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Production Systems

Efficacy and selectivity of antibroadleaved herbicides at durum wheat against volunteers of coriander, Clearfield canola, Clearfield sunflower and ExpressSun sunflower

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Abstract. *During the period 2010 - 2012, on the experimental field of the Field Crops Institute, Chirpan was carried out a field experiment with durum wheat cultivar Elbrus (Triticum durum var. valenciae). A total of 24 variants were investigated. They include vegetation-applied herbicides, soil-applied herbicides and herbicide tank mixtures. Volunteers of Clearfield canola in the durum wheat crops are controlled successfully by vegetation-applied herbicides Derby, Mustang, Sunsac and Weedmaster and soil-applied herbicides Marathon, Stomp and Cougar. Volunteers of Clearfield and ExpressSun sunflower are controlled by herbicides Arat, Derby, Derby super, Mustang, Sunsac, Secator, Lintur, Weedmaster, Marathon, Stomp, Racer and Cougar. Volunteers of coriander in wheat crops are controlled by herbicides Derby, Mustang, Sunsac, Secator, Lintur, Weedmaster, Granstar super, Eagle and Cougar. Herbicide tank mixtures Derby super + Sanafen, Secator + Sanafen, Granstar super + Starane, Laren + Dicotex and Ally max + Sanafen control successfully volunteers of coriander, Clearfield canola, Clearfield and ExpressSun sunflower. Herbicide Cougar causes phytotoxicity on durum wheat. The highest grain yield was obtained by treatment with herbicide tank mixture Granstar super + Starane, Derby super + Sanafen, Secator + Sanafen, Ally max + Sanafen and Laren + Dicotex and herbicides Derby super, Derby, Secator, Sunsac, Mustang , Weedmaster and Arat.*

Keywords: durum wheat, volunteers, herbicides, efficacy, selectivity

Introduction

In Bulgaria, durum wheat is grown mainly in crop rotations with sunflower or canola. In the country sunflower is grown mainly by Clearfield and ExpressSun technologies. Clearfield technology was introduced in 2011 in winter oilseed canola. Hybrids of Clearfield canola, Clearfield sunflower and ExpressSun sunflower are characterized by resistance to herbicides different than that of conventional canola and sunflower hybrids. This resistance is transmitted to hybrid generation (Covarelli and Stagnari, 2002; Smajlagić and Đikić, 2011; Lobkov et al., 2012).

In recent years coriander significantly increased its areas and became the sixth culture in Bulgaria, deferring only to wheat, sunflower, maize, canola and barley. Currently, about 200 000 hectares in Bulgaria are already “weeded" volunteers of coriander. Volunteer seeds of coriander, Clearfield canola, Clearfield sunflower and ExpressSun sunflower are becoming a big problem in the durum wheat crops (Nakayama et al., 2010; Gupta et al., 2011; Tsyuganov and Potarenko, 2011).

The aim of the study is to investigate the efficacy and selectivity of some antibroadleaved herbicides in durum wheat against volunteers of coriander, Clearfield canola, Clearfield sunflower and ExpressSun sunflower.

Material and methods

During the period 2010 – 2012, at the experimental field of the Field Crops Institute, Chirpan was carried out a field experiment with durum wheat cultivar Elbrus (Triticum durum var. valenciae). The experiment was carried out by the block method, in four replications, the size of the experiment plot being 15 m^2, on leached vertisol soil type, after predecessor winter oilseed canola. A total of 24 variants were investigated. They include vegetation-applied herbicides, soil-applied herbicides and herbicide tank mixtures. Active substances, doses and treatment periods of the investigated herbicides and herbicide tank-mixtures are shown in Table 1.

Because of the low adhesion of the herbicide Arat it was used in addition with adjuvant Dash - 500 ml/ha and herbicides Granstar, Granstar super, Laren and Ally max with adjuvant Trend – 0.1 %. Because almost all herbicides are antibroadleaved they were combined with antigrass herbicide Traxos, which was used at a dose of 1.3 l/ha. Treatment with Traxos was made 10 days before the application of other herbicides in order to avoid possible interaction between the preparations. All herbicides and tank mixtures were applied in a working solution of 200 l/ha.

The efficacy and selectivity of a group of antibroadleaved herbicides was studied. The influence of the investigated herbicides on grain yield was established. The efficacy of herbicides against weeds and volunteers of coriander, Clearfield canola, Clearfield sunflower and ExpressSun sunflower was defined according to a 100 % visual scale of EWRS (European Weed Research Society). Selectivity of herbicides toward durum wheat was determined according to the 9-rate scale of EWRS (rating 1 – without damages, rating 9 – culture is completely destroyed). The math processing of the data was done according to the method of analysis of variances.

