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GROWTH, NUTRIENT UPTAKE AND YIELD OF MAIZE (*Zea mays* L.) AS INFLUENCED BY WEED CONTROL AND POULTRY MANURE

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ABSTRACT
Field trials were conducted in 2009, 2010 and 2011 rainy seasons at the Institute for Agricultural Research farm Samaru, in the Northern Guinea Savanna Zone of Nigeria, to find the effects of weed control and poultry manure treatments on growth, nutrient uptake and yield of maize. The least weed density and weed dry weight were by plots treated with Atrazine + Metolachlor at 2.6 kg a.i ha^{-1}. The tallest plants with higher leaf area index, heavier total dry matter which resulted in significantly higher nitrogen uptake were by plots treated with Atrazine + Metolachlor at 2.6 kg a.i ha^{-1}. In the combine data plots treated with Atrazine + Metolachlor at 2.6 kg a.i ha^{-1} led to early days to 50% tasseling and silking. Plots that were treated with Atrazine + Metolachlor at 2.6 kg a.i ha^{-1} and those weeded twice produced the highest grain yield. Plots that received 6t ha^{-1} poultry manure consistently recorded higher values for weed density and weed dry weight. At both sampling periods of 3 and 12WAS, application of 6t ha^{-1} poultry manure produced the tallest plants with higher leaf area index and heavier total dry matter. Application of 6t ha^{-1} poultry manure or NPK fertilizer resulted in significantly higher nitrogen uptake while application of NPK fertilizer resulted in the highest P uptake. In all the seasons and the mean plots that received 6t ha^{-1} poultry manure or NPK fertilizer resulted in the highest grain yield.

KEYWORDS: Growth, Nutrient uptake, Maize, Weed control, Poultry manure.

INTRODUCTION
Maize (*Zea mays* L.) or Corn is the most important cereal crop in sub-saharan Africa (FAO, 2006). It is a staple cereal grain for millions of people in the region where it has become increasingly important as food and source of income for inhabitants of African savanna where it thrives best (Halilu *et al.,* 2012). Its genetic plasticity has made it the world most widely distributed crop from the tropics to the temperate zone. The spread of maize can also be attributed to its adaptability to a wide range of soils and climatic conditions (FAO, 2006). In Nigeria, maize is cultivated on more than six million hectares, spreading through the six Agro-ecological zones with annual production of 26 million tons from 3,845,000 hectares in 2008 (FAO, 2009). Maize grain is used as food, feed and industrial material in the manufacturing of corn sugar, corn oil, corn protein, cornflakes, corn syrup etc. Despite the numerous importance of maize, the yield obtained in Nigeria is far below expectation due to numerous factors which includes; adverse weed infestation, low soil fertility and availability of labour (Mahadi *et al.,* 2013). Successful maize production requires an understanding of various management practices as well as environmental conditions that affect its performance. In Nigeria, adverse weed infestation in maize fields contributed to drastic reduction of maize yield. Apart from competing with the crop for growth resources weed also serves as alternate hosts to insects, rodents and pathogens which can lead to outbreak of diseases. Akobundu and Ekeleme (2000) have reported a yield of 51-100% due to weed infestation in maize; also Lagoke *et al.* (1998) reported yield loss of 60-81% in maize due to weed infestation. In Nigeria farmers have adopted the use of herbicides for weed control in maize due to its efficiency and affordability. Maize as a cereal requires adequate soil fertility for high productivity. The crop requires large amounts of N, P and K in addition to other micro elements. Idachaba (2006) reported that crop output of countries correlate strongly and positively with fertilizer consumption.

Several researchers including Lombin (1987) reported low organic matter content, low cation exchange capacity and low inherent fertility as characteristic features of Nigeria soils and identified N as P as the most limited nutrient in the soil. High cost of inorganic fertilizers as its challenges of availability have affected its accessibility to resource poor farmers thereby resulting in the use of insufficient qualities at the right time of need which often lead to poor yields (Mahadi *et al.,* 2013). In order to overcome the problems associated with costs of inorganic fertilizers as well as its challenges of availability, it becomes necessary to harness and advocate for alternative means of sustaining and improving soil nutrient status. This can be by application of organic manure which can be sourced from various sources and include; cow dung, sheep and goat manure, poultry manure etc. Manure is an important resource for sustainable crop production and soil fertility (Bahman and James, 1999). Nitrogen and phosphorus uptake was found to be greatly influenced by the levels of organic manure which is associated with the increase in supplementation of soil reservoir from the organic manure (Brandhari *et al.,* 2001). Organic manure also enhances microbial activities due to available organic carbon. Among the several sources of organic manure, poultry manure has been found to be very promising as it contains higher amounts of mineral nutrients which is easily mineralize in the soil for plant uptake (Anon, 2007a) compared to cow dung which is the common source of manure used by farmers in the savanna ecology of Nigeria. Poultry manure also contains little or no variable weed seeds which will definitely reduce the level of weed infestation on farmer fields.

