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Efficacy of Certain Tribenuron-Methyl Formulations for the Control of Broad-Leaved Weeds in Wheat under Field Conditions

El-Kholy, R. M. A. and M. F. El-Tawil
Department of Plant Protection, Fac. of Agric. (Cairo), Al-Azhar University, Egypt.

ABSTRACT

Two field experiments were conducted during 2017-2018 and 2018-2019 seasons to evaluate the effect of eight tribenuron-methyl formulations (four as WG 75% and four as DF 75%) beside hand weeding (twice at 21 and 42 DAS) on broad-leaved weeds (BLWs) in wheat under field conditions. All the agricultural practices were carried out uniformly as recommended. All treatments were arranged in randomized complete block design and replicated four times each of 42 m^2 (6×7 m). All formulations were applied at the rate of 8.0 gm $fed.^{-1}$ in 200 L. water $fed.^{-1}$ by Knapsack sprayer (CP3) at 30 days after sowing (DAS). After two months from sowing (2MAS) (one month after treatment, one MAT), weeds were collected from an area of $2m^2$ which was randomly selected from each plot (by using a square woody frame, 50 cm×50 cm). The removed annual BLWs were identified and counted for density as number m^{-2} and biomass [fresh weight gm m^{-2}] in all treatments. In the untreated control, biomass, biomass%, density and density% for each BLW were recorded. The common prevailed annual BLWs in the experimental wheat field during both seasons were annual Sowthistle (*Sonchus oleraceus* L.), cheese weed, little mallow (*Malva parviflora* L.), chicory (*Cichorium pumpilum* Jacq.), dentated dock (*Rumex dentatus* L.), medic (*Medicago intertexta* (L.) Mill.), scarlet pimpernel (*Anagallis arvensis* L.), sea beet, wild beet (*Beta vulgaris* L.) and sweet clover, Indian melilot (*Melilotus indica* L.). The results clearly indicated that biomass and density were varied according to the dominant weed species and from season to another. The BLWs were the most dominant and also they were common in wheat fields and the biomass and density of BLWs were varied between years and weeds. The herbicidal treatments gave the minimum weed biomass and density and gave good weed control efficiency (WCE %) than hand weeding treatments. Granstar formulation completely controlled *C. pumpilum* weed (in the first season), *A. arvensis*, *R. dentatus* and *S. oleraceus* weeds (in the second season). Skylla formulation completely controlled *M. parviflora* and *R. dentatus* weeds in the first season. The tested tribenuron-methyl formulations did not cause complete control for *B. vulgaris*, *M. intertexta* and *M. indica* weeds in both seasons. In all cases, the herbicidal treatments increased significantly the biological yield, grain yield, straw yield, harvest index and thousand grain weight in comparison with untreated control. Also, Granstar, Skylla and Cash Cool herbicides were the most effective, while Ownostar was the least effective. We can concluded that, Granstar, Skylla and Cash Cool formulations are the most effective in controlling broad-leaved weeds in wheat field and consequently increased the grain yield.

Keywords: Wheat, Broad-leaved weeds, Post-emergence herbicides, Tribenuron-methyl formulations.

INTRODUCTION

Wheat (*Triticum aestivum* L.) is an annual winter crop belongs to family Gramineae and is considered one of the most important cereal crops in Egypt and in the world (Safina and Absy, 2017). This crop is recorded as a staple food for billions of people all over the world and its straw is used a major animal feed (Saad *et al*., 2011). Wheat grain in Egypt represented almost 10 percent of the total value of agricultural production and about 20 percent of all agricultural imports (FAO, 2016).

Weeds are considered to be a serious problem in wheat crop (Saad *et al*., 2011 and Mehmeti *et al*., 2018). Weeds compete with wheat plants to absorb more nutrients, water, sunlight and other crop important growth requirements. These weeds caused a reduction in the quantity and quality of wheat yield and content of grain protein of wheat, which reflected on the market of wheat value, and also increase the cost of harvesting and cleaning (Saad *et al*., 2011 and Safina and Absy, 2017). This competition lead to grain yield reduction ranged between 7% (Montazeri *et al*., 2005 and Shah *et al*., 2005), and 92% (Tiwari and Parihar, 1997), and in serious cases complete crop failure may be happened (Abdul-Khaliq and Imran, 2003).

Nowadays, different methods are used to control the broad-leaved weeds in wheat crop including cultural, biological, mechanical and chemical practices. Weed control by post-emergence herbicides including tribenuron-methyl derivatives is one of the recent origins that are being emphasized in modern agriculture (El-Kholy and Abdelmonem, 2007; Saad *et al*., 2011; El-Kholy *et al*., 2013; Hamada, 2014; Enayati *et al*., 2016; Khalil, 2017 and Mohmmadi and Ismail, 2018). They concluded that herbicides such as tribenuron-methyl can be held accountable for decreasing growth, biomass and density of weeds and increasing wheat grain yield.

