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Economic Evaluation of Weed Management Methods on Soybean in Mosogar, Delta State

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ABSTRACT

Field studies were carried out during the rainy seasons of 2015 and 2016 between July and November at the College of Physical Education farm, Mosogar Nigeria in the wet rain-forest ecological zone (Attitude 22 meters above sea level, Lat 5^0 55^1N, long $5^0$$46^1$E) to evaluate the effectiveness of weed management methods and their economic analysis. The treatments consisted of five weed management methods (control, hoe weeding (3 and 6weeks after planting (WAP), pendimethalin (1.16kg ai/ha) at 1 day after planting (DAP), fusilade forte at (0.23kg ai/ha) at 3 weeks after planting (WAP) and pendimethalin (1.16kg ai/ha) + fusilade forte (0.23kg ai/ha) and three cropping densities (500,000, 333,333 and 266,666 plants/ha) combined in a 5 by 3 factorial experiment laid out in Randomised Complete Block Design (RCBD) in three replicates. The results obtained showed that the dominant weed species in the experimental site was *Panicum maximum*. Weed managements methods reduced weed density, weed biomass and increased % weed control efficiency (WCE) when compared with the control. Pendimethalin + fusilade forte was most effective among the weed management methods. It was also found to be more profitable than hoe weeding (3 and 6 WAP) in both seasons and it was thus recommended for weed management in the zone.

Keywords: economic analysis, weed management methods, soybean

INTRODUCTION

Weeds compete with soybean for water, nutrient and sunlight. To avoid competition it is therefore necessary to keep fields free of weeds. Weed problem are in particular, high in soybean because it is a rainy season crop. This accounts for high losses in yield due to weed infestation. Kachroo *et al*. (2003) reported a yield loss in soybean due to weed infestation of 84%. Works by Daugovish *et al*. (2003) put yield loss at 80% while Sodangi *et al*. (2006) reported 90% in the Sudan Savannah zone of Nigeria. Weeds also cause economic loss in soybean production from cost of herbicides and or cultural methods of weed management that must be used. This is why the choice of weed management methods depends not only on its efficacy but also on its cost and time. Sodangi *et al*. (2013) studied the effect of weeding methods in the production of soybean in southern guinea savannah zone (Bornu State) and reported that paraquat treatment recorded net benefit and marginal rate of return that was higher than the other treatments (no weeding, how weeding at 3, 5 and 7 WAP and hoe weeding at 3 and 5 WAP) in 2006 cropping season. However, in the 2007 planting season the authors recorded the highest net benefit and marginal rate of return in hoe weeding twice at 3 and 5 WAP treatment. Habimana *et al*. (2014) reported that among herbicide control treatments applied to soybean in Rwanda benefit cost ratio was recorded higher (3.55) under metribuzin (0.5kgai/ha) at 3 DAS (days after sowing) followed by imazethapyr (100g ai/ha) at 20 DAS. This was followed by metribuzin at 0.5kg ai/ha (at 3 DAS) followed by 1C at 30 DAS. In the study, hand weeding at 20 and 40 DAS

recorded the lowest benefit cost ratio (3.29). Smita *et al*. (2014) found that imazethypyr at 0.1kg + quizalofopethyl at 0.075kg ai/ha as PoE (post emergence) had highest gross return and net return when compared with other herbicides weed control method in soybean.

Manual or hoe weeding is an aged long practice in weed management in many crop production practices especially in subsistence agriculture (Etejere *et al*., 2013). It is however, observed that the frequency and amount of rains in the wet-rainforest ecological zone do not allow timely manual or hoe weeding. The difficulty of hoe weeding on a large scale on account of high cost and shortage of labour associated with peak periods of weeding makes alternative methods of weed management a subject of great concern. Chemical weed management is an important method of eliminating early weed in increasing yield and reducing labour cost in the tropics (Akobundu, 1980). On the other hand, using hoe in weeding could result to stand losses if the implement is not used carefully. There is need therefore the evaluate weed management strategies in order to know the economic returns associated with each.

