U. of K. J. Agric. Sci. 23(2), 190-202, 2015

Evaluation of Some Herbicides for Weed Control in Wheat (*Triticum aestivum* L.) in Northern Sudan

Khogali, I. Idris[1] and Elsadig S. Mohamed[2]

[1] Agricultural Research Corporation, Shambat Research Station, Sudan
[2] Agricultural Research Corporation, Gezira Research Station, Sudan

Abstract: A field trial was conducted at Hudeiba Research Station Farm, River Nile State, Sudan, during 2001/2002, 2002/2003 and 2003/2004 winter seasons. The objective was to evaluate the activity and selectivity of three pre-emergence herbicides for weed control in wheat. The herbicides treatments were pendimethalin (Stomp) at 1.2, 1.8 and 2.4 kg a.i. ha^{-1}, oxyfluorfen (Goal) at 0.24, 0.36 and 0.48 kg a.i ha^{-1} and oxadiazon (Ronstar) at 0.72, 1.08 and 1.44 kg a.i ha^{-1}. The prevailing weed species in the experimental sites were *Ipomoea* sp*,* wild mustard (*Sinapis arvensis* L.), common beet (*Beta vulgaris* L.), sweet signal grass [*Brachiaria eruciformis* (Sm)] and Bermuda grass [*Cynodon dactylon* (L.) Pers.]. The results showed that the losses in grain yield of wheat, due to weeds competition, were 37%, 29% and 21% for seasons 2001/2002, 2002/2003 and 2003/2004, respectively. The herbicide pendimethalin, at all rates tested, showed no phytotoxicity symptoms on wheat. The higher rates of oxadiazon and oxyfluorfen, however, showed slight phytotoxicity to the wheat crop. All herbicide treatments of Ronstar and Goal resulted in good to excellent control (72%–97%) of both grassy and broad-leaved weeds. The herbicide pendimethalin displayed excellent activity against grasses and poor to satisfactory activity (0%-67%) against broad-leaved weeds. The weed *Cynodon dactylon* tolerated all herbicide treatments. With the exception of Stomp, all herbicide treatments significantly increased wheat grain yield compared to the weedy check.

Key words: Weeds; oxyfluorfen; oxadiazon; pendimethalin; wheat

INTRODUCTION

Wheat (*Triticum aestivum* L.) belongs to the family Poaceae, and it is an important cereal grain crop world-wide. It ranks first among the food grains that are consumed by humans. The crop is grown across a wide range of environments around the world.

In the Sudan, wheat has become an important staple food crop. It is grown during the winter season. The cultivation and consumption of wheat were historically limited to Northern Sudan (Lat.16-22°N). The social changes that have occurred during the last decades have led to great increase in the consumption of wheat and, therefore, growing of wheat has extended to the warmer regions of central Sudan in several irrigated schemes such as Gezira, Rahad and New Halfa (Assad *et al*. 2009).

Weeds reduce wheat yield and profit by competing with the crop for moisture, light, space, and nutrients. They also interfere with harvest and lower the quality of the grain. Yield losses and harvest problems caused by weeds in wheat varies depending on the weed species, weed population, time of weed emergence, growing conditions, and status of the wheat crop.

Work at Gezira Research Station showed that weeds had no adverse effects on wheat growth and yield (Babiker 1978). The implementation of the policy of diversification and intensification in irrigated agriculture in Sudan has been accompanied by serious weed problems and changes in weeds flora. The introduction of new wheat cultivars and changes in husbandary practices have also induced changes in crop/weed interrelationship. Weed surveys and studies on competition and management of weeds in wheat were conducted in different regions of the Sudan. The results of these studies were reviewed by Mohamed (1996); they showed that there are some variations in composition and distribution of weed flora. Studies on weed competition showed that unrestricted weed growth and delayed weeding reduced wheat yield by 20%. The use of uncleaned wheat seeds has led to spread of some serious

