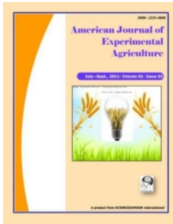

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Evaluation of Fluazifop-P-Butyl and Propanil for Weed Control in Sesame (*Sesamum indicum* L.) in Southern Guinea Savanna, Nigeria

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Authors' contributions

This work was carried out in collaboration between all authors. Author TA designed the trial and analyzed the data. Author PAS conducted the field trials. Author EIM reviewed literature and wrote the manuscript. All authors read and reviewed the final manuscript. All authors read and approved the final manuscript.

Research Article

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ABSTRACT

Aims: To evaluate the effects of rates of the post-emergence herbicides Fluazifop and Propanil for weed control in sesame (*Sesamum indicum* L.) grown in Makurdi.
Study Design: Randomized Complete Block Design.
Place and Duration of Study: The trials were conducted in the growing seasons of 2009 and 2010 at the Teaching and Research Farm of the University of Agriculture, Makurdi (07º 41´N and 08º 37´E) in the Southern Guinea Savanna zone of Nigeria.
Methodology: The eight (8) treatments consist of three rates of Fluazifop (0.15, 0.22 and 0.30 kilogram active ingredient per hectare (kg a.i./ha) and three rates of Propanil (0.72, 1.44 and 2.16 kg a.i./ha), hoe-weeded at 3 weeks after planting (WAP) and a weedy check. The sesame seeds (variety "E8") used for trials was planted by broadcasting on plot sizes of 5m×4m (20m^2). The herbicide applications were carried out as post-emergence at 15 days after planting. Fertilizer NPK (20:10:10) was applied at 4 WAP at the rate of 150 kg ha^{-1} by broadcasting.
Results: The three rates of Fluazifop significantly controlled grasses without any crop injury. However, Propanil controlled both grasses and sedges, but on broadleaf weeds, the effect increased with increasing at 4 WAP. Grain yield was highest (858 kg ha^{-1}) at 0.72 kg a.i./ha of Propanil, that was followed by treatments that received 1.44kg a.i./ha of the same

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herbicide. The least grain yield (467 kg ha^{-1}) was obtained with the weedy check.
Conclusion: The highest benefit-cost ratio of 3.53 was obtained from Propanil at rate of 0.72kg a.i./ha. This is an indication that Propanil could be used to control weeds in sesame to boost its productivity in the study area.

Keywords: Sesame production; herbicide rates; post-emergence; weed control.

1. INTRODUCTION

Sesame (*Sesamum indicum* L.) is an oil crop grown in 15 states of Nigeria stretching from the North East, North Central, the Middle Belt and Federal Capital Territory of the Sudan and Guinea Savannas (Philips, 1977; Ingawa et al., 1986). It is an important crop because the seed contains about 51% oil, 17-19% protein and 16-18% carbohydrate (Yermanos et al., 1972). Sesame oil is used for the manufacture of margarine, salad oil, cooking oil, soap, paints, lubricants and lamp fuel. Ryu et al. (1992) reported that sesame oil contains sesamoline and sesamine which is used as synergist for insecticides. Sesame seed is eaten raw or fried in the form of cakes, or fried, pounded and mixed with sorghum and millet flour to a pastry or fried, pounded and mixed with water to give a sustaining drink (Van Rheenen, 1973). The yield reductions caused by weeds in sesame had been documented. Jain et al*.* (1985) have stressed that early growth of sesame is slow, so it is important to suppress weed growth at an early stage. Belyan (1993) and Sinha et al. (1992) reported weed induced yield reduction up to 135% compared to weed-free check and need for a critical free period of 50 days after planting (DAP).

Manual hoe-weeding is the commonest method of weed control by farmers in the Guinea Savanna Zone of Nigeria. This method is not only labour intensive, expensive and strenuous, but also cause mechanical damage to growing stems and roots of plants. In addition to high cost, labour availability is uncertain thus making timeliness of weeding difficult to attain, leading to greater yield loss (Adigun et al., 2003).

