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Performance of Maize (*Zea mays* [L.]) as Influenced by Row Arrangement and Cow dung Rates Grown in Intercrop with Watermelon (*Citrullus lanatus* [L.]) in Sudan Savanna

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Authors' contributions

This work was carried out in collaboration among all authors. Author IJD designed the study and performed the statistical analysis. Author BKA wrote the protocol, carried out the field work and wrote the first draft of the manuscript. Author BHK managed the analyses of the study and the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Field trials were carried out at the Teaching and Research Farm of Faculty of Agriculture, University of Maiduguri, Borno State, Nigeria during the 2014 and 2015 rainy seasons to study the performance of maize in maize/watermelon intercrop under varied row arrangements and cow dung rates in a Sudan Savanna Agro-ecology. The treatments consisted of factorial combinations of three row arrangements of maize: watermelon (1:1,1:2 and 2:1) and five levels of cow dung rates (0, 5, 10, 15 and 20t per ha) laid out in a split plot design and replicated three times. Cow dung was assigned to the main plots while row arrangements were assigned to the sub plots. The parameters of maize studied were: number of cobs per plant, cob length, cob diameter, 100 grain weight and grain yield per ha. The results showed that 1:2 row arrangement gave significantly greater cob diameter of maize. While 2:1 row arrangement gave significantly higher maize grain yield per ha. Application of 10t cow dung per ha to the mixture was found to be optimum for the maize grain yield per ha. The interaction or combination of 2:1 row arrangement and 10t cow dung per ha was

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optimum for the grain yield per ha. Based on the results of the present study, 2:1 row arrangement with application of 10t cow dung per ha should be adopted for growing of maize in intercrop with watermelon in the Sudan Savanna environment.

Keywords: Intercrop; row arrangement; cow dung rate; maize yield.

1. INTRODUCTION

Maize or corn (*Zea mays* L.) is the most important cereal crop in Sub-Saharan Africa and one of the three top most important cereal crops (i.e with rice and wheat) in the world. It accounts for 15-20% of the total daily calories in the diet of more than 20 developing countries found in Latin America and Africa [1]. It originated from South and Central America. Maize was introduced to Africa in the 1500 BC and has since become one of Africa's dominant food crops [2].

Maize is a renowned field crop in all the agro-ecological zones of West and Central Africa [1], and its relevance as a high ranking cereal crop in the sub-region has been soaring over the last few decades [3]. Indeed, maize has steadily displaced the traditional African cereal crops like millet and sorghum [4]. Worldwide production of maize is 875 million tons, with the largest producers, the United States, producing 42%, Africa produce 6.5% and the largest African producer is Nigeria with nearly 8 million tons, followed by South Africa. Worldwide consumption of maize is more than 166 million tons, with Africa consuming 30% and South Africa 21%. Eastern and Southern Africa uses 85% of its production as food, while Africa as a whole use 95% compared to other regions that use most of its maize as animal feed [2].

In Africa, Nigeria in particular, the growing of maize is done in mixture (intercrop) mainly with low growing (trailing) crops such as local melons, cowpea, etc. Recently farmers have started growing the maize in mixture with watermelon (which is also a trailing crop) and the practice is on the increase. However, there is no established row arrangement for growing the maize in mixture with the watermelon.

Generally, the savanna soil is inherently low in fertility which is a constraint to production of most crops especially when they are grown in mixture with each other. Also the high cost and scarcity of inorganic fertilizers that is not affordable by the local farmers, its toxicity to aquatics, animals, man and his environment as most are washed to river, lakes, streams and its leaching before taken up by plant which end up as waste of money makes total reliance on inorganic material alone not reliable. Today the use of organic fertilizer in crop production is encouraged due to its numerous advantages like affordability, availability, environmentally friendly, etc. Crops especially vegetables that are cultivated using organic manure are seen as natural and very safe for consumption. Thus, the study was conceived to determine the appropriate row arrangement and optimum organic manure (cow dung) rate for maximum performance of maize when grown in intercrop with watermelon in the Sudan savanna.

2. MATERIALS AND METHODS

Field experiments were conducted at the Faculty of Agriculture Teaching and Research Farm, University of Maiduguri (11^{o}4'N and 13^{o}10'E with altitude of 314 above sea level), Nigeria during the raining seasons of 2014 and 2015, following pre-soil physio-chemical analysis of the experimental site and the nutrient analysis of the organic manure used before cropping [5].