Growth and development of a crop is determined by the effectiveness of a crop in absorbing, translocating and partitioning nutrients for dry matter accumulation. The uptake of nutrients and their subsequent distribution to various parts of maize plants varied primarily with factors like the native soil fertility, application of chemical fertilizers, the growth stage of the plant and the environmental conditions (Ologunde, 1974). Considering the fact that chemical fertilizer among other factors may affect nutrient uptake and distribution within plants, it becomes necessary to determine the effect of herbicides on this regard especially in the savanna zone of Nigeria where maize is largely grown with the use of herbicides year in year out for weed control. From a physiological point of view crop yield and its components are directly or indirectly correlated to crop growth parameters. Any factor that hastens crop growth will invariably increase yield, while any factor that retards growth will invariably translate to reduction in crop yield. Based on the foregoing this study was conducted to determine the growth, nutrient uptake and yield of quality protein maize variety as influenced by weed control treatments and poultry manure.

MATERIALS & METHODS

Experimental site

This study was conducted at the Institute for Agricultural Research farm at Samaru (11^{o} 11'N, 07^{o} 38'E, 686 m altitude) located in the Northern guinea savanna zone of Nigeria during the 2009, 2010 and 2011 rainy seasons. The rainfall pattern of the area is unimodial with a peak usually in August. The soils of the experimental sites were loams, moderately acidic with low nitrogen (N), phosphorus (P), potassium (K) and cation exchange capacity (CEC), while calcium (Ca) and Magnesium (mg) were moderate (Table 1). Poultry manure used in 2009 season had higher N, P and Mg than those used in subsequent years while those used in 2010 season had higher amounts of P and Ca. However poultry manure used in 2011 season had the highest value for sodium (Na).

TABLE 1: Physical and chemical properties of soil samples from the experimental sites at 0– 15cm.

Composition	2009	2010	2011
	0 – 15 cm		
Physical properties (%)			
Sand	47	43	44
Silt	37	38	40
Clay	16	19	16
Textural class	Loam	Loam	Loam
Chemical properties			
pH in H20	5.3	5.7	5.4
pH in $Cacl_2$	4.7	5.1	5.3
Organic carbon (g/kg)	0.54	0.62	0.64
Total Nitrogen (g/kg)	0.66	0.64	0.58
Available exchangeable P (mg/kg)	14.0	16.5	13.3
Exchangeable base (cmol/meq)			
Ca	3.17	3.62	2.16
Mg	1.62	1.58	1.57
K	0.96	0.72	0.65
Na	0.94	0.81	1.10
CEC	5.60	6.20	5.80

TABLE 2: Chemical properties of poultry manure samples

Chemical composition	2009	2010	2011
Total Nitrogen (%)	4.08	3.73	3.96
Available phosphorus (%)	1.87	1.93	0.91
Potassium (%)	2.36	1.84	2.10
Calcium (%)	1.67	1.81	1.73
Magnesium (%)	1.41	1.27	1.35
Sodium (%)	0.52	0.61	0.67

Crop variety

SAMMAZ 14, or Quality protein maize variety maturing between one hundred and ten days to one hundred and twenty days with a yield potential of 5 tons ha^{-1} was used in this study. This variety was obtained from the Seed Production Unit of the Institute for Agricultural Research, Samaru.

Treatments, Experimental Design and Agronomic Practices

The trial consisted of factorial combinations of eight weed control treatments (Bullet, a proprietary mixture of Atrazine + Acetochlor + Terbuthylazine at a ratio of 250:225:225 g/l respectively produced by Monsanto chemical company applied at the rate of 2.1 and 2.8 kg a.i ha^{-1}, Primextra gold, a proprietary mixture of Atrazine + Metolachlor at a ratio of 290:370 g/l respectively produced by Syngenta chemical company applied at the rate of 1.9 and 2.6 kg a.i ha^{-1}, Atrazine (500g/l) produced by Candel chemical company applied at the rate of 1.0 and 1.5 kg a.i ha^{-1}, hoe weeded at 3 and 6 weeks after sowing (WAS) and a weedy check) and four levels of poultry manure (0, 2, 4 and 6 t ha^{-1}) and a recommended NPK mineral fertilizer check at the rate of 120kgN, 26kgP and 50kgK ha^{-1}. The treatments were factorially arranged and laid out in a split plot design with three replicates. The weed control treatments were assigned to the main plots while the fertilizer treatments were assigned to the sub-plots. The gross and net plot sizes were 18 m^2 and 12 m^2 respectively. The experimental site was harrowed twice to a fine tilth and ridged 75cm apart. Poultry manure was incorporated on treatment basis two weeks prior to planting. Maize seeds were planted on the 11th June 2009, 3rd June 2010 and 7th June 2011. Two seeds were sown per hole manually along the ridges at an intra-row spacing of 25 cm. The plants were later thinned to one plant per stand at two WAS. The pre-emergence herbicides were applied on treatment basis immediately after planting using a Cp3 knapsack sprayer set at a pressure gauge of $2.1kg/m^2$. The hoe weeded plots were weeded twice at 3 and 6 WAS in each year of the trial. Inorganic fertilizer was applied by side dressing at the rate of 120kgN, 25.8kgP and 49.8kgK ha^{-1} using NPK 15:15:15 and urea 46% N to supply the inorganic fertilizer treatment. The N was applied in two split doses at 3 and 6 WAS. The crops were harvested at maturity when the leaves, stems and ears have turned brown and dried. After harvest the ears were de-husked and the cobs were threshed on the floor and winnowed to remove chaffs and obtain clean grains.

