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Effect of Variety and Spacing on Growth and Yield of Maize (*Zea mays* L.) in Bauchi State, Nigeria

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Authors' contributions

This work was carried out in collaboration between all authors. Author MUS designed the study, wrote the protocol and wrote the first draft of the manuscript. Author MAW managed the literature searches, analyses of the study, performed the spectroscopy analysis and author MA managed the experimental process and author JS identified the species of plant. All authors read and approved the final manuscript.

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ABSTRACT

A field experiment was conducted at the Abubakar Tafawa Balewa University teaching and research farm Bauchi state of Nigeria, during the 2013 rainy season, to investigate the effect of variety and intra-row spacing on growth and yield of maize (*Zea mays* L.) in Bauchi state. The Treatments consist of three varieties of corn (DMR, TZEE and QPM) and three intra-rows spacing (20, 25 and 30 cm). The experiment was laid-out in a randomized complete block design, replicated three times. Data was collected on plant height, number of leaves, leaf area, leaf area index, number of cobs per plot, cob length, 100 seeds weight and grain yield. The results obtained showed that varieties differ significantly, in which, DMR significantly produced the highest yield, and followed by QPM and TZEE which are similar in yield performance. Intra-row spacing of 25 cm was observed to be significantly (p=0.05) higher than 20 cm and 30 cm spacing in all the characters

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studied. Based on the results of the study, it may be concluded that DMR variety and 25 cm intra-row spacing proved more promising in the study area.

Keywords: Variety; spacing; yield; maize.

1. INTRODUCTION

Sustainability in agriculture relates to the capacity of an agro ecosystem to predictably, maintain production through time. A key concept of sustainability, therefore, is stability under a given set of environmental and economic circumstances that can manage on a site-specific basis [1]. Worldwide production of maize is 785 million tons, with the largest producer, the United States, producing 42%. Africa produces 6.5% and the largest African producer is Nigeria with nearly 8 million tons, followed by South Africa. Africa imports 28% of the required maize from countries outside the continent. Most maize production in Africa is rain fed. Irregular rainfall can trigger famines during occasional droughts. According to FAO 2007, about 158 million hectares of maize are harvested worldwide. Africa harvests 29 million hectares, with Nigeria, the largest producer in sub-Saharan Africa, harvesting 3%, followed by Tanzania. Worldwide consumption of maize is more than 116 million tons, with Africa consuming 30% and sub-Saharan Africa 21% [2].

Maize is a major staple food crop in Nigeria and across Africa. In view of the high level demand for maize in industries for flour mills, breweries, confectioneries, as well as for both human and animal consumption [3]. However, as matters of major concern, every attempt to boost its production will enhance food security. According to the food and agriculture organization, Nigeria's maize production during the period rose from 7.1 million tons in 2006 to 7.8 million tons in 2007. Nigeria cans double her current maize production of about 7 million tons to 14 million tons [4].

Quality Protein Maize is a cheap and alternate source of protein for poor who do not have resources to buy eggs or meat to meet their dietary protein requirement. As an added benefit, QPM increased levels of lysine, aid in assimilating zinc and iron from QPM grain. Medium duration QPM hybrids released are either superior or at par in productivity with their similar duration normal maize hybrids. Therefore, cultivation of QPM provides an opportunity to farmers to produce nutritionally superior maize grains and increase productivity and profitability, one from the high value cereal grain product and the other from use of feed and fodder in livestock industry. Maize is also a major component of the poultry feed mixture. Use of QPM as poultry feed leads to early development of broilers, save energy and feed, and also the extra cost incurred on lysine and tryptophan fortification [5].

