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Herbicidal Efficacy of Haloxyfop-P-Methyl for Post-Emergence Grassy Weeds Control in Groundnut (Arachis Hypogaea L.)

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Abstract

A post emergence herbicide that will reduce labors demand and cost is the desire of crops farmer. This is because hand and hoe weeding is expensive, need more labors and due to scarcity of labors, particularly at the peak of the season. Hoe weeding may damage roots and pegs, hence reduce groundnut yield. In view of this the performance of haloxyfop-P-methyl was evaluated on groundnut crop in Sudan. An experiment was conducted during summer seasons of 2021/2022 and 2022/2023 at Elobied Research Station Farm, Sudan, under light soil, rain fed conditions to evaluate the herbicidal efficacy of Haloxyfop-p-methyl (Agroharvest 10.8 EC) for post-emergence grassy weed control in groundnut (Arachis hypogaea L.) .The herbicide was applied at 0.100, 0.200, 0.300 and 0.400 L/fed (1 fed= 0.42 ha), 3 weeks after sowing using a knapsack sprayer at a volume rate of 80 to 90 L/fed. Grassy weed, weeded and unweeded controls were included for comparison. Some herbicide treated plots received one supplementary hand weeding four weeks after application. In both seasons, Haloxyfop-p-methyl at 0.100 and 0.200 L/fed without supplementary weeding displayed poor to satisfactory control of grassy weeds early and late in the season. While the dose of 0.3 and 0.4 l/fed resulted in excellent (86-92%) and good to excellent (77-84%) control of grasses in the first and second season, respectively. The herbicides treatments significantly reduced weed biomass and weed ground cover compared to the weedy and grassy weeds controls in both seasons. Unrestricted weed growth significantly reduced groundnut pods yield by 51-57% in comparison to the weedy and grassy weed control. The herbicide treatments significantly increased groundnut pods yields in comparison with the weedy control. Haloxyfop-p-methyl product at 0.3 and 0.4 l/fed with one supplementary hand weeding revealed groundnut pods yield comparable to the weeded control.

Keywords: *Groundnut, Weed Control, Haloxyfop-P-Methyl, Herbicides.*

INTRODUCTION

Groundnut or peanut (*Arachis hypogaea* L.) is one of the most important oilseed crops worldwide [1], [2]. It is mainly grown in the tropical, subtropical and warm temperate climates [3], [4]. The crop grows well in light sandy loam soil with an annual rainfall of 380 to 650 mm or its equivalent in irrigation [5]. Global groundnut production for the 2014/15 production year stood at 39.42 million metric tons with a total of 23.65 million hectares of area under cultivation and an average yield of 1.67 tons/ha. China, India, Nigeria and The United States are the world's leading producers with 41.81, 12.43, 7.61 and 5.96% share of world production, respectively [6]. In Sudan, groundnut is an important oil and cash crop grown in large areas under rain-fed conditions with an annual cultivated area of 0.75 million hectares [7] and about 83% of groundnut is grown in rainfed traditional sector areas and 17% in irrigation sector areas [8]. Production is not only confined to the rain-fed sector as it is also grown under irrigation in the central clay plains. The main problems limiting production of peanut are poor cultural practices and inadequate weed management. Groundnut cannot compete effectively with weeds, particularly 3–6 weeks after sowing; therefore, early removal of weeds is important before flowering and during pegging [9]. The reduction of groundnut yields due to weed competition can reach up to 75% and the major loss was reported at early stage of crop development [10]. The first three to four week of crop growth period is critical for weed control in peanut [11]. Akobundu [23] recorded that weeds may account for 30 to 40 % of potential yield losses. Hoe weeding, which is the major method of weed management in groundnut

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production in the Sudan is costly and requires a lot of labour, which are not readily available during peak season. Roots and pegs of the groundnut plants may be damage by hoe weeding and reduce crop yield. The selection of suitable herbicides, chemical weed management may be a cheaper weed control measure in groundnut production [24]. Chemical control is an excellent alternative method to manual weeding. However, pre and post-emergence application of herbicides may allow the emergence of weeds after some time. However, the use of herbicides especially post-emergence protect crop from adverse effect of early weed competition. Research done by Jhala et al. [12], Bhale *et al.* [13] and Gunri *et al.* [14] have shown that an integrated weed management practice of herbicides and manual weeding were effective at weed control, supported groundnut growth and increased yield. The objective of this study was to evaluate the efficacy and selectivity of the post-emergence herbicide Haloxyfop-p-methyl{ Agroharvest 10.8 EC) for grass weeds control in groundnut.

