



Comparative Economic of Different Weed Control Methods and Poultry Manure Rates among Different Maize (*Zea mays* L.) varieties

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ABSTRACT

Different Field experiment was conducted during the 2016 and 2017 rainy season to evaluate the efficacy of different weed control methods and poultry manure rates on yield and economic returns in three varieties of maize (SAMMAZ 15, SAMMAZ 21 and SAMMAZ 35) at Kano in Sudan savanna zone of Nigeria. The trials consisted of six weed control methods (S-Metolachlor 290 g/L + Atrazine 370 g/L at 2.0kg a.i. ha⁻¹ followed by Nicosulfuron at 100 g a.i.ha⁻¹, S-Metolachlor 290g/L + Atrazine 370 g/L at 2.0kg a.i. ha⁻¹ followed by Bentazone 480 g/L at 2.5kg a.i. ha⁻¹, Metolachlor 375 g/L + Terbutylazine 125 g/L + Mesotrione 37.5 g/L at 2.5 kg a.i ha⁻¹ followed by Nicosulfuron at 0.1 kg a.i. ha⁻¹, Metolachlor 375g/L + Terbutylazine 125 g/L + Mesotrione 37.5 g/L at 2.5kg a.i ha⁻¹ followed by Bentazone at 2.5kg a.i. ha⁻¹, two hoe weeded at 3 and 6 WAS and Weedy check) and three levels of poultry manure (0, 4, and 8 t ha⁻¹ and a recommended NPK fertilizer as check at the rate of 120 kg N, 60 kg P₂O₅ and 60 kg K₂O ha⁻¹). The experiment was laid out in a split-split plot design with variety allocated to the main plot, poultry manure to the sub-plot while weed control method to the sub-sub plot, and was replicated three times. The result from the study showed that Metolachlor 290g/L + Atrazine 370 g/L at 2.0kg a.i. ha⁻¹ followed by Bentazone at 2.5kg a.i. ha⁻¹ in combination with 8 t ha⁻¹ poultry manure suppressed weed infestation and increased the growth and grain yield of maize. Net income was higher when herbicide in combination with poultry manure at 8 t ha⁻¹ was used.

Keywords: Weed Control, Pre and Post Emergence Herbicides, Maize yield, Economic Analysis.

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INTRODUCTION

Maize (*Zea mays* L.) is an important cereal crop in the world; Nigeria is the second largest producer in Africa. The grains are used in a variety of ways by the human; in fact, many of our daily diets contain maize either directly or indirectly. The production of meat, eggs and dairy products would be difficult without it as it is a highly desirable ingredient because of its high energy and feed value of the kernel, leaf and stem (Abubakar, *et al.*, 2000). It's also used for the production of bio-fuels in the developed countries and also for the manufacture of pharmaceuticals and industrial products such as starch, ethanol and plastic, and as a base for antibiotic production across the globe (Tesfay *et al.*, 2014). Due to its expanded use in agro industries, it is recognized as a leading commercial crop of great agronomic value.

Recently, with the release of improved cultivars and hybrids, the grain yield has increased but still the maize faces many problems. Farmers usually give prime importance to few cultural practices and neglecting other factors like type of varieties, soil conditions as well as weed infestation. The crop is usually grown during the rainy or dry seasons, fertilizer prices are higher and manual method of weed control is difficult to imply. There are other ways of amending soil nutrients and methods of weed control are more feasible, use of organic manures is important as pointed out by Mahadi *et al.* (2012) that, organic manure can improve crop productivity, and further stated that, poultry manure can be used as important source of nutrients for sustainable crop production.

Several types of weed species acts strong as competitors with the crop there by decreases quality and grain yield. Perennial weeds like *Striga hermonthica*, *Amaranthus spinosus*, *Rottboelia cochinchinensis*, *Cyperus rotundus* and *Cynodon dactylon* were among the worst weeds infesting maize worldwide, and thus cause serious injury as well as increase the cost of production, with

adequate weed management strategies attempt will be made to limit the deleterious effects of weeds growing with crop plants. Hand weeding is not effective against those weeds (Chikoye *et al.*, 2009). Presence of weeds in maize increases cost of production which leads to a drastic decrease in farmer's income. Partial economic analysis showed that, the herbicide technology were cost effective and yielded higher returns than conventional methods (Muthamia *et al.* (2001). Malik *et al.* (2006) reported that herbicides proved effective in controlling weeds and produced relatively more growth and yield attributes. Similar development by Chikoye *et al.* (2004) noted that chemical control is a better alternative to manual weeding because it is cheaper, faster and gave effective weed control, higher grain yield, and higher returns.

