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Efficacy of S-metolachlor, Diuron and their Tank Mixture for Weed Control in Sesame (*Sesamum indicum* L.), Gezira State, Sudan

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Abstract*: Field experiment was conducted at Gezira Research Station Farm, Wad Medani, Sudan to evaluate the efficacy and selectivity of s-metolachlor (Dual Gold 96% EC), diuron (Easy 80%WDG) and their mixture on weed control in sesame. The herbicides s-metolachlor at (0.97 and 1.21 kg a.i./ha), diuron at (0.36 and 0.48 kg a.i./ha) and their tank mixture at (0.97+0.36 and 1.21+0.36 kg a.i./ha) were applied as pre-emergence. Weeded and un-weeded treatments were added for comparison. The treatments were laid out in a randomized complete block design (RCBD) with four replicates. S-metolachlor at the two tested rates gave good control of grassy weeds (73% - 75%), (63%-73%) 4 and 8 weeks after sowing. Diuron at the two rates gave 75%- 86% broadleaved weed control four weeks after sowing and (51-61%) 8 weeks after sowing. Whereas, S-metolachlor in the tank mixture with diuron at the rate (0.97+0.36 kg a.i./ha) gave excellent control of grassy weeds (87%) early in the season and good control (71%) late in the season and gave 71%-88% grass weed control and 69%-90% broadleaved weed control at the rate of 1.21+0.36 kg a.i./ha throughout the season. S-metolachlor at 0.97 kg a.i./ha, and it's mixture with diuron at the two rates tested reduced significantly sesame plant population by (57%-71%) and gave low sesame yield even with the high performance on weeds. The highest yield (505 kg/ha) was obtained by the application of diuron at 0.48 kg a.i./ha comparable to the hand weeded control (670 kg/ha). For effective weed control and higher yield, a pre-emergence application of diuron at0.48 kg a.i./ha could be recommended.*

Keywords: Sesame, weed control, s-metolachlor, diuron

(1) Introduction

Sesame (*Sesamum indicum* L.) from Pedaliaceae family is one of the most important and strategic oil crops in the world. Over 2.5 million rain-fed hectares of Sudan's cultivable land is under sesame seed production, concentrated mainly in the clay plains of east and central Sudan (Abu Adel, 2010).

Weed competition is considered one of the major factors limiting the yield of sesame. Under weedy conditions 74-81% yield reduction was reported by (Kropff and Spitters, 1991, El Khawad *et al.,* 2017). Productivity of sesame largely depends on weed-free conditions, particularly in its early growth period. The period from 2 to 4 weeks after sowing is the most critical period of weed competition in sesame (Duary and Hazra, 2013).Worldwide many herbicides have been used successfully in sesame growing regions such as fluometuron, linuron, diuron, metobromuron, metolachlor, alachlor, fluchloralin, trifluralin and pendimethalin (Grichard *et al.*,2011).The conventional method like manual weeding and hand hoeing is the common practice to control weeds in sesame in Sudan. This method is labor intensive, expensive and uncertain, thus making timeliness of weeding difficult to attain, leading to greater yield loss (Adigun *et al.,* 2003).On the other hand Chemical weed control is labor saving, more adequate to large production and more profitable in the production of deferent crops (Grichar *et al.,* 2011). The objective of this study

(2)MATERIALS AND METHODS

A field experiment was conducted at the Gezira Research Station Farm (GRSF), Wad Medani (latitude. 14° 24` N, longitude. 33° 29´ E) during (2017/18) summer season. Sesame; variety (Bromo) was sown on the top of the 80 cm ridge by drilling. The sowing date was the 3rd week of July 2017. Plants were thinned to a single plant/hole (5cm between plants) four weeks after sowing. Nitrogen, as urea, was applied 30 days after plant emergence and before thinning at 95.2 Kg N/ha (40kg N/fed) immediately before the third irrigation. The experiment was laid out in a randomized complete block design (RCBD) 4 replicates.

