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Performance of maize as influenced by population density and organic manure types at Samaru, Zaria, Nigeria

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Abstract

A field trial was conducted to study the performance of maize at different population density and organic manure types during the 2014 cropping season at the Teaching and Research Farm of Samaru College of Agriculture, Ahmadu Bello University, Zaria located on latitude 11°11'N and longitude 7°38'E and about 686m in the Northern Guinea ecological zone. The treatments were laid out in a split plot design with population density of one plant stand^{-1}, two plants stand^{-1}, three plants stand^{-1} and four plants stand^{-1} in the main plots; whereas organic manures each at 10 tons ha^{-1} except the control of no manure, goat manure, cow dung and poultry manure in the sub plots, replicated three times to give a total of 48 plots. Results indicated that one plant stand^{-1} and poultry manure on maize significantly produced higher means on the parameters assessed, while four plants stand^{-1} and the control of no manure applied significantly produced lower means on the same parameters assessed.

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Introduction

The art of planting a crop sole or as mixed at different plant population densities is a common practice by majority of Nigerian farmers (Iremiren *et al.,* 2013). The practice aimed at maximizing the scarce land and labor resources as well as to guide against total crop failure amongst other advantages (Iremiren *et al.,* 2013). Maize, a staple cereal food, is a notable food crop common in the food menu of a greater number of the Nigerian families (Ijoyah *et al.*, 2012). The crop is grown sole and as mixed crop at different plant population stand^{-1} and hectare^{-1} with or without fertilizer application due to scarcity and prohibitive procurement cost which is the major reason why most small-scale farmers in tropical Africa often apply little or no fertilizer (Ayeni *et al.*, 2008). The crop therefore, depends entirely on native soil fertility and nutrients from trash materials for growth (Iremiren *et al.,* 2005; Iremiren *et al.,* 2013). The scarcity and high cost of fertilizers in the present day Nigeria, has led to intensification of research into low-cost, internally sourced, cheap, affordable and adoptable organic materials that could serve as fertilizers (Iremiren *et al.,* 2013). Earlier reports had indicated the great potential on the use of organic sources as fertilizer for maize production (Famaye *et al.*, 2011) and better growth performance of coffee seedlings in Nigeria but not yet on maize (Udoh and Ogunkunle, 2012). Farmers' complaint of low yield from multiple cropping of field over the years prompted the conduction of investigation into the optimal plant population density and manure types for better yield of maize (*Zea mays* L.) for optimal economic benefits to the farmers, as well as for sustainable use of scarce land resources (Iremiren *et al.,* 2013).

Materials and methods

A field trial was conducted to study the performance of maize at different population density and organic manure types during the 2014 cropping season at the Teaching and Research Farm of Samaru College of Agriculture, Ahmadu Bello University, Zaria located on latitude 11^{o}11'N and longitude 7^{o}38'E and about 686m in the Northern Guinea ecological zone. The treatments were laid out in a split plot design with population density of one plant stand^{-1}, two plants stand^{-1}, three plants stand^{-1} and four plants stand^{-1} in the main plots; whereas organic manures each at 10 tons ha^{-1} except the control of no manure, goat manure, cow dung and poultry manure in the sub plots, replicated three times to give a total of 48 plots. The site was ploughed, harrowed, and prepared to a fine tilt with all the manure types incorporated into the field. Seeds of maize were sown at a spacing of 30 x 75cm in plots size of 3 x 3.75m. Data collected included plant height, number of leaves plant^{-1}, leaf area plant^{-1}, number of cobs plant^{-1}, number of rows cob^{-1}, and number of grains row^{-1}, fresh cob yield plot^{-1} and fresh cob yield ha^{-1}. The data collected was subjected to statistical analysis using mixed model procedure, software version 8. Means were separated using the least significant difference at 5% level of probability (Rangaswamy, 2010).

Soil Analysis

Pre-sowing analysis of the site soil was carried out by collecting soil samples at 0-30 cm randomly across the plot, air dried, sieved and mixed into composite and then representative samples were analyzed for total N by Kjeldahl approach, available P by Bray-P1 extraction followed by molybdenum blue colorimeter (Iremiren *et al.*, 2013). Exchangeable K, Ca, Mg were extracted using 1N ammonium acetate at pH 7. The K content was determined by use of flame photometer, while Ca and Mg were by atomic absorption spectrophotometer (AAS). Soil pH was determined by pH meter in 1:2.5 soil/water suspensions. Soil organic matter (SOM) was determined by wet dichromate method (Rangaswamy, 2010).

Results

Table 1 shows that the physical properties of the soil in 2013 dry season was sandy-loam with high proportion of sand (84.88%), low silt (7.52%) and clay (10.24%). The chemical analysis revealed that the soil contains low amount of organic carbon (5.34%), pH in water (6.50), total nitrogen (3.66%), total phosphorus (2.14 mg kg^{-1}), potassium (1.68 mg kg^{-1}), magnesium (0.56 mg kg^{-1}), sodium (0.51 mg kg^{-1}) calcium (1.36 mg kg^{-1}) and cation exchange capacity

(CEC) (5.22 mg kg^{-1}) **(**Iremiren *et al.*,2013**)** .