This research work was intended to chemically protect maize from the effect of weeds growing at pre and post emergence stage and the problems associated with low soil fertility. It was initiated with the objectives of finding out the effect of weed control method on weeds and yield related traits and also evaluates the economics of weed management in maize production.

MATERIALS AND METHODS

Study Area

The experiments were conducted during the rainy seasons of 2016 and 2017 at the Research Farm of Faculty of Agriculture, Bayero University Kano (Lat 11° 58' N, and Long 8°26' E and 475m above sea level) and Livestock Development Centre, Dangora, Kiru local Government, Kano Nigeria (Lat 11° 30' N, and Long 7° 82' E and 670 m above sea level).

Treatment and Experimental Design

The experiment consisted of a factorial combinations of six weed control methods (WCM) using two pre-emergence and two post-emergence herbicides (T_1 = S-Metolachlor 290g/l + Atrazine 370g/l at 2.0kg a.i.ha⁻¹ followed by Nicosulfuron at 100g a.i.ha⁻¹, T_2 = S-Metolachlor 290g/l +

Atrazine 370g/l at 2.0kg a.i.ha⁻¹ followed by Bentazone 480g/l at 2.5kg a.i.ha⁻¹, T₃ = Metolachlor 375g/l + Terbutylazine 125g/l + Mesotrione 37.5g/l at 2.5 kg a.i.ha⁻¹ followed by Nicosulfuron at 100g a.i.ha⁻¹, T₄ = Metolachlor 375g/l + Terbutylazine 125g/l + Mesotrione 37.5g/l at 2.5kg a.i.ha⁻¹ followed by Bentazone 480g/l at 2.5kg a.i.ha⁻¹, T₅ = Two hoe weeded at 3 and 6WAS and T₆ = Weedy check), three levels of poultry manure (0, 4, and 8tha⁻¹) and NPK at the rate of 120kgN, 60kg P₂O₅ and 60kgK₂O ha⁻¹ and three maize varieties (SAMMAZ 15, SAMMAZ 21 and SAMMAZ 35).

The experiments in both years and locations were laid out in a split-split plot design with the varieties allocated to the main plot, poultry manure to the sub-plot while weed control method to the sub-sub plot, and was replicated three times. Field consisted of six (6) gross plot ridges of 0.75m apart and 3m long (13.5m²). The two (2) inner ridges were used as net plots (4.5m²) while the outer row of the net plot was used for destructive and non-destructive sampling purposes. Two seeds were sown at inter and intra row spacing of 75cm X 25cm and later thinned to one plant per stand at 2 WAS.

Field procedure

The fields were mechanically ploughed, harrowed and ridged with tractor, poultry manure at 0, 4, and 8tha⁻¹ and NPK (120kgN, 60kgP₂O₅ and 60kgK₂O ha⁻¹) was gently incorporated two weeks before sowing. The first year planting was on 17th and 26th July at BUK and Dangora in 2016 while that of the second year was planted on the 15th June 2017 and 19th June 2017 at BUK and Dangora respectively. Seeds were sown at depth of 4-5cm. Prior to planting; they were treated with Apron star (Thiametoxam + Metalaxyl-N and Difenconazole) at the rate of 1 sachet of 10 g/2 kg of seed. Plots receiving herbicide treatments were sprayed as pre emergency a days after planting and post-emergence at 6 WAS with knapsack sprayer (20L) capacity using green deflector nozzle with swath

width of 1.4m. Similarly, Hoe weeding was done as indicated in the treatment combinations. Harvesting was done by removing the cobs after they mature and de-husked manually and the cobs were sun dried and later thrashed to obtain the grains.