Tropical *Zea mays* extra-early (TZEE) maturing is resistance to striga hermonthica, drought tolerant with good levels of resistance to maize streak virus and southern corn's leaf blight. It has been developed at the international institute of tropical Agriculture [6]. Global cereal demand in 2020 is estimated at 2.1 billion MT and will for the first time, show a major shift in favors of maize. Demand for Maize is estimated at 852 million MT compared with 760 million MT for wheat and 503 million MT for rice. The greatest areas of growth will be in developing nations, which are also mainly tropical maize producing nations. Industrial nations of the world such as the USA and the EU are projected to show the least areas of growth. Corn crops are advancing from low-tech commodities to high-tech, high-value, and high-demand products. Through science, technology and education seed companies are helping growers increase productivity in corn [7].

The distance between rows, the distance between plants in a row, and the number of plants in a hill influence the number of plants per unit area. Select an optimal plant spacing that allows for ease of field operations, such as fertilizer application or weeding, minimizes competition among plants for light, water, and nutrients, and creates a favorable microclimate in the canopy to reduce the risk for pests and diseases.

As the world's population grows, as demographics and food habits change we find ourselves in greater need for corn grain to satisfy the demand. It is projected that there will be an increase in global maize demand. In order to satisfy the growing demand seed supplying companies have been quick to introduce technologies to help the farming communities increase productivity and also to add value to their business. In view of the foregoing, therefore, the study was conducted to determine suitable maize variety and the best spacing for optimum output on the growth and yield in Bauchi State, Nigeria.

2. MATERIALS AND METHODS

The experiment was conducted at the Abubakar Tafawa Balewa University Bauchi Teaching and Research Farm during the 2013 wet season. The effect of variety, intra-row spacing on the growth and yield of maize (*Zea mays* L.) was investigated. The test varieties were Quality protein maize (QPM) that matures in 110-140 days. Downy mildew resistance maize (DMR) matures in 120 days. Tropical zea Mays extra early (TZEE) matures in 115 days. Three intra-row spacings (75cm x 20 cm, 75 cm x 25 cm, and 75 cm x 30 cm) which were laid out in a randomized complete block design (RCBD) with three replications. Sowing was done manually by planting two seeds per hole and later thinned to one plant per stand and all other agronomic practices were kept uniform for both experimental sites. Data was collected on the following parameters: Plant height, Number of leaves, Leaf area, Leaf area index, cob length, Number of cobs per plant, Number of cobs per plot, 100 seed weight and Grain yield. The Data thus collected was analyzed following the ANOVA technique and mean differences were adjudged by Duncan Multiple Range Test (DMRT) [8].

3. RESULTS AND DISCUSSION

The effect of variety and intra-row spacing on plant height is shown in Table 1, statistical analysis showed that plant height was not significantly affected by variety at 3 and 6 weeks after planting except at 9 weeks after planting with the variety DMR significantly ($P \leq 0.05$) produced the high tallest plant. At the different intra-row spacing, however no significant difference was observed at 3 weeks after planting but at 6 and 9 weeks after planting there was significant difference with 30 cm row spacing, followed by 25 cm while 20 cm row spacing produced the shortest plants at 9 weeks after planting.

The effect of the treatments on Number of leaves per plant as presented in Table 2; shows statistically, that there was no significant difference by variety and intra-row spacing at 3 and 6 weeks after planting. Except at 9 weeks after planting were DMR variety and 25 cm observed to have more number of leaves, followed by QPM with 30 cm spacing and TZEE with 20 cm spacing gave the least.

The result presented in Table 3 shows the effect of variety and intra-row spacing on leaf area. Statistically the result shows that, there was no significant effect on leaf area at 3 and 6 (WAP) observed under variety except at 9(WAP), where DMR variety gave more leaf area (488.34), followed by TZEE (414.02) and the least was produced by QPM (407.89). No significant difference was noticed with respect to spacing.

There is a significant difference in the effect of variety on leaf area index of maize at 9 weeks after planting. DMR variety gave the highest leaf area index. However, QPM and TZEE variety were statistically the same. The intra-row spacing statistically indicates that 20 cm has higher leaf area index at 3 WAP and 9 WAP respectively. No significant difference was observed at 9 WAP (Table 4).

