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PRODUCTIVITY OF MAIZE (*ZEA MAYS* L.) AS INFLUENCED BY FERTILIZER RATES AND INTRA-ROW SPACING IN SAMARU NORTHERN GUINEA SAVANNA

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ABSTRACT

Field trials were carried out in 2017 and 2018 wet seasons at Institute for Agricultural Research Farm, Ahmadu Bello University to examine the impact of intra-row spacings and NPK fertilizer rates. Three intra-row spacings (30, 40 and 50 cm) and three NPK fertilizer rates (60-30-30, 90-45-45, and 120-60-60 kg/ha) were used. The treatments were arranged and replicated three times in a Randomized Completely Block Design. All recommended agronomic practices were followed. Plant and ear height, days to 50% tasseling, grain yield, and 100-grain weight were among the variables measured. According to the results, every increase in NPK fertilizer resulted in a notable improvement in the crop's growth and yield metrics. Increased inter-row distance increased the 100-grain weight. However, lower intra-row spacing resulted in much taller plants, but took longer days to reach 50% tasseling. Based on the outcomes in this study, it could be concluded that utilizing a 30 cm intra-row spacing and application of 120-60-60 NPK fertilizer rate resulted in good maize growth and output in the research location and is hereby recommended.

Keywords: Productivity, *Zea mays*, fertilizer rates, plant densities and Northern Guinea Savanna

INTRODUCTION

Maize, *Zea mays* L. or corn, is a common term in the United States. Its rising significance and production potential, it finds frequent application in animal feed, human nutrition, and agro-allied sectors. According to Erenstein *et al*. (2022), it is the most important grain crop in Nigeria and all of West and Central Africa. In drier locations of Nigeria where traditional sorghum and millet niches are cultivated, the crop is incorporated into a variety of maize-based cropping systems (Sileshi *et al*., 2011). According to Directorate of Information and Publications of Agriculture (DIPA) (2006) and Zeidan *et al*. (2006), rapid loss of soil fertility caused by intensive land use, the gradual decrease in maize output may have been caused by shorter fallow times and the use of inappropriate plant spacing, resulting in an impact on plant population and ultimately production. This was made feasible by researchers' invention of extra-early and early maize.

Improved agronomic practices, like growing crops using improved varieties, managing weeds, preventing pest and disease outbreaks, and maintaining proper plant density and growth, have been shown to boost crop output and growth (Tadele, 2017). In order to achieve high yields, farmers are advised to utilize plant densities of 75 x 25 cm or 75 × 50 cm, with one or two plants per stand, respectively (Iken and Amusa, 2004). In the northern Guinea savanna, the appropriate fertilizer recommendations for open-pollinated maize varieties are 120 kg N, 60 kg P_2O_5, and 60 kg K_2O per hectare, whereas for hybrid varieties they are 150 kg N, 75 kg P_2O_5, and 75 kg K_2O per hectare (Chude *et al*., 2011).

Asghar *et al*. (2010) stated that the genetic composition of the crop and its growing environment both affect maize variety's potential output. Consequently, a favorable environment and a variety with a strong genetic makeup result in a higher yield advantage for the crop. The ideal fertilizer rate and plant density of recently developed and released maize varieties should be evaluated, as maize researchers are continually developing and releasing novel types of the crop. Numerous studies have demonstrated that adequate plant populations and fertilizer doses stimulate improved crop development and output, which will increase the availability of food and save the environment over time (Buah *et al*., 2009). Thus, producing plant types that are more efficient at utilizing the nutrients that are available, along with prudent soil management techniques, continues to be a dependable strategy for addressing issues related to nutrient deficits in Nigeria's Savannah regions. It was against this background this research was aimed at identifying optimum fertilizer rate and intra-row spacing for sustainable increase in maize yield in the study area. This information would undoubtedly boost

maize productivity, which will assist Nigeria's savanna agroecology.