Data Collection

Data collected were on growth, yield characters and grain yield (t^{-1}). Cobs were air dried to 13% moisture before weighing. A total of 9 quadrants per plot were randomly placed to record the weed related data at 12 WAS such as weed dry weight (kg) and weed control efficiency (%) as described by DAS (2011). The harvested weeds were first air dried and later oven dry to record the weed biomass using Mp 1001 electronic balance with precision of 0.1g.

Partial Economic Analysis:

The partial economic analysis was carried out for each of weed control method, taking into cognizance the current price of various inputs (Hiring of land, inputs, land preparation to harvesting and processing). The average price of a measure of 2.5kg per measure was obtained from the open market at Kwanar Dangora and Janguza market. It was used to calculate the income or revenue, the economic analysis was carried out using partial budgeting as described by Imoloame (2017).

$$GM = TR - TVC$$

$$TR = (Y_m \times P_m)$$

$$TVC = M + L$$

Where:-

GM = Gross margin ha^{-1} for each treatment; TR = Total revenue in Naira ha^{-1} for each treatment

TVC = Total variable cost in Naira ha^{-1} for each treatment

Y_m = Maize Grain yield ($kg\ ha^{-1}$) for each treatment

P_m = Price of maize per every measure (kg)

M = Value of materials inputs (seed, fertilizers, insecticide and herbicides)

L = Value of labour (land fees, land preparation, planting, fertilizer application, herbicide application, weeding, harvesting, processing, bundling of the straw processing and packaging) for each treatment.

Data Analysis

Fisher's method of analysis of variance was applied for the analysis and interpretation of data collected in each year using Gen-start 17th edition. The level of significance used in F ratio was $p < 0.05$. Where F ratio is significant, means were separated using Student Newman-Keuls-test (SNK).

RESULTS AND DISCUSSION

The effect of weed dry weight is presented in Table 1. Higher dry weed weight of 187.4 kg ha⁻¹ in 2016, 156.6 kg ha⁻¹ in 2017 and the mean of 172.0 kg ha⁻¹ were observed in weedy check which was statistically at par with all other treatments. Metolachlor 375 g/l + Terbutylazine 125 g/l + Mesotrione 37.5 g/l, at 2.5 kg a.i. ha⁻¹ followed by Bentazone at 2.5 kg a.i. ha⁻¹ showed promising results by suppressing weeds and thus resulted in less weed dry weight across all seasons and the mean (63.2 kg ha⁻¹ in 2016, 80.7kg ha⁻¹ in 2017 and 72.0 kg ha⁻¹). These results indicated that herbicides suppressed growth of weeds in the field and thus less weed biomass was recorded as compared to weedy check plots. Mahadi *et al.* (2012) reported that pre emergence herbicides followed by post emergence resulted in effective weed control and produced relatively more weight of cobs, number of grains per cob, 1000-grain weight, stover weight as well as higher grain yield (Table 1).

Recommended rate of NPK fertilizer during both seasons and the mean resulted in less dry weight of weeds of 99.2 kg ha⁻¹ 2016 and 90.3 kg ha⁻¹ 2017 and 96.1kg ha⁻¹ of the mean while the highest weed dry weight (147.7t ha⁻¹ in 2016, 135.9t ha⁻¹ in 2017 and the mean 141.7t ha⁻¹) was

recorded in control (0 t ha^{-1}) plots. It had been reported that, weed consume greater amount of nutrients as compared to the associated crop (Galal and Shehata, 2015) and thus resulting in depriving the crop for adequate nutrients resulting been stunted indicating the harmful effects weeds. These are the reasons for the significantly decrease in yield of any crop (Adigun and Lagoke, 2003). Variety did not show any significant difference across both seasons on the characters (weed dry weight and weed control efficiency) evaluated. There was no significant interaction between the factors evaluated.

Table 1: Effect of Weed Control Method, Poultry Manure and Varieties on Weed Dry Weight and Weed Control Efficiency on Maize at BUK and Dangora During 2016 and 2017, Rainy Seasons.

