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Control of broadleaf weeds in winter wheat (*Triticum aestivum* L.)

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Abstract

Weeds compete with the winter wheat (*Triticum aestivum* L.) for water, light, nutrients, space, etc. They may interfere with harvest and other operations. During the period from 2014 to 2016 a trial was conducted with the winter wheat variety Enola. The experiment was stated on the experimental field of the base for training and implementation of the Agricultural University of Plovdiv, Bulgaria. Its aim was to study the efficacy and selectivity of three herbicide products for registration in Bulgaria: RXR 49 (metsulfuron-methyl + tribenuron-methyl + florasulam), SGE 27 (metsulfuron-methyl + tribenuron-methyl + fluroxypyr) and R7U12 (thifensulfuron-methyl + fluroxypyr). The herbicide application was applied in end of tillering – beginning of spindling phenophase of the crop (BBCH 29-31). The highest herbicide efficacy and highest yields were achieved in the treatment with SGE 27 (7.14 t ha^{-1}) at rate 750 ml ha^{-1}. All studied herbicide substances did not cause any visual signs of crop phytotoxicity.

Key words: winter wheat, weeds, herbicides, efficacy, selectivity

Introduction

The weeds are the main concurrent of the winter wheat during vegetation. The high weed infestation can decrease the grain yield up to 70% (Bekelle, 2004). In the modern agriculture the weed management is performed mainly by chemical means. The choice of appropriate herbicide, optimal time and phenophase of application are one of the most important parts of the cropping system (Inayat and Ahmad, 2005; Gul Hassan et al., 2008; Abbas et al., 2009). To study the control of the weeds in winter wheat number of experiments were conducted. Chopra et al. (2008) reported that carfentrazone 20 g ha^{-1} and metsulfuron 4 g ha^{-1} control the broadleaf weeds for 83.7% and 84.1%, respectively. Good control against annual dicotyledonous weeds after application of iodosulfuron at 150-200 g ha^{-1} and amidosulfuron + iodosulfuron potassium methyl at 200-250 g ha^{-1} was recorded (Soroka and Soroka, 2003). For control of broadleaf weeds Ghulam et al. (2009) recommend the application of Buctril Super 60% EC at rate of 835 ml ha^{-1} and Starane-M at rate of 875 ml ha^{-1}. WangCang et al. (2016) established that the combinations of 29% fluroxypyr WP 111.31 g ha^{-1} + 5% carfentrazone-ethyl WP 3.31 g ha^{-1} and 50 g/l florasulam SC 7.50 g ha^{-1} + 40% carfentrazone-ethyl WG 15 g ha^{-1} have excellent efficacy against *Descurainia sophia (L.) Webb ex Prantl, Capsela bursa-pastoris (L.) Med., Galium aparine L.* High efficacy against *G. aparine* was recorded after the combine treatment with carfentrazon + MCPP, tritosulfuron + dicamba, piraflufen + isoproturon and amidosulfuron + iodosulfuron (Cirujeda et al., 2007).

The aim of the study is to evaluate the biological efficacy and selectivity of the herbicides RXR 49, SGE 27 and R7U12 to the winter wheat.

Material and methods

The study was stated on the experimental field of the base for training and implementation of the Agricultural University of Plovdiv, Bulgaria from 2014 to 2016. The experiment was performed by the randomized block design in 4 replications. The size of the harvesting plot was 20 m^2. The grown winter wheat variety was Enola. The sowing was done in the optimal time for the crop in the region. Predecessor for the crop in 2014 was Cleafield® oilseed rape, and in 2015 was silage maize. The performed soil tillage before the wheat sowing was deep ploughing followed by disking and cultivation. Fertilization with 300 kg ha^{-1} with NPK 15:15:15 before sowing and spring dressing with 300 kg ha^{-1} NH_4NO_3 was performed.

The herbicides were applied in tillering – beginning of spindling phenophase of the wheat (BBCH 29-31). The variants of the trial are shown in Table 1. The efficacy of the herbicides was recorded on the 14th, 28th and 56th day after application. The efficacy of the herbicides was evaluated by the visual scale of EWRS (European Weed Research Society). The level of phytotoxicity by the 9 score scale of EWRS was determined. At score 0 there are no damages on the crop, and at score 9 the crop is completetly destroyed. The weed infestation was presented by *Gallium aparine* L., *Vicia* sp., *Agrostemma githago* L., *Papaver rhoeas* L., *Anthemis arvensis* L., *Consolida regalis* Gray and the volunteers Cleafield® *Brassica napus* L. and *Coriandrum sativum* L.

