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EVALUATION OF OXYFLOURFEN AND PENDIMETHALIN FOR WEED CONTROL IN GROUNDNUTS (*ARACHIS HYPOGAEA* L.) UNDER RAINDFED CONDITIONS ON SANDY SOIL OF NORTH KORDOFAN, SUDAN

Osman.Y. Mohammed[1]✉, Elgilani A. Abdalla[1], Dafalla A. Dawoud[2], Mukhtar A. M[3]

[1] Agricultural Research Corporation, Elobeid Research Station, P.O. Box *429*, Elobeid, Sudan.
[2] Agricultural Research Corporation, Gezira Research Station, P.O. Box 126, Gezira, Sudan.
[3] Faculty of Agricultural Sciences, University of Dongola, Sudan.

✉ Corresponding author: soly86@yahoo.com

ABSTRACT

An experiment was carried out under rain-fed conditions during 2020/21 - 2021/22 cropping seasons on sandy soil at Elobeid Research Station Farm to evaluate the efficacy and selectivity of oxyflourfen and pendimethalin for pre-emergence weed control in groundnuts. Oxyflourfen was applied at 0.096, 0.12, and 0.144 kg active ingredient (a.i). /fed and pendimethalin at 0.65, 0.70, and 0.75 kg a.i/fed. Some herbicide-treated plots received supplementary hand weeding at 4 weeks after sowing. Weeded and un-weeded treatments were included for comparison. In both seasons, oxyflourfen at 0.12 - 0.144 Kg a.i. /fed, without supplementary weeding displayed excellent (83 - 100%) and satisfactory to excellent (67 - 85%) control of grassy weeds early and late in the season, respectively. Moreover, the same rates resulted in excellent (87 - 94%) and good to excellent (78-84%) control of broadleaved weeds early and late in the season, respectively. Pendimethalin, without supplementary weeding, at the rate of 0.70 kg a.i/fed, resulted in good (77-79%) and satisfactory to excellent (63-87%) control of grasses early and late in the season, respectively. However, pendimethalin at the same rate resulted in good to excellent (79 - 85%) and satisfactory to excellent (60-81%) control of broadleaved weeds early and late in the season compared to the unweeded control, respectively. All herbicide treatments reduced weed ground cover and weed biomass in comparison to the unweeded control. Oxyflourfen at 0.144 kg a.i/fed and pendimethalin at 0.75 kg a.i/fed showed phytotoxic symptoms to groundnut plants. Unrestricted weed growth significantly reduced groundnut pod yield by 57 - 67% compared to the weeded control in two seasons.

Keywords: Groundnut yield, Efficacy, Oxyflourfen, Pendimethalin, Weed control.

الملخص

أجريت التجربة في الموسمين الصيفين (2020-2021) و (2021-2022) في المزرعة التجريبية لمحطة بحوث الأبيض تحت ظروف الأمطار وتربة رملية لتقييم فعالية وإختيارية مبيدي الحشائش أوكسي فلورفين وبنديمثالين كمبيدي حشائش قبل الإنبثاق لمكافحة الحشائش في الفول السوداني. طبق الأوكسي فلوروفين بمعدل (0.096، 0.12 و 0.144 كجم مادة فعالة/الفدان) والبنديمثالين طبق بمعدل طبق (0.65، 0.70 و0.75 كجم مادة فعالة/الفدان). بعض معاملات المبيدين أتبعت بالازالة اليدوية (حشة مساعدة) بعد 4 أسابيع من تطبيق المبيدين. معاملتي الشاهد الخالي من الحشائش والموبوء بها تضمنت للمقارنة. اللأوكسي فلوروفين في الموسمين بمعدل 0.12 و 0144 كجم مادة فعالة/الفدان بدون حشة مساعدة أعطت مكافحة ممتازة (83- 100%) ومكافحة مرضية إلى ممتازة للحشائش رفيعة الأوراق بداية ونهاية الموسم تواليا.علاوة على ذلك نفس الجرع أعطت مكافحة ممتازة (87- 94%) ومكافحة جيدة إلى ممتازة (78- 84%) للحشائش عريضة الأوراق بداية ونهاية الموسم تواليا مقارنة بالشاهد الموبوء بالحشائش. البنديمثالين بدون حشة مساعدة بمعدل 0.70 كجم مادة فعالة/الفدان أعطى نتيجة جيدة (77- 79%) و مكافحة مرضية إلى ممتازة (63- 87%) على الحشائش رفيعة الأوراق بداية ونهاية الموسم تواليا مقارنة بالشاهد الموبوء بالحشائش. ضيف إلى ذلك نفس الجرع أعطت مكافحة جيدة إلى ممتازة (79- 85%) ومكافحة مرضية إلى ممتازة (60- 81%) على الحشائش عريضة الأوراق بداية ونهاية الموسم تواليا مقارنة بالشاهد الموبوء بالحشائش. كل معاملات المبيدين أنقصت تغطية الحشائش والوزن الجاف للحشائش مقارنة بالشاهد الموبوء بالحشائش. الأوكسي فلورفين بمعدل 0.144كجم مادة فعالة/الفدان والبنديمثالين بمعدل 0.75كجم مادة فعالة /الفدان أظهرت أعراض سمية على الفول السوداني بداية الموسم. الشاهد الموبوء بالحشائش معنوياً أنقص إنتاجية القرون بمعدل (57- 67%) مقارنة بالشاهد الخالي من الحشائش في الموسم الأول والثاني على التوالي. كل معاملات المبيدين زادت إنتاجية القرون مقارنة بالشاهد الخالي من الحشائش.

