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MANAGEMENT STRATEGIES FOR HERBICIDE-RESISTANT WEEDS BY USING DIFFERENT HERBICIDES IN SEQUENTIAL APPLICATION FOR EFFECTIVE AND SAFE WEED CONTROL IN WHEAT.

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ABSTRACT

Three field experiments were carried out during the successive winter seasons on 2017/2018 and 2018/2019 at Sids Agricultural Research Station farm, A.R.C., Bani Swif Governorate, Egypt, to management resistance development by using herbicides with different sites of action (SOA's) in the sequential application at reduced rates with adjuvants (mineral oil) on productivity, quality and associated weeds of wheat (*Triticum aestivum* L.). Experiment No.1 studied the efficacy of certain graminicide Topic 15% WP (clodinafop propargyl), Eferst 70% WG (flucarbazone sodium), both used at full rate, alone, and in sequence at reduced rate with mineral oil 1%, Experiment No.2 studied controlling broad leaved weeds herbicides Garenary 75% WG (tribenuron-methyl), Brominal 24 % EC (bromoxynil-octanoate), both used at full rate, alone, and in sequence at reduced rate with mineral oil 1% and Experiment 3: studied controlling grassy and broad-leaved weeds used herbicides Otheilo OD 5.25% OD (diflufenican 5%+ iodosulfuron methyl sodium 0.25+ Mesosulfuron methyl 0.75%) a ready formulated at full rate, alone, and the sequential application (Topic, Eferst, Garenary and Brominal) at reduced rates with mineral oil. All experiments included hand weeding at 20 and 40 days after sowing and weedy check. Each experiment was laid out in a Randomized Complete Blocks Design with four replicates. Results of Exp.No.1 indicated that the sequential application of herbicides at reduced rate Eferest (10 g/fed.) followed by Topik (70 g/fed.) both with mineral oil (1%), gave more efficiency weed control than that obtained by each alone, whereas, the fresh weight of grassy weeds were (23.3 and 33.5 g/m^2) and grain yield (22.88 and 23.70 ardab/fed.) in the 1st and the 2nd seasons, respectively. Exp.2: Results showed that the sequential application of Gerenary (4 g/fed.) followed by brominal (500 cm^3/fed.), both at reduced rate plus mineral oil at 1%, better decreasing fresh weight of broadleaved weeds by (29.0 and 34.0 g/m^2) as compared to other treatments with while, increasing on wheat yield (23.45 and 24.12 ardab/fed.) in both seasons, respectively. Results of Exp.No.3: showed that the maximum weed control efficiency was achieved with sequential application of Gernary in combination with Topik both at reduced rates with mineral oils (1%), whereas, gave decreasing total weeds fresh weight by (55.75 and 48.0 g/m^2) compared to the other treatments, similar trend was observed in grain yield of wheat and its components. Therefore, it could be concluded from this study that, to avoid the appearance of the development herbicide-resistant weeds should be chosen various herbicides with different site of action in sequence application at reduced rates with adjuvants (mineral oil) to achieve efficiency of weed control without loosing in wheat yield and its components.

***Key words**: Wheat, Triticum aestivum L., Sequential Herbicide, Adjuvants, Hand weeding, Weed control efficiency.*

1. INTRODUCTION

Wheat (*Triticum aestivum* L.) is the most important cereal crop in the world, as well as in Egypt since it is the stable food for humans. The total consumption of wheat is about 16 million tons, while the total wheat production is about 8.35 million tons (Agricultural Statistic 2018). Therefore, there is a gap between the consumption and the local wheat production, which means that Egypt still imports about 7.65 million tons annually. So, it is extremely important to search for the best cultural practices to increase wheat production, such as sowing methods, fertilization, weed control…etc.

Weed control is one of the essential cultural practices for raising wheat yield and improving its quality. Several techniques (e.g. mechanical and chemicals) are used for weed control. Mechanical methods, such as hand weeding require enormous labour and time input. Nowadays, the chemical method provide an effective strategy for weed control. Herbicides helped farmers to increase yield while reducing labour. Clodinafop-propargyl and tribenuron-methyl are post-emergence herbicides that are used for the selective control of grasses and broad-leaved weeds in wheat fields (Baghestani *et al.*, 2008 and Akbar *et al.*, 2009).

Individual herbicide application through crop growth season is not effective, because it serves a narrow spectrum of weed control.

Herbicide tolerance can occur because of repeated application the same herbicide or herbicides with the same site of action at the same area every year. Whereas, (Beckie, 2006; Norsworthy *et al*., 2012 and Abbas *et al*., 2018) indicated that the repeated use of herbicides with the same mode of action (MOA) is the largest contributing factor in the fast evolution of herbicide resistance.

Therefore, chemical weed control for controlling the same target of weeds, the herbicides having different site of action should be used on sequential application at reduced rates to provide efficienct weed control (Iqbal *et al*., 2009; Jabran *et al*., 2010 and Shah *et al.*, 2013). Also, Woodyard *et al.* (2009) and Abbas *et al*. (2018) found that the combined effect of herbicides in sequential use is greater than the individual effect of each herbicide. Also, the sequential application will reduce the phytotoxic effect, which is the major constraint in using herbicide mixtures at recommended dose.

Researchers reported that successful weed control often depends on the appropriate use of adjuvants with herbicide because the adjuvant leads to improve the efficiency of herbicides at reduced rates, consequently, increasing crop productivity compared with the recommended rate alone (Soliman *et al*., 2011).

Therefore, this work was designed to study the management of herbicide – resistant weeds by using the sequential herbicides with different sites of action applied at reduced rates. Moreover , to study the activity of the previous sequential herbicides when used at reduced rates with mineral oil at 1 % in an attempt to produce a better weed control without affecting the yield and yield components of wheat.

2. MATERIALS AND METHODS

Three field experiments were conducted during 2017/2018 and 2018/2019 on winter seasons at Sids Agricultural Research Station, Bani Swif Governorate, Agricultural Research Center (A.R.C), Egypt, to study the effect of the sequential herbicides applied at reduced rates with different sites of action (SOA's) mixture with mineral oil on productivity, quality of wheat and associated weeds. Each field experiment including the following treatments:

2.1.1. Experiment 1 (controlling grassy weeds)

1. Clodinafop prorargyl commercially known as "Topic 15% WP" applied at the recommended rate (full rate) (21 g a.i./fed.) alone as post-emergence applied at 3-5 leaf stage wheat.
2. Flucarbazona sodium commercially known as "Eferest, 70% WG" applied at the recommended rate (14 g *a.i.* /fed.) alone as post-emergence applied at 2-4 leaf stage of wheat.
3. Flucarbazona sodium at reduced rate 50% from full rate (7 g a.i./fed.) + Mineral oil at 1% followed by Clodinafop prorargyl applied at reduced rate 50% from full rate (10.5 g *a.i.* /fed) + Mineral oil at 1 %.
4. Hand weeding twice at 20 and 40 days after sowing (DAS).
5. Unweeded check (Control).