Plant height (cm)

Table 2 shows a significant difference at P≤0.05 between means due to population density and organic manure types at 4WAS, 8WAS and 12WAS during the 2014 cropping season. One plant stand^{-1} significantly produced the lowest means of 45.34, 85.24, and 95.26 on plant height; whereas four plants stand^{-1} significantly produced the highest means of 55.48, 95.38 and 105.34 throughout the sampling periods on plant height of maize. Table 2 also shows a significant difference at P≤0.05 between means due to organic manure types at 4WAS, 8WAS and 12WAS during the 2014 cropping season. The control of no manure applied significantly produced the lowest means of 44.35, 83.54, and 93.46 on plant height; whereas poultry manure significantly produced the highest means of 54.58, 93.68 and 104.64 throughout the sampling periods on plant height of maize.

Table 1. Physical and chemical properties of the soil used for the experiment during the 2014 cropping season.

Mechanical composition	Soil depth 0-30cm
Sand %	84.88
Silt%	7.52
Clay%	10.24
Organic carbon%	5.34
$_{P}H$ in H_2O	6.50
Total nitrogen %	3.66
Available phosphorus mg kg^{-1}	2.14
Available potassium mg kg $^{-1}$	1.68
Available calcium mg kg $^{-1}$	0.56
Available sodium mg kg $^{-1}$	0.51
ailable magnesium mg kg $^{-1}$	1.36
Cation exchange capacity (CEC) mg kg $^{-1}$	5.22

Table 2. Growth parameters of maize as influenced by population density and organic manure in 2014 cropping season at Samaru, Zaria.

	Plant height (cm) plant^{-1}			Number of leaves plant^{-1}			Leaf area (cm^2) plant^{-1}		
Population density (PD)	4WAS	8WAS	12WAS	4WAS	8WAS	12WAS	4WAS	8WAS	12WAS
One plant stand^{-1}	45.34d	85.24d	95.26d	6.71c	9.83c	13.42c	50.25a	53.32a	54.32a
Two plants stand^{-1}	48.65c	88.75c	98.55c	8.24b	13.23b	15.21b	49.23a	52.86a	53.34a
Three plants stand^{-1}	53.24b	93.22b	103.11b	9.52b	15.12b	17.22b	48.78a	51.27a	52.27a
Four plants stand^{-1}	55.48a	95.38a	105.34a	12.33a	17.55a	19.15a	48.33a	50.34a	51.34a
SE±	2.32	2.38	2.42	1.21	2.34	2.36	NS	NS	NS
Organic manure (OM)									
No manure	44.35d	83.54d	93.46d	6.55c	8.84c	10.44c	50.14a	53.34a	54.31a
Goat	47.45c	86.65c	95.65c	7.24b	11.24b	12.22b	49.22a	52.83a	53.30a
Cow dung	52.44b	91.42b	101.31b	8.52b	13.13b	14.24b	48.68a	51.22a	52.25a
Poultry	54.58a	93.68a	104.64a	11.33a	16.65a	17.25a	48.24a	50.35a	51.31a
SE±	1.88	2.08	2.12	0.91	1.14	1.16	NS	NS	NS
PD x OM	*	*	*	*	*	*	*	*	*

Key: - PD = Population density, OM = Organic manure, NS = Not significant, * = Significant at 5% level of probability.

Number of leaves plant^{-1}

Table 2 shows a significant difference at P≤0.05 between means due to population density and organic manure types at 4WAS, 8WAS and 12WAS during the 2014 cropping season. One plant stand^{-1} significantly produced the lowest means of 6.71, 9.83, and 13.42 on number of leaves plant^{-1}; whereas four plants stand^{-1} significantly produced the highest means of 12.33, 17.55 and 19.15 throughout the sampling periods on number of leaves plant^{-1} of maize. Table 2 also shows a significant difference at P≤0.05 between means due to organic manure types at 4WAS, 8WAS and 12WAS during the 2014 cropping season. The control of no manure applied

significantly produced the lowest means of 6.55, 8.84, and 10.44 on number of leaves plant^{-1}; whereas poultry manure significantly produced the highest means of 11.33, 16.65 and 17.25 throughout the sampling periods on number of leaves plant^{-1} of maize.

Leaf area (cm^2) plant^{-1}

Table 2 shows no significant difference at P≤0.05 between means due to population density and organic manure types at 4WAS, 8WAS and 12WAS during the 2014 cropping season.

Table 3. Yield parameters of maize as influenced by population density and organic manure in 2014 cropping season at Samaru, Zaria.

