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HERBICIDE TANK-MIXTURES EFFICIENCY ON WEEDS AND WHEAT PRODUCTIVITY

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ABSTRACT

Two field experiments were conducted at the Experimental Farm of the National Research Centre at Shalakan, Kalubia Governorate, Egypt during the 2005/2006 and 2006/2007 seasons to evaluate the response of two wheat cultivars (Gemmiza-9 and Giza-168) and associated weeds to numerous weed management treatments (metosulam, thifensulfuron, pyraflufen-ethyl, imazamethabenz, fenoxaprop, metosulam+ imazamethabenz, metosulam+fenoxaprop, thifensulfuron+ imazamethabenz, thifensulfuron+ fenoxaprop, pyraflufenethyl+imazamethabenz, pyraflufenethyl+ fenoxaprop, isoproturon, hand pulling once and weedy check. Results illustrated that all weeded treatments decreased dry weight of each weed group comparing to the unweeded one. Isoproturon came in the first order for controlling grassy and total weeds, but statistically leveled with those of metosulam+fenoxaprop and fenoxaprop alone for grassy weeds as well as metosulam+fenoxaprop, metosulam+imazamethabenz and thifensulfuron+fenoxaprop for total weeds. All herbicide mixtures resulted in synergistic interactions, where metosulam or thifensulfuron with fenoxaprop were the most synergized combinations. Dry weights of grassy, broadleaved and total weeds were lower with Gemmiza-9 cultivar than Giza-168. The highest biological, straw and grain yields were achieved with application of metosulam+fenoxaprop. Gemmiza-9 was the potent cultivar for producing the maximal values of biological and straw yields ha^{-1}, while grain yield was not affected by varietal differences. There were high negative and significant correlations between dry weight of total weeds with each of wheat plant height, SPAD value, spike length and weight, spikelets No./spike, grain weight/spike, 1000-grain weight, straw and grain yields. While, positive and high marked associations were recorded between grain yield with each other crop traits.

Key words: Herbicide tank-mixtures, Weeds, Synergistic interactions, Wheat cultivars productivity.

INTRODUCTION

Using chemical weed management in intensively grown crops (e.g. wheat) is easier and more economical than manual or mechanical ones, especially after hand labors scarce and pay rise. But under the warnings against manipulating herbicides recently, the supply of their authorized components became extremely restricted. As well known, wheat is a vital and strategic food crop. Most available herbicides used in wheat are assigned for controlling particular weeds, unlike little (e.g. isoproturon) that controls broad spectrum of weeds. However, one or more of these weed species may appear herbicide resistance. So, it is essential to use mixtures (combinations) of herbicides for broadening the spectrum of weeds controlled and for reducing the risk of evolution weed resistance against herbicides. The benefits of using herbicide mixtures are also include saving time, control efforts and costs as well as rationalizing water consumption. Besides, using mixtures reduces pollution by lowering herbicide application rate (comparing with using the individuals). The herbicides used in combination must be complemented each other very well, i.e. differing in their sites of action and vary in weed species which they control. The significance of multiplicity the sites of action is to reduce the potential for herbicide resistance in weeds. The impact on more than one site of action reduces the potential for herbicide resistance in weeds (Shaner *et al.*, 1997). On the other hand, weed control achieved from a combination of herbicides may be greater than (synergistic), less than (antagonistic) or equal (additive) to the summed effect of the same herbicides applied alone (Colby, 1967, Hatzios & Penner, 1985 and Green, 1989).

Continuously, selection the suitable cultivar is considered one of the distinctive cultural patterns for weed suppression. Wheat cultivars are varying in their competitive ability with weeds (Sodhi & Dhaliwal, 1998, Seavers & Wright, 1999 and Abouziena *et al.*, 2008). Also, wheat yield of less competitive genotypes was reduced by 7-9 % than those of more competitive ones (Huch, 1998). However, more competitive cultivars are not necessarily higher yielding (Cardina, 1995). Moreover, wheat cultivars differed in their response to herbicides (Abusteit *et al.*, 1991 and Brar *et al.*, 1997).

The objectives of this research were to study the response of wheat cultivars and the accompanied weeds to some herbicides used alone or in tank-mixtures, as well as to identify and characterize the nature of the interaction between each pair of the herbicides (applied in mixtures) with respect to the effect on weeds.

MATERIALS AND METHODS

Two field experiments were conducted at the Experimental Farm of the National Research Centre at Shalakan, Kalubia Governorate, Egypt during the 2005/2006 and 2006/2007 seasons. The soil texture was clay loam and the preceding crop was soybean in both seasons. Each experiment included 28 treatments which were the combinations of:

1- Two wheat cultivars, i.e. Gemmiza-9 and Giza-168,
2- Fourteen weed management treatments, i.e. metosulam 95.2 cm^3, thifensulfuron 57.1 g, pyraflufen-ethyl 595 cm^3, imazamethabenz 2.02 l., fenoxaprop 1.2 *l.* metosulam 71.4 cm^3 + imazamethabenz 1.52 *l.*, metosulam 71.4 cm^3 + fenoxaprop 0.9 *l.* thifensulfuron 42.8 g + imazamethabenz 1.52 *l.* thifensulfuron 42.8 g + fenoxaprop 0.9 *l.* pyraflufenethyl 446.3 cm^3 + imazamethabenz 1.52 *l.* pyraflufen-ethyl 446.3 cm^3 + fenoxaprop 0.9 *l.*, isoproturon 2.97 *l.* ha^{-1}, in addition to hand weeding (hoeing) once at 45 days from sowing and weedy check (unweeded).

