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PHYTOTOXICITY AND EFFECTIVENESS OF SOME HERBICIDES IN WHEAT PLANTATIONS

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ABSTRACT

Weeds are severely competition with wheat crop and it highly reduces crop yield. So, the present study was conducted on wheat cultivations during two seasons 2013/2014 and 2014/2015 to evaluated phytotoxicity effects of some herbicides on wheat (*Triticum aestivum*). Effectiveness of these herbicides on weed control in wheat crop and yield evaluation and quality of wheat was evaluated as well after treatment by herbicides. The field experiment was carried out in agricultural experimental station of Etay El-barod, El-Beheira Governorate, using randomized complete block design (RCBD) with four replicates for each treatment and unweeded check, having two rates of both herbicide recommended and double recommended rates (R, 2R). Treatments comprised of post-emergence application of pyroxsulam, flumetsulam+ florasulam, tribenuron-methyl, diclofop-methyl and tralkoxydim. The results indicated an increase in wheat plant height with all herbicides used compared to unweeded check. Tribenuron-methyl and flumetsulam + florasulam treatments did not cause any visible phytotoxicity, while pyroxsulam, diclofop-methyl and tralkoxydim treatments recorded a low indexes of phytotoxicity on wheat plants which disappeared completely after 8 weeks from post application, compared to unweeded check. Results also, indicated that all herbicide treatments decreased weed density. Herbicide treatments achieved the highest weed control expressed in lowest fresh weight after 56 days from application for broadleaved, grassy and total weeds. Herbicide treatments caused an excellent increase in yield attributes (spike length, biological and grain yield) and yield quality (weight of 1000 grains, total carbohydrates and crude protein) compared to unweeded check in both seasons. The maximum grain yield was recorded at two trials by pyroxsulam compared to unweeded check.

INTRODUCTION

Wheat (*Triticum aestivum*) is one of the most important cereal crops in the world and it has the widest distribution among cereal crops. Wheat is a staple food for billions of people all over the world. It is a staple food of about one third of the world's population **(Laila et al 2014).** In Egypt, wheat is considered to be one of the most strategic crops, since wheat flour is the major dietary component for people as bread creates the daily basic source of nutrients of the majority of the population and its straw is used as a major animal feed. Wheat was cultivated over an area of 3.4 million feddans producing 9.3 million tonnes of cereal in 2015/2016. Wheat is of special importance in Egypt because the local production is not sufficient in yielding the annual demands of the local requirements since the demand of wheat crop is ever increasing because of rapid increase in human populations making it imperative to achieve matching increases in the rate of wheat production. Egypt imported about 8.9 million tonnes of wheat in 2015, so increasing the productivity of wheat is one of the main goals of the Egyptian agricultural policy. This can be achieved through horizontal expansion of the cultivation of newly reclaimed land and vertical expansion through the use of better agricultural practices including breading of high yield varieties, genetic

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modification of local varieties and controlling weeds **(Kandil and Ibrahim, 2011 and El Metwally et al 2015b).**

Weeds are considered to be a major problem in wheat field that cause great losses in grain yield because weeds compete with wheat plants for nutrients, moisture, space, light, many other growth factors and can host pests and diseases which not only reduce crop yield but also cause the quality of the wheat to deteriorate and thereby reduce its market value. Weeds also increase harvesting costs. So, weed control is one of the most effective cultural strategies for increasing wheat yield **(Marzouk, 2013).** Weeds account for about 20-30% loss of wheat yield. Annual wheat yield losses by weeds infestations are much higher than those caused by other pests. Therefore most agricultural weed problems require the destruction of weeds without simultaneous damage to the crop amongst which the weeds are growing. Hand weeding is not only ineffective but also very expensive because of increased labor cost. Herbicides are used in agriculture to remove weeds that would otherwise compete with the crop, and to obtain maximum wheat yield, weeds should be controlled at the proper time in the right manner. It is very important to determine the critical period of weed-crop competition to plan an effective weed control method **(Saad et al 2011 and El Metwally et al 2015a).**

Presently, various herbicides are used to control weeds in wheat crop worldwide due to its quick, relatively cheap, high effectiveness and reliability in controlling weeds in wheat. Herbicides gave more (3974 kg ha^{-1}) grain yield as compared to hand weeding (3670 kg ha^{-1}), with a more cost benefit ratio (1:2.88) **(Yasin et al 2010).** Controlling weeds by herbicidal treatments increased grain yield by about 40.3 and 13.6%, compared to unweeded and hand-weeding treatments, respectively **(El Metwally et al 2015b).** Herbicides control a wide range of broad leaved and grassy weeds depending on the selectivity of the herbicides. The selective and systemic herbicides absorb by the roots or foliage and translocated throughout the plant **(Manley et al 1999).** Herbicides are divided into several groups depending on the mechanism of action according to the **Herbicide Resistance Action Committee (HRAC).**

Therefore, the main objective of this study was to evaluate phytotoxicity effects of some herbicides on wheat, evaluate effectiveness of herbicides on weed control in wheat crop, yield evaluation and quality of wheat after treatment by herbicides.

MATERIALS AND METHODS

1. Herbicides utilized

The herbicides utilized and their own common, trade and chemical names, chemical family, mode of action, rates used, selectivity and application time are listed in **Table (1)**.

2. Field trial

The field experiment was conducted in the agricultural experimental station of Etay El-barod (Zarzora), El-Beheira Governorate. Wheat plant (*Triticum aestivum*) assort Sids 12 planted end of November during the two winter successive seasons 2013 /2014 and 2014 / 2015. Experimental areas were divided according to the randomized complete block design with four replicates for each treatment and control. Area of each replicate is about (20 m^2). After that herbicides were applied according to trial protocols shown in **Table (1)**.

The soil of experimental site is classified as clay soil. The physical and chemical properties of the experimental soil were analyzed according to **(Jackson, 1973 and Page et al 1982)** as listed in **Table 2 (a, b)**.

3. Phytotoxicity measurements of wheat

- Plant height (cm): an average of 10 plant samples for each plot were determined before application and after 1,2,4,8 weeks after application by measuring the height from the soil surface to the top of the upmost leaf and up to the top of spike after heading.
- Phytotoxicity (%): was visually assessed at 1, 2, 4 and 8 weeks after application. To evaluate the phytotoxicity of herbicides a percentage score was used, with zero (0%) being given to phytotoxicity of the control and one hundred (100%) to the complete death of wheat plants according to the methodology proposed by **(SBCPD, 1995).**

4- Effectiveness of herbicides on weed control in wheat crop

- Data for weed density (m^{-2}) was recorded for each weed before application and after 1,2,4,8 weeks after application using standard procedures during the course of study where, a quadrate measuring (50 × 50 cm) was randomly placed at 4 randomly selected spots in each experimental plot and density of each weed was recorded.

Table 1. Common name, trade name, chemical name, chemical group, mode of action, selectivity, rate/feddan and application timing of the used herbicides

Treat.	Common name	Trade name	Chemical name	Chemical groups	Mode of action	Selectivity	Rate of Application (Rate/ fed.)	Type and time of Application
1	Pyroxsulam	Pallas OD 4.5%	N-(5,7-dimethoxy[1,2,4]triazolo[1,5-a]pyrimidin-2-yl)-2-methoxy-4-(trifluoromethyl)-3-pyridinesulfonamide	Triazolopyrimidine "TPS"	Inhibition enzyme acetolactate synthase (ALS)	Broad and Narrow leaves	160 cm^3	Post-emergence (after 30 days form sowing)
2							320 cm^3	
3	Flumetsulam	Derby SC 17.5%	N-(2,6-difluorophenyl)-5-methyl[1,2,4]triazolo[1,5-a]pyrimidine-2-sulfonamide	Triazolopyrimidine "TPS"	Inhibition enzyme acetolactate synthase (ALS)	Broad leaved	30 cm^3	
4	Florasulam		N-(2,6-difluorophenyl)-8-fluoro-5-methoxy[1,2,4]triazolo[1,5-c]pyrimidine-2-sulfonamide				60 cm^3	
5	Tribenuron-methyl	Granstar DF 75%	methyl 2-[[[[(4-methoxy-6-methyl-1,3,5-triazin-2-yl) methylamino] carbonyl] amino] sulfonyl]benzoate	Sulfonylurea "SU"	Inhibition enzyme acetolactate synthase (ALS)	Broad leaved	8.0 g	
6							16.0 g	
7	Diclofop-methyl	Fakto EC 36%	methyl 2-[4-(2,4-dichlorophenoxy) phenoxy] propanoate	Aryloxyphenoxy-propionate "Fops"	Inhibition enzyme acetyl CoA carboxylase (ACCase)	Narrow leaves (Grassy)	750 cm^3	
8							1500 cm^3	
9	Tralkoxydim	Avalanche WDG 40%	2-[1-(ethoxyimino) propyl]-3-hydroxy-5-(2,4,6-trimethylphenyl)-2-cyclohexen-1-one	Cyclohexanedione "Dims"	Inhibition enzyme acetyl CoA carboxylase (ACCase)	Narrow leaves (Grassy)	250 g	
10							500 g	
11	Unweeded check	--------------------------------------					------	-------