Tribenuron-methyl is a selective herbicide used for controlling broad-leaved weeds in wheat fields (Adameczewski *et al*., 2014 and Kieloch *et al*., 2014) and commercially available in different formulations. This herbicide is applied at wheat's tilling stage or 3-4 leaf stage of weeds (Zadoks *et al*., 1974 and Kieloch *et al*., 2014). Tribenuron-methyl belongs to the sulfonylurea herbicide group, which prohibits acetolactate synthesis (ALS) activation (Cui *et al*., 2012; Han *et al*., 2012 and Adameczewski *et al*., 2014). This enzyme catalyzes first or one step in the biosynthesis of branched-chain amino acids such as a leucine, isoleucine and valine via biosynthesis of acetolactate (Kieloch *et al*., 2014). Cui *et al*. (2012) and Han *et al*. (2012) reported that branched-chain amino acids are essential for plant growth and stop or reduce the activity of acetolactate synthase enzymes by disturbing the process of cell division leading to plant death.

Therefore, the objective of this study is to evaluate the herbicidal activity of eight commercial formulations of tribenuron-methyl comparing with hand weeding for controlling annual broad-leaved weeds (BLWs) in wheat fields.

MATERIALS AND METHODS

This study was carried out in a private farm in El-Mawaseer Village, Itay El-Baroud, Beherah Gov., to evaluate the effect of eight tribenuron-methyl formulations (4 as DFs and 4 in WGs) comparing to hand weeding for the control of annual BLWs during the two growing seasons (2017-2018 and 2018-2019).

Wheat seeds (*Triticum aestivum* L., cv. Gommezah11) were supplied from Central Administration of Seeds (CAS), ARC, Ministry of Agriculture and Land Reclamation. These seeds were planted by drill sowing method (Safina and Absy, 2017) in 15 and 21 November throughout 2017 and 2018, respectively, at the seed rate of 80 Kg fed.$^{-1}$ (Abouziena *et al*., 2008).

All herbicidal, hand weeding and untreated control treatments were arranged in randomized complete block design (RCBD) with four replicates for each. The area of each treatment was 168 m^2 [each replicate was 42 m^2 (6×7 m)]. Eight tribenuron-methyl formulations were used in this study and all formulations were applied at the rate of 8.0 gm fed.$^{-1}$ in 200 L. of water fed.$^{-1}$ by Knapsack sprayer (CP3) at 30 days after sowing (DAS). Four formulations (Cash Cool, Gerostar, Skylla and Tongstar) were used as 75% WG and the other four formulations (Granary, Granstar, Ownostar and Tribonate) were used as 75% DF. The hand weeding treatment was applied (twice) at 21 and 42 DAS (before the first and second irrigation, respectively). All the agricultural practices were carried out uniformly according to the recommendations.

Thirty days after treatment, weeds were collected from an area of 2m^2 which randomly selected from each plot using a square woody frame, 50 cm×50 cm. The gathered annual BLWs were identified according to Zaki (2000), then counted (number m^{-2}) and freshly weighed (gm m^{-2}) for density, density %, biomass and biomass % assessment as follow:

Biomass = mean fresh weight of weed (s) in gm m^{-2}.

Biomass% = (Mean fresh weight of each weed/ Mean fresh weight of total weeds) ×100.

Density = mean number of weed (s) m^{-2}.

Density% = (Mean number of each weed/ Mean number of total weeds) ×100.

Weed control efficiency (WCE %): were calculated according to Devasenapathy and Remesh (2008) with some modifications as follow,

(WCE %) = (FWC-FWT/FWC) ×100.

Where:

FWC: Fresh weight [gm m^{-2}] for BLWs or Mean number of weed (s) in the untreated treatment.

FWT: Fresh weight [gm m^{-2}] for BLWs or Mean number of weed (s) in each treatment.

At full maturity, wheat plants were harvested by a small combine and dried under natural conditions for 5 days, and the following parameters were recorded:

Biological yield (B.Y.) = weight of total plants in each plot [Kg plot^{-1}].

Grain yield (G.Y.) = grain weight in each plot [Kg plot^{-1}].

Harvest Index (H.I.) = G.Y. / B.Y. × 100.

Straw Yield (S.Y.) = straw weight in each plot [Kg plot^{-1}].

Thousand Grain Weight (TGW) = weigh of 1000 grains in each plot (in gm).

- **Yield Over Control (YOC)** or increase % were recorded according to (Tanji *et al*., 2017) with some modifications as follow,

(YOC) = (T-C/T) ×100.

Where:

T= Mean value of the parameter in each treatment.

C= Mean value of the parameter in unweeded control.

The results of this study were subjected to analysis of variance (ANOVA) and the means of each result were compared by L.S.D at 1 and 5% probability according to the method described by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

A- Weeds:

Data shown in Table (1) illustrate the common BLWs prevailed in experimental wheat field during both seasons (2017-2018 and 2018-2019).

Table 1. The common broad-leaved weeds prevailed in the experimental wheat (cv. Gommezah 11) field during 2017-2018 and 2018-2019 seasons.