Data collection: Data were taken on the following parameters:

Weed density: This was obtained from a randomly placed 1m x 1m quadrat once in each experimental plot at 12 weeks after sowing. Weeds within each quadrat were counted and recorded as weed density per plot.

Weed dry weight: This was also obtained from a randomly placed 1m x 1m quadrat once in each experimental plot at 12 weeks after sowing. Weeds within each quadrat were uprooted, properly shaking and washed to remove soils from roots and oven dried at 70^0c to a constant weight (g/m^2) which were converted to kg/ha basis.

Plant height: The height of five randomly tagged plants within the net plot was measured from the ground level to the tip of the highest leaf at 6 and 12 weeks after sowing.

Leaf area index: The leaf area was determined at 8 and 12 WAS by measuring the leaf area of the plant as follows.

LA = L x W x 0.75

Where

L	=	Length of the leaf
W	=	Maximum width
0.75	=	Crop factor.

The leaf area/net plot (PLA) = L x W x 0.75 x n x N

Where

n	=	number of leaves measured per plant
N	=	Number of plants measure per plot
PLA	=	Leaf area/plot
LAI	=	PLA/Net plot area

Total dry matter: Five randomly selected plants were uprooted from the soil at 8 and 12 WAS and were oven dried at 70^0C to a constant weight and the mean weight was recorded.

N**umber of days to 50% tasseling and silking:** This was determined by recording the number of days from the date of sowing to the time when about 50% of the plants in each net plot have tasselled and or silked.

Determination of leaf N, P and K contents (Plant tissue analysis)

The chemical analysis of the leaf subtending the ear was carried out. Samples were randomly taken from each net plot at full vegetative growth (12WAS) and oven dried at 70^0C to a constant weight. The samples were then ground with a clean Wiley mill and sieved with a 0.5mm mesh. The samples were analysed to determine the content of N,P and K. For determination of N, the microkjeldahl method as described by Bremmer (1965) was used , P content was determined calorimetrically using a spectrometer, the procedure involved the use of venedomlybdate yellow method (Murphy and Riley., 1962). A flame photometer was used to determine K content.

Grain Yield: Grain yield was determined after harvest. Harvested cobs from the net plots were sun dried shelled and clean grains were weighed per plot which were further converted to Kg/ha.

Data Analysis: Data collected were subjected to analysis of variance (ANOVA) and the means separated using Duncan's multiple range test (Duncan 1955).

RESULTS

Weed density and weed dry weight were significantly affected by weed management and poultry manure treatments. In all the seasons and the mean, plots that received Atrazine + Metolachlor at 2.6 kg $a.i/ha^{-1}$ had significantly lower ($P<0.05$) weed density which were statistically similar to plots that received Atrazine + Acetochlor + Terbuthylazine at 2.8 kg $a.i/ha^{-1}$ in 2009 and 2010 seasons, while the weedy check plots recorded significantly the highest ($P>0.05$) weed density. Plots that received $6tons/ha^{-1}$ poultry manure had significantly the highest ($P>0.05$) weed density while plots that did not receive poultry manure or NPK inorganic fertilizer had significantly the least ($P<0.05$) weed density. Also weed dry weight was lowest in plots treated with Atrazine and Metolachlor at 2.6 kg $a.i/ha^{-1}$ while the weedy check recorded the highest weed dry weight. Plots that did not receive poultry manure or NPK inorganic fertilizer significantly had the least ($P<0.05$) weed dry weight while the weedy check plots recorded the highest weed dry weight (Table 3). Table 4 shows the significant effect of weed management and poultry manure treatment plant height of QPM. At 6WAS in 2009 and the mean, plots treated with Atrazine + Metolachlor at 2.6 kg $a.i/ha^{-1}$ had significantly the tallest plants. In 2010 season, plots treated with Atrazine + Acetochlor + Terbulthylazine at 2.8 kg $a.i/ha^{-1}$ produced the tallest plants which were statistically comparable to plants that received Atrazine + Metolachor at 2.6 kg $a.i/ha^{-1}$. However in 2011 season, plots weeded twice at 3 and 6 WAS had significantly taller plants which were statistically comparable to all the other treatments except plots that received Atrazine + Aectochlor + Terbuthylazine at 2.1kg $a.i/ha^{-1}$ and those in the weedy check. At 12 WAS, plots that received Atrazine + Metolachor at 2.6 kg $a.i/ha^{-1}$ consistently had significantly taller plants which were comparable to plants in plots weeded twice in 2011 season. The weedy check plots consistently produced the shortest plants at both sampling periods (Table 4). At both sampling periods and in all the seasons, plots that received 6tons/ha^{-1} of poultry manure produced the tallest plants while plots that did not receive poultry manure or inorganic fertilizer produced the shortest plants (Table 4).