Treatment	Weed Dry Weight (kg)			Weed Control Efficiency (%)		
	2016	2017	Mean	2016	2017	Mean
<u>Weed Control Method</u>						
S-Metolachlor 290 g/l + Atrazine 370 g/l at 2.0 Kg a.i. ha ⁻¹ followed by Nicosulfuron at 0.1 kg a.i. ha ⁻¹	126.3 _b	105.4 _b	115.9 _a	60.1 _b	62.4 _d	61.3 _c
S-Metolachlor 290 g/l + Atrazine 370 g/l at 2.0 Kg a.i. ha ⁻¹ followed by Bentazone at 2.5 kg a.i. ha ⁻¹	108.2 _b	101.4 _b	104.8 _b	80.2 _b	68.4 _c	74.3 _c
Metolachlor 375 g/l + Terbutylazine 125 g/l + Mesotrione 37.5 g/l at 2.5 Kg a.i. ha ⁻¹ followed by Nicosulfuron at 0.1 kg a.i. ha ⁻¹	99.4 _b	94.4 _b	96.9 _b	91.9 _{ab}	78.0 _c	84.9 _b
Metolachlor 375 g/l + Terbutylazine 125 g/l + Mesotrione 37.5 g/l at 2.5 kg a.i. ha ⁻¹ followed by Bentazone at 2.5 kg a.i. ha ⁻¹	63.2 _c	80.7 _c	72.0 _c	134 _a	95.4 _a	114.7 _a
Two hoe weeding at 3 and 6WAS	89.3 _b	99.7 _b	94.5 _b	88.4 _b	70.8 _b	79.6 _b
Weedy check	187.4 _a	156.6 _a	172 _a	-4.0 _d	0.0 _e	-2.0 _d
SE ±	4.54	3.52	8.06	4.65	4.27	4.46
<u>Poultry Manure (t ha⁻¹)</u>						
0	147.7 _a	135.9 _a	141.7 _a	69.0	21.3 _c	55.8
4	100.4 _b	93.1 _b	96.8 _c	75.8	31.1 _b	69.0
8	101.9 _b	106.7 _a	102.9 _b	74.5	71.7 _a	73.1
NPK (120:60:60)	99.2 _b	90.3 _b	96.1 _c	81.2	73.6 _a	77.4
SE ±	5.48	5.54	5.51	5.85	2.75	4.30
<u>Variety</u>						
SAMMAZ 15	111.1	110.6	110.85	88.1	58.3	73.2
SAMMAZ 21	115.3	106.4	110.9	66.3	65.9	66.1
SAMMAZ 35	110.6	101.8	106.2	70.9	63.3	67.1
SE ±	8.77	2.08	5.43	11.44	6.92	9.18
<u>Interaction</u>						
V x PM	NS	NS	NS	NS	NS	NS
V x WCM	NS	NS	NS	NS	NS	NS
PM x WCM	NS	NS	NS	NS	NS	NS
V x PM x WCM	NS	NS	NS	NS	NS	NS

Means with the same letters on vertical row are not significantly different at ($p = < 0.05\%$) using SNK= student Newman-Keuls test.

The effect of weed control efficiency is presented in Table 1. Application of Metolachlor 375 g/l + Terbutylazine 125 g/l + Mesotrione 37.5 g/l at 2.5 kg a.i. ha⁻¹ followed by Bentazone at 2.5 kg a.i. ha⁻¹ statistically recorded higher weed control efficiency (134% in 2016, 95.4% in 2017 and the mean of 114.7%), that was statistically similar with the Metolachlor 375 g/l + Terbutylazine 125 g/l + Mesotrione 37.5 g/l at 2.5 kg a.i. ha⁻¹ followed by Nicosulfuron at 0.1kg a.i. ha⁻¹ (91.9%) in 2016 as compared with the other treatments. In a related development, (Munsif *et al.*, 2009; and Mehmeti *et al.*, 2012) pointed out that, Atrazine + Terbutylazine at 3.0 kg ha⁻¹ or Atrazine + Metolachlor at 4.0 kg ha⁻¹ suppressed weeds and gave higher grain yield of maize. Weedy check recorded the lowest control efficiencies (-4.0% in 2016, 0.0% in 2017 and the mean -2.0%). The result is similar to that of Imoloame *et al.*, (2011). They showed the superiority to some treatments over others in controlling weeds thereby increasing maize growth and yield.

