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YIELD AND YIELD COMPONEMTS OF EXTRA EARLY MAIZE (*ZEA MAYS* L.) AS INFLUENCED BY INTRA-ROW SPACING, NITROGEN AND POULTRY MANURE RATES

Sharifai, A.I., Mahmud, M., Tanimu, B. and Abubakar, I.U.
Department of Agronomy Institute of Agricultiral Research, Ahmadu Bello University, Zaria
Correspondence author: aminusharifai@yahoo.co.uk, aminusharifai@gmail.com

ABSTRACT
Field trials were conducted during the rainy seasons of 2006, 2007 and 2008 at the Institute for Agricultural Research (I.A.R.) Farm, Samaru to determine the performance of extra early maize (Zea mays L.) as affected by intra-row spacing, nitrogen and poultry manure rates. The treatments consisted of factorial combinations of three intra-row spacing (20, 25 and 30 cm), three rates of nitrogen (40, 80 and 120 kg ha^{-1}) and four rates of poultry manure (0, 2, 4 and 6 t ha^{-1}). The treatments were laid out in a split-plot design with three replications. Combinations of nitrogen and poultry manure rates were assigned to main plot, while intra-row spacing was assigned to the sub plot. The results showed increase in intra-row spacing from 20 to 25 cm significantly increased number of rows cob^{-1}, cob diameter, 100-grain weight and grain yield. The effect of nitrogen on such yield components as cob diameter, cob length and 100-grain weight was significant as the response was in the range of 80 to 120 kg ha^{-1}. Varying level of poultry manure had a significant effect on the performance of the crop. The high level of 2 t ha^{-1} poultry manure significantly out yielded the control but at par with 4 and 6 t ha^{-1} in most of the yield attributes. The optimum yield (2.26 t ha^{-1}) was obtained by the combination of 25 cm intra row spacing, 82 kg N ha^{-1} and 1.91 t poultry manure ha^{-1} and should therefore be adopted by extra early maize farmers in Northern Guinea Savanna agro ecology.
Keywords: Nitrogen, intra-row spacing, poultry manure, cob diameter, cob length, 100-grain weight and grain yield.

INTRODUCTION

Maize (*Zea mays* L.) is one of the most important staple food crops in West and Central Africa. The Savanna of West and Central Africa has one of the greatest potential for its major production because of relatively higher incident of solar radiation and lower incident of pest and diseases during the cropping season (Badu-Apraku *et al.,* 2006). In 2008, the world production was 822.7 million tonnes, 53.4 million tonnes for Africa and 7.5 million tonnes for Nigeria (FAO, 2010). Maize production has expanded dramatically in the Northern Guinea Savanna of West Africa where it has replaced traditional cereals and serves as both a food and a cash crop. In West Africa, Manyong *et al*. (1996) assessed maize as one of the five main crops of the farming systems in 124.7 million hectare or 72% of West Africa. The Northern Guinea Savanna alone took about 92% of total area grown to maize in Nigeria. Maize is also widely believed to have the greatest potential among food crops for attaining the technological breakthroughs that will improve food production in the region (Kamara and Sanginga, 2001).

Growing maize at appropriate spacing is one of the bases for higher yield, whereas intra-row spacing at sub optimum is a major constrain to attaining the yield potential of the crop (Alofe *et al.,* 1988). Intra-row spacing for maximum grain yield in maize varies from 20 to 45 cm (Olson and Sanders, 1988). There is no single recommendation for all environments and all maize types and varieties because optimum spacing for optimum maize yield could vary depending on climatic factors such factors as soil fertility, variety and type, planting date and planting pattern among others (Luis, 2001). The intra-row spacing used by the local farmers for open pollinated extra-early maize was found to be the same as for hybrid, medium and late maturing varieties. This could be a reason for the low yield obtained by farmers. Morphologically, extra-early maize varieties are generally shorter in height (185-190 cm), have fewer number of leaves per plant, flowering occurs at about 40 days after sowing (Elemo, 1997).

Because of the high nutrient demand by maize, its production requires high inputs of fertilizer. However, because of high cost, unavailability and low levels of soil organic matter, alternative organic sources of nutrients particularly N needs to be included in maize fertilization. The use of animal manure is needed to ensure an efficient nutrient management in the maize-based cropping systems in the Northern Guinea Savanna. Research conducted in Northern Guinea Savanna and elsewhere had shown great improvement in the yield of crop as a result of improvement in organic matter content of the soil (Boateng *et al*., 2006). The present study was therefore designed to determine the influence of intra-row spacing, nitrogen and poultry manure rates on the yield and yield components of extra-early maize.