The significant effect of weed management and poultry manure on leaf Area index (LAI) of QPM is shown in (Table 5). At 8WAS in all the seasons and the mean, plots that received Atrazine + Metolachlor at 2.6 kg a.i/ha^{-1} recorded significantly higher (P> 0.05) leaf area index which were comparable to plots that received Atrazine at 1.5 kg a.i/ha^{-1} in 2009 and 2010 seasons and those weeded twice in 2010 season. However at 12 WAS, in all the seasons plots treated with Atrazine + Metolachlor at 2.6 kg a.i/ha^{-1} and those weeded twice in 2009 season had the highest LAI.

TABLE 3: Effect of weed control and poultry manure on weed density and weed dry weight of maize at Samaru during 2009, 2010 and 2011 rainy season

Treatments		Weed density (12 WAS)				Weed dry weight (kg/ha) 12 WAS			
		2009	2010	2011	Mean	2009	2010	2011	Mean
Weed control	Rate(kga.i/ha)								
Atrazine + Acetochlor + Terbuthylazine	2.1	67.0cd	57.2d	57.8d	60.7d	43.2d	43.6c	44.8d	43.9d
“	2.8	61.0ef	51.0e	54.7e	55.5e	38.7ef	29.7e	34.9f	34.4f
Atrazine + Metolachlor	1.9	67.3cd	57.1d	56.6de	60.3d	41.5de	35.5d	41.6e	39.6e
“	2.6	57.6f	49.4e	47.0f	51.4f	33.5g	27.5e	31.4g	30.8g
Atrazine	1.0	88.1b	69.4b	72.0b	76.5b	70.2b	67.6b	72.8b	70.2b
“	1.5	69.2c	67.2b	63.1c	66.5c	56.2c	43.5c	56.2c	52.0c
Hoe weeded at 3 & 6 WAS		64.9de	63.2c	56.2de	61.4d	38.4f	36.0d	40.7e	38.4e
Weedy check		113.3a	120.2a	125.9a	119.8a	219.6a	236.8a	240.4a	232.3a
SE±		1.12	0.71	0.76	0.52	1.07	0.82	1.36	0.62
Poultry manure (T/ha)									
0		70.6c	64.1d	64.5d	66.4d	66.5ab	63.0c	67.7b	65.7b
2		71.6c	65.8c	65.7cd	67.7c	68.0ab	65.9ab	69.9b	68.0b
4		73.1bc	67.1bc	66.4bc	68.9b	69.0a	64.5bc	73.5a	69.0ab
6		77.4a	68.9a	68.8a	71.7a	69.0a	66.8a	73.4a	69.7a
NPK 120:26:50		75.1ab	68.2ab	67.8ab	70.3b	65.8b	64.9abc	67.3b	66.0c
SE±		0.88	0.56	0.60	0.41	0.84	0.65	1.07	0.49
Interaction									
W x P		NS	NS	NS	NS	NS	NS	NS	NS

Means followed by the same letter(s) within a column of each treatment group are statistically different at 5% level of probability using DMRT. WAS = Weeks after sowing, NS = Not significant.

TABLE 4: Effect of weed control and poultry manure on Plant height of maize at Samaru during 2009, 2010 and 2011 rainy season

Treatments		Plant height (6 WAS)			cm	Plant height (12 WAS)			
		2009	2010	2011	Mean	2009	2010	2011	Mean
Weed control	Rate(kga.i/ha)								
Atrazine + Acetochlor + Terbuthylazine	2.1	78.8b	78.6d	84.0b	80.5c	166.6bc	163.9c	167.4c	166.0c
“	2.8	78.0b	91.5a	88.7ab	86.0b	174.4b	171.3bc	169.2c	171.6b
Atrazine + Metolachlor	1.9	80.2b	84.0bcd	92.4ab	85.5b	174.6b	174.0b	177.8b	175.5b
“	2.6	89.8a	88.4ab	92.2ab	90.1a	192.6a	184.4a	190.8a	189.3a
Atrazine	1.0	82.1b	80.6cd	90.0ab	84.2b	162.1c	166.2bc	167.2c	165.2c
“	1.5	83.0b	84.7bc	91.8ab	86.6b	163.1bc	172.9b	174.1bc	170.0bc
Hoe weeded at 3 & 6 WAS		80.2b	81.7cd	94.8a	85.6b	168.3bc	162.9c	189.2a	173.4b
Weedy check		58.5c	61.4e	61.7c	60.5d	92.4d	79.0d	85.2d	85.5d
SE±		2.26	1.25	2.35	1.18	2.98	2.91	2.54	1.63
Poultry manure (T/ha)									
0		52.0d	57.0e	59.9d	56.3d	99.0c	84.1e	93.8d	92.3e
2		69.9c	71.9d	77.1c	73.0c	123.6d	128.8d	136.2c	129.5d
4		88.1b	87.2c	97.0b	90.7b	185.5c	187.0c	192.3b	188.3c
6		95.5a	99.3a	106.5a	100.4a	203.9a	201.6a	206.1a	203.9a
NPK 120:26:50		88.7b	91.3b	94.2b	91.4b	196.9a	195.0b	197.0b	196.3b
SE±		1.79	0.99	1.86	0.93	2.36	2.30	2.01	1.29
Interaction									
W x P		NS	NS	NS	NS	NS	NS	NS	NS

Means followed by the same letter(s) within a column of each treatment group are statistically different at 5% level of probability using DMRT, WAS = Weeks after sowing, NS = Not significant.