Table 2a. Physical properties of tested soil at different depths during 2013-2014 and 2014-2015 seasons

Depths (cm)	Season 2013/2014		Season 2014/2015	
	Bulk density (g/cm^3)	Soil porosity (%)	Bulk density (g/cm^3)	Soil porosity (%)
0–10	1.252	48.74	1.111	55.55
10–20	1.425	47.66	1.211	50.42
20–30	1.495	45.80	1.325	49.52

Table 2b. Physical and chemical properties of the experimental soil during 2013-2014 and 2014-2015 seasons

Properties	Season 2013/2014	Season 2014/2015
	Pre-planting	Pre- planting
Chemical analysis		
E.C.	1.98	2.12
pH (1 :2.5)	8.00	8.01
$CaCo_3$ %	3.51	3.00
O.M %	2.16	2.23
N(ppm) (available)	30.08	17.1
P(ppm) (available)	10.5	20.7
K(ppm) (available)	207.78	392.00
Soluble cations and anions(meq/l)		
Ca^{++}	2.904	195.53
Mg^{++}	4.10	48.58
K^{+}	4.49	51.35
Na^{+}	8.30	202.8
Cl^{-}	8.0	260.05
Co_3^{--}	-	-
$H Co_3^{-}$	8.5	263.033
So_4^{--}	3.3	500.52
Particle size distribution (mechanical analysis)		
Course sand %	7.26	6.59
Find sand %	26.91	27.64
Silt %	13.85	12.60
Clay %	51.98	53.17
Texture grade	Clay	Clay

- Fresh weight of weeds was recorded for one square meter that was collected after 56 day from treatment using a quadrate of 50 cm x 50 cm placed at 4 randomly selected spots in each experimental plot. Fresh weight (g/m^2) for each weed species and the total of all weeds were calculated and weed control percentages were calculated by the following equation:-

$$\textit{Weeds control \%} = \frac{\textit{weight of control weeds} - \textit{weight of treated weeds}}{\textit{weight of control weeds}} \times 100$$

5. Yield evaluation and quality of wheat

Yield parameters

- Main spike length (cm)
- Biological yield (kg/20m^2)
- Grain yield (kg/20m^2)

Quality measurements

- Weight of 1000 grains (g) was determined according to **A.A.C.C. (2000)**.
- Carbohydrate yield was calculated from total carbohydrate in milled dried grain which was estimated by alkaline potassium ferricyanide reagent. According to **A.O.A.C. (1990)**.
- Total nitrogen (TN) was measured using Kjeldahl's method, and total crude protein (TCP) as a percentage was determined by multiplying TN content in grains by 5.7 according to **A.O.A.C. (1990).**

6. Statistical analysis

All data were subjected to analysis of variance (ANOVA) using SAS statistical software **(SAS Institute, 2003),** and means were separated using Duncan multiple range test (DMRT) set at 0.05. Data were analyzed separately by location because of weather conditions, application dates, estimated dates and weed species were different at each location. Data was expressed as means ± standard deviation.

RESULTS AND DISCUSSION

Data illustrated in **Tables (3 & 4)** indicate the major weed flora classification in the field experimental site included the common broad leaved and grassy weeds during the two seasons 2013/2014 and 2014/2015. Similar finding were obtained by **El-Metwally and El-Rokiek, (2007); Singh et al (2008); Saad et al (2011); El-Rokiek et al (2012); El-Kholy et al (2013); Dalga et al (2014) and El Metwally et al (2015b).** Also, the finding is in conformity with **Mahmoud et al (2016)** who reported that wheat field trials were infected with both grassy and broad leaf weeds. The dominant broadleaf weeds in El-Beheira and Alexandria were *Beta vulgaris, Malva parviflora, Medicago polymorpha, Sonchus oleraceus, Anagallis arvensis* and *Coronopus squamatus*, While the dominant grassy weeds was *Phalaris minor.*

- **Phytotoxicity of herbicides on wheat**

1. Effect of utilized herbicides on wheat plant height

Data presented in **Table (5)** revealed that herbicide treatments have a significant (p≤0.05) effect on plant height of wheat. All herbicide treatments during the entire two growing seasons increased the plant height of wheat compared to unweeded check especially after 4, 8 week post application. The wheat plant heights were obtained by the application rates 250 & 500 g/fed., of tralkoxydim. Heights were 34.75 & 34.00 cm (4 WAA), 76.75 & 73.00 cm (8 WAA) in the first season and 45.50 & 42.00 cm (4 WAA), 88.25 & 86.75 cm (8 WAA) in the second season, respectively compared to unweeded check 30.75 (4 WAA) & 69.25cm (8 WAA) in the first season and 40.25 (4 WAA), 84.50 cm (8 WAA) in the second season, respectively. **Kandil and Ibrahim, (2011)** reported that tralkoxydim significantly increased plant height due to good control of wheat weeds and minimizing weed competition which gave a good chance of wheat growth in good conditions. Whereas, when pyroxsulam was applied with the rates 160 & 320 cm^3/fed., it produced smaller plants in a height of 34.00 & 32.25 cm (4 WAA), 72.25 & 70.75 cm (8 WAA) in the first season and 41.25 & 40.75 cm (4 WAA), 87.50 & 87.00 cm (8 WAA) in the second season, respectively but which is more compared to unweeded check. This can be attributed to its ability to eliminate all grassy and broad leaved weeds. These findings are in conformity with **Mitiku and Dalga, (2014) & El-Metwally et al (2015a).** The results also revealed that the treatments of tribenuron-methyl, diclofop-methyl and Derby (Flumetsulam + Florasulam) recorded an increase in plant height compared to the unweeded check. These results were in line with the finding by **El-Metwally and El-Rokiek, (2007)** they reported that plant height was

Table 3. Weeds dominant in wheat at the experimental site during 2013-2014 season

Family	Names			Life cycle	Species
	Scientific	English	Arabic		
Primulaceae	*Anagallis arvensis*	Scarlet pimpernel	الزغلنت	Annual	Broad leaved
Leguminosae	*Medicago polymorpha*	Burclover, Toothed medik	النفل	Annual	Broad leaved
Compositae	*Sonchus oleraceus*	Hare’s thistle	الجعضيض	Annual	Broad leaved
Gramineae	*Phalaris spp.*	Lesser canary grass	الفلارس (شعير الفأر)	Annual	Narrow leaves (Grassy)

Table 4. Weeds dominant in wheat at the experimental site during 2014-2015 season

Family	Names			Life cycle	Species
	Scientific	English	Arabic		
Primulaceae	*Anagallis arvensis*	Scarlet pimpernel	الزغلنت	Annual	Broad leaved
Leguminosae	*Medicago polymorpha*	Burclover, Toothed medik	النفل	Annual	Broad leaved
Chenopodiaceae	*Beta vulgaris*	Sea beet, Wild beet	السلق البرى	Annual	Broad leaved
Cruciferae	*Coronopus squamatus*	Water cress	الحارة	Annual	Broad leaved
Compositae	*Sonchus oleraceus*	Hare’s thistle	الجعضيض	Annual	Broad leaved
Malvaceae	*Malva parviflora*	Small-flowered mallow	الخبيزة	Annual	Broad leaved
Umbelliferae	*Ammi majus*	Bishop’s weed	الخلة	Annual	Broad leaved
Gramineae	*Phalaris spp.*	Lesser canary grass	الفلارس (شعير الفأر)	Annual	Narrow leaves (Grassy)

Table 5. Plant height (cm) of wheat as affected by herbicides before application and after 1,2,4,8 WAA during 2013-2014 and 2014-2015 seasons