Poultry manure significantly influence weed control efficiency during 2017 seasons only with application of NPK fertilizer and 8 t ha⁻¹ poultry manure resulted in statistically similar higher control efficiencies (73.6 and 71.7%) as compared with the other treatments. Lower control efficiency was recorded in weedy check plots across all seasons and the mean. The response observed in this work has manifested the role played by organic manure in the supply of nutrients and the effectiveness of the above WCM. Mahadi *et al.* (2013) pointed out that, poultry manure provides an excellent source of organic matter that was used to restoring depleted nutrients lost by many agricultural and other activities; it also improves structure of the soil. There was no significant difference between the varieties evaluated weed weight and weed control efficiency and also no significant interaction between the factors (Table 1).

Economic Analysis

The combined results 2016 and 2017 seasons for BUK, partial economic analysis on the use of WCM and poultry manure on the production of maize varieties are presented in Table 2. The results showed the value of output per hectare (total revenue), total cost of production, gross margin and average rate of return on maize production. The results indicated that, production cost varied from ₦69, 500 without any poultry manure or fertilizer and no weed control method was used, to ₦122, 200 using NPK fertilizer for two hoe weeding at 3 and 6 WAS using any of the varieties, with the value of total revenue varying from ₦27, 720 to ₦151,410 for SAMMAZ 15, ₦36, 610 to ₦215,550 with SAMMAZ 21 and ₦42, 350 to ₦198, 940 for SAMMAZ 35 (Table 2). This disagreed with the report of Joshua and Oni (2002) that, herbicide use is more profitable than hoe weeding in the production of various crops. In addition, Weed-free or frequent weeding resulted in the highest total cost of production for both varieties.

Production of maize was most profitable with NPK fertilizer for two hoe weeding at 3 and 6 WAS using SAMMAZ 21 ₦221, 550 with a return of ₦1.81k per every naira invested closely followed by application of poultry manure at 8 t ha⁻¹ poultry manure and Metolachlor 375 g/l + Terbuthylazine 125 g/l + Mesotrione 37.5 g/l at 2.5 kg a.i. ha⁻¹ followed by Nicosulfuron at 0.1 kg a.i. ha⁻¹ using SAMMAZ 21 which gave a gross margin of ₦194,180 and a return of ₦1.69k per every naira invested, which was followed by the production of maize using 8 t ha⁻¹ poultry manure and two hoe weeding at 3 and 6 WAS using the SAMMAZ 35 which gave a gross margin of ₦189, 910 and yielded an average rate of return of ₦1.63 k per every naira (₦) invested. In contrast, the lowest return for each naira invested was observed in weedy check plots that were not fertilized using all of the varieties and this

Table 2: Partial Economic Analysis of Poultry Manure and Weed Control Method on Production of Maize Varieties in 2016 and 2017 Seasons BUK

Treatment		Grain Yield (kg/ha)				Total Revenue (TR) (₦/ha)			Gross Margin (₦/ha) = (TR-TVC)			Average Rate of Return (AAR) = (TR/TVC) (₦/ha)		
P M	WCM	SM 15	SM 21	SM 35	TVC	SM 15	SM 21	SM 35	SM 15	SM 21	SM 35	SM 15	SM 21	SM 35
0	T1	714	688	882	73500						-			
											1176			
						49980	48160	61740	-23520	-25340	0	-0.68	-0.65	-0.84
	T2	829	887	869	76348						-			
											1551			
						58030	62090	60830	-18318	-14258	8	-0.76	-0.81	-0.79
	T3	885	952	950	79472						-			
											1297			
						61950	66640	66500	-17522	-12832	2	-0.77	-0.83	-0.83
	T4	984	1090	1078	82580	68880	76300	75460	-13700	-6280	-7120	-0.83	-0.92	-0.91
	T5	1033	1015	1014	88850						-			
											1787			
						72310	71050	70980	-16540	-17800	0	-0.81	-0.79	-0.79
4	T6	396	523	605	69500						-			
											2715			
						27720	36610	42350	-41780	-32890	0	-0.40	-0.53	-0.61
	T1	1304	1933	1346	83750						1046			
						91280	0	94220	7529	51559	9	1.08	1.61	1.12
											1376			
	T2	1249	1890	1430	86340						0	1.01	1.53	1.15
						87430	0	100100	1090	45960	0			
						11256	16072				4847			
	T3	1608	2296	1976	89840						9	1.25	1.78	1.53
						0	0	138320	22719	70879				