MATERIALS AND METHODS

Field trials were conducted during the rainy seasons of 2006, 2007 and 2008 at the experimental Farm of Institute for Agricultural Research (I.A.R.), Samaru (11°11′N 7°38′E and 686m above sea level) located in the Northern Guinea savannah agro-ecological zone of Nigeria, to study the performance of extra-early maize (*Zea mays* L.) as affected by intra-row spacing, nitrogen and poultry manure rates. The treatments consisted of factorial combinations of three levels each of intra-row spacing (20, 25 and 30 cm), and nitrogen (40, 80 and 120 kg ha^{-1}) and four levels of poultry manure (0, 2, 4 and 6 t ha^{-1}). These treatments were laid out in a split plot design with combination of nitrogen and poultry manure rates assigned to the main plot, while intra-row spacing was assigned to the subplot and replicated three times. The gross plot size was 4.0 m x 4.5 m (18 m^2) and net plot size was 4 m x 1.5 m (6 m^2). Composite soil samples of the experimental site and poultry manure used during the experimental periods were collected prior to establishment of the trial for each year and analysed for their chemical properties in each year. The soil in the experimental area is sandy loam; low in organic carbon and total N. While poultry manure used has high total N (Table 1), while details of meteorological records for the three years are presented in appendix I. An extra early maturing maize (*Zea mays* L.) variety SAMMAZ 12 (previously known as 95-TZEE-W) was used in the study. It was obtained from IAR seed Unit in Samaru, Zaria. The variety is suited to the Sudan and lowland ecologies because of its earliness (80-85 days). The grain is white, semi-dent and has yield potential of 2.0 - 2.8 t ha^{-1}. It is resistant to maize streak virus and has a tendency of escaping drought because of its earliness.

Prior to land preparation, Glyphosate was applied at 4litre ha^{-1} in the experimental site. After 12 days of application the site was ploughed and harrowed to obtain a fine tilth in each season. Ridging was done at 75 cm apart and the field sub divided into plots and replications as per the experimental layout. Seeds were sown manually on 21 June, 12 July and 26 June of 2006, 2007 and 2008 respectively. Two seeds were planted per hole as per the intra-row spacing of 20, 25 and 30 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), giving the population of 66 666, 53 333 and 44 444 plants ha^{-1} respectively. Weeds were controlled with pre emergence herbicide Atrazine + Metalacholor (Primextra) at the rate of 2 kg a.i ha^{-1} applied one day after sowing. Remolding was done at 5 WAS to check the growth of emerging weeds. A basal fertilizer application of 19.97 kg K ha^{-1} (45 kg K_2O) and 37.35 kg P ha^{-1}(45 kg P_2O_5) were applied at planting using muriate of potash (MOP) and single super phosphate (SSP) as sources respectively. The incorporation of poultry manure as per treatment was done two weeks before sowing. Nitrogen in the form of urea (46%N) was applied in two split doses as per treatment at 3 and 5 WAS by side dressing. There was no serious incidence of pest and disease recorded during the three cropping seasons. Therefore no control measure was taken. Harvesting was done when the crops reached physiological maturity i.e. when the attachment of the grain to the cob was observed to be black and leaves turned yellow and brown and kernels were dried in the field. The cobs were plucked, dehusked and further sun-dried. The cobs were then weighed, threshed and winnowed to obtain clean grain.

Data collected includes number of cobs $plant^{-1}$, number of kernel row cob^{-1}, cob diameter, cob length, 100-grain weight and grain yield. All data collected were subjected to General Linear model procedure (GLM) of the Statistical Analysis System (SAS institute Inc. 1990) and differences between the treatments were compared using Duncan Multiple Range Test as described by Duncan (1955). Polynomial responses of grain yield to the treatments were done using a regression analysis as suggested by Barr and Goodnight (1972). Optimum levels of nitrogen and poultry manure for maximum grain yield were calculated as suggested by Garg and Bansal (1972) and Reddy *et al*. (1975).

