

Growth, Yield and Weed Suppression of Groundnut Varieties (*Arachis hypogaea* L.) as Influenced by Intra-Row Spacing in the Sudan Savannah Ecological Zone of Nigeria

Kabir, M. M.; Bello, T. T.; and Shittu, E. A. 

Department of Agronomy, Bayero University, Kano, P.M.B 3011, Kano, Nigeria.

Corresponding author: seabraham.agr@buk.edu.ng

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Abstract

Field trials were conducted during the 2023 rainy season at the Teaching and Research Farm, Faculty of Agriculture, Bayero University Kano, and the Institute of Agricultural Research (IAR) research farm Minjibir, Kano, Nigeria, to evaluate the growth, yield, and weed suppression of groundnut varieties as influenced by intra-row spacing. The experiment treatments consisted of five varieties of groundnut, which were made up of four improved varieties (SAMNUT-21, SAMNUT-23, SAMNUT-24, SAMNUT-27) and a local variety (Maibargo) with three intra-row spacings (20, 30, and 40 cm), respectively, which were factorially combined and laid out in a Randomized Complete Block Design (RCBD) and replicated three times. Results showed that variety significantly ($P < 0.001$) influenced plant height, number of branches, number of leaves, and canopy spread. SAMNUT-23 and Maibargo exhibited superior growth characteristics compared to other varieties. Intra-row spacing also significantly ($P < 0.001$) affected plant growth, with wider spacing generally leading to increased plant height, number of branches, and canopy spread. Additionally, variety and intra-row spacing interaction significantly impacted weed control, with narrower spacing and certain varieties demonstrating better weed suppression. In terms of yield, SAMNUT-23 consistently outperformed other varieties in pod ($1013.7 \text{ kg ha}^{-1}$), haulm (2012 kg ha^{-1}), and kernel yield (599.7 kg ha^{-1}). Thus, the combination of SAMNUT-23 with 20 cm intra-row spacing proved to be the most effective in maximizing yield and minimizing weed competition. These findings highlight the importance of variety selection and optimal spacing in improving groundnut productivity.

Keywords: Groundnut, Intra-Row Spacing, Growth, Yield, Weed Suppression.

Introduction

Groundnut (*Arachis hypogaea* L.) is a globally valuable and nutritionally rich product with a high content of essential mineral elements (Na, Cu, Zn, Fe, Ca, Mg, and K), vitamins (E, K, and B), and essential minerals, making it a crucial source of nutrition for humans and animals (Bakal and Arioglu, 2019; Ergun and Zarifikhosroshahi, 2020; Yasli *et al.*, 2020; Yilmaz *et al.*, 2022). In 2020, the world produced 53.7 million tonnes of peanut shells, with Asia and Africa contributing 90%, and China and India accounting for over half of the total. Groundnut oil contains seven major fatty acids, with linoleic and oleic acids accounting for 80% of the total composition. These acids influence nutrition, shelf life, and flavor. High

oleic content extends product shelf life, reduces cardiovascular disease risk, and lowers cholesterol levels (Jackson *et al.*, 2024).

This study explores the relationship between plant population density, resource competition, and weed interference. It posits that plant growth and yield are influenced by the availability of essential resources like light, water, and nutrients. The study also explores the impact of intra-row spacing on canopy development, root expansion, and resource utilization efficiency. Nigeria's groundnut production, especially in the Sudan savannah ecological zone, is hindered by suboptimal agronomic practices, particularly in plant spacing and weed management. Inappropriate spacing leads to competition and resource underutilization, affecting growth and yield (Amare and Gebremedhin, 2020). High weed infestations cause substantial yield losses (Horvath *et al.*, 2023).

Small-scale farmers in Sub-Saharan Africa cultivate groundnut farms to meet household food needs and sell output, potentially escaping poverty traps by increasing income and improving soil fertility (Tabe Ojong, 2021; Lokossou *et al.*, 2022). Groundnut yield is low due to environmental factors like soil type, sowing time, seed rate, fertilizers, and irrigation time, with row spacing playing a crucial role in achieving higher yields (Desmae *et al.*, 2022; Haro *et al.*, 2022). Agronomic practices significantly impact groundnut productivity, with intra-row spacing optimizing growth, yield, and weed suppression, and plant density being a crucial technique affecting development, yield, and quality. In order to maximize grain seed yield, optimal density guarantees that there is less interspecies competition and that growth resources are efficiently captured and used both above and below ground (Qodliyi and Nyoto, 2018; Elahi *et al.*, 2022; Zhu *et al.*, 2023).