Population density (PD)	Number of cobs plant^{-1}	Number of rows cob^{-1}	Number of grains row^{-1}	Cob yield plot^{-1} (kg)	Cob yield hectare^{-1} (tons)
One plant stand^{-1}	1.12	16.11	28.40	4.26	5.11
Two plants stand^{-1}	1.10	12.24	27.60	3.46	4.15
Three plants stand^{-1}	1.00	10.70	23.11	2.87	3.60
Four plants stand^{-1}	1.00	8.45	21.60	2.41	2.95
SE±	NS	2.15	2.20	1.12	1.21
Organic manure (OM)					
No manure	1.11	10.08	20.36	2.22	2.60
Goat	1.10	12.21	22.56	2.43	3.11
Cow dung	1.00	13.28	25.07	3.44	3.42
Poultry	1.00	15.80	28.57	4.18	5.00
SE±	NS	1.32	1.36	1.10	1.14
PD x OM	NS	*	*	NS	NS

Key**: -** PD = Population density, OM = Organic manure, NS = Not significant, * = Significant at 5% level of probability.

Number of cobs plant^{-1}

Table 3 shows no significant difference at P≤0.05 between means due to population density and organic manure types during the 2014 cropping season on maize.

Number of rows cob^{-1}

Table 3 shows a significant difference at P≤0.05 between means due to population density during the 2014 cropping season on maize. One plant stand^{-1} significantly produced a higher mean of 16.11 on number of rows cob^{-1} of maize assessed, while four plants stand^{-1} significantly produced a lower mean of 8.45 during the sampling period on maize.

Table 3 shows a significant difference at P≤0.05 between means due to organic manure types during the 2014 cropping season on maize. The control of no manure applied significantly produced a lower mean of 10.8 on number of rows cob^{-1} of maize assessed, while poultry manure significantly produced a higher mean of 15.80 during the sampling period on maize.

Number of grains row^{-1}

Table 3 shows a significant difference at P≤0.05 between means due to population density during the 2014 cropping season on maize. One plant stand^{-1} significantly produced a higher mean of 28.40 on number of grains row^{-1} of maize assessed, while four plants stand^{-1} significantly produced a lower mean of 21.60 during the sampling period on maize. Table 3 shows a significant difference at P≤0.05 between means due to organic manure types during the 2014 cropping season on maize. The control of no manure applied significantly produced a lower mean of 20.36 on number of grains rows^{-1} of maize assessed, while poultry manure significantly produced a higher mean of 28.57 during the sampling period on maize.

Fresh cob yield (kg) plot^{-1}

Table 3 shows a significant difference at P≤0.05 between means due to population density during the

2014 cropping season on maize. One plant stand^{-1} significantly produced a higher mean of 4.26 on cob yield plot^{-1} of maize assessed, while four plants stand^{-1} significantly produced a lower mean of 2.41 during the sampling period on maize. Table 3 shows a significant difference at P≤0.05 between means due to organic manure types during the 2014 cropping season on maize. The control of no manure applied significantly produced a lower mean of 2.22 on cob yield plot^{-1} of maize assessed, while poultry manure significantly produced a higher mean of 4.18 during the sampling period on maize.

Fresh cob yield (tons) hactare^{-1}

Table 3 shows a significant difference at P≤0.05 between means due to population density during the 2014 cropping season on maize. One plant stand^{-1} significantly produced a higher mean of 5.11 on cob yield hectare^{-1} of maize assessed, while four plants stand^{-1} significantly produced a lower mean of 22.95 during the sampling period on maize. Table 3 shows a significant difference at P≤0.05 between means due to organic manure types during the 2014 cropping season on maize. The control of no manure applied significantly produced a lower mean of 2.60 on cob yield plot^{-1} of maize assessed, while poultry manure significantly produced a higher mean of 5.00 during the sampling period on maize.

Discussions

Wherever a crop was sown at one plant stand^{-1}, it performed much better than when sown at two or more plants stand^{-1}. This because the one plant stand^{-1} was provided with adequate space for comfort as well as adequate nutrients which enabled it to grow healthier and yielded higher than the crowded ones that were under competition for space and soil nutrients which made them to be uncomfortable for normal growth processes and produced higher grain yield. Similar observations were reported by (Udoh and Ogunkunle, 2012; Iremiren *et al.*, 2013; Ijoyah *et al.*, 2012; Famaye *et al.*, 2011). That the more space provided for any crop the more the performance of the crop in terms of yield; whereas the less the space provided, the lower the performance of the crop with respect to yield and other traits. Poultry manure which was known to contain higher nitrogen over the rest of the organic sources of nutrition provided maize with adequate nutrients which enabled plants under this treatment to produce more cobs and other traits than the rest of the organic sources. This observation is in line with (Iremiren *et al.*, 2013; Ijoyah *et al.*, 2012). That higher nitrogen supply will determine the performance of any crop especially on growth and yield.

Conclusion

Sowing maize at the rate of one plant stand^{-1} and applying poultry manure significantly enhanced the yield performance, while sowing maize at the rate of four plants stand^{-1} and no organic manure applied produced lower grain yield in Samaru, Zaria.

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