RESULTS

Table 2 shows the effect of intra-row spacing, nitrogen and poultry manure rates on number of cob $plant^{-1}$, number of rows cob^{-1} and cob diameter. In all the years, there were no significant differences in all the intra-row spacing treatments on number of cob $plant^{-1}$. Highest intra-row spacing (30 cm) produced significantly more number of rows cob^{-1} in 2006, 2007 and combined seasons only than at 20 cm. No significant difference among nitrogen treatments were observed on number of cob $plant^{-1}$ and number of rows cob^{-1}. In 2006 and 2007, increase in nitrogen from 40 to 80 kg ha^{-1} produced significantly wider cobs. Further increase to 120 kg N ha^{-1} had statistically similar effect. However in 2008 and combined seasons 80 kg N ha^{-1} produced significantly wider cobs only than at 40 kg N ha^{-1}. In all the parameters tested, poultry manure treatments had no significant effect in all the years except in combined seasons for number of cob $plant^{-1}$, where 4 t poultry manure ha^{-1} produced significantly more cobs only than at control and in 2006, 2007 and combined seasons on cob diameter where 2 t poultry manure ha^{-1}produced significantly wider cobs only than the control. Significant ($P<0.05$) interaction was observed between intra-row spacing and poultry manure on cob diameter in 2007 rainy season, where application of 2 t poultry manure ha^{-1} produced significantly wider cobs (Table 4).

Table 3 shows the effects of intra-row spacing; nitrogen and poultry manure on cob length, 100-grain weight and grain yield in all years and combined. Intra-row spacing had no significant effect on cob length at all the years and combined. Intra-row spacing significantly increase 100-grain weight in 2006, 2007 and combined.

In 2006; 2007 and combined 30cm intra-row spacing produced significantly heavier 100-grain weight than 20cm. Intra-row spacing of 30cm in 2006 and 2008 produced significantly lower grain yield than 20 and 25cm which were statistically at par. In 2007, the highest grain yield was obtained at 25 cm intra-row spacing followed by 20 and 30 cm which were statistically at par. When the three years data were combined, 25cm had the highest grain yield than 30cm which produced significantly similar grain yield with 20cm.

Application of 120 kg N ha^{-1} produced significantly longer cobs, heavier 100-grain weight and higher grain yield in 2006, 2007 and combined seasons only than at 40 kg N ha^{-1}. Increase application of poultry manure from 0 to 4 t ha^{-1} gave statistically longer cobs in 2006 and 2007; further increase to 6 t ha^{-1} and beyond resulted in similar cob length but longer than at control. In 2008 and combined, there was no significant difference among the poultry manure rates. Similar trend was observed on grain yield in 2006 and combined on poultry manure application. Significant interactions between nitrogen and poultry manure was observed on 100-grain weight in 2006 and grain yield in2007; between intra-row spacing and poultry manure on grain yield in 2007; between intra-row spacing and nitrogen on 100-grain weight in 2006 and grain yield in 2007 (Tables 5 and 6).

Regression Analysis

The regression analysis of grain yield against nitrogen rates gave the following optimum yields 4868.94 at 107 kg N ha^{-1} in 2006, 1702.86 kg ha^{-1} at 94 kg N ha^{-1} in 2007, 2039.7 kg ha^{-1} at 72 kg N ha^{-1} in 2008 and 2285.3 kg ha^{-1} at 82 kg N ha^{-1} in the combined (Fig 1). Similarly, when grain yield was regressed against poultry manure rates the optimum yields was 4298.00 kg ha^{-1} at 3.35 t ha^{-1}, 1851.41 kg ha^{-1}at 3.81 t ha^{-1} , 2096.57 kg ha^{-1}at 2.55 t ha^{-1} and 2260.12 kg ha^{-1}at 1.91 t ha^{-1} for 2006 , 2007 , 2008 and combined respectively (Fig 2).

Table 1: Chemical properties of soils at the experimental sites and poultry manure during 2006, 2007 and 2008 rainy seasons at Samaru.

	2006		2007		2008	
	0-15cm	**15-30cm**	**0-15cm**	**15-30cm**	**0-15cm**	**15-30cm**
Chemical Properties of the soil						
Organic Carbon %	0.56	0.27	0.65	0.49	0.65	0.58
Total N %	0.053	0.035	0.070	0.035	0.088	0.032
Available exchangeable P (mg kg^{-1})	10.50	3.50	14.00	8.75	22.75	8.75
Exchangeable bases (C mol kg^{-1})						
Ca	2.08	3.12	4.17	1.56	2.08	2.60
Mg	1.30	1.89	1.52	1.25	1.57	1.57
K	4.22	0.19	0.38	0.19	0.19	2.30
Na	0.22	0.16	0.07	0.04	0.04	0.03
H + Al	0.40	0.40	0.60	0.40	0.60	0.20
CEC	9.60	7.40	8.70	5.40	6.50	8.60
Chemical Properties of the poultry manure			**2006**	**2007**	**2008**	
Exchangeable bases (C mol kg^{-1})						
K			2.10	0.75	0.83	
Ca			1.77	1.04	1.35	
Mg			1.43	0.63	0.77	
Na			1.10	0.90	1.35	
N %			3.72	3.50	4.04	
Available exchangeable P (mg kg^{-1})			2.93	0.15	0.09	

Table 2: Effects of intra-row spacing, nitrogen and poultry manure rates on number of cob plant^{-1}, number of rows cob^{-1} and cob diameter (cm) of extra early maize *(Zea mays L.)* during 2006, 2007 and 2008 rainy seasons at Samaru, Zaria.