2.1.2. Experiment 2 (controlling broad-leaved weeds)

1. Tribenuron methyl commercially known as "Gernary 75 %WG", applied at the recommended rate (6 g *a.i.*/fed.) alone as post-emergence applied at 2-4 leaf stage of wheat.
2. Bromoxynil-octanoate commercially known as "Brominal 24 %EC" applied at the recommended rate (240 g *a.i./*fed.) alone as post-emergence applied at 3-5 leaf stage of wheat.
3. Tribenuron methyl at reduced rate (3 g a.i. /fed.) + Mineral oil at 1%, followed by Bromoxynil-octanoate applied at reduced rate (120 g *a.i.* /fed) + Mineral oil at 1 %.
4. Hand weeding twice at 20 and 40 days after sowing (DAS).
5. Unweeded check (Control).

2.1.3. Experiment 3 (controlling total weeds)

1. "Othilo OD 6% OD "Ready formulated (Diflufenican 5% + lodosulfuron methyl sodium 0.25% + Mesosulfuron methyl 0.75%) applied at the recommended rate

(30cm^3 g *a.i.*/fed.) alone as post-emergence applied at 2-4 leaf stage of wheat.

2. Tribenuron methyl at reduced rate 25% from full rate (4.5 g *a.i.* /fed.) + Mineral oil at 1% followed by Clodinafop prorargyl applied at reduced rate 25% from full rate (15.8 g *a.i.* /fed) + mineral oil at 1 %.

3. Bromoxynil-octanoate at reduced rate (180 g *a.i.* /fed.) + mineral oil at 1%, followed by Clodinafop prorargyl applied at reduced rate (15.8 g *a.i.*. /fed.) + mineral oil at 1 %.

4. Tribenuron methyl at reduced rate (4.5 g *a.i.* /fed.) + mineral oil at 1% followed by Flucarbazona sodium applied at reduced rate (10.5 g *a.i.* /fed) + mineral oil at 1 %.

5. Bromoxynil-octanoate at reduced rate (180 g *a.i.* /fed.) + mineral oil at 1%, followed by Flucarbazona sodium applied at reduced rate (10.5 g *a.i.* /fed.) + mineral oil at 1 %.

6. Hand weeding twice at 20 and 40 days after sowing (DAS).

7. Unweeded check (Control).

All herbicides treatments were sprayed by knapsack sprayer CP3 in water volume 200 L/fed.

In all experiments 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 Sids12 was sown by drill sowing method on the third week of November in each season. All agricultural practices (i. e. fertilizer, irrigation, and pest and diseases control) were carried out according to the local recommendations. Harvest was at the second week of May in both seasons. The soil texture of the experiments was clay loam in both seasons.

The following Table explains, Trade, common and chemical names, family group and site of action of the herbicides according to the pesticides manual (2012) and number of group according to (WSSA) classification:

Trade name	Common name	Chemical name	Family group	Site of Action	WSSA Group
Topic 15% WP	Clodinafop prorargyl	prop-2-ynyl (R)-2-[4-(5-chloro-3-fluoropyridin-2-yloxy)phenoxy]propionate	Aryloxyphenoxypropionate	Inh. (ACCase) enzyme	(1)
Eferest 70% WG	Flucarbazona sodium	4,5-dihydro-3-methoxy-4-methyl-5-oxo-*N*-(2-trifluoromethoxyphenylsulfonyl)-1*H*-1,2,4-triazole-1-carboxamide sodium salt	sulfonylaminocarbonyltriazolinone	Inh. (ALS/ AHAS) synth.	(2)
Gernary 75 % WG	Tribenuron methyl	methyl 2-[4-methoxy-6-methyl-1,3,5-triazin-2-yl(methyl)carbamoylsulfamoyl] benzoate	Sulfonylurea	Inh. (ALS/ AHAS) synth.	(2)
Brominal 24 % EC	bromoxynil-octanoate	3,5-dibromo-4-hydroxybenzonitrile	Hydroxybenzonitrile	Inh. Photosystem II	(6)
Othilo OD 6% OD	Diflufenican 5%	2′,4′-difluoro-2-(α,α,α-trifluoro-*m*-tolyloxy)nicotinanilide	Pyridinecarboxamide + sulfonylurea	Inh.carotenoid biosynthesis	(12)+
	lodosulfuron methyl sodium 0.25%	methyl 4-iodo-2-(4-methoxy-6-methyl-1,3,5-triazin-2-ylcarbamosulfamoyl)benzoate, sodium salt		Inh. (ALS/ AHAS) synth.	(2) +
	Mesosulfuron methyl 0.75%	methyl 2-[(4,6-dimethoxypyrimidin-2-ylcarbamoyl)sulfamoyl]-α-(methanesulfonamido)-*p*-toluate			(2)
Super royal oil 95% EC	Aliphatic hydro carbons		Mineral oil		

2.2. The following data were recorded

2.2.1. Weed

Weeds were hand pulled from one square meter chosen at random from each plot after 60 days from sowing and identified according to Tackholm (1974). The fresh weights of annual broad-leaved, grassy and total annual weeds were estimated (g\m^2).

2.2.2. Yield and its Components

At harvest, samples of ten plans were taken at random collected from each plot to estimate; number of spikes/m^2, spike length (cm), number of grains/spike, weight of grain /spike (g) and 1000-grain weight (g). The straw yield (ton/fed) and Grain yield in each plot was taken and calculated (ardab/fed.); (one ardab = 150 kg).

2.2.3. Grain quality: Protein percentage

Protein determination was carried out by the improved Kjeldhal method of **A.O.A.C (2000).** modified by distilling the ammonia into saturated boric solution and titration was carried out by using standard acid (hydrochloric acid). Protein percentage was calculated by multiplying the total nitrogen in wheat meal × 5.7.

2.3. Statistical analysis

All data obtained were statistically analyzed according to procedures outlined by Gomez and Gomez (1984). Duncan's (1955) multiple range tests were used for the comparison among means. Weed fresh weight were square root transformed (√ x+0.5) prior to analysis to correct for normal distribution. Data Tables are reported as original and transformed data.