MATERIALS AND METHODS

The experiment was carried out in the northern Guinea savanna at the Institute for Agricultural Research's experimental farm at Ahmadu Bello University in Zaria 686 meters above sea level, at latitude 11° 11' N and longitude 07° 38' E during 2017 and 2018 cropping seasons respectively. The experiment consisted of three plant densities (75 cm x 30 cm, 75 cm x 40 cm, and 75 cm x 50 cm) and three NPK fertilizer rates (60-30-30, 90-45-45 and 120-60-60 kg ha^{-1}) replicated three times in a Complete Randomized Block Design (RBCD). Plots of 5 m by 3 m (15 m^2) with four rows each were used. All agronomic practices were duly followed. Plant height, number of days to 50% tasseling, ear height, anthesis-silking interval, 100 grain weight, and grain yield kg ha^{-1} were among the data recorded. SAS software version 9.0 (SAS, 2002) was utilized for the analysis of variance (ANOVA), and the Duncan Multiple Range Test (DMRT) was used to differentiate significant means at 5% probability (Snedecor and Cochran, 1967).

RESULTS AND DISCUSSION

The results of the effect of varying intra-row spacing and NPK fertilizer rate on growth and yield of maize is presented in Table 1 and 2 respectively. The result in Table 1 showed that varying intra-row spacing from 30 cm – 50 cm significantly ($p \leq 0.05$) reduce all the growth parameters measured with 30 cm significantly recorded the highest mean in 2017 and 2018 cropping seasons respectively. Similarly, increasing fertilizer rate to 120:60:60 significantly ($p \leq 0.05$) increased all the growth parameters measured with fertilizer rate applied at 120:60:60 consistently gave highest mean values in both 2017 and 2018 cropping seasons. The conclusion drawn from the data was that there was competition for limited resources, such as sunlight, nutrients, and water. The competitiveness increases with crop spacing which subsequently impacts crop performance. Consequently, crops planted 30 centimeters apart grew higher due to competition for sunlight. The increased number of plants per unit area accounted for the improved grain yield attained at the moment. The current improved grain yield can be attributed to the higher number of plants per unit area. Each time NPK fertilizer is increased from 60-30-30 to 120-60-60 substantially boosted the crop's growth and yield attributes. This reveals the significance it is to fertilize maize. Most savanna soils lacked the necessary minerals for plant growth, making them unfertile. Consequently, fertilizer application to maize becomes essential for any significant crop yield.

The effect of varying NPK fertilizer rate on yield is presented in Table 2. Varying intra-row spacings increased 100 grain weight significantly ($p \leq 0.05$). However, increasing intra-row spacing from 30 cm – 50 cm inversely reduce total grain yield in both 2017 and 2018 cropping seasons. Furthermore, varying NPK fertilizer rate to 120:60:60 significantly ($p \leq 0.05$) increased 100 grain weight and grain yield ha^{-1} respectively. The highest yield of 2221 kg ha^{-1} was obtained at 120:60:60 application rate.

Table1: Effect of treatments on growth parameters during 2017 and 2018 cropping season in Samaru, northern guinea savanna of Nigeria

	Plant height (cm)		Ear height (cm)		Days to 50% tassel	
Treatment	**2017**	**2018**	**2017**	**2018**	**2017**	**2018**
Intra-row spacing (cm)						
30	156.3a	146.3a	63.2a	62.2a	62.2a	61.2a
40	145.6b	135.6b	60.8b	60.8b	60.3b	59.3b
50	140.3c	130.3c	57.6c	57.6a	57.8c	57.8c
SE (±)	4.71	4.31	2.98	2.18	0.25	0.25
NPK Fertilizer (kg ha^{-1})						
60:30:30	138.9c	128.9c	56.7c	55.7c	59.3c	59.3c
90:45:45	145.6b	135.6b	59.4b	58.4b	60.2b	60.2
120:60:60	157.8a	147.8a	64.4a	63.4a	61.8a	61.8a
SE (±)	4.71	4.31	2.98	2.18	0.25	0.25
Interaction						
F x P	NS	NS	NS	NS	NS	NS

Means followed by different letter within the same column is significantly different at 5% level of probability using Duncan Multiple Range Test (DMRT)

Table 2: Effect of treatments on yield parameters during 2017 and 2018 cropping season in Samaru, northern guinea savanna of Nigeria