Treatments	Rate/fed.	Plant height (cm)									
		Season 2013/2014					Season 2014/2015				
		Before Application	After 1 WAA	After 2 WAA	After 4 WAA	After 8 WAA	Before application	After 1 WAA	After 2 WAA	After 4 WAA	After 8 WAA
Pyroxsulam	160 (cm^3)	11.25^{bc} ±1.50	12.25^{bc} ±2.96	15.25^{bcd} ±2.94	34.00^{ab} ±4.86	72.25^{de} ±2.75	23.75^{bc} ±2.62	25.75^{ef} ±1.52	31.00^{c} ±3.97	41.25^{def} ±1.68	87.50^{b} ±2.70
Pyroxsulam	320 (cm^3)	11.50^{abc} ±3.08	11.75^{c} ±1.52	13.50^{d} ±1.24	32.25^{bcd} ±2.93	70.75^{ef} ±0.97	24.25^{ab} ±6.89	25.50^{f} ±1.57	28.75^{d} ±2.99	40.75^{ef} ±0.95	87.00^{b} ±1.84
Flumetsulam + Florasulam	30 (cm^3)	11.00^{c} ±1.42	13.25^{ab} ±3.50	15.25^{bcd} ±1.95	33.50^{ab} ±3.34	73.00^{d} ±2.81	20.25^{f} ±2.58	26.25^{def} ±1.53	33.75^{ab} ±3.93	44.75^{ab} ±4.10	89.50^{a} ±1.47
Flumetsulam + Florasulam	60 (cm^3)	11.75^{ab} ±2.55	12.25^{bc} ±0.97	14.75^{cd} ±2.98	32.75^{b} ±0.99	73.50^{cd} ±1.45	21.50^{e} ±1.56	26.25^{def} ±0.59	33.75^{ab} ±4.27	42.50^{cde} ±1.26	89.50^{a} ±4.53
Tribenuron -methyl	8.0 (g)	11.00^{c} ±0.96	13.00^{abc} ±2.82	15.50^{bc} ±1.30	33.75^{ab} ±4.11	75.25^{bc} ±4.21	22.25^{de} ±5.69	26.50^{cdef} ±3.77	35.00^{ab} ±1.86	43.75^{abc} ±2.50	88.50^{ab} ±1.74
Tribenuron -methyl	16.0 (g)	11.00^{c} ±1.85	12.50^{abc} ±1.29	14.75^{cd} ±0.92	32.50^{bc} ±1.40	71.50^{de} ±1.48	22.75^{cd} ±1.71	27.00^{abcd} ±0.87	34.50^{ab} ±3.29	45.50^{a} ±1.39	88.25^{ab} ±1.14
Diclofop -methyl	750 (cm^3)	11.00^{c} ±1.61	11.75^{c} ±1.05	15.00^{bcd} ±2.81	31.00^{cd} ±2.44	72.00^{de} ±1.44	22.50^{de} ±0.92	26.75^{bcde} ±3.94	33.50^{b} ±5.21	43.00^{bcd} ±3.37	87.75^{ab} ±1.87
Diclofop -methyl	1500 (cm^3)	11.25^{bc} ±2.58	12.50^{abc} ±3.68	15.50^{bc} ±1.26	34.00^{ab} ±2.87	78.00^{a} ±1.89	25.00^{a} ±9.84	27.50^{abc} ±2.73	35.25^{a} ±1.89	42.25^{cde} ±1.30	88.25^{ab} ±3.97
Tralkoxydim	250 (g)	12.00^{a} ±3.81	13.75^{a} ±1.49	17.25^{a} ±3.15	34.75^{a} ±1.29	76.75^{ab} ±4.50	22.75^{cd} ±1.70	28.00^{a} ±3.89	35.00^{ab} ±0.88	45.50^{a} ±3.45	88.25^{ab} ±1.98
Tralkoxydim	500 (g)	11.75^{ab} ±1.59	12.75^{abc} ±3.95	16.75^{ab} ±0.93	34.00^{ab} ±2.87	73.00^{d} ±1.85	21.75^{de} ±1.28	26.75^{bcde} ±2.50	35.00^{ab} ±3.82	42.00^{cdef} ±1.82	86.75^{b} ±1.09
Unweeded check	----	11.00^{c} ±4.74	13.00^{abc} ±1.81	16.50^{abc} ±3.19	30.75^{d} ±1.50	69.25^{f} ±3.95	23.75^{bc} ±3.67	27.75^{ab} ±8.18	34.25^{ab} ±3.25	40.00^{f} ±4.84	84.50^{c} ±6.30

* WAA: week after application.

*Data presented as the means of four replicates ± SD. Different letters refer to significant difference ($p \leq 0.05$)

markedly increased due to controlling weeds by different herbicide treatments as compared to the unweeded check. The highest values were detected with Derby 30 cm^3 (flumetsulam + florasulam) followed by Granstar 8 g (tribenuron-methyl) and Illoxan 1 L (diclofop-methyl) respectively, and the lowest values were recorded with the unweeded check.

2. Effect of utilized herbicides on percentage of phytotoxicity on wheat.

Data in **Table (6)** showed phytotoxicity percentage in wheat by herbicide treatments, where herbicides tribenuron-methyl (8 &16 g/fed.) and Derby (flumetsulam + florasulam) (30 & 60 cm^3/fed.) did not cause any visible phytotoxicity in both seasons due to selectivity of herbicides on control broad leaved weeds only. These results are compatible with **Baghestani et al (2007b)**, as no wheat injury was observed in response to tribenuron-methyl herbicide treatments according to **Baghestani et al (2007a).**

The phytotoxicity on wheat crop presented a different response when pyroxsulam, diclofop-methyl and tralkoxydim treatments were applied. Low indexes of phytotoxicity on wheat plants were recorded. Phytotoxicity caused by herbicides was very low after 1 WAA; Pyroxsulam (160 & 320 cm^3/fed.) caused 15 and 12.5 % phytotoxicity to wheat in both seasons respectively, diclofop-methyl 10 and 12.5 % with the rates 750 & 1600 cm^3/fed., respectively and similarly in the second season. Tralkoxydim caused the lowest phytotoxicity 7.5, 10.0 and 5.0, 7.5 with the rates 250 & 500 g/fed., at the two seasons, respectively. Medium differences in the phytotoxicity were observed after 2 WAA only in these treatments, values of phytotoxicity ranged between 35 to 40% in treatments of pyroxsulam to diclofop-methyl in the first season and between 12.5 to 25.0% in treatments of tralkoxydim to diclofop-methyl in the second season. The symptoms of phytotoxicity dissipated over time and disappeared completely after 8 WAA, except plants treated by diclofop-methyl herbicide showed very slight phytotoxicity in the second season, this is due to rainfall after approximately 10 days of herbicide application.

Reddy et al (2013) found that pyroxsulam herbicide treatments caused 8 to 13% leaf chlorosis after two weeks of treatment application. However, injury symptoms disappeared and wheat recovered completely within 3 to 4 weeks. An ocular assessment of the tralkoxydim and diclofop-methyl treatments recorded an amount of damage from the treatments causing deficiency of color not more than 1 to 3 percent **(Ziveh and Mahdavi, 2012).** Tralkoxydim causes a visible response that was rated as 1% injury and in other studies tralkoxydim has caused 30% injury to wheat **(Howatt, 2005).**

- **Effectiveness of herbicides on weed control in wheat crop**

1. Effect of tested herbicides on weeds density

The statistical analysis showed that treatment by herbicides had a significant ($p \leq 0.05$) effect on weed density per m^2. Generally, all the tested herbicides significantly decreased weed density compared to the unweeded check treatment throughout the whole growth intervals during 2013-2014 and 2014-2015 seasons.

In the first season, the maximum weed density recorded for each of broadleaved weeds *Anagallis arvensis, Medicago polymorpha* and *Sonchus oleraceus* 8 week after application (WAA) in the unweeded check were 197.50, 19.25 and 0.50 weeds m^{-2}. While minimum weed density recorded with pyroxsulam (320 cm^3/fed.) was 1.50, 0.0 and 0.0 weeds m^{-2} respectively as shown in the **Table (7).**

Data in **Table (8)** illustrate that maximum weed density in the second season for each of broadleaved weeds *Anagallis arvensis, Medicago polymorpha, Beta vulgaris, Coronopus squamatus, Sonchus oleraceus, Malva parviflora* and *Ammi majus* 8 WAA. Density with the unweeded check was 105.25, 23.00, 18.50, 33.50, 5.25, 2.25 and 5.75 weeds m^{-2}. Whilst minimum weed density was recorded with pyroxsulam (320 cm^3/fed.) 8.50, 0.25, 0.00, 1.00, 0.00, 0.00 and 0.00 weeds m^{-2} respectively.