Crop physiological processes can be harmed by improper plant density and spacing, which can result in decreased yields and inefficient use of the limited growth resources. While closely packed plants decrease vegetative and lateral development, leaving inadequate horizontal growth space, widely spaced groundnut types allow weeds, pests, and diseases to proliferate (Mani *et al.*, 2021; Iddrisu *et al.*, 2024). Population density, growth, and other factors are closely related to spacing, which has an impact on crop productivity and growth (Haarhoff and Swanepoel, 2022). Proper spacing is crucial for maintaining plant population per given area and increasing yields in line sowing, and assessing the effects of different varieties on groundnut growth is essential for evaluating suitable varieties. The purpose of the trials was to evaluate how variety and intra-row spacings affected groundnut performance and weed suppression.

Materials and Methods

Site description

Two field trials were carried out the 2023 rainy season at the Teaching and Research farm of Faculty of Agriculture, Bayero University Kano (Latitude 11° 58' N and longitude 8°41' E) and Institute for Agricultural Research (IAR) Farm Minjibir (Latitude 12°17' N and longitude 8° 55' E) situated within the Sudan savannah zone of Nigeria. Both areas share the same

climatic conditions such as, average annual rainfall of 696 mm, mean annual temperature ranges of 19.7 - 26.4 °C with 44 °C and 32 °C as the maximum and minimum temperatures obtained between April and January, respectively (Mamman *et al.*, 2000). The areas are characterized by a long dry season of about 8 months (October - June) and a short rainy season (June/July -September/October) with the peak in August. The total amount of rainfall received was 989.8 mm and 790.4 mm for BUK and Minjibir, respectively.

Field layout

The field was cleared of shrubs and debris and shortly followed by harrowing, and ridges were made. Each plot has a total of six ridges of 4.8 m long and a breadth of 4.5 m, making a gross plot size of 21.6 m², while the net plot size comprised four inner rows (14.4 m²). A pathway of 0.5 m and 1.0 m was left within rows and replications for ease of movement.

Treatment and experimental design

The treatments comprised five varieties of groundnut, of which four are improved varieties (SAMNUT 21, SAMNUT 23, SAMNUT 24, SAMNUT 27) and a local variety (Maibargo) with three intra-row spacings (20, 30, and 40 cm), respectively. The treatments were factorially combined, laid out in Randomized Complete Block Design (RCBD), and replicated three (3) times.

Cultural Practices

Seed sowing

Prior to sowing, seeds were separately treated with a seed dressing chemical, Apron Plus (Thiametoxam + Metalaxyl-N and Difenoconazole) at the rate of 10 g a.i./3 kg seeds to control soil-borne pests. Seeds were sown directly into the field at a depth of 3 cm and at the rate of two seeds per hole by dibbling at 0.75 m on rows and with varying intra-row spacings as per treatment combination.

Fertilizer application

Fertilizer was applied at the rate of 20-40-20 using NPK 15:15:15/ha and SSP 18% at 3 and 6 weeks after sowing (WAS). Half of SSP and all of N and K were applied at 3 WAS while the remaining half of P was applied at 6 WAS.

Weeding and Pest Control

The first weeding was carried out manually by hand hoeing at 3 weeks after sowing (WAS), and the second weeding was at 6 WAS. We regularly visited the experimental field to assess the occurrence of pests and diseases, managing them with appropriate control measures.

Harvesting

Harvest was carried out when the crop attained physiological maturity, i.e., when most of the leaves had turned brown and the groundnut pods had a pronounced brown color. The

harvest operation was done manually using a hoe by digging out the whole plant, including the pods, and picking up the remaining pods from the soil with hands. Thereafter, the pods were detached from the haulm and allowed to dry for several days under the sun.

Data Collection

Data were collected on weed parameters and crop performance.

i. Weed parameters

Weed Cover Score at Harvest: The weed cover was scored visually using a scale of 5, where 1 represents low weed cover, 2 represents moderate weed cover, 3 represents moderately high weed cover, 4 represents high weed cover, and 5 represents the highest weed cover.

Weed density: The weed count was taken from randomly placed 1 m² quadrants in each plot, and the value was recorded.