Results and discussion

Broadleaved weeds in the experiment are *Cirsium arvense, Convolvulus arvensis, Cardaria draba, Anthemis arvensis, Galium*

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Table 1. Investigated variants

№	Variants	Active substance	Doses
1	Check – weeded	-	-
		Tillering stage	
2	Arat	tritosulfuron + dicamba	150 g/ha
3	Arat	tritosulfuron + dicamba	200 g/ha
4	Derby 175 SC	florasulam + flumetsulam	70 ml/ha
5	Derby super WG	florasulam + aminopyralid	33 g/ha
6	Derby super WG + Sanafen	florasulam + aminopyralid 2.4-D	25 g/ha 500 ml/ha
7	Mustang 306.25 SC	florasulam + 2.4-D	800 ml/ha
8	Sunsac	metosulam + 2.4-D	1 l/ha
9	Secator OD	iodosulfuron + amydosulfuron	100 ml/ha
10	Secator OD + Sanafen	iodosulfuron + amydosulfuron 2.4-D	100 ml/ha 500 ml/ha
11	Lintur 70 WG	triasulfuron + dicamba	150 g/ha
12	Weedmaster 646 CL	2.4-D + dicamba	1 l/ha
13	Granstar 75 DF	tribenuron-methyl	20 g/ha
14	Granstar super 50 SG	tribenuron-methyl + tifensulfuron-methyl	40 g/ha
15	Granstar super 50 SG + Starane 250 EK	tribenuron-methyl + tifensulfuron-methyl fluroxypyr	40 g/ha 300 ml/ha
16	Laren 20 SG	metsulfuron-methyl	30 g/ha
17	Laren 20 SG + Dicotex 400	metsulfuron-methy l2M-4X	30 g/ha 1 l/ha
18	Ally max SG	metsulfuron-methyl + tribenuron-methyl	35 g/ha
19	Ally max SG + Sanafen	metsulfuron-methyl + tribenuron-methyl 2.4-D	35 g/ha 1 l/ha
		After sowing – Before emergence	
20	Marathon	pendimethalin + isoproturon	4 l/ha
21	Stomp new 330 EK	pendimethalin	5 l/ ha
22	Racer 25 EK	flurochlridone	2.5 ml/ha
23	Eagle 75 DF	chlorsulfuron	25 g/ha
24	Cougar	isoproturon + diflufenican	2 l/ha

aparine, Chamomilla recutita, Papaver rhoes, Consolida regalis, Sinapis arvense, Raphanus raphanistum, Myagrum perfoliatum, Falopia convolvulus. Grassy weeds are *Avena fatua, Alopecuros myosoroides, Lolium multiflorum, Lolium temulentum, Bromus arvensis*. Volunteers are from coriander, Clearfield canola, Clearfield sunflower and ExpressSun sunflower. They were sown by hand during the durum wheat sowing.

The studied vegetation-applied and soil-applied herbicides are effective against most of the annual and perennial broadleaved weeds presented in the experiment (Table 2). Herbicide Arat is less effective against *Cirsium arvense, Consolida regalis, Falopia convolvulus*, especially in the lower dose of 150 g/ha. Lintur shows low efficiency against *Falopia convolvulus* only. Laren is ineffective against *Galiun aparine* and less effective against *Falopia convolvulus* and *Consolida regalis*. Ally max and Granstar super are less effective against *Galiun aparine* only and Granstar is less effective against *Falopia convolvulus* and *Consolida regalis*.

All herbicides applied after sowing before emergence of wheat (ASBE) are ineffective against perennial broadleaved weeds such as *Cirsium arvense* and *Convolvulus arvensis*, because they germinate in spring. Marathon is the most efficient herbicide in this group. It has lower efficacy against *Galiun aparine, Falopia convolvulus* and *Consolida regalis* only. Stomp, except against them, is less effective against *Papaver rhoes,* too. Herbicide Eagle is ineffective against *Galiun aparine, Falopia convolvulus* and *Myagrum perfoliatum* and Cougar against *Galiun aparine* and *Consolida regalis*.