As for the effect of tested herbicide applications on grassy weed density (*Phalaris spp.*), data in **Tables (7 & 8)** illustrate the effect of the evaluated herbicides on the mean weed density of *Phalaris spp*. in both seasons of 2013-2014 and 2014-2015. The highest mean weed density of *Phalaris spp.* was recorded by the unweeded check (84.00 and 22.00 weed m^{-2}) in the 1st and 2nd seasons, respectively. The lowest density was recorded by pyroxsulam (320 cm^3/fed.) (1.50 and 0.25 weed m^{-2}) followed by (4.00 and 2.75 weed m^{-2}) with the lower rate of pyroxsulam (160 cm^3/fed.). These results are compatible with **Chaudhary, (2016)** who found that low weed density of narrow leaved

Table 6. Phytotoxicity percentage of herbicides for wheat after 1,2,4,8 WAA during 2013-2014 and 2014-2015 seasons

Treatments	Rate/fed.	Phytotoxicity (%)							
		Season2013/2014				Season2014/2015			
		After 1 WAA	After 2 WAA	After 4 WAA	After 8 WAA	After 1 WAA	After 2 WAA	After 4 WAA	After 8 WAA
Pyroxsulam	160 (cm^3)	15.00^{a} ±2.78	35.00^{a} ±6.33	7.50^{a} ±1.57	0.00^{a} ±0.00	12.50^{a} ±3.27	17.50^{a} ±2.28	5.00^{bc} ±1.15	0.00^{b} ±0.00
Pyroxsulam	320 (cm^3)	15.00^{a} ±1.53	35.00^{a} ±3.79	10.00^{a} ±0.98	0.00^{a} ±0.00	12.50^{a} ±2.45	17.50^{a} ±5.01	7.50^{b} ±2.00	0.00^{b} ±0.00
Flumetsulam + Florasulam	30 (cm^3)	0.00^{b} ±0.00	0.00^{b} ±0.00	0.00^{b} ±0.00	0.00^{a} ±0.00	0.00^{b} ±0.00	0.00^{b} ±0.00	0.00^{c} ±0.00	0.00^{b} ±0.00
Flumetsulam + Florasulam	60 (cm^3)	0.00^{b} ±0.00	0.00^{b} ±0.00	0.00^{b} ±0.00	0.00^{a} ±0.00	0.00^{b} ±0.00	0.00^{b} ±0.00	0.00^{c} ±0.00	0.00^{b} ±0.00
Tribenuron -methyl	8.0 (g)	0.00^{b} ±0.00	0.00^{b} ±0.00	0.00^{b} ±0.00	0.00^{a} ±0.00	0.00^{b} ±0.00	0.00^{b} ±0.00	0.00^{c} ±0.00	0.00^{b} ±0.00
Tribenuron -methyl	16.0 (g)	0.00^{b} ±0.00	0.00^{b} ±0.00	0.00^{b} ±0.00	0.00^{a} ±0.00	0.00^{b} ±0.00	0.00^{b} ±0.00	0.00^{c} ±0.00	0.00^{b} ±0.00
Diclofop -methyl	750 (cm^3)	10.00^{a} ±4.16	37.50^{a} ±2.89	7.50^{a} ±2.00	0.00^{a} ±0.00	10.00^{a} ±2.16	17.50^{a} ±3.21	7.50^{b} ±1.97	2.50^{a} ±1.68
Diclofop -methyl	1500 (cm^3)	12.50^{a} ±1.18	40.00^{a} ±5.50	10.00^{a} ±1.36	0.00^{a} ±0.00	12.50^{a} ±2.22	25.00^{a} ±3.31	20.00^{a} ±4.19	2.50^{a} ±0.68
Tralkoxydim	250 (g)	7.50^{ab} ±1.83	37.50^{a} ±4.33	5.00^{ab} ±3.33	0.00^{a} ±0.00	5.00^{ab} ±1.03	12.50^{a} ±5.00	0.00^{c} ±0.00	0.00^{b} ±0.00
Tralkoxydim	500 (g)	10.00^{a} ±3.19	37.50^{a} ±2.24	5.00^{ab} ±2.75	0.00^{a} ±0.00	7.50^{ab} ±2.62	15.00^{a} ±2.03	2.50^{bc} ±0.79	0.00^{b} ±0.00
Unweeded check	----	0.00^{b} ±0.00	0.00^{b} ±0.00	0.00^{b} ±0.00	0.00^{a} ±0.00	0.00^{b} ±0.00	0.00^{b} ±0.00	0.00^{c} ±0.00	0.00^{b} ±0.00

* WAA: week after application.

*Data presented as the means of four replicates ± SD. Different letters refer to significant difference ($p \leq 0.05$).

Table 7. Effect of herbicides on weed density (number/m²) for each weed before application and after 1,2,4,8 WAA during 2013-2014 season

Treatments	Rate/ fed.	Time / Weeds	Weed density (number/m²)				
			Before Application	After 1 WAA	After 2 WAA	After 4 WAA	After 8 WAA
Pyroxsulam	160 (cm^3)	*Anagallis arvensis*	443.00^{e} ±16.83	276.50^{g} ±11.41	244.50^{e} ±25.08	97.50^{d} ±9.29	9.00^{e} ±1.91
		Medicago polymorpha	6.75^{b} ±0.50	6.25^{bc} ±0.62	3.25^{d} ±0.91	0.50^{cd} ±0.10	0.00^{c} ±0.00
		Sonchus oleraceus	2.00^{b} ±0.46	1.25^{b} ±0.35	0.25^{b} ±0.09	0.00^{a} ±0.00	0.00^{b} ±0.00
		Phalaris spp.	113.50^{g} ±6.58	79.25^{e} ±3.74	49.75^{f} ±4.60	26.00^{e} ±1.86	4.00^{d} ±1.13
Pyroxsulam	320 (cm^3)	*Anagallis arvensis*	468.00^{bc} ±25.81	333.75^{c} ±17.95	275.75^{b} ±8.94	118.25^{c} ±10.56	1.50^{g} ±0.99
		Medicago polymorpha	6.75^{b} ±0.96	6.75^{b} ±0.51	1.00^{e} ±0.17	0.00^{d} ±0.00	0.00^{c} ±0.00
		Sonchus oleraceus	5.75^{a} ±0.51	5.50^{a} ±0.38	1.50^{a} ±0.23	0.00^{a} ±0.00	0.00^{b} ±0.00
		Phalaris spp.	149.00^{d} ±9.86	83.00^{d} ±1.99	68.00^{b} ±6.82	27.75^{d} ±0.93	1.50^{e} ±0.73
Flumetsulam + Florasulam	30 (cm^3)	*Anagallis arvensis*	468.50^{b} ±14.29	300.50^{e} ±9.32	262.00^{c} ±19.89	120.00^{c} ±8.82	14.00^{d} ±3.63
		Medicago polymorpha	5.25^{c} ±0.97	5.25^{d} ±0.27	4.50^{bc} ±0.77	1.00^{c} ±0.37	1.25^{b} ±0.11
		Sonchus oleraceus	0.50^{de} ±0.05	0.50^{bc} ±0.12	0.00^{b} ±0.00	0.00^{a} ±0.00	0.00^{b} ±0.00
Flumetsulam + Florasulam	60 (cm^3)	*Anagallis arvensis*	523.00^{a} ±12.41	324.75^{d} ±31.97	250.00^{d} ±7.15	93.50^{e} ±15	4.50^{f} ±2.04
		Medicago polymorpha	5.00^{c} ±0.21	5.00^{d} ±0.86	3.75^{cd} ±0.88	0.75^{cd} ±0.44	0.00^{c} ±0.00
		Sonchus oleraceus	0.50^{de} ±0.07	0.50^{bc} ±0.13	0.25^{b} ±0.06	0.00^{a} ±0.00	0.00^{b} ±0.00
Tribenuron - methyl	8.0 (g)	*Anagallis arvensis*	453.75^{d} ±9.70	290.25^{f} ±3.56	238.75^{f} ±15.92	127.50^{b} ±10.21	47.00^{b} ±7.82
		Medicago polymorpha	5.75^{bc} ±0.56	5.50^{cd} ±0.43	5.00^{b} ±1.64	2.75^{b} ±0.48	1.50^{b} ±0.56
		Sonchus oleraceus	1.25^{c} ±0.09	1.25^{b} ±0.31	0.25^{b} ±0.03	0.00^{a} ±0.00	0.00^{b} ±0.00
Tribenuron - methyl	16.0 (g)	*Anagallis arvensis*	436.25^{f} ±7.25	341.50^{b} ±15.04	238.00^{f} ±17.82	128.75^{b} ±3.99	28.25^{c} ±4.70
		Medicago polymorpha	6.50^{b} ±0.55	6.50^{b} ±0.78	4.00^{cd} ±0.79	0.25^{cd} ±0.05	0.00^{c} ±0.00
		Sonchus oleraceus	0.75^{cd} ±0.15	0.75^{bc} ±0.26	0.00^{b} ±0.00	0.00^{a} ±0.00	0.00^{b} ±0.00
Diclofop -methyl	750 (cm^3)	*Phalaris spp.*	118.50^{f} ±5.94	79.75^{e} ±4.74	65.50^{c} ±2.99	37.75^{b} ±2.91	15.50^{b} ±2.07
Diclofop -methyl	1500 (cm^3)	*Phalaris spp.*	182.00^{a} ±4.99	102.25^{bc} ±6.27	66.50^{c} ±1.82	38.25^{b} ±4.14	16.25^{b} ±2.94
Tralkoxydim	250 (g)	*Phalaris spp.*	132.25^{e} ±3.92	103.50^{b} ±5.43	60.50^{e} ±0.95	36.00^{c} ±2.87	15.50^{b} ±1.04
Tralkoxydim	500 (g)	*Phalaris spp.*	157.75^{c} ±1.94	101.5^{c} ±2.23	63.25^{d} ±3.15	25.25^{e} ±0.99	11.00^{c} ±2.89
Unweeded check	----	*Anagallis arvensis*	466.25^{c} ±31.27	422.25^{a} ±22.65	420.25^{a} ±40.77	360.50^{a} ±18.39	197.50^{a} ±16.38
		Medicago polymorpha	8.75^{a} ±1.50	9.25^{a} ±0.82	9.75^{a} ±1.85	14.00^{a} ±0.89	19.25^{a} ±2.01
		Sonchus oleraceus	0.00^{e} ±0.00	0.00^{c} ±0.00	0.00^{b} ±0.00	0.25^{a} ±0.11	0.50^{a} ±0.21
		Phalaris spp.	166.50^{b} ±10.73	154.50^{a} ±7.04	126.5^{a} ±6.07	88.50^{a} ±8.77	84.00^{a} ±3.84

* WAA: week after application.