The treatments consisted of factional combinations of three row arrangements (1:1,2:1,1:2) and five rates of dung ($0_{[\text{without cow-dung}]}$ 5,10,15 and 20 tha^{-1}). The treatments were laid out in a split plot design and replicated three times. Well decomposed cow dung manure sourced from the Livestock Unit of the University Teaching and Research Farm was air dried (curing) for 5 days under shade and made into specified treatment-rates. These were allocated to the main plots, while the row arrangements were assigned to the sub-plots. There were a total of 45 (factorial combination treatments) plots and each measuring 3.0 x 4.5m (gross size of 13.5m^2, while the net plot consisted of the three most central rows in each plot (6.75m^2). The cow dung specified treatment-rates were applied into the treatment design two weeks before sowing [6]. The maize and watermelon seeds were sown at spacings of 75 x 50cm and 1 x 1.5m, respectively, on 13th June in 2014 and on 15th June in 2015.

The variety of maize used was SAMMAZ 29 (2000syn EE WSTR) and for watermelon the variety Sugar Baby was used. Two hoe weedings were done at 3 and 7 weeks after sowing (WAS) to control weeds throughout the period of experiments. Parameters on yield components and yield of maize such as: number of cobs/plant, cob length, cob diameter, 100 grain weight and grain yield per ha were assessed using standard producers [7]. Data collected were subjected to analysis of variance [8] and differences between means determined according to Duncan's Multiple Range Test (DMRT) [9] in the General Linear Model (GLM) of SPSS [10].

3. RESULTS AND DISCUSSION

Results of the soil analysis in Table 1 revealed that soil of the experimental site was a sandy loam in both the cropping seasons. The value of the soil chemical properties shows that the soil is generally low in nutrient status. This finding is in agreement with Rayer [11] who reported that the Sudan savanna soils are low in nutrient status. Though in the second year the soil appeared to have relatively increased nutrient level, this must be due to the residual effect of the manure applied during the first year. Results of nutrient analysis of the applied cow dung is shown in Table 2. From the values obtained the cow dung used in both years were rich in nutrients [12].

The effects of row arrangement and cow dung rates on the maize yield components measured: number of cobs per plant, cob length, cob diameter and 100 grain weight for the two years and combined mean are shown in Table 3. There was no significant effect of row arrangement and cow dung rates on the number of cobs per plant and cob length for both the years and combined mean (Table 3).

Also, there was no significant interaction effect of the factors on these parameters. However, there was significant effect of row arrangement on the maize cob diameter in both years and the combined mean (Table 3). Generally, the result shows that 1:2 row arrangement resulted in significantly larger cob diameter than the other row arrangements in both the years and the

Table 1. Physio-chemical properties of the soil at the experimental site before cropping during the 2014 and 2015 rainy seasons

Soil properties	Soil depth (cm)			
	2014		2015	
	0-15	15-30	0-15	15-30
Physical properties (g/kg)				
Sand	760.00	760.00	710.00	760.00
Silt	100.00	120.00	70.50	70.50
Clay	140.00	120.00	70.50	70.50
Textural class	Sandy loam	Sandy loam	Sandy loam	Sandy loam
Chemical composition				
pH in water	6.27	6.27	7.91	7.46
Organic carbon (%)	0.43	0.23	0.72	0.29
Total nitrogen (%)	0.13	0.06	0.20	0.10
Available P (mg/kg)	3.15	4.90	16.80	19.60
Exchangeable cation (Cmol/kg)				
K	0.61	0.47	0.13	0.76
Mg	0.60	0.40	3.60	4.20
Ca	1.20	1.00	10.20	8.60
Na	0.13	0.05	0.32	0.24
CEC	2.54	1.92	15.25	13.80

Mg kg. milligram per kilogram; CEC. Cation Exchange capacity Cmol/kg. centimol per kilogram

Table 2. Some chemical properties of the cow dung used for the trials during the 2014 and 2015 rainy seasons

Parameters	Value (%)	
	2014	2015
N	2.94	2.87
P	0.23	0.25
K	1.15	1.17
Ca^{+}	2.41	2.35
Mg^{2+}	0.49	0.51

Table 3. Effect of row arrangement and cow dung dates on number of cobs/plant, cob length (cm), cob diameter (cm) and 100 grain weight (g) during 2014, 2015 and combined mean