	Number of cob plant^{-1}				Number of rows cob^{-1}				Cob diameter (cm)			
Treatments	2006	2007	2008	Combined	2006	2007	2008	Combined	2006	2007	2008	Combined
Intra-row spacing (I) cm												
20	1.06	1.00	1.00	1.02b	14.36	13.09b	13.81b	13.39b	4.12b	5.85b	6.66	5.45b
25	1.11	1.08	1.00	1.07ab	13.97	13.47ab	14.03ab	14.09a	4.34a	6.07ab	6.72	5.53ab
30	1.14	1.14	1.03	1.01a	14.28	14.03a	14.53a	14.14a	4.39a	6.21a	6.81	5.76a
SE±	0.053	0.048	0.016	0.024	0.181	0.334	0.197	0.148	0.045	0.110	0.192	0.078
Nitrogen kg ha^{-1} (N)												
40	1.08	1.08	1.00	1.06	14.33	13.11	14.47	13.97	4.11b	5.98b	6.38b	5.45b
80	1.11	1.06	1.00	1.06	14.14	13.75	13.94	13.94	4.38a	6.12a	6.78a	5.76a
120	1.11	1.08	1.03	1.08	14.14	13.64	13.94	13.91	4.37a	6.03a	6.72ab	5.70ab
SE±	0.053	0.039	0.016	0.023	0.158	0.374	0.263	0.137	0.0645	0.139	0.214	0.092
Poultry manure t ha^{-1} (PM)												
0	1.04	1.00	1.00	1.00b	14.00	14.19	14.19	14.12	4.22b	5.69b	6.43	5.31b
2	1.11	1.15	1.00	1.05ab	14.41	14.15	13.78	14.11	4.36a	6.12a	6.67	5.66a
4	1.11	1.04	1.00	1.09a	13.96	13.78	14.15	13.96	4.38a	6.13a	6.97	5.75a
6	1.15	1.11	1.04	1.10a	14.44	11.89	14.37	13.75	4.45a	6..23a	6.84	5.83a
SE±	0.061	0.045	0.019	0.026	0.182	0.432	0.303	0.155	0.0745	0.160	0.247	0.103
Interaction												
NxPM	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
IxPM	NS	NS	NS	NS	NS	NS	NS	NS	NS	*	NS	NS
IxN	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
NxIxPM	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Any two means not sharing a letter differ significantly from each other at 5% probability level. NS= not significant, *= significant at $P < 0.05$

Table 3: Effects of intra-row spacing, nitrogen and poultry manure rates on cob length (cm), 100-grain weight (g) and grain yield (kg ha^{-1}) of extra early maize *(Zea mays L.)* during 2006- 2008 and combined rainy seasons at Samaru, Zaria.