*Data presented as the means of four replicates ± SD. Different letters refer to significant difference ($p \leq 0.05$).

Table 8. Effect of herbicides on weed density (number/m²) for each weed before application and after 1,2,4,8 WAA during 2014-2015 season

Treatments	Rate/fed.	Time / Weeds	Weed density (number/m²)				
			Before Application	After 1 WAA	After 2 WAA	After 4 WAA	After 8 WAA
Pyroxsulam	160 (cm^{3})	*Anagallis arvensis*	312.75^{a} ±8.70	267.50^{a} ±12.08	148.50^{b} ±6.99	105.25^{b} ±4.50	27.25^{c} ±3.71
		Medicago polymorpha	19.25^{ab} ±1.00	14.00^{bc} ±1.41	12.50^{b} ±0.66	8.25^{b} ±0.95	3.00^{b} ±0.76
		Beta vulgaris	20.25^{d} ±0.95	12.50^{ef} ±2.29	8.50^{d} ±1.40	3.25^{b} ±0.96	0.25^{b} ±0.07
		Coronopus squamatus	40.00^{c} ±2.81	20.25^{f} ±1.50	14.00^{e} ±0.82	9.75^{c} ±1.74	2.75^{b} ±1.03
		Sonchus oleraceus	5.50^{a} ±0.27	4.00^{a} ±0.51	2.75^{ab} ±0.61	1.00^{b} ±0.15	0.25^{b} ±0.11
		Malva parviflora	2.00^{ab} ±0.21	1.75^{ab} ±0.30	0.75^{ab} ±0.09	0.25^{b} ±0.08	0.00^{b} ±0.00
		Ammi majus	1.00^{b} ±0.15	0.75^{c} ±0.09	0.75^{b} ±0.26	0.25^{b} ±0.01	0.00^{b} ±0.00
		Phalaris spp.	60.50^{a} ±1.09	35.00^{a} ±1.15	24.50^{c} ±1.19	21.00^{b} ±2.82	2.75^{d} ±0.92
Pyroxsulam	320 (cm^{3})	*Anagallis arvensis*	268.75^{b} ±5.95	203.25^{b} ±9.28	152.75^{a} ±3.04	93.25^{c} ±9.17	8.50^{e} ±2.31
		Medicago polymorpha	20.50^{a} ±2.01	14.75^{b} ±0.97	11.25^{b} ±1.05	4.50^{d} ±0.19	0.25^{c} ±0.05
		Beta vulgaris	17.25^{e} ±1.50	15.50^{d} ±1.24	13.75^{c} ±0.98	1.25^{bc} ±0.61	0.00^{b} ±0.00
		Coronopus squamatus	37.25^{d} ±1.25	34.00^{c} ±2.81	29.75^{b} ±1.40	12.75^{b} ±0.97	1.00^{bc} ±0.41
		Sonchus oleraceus	4.25^{ab} ±0.54	3.00^{ab} ±0.36	1.75^{bc} ±0.26	0.50^{b} ±0.11	0.00^{b} ±0.00
		Malva parviflora	2.00^{ab} ±0.61	1.50^{ab} ±0.13	0.75^{ab} ±0.15	0.00^{b} ±0.00	0.00^{b} ±0.00
		Ammi majus	0.25^{b} ±0.05	0.25^{c} ±0.05	0.25^{b} ±0.01	0.00^{b} ±0.00	0.00^{b} ±0.00
		Phalaris spp.	39.50^{c} ±1.41	32.00^{b} ±2.72	24.75^{c} ±2.54	13.75^{d} ±1.05	0.25^{e} ±0.09
Flumetsulam + Florasulam	30 (cm^{3})	*Anagallis arvensis*	217.25^{e} ±4.75	165.75^{e} ±3.42	104.00^{e} ±2.85	70.50^{f} ±7.35	10.00^{de} ±2.03
		Medicago polymorpha	19.00^{ab} ±1.22	12.50^{cd} ±1.09	8.25^{c} ±0.95	6.00^{bcd} ±1.14	2.75^{b} ±0.92
		Beta vulgaris	44.00^{a} ±1.87	32.00^{b} ±1.82	17.50^{b} ±1.02	0.75^{bc} ±0.16	0.00^{b} ±0.00
		Coronopus squamatus	40.75^{c} ±2.70	35.25^{c} ±1.92	27.75^{c} ±0.97	7.50^{d} ±0.94	0.25^{c} ±0.17
		Sonchus oleraceus	2.25^{b} ±0.44	1.50^{b} ±0.58	0.50^{c} ±0.30	0.25^{b} ±0.03	0.00^{b} ±0.00
		Malva parviflora	1.25^{b} ±0.15	0.75^{b} ±0.21	0.75^{ab} ±0.07	0.00^{b} ±0.00	0.00^{b} ±0.00
		Ammi majus	1.75^{b} ±0.61	1.75^{bc} ±0.25	1.50^{b} ±0.48	0.25^{b} ±0.10	0.00^{b} ±0.00
Flumetsulam + Florasulam	60 (cm^{3})	*Anagallis arvensis*	227.25^{d} ±2.50	190.00^{c} ±9.08	129.50^{c} ±6.12	90.75^{d} ±3.47	11.75^{de} ±3.37
		Medicago polymorpha	17.75^{b} ±0.97	15.00^{ab} ±0.52	11.50^{b} ±1.32	6.75^{bcd} ±0.87	2.25^{b} ±0.96
		Beta vulgaris	18.75^{de} ±1.28	13.75^{de} ±0.97	8.75^{d} ±0.89	0.00^{c} ±0.00	0.00^{b} ±0.00
		Coronopus squamatus	37.25^{d} ±0.92	30.75^{d} ±1.10	27.50^{c} ±2.11	13.75^{b} ±1.05	0.25^{c} ±0.17
		Sonchus oleraceus	2.50^{b} ±0.65	2.00^{b} ±0.70	0.75^{bc} ±0.12	0.25^{b} ±0.09	0.00^{b} ±0.00
		Malva parviflora	1.50^{b} ±0.38	0.75^{b} ±0.15	0.50^{b} ±0.31	0.00^{b} ±0.00	0.00^{b} ±0.00
		Ammi majus	0.25^{b} ±0.08	0.25^{c} ±0.06	0.25^{b} ±0.02	0.00^{b} ±0.00	0.00^{b} ±0.00
Tribenuron - methyl	8.0 (g)	*Anagallis arvensis*	263.50^{c} ±13.44	179.75^{d} ±4.92	113.50^{d} ±11.21	89.75^{d} ±3.70	38.00^{b} ±6.01
		Medicago polymorpha	13.75^{c} ±0.67	11.50^{d} ±1.04	8.00^{c} ±0.41	5.50^{cd} ±1.02	1.50^{bc} ±0.77
		Beta vulgaris	18.25^{de} ±0.57	11.25^{f} ±0.87	7.25^{d} ±0.85	1.00^{bc} ±0.22	0.00^{b} ±0.00
		Coronopus squamatus	32.25^{e} ±2.01	24.75^{e} ±1.29	20.00^{d} ±0.89	13.25^{b} ±3.10	0.50^{c} ±0.31
		Sonchus oleraceus	2.25^{b} ±0.11	1.25^{b} ±0.22	1.00^{bc} ±0.31	0.50^{b} ±0.13	0.25^{b} ±0.10
		Malva parviflora	1.25^{b} ±0.32	1.25^{ab} ±0.27	0.75^{ab} ±0.16	0.25^{b} ±0.05	0.00^{b} ±0.00
		Ammi majus	0.75^{b} ±0.09	0.25^{c} ±0.01	0.25^{b} ±0.10	0.00^{b} ±0.00	0.00^{b} ±0.00
Tribenuron - methyl	16.0 (g)	*Anagallis arvensis*	204.25^{f} ±20.28	156.75^{f} ±7.78	105.75^{e} ±9.70	79.50^{e} ±14.77	18.75^{cd} ±2.95
		Medicago polymorpha	19.25^{ab} ±0.23	15.75^{ab} ±1.25	11.50^{b} ±0.91	7.25^{bc} ±0.72	2.25^{b} ±0.32
		Beta vulgaris	37.25^{b} ±0.99	24.75^{c} ±1.82	14.00^{c} ±0.88	2.50^{bc} ±0.73	0.00^{b} ±0.00
		Coronopus squamatus	55.00^{a} ±0.87	37.25^{b} ±3.99	27.00^{c} ±2.15	10.75^{c} ±0.82	2.00^{bc} ±0.44
		Sonchus oleraceus	4.25^{ab} ±0.62	2.50^{ab} ±0.09	1.25^{bc} ±0.50	1.00^{b} ±0.25	0.00^{b} ±0.00
		Malva parviflora	3.50^{a} ±0.13	2.50^{a} ±0.35	2.00^{ab} ±0.20	0.50^{b} ±0.29	0.25^{b} ±0.07
		Ammi majus	4.25^{a} ±0.41	3.25^{b} ±0.62	1.50^{b} ±0.48	0.50^{b} ±0.07	0.00^{b} ±0.00
Diclofop -methyl	750 (cm^{3})	*Phalaris spp.*	37.75^{c} ±2.34	29.75^{c} ±1.40	23.75^{c} ±1.09	18.25^{c} ±1.74	11.00^{b} ±0.89
Diclofop -methyl	1500 (cm^{3})	*Phalaris spp.*	28.75^{d} ±1.52	21.25^{d} ±0.97	16.50^{d} ±1.83	6.50^{e} ±0.57	2.25^{d} ±0.53
Tralkoxydim	250 (g)	*Phalaris spp.*	46.50^{b} ±0.79	35.25^{a} ±2.11	27.75^{b} ±0.96	21.00^{b} ±1.64	9.50^{c} ±1.99
Tralkoxydim	500 (g)	*Phalaris spp.*	39.50^{c} ±1.61	32.50^{b} ±1.24	24.00^{c} ±2.52	16.75^{c} ±2.20	9.00^{c} ±0.86
Unweeded check	----	*Anagallis arvensis*	142.50^{g} ±9.48	148.00^{g} ±14.81	146.75^{b} ±5.33	119.00^{a} ±6.04	105.25^{a} ±11.53
		Medicago polymorpha	13.50^{c} ±1.06	17.00^{a} ±2.15	22.25^{a} ±1.51	25.50^{a} ±1.31	23.00^{a} ±1.12
		Beta vulgaris	30.25^{c} ±1.32	36.25^{a} ±2.74	39.50^{a} ±0.94	35.25^{a} ±2.72	18.50^{a} ±1.76
		Coronopus squamatus	52.25^{b} ±1.75	52.00^{a} ±1.15	57.50^{a} ±1.52	54.25^{a} ±1.50	33.50^{a} ±3.02
		Sonchus oleraceus	2.00^{b} ±0.33	2.00^{b} ±0.74	4.00^{a} ±0.34	4.00^{a} ±0.84	5.25^{a} ±0.46
		Malva parviflora	1.75^{b} ±0.28	2.50^{a} ±0.27	2.25^{a} ±0.70	3.50^{a} ±0.39	2.25^{a} ±0.32
		Ammi majus	4.00^{a} ±1.00	5.50^{a} ±0.67	4.25^{a} ±0.43	7.75^{a} ±0.66	5.75^{a} ±0.39
		Phalaris spp.	38.50^{c} ±3.32	36.00^{a} ±2.56	35.00^{a} ±3.98	29.75^{a} ±1.65	22.00^{a} ±1.27