annual weed species, such as wild sorghum (*Sorghum arundinaceum* (Dew.) Stapf.), *Sinapis arvensis* L. and *Chenopodium* sp. (Bedry and Elamin 2011). Moreover, some farmers delay the control of weeds or do not control them, and this increases the seed bank of weeds seeds. The yield losses are mainly due to delayed weeding or insufficient weed control (Hamdoun and El Tigani 1977). The effect of varying population densities of *Sinapis arvensis* and wild sorghum on the growth and yield of wheat was studied at Hudeiba and Gezira Research Stations (Mohamed 1996). The results showed that the presence of six plants/ m^2 of *S. arvensis* reduced wheat grain yield by 67%, and reduction in grain yield increased with increasing densities. Wild sorghum at a population of 2-10 plants/m^2 row reduced wheat grain yield by 18%-35%.

Several herbicides have been evaluated for weed control in wheat in different countries (Patrick *et al*. 2001; Vasilakoglou *et al*. 2006; Aslam *et al*. 2007; Abouziena *et al*. 2008 and Grey *et al*. 2012). In Sudan, the efficacy and selectivity of the herbicide Puma (phenoxy-p-ethyl) and Topik (clodinafob-propargyl), as post-emergence herbicide treatments, were evaluated for weed control including wild sorghum in wheat in Gezira and New Halfa (Babiker and Mohamed 1992; Osman 1993). Pre-emergence herbicides, as a prophylactic measure, were tested at New Halfa, Eastern Sudan (Osman 1992 and 1993)

To eliminate or protect early competition of weeds in crops, pre-emergence herbicides can be of great potential value. Therefore, this study was conducted to evaluate the efficacy of three pre-emergence herbicides, namely, Stomp, Goal and Ronstar for weed control in wheat.

MATERIALS AND METHODS

A field experiments was conducted during 2001/02, 2002/03 and 2003/04 winter seasons at Hudeiba Research Station Farm (Lat. 17°34´N, Long. 33°56´E) in the River Nile State. The soil is clay loam in texture with a pH of 8.0 to 8.6, organic carbon of 0.37 and total nitrogern of 0.03%. The herbicide treatments were pendimethalin (Stomp) at 1.2, 1.8 and 2.4 kg a.i. ha^{-1}, oxyfluorfen (Goal) at 0.24, 0.36 and 0.48 kg a.i ha^{-1} and oxadiazon (Ronstar) at 0.72, 1.08 and 1.44 kg ai ha^{-1}. The treatments were

arranged in a randomized complete block design with four replicates. In each season, the experimental sites were disc-ploughed, harrowed, levelled and then divided into small plots (3x7 m). In all experiments, the wheat cultivar Wadielneil was planted on flat at a seed rate of 50 kg/fed (fed= 4200m^2) in rows 30 cm apart. The sowing date was either in the second or in the third week of November. Nitrogen fertilizer, in the form of urea, was applied at the rate of 86 kg N/ha immediately before the third irrigation. Weeded and unweeded plots were included in the trial for comparison. In the weeded check, weeds were removed by hand twice at 21 and 42 days after sowing. The unweeded control plots were kept weedy throughout the growing season.

Aqueous solutions of the different herbicide treatments were applied immediately after sowing as pre-emergence treatment using a knapsack sprayer calibrated to deliver 286L/ha. Visual observations of phytotoxicity of the herbicide treatments on the crop were periodically observed.

The effects of treatments on weeds were assessed by counting total and individual weed species at 4 and 8 weeks after planting. This was done by placing a 1x1 m quadrate at random in each plot. Weeds inside each quadrate were identified, and the total and individual weed species were counted. The percentage control of grassy and broad-leaved weeds, as compared with the weedy check, for each treatment were calculated. At harvest, ten plants of wheat were taken at random to determine the plant height and number of seeds per spike. At the end of season, the crop was harvested manually by cutting at the soil level. The net harvested area was 10.8 m^2 in the centre of each plot. Grain yield and 1000–seed weight were recorded. The data were subjected to analysis of variance and means were tested for significance using the Duncan's Multiple Range Test (DMRT) at P= 0.05.