Arabic or vernacular names	English names	Scientific names	Family names
Gooded	Annual Sowthistle	*Sonchus oleraceus* L.	Compositae
Khobezah	Cheese weed, Little mallow	*Malva parviflora* L.	Malvaceae
Handaqooq	Sweet clover, Indian melilot	*Melilotus indica* L.	Leguminosae
Hommeid	Dentated dock	*Rumex dentatus* L.	Polygonaceae
Nafal	Medic	*Medicago intertexta* (L.) Mill.	Leguminosae
Salq	Sea beet, Wild beet	*Beta vulgaris* L.	Chenopodiaceae
Shikoria, Sirees	Chicory	*Cichorium pumpilum* Jacq.	Compositae
Zaghalant	Scarlet pimpernel	*Anagallis arvensis* L.	Primulaceae

B- Biomass and density of BLWs:

Results in Table (2) illustrate that *B. vulgaris* weed recorded the highest biomass values (65.57 and 54.58 gm m^{-2}) in the 1st and 2nd seasons, respectively, which represent the highest biomass rates (31.50 and 24.83 %). On the other side, *M. parviflora* weed recorded the lowest biomass values (10.48 and 10.26 gm m^{-2}) which represent the lowest biomass rates in both seasons (5.03 and 4.67 %), respectively.

Also, *B. vulgaris* and *M. intertexta* weeds recorded the highest density values of 5.75 m^{-2} and 6.50 m^{-2} which represent density rates of 19.01% and 18.06% from BLWs in the 1st and 2nd seasons, respectively. On the other side, *M. parviflora* weed recorded the lowest density values of 1.50 and 2.25 m^{-2} which represented density rates of 4.96 and 6.26% from BLWs. Also, the total numbers of BLWs were 30.25 and 36.00 m^{-2}, whereas the total biomasses were 208.11 and 219.83 gm m^{-2} in the 1st and 2nd seasons, respectively.

These results clearly indicated that biomass (mean fresh weight in gm m^{-2}) and density (mean number of weeds in m^{-2}) were varied according to the dominant weed species and from season to another. These findings were in harmony with those obtained by many researchers such as El-Kholy and Abdelmonem (2007), Abouziena *et al*. (2008), El-Kholy *et al*. (2013), Hamada (2014), Choudhary *et al*. (2016), Khalil (2017), El-Kholy *et al*. (2017) and Mohammadi and Ismail (2018). Who concluded that the BLWs were common in wheat fields and their biomass and density were varied between year (s) and weed (s).

Table 2. Biomass and density of the annual broad-leaved weeds in the experimental wheat (cv. Gommezah 11) field at 60 days after sowing.

Names of weeds	First season (2017-2018)				Second season (2018-2019)			
	Biomass		Density		Biomass		Density	
	Fresh weight (gm m^{-2})	%	Mean number m^{-2}	%	Fresh weight (gm m^{-2})	%	Mean number m^{-2}	%
Anagallis arvensis	14.32	06.88	02.50	08.26	22.37	10.18	03.25	09.03
Beta vulgaris	65.57	31.50	05.75	19.01	54.58	24.83	06.25	17.36
Cichorium pumpilum	23.16	11.13	04.25	14.05	30.86	14.04	05.25	14.58
Malva parviflora	10.48	05.03	01.50	04.96	10.26	04.67	02.25	06.26
Medicago intertexta	27.18	13.06	05.50	18.18	33.35	15.17	06.50	18.06
Melilotus indica	18.06	08.68	04.50	14.88	20.65	09.39	04.75	13.19
Rumex dentatus	27.18	13.07	02.25	07.44	22.88	10.41	03.50	09.72
Sonchus oleraceus	22.16	10.65	04.00	13.22	24.88	11.31	04.25	11.80
Total	208.11	100.00	30.25	100.00	219.83	100.00	36.00	100.00

C- Effect of weed control treatments on biomass and density of BLWs:

The results in Table (3) indicate that, in the first season, all the herbicidal treatments significantly (*p=0.05*) decreased the biomass of BLW in comparison with hand weeding and untreated control. Granstar followed by Skylla, Cash Cool and Tribonate were the most effective, while the Ownostar was the least effective. The other treatments gave an intermediate effect. Similar trend of results was also observed in the second season (Table, 3).

On the other hand, the results clearly indicate that all the tested treatments decreased weed density (mean number m^{-2}) in comparison with hand weeding and untreated treatments. Granstar, Skylla and Cash Cool were the most effective, while Ownostar, Tongstar and Granary, Tribonate and Gerostar were the least effective. The maximum biomass of weeds of 208.11 m^{-2} and 219.83m^{-2} were recorded in the untreated control in both seasons, respectively, while the minimum weed biomass of 3.49 and 2.00 gm m^{-2} were recorded in Granstar treatment in both seasons, respectively. The same trend was also observed in the case of density in both seasons.