* WAA: week after application

*Data presented as the means of four replicates ± SD. Different letters refer to significant difference (p≤ 0.05).

and broad leaved weeds at four weeks after spray (3.61 and 2.25 weed m^{-2}) was obtained by Pallas compared to control (103.08 and 38.00 weed m^{-2}) respectively. Also the results were supported by **Mitiku and Dalga, (2014)** who reported minimum weed density with a Pallas treated plot (10.67 m^2) whereas maximum weed density was recorded at control plot (69 m^2).

2. Effect of tested herbicides on fresh weight of wheat weeds after 56 day post treatment.

2.1. Broad leaved weeds

In both tested seasons, all herbicide treatments significantly (p≤0.05) decreased the fresh weight of prevailed broad leaved weeds compared to unweeded check.

Results in **Table (9)** indicated the mean of fresh weight (g m^{-2}) during the first season 2013-2014 for broadleaved weeds, *Anagallis arvensis, Medicago polymorpha* and *Sonchus oleraceus*. In this **Table (9)** the unweeded check was 122.12, 27.74 and 0.87 g m^{-2}, respectively. While all used herbicides significantly reduced fresh weights of broad leaved weeds and caused the disappearance of some weeds, thus gave high weed control percentage compared to the unweeded check treatment. The highest weed control percentage 99.59 & 99.24% was recorded by pyroxsulam (320cm^3 /fed.) and flumetsulam + florasulam (60 cm^3/fed.), respectively **(Table 9)**.

At the second season 2014-2015, the same trend was observed where maximum fresh weed weights (g m^{-2}) of broadleaved weeds predominant, *Anagallis arvensis, Medicago polymorpha, Beta vulgaris, Coronopus squamatus, Sonchus oleraceus, Malva parviflora* and *Ammi majus* were recorded in the unweeded check weights of 41.70, 178.00, 149.50, 101.73, 11.88, 6.18 and 5.35 g m^{-2} respectively. The data of all herbicide treatments gave minimum fresh weight of broadleaved weeds, i.e. gave higher weed control percentage compared to unweeded check treatment as shown in the **Table (10)**.

In terms of figures, the weed control percentage of broad leaved weeds reached 98.86 & 99.81% for pyroxsulam (160 & 320 cm^3/fed.), 99.46 & 99.40% for flumetsulam + florasulam (30 & 60cm^3/fed.) and 99.09 & 99.43% for tribenuron - methyl (8 & 16 g/fed.), respectively. The results clearly indicated that the fresh weed weight of the broadleaved weeds varied from season to another according to their species. All herbicide treatments were superior compared to unweeded check in reducing the fresh weight of broadleaved weeds after 56 days from herbicide application. These results of pyroxsulam herbicide conform with **Mahmoud et al (2016).** Derby (flumetsulam + florasulam) and Granster (tribenuron methyl) treatments had differential effect on individual broadleaved weeds and were highly effective (WCE %) during the two seasons 2010-2011 and 2011-2012 **(El-Kholy et al 2013)**.

2.2. Grassy weeds

Data in **Table (11)** indicated the fresh weight of predominant grassy weeds in the experimental wheat field during the two seasons (one grassy weed *Phalaris spp.*). All the herbicide treatments had significantly (p≤0.05) reduced the fresh weight of grassy weeds compared to unweeded check and recorded 86.37 & 81.25 g m^{-2} at both seasons, respectively. Maximum significant control percent was realized by pyroxsulam (160 & 320 cm^3/fed.) where it recorded 92.05 and 95.86% reduction in fresh weight at first season but in the second season pyroxsulam (320 cm^3/fed.) gave 100% reduction in fresh weight of grassy weeds followed by 93.82% at the rate160 cm^3/fed. The other herbicide treatments had less control than pyroxsulam against grassy weeds, this may be due to severe infestation of *Phlaris spp*. This result agreed with **Mahmoud et al (2016)** who reported that pyroxsulam provided excellent control for *Phlaris minor* at Alexandria and El-Beheira governorates. **Marzouk, (2013)** reported that grassy weeds were controlled by diclofop-methyl where it reduced fresh weight of grassy weeds by 81.50%, followed by tralkoxydim (80.01%) in 2010-2011 season. Similar trend of results was found in 2011-2012 season.

- **Effect of tested herbicides on yield attributes and quality of output wheat**

Data in **Table (12)** indicated that the weeds affect yield attributes and quality of wheat as it competes with wheat for nutrients and other requirements through the following:

- **Spike length:** a minimum of spike length was recorded in unweeded check (16.00 and 16.75 cm) during two seasons respectively. The results revealed that all the herbicide treatments significantly (p≤0.05) increased the spike length compared to unweeded check. In first season, the maximum

Table 9. Fresh weight of broad leaved weeds (gm/m^2) as affected by herbicides after 56 days from herbicide application during 2013-2014 seasons

Treatments	Rate/fed.	Fresh weight of broad leaved weeds (gm/m^2)			Total of all weeds	% of weed control
		Anagallis arvensis	*Medicago polymorpha*	*Sonchus oleraceus*		
Pyroxsulam	160 (cm^3)	2.95^d ±1.53	0.00^d ±0.00	0.00^b ±0.00	2.95	98.05
Pyroxsulam	320 (cm^3)	0.63^f ±0.42	0.00^d ±0.00	0.00^b ±0.00	0.63	99.59
Flumetsulam + Florasulam	30 (cm^3)	1.75^e ±0.26	0.32^c ±0.03	0.00^b ±0.00	2.07	98.62
Flumetsulam + Florasulam	60 (cm^3)	1.15^{ef} ±0.19	0.00^d ±0.00	0.00^b ±0.00	1.15	99.24
Tribenuron - methyl	8.0 (g)	18.99^b ±3.37	0.99^b ±0.08	0.00^b ±0.00	19.98	86.74
Tribenuron - methyl	16.0 (g)	12.62^c ±1.31	0.03^d ±0.06	0.00^b ±0.00	12.65	91.61
Unweeded check	----	122.12^a ±6.71	27.74^a ±3.42	0.87^a ±1.00	150.72	0.00

*Data presented as the means of four replicates ± SD. Different letters refer to significant difference (p≤ 0.05).