8	T4	1710	2470	1992	93550	11970	17290				4588			
						0	0	139440	26149	79349	9	1.27	1.84	1.49
	T5	1804	2397	2254	100500	12628	16779				5728			
						0	0	157780	25780	67290	0	1.25	1.66	1.56
	T6	784	953	733	73100						-			
											2179			
						54880	66710	51310	-18220	-6390	0	-0.75	-0.91	-0.70
	T1	1727	2054	1661	86750	12089	14378				2951			
						0	0	116270	34139	57029	9	1.39	1.65	1.34
	T2	1549	1992	1942	92900	10843	13944				4303			
NPK						0	0	135940	15529	46539	9	1.16	1.50	1.46
	T3	1807	2710	2022	119500	12649	18970				2203			
						0	0	141540	6989	70199	9	1.05	1.58	1.18
	T4	1933	3026	2440	118950	13531	21182				5185			
						0	0	170800	16360	92870	0	1.13	1.78	1.43
	T5	1920	2915	2586	120450	13440	20405				6056			
						0	0	181020	13949	83599	9	1.11	1.69	1.50
	T6	818	969	809	77480						-			
											2085			
						57260	67830	56630	-20220	-9650	0	-0.73	-0.87	-0.73
NPK	T1	1480	2052	1820	99340	10360	14364				2805			
						0	0	127400	4259	44299	9	1.04	1.44	1.28
	T2	1521	2270	1704	101500	10647	15890				1777			
						0	0	119280	4969	57399	9	1.04	1.56	1.17
	T3	1830	2774	2313	114300	12810	18165				4760			
						0	0	161910	13799	79879	9	1.12	1.69	1.41
NPK	T4	2010	2595	2713	116800	14070	19418				7310			
						0	0	189910	23899	64849	9	1.20	1.55	1.63

T5	2163	3165	2842	122200	15141	22155				7673			
					0	0	198940	29209	99349	9	1.23	1.81	1.62
T6	786	945	826	78800						-			
										2098			
					55020	66150	57820	-23780	-12650	0	-0.69	-0.83	-0.73

Calculation of total revenue as based on ₦70.00k / measure of (2.5kg) of maize at prevailing price at Dangora and environs, SM = SAMMAZ (15, 21 and 35), NPK = 120 kg N, 60 kg P₂O₅ and 60 kg K₂O, TVC = Total variable cost, ha⁻¹, WCM = Weed Control Method, PM = Poultry Manure, T₁ = S-Metolachlor 290 g/l + Atrazine 370 g/l at 2.0 Kg a.i. ha⁻¹ followed by Nicosulfuron at 0.1 kg a.i. ha⁻¹, T₂ = S-Metolachlor 290 g/l + Atrazine 370 g/l at 2.0 Kg a.i. ha⁻¹ followed by Bentazone at 2.5 kg a.i. ha⁻¹, T₃ = Metolachlor 375 g/l + Terbutylazine 125 g/l + Mesotrione 37.5 g/l at 2.5 Kg a.i. ha⁻¹ followed by Nicosulfuron at 0.1 kg a.i. ha⁻¹, T₄ = Metolachlor 375 g/l + Terbutylazine 125 g/l + Mesotrione 37.5 g/l at 2.5 kg a.i. ha⁻¹ followed by Bentazone at 2.5 kg a.i. ha⁻¹, T₅ = Two hoe weeding at 3 and 6WAS, T₆ = Weedy check.

resulted in a gross margin of a lost ranging from -0.40, -0.53 and -0.61 respectively which is a lost in the investment (Table 2). The finding also coincides with that of Muthamia *et al.* (2001) who pointed out that, economic analysis showed that herbicide technology were more effective and yielded higher returns in maize production than the conventional WCM.