Plots in the weedy check consistently recorded the least LAI in all the seasons and at both sampling periods. Plots that received 6tons/ha^{-1} poultry manure significantly had the highest LAI (P>0.05) which was statistically similar to plots that received NPK inorganic fertilizer at 12 WAS in

2010. The least LAI were by plots that were not treated with poultry manure or NPK fertilizer (Table 5).

Table 6 shows the significant effect of weed management and poultry manure treatments on total dry matter TDM of QPM. At 6WAS, in all the seasons and the mean plots treated with Atrazine + Metolachor at 2.6 kg a.i/ha^{-1} produced significantly heavier total dry matter per plant which were statistically comparable to plots weeded twice and those that received Atrazine + Metolachlor at 1.9 kg a.i/ha^{-1} in 2010, while At 9WAS plots that received Atrazine + Metolachlor at 2.6 kg a.i/ha^{-1} produced the heaviest TDM, which was similar to plots weeded twice in 2009 and 2011 and those that received Atrazine + Metolachlor at 1.9 kg a.i/ha^{-1} in 2011. The weedy check plots recorded the least TDM. Also plots that received 6 tons/ha^{-1} poultry manure produced the heaviest TDM at both sampling period throughout the season but were statistically the same with plots that received NPK fertilizer at 6WAS in 2009 and 2011. Plots that were not treated with poultry manure or NPK fertilizer recorded the least TDM (Table 6).

TABLE 5: Effect of weed control and poultry manure treatments on leaf area index of maize at Samaru during 2009, 2010 and 2011 rainy season

Treatments		Leaf Area Index (8 WAS)				Leaf Area Index (12 WAS)			
		2009	2010	2011	Mean	2009	2010	2011	Mean
Weed control	Rate(kga.i/ha)								
Atrazine + Acetochlor + Terbuthylazine	2.1	2.08d	1.70e	1.96bc	1.91e	2.31b	1.97c	2.05c	2.11de
“	2.8	2.09d	1.92cd	2.09b	2.04bcd	2.29b	2.06bc	2.13bc	2.16de
Atrazine + Metolachlor	1.9	2.10cd	1.94c	2.03b	2.03cd	2.30b	2.07bc	2.51a	2.29b
“	2.6	2.36a	2.12a	2.40a	2.29a	2.53a	2.35a	2.41a	2.43a
Atrazine	1.0	2.18bcd	1.82d	1.88c	1.96de	2.26b	1.93c	2.06c	2.09e
“	1.5	2.31ab	2.06ab	1.99bc	2.12b	2.29b	2.03bc	2.24b	2.19cd
Hoe weeded at 3 & 6 WAS		2.22bc	1.99bc	1.99bc	2.07bc	2.50a	2.16b	2.13bc	2.27bc
Weedy check		1.22e	1.09f	1.05d	1.12f	1.14c	0.97d	1.16d	1.09f
SE±		0.03	0.02	0.04	0.02	0.03	0.04	0.03	0.02
Poultry manure (T/ha)									
0		1.29e	1.09e	1.05d	1.14e	1.47e	1.21d	1.16e	1.28c
2		1.59d	1.48d	1.44c	1.50d	1.90d	1.56c	1.70d	1.72d
4		2.33c	1.97c	2.28b	2.19c	2.40c	2.16b	2.25c	2.27c
6		2.64a	2.37a	2.54a	2.52a	2.72a	2.42a	2.77a	2.64a
NPK 120:26:50		2.51b	2.24b	2.32b	2.35b	2.53b	2.35a	2.54b	2.47b
SE±		0.02	0.02	0.03	0.01	0.02	0.03	0.03	0.01
Interaction									
W x P		NS	NS	NS	NS	NS	NS	NS	NS

Means followed by the same letter(s) within a column of each treatment group are statistically different at 5% level of probability using DMRT, WAS = Weeks after sowing, NS = Not significant.