Two herbicides; s-metolachlor at (0.97 and 1.21 kg a.i/ha), diuron at (0.36 and 0.48 kg a.i/ha) and their mixtures at (0.97+0.36 and 1.21+0.36 kg a.i/ha) were tested as pre-emergence treatments as aqueous solution by Knapsack sprayer which calibrated to deliver 230 l/ha. The un-weeded and hand-weeded treatments were included for comparison.

2.1 Data collection

The effects of herbicide treatments on weeds were assessed by counting total and individual weed species in 5 fixed quadrates (25 x 40 cm) and percent ground covered by weeds at 4 and 8 weeks after sowing (WAS), respectively. Grassy and broadleaf weeds, as compared with the weedy check for each treatment was calculated as following:

$$\frac{Wx - Wy}{Wx} \times 100$$

Wx= number of weeds in un-weeded control

Wy= number of weeds in herbicide treatment.

The scale of weed control was: 0-49 = poor control, 50-59 = moderate, 60-69 = satisfactory, 70-79 = good and 80 ≥ excellent weed control. One m² in each plot, were cut, air dried and weighed (weed biomass).

2.2 Yield and yield components

Plant population in each plot were counted and converted into Plant /ha. Five plants were selected randomly and the height of each plant was and the average height of the five plants was then calculated. Five plants were selected randomly and the number of capsules in each plant was counted. The crop in each plot was harvested separately after discarding 1m from each side. The harvested areas from each plot were 1.25 ×0.8 (1 m^2). Hundred seeds were counted, weighted and expressed in gram. Data were subjected to analysis of variance and means were separated for significance according to Duncan's Multiple Range Test (DMRT).

(3) RESULTS

3.1 Effect on weeds

The results presented in (table 2) showed that s-metolachlor at the two doses gave (10-49%) total weed control 4 weeks after sowing and (41-44%) 8 weeks after sowing. Diuron at 0.36kg a.i./ha gave 21-52% weed control 4 and 8 WAS while the rate of 0.48 kg a.i/ha gave 76-77% weed control early and late in the season. However, the tank mixture of S-metolachlor and diuron at the rate 0.97+0.36 kg a.i./ha gave satisfactory weed control throughout the growing season with the best performance of s-metolachlor + diuron at 1.21+0.36 kg a.i./ha which gave 84% weed control 4 WAS and 58% 8 WAS.

S-metolachlor at the two rates tested (0.97 and 1.21 kg a.i./ha) gave good control of grassy weeds (73% - 75%)(63%-73%) at 4 and 8 WAS. S-metolachlor in the tank mixture with diuron at the rate 0.97+0.36 kg a.i./ha gave excellent control of grassy weeds (87%) early in the season and good control (71%) late in the season. The rate of 1.21+0.36 kg a.i./ha gave excellent control (88%) early and good control (71%) late in the season. The late emerging weeds were due the poor effect of these herbicides on broadleaf weeds in addition to the fact that most of the weeds grow in the furrows before (Table 4).

Diuron at the rate of 0.36 kg a.i./ha gave good control (75%) of broadleaf weeds early in the season and moderate control (51%) late in the season. While the rate of 0.48 kg a.i./ha gave excellent control 86% of broadleaf weeds early in the season and moderate control 51% late in the season. Diuron in mixture with s-metolachlor at two rates 0.97+0.36 and 1.21+0.36 kg a.i./ha gave excellent broadleaved weed control (86%-90%) at 4 WAS and satisfactory to good control (69%-73) at 8 WAS (Table 4).

Data presented in table 4 showed that diuron at 0.48 kg a.i./ha and its tank mixtures with s-metolachlor showed low weed ground cover percentage (5% and 7-10%) compared to the un-weeded control (33%) 4WAS.