Treatment	No. of Cobs/plant			Cob length (cm)			Cob diameter (cm)			100 grain weight (g)		
	2014	2015	Mean	2014	2015	Mean	2014	2015	Mean	2014	2015	Mean
Row arrangement (A)												
1:1	2.03a	1.96a	1.99a	18.3a	18.0a	18.2a	3.62b	3.26b	3.44b	20.3a	19.3a	19.8a
1:2	1.98a	1.93a	1.95a	18.6a	18.2a	18.4a	3.98a	3.68a	3.83a	21.2a	20.2a	20.7a
2:1	2.06a	1.98a	2.03a	19.9a	19.0a	19.5a	3.20c	3.02c	3.11c	22.2a	21.2a	21.7a
SE ±	0.44	0.11	0.23	0.10	0.11	0.13	0.09	0.12	0.11	0.16	0.13	0.15
Cow dung t/ha (B)												
0	1.90a	1.93a	1.91a	17.0a	18.3a	17.6a	3.35c	3.16c	3.25c	19.8a	18.3a	19.0a
5	1.98a	1.93a	1.95a	18.1a	18.2a	18.2a	3.50c	3.18c	3.34c	19.9a	18.6a	19.2a
10	2.00a	1.96a	1.98a	18.2a	19.4a	18.8a	3.79b	3.59b	3.69b	20.1a	18.9a	19.5a
15	2.03a	2.00a	2.01a	19.6a	19.6a	19.6a	3.91a	3.85a	3.88a	20.3a	19.5a	19.9a
20	2.06a	2.02a	2.04a	19.9a	19.8a	19.8a	3.93a	3.86a	3.89a	21.2a	20.2a	20.7a
SE ±	0.48	0.49	0.44	0.28	0.16	0.25	0.18	0.12	0.15	0.07	0.14	0.11
Interaction												
A *x* B	NS	NS	NS	NS	NS	NS	*	*	*	NS	NS	NS

Means followed by the same letter(s) in a column are Non-significant different at P=0.05 (DMRT)
**Significant; NS. Non-significant*

Table 4. Interaction effect of row arrangement and cow dung rates on cob diameter (cm) at harvest in 2014, 2015 and combined mean

	Cow dung rates (t/ha)				
	0	5	10	15	20
			2014		
Row arrangement					
1:1	3.46de	3.56bcd	3.60b	3.66b	3.88a
1:2	3.56bcd	3.60b	3.63b	3.94a	4.00a
2:1	3.42e	3.50cd	3.54bc	3.61b	3.76ab
SE ±	0.19				
2015					
Row arrangement					
1:1	3.21de	3.22cd	3.37bcd	3.441b	3.67ab
1:2	3.41bc	3.43b	3.44bcd	3.76ab	3.89a
2:1	3.19cd	3.21cde	3.30bcd	3.43bcd	3.45b
SE ±	0.19				
Combined mean					
Row arrangement					
1:1	3.29cde	3.35cde	3.38bcd	3.41b	3.55ab
1:2	3.33cde	3.43cd	3.45b	3.62ab	3.67a
2:1	3.10de	3.16de	3.28cde	3.44b	3.47b
SE ±	0.18				

Means having the same letter(s) are not statistically different at P=0.05 (DMRT)

combined mean. The 2:1 row arrangement produced significantly the least cob diameter in both the locations and combined mean. The larger cob diameter from 1:2 row arrangement could essentially be due to the fewer maize population in the maize/watermelon mixture, the watermelon serving as live mulch. This finding is in agreement with [13] who reported that maize cob diameter increased with decreased plant population.

Application of cow dung significantly influenced maize cob diameter in both years and combined mean (Table 3).

Cow dung of 20t/ha significantly produced larger cob diameter but statistically similar with that from 15t/ha of cow dung in both the years and the combined mean. The greater performance of the maize with the application of higher cow dung rates could be attributed to sufficient supply of essential elements that led to increased growth and development of the maize crop [14]. This finding corroborates with the report of Okuruwa [15] who observed significant increase in LAI and dry matter accumulation in maize with successive increase in cow dung rates. There was significant interaction effect of the factors on the cob diameter in both years and the combined means (Table 3). The combination of 1:2 row arrangement and 15t cow dung/ha was found to be optimum for the maize cob diameter in both years and the combined (Table 4).

The 100 grain weight, like the number of cobs/plant and cob length, did not respond significantly to the treatments but the grain yield/ha responded significantly to both the factors in both the years and combined mean (Table 5). Generally, 2:1 row arrangement produced higher maize yield in both years and combined mean, followed by 1:1 row arrangement. The 1:2 row arrangements produced the least maize yield in both years and combined mean. The high yield/ha obtained from the 2:1 row arrangement could be due to the high

Table 5. Effect of row arrangement and cow dung rates on yield of maize (kg/ha) at harvest in 2014, 2015 and combined mean

Treatment	Maize yield (kg/ha)		
	2014	2015	Combined
Row arrangement (A)			
1:1	1995.6b	1999.9b	1997.7b
1:2	1943.7c	1916.5c	1930. 1c
2:1	2011.8a	2001.9a	2006.8a
SE±	22.0	22.0	20.2
Cow dung t/ha (B)			
0	1770.6d	1573.1d	1671.8d
5	1889.0c	1859.1c	1874.05c
10	2002.8ab	1998.0ab	2000.4ab
15	2030.8a	2060.8a	2045.8a
20	2111.9a	2074.7a	2093.3a
SE±	22.0	22.0	20.2
Interaction			
A *x* B	*	*	*