Physiological and chemical compatibility were tested (in Lab.) and achieved for each pair of the mixed herbicides before field application. Also, common, trade and chemical names of each herbicide are shown in Table (1). All herbicides were sprayed as post emergence at 25 days from sowing using a knapsack sprayer with one nozzle and the carrier was 476 l. water/ha.

A strip plot design with four replicates was used, where the vertical plots were occupied by the cultivars, while weed management treatments were allocated in the horizontal ones. The experimental unit area was 10.5 m^2 (3.5 m length and 3 m width).

Wheat grains were broadcasted at a rate of 145 kg/ha., then followed by irrigation. The sowing date was Nov. 27th and 13th in the 1st and 2nd seasons, respectively. All other recommended cultural practices were adopted throughout the two seasons.

Recorded data:

I-Weeds:

a- Weed dry weight:

Weeds were hand pulled from one square meter of each experimental unit at 90 days after sowing, then identified and classified into grasses and broad-leaved groups. After air drying for 8 days and oven drying at 105°C for 24 hours, dry weight of both weed groups as well as total dry weight were recorded

Table (1): Common, trade and chemical names of used herbicides.

Common name	Trade name	Chemical name
Metosulam	*Sinal 10% SC*	*N-(2, 6-dichloro- 3- methyl phenyl)-5,7-dimethoxy[1, 2, 4]triazolo[1,5-a] pyrimidine-2-sulfonamide*
Thifensulfuron	*Harmony 75% DF*	*3-[[[[(4-methoxy-6-methyl-1,3,5-trazin-2-yl) amino[carbonyl]amino] sulfonyl]-2-thiophenecar-boxylic acid*
Pyraflufen-ethyl	*Ecopart 2% SC*	*Pyraflufen-ethyl(ethyl-2-chloro-5-(4-chloro-5-difluo-romethoxy-1-methyl-1H-pyrazol-3-yl)4-fluorophe-noxy acetate*
Imazamethabenz	*Assert 25% SC*	*(±)-2-[4,5-dihydro-4-methyl-4-(1-methylethyl)-5-oxo-1H-imidazol-2-yl]-4(and 5)-methyl benzoic acid (3:2)*
Fenoxaprop	*Puma super 7.5% EW*	*(±)-2-[4-[(6-chloro-2-benzoxazolyl)oxy]phenoxy] propanoic acid*
Isoproturon	*Arelon 50% FL*	*[3-(4-isopropyl phenyl)-1,1-dimethyl urea]*

b- Nature of the herbicidal interaction:

A study was conducted to determine the nature of the interactions between each pair of herbicides involved in tank-mixture for the control of total weeds. These interactions were calculated by the mathematical method described by Colby (1967). In this regard, the following formula is used: $E = X + Y - (XY/100)$, where: E is the expected response (value), X and Y are weed control % by herbicide A and B alone, respectively. Afterward, we used one-tail T test ($P = 0.01$) for the comparison between the actual (observed) and expected inhibition values, according to the applied design. When the actual response of the herbicide combination was significantly less, more than or equal the expected value, the interaction was declared antagonistic, synergistic and additive, respectively. In addition, means of the differences between the actual and the expected values were compared using Duncan's test at 0.05 level of significance.

II-Wheat:

A- Growth traits:

After heading stage, flag leaf area and angle were measured on five plants chosen randomly from each plot. Also, total chlorophyll content (SPAD value) of flag leaf was determined by chlorophyll meter (SPAD-502) according to Soil Plant Analysis Department Section, Minolta Camera Co., Osaka, Japan as reported by (Minolta Camera Co., 1989).

B- Yield and its attributes:

Harvesting date was June 15th and 7th in the 1st and 2nd seasons, respectively, where plants of square meter per each experimental plot were collected to estimate biological, straw and grain yields ha^{-1}. Afterward, ten shoots were taken from each and the following traits were measured: plant height, spike length, spike weight, spikelets No./spike, grain weight/spike, weight of 1000 grain and then migration coefficient was computed (migration coefficient = spike grain weight x 100 / spike weight).

Simple correlation study:

All possible coefficients of simple correlation (r) were calculated (according to Snedecor & Cochran, 1980) among each pair of the following traits: total dry weight of weeds, SPAD value, plant height, spike length and weight, spikelets No. and grain weight/ spike, weight of 1000 grain as well as straw and grain yields under overall the experiment.

Statistical analysis:

The obtained data from each season were subjected to the proper statistical analysis of variance according to Gomez & Gomez (1984). The combined analysis of variance for the data of the two seasons was performed after testing the error homogeneity and LSD at 0.05 level of significance was used for the comparison between means.