In Nigeria, over 65% yield losses in sesame have been attributed to weeds on farmer's fields in Jigawa, Katsina, Benue and Nasarawa States (Busari et al., 1998). Considering the growing potentials of the export and domestic market demand for sesame seeds, this level of loss is very high. Weeds therefore, need to be put under a routine check below levels capable of causing economic damages. Although, the production of sesame, has been remarkable in Nigeria (Dipcharima,1998; Kabiru, 1998) not much work has been carried out on post-emergence herbicide due to their limited availability in Nigeria (those that are selective to sesame and yet-provide excellent control of broadleaved, grasses, and sedges) for use in sesame. Most of the herbicides labeled have been at crop establishment. Post-emergence herbicides do not only control weeds during the life cycle of the crop, but also enhance harvesting and reduce weed seed production. The purpose of this study was to evaluate the different rates of Fluazifop and Propanil herbicides for post-emergence weed control on farmer's sesame fields in Nigeria.

2. MATERIALS AND METHODS

Field trials were conducted in the growing seasons of 2009 and 2010 on adjacent sites at the Teaching and Research Farm of the University of Agriculture Makurdi (07° 41´N and 08° 37´E, and 90m above mean sea level), in the Southern Guinea Savanna agro-ecological zone of Nigeria. The total rainfall was 1200mm and 1400mm in 2009 and 2010, respectively. Mean monthly temperature of 27ºC in 2009 and 28ºC in 2010. The soil at the site was sandy loam, with a pH of 6.0. The sesame variety "E8" used in the trials was obtained from OLAM Nig. Ltd. The seed were treated with 33% permethrin + 15% carbendazim + 12% chlorothalonil, (avoid picking by insects and birds) and sown at the rate of 4 kg ha^{-1}. The seeds were planted by broadcasting, to achieve a plant population of 1284487 plants per hectare. The eight (8) treatments consist of three rates of Fluazifop (0.15, 0.22 and 0.30 kg a.i./ha and three rates of Propanil (0.72, 1.44 and 2.16 kg a.i./ha), hoe-weeding at 3 weeks after planting (WAP) and a weedy check. The plot was 5m×4m (20 m^2).The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. The herbicides applications were carried out as post-emergence at 15 DAP using Knapsack sprayer with a pressure of 2 bars in 200 L ha^{-1} of water using a flat fan nozzle. The fertilizer NPK (20:10:10) was applied at 4 WAP at the rate 150 kg ha^{-1} by broadcasting.

2.1 Data Collection and Analysis

Weed stand count and fresh weight were estimated based on samples obtained using a 1m×1m quadrate at 15 DAP and after harvest respectively. Crop injury was evaluated at 4 and 8 WAP based on a scale of 1 – 9 where 1 represents no crop injury and 9 represents complete crop injury.

A total of five plants were selected at random and tagged in each plot where the following parameters were measured: Plant height, number of branches per plant. Harvesting was done manually at physiological maturity (when the stems turn dark brown). Plants were uprooted and stalked in the field for two weeks to enhance complete drying before threshing. Seed yield in each of the plots were taken by weighting the seeds with a weight balance to get the yield per plot, and by extrapolation, yield per hectare. Three batches of 100 seeds were weighed in each plot and a mean obtained, and by extrapolation, 1000 seed weight was obtained. Stover yield from the net plots of 5m×4m (20 m^2) were weighed and expressed in kg ha^{-1}. Common weeds found in the experimental plots before seeding, 15 DAP and at harvest were identified and recorded in both years, using visional scoring of low, medium and high.

The data obtained were subjected to analysis of variance (ANOVA) for test of significance, using Genstat, treatment means were compared using LSD at 5% level of probability. The two year data was subjected Bartlett test for homogeneity and subsequently combined.

3. RESULTS AND DISCUSSION

The composition of weed flora at 15 WAP showed a total of 19 weed species comprising of 12 annual weeds and 7 perennial weeds respectively. From the foregoing broadleaved were highest 13 (68.42%) followed by 4 (21.05%) grasses and 2 (10.52%) sedges (Table 1). *Imperata cylindrica* and *Rottboelia cochinchinensis* recorded high relative abundance at 15 DAP and subsequently no record of any occurrence at harvest (Table 1). This can be attributed to the effectiveness of the treatments applied (ASGA, 2007). Also, the results of this findings showed that *Euphorbia heterophylla* had a low relative abundance at 15 DAP, but at harvest the relative abundance was moderate. This is attributed to weed seed dormancy as earlier reported (Akobundu, 1987).

