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Improving the Efficiency of Some Herbicides in Weed Control and Yield Components of Wheat by Some Adjuvants

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Abstract: Two field experiments were carried out during 2012/2013 and 2013/2014 winter seasons, at the Mallawy Agricultural Research Station, Agriculture Research Center (ARC) Egypt, to study the effect of vegetable and mineral oils as adjuvant, on the efficacy of certain Broad-leaved weeds herbicide Brominal 24% EC (Bromoxynil octanoate), graminicide Illoxan36% EC (Diclofop-methyl) and Panther 55% SC (Isoproturon + Diflufenican) a ready formulated herbicide for controlling grassy and broad-leaved weeds. The above herbicides were used at the local recommended rate and at reduced rate with or without adjuvant on associated weeds, grain yield and yield components of bread wheat (*Triticum aestivum* L.). Results indicated that the addition of (mineral or vegetable oils) at 1% of spraying volume could replace 25% of Brominal, Illoxan and Panther without loosing any significant activity on the control of weeds or yield. The recommended (full) rates of Brominal, Illoxan and Panther at 240, 360 and 330 g a.i. /fed. alone showed statistically similar results as reducing rate of these herbicides at 180, 240, 247.5 g a.i. /fed. plus adjuvants (mineral or vegetable oils) at 1% with respect to reducing dry weight of weeds and increasing yield of wheat and its components. Concerning yield and yield components the sequence of reduced rate of Brominal (180 g a.i. /fed) and Illoxan (280 g a.i. /fed.) when tank mixed with mineral or vegetable oils, gave the highest values of yield components of wheat (no. of spikes /$m^{2,}$ no. of grains/spike, grain weight/spike (g) and 1000-grain weight as well as grain yield which were the same as the recommended rates.

Key words: Wheat · *Triticum aestivum* L · Weed control · Adjuvants · Mineral oil · Vegetable oils

INTRODUCTION

As known, *Triticum aestivum* L. is one of the most important cereal crops in Egypt and the world. It is grown in Egypt in an area of 3.38 million feddans (feddan= 4200 m^2) with total production of 9.46 million ton [1]. It is used for making bread, bakeries and other industrial purposes. In Egypt, there is a large gap between wheat production and the total human consumption. Therefore, efforts are made to minimize the gap between the production and the consumption, through increasing grain yield /area and extending cultivated wheat area. Weed control is among agricultural practices, in the front to rise up grain yield /unit area.

Weeds are considered a great constraint in agriculture, particularly in wheat. Wheat is often infested with numerous types of weeds, which compete with crop plants resulting in grain yield depression. Getting rid of weeds is achieved through direct methods such as herbicides application or by hand weeding and other indirect measures, such as agricultural practices as crop rotation, land preparation and plant density which is controlled by seeding rates.

Whereas, herbicides resulted in environmental pollution, so that a great effort extended to reduce herbicides usage. One of these efforts is decreasing the recommended rate of herbicides by addition of adjuvants without any loosing in its efficiency.

Adjuvants significantly contribute to the weed control obtained by herbicides. Researchers reported that successful weed control often depends on the appropriate use of adjuvants with herbicide spray to ensure uniform application and target coverage, to facilitate foliar penetration and sometimes to enhance selectivity. In this respect, Mohassel *et al.* [2] revealed that Diclofop-methyl was enhanced by the adjuvants against little seed canary

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grass and wild oat; Tagour *et al.* [3] showed that the use of adjuvant at 4% can play a good role in enhancing Panther efficacy either at full or reduced rates for weed control in wheat; Soliman *et al.* [4] indicated that the adjuvant led to improving the efficiency of herbicides low rates in weed control and increasing crop productivity without significant differences compared with the recommended rate without adjuvant; Akbar *et al.* [5] found that the tank mixture of clodinafop-propargyl plus tribenuron-methyl with adjuvants showed a synergistic effect in controlling wild oat and wild mustard. Also Hammami *et al.* [6] evaluated the effects of clodinafop-propargyl as influenced by adjuvants, on wild oat. They found that the performance against wild oat by clodinafop-propargyl, plus adjuvant at 0.2% was higher by 2.92 times, compared with the use of this herbicide without adjuvants.

