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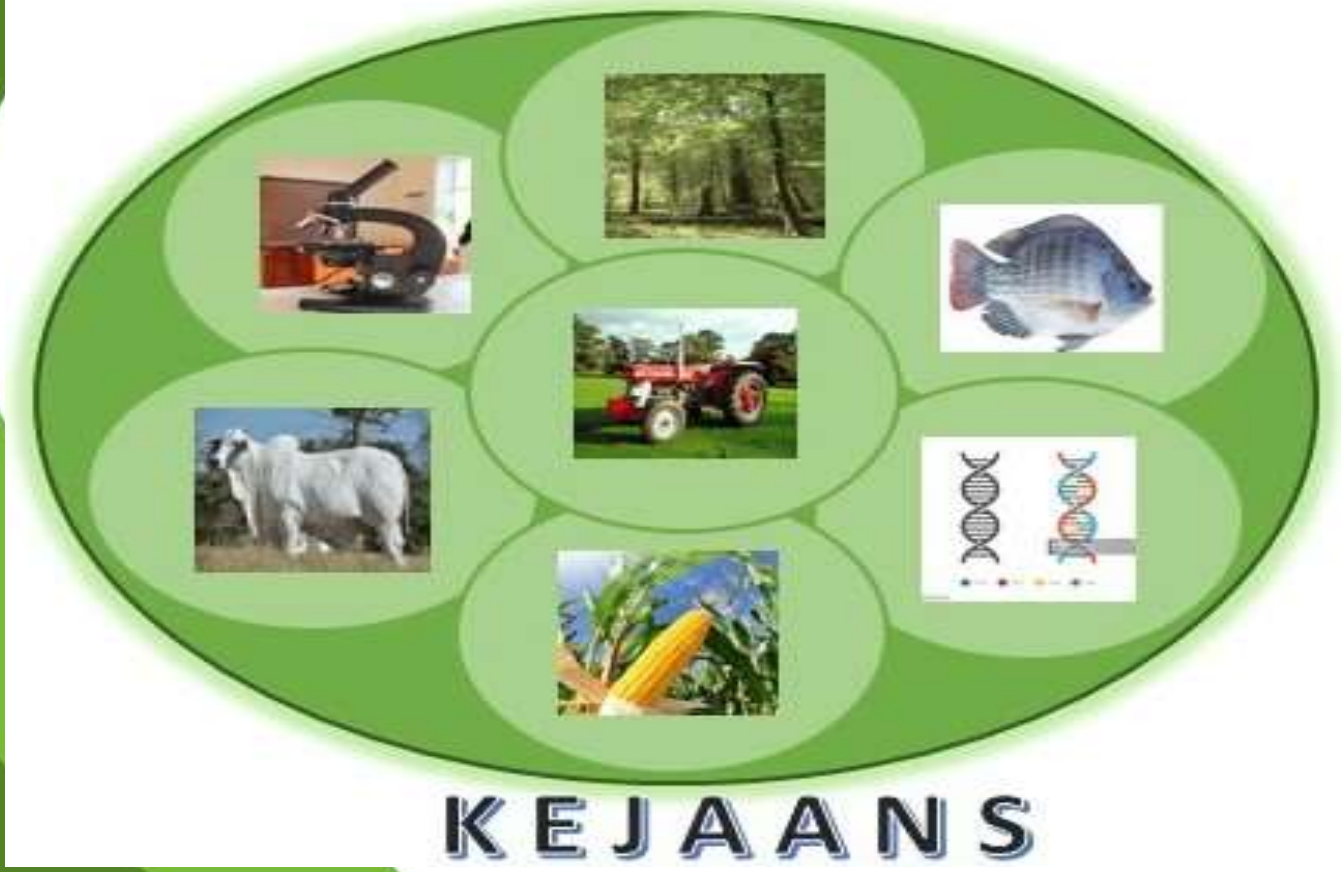

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EFFECT OF STAND DENSITY ON THE GROWTH RESPONSE OF SOME SELECTED SOYBEAN (*Glycine max* L.) VARIETIES IN SUDAN SAVANNA ZONE OF NIGERIA