S-metolachlor at 0.97 kg a.i./ha resulted in high weed ground cover percentage compared to other treatments. The high percent weed ground cover observed in the herbicide treated plots could be attributed to the poor control of broadleaf weeds such as *I. cordofana* which is characterized by its high canopy cover. The total dry weight of weeds significantly varied due to different herbicides treatments throughout the growing season (table 5). Application of diuron at the two rates tested significantly reduced total dry weight of weeds by 60-77% respectively. Whereas, the tank mixture of diuron with s-metolachlor at 0.97+0.36 kg a.i./ha gave 47% reduction in weed dry weight.

3.2 Effect on crop

Application of s-metolachlor at the two tested rates didn't show any phytotoxic symptoms on the crop. While diuron caused slight yellowing on the leaves which disappeared after few days but it didn't effect on sesame population significantly. The tank mixture of s-metolachlor with diuron at the two rates tested showed phytotoxic effect on sesame plants and this resulted in significant reduction in plant population (75000-11500 plant/ha) compared to hand-weeded control (265.000 plant/ha).

All herbicides treatments showed no significant adverse effect on plant height and the tank mixture of s-metolachlor with diuron at the rate of (1.93+0.36) kg a.i./ha resulted in higher plant height (table 6). The observed increase in sesame plant height in this treatment attributed to the reduced plant population and good weed control which resulted in minimum weed competition for space, water and available nutrients.

There were no significance differences between all herbicides treatments on the number of branches per plant. Unrestricted weed growth for the whole season reduced the number of branches per plant of sesame by 33.3% as compared to hand-weeded control (table 6).

Unrestricted weeds growth significantly reduced number of capsules/plant by 30%. The highest number of capsules/plant was obtained in response to the application of s-metolachlor +diuron (45) at 1.21 + 0.36 kg a.i./ha. The other herbicide treatments gave similar results to those obtained by hand weeded control treatment (Table 5).

3.3 Effect of herbicide treatments on sesame seed weight and yield

As presented in table 10 weed infestation reduced sesame yield by 81% as compared to the hand-weeded control.

Herbicides treatments significantly increased sesame seed yield compared to un-weeded control.The highest seed yield (670 kg/ha) was obtained by hand weeding control and the lowest seed yield (127 kg/ha) recorded in the weedy check (Table 7). The highest yield (505 kg/ha) was obtained by application of diuron at 0.48 kg a.i./ha. S-metolachlor alone or in tank mixture with diuron at the two rates gave low seed yield compare to other treatments. There were no significant differences observed in 1000 seed weight between all herbicides treatments and the hand weeded and weedy controls (table 7).

(4) DISCUTION

In general, high infestation of broadleaf weeds dominated the experimental plots throughout the growing season, with

Ipomoea cordofana, *Ocimum basilicum*, *Corchorus* spp., and *Digera muricata*, being the main species. Whereas, grass weeds showed moderate infestation at 4 and 8 WAS, the most prevalent grass weeds in the 4 and 8 WAS include, *Setaria pallide-fusca*, *Ischaemum afrum* (Table 1). All herbicide treatments significantly reduced weed infestation compared to un-weeded control and unrestricted weed growth reduced growth and yield of sesame by 81%. As shown intable3diuron displayed good control 65% at the low rate and excellent control 86% against broadleaved weeds at the high rate early in the season and since broadleaves are the majority of the total weeds, the performance of diuron against total weeds was excellent and this reflected on growth and yield of sesame. These results in agreement with the result of Ibrahem *et al* ., (1988) who obtain an excellent control of broad leaved weeds by application of diuron at the rate of 0.96 kg a.i./ha. S-metolachlor displayed excellent control 93% against grasses, but, its performance against total weeds was poor 10%-49% and hence the growth and yield of sesame was greatly affected comparable with the weeded control. Sesame is a sensitive crop to herbicides and many pre-emergence herbicides used in sesame growing regions worldwide reduce sesame populations. These herbicides act differently under certain environmental conditions. The results obtained in this study revealed that the tank mixture of s-metolachlor with diuron at the two rates tested showed phytotoxic effect on sesame plants and this resulted in significant reduction in plant population (75000-11500 plant/ha) compared to hand-weeded control (265.000 plant/ha) .While the application of diuron showed a slight phyto- toxicity symptoms which did not effect of sesame stand and gave high seed yield.