	Cob length (cm)				**100-grain weight (g)**				**Grain yield (kg ha^{-1})**			
Treatments	2006	2007	2008	Combined	2006	2007	2008	Combined	2006	2007	2008	Combined
Intra-row spacing (I) cm												
20	14.01	11.30	13.19	12.84	19.63b	17.54b	20.97	19.64b	3121a	1493b	1923a	2189ab
25	14.03	10.94	13.53	12.83	20.60ab	19.05ab	20.44	20.33ab	3294a	1679a	2349a	2316a
30	13.81	11.75	13.12	12.90	21.45a	19.41a	21.51	20.51a	2572b	1426b	1563b	1968b
SE±	0.206	0.336	0.541	0.226	0.385	0.630	0.357	0.266	188.9	57.8	123.1	81.3
Nitrogen kg ha^{-1} (N)												
40	13.06b	10.56b	13.31	12.49b	20.26b	17.64b	20.96	20.01b	2598b	1269b	1990	1838b
80	13.91ab	11.64a	13.09	12.88ab	21.02ab	19.96a	21.09	20.45ab	3149a	1699a	2101	2103ab
120	14.34a	11.74a	13.46	13.20a	21.60a	19.88a	20.88	21.69a	3377a	1633a	1955	2317a
SE±	0.237	0.429	0.534	0.230	0.469	0.671	0.304	0.299	192.2	193.2	144.7	128.1
Poultry manure t ha^{-1} (PM)												
0	13.26b	10.46b	13.54	12.73	20.26b	19.13	19.63.b	19.37b	2756b	973c	1568b	1836b
2	13.89ab	11.39ab	12.65	12.73	20.49b	19.47	21.23a	20.40a	2969ab	1643b	1669b	2103ab
4	14.43a	11.65a	12.62	12.96	22.11a	19.42	21.15a	20.89a	3532a	1848a	2037ab	2285a
6	14.23a	11.82a	14.34	13.01	21.98a	18.88	20.89a	20.24a	3287ab	1672ab	2143a	2358a
SE±	0.273	0.495	0.616	0.266	0.542	0.775	0.351	0.346	221.9	223.0	167.1	147.9
Interaction												
NxPM	NS	NS	NS	NS	*	NS	NS	NS	NS	*	NS	NS
IxPM	NS	NS	NS	NS	NS	NS	NS	NS	NS	*	NS	NS
IxN	NS	NS	NS	NS	*	NS	NS	NS	NS	*	NS	NS
NxIxPM	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Any two means not sharing a letter differ significantly from each other at 5% probability level. NS= not significant, *= significant at $P < 0.05$

Table 4: Interaction between Intra-row spacings and poultry manure on cob diameter in 2007 rainy season

	Intra-row spacing (cm)		
Treatment	**20**	**25**	**30**
Poultry manure t ha^{-1}			
0	5.93d	5.01d	6.22a-c
2	5.74a	6.53a	6.41ab
4	6.29ab	6.02a-c	6.08a-c
6	6.30ab	5.83bc	6.11a-c
SE± 0.221			

Any two means not sharing a letter differ significantly from each other at 5% probability level.

Table 5: Interaction between nitrogen and poultry manure on 100-grain weight in 2006 rainy season

	Nitrogen kg ha^{-1}		
Treatment	**40**	**80**	**120**
Poultry manure t ha^{-1}			
0	18.81c	21.69ab	20.27a-c
2	19.51bc	20.18a-c	22.40a
4	19.94bc	21.61ab	21.97ab
6	22.77a	20.60a-c	21.77ab
SE± 0.9384			
Intra-row spacing (I) cm			
20	18.94d	19.92cd	21.33a-c
25	20.00b	21.60a-c	20.92a-c
30	21.83ab	21.54a-c	22.56a
SE± 0.6667			

Any two means not sharing a letter differ significantly from each other at 5% probability level.

Table 6: Interaction of nitrogen x intra-row spacing, nitrogen x poultry manure and intra -row spacing x poultry manure on grain yield in 2007 rainy season

6a	Nitrogen kg ha^{-1}		
Treatment	**40**	**80**	**120**
Intra-row spacing (I) cm			
20	1324.12cd	1580.83bc	1584.92bc
25	1065.33d	1912.90a	1607.00bc
30	1418.04c	1605.97bc	1708.15ab
SE± 100.16			

6b	Nitrogen (kg ha^{-1})		
Treatment	**40**	**80**	**120**
Poultry manure t ha^{-1}			
0	3146.2a-c	2334.7c	3240.9a-c
2	3387.9a-c	4156.1a	2841.2bc
4	3927.4ab	34.28.7a-c	2787.4c
6	3045.5bc	2677.6c	2657.8c
SE± 384.47			

6c	Intra-row spacing (cm)		
Treatment	**20**	**25**	**30**
Poultry manure t ha^{-1}			
0	958.83ef	1059.70ef	902.33f
2	1977.30a	1695.17a-c	1870.37ab
4	1408.50cd	1661.30bc	1946.21ab
6	1641.87bc	1288.24de	1999.88a
SE± 115.65			

Any two means not sharing a letter differ significantly from each other at 5% probability level.