Weed stand count at 15 DAP was not significantly different among treatment means (Table 2). Propanil at 0.72kg a.i./ha did not significantly reduce the density of broadleaf weeds. This may be due to under dosage or application of a single herbicide. Propanil at 1.44 and 2.16 kg a.i./ha significantly reduced the density of broadleaf, grasses and sedges remains a subject of further research to find out whether this control provide any corresponding agro-economic benefit or not.

Results obtained of fresh weed weight showed that weed weight reduced with the intensity of control (Table 2). This result was in concordance with the Economic threshold concept earlier reported (Auld et al., 1987; Avav et al., 1995). Going by this concept, it can be deduced that the highest results were obtained at 1.44 and 2.16 kg a.i./ha of Propanil and 0.30 kg a.i./ha of Fluazifop followed by 0.22 kg a.i./ha of Fluazifop; while 0.15 kg a.i./ha gave the least fresh weed weight. This result agreed with that of Kropff and Spitters (1991) earlier reported.

Generally, Fluazifop did not cause crop injury (Table 2). This may be because it was applied at rates below those causing agro-economic crop injuries and losses as well as the fact that sesame itself is tolerant to Fluazifop. Similar report was obtained by (Sapin et al., 2000). However, Propanil at 0.72, 1.44 and 2.16 kg a.i./ha caused significant injuries at 4 WAP, but at 8 WAP, there was crop recovery from the shock due to phytotoxins. Phytotoxity due to Propanil increased with increasing concentration, while crop recovery increased with decreasing concentration of Propanil. Supporting evidence has been presented by George (2000), who reported that at higher concentration of Propanil, other processes such as oxidative phosphorylation are inhibited and different rates of metabolism of the herbicide in the plant.

Treatments affected plant height, number of branches, number of capsules and number of seeds per capsule that were highly significant (P=0.05). Fluazifop (0.15, 0.22 and 0.30 kg a.i./ha) and 0.72 kg a.i./ha of Propanil and hand weeding did not stunt the crop. The result that 2160g a.i./ha of Propanil significantly reduced plant height may have resulted from phytotoxicity effect due to over dosage. This report was contrary to the findings of (Smith, 1974) who concluded that Propanil at higher rates did not affect crop performance when applied before the booting stage of rice. Fluazifop (0.15, 0.22 and 0.30kg a.i./ha and Propanil at 0.72 and 1.44 kg a.i./ha, and hand weeding increased the number of branches per plant (Table 3). This was a result of effective weed control in these treatments compared to weedy check. The number of seeds recorded per capsule decreased with increasing concentration of Propanil. This can be associated with the effects of phytotoxity/crop injury earlier discussed. The highest number of seeds per capsule was obtained in hand-weeded treatments, followed by 0.30, 0.15 and 0.22 kg a.i./ha of Fluazifop as a result of no crop injury. Generally, Propanil at all rates reduced the number of seeds per capsule; the highest concentration recorded the least number of seeds per capsule. This may be attributed to the higher crop injury recorded as against those of Fluazifop treatments.

The results revealed that stover yield, and 1000 seed weight were significantly (P=0.05) affected by the different treatments (Table 4). Fluazifop at all rates and hand weeding significantly increased 1000-seed weight. The highest 1000-seed weight (3.90) was obtained on plots treated with 0.22 kg a.i./ha of Fluazifop followed by hand weeding (3.11) and 0.30 kg a.i./ha of Fluazifop (3.03).

This was because Fluazifop and hand weeding are characterized by low phytotoxicity effects on the crop. Generally, in the Propanil treated plots, 1000 seed weight was lower and ranged between 2.83 – 2.93g that was comparable to the weedy check (1.20).