The combined results for 2016 and 2017 seasons at Dangora on the partial economic analysis on the use of WCM and poultry manure rates on the production of three maize varieties are presented in Tables 3. The results showed that, the production cost varied from ₦56, 790 under zero poultry manure to weed control method was used to ₦139, 320 which is higher when NPK fertilizer and two hoe weeding at 3 and 6 WAS were used for any of the variety. This confirm the results of Iyagba, (2010) who reviewed weed management on root crops and found there are variations in cost of production under different weed management treatments. The value of the output or total revenue varied from ₦60, 970 to ₦278, 670 for SAMMAZ 15, ₦66, 570 to ₦332, 150 for SAMMAZ 21 and ₦84, 000 to ₦321, 790 for SAMMAZ 35.

The average rate of return on maize production was most profitable with application of NPK fertilizer for two hoe weeding at 3 and 6 WAS which resulted in a gross margin of ₦192, 830 and a return of ₦2.38 k per every naira invested and was closely followed by planting SAMMAZ 35 which gave a gross margin of ₦182, 470 and a return of ₦2.30 k per every naira invested. The same application of NPK fertilizer and 3Maizeforce at 2.5 kg a.i ha⁻¹ followed by Bentazone 2.5 kg a.i. ha⁻¹ using SAMMAZ 21 which gave a gross margin of ₦177, 000 and return of ₦2.30 k per naira invested, and this was followed by production of maize using NPK fertilizer with SAMMAZ 35 and Metolachlor 375 g/l + Terbuthylazine 125 g/l + Mesotrione 37.5 g/l at 2.5 kg a.i. ha⁻¹ followed by Nicosulfuron at 0.1 kg a.i.ha⁻¹ which generated a gross margin of ₦158, 200 and a return of ₦2.29 k per every naira invested (Table 3).

Table 3: Partial Economic Analysis of Poultry Manure and Weed Control Method on Production of Maize Varieties in 2016 and 2017 Seasons at Dangora

Treatment		Grain Yield (kg/ha)				Total Revenue (TR) (₦/ha)			Gross Margin (/ha) = (TR-TVC) (₦/ha)			Average Rate of Return (AAR) = (TR/TVC) (₦/ha)		
P M	WCM	SM 15	SM 21	SM 35	(TVC) (₦/ha)	SM 15	SM 21	SM 35	SM 15	SM 21	SM 35	SM 15	SM 21	SM 35
0	T1	1137	1936	1789	59290	79590	135520	125230	20300	76230	65940	1.34	2.28	2.11
	T2	1679	1962	1791	68470	117530	137340	125370	49060	68870	56900	1.71	2.00	1.83
	T3	1876	2167	1993	65450	131320	151690	139510	65870	86240	74060	2.00	2.31	2.13
	T4	1981	2079	2344	67190	138670	145530	164080	71480	78340	96890	2.06	2.16	2.44
	T5	1909	2536	1881	84950	133630	177520	131670	48680	92570	46720	1.57	2.08	1.54
	T6	871	951	1200	56790	60970	66570	84000	4180	9780	27210	1.07	1.17	1.47
4	T1	2112	2295	2524	81210	147840	160650	176680	66630	79440	95470	1.82	1.97	2.17
	T2	2600	2601	2654	84620	182000	182070	185780	97380	97450	101160	2.15	2.15	2.19
	T3	2870	2973	2872	89600	200900	208110	201040	111300	118510	111440	2.24	2.32	2.24
	T4	2880	2919	3138	98670	201600	204330	219660	102930	105660	120990	2.04	2.07	2.22
	T5	3546	3362	3863	118990	248220	235340	270410	129230	116350	151420	2.08	1.97	2.27
	T6	1101	1014	1267	62930	77070	70980	88690	14140	8050	25760	1.22	1.12	1.40
8	T1	2451	3153	3474	103290	171570	220710	243180	68280	117420	139890	1.66	2.13	2.35
	T2	2958	3223	3316	108990	207060	225610	232120	98070	116620	123130	1.89	2.07	2.12
	T3	3448	4074	3421	127070	241360	285180	239470	114290	158110	112400	1.89	2.24	1.88
	T4	3581	4242	4039	136730	250670	296940	282730	113940	160210	146000	1.83	2.17	2.06
	T5	3858	4346	4318	136560	270060	304220	302260	133500	167660	165700	1.97	2.22	2.21
	T6	1319	1218	1242	87180	92330	85260	86940	5150	-1920	-240	1.05	-0.97	-0.99
NPK	T1	2858	3244	2871	98850	200060	227080	200970	101210	128230	102120	2.02	2.29	2.03
	T2	3334	3704	3472	114190	233380	259280	243040	119190	145090	128850	2.04	2.27	2.12
	T3	3563	3949	4002	121940	249410	276430	280140	127470	154490	158200	2.04	2.26	2.29
	T4	3744	4469	4049	135830	262080	312830	283430	126250	177000	147600	1.92	2.30	2.08
	T5	3981	4745	4597	139320	278670	332150	321790	139350	192830	182470	2.00	2.38	2.30
	T6	1175	1238	1555	98740	82250	86660	108850	-16490	-12080	10110	-0.83	-0.87	1.10