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ABSTRACT

A field experiment was conducted during the 2024 wet season at Abdullahi Fodiyo University of Science and Technology Aliero, Nigeria, to assess the effect of plant density on growth of soybean varieties. The treatment consisted of a Factorial combination of four improved soybean varieties (TGX 2020-4E, TGX 1904-6F, TGX 1951-3F and TGX 1989-19F), with four plant density. The experiments were laid out in a Randomized Complete Block Design with three replications. The results showed significant differences among plant density on canopy height at 8 and 12 WAS, were 4 plant produced tallest plants, among the varieties, TGX 1904 recorded the highest plants at 4 and 8 WAS but at 12 WAS TGX 1989 recorded the tallest plants. The result also showed no significant differences among plant density and variety at all growing stage except at 12 WERE was one plant produced the highest number of leaves and TGX 1951 among the varieties. The result indicated significant differences on canopy spread at 8 and 12 WAS and number of branches per plant at harvest were one plant produced widest canopy spread while one and two plant stand provided more branches. Therefore it can be concluded that 2-3 plants conjunction with TGX 1904 and TGX 1989 varieties is recommended for growth improvement of the soybean crop in Sudan Savanna agro ecological zone of Nigeria.

Keywords: Growth, Plant density, variety, Sudan savanna

Introduction

Soybean (*Glycine max* L.) is an annual *herbaceous* leguminous crop which belongs to the family *Fabaceae*, subfamily *Fabiodeae*, genus Glycine and sub-genus Soja (Chikezie *et al.*, 2019). Soybean is native to East Asia, with their origins traced back to Northeastern China, where they have been cultivated for over 5,000 years. Historical records indicate that soybean was first domesticated in the Yangtze River Valley of China. The plant was domesticated likely around 1,000 BC (Gupta and Nguyen, 2020). The global production of soybean has been increasing over the years due to its high demand for food, animal feed, and industrial purposes. As of 2023, global production is estimated at over 380 million metric tons MMT, with major producers including the United States, Brazil, Argentina, China, and India (USDA, 2023). Soybean is one of the most economically important grain legume crops globally due to its versatile uses in food, animal feed and industry. Its economic value is derived from its high protein and oil

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content, making it a vital crop for both developed and developing countries. Soybean has a composition of protein content of over 40%, edible vegetable oil content of 20.5%, Carbohydrate content of about 30.5%, a total sugar content of about 10% and an ash content of about 5% (Talaka *et al.,* 2020). Apart from it primarily use as source of oil, some soybean products that enhanced its nutritional qualities have been developed and are available in the market.

These include Soy milk (100 % Soybean), Soy oil (100 % soybean), Biscuits (100 % soybean) and Cassoy 30% Soybean (Abdullahi, 2019). Soybean oil is used in the production of Margarine, Salad oil and Butter. The dried beans can be boiled, roasted and made into coffee substitute, vegetable milk, cheese and yoghurt. It can also be made into local food such as pap, porridge and spices such as "daddawa"and the ground paste is used as a substitute for Melon seed for soup preparation (Talaka *et al.,* 2020). Soybean are adaptable to a variety of climates, but their growth potential is maximized in temperate and tropical regions with a long growing season, adequate moisture and moderate temperatures. In regions with cooler climates, shorter-season Soybean varieties are more appropriate. Similarly, in areas with irregular rainfall, drought-resistant varieties are preferable (Zhang, 2023).

The objective of the study, therefore, was to evaluate the growth performance of some varieties of Soybean cultivated under different plant density to ascertain which treatment and treatment combination that would enhances growth of Soybean in this agro ecology.

Materials and Methods

Experimental Site

The field experiment was conducted during 2024 wet seasons at Abdullahi Fodio University of Science and Technology Aliero (AFUSTA) University Research farm Aliero, the farm on Latitude 12.2900°N; Longitude 4.4671°E; 256m above sea level located in Sudan savanna ecological zone of Nigeria. The area is characterized by moderate annual rainfall distribution and total of 560mm most of which fall between May and October.

Treatment and Experimental Design

The treatment consisted of factorial combination of four soybean varieties namely; (TGX 2020-4E, TGX 1904-6F, TGX 1951-3F and TGX 1989-19F). Seeds were obtained from the National Cereal Research Institute (NCRI), Badeggi. Niger state and four plant density (1 plant, 2 plants, 3 plants and 4 plants per stand) which were laid out in a Randomize Complete Block Design (RCBD) with three replications

Field layout

The dimension of the individual plot was 2.5m x 4.5m (11.25 m^2). There was pathway of 0.5m between the adjoining plots within the blocks and 1m distance between the blocks.

The net plot sizes were 2.0 × 3.0 m (6.0 m^2).