TABLE 6: Effect of weed control and poultry manure treatments on total dry matter of maize at Samaru during 2009, 2010 and 2011 rainy season

Treatments		Total Dry Matter (6 WAS)			Kg/ha^{-1}	Total Dry Matter (12 WAS)			
		2009	2010	2011	Mean	2009	2010	2011	Mean
Weed control	Rate (kga.i/ha)								
Atrazine + Acetochlor + Terbuthylazine	2.1	41.3b	55.3bc	67.0e	54.5d	109.8b	113.9f	130.0d	117.9e
“	2.8	42.8b	53.5bc	86.8c	61.0c	110.8b	125.4e	145.4c	127.2d
Atrazine + Metolachlor	1.9	44.1b	59.4ab	90.8bc	64.8bc	113.7b	159.5ab	156.5ab	143.2b
“	2.6	52.2a	65.0a	98.6a	72.0a	132.8a	176.3a	166.1a	158.4a
Atrazine	1.0	36.8c	48.0c	77.9d	54.2d	109.6b	128.7de	141.5c	126.6d
“	1.5	45.2b	52.5bc	92.0abc	63.2bc	111.9b	138.8cd	149.7bc	133.4c
Hoe weeded at 3 & 6 WAS		50.4a	59.7ab	95.4ab	68.5ab	125.0a	144.2c	159.4ab	142.8b
Weedy check		29.2d	26.1d	35.4f	30.2e	60.8c	47.3g	59.2e	55.8f
SE±		1.20	1.44	2.22	0.99	2.04	3.11	3.19	1.68
Poultry manure (T/ha)									
0		22.2d	22.9e	36.0e	27.0e	53.8e	58.7e	57.7e	56.7e
2		31.2c	36.8d	58.2d	42.1d	81.8d	96.7d	89.0d	89.2d
4		44.8b	59.9c	94.6c	64.4c	129.7c	144.9c	160.8c	145.1c
6		58.5a	73.2a	112.6a	81.4a	146.7a	178.0a	196.9a	173.9a
NPK 120:26:50		56.8a	69.2b	101.0a	75.7b	134.3b	168.1b	187.9b	163.4b
SE±		0.95	1.14	1.76	0.78	1.61	2.46	2.52	1.33
Interaction									
W x P		NS	NS	NS	NS	NS	NS	NS	NS

Means followed by the same letter(s) within a column of each treatment group are statistically different at 5% level of probability using DMRT. WAS = Weeks after sowing, NS = Not significant.

The significant effect of weed management and poultry manure treatments on number of days to 50% tasseling and silking of QPM is shown in (Table 7). All the weed management treatments significantly reduced the number of days to 50% tasseling and silking of QPM compared to the weedy check plots which significantly increased the number of days to 50% tasseling and silking of QPM. Similarly plots that received poultry manure of NPK inorganic fertilizer significantly reduced the number of day to 50% tasseling and silking of QPM as compared to plots that did not received poultry manure or NPK fertilizer which significantly increased the number of days to 50% tasseling and silking of QPM (Table 7).

TABLE 7: Effect of weed control and poultry manure treatment on number of days to 50% tasseling and silking of maize at Samaru during 2009, 2010 and 2011 rainy season

Treatments		Days to 50% Tasseling				Days to 50% Silking			
		2009	2010	2011	Mean	2009	2010	2011	Mean
Weed control	Rate(kga.i/ha)								
Atrazine + Acetochlor + Terbuthylazine	2.1	63.6bcd	63.2b	60.9bc	62.5bc	70.2cd	69.0bc	66.4c	68.5cd
"	2.8	64.5b	63.0bc	61.6b	63.0b	69.4d	69.4b	67.0bc	68.6bc
Atrazine + Metolachlor	1.9	63.6bcd	61.9cd	60.7bc	62.1bcd	67.4e	67.6d	66.6bc	67.2e
"	2.6	63.2cd	61.3d	59.0c	61.2d	69.2d	68.0cd	66.6bc	68.0d
Atrazine	1.0	62.9d	60.9d	61.6b	61.8cd	69.9cd	68.1cd	67.8b	68.6bc
"	1.5	64.2bc	61.2d	60.7bc	62.0cd	70.7c	68.7bcd	66.7bc	68.7bc
Hoe weeded at 3 & 6 WAS		63.8bcd	61.2d	60.4bc	61.8cd	72.1b	68.4bcd	66.9bc	69.1b
Weedy check		68.4a	67.1a	67.6a	67.7a	75.8a	75.1a	76.8a	75.9a
SE±		0.38	0.27	0.56	0.25	0.30	0.40	0.43	0.22
Poultry manure									
0		68.3a	65.9a	65.0a	66.4a	77.6a	75.4a	73.5a	75.5a
2		67.0b	65.7a	64.1a	65.6b	73.7b	73.0b	71.5b	72.7b
4		62.3c	60.4b	58.8b	60.5c	67.7c	66.7c	65.5c	66.6c
6		62.1c	60.2b	59.9b	60.7c	67.2cd	65.6d	64.8c	65.9d
NPK 120:26:50		61.6c	60.1b	60.0b	60.5c	66.7d	65.7d	65.2c	65.9d
SE±		0.30	0.21	0.45	0.19	0.23	0.31	0.34	0.17
Interaction									
W x P		NS	NS	NS	NS	NS	NS	NS	NS

Means followed by the same letter(s) within a column of each treatment group are statistically different at 5% level of probability using DMRT. WAS = Weeks after sowing, NS = Not significant.