Weed dry weight (kg ha⁻¹): The weeds from a randomly placed 1 m² quadrant were collected and dried in an oven at 65°C to a constant weight. The dried weeds were weighed using an electric balance (ADAM model with a precision of 0.1 g), and the value was recorded and extrapolated into hectares.

ii. Crop growth and yield parameters.

Data were collected on the number of branches per plant, number of leaves, canopy spread, pod yield, kernel yield, and haulm yield using standard agronomic procedures.

Data Analysis

The data collected was subjected to two-way analysis of variance (ANOVA) via GenStat statistical software. Significant treatment means were separated using Student Newman's Keuls test (SNK) at the 5% level of significance.

Results

Weed density, weed dry weight and weed cover score

Groundnut varieties significantly influenced weed dry weight at both locations and weed density and weed cover score at Minjibir, while non-significant effects were observed at BUK (Table 1). Higher weed dry weight was observed on SAMNUT-24 at BUK, while SAMNUT-23 had the lowest. At Minjibir, SAMNUT-27 consistently recorded the highest weed density, weed dry weight, and cover score. Intra-row spacing significantly influenced weed density, weed dry weight, and weed cover score in both locations. Weed density, dry weight, and cover score significantly increase with increasing intra-row spacing in both locations (Table 1). The interaction between groundnut variety and intra-row spacing had a significant effect on weed density at Minjibir (Table 2), where the SAMNUT 27 spaced 40 cm significantly ($P < 0.05$) produced higher weed density, although at par with other interaction combinations.

Table 1: Weed cover score, weed density and weed dry weight of groundnut as influenced by variety and intra-row spacing at BUK and Minjibir during 2023 wet season

	Minjibir			BUK		
Treatment	Weed cover score	Weed density (m ⁻²)	Weed dry weight (g)	Weed cover score	Weed density (m ⁻²)	Weed dry weight (g)
Variety (V)						
SAMNUT-21	2.1	55.5	1167abc	2.4b	66.6b	904b
SAMNUT-24	1.8	54.5	1528a	2.0b	68.6b	1087b
SAMNUT-23	1.7	53.5	779c	1.8b	55.5b	898b
SAMNUT-27	2.2	62.0	1511ab	3.1a	82.6a	1547a
<i>Maibargo</i>	1.9	51.3	1044c	1.8b	61.7b	1204b
Probability level	0.062	0.512	0.001	0.001	0.002	0.003
SE _±	0.12	4.36	113.2	0.18	4.78	116.9
20	1.37c	37.6c	780c	1.7b	52.8b	931b
30	1.89b	54.9b	1163b	2.4a	69.2a	1157ab
40	2.71a	73.7a	1675a	2.5a	73.21a	1296a
Probability level	0.001	0.001	0.001	0.001	0.001	0.027
SE _±	0.22	3.38	87.7	0.14	3.70	90.6
Interaction						
V × S	0.898	0.645	0.054	0.071	0.024	0.182

Means with the same letter(s) in the same column are not significantly different ($P < 0.05$) using Students-Neuman Keuls (SNK). Weed cover score using visual observation on a scale of 1-5, with 1 as low and 5 as highest.

Table 2: Interaction between variety and intra-row spacing on weed density of groundnut at Minjibir in 2023 rainy season

	Intra-row Spacing (cm)		
	20	30	40
Variety			
SAMNUT-21	50.6bc	67.3abc	48.6bc
SAMNUT-24	67.6bc	62.0bc	70.6abc
SAMNUT-23	37.3c	64.6abc	83.6ab
SAMNUT-27	77.0abc	68.6abc	102.3a
<i>Maibargo</i>	41.3c	61.0bc	33.0c
SE _±	8.28		

Means with the same letter(s) in the same column are not significantly different ($P < 0.05$) using Students-Neuman Keuls (SNK).

Growth characters

Number of branches per plant

The number of branches was significantly influenced by variety across all sampling periods in both locations. Maibargo and SAMNUT-21 varieties significantly produced a higher

number of branches compared to SAMNUT-24, which had fewer branches. (Table 3). Intra-row spacing had no significant effect ($P > 0.05$) on the number of branches at all sampling periods at BUK. However, it was significant at Minjibir, where the wider spacing of 40 cm significantly produced more branches at all sampling periods than the rest of the intra-row spacings. A significant interaction between variety and intra-row spacing was observed at 12 WAS, where the Maibargo variety spaced at 40 cm and SAMNUT 23 spaced at 20 cm significantly ($P < 0.001$) resulted in producing more branches per plant, although statistically comparable with the rest of the interactions.