3. RESULTS AND DISCUSSION

3.1. Experiment 1(controlling grassy weeds)

3.1.1. Effect of Weed Control Treatments on:

3.1.1.1. Weeds

During both wheat growing seasons, the dominant grassy weed species were *Avena fatua* L. and *Phalaris minor* L..

It is clear from the data recorded in Table (1) that the sequence application of Eferst followed by Topic both at reduced rate (10 and 70 g/fed., respectively) plus mineral oils at 1 % showed better control of annual grassy weeds fresh weight (23.3 and 33.5 g/m^2), as compared with the recommended rates alone in both seasons, respectively. Moreover, topic at the recommended rate alone (140 g/fed.) was higher than both the hand weeding twice and Eferst at the recommended rate (20 g/fed.).

Results indicate that mineral oils promoted and facilitated foliar penetration to enhance selectivity of Eferst and Topic. Thus, it was possible to reduce the rate of Eferst to 10 g/fed. and Topic to 70 g/fed., without loosing any significant efficacy in controlling the annual grasses, as compared to the recommended rate alone. In this respect, Rashed-Mohhasel *et al.* (2009) reported that when Adigor® and Propel™ as adjuvants were tank mixed with the tested herbicides, particularly clodinafop-propargyl, the herbicidal had improved efficacy on wild oat. Also, Hammami *et al*. (2014) 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. The high effectiveness of the sequence application of herbicides Topic and Eferst against annual grass weeds could be attributed to the high susceptibility of grasses to the herbicidal activity. Whereas, Topic inhibits fatty acid synthesis, used in building new membranes required for cell growth. While, Eferst is inhibiting biosynthesis of protein, hence

Table (1): Efficiency of herbicides alone, and sequential application plus mineral oil on fresh weight of annual grassy (g/m^2) at 60 DAS in two seasons.

Treatments		Grassy weeds (g/m^2)			
		2017/18		2018/19	
Trade N. (rate/fed.)	**Common N. (g *a.i.* /fed.)**	**O***	**T***	**O***	**T***
Topic 140 g	Clod.-prop. 21	49.5	7.5 **cd**	59.0	8.1 **d**
Eferest 20 g	Flu. sodium 14	212.8	15.0 **b**	233.5	15.8 **b**
Eferest 10 g (50% reduced rate) + Min. at 1% *foll.*** by Topik 70 g (50% reduced rate) + Min. at 1%	Flu. 7 + Min. 1 L *foll.* by Clod. 10.5+ Min. 1 L	23.3	5.10 **d**	33.5	5.80 **e**
Hand weeding twice at 20 and 40 DAS		95.8	9.8 **c**	137.5	12.0 **c**
Untreated check.		568.3	23.5 **a**	749	27.8 **a**

O*= Original data and T*=Transformed data. ** *foll.*= followed

Any two means in the same column sharing same letters did not differ significantly by Duncan at 5% level of probability.

stopping cell division and plant growth (WSSA, 1982). In addition, adding adjuvant to herbicides had capacity to give enhancing herbicidal effect as reflected by higher reduction in weed growth. The same conclusion was mentioned by (Campagna *et al*., 2008; Frabboni and Russo, 2008; Pourazar and Baghestani, 2010 and Tagour *et al*., 2011). Also, Wrubel and Gressel (1994) and Powles *et al*. (1997) indicated that the sequence application of herbicides should use herbicides with different SOA's against the same target weeds.

3.1.1.2. Wheat yield and its components

Data in Tables (2 and 5) showed wheat yield and its components as affected by different weed control treatments. The sequence of Eferst at 10 g/fed. and Topic 70 g /fed; both at (reduced rate) tank mixed with mineral oil gave increasing grain yield, as compared to other treatments. This treatment provides the highest grain yield per faddan by (22.88 and 23.7 ardab/fed.) in both seasons, respectively. 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 and accumulates the photosynthesis products in grains. For controlling the same target, weeds use Eferst and Topic at reduces dose (10 and 70 g/fed., respectively) + mineral oil in sequence gave the highest straw yield than Eferst at the recommended rate. In contrast, the lowest straw yield/fed was obtained from Eferst at the recommended rate alone in both seasons, respectively. Similar findings were reported by Pourazar and Baghestani (2010), Zhu *et al*. (2010) and Haile and Girma (2010) who indicated that Topik herbicide gave high grain yield with the highest stability in wheat. However, Knezevic *et al*. (2010) indicated that application of herbicides with adjuvants caused the increase of yield in comparison with plots treated with herbicide alone.

The sequential treatment Eferst and Topic at reduced dose (10 and 70 g/fed., respectively) + mineral oil gave the longest spike length, the highest increase number of spike/m^2, number of grains/spike, grain weight/spike and 1000 grains weight in both seasons compared with the recommended rate alone and hand weeding twice in both seasons. While, Topic at the recommended rate ranked second treatment. Otherwise, the lowest spike length, number of spike/m^2, number of grains/spike, grain weight/spike, 1000 grains weight, grain and straw yield were obtained with Eferest at the recommended rate.

3.1.1.3.Protein Percentage

It is clear from the data in Table (4) that the highest value of crude protein of grain percentage was obtained by sequential application of Eferst followed by Topic at reduced rate 50% with mineral oil at 1% and topic at the recommended rate alone by (13.52 - 13.45% and 13.75 – 13.13% in both seasons, respectively). On the other side, the lowest values of crude protein of grain were obtained by Eferst at the recommended rate alone in both seasons.

3.2. Experiment 2 (controlling broad-leaved weeds)

3.2.1. Effect of Weed Control Treatments on

3.2.1.1. Weeds

During both growing seasons of wheat, the major dominant broadleaved weeds were: *Brassica nigra* L., *Beta vulgaris* L., *Sonchus oleraceus* L., *Medicago polymorpha* L., *Anagallis arvensis*, *Ammi majus* and *Rumex dentatus* L

The results presented in Table (6) showed that, the sequential application both Gernary followed by Brominal at a reduced rate (4 g and 500 cm^3/fed., respectively) with mineral oils at 1% increased the activity against broad-leaved weeds. Whereas, the fresh weight of broad leaved weeds (29.0 and 34.0 g/m^2) in the first and the second seasons, respectively. Brominal at the recommended rate caused a reduction in the fresh weight of broad-leaved weeds; this reduction was significantly equal to that obtained from hand weeding twice. Brominal at full rate and hand weeding twice were less effective than that obtained by sequential application treatments in controlling broad-leaved weeds. While, the herbicide Gernary at the recommended rate alone ranked second order after the sequential application. The effectiveness of the sequence application of herbicides Gernary and Brominal against annual broad leaved weeds could be attributed to the high susceptibility of weeds to the herbicidal activity, whereas, Gernary inhibition activity of the enzyme acetolactate synthase (ALS), consequently, block protein biosynthesis and subsequent growth processes in weeds. While, Brominal inhibiton photosynthetic electron transport at the photosystem II (WSSA, 1982). Also, adjuvants improve the herbicide’s efficacy

Table (2): Efficiency of herbicides alone and sequential application plus mineral oil on spike length (cm) and the Number of spikes/m^2 on two successive seasons.