MATERIALS AND METHODS

Study Area

Field experiments were conducted during the rainy season of 2015 and 2016 between July and November at Delta State College of Physical Education, Mosogar, Nigeria. The town is located in the wet rain forest zone of Nigeria with latitude 5^0, 55^1N and longitude 5^046^1E. It is characterised with bimodal rainfall distribution pattern. The total rainfall received during the cropping at the site in 2015 was 2324.6mm with mean temperature of 27.5 while in 2016 rainfall was 2126.6mm with a mean temperature of 27.2. The soil texture was sandy loam, and slightly acidic (pH = 4.7)

Experiment Layout

The experiment was a 5 x 3 factorial experiment laid out in a Randomised Complete Block Designed (RCBD) with three replicates. Each plot or experimental unit has a dimension of 3m x 2m. Each plot has an alley way of 1m while replicate has 1m apart.

Treatments

The treatments consisted of five weed management methods (control, how weeding at 3 and 6 WAP, pendimethalin (1.16kgai/ha) 1DAP fusilade forte (0.23kg ai/ha) at 3 WAP and pendimethalin (1.16kg ai/ha) 1DAP plus fusillade forte at 0.23kg ai/ha 3WAP) and three cropping densities (500,000, 333,333 and 266,666 plants per ha).

Field Procedure

The field was manually cleared and the trash was packed. This was done within the first week of June to allow the first flush of weed to grow. Two weeks before the planting of seeds the first flush of weed was killed with glyphosate (fore-up) at 41/ha (Dugje *et al.*, 2009). The seeds of soybean (Variety TGX 1740-1F) were planted on 14/07/2015 and 14/07/2016. The herbicides (pendimethalin and fusilade forte) were applied with the aid of a hand operated knapsack sprayer (CP 16) with flat fan nozzle (swathe width ½m). The sprayer was calibrated to deliver 220l/ha. The hoe weeding treatment was carried out at 3 WAP and 6 WAP with the aid of hoe. The seeds of soybean sown at 6 seeds per hole were thinned to two seedlings per stand at 2 WAP. Basal application of 20kg N/ha, 40kg P/ha and 20kg K/ha in the 2015 and 2016 cropping seasons was carried out at 2 WAP.

Data Collection

The parameters measured were weed density, weed dry matter, weed control efficiency, plant height, leaf area, 100 seed weight, soybean grain yield and cost benefit analysis was also determined. Data collected were subjected to analysis of variance and means were separated using fisher's least significance difference test (LSD) at 5% level of probability.

RESULTS AND DISCUSSION

Weed species composition

Weed species encountered in the experimental site were made up of mainly broad leaves, grasses and few sedges in both seasons. *Panicum maximum* had high relative abundance in both seasons (table 1)

Weed Management

The effect of herbicides and cropping density on weed management (Table 2 and 3) showed weed density, weed biomass and % weed control efficacy (%WCE) to be significantly affected by weed management methods. Among the methods of weed management hoe weeding was most effective in controlling weeds followed by pendimethalin + fusilade forte. The reduction in weed density, weed dry matter and increased %WCE was attributed to the effect of the weed management methods on weeds which reduced weed seed germination and photosynthesis. Works by Chauhan *et al*. (2002), Takim and Adereti (2012), Peer *et al*. (2013) and Mahadi (2014) are in agreement with these findings. It was observed in this study that hoe weeding management method (3 & 6 WAP) recorded 100% WCE at 8 WAP because the second hoe weeding treatment (6 WAP) was applied two needs before the first weed data measurement (8 WAP) hence weeds were not identifiable and measureable. Also, the use of hoe weeding method among hand weed methods was effective as it uprooted the weeds along with the roots. Finally, the land preparation method used in this study, where glyphosate (force-up) was used to kill the first flush of weeds, under the minimum-tillage method of land preparation enhanced the hoe weeding method. Among the weed management methods, only hoe weeding (3 and 6 WAP) recorded % WCE that is > 70 at harvest in both season.