*Means followed by the same letter(s) in a column are not significantly different at P = 0.05 (DMRT). *Significant*

Table 6. Interaction effect of row arrangement and cow dung rates on maize grain yield/ha (kg) at harvest in 2014, 2015 and combined mean

	Cow dung rates (t/ha)				
	0	5	10	15	20
			2014		
Row arrangement					
1:1	1786.5c	1979.5bc	1996.9b	2001.9ab	2015.3a
1:2	1744.2d	1937.8c	1955.2c	1958.2c	1960.6c
2:1	1986.3c	1979.5bc	2000.1ab	2010.6ab	2040.1a
SE ±	20.31				
2015					
Row arrangement					
1:1	1790.8c	1981.0bc	1996.9b	2000.0ab	2020.3a
1:2	1722.8d	1923.9c	1945.9c	1950.0c	1955.6c
2:1	1998.0c	1989.0b	2010.0ab	2020.7a	2030.1a
SE ±	19.31				
Combined mean					
Row arrangement					
1:1	1788c	1979.4bc	1997.9b	1998.9b	2007.3a
1:2	1734.0d	1930.8c	1950.0c	1952.2c	1957.6c
2:1	1993.3c	1983.5bc	2005.9ab	2010.1a	2023.1a
SE ±	19.9				

Means having the same letter(s) are not statistically different at P=0.05(DMRT) population of maize plants obtained in this planting pattern. Application of cow dung up to 10t/ha increased yield significantly and remained constant beyond this level (Table 5). The increase in yield due to application of cow dung could be attributed to sufficient supply of nutrients which supported better development of the maize crop [14]. There was significant interaction effect of row arrangement and cow dung on the maize yield in both years and the combined mean (Table 5). The combination of 2:1 row arrangement and 10t cow dung/ha was found to be optimum for the maize yield/ha in both the years and combined mean (Table 6).

4. CONCLUSION

From the results of the present study, the use of 2:1 row arrangement with application of 10t/ha of cow dung is most suitable for production of maize in mixture with watermelon in the Sudan Savanna.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Adetiminrin VO, Vroh V, Menkir I, Mitchell SE, Kresovich S. Diversity analysis of elite maize inbreed lines adapted to West and Central Africa using SSR markers. Maydica. 2008;53:199-207.
2. IITA. Impact, challenges and prospects of maize research and development in West and Central Africa. International Institute of Tropical Agriculture. 2009;21.
3. Fakorade MA, Badu A, Kamara B, Menkir AY, Agala SO. Maize revelation in the West and Central Africa: An overview. In Maize Revolution West and Central Africa, Badu-Apraku, Fakorede MAB, A Menkir (eds) Proceedings for a Regional Maize Workshop. IITA cotonou, benin republic 14 – 18 May, 2001, WECAMAN/IITA; 2003.
4. Quarrie S, Lazic A, Janic V, Koncevic D, Steed A, Pekic S. Bulk segregant analysis with molecular markers and its use in improving resistance in maize. Journal of Experimental Botany. 1999;50(37):1299–1306.
5. Washington DC. AOAC official method of ananlysis association of official analysis chemist; 1980.
6. Dantata IJ, Omoayena BO, Azare IM, Abdulhamed IA. Influence of camel-horse dung and variety on the productivity of irrigated cucumber in a semi-arid area of Bauchi State, Nigeria. Dutse Journal of Agriculture and Food Security. 2016;3(2).
7. Danata IJ, Assessing watermelon cultivars under different planning distances in Bauchi North, Nigeria. Asian Journal of Applied Sciences. 2014;2(3):381–387.
8. Steel RGD, Torrie JH. Principles and procedures of statistics, 2nd edition, McGraw – Hill Book Co. Inc., New York.
9. Duncan DB. Multiple range and multiple F – test. Biometrics. 1955;11:1–42.
10. SPSS. Statistical Package for Social Science. SPSS/STAT version 7.5 for windows; 1996.
11. Rayer AJ. Studies on some physio-chemical parameters of the soils of Borno state. Annals of Borno. 1987;4:283–291.
12. Chude VO, Malgwi WB, Amapu IY, Ano OA. Manual on soil fertility assessment. Federal fertilizer department (FFD) in collaboration with national programme for food security, Abuja, Nigeria; 2011.
13. Allessi J, Power JF. Effect of plant population, row spacing and relative maturity on dry land corn in the Northern plains. Agronomy Journal. 2004;66(2): 316–319.
14. Ajayi FA, Dauda SN, Dor EN. Growth and yield of watermelon as affected by cow dung application. Journal of Agricultural and Social Science. 2008;4(3):121–124.
15. Okuruwa EA. Effect of NPK fertilizer and inorganic manure on the growth and yield of maize (*Zea may* L.) hybrid crop. 1998; 22:119–124.

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