Treatments		Spike length (cm)		No. of spikes/m^2	
Trade N. (rate/fed.)	**Common N. (g *a.i.* /fed.)**	**2017/18**	**2018/19**	**2017/18**	**2018/19**
Topic 140 g	Clod.-prop. 21	10.85 **b**	11.91 **b**	461.5 **a**	465 **a**
Eferest 20 g	Flu. sodium 14	8.10 **c**	8.70 **b**	395 **b**	382.5 **b**
Eferest 10 g (50% reduced rate) + Min. at 1% *foll.*** by Topik 70 g (50% reduced rate) + Min. at 1%	Flu. 7 + Min. 1 L *foll.* by Clod. 10.5+ Min. 1 L	12.65 **a**	13.70 **a**	473.5 **a**	472 **a**
Hand weeding twice at 20 and 40 DAS		9.93 **b**	10.96 **b**	446.3 **a**	450 **a**
Untreated check.		7.80 **c**	7.96 **c**	376.3 **b**	380 **b**

* Means followed by the same letters are not statistically different at 5% level.

Table (3): Efficiency of herbicides alone and sequential application plus mineral oil on the number of grain/spike and weight of grain/spike on two successive seasons.

Treatments		No. of grain/spike		Grain weight/Spike	
Trade N. (rate/fed.)	**Common N. (g *a.i.* /fed.)**	**2017/18**	**2018/19**	**2017/18**	**2018/19**
Topic 140 g	Clod.-prop. 21	56 **ab**	58.7 **ab**	3.546 **a**	3.754 **a**
Eferest 20 g	Flu. sodium 14	51 **b**	56.2 **b**	2.900 **b**	3.591 **b**
Eferest 10 g (50% reduced rate) + Min. at 1% *foll.*** by Topik 70 g (50% reduced rate) + Min. at 1%	Flu. 7 + Min. 1 L *foll.* by Clod. 10.5+ Min. 1 L	59 **a**	60.4 **a**	3.696 **a**	3.813 **a**
Hand weeding twice at 20 and 40 DAS		52.5 **ab**	55.5 **b**	3.172 **b**	3.492 **b**
Untreated check.		39.5 **c**	40.1 **c**	2.383 **c**	2.857 **c**

* Means followed by the same letters are not statistically different at 5% level.

Table (4): Efficiency of herbicides alone and sequential application plus mineral oil on 1000 grains weight (g) and crud protein% on two successive seasons.

Treatments		1000 grains weight (g)		Crude protein%	
Trade N. (rate/fed.)	**Common N. (g *a.i.* /fed.)**	**2017/18**	**2018/19**	**2017/18**	**2018/19**
Topic 140 g	Clod.-prop. 21	59.40 **a**	60.35 **a**	13.45 **a**	13.13 **a**
Eferest 20 g	Flu. sodium 14	51.20 **b**	56.51 **b**	10.41 **c**	11.80 **b**
Eferest 10 g (50% reduced rate) + Min. at 1% *foll.*** by Topik 70 g (50% reduced rate) + Min. at 1%	Flu. 7 + Min. 1 L *foll.* by Clod. 10.5+ Min. 1 L	62.51 **a**	65.34 **a**	13.52 **a**	13.75 **a**
Hand weeding twice at 20 and 40 DAS		58.28 a	59.11 **a**	12.14 **ab**	12.43 **ab**
Untreated check.		41.93 **c**	45.81 **c**	8.35 **d**	8.46 **c**

* Means followed by the same letters are not statistically different at 5% level.

Table (5): Efficiency of herbicides alone and sequential application plus mineral oil on grain yield (ardab/fed) and straw yield (ton)/fed. on two successive seasons.

Treatments		Grain yield (ardab/fed)		Straw yield (Ton/fed)	
Trade N. (rate/fed.)	**Common N. (g *a.i.* /fed.)**	**2017/18**	**2018/19**	**2017/18**	**2018/19**
Topic 140 g	Clod.-prop. 21	19.95 **b**	21.36 **b**	4.89 a	4.44 **ab**
Eferest 20 g	Flu. sodium 14	14.53 **c**	15.64 **c**	2.71 b	3.21**b**
Eferest 10 g (50% reduced rate) + Min. at 1% *foll*.** by Topik 70 g (50% reduced rate) + Min. at 1%	Flu. 7 + Min. 1 L *foll*. by Clod. 10.5+ Min. 1 L	22.88 **a**	23.70 **a**	4.94 **a**	4.88 **a**
Hand weeding twice at 20 and 40 DAS		19.38 **b**	19.98 **b**	3.81 **ab**	4.06 **ab**
Untreated check.		9.96 **d**	7.57 **d**	2.01 **c**	2.49 **c**

* Means followed by the same letters are not statistically different at 5% level**.**

Table (6): Efficiency of herbicides alone and sequential application plus mineral oil on the fresh weight of annual broad-leaved (g/m^2) at 60 DAS in two seasons.

Treatments		Broad-Leaved weeds (g/m^2)			
		2017/2018		2018/2019	
Trade N. (rate/fed.)	**Common N. (g *a.i.* /fed.)**	**O***	**T***	**O***	**T***
Gernary 8 g	Trib.-methyl 6	52.5	7.5 **bc**	62.5	8.3 **bc**
Brominal 1 l	Brom. 240 cm^3	100.3	10.04 **b**	95.0	10.0 **b**
Gernary 4 g (50% reduced rate) + Min. at 1% *foll*.** by Brominal 500 cm^3 (50% reduced rate) + Min. at 1%	Trib. 3 + Min. 1 L *foll* by Brom. 120 cm^3+ Min. 1 L	29.0	5.5 **c**	34.0	6.2 **c**
Hand weeding twice at 20 and 40 DAS		117.5	10.8 **b**	102.5	10.6 **b**
Untreated check.		1280.0	36.0 **a**	1120.0	33.8 **a**

O*= Original data and T*=Transformed data. *foll*.** = followed.
Any two means in the same column sharing same letters did not differ significantly by Duncan at 5% level of probability.