Economic Analysis

The economic evaluation of the weed control methods was presented in Table 4. The lowest cost of production was obtained in control plots. Hoe weeded plots (3 and 6 WAP) recorded the highest cost of production for both seasons of the experiments. Among the herbicides methods of management, pendimethalin + fusilade forte recorded the highest cost of production. Generally, all the weed management methods had higher net benefits over the control. The mean values of the economic analysis showed that pendimethalin + fusilade (1.16 + 0.23 kg ai/ha) gave the highest net benefit. The low cost of production coupled with high yield could be the reason why the herbicide treatment had higher benefit over the hoe weeding (3 and 6 WAP) method of weed management. Similar findings were obtained by Sodangi *et al*. (2013), Habimana *et al*. (2014) and Smita *et al*. (2014) in soybean production. The higher benefit obtained in the herbicides methods of weed management in this study supports the position of Magani *et al*. (2012) and Omovbude and Udensi (2013) who reported that hand weeding is not as profitable as herbicides despite giving the best yield or effectiveness. Herbicides weed management methods are a better alternative to manual weed management because they are cheaper, faster and a practical way of cropping with weeds in large scale crop production.

CONCLUSION

This study indicated that pendimenthalin 1.16kgai/ha at 1 DAP followed by fusilade forte 0.23kg ai/ha at 3 WAP was the most economically rewarding method of weed management in soybean. The hoe weeding method (3 and 6 WAP) was less profitable and labour intensive or expensive.

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Table 1: Common weed species present at the experimental site before planting of soybean and the level of occurrence in the 2015 and 2016 cropping seasons (Mosogar).

Weed Species	Weed Family	Life Cycle	Level of Infestation	
			2015	2016
Chromolaena odorata (L.) R.M. King & Robinson	Asteraceae	P	++	++
Synedralla nodiflora	Asteraceae	A	++	+
Tridax procumbens L	Asteraceae	A	++	++
Aspilia Africana (pers) C.D. Adams	Asteraceae	A	++	++
Amaranthus spinosis L.	Amaranthaceae	A	+	+
Ageratum conyzoides L.	Asteraceae	A	+	+
Euphorbia hirta L.	Euphorbiaceae	A	+	+
Euphorbia heterophylla	Euphorbiaceae	P	+	+
Phyllantas amarus schum & thonn	Euphorbiaceae	A	+	+
Sida acuta Burn F.	Euphorbiaceae	A	++	+
Talinum triangulare Jacq Willd	Portulacaceae	P	+	+
Centrosema pubescens	Fabaceae	A	+	+
Calapogonium mucunoides	Fabaceae	A	++	++
Commelina benghalensis L.	Commelinaceae	P	+	+
Panicum maximum Jacq	Poaceae	P	+++	+++
Rottbollia cochinchinensis	Poaceae	P	++	++
Digitaria horizontalis Willd	Poaceae	P	+	+
Axonopus compressus	Poaceae	P	++	++
Cyperus rotundus L.	Cyperaceae	P	++	+
Cyperus esculentus L.	Cyperaceae	P	+	+

+++ = High Occurrence, ++= Moderate Occurrence , + = Low Occurrence, A = Annual, S = Sedge, G= Grass, P = Perennial

Table 2: Effect of weed control and cropping densities on weed density, weed biomass, and % WCE in soybean in 2015 cropping season (Mosogar).

