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Effect of Spacing on Grain and Stover Yield of Maize (ZEA Mays L) in Makurdi Southern Guinea Savanna of Nigeria

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Abstract:
A field experiment was conducted at the College of Agronomy Teaching and Research Farm of the University of Agriculture Makurdi during the rainy season (July – November) of 2015 to evaluate the response of three plant densities /53, 333, 66,666 and 106,666 plants /ha) on four varieties of maize (ZEA Mays L) for grain and Stover yield in Makurdi, Benue State in the Southern guinea savanna ecology of Nigeria. The maize varieties (IWDC$_3$, SAMMAZ 11, 2009 TZEE – ORI and LOCAL) were evaluated under three different spacing of 25cm, 40cm and 50cm x 75cm. parameters observed were shoot fresh and dry weight, days to 50% flowering, plant height, ear height, ear weight/plants, Stover yield, biological yield/plant, cob length, cob circumference, number of kernel rows/cob, number of kernels/row, number of kernels/cob, grain yield/plant, 100 seed weight, harvest index and grain yield. The study revealed that plant height, days to 50% anthesis, shoot fresh and dry weight, ear weight/plant, Stover yield, biological yield/plant, cob length, cob circumference, grain yield/plant, 100 seed weight, harvest index and grain yield were significantly influenced by spacing at P<0.05. The result of Stover yield (t/ha) indicated that the highest value of 2.45 t/ha was realized from 25cm (plant density of 106,666 stands/ha) while the value of 1.47 t/ha was observed for 50cm (plant density of 53,333 stands/ha). In respect to grain yield (t/ha), highest value of 3.53 t/ha was obtained from 40cm (plant density of 66,666 stands /ha) and the least value of 2.96 t/ha was realized in 50cm. This implies that maximum grain and Stover yield were obtained from a closer spacing of about 66,666 – 106666 stands/ha is suitable for the production of high yield grain and Stover of maize during the rainy season in the southern guinea of Nigeria.

Keywords: *Effect, maize, grain, Stover, variety, yield, Makurdi, Nigeria*

1. Introduction

Maize (ZEA Mays L) is one of the major cereal crops grown in the humid tropics and sub – Saharan Africa. It is a versatile crop and ranks third following wheat and rice in the world production as reported by Food and Agriculture Organization (FAO, 2002). Maize crop is a key source of food and livelihood for millions of people in many countries of the world. It is produced extensively in Nigeria, where it is consumed roasted, baked, fried, pounded or fermented (Agbato, 2003). In advanced countries, it is an important source of many industrial products such as corn sugar, corn oil, corn flour, starch, syrup, brewer's grit and alcohol (Dutt, 2005). Maize is major components of livestock feed and it is palatable to poultry, cattle and pigs as it supplies them energy (Iken *et al*; 2001). The stalk, leaves, grain and immature ears are cherished by different species of livestock (Dutt, 2005).

Maize Stover which is commonly known as corn Stover is broad term which describes all of the above ground biomass from the corn crop except the grain. The biomass is comprised of structural components including stalks, leaves, tassel, husk and cobs (Perlack *et al*, 2005). Corn residue plays several important roles in a cropping system. Return of corn residue to the soil is also important in maintaining soil organic matter, which in turn influences soil structure, fertility and water holding capacity (Nafziger, 2011).

An optimum plant population is essential for maximum yield in maize. A direct relationship between plant population and final yield to some extent, is obvious because total yield is positively and significantly correlated with the number of ears and hence the number of harvestable plants. A plant population density of 53,333 plant/ha is recommended. This is obtainable with a 75cm x 50cm spacing at 2 plants per hill or 75cm x 25cm at 1 plant per hill. Farmers are known to prefer wide spacing so as to afford easy movement for weeding and other operations (Iken and Amusa, 2004). The objective of this work is to find out the effect of spacing on grain and Stover yield of maize varieties in Makurdi, Southern guinea savanna of Nigeria.