RESULTS AND DISCUSSION

A- Weeds growth:

The most commonly surveyed weeds in the experimental situations through the two growing seasons were: bristle-spiked (*Phalaris paradoxa*, L.), wild oat (*Avena fatua*, L.) and annual bluegrass (*Poa annua*, L.), as grasses and burclover (*Medicago polymorpha*, L.) and lambsquarters (*Chenopodium album*, L.) as broadleaf weeds.

a- Effect of weed management:

There is a significant effect of weed management on dry weight of grassy, broad-leaved and total weeds (Table, 2). All weeded treatments decreased dry weight of each weed group as well as total weeds comparing to the unweeded one. However, the weeded treatments differed in their efficiency in weed suppression. In this respect, isoproturon came in the first order for controlling grassy and total weeds, but statistically leveled with those achieved by metosulam+fenoxaprop and fenoxaprop (alone) for grassy weeds as well as metosulam+fenoxaprop, metosulam+ imazamethabenz and thifensulfuron+fenoxaprop for total weeds. Such marked treatments diminished the dry weight of grasses by 99.7, 98.9 and 98.9 % as well as total dry weight by 99.7, 99.5, 99.4 and 99.3 %, respectively compared with the weedy check. Concerning the broad-leaved weeds, plots sprayed with metosulam and/or thifensulfuron individually or in tank-mixture with either imazamethabenz or fenoxaprop were entirely free of broad-leaved weeds (100 % control), but, still significantly equal with isoproturon.

Among the tank-mixtures, high compatibility was exhibited between metosulam and thifensulfuron each with either imazamethabenz or fenoxaprop for depressing dry weights of all weed categories, except thifensulfuron+imazamethabenz with respect to grasses. These observations is explained according to the effect of each herbicide used alone or in combination regarding the effect on weed control spectrum.

Isoproturon (an urea herbicide) is used for selective control of both grasses and broad-leaved weeds in cereals. The herbicidal action of urea herbicides is due to inhibition of the Hill reaction in photosynthetic electron transport with consequent inhibition of ATP and $NADPH_2$ formation. This results in irreversible damage to photosynthetic process and a permanent lack of food production (Cremlyn, 1991). Accordingly, isoproturon achieved the best control of all weed classes. Isoproturon recorded high efficiency against broad leaved and grassy weeds in wheat (Abd El-Samie, 2001 and Metwally & Hassan, 2001).

On the other hand, metosulam and thifensulfuron are selective post emergence herbicides to control many annual broad-leaved weeds. Imazamethabenz is a selective post emergence herbicide used to control wild oats and certain annual broad leaf weeds in wheat. The three mentioned herbicides act by inhibiting the enzyme AHAS (also called ALS, acetohydroxy acid synthase) which is common to the bio-synthetic pathway for three branched-chain aliphatic acids (isoleucine, leucine and valine). The reduction in the levels of the three amino acids causes a disruption in protein synthesis and other sequent biochemical, which, in turn, inhibit plant growth (Ashton & Monaco, 1991, WSSA, 1994 and Ware & Whitacre, 2004).

Fenoxaprop-p-ethyl can be applied post emergence for controlling grassy weeds in wheat. Such herbiciede inhibits Acetyl Co Enzyme Carboxylase (ACCase), the enzyme catalyzing the first committed step in fatty acids synthesis. Inhibition of fatty acid synthesis presumably blocks the production of phospholipids used in building new membranes required for cell growth (WSSA, 1994).

Due to these variations in selectivity and action mechanisms, using some of the forenamed herbicides in tank-mixtures is expected to give chemical integration and achieve more efficient control of weeds.

Activity of herbicide combinations:

All herbicide combinations resulted in synergistic interactions, where the actual response of each surpassed the expected one (Figure, 1). Antagonistic and additive responses were not observed.

Table (2): Weeds dry weight as influenced by varietal differences and herbicides mixtures and their interaction in wheat (combined data of 2005/2006 and 2006/2007 seasons).

Treatments	Cultivar		Mean	Cultivar		Mean	Cultivar		Mean
	Gemmiza-9	Giza-168		Gemmiza-9	Giza-168		Gemmiza-9	Giza-168	
Weed management:	Grassy weeds (g.m^{-2})			Broad-leaved weeds (g.m^{-2})			Total weeds (g.m^{-2})		
Metosulam	73.8	77.0	**75.4**	0.0	0.0	**0.0**	73.8	77.0	**75.4**
Thifensulfuron	75.2	79.1	**77.1**	0.0	0.0	**0.0**	75.2	79.1	**77.1**
Pyraflufen-ethyl	83.9	82.4	**83.1**	8.4	8.6	**8.5**	92.4	91.1	**91.7**
Imazamethabenz	4.3	3.8	**4.1**	61.4	70.7	**66.0**	65.8	74.5	**70.2**
Fenoxaprop	0.7	3.5	**2.1**	73.0	83.5	**78.2**	73.8	87.0	**80.4**
Metosulam+imazamethabenz	1.9	3.1	**2.5**	0.0	0.0	**0.0**	1.9	3.1	**2.5**
Metosulam+fenoxaprop	1.5	2.6	**2.0**	0.0	0.0	**0.0**	1.5	2.6	**2.0**
Thifensulfuron+imazamethabenz	3.4	3.7	**3.6**	0.0	0.0	**0.0**	3.4	3.7	**3.6**
Thifensulfuron+fenoxaprop	2.6	3.0	**2.8**	0.0	0.0	**0.0**	2.6	3.0	**2.8**
Pyraflufen-ethyl+imazamethabenz	4.5	5.3	**4.9**	5.6	5.0	**52.3**	10.1	10.4	**10.2**
Pyraflufen-ethyl+fenoxaprop	4.1	4.6	**4.4**	5.9	7.5	**6.7**	10.1	12.1	**11.1**
Isoproturon	0.0	0.9	**0.6**	0.8	0.9	**0.8**	0.8	1.8	**1.3**
Hand weeding	90.8	93.9	**92.3**	33.9	42.2	**38.1**	124.7	136.1	**130.4**
Weedy check	183.5	197.2	**190.3**	209.0	213.3	**211.1**	392.3	410.6	**401.5**
Mean	**37.9**	**40.0**		**28.46**	**30.85**		**66.3**	**70.9**	
LSD (0.05):									
Cultivars (C)	0.9			1.1			1.3		
Weed management (W)	1.5			1.7			2.0		
C x W	3.3			2.9			4.7		