Table 1. Common Weeds at the experimental site before planting sesame at Makurdi 2009 and 2010 combined

Weed species	Family	Life Cycle	Composition (15 DAP) Br.	G.	S	Relative Abundance BP	15 DAP	Harvest
Ageratum conyzoides	Asteraceae	A	✓	–	–	+	–	+
Aspillia Africana	Asteraceae	P	✓	–	–	++	–	–
Andropogon gayanus	Poaceae	P	–	✓	–	+	–	–
Amaranthus spinosis	Amarantheaeae	A	✓	–	–	+	–	–
Commelina diffusa	Commelinaceae	P	✓	–	–	+	–	–
Commelina erecta	Commelinaceae	A	✓	–	–	++	++	–
Commelina benghalensis	Commelinaceae	P	✓	–	–	++	++	–
Chromolaena adorata	Asteraceae	A	✓	–	–	+++	–	+
Cocorus tridens	Amarantheceae	A	✓	–	–	+++	++	++
Cyperus esclentus	Cyperaceae	P	–	–	✓	+++	–	–
Cyperus rotundus	Cyperaceae	P	–	–	✓	+++	–	–
Euphorbia heterophylla	Euphorbiaceae	A	✓	–	–	++	+	++
Phyllanthus amarus	Euphorbiaceae	A	✓	–	–	+++	–	–✓
Imperata cylindrica	Poaceae	A	–	✓	–	++	+++	–
Mimosa pigra	Mimosaceae	P	✓	–	–	+++	++	++
Rottboellia cochinchinensis	Poaceae	A	–	✓	–	++	+++	–
Tridax procumbens	Asteraceae	A	✓	–	–	++	+	+
Terphrosia bracterolate	Fabaceae	A	–	✓	–	++	–	–
Colocia trigyna	Amarantheceae	A	✓	–	–	++	–	–
Total			13	4.0	2.0			
Percent occurrence			68.42%	21.25%	10.52%			

+=Low infestation
++=Moderate infestation
+++=High infestation
BP=Before Planting
DAP=Days After Planting
Br=Broadleaf, G= Grasses, S = Sedges
A= Annual, P =Perennials

Table 2. Effects of rates of post emergence herbicides for weed control in sesame at Makurdi 2009 and 2010 combined

Treatments	Herbicide rate (kg a.i./ha)	Phytotoxicity		Fresh Weed weight (kg ha^{-1}) at harvest	Weed Density at Harvest count/m^2			Weed stand count/m^2 at 15DAP
		4 WAP	8 WAP		BL.	Gr.	S	
Fluauzifop	0.15	1.00	1.00	125.0	6.3	1.0	1.0	73.3
"	0.22	1.00	1.00	63.3	4.0	1.0	1.3	83.3
"	0.30	1.00	1.00	50.0	6.0	1.0	1.0	134.3
Propanil	0.72	3.02	1.00	66.7	4.0	1.0	1.0	91.0
"	1.44	5.30	3.67	50.0	1.3	1.3	1.0	110.0
"	2.16	6.50	4.00	50.0	1.0	1.7	1.0	98.0
Hand Weeding at 3 WAP		1.00	1.00	72.3	1.0	1.0	1.7	83.3
Weedy Check		1.00	1.00	99.7	9.0	9.0	9.0	105.7
LSD (0.05)		1.00	1.02	20.02	4.49	0.75	0.82	NS

** Scale 1 – 9; where 1 = no crop injury and 9 = complete crop injury*
WAP = Weeks After Planting.
Kg a.i./ha =kilogram active ingredient per hectare

This may be associated with phytotoxicity effects in which the trend showed that, 1000 seed weight decreased with increasing concentration of Propanil. Among all the treatments, hand weeding recorded the highest stover yield while the least was obtained with 0.30 kg a.i./ha Fluazifop treated plots.