2. Materials and Methods

The experiment was conducted during the rainfed cropping season of 2015 at the teaching and research farm of the college of agronomy, federal university of Agriculture Makurdi, Nigeria. The site is located at latitude 07° 14N, longitude 08° 37E and 98m above sea level. Classes of soil observed were sandy – loam with pH of 5.5-6.5. Average monthly rainfall ranges from 92. 4mm to 237.2mm. Average monthly temperature ranges from 28.5°c to 31°c. Average relative humidity ranges 84.5% to 85.4%, and solar radiation of 5.5 hours to 6.3 hours. Information obtained from Meteorological station Makurdi, Nigeria and Soil Science Laboratory, University of Agriculture Makurdi are presented in table 1 and 2 respectively.

Four (4) varieties of maize ($IWDC_3$, SAMMAZ 11, 2009 TZEE – ORI and LOCAL) were evaluated under three different spacing (25cm x 75cm, 40cm x 75cm and 50cm x 75cm) given the population density of 106,666, 66,666 and 53,333 stands per hectare. The experiment was laid out in a Randomized Complete Block Design (RCBD) replicated three times, each having 12 plots measuring 2m x 4m. Three seeds were sown on ridges and later thinned down to two stand/hill three WAP. Manual weeding was employed three times to control spear grass. Complete fertilizer (NPK 15 – 15 – 15) was applied at the rate of 300kg/ha at 3WAP and was followed by top dressing with Urea at the rate of 200kg/ha at five WAP. Harvesting was carried out at about 12 – 15 WAP. The Stover, ears and cobs were sundried to a constant weight before taking data on yield. Data collected were shoot weight, days to 50% flowering, plant height at harvest, ear height at harvest, ear weight/plant, Stover yield in ton/ha, biological yield/plant, cob length, cob circumstance, number of kernel rows/cob, number of kernels/ row, number of kernels/cob, weight of grain/plant, 100 seed weight, harvest index and grain yield in ton/ha were recorded. Data were analyzed using Genstat software (Genstat 1.0 D. E, 2012) and least significant difference (LSD) for the separation of mean ($P < 0.05$).

Months	Average Monthly Rainfall (Mm)	Average Monthly Temperature (°c)		Average Relative Humidity (%)	Average Solar Radiation (Hrs)
July	223.3(15)	Max	Min	85.2	6.2
		30.2	21.4		
August	237.2 (18)	28.5	21.7	84.7	5.7
September	110.0 (12)	31.3	22.1	84.5	5.5
October	92.4 (9)	31.7	23.1	85.4	6.3
November	90.6 (5)	20.2	20.5	75.2	6.8

Table 1: Meteorological Information for Makurdi Nigeria (July – November 2015
Value in Parenthesis Indicate Number of Rainy Days
Source: Air Force Base Makurdi, Meteorological Station

Parameters	Values
Bulk density (9/cm³)	1.46
Sandy	77.6
Silt (%)	13.2
Clay (%)	9.2
Textural class	Loamy sand
PH in water	5.50
PH	6.50
Porosity (%)	4.50
Organic matter (%)	0.92
Total nitrogen (%)	0.06
Available phosphorus (pm)	2.0
Exchangeable potassium (CMO/kg)	0.28
Exchangeable calcium (CMO/kg)	3.6
Exchangeable magnesium (m01/kg)	1.52
Exchangeable sodium (cm01/kg	0.55
Cation exchange capacity (cm0/kg	6.80
Base saturation (%)	87.5

Table 2: Physical and Chemical Properties of the Soil of the Experimental Site before Planting in Year 2015
Type of Soil: Sandy – Loam
Source: Soil Science Laboratory, University of Agriculture Makurdi, Nigeria

3. Result

Effects of spacing on height, flowering and shoot weight of maize in Table 3. Plant height was significantly influenced by spacing. Taller plants were observed in spacing of 50cm x 75cm, followed by 40cm x 75cm. Intra-row of 25cm recorded the least value of 147.25cm while 50cm recorded the highest value of 165.00cm.