On the other hand, the synergistic effects (i.e. the differences between actual and expected inhibitions are positive) were statistically varied (Figure, 2). Herein, each of metosulam or thifensulfuron with fenoxaprop were the most synergized combinations, being recorded the higher value in this respect. Such potency may be attributed to that the involved herbicides (mixed together) have different sites of action and differ in their effectiveness on weed species. The inhibition impact on more than one site of action is expected to reduce the potential for weed resistance to herbicides.

b- Effect of cultivars:

The abundance of weeds was significantly differed between the two studied wheat cultivars (Table, 2). Herein, the lower dry weights of grassy, broad-leaved and total weeds values were found with Gemmiza-9 cultivar than with Giza-168. These reductions amounted to 5.3, 7.8 and 6.5 %, respectively. This explains the more weed suppression ability of Gemmiza-9 than Giza-168. Such differences may be due to the variation in rooting systems, vegetative growth habit (height and tillering), and allelopathic effects. In this respect, Gemmiza-9 plants were taller than Giza-168 ones (Table, 3). Similar results were obtained by Sodhi & Dhaliwal (1998) and Hussein (2002).

c- Effect of the interaction:

Remarkable impact of the interaction between weed management and wheat cultivars on dry weights of weeds was obtained as presented in Table (2). In this regard, spraying isoproturon in plots of Gemmiza-9 achieved the highest decreases in dry weight of grassy and total weeds. On the other hand, the lowest dry weight of broad-leaved weeds (100 % control) was produced from plots cultivated with either cultivars as well as treated by metosulam and thifensulfuron (each used either alone or mixed with imazamethabenz or fenoxaprop). Unlike, under weedy check plots, Giza-168 was the more infested by the various weed types compared to Gemmiza-9.

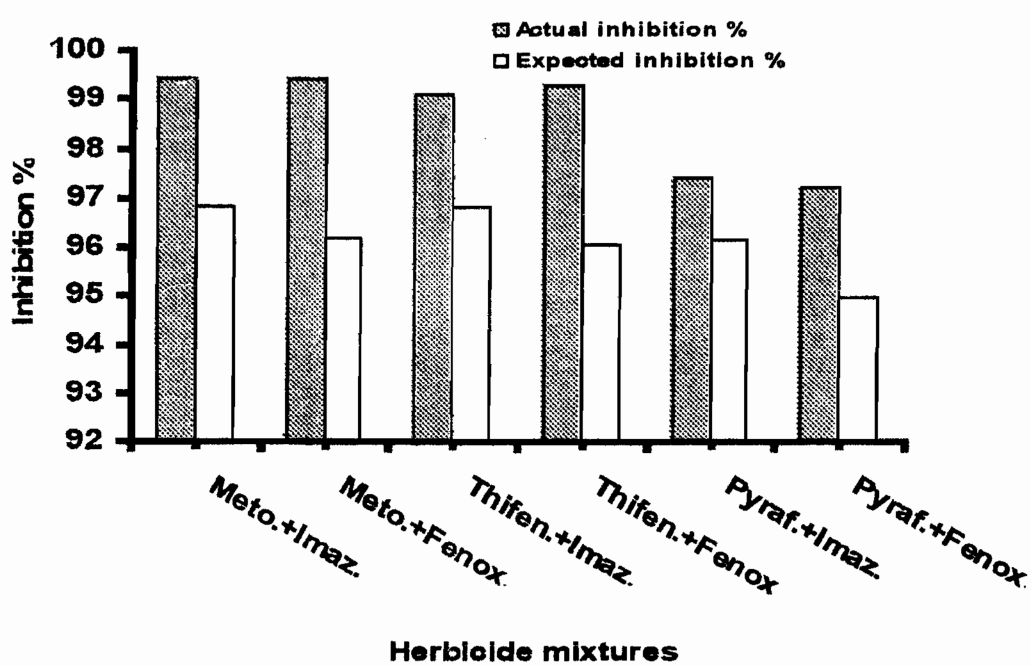

Figure (1): Actual and expected inhibitions % of herbicidal mixtures on dry weight of total weeds in wheat. Imaz; imazamethabenz, Fenox.;fenoxaprop, Meto.; metosulam, Thifen.; thifensulfuron, Pyr.; pyraflufen-ethyl.