The maximum BLW density (mean number m^{-2}) of 30.25 and 33.75 were recorded in the weedy chick plots in both seasons, respectively. Granstar and Skylla followed by Cash Cool gave the minimum density m^{-2} which gave 2.25, 2.25 and 2.75 m^{-2} in 1st season and 2.00, 3.75 and 4.25 m^{-2} in 2nd season, respectively. All formulations gave WCE% more than 90% in both seasons, and the herbicides gave WCE% more than hand weeding. Granstar gave the highest WCE% in the first season (98.32%) followed by Skylla (97.76%), Cash Cool (97.66%), Tribonate (96.90%), Gerostar (95.60%), Granary (95.39%), Tongstar (95.23%), Ownostar (92.93%) and hand weeding (90.29%). The same trend was also observed in the second season.

Table 3. Efficacy of different tribenuron-methyl formulations and hand weeding on biomass and density of total broad-leaved weeds in wheat (cv. Gommezah 11) field at 60 days after sowing.

Treatments	Rates*	First season (2017-2018)				Second season (2018-2019)			
		** Biomass	*** WCE%	**** Density	Reduction %	** Biomass	*** WCE%	**** Density	Reduction %
Cash Cool 75% WG	08.0gm	04.88	97.66	02.75	90.91	06.33	97.12	04.25	87.41
Gerostar 75% WG	08.0gm	09.15	95.60	04.75	84.30	07.12	96.76	04.50	86.66
Skylla 75% WG	08.0gm	04.65	97.76	02.25	92.56	07.94	96.62	03.75	88.89
Tongstar 75% WG	08.0gm	09.93	95.23	04.50	85.12	07.30	96.39	04.25	87.41
Granary 75% DF	08.0gm	09.60	95.39	04.50	85.12	12.51	94.31	05.75	82.96
Granstar 75% DF	08.0gm	03.49	98.32	02.25	92.56	03.66	98.33	02.00	94.07
Ownostar 75% DF	08.0gm	14.72	92.93	04.50	85.12	13.84	93.70	04.75	85.92
Tribonate 75% DF	08.0gm	06.44	96.90	04.25	85.95	05.65	97.43	04.50	86.67
Hand weeding	Twice (21, 42 DAS)	20.21	90.29	05.25	82.64	27.96	87.28	07.75	78.00
Untreated control	------	208.11	00.00	30.25	00.00	219.83	0.00	33.75	00.00
L.S.D for treatments	at 5%	= 03.13		= 01.61		= 09.91		= 02.88	
without control	at 1%	= 04.22		= 02.18		= 13.38		= 03.89	
L.S.D for treatments	at 5%	= 13.02		= 02.66		= 15.23		= 03.77	
with control	at 1%	= 17.52		= 03.59		= 20.51		= 05.08	

Rates*=Rate of application in 200L. water fed^{-1} (applied at 30 days after sowing) according to the recommendations of Agricultural Pesticide Committee (APC) 2017, Ministry of Agriculture and Land Reclamation.
Biomass=Mean fresh weight (gm m^{-2}) of weeds resulted from 4 replicates (1/100 from Feddan (8 times) at 60 DAS.**
WCD%*=Weed control efficiency (FWC-FWT/FWC)× 100) at 60 DAS.**
Density**=Mean number of weed population in m2 resulted from 4 replicates (1/100 from Feddan (8 times) at 60 DAS.**
DAS***= Days after sowing.**

From these data, the results clearly indicate that the herbicidal treatments gave the minimum weed density and biomass and gave good WCE% than hand weeding treatment. Such results were supported by El-Kholy and Abdelmonem (2007), Shehzad *et al*. (2012), El-Kholy *et al*. (2013) and Safina and Absy (2017). They concluded that hand weeding is ineffective technique and very expensive, so, herbicides even are become a key factor for BLW control. Sabra *et al*. (1999) found that tribenuron-methyl gave 97.30 % reduction of BLW populations. They added that Sinal (metosulam) recorded 100% reduction in BLW and this compound has the same mode of action as tribenuron-methyl which inhibits acetolactate synthase (ALS). Fenni *et al*. (2001) proved that tribenuron-methyl was the most efficient treatment on BLWs in wheat crop, as it reduced weed densities by 85 and 88% at 25 and 51 days after transplanting, respectively. Shourbalal and Hashemi (2017) mentioned that tribenuron-methyl possesses high bio-activity and as a result, it is consumed at very low levels with a wide range of action. Finally, Safina and Absy (2017) reported that Cash Cool gave 92% WCE of BLW, while hand pulling gave 82% WCE, and they concluded that herbicides performed better in order to effective weed control and maximum utilization of environmental resources for growth and development. These results were supported by Mehmeti *et al*. (2018).