Herbicides Granstar, Granstar super, Laren, Ally max and Eagle are ineffective against the volunteer of Clearfield canola, Clearfield sunflower and ExpressSun sunflower (Table 3). Added to Granstar super, Laren and Ally max of Starane – 300 ml/ha, Dicotex – 1 l/ha or Sanafen – 1 l/ha in the form of tank mixtures lead to successful control of these volunteers. Herbicides Arat and Lintur are less efficient against volunteers of Clearfield canola. However, these two herbicides are effective against volunteers of Clearfield and ExpressSun sunflowers and Lintur also against volunteers of

Table 2. Efficacy of some herbicides against annual broadleaved weeds in durum wheat according to the 100 % visual scale of EWRS (mean 2010 – 2012)

Herbicides / Weeds	Galiun aparine	Chamomilla recutita	Papaver rhoes	Consolida regalis	Sinapis arvense	Raphanus raphanistum	Anthemis arvensis	Myagrum perfoliatum	Falopia convolvulus
Check – weeded	0	0	0	0	0	0	0	0	0
Tillering stage									
Arat	100	100	100	75	100	100	100	100	85
Arat	100	100	100	82	100	100	100	100	95
Derby 175 SC	100	100	100	100	100	100	100	100	100
Derby super WG	100	100	100	98	100	100	100	100	100
Derby super WG + Sanafen	100	100	100	98	100	100	100	100	100
Mustang 306.25 SC	100	96	95	95	100	100	96	95	100
Sunsac	90	100	100	100	100	100	100	97	95
Secator OD	100	100	98	98	100	100	100	100	100
Secator OD + Sanafen	100	100	98	98	100	100	100	100	100
Lintur 70 WG	100	100	100	45	100	95	100	100	100
Weedmaster 646 CL	100	100	100	98	100	100	100	98	100
Granstar 75 DF	45	100	100	100	100	100	100	100	80
Granstar super 50 SG	65	100	100	100	100	100	100	100	92
Granstar super 50 SG + Starane 250 EK	100	100	100	100	100	100	100	100	100
Laren 20 SG	0	100	100	65	100	100	100	100	75
Laren 20 SG + Dicotex 400	35	100	100	80	100	100	100	100	75
Ally max SG	65	100	100	100	100	100	100	100	100
Ally max SG + Sanafen	90	100	100	100	100	100	100	100	100
After sowing – Before emergence									
Marathon	85	100	100	40	100	100	100	100	40
Stomp new 330 EK	85	100	85	30	100	100	100	100	35
Racer 25 EK	80	100	92	35	100	100	100	90	45
Eagle 75 DF	0	100	100	30	100	100	100	0	100
Cougar	0	100	100	35	100	100	100	100	40

coriander. Herbicides Arat, Granstar, Laren, Ally max, Marathon, Racer and Stomp are ineffective against volunteers of coriander. Herbicide Granstar super and tank mixtures of Laren and Ally max with Dicotex – 1 l/ha or Sanafen – 1 l/ha, successfully control these volunteers. The new herbicide Derby super, compared to older herbicides Mustang and Derby, even at its maximum dose of 33 g/ha has lower efficacy against volunteers of Clearfield canola and coriander, though efficacy against broadleaved weeds did not differ significantly from them. Tank mixture of Derby super – 25 g/ha with Sanafen – 500 ml/ha successfully controls volunteers of Clearfield canola and coriander. Herbicide Secator successfully controls volunteers of Clearfield sunflower, ExpressSun sunflower and coriander, but has fewer efficacies against volunteers of Clearfield canola. Tank mixture of Secator with Sanafen – 500 ml/ha successfully controls volunteers of Clearfield canola. Herbicides Sunsac and Weedmaster have very good efficacy against all weeds and volunteers presented in the experiment. Herbicide Cougar causes high phytotoxicity to durum wheat – rating 4 by the scale of EWRS. It even leads to a decrease in grain yield, even in the good efficacy of the herbicide to weeds and volunteers. The use of herbicides Weedmaster and Racer also leads to phytotoxicity, but at much lesser degree – rating 2 by the scale of EWRS. Herbicides Arat, Derby, Derby super, Mustang, Sunsac, Secator, Lintur, Granstar, Granstar super, Laren, Ally max, Sanafen, Starane, Marathon, Stomp and Eagle have very high selectivity for durum wheat - rating 1 by the scale of EWRS.

The obtained grain yields are the result of the cumulative effect of the efficacy and selectivity of the investigated herbicides (Table 4).