Introduction

Groundnuts (*Arachis hypogaea* L.) are an important oil crop grown in more than 100 tropical and sub-tropical countries of the world (Osman, 2003). In Sudan, about 83% the land are is grown in rainfed traditional sector areas 17% 17% in irrigation sector areas (Mukhtar and Assar, 2005). The main problems limiting the production of groundnuts are poor cultural practices and inadequate weed management. Groundnuts cannot compete effectively with weeds, particularly 3–6 weeks after sowing; therefore, early removal of weeds is important before flowering and during pegging (El Naim *et. al.,* 2011). The reduction of groundnut yields due to weed competition is the major loss at the early stages of crop development that can reach up to 80% (Gill *et al*., 1986). The first three to four weeks of the crop growth period are critical for weed control in groundnuts (Kalaiselvan *et. al.,* 1991). Akobundu (1987) recorded that weeds may account for 30 to 40 % of potential yield losses. Different methods, such as hand and mechanical weeding, reduce yield loss in groundnuts due to weed competition. However, the use of herbicides, especially pre-emergence, protects the crop from the adverse effects of early weed competition. The objective of this study was to evaluate the efficacy

and selectivity of the pre-emergence herbicides oxyfluorfen and pendimethalin for weed control in groundnuts under rain-fed conditions in the sandy soil of North Kordofan.

Materials and Methods

An experiment was conducted during the 2020/2021 and 2021/2022 cropping seasons at Elobeid Research Station Farm under sandy rain-fed conditions. The field was cleaned of previous debris and divided into subplots of 15 m^2. Two seeds of groundnuts (Cultivar (cv) Gubeish) were planted per hole in the last week of July, depending on the effective onset of rains. They were planted on rows 30 cm apart and intra-row spacing of 20 cm. Oxyflourfen (Harris 240 EC) was applied at doses of 0.096, 0.12, and 0.144 Kg a.i./fed, while pendimethalin **(**PendiMight 500 EC) was applied at the rates of 0.65, 0.70, and 0.75 Kg a.i./fed. Herbicides were applied immediately after sowing using a knapsack sprayer at a volume rate of 105 and 119 L/fed, in the first and second seasons, respectively. Weeded and unweeded controls were included for comparison. Some herbicide-treated plots received one supplementary hand weeding four weeks after application. The weeded control received four hand weedings at biweekly intervals starting from sowing. Treatments were arranged in a randomized complete block design (RCBD) with four replicates. Treatment effects were assessed by counting total and individual weeds in four fixed quadrates (25x40cm) 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 a 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. Plant population and groundnut pod yield were determined at harvest. Weed dry weight, plant population, and groundnut pods yield were subjected to analysis of variance, and means were separated for significance according to Duncan's Multiple Range Test (DMRT).

Results and Discussion

Effects on weeds

The total weeds in the untreated plots was 189 – 240 and 384 – 132 plants/m^2 in the first and second seasons, respectively. In the first season, narrow-leaved grasses represented 29 - 49% of the total weed flora, and the rest were broad-leaved. In the second season, the grasses represented 22 - 60% and the rest were broadleaved weeds. The dominant weeds in the experimental site throughout both seasons were *Eragrostis aspera*, *Cenchrus biflorus*, *Sesamum alatum*, *Fimbristyls dichotomo*, *Trianthema pentandra, Ocimum basilicum, Heliotropuim supinum, Ethuliacony zoides,* and *Indigofrasemi trijuga*. The reaction of these weeds to herbicide treatments is presented in Tables 1.