	100 grain weight (g)		Grain yield (kgha^{-1})	
Treatment	**2017**	**2018**	**2017**	**2018**
Intra-row spacing (cm)				
30	26.0c	24.5c	2350a	2100a
40	27.0b	25.5b	2132b	2001b
50	29.9a	28.4a	1896c	1776c
SE (±)	0.66	0.56	7.92	6.81
NPK Fertilizer (kg ha^{-1})				
60:30:30	26.1c	24.6c	1851c	1731c
90:45:45	28.7b	27.2b	2152b	2031b
120:60:60	29.5a	28.0a	2374a	2221a
SE (±)	0.66	0.56	7.92	6.81
Interactions				
F x P	NS	NS	NS	NS

Means followed by different letter within the same column is significantly different at 5% level of probability using Duncan Multiple Range Test (DMRT)

The findings indicated that maize planted with a 30-cm intra-row spacing significantly ($p \leq 0.05$) increased plant and ear heights, days to 50 % tassel and grain yield than other intra-row spaces while 100 grain weight produced highest grain 50 cm apart within rows. The results presented go contrary to what Kareem *et al*. (2020) observed. A denser plant population and the treatment of 120 kg NPK ha^{-1} contributed to the maize's higher height. This is consistent with research by Muhammad *et al*. (2019), which showed that taller plants in Sudan savanna were obtained with the application of 120-60-60 NPK fertilizer. This may be linked to nitrogen's role in supporting the apical growth of roots and shoots, which aids in the vegetative growth of plants.

As noted by Faschina *et al*. (2002), the use of inorganic fertilizer offered the plants with sufficient nutrients, resulting in enhanced cell activity, cell multiplication, cell enlargement, and ultimately, luxuriant development. Fertilizer application causes lush growth, this causes a rise in the production of dry matter (Obi *et al*., 2005). Achieving optimal plant density and managing water, fertilizer, and chemical inputs are crucial for enhancing the growth factors that contribute to elevated yields. With distinct methods of utilizing nutrients and solar radiation, plants grown at optimal density are able to develop healthily in both their aerial and subsurface components. Plant growth slows down and grain production declines as a result of intense competition between crops for light above ground and nutrients below it caused by higher plant density than the ideal level. This aligns with the findings of Muhammad *et al*. (2019) that high plant density (75 cm x 20 cm) decreased maize grain yield in Sudan savanna because of heightened plant competition for essential minerals.

In the current experiment, the greater levels of combined application of potassium, phosphorus, and nitrogen greatly boosted the growth parameters, characteristics of yield, and finally the grain yield of maize. Achieving balanced nutrition is necessary to maximize maize yield. There is a strong correlation between the concentration of N, P and K elements in grains and the whole plant and grain yield of maize (Setiyono *et al*., 2010). The highest plant height, ear height means, days to 50% tasseling, 100% weight, and yield per hectare were obtained with an application of 120:60:60. This could be explained by the fact that NPK is one of the vital nutrients that support meristematic growth as well as other physiological processes in plants. Consequently, this leads to effective uptake of water and nutrients, as well as the blocking of sunlight and carbondioxide.

In order to produce enough photo-assimilates, which will then be transferred to different sinks to produce more total dry matter, these activities encourage larger photosynthetic activities (Jaliya *et al*., 2008). The ultimate yield was increased as a result of the enhanced vegetative components' greater influence on yield parameters such as yield of grain (kg ha^{-1}) as well as the hundred grain weight. In the same vein, success in producing higher yield could be attributed to availability

of potassium nutrition which is a component of the fertilizer used. This is due to the fact that potassium nutrition plays a big role in the stages of grain formation and filling during the cereal-making process. Thus, increased potassium feeding leads to increased grain production. Furthermore, there were no significant interactions observed among the treatments tested in this trial. The findings demonstrated that applying 120:60:60 kg ha^{-1} enhanced the maize plant's capacity for growth and output.

CONCLUSION

With the results obtained in this study, farmers can be advised to plant their maize at 30 cm intra-row using 120-60-60 NPK fertilizer for good performance in the northern guinea savanna.

RECOMMENDATION

Based on the result obtained in this work, the use of 30 cm intra-row spacing and application of 120-60-60 NPK ha^{-1} at Samaru is hereby recommended in the study area and any environment having similar ecology.

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