D - Effect of weed control treatments on individual BLWs:

Concerning the effect of weed control treatments on individual BLWs, data in Tables (4 and 5) indicate that all treatments had differential efficacy on individual BLWs during the two growing seasons (2017-2018 and 2018-2019). In most cases, the obtained results indicated that all herbicidal treatments gave good control of BLWs than hand weeding treatment. Granstar formulation completely controlled *C. pumpilum* in the first season and *A. arvensis*, *R. dentatus* and *S. oleraceus* weeds in the second season. Also, Skylla formulation caused complete control to *M. parviflora* and *R. dentatus* weeds in the first season. However, *B. vulgaris*, *M. intertexta* and *M. indica* weeds did not completely controlled with any tribenuron-methyl formulations in both seasons, which may be due to some resistance to these formulations. In some cases, hand weeding gave good control more than herbicides which was observed with *A. arvensis*, *C. pumpilum* and *M. indica* weeds in the first season and with *M. parviflora* weed in the second season. For example, Ownostar gave 67.16 WCE% on *A. arvensis*, while hand weeding gave 80.99 WCE% on the same weed in the first season (Table, 4).

Table 4. Weed control efficiency rates of different tribenuron-methyl formulations for individual broad-leaved weeds in experimental wheat (cv. Gommezah 11) field at 60 days after sowing during 2017-2018 season.

Treatments	Rates	*Anagallis arvensis*	*Beta vulgaris*	*Cichorium pumpilum*	*Malva parviflora*	*Medicago intertexta*	*Melilotus indica*	*Rumex dentatus*	*Sonchus oleraceus*
Cash Cool 75% WG	08.0gm	95.64	98.47	98.02	92.94	98.67	94.19	98.24	98.02
Gerostar 75% WG	08.0gm	90.55	97.48	97.88	88.55	97.13	90.59	94.11	95.58
Skylla 75% WG	08.0gm	92.30	97.70	96.37	100.00	98.49	97.45	100.00	96.39
Tongstar 75% WG	08.0gm	89.53	97.45	94.04	87.50	96.80	90.25	96.21	95.26
Granary 75% DF	08.0gm	91.42	97.62	93.48	91.98	96.72	88.70	95.14	96.55
Granstar 75% DF	08.0gm	96.37	98.39	100.00	98.86	98.61	95.18	97.90	98.86
Ownostar 75% DF	08.0gm	67.16	94.72	87.61	91.32	94.26	88.43	92.31	97.81
Tribonate 75% DF	08.0gm	91.28	97.59	98.66	93.51	96.87	94.24	97.39	97.28
Hand weeding	Twice (21, 42 DAS)	80.99	92.04	91.41	89.22	90.54	94.35	84.73	94.28

Table 5. Weed control efficiency rates of different tribenuron-methyl formulations for individual broad-leaved weeds in experimental wheat (cv. Gommezah 11) field at 60 days after sowing during 2018-2019 season.

Treatments	Rates	*Anagallis arvensis*	*Beta vulgaris*	*Cichorium pumpilum*	*Malva parviflora*	*Medicago intertexta*	*Melilotus indica*	*Rumex dentatus*	*Sonchus oleraceus*
Cash Cool 75% WG	08.0gm	97.59	97.76	97.31	96.01	97.69	95.45	96.55	96.70
Gerostar75% WG	08.0gm	97.36	98.28	97.50	89.18	97.96	95.11	91.26	95.90
Skylla75% WG	08.0gm	94.46	96.91	98.99	97.37	97.30	95.59	94.23	96.82
Tongstar75% WG	08.0gm	96.91	97.27	96.66	94.83	97.39	95.06	95.15	97.79
Granary75% DF	08.0gm	97.23	97.43	93.06	88.79	97.39	88.13	89.29	94.29
Granstar 75% DF	08.0gm	100.00	99.45	98.22	96.98	98.11	94.19	100.00	100.00
Ownostar75% DF	08.0gm	91.15	96.17	89.34	88.40	96.85	92.44	91.61	96.82
Tribonate75% DF	08.0gm	96.47	98.30	98.25	96.98	96.88	94.87	97.16	98.55
Hand weeding	Twice (21, 42 DAS)	85.29	92.07	89.47	89.28	85.88	78.79	85.10	87.38

In general, the efficiency of the tested tribenuron-methyl formulations was varied according to weed species and between years. These findings are in agreement with those observed by previous reports (Helalia, 1993; Abou-Donia *et al*., 2007; Abouziena *et al*., 2008; Nasser Ud-din *et al*., 2011; El-Kholy *et al*., 2013; Safina and Absy, 2017 and Mohammadi and Ismail, 2018), who concluded that herbicides are more efficient, up-date and time saving than hand weeding and their efficacy on BLWs is dependent upon the type of herbicides and weed species. Khalil *et al.* (2008) mentioned that there was significant difference in weed density for hand weeding and herbicide treatments.

They concluded that chemical weed control is preferred because of its better efficiency along with less cost and time involvement. Safina and Absy (2017) indicated that weed count m^{-2} and percent of weed control are important parameters for studying weed management methods. Also, Cash Cool herbicide gave 93% WCE of BLW, while hand weeding gave 82% WCE of BLW. The herbicides performed better in order to effective weed control and maximum utilization of environmental resources for growth and development. Mohammadi and Ismail (2018) demonstrated that the number of *Malva sylvestris* and *Sonchus asper* were 0.25 and 0.00 in both hand weeding and tribenuron-methyl treatments, while in unweeded treatments were 1.75 m^{-2} and 1.50 m^{-2}, respectively. They reported that chemical treatments did not cause any damage to the wheat crop such as that happens during manual weeding.