RESULTS AND DISCUSSION

Effect on weeds

Total number of weeds in the weedy check for 2001/02, 2002/03 and 2003/04 seasons were 197, 131 and 109 plants/ m^{-2}, respectively, at 4 weeks after sowing. Of the total weed species 54%- 88% were broad-leaved and the rest were grassy. The most dominant weed species throughout the three seasons in the experimenal site were *Ipomoea* sp., *Sinapis arvensis* L., *Beta vulgaris* L., [*Brachiaria eruciformis* (Sm)], and [*Cynodon dactylon* (L.) Pers.]. All herbicides tested affected and maintained good to excellent control (72%- 97%) of grassy weeds (Tables 1-2). However, in 2002/03 season, the herbicides displayed poor performance because of the presence of the resistant weed *Cynodon dactylon* (Table 2). The tolerance of *Cynodon dactylon* to most herbicides was reported by Johnson (1998) and Fagerness *et al.* (2002).

The herbicides oxyfluorfen and oxadiazon gave satisfactory to excellent control (70%-97%) of broad-leaved weeds, however, the herbicide pendimethalin displayed moderate to poor activity (0%-67%) against broad-leaved weeds (Tables 1 and 2). Similar findings were obtained by Mohamed and Nourai (1997).

Table 1. Effects of different herbicide treatments on weeds control in wheat in 2001/2002

Treatment	Rate (Kg a.i ha-1)	Weed control (%)			
		Grasses		Broad-leaved weeds	
		4 WAS*	8 WAS	4 WAS	8 WAS
Pendimethalin	1.20	94	90	27	0
Pendimethalin	1.80	84	80	43	2
Oxyfluorfen	0.24	83	76	72	76
Oxyfluorfen	0.36	97	97	73	80
Oxadiazon	0.72	94	78	75	71
Oxadiazon	1.08	87	86	86	79
Weed-free check	-	100	100	100	100
Weedy check	-	0	0	0	0

WAS= weeks after sowing

Table 2. Effects of different herbicide treatments on weeds control in wheat in 2002/2003 and 2003/2004 seasons

Treatment	Rate (Kg a.i ha^{-1})	Weed control (%)			
		Grasses		Broad-leaved weeds	
		4 WAS*	8 WAS	4 WAS	8 WAS
Season 2002/2003					
Pendimethalin	1.20	70	60	51	40
Pendimethalin	1.80	36	17	67	63
Pendimethalin	2.40	73	37	67	58
Oxyfluorfen	0.24	33	37	84	85
Oxyfluorfen	0.36	57	83	96	93
Oxyfluorfen	0.48	80	26	95	95
Oxadiazon	0.72	48	63	97	93
Oxadiazon	1.08	54	17	97	94
Oxadiazon	1.44	61	34	97	90
Weed-free check	-	100	100	100	100
Weedy check		0	0	0	0
Season 2003/2004					
Pendimethalin	1.20	94	94	52	59
Pendimethalin	1.80	90	72	25	59
Pendimethalin	2.40	79	100	45	61
Oxyflurofen	0.24	73	88	79	70
Oxyflurofen	0.36	75	88	83	95
Oxyflurofen	0.48	88	86	88	96
Oxadiazon	0.72	81	87	90	90
Oxadiazon	1.08	87	95	91	87
Oxadiazon	1.44	69	88	97	95
Weed-free check	-	100	100	100	100
Weedy check	-	0	0	0	0

WAS= week after sowing

Table 3. Effect of herbieides on yield and yield components of wheat season 2001/2002

