucumber during 2023/2024 and 2024/2025 dry seasons and combined data at Jega Sudan Savanna of Kebbi State

	Number of leaves per plant								
	3 WAS			**6 WAS**			**9 WAS**		
Trellising	**2023**	**2024**	**Combined**	**2023**	**2024**	**Combined**	**2023**	**2024**	**Combined**
Trellised	4.81	5.65[b]	5.49	6.77	8.17	7.47[a]	7.95	10.38[a]	9.17[a]
Un-trellised	4.78	6.17[a]	5.22	6.47	7.19	6.83[b]	7.85	9.15[b]	8.50[b]
SE±	0.634	0.894	0.532	0.832	0.718	0.657	0.889	1.513	1.444
Interaction									
S x T	NS	NS	NS	NS	*	*	NS	NS	NS

Means followed by the same letter(s) within a column in each treatment are not significantly different at 5% using DMRT. *= Significant at 5%, NS= not significant. WAS= Weeks after sowing

Trellising significantly influenced plant leaf length at all the sampling stages. Trellised cucumber produced longer leaf then untrellising plant which may be due to the proper sunlight penetration. The observation was agreed with Muhammad *et al*., 2023; Ansa and Garjila, 2019.

Table 4: Effect of trellising on Leaf length of cucumber during 2023/2024 and 2024/2025 dry seasons and combined data at Jega Sudan Savanna of Kebbi State

	Leaf length (cm)								
	3 WAS			**6 WAS**			**9 WAS**		
Trellising	**2023**	**2024**	**Combined**	**2023**	**2024**	**Combined**	**2023**	**2024**	**Combined**
Trellised	8.54	8.35[a]	8.45	11.34	12.76	12.05a	12.78[a]	16.40[a]	14.59[a]
Un-trellised	8.14	8.29[b]	8.22	11.15	12.07	11.61b	12.28[b]	15.88[b]	14.08[b]
SE±	**1.091**	**1.33**	**1.486**	**0.569**	**0.967**	**0.839**	**0.991**	**0.468**	**0.781**
Interaction									
S x T	NS	NS	NS	NS	NS	NS	NS	NS	NS

Means followed by the same letter(s) within a column in each treatment are not significantly different at 5% using DMRT. *= Significant at 5%, NS= not significant. WAS= Weeks after sowing

The result at table 5 showed that trellised cucumber produced the largest leaf width then untrellising cucumber throughout the sampling stages and also significant differences was

observed. Possibly due to the available resources the occurred by vertical growing of the plant. this result is alien with the finding of Muhammad *et al*. (2023); Ansa and Garjila. (2019).

Table 5: Effect of trellising on Leaf width of cucumber during 2023/2024 and 2024/2025 dry seasons and combined data at Jega Sudan Savanna of Kebbi State

	Leaf width (cm)								
	3 WAS			6 WAS			9 WAS		
Trellising	**2023**	**2024**	**Combined**	**2023**	**2024**	**Combined**	**2023**	**2024**	**Combined**
Trellised	11.85[a]	11.03	11.44[a]	13.91[a]	14.64[a]	14.28[a]	14.68[a]	16.29[a]	15.48[a]
Un-trellised	10.35[b]	10.35	10.35[b]	12.92[b]	14.15[b]	13.53[b]	14.15[b]	15.90[b]	15.02[b]
SE±	**1.227**	**1.170**	**1.907**	**0.918**	**0.615**	**1.056**	**0.567**	**0.306**	**0.669**
Interaction									
S x T	*	NS	NS	*	NS	NS	*	NS	NS

Means followed by the same letter(s) within a column in each treatment are not significantly different at 5% using DMRT. *= Significant at 5%, NS= not significant. WAS= Weeks after sowing

Leaves area index (LAI)

The result (Table 6) showed that there was significant effect of trellising on vegetative growth of cucumber. Improved canopy architecture and aeration likely contributed to these gains. Moreover, trellised plants produced significantly leaves area index (LAI) compared with untrellised ones, which suggests superior leaf expansion and enhanced photosynthetic efficiency. The finding was supported Peter *et al*., 2024a work.

Table 6: Effect of trellising on Leaf Area Index (LAI) of cucumber during 2023/2024 and 2024/2025 dry seasons and combined data at Jega Sudan Savanna of Kebbi State

	Leaf Area Index (LAI)								
	3 WAS			6 WAS			9 WAS		
Trellising	**2023**	**2024**	**Combined**	**2023**	**2024**	**Combined**	**2023**	**2024**	**Combined**
Trellised	1.11[a]	1.19	1.16	1.78	3.49	2.63	3.41	6.34	4.74
Un-trellised	0.67[b]	1.21	0.94	1.56	2.81	2.19	3.12	5.28	4.11
SE±	**0.15**	**0.2**	**0.15**	**0.150**	**0.241**	**0.152**	**0.150**	**0.253**	**0.154**
Interaction									
S x T	NS	NS	NS	NS	NS	NS	NS	NS	NS

Means followed by the same letter(s) within a column in each treatment are not significantly different at 5% using DMRT. *= Significant at 5%, NS= not significant. WAS= Weeks after sowing

Fruit Yield and Yield Qualities

The result (Table 7) revealed that trellising significantly enhanced more number fruits (7.07) then untrellised cucumber (5.50) combined data. earlier flowered (33.08 days)then non trellised cucumber (33.42), , and also significant effect was observed at trellised cucumber on

fresh fruit yield per hectare (t ha^{-1}) trellised plant recorded the high fruit weight (11.77 t ha^{-1}) then non-trellised cucumbers(7.60 t ha^{-1}) possibly due to better light penetration and available resource. This observation agrees with Muhammad *et al*. (2023), and Peter et al. (2024).

