© 2019 IJSRSET | Volume 6 | Issue 2 | Print ISSN: 2395-1990 | Online ISSN: 2394-4099
Themed Section: Engineering and Technology
DOI: https://doi.org/10.32628/IJSRSET196224

Influence of Nitrogen Fertilization, Its Time of Application and Intra -Row Spacing on Growth Performance of Extra Early Maize in the Sudan Savanna, Nigeria

Musa M. Usman[*1], Khalid A. Mohamed[2], Shihab El deen E. Hassan[2]

[*1]Department of Agricultural Education, Isa Kaita College of Education P.M.B. 5007 Dutsinma, Katsina State, Nigeria.

[2]Faculty of Agriculture and Natural Resources, University of Bakht Alruda, Ed Dueim, Sudan.

musausman822@gmail.com, +2348060869700

ABSTRACT

Field experiments were conducted during the 2016 and 2017 dry seasons at Institute for Agricultural Research Farm Kadawa and Zobe Irrigation Fields in Kano and Dutsinma respectively to study the influence of intra-row spacing, nitrogen fertilizer and time of its application on the performance of Extra Early maize. The treatments tested consisted of factorial combinations of three levels of nitrogen (0, 60, and 120 kg/ha), three intra row spacings (15 cm, 25 cm, and 35 cm) and three different times of fertilizer application (at planting+4WAS, 2WAS+4WAS and 2WAS+4WAS+6WAS). The treatments were laid in a split-plot design in four replications with the combination of nitrogen levels and its times of application assigned to the main plot, while intra row spacing assigned to sub-plot. The results of the investigation showed that 25 cm and 35 cm intra row spacing produced the tallest plants, higher number of leaves per plant and number of grains per row at Dutsinma. At Kadawa most of the parameters showed no significant effect on intra row spacing. Nitrogen fertilizer at 120 kg/ha resulted in higher values of growth parameters at both locations. Time of fertilizer application affected growth performance such as plant height, number of leaves per plant and number of days to tasseling and silking at both locations.

Keywords: *Maize, Intra-row spacing, Nitrogen, Kadawa, Zobe*

I. INTRODUCTION

Maize (Zea mays L.) is an important cereal crop in the world as it is ranked first in production and productivity (FAOSTAT, 2013). It is regarded as a strategic food and feed crop that provides great energy for humans and livestock. It is important in industrial production of ethanol. Much of world maize production is utilized for animal feed, but human consumption in many developing and developed countries is on the increase (Lakew et al., 2016).

Maize is a major staple food crop in Nigeria and across Africa. There is high demand for maize in industries for flour mills, breweries, confectioneries as well as for both human and animal consumption (Sabo, et al., 2016). Despite high production rate of maize in Nigeria, average yields of 1.8 MT/ha (FAOSTAT, 2014) are still considered low as yields could be increased without increasing the area currently used for its cultivation. This low yield issue can be addressed especially through the use of optimum intra row spacing, optimum fertilizer rates applied at the right times and use of high yielding varieties (Sahel, 2017). Nitrogen rates and time of application are among the major abiotic factors limiting the productivity of the crop (Abebe and Feyisa, 2017).

Therefore, the main objectives of this study are;

a) To determine the effect of different levels of nitrogen fertilizer on performance of extra early maize.
b) To assess the response of extra early maize to different times of nitrogen fertilizer application.
c) To determine the influence of intra- row spacing on growth performance of extra early maize.
d) To evaluate the combined effects of nitrogen fertilizer, times of nitrogen fertilizer application and intra row spacing on growth performance of extra early maize in the Sudan Savanna, Nigeria.

II. METHODS AND MATERIAL

A. Experimental Location and Treatments

The experiment was conducted for two seasons (2016 and 2017 dry seasons) under irrigation at the Irrigation Research Station of the Institute for Agricultural Research (IAR) Kadawa: (ll°39'N, 08º20'E and 500 m above sea level), and Zobe irrigation fields at Dutsinma. (12027'N, 07°29'E and 542 m above sea level) both in the Sudan Savanna ecological zone of Nigeria. An extra early maturing maize (zea mays L.) variety SAMMAZ 12 (previously known as 95-TZEE-W) was used in the study. The treatments consisted of factorial combinations of three levels of Nitrogen (0 ,60 ,and 120 kgha-1) , three intra row spacings [15 cm, 25 cm and 35 cm] and three different times of fertilizer applications as follows; At planting+4WAS, 2WAS+4WAS and 2WAS+4WAS+6WAS. These treatments were laid out in a split plot design with nitrogen levels and its times of application assigned to main plot and intra-row spacing assigned to sub plot and replicated four times.

The areas for the gross and net plots of each sub plot were 15 m2 (3 m x 5 m) and 7.5 m2 (1.5 m x 5 m). There were four ridges in the gross plot and two ridges in the net plot of each sub plot. The seeds were sown by hand at the rate of two seeds per hole as per the intra-row spacing of 15, 25 and 35 cm respectively, keeping the inter row spacing of 75 cm-constant. Seedlings were thinned to one plant per stand at two weeks after sowing (WAS).