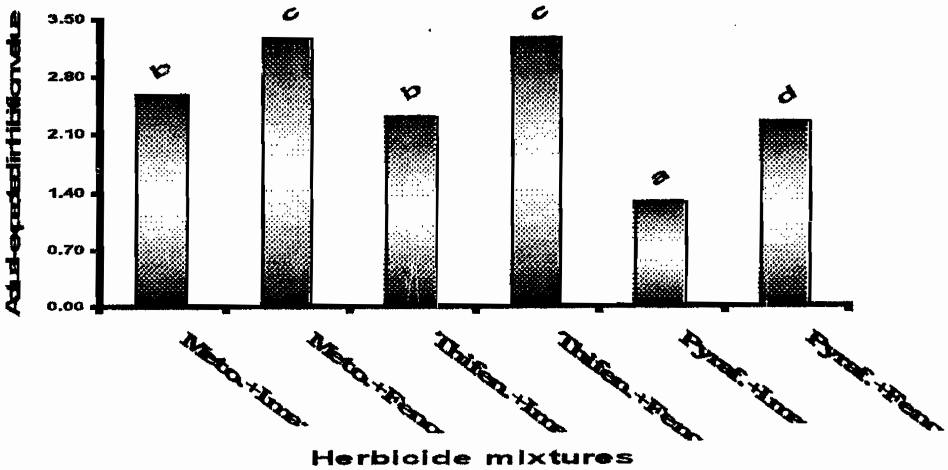

Figure (2):: Actual and expected inhibitions values difference of herbicidal mixtures on dry weight of total weeds in wheat. Imaz; imazamethabenz, Fenox.; fenoxaprop, Meto.; metosulam, Thifen.; thifensulfuron, Pyr.; pyraflufen-ethyl.

B- Wheat growth:

a- Effect of weed management:

Results in Table (3) illustrate significant impact of weed management treatments on flag leaf area, angle and chlorophyll content (SPAD value). Mixing fenoxaprop with metosulam or with pyraflufen-ethyl exceeded the rest of other weeded practices for enhancing flag leaf area and SPAD value, respectively. While, thifensulfuron+imazamethabenz was the potent herbicide tank-mixture for widening flag leaf angle. Contrariwise, wheat plants possessed the lowest values of the abovementioned traits when weeds were left freely (weedy check treatment). The enhancement of wheat growth in the weeded plots might be attributed to the efficiency in weed elimination (Table, 2), and consequently the reduction of weed competitive ability against wheat plants. Such conditions mean more efficient use of the environmental growth factors by wheat plants reflecting on improving their growth. These results are in good harmony with those of Ahmed (2001).

b- Cultivars performance:

While flag leaf area and angle were not affected by wheat cultivar, available data reveal that SPAD value of flag leaf markedly varied (Table, 3). In this respect, Gemmiza-9 plants were more greener than Giza-168 being recorded higher SPAD value. Shaban *et al.* (2004) showed that wheat cultivars were markedly differed in leaf chlorophyll concentration.

c- Effect of the interaction:

Significant interactions between weed management and wheat cultivars on wheat growth traits are noticed in Table (3). Gemmiza-9 recorded the highest values of flag leaf area and SPAD when treated with metosulam+fenoxaprop and pyraflufen-ethyl+fenoxaprop, respectively. Moreover, flag leaf angle was most extended by application of imazamethabenz with metosulam or with thifensulfuron in Giza-168 cultivar. Contrarily, the minimal values were produced for flag leaf area and SPAD by Gimmeza-9 and for flag leaf angle by Giza-168, each in the unweeded plots.

C- Wheat yield and its attributes:

a- Effect of weed management:

Wheat yield attributes, i.e. plant height, spike length and weight, spikelets No./spike, grain weight/spike and 1000-grain weight were significantly responded to weed management treatments, as shown in Table (4). With the exception of the single applied herbicides (for plant height), pyraflufen-ethyl (for spike weight) in addition to imazamethabenz (for spike length, spikelets No. and grain weight/spike) and fenoxaprop (for 1000-grain weight), all other weeded practices exceeded the unweeded check.

Table (3): Area, angle and SPAD value of wheat flag leaf as influenced by varietal differences and herbicides mixtures and their interaction (combined data of 2005/2006 and 2006/2007 seasons).

Treatments	Cultivar		Mean	Cultivar		Mean	Cultivar		Mean
	Gemmiza-9	Giza-168		Gemmiza-9	Giza-168		Gemmiza-9	Giza-168	
Weed management:	**Flag leaf area (cm^2)**			**Flag leaf angle**			**SPAD value**		
Metosulam	37.4	35.9	**36.6**	34.0	30.5	**32.2**	40.1	37.5	**38.8**
Thifensulfuron	35.9	34.2	**35.0**	42.5	43.3	**42.9**	40.5	44.1	**42.3**
Pyraflufen-ethyl	29.6	32.3	**30.9**	50.0	51.6	**50.8**	40.9	38.8	**39.8**
Imazamethabenz	34.4	31.4	**32.9**	36.1	39.1	**37.6**	43.3	41.3	**42.3**
Fenoxaprop	32.6	33.6	**33.1**	45.0	37.1	**41.0**	43.4	39.4	**41.4**
Metosulam+imazamethabenz	34.0	45.2	**39.6**	33.0	60.8	**46.9**	40.3	41.7	**41.0**
Metosulam+fenoxaprop	47.7	45.9	**46.8**	52.5	52.5	**52.5**	42.4	40.2	**41.3**
Thifensulfuron+imazamethabenz	42.7	44.3	**43.5**	51.6	60.8	**56.2**	42.5	39.0	**40.8**
Thifensulfuron+fenoxaprop	45.8	43.4	**44.6**	43.8	49.1	**46.5**	41.5	38.7	**40.1**
Pyraflufen-ethyl+imazamethabenz	38.8	36.0	**37.4**	43.0	41.1	**42.0**	41.4	44.4	**42.9**
Pyraflufen-ethyl+fenoxaprop	38.5	39.4	**39.0**	42.0	32.4	**37.2**	46.7	45.1	**45.9**
Isoproturon	42.4	42.6	**42.5**	46.6	25.1	**35.9**	42.1	42.9	**42.5**
Hand weeding	37.9	36.6	**37.2**	40.8	37.1	**39.0**	40.1	40.5	**40.3**
Weedy check	26.2	29.2	**27.7**	36.6	27.3	**32.0**	36.8	39.0	**37.9**
Mean	**37.4**	**37.9**		**42.7**	**42.0**		**41.6**	**40.9**	
LSD (0.05):									
Cultivars (C)	n.s			n.s			0.1		
Weed management (W)	1.2			4.1			1.1		
C x W	1.7			7.7			0.9		

Table (4): Wheat yield and its components as influenced by varietal differences and herbicides mixtures (combined data of 2005/2006 and 2006/2007 seasons).