MATERIALS AND METHODS

Experiment

A field experiment was conducted under rain-fed conditions for two consecutive seasons (2021/22 and 2022/23) at Elobied Research Station Farm in North Kordofan state (Sudan) located between latitude 11° 15' and 16° 30' N and longitude 27° and 32° E. The climate of the area is arid and semiarid zone. The soil is sandy with low fertility. Annual rainfall ranges between 350-500 mm. Average maximum daily temperatures varied between 30° C to 35° C most of the year [32, 33]. The aim is to study the Herbicidal efficacy of Haloxyfop-p-methyl for post-emergence grassy weeds control in groundnut (Arachis hypogaea L.). The field was divided into subplots of 15 m^2. Two seeds of groundnut (cv. Gubeish) were planted per hole at July, 17th and July 12th depending on the effective onset of rain for first and second season respectively. They were planted on rows 30 cm apart and intra row spacing of 20 cm. Haloxyfop-p-methyl (Agroharvest 10.8 EC) was applied at four doses of 0.100, 0.200, 0.300 and 0.400 L/fed (1 fed= 0.42 ha). The herbicide was applied 3 weeks after sowing using a knapsack sprayer at volume rate of 80 and 85 L/fed. Weeded and unweeded controls were included for comparison. Some herbicide treated plots received one supplementary hand weeding's four weeks after application. Broadleaved weeds were manually removed from all plots, expect the unweeded control plots. The weeded control received three hand weeding at biweekly intervals starting from sowing. Treatments were arranged in a randomized complete block design (RCBD) with four replicates. Treatments effects were assessed by counting total and individual weeds in four fixed quadrates (25x40 cm) and percent weed ground cover at four and eight weeks after sowing (WAS), henceforth, referred to as early and late season weeds, respectively. Weeds in 1 m^2 area from each subplot were cut, one month before harvest, air- dried and weighed. The scale of weed control was: 0- 49 = poor; 50- 59 = moderate; 60- 69 = satisfactory; 70- 79= good and >80% = excellent.

Characters Studied

The following parameters were measured:

Number of weeds per m^2. After four and eight weeks from sowing.

Weeds ground cover percentage

Weed dry weight (Biomass) (kg ha^{-1})

Plant population (plant ha^{-1}) at physiological maturity

Final pod yield (Kg ha^{-1}): was determined as follows:

$$Pods\ yield\ (Kg/ha = \frac{pods\ yield\ (kg)\ of\ 7\ plants}{harvested\ plot\ area\ (m2)} \times 10000$$

Statistical Analysis

Data were statistically analyzed using STAR (Statistical Tool for Agricultural Research) software version 2.0.1. For comparison between means, they were separated using Duncan Multiple Range Test (DMRT), at 0.05 level of significance, according to the procedure described by Gomez and Gomez [22].

RESULTS AND DISCUSSION

Effects on Weeds

The total weeds in the untreated plots were 195– 217 and 227–219 plants/ m^2 in the first and second season, respectively. The dominant weeds in the experimental site throughout the seasons were *Eragrostis aspera, Cenchrus biflorus, Echinocloa colonum* and *Fimbristyls dichotomo.* The reaction of these weeds to herbicide treatments are presented in (Table 1 and 2).

Table 1. Weed dominance and herbicidal efficacy of Haloxyfop-p-methyl individual weed on groundnuts (4WAS) at Elobied Research Station, season 2021/2022.