Therefore, this work was designed to study the activity of certain post-emergence herbicides (Brominal 24% EC, Illoxan 36% EC and Panther 55% SC) when tank mixed with mineral oil at 1 % or vegetable oil at 1 % as adjuvants in an attempt to produce a better weed control with the lowest possible cost without affecting the yield and yield components of wheat.

MATERIALS AND METHODS

Two field experiments were conducted during the two successive growing winter seasons 2012/13 and 2013/14 at Mallawy Agricultural Research Station, Agricultural Research Center (ARC) Egypt. Each field experiment included the following treatments:

- T1. Bromoxynil octanoate (3,5-dibromo-4-hydroxybenzonitrile) known commercially as " Brominal 24% EC " applied at the rate of 240 g a.i./fed. as a local recommendation (alone) as post-emergence applied 3-5 leaf stage of wheat to control the annual broad-leaved weeds.
- T2. Bromoxynil octanoate at the rate of 180 g a.i. /fed. (75% reduced rate alone)
- T3. Bromoxynil octanoate at the rate of 180 g a.i. /fed. (75% reduced rate) + Mineral oil at 1 %.
- T4. Bromoxynil octanoate at the rate of 180 g a.i. /fed. (75% reduced rate) + Vegetable oil at 1 %.
- T5. Diclofop-methyl (methyl 2-[4-(2,4-dichlorophenoxy)phenoxy]propanoate) known commercially as "Illoxan36% EC" applied at the rate of 360 g a.i./fed. as a local recommendation (alone) as post-emergence applied 3-5 leaf stage of wheat to control the annual grassy weeds.
- T6. Diclofop methyl applied at the rate of 280 g a.i./fed (75% reduced rate alone)
- T7. Diclofop methyl applied at the rate of 280 g a.i. /fed (reduced rate) + Mineral oil at 1%.
- T8. Diclofop methyl applied at the rate of 280 g a.i./fed (reduced rate) + Vegetable oil at 1%.
- T9. Bromoxynil octanoate at the rate of 240 g a.i. /fed. (local recommendation) followed by Diclofop methyl applied at the rate of 360 g a.i./fed (local recommendation)
- T10. Bromoxynil octanoate at the rate of 180 g a.i. /fed. (reduced rate) followed by Diclofop methyl applied at the rate of 280 g a.i. /fed. (reduced rate) alone.
- T11. Bromoxynil octanoate at the rate of 180 g a.i. /fed. (reduced rate) + Mineral oil at 1% followed by Diclofop methyl applied at the rate of 280 g a.i./fed (reduced rate) + Mineral oil at 1 %.
- T12. Bromoxynil octanoate at the rate of 180 g a.i. /fed. (reduced rate) + Vegetable oil at 1 % followed by Diclofop methyl applied at the rate of 280 g a.i./fed (reduced rate) + Vegetable oil at 1 %.
- T13. Isoproturon (*N,N*-dimethyl-*N'*-[4-(1-methylethyl)phenyl]urea) + Diflufenican (*N*-(2,4-difluorophenyl)-2-[3-(trifluoromethyl)phenoxy]-3-pyridinecarboxamide) known commercially as " Panther 55% SC " applied at the rate of 330 g a.i./fed as a local recommendation (alone) as post-emergence applied 2-4 leaf stage of wheat to control the annual weeds (ready formulated).
- T14. Isoproturon + Diflufenican applied at the rate of 247.5 g a.i. /fed. (75% reduced rate alone)
- T15. Isoproturon + Diflufenican applied at the rate of 247.5 g a.i. /fed (reduced rate) + Mineral oil at 1%.
- T16. Isoproturon + Diflufenican applied at the rate of 247.5 g a.i. /fed (reduced rate) + Vegetable oil at 1%.
- T17. Hand weeding twice at 30 and 45 days after sowing (DAS).
- T18. Unweeded check (Control).