Table 3. Effects of rates of post – emergence herbicides for weed control in sesame at Makurdi 2009 and 2010 combined

Treatments	Herbicide Rate (kg a.i./ha)	Plant height (cm)	No. of branches/ plant	No. of capsules / plant	No. of seeds/ capsule
Fluazifop	0.15	94.7	7.67	81.3	80.7
"	0.22	106.7	9.33	88.0	78.0
"	0.30	121.7	8.67	95.0	114.3
Propanil	0.72	104.1	7.67	94.7	85.7
"	1.44	65.0	7.00	47.7	57.7
"	2.16	37.7	4.67	34.0	40.0
Hand Weeding at 3 WAP		121.7	9.33	100.3	123.7
Weedy check		30.0	2.00	63.0	34.7
LSD (0.05)		14.28	1.98	16.80	13.57

Kg a.i./ha =kilogram active ingredient per hectare; WAP= Weeks After Planting

Table 4. Effect of rates of post – emergence herbicides on stover yield, 1000 seed weight and grain yield of sesame at Makurdi 2009 and 2010 combined

Treatment	Herbicide rate (kg a.i./ha)	Stover yield (kg ha^{-1})	1000 seed weight (g)	Grain yield (kg ha^{-1})
Fluazifop	0.15	5150	3.27	583
"	0.22	5933	3.90	742
"	0.30	3267	3.03	667
Propanil	0.72	5200	2.94	858
"	1.44	4567	2.86	758
"	2.16	6183	2.82	650
Hand Weeding at 3 WAP		6317	3.11	725
Weedy Check		5433	1.12	467
LSD (0.05)		2651.5	0.41	NS

WAP= Weeks after Planting; Kg a.i./ha =kilogram active ingredient per hectare

The grain yield was not significantly affected by the various treatments (Table 4). Although not significant, there were marginal differences among treatments. In all cases, yield was increased compared to the untreated weedy check. The highest grain yield (858 kg ha^{-1}) was obtained at 0.72 kg a.i./ha of Propanil even though it recorded 1000 – seed weight of 2.94 g compared to (758 kg ha^{-1}) of 1.44 kg a.i./ha of the same herbicide with a 1000 seed weight of 2.86 g. The least grain yield was obtained with the weedy check (467 kg ha^{-1}) that also recorded the least 1000 seed weight of 1.12 g. These results are similar to that obtained earlier (Ndaruhu et al., 1996).

Table 5. Economics of weed management in sesame production at Makurdi, southern Guinea Savanna, Nigeria, 2011

Treatment	Herbicide Rate (g a.i./ha)	Cost of weed control (₦ ha^{-1})	Common cost (₦ ha^{-1})	Total cost (₦ ha^{-1})	Grain yield (kg ha^{-1})	Crop value (₦ ha^{-1})	Net Benefit (₦48,208.34)	B:C Ratio
Fluazifop	150	3000	21666.66	24666.66	583	72875	48208.34	1.95
Fluazifop	225	4500	21666.66	26166.66	742	92750	66583.34	2.54
Fuazifop	300	6000	21666.66	27672.66	667	83375	55702.34	2.00
Propanil	720	2000	21666.66	23666.66	858	107250	83583.34	3.53
Propanil	1440	4000	21666.66	25666.66	750	94750	69083.34	2.69
Propanil	2160	6000	21666.66	21672.66	650	81250	59577.34	2.75
Hand weeding		13,333	21666.66	34999.66	725	90625	55625.34	1.58
Weedy check		-	21666.66	21666.66	467	58375	36708.34	1.69

Common costs=cost of slashing=₦11666.66/ha, Tillage= ₦ 1500/ha, Seeds ₦500/ha (₦125/kgx4), Planting ₦1000/ha,Harvesting ₦ 4000/ha, Threshing and Winnowing= ₦3000/ha.
1 Litre of Fluazifop=₦ 3000
1 Litre of Propanil= ₦1000
Estimates are based on prevailing prices in Makurdi.
₦ =Unit of money in Nigeria
150 Naira is equivalent to 1 USD

The higher benefit-cost ratio (1.69) compared to hand weeding (1.58) seem to support the farmers position that hand weeding is not profitable (Table 5). The highest benefit-cost ratio of 3.53 was obtained from Propanil at the of 0.72 kg a.i./ha. This is an indication that Propanil, which is cheap and available in the study area, could be used to increase the productivity of sesame in the Southern Guinea Savanna, Nigeria.

4. CONCLUSION

The highest benefit-cost ratio of 3.53 was obtained from Propanil at rate of 0.72 kg a.i./ha. This is an indication that Propanil could be used to control weeds in sesame to boost its productivity in the study area.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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