Seed treatment and sowing

In order to protect the seeds from soil borne diseases and pests, the seeds were dressed with Apron- star at the rate of 10 g of the chemical per 2.0 kg of seed before sowing.

Sowing was done on June 2024 at the spacing of 75 cm inter-row and 25 cm intra-rows. Seven soybean seeds were sown at the depth of 3-5 cm by dibbling and were thinned down according to treatments at 14 days after sowing (DAS)

Data Collection

Data were collected on stand establishment count at 14 days after sowing(DAS) and plant height (cm), number of leaf, canopy spread at

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4, 8 and 12 week after sowing (WAS) and number of branches plant at harvest.

Five soybean hills from each net plot of all the treatments were randomly sampled, their height were measured from the ground level of each plant to the tip of the longest leaf at 4, 8and 12 WAS using graduated Meter rule. Number of leaf and branches were counted manually following the same interval. Canopy spread was measured by taking the dimension of the spread from the center (radius) using Meter ruler.

Data-Analysis

The data obtained was subjected to Analysis of Variance (ANOVA) using SAS where treatments shows significant differences (DMRT) was used to separate significant means at 5% level of probability.

Results and Discussion

Stand Establishment Count and Canopy Height (cm).

The results showed that there was no significant (P>0.05) different effect of stand density and variety on stand establishment count of soybean (Table 1.0).The results showed there was a significant effect (P<0.05) of stand density on canopy height at 8 and 12 WAS where 4 plants per stand consistently produced the tallest canopy height than all other treatments (Table 1.0). This implied that the varieties responded differently in height under the various stand density. This result was similar to the finding Liu et *al.* (2023), who reported As planting densities increased, plant height and internodes length increased and the grain per plant decreased. Because increased competition for light in higher-density stimulates a physiological response where plants grow taller in attempt to outcompete neighbors and reach more light.

The result showed significant (P<0.05) variation among the varieties for canopy height at both 4 and 8 WAS. At 12 WAS, there was no significant (P>0.05) different effect of variety on canopy height of soybean plants. TGX 1904 recorded the tallest (33.98 cm and 85.36 cm) plants at 4 and 8 WAS respectively comparable with the other varieties at 4 WAS except TGX 2020-4E (29.29 cm) but performed differently from the other varieties at 8 WAS. At 12 TGX 1989-19F recorded the tallest (99.22cm) plants comparable with the other varieties except TGX 2020-4E which recoded the shortest (29.28 cm, 43.94 cm and 58.83 cm) plants at 4, 8 and 12 respectively. This is probably due to genetic differences in the varieties on their ability to trap sunlight or nutrients which promote their vegetative growth and made the plants taller. The differential performance of the varieties can be attributed to the inherent genotypic variation (Mudibu *et al*., 2014).

Number of leaves

Result shows that there was no significant (P>0.05) different effect of stand density at all growing stages except at 12 WAS which shows a significant (P<0.05) different effect (Table1.0). One plant stand recorded the highest (36.50) number of leaves different from the other treatments while 4 plants stand recorded the least (30.33) number of leaves comparable to other treatments.

This result was similar to the findings of Zhang *et al.* (2023), who reported that plant density significantly influences the number of leaves per plant in Soybean. At lower densities (e.g. one plant per stand), individual Soybean plants tend to produce more leaves due to reduced competition for light, water and nutrients.

The result also shows that there was no significant (P>0.05) different effect of variety

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at all growing stages except at 12 WAS which shows a significant (P<0.05) different effect (Table 2).TGX 1951-3Frecorded the highest (30.94) number of leaves different from the other varieties while TGX 2020-4E recorded the least (22.52) number of leaves comparable with the remaining varieties. This could be because of the assumption that lower plant density typically produces more leaves due to reduced intra-specific competition with more space; each plant receives greater access to sunlight, nutrients and water, which promotes enhanced vegetative growth and branching as reported by Ball *et al.* (2000).