Table 3: Number of branches per plant of groundnut as influenced by variety and intra-row spacing at BUK and Minjibir during 2023 wet season

Treatment	BUK			Minjibir		
	6	9	12	6	9	12
Variety (V)						
SAMNUT -21	15.5a	27.0a	27.8a	13.4a	18.7a	19.6a
SAMNUT -24	10.2c	11.6c	13.7c	10.1c	13.1c	17.4b
SAMNUT -23	13.3b	15.9b	18.1b	11.8b	16.6b	18.6a
SAMNUT -27	12.0b	18.2b	20.4b	11.6b	13.7c	17.1b
<i>Maibargo</i>	16.5a	24.4a	26.5a	14.5a	19.4a	22.8a
Level of probability	0.01	0.001	0.001	0.001	0.006	0.001
SE $\pm$	0.592	1.164	1.233	0.372	0.256	0.289
20	14.0	19.0	20.3	9.2c	11.6c	16.7c
30	13.0	19.5	20.8	10.6b	12.7b	17.6b
40	13.6	19.9	22.8	12.4a	15.0a	18.9a
Level of probability	0.319	0.787	0.162	0.001	0.001	0.001
SE $\pm$	0.458	1.275	0.955	0.288	0.199	0.224
Interaction						
V $\times$ S	0.149	0.182	0.280	0.976	0.956	0.206

Means with the same letter in the same column are not significantly different ($P < 0.05$) using Students-Neuman Keuls (SNK).

Number of leaves per plant

Table 4 shows the number of leaves per plant of groundnut as influenced by variety and intra-row spacing at BUK and Minjibir. Results indicated that the number of leaves was significantly influenced by variety and intra-row spacing across all sampling periods at BUK and between 9 and 12 WAS at Minjibir. The SAMNUT 23 and Maibargo varieties substantially produced a larger number of leaves than SAMNUT 24, which had fewer leaves at both locations and sampling periods, respectively. On the other hand, intra-row spacing had a significant influence on the number of leaves at Minjibir, while it was non-significant at BUK across the sampling periods. Plants spaced at 40 cm significantly ($P < 0.05$) resulted

in a greater number of leaves than those with narrow spacing across the sampling periods. The interaction between groundnut variety and intra-row spacing on the number of leaves was significant at 12WAS in Minjibir (Table 5). The combination of SAMNUT 23 with 20 cm spacing and Maibargo spaced at 40 cm significantly resulted in a higher number of leaves comparable with other interaction combinations, although SAMNUT 24 and 27 spaced at 30 cm resulted in the lowest number of leaves at 12 WAS.

Table 4: Number of leaves of groundnut as influenced by variety and intra-row spacing at BUK and Minjibir during 2023 wet season.

Treatment	BUK			Minjibir		
	Weeks after sowing (WAS)					
	6	9	12	6	9	12
Variety (V)						
SAMNUT -21	343.6ab	566.0b	736.6b	322.1	507.9bc	584.5bc
SAMNUT -24	268.1c	499.9bc	694.6bc	331.4	522.3b	492.4c
SAMNUT -23	322.4b	815.7a	1228.8a	348.2	609.0a	692.1a
SAMNUT -27	265.0c	598.0b	722.6b	333.6	461.8c	505.9c
Maibargo	417.0a	833.0a	879.6ab	358.6	611.6a	649.1ab
Level of probability	0.001	0.001	0.038	0.183	0.002	0.001
SE±	20.50	45.0	129.5	11.17	27.8	30.5
Intra-row spacing [S](cm)						
20	333.2	639.0	819.0	320.7b	457.5c	562.1b
30	303.1	633.0	747.0	332.2b	522.7b	486.7c
40	333.3	715.0	991.0	363.4a	467.3a	705.6a
Level of probability	0.316	0.195	0.227	0.005	0.001	0.001
SE±	15.88	34.9	100.3	8.65	21.5	23.6
Interaction						
V x S	0.101	0.723	0.446	0.177	0.299	0.013

Means with the same letter(s) in the same column are not significantly different ($P < 0.05$) using Students-Neuman Keuls (SNK).