Calculation of total revenue as based on ₦70.00k / measure of (2.5kg) of maize at prevailing price at Dangora and environs, SM = SAMMAZ (15, 21 and 35), NPK = 120 kg N, 60 kg P₂O₅ and 60 kg K₂O, TVC = Total variable cost, ha⁻¹, WCM = Weed Control Method, PM = Poultry

Manure, T₁ = S-Metolachlor 290 g/l + Atrazine 370 g/l at 2.0 Kg a.i. ha⁻¹ followed by Nicosulfuron at 0.1 kg a.i. ha⁻¹, T₂ = S-Metolachlor 290 g/l + Atrazine 370 g/l at 2.0 Kg a.i. ha⁻¹ followed by Bentazone at 2.5 kg a.i. ha⁻¹, T₃ = Metolachlor 375 g/l + Terbutylazine 125 g/l + Mesotrione 37.5 g/l at 2.5 Kg a.i. ha⁻¹ followed by Nicosulfuron at 0.1 kg a.i. ha⁻¹, T₄ = Metolachlor 375 g/l + Terbutylazine 125 g/l + Mesotrione 37.5 g/l at 2.5 kg a.i. ha⁻¹ followed by Bentazone at 2.5 kg a.i. ha⁻¹, T₅ = Two hoe weeding at 3 and 6WAS, T₆ = Weedy c

In contrast, the lowest return for each naira invested was observed in weedy check plots that were fertilized with NPK fertilizer using both varieties. This result also confirms the report of Adigun and Lagoke (2003) that hoe weeding is costly while weedy check is less cost with no/minimal returns and also in another development Joshua and Oni (2002) pointed out that, herbicides resulted in higher economic returns either in sole cropping or in mixtures.

CONCLUSION

All the weeds recorded in the experimental fields proved compete with maize. Therefore, weed management needs to be addressed in growing maize. Maize is grown mostly in raining season therefore weed control using hand weeding is practically impossible if the area is larger. But small farmers may be able to use hoe weeding at and 6 WAS. Therefore application of herbicides is effective and economical for farmers having large area. To get maximum grain yield and higher net return, application of Metolachlor 290g/L + Atrazine 370 g/L at 2.0kg a.i. ha⁻¹ followed by Bentazone at 2.5kg a.i. ha⁻¹ in combination with 8 t ha⁻¹ poultry manure suppressed weed infestation and increased the growth and grain yield of SAMMAZ 21 and 35 maize varieties. Net income was higher when the above herbicide treatment in combination with poultry manure at 8 t ha⁻¹ was used.

Based on the monetary return, grain yield was best at Metolachlor 375 g/l + Terbutylazine 125 g/l + Mesotrione 37.5 g/l at 2.5 kg a.i. ha⁻¹ followed by Bentazone at 2.5 kg a.i. ha⁻¹ combined with the 8 t ha⁻¹ poultry manure for SAMMAZ 21 and 35 in term of profitability.

However, the maize varieties used in the trial did not responds differently to weed characteristics evaluated, so there is need for more research to find out if maize varieties differs in their ability to compete with weeds so that room for improvement will also be necessary for sustaining maize

production, this may likely be the reason for non significant interaction observed with some characters evaluated.

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