Treatments	Herbicide rate(L/fed)	* % Weeds ccontrol		
		Eragrostis aspera	*Cenchrus biflorus*	*Fimbristyls dichotomo*
Haloxyfop-p-methyl	0.100	27	68	71
Haloxyfop-p-methyl	0.200	43	72	88
Haloxyfop-p-methyl	0.300	78	80	92
Haloxyfop-p-methyl	0.400	88	81	95
**Number of weeds/m^2		82	78	35

WAS= weeks After Sowing

*% relative to the total number of species present in the untreated control

** Number of individual weed species in the untreated control.

Table 2. Weed dominance and herbicidal efficacy of Haloxyfop-p-methyl on individual weed on groundnut (4WAS) at Elobied Research Station, season 2022/2023.

Treatments	Herbicide rate (L/fed)	* % Weeds ccontrol			
		Eragrostis aspera	*Cenchrus biflorus*	Echinocloa colonum	*Fimbristyls dichotomo*
Haloxyfop-p-methyl	0.100	27	51	40	72
Haloxyfop-p-methyl	0.200	38	59	55	80
Haloxyfop-p-methyl t	0.300	75	74	65	92
Haloxyfop-p-methyl	0.400	82	87	80	100
**Number of weeds/m^2		49	39	18	25

WAS= weeks After Sowing

*% relative to the total number of species present in the untreated control

** Number of individual weed species in the untreated control.

In first season, early in the season, Haloxyfop-p-methyl at rates 0.300 and 0.400 L/fed effected excellent (86 - 92%) control of grasses at 4 WAA. whereas, at 0.100L/fed and 0.200L/fed poor (37%) to satisfactory (62%) control of grasses weed was reported. Late in the season, Haloxyfop-p-methyl without supplementary weeding at 0.100, 0.200, 0.300 and 0.400L/fed display 23, 50, 69 and 81% control of grasses, respectively. (Table 3). The product at 0.100 and 0.200 L/fed with one supplementary weeding (4WAA) gave moderate (58%) to satisfactory (66%) control of grassy weeds, respectively. However, at 0.300- 0.400 L/fed, the product with one supplementary weeding (4WAA) displayed excellent (80-94%) control of grass weeds late in the season. All herbicide rates reduced weed biomass by (60-84%) in comparison to the weedy and grassy controls (Table 3). These results are in align with those obtained by Nasr Eldin, [15]. The highest results obtained in application of Haloxyfop-p-methyl at rates of 0.300 and 0.400 L/fed, the product with one supplementary weeding (4WAA) displayed excellent (80-94%) control of grass weeds late in the season. May be due to good weed control that allows vigorous growth of the crop and develop larger vegetative parts consequently high light interception for increased dry matter. This is further confirmed by low crop performance in the low rates with respect to yield characters. This low performance could be attributed to the effect of weeds resulting from interference and competition with the crops for moisture, nutrients light and space. Weeds lead to yield loss of crops generally and groundnut specifically as observed by Ahmed et al [25] who observed significant decrease in yield attributes in the weedy check when compared to two hoe weeding. Similarly Weiss [26] and Yadava and Kaura [27] reported that uncontrolled weed in groundnut led to significant decrease in pod yield and concluded that the significant difference was due to competition for light, nutrient and space to allow the groundnut to grow. Pannu *et al.* [28] reported that the portioning of biomass in groundnut was significantly affected by the presence of weeds during the whole season and therefore both dry weight and yield were significantly less in the plot kept weedy. According to Prusty *et al.* [29] yield of groundnut was reduced by 25 to 70 % depending on the intensity of weed infestation. They concluded that groundnut crop is highly sensitive to competition by weeds and yield reduction could be severe reaching up to 70%. Clewis *et al.* [30] reported the presence of weeds in groundnut reduced harvesting efficiency and increased yield losses up to 40%. The highest rate of the herbicide (0.300 and 0.400 L/fed) applied gave good weed control as compared to the other rates; this could be due to the fact that herbicides exhibit their herbicidal effect with increasing dosage, which results in the drastic reduction of susceptible weeds that gave rise to increased dry matter accumulation resulting to high pod yield. Ibrahim *et al* [31] concluded that application of haloxyfop-R-methyl ester reduced crop injury, enhanced weed control efficiency and yield of ground nut.