Treatment	Rate (kg a.i. ha^{-1})	Plant height (cm)	No. of seeds/spike	1000-seed weight (g)	Grain yield (kg/ha)	Increase in grain yield (%)
Pendimethalin	1.20	87.8a	40.9ab	38.8	2991b	11
Pendimethalin	1.80	86.7a	44.3a	37.6	2804b	4
Oxyflurofen	0.24	87.9a	40.8ab	38.2	4097a	52
Oxyflurofen	0.36	88.9a	43.6a	39.1	4378a	62
Oxadiazon	0.72	87.1a	39.9ab	39.4	4066a	51
Oxadiazon	1.08	89.1a	41.9ab	38.9	4154a	54
Weed-free check	-	86.0a	40.2a	40.1	4279a	59
Weedy check	-	78.9b	36.7b	40.4	2697b	
SE $\pm$		1.712	1.823	NS	132.579	

Means within a column followed by the same letters (s) are not significantly different at $P \geq 0.05$, according to DMRT.

Effect on crop

Visual observations showed that the herbicides oxadiazon at 1.44 kg ai ha^{-1} and oxyflurofen at 0.48 kg ai ha^{-1} were phytotoxic to wheat. They caused chlorosis during the early stages of growth, but the symptoms disappeared and the crop completely recovered 5 weeks after sowing. The herbicide pendimethalin delayed germination of wheat for a couple of days. The other herbicide treatments, however, showed no phytotoxicity symptoms on the crop.

Unrestricted weed growth accounted for 37%, 29% and 21% loss in wheat yield in 2001/02, 2002/03 and 2003/04 seasons, respectively, as compared to the weed - free check (Tables 3 and 4).

Table 4. Effects of herbicides on yield and yield components of wheat in 2002/2003 and 2003/2004

Treatment	Rate (kg a.i. ha -1)	Plant height (cm)	No. of seeds/spike	1000-seed weight (g)	Grain yield (kg/ha)	Increase in grain yield (%)
			Season 2002/03			
Pendimethalin	1.20	81.9b	36.1bc	39.1ab	2897de	9
Pendimethalin	1.80	87.9a	44.7a	39.1ab	3293abcd	25
Pendimethalin	2.40	85.3ab	43.0a	39.0ab	2865de	9
Oxyfluorfen	0.24	85.7ab	41.8ab	38.2ab	3108cd	18
Oxyfluorfen	0.36	87.1a	41.0abc	38.6ab	3433abc	31
Oxyfluorfen	0.48	87.7a	45.6a	39.0ab	3536abc	34
Oxadiazon	0.72	87.8a	40.6abc	38.7ab	3623ab	38
Oxadiazon	1.08	88.0a	44.1a	39.4a	3207bcd	22
Oxadiazon	1.44	84.6ab	42.3a	39.1ab	3124cd	19
Weed-free check	-	83.8ab	39.8abc	38.3ab	3679a	40
Weedy check	-	84.1ab	35.8b	37.2b	2630e	
SE +		1.381	1.79	0.608	132.57	
			Season 2003/2004			
pendimethalin	1.20	82.8	30.7bc	41.7abc	3325bc	12
pendimethalin	1.80	81.5	29.4c	41.6abc	3273bc	10
pendimethalin	2.40	81.0	29.2c	41.3bc	3395abc	14
Oxyfluorfen	0.24	86.2	33.6abc	41.6bc	3611ab	22
Oxyfluorfen	0.36	85.2	32.8bc	40.3bc	3841ab	29
Oxyfluorfen	0.48	82.8	29.9c	39.4c	3599ab	21
Oxadiazon	0.72	83.2	35.4ab	42.4ab	3962a	33
Oxadiazon	1.08	82.2	30.1c	41.5abc	3655ab	23
Oxadiazon	1.44	81.5	28.7c	41.5abc	3620ab	22
Weed-free check	-	84.5	37.9a	43.9a	3780ab	27
Weedy check	-	83.0	29.8c	42.7ab	2970c	
SE +		NS	1.569	0.732	184.86	

Means within a column followed by the same letter(s) are not significantly different at P> 0.05, according to DMRT.

With the exception of pendimethalin, all herbicide treatments significantly increased the grain yield of wheat, as compared with the weedy check (Tables 3 and 4). The increase in yield due to these herbicides ranged from 18% to 62%. These results support those of Khan *et al*. (2003) and Aslam *et al*. (2007). They reported that herbicidal treatments significantly increased the grain yield in wheat. These results showed that early removal of weeds by pre-emergence herbicides enabled the crop to maximize the use of the available resources.