Table 1.0: Stand establishment count, canopy height and number of leaves of Soybean Varieties as influenced by Stand density at Aliero during 2024 wet season

Treatments		Canopy Height (cm)			Number of leaves		
	Stand Count	4WAS	8WAS	12WAS	4WAS	8WAS	12WAS
Stand Density (S)							
1plant	34.21	28.29^{ab}	60.98^{c}	65.55^{d}	6.05^{a}	23.77	36.50^{a}
2 plants	34.22	28.31^{ab}	68.50^{b}	82.55^{c}	6.00^{a}	23.66	35.49^{ab}
3 plants	34.37	29.61^{a}	68.92^{b}	84.27^{b}	5.94^{ab}	23.50	34.83^{b}
4 plants	34.48	29.98^{a}	75.19^{a}	90.02^{a}	5.93^{ab}	23.47	30.33^{c}
SE±	0.38	0.16	0.27	0.67	0.10	0.60	0.99
Variety (V)							
TGX 2020-4E	40.01	29.28^{ab}	43.94^{d}	58.83^{c}	5.92^{ab}	23.90^{ab}	22.52^{c}
TGX 1904-6F	40.56	30.22^{a}	87.22^{c}	96.11^{ab}	5.95^{ab}	23.93^{ab}	27.95^{ab}
TGX 1951-3F	40.56	30.11^{ab}	80.27^{a}	90.20^{b}	5.99^{a}	24.55^{a}	26.05^{b}
TGX 1989-19F	40.62	30.13^{ab}	83.94^{b}	99.22^{a}	6.01^{a}	24.58^{a}	30.94^{a}
SE±	0.33	0.17	0.26	0.66	0.20	0.59	0.90
Interaction (S x V)	NS	NS	*	*	NS	NS	*

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

Canopy spread (cm)

The results show that there was no significant (P>0.05) different effect at 4 WAS but displayed significant (P<0.05) different effect at both 8 and 12 WAS. 1 plant per stand produced the widest (60.91 cm and 72.47 cm) canopy spread at both 8 and 12 WAS respectively comparable with 2 and 3 plants per stand. 4 plants per stand produced the tightest (51.95 cm and 55.13 cm) canopy spread at both 8 and 12 WAS respectively (Table 2.0). Canopy spread in Soybean is strongly influenced by plant density and growth stage, plants grown at low densities exhibit wider spread per plants due to increased branching and

Leaf expansion as a result of minimal competition as reported by Chikizie *et al.*

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(2019). The results show that there was no significant (P>0.05) different effect among the four varieties on canopy spread at all growing stages. Zhang *et al.* (2023), found that canopy development was primarily influenced by plant density and row spacing, with no significant differences observed among varieties.

Numberof branches plant at harvest

The results showed there was a significant effect (P<0.05) of stand density onnumber of branches plant^{-1} at harvest 2 and 3 plants per stand consistently produced more branches than all other treatments (Table 3.0). Liu *et al.* (2020) reported that at lower densities (One or two plants per stand), soybean plants received more sunlight and have more room to grow, encouraging the development of auxiliary buds and lateral branches.

The results indicated that there was no significant (P>0.05) different effect among the four varieties on number of branches plant at harvest.

Table 2: Canopy spread (cm) and number of branches plant^{-1} at harvest of Soybean Varieties as influenced by Stand density at Aliero during 2024 wet season

Treatments	**Number of branches (plant^{-1}) at harvest**	**Canopy Spread**		
		4WAS	**8WAS**	**12WAS**
Stand Density (S)				
1 plant	4.28^{a}	23.16^{a}	60.91^{a}	72.47^{a}
2 plants	4.20^{ab}	23.14^{a}	55.61^{b}	57.69^{b}
3 plants	3.60^{b}	22.93^{ab}	53.13^{c}	56.08^{c}
4 plants	3.15^{c}	22.91^{ab}	51.95^{d}	55.13^{d}
SE±	**0.10**	**1.05**	**1.38**	**1.62**
Variety (V)				
TGX 2020-4E	3.33^{ab}	26.90^{ab}	57.60^{ab}	65.82^{ab}
TGX 1904-6F	3.36^{ab}	26.99^{ab}	57.61^{ab}	65.83^{ab}
TGX 1951-3F	3.60^{a}	27.92^{a}	58.99^{a}	65.99^{a}
TGX 1989-19F	3.93^{a}	27.97^{a}	59.03^{a}	66.96^{a}
SE±	**0.11**	**1.04**	**1.40**	**1.56**
Interaction (S x V)	*	**NS**	*	*

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

Conclusion

This study has given significant indications on the adequate stand density and suitable variety for a better soybean growth. The results indicated that stand density at various levels influenced growth parameters of soybean. Therefore it can be concluded that 2-3 plant per stand in conjunction with 'TGX 1904' and 'TGX 1989' varieties is recommended for growth improvement of the crop in the Sudan Savanna agro ecological zone of Nigeria.

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