Ear height was not significantly affected by spacing at P<0.05. Days to 50% anthesis were similar for 40cm and 50cm but differed significantly from 25cm. The least value was obtained in the intra – row spacing of 25cm (57.42) while the highest value was recorded for 50cm (58.83). Days to 50% silking were not significant. Shoot fresh weight and dry weight at spacing of 40cm and 50cm were similar but differed significantly from 25cm as shown in Table 3.

Effects of spacing on yield and yield attributes of maize is presented in Table 4 Ear weight/plant was not influenced by spacing between 40cm and 50cm intra-row but differed significantly from 25cm intra-row. Higher values were produced from 40cm and 50cm (97.7g and 92.8g) while 25cm recorded the lowest value of 62.5g. Stover yield in ton per hectare was influenced significantly by spacing. The least value of Stover yield was recorded in 50cm (1.467 t/ha) while the highest value of 2.452 t/ha was recorded in 25cm intra – row. Biological yield /pant was significant. Minimum value of 83.19g was recorded for 25cm while maximum value of 176.6g was obtained from 50cm. Cob length of 40cm and 50cm were similar but differed significantly from that of 25cm. The least value of 13.28cm was obtained in 25cm intra-row while the highest value of 15.00cm was recorded for 50cm intra-row. Cob circumference of 40cm and 50cm were not significant but differed significantly from 25cm. Kernel attributes (kernel rows/cob and number of kernel/cob were not influenced by spacing. Grain yield/plant of 40cm and 50cm were similar but differed significantly from 25cm. The least value of 30.2g was recorded in 25cm and the highest value of 55.6g was produced in 50cm. 100 seed weight was significantly influenced by spacing. The least value of 22.97g was recorded in 25cm while the highest value of 28.66g was produced from 50cm. Harvest index for 40cm and 50cm were similar but differed significantly from that of 25cm. The least value of 0.392g was recorded in 25cm while the highest value of 0.483g was observed for 40cm. Grain yield in ton/ha for 40cm and 50cm were significant but have shown no significant between 25cm and 50cm. The highest value of 3.530t was obtained in 40cm while the least value of 2.964t was recorded in 50cm.

Spacing	PH (cm)	EH (cm)	DFA	DFS	5fW (g)	SDW (g)
25cm	147.3	66.1	57.4	59.6	1.63	0.50
40cm	157.8	66.2	58.5	59.7	2.10	0.70
50cm	165.0	63.6	58.8	59.8	2.11	0.73
LSD (5%)	4.74	3.51	0.66	0.44	0.18	0.09

Table 3: Main Effect of Spacing on Height, Flowering and Shoot Weight of Maize
PH = Plant Height at Harvest, EH = Ear Height at Harvest
DFA = Days to 50% Anthesis, DFS = Days to 50% Silking,
SFW = Shoot Fresh Weight, and SDW = Shoot Dry Weight at 3 WAP

	Spacing	25cm	40m	50cm	LSD (5%)
EWP (g)		62.5	97.7	92.8	9.62
SY (t/ha)		2.45	1.96	1.47	0.26
BYP (g)		83.1	107.8	116.6	11.6
CL (cm)		13.3	14.9	15.1	1.42
CC (cm)		13.6	14.3	14.4	0.4
KRC		13.1	13.3	13.4	0.77
KPR		30.1	32.4	34.0	3.1
NKC		385	391	413	101.4
GYP (g)		30.2	52.9	55.6	7.28
100SW (g)		22.97	25.62	28.66	1.38
HI (g)		0.39	0.48	0.47	0.07
GY (t/ha)		3.22	3.53	2.96	0.46