Table 1: Weed dominance and herbicidal efficacy of oxyflourfen and pendimethalin on individual weed on groundnuts (4WAS) at Elobeid Research Station, season 2020/2021.

Treatments	Herbicide rate (kg a.i/fed)	Control (*%)				
		Eragrostis aspera	*Cenchrus biflorus*	*Ethuliacoyzoides*	*Fimbristylsdichotomo*	*Indigofrasemitrijuga*
Oxyflourfen	0.096	83	97	90	85	99
Oxyflourfen	0.120	79	100	100	100	100
Oxyflourfen	0.144	91	100	100	100	79
Pendimethalin	0.650	100	100	64	100	56
Pendimethalin	0.700	100	100	46	100	26
Pendimethalin	0.750	98	100	100	100	65
**Number of weeds/m^2		40	24	18	13	31

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 oxyflourfen and pendimethalin on individual weed on groundnut (8WAS) at Elobeid Research Station, season 2021/2022.

Treatments	Herbicide rate (kg a.i/fed)	Control (* %)					
		Eragrostis aspera	*Cenchrusbiflorus*	*Ethuliacony zoides*	*Trianthemapentandra*	*Sesame alatum*	*Indigofrasemitrijuga*
Oxyflourfen	0.096	89	70	73	69	81	87
Oxyflourfen	0.120	93	79	84	80	94	93
Oxyflourfen	0.144	91	94	89	91	98	95
Pendimethalin	0.650	88	100	23	70	53	60
Pendimethalin	0.700	89	100	46	77	77	56
Pendimethalin	0.750	98	99	51	82	90	70
**Number of weeds/m^2		45	20	88	17	13	90

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 the first season, oxyflourfen, irrespective of the rates and supplementary weeding, affected excellent (96 - 100%) control of grasses at 4 WAA. However, late in the season, oxyflourfen without supplementary weeding at 0.096, 0.12, and 0.144 kg a.i/fed displayed 31, 74, and 81% control of grasses, respectively (Table 3). The herbicide at 0.096 kg a.i./fed without supplementary weeding gave good (72%) to satisfactory (62%) control of broadleaved weeds early and late in the season, respectively. At 0.12 - 0.144 Kg a.i./fed, the product without supplementary revealed excellent (87-90%) and good to excellent (78 - 84%) control of broadleaved weeds early and late in the season, respectively. Similar

findings were also reported by El Faith *et. al*. (2012). Pendimethalin, irrespective of rate and supplementary weeding, resulted in good to excellent (77 - 83%) control of grasses early in the season (Table 3). However, the herbicide rates of 0.65 – 0.7 kg a.i/fed depicted satisfactory (61 - 63%) control of grasses, and good (78%) control of grasses was achieved late in the season. Pendimethalin, irrespective of rate, resulted in excellent (85 - 97%) control of broadleaved weeds early in the season. However, late in the season, pendimethalin without supplementary weeding gave moderate (59%) control of broadleaved weeds at the rate of 0.65 kg a.i/fed and good to excellent (77 - 81%) control of broadleaved weeds at the two higher rates (Table 3). All rates of herbicides, which were supplemented with one hand weeding at 4 weeks after sowing, resulted in good to excellent (79-96%) control of grass and broadleaved weeds late in the season. This result agrees with the findings of Sumathi *et al.* (2000), Burke *et al.* (2004), and ElSehly (2005), Raj *et al.* (2008), and El Faith *et*. *al*. (2012), who found that pendimethalin and oxyflourfen were the most effective herbicides against several grassy weeds when used as pre-emergence application. All herbicide rates reduced weed ground cover by about 66 - 89% early in the season and 64-86% late in the season in comparison to the unweeded control. Herbicide treatments significantly reduced weed biomass by 52 – 82% compared to the unweeded control (Table 3).

Table 3: Effects of Oxyflourfen and Pendimethalin on weed control, weed biomass, and weed ground cover on groundnut at Elobied Research Station Farm, season 2020/2021.