Tribenuron-methyl was very effective in controlling weeds in wheat and sulfonylurea herbicide group is more suitable to control weeds in the wheat crop. Saad *et al.* (2011) concluded that tribenuron-methyl (Granstar) exhibited higher efficacy against *B. vulgaris*, *C. murale* and *M. hispida* weeds than Brominal, Derby and Panter.

D- Effect of weed control treatments on some agronomic traits of wheat:

The effect of weed control treatments on some selected agronomic traits of wheat during the two growing seasons (2017-2018 and 2018-2019) are listed in Tables 6 and 7.

In most cases, the herbicidal treatments increased significantly (*p=0.05*) the biological yield, grain yield, straw yield, harvest index and thousand grain weight comparing with the untreated control and Granstar, Skylla and Cash Cool were the most effective herbicides, while Ownostar was the least effective. For example, Granstar, Skylla and Cash Cool recorded the highest biological yield of 117.86, 117.32 and 115.70 kg plot^{-1} in the first season and of 117.50, 115.82 and 113.96 kg plot^{-1} in the second season, respectively, comparing to Ownostar which gave106.32 and 104.22 kg plot^{-1} in both seasons, respectively.

The corresponding biological yields of hand weeding and untreated treatments were 105.74 and 101.81 kg plot^{-1} in the first season and 104.45 and 99.65 kg plot^{-1} in the second season, respectively. Similar trend was also observed with grain yield, straw yield, harvest index and TGW in two growing seasons (tables 6 and 7). The herbicidal treatments significantly (*p=0.05*) increased grain and straw yield, harvest index and TGW values in comparison with hand weeding and untreated treatments. For example, Granstar, Skylla and Cash Cool herbicides gave grain yield values of 34.95, 33.81 and 32.39 kg plot^{-1} in the first season and of 36.71, 33.62 and 31.63 kg plot^{-1} in the second season, respectively, comparing to those of hand weeding (24.66 and 24.32 kg plot^{-1}) and untreated (21.08 and 20.63 kg plot^{-1}) treatments, respectively. Similar findings were recorded for straw yield, harvest index and thousand grain weights in both seasons.

Table 6. Efficacy of different tribenuron-methyl formulations and hand weeding on some agronomic traits in wheat (cv. Gommezah 11) field during 2017-2018 season after 5 days from harvest.

Treatments	Rates	Biological yield (Kg plot^{-1})	YOC* %	Grain yield (Kg plot^{-1})	YOC* %	Straw yield (Kg plot^{-1})	YOC* %	H.I. %**	Increase %	TGW*** (gm)	Increase %
Cash Cool 75% WG	08.0gm	115.70	12.01	32.39	34.92	83.31	03.09	27.99	26.04	32.96	26.24
Gerostar 75% WG	08.0gm	109.43	06.96	28.06	24.87	81.37	00.79	25.64	19.27	31.47	22.75
Skylla 75% WG	08.0gm	117.32	13.26	33.81	37.65	83.57	03.39	28.80	28.76	33.82	28.12
Tongstar 75% WG	08.0gm	110.44	07.81	27.46	23.23	82.98	02.67	24.86	16.73	29.96	19.31
Granary 75% DF	08.0gm	110.72	08.05	26.95	21.78	83.77	03.61	24.34	14.95	29.38	17.86
Granstar 75% DF	08.0gm	117.86	13.62	34.95	39.68	82.91	02.63	29.65	30.18	34.84	30.23
Ownostar 75% DF	08.0gm	106.32	04.16	24.74	14.79	81.48	00.92	23.29	11.12	30.20	19.50
Tribonate 75% DF	08.0gm	111.48	08.67	30.27	30.36	81.22	00.59	27.16	23.78	31.75	23.43
Hand weeding	Twice (21, 42 DAS)	105.74	03.72	24.66	14.52	81.08	00.43	23.32	11.23	27.11	10.33
Untreated control	----	101.81	00.00	21.08	00.00	80.73	00.00	20.70	00.00	24.31	00.00
L.S.D for treatments without control	at 5%	= 07.58		= 05.50		= 15.03				= 03.21	
	at 1%	= 10.24		= 07.42		= 20.30				= 04.33	
L.S.D for treatments with control	at 5%	= 07.34		= 05.30		= 14.37				= 03.19	
	at 1%	= 09.88		= 07.14		= 19.35				= 04.30	

YOC*: Yield Over Control (Increase %). **H.I. **: Harvest index = (Grain yield/Biological yield) × 100.**
TGW*: Thousand grain weight (gm).** **DAS****= Days after sowing.**

Table 7. Efficacy of different tribenuron-methyl formulations and hand weeding on some agronomic traits in wheat (cv. Gommezah 11) field during 2018-2019 season after 5 days from harvest.