(Costa *et al*., 2005) so that the concentration or the total amount of herbicide required to achieve agiven effect is reduced (Nadeem *et al*., 2008). Mineral oil as adjuvant, allows increased herbicide penetration (Green, 2001). Shaban *et al*. (2015) indicated that the addition of adjuvants at 1% of spraying volume could replace 25% of Brominal without losing any significant activity on the control of weeds or yield. The recommended (full) rates of Brominal, at 240 g *a.i.*/fed. alone showed statistically similar results as reducing rate of these herbicide at 180 g *a.i.* /fed. plus adjuvants at 1% with respect to reducing dry weight of weeds and increasing yield of wheat and its components.

3.2.1.2. Yield and yield attributes of wheat

Results in Tables (7 to 10) indicated that the sequential both Gernary followed by Brominal at reduced rate tank-mixed with mineral oil gave the highest values of grain yield /fed. The increments in grain yield/fed. were amounted by (23.45 and 24.12 ardab/fed.) in the first and in the second seasons, respectively. Mainly, due to the higher weed control efficiency both Gernary followed by Brominal at reduced rates with adjuvant attributed to the competition ability of weeds was poor which gave a competitive advantage to the wheat plants in utilizing the necessary demands of nutrients and water, leading to increasing the wheat growth resulted in the higher grain and straw yield as well as the yield components. The results of the present investigation are in harmony with those

Table (7): Efficiency of herbicides alone and sequential application plus mineral oil on spike length (cm) and the Number of spikes/m^2 on two successive seasons.

Treatments		Spike length (cm)		No. of spikes/m^2	
Trade N. (rate/fed.)	**Common N. (g *a.i.* /fed.)**	**2017/18**	**2018/19**	**2017/18**	**2018/19**
Gernary 8 g	Trib.-methyl 6	10.53 **ab**	11.60 **ab**	475 **a**	480 **a**
Brominal 1 l	Brom. 240 cm^3	8.13 **ab**	8.25 **ab**	470 **a**	470 **a**
Gernary 4 g (50% reduced rate) + Min. at 1% *foll.*** by Brominal 500 cm^3 (50% reduced rate) + Min. at 1%	Trib. 3 + Min. 1 L *foll* by Brom. 120 cm^3+ Min. 1 L	13.80 **a**	14.85 **a**	480 **a**	490 **a**
Hand weeding twice at 20 and 40 DAS		9.05 **b**	9.16 **b**	460.5 **a**	450 **a**
Untreated check.		7.85 **c**	8.00 **c**	369.3 **b**	371 **b**

* Means followed by the same letters are not statistically different at 5% level.

Table (8): Efficiency of herbicides alone and sequential application plus mineral oil on the number of grain/spike and weight of grain/spike on two successive seasons.

Treatments		Grain/spike (No.)		Grain weight/ Spike (g)	
Trade N. (rate/fed.)	**Common N. (g *a.i.* /fed.)**	**2017/18**	**2018/19**	**2017/18**	**2018/19**
Gernary 8 g	Trib.-methyl 6	59.8 **a**	62.8 **a**	3.797 **a**	3.915 **a**
Brominal 1 l	Brom. 240 cm^3	58.5 **a**	60.7 **a**	3.545 **b**	3.852 **b**
Gernary 4 g (50% reduced rate) + Min. at 1% *foll.*** by Brominal 500 cm^3 (50% reduced rate) + Min. at 1%	Trib. 3 + Min. 1 L *foll* by Brom. 120 cm^3+ Min. 1 L	61.3 **a**	64.5 **a**	3.835 **a**	3.992 **a**
Hand weeding twice at 20 and 40 DAS		55.3 **a**	57.2 **a**	3.192 **c**	3.669 **c**
Untreated check.		40.5 **b**	42.3 **b**	2.499 **d**	2.789 **d**

* Means followed by the same letters are not statistically different at 5% level.

Table (9): Efficiency of herbicides alone and sequential application plus mineral oil on 1000 grains weight (g) and crude protein% on two successive seasons.

Treatments		1000 grains weight (g)		Crude protein%	
Trade N. (rate/fed.)	**Common N. (g *a.i.* /fed.)**	**2017/18**	**2018/19**	**2017/18**	**2018/19**
Gernary 8 g	Trib.-methyl 6	63.45 **ab**	65.51 **ab**	12.50 **a**	13.00 **a**
Brominal 1 l	Brom. 240 cm^3	61.75 **bc**	63.80 **bc**	10.66 **b**	11.20 **c**
Gernary 4 g (50% reduced rate) + Min. at 1% *foll.*** by Brominal 500 cm^3 (50% reduced rate) + Min. at 1%	Trib. 3 + Min. 1 L *foll* by Brom. 120 cm^3+ Min. 1 L	66.80 **a**	67.61 **a**	13.22 **a**	13.88 **a**
Hand weeding twice at 20 and 40 DAS		57.94 **c**	59.21 **c**	11.88 **ab**	11.45 **b**
Untreated check.		42.87 **d**	43.36 **d**	8.22 **c**	8.54 **d**

* Means followed by the same letters are not statistically different at 5% level.

Table (10): Efficiency of herbicides alone and sequential application plus mineral oil on grain yield/fed. and straw yield/fed. on two successive seasons.

Treatments		Grain yield (ardab/fed)		Straw yield (ton/fed)	
Trade N. (rate/fed.)	**Common N. (g *a.i.* /fed.)**	**2017/18**	**2018/19**	**2017/18**	**2018/19**
Gernary 8 g	Trib.-methyl 6	22.23 **b**	23.74 **ab**	3.98 **ab**	4.05 **a**
Brominal 1 l	Brom. 240 cm^3	21.81 **bc**	22.71 **b**	3.90 **b**	3.49 **b**
Gernary 4 g (50% reduced rate) + Min. at 1% *foll.*** by Brominal 500 cm^3 (50% reduced rate) + Min. at 1%	Trib. 3 + Min. 1 L *foll* by Brom. 120 cm^3+ Min. 1 L	23.45 **a**	24.12 **a**	4.00 **a**	4.41 **a**
Hand weeding twice at 20 and 40 DAS		19.84 **c**	20.98 **c**	3.85 **b**	3.54 **b**
Untreated check.		10.04 **d**	11.08 **d**	2.61 **c**	2.02 **c**

* Means followed by the same letters are not statistically different at 5% level.

obtained by Shaban *et al*. (2015) as reducing the rate of brominal at 180 g *a.i.* /fed. plus adjuvants (mineral or vegetable oils) at 1% with increasing yield of wheat and its components compared to unweeded control.