Most of the herbicide treatments used in this investigation increased the number of seeds per spike compared to the weedy check treatment (Tables 3 and 4). These results are in line with those of Khan *et al*. (2003) and Aslam *et al*. (2007) who concluded that herbicidal application produced more seeds per spike than untreated control treatment because weed competition in wheat contributed to reduction in number of seeds per spike. They also reported that number of grains per spike was the most important trait contributing to grain yield in wheat. Aslam *et al*. (2007) reported that change in number of grains per spike drastically influences the ultimate grain yield of wheat.

In season 2001/2002, weeds reduced the plant height of the crop. The number of weeds in this season was relatively higher than in the other two seasons (Table 3).

Stasitical analysis of the data revealed that 1000 seeds weight was not affected by the different herbicide treatments (Tables 3 and 4).

It is evident from the results that grain yield of wheat was significantly reduced as a result of uncontrolled weed growth and was increased by up to 62% when weeds were controlled by herbcide treatments.

Based on these results, it can be concluded that the effectiveness of the herbicides oxyflurofen at 0.24 and 0.36 kg ai ha^{-1} and oxadiazon at 0.72 and 1.08 kg ai ha^{-1} against weeds in wheat, makes them possible candidates for the control of weeds in wheat in northern Sudan. This is substantiated by the scarcity of labour and its high cost.

REFERENCES

Abouziena, H.F.; Shararfaida, A.A. and El- desoki, E.R. (2008). Efficacy of cultivar selectivity and weed control treatments on wheat yield and associated weeds in sandy soils. *World Journal of Agricultural Science* 4 (3), 384- 389.

Aslam, M.; Hassian, M.; Hussian, G. and Rashid, A. (2007). Efficacy of different herbicides for weed control in wheat crop. *Pakistan Journal of Weed Science Research* 13(1-2), 1-7.

Assad, F.G., Ibrahim, E.M. and Mohamed, A.A.E. (2009). Effect of irrigation intervals and NPK on yield and seed quality of wheat (*Triticum aestivum* L.). *Sudan Journal of Agricultural Research* 13, 37- 46.

Babiker, A.G.T. and Mohamed, A.H. (1992). Wild sorghum, importance and control in wheat. Pages 73–76 in Nile Valley Regional Program on Cool-Season Food Legumes and Wheat, Annual Report 1991/92, Sudan. ICARDA/NVRP DOC-25.

Bedry, K.A.M. and Elamin, A.E.M. (2011). Chemical Control of Wild Sorghum [*Sorghum arundinaceum* (Dew.)] in Faba Bean (*Vicia faba* L.) in Northern Sudan. *University of Khartoum Journal of Agricultural Sciences* 19(1), 78- 90.

Fagerness, M.J.; Yelverton, F.H. and Cooper, R.J. (2002). Bermuda grass [*Cynodon dactylon* (L.) Pers.] and Zoysiagrass (*Zoysia japonica*) establishment after emergence herbicide applications. *Weed Technology* 16, 597-602

Grey, T.L.; George, S.C, III, Lynn, S. and Culpepper, A.S. (2012). Italian ryegrass (*Lolium perenne*) control and winter wheat response to post herbicides. *Weed Technology* 26, 644- 648.

Hamdoun, A.M. and El Tigani, K.M. (1977). Weed control problems in the Sudan. PANS 23, 190- 194.

Johnson, B.J. (1998). Influence of spring- applied herbicides on bermuda grass (*Cynodon dactylon*) greens overseeded with roughstalk blue grass (*Poa triviatis*). *Weed Technology* 12, 1-6.

Khan, M.H.; Hassan, G.; Khan, N. and Khan, M.A. (2003). Efficacy of different herbicides for controlling broadleaf weeds in wheat crop. *Asian Journal Plant Science* 2(3), 254- 56.