The treatments were arranged in a Randomized Complete Blocks Design with four replicates in both seasons. The plot area was 10.5 m^2(3.5 m length and 3.0 m width). Each plot included 15 rows. *Triticum aestivum* cultivar Sids 12 was sown by drill sowing method on the third week of November in each year. All herbicides treatments and herbicide in combination with adjuvants (Mineral and Vegetable oils) were sprayed as tank mix as post emergence application (four weeks after sowing). A knapsack sprayer equipped with one nozzle boom was used and the water volume was 200 L/fed. All agricultural

practices (i. e. fertilizer, irrigation, pest and diseases control) were carried out according to the local recommendations. The soil texture of the experiments was clay loam in both seasons. Harvest was done at the second week of May in both seasons.

Data Recorded: During the growing seasons, the following data were recorded:

Weed Survey: Weeds were hand pulled from one square meter chosen at random from each plot after 60 days from sowing and identified according to Tackholm [7]. The dry weight of annual broad-leaved, grassy and total annual weeds per one square meter was recorded.

Yield and its Components: At harvest, samples of ten plans were taken at random from central area of each plot to study no. of grains/spike, grain weight/spike (g) and 1000-grain weight (g) beside the character number of spikes/m^2. Grain yield in each plot was taken and calculated (ardab/fed.); (one ardab = 150 kg).

Statistical Analysis: All data obtained were statistically analyzed according to procedures outlined by Gomez and Gomez [8]. Duncan's [9] multiple range test was used for the comparison among means.

RESULTS AND DISCUSSION

Effect of Weed Control Treatments on Dry Weight (g/m^2) of Annual Weeds: During both growing seasons of wheat, the dominant grassy weed species were *Avena fatua* L. and *Phalaris minor* L., while the major broad-leaved weeds were: *Brassica nigra* L., *Beta vulgaris* L., *Sonchus oleraceus* L., *Medicago polymorpha* L., *Anagallis arvensis, Ammi majus* and *Rumex dentatus* L.

Grassy Weeds (g/m^2): It is clear from the data recorded in Table (1) that, adjuvants (mineral or vegetable oils) at 1% significantly increased the activity of Illoxan and Panther when used at reduced rate (280 and 247.5 g a.i/fed, respectively), the latter rates plus adjuvants significantly showed better control of annual grassy weeds, as compared to the reduced rate alone and hand weeding. Illoxan and Panther with reduced rate plus adjuvants (mineral or vegetable oils) at 1 % significantly showed similar activity of the recommended rate alone

Concerning the efficacy of Illoxan on annual grassy weeds it is cleared that adding mineral or vegetable oils to the reduced rate significantly increased the control of this group of weeds, compared to that obtained by this herbicide alone. Similar results to the recommended rates alone and significantly better than hand weeding. Also Panther at reduced rate (247.5 g a.i/fed.) in tank mix with mineral or vegetable oils or Illoxan at reduced rate 280 g a.i/fed. plus adjuvant (mineral or vegetable oils) at 1% were not significantly different in effect than from these herbicides without adjuvant.

The above results indicate that mineral or vegetable oils as adjuvant promoted the effects of Illoxan and Panther, thus, it was possible to reduce the rate of Illoxan to 280 g a.i/fed and Panther to 247.5 g a.i/fed, without loosing any significant efficacy in controlling the annual grasses, as compared to the recommended rate alone or the hand weeding treatments.

Broad-leaved Weeds (g/m^2): It is clear from the data recorded in Table (1) that, significant difference between the efficacy of various treatments in controlling weeds were obvious. Brominal when used alone at the rate of 240 g a.i/fed or at the rate of 180 g a.i/fed, with mineral or vegetable oils at 1% and Panther when used at rate of 330 g a.i/fed or 247.5 g a.i/fed plus mineral or vegetable oils at 1%, gave significant differences as compared to all other treatments and gave the best control of braod-leaved weeds 97.7, 99.3, 98.4 and 95.9, 95.0, 93.4 %, respectively, in the first season and by 96.5, 98.2, 97.1 and 92.2, 93.1, 91.0%, respectively, in the second season.

Brominal at 240 g a.i/fed. and Panther at 330 g a.i/fed (the recommended rate) caused a reduction in the dry weight of broad-leaved weeds. This reduction was significantly equal to that obtained from Brominal at 180 g a.i/fed. and Panther at 247.5 g a.i/fed, when applied in tank mix with mineral or vegetable oils at 1%.

Brominal at 180 g a.i/fed. and Panther at 247.5 g a.i/fed. was significantly less effective than all other treatments in controlling broad-leaved weeds, whoever, it was still significantly better than control. Similar finding were obtained by Yehia *et al*. [10].