Table 7: Effect of trellising on Days to 50% flower, number of fruit and fresh fruit yields weight (t ha^{-1}) of cucumber during 2023/2024 and 2024/2025 dry seasons and combined data at Jega Sudan Savanna of Kebbi State

	Days to 50% flower			No: of fruit			Fruit weight (t ha^{-1})		
Trellising	**2023**	**2024**	**Combined**	**2023**	**2024**	**Combined**	**2023**	**2024**	**Combined**
Trellised	37.17	29.00	33.08	6.62[a]	7.53[a]	7.07[a]	9.15[a]	14.39[a]	11.77[a]
Un-trellised	38.00	38.83	33.42	5.54[b]	5.50[b]	5.52[b]	5.66[b]	9.94[b]	7.60[b]
SE±	2.025	1.423	1.464	1.698	1.250	1.654	0.440	0.443	0.462
Interaction									
S x T	NS	NS	NS	NS	NS	NS	NS	NS	NS

Means followed by the same letter(s) within a column in each treatment are not significantly different at 5% using DMRT. *= Significant at 5%, NS= not significant. WAS= Weeks after sowing

Fruit qualities

The result (Table 8) revealed that trellising had significant on fruit length, fruit girth and non-marketable fruits. Trellising reduced longest, bigger and the less number of non-marketable (5.68%) fruits by minimizing fruit-soil contact and lowering disease incidence. Similar findings were reported by Muhammad *et al*. (2023), and Peter et al. (2024). Although trellised plants occasionally suffered minor fruit abrasions from wind movement against the supports, their overall fruit quality and yield were substantially higher than un-trellised plants.

Table 8: Effect of trellising on fruit length, fruit diameter and percentage of non-marketable fruit of cucumber during 2023/2024 and 2024/2025 dry seasons and combined data at Jega Sudan Savanna of Kebbi State

	fruit length (cm)			Fruit diameter (cm)			Non-marketable (%)		
Trellising	**2023**	**2024**	**Combined**	**2023**	**2024**	**Combined**	**2023**	**2024**	**Combined**
Trellised	15.15[a]	14.64[a]	14.90[a]	6.41[a]	6.17[a]	6.41[a]	6.04[b]	5.31[b]	5.68[b]
Un-trellised	13.09[b]	13.36[b]	13.22[b]	5.88[b]	5.93[b]	5.91[b]	10.83[a]	14.55[a]	12.69[a]
SE±	1.961	0.897	1.588	0.436	0.297	0.444	0.569	0.467	0.539
Interaction									
S x T	NS	*	NS	NS	NS	NS	NS	NS	NS

Means followed by the same letter(s) within a column in each treatment are not significantly different at 5% using DMRT. *= Significant at 5%, NS= not significant. WAS= Weeks after sowing.

Summary

Trellising proved to be a profoundly beneficial practice. Trellised plants were significantly taller, had more leaves, and exhibited larger leaf dimensions than non-trellised plants. Most importantly, trellising resulted in a 55% increase in fruit yield (11.77 t ha^{-1} and 7.6 t ha^{-1}) and significantly improved fruit quality. It significantly increased fruit length and diameter while reducing the proportion of non-marketable fruits by over 50% (5.68% and 12.69%) by preventing soil contact, deformities, and diseases.

Conclusion

Trellising significantly enhanced the vegetative and reproductive performance of cucumber in the Sudan Savanna. The practice improved plant growth, yield, and fruit quality while reducing losses due to soil contact and physical damage. Therefore, trellising is recommended for cucumber growers in northern Nigeria to achieve higher productivity and profitability.

Agronomic Implications

Trellising is labor-intensive but offers improved land utilization, easier harvesting, and effective pest and disease management. Its role in increasing photosynthetic efficiency correlates strongly with higher fruit yields and quality, making it a vital practice for cucumber cultivation in resource-limited environments like the Sudan Savanna.

Recommendation

Adopt trellising widely: Training cucumber vines on sturdy supports should be standard practice. Trellises improve light and air circulation, boosting growth and fruit set. They also keep fruits clean, markedly reducing losses. If possible, use flexible netting or avoid overly abrasive supports to minimize fruit scars.

Further research: Future trials should explore the interaction of spacing with water management. For example, testing drip irrigation at different densities could optimize both water use and yield. Economic analyses are also needed to weigh the cost of disease control at high densities versus the value of increased yield. Additionally, experimenting with improved trellis designs (e.g., tensioned nets) might reduce fruit damage while retaining support benefits.

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