Table 3. Efficacy of some herbicides against perennial broadleaved weeds and volunteers in durum wheat according to the 100 % visual scale of EWRS and selectivity according to the 9-rate scale of EWRS (mean 2010 – 2012)

Herbicides / Weeds	Cirsium arvense	Convolvulus arvensis	Cardaria draba	Sonchus arvensis	Brassica napus *	Helianthus annuus **	Helianthus annuus ***	Coriandrum sativum****	Selectivity
Check – weeded	0	0	0	0	0	0	0	0	1
Tillering stage									
Arat	95	0	92	95	65	100	100	0	1
Arat	100	0	100	98	75	100	100	0	1
Derby 175 SC	100	0	100	100	100	100	100	100	1
Derby super WG	100	0	100	100	90	100	100	60	1
Derby super WG + Sanafen	100	0	100	100	100	100	100	100	1
Mustang 306.25 SC	96	0	95	100	100	100	100	100	1
Sunsac	100	0	100	100	100	100	100	100	1
Secator OD	100	0	90	90	82	100	100	100	1
Secator OD + Sanafen	100	0	100	100	100	100	100	100	1
Lintur 70 WG	100	86	100	100	65	100	100	100	1
Weedmaster 646 CL	100	0	100	100	100	100	100	100	2
Granstar 75 DF	100	0	90	100	0	5	0	0	1
Granstar super 50 SG	90	0	90	100	10	15	10	100	1
Granstar super 50 SG + Starane 250 EK	100	0	100	100	100	100	100	100	1
Laren 20 SG	100	80	90	100	0	5	0	0	1
Laren 20 SG + Dicotex 400	100	80	90	100	100	100	100	100	1
Ally max SG	100	0	100	100	0	10	5	0	1
Ally max SG + Sanafen	100	0	100	100	100	100	100	100	1
After sowing – Before emergence									
Marathon	0	0	0	0	100	100	100	0	1
Stomp new 330 EK	0	0	0	0	100	100	100	0	1
Racer 25 EK	0	0	0	0	90	100	100	0	2
Eagle 75 DF	0	0	0	0	0	10	0	100	1
Cougar	0	0	0	0	100	100	100	100	4

* - volunteers of Clearfield canola
** - volunteers of Clearfield sunflower
*** - volunteers of ExpressSun sunflower
**** - volunteers of coriander

The highest grain yields are obtained by herbicide tank mixtures Derby super – 25 g/ha + Sanafen – 500 ml/ha, Secator – 100 ml/ha + Sanafen – 500 ml/ha, Granstar super – 40 g/ha + Starane – 300 ml/ha, Larren – 30 g/ha + Dicotex – 1 l/ha and Ally max – 35 g/ha + Sanafen – 1 l/ha. The lowest yield was obtained when using the herbicide Cougar after sowing before emergence. It is the result of the high phytotoxicity of this herbicide toward durum wheat, despite its good efficacy against annual broadleaved weeds and volunteers of coriander, Clearfield canola, Clearfield sunflower and ExpressSun sunflower. Lower grain yields are obtained by soil treatment with Eagle and vegetation treatment with Granstar and Lintur. These yields are the result of the lower efficacy of these herbicides against some annual broadleaved weeds and volunteers.

Conclusions

Volunteers of Clearfield canola in the durum wheat crops are controlled successfully by vegetation-applied herbicides Derby, Mustang, Sunsac and Weedmaster and soil-applied herbicides Marathon, Stomp and Cougar. Antibroadleaved herbicides Granstar, Granstar super, Larren, Ally max and Eagle are ineffective

Table 4. Influence of some herbicides on grain yield of durum wheat (2010 – 2012)

