Current Agriculture Research Journal Vol. **2**(2), 89-93 (2014)

Comparative Efficiency of Tillage Practices in Maize

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http://dx.doi.org/10.12944/CARJ.2.2.04

(Received: July 23, 2014; Accepted: September 29, 2014)

ABSTRACT

Weed management practices used by small scale farmers determine maize productivity. The trials were executed in Kigumo district during the long and short rains in 2010 to compare effectiveness of glyphosate and hand weeding on weed management in maize (*Zea mays* L.). Treatments were arranged in a Completely Randomized Complete Block Design replicated three times in a split plot arrangement. The main plots were two maize varieties DUMA SC41 and DK8031 and the subplots three weed management practices,(glyphosate, hand weeding and no tillage). Data collected included weed count by species,fresh and dry weed biomass and maize grain yield. Data was subjected to ANOVA using Genstat computer software package at P<0.05. Treatments means were separated by Student-Newman Keuls Test. Results revealed that there were significant differences in weed count among weed management practices (P < 0.05). Weeds, significantly established faster under hand weeding than other weed management practices. There were no significant differences among weed management practices in biomass and maize grain yield (P < 0.05). The two maize varieties significantly differed in grain yield under different weed management practices, DK8031 under glyphosate had the highest yield among the tillage practices involved.

Key words: Small scale farmers, Tillage practices, Weed management, Maize.

INTRODUCTION

In the past, 19 years, maize *(Zea mays* L.) worldwide popularity was second after wheat and second most important food crop in Africa after cassava,[1] but today maize is the top world staple food[2]. In Kenya maize is the staple food for 80% of the society[3], the country is ranked third after Mexico and Malawi with per capita consumption of 125kg[4].

Maize yields in Kenya have been considerably low on average 2t/ha against a potential production of 6t/ha[5]. This is due to various constraints which include abiotic ones such as lack or low farm inputs, and weather conditions and biotic ones such as weeds, insect pests, arthropods, diseases. Among the biotic factors weeds are the major constraints with crop yield losses estimated on average 80% depending on weed species[6].

Conventional tillage method most commonly used by peasant farmers to control weeds in maize production is hand weeding which is tedious, drudgery and inefficient[7]. The critical period of weed competition in maize is 2-6 weeks after crop emergence and maize also requires a minimum of three weedings to keep weeds at threshold for maximum yield.

Weeding accounts for 60% of time the peasant farmer spends in farming and saving this time means the farmer can engage in other profitable income generating activities according to[8]. The same authors also noted that use of conventional tillage has reduced maize crop yields and profitability, increased the costs of production due to use of more fertilizer and fuel to plough the land and is also responsible for soil degradation. According to[9], use of glyphosate and lasso in no till system reduced

cost of production by 50% compared to conventional tillage. The aim of the study was to compare the effectiveness of glyphosate (zero tillage) with that of hand weeding (conventional tillage) on weed management in maize production.

MATERIALS AND METHODS

The study was carried out in Kigumo District in Central province of Kenya, the trial site was about 115 km in a North West direction from Nairobi and lies at an altitude of about 1800m above sea level and traversed by longitude 36^0 59'E and latitude 0^0 41.7'S. The experiment was arranged in a randomized complete block design (RCBD) with the main plot containing two maize varieties namely DK8031 and DUMA SC 41. The subplots consisted of three weed management practices namely hand weeding three times, glyphosate applied three times and no tillage (control). The treatment combinations were replicated three times and repeated for two seasons (long and short rains). The plot size was 5 x 3 m, with maize planted at a spacing of 75 cm between and 30 cm within rows. Planting holes were prepared at 5cm depth and 20g/hole (200kg/ha) of NPK (23:23:0) fertilizer was applied and thoroughly mixed with soil before planting two seeds and covering with soil. Glyphosate (36% EC a.i) treated plots were sprayed using a 15 litre knapsack sprayer at 1.0 5kg /cm^2 five days prior to maize planting and repeated (directed spray) at 3WAP (3weeks after planting),7WAP and11WAP. Conventional tillage was achieved by hand hoeing before planting followed by hand weeding three times at 3WAP,7WAP and11WAP. Under no tillage practice, maize was planted after hand hoeing but no weeding was done until crop maturity. Data was collected in a net area of 3 by 1.5m at the centre of each plot. Percentage maize germination and vigour, weed count by species, fresh and dry weed biomass, plant height and maize grain yield were recorded. Data was analyzed using Gen Stat computer software package. ANOVA was used to assess treatment effects at $p< 0.05$. Treatment means were separated by Student Newman Keuls.