Table 5: Interaction between variety and intra-row spacing on number of leaves at 12 WAS at Minjibir during 2023 wet season

	Intra-row Spacing (cm)		
Variety	20	30	40
SAMNUT-21	521.5bcd	549.5bcd	682.5abc
SAMNUT-24	457.2cd	368.5d	651.5abc
SAMNUT-23	795.2a	557.8bcd	723.1ab
SAMNUT-27	505.5bcd	320.4d	666.5abc
<i>Maibargo</i>	530.8bcd	637.3abc	804.5a
SE $\pm$	52.8		

Means with the same letter(s) across row and column are not significantly different ($P < 0.05$) using Students-Neuman Keuls (SNK).

Canopy Spread (cm)

The results obtained indicated that groundnut varieties significantly affected canopy spread at 6, 9, and 12 WAS at BUK, while it had no significant ($P > 0.05$) effect throughout the sampling periods at Minjibir (Table 6). The Maibargo, SAMNUT 23, and SAMNUT 27 varieties consistently produced wider canopies, while SAMNUT-24 had a lower canopy, although at par with SAMNUT 21 at 6. A similar pattern of results was equally obtained at 9 and 12 WAS in BUK. On the other hand, intra-row spacing had no significant effect on canopy cover at BUK throughout the sampling periods, while at Minjibir, the wider spacing of 40 cm and 30 cm significantly produced a wider canopy at 6 and 9 WAS, while at 12 WAS, the 40 cm significantly produced a wider canopy compared with the 20 cm intra-row spacing that resulted in narrow spacing throughout the sampling period. The interaction between variety and intra-row spacing on canopy spread was not significant ($P > 0.05$) throughout the sampling periods and across the locations.

Table 6: Canopy spread of Groundnut as influenced by variety and intra-row spacing at BUK and Minjibir during 2023 wet season

Treatment	BUK			Minjibir		
	6	9	12	6	9	12
Variety (V)						
SAMNUT -21	33.6ab	41.3cd	47.0b	34.0	42.78	52.1
SAMNUT -24	30.7b	39.2d	46.2b	35.1	43.00	52.3
SAMNUT -23	36.5a	45.5bc	50.6ab	35.8	42.44	53.5
SAMNUT -27	36.4a	48.3ab	55.4a	34.0	41.44	51.5
Maibargo	37.9a	52.4a	55.8a	34.1	44.11	54.2
Level of probability	0.005	0.001	0.001	0.144	0.529	0.843
SE $\pm$	1.325	1.708	2.404	0.594	1.070	0.625
20	34.5	43.8	49.6	31.3b	39.60b	48.4c
30	34.7	45.9	51.3	35.6a	42.92ab	52.6b
40	36.0	46.4	52.1	36.9a	45.75a	56.3a
Level of probability	0.551	0.358	0.417	0.001	0.001	0.001
SE $\pm$	1.027	1.323	1.862	0.460	0.829	0.484
Interaction						
V x S	0.191	0.979	0.907	0.986	0.413	0.492

Means with the same letter(s) in the same column are not significantly different at ($P < 0.05$) using Students-Neuman Keuls (SNK).

Yield and yield related characters

Table 7 presents the pod yield, haulm yield, and kernel yield of groundnut as influenced by variety and intra-row spacing at BUK and Minjibir. Results reveal that the SAMNUT-23 variety produced significantly ($P < 0.001$) higher pod yield compared to SAMNUT 21, which produced lower pod yield at both locations. Haulm yield was only significant at BUK, where the SAMNUT 23 and Maibargo varieties resulted in higher yield compared to SAMNUT 21, which had a lower yield, although it was at par with other varieties. The SAMNUT 23 significantly resulted in higher kernel yield compared with other varieties, although SAMNUT 21 resulted in the lowest kernel yield at both locations. On the other hand, the yield-related characters were highly ($P < 0.001$) significant due to intra-row spacings at BUK only, where plants spaced 20 cm significantly produced higher pod, haulm, and kernel yields, respectively.

The interaction between variety and intra-row spacing on pod yield and kernel yield was significant at BUK and is shown in Table 8. Kernel yield of all the varieties consistently decreased with an increase of intra-row spacing. SAMNUT 23 spaced at 20 cm significantly ($P < 0.001$) produced higher pod and kernel yield, while SAMNUT 27 and Maibargo varieties spaced at 40 cm significantly resulted in lower pod and kernel yield, respectively.