Total Annual Weeds (g/m^2): The sequence of Brominal for controlling broad-leaved weeds at the reduced rate (180 g a.i/fed) plus adjuvant (mineral or vegetable oils) at 1 %; followed by Illoxan for controlling grassy weeds) plus adjuvant (mineral or vegetable oils) at 1 %, provided as affective total weeds (grassy and broad-leaved weeds) control, as recommended rate (240 + 360 g a.i/fed) without adjuvants. The addition of adjuvant (mineral or vegetable oils) at 1%, enhanced foliar activity of these herbicides. This could be explained by evidence that, adjuvants allowed a higher amount of active ingredient to penetrate

the cuticle relatively rapidly; and accumulate at the site of action where the herbicides act to inhibit weed growth [11].

Wheat Yield and Yield Components: Data in Tables (2 and 3) showed yield and yield component of wheat as affected by weed control treatments in the presence and absence of adjuvants.

Number of Spikes /m^2: All the treatments under the present study increased this character significantly. The highest number of spikes/m^2 were obtained from the sequence of Brominal and Illoxan alone at the recommended doses (240 and 360 g a.i/fed., respectively) or reduced rates (180 and 280 a.i/fed., respectively) + mineral or vegetable oil and hand weeding in the first season. Whereas, in the second season the highest values of this trait were obtained from the sequence of Brominal and Illoxan alone at the recommended doses (240 and 360 g a.i/fed., respectively) or reduced rates (180 and 280 a.i/fed., respectively) with or without hand weeding and Panther at 247.5 g a.i/fed. plus mineral and vegetable oils as compared to unweeded.

No. of Grains/spike: The sequence Brominal at 180 g a.i/fed and Illoxan at 280 g a.i/fed. tank mixed with mineral or vegetable oil, Brominal at 240 g a.i/fed and Illoxan at 360 g a.i/fed alone, hand weeding twice, Panther at 247.5g a.i/fed tank mixed with mineral or vegetable oil and Illoxan at 280 g a.i/fed. tank mixed with mineral gave the highest no. of grains/spike in the first season. Whereas, in the second season the sequence of Brominal at 180 g a.i/fed and Illoxan at 280 g a.i/fed. tank mixed with mineral and vegetable oils, Brominal at 240 g a.i/fed, followed by Illoxan at 360 g a.i/fed, gave the highest significant increases in no. of grains/spike, as compared to the check.

Grain Weight /spike (g): The sequence of Brominal at 180 g a.i/fed and Illoxan at 280 g a.i/fed. tank mixed with mineral or vegetable oils, Brominal at 240 g a.i/fed and Illoxan at 360 g a.i/fed and hand weeding twice gave the highest grains weight/spike, in the first season. Meanwhile, in the second season, the sequence of Brominal at 180 g a.i/fed and Illoxan at 280 g a.i/fed. tank mixed with mineral or vegetable oils. Brominal at 240 g a.i/fed and Illoxan at 360 g a.i/fed, hand weeding twice, Panther at 247.5 g a.i/fed tank mixed with mineral or vegetable oils, Panther at 330 g a.i/fed and Illoxan at 280 g a.i/fed. tank mixed with mineral oil gave the highest significant increase of this trait.

Table 1: Effect of some herbicides with or without adjuvants on the dry weight of weeds (g/m²) at 60 DAP in 2012/13 and 2013/14 seasons