RESULTS

During the trials rainfall distribution was poor leading to fair and poor crop performance for the long and short rain seasons respectively (Table 1).

Maize planted under zero tillage, using glyphosate and that planted under conventional tillage did not differ significantly ($p > 0.05$) in terms of percent germination, vigour and weed count($p > 0.05$) during the long rainy season. However there were significant differences ($p < 0.05$) between zero and conventional tillage practices in the number of weed species during the short rain season (Table 2). There were more biomass of broadleaf weed species followed by grasses then sedges irrespective of maize variety and weed management practice (Table 3). Under each maize variety, glyphosate and hand weeding had equal and significantly lower biomass of grasses, broadleaf and sedges compared to no tillage weed management practice ($P < 0.05$) (Table 3). In both long and short rain seasons the two tillage practices did not significantly differ in terms of maize grain yield for the two maize varieties ($P <0.05$) although each of the varieties under glyphosate had higher grain yield than under hand weeding in both seasons (Table 4).

Table. 1: Kigumo district rainfall data(mm) during the year 2009 - 2010+

Month	Year 2009		Year 2010	
	Rainfall amount (mm)	Number of wet days	Rainfall amount (mm)	Number of wet days
Jan	12	4	162	11
Feb	33	3	18.4	11
Mar	37.2	8	233.5	18
Apr	175	15	280.6	25
May	445.5	26	280.6	25
June	11	66	176.9	13
July	7	5	24.7	8
Aug	22.5	8	112	16
Sept	46	9	24.5	11
Oct	380.5	19	250.6	15
Nov	216	15	148.2	13
Dec	305	21	0	0
Total	1691	199	1712	166

Legend for Table 1 : + Source: Ministry of Agriculture Kigumo district Kenya

DISCUSSION

The study showed there were no significant differences in percentage germination and crop vigour between the two tillage practices, the two maize varieties in both seasons. The results of the three weed counts done at 11, 15 and 19 weeks after planting (WAP), showed that there were significant differences in number of weed species between glyphosate (zero tillage) and those of hand weeding (conventional tillage).Glyphosate was more effective in suppressing the weeds than hand weeding.

The weed biomass for the two tillage practices were not significantly different but hand weeding (conventional tillage) had higher weed biomass compared with glyphosate (zero tillage). This conforms to findings by[10] that although glyphosate (zero tillage) effectively suppressed weeds than hand hoeing at 3WAP in the absence of weeding, at harvest the weed populations and weed dry matter on zero-tillage were similar to the hand hoe treatment.

Table. 2: Average weed counts/4.5m² during the short rains season 2010

Maize variety	Weed management	Weed counts/4.5m²					Average
		1st 3WAP	2nd 7WAP	3rd 11WAP	4th 15WAP	5th 19WAP	
DUMA	Glyphosate	29.1[a]	15.1[a]	3.3[a]	7.7[a]	10.7[a]	13.2
SC 41	No tillage	39.5[a]	35.9[b]	37.1[c]	44.6[c]	40.1[c]	39.4
	Hand weeding	29.1[a]	15.5[a]	16.4[b]	22.1[b]	24.6[ab]	21.5
DK8031	Glyphosate	23.3[a]	11.3[a]	2.8[a]	6.1[a]	7.0[a]	10.1
	No tillage	38.3[a]	27.9[a]	29.3[c]	31.2[b]	27.1[b]	30.8
	Hand weeding	23.7[a]	9.8[a]	14.3[b]	19.9[b]	19.5[ab]	17.4
Lsd		29.50	18.29	11.32	13.66	12.23	
CV%		59.60	61.90	62.30	35.00	39.40	