Table 7: Pod yield, Haulm yield and Kernel yield of Groundnut as influenced by variety and intra-row spacing at BUK and Minjibir during 2023 wet season

Treatment	BUK			Minjibir		
	Pod yield (kg ha ⁻¹)	Haulm yield (kg ha ⁻¹)	Kernel yield (kg ha ⁻¹)	Pod yield (kg ha ⁻¹)	Haulm yield (kg ha ⁻¹)	Kernel yield (kg ha ⁻¹)
Variety (V)						
SAMNUT -21	168.6d	1063b	94.05c	130.0c	941	69.3c
SAMNUT -24	271.8b	1551ab	167.2b	177b	1334	109.6b
SAMNUT -23	1013.7a	2012a	599.7a	639.6a	1505	363.9a
SAMNUT -27	237.9c	1581ab	120.4c	262.3b	1444	144.6b
Maibargo	386.7b	1947a	291.4b	306.1b	1661	219.9b
Level of probability	0.001	0.043	0.001	0.001	0.062	0.001
SE _±	60.00	225.3	22.20	47.00	144.6	41.40
Intra-row spacing (S) (cm)						
20	570.4a	2200a	334.2a	303.0	1756	138.0
30	316.9b	1510b	221.5b	286.5	1283	185.0
40	270.0b	1182b	117.9c	229.5	1273	124.5
Level of probability	0.001	0.001	0.001	0.621	0.439	0.560
SE _±	46.50	174.5	17.25	54.60	112.0	32.10
Interaction						
V x S	0.041	0.918	0.001	0.930	0.308	0.897

Means with the same letter(s) in the same column are not significantly different at 5% using Students-Neuman Keuls (SNK).

Table 8: Interaction between variety and intra-row spacing on pod yield and kernel yield at BUK during 2023 rainy season

	Intra row spacing (cm)		
	20	30	40
Variety (V)	Pod yield (Kg ha ⁻¹)		
SAMNUT -21	247.9d	139.0d	118.95d
SAMNUT -24	382.0bd	260.4d	172.8d
SAMNUT -23	1566.7a	736.0bc	738.3b
SAMNUT -27	288.9d	239.7d	185.2d
Maibargo	366.3bd	209.4d	134.4d
SE±	103.8		
	Kernel yield (Kg ha ⁻¹)		
SAMNUT -21	135.1c	80.55c	66.6
SAMNUT -24	242.7c	155.4c	103.5c
SAMNUT -23	930.1a	609.9b	260.5c
SAMNUT -27	152.1c	128.5c	80.5d
Maibargo	210.4c	135.4c	78.4d
SE±	38.55		

Means with the same letter(s) across rows and column are not significantly different ($P \leq 0.05$) using Students-Neuman Keuls (SNK).

Discussion

Row spacing significantly impacts weed suppression, with closer spacing resulting in a minimum weed cover score, weed density, and dry weight. The SAMNUT-24 and SAMNUT-27 varieties showed higher weed dry weight and density at BUK and Minjibir, suggesting lower competitive ability against weeds and less effective suppression of weed growth. The ability of SAMNUT-23 and Maibargo varieties to suppress weeds better than other varieties could be attributed to the fact that SAMNUT-23 has a relatively high LAI and Maibargo, with its spontaneous spreading growth habit, thereby cutting solar radiation and starving the weeds from photosynthesizing. This finding is in line with those of Koroma (2023) and Shittu *et al.* (2022 a & b; 2023), who reported that the SAMNUT 23 variety has the genetic potential of growing taller and forming a canopy, which in turn suppresses the growth of weeds. BUK experiences higher weed dry weight than Minjibir due to higher rainfall, which promotes weed growth and sprouting. This aligns with Wacławowicz *et al.* (2023), who reported that increased rainfall in the crop growth stages enhances weed proliferation and increased density.