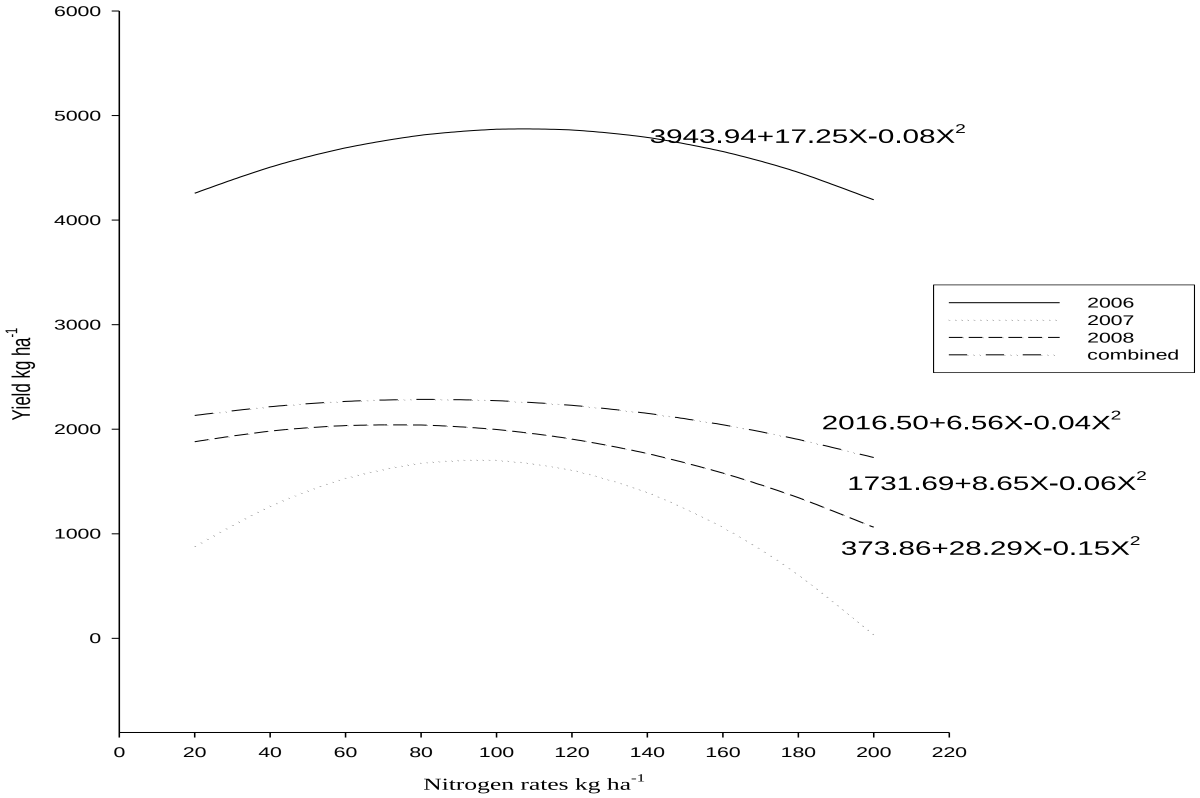

Fig 1: Regresion response of nitrogen rate against grain yield in 2006, 2007 2008 and combined