3.2.1.3. Protein Percentage

It is clear from the data in Table (9) that the highest value of crude protein of grain percentage was obtained with the sequential application of Gernary followed by Brominal at reduced rate (50% from full rate) with mineral at 1% and Grenary at the recommended rate alone by (13.22 and 12.50 % and 13.88 – 13.00%) in both seasons, respectively.

3.3. Experiment 3 (controlling total annual weeds)

3.3.1. Effect of Weed Control Treatments on Total Fresh Weight (g/m^2)

During both wheat growing seasons, the dominant grassy weed species were *Avena fatua* L. and *Phalaris minor* L., while the major broadleaved weeds were: *Brassica nigra* L., *Beta vulgaris* L., *Sonchus oleraceus* L., *Medicago polymorpha* L., *Anagallis arvensis, Ammi majus* and *Rumex dentatus* L **.**

Table (11) shows the effect of various chemical treatments and hand weeding twice on the control of the total annual weeds present at the site of application in comparison with the untreated treatment. Applying Gernary for controlling broad-leaved weeds at the reduced rate 25% (6 g/fed.) plus mineral oil at 1%; in sequence with Topic for controlling grassy weeds at reduced rate 25% (105 g/fed.) plus mineral oil at 1%, gave excellent results in control of the total annual weeds and higher than Othelo OD at the recommended rate reducing total weeds fresh weight by (55.75 – 79.75 and 48.0 – 96.0 g/m^2). Whereas, the sequential application Gareney at reduced rate 25% (6 g/fed.) + Min. at 1% followed by Eferst at reduced rate 25% (15 g/fed.)+ Min. at 1% ranked second on the controlling effect by (121.8 and 140.3 g/m^2) in both seasons, respectively. The rest, sequential application treatments plus mineral oil, gave good results on control total annual weeds ranged from (137.25 to 213.25 and 161.0 to 232.8 g/m^2) two successive seasons, respectively.

Therefore, the data obtained from this study cleared that to achieve successfully weed control, the herbicides should have different mechanisms of action, and used in sequential application at reduced rates mixed with (mineral oil) and to enhance the efficacy of weed control. In this respect, Woodyard *et al.*, (2009) found that such types of sequence may be used at lower doses than the full rate of each herbicide to

Table (11): Efficiency of sequential herbicides plus mineral oil on the total fresh weight weeds (g/m^2) at 60 DAS in two seasons.

Treatments		Total weeds (g/m^2)			
		2017/2018		2018/2019	
Trade N. (rate/fed.)	**Common N. (g *a.i.* /fed.)**	**O***	**T***	**O***	**T***
Othilo OD 500 cm^3	(Diflu.+ lodo.. + Mes.) 30 cm^3	79.75	9.37 **de**	96.0	9.69 **cd**
Granary 6 g (25% reduced rate) + Min. at 1% *foll*.** by Topic 105 g (25% reduced rate) + Min. at 1%	Trib. 4.5 + Min. 1 L *foll*. by Clod. 15.8 + Min. 1 L	55.75	7.89 **e**	48.0	7.35 **d**
Brominal 750 cm^3 + Min. at 1% *foll*. by Topic 105 g + Min. at 1%	Brom. 180 cm^3 + Min. 1 L *foll*. by Clod. 15.8.+ Min. 1 L	137.25	12.02 **bcd**	161.0	13.12 **bc**
Granary 6 g + Min. at 1% *foll*. by Eferest 15 g + Min. at 1%	Trib. 4.5 + Min. 1 L *foll*. by Flu. 10.5g + Min. 1 L	121.8	11.44 **cd**	140.3	12.33 **bc**
Brominal 750 cm^3+ Min. at 1% *foll*. by Eferest 15 g + Min. at 1%	Brom. 180 cm^3 + Min. 1 L *foll*. by Flu. 10.5g + Min. 1 L	155.75	12.85 **bc**	187.0	14.14 **b**
Hand weeding twice at 20 and 40 DAS		213.25	15.05 **b**	232.8	15.68 **b**
Untreated check.		2024.3	45.39 **a**	1769	42.33 **a**

O*= Original data and T*=Transformed data. *foll*.**=followed by.

Any two means in the same column sharing same letters did not differ significantly by Duncan at 5% level of probability.

achieve effective weed control avoiding the appearance of weed tolerance to herbicide. Also, there results are in harmony with El-Metwally *et al.*(2007) and Akbar *et al.* (2013). Also, Knezevic *et al*. (2009) showed that herbicides used in sequence applications at reduced rate with mineral oil increase weed control compared with a single herbicide. Abbas, *et al*. (2018) showed that two herbicides applications at reduced rate with adjuvant, increase weed control compared with a single herbicide.

3.3.2. Yield and yield attributes of wheat

Data in Tables (12 to 15) showed that the sequential herbicides Gernary for controlling broad-leaved weeds at the reduced rate 25% (6 g/fed.) plus mineral oil at 1%; followed by Topic for controlling grassy weeds at reduced rate 25% (105 g/fed.) plus mineral oil at 1%, gave the best treatments in both seasons, respectively. It is evident that this treatment increased grains yield/fed. by about 23.53 – 24.05 ardab/fed. in both seasons, respectively. These increases might be mainly due to the higher weed control efficiency (Table 11), and also to their positive effects in raising grain yield per feddan and its related components (spike length, number of spike/m^2, number of grains/spike, grain weight/spike and 1000 grains weight (Tables12 to 15) leading to the higher grain yield/fed. Similar finding was reported by Hefny, *et al*. (2015). They found that the application of Granstar 75% DF + Topik 15% WP mixture increased spike length, number of spikes/m^2, number of spikelet's/spike, 1000-grain weight, grain yield/fed. and biological yield/fed.. While, the lowest grain yield was obtained from the control treatment as a resultant of the competition between wheat and weed plants for the essential environmental resources, *i.e.*, light, water and nutrients. These results are in harmony with those obtained by Shaban *et al*. (2009) who indicated that the reduction in wheat yield due to the total annual weeds was 46.8 and 46.4% in 2006/07 and 2007/08 seasons, respectively. Also, Kazemi and Shimi, (2005); Bijanzadeh *et al*. (2010); Hossein, *et al*. (2011); Rao *et al*. (2014); Yaduraju *et al*. (2015) and Kulasekaran *et al*. (2017) found low productivity of wheat by weeds of 10 - 60%.