Treatments	Plant height (cm)	Spike				Weight of 1000-grain (g)	Migration coefficient	Yield (ton ha^{-1})		
		Length (cm)	Weight (g)	Spikelets No.	Grain weight (g)			Biological	Straw	Grain
Weed management										
Metosulam	103.0	10.38	3.59	20.63	2.61	45.0	0.732	20.15	12.90	7.25
Thifensulfuron	103.1	10.35	3.55	20.39	2.57	44.9	0.726	20.00	13.20	6.80
Pyraflufen-ethyl	102.1	9.86	3.31	19.67	2.47	45.3	0.748	18.50	12.15	6.35
Imazamethabenz	101.7	9.76	3.42	19.45	2.47	44.8	0.725	18.85	12.30	6.55
Fenoxaprop	102.6	10.22	3.43	20.26	2.50	42.4	0.734	19.50	12.70	6.80
Metosulam+imazamethabenz	107.5	11.31	4.07	21.90	3.00	47.1	0.739	23.15	14.40	8.75
Metosulam+fenoxaprop	108.3	11.44	4.34	22.24	3.25	47.5	0.750	23.60	14.55	9.05
Thifensulfuron+imazamethabenz	105.5	11.00	3.82	21.76	2.88	45.5	0.742	21.95	13.50	8.45
Thifensulfuron+fenoxaprop	106.2	11.14	4.03	21.77	2.91	46.3	0.724	22.35	13.75	8.60
Pyraflufen-ethyl+imazamethabenz	104.6	10.65	3.67	20.85	2.68	46.0	0.733	20.70	13.00	7.70
Pyraflufen-ethyl+fenoxaprop	104.9	10.94	3.71	21.57	2.73	45.6	0.741	21.10	13.15	7.95
Isoproturon	105.2	10.79	3.77	21.71	2.92	46.2	0.773	21.45	13.30	8.15
Hand weeding	104.0	10.52	3.62	20.80	2.65	45.9	0.732	20.40	13.10	7.30
Weedy check	100.6	9.70	3.26	19.13	2.35	40.4	0.722	16.95	11.10	5.85
LSD (0.05)	**3.3**	**0.40**	**0.10**	**0.80**	**0.13**	**2.8**	**0.036**	**0.78**	**0.81**	**0.23**
Cultivar										
Gemmiza-9	108.0	10.28	4.03	20.97	2.92	47.5	0.721	21.24	13.57	7.67
Giza-168	100.4	10.87	3.34	20.76	2.51	42.9	0.753	19.99	12.58	7.41
LSD (0.05)	**3.7**	**0.28**	**0.05**	**n.s**	**0.05**	**3.3**	**0.005**	**0.19**	**0.36**	**n.s**

Of the weeded treatments, metosulam+ fenoxaprop treatment resulted in more values of both spike weight and grain weight/ spike surpassing other ones. Such superior treatment recorded also the higher values of plant height, spike length, spikelets No./spike and 1000-grain weight. Moreover, the highest value of migration coefficient was recorded with application of isoproturon which exceeded all other treatments, except metosulam+ fenoxaprop, thifensulfuron + imazamethabenz, pyraflufen-ethyl+fenoxaprop and metosulam+ imazamethabenz.

Concerning wheat yields ha.$^{-1}$, all weeded plots produced more yields over the weedy check one. The highest biological, straw and grain yields were achieved with applying metosulam+fenoxaprop (which reached 39.2, 31.1 and 54.7 % increases over weedy check, respectively) exceeding other weeded ones (in grain yield) with exception of metosulam+imazamethabenz (in biological and straw yields), in addition to thifensulfuron+ fenoxaprop (in straw yield). Such superior weeded treatments minimized weed-crop competition (Table, 2) and saved more available environmental resources for crop plants that improved growth traits (Table, 3). This in turns increased plant height (at harvest), and produced more assimilates synthesized, translocated, and accumulated in various plant organs which positively reflected on biological, straw and grain yields/ha. The positive effect of weeded practices on wheat yields and its components have been confirmed by El-Metwally & El-Rokiek (2007).

Furthermore, it is worth to note that all herbicides tended to exert improvements in the forenamed wheat traits when applied in mixtures than in single applications.

b- Cultivars performance:

Data in Table (4) illustrate that Gemmiza-9 was the potent cultivar in plant height, spike weight, grain weight/spike and 1000-grain weight, as well as biological and straw yields ha.$^{-1}$ Such cultivar exceeded Giza-168 in the abovementioned traits by 7.6, 20.7, 16.3, 10.7, 6.3 and 7.9 %, respectively. This may be due to the relatively higher competitive ability of Gemmiza-9 against weeds as exhibited before. But, Giza-168 was the superior one in spike length and migration coefficient. Superiority of Giza-168 in migration coefficient might be attributed to the more reduction in spike weight relative to spike grain weight than that of Gemmiza-9. The differences between wheat cultivars might be due to the genetical variations. Confirming results in this respect were cited by El-Habbal *et al.* (2000) and Hassan & GabAllah (2000). On the other hand, the two studied cultivars are statically leveled in spikelets No./spike and grain yield ha.$^{-1}$

c- Effect of the interaction:

Considerable effects of the interaction between weed management and wheat cultivars on yield and its components were recorded (Tables, 5 & 6). Gemmiza-9 cultivar treated with metosulam+fenoxaprop combination achieved the greatest values of plant height, spike weight, spikelets No./spike, grain weight/spike, 1000-grain weight, as well as biological, straw and grain yields ha.$^{-1}$. While, application of metosulam+fenoxaprop in Giza-168 or isoproturon in Gimmeza-9 were the effective combination treatments for promoting spike length and migration coefficient, respectively. On the other hand, plots of Gemmiza-9 and Giza-168 under weedy conditions produced the lowest yields, being recorded 28.7 and 32.4 %, 23.2 and 29.8 % as well as 37.6 and 36.6 % reductions in biological, straw and grain yields, respectively, relative to the superior treatment (metosulam+fenoxaprop x Gimmeza-9).

Simple correlation study:

In this part, the aim was to detect direction and strength of the relationship between each pair of dry weight of total weeds, wheat plant height, SPAD value, spike length and weight, spikelets No./spike, grain weight/ spike, 1000-grain weight, straw and grain yields (Table, 7). It could be concluded that there are high negative and significant correlations between dry weight of total weeds with each involved trait of wheat. This observation is in compatibility and previously confirmed with the results regarding the effect of the non-controlling of weeds (in the unweeded plots).

Table (5): Wheat yield components as influenced by the interaction between varietal differences and herbicides mixtures (combined data of 2005/2006 and 2006/2007 seasons).

Treatments	Cultivar											
	Gemmiza-9	Giza-168	Gemmiza-9	Giza-168	Gemmiza-9	Giza-168	Gemmiza-9	Giza-168	Gemmiza-9	Giza-168	Gemmiza-9	Giza-168
Weed management:	Plant height (cm)		Spike length (cm)		Spike weight (g)		Spikelets No.		Spike grain weight (g)		Weight of 1000-grain (g)	
Metosulam	107.1	99.0	10.02	10.73	3.98	3.20	20.90	20.36	2.79	2.43	46.7	43.4
Thifensulfuron	107.0	99.2	10.05	10.66	3.90	3.19	20.68	20.10	2.72	2.42	48.3	41.6
Pyraflufen-ethyl	106.0	98.3	9.60	10.13	3.63	2.99	19.41	19.93	2.59	2.35	49.0	41.7
Imazamethabenz	105.8	97.7	9.40	10.13	3.76	3.09	19.56	19.35	2.63	2.30	47.3	42.4
Fenoxaprop	106.8	98.4	9.76	10.68	3.86	3.01	20.56	19.96	2.70	2.30	43.2	41.5
Metosulam+imazamethabenz	111.4	103.6	11.05	11.58	4.43	3.70	22.11	21.70	3.25	2.76	49.7	44.6
Metosulam+fenoxaprop	112.3	104.2	11.25	11.63	4.60	4.07	22.25	22.23	3.43	3.08	50.1	45.0
Thifensulfuron+imazamethabenz	108.9	102.2	10.71	11.28	4.23	3.42	21.83	21.70	3.09	2.66	48.5	42.4
Thifensulfuron+fenoxaprop	109.2	103.3	10.86	11.41	4.36	3.70	21.86	21.68	3.15	2.68	47.9	44.8
Pyraflufen-ethyl+imazamethabenz	108.0	101.3	10.40	10.91	4.01	3.33	21.16	20.55	2.90	2.47	47.6	44.3
Pyraflufen-ethyl+fenoxaprop	108.6	101.3	10.90	10.98	4.06	3.36	21.65	21.50	2.94	2.53	49.7	41.5
Isoproturon	108.8	101.5	10.43	11.15	4.13	3.41	21.78	21.65	3.31	2.53	50.0	42.4
Hand weeding	107.5	100.5	10.20	10.85	3.92	3.33	21.16	20.45	2.85	2.45	47.9	43.8
Weedy check	105.3	95.9	9.38	10.03	3.59	2.38	18.70	19.56	2.55	2.16	38.8	42.0
LSD (0.05)	3.8		0.55		0.17		0.73		0.18		3.9	

Table (6): Wheat yields as influenced by the interaction between varietal differences and herbicides mixtures (combined data of 2005/2006 and 2006/2007 seasons).