			Grassy weeds		Broad-leaved weeds		Total weeds	
	Treatments	Rate a.i.g/fed	2012/13	2013/14	2012/13	2013/14	2012/13	2013/14
1	Brom. (local recommendation alone)	240 cm^3	351.2 b	255.0 b	11.0 f	10.0 f	362.2 cd	256.0 bc
2	Brom. (75% reduced rate alone)	180 cm^3	336.3 b	240.8 bc	66.4 d e	56.8 de	402.7 c	297.6 b
3	Brom.(reduced rate) + Min. at 1%	180 cm^3 + 2 L	321.1 b	227.3 c	3.1 f	5.0 f	423.2 d	232.3 cd
4	Brom.(reduced rate) + Veg. at 1%	180 cm^3 + 2 L	325.4 b	229.0 c	7.4 f	8.3 f	332.8	237.3 cd
5	Diclofop-methyl (local recommendation alone)	360 cm^3	7.1 g	15.1 g	405.2 b	239.4 bc	412.3 bc	245.5 bcd
6	Diclofop-methyl (75% reduced rate alone)	280 cm^3	46.3 ef	44.9 f	411.7 b	242.8 b	458.0 b	287.7 b
7	Diclofop-methyl (reduced rate)+ Min. at 1%	280 cm^3 + 2 L	4.1 g	8.6 g	335.9 c	206.4 c	334.0 d	215.0 d
8	Diclofop-methyl(reduced rate) + Veg. at 1%	280 cm^3+ 2 L	8.3 g	14.7 g	324.4 c	213.4 bc	332.7 d	228.1 cd
9	Brom. (local recommendation alone) followed by Diclofop-methyl (local recommendation alone)	240 cm^3 + 360 cm^3	10.8 g	13.3 g	29.3 ef	14.0 f	40.1 gh	27.3 g
10	Brom. (75% reduced rate) followed by Diclofop-methyl (75% reduced rate)	180 cm^3+ 280 cm^3	45.1 ef	47.8 f	72.4 d	62.4 d	117.5 ef	110.2 ef
11	Brom (reduced rate) + Min. at 1% followed by Diclofop-methyl (reduced rate)+ Min. at 1%	180 cm^3+ 2 L + 280 cm^3 + 2 L	5.0 g	6.0 g	10.7 f	5.3 f	15.7 h	11.3 g
12	Brom. (reduced rate) + Veg. at 1% followed by Diclofop-methyl (reduced rate) + Veg. at 1%	180 cm^3+ 2 L + 280 cm^3 + 2 L	17.1 fg	11.2 g	15.7 f	9.0 f	32.8 h	20.2 g
13	Isoproturon + Diflufenican. (local recommendation alone)	330 cm^3	140.6 d	110.6 e	19.6 f	22.4 ef	160.2 e	133.0 e
14	Isoproturon + Diflufenican (75% reduced rate)	247.5 cm^3	229.6 c	159.8 d	88.3 d	74.4 d	317.9 d	234.2 cd
15	Isoproturon + Diflufenican (reduced rate)+ Min. at 1%	247.5 cm^3 + 2 L	123.9 d	110.6 e	23.9 f	19.9 f	147.8 e	130.5 e
16	Isoproturon + Diflufenican (reduced rate) + Veg. at 1%	247.5 cm^3 + 2 L	134.5 d	110.4 e	31.6 ef	25.7 ef	166.1e	136.1 e
17	Hand weeding twice		67.4 e	51.1 f	19.7 f	19.6 f	87.1 fg	70.7 f
18	Untreated		459.8 a	317.5 a	478.6 a	286.9 a	938.4 a	604.4 a

Brom. = Bromoxynil octanoate, Min. = mineral oil, Veg. = vegetable oil.

Table 2: Effect of some herbicides with or without adjuvants on yield component of wheat in 2012/13 and 2013/14 seasons