3.3.3. Protein Percentage: As shown in Table (14) all weed control treatments had significant effect on crud protein percentage of wheat grain in both seasons. The highest values of crude protein of grain percentage were obtained by the sequential application (Gernary followed by Topic) at reduced rate 25% with mineral oil at 1% by (14.01 – 15.52 %) compared with other treatments in both seasons, respectively. On the contrary, the lowest values of crude protein of grains were obtained in the sequential application (Brominal followed by Everest) at reduced rate 25% with mineral oil at 1% (10.66 – 10.11%) in both seasons, respectively.

Table (12): Efficiency of herbicides alone and sequential application plus mineral oil on spike length and Number of spikes/m^2 on two successive seasons.

Treatments		Spike length (cm)		Spikes/m^2 (No.)	
Trade N.(rate/fed.)	**Common N. (g *a.i.* /fed.)**	**2017/18**	**2018/19**	**2017/18**	**2018/19**
Othilo OD 500 cm^3	(Diflu.+ lodo.. + Mes.) 30 cm^3	12.63 **ab**	12.59 **b**	483 **a**	482 **ab**
Granary 6 g (25% reduced rate) + Min. at 1% *foll.*** by Topic 105 g (25% reduced rate) + Min. at 1%	Trib. 4.5 + Min. 1 L *foll.* by Clod. 15.8 + Min. 1 L	13.95 **a**	14.89 **a**	491.5 **a**	490 **a**
Brominal 750 cm^3 + Min. at 1% *foll.* by Topic 105 g + Min. at %	Brom. 180 cm^3 + Min. 1 L *foll.* by Clod. 15.8.+ Min. 1 L	9.45 **bc**	9.64 **d**	478 **b**	466.2 **cd**
Granary 6 g + Min. at 1% *foll.* by Eferest 15 g + Min. at 1%	Trib. 4.5 + Min. 1 L *foll.* by Flu. 10.5g + Min. 1 L	12.15 **ab**	11.78 **c**	487**a**	478 **bc**
Brominal 750 cm^3+ Min. at 1% *foll.* by Eferest 15 g + Min. at 1%	Brom. 180 cm^3 + Min. 1 L *foll.* by Flu. 10.5g + Min. 1 L	9.85 **bc**	9.11**d**	469 **bc**	459 **cd**
Hand weeding twice at 20 and 40 DAS		8.10 **c**	8.95 **de**	462 **bc**	421 **d**
Untreated check.		7.55 **d**	7.61 **e**	381.5 **c**	390 **e**

* Means followed by the same letters are not statistically different at 5% level.

Table (13): Efficiency of herbicides alone and sequential application plus mineral oil on number of grain/spike and weight of grain/spike on two successive seasons.

Treatments		Grain/spike (No.)		Weight of grain/spike (g)	
Trade N. (rate/fed.)	**Common N. (g *a.i.* /fed.)**	**2017/18**	**2018/19**	**2017/18**	**2018/19**
Othilo OD 500 cm^3	(Diflu.+ lodo.. + Mes.) 30 cm^3	62.25 **abc**	64.10 **a**	4.015 **a**	4.101 **a**
Granary 6 g (25% reduced rate) + Min. at 1% *foll.*** by Topic 105 g (25% reduced rate) + Min. at 1%	Trib. 4.5 + Min. 1 L *foll*. by Clod. 15.8 + Min. 1 L	66.25 **a**	67.81 **a**	4.024 **a**	4.360 **a**
Brominal 750 cm^3 + Min. at 1% *foll*. by Topic 105 g + Min. at 1%	Brom. 180 cm^3 + Min. 1 L *foll*. by Clod. 15.8.+ Min. 1 L	58 **cd**	61.11**b**	3.811 **ab**	3.793 **ab**
Granary 6 g + Min. at 1% *foll*. by Eferest 15 g + Min. at 1%	Trib. 4.5 + Min. 1 L *foll*. by Flu. 10.5g + Min. 1 L	63.5 **ab**	62.82 **ab**	3.893 **ab**	3.901 **ab**
Brominal 750 cm^3+ Min. at 1% *foll*. by Eferest 15 g + Min. at 1%	Brom. 180 cm^3 + Min. 1 L *foll*. by Flu. 10.5g + Min. 1 L	60.5 **bc**	62.33 **ab**	3.411 **b**	3.696 **b**
Hand weeding twice at 20 and 40 DAS		54 **d**	56.33 **c**	3.325 **b**	3.490 **b**
Untreated check.		41.5 **e**	40.76 **d**	2.537 **c**	2.717 **c**

* Means followed by the same letters are not statistically different at 5% level

Table (14): Efficiency of herbicides alone and sequential application plus mineral oil on 1000 grains weight and Crude protein % on two successive seasons.

Treatments		1000 grains weight (g)		Crud protein %	
Trade N. (rate/fed.)	**Common N. (g *a.i.* /fed.)**	**2017/18**	**2018/19**	**2017/18**	**2018/19**
Othilo OD 500 cm^3	(Diflu.+ lodo. + Mes.) 30 cm^3	68.57 **b**	69.61 **a**	13.75 **b**	13.45 **b**
Granary 6 g (25% reduced rate) + Min. at 1% *foll.*** by Topic 105 g (25% reduced rate) + Min. at 1%	Trib. 4.5 + Min. 1 L *foll*. by Clod. 15.8 + Min. 1 L	73.75 **a**	70.11 **a**	14.10 **a**	15.52 **a**
Brominal 750 cm^3 + Min. at 1% *foll*. by Topic 105 g + Min. at 1%	Brom. 180 cm^3 + Min. 1 L *foll*. by Clod. 15.8.+ Min. 1 L	60.29 **d**	67.53 **b**	11.05 **bc**	11.13 **c**
Granary 6 g + Min. at 1% *foll*. by Eferest 15 g + Min. at 1%	Trib. 4.5 + Min. 1 L *foll*. by Flu. 10.5g + Min. 1 L	70.80 **a**	69.34 **ab**	12.45 **b**	12.61 **bc**
Brominal 750 cm^3+ Min. at 1% *foll*. by Eferest 15 g + Min. at 1%	Brom. 180 cm^3 + Min. 1 L *foll*. by Flu. 10.5g + Min. 1 L	64.55 **c**	62.61 **c**	10.66 **c**	10.11 **d**
Hand weeding twice at 20 and 40 DAS		58.03 **d**	59.11 **d**	11.42 **bc**	11.26 **c**
Untreated check.		45.50 **e**	47.10 **e**	8.53 **d**	8.27**d**

* Means followed by the same letters are not statistically different at 5% level

Table (15): Efficiency of herbicides alone and sequential application plus mineral oil on Grain yield/fed. and Straw yield/fed. on two successive seasons.