Table 1. Variants of the trial

Variants	Active substances	Rates ml (g) ha^{-1}
1. Untreated control	-	-
2. RXR 49	metsulfuron-methyl + tribenuron-methyl + florasulam	35
3. RXR 49	metsulfuron-methyl + tribenuron-methyl + florasulam	45
4. SGE 27	metsulfuron-methyl + tribenuron-methyl + fluroxypyr	500
5. SGE 27	metsulfuron-methyl + tribenuron-methyl + fluroxypyr	750
6. R7U12	thifensulfuron-methyl + fluroxypyr	500
7. R7U12	thifensulfuron-methyl + fluroxypyr	750
8. Derby Super WG	300.5 g/kg aminopyralid + 150.2 g/kg florasulam	33
9. Secator OD	100 g/l amidosulfuron + 25 g/l iodosulfuron	120

Results and discussion

According to Fetvadzieva et al. (1991) there is a large number of possibilities for chemical weed control. Khan et al. (2003) conducted a trial to investigate the effectiveness of different herbicides against broadleaf weeds. The different herbicides significantly influenced the weed density, the number of the broadleaf weeds per m^2 and the grain yield.

Table 2. Efficacy of the studied herbicides on the 14th day after treatments

Variants / Weeds	2015									2016								
	1	2	3	4	5	6	7	8	9	1	2	3	4	5	6	7	8	9
G. aparine	-	80	85	85	95	85	90	70	70	-	85	85	90	95	85	95	80	80
Vicia sp.	-	90	90	85	95	80	85	90	90	-	85	90	90	95	85	90	90	90
A. githago	-	90	90	85	90	70	75	90	90	-	85	90	90	90	75	80	90	95
P. rhoeas	-	90	90	85	90	70	80	75	70	-	85	90	85	90	70	75	75	75
A. arvensis	-	90	90	85	90	80	90	90	90	-	85	90	90	90	85	90	90	95
C. regalis	-	90	90	90	90	80	90	90	90	-	95	95	95	95	85	95	90	95
B. napus	-	0	0	0	0	20	40	0	0	-	0	0	0	0	25	40	0	0
C. sativum	-	60	75	80	90	30	45	40	45	-	65	80	85	95	35	50	50	55

The obtained results on the 14th day after the treatments in our study showed very good efficacy against *G. aparine*, *Vicia* sp., *A. githago*, *P. rhoeas*, *A. arvensis* and *C. regalis* for both years of investigation (Table 2). The obtained data are similar for the two experimental years. Lower, from 20 to 40% efficacy for both rates (500 or 750 ml ha^{-1}) of R7 U12 was recorded in comparison with the other treatments. Very high resistance of the volunteer *B. napus* at all treatments was found. The efficacy of the studied herbicides against the volunteer *C. sativum* was also low, but at variant 5 the treatment with SGE 27 (750 ml ha^{-1}) showed 90 to 95% efficacy against this weed. On the 28th day after the application increasing of the herbicide efficacy was observed (Table 3). There was a tendency for the efficacy which was repeated from the first evaluation date. That corresponds with results from our previous study where the efficacy of the evaluated herbicide products was identical on both dates of the evaluation (Mitkov et al, 2017). The obtained results were identical for the two years of the study.

Table 3. Efficacy of the studied herbicides on the 28th day after treatments

Variants / Weeds	2015									2016								
	1	2	3	4	5	6	7	8	9	1	2	3	4	5	6	7	8	9
G. aparine	-	85	90	90	98	90	95	80	80	-	90	95	95	98	90	98	85	85
Vicia sp.	-	95	95	90	98	85	90	95	95	-	90	95	95	98	90	95	95	95
A. githago	-	95	95	90	95	80	85	95	98	-	90	98	95	98	85	90	95	98
P. rhoeas	-	95	95	90	95	80	85	80	75	-	90	95	90	95	75	80	80	80
A. arvensis	-	95	98	90	95	90	95	95	98	-	90	98	95	98	90	95	95	98
C. regalis	-	95	98	95	95	85	95	95	95	-	98	98	98	98	90	98	95	98
B. napus	-	0	0	0	0	25	45	0	0	-	0	0	0	0	30	45	0	0
C. sativum	-	65	80	85	95	40	55	50	55	-	70	85	90	98	40	55	55	60