Table 10. Fresh weight of broad leaved weeds (gm/m^2) as affected by herbicides after 56 days from herbicide application during 2014-2015 seasons

Treatments	Rate/ fed.	Fresh weight of broad leaved weeds (gm/m^2)							Total of all weeds	% of weed control
		Anagallis arvensis	*Medicago polymorpha*	*Beta vulgaris*	*Coronopus squamatus*	*Sonchus oleraceus*	*Malva parviflora*	*Ammi majus*		
Pyroxsulam	160 (cm^3)	1.23^{cd} ±0.15	2.25^b ±0.19	0.08^b ±0.15	0.83^b ±0.12	0.75^b ±0.17	0.33^b ±0.06	0.18^c ±1.09	5.63	98.86
Pyroxsulam	320 (cm^3)	0.75^d ±0.13	0.13^e ±0.25	0.00^b ±0.00	0.08^c ±0.15	0.00^d ±0.00	0.00^c ±0.00	0.00^d ±0.00	0.95	99.81
Flumetsulam + Florasulam	30 (cm^3)	0.85^d ±0.06	1.83^{bc} ±0.09	0.00^b ±0.00	0.00^c ±0.00	0.00^d ±0.00	0.00^c ±0.00	0.00^d ±0.00	2.68	99.46
Flumetsulam + Florasulam	60 (cm^3)	1.28^{cd} ±0.11	1.23^{cd} ±0.05	0.00^b ±0.00	0.00^c ±0.00	0.20^c ±0.08	0.00^c ±0.00	0.25^b ±0.07	2.95	99.40
Tribenuron - methyl	8.0 (g)	3.38^b ±0.15	1.08^{cde} ±0.72	0.00^b ±0.00	0.00^c ±0.00	0.05^{cd} ±0.10	0.00^c ±0.00	0.00^d ±0.00	4.50	99.09
Tribenuron - methyl	16.0 (g)	1.53^c ±0.05	0.73^{de} ±0.49	0.00^b ±0.00	0.20^{bc} ±0.23	0.00^d ±0.00	0.38^b ±0.13	0.00^d ±0.00	2.83	99.43
Unweeded check	----	41.70^a ±4.01	178.00^a ±9.41	149.50^a ±3.29	101.73^a ±5.23	11.88^a ±1.91	6.18^a ±0.94	5.35^a ±1.86	494.33	0.00

*Data presented as the means of four replicates ± SD. Different letters refer to significant difference (p≤ 0.05).

Table 11. Fresh weight of grassy weeds (gm/m^2) as affected by herbicides after 56 days from herbicide application during 2013-2014 and 2014-2015 seasons

Treatments	Rate/fed.	Fresh weight of grassy weeds (gm/m^2)			
		2013/2014		2014/2015	
		Phalaris spp.	% of weed control	*Phalaris spp.*	% of weed control
Pyroxsulam	160 (cm^3)	6.87^e ±0.97	92.05	5.03^e ±1.67	93.82
Pyroxsulam	320 (cm^3)	3.58^f ±0.88	95.86	0.00^f ±0.00	100.00
Diclofop -methyl	750 (cm^3)	24.84^b ±4.39	71.25	16.55^b ±1.51	79.63
Diclofop -methyl	1500 (cm^3)	17.20^d ±2.61	80.09	6.93^d ±1.61	91.48
Tralkoxydim	250 (g)	20.66^c ±2.90	76.08	15.53^c ±0.85	80.89
Tralkoxydim	500 (g)	15.67^d ±1.15	81.86	15.30^c ±2.58	81.17
Unweeded check	----	86.37^a ±3.09	0.00	81.25^a ±8.96	0.00

*Data presented as the means of four replicates ± SD. Different letters refer to significant difference (p≤ 0.05).

spike length recorded was 18.25 cm with flumetsulam + florasulam (60 cm^3/fed.). The rest of the treatments had no significant differences between the treatments as in length (17.75 or 17.50 cm) except with diclofop-methyl (750 cm^3/fed.) which recorded 17.25 cm. For the second season maximum spike length was recorded as 18.50 cm by pyroxsulam (320 cm^3/fed.) and diclofop-methyl (1500 cm^3/fed.), but the remaining treatments had no significant differences between them in length (18.25 or 18.00 or 17.75 cm) except for with tralkoxydim (250 g/fed.) which recorded 17.50 cm. These results are compatible with **El-Rokiek et al (2012)** they reported that Derby herbicide significantly increased spike length for wheat (10.4 cm) in comparison to the unweeded control (7.1 cm). Also, these results are in good harmony with those obtained by **Mitiku and Dalga, (2014)** they reported that maximum spike length recorded was by the application of Pallas (pyroxsulam). These results are also compatible with **Soliman and Hamza, (2015); El Metwally et al (2015b) and El-Metwally & El-Rokiek, (2007)**.

- **Biological yield:** The statistical analysis of the data showed that different treatments of herbicides had a significant increase in the biological yield compared with unweeded check which recorded minimum biological yield of 22.03 and 25.40 kg/20m^2 in both seasons (2013-2014 and 2014-2015) respectively. While maximum limits for biological yield in the first season of 32.80, 31.18 then 29.48 kg/20m^2 were produced by tralkoxydim (250 g/fed.), pyroxsulam (160 cm^3/fed.) then diclofop-methyl (1500 cm^3/fed.). The rest of the herbicide treatments recorded biological yield that ranged from 29.15 to 27.20 kg/20m^2. But in the second season pyroxsulam (160 and 320 cm^3/fed.) and flumetsulam + florasulam (30 cm^3/fed.) recorded the highest biological yield of 33.83, 33.55 and 33.00 kg/20m^2 respectively. The remaining herbicide treatments recorded biological yield that ranged from 32.95 to 29.23 kg/20m^2. These results were in line with the findings of **El-Metwally & El-Rokiek, (2007); Abouziena et al (2011) and El-Kholy et al (2013)**.

- **Grain yield:** The different herbicidal treatments had a significant (p≤0.05) effect on the grain yield, where all treatments significantly exceeded the unweeded check treatment in grain yield (kg/20m^2) during the two growing seasons. Perusal of the ANOVA showed that maximum grain yield was recorded (10.95 & 10.45 kg/20m^2) and (11.46 &10.91 kg/20m^2) by pyroxsulam (160 & 320 cm^3/fed.) during the two seasons respectively, followed by 10.13 kg/20m^2 with tralkoxydim (250 g/fed.) in first season and 10.83 kg/20m^2 with flumetsulam + florasulam (30 cm^3/fed.) in second season. In the same regard, the remining treatments increased grain yield ranging from 9.38 to 8.63 kg/20m^2 in first season and from10.73 to 9.89 kg/20m^2 in second season compared to the unweeded check treatment which recorded minimum grain yield of 7.70 and 9.30 kg/20m^2 in both two seasons respectively. These results were in line with the findings of **Mitiku and Dalga, (2014)** who reported the maximum grain yield that was harvested in Pallas (pyroxsulam) treated plots with the mean of 4161 kg/ha while minimum grain yield was

Table 12. Attributes and quality of wheat affected by herbicides application during 2013-2014 and 2014-2015 seasons