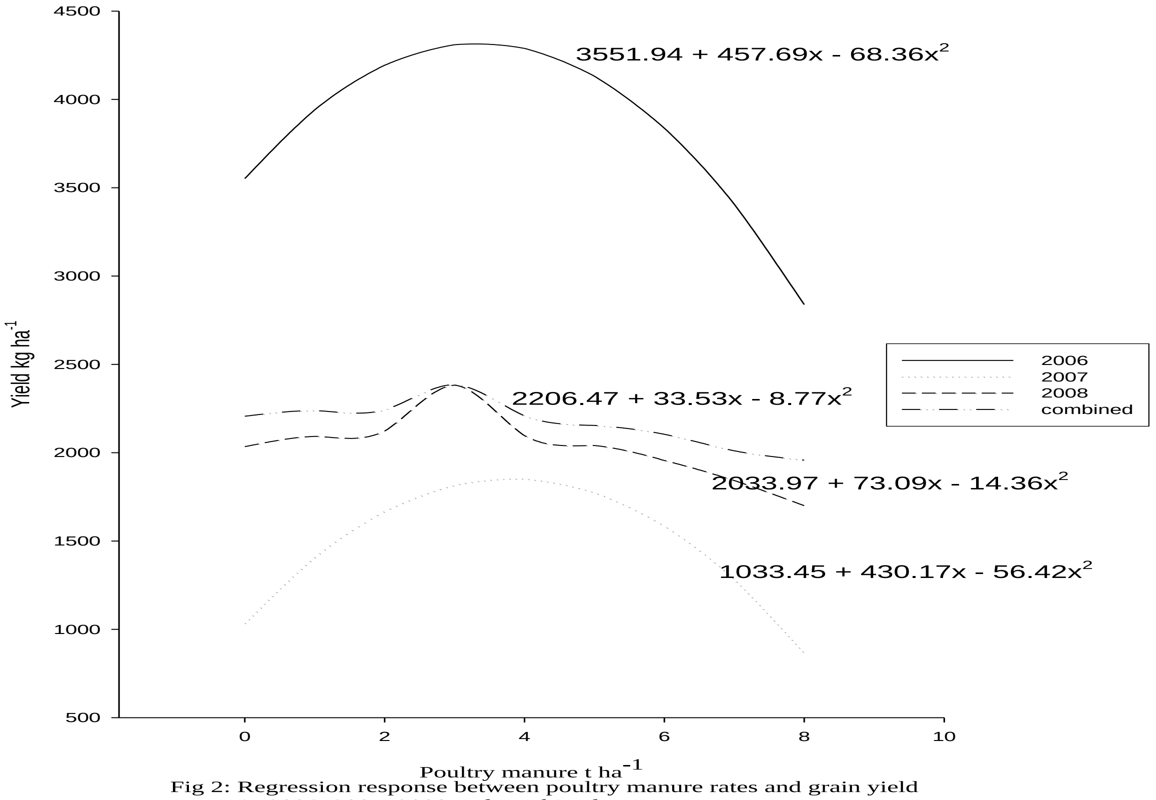

Fig 2: Regression response between poultry manure rates and grain yield in 2006, 2007, 2008 and combined

Appendix I: Samaru Meteorological Observation in 2006, 2007 and 2008 Rainy Seasons.

Month	Rainfall (mm)			Temperature (^oC)						Relative Humidity (%)					
				Minimum			Maximum			10.00H			16.00H		
	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008	2006	2007	2008
January	-	-	-	15.7	12.9	13.6	34.8	28.8	29.0	15.5	18.4	19.7	14.4	12.4	15.1
February	-	-	-	18.3	16.3	15.7	37.2	34.9	32.0	20.4	13.0	12.7	14.5	9.8	9.4
March	-	-	-	28.3	19.0	19.9	58.7	37.1	38.6	27.9	19.2	19.5	21.3	9.2	13.8
April	1.6	-	72.6	21.4	22.8	29.1	38.5	37.8	57.2	25.0	48.4	34.0	16.3	30.2	23.9
May	121.9	194.8	95.0	21.6	21.8	21.9	33.6	34.0	35.0	71.0	68.0	63.0	49.5	53.6	46.2
June	126.5	109.0	111.7	21.1	20.4	20.9	32.2	31.2	33.1	72.3	76.9	72.3	56.8	62.7	55.1
July	232.2	228.6	201.3	20.8	20.8	20.0	30.8	29.8	30.5	78.8	79.6	79.6	66.6	66.9	68.0
August	215.5	328.0	352.6	20.4	21.3	19.5	29.9	28.8	29.7	81.5	77.0	82.0	69.1	74.3	73.2
September	281.5	31.9	217.5	20.2	20.2	25.5	30.9	31.5	31.4	80.1	76.2	77.1	70.5	59.1	66.0
October	28.5	8.3	89.0	20.7	18.2	18.2	32.3	34.9	33.2	68.0	59.0	58.8	55.5	38.5	51.8
November	-	-	-	13.6	15.2	12.8	31.1	35.3	33.8	22.2	22.8	21.2	22.3	18.0	23.1
December	-	-	-	12.5	13.5	14.6	30.6	32.5	32.1	18.2	17.6	20.8	14.5	16.1	17.8
Total	1007.9	900.6	1140.0	234.6	222.4	231.7	420.6	397.0	415.6	580.9	576.1	560.7	471.3	450.8	463.4
Mean	**84.0**	**75.1**	**95.0**	**19.6**	**18.5**	**19.3**	**35.1**	**33.1**	**34.6**	**48.4**	**48.0**	**46.7**	**39.9**	**37.6**	**38.6**

Source: Meteorological Unit, Institute for Agricultural Research Ahmadu Bello University, Zaria, Nigeria

Discussion

The higher yield and yield components observed in 2006 could be attributed to better weather condition compared to the other years. The minimum day temperature during the growing season (18.6^0C) in 2006 was lower especially when compared with the 2007 and 2008 (19.6 and 19.3^0C) growing seasons. The mean temperature and relative humidity recorded at the time of pollination and fertilization in 2006, 2007, 2008 were 19.6 ^OC and 48.4%; 18.5^OC and 48%; 19.3 ^OC and 46.7%, respectively (Appendix I). It is known that higher air temperature adversely affected crop productivity (Hussaini *et al.,* 2001). The mean rainfall in 2006 was 84 mm and was evenly distributed from July to September and this period corresponds with flowering and grain filling stages. However in 2007, there was early cessation of rainfall at the end of September and was not evenly distributed (Appendix I). In 2008 rainy season there was more rain and it was not evenly distributed (Appendix I) and water logging at the center of the field was observed. This could cause the leaching of the soil nutrients down the soil profile beyond the root zone of the crop or the nutrients washed away, consequently causing reduction in yield.