Mohamed, E.S. (1996). Weed control in wheat. Pages 196-209 In Ageeb, Osman A.; Elahmadi Abdalla B.; Solh Mahmoud B. and Saxena Mohan C. (eds.) 1996. Wheat production and improvement in the Sudan. *Proceedings of the National Research Review Workshop, 27-30 August 1995, Wad Medani, Sudan, ICARDA/ Agricultural Research Corporation. ICARDA: Aleppo, Syria. Viii+* 262 pp.

Mohamed, E.S. and Nourai, A.H. (1997). Chemical weed control in garlic (*Allium sativum* L.). *University of Khartoum Journal of Agricultural Sciences* 5(1), 40- 51.

Osman, A.G. (1992). Chemical weed control in wheat in New Halfa. Pages 70–73 in Nile Valley Regional Program on Cool-season Food Legumes and Wheat, *Annual Report 1991/92,* Sudan. ICARDA/NVRP DOC -31.

Osman, A.G (1993). Chemical weed control in wheat in New Halfa. Pages 75–77 in Nile Valley Regional Program on Cool-season Food Legumes and Wheat, *Annual Report 1992/93,* Sudan. ICARDA/NVRP DOC-31.

Patrick, W.G.; Phillip, W.S.; Jennifer, G.H. (2001). Dose responses of weeds and winter wheat to MKH 6561. *Weed Science* 49, 788-791.

Vasilakoglou, I.B.; Dhima, K.V. and Eleftherohorinos, I.G. (2006). Hoary cress (*Cardaria droba*) control in winter wheat with postemergence herbicides. *Weed Technology* 20,585-592.

تقويم بعض المبيدات لمكافحة الحشائش في محصول القمح فى شمال السودان

خوجلي عز الدين إدريس[1] والصادق سليمان محمد[2]

[1]هيئة البحوث الزراعية ، محطة بحوث شمبات ، السودان
[2] هيئة البحوث الزراعية ، محطة بحوث الجزيرة ، السودان

المستخلص: أُجريت هذه التجربه بمزرعة محطة بحوث الحديبة في ولاية نهر النيل ، السودان خلال موسمي الشتاء للاعوام 2002/2001م و 2003/2002م و 2004/2003م بهدف تقويم فعالية واختيارية ثلاثة مبيدات تضاف قبل الإنبات لمكافحة الحشائش في محصول القمح . والمبيدات هي مبيد الأستومب بتراكيز 1.20 و 1.80 و 2.40 كيلو جرام مادة فعالة للهكتار ، القول بتراكيز 0.24 و 0.36 و 0.48 كيلو جرام مادة فعالة للهكتار والرونستار بتراكيز 0.72 و1.08 و 1.44 كيلو جرام مادة فعالة للهكتار . أهم الحشائش السائدة في هذه التجربة هي مطاط و فجيلة وسبانخ وأم ركيبات والنجيلة . أتضح إن الضرر الذي تسببه الحشائش لمحصول القمح قد بلغ 37% و 29% و 21% فى 2002/2001 و 2003/2002 و 2004/2003 على التوالي . أدى التركيز العالي لمبيدي الرونستار والقول إلى حدوث سمية لمحصول القمح . أظهرت جميع معاملات المبيدات مكافحة جيدة وممتازة (72%-97%) للحشائش ذات الأوراق العريضة وضيقة الأوراق . بينما أعطى مبيد الأستومب مكافحة ضعيفة إلى متوسطة للحشائش ذات الأوراق العريضة (0%-67%) . فى موسم 2003/2002 ، أعطت معظم معاملات المبيدات مكافحة ضعيفة للحشائش ضيقة الاوراق وذلك لوجود حشيشة النجيلة والتي أظهرت تحملاً لكل المعاملات . جميع معاملات المبيدات أدت إلى زيادة معنوية في إنتاجية محصول القمح مقارنة بالشاهد غير المعشب بإستثناء معاملات مبيد الأستومب .