Treatments	Rate/fed.	Yield attributes						Yield quality					
								1000-grains weight (g)		Chemical composition of wheat grains			
		Spike length (cm)		Biological yield (kg/20m^2)		Grain yield (kg/20m^2)				Total carbohydrates % (g/100g DW)		Crude protein (%)	
		2013/14	2014/15	2013/14	2014/15	2013/14	2014/15	2013/14	2014/15	2013/14	2014/15	2013/14	2014/15
Pyroxsulam	160 (cm^3)	17.50^{ab} ±0.77	18.25^{ab} ±1.09	31.18^{b} ±0.83	33.83^{a} ±0.33	10.95^{a} ±0.16	11.46^{a} ±0.51	46.74^{a} ±1.60	52.22^{a} ±1.14	72.84^{bc} ±0.20	73.68^{c} ±0.53	11.03^{b} ±0.11	10.17^{bcd} ±0.04
Pyroxsulam	320 (cm^3)	17.75^{ab} ±0.40	18.50^{a} ±0.85	29.05^{c} ±0.65	33.55^{ab} ±1.42	10.45^{b} ±0.26	10.91^{ab} ±0.37	44.99^{cd} ±0.77	50.86^{b} ±0.50	73.03^{b} ±0.15	73.98^{bc} ±0.21	10.99^{bc} ±0.16	10.57^{ab} ±0.17
Flumetsulam + Florasulam	30 (cm^3)	17.50^{ab} ±0.99	17.75^{ab} ±0.37	28.78^{c} ±1.37	33.00^{b} ±0.78	8.83^{de} ±0.41	10.83^{b} ±0.32	44.87^{d} ±1.67	50.35^{bcd} ±2.24	72.90^{bc} ±0.66	73.93^{bc} ±0.18	10.97^{bcd} ±0.13	10.13^{cd} ±0.09
Flumetsulam + Florasulam	60 (cm^3)	18.25^{a} ±0.19	18.00^{ab} ±0.66	27.78^{d} ±0.22	32.20^{c} ±0.79	8.68^{e} ±0.22	10.09^{d} ±0.43	45.41^{bcd} ±1.42	52.19^{a} ±0.76	73.10^{b} ±0.35	74.06^{abc} ±0.14	11.33^{a} ±0.07	10.62^{a} ±0.14
Tribenuron - methyl	8.0 (g)	17.75^{ab} ±0.66	18.00^{ab} ±0.82	28.60^{c} ±0.80	31.30^{d} ±0.41	9.23^{cd} ±0.23	10.34^{bcd} ±0.21	44.24^{e} ±2.23	49.89^{cde} ±0.95	72.62^{bc} ±0.40	73.22^{d} ±0.09	10.71^{bcde} ±0.23	10.43^{abc} ±0.19
Tribenuron - methyl	16.0 (g)	17.75^{ab} ±1.35	17.75^{ab} ±0.84	29.03^{c} ±0.53	32.95^{bc} ±2.01	9.28^{c} ±0.42	10.44^{bcd} ±0.3	45.55^{bc} ±0.89	49.79^{de} ±1.19	73.81^{a} ±0.17	74.13^{abc} ±0.32	10.65^{de} ±0.14	10.23^{abcd} ±0.25
Diclofop - methyl	750 (cm^3)	17.25^{b} ±0.60	18.25^{ab} ±0.54	27.20^{d} ±2.08	29.88^{e} ±1.13	8.63^{e} ±0.27	9.89^{d} ±0.14	45.77^{b} ±0.26	50.41^{bc} ±2.04	72.33^{c} ±0.29	73.22^{d} ±0.38	10.67^{cde} ±0.04	10.09^{cd} ±0.20
Diclofop - methyl	1500 (cm^3)	17.50^{ab} ±1.31	18.50^{a} ±0.73	29.48^{c} ±0.46	31.45^{d} ±0.41	9.38^{c} ±0.36	10.38^{bcd} ±0.38	45.72^{b} ±1.78	49.92^{cde} ±0.75	71.38^{d} ±0.41	72.53^{e} ±0.47	10.71^{bcde} ±0.12	10.17^{bcd} ±0.16
Tralkoxydim	250 (g)	17.50^{ab} ±0.33	17.50^{bc} ±0.59	32.80^{a} ±0.99	29.23^{e} ±0.56	10.13^{b} ±0.15	10.11^{cd} ±0.48	45.22^{bcd} ±1.14	49.52^{e} ±0.68	73.09^{b} ±0.33	74.15^{ab} ±0.19	10.73^{bcde} ±0.23	10.03^{cd} ±0.06
Tralkoxydim	500 (g)	17.75^{ab} ±0.50	18.00^{ab} ±0.84	29.15^{c} ±0.54	32.85^{bc} ±0.63	9.33^{c} ±0.18	10.73^{bc} ±0.32	45.18^{bcd} ±0.81	50.75^{b} ±1.26	73.91^{a} ±0.54	74.46^{a} ±0.27	10.83^{bcde} ±0.18	10.34^{abc} ±0.10
Unweeded check	----	16.00^{c} ±1.63	16.75^{c} ±0.63	22.03^{e} ±1.94	25.40^{f} ±1.32	7.70^{f} ±0.45	9.30^{e} ±0.43	43.65^{f} ±1.96	48.92^{f} ±1.99	70.50^{e} ±0.35	71.64^{f} ±0.28	10.53^{e} ±0.21	9.86^{d} ±0.14

*Data presented as the means of four replicates ± SD. Different letters refer to significant difference ($p \leq 0.05$).

recorded at the control plots with mean 2317 kg/ha. This is due to pyroxsulam being more toxic for both grassy and broadleaved weeds than other herbicides. This was confirmed by both of **Sareta et al (2016)** and **Dalga et al (2014)**. Treating with tralkoxydim herbicide significantly increased grains yields as compared to unweeded control **(Kandil and Ibrahim, 2011; Pandey and Verma, 2002)**. The increase in grain yield for the remaining herbicide treatments was confirmed by several authors (**Abouziena et al 2011; El-Rokiek et al 2012; El-Metwally and El-Rokiek, 2007; Ali et al 2016; Javaid et al 2010).**

- Weight of 1000 grains: It is an important yield component in wheat quality. Analysis of the data has shown that all treatments were significantly effective on augment 1000 grain weight compared with unweeded check treatment in both seasons. Where the highest 1000 grain weight (46.74 g) was obtained with pyroxsulam (160 cm^3/fed.) followed by (45.77 and 45.72 g) with diclofop-methyl (750 and 1500 cm^3/fed.) and these two treatments were statistically similar to each other, the rest of the treatments were given 1000-grain weight from 45.55 to 44.24 at first season. While that maximum 1000 grain weight in second season was recorded 52.22 and 52.19 g with pyroxsulam (160 cm^3/fed.) and flumetsulam + florasulam (60 cm^3/fed.) respectively and these treatments were statistically similar and the remaining treatments ranged from 50.86 to 49.52 g. While the lowest 1000 grain weight 43.65 and 48.92 g were observed in the unweeded check in both seasons, respectively. The result was in agreement with **Sareta et al (2016)** they reported the highest 1000 grains weight was recorded (47.85 g) with pyroxsulam herbicide while the lowest 1000 grains weight recorded (46.8 g) in the weed check. Too, similar results were reported by **Chaudhary, (2016)** and **El-Metwally et al (2015a)**. For the results of the rest of the herbicides treatments are compatible with **El-Metwally and El-Rokiek, (2007); Marzouk, (2013); Shehzad et al (2012) and Javaid & Tanveer, (2013).**

Chemical composition of wheat grains

- Total carbohydrates: Using all tested herbicide treatments led to a significant increase in carbohydrate content. Where the highest total carbohydrate (73.91 and 73.81%) was obtained in the first season from treatments tralkoxydim (500 g/fed.) and tribenuron methyl (16 g/fed.) followed by (73.10 & 73.09%) by flumetsulam + florasulam (60cm^3/fed.) and tralkoxydim (250 g/fed.) respectively and these treatments were statistically similar. For the second season, it recorded highest total of carbohydrate (74.46%) with tralkoxydim (500 g/fed.) follow by (74.15, 74.13 & 74.06%) with tralkoxydim (250 g/fed.), tribenuron methyl (16 g/fed.) and flumetsulam + florasulam (60cm^3/fed.) respectively and these treatments were statistically similar almost. In contrast, the lowest statistical values of total carbohydrate (70.50 & 71.64%) showed in the unweeded check in both seasons, respectively. Similar result was obtained by **El-Metwally et al (2015b)** and **El-Rokiek et al (2012).**

- Crude protein: All used herbicides significantly improved of crude protein percentage in wheat grains, where maximum recorded of crude protein percentage in both seasons 11.33% and 10.62% with flumetsulam + florasulam (60 cm^3/fed.) respectively, follow them 11.03% recorded by pyroxsulam (160 cm^3/fed.) in first season and 10.57% recorded by pyroxsulam (320 cm^3/fed.) in second season, the highest percentage recorded by higher concentration of pyroxsulam. It was due to severe infestation of many broadleaved weeds in the second season compared to the first season. Increase in the remaining treatments ranged from 10.99% to10.65 % in first season and 10.43% to 10.03% in second seasons. In contrast, the minimum of crude protein 10.53% and 9.86%, that obtained from the unweeded check in both seasons, respectively. These results are compatible with **El-Rokiek et al (2012)** they reported that the marked increases of protein contents in the grains due to used treatment of Derby (flumetsulam + florasulam) herbicide compared to the unweeded control. **El-Metwally et al (2015a)** found that the use of pyroxsulam herbicide led to increases crude protein (10.62 & 10.45 %) in wheat grains compared to the unweeded (9.19 & 9.28 %) in the two seasons (2012/2013 & 2013/2014), respectively. Results of the remaining treatments were supported by several authors **(El-Metwally et al 2015b; Kandil and Ibrahim, 2011; Peltzer and Bowran, 1996).**

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