Legend for Table 2: In the table means bearing the same letter are not significantly different along the columns

Table. 3: Dry weight (g) weed biomass for both long and short rain seasons

Maize variety	Weed management	Long rains (2010) Weed category			Short rains (2010) Weed category			Average
		Broad Leaf	Grasses	Sedge	Broad Leaf	Grasses	Sedge	
DUMA	Glyphosate	432[ab]	174[b]	0.65[a]	141[a]	109[a]	0.1[a]	142.8
SC41	No tillage	1371[b]	2504[d]	4.47[a]	1262[b]	3090[c]	9.8[a]	1373.6
	Hand weeding	600[ab]	431[c]	2.5[a]	74[a]	35.7[a]	1.8[a]	190.8
DK8031	Glyphosate	271[a]	62[a]	0.41[a]	134[a]	3.6[a]	0.6[a]	78.6
	No tillage	980[ab]	277[b]	6.3[a]	1268[b]	1890[b]	13.5[ab]	739.1
	Hand weeding	493[ab]	144[a]	4.2[a]	22[a]	28.1[a]	5.3[a]	116.1
Lsd		631.6	103.2	9.302	675.6	619.2	10.05	
CV%		57.9	1011.5	139.5	105.2	54.7	133.2	

Legend for Table 3: In the table means bearing the same letter are not significantly different along the columns

Table. 4: DUMA SC41 and DK8031 maize grain yield (T/HA) for both long and short rain seasons

Maize variety	Weed management	Long rains	Short rains	Average
DUMA SC41	Glyphosate	1.01[a]	0.87[a]	0.94
	No tillage	0.40[a]	0.08[a]	0.24
	Hand weeding	0.73[a]	0.85[a]	0.79
DK8031	Glyphosate	2.19[a]	1.37[a]	1.78
	No tillage	1.14[a]	0.36[a]	0.75
	Hand weeding	1.65[a]	1.36[a]	1.51
Lsd		1.48	1.39	
CV%		58.4	77.4	

Legend for Table 4: In the table means bearing the same letter are not significantly different along the columns

The tillage practices were found to have significant effect on plant height where DK8031 variety under glyphosate (zero tillage) average plant height was 1.89m while under hand weeding (conventional tillage) the average plant height was 1.69m. DUMA SC41 variety under glyphosate (zero tillage) the average plant height was 1.42 m while under hand weeding (conventional tillage) it was 1.30 m. These results conform to those of [11] who reported that reduced tillage produced maximum height of 198.6 cm while hand weeding (conventional tillage) produced maximum height of 192.6cm indicating that tillage practices had significant effect on plant height. There was no significant difference between the two tillage practices in number of cobs per plant, average cob weight and mean grain yield of the maize varieties in both seasons although glyphosate had higher grain yield than hand weeding in both seasons. There were significant differences between the two maize varieties in grain yield (tones /ha). DK8031 had significantly higher grain yield than DUMA SC41. Better performance of glyphosate could be due to lack of soil disturbance in zero tillage which creates a favourable environmental conditions for buried weed seeds germination by exposing them on to the soil surface. This is in agreement with[12] who found that use of herbicides in weed management in maize production resulted into higher yields under zero tillage than under hand weeding (conventional tillage).

Tillage had no effect on crop percentage germination and vigour at 5WAP. Glyphosate was more effective in weed suppression than hand weeding. Tillage practices had effect on maize plant height but none on number of cobs per plant, average cob weight and dry grain yield. Glyphosate was found to be more suitable for use in weed management than hand weeding for soil and water conservation purposes and saving time taken in hand weeding while DK8031 variety was suitable for use in agro-ecological zone UM1 than DUMA SC41 variety.

ACKNOWLEDGEMENTS

First I would like to thank ASARECA for financial support through Hottentiah W. Mwangi (Mrs) and Dr.Z.M.Kinyua sponsored projects, secondly I wish to express my gratitude to Kenya Agricultural Research Institute and the University of Nairobi for their infrastructural support during the project execution.

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