Table 4: Main Effect of Spacing on Yield and Yield Attributes of Maize
EWP = Weight of Ear/Plant, SY = Stover Yield, BYP = Biological Yield/Plant, CL = Cob Length, CC = Cob Circumference, KRC = Number of Kernel Rows/Cob, KPR = Number of Kernels /Row, NKC = Number of Kernels/Cob, GYP = Weight of Grain/Plant, 100SW = 100 Seed Weight, HI = Harvest Index and GY = Grain Yield

4. Discussion

Plant height, days to 50% anthesis, shoot fresh weight and dry weight were significantly influenced by spacing. However, ear height and days to 50% silking were not significant. Taller plants and ear heights were obtained at the spacing of 40cm and 50cm. This finding does not agree with the result of Adhikari *et al*; (2001) which stated that, with increase in plant density equally increased the plant height of maize. Similarity observed for intra-row spacing of 40cm and 50cm which differed significantly from 25cm, implies that increasing spacing correspond with increase in dry matter weight of a plant. This finding is closely related to the findings of Ali *et al*;(2003) who reported that, competition between maize plants for height, soil fertility and other environmental factors were markedly increased with highest population but decreased with lower plant population. In respect to ear weight/plant and biological yield/plant, higher values were obtained from the spacing of 40cm and 50cm intra – row. This finding is similar to the findings of Barbier et al; (2006) and Azam et al; (2007) who reported that, wider spaced maize plants obtained more soil moisture and nutrients than narrowed spaced plants. Stover yield in ton/ha recorded the highest value at the spacing of 25cm. This could be as a result of high population density of the maize plants. This finding is also similar to the findings of Scars brook and Dos (1973) who reported that, stover yield of hybrid maize usually increase with each increment in plant population up to 80,000 plants per hectare. Cob lengths and cob circumference were significant with the least values obtained at 25cm and the highest values recorded at the spacing of 40cm and 50cm. All the kernels attributes were not significant. The kernel rows were observed to be even in numbers, the intra – row spacing of 40cm and 50cm resulted in higher number of kernels/cob, increase in cob length and circumference possibly because wider spaced plants experienced a decrease in competition for natural resources such as sunlight and soil nutrients. This is in consistent with the findings of Roy and Biswas (1992) who reported that, increased spacing of 25cm resulted in maximum number of grains/cob while spacing of 15cm resulted in minimum number of grains/cob. It is also similar with the findings of Hussein *et al*; (2008) who reported that, the higher values of number of grains per cobs, ear length, ear weight, grain weight per cob and grain index were recorded when maize plants were sown at wider spacing and attributed the results obtained to possible decrease in intra – specific competition for sunlight and soil nutrients.

Grain yield/plant, 100 seed weight and harvest index have been observed to be significant at $P<0.05$. Higher values were obtained at 40cm and 50cm and the least values at 25cm. This result showed that plants that were highly populated produced maximum grain yield per hectare as shown in Table 4, but the yield attributes (grain yield/plant, 100 seed weight and harvest index have shown that wide spacing produced the maximum values. It implies that there were differences in grain yield and its components. This observation is similar with the findings of Ahmed and Sadek (1992) who reported that, maize cultivars differ in their growth characters, yield and its components.

The result of Stover yield in ton/ha indicated that the highest value of 2.45 t/ha was recorded from 25cm (plant density of 106,666 stands /ha) while the least value of 1.47 t/ha was observed for 50cm (plant density of 53,333 stand /ha. In respect to grain yield in ton/ha, highest value of 3.53 was produced from 40cm (plant density of 66,666 stand) and the least value of 2.96 t/ha was obtained from 50cm (plant density of 53,333 stands/ha). These results have shown that maximum grain and Stover yield were realized from a more closer pacing than the recommended density of 53,333 plants/ha for hybrid maize. Therefore, a closer spacing with a plant density around 66,666 – 106,666 stands /ha is suitable for the production of high yield grain and Stover of maize during the rainy season in Makurdi, southern guinea savanna of Nigeria.

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