Treatments	Herbicide rate (kg a.i/fed)	Weed control (%)				Weed biomass (g/m^2)	Weed ground cover (%)	
		Broadleaved		Grasses				
		4 WAA	8WAA	4WAA	8WAA		4WAA	8WAA
Oxyflourfen	0.096	72	62	99	31	14^{bc}	13	15
Oxyflourfen +	0.096	72	91	99	79	8^{de}	13	10
Oxyflourfen	0.120	87	78	96	74	10^{cd}	9	15
Oxyflourfen +	0.120	87	94	96	88	6e	9	10
Oxyflourfen	0.144	90	84	100	81	9^{de}	7	19
Oxyflourfen +	0.144	90	96	100	92	7^{e}	7	10
Pendimethalin	0.650	86	59	80	61	16^{b}	13	23
Pendimethalin+	0.650	86	89	80	88	8^{de}	13	9
Pendimethalin	0.700	85	81	77	63	14^{bc}	5	12
Pendimethalin+	0.700	85	93	77	90	7e	5	9
Pendimethalin	0.750	97	77	83	78	13^{bc}	7	11
Pendimethalin+	0.750	97	89	83	91	7e	7	9
Weeded control	-	-	-	-	-	-	-	-
Un weed control	-	-	-	-	-	39^{a}	38	63
SE±	-	-	-	-	-	1		
CV%	-	-	-	-	-	27		

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

In the second season, oxyfluorfen at all rates with and without supplementary weeding displayed good to excellent

(74-87%) control of grasses early in the season. At 8 WAA, the product at 0.096, 0.12, and 0.144 kg a.i./fed without supplementary weeding gave 41%, 67%, and 85% control of grasses (Table 4). Oxyflourfen, irrespective of the rate, depicted excellent (85 – 97%) control of broadleaved weeds early in the season. Late in the season, the product 0.12 - 0.144 Kg a.i./fed, without supplementary, displayed good to excellent (78-85%) control of broadleaved weeds, whereas a satisfactory (62%) control was achieved by the product at 0.096 kg a.i/fed. Pendimethalin, irrespective of rate, resulted in excellent (88 -90%) control of grasses early in the season (Table 3). However, late in the season, the control of grasses by the product at 0.7 – 0.75 kg a.i/fed was excellent (87-89%) and good (70%) at 0.65 kg a.i/fed. The product at 0.65, 0.7, and 0.75 kg a.i/fed without supplementary weeding showed 63, 79, and 91% control of broadleaved weeds early in the season, respectively. Pendimethalin at the rates of 0.65 and 0.70 kg a.i./fed without supplementary weeding gave moderate to satisfactory (56-60%) control of broadleaved weeds late in the season, and good control (77%) of broadleaved weeds was achieved at 0.75 kg a.i./fed (Table 3). Supplementary weeding to herbicide treatments improved weed control late in the season compared to the respective treatment without supplementary weeding.

Table 4: Effects of Oxyflourfen and Pendimethalin on weed control weed biomass and weed ground cover on groundnut at Elobeid Research Station Farm, season 2021/2022.

Treatments	Herbicide rate (kg a.i/fed)	Weed control (%)				Weed biomass (g/m^2)	Weed ground cover (%)	
		Broadleaved		Grasses				
		4 WAA	8WAA	4WAA	8WAA		4WAA	8WAA
Oxyflourfen	0.096	85	62	74	41	11^{cd}	6	15
Oxyflourfen +	0.096	85	91	74	87	6e	6	9
Oxyflourfen	0.120	94	78	83	67	9^{de}	4	15
Oxyflourfen +	0.120	94	94	83	95	6e	4	7
Oxyflourfen	0.144	97	80	87	85	11^{cd}	4	12
Oxyflourfen +	0.144	97	96	87	92	6^{e}	4	6
Pendimethalin	0.650	63	56	88	70	16^{b}	7	15
Pendimethalin +	0.650	63	89	88	99	8de	7	9
Pendimethalin	0.700	79	60	90	87	14^{bc}	7	16
Pendimethalin +	0.700	79	87	90	98	7e	7	8
Pendimethalin	0.750	91	77	93	89	13^{bc}	5	13
Pendimethalin +	0.750	91	92	93	100	7e	5	5
Weeded control	-	-	-	-	-	-	-	-
Un Weeded control	-	-	-	-	-	46^{a}	37	59
SE±	-	-	-	-	-	1.9		
CV%	-	-	-	-	-	22.6		

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

All herbicide-treated plots, in both seasons, with and without supplementary weeding, reduced weed ground cover by about 66-89% at 4 weeks after sowing and 63- 92% at 8 weeks after sowing (Tables

3 and 4). Herbicide-treated plots with or without supplementary weeding significantly reduced weed biomass in comparison to the unweeded control in both seasons (Tables 3 and 4). Similar results were also reported by Meena and Mehta (2009), Kumar *et al.* (2013).