B. Observation and Data Collection

Five maize plants from each sub plot were randomly tagged for observations during the crop growth period. The following observations were measured.

1- Plant height (cm)
2- Number of leaves per plant
3- Days to 50% Tasseling
4- Days to 50% Silking

Statistical Analysis

General linear model procedure (GLM) of the Statistical Analysis System (SAS) package (SAS: 1990] was used for statistical analysis of all the data collected and differences between the treatments means were compared using Duncan's Multiple Range Test as described by Duncan (1955).

III. RESULTS AND DISCUSSION

A. Growth Parameters

Tables 1 and 2 show the influence of intra row spacing, nitrogen fertilizer level and time of fertilizer application on the plant height, number of leaves per plant, days to tasseling and days to silking of extra early maize at Dutsinma and Kadawa during 2016 and 2017 dry seasons. In Dutsinma in both years there was significant influence of intra row spacing on maize height. 25 cm and 35 cm spacing produced tallest plants than the 15 cm spacing in both years. Nitrogen fertilizer application of 60 kgN/ha rate gave significantly taller plants followed by 120 kg N/ha, while the control produced shortest plants. This was due to nitrogen ability of enhancing cell division expansion and chlorophyll production. Ahmed et al., (2016) reported similar case that nitrogen has favorable effect on growth of maize through increase in cell division, cell expansion and increase in size of all morphological parts. Time of fertilizer application did not influence plant height at 4WAS in both years

and at 6 and 8WAS in 2017. At 6WAS, at planting and 4WAS produced tallest plants than the remaining times of fertilizer application in 2016. The application of nitrogen to maize at planting promotes early growth because it supplies the nutrient in the zone where roots are active (Zerihun and Hailu, 2017).

In 2016 and 2017 seasons at Kadawa location there was no significant influence of intra row spacing on maize height. Plant height was varied significantly due to application of Nitrogen fertilizer where 60 kgN/ha rate gave significantly taller plants which was comparable to 120 kgN/ha and the control recorded shortest plants in 2016. Time of fertilizer application at 4WAS, 2WAS+4WAS+6WAS and 2WAS+4WAS gave taller plants than at planting+4WAS which produced shortest plant in 2016.

Number of leaves per plant

The number of leaves per plant is a genetically controlled factor but environment and nutritional level may also influence it. The more number of leaves the more chlorophyll content and viz photosynthesis rate, which results to more grain yield. At both locations and in both years intra row spacing had no effect on number of leaves of extra early maize. A non-significant response to varying intra-row spacing on this trait could be genetic rather than environmental or treatment factors. Nitrogen application of 60 kgN/ha gave the highest number of leaves followed by 120 kgN/ha while control produced the lowest number of leaves. Time of fertilizer application did not influence number of leaves at 4 and 8WAS in both years and at 6WAS in 2017. At 6WAS in 2016, at planting+4WAS and 2WAS+4WAS produced similar but higher number of leaves than 2WAS+4WAS+6WAS which produced less as shown on TABLE 1.

Table 1 : Growth parameters of extra early Maize as influenced by intra -row spacing, Nitrogen fertilizer levels and time of fertilizer application at Dutsinma during 2016 and 2017 cropping seasons.

Treatments	Seasons							
	2016				2017			
	PH (cm)	LN/P	DOT	DOS	PH (cm)	LN/P	DOT	DOS
Spacing(S)								
15	172.2b	11.3	48.5a	55.4	160.6b	12.2	50.6	56.0
25	181.4a	11.5	47.6b	55.8	166.4a	12.3	50.3	54.7
35	179.8a	11.2	47.5b	54.9	168.2a	12.3	50.0	55.4
SE ±	2.1	0.14	0.25	0.41	1.9	0.11	0.27	0.42
Nitrogen (kg/ha)(N)								
0	166.5b	10.8b	47.7	55.5	160.7b	12.3	50.7	55.9
60	185.8a	11.6a	47.7	55.4	164.5b	12.4	50.4	55.3
120	181.1a	11.6a	48.2	55.1	170.0a	12.1	49.9	54.8
SE ±	2.1	0.14	0.25	0.41	1.9	0.11	0.27	0.42
Time of application (T)								
At planting +4WAS	182.6a	11.5a	48.1	55.5	165.5	11.5a	50.0	55.1
2WAS+4WAS	170.6b	11.1b	47.8	55.8	165.8	11.1b	50.5	55.6
2WAS+4WAS+ 6WAS	180.2a	11.4ab	47.7	54.7	163.9	11.4ab	50.6	55.3
SE ±	2.1	0.14	0.25	0.41	1.9	0.11	0.27	0.42
Interaction								
ST	NS	NS	NS	NS	NS	NS	NS	**
SN	NS	NS	NS	NS	NS	NS	NS	NS
NT	NS	NS	NS	NS	**	NS	NS	NS
SNT	NS	NS	NS	NS	NS	NS	NS	NS