TABLE 8: Effect of weed control and poultry manure on leaf N, P and K content of maize at Samaru during 2009, 2010 and 2011 rainy season

Treatments		Leaf N Content				Leaf P Content				Leaf K Content			
		2009	2010	2011	Mean	2009	2010	2011	Mean	2009	2010	2011	Mean
Weed control	Rate (kga.i/ha)												
Atrazine + Acetochlor + Terbuthylazine	2.1	1.47e	1.62e	1.50c	1.53g	0.15	0.16	0.16	0.16	1.85	1.71	1.85	1.80
"	2.8	1.54de	1.79d	1.67b	1.67e	0.15	0.17	0.15	0.16	1.92	1.82	1.73	1.82
Atrazine + Metolachlor	1.9	1.86c	1.89c	1.52c	1.75d	0.16	0.17	0.17	0.16	1.73	1.64	1.92	1.76
"	2.6	2.03a	2.10a	2.03a	2.05a	0.17	0.18	0.16	0.17	1.95	1.89	1.90	1.91
Atrazine	1.0	1.60d	1.66e	1.54c	1.60f	0.16	0.17	0.17	0.16	1.71	1.82	1.73	1.75
"	1.5	1.91bc	1.96bc	1.66b	1.84c	0.18	0.16	0.16	0.16	1.68	1.72	1.85	1.75
Hoe weeded at 3 & 6 WAS		1.99ab	2.00b	1.67b	1.88b	0.17	0.17	0.18	0.17	1.83	1.81	1.93	1.85
Weedy check		1.25f	1.17f	1.20d	1.20h	0.16	0.16	0.17	0.16	1.72	1.85	1.74	1.77
SE±		0.03	0.02	0.02	0.01	0.12	0.13	0.12	0.13	0.19	0.18	0.16	0.17
Poultry manure (T/ha)													
0		1.09d	1.09d	0.95d	1.04d	0.15d	0.12d	0.11b	0.13c	1.19e	1.29e	1.21e	1.23e
2		1.48c	1.38c	1.34c	1.40c	0.17c	0.14c	0.12b	0.14c	1.26d	1.46d	1.38d	1.37d
4		1.61b	1.75b	1.64b	1.67b	0.21b	0.19b	0.20a	0.20b	1.44c	1.72c	1.54c	1.57c
6		2.18a	2.31a	2.21a	2.23a	0.27a	0.23a	0.22a	0.24a	1.82b	2.22b	2.08b	2.04b
NPK 120:26:50		2.18a	2.33a	2.21a	2.24a	0.28a	0.24a	0.22a	0.25a	1.96a	2.41a	2.37a	2.25a
SE±		0.03	0.02	0.02	0.05	0.05	0.01	0.01	0.01	0.01	0.02	0.03	0.01
Interaction													
W x P		NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Means followed by the same letter(s) within a column of each treatment group are statistically different at 5% level of probability using DMRT, WAS = Weeks after sowing, NS = Not significant.

The significant effect of weed management and poultry manure treatments on leaf N, P and K content is shown in (Table 8). In all the seasons and the mean, plots treated with Atrazine + Metolachlor at 2.6 kg a.i/ha^{-1} significantly resulted in leaves with the highest N content which were statistically the same with plots weeded twice in 2009 season. Plots that received 6tons/ha^{-1} poultry manure and those that received NPK inorganic fertilizer had the highest leaf N content. Plots that received 6tons/ha^{-1} of Poultry manure and those that received NPK inorganic fertilizer consistently had the highest leaf P content, however plots that received NPK Mineral fertilizer had the highest leaf K content. The weedy check plots and plots that did not receive poultry manure or NPK inorganic fertilizer resulted in the least leaf N, P and K content. The interaction effect of the factors on all parameters was not significant. The significant effect of weed management and poultry manure treatments on grain yield of maize is shown in (Table 9). Plots treated with Atrazine + Metolachlor at 2.6 kg a.i ha^{-1} and those weeded twice produced the highest grain yield while those that received 6tons ha^{-1} of Poultry manure and those that received NPK inorganic fertilizer consistently gave higher yield.

TABLE 9: Effect of weed control and poultry manure treatment on grain yield of maize at Samaru during 2009, 2010 and 2011 rainy season

Treatments		Grain Yield (kg/ha)			
		2009	2010	2011	Mean
Weed control	Rate (kga.i/ha)				
Atrazine + Acetochlor + Terbuthylazine	2.1	1847.6e	1551.4d	1834.1d	1744.3e
“	2.8	2077.7d	1806.0c	1879.8d	1904.5d
Atrazine + Metolachlor	1.9	1981.9d	2186.6b	2040.0cd	2069.5c
“	2.6	2775.0a	2683.2a	2829.8a	2762.7a
Atrazine	1.0	2032.1d	1957.3c	2116.2c	2035.2c
“	1.5	2251.2c	2665.8a	2505.0b	2474.0b
Hoe weeded at 3 & 6 WAS		2604.8b	2652.9a	2923.0a	2726.9a
Weedy check		510.1f	386.7e	524.6e	473.8f
SE±		55.49	49.60	56.01	31.91
Poultry manure (T/ha)					
0		472.2d	416.4d	622.3e	503.6d
2		954.7c	927.7c	1223.6d	1035.4c
4		2233.0b	2043.5b	2288.7c	2188.4b
6		3229.3a	3305.8a	3024.2b	3186.4a
NPK 120:26:50		3129.7a	3237.8a	3249.0a	3205.5a
SE±		43.9	39.27	44.35	25.22
Interaction					
W x P		NS	NS	NS	NS

Means followed by the same letter(s) within a column of each treatment group are statistically different at 5% level of probability using DMRT, WAS = Weeks after sowing, NS = Not significant.