A chlorosis symptoms were observed at the application of diuron at the rate of 0.8 and 1.7 kg a.i./ha in USA and severe crop damage in irrigated and rain-feds conditions (Culp and McWhorter, (1959); Moore, 1974).

In conclusion the performance of diuron against total weeds was excellent and this reflected on growth and yield of sesame. Conversely s-metolachlor resulted in poor performance against total weeds and hence low seed yield. The tank mixture of diuron with s-metolachlor gave excellent control for grasses and broadleaved weeds but with severe effect on sesame population and low seed yield.

Table 1. Common Weeds at the experimental site on sesame at GRSF

Weed species	**Family**	**Com.**	**Relative abundance** 4WAP	8WAP
Ipomoea cordofana **Choisy.**	Convolvulaceae	B	+++	+++
*Ocimum basilicum***L**.	Labiatae	B	+++	+++
Corchorus spp. **L**.	Tiliaceae	B	+++	+++
*Digeramuricata***(L.) Mart**.	Amaranthaceae	B	+++	+++
*Brachiariaeruciformis***(Sm.) Griseb.**	Poaceae	G	+++	+++
Steria pallide-fusca(Shumach) **Stapf &IIubard**	Poaceae	G	+++	++
Sorghum sudanenses **Piper.) Stapf**	Poaceae	G	-	+
*Echinchloa colona***(L.)Link**	Poaceae	G	+	+
*Panicum hygrocharis***L**.	Poaceae	G	-	++
*Ischaemum afrum***J.FGmel) Dandy,comb.**	Poaceae	G	++	++
Dinebra retroflexa (**Yahl.) Panz**	Poaceae	G	-	++
Eragrostis megastachya(**Koel.) Link**.	Poaceae	G	+	++
Rullia patua **Jacq.**	Acantheaceae	B	-	+
Abutilon glaucum **(Forst.f.) Schlecht.**	Malvaceae	B	++	+
*Sonchus corntus***Hochst.exOliv. &Hierh.**	Asteraceae	B	+	+
Tephrosia uniflora **Pers.**	Fabaceae	B	+	+
Aristolochia bracteolate **Lam.**	Aristolochiaceae	B	+	+
Commelina cotschyi **Hassk.**	Commelinaceae	G	+	+
Ryncosia minima **(L.)**	Fabaceae	B	-	+
*Boerhavia repens***(L.)**	Nyctaginaceae	B	+	+
Phyllanthus mederaspatensis **(L.)**	Euphorbiaceae	B	+	+
Euphorbia aegyptiaca **Hochst.exBoiss**	Euphorbiaceae	B	+	+
*Heliotropium sudanicum***F.W.Ander.**	Boraginaceae	B	+	+
*Cyprus rotundus***(L.) Pers.**	Cyperaceae	S	+	+

+++ High infestation; ++ Moderate infestation; + Low infestation; Comp. composition; B Broadleaves; G Grasses; S sedges

Table 2. Effect of herbicides treatments on total weeds control

Treatments	Herbicides rate (Kg a.i./ha)	Weed control (%) Total weeds	
		4WAS	8WAS
S-Metolachlor	0.97	10	44
	1.21	49	41
Diuron	0.36	21	52
	0.48	77	76
S-Metolachlor+Diuron	0.97+0.36	73	53
	1.21+0.36	84	58
Hand weeded control	-	100	100
Un-weeded control	-	-	-