Means within the same column followed by the same letter(s) are not significantly different at 5% level of probability according to Duncann's Multiple Range test (DMRT). NS=not signifi cant; PH=Plant Height; LN/P=Leaf number/plant; DOT=Days to Tasseling; DOS=Days to Silking

Days to Tasseling

Mean days to tasseling indicates that the pollen shedding ability of maize genotypes is an indicator of the earliness of genotypes. At both locations and in both years at Kadawa intra row spacing had no significant influence on number of days to 50% tasseling except at Dutsinma in 2016 where 15 cm spacing statistically recorded higher number of days to 50% tasseling than the remaining intra row spacing which were similar. Nitrogen fertilizer had no significant effect on number of days to 50% tasseling in both years except at Kadawa in 2017 where application of 60 kgN/ha registered the highest number of days to 50% tasseling than control and 120 kgN/ha levels that were statistically similar. Time of fertilizer application had no significant effect on number of days to 50% tasseling in both years at Dutsinma, while in both years at Kadawa at planting and 4WAS recorded higher number of days to 50% tasseling than the remaining times of fertilizer application which were similar statistically.

Days to Silking

Silking followed the same trend as tasseling, at both locations and in both years intra row spacing had no significant effect on number of days to 50% silking. Application of nitrogen fertilizer at Dutsinma in both years and at Kadawa in 2016 had no significant impact on number of days to 50% silking of maize crop, but at Kadawa 2017 60 kgN/ha recorded higher number of days to 50% silking than 120 kgN/ha and control that were statistically similar. Namakka et al. (2009) reported that an increase in nitrogen application up to 120 kgN/ha delayed number of days to 50% tasseling and silking. Time of fertilizer application had no significant influence on number of days to 50% silking at Dutsinma in both years but at Kadawa, at planting and 4WAS recorded higher number of days to silking.

Table 2: Growth parameters of extra early Maize as influenced by intra-row spacing, Nitrogen fertilizer levels and time of fertilizer application at Kadawa during 2016 and 2017 cropping seasons.

Treatments	Seasons							
	2016				2017			
	PH (cm)	LN/P	DOT	DOS	PH (cm)	LN/P	DOT	DOS
Spacing(S)								
15	129.2	11.1	56.5	60.8	77.0	9.5	56.1	60.1
25	130.3	11.0	55.8	60.1	75.7	9.5	56.4	60.0
35	130.2	11.1	55.8	60.5	76.7	9.5	56.2	60.3
SE ±	1.25	0.15	0.44	0.44	0.99	0.15	0.48	0.41
Nitrogen(kg/ha)(N)								
0	128.1	10.8	55.5	59.8	76.3ab	9.1b	55.7	60.1b
60	130.0	11.1	56.7	61.0	74.3b	9.8a	57.4	61.6a
120	131.7	11.2	55.9	60.5	78.8a	9.5ab	55.5	59.8b
SE ±	1.25	0.15	0.44	0.44	0.99	0.15	0.48	0.41
Time of application (T)								
At planting+4WAS	129.9	11.2	58.3a	62.6a	73.7b	9.5	57.7a	61.9a
2WAS+4WAS	129.2	11.1	55.1b	59.8b	72.2b	9.5	55.3b	59.6b
2WAS+4WAS+6WAS	130.6	10.9	54.7b	59.0b	80.5a	9.5	55.7b	59.9b
SE ±	1.25	0.15	0.44	0.44	0.99	0.15	0.48	0.41
Interaction								
ST	NS	NS	NS	NS	NS	NS	NS	NS
SN	NS	NS	NS	NS	NS	NS	NS	NS
NT	NS	NS	NS	NS	NS	NS	**	NS
SNT	NS	NS	NS	NS	NS	NS	NS	NS

Means within the same column followed by the same letter(s) are not significantly different at 5% level of probability according to Duncan's Multiple Range test (DMRT). NS=not significant; PH=Plant Height; LN/P=Leaf number/plant; DOT=Days to Tasseling; DOS=Days to Silking

IV. CONCLUSION

Higher growth performance of maize was observed in Dutsinma for both seasons compared to Kadawa. These could be attributed to the favorable agro-climatic conditions particularly solar radiation and temperature. It can be concluded that extra early maize variety if grown with 120 kgN/ha and intra-row spacing of 25 cm fertilizer applied throughout the growing period will result in increased growth performance and subsequent yield at Dutsinma and Kadawa under dry season.

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Cite this article as:

Musa M. Usman, Khalid A. Mohamed, Shihab El deen E. Hassan, "Influence of Nitrogen Fertilization, Its Time of Application and Intra -Row Spacing on Growth Performance of Extra Early Maize in the Sudan Savanna, Nigeria", International Journal of Scientific Research in Science, Engineering and Technology (IJSRSET), Online ISSN : 2394-4099, Print ISSN : 2395-1990, Volume 6 Issue 2, pp. 430-434, March-April 2019. Available at doi: https://doi.org/10.32628/IJSRSET196224
Journal URL : http://ijsrset.com/IJSRSET196224