DISCUSSION

The result of this study showed that plots treated with herbicides and those weeded twice reduced weed infestation as reflected in lower weed density and weed dry weight. The reduction of weed infestation by these treatments particularly at higher doses can be attributed to the phytotoxic effect of herbicides on weeds which increased with increase in dosage and led to inhibition of seed germination and photosynthesis on weeds. Ishaya *et al.* (2012) and Mahadi *et al.,* 2013 have reported reduction in weed dry matter production due to herbicide application in crops while Ekpo *et al.,* 2012, reported a reduction in weed density due to herbicide application in crops. Atrazine applied alone could not give a broad spectrum weed control as compared to its application in mixtures with other herbicides which can be attributed to narrow spectrum weed control however mixing it with acetochlor, terbuthylazine or metolachlor increased the spectrum of weed species controlled due to the synergic effect of the herbicides. Ishaya *et al.* (2012) Mahadi *et al.* (2011) reported broad spectrum weed control by Atrazine in mixtures with other herbicides. Crop growth parameters were consistently increased by herbicides treatments compared to the weedy check which depressed these parameters. The increase in growth parameters such as plant height, leaf area index and total dry matter particularly by plots treated with atrazine + metolachlor at 2.6 kg a.i/ha can be attributed to effective weed control in these plots, this minimised competition for growth resources between crops and weeds which led to greater efficiency in utilizing growth and yield resources by the crops. According to (Lagoke *et al.,* 1998) Crops are known to attain better canopy in less weed competitive environment then in a weedy environment.

In particular Atrazine + Metolachlor at 2.6 kg a.i/ha produced the tallest plants with higher leaf area index and total dry matter because of its broad spectrum weed control which reduced the level of weed competition and hence increase crop growth. Ishaya 2004 and Mahadi *et al* 2012 report similar findings. The number of days to 50% tasseling and silking of maize was significantly reduced by all the herbicides and the two hoe weeded treatment thereby enabling the plants to attain physiological maturity earlier than those in the weedy check plots. The early attainment of physiological maturity by herbicide and hoe weeded plots can be attributed to reduction in competition by weeds which in turn increased growth and development of the crop, Mahadi *et al.* (2012) reported similar observation.

The significant increase in all weed and crop growth parameters such as plant height, leaf area index, total dry matter and yield by higher rates of poultry manure can be attributed to increase in mineralized nutrients which improved the soil physical and chemical properties thereby increasing the availability of macro and micro nutrients which improved growth, development and yield. Organic manure has been reported to increase water holding capacity soil aeration, nutrient retention and microbial activity (Anon, 2007 a). Mahadi *et al.,* 2012 and 2013a reported a significant increase in crop growth and development with increase in cow dung and poultry manure application respectively. Adediran and Banjoko (2003) and Nagaraj *et al.* (2004) reported similar findings. Early attainment of physiological maturity in plots treated with herbicides and those weeded twice and in by plants that received higher rates of poultry manure and inorganic fertilizer can be attributed to effective weed control and increased nutrient availability which reduced crop competition for nutrients thereby hastening crop growth and development, this in turn enabled the plant to tassel and silk early thereby giving the plant more time for grain filling (Mahadi *et al.,* 2012) reported similar findings. The significant increase in leaf N content in plots treated with Atrazine + Metolachlor at 2.6 kg a.i/ha can also be attributed to the effective weed control by this treatment which reduced the level of competition for nutrient thereby enabling the plants to vigorously extract high amount of N compared to the other plots which had stiffer weed crop competition thereby extracting lower amounts of N from the soil. It is well known that plants take up large amount of N from the soil this however varies depending on the degree of weed crop competition among other factors. As expected the weedy check significantly had the least leaf N content which might be due to stiff weed competition for N. The increase in leaf N, P and K content by plants that received higher rates of poultry manure and those that received NPK fertilizer could be due to improved soil fertility which enhanced the uptake of these nutrients in adequate amounts as compared to plots that received lower amounts of the nutrient.

CONCLUSION

Based on the result of this study it can be concluded that application of Atrazine + Metolachlor at 2.6 kg a.i ha^{-1} gave the best weed control as reflected in lower weed density and weed dry weight. It also resulted in the tallest plants with wider leaf area index, heavier total dry matter, higher nitrogen uptake and highest grain yield which was statistically comparable to the hoe weeded. Application of poultry manure at 6t ha^{-1} or NPK mineral fertilizer at 120kgN, 26kgP and 50kgK ha^{-1} gave the highest maize yield in the savanna ecological zone of Nigeria.

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