Treatments	Rates	Biological yield (Kg plot^{-1})	YOC* %	Grain yield (Kg plot^{-1})	YOC* %	Straw yield (Kg plot^{-1})	YOC* %	H.I. %**	Increase %	TGW*** (gm)	Increase %
Cash Cool 75% WG	08.0gm	113.96	12.56	31.63	34.77	82.33	04.02	27.75	25.40	31.77	23.95
Gerostar 75% WG	08.0gm	109.55	09.04	29.50	30.08	80.05	01.29	27.43	24.53	31.26	22.71
Skylla 75% WG	08.0gm	115.82	13.96	33.62	38.64	82.20	03.87	29.03	28.69	32.81	26.36
Tongstar 75% WG	08.0gm	109.31	09.66	26.90	23.31	83.41	05.26	24.89	15.13	30.24	20.10
Granary 75% DF	08.0gm	109.63	09.10	26.82	23.08	82.81	04.58	24.46	15.49	29.02	16.72
Granstar 75% DF	08.0gm	117.50	15.19	36.71	43.80	82.79	04.55	29.54	29.92	33.85	28.63
Ownostar 75% DF	08.0gm	104.22	04.38	25.11	17.84	79.11	00.11	24.09	14.07	29.79	18.89
Tribonate 75% DF	08.0gm	109.63	09.11	29.85	30.89	79.78	00.95	27.33	23.98	31.87	24.19
Hand weeding	Twice(21,42DAS)	104.45	04.59	24.32	15.17	80.13	01.38	23.28	11.08	27.01	10.55
Untreated control	----	99.65	00.00	20.63	00.00	79.02	00.00	20.70	00.00	24.16	00.00
L.S.D for treatments without control	at 5%	= 11.30		= 03.24		= 04.90				= 02.72	
	at 1%	= 15.26		= 04.38		= 06.61				= 03.67	
L.S.D for treatments with control	at 5%	= 10.83		= 03.13		= 05.65				= 02.77	
	at 1%	= 14.58		= 04.22		= 07.60				= 03.74	

YOC*: Yield Over Control (Increase %). **H.I. **: Harvest index = (Grain yield/Biological yield) × 100.**
TGW*: Thousand grain weight (gm).** **DAS****= Days after sowing.**

Based on the obtained results, chemical treatments significantly reduced the biomass and density of BLW and consequently increased the yield and yield components of wheat crop in the two growing seasons. These results are in agreement with those obtained by many researchers. Abouziena *et al*. (2008) indicated that the absence of hand weeding and the application of tribenuron-methyl led to a significant increase of grain and biological yields by 51 and 48% over the untreated control. They reported that tribenuron-methyl increased biological yield (4.3 T fed.$^{-1}$), while hand weeding gave 4.2 T fed.$^{-1}$. The untreated gave 1.8 T fed.$^{-1}$. Saad *et al*. (2011) mentioned that the wheat yield increase can be due to increasing the number of yield grains increasing of the grain weights and its components. They added that tribenuron-methyl was the most effective against BLWs and consequently resulted in higher wheat grain yield and higher TGW. Singh *et al*. (2013) reported that effectiveness of herbicide applications caused increased the grain yield of wheat. Mukherjee *et al*. (2015) revealed that the application of tribenuron-methyl at 22.5 and 45 gm ha^{-1} significantly controlled the weed populations in wheat as compared to unweeded control and enhanced its grain and straw yield.

Safina and Absy (2017) reported that the increase in straw yield may be due to minimizing the weed-wheat competition and giving wheat plants the more space without weeds to grew and teller. Tanji *et al*. (2017) indicated that wheat yield increase due to weed control treatments ranged from 11 to 71% compared to the yield observed in non-treated plots. Increased grain yields recorded in all plots treated with herbicides could be attributed to the excellent control of weeds and improved grain yields through better utilization of available resources like fertilizer, sunlight and space. Mohammadi and Ismail (2018) showed that tribenuron-methyl was very effective in controlling weeds in wheat crop. They added that sulfonylurea group of herbicide is more suitable to control BLWs in wheat crop and therefore plants without weed competition enhance grain yields and consequently increase the farmers' income. Mehmeti *et al*. (2018) reported that in wheat production, it is necessary to undertake control of weeds which cause losses of wheat grain yield. They reported that all herbicides treated plots reduced weed infestation and increased wheat grain yield.

Iqbal and Wright (1999) and Oudhia (2000) concluded that the harmful effect of weeds may be attributed to allelopathy of weeds on wheat plants, number of spike bearing tillers, grains per spike, net assimilation rate and removal macro and micro-nutrients from soil. Abouziena *et al.* (2008) mentioned that allowing weeds to grow with wheat plants in unweeded treatment caused a significant decrement in number of tillers m^{-2}, number of grain spike^{-1} and consequently led to a high reduction in grain yield amount by 41%, compared with hand weeding treatment. Hossain *et al*. (2009) mentioned that the wheat yield was gradually decreased with the increase of weed densities. This higher yield under weed control treatments might be due to the decrease on weed-crop competition resulting in higher absorption of nutrients and sufficient interception of sunlight as well as air circulation.