Table 1. Effect of variety and intra-row spacing on plant height (cm) of maize at 3, 6 and 9 WAP

Treatments	Weeks after planting		
	3	6	9
Variety			
QPM	8.92	27.64	94.86^b
DMR	9.73	31.93	164.99^a
TZEE	8.93	29.30	97.28^b
LS	NS	NS	*
LSD (p=0.05)	-	-	59.1
Intra-row spacing (cm)			
20	9.14	32.83^a	101.22^b
25	10.09	25.90^b	109.97^b
30	8.36	30.13^b	215.50^a
LS	NS	*	*
LSD (P= 0.05)	-	5.9	59.1

(QPM)=Quality Protein Maize, (DMR) = Downy Mildew Resistant, (TZEE) = Tpropical Zea mays Extra Early.
*NS = Not Significant; LS =Level of Significance; LSD = Least Significance Difference; * = Significance at p=0.05*

Table 2. Effect of variety and intra-row spacing on number of leaves of maize at 3, 6 and 9 WAP

Treatments	Weeks after planting		
	3	**6**	**9**
Variety			
QPM	4.22	8.56	10.78
DMR	4.67	8.89	12.01
TZEE	4.67	8.11	9.44
LS	NS	NS	*
LSD (p=0.05)		1.46	
Intra-row spacing (cm)			
20	4.44	8.56	9.89
25	4.44	8.44	11.89
30	4.37	8.52	10.58
LS	NS	NS	*
LSD (P= 0.05)		1.46	

(QPM)=Quality Protein Maize, (DMR) = Downy Mildew Resistant, (TZEE) = Tpropical Zea mays, Extra Early.
*NS = Not Significant; LS = Level of Significance; LSD = Least Significance Difference; * = Significance at p=0.05*

Significant (p=0.05) difference was however observed between varieties as indicated in Table 5, with DMR (16.06) significantly produced longer panicle than QPM (13.83) and TZEE (13.62) varieties. With respect to intra-row spacing however, 25 cm significantly produced longer cob length, which was statistically the same with 20 cm, while intra-row spacing of 30 cm gave the least cob length.

Statistical analysis showed that number of cobs was significantly affected by varieties of maize. DMR produced more number of cobs per plot than QPM and TZEE. However, intra-row spacing 25 cm (23.11) gave the highest number of cobs per plots, followed by 30 cm (21.56) while 20 cm (17.78) gave the least.

It was observed that there is significant difference on 100 seeds weight among varieties, as shown in Table 6. Variety DMR produced significantly heavier 100 seeds, QPM and TZEE on the other hand were statistically at par. In respect of spacing, no significant difference was noticed statistically.

A significant difference was observed among varieties on grain yield per hectare. Variety DMR produced significantly (p=0.05) highest grain yield per hectare followed by QPM and TZEE which were at par. However, significant difference was noticed under spacing, 25 cm (2521.7 kg/ha) produced the highest grain yield, followed by 30 cm (1871.7 kg/ha) and 20 cm (1741.8) gave the same spacing.

Table 3. Effect of variety and intra-row spacing on leaf area (cm^2) of maize at 3, 6 and 9 WAP

Treatments	Weeks after planting		
	3	**6**	**9**
Variety			
QPM	83.39	252.21	407.89^b
DMR	97.44	261.27	488.34^a
TZEE	82.86	222.27	414.02^b
LS	NS	NS	*
LSD (p=0.05)		74.4	
Intra-row spacing (cm)			
20	84.70	264.04	402.26
25	82.84	217.82	450.04
30	96.14	254.18	457.96
LS	NS	NS	NS

(QPM)=Quality Protein Maize, (DMR) = Downy Mildew Resistant, (TZEE) =Tpropical Zea mays, Extra Early
*NS = Not Significant; LS = Level of Significance; LSD = Least Significance Difference; *= Significance at p=0.05*