*WAS means weeks after sowing

Table 3.Effect of herbicides treatments on individual weed species

Treatments	Herbicides rate (Kg.ai/ha)	% Weed control			
		Ipomea cordofana (تبر)	*Ocimum bacilicum* (ريحان)	*Digera muricata* (لبلاب احمر)	*Steria Pallide-fusca* (لصيق)
	0.97	0	25	7	0
S-metalochlor	1.21	23	28	67	100
	0.36	0	25	7	40
Diuron	0.48	35	88	100	100
	0.97+0.36	19	100	100	100
S-metalochlor + Diuron	1.21+0.36	42	100	100	100

Table 4. Effect of the herbicide treatments on annual grasses and broad leaved control

Treatments	Herbicides rate (Kg.ai/ha)	Control%			
		Grasses		Broadleaved	
		4WAS	8WAS	4WAS	8WAS
	0.97	73	73	46	28
S-metalochlor	1.21	75	63	53	49
	0.36	54	37	75	51
Diuron	0.48	78	53	86	61
	0.97+0.36	87	71	86	73
S-metalochlor + Diuron	1.21+0.36	88	71	90	69
Hand weeded control	-	-	-	-	-
Un-weeded control	-	-	-	-	-

Table 5. Effect of herbicide treatments on weed ground cover and weed dry weight

Treatments	Herbicides rate (Kg.ai/ha)	Weed ground cover (%) 4WAS	8WAS	weed dry weight (g/m^2)
S-Metolachlor	0.97	27.5	52	304.25de
	1.21	14.7	45	522.5ab
Diuron	0.36	31	50	233.5de
	0.48	5.2	28	186.75e
S-Metolachlor+Diuron	0.97+0.36	7	45	307.5de
	1.21+0.36	10	47	545ab
Un-weeded control	-	33	70	585ab
SE±	-	-	-	**49.655**
CV %	-	-	-	**24.65 %**

*WAS weeks after sowing
* Means in the same column followed by the same letter(s) are not significantly different according to least significant difference test(LSD) at $P \leq 0.05$.

Table 6. Effects of pre–emergence herbicides for weed control in sesame characteristics

Treatments	Herbicides rate (Kg a.i./ha)	plant population (plant/ha)	Plant height	No of branches/ plant	No of capsules/ plant
S-Metolachlor	0.97	200.000 abc	75.0 b	4.0 ab	18.0 d
	1.21	205.000 abc	81.7 b	3.7 ab	21.0 cd
Diuron	0.36	245.000 ab	76.0 b	4.0 ab	25.5 cd
	0.48	195.000 abc	103.5 ab	4.5 a	29.5 bcd
S-metolachlor+ Diuron	0.97+0.36	117.500 de	91.7 ab	4.7 a	31.5 bcd
	1.21+0.36	75.000 e	95.2 ab	4.7 a	44.5 ab
Hand weeded control		265.000 a	85.2 ab	4.5 ab	25.2 cd
Un-weeded control		222.500 abc	77.25 b	3.0 b	17.75 d
SE±		**21896**	**10.324**	**0.5563**	**5.4083**
CV%		**26.08%**	**23.07%**	**26.31%**	**37.11%**

* Means in the same column followed by the same letter(s) are not significantly different according to least significant difference test (LSD) at $P \leq 0.05$.

Table 7. Effect of pre-emergence herbicides treatment on 1000 seed weight and sesame yield

Treatments	Herbicides rate (Kg a.i./ha)	1000 seed weight(g)	seed yield(Kg/ha)
S-Metolachlor	0.97	3.2	210 cd
	1.21	3.1	337.5 bc
Diuron	0.36	3.1	227.5 cd
	0.48	3.3	505 ab

S-Metolachlor+Diuron	0.97+0.36	3.3	377.5 bc
	1.21+0.36	3.2	290 cd
Hand weeded control		3.2	670 a
Un-weeded control		3.1	127.5 d
SE±		**0.0775**	**61.764**
CV%		**4.82%**	**35.96%**

* Means in the same column followed by the same letter(s) are not significantly different according to least significant difference test(LSD) at $P \leq 0.05$.

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