We can concluded that, Granstar, Skylla and Cash Cool formulations are highly effective in controlling broad-leaved weeds in wheat crop and consequently increased its grain yield components.

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فاعلية بعض مستحضرات ترايبينيورون- ميثيل في مكافحة الحشائش عريضة الأوراق في القمح تحت الظروف الحقلية

رمضان مصطفى عبده الخولي و محمد فوزي محمد الطويل
قسم وقاية النبات – كلية الزراعة بالقاهرة – جامعة الأزهر – مصر.

تضمن هذا البحث إجراء تجربة حقلية في موسمين متتاليين 2017- 2018 و 2018- 2019م لتقييم فاعلية ثمانية مستحضرات تجارية لمبيد الحشائش ترايبينيورون-ميثيل ضد الحشائش عريضة الأوراق في القمح تحت الظروف الحقلية (أربعة منها في صورة WG 75% وهي كاش كول وجيروستار وسكايللا و تونجستار، وأربعة مستحضرات أخرى في صورة DF 75% وهي جراناري وجرانستار وأونوستار وترايبونات) بالإضافة إلى النقاوة اليدوية مرتين (بعد 21 و 42 يوم من الزراعة (قبل الرية الأولى والثانية)) على الترتيب. وأجريت كل الممارسات الزراعية تبعا للتوصيات الموصى بها. وتم توزيع معاملات مبيدات الحشائش المختبرة بالإضافة إلى معاملة النقاوة اليدوية والمقارنة غير المعاملة بتصميم المربعات كاملة العشوائية بواقع أربعة مكررات لكل معاملة حيث كانت مساحة المعاملة الواحدة 168م² (42م² للمكررة الواحدة 6×7م بنسبة 100/1 من مساحة الفدان). وتم تطبيق معدل الاستخدام الحقلي للثمانية مستحضرات وكان 8 جرام / 200 لتر ماء للفدان بعد 30 يوم من الزراعة باستخدام رشاشة CP3. وبعد شهرين من الزراعة (شهر من المعاملة) تم حصر وجمع الحشائش عريضة الأوراق من مساحة 2م² تم اختيارها بشكل عشوائي من كل مكررة باستخدام المربع الخشبي 50×50سم (0,25 م²). وتم التعرف على تلك الحشائش وحصرها عدداً/م² وتم حساب وزنها (الوزن الغض بالجرام/م²) لكل المعاملات. وبالنسبة للحشائش عريضة الأوراق في المقارنة غير المعاملة فقد تم عدها وحصرها وحساب وزنها الطازج ونسبته المئوية وكذلك كثافتها ونسبتها المئوية. وكانت الحشائش الحولية الشائعة التي تم حصرها في حقل القمح في الموسمين المختبرين هي الجعضيض والخبيزة والسريس والحميض والنفل والزغلنت والسلق وأخيراً الحندقوق.ولقد أوضحت النتائج المتحصل عليها أن هناك اختلافاً في الوزن الغض وكذا كثافتها تبعاً لأنواع الحشائش السائدة ومن موسم لآخر. ولقد اعطت معاملات مبيدات الحشائش أقل وزن حيوي وأقل كثافة للحشائش كما أعطت المعاملات نسبة مكافحة أعلى من معاملة النقاوة اليدوية. وفي معظم الحالات اعطت معاملات مبيدات الحشائش مكافحة جيدة للحشائش عريضة الأوراق مقارنة بالنقاوة اليدوية. وأعطى مستحضر جرانستار مكافحة بنسبة 100% لحشيشة السريس في الموسم الأول ولحشائش الزغلنت والحميض والجعضيض في الموسم الثاني. وأعطى مستحضر سكايللا مكافحة بنسبة 100% لحشيشتي الخبيزة والحميض في الموسم الأول. ولم تعط أي معاملات في الموسمين لأي من مستحضرات ترايبينيورون-ميثيل على حشائش السلق والنفل والحندقوق مكافحة بنسبة 100%. وفي كل الحالات فإن استخدام المستحضرات التجارية لمبيدات الحشائش المختبرة ضد الحشائش عريضة الأوراق في القمح قد أدى إلى زيادة معنوية في المحصول البيولوجي ومحصول الحبوب ومحصول القش (التبن) ونسبة التصافي وكذلك وزن الألف حبة مقارنة بغير المعامل. وعموماً كانت مستحضرات جرانستار وسكايللا وكاش كول هي الأكثر فاعلية بينما كان مستحضر أونوستار هو الأقل فاعلية. ويمكن القول بأن مستحضرات جرانستار وسكايللا وكاش كول هي الأكثر فاعلية في مكافحة الحشائش عريضة الأوراق في محصول القمح مما أدى إلى زيادة محصول الحبوب لمحصول القمح.