Table 3. Effects of Haloxyfop-p-methyl on grass weeds control, weed biomass and weed ground cover on groundnut at Elobied Research Station Farm, season 2021/2022.

Treatments	Herbicide rate (L/fed)	% Weed control		Weed biomass (g/m^2)	Weed ground cover (%)	
		Grasses				
		4WAA	8WAA		4WAA	8WAA
Haloxyfop-p-methyl	0.100	37	23	25^{b}	20	37
Haloxyfop-p-methyl +	0.100	37	58	19^{cde}	20	16
Haloxyfop-p-methyl	0.200	62	50	21^{c}	14	20
Haloxyfop-p-methyl +	0.200	62	66	18^{cde}	14	10
Haloxyfop-p-methyl	0.300	86	69	17^{def}	11	13
Haloxyfop-p-methyl +	0.300	86	80	16^{ef}	11	10
Haloxyfop-p-methyl	0.400	92	81	17^{def}	9	15
Haloxyfop-p-methyl +	0.400	92	94	13^{e}	9	8

Weeded control				-	-	-
Weedy grasses control				52[a]	39	56
Un weeded control				63[a]	50	68
SE±				1.0		
CV%				17.0		

+= supplementary hand weeding four weeks after application , WAA= weeks after application

In the second season, Haloxyfop-p-methyl at rates 0.100 and 0.200 L/fed, without supplementary weeding, displayed poor to satisfactory (42 - 60%) control of grasses throughout the season. The herbicide at 0.300 and 0.400 L/ fed showed good to excellent control (77 - 84%) of grass weeds early in the season, respectively. However, the same product rates, without supplementary weeding, resulted in satisfactory to good control (60 - 72%) of grasses weeds late in the season (Table 4). Haloxyfop-p-methyl with one supplementary weeding (4WAA) at 0.100, 0.200, 0.300 and 0.400 L/fed display 65%, 78%, 82% and 91% control of grasses, late in the season, respectively.(Table 4). All herbicide rates reduced weed ground cover and weed in comparison to the weedy and grassy controls depending on herbicide rate. (Table 4). These findings are consistent with the findings obtained by Mohamed *et al.,* [16], Pannu *et al.* [28], Prusty *et al.* [29], and Clewis *et al.* [30].

Table 4. Effects of Haloxyfop-p-methyl on grass weeds control, weed biomass and weed ground cover on groundnut at Elobied Research Station Farm, season 2022/2022.

Treatments	Herbicide rate (L/fed)	% Weed control		Weed biomass (g/m^2)	Weed ground cover (%)	
		Grasses				
		4WAA	8WAA		4WAA	8WAA
Haloxyfop-p-methyl	0.100	42	33	27[b]	25	53
Haloxyfop-p-methyl +	0.100	42	65	14[de]	25	38
Haloxyfop-p-methyl	0.200	60	52	23[bc]	21	44
Haloxyfop-p-methyl +	0.200	60	78	11[de]	21	23
Haloxyfop-p-methyl	0.300	77	60	16[cd]	10	35
Haloxyfop-p-methyl +	0.300	77	82	9[e]	10	20
Haloxyfop-p-methyl	0.400	84	72	13[de]	6	20
Haloxyfop-p-methyl +	0.400	84	91	5[e]	6	6
Weedy grasses control				47[a]	50	77
Un Weeded control				63a	67	90
Weeded control	-	-	-	-	-	-
SE±				3.0		
CV%				33.0		

+= supplementary hand weeding four weeks after application , WAA= weeks after application