Treatments		Rate a.i.g/fed	No. of spikes/m^2		No. of grain/spike	
			2012/13	2013/14	2012/13	2013/14
1	Brom. (local recommendation alone)	240 cm^3	338.0 cd	343.0 cde	55.55 de	46.40 ghi
2	Brom. (75% reduced rate alone)	180 cm^3	318.5 d	319.5 de	53.53 e	45.10 hi
3	Brom.(reduced rate) + Min. at 1%	180 cm^3 + 2 L	339.5 cd	349.0 cde	55.90 de	47.30 fghi
4	Brom.(reduced rate) + Veg. at 1%	180 cm^3 + 2 L	344.0 cd	351.0 cde	56.30 cde	46.50 ghi
5	Diclofop-methyl (local recommendation alone)	360 cm^3	331.0 cd	337.0 cde	55.75 de	49.35 defg
6	Diclofop-methyl (75% reduced rate alone)	280 cm^3	314.5 d	331.5 cde	54.15 de	48.23 fgh
7	Diclofop-methyl (reduced rate)+ Min. at 1%	280 cm^3 + 2 L	347.0 cd	343.8 cde	57.78 abcd	50.25 defg
8	Diclofop-methyl(reduced rate) + Veg. at 1%	280 cm^3 + 2 L	337.5 cd	336.5 cde	56.50 cde	51.25 def
9	Brom. (local recommendation alone) followed by Diclofop-methyl (local recommendation alone)	240 cm^3 + 360 cm^3	455.0 a	439.0 ab	61.75 abc	62.15 abc
10	Brom. (75% reduced rate) followed by Diclofop-methyl (75% reduced rate)	180 cm^3 + 280 cm^3	392.0 b	401.0 abc	57.28 bcd	59.40 bc
11	Brom (reduced rate).+ Min. at 1% followed by Diclofop-methyl (reduced rate)+ Min. at 1%	180 cm^3 + 2 L + 280 cm^3 + 2 L	468.0 a	455.0 a	63.03 a	64.58 a
12	Brom. (reduced rate) + Veg. at 1% followed by Diclofop-methyl (reduced rate) + Veg. at 1%	180 cm^3 + 2 L + 280 cm^3 + 2 L	466.5 a	445.5 ab	62.50 ab	63.20 ab
13	Isoproturon + Diflufenican. (local recommendation alone)	330 cm^3	355.0 bcd	379.0 bcd	57.95 abcd	51.35 def
14	Isoproturon + Diflufenican (75% reduced rate)	247.5 cm^3	338.5 cd	357.0 cd	55.58 de	48.55 fgh
15	Isoproturon + Diflufenican (reduced rate)+ Min. at 1%	247.5 cm^3 + 2 L	367.0 bc	389.0 abcd	58.55 abc	54.50 d
16	Isoproturon + Diflufenican (reduced rate) + Veg. at 1%	247.5 cm^3 + 2 L	364.5 bc	387.0 abcd	58.40 abcd	53.20 de
17	Hand weeding twice		443.0 a	428.0 ab	59.60 abcd	58.48 c
18	Untreated		248.0 e	286.0 e	45.95 f	46.40 i

Brom. = Bromoxynil octanoate, Min. = mineral oil, Veg. = vegetable oil.

Table 3: Effect of some herbicides with or without adjuvants on yield and yield component of wheat in 2012/13 and 2013/14 seasons