On the 56th day after the herbicide application high efficacy against the weeds is obtained, from 85 to 100% (Table 4). The low efficacy against the volunteer *C. sativum* at variants 2, 6, 7, 8 and 9 was kept also on this evaluation date. The most resistant weed in the study was the volunteer Clearfield® *B. napus* L. For this weed the efficacy in variants 6 and 7 was unsatisfactory (from 25 to 45%). For the other treatments the effectiveness was 0%. Secondary weed infestation was not observed for any of the treatments. All studied herbicide substances did not cause any visual signs of phytotoxicity on the crop.

Table 4. Efficacy of the studied herbicides on the 56th day after treatments

Variants / weeds	2015								
	1	2	3	4	5	6	7	8	9
G. aparine	-	90	95	98	100	95	98	85	85
Vicia sp.	-	100	100	95	100	90	95	100	98
A. githago	-	98	100	95	98	85	90	100	100
P. rhoeas	-	98	100	95	98	90	95	85	80
A. arvensis	-	100	100	100	100	95	100	100	100
C. regalis	-	100	100	100	100	100	100	100	100
B. napus	-	0	0	0	0	25	45	0	0
C. sativum	-	70	85	90	98	45	60	55	60
Variants / weeds	2016								
	1	2	3	4	5	6	7	8	9
G. aparine	-	95	98	100	100	95	100	90	90
Vicia sp.	-	95	100	98	100	95	98	100	98
A. githago	-	95	100	98	100	90	95	100	100
P. rhoeas	-	95	100	95	100	90	90	85	85
A. arvensis	-	95	100	100	100	95	100	100	100
C. regalis	-	100	100	100	100	100	100	100	100
B. napus	-	0	0	0	0	30	45	0	0
C. sativum	-	75	90	95	100	50	65	60	65

The intensive weeding in wheat can decrease the crop yield up to 70% (Bekelle, 2004). The lowest grain yield was recorded for the untreated control when compared with the other variants. During the two years differences for all treated variants in comparison with the untreated control were proved (Table 5). Data analysis with Duncan's multiple range test (1955) showed that the highest grain yields were achieved after the treatments with RXR 49 and SGE 27 with both the application rates. The yields after the application of the herbicides R7U12, Derby Super WG and Secator OD were lower (Table 5).

Table 5. Winter wheat grain yield, t ha^{-1}

Variants	Rates g (ml) ha^{-1}	2015		2016		Average	
		Yield t ha^{-1}	By Duncan	Yield t ha^{-1}	By Duncan	Yield t ha^{-1}	By Duncan
1. Untreated control	-	3.47	a	3.69	a	3.58	a
2. RXR 49	35	6.88*	c	7.21*	c	7.05*	c
3. RXR 49	45	6.96*	c	7.29*	c	7.13*	c
4. SGE 27	500	6.85*	c	7.25*	c	7.05*	c
5. SGE 27	750	6.93*	c	7.34*	c	7.14*	c
6. R7U12	500	5.97*	b	6.23*	b	6.10*	b
7. R7U12	750	6.03*	b	6.29*	b	6.16*	b
8. Derby Super WG	33	5.63*	b	5.91*	b	5.77*	b
9. Secator OD	120	5.75*	b	5.99*	b	5.87*	b

All variants with star (*) do not have considerable difference with the untreated control. The numbers followed by different letters are with proved differences at $p<0.05$.

Conclusions

The highest efficacy against *G. aparine* and *P. rhoeas* was observed for the herbicides RXR 49, SGE 27 and R7U12 independently of the application rate. The herbicide R7U12 overcomes insignificantly the other treatments for its efficacy aganst the *B. napus*. The herbicides RXR 49 and SGE 27 were more efficient in comparison with R7U12, Derby Super WG and Secator OD against the volunteer *C. sativum*. During the study visual signs of phytotoxicity were not recorded which indicates the high selectivity of the studied products. The lowest grain yield was recorded for the untreated control, and the highest grain yields are achieved after the treatments with RXR 49 and SGE 27.

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