Effects on Crop Stand and Growth

All tested herbicide rates showed no phytotoxic symptoms on groundnut and had no adverse effects on groundnut population and the attained crop stand was comparable to that of the weeded control (Table 5 and 6). Unrestricted weed growth significantly reduced groundnut pods yield by about 57% in first season and 51% in the second season compared to the weeded control (Table 5 and 6). In both seasons, all herbicides treatments increased groundnut pods yield in comparison with the weedy and grassy control. The above results are similar to that of Bollich *et al.* [17], Hassan and Metwally [18] and Kumar *et al.* [19] and Youssry [20] results. Haloxyfop-p-methyl at 0.3 and 0.4 l/fed with one supplementary weeding displayed groundnut pods yield comparable to the weeded control. Based on these results, it can be concluded that post-emergence herbicide demonstrated weed control efficacy comparable to early-stage hand weeding. These results are consistent with those of Naidu *et al.* [21] and Nasr Eldin [15], who reported that haloxyfop-p-methyl significantly reduced weed growth, promote vigorous crop growth, increased photosynthesis and biomass accumulation and ultimately helped to smother weeds.

Table 5. Effects of Haloxyfop-p-methyl on plant population and pods yield on groundnut at Elobied Research Station Farm, season 2021/2022.

Treatments	Herbicide rate (L / fed)	Plant population (plant m^{-2})	Yield (Kg ha^{-1})
Haloxyfop-p-methyl	0.100	41.0^{ab}	1064.9^{cd}
Haloxyfop-p-methyl +	0.100	39.7^{ab}	1239.7^{bcd}
Haloxyfop-p-methyl	0.200	42.0ab	1380.0^{abcd}
Haloxyfop-p-mehyl +	0.200	41.3^{ab}	1495.0^{abc}
Haloxyfop-p-methyl	0.300	43.3^{a}	613^{abcd}
Haloxyfop-p-methyl +	0.300	42.0^{ab}	1409.9^{abc}
Haloxyfop-p-methyl	0.400	40.3^{ab}	1621.5^{ab}
Haloxyfop-p-methyl +	0.400	40.7^{ab}	2070.0^{a}
Weeded control	-	39.6^{ab}	2088.4^{a}
Weedy grasses control	-	41.6^{ab}	$922,3^{c}$
Un weeded control		41.0^{ab}	552.0^{d}
SE±	-	5.0	13.0
CV%	-	12.0	15.0

N.B. Similar letters in the same column are not significantly different at the 0.05 level of probability according to DMRT.

Table 6. Effects of Haloxyfop-p-methyl on plant population and pods yield on groundnut at Elobied Research Station Farm, season 2022/2023.

Treatments	Herbicide rate (L / fed)	Plant population (plant m^{-2})	Yield (Kg ha^{-1})
Haloxyfop-p-methyl	0.100	41.6^{a}	1281.1^{de}
Haloxyfop-p-methyl +	0.100	45.0^{a}	1297.2^{de}
Haloxyfop-p-methyl	0.200	42.6^{a}	1297.2^{de}
Haloxyfop-p-methyl +	0.200	44.3^{a}	1511.1^{bcd}
Haloxyfop-p-methyl	0.300	40.6^{a}	1380.0^{cde}
Haloxyfop-p-methyl +	0.300	42.7^{a}	1835.4^{a}
Haloxyfop-p-methyl	0.400	44.3^{a}	1623.8^{abc}
Haloxyfop-p-methyl +	0.400	41.6^{a}	1936.6^{a}
Weeded control	-	40.6^{a}	2067.7^{a}
Weedy grasses control	-	45.0^{a}	1023.5^{e}
Un weeded control		43.3^{a}	667.0^{f}
SE±	-	2.0	1.0
CV%	-	13.0	15.0

N.B. Similar letters in the same column are not significantly different at the 0.05 level of probability according to DMRT.

CONCLUSION

From the results of these trials it can be concluded that application of Haloxyfop-p-methyl was effective on control of grassy weeds. All herbicide treatments had no significant adverse effects on groundnut plants. All herbicide treated plots, irrespective of supplementary weeding, increased groundnut pods yield compared to the weedy and grassy control. Haloxyfop-p-methyl at rate 0.400 L/fed with one supplementary weeding gave pods yield comparable with that gave by weeded control. Residue analysis. According to the results obtained from TLC the RF value for haloxyfop-p-methyl is 0.6 mm, there is no residue of haloxyfop -p-methyl in Groundnut seeds, Therefore the use of Haloxyfop-p-methyl in groundnut crop is safe if used at the recommended dose.

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