Treatments		Grain yield (ardab/fed)		Straw yield (ton/fed)	
Trade name (rate/fed.)	**Common N. (g *a.i.* /fed.)**	**2017/18**	**2018/19**	**2017/18**	**2018/19**
Othilo OD 500 cm^3	(Diflu.+ lodo. + Mes.) 30 cm^3	21.45 **b**	22.96 **b**	4.13 **a**	3.48 **b**
Granary 6 g (25% reduced rate) + Min. at 1% *foll*.** by Topic 105 g (25% reduced rate) + Min. at 1%	Trib. 4.5 + Min. 1 L *foll*. by Clod. 15.8 + Min. 1 L	23.53 **a**	24.05 **a**	4.31 **a**	4.20 **a**
Brominal 750 cm^3 + Min. at 1% *foll*. by Topic 105 g + Min. at 1%	Brom. 180 cm^3 + Min. 1 L *foll*. by Clod. 15.8.+ Min. 1 L	19.40 **bc**	21.06 **c**	3.97 **ab**	3.85 **a**
Granary 6 g + Min. at 1% *foll*. by Eferest 15 g + Min. at 1%	Trib. 4.5 + Min. 1 L *foll*. by Flu. 10.5g + Min. 1 L	20.83 **b**	22.58 **b**	4.51 **a**	4.11 **a**
Brominal 750 cm^3+ Min. at 1% *foll*. by Eferest 15 g + Min. at 1%	Brom. 180 cm^3 + Min. 1 L *foll*. by Flu. 10.5g + Min. 1 L	17.68 **c**	16.36 **e**	4.01 **a**	3.81 **a**
Hand weeding twice at 20 and 40 DAS		18.95 **bc**	19.75 **d**	3.87 ab	3.23 **bc**
Untreated check.		7.16 **d**	8.86 **f**	2.69 **c**	2.73 **d**

* Means followed by the same letters are not statistically different at 5% level

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ادارة استراتيجيات الحشائش المقاومة للمبيدات باستخدام مبيدات متنوعه فى تطبيقات متتالية لمكافحة الحشائش بفاعليه وآمان فى محصول القمح.

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ملخص

اقيمت ثلاثة تجارب حقلية فى موسمى 2017\2018 و2018\2019 بالمزرعة البحثية بمحطة البحوث الزراعية بسدس- محافظة بنى سويف لدراسة إدارة مقاومة الحشائش للمبيدات باستخدام مبيدات مختلفة مواقع التأثير بإضافات متتاليه بمعدلات مخفضة مع زيت معدنى، على انتاجية وجودة والحشائش المصاحبه لمحصول القمح. كانت التجربة رقم1: لدراسة مكافحة الحشائش النجيلية بمبيدات (توبيك 15%WP وافرست 70%WG حيث استخدم كلاهما بالجرعة الكامله (منفردة) وبتطبيقات متتالية بمعدلات مخفضة مع زيت معدنى 1%. جاءت التجربة رقم 2: دراسة مكافحة الحشائش عريضة الاوراق بمبيدات (جرنارى 75%WG وبرومينال 24%EC) استخدم كلاهما بالجرعة الكاملة (منفردة) وبتطبيقات متتالية بمعدلات مخفضة مع زيت معدنى 1%. اما التجربة رقم 3: كانت لدراسة مكافحة الحشائش عريضة وضيقة الاوراق باستخدام مبيد أوثيلوا أودى 5.25%OD (جاهز التصنيع) بالمعدل الكامل، والمبيدات (توبيك، افرست، جرنارى وبرومينال) حيث تطبق فى تعاقبات بمعدلات مخفضه مع 1%زيت معدنى. تضمنت كل تجربة نقاوة مرتين (20 و40 يوم من الزراعة) وبدون معامله (كنترول). استخدمت كل تجربة تصميم القطاعات كاملة العشوائيه فى اربع مكرارات. اشارت دراسه لمكافحة الحشائش النجيلية (تجربة1) تطبيق معاملة افرست (10 جم/فدان) متبوعا بالتوبيك (70 جم/فدان) حيث تم استخدام كلا منهما بمعدلات مخفضه مع زيت معدنى 1% كانت اكثر فعالية فى مكافحة الحشائش من كل المبيدين منفرداً، حيث كان الوزن الغض للحشائش النجيلية (23.3 و 33.5 جم/م^2) ومحصول الحبوب (22.88 و 23.70 اردب/فدان) فى الموسمين الاول والثانى، على التوالى. اوضحت النتائج فى (تجربه رقم 2) ان مبيد جرنارى (4 جم/فدان) متبوعا ببرومينال (500 سم^3/فدان) حيث استخدم كلاهما بمعدلات مخفضه مع زيت معدنى 1% اعطت افضل انخفاض فى الوزن الغض للحشائش عريضة الاوراق (29.0 و34.0 جم/م^2) مقارنه بالمعاملات الاخرى وبالتالي زيادة المحصول (23.45 و 24.12 اردب/فدان) فى كلا الموسمين، على التوالى. كما اوضحت النتائج فى (تجربة رقم3) ان تطبيق جرناري متبوعا بالتوبيك كلا منهما بمعدلات مخفضه مع زيت معدنى 1%حققت اكثر فعالية فى مكافحة الحشائش حيث كان انخفاض الوزن الغض للحشائش الكلية بمقدار (55.75 و84.0 جم/م^2) مقارنة بالمعاملات الاخرى، وكان نفس الاتجاه فى محصول الحبوب ومكوناته. ثبت من تلك الدراسة ان من الممكن استنتاج انه لتجنب ظهور مقاومة الحشائش للمبيدات يجب اختيار مبيدات متنوعه ذات مواقع تأثير مختلفة وتطبق فى تعاقبات بمعدلات مخفضه مع مواد مضافة (زيت معدنى) للحصول على فاعلية لمكافحة الحشائش بدون ضرر على المحصول ومكوناته.