Yield and yield components studied responded significantly ($P < 0.05$) to variation in intra-row spacing. Number of cobs plant^{-1}, number of rows cob^{-1}, cob diameter were all significantly decreased when intra-row spacing decreased from 30 to 20 cm. This resulted in limited supplies of carbon and nitrogen and consequent increase in barrenness and decrease in grain number plant^{-1}as result of intense intra-plant competition for light, soil nutrient and soil water. Maize intra-row spacing for maximum economic yield varies from 18 to 45 cm depending on planting date, water availability, soil fertility and maturity (Sangoi, 2001). The increase in yield might be due to better light utilization by the closely spaced plants, hence higher dry matter for grain filling. This result was in agreement with the findings of Okan *et al.* (2004) who obtained highest yield from lowest intra-row spacing (20 cm).

Nitrogen fertilization significantly increased extra early maize development. The trend was manifested in all seasons. Yield component such as cob diameter, 100-grain weight and grain yield ha^{-1} were all optimized at 80 kg N ha^{-1}. This could be due to the fact that excessive nitrogen reduce grain yield but enhanced plant growth.

This finding corroborated those of Hussaini *et al.* (2001), Mani (2004), Sharifai *et al.* (2008) and Namakka *et al.* (2009). 100-grain weight was significantly increased with nitrogen application up to 80 kg ha^{-1}. This is because an increase in nitrogen application positively enhance the chlorophyll content in plant thereby improving photosynthetic activities that promotes assimilate production and this will result in the increase in final yield. Nitrogen fertilization significantly ($P < 0.005$) increased maize grain yield with each increase in nitrogen between 40 to 80 kg ha^{-1}. Hussaini, *et al.* (2001) reported similar response where they attributed this significant increase in yield to favourable effect of nitrogen on cob length and cob diameter, which all have direct bearing on the final grain yield. The increase in yield could be as a result of good dry matter production for grain filling as a result of higher number of leaves.

It was observed that poultry manure application significantly increased most of the yield components compared with plots that received no poultry manure. Yield and yield components of maize such as cob diameter and 100-grain weight were all highest at 4 t poultry manure ha^{-1} in 2006, 2007 and combined means. This could be attributed to the ability of poultry manure to supply essential nutrients and micronutrients for crop production. They are also valuable sources of soil organic matter. Organic matter improves soil structure; increases water holding capacity of soil and are source of slow-release nutrient. Soil organic matter also contributes to greater efficiency of fertilizer use.

The significant response of 100-grain weight and grain yield to applied nitrogen and poultry manure signified the importance of N in the development of maize. The increase in these parameters could be due to synergy effects of nitrogen and poultry manure. The interactions ascertain the affirmation that the combined application of both organic and inorganic manure is essential for crop yield. Boateng *et al.* (2006) reported similar result where interaction between N and Poultry manure increases the yield of maize crop and improve the soil structures and chemical nutrients of the soil.

The significant interaction between intra-row spacing and poultry manure on cob diameter, 100 grain weight and grain yield showed the importance of poultry manure on yield and yield components of maize crop. Poultry manure increases both soil physical and chemical properties. The yield increase with poultry manure application at 2 t ha^{-1} at closer spacing might be due to availability of nutrients for crop use.

The significant interaction between intra-row spacing and nitrogen on grain yield showed the importance of nitrogen on yield of maize crop. The yield increase with higher nitrogen rates at closer spacing might be due to improved rooting depth, leaf area expansion and thus the efficiency in the use of solar radiation which indirectly increases dry matter production for grain filling, therefore increases yield. Tenaw (2000) reported similar trend where nitrogen x intra-row spacing gave yield component and yield at the lowest intra-row spacing of 18 cm x 60 kg N ha^{-1}.

From the results of the regression analysis it was observed that optimum yield was a combination of 20 cm intra-row spacing, 82 kg N ha^{-1} and 1.91 t poultry manure ha^{-1} in combined.

Based on the results obtained it can be concluded that optimum grain yield of extra early maize was obtained at 25cm intra-row spacing, 82 kg N ha^{-1} and 1.91 t poultry manure ha^{-1}.

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