	Weed density 8WAP (nos./m^2)	**Weed dry wt. (g/m^2)**	**% WCE 8WAP**	**Weed density at harvest**	**Weed fresh wt. at harvest (g/m^2)**	**% WCE at harvest**
Weed control						
Unweeded	684.3c	109.5c	0.00	184.38	1414.7	0.00
Hoe weeding (3&6WAP)	0.0	0.0	100.0	87.00	204.4	86.53
Pendimethalin (1.16kg a.i./ha)	205.4a	24.3a	77.36	96.33	763.9	51.26
Fusilade forte (0.23kg a.i./ha)	391.6b	64.0b	41.23	126.44	921.5	41.00
Pm+ Ff(1.16+0.23kg a.i./ha)	193.9a	16.5a	84.61	76.33	659.3	57.83
LSD (0.05)	42.05	7.93	2.91	2.57	33.98	1.46
Density						
500,000	277.5a	40.3a	57.13	98.47	529.0	56.28b
333,333	269.4a	42.4a	62.34	114.47	753.2	43.35a
266,666	338.2b	45.8a	62.45	129.33	1096.1	42.35a
LSD (0.05)	32.57	6.14	2.26	1.99	26.32	1.13
Interaction						
WXD	72.83*	13.74*	5.05*	4.46*	58.94*	2.52*

Table 3: Effect of weed control and cropping densities on weed density, weed biomass, and % WCE in soybean in 2016 cropping season (Mosogar).

	Weed density 8WAP (nos/m^2)	**Weed dry wt.8WAP (g/m^2)**	**% WCE 8WAP**	**Weed density at harvest**	**Weed dry wt. at harvest (g/m^2)**	**% WCE at harvest**
Weed control						
Unweeded	474.2	168.6	0.00	128.6	123.9	0.00
Hoe weeding (3&6WAP)	0.0	0.0	100.0	46.6	25.1	80.6
Pendimethalin(1.16kg a.i.ha)	229.4	42.1	75.3	78.2	65.4	56.8
Fusilade forte (0.23kg a.i./ha)	392.1	51.3	69.8	99.9	92.9	37.2
Pm + Ff(1.16+0.23kg a.i./ha)	172.7	25.1	85.3	56.4	49.6	66.0
LSD (0.05)	7.87	4.50	2.21	2.4	11.7	5.9
Density						
500,000	173.6	42.2	66.4	54.1	35.9	51.9
33,333	261.1	58.1	66.8	77.4	74.8	45.9
266,666	326.4	71.6	65.0	114.4	103.5	46.7
LSD (0.05)	6.10	3.48	1.71	1.8	9.1	4.5
Interaction						
WXD	13.63*	7.79*	3.83	4.1*	20.3*	10.2*

Table 4: Grain yield and economic evaluation of weed control methods on soybean in 2015 and 2016 cropping season (Mosogar).

Weed Control Treatments	Rate (kg ai/ha)	Rate (L/ha)	Grain Yield	Production Cost ₦/ha	Gross Benefit ₦/ha	Net Benefit ₦/ha	Benefit Cost Ratio
2015							
Unweeded	_	_	456.5a	99,900.00	91,300.00	-8,600.00	-0.09
Hoe weeding (3 & 6WAP)	_	_	1263.7d	141,900.00	252,740.00	110,840.00	0.78
Pendimethalin	1.16	3.5	1014.8c	107,750.00	202,960.00	95,210.00	0.88
Fusilate forte	0.23	1.5	787.4b	107,750.00	157,980.00	50,230.00	0.47
Pend. + Fusilade forte	1.16 + 0.23	3.5 + 1.5	1094.9c	115,600.00	218,980.00	103,380.00	0.89
2016							
Unweeded	_	_	843.5a	109,900.00	210,875.00	100,975.00	0.92
Hoe weeding (3&6WAP)	_	_	1480.9e	151,900.00	370,225.00	218,325.00	1.44
Pendimethalin	1.16	3.5	1215.5c	117,800.00	303,875.00	186,075.00	1.58
Fusilade forte	0.23	1.5	1029.4b	118,250.00	257,350.00	139,100.00	1.18
Pend. + Fusilade forte	1.16 + 0.23	3.5 + 1.5	1354.1d	128,650.00	338,525.00	209,875.00	1.63

₦ = Nigeria Currency, Soybean grain price ₦200 per kg as at December, 2015. N=250 per kg Soybean grain price as at December 2016.