Treatments	Cultivar							
	Gemmiza-9	Giza-168	Gemmiza-9	Giza-168	Gemmiza 9	Giza-168	Gemmiza-9	Giza-168
Weed management:	Migration coefficient		Biological yield (ton ha^{-1})		Straw yield (ton ha^{-1})		Grain yield (ton ha^{-1})	
Metosulam	0.702	0.762	21.1	19.2	13.8	12.0	7.3	7.2
Thifensulfuron	0.697	0.755	20.8	19.2	13.6	12.8	7.2	6.4
Pyraflufen-ethyl	0.713	0.783	18.9	18.1	12.6	11.7	6.3	6.4
Imazamethabenz	0.700	0.750	19.2	18.5	12.7	11.9	6.5	6.6
Fenoxaprop	0.700	0.768	20.2	18.8	13.4	12.0	6.8	6.8
Metosulam+imazamethabenz	0.730	0.748	23.8	22.5	14.8	14.0	9.0	8.5
Metosulam+fenoxaprop	0.743	0.757	24.4	22.8	15.1	14.0	9.3	8.8
Thifensulfuron+imazamethabenz	0.705	0.778	22.1	21.8	13.6	13.4	8.5	8.4
Thifensulfuron+fenoxaprop	0.720	0.728	22.7	22.0	13.8	13.7	8.9	8.3
Pyraflufen-ethyl+imazamethabenz	0.723	0.743	21.6	19.8	13.7	12.3	7.9	7.5
Pyraflufen-ethyl+fenoxaprop	0.727	0.755	21.7	20.5	13.4	12.9	8.3	7.6
Isoproturon	0.802	0.745	22.0	20.9	13.6	13.0	8.4	7.9
Hand weeding	0.730	0.735	21.5	19.3	14.3	11.9	7.2	7.4
Weedy check	0.707	0.738	17.4	16.5	11.6	10.6	5.8	5.9
LSD (0.05)	0.052		1.0		0.9		0.4	

Table (7): Simple correlation among total dry weight of weeds, SPAD value and wheat yield and its attributes

Variables	1	2	3	4	5	6	7	8	9
Total weeds dry weight (1)									
SPAD value (2)	-0.419**								
Plant height (3)	-0.305**	0.162*							
Spike length (4)	-0.487**	0.105	0.118						
Spike weight (5)	-0.414**	0.168*	0.736**	0.189*					
Spikelets No. (6)	-0.562**	0.270**	0.465**	0.640**	0.530**				
Spike grain weight (7)	-0.465**	0.174*	0.657**	0.278**	0.886**	0.579**			
Weight of 1000-grain (8)	-0.346**	0.178*	0.503**	0.088	0.559**	0.327**	0.514**		
Straw yield (9)	-0.461**	0.165*	0.548**	0.310**	0.639**	0.546**	0.596**	0.368**	
Grain yield (10)	-0.660**	0.239**	0.351**	0.583**	0.624**	0.656**	0.689**	0.302**	0.509**

* Significant at 0.05 level of probability

** Significant at 0.01 level of probability

In the second order, and in entirely opposite direction, positive and high marked associations were recorded between wheat grain yield with each other crop traits (Table, 7). Similar results were shown regarding those correlations of straw yield except that of its association with SPAD value which was significant at 0.05 level only. Positive and significant correlation coefficients among each pair of wheat yield and its criteria were also observed by El-Bially & Abd El-Samie (1995).

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فاعلية مخاليط الخزان للمبيدات العشبية على الحشائش وإنتاجية القمح

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فى دراسة عن تأثير مكافحة الحشائش على إنتاجية صنفين من القمح (جميزة-٩ ، جيزة-١٦٨) والحشائش المصاحبة أقيمت تجربتان حقليتان خلال موسمى ٢٠٠٥/٢٠٠٦ و٢٠٠٦/٢٠٠٧ بمحطة تجارب المركز القومى للبحوث بشلقان - محافظة القليوبية. تضمنت معاملات مكافحة الحشائش استعمال مبيد ميتوسولام، ثيفنسالفيورون، بيرافلوفين-ايثيل، ايمازاميثابنز، فينوكسابروب، ميتوسولام+ايمازاميثابنز، ميتوسولام+فينوكسابروب، ثيفنسالفيورون+ايمازاميثابنز، ثيفنسالفيورون+فينوكسابروب، بيرافلوفين-ايثيل+ايمازاميثابنز، بيرافلوفين-ايثيل+فينوكسابروب، أيزوبروتيرون، النقاوة اليدوية مرة واحدة، بدون مكافحة (مقارنة). أوضحت النتائج أن جميع معاملات مكافحة الحشائش أحدثت نقصا معنويا فى الوزن الجاف للحشائش نسبة الى معاملة المقارنة. سجل الأيزوبروتيرون أفضل مقاومة للحشائش ضيقة الأوراق والكلية متساويا احصائيا مع كل من ميتوسولام+فينوكسابروب وفينوكسابروب فى تأثيرها على الحشائش ضيقة الأوراق ومع كل من ميتوسولام+فينوكسابروب، ميتوسولام+ايمازاميثابنز، ثيفنسالفيورون+فينوكسابروب فى تأثيرها على الحشائش الكلية. أظهرت جميع مخاليط المبيدات العشبية تأثيرا إضافيا وكانت أكثر المخاليط توافقا هى ميتوسولام+فينوكسابروب، ثيفنسالفيورون+فينوكسابروب. كانت الحشائش أقل تواجدا فى الصنف جميزة-٩ عن جيزة-١٦٨. سجلت معاملة ميتوسولام+فينوكسابروب أعلى زيادة فى المحصول البيولوجى ومحصول القش والحبوب. أظهر الصنف جميزة-٩ تفوقا على جيزة-١٦٨ فى المحصول البيولوجى ومحصول القش بينما لم يختلف محصول الحبوب بين الصنفين. كان هناك ارتباطا معنويا وسالبا بين الوزن الجاف للحشائش الكلية وكل من ارتفاع نبات القمح، تركيز الكلوروفيل SPAD، طول ووزن السنبلة، عدد السنيبلات بالسنبلة، وزن حبوب السنبلة، وزن ال ١٠٠٠ حبة، محصول القش والحبوب. وعلى العكس من ذلك كان هناك ارتباط معنوى وموجب بين محصول الحبوب وتلك الصفات المحصولية.