Table 4. Effect of variety and intra-row spacing on leaf area index of maize (*Zea maize* L.) at 3, 6 and 9 WAP

Treatments	Weeks after planting		
	3	6	9
Variety			
QPM	0.047	0.126	0.233[b]
DMR	0.055	0.142	0.290[a]
TZEE	0.045	0.142	0.197[b]
LS	NS	NS	*
LSD (p=0.05)			0.05
Intra-row spacing (cm)			
20	0.061[a]	0.166[a]	0.262
25	0.043[b]	0.133[b]	0.236
30	0.042[b]	0.110	0.222
LS	*	*	NS
LSD (P= 0.05)	0.02	0.03	

(QPM)=Quality Protein Maize, (DMR) = Downy Mildew Resistant, (TZEE) = Tpropical Zea mays, Extra Early.
*NS = Not Significant; LS = Level of Significance; LSD = Least Significance Difference; *= Significance at p=0.05*

Table 5. Effect of variety and Intra-row spacing on yield related parameters of maize

Treatments	Cob length (cm)	Number of cobs/plot
Variety		
QPM	13.83[b]	17.56[b]
DMR	16.06[a]	26.11[a]
TZEE	13.62[b]	18.75[b]
LS	*	*
LSD (p=0.05)	1.17	3.16
Intra-row spacing (cm)		
20	14.29[ab]	17.78[b]
25	15.19[a]	23.11[a]
30	14.01[b]	21.56[a]
LS	*	*
LSD (P= 0.05)	1.17	3.16

(QPM)=Quality Protein Maize, (DMR) = Downy Mildew Resistant, (TZEE) = Tpropical Zea mays, Extra Early.
*NS = Not Significant; LS = Level of Significance; LSD = Least Significance Difference; *= Significant at p=0.05*

Table 6. Effect of variety and intra-row spacing on the yield parameter of maize

Treatments	100 seed weight (g)	Grain yield kg/ha
Variety		
QPM	26.00[b]	1990.49[b]
DMR	30.00[a]	2561.2[a]
TZEE	25.00[b]	1582.8[b]
LS	*	*
LSD (p=0.05)	2.6	634.3
Intra-row spacing (cm)		
20	25.33	1741.8[b]
25	29.00	2521.7[a]
30	26.67	1871.0[b]
LS	NS	*
LSD		634.3

(QPM)= Quality Protein Maize, (DMR) = Downy Mildew Resistant, (TZEE) = Tpropical Zea mays, Extra Early.
*NS = Not Significant; LS = Level of Significance; LSD = Least Significance Difference; *= Significance at p=0.05*

4. CONCLUSION

From the above discussion it is concluded that among the three varieties of maize used in the experiment, DMR gave the highest yield attributing characters like plant height, number of leaves, leaf area, leaf area index, cob length, number of cobs per plot and 100 seed weight as well as highest grain yield. The intra-row spacing of 25 cm showed better performance than 20 cm and 30 cm. Therefore, farmers may adopt DMR variety with 25 cm spacing for a more profitable production of maize.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Scott H. Hutchins. The role of technology in sustainable agriculture. Radcliffes IPM World Textbook |CFANS| University of Minnesota. 2013;1-3.
2. Available: http://www.nue.uk.edu

3. FAO. Quarterly bulletin of statistics. Food and Agricultural Organization of United Nation Rome Italy. 2002;300.
4. Available: http://wwwiita.org
5. Available: www.infobridge.org/asp/practice
6. IITA. Sustainable food production in sub-Saharan Africa. International institute of tropical Agriculture, Ibadan, Nigeria (IITA); 1992.
7. Available: www.advantaseeds.com
8. Gomez LA, Gomez AA. Statistical procedures for agricultural research. Second edition. John Awilley Inter Science Publication New York. 1984;97-411.

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