Effects on crop

Oxyflourfen at 0.144 kg a.i/fed and pendimethalin at 0.75 kg a.i/fed showed visible phytotoxic symptoms on groundnut plants, which disappeared later in the season. Oxyflourfen at 0.144 kg a.i/fed and pendimethalin at 0.75 kg a.i/fed markedly reduced plant populations in comparison to the other treatments in the two seasons (Tables 5 and 6). At harvest, the crop stand of herbicide-treated plots was not significantly different from the weeded and unweeded control plots. Unrestricted weed growth significantly reduced groundnut pod yield by about 67% in the first season and 57% in the second season compared to the weeded control (Tables 5and 6). This agreed with the findings of Kumar *et al.* (2013), who reported Presence of weeds in the groundnut field revealed the losses varied from 61 - 63 %. All herbicide-treated plots, with or without supplementary weeding increased groundnut pod yield compared to the unweeded control in both seasons (Tables 5 and Table 6). The increase was significant in all treatments except oxyflourfen treatments without supplementary weeding in the second season.

Table 5: Effects of oxyflourfen and pendimethalin on plant population and pods production of groundnuts at Elobeid Research Station Farm, season 2020/2021.

Treatments	Herbicide rate (Kg a.i / fed)	Plant population	Yield Kg/fed
Oxyflourfen	0.096	141^{acd}	624^{bc}
Oxyflourfen +	0.096	144^{abc}	805^{ab}
Oxyflourfen	0.120	142^{abc}	684^{abc}
Oxyflourfen +	0.120	143^{abc}	950^{a}
Oxyflourfen	0.144	129^{cd}	765^{ab}
Oxyflourfen +	0.144	140^{abc}	800^{ab}
Pendimethalin	0.650	139^{abc}	468^{d}
Pendimethalin +	0.650	155^{a}	650^{abc}
Pendimethalin	0.700	145^{abc}	638^{abcd}
Pendimethalin +	0.700	140^{abc}	900^{ab}
Pendimethalin	0.750	126^{cd}	649^{bc}
Pendimethalin +	0.750	131^{cd}	700^{bc}
Weeded control	-	145^{abc}	935^{a}
Un weeded control	-	138^{abc}	310^{e}
SE+	-	7.6	57
CV%	-	11	19

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

Table 6: Effects of oxyflourfen and pendimethalin on plant population and pods production on Groundnut at Elobied Research Station Farm, season 2021/2022.

Treatments	Herbicide rate (Kg a.i / fed)	Plant population	Yield Kg/fed
Oxyflourfen	0.096	214^{a}	479^{abc}
Oxyflourfen+	0.096	186^{ab}	500^{ab}
Oxyflourfen	0.120	174^{ab}	467^{abc}
Oxyflourfen+	0.120	190^{ab}	540^{ab}
Oxyflourfen	0.144	160^{ab}	479^{abc}
Oxyflourfen	0.144	186^{ab}	570^{ab}
Pendimethalin	0.650	192^{ab}	456^{ab}
Pendimethalin +	0.650	189^{ab}	500^{ab}
Pendimethalin	0.700	156^{ab}	479^{ab}
Pendimethalin+	0.700	160^{ab}	550^{ab}
Pendimethalin	0.750	186^{ab}	490^{ab}
Pendimethalin +	0.750	154^{ab}	630^{a}
Weeded control	-	192^{ab}	645^{a}
Un Weeded control	-	188^{ab}	280^{c}
SE±	-	10.8	48
CV%	-	27	20

Conclusions

1. All herbicide-treated plots gave good to excellent control of grass and broadleaved in both seasons.
2. All herbicide treatments had no significant adverse effects on groundnuts plants, except oxyflourfen at 0.144 Kg a.i./fed and pendimethalin at 0.75Kg a.i./fed, which showed visible phytotoxicity to groundnuts seedlings.
3. All herbicide-treated plots significantly increased groundnut pod yield compared to the un-weeded control.

Ethics Statement

The authors affirm that this paper is their original work and has not been previously published or submitted elsewhere. It accurately acknowledges the meaningful contributions of all co-authors, fully discloses all sources used, and reflects the personal and active involvement of each author, who collectively accept public responsibility for its content.

Conflicts of Interest

The authors declare no conflicts of interest.

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