In comparison to wider row spacing (40 cm), the minimum weed cover score, weed density, and weed dry weight observed with closer spacing (20 cm) may be explained by the fact

that closely spaced groundnuts covered the ground earlier than widely spaced crops, suppressing weeds and denying them solar radiation. This is consistent with the justification provided by Dolie and Nongmaithem (2019), Jallow et al. (2019), and Mohammed and Getnet (2019), who independently reported the weed suppression capacity of groundnut varieties in a variety of ecologies due to their close spacing. This was influenced by the varieties' early canopies, which were able to suffocate weeds and impede their growth. Hence, SAMNUT-23 with an intra-row spacing of 20 cm provided the best weed-suppressing ability due to lower weed density and weed cover compared to suggesting the efficacy of this combination, while SAMNUT-27 and 40 cm intra-row spacing combination resulting in higher weed parameters may promote weed growth. Groundnut varieties' crop canopy closure rates, allelopathic compounds, and intra-row spacing affect weed growth, with denser canopy shading out weeds and allelopathic compounds inhibiting growth. This corroborates the findings of Scavo *et al.* (2021), Kong *et al.* (2024), and Shittu *et al.* (2025), who reported the role of allelopathy mediating plant-plant interaction.

The superiority of the SAMNUT-23 and Maibargo varieties in terms of number of leaves, number of branches, and canopy spread could be attributed to their genetic makeup to possess such peculiarities compared with other varieties under consideration, as SAMNUT-23 has the habit of not shedding its leaves and Maibargo has more branches, thus more leaves leading to higher canopy formation. Similar findings were earlier reported by Shittu *et al.* (2023) and Abubakar *et al.* (2024).

The ability of SAMNUT-23 performed better than other varieties in terms of yield and yield components by producing higher pod, haulm, and kernel yield. This could be attributed to the genetic make-up of the variety, varietal adaptation to ecology, and its ability to adequately intercept solar radiation at different leaf orientations, which enhances its photosynthetic efficiency and better translocation of photosynthates from source to sink with higher accumulation of photosynthates in the seeds; this result is in conformity with that of Ladan *et al.* (2019). According to Shittu *et al.* (2023), the relatively bigger kernel size of SAMNUT 23 favors its kernel weight and yield compared to SAMNUT 14 and 22. An intra-row spacing of 20 cm produced the highest yield characteristics; this could be due to high planting density per unit area and less crop-weed competition compared to the wider spacing of 40 cm, which produced the lowest. This might be due to reduced plant density per unit area with a lower number of pods per plant. This finding is in agreement with those reported by several scientists that intra-row spacing significantly affects groundnut productivity (Gutu *et al.*, 2019; Mohammed and Getnet, 2019; Tyoakoso *et al.*, 2020; Ibrahim *et al.*, 2021; Nguyen *et al.*, 2023). The significant interaction obtained between SAMNUT 23 and 20 cm intra-row spacing on pod yield and kernel yield could be attributed to the genetic potential of the variety coupled with plant population per unit area, which resulted in a higher number of branches per plant, canopy spread, and varietal adaptation to the ecology, which translated to high photosynthetic efficiency and dry matter production as earlier reported by Nguyen *et al.* (2023) and Shittu *et al.* (2023).

Conclusion and Recommendation

The study demonstrated that groundnut variety and intra-row spacing significantly influenced weed density, dry weight, and cover score. Among the varieties, SAMNUT-27 exhibited the highest weed infestation, while SAMNUT-23 consistently had lower weed dry weight. Intra-row spacing played a crucial role, with wider spacing (40 cm) resulting in increased weed competition.

The findings further indicated that SAMNUT-23 variety outperform of varieties in weed suppression, plant growth, and yield, likely due to its genetic potential and canopy architecture. Narrower intra-row spacing (20 cm) resulted in better weed control, higher plant density, and increased yield. The combination of SAMNUT-23 with 20 cm intra-row spacing proved to be the most effective in maximizing yield and minimizing weed competition. Thus, it can be suggested for farmers in the study area to prioritize the cultivation of high-yielding and weed-suppressive varieties like SAMNUT-23 and use narrower intra-row spacing (20 cm) for better weed control and resource utilization.

Limitation of the Study

The study was conducted in only two locations (BUK and Minjibir), limiting the generalizability of the findings to other agro-ecological zones. It did not consider soil fertility variations, inter-row spacing, or environmental factors like rainfall and temperature variations, which could have influenced plant growth and yield. The study also lacked extensive evaluation of environmental factors.

Future Research Directions

Future research should focus on validating findings across different agro-ecological zones, examining the impact of inter-row and intra-row spacing on weed competition and yield performance, analyzing weed species composition in different groundnut varieties and spacing regimes, exploring soil fertility management's influence on yield, and assessing the long-term impact of spacing and variety selection on soil health and sustainability.

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