Treatments		Rate a.i.g/fed	Grain weight/Spike		1000 grain weight (g)		Grain yield (ardab/fed)	
			2012/13	2013/14	2012/13	2013/14	2012/13	2013/14
1	Brom. (local recommendation alone)	240 cm^3	2.36 gh	2.27 gh	46.7 cdef	52.70 bcd	17.86 efg	17.48def
2	Brom. (75% reduced rate alone)	180 cm^3	2.28 hi	2.18 gh	44.5 fg	50.67 d	17.38 gh	16.75 f
3	Brom.(reduced rate) + Min. at 1%	180 cm^3 + 2 L	2.42 efgh	2.49 efg	47.3 bcdef	52.21 cd	18.15 ef	18.50cd
4	Brom.(reduced rate) + Veg. at 1%	180 cm^3 + 2 L	2.49 defgh	2.36 fg	47.0 cdef	52.89 bcd	18.83 d	18.43cd
5	Diclofop-methyl (local recommendation alone)	360 cm^3	2.49 defgh	2.83 bcdef	47.5 bcdef	52.07 cd	17.53 fgh	17.25 ef
6	Diclofop-methyl (75% reduced rate alone)	280 cm^3	2.37 fgh	2.58 defg	44.9 efg	50.52 d	17.13 h	16.49 f
7	Diclofop-methyl (reduced rate)+ Min. at 1%	280 cm^3 + 2 L	2.70 bcdef	2.96 abcd	47.7 bcde	52.86 bcd	18.83 d	17.99cde
8	Diclofop-methyl(reduced rate) + Veg. at 1%	280 cm^3 + 2 L	2.53 cdefgh	2.85 bcdef	47.5 bcdef	51.07 d	18.32 de	17.25 ef
9	Brom. (local recommendation alone) followed by Diclofop-methyl (local recommendation alone)	240 cm^3 + 360 cm^3	2.90 ab	3.31 ab	49.9 abc	55.93 abc	22.87 b	21.30ab
10	Brom. (75% reduced rate) followed by Diclofop-methyl (75% reduced rate)	180 cm^3 + 280 cm^3	2.71 bcde	2.39 fg	48.6 abcd	54.17 abcd	22.05 c	20.92 b
11	Brom (reduced rate).+ Min. at 1% followed by Diclofop-methyl (reduced rate)+ Min. at 1%	180 cm^3 + 2 L + 280 cm^3 + 2 L	3.03 a	3.46 a	51.0 a	57.19 a	23.51 a	22.28 a
12	Brom. (reduced rate) + Veg. at 1% followed by Diclofop-methyl (reduced rate) + Veg. at 1%	180 cm^3 + 2 L + 280 cm^3 + 2 L	2.92 ab	3.41 a	50.2 ab	56.64 ab	22.35 bc	21.55ab
13	Isoproturon + Diflufenican. (local recommendation alone)	330 cm^3	2.51 cdefgh	3.07 abcd	48.6 abcd	52.67 bcd	18.44 de	18.49cd
14	Isoproturon + Diflufenican (75% reduced rate)	247.5 cm^3	2.40 efgh	2.62 cdefg	45.5 defg	51.23 d	18.10 ef	17.56def
15	Isoproturon + Diflufenican (reduced rate)+ Min. at 1%	247.5 cm^3 + 2 L	2.75 abcd	3.16 ab	49.6 abc	53.55 abcd	18.90 d	18.83 c
16	Isoproturon + Diflufenican (reduced rate) + Veg. at 1%	247.5 cm^3 + 2 L	2.66 bcdefg	3.11 abc	48.2 abcd	52.95 bcd	18.89 d	18.65cd
17	Hand weeding twice		2.83 abc	3.28 ab	49.1 abc	54.83 abcd	22.07 c	21.04 b
18	Untreated		2.06 i	1.84 h	43.4 g	44.72 e	9.75 i	10.40 g

Brom. = Bromoxynil octanoate, Min. = mineral oil, Veg. = vegetable oil.

1000 Grain Weight: Data in Table (3) indicated that all weed control treatments under the present study significantly increased 1000-grain weight of wheat in both seasons. The sequence of Brominal at 180 g a.i/fed and Illoxan at 280 g a.i/fed. tank mixed with mineral or vegetable oil, Brominal at 240 g a.i/fed and Illoxan at 360 g a.i/fed, Panther at 247.5 g a.i/fed tank mixed with mineral oil, hand weeding twice, Brominal at 180 g a.i/fed followed by Illoxan at 280 g a.i/fed., Panther at 330 g a.i/fed and Panther at 247.5 g a.i/fed tank mixed with vegetable oil, gave the highest values of this trait in both seasons without significant difference between these treatments.

Grain Yield per Feddan: It cleared that the sequence of Brominal at 180 g a.i/fed and Illoxan at 280 g a.i/fed. (reduced rates) tank mixed with mineral or vegetable oils and Brominal at 240 g a.i/fed, followed by Illoxan at 360 g a.i/fed. (recommended rates) gave a significant increase in grain yield, as compared to control. These treatments provided the highest grain yield per unit area by 141.0, 129.2, 128.7 and 114.2, 107.2, 105.0% in the first and second season, respectively, as compared to the control. This may be due to the role of weed control in decreasing the removal of nutrients from soil by weeds, thus stimulating crop growth and allow the plant to photosynthesize an accumulates the photosynthesis products in grains and that depends on the competitive ability of the crop species which determined by time of emergence, rate of growth and ability to obtain growth requirements. Similar findings were reported by Helal [12] and Nassar [13].

Such finding may be useful from the point of view of reducing the cost of weed control and therefore increasing the treated area without any effect on the performance of herbicide or the grain yield of wheat. Results are in general agreement with those previously obtained by Walia and Gill [14].

CONCLUSION

From the previous results, it could be concluded that addition of adjuvants to reduced herbicides rates with about 25% (compared to recommended) rates resulted in enhancing the efficiency of weed control (broad and grassy weeds), increasing grain yield and yield components of wheat decreasing environmental pollution, decreasing public health problems and reduced cost of weed control process.

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