Herbicides	2010		2011		2012		Mean	
	kg/ha	%	kg/ha	%	kg/ha	%	kg/ha	%
Check – weeded	4750	100	4983	100	4444	100	4726	100
				Tillering stage				
Arat	5239	110.3	5343	107.2	4867	109.5	5150	109.0
Arat	5273	111.0	5430	109.0	4878	109.8	5194	109.9
Derby 175 SC	5287	111.3	5417	108.7	4888	110.0	5197	110.0
Derby super WG	5296	111.5	5433	109.0	4894	110.1	5208	110.2
Derby super WG + Sanafen	5363	112.9	5466	109.7	4989	112.3	5273	111.6
Mustang 306.25 SC	5254	110.6	5372	107.8	4867	109.5	5164	109.3
Sunsac	5268	110.9	5392	108.2	4878	109.8	5179	109.6
Secator OD	5358	112.8	5466	109.7	4981	112.1	5268	111.5
Secator OD + Sanafen	5372	113.1	5466	109.7	5012	112.8	5283	111.8
Lintur 70 WG	5163	108.7	5283	106.0	4832	108.7	5093	107.8
Weedmaster 646 CL	5254	110.6	5377	107.9	4859	109.3	5163	109.2
Granstar 75 DF	5102	107.4	5217	104.7	4721	106.2	5013	106.1
Granstar super 50 SG	5225	110.0	5230	105.0	4894	110.1	5116	108.3
Granstar super 50 SG + Starane 250 EK	5372	113.1	5451	109.4	5025	113.1	5283	111.8
Laren 20 SG	5197	109.4	5233	105.0	4894	110.1	5108	108.1
Laren 20 SG + Dicotex 400	5349	112.6	5416	108.7	5012	112.8	5259	111.3
Ally max SG	5225	110.0	5255	105.5	4930	110.9	5137	108.7
Ally max SG + Sanafen	5368	113.0	5446	109.3	5017	112.9	5255	111.2
				After sowing – Before emergence				
Marathon	5239	110.3	5410	108.6	4800	108.0	5150	109.0
Stomp new 330 EK	5220	109.9	5393	108.2	4784	107.7	5132	108.6
Racer 25 EK	5197	109.4	5410	108.6	4748	106.8	5118	108.3
Eagle 75 DF	5092	107.2	5217	104.7	4702	105.8	5004	105.9
Cougar	5011	105.5	5073	101.8	4683	105.4	4922	104.1
LSD P<0.5	168	3.5	154	3.1	116	2.6		
LSD P< 0.1	224	4.7	206	4.1	154	3.5		
LSD P<0.01	293	6.2	270	5.4	202	4.5		

against them.

Volunteers of Clearfield and ExpressSun sunflower are controlled by herbicides Arat, Derby, Derby super, Mustang, Sunsac, Secator, Lintur, Weedmaster, Marathon, Stomp, Racer and Cougar. Herbicides Granstar, Granstar super, Larren, Ally max and Eagle are ineffective against these two groups of sunflower volunteers.

Volunteers of coriander in wheat crops are controlled by herbicides Derby, Mustang, Sunsac, Secator, Lintur, Weedmaster, Granstar super, Eagle and Cougar. Herbicides Arat, Granstar, Laren, Ally max, Marathon, Racer and Stomp are ineffective against them. Herbicide tank mixtures Derby super + Sanafen, Secator + Sanafen, Granstar super + Starane, Laren + Dicotex and Ally max + Sanafen successfully control volunteers of coriander, Clearfield canola, Clearfield and ExpressSun sunflower.

Herbicide Cougar causes high phytotoxicity on durum wheat and leads to decrease of grain yield. This herbicide must not be applied in durum wheat crops.

The highest grain yield was obtained by treatment with herbicide tank mixture Granstar super + Starane, Derby super + Sanafen, Secator + Sanafen, Ally max + Sanafen and Laren + Dicotex and herbicides Derby super, Derby, Secator, Sunsac, Mustang , Weedmaster and Arat.

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Preparation of papers

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The manuscript should be structured as follows: Title, Names of authors and affiliation address, Abstract, List of keywords, Introduction, Material and methods,Results, Discussion, Conclusion, Acknowledgements (if any), References, Tables, Figures.

The title needs to be as concise and informative about the nature of research. It should be written with small letter /bold, 14/ without any abbreviations.

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Discussion: The objective of this section is to indicate the scientific significance of the study. By comparing the results and conclusions of other scientists the contribution of the study for expanding or modifying existing knowledge is pointed out clearly and convincingly to the reader.

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Oldenbroek JK, 1999. Genebanks and the conservation of farm animal genetic resources, Second edition. DLO Institute for Animal Science and Health, Netherlands.

Book chapter or conference proceedings: Author(s) surname and initials, year. Title. In: Title of the book or of the proceedings followed by the editor(s), volume, pages. Name of publisher, place of publication. Example:

Mauff G, Pulverer G, Operkuch W, Hummel K and Hidden C, 1995. C3-variants and diverse phenotypes of unconverted and converted C3. In: Provides of the Biological Fluids (ed. H. Peters), vol. 22, 143-165, Pergamon Press. Oxford, UK.

Todorov N and Mitev J, 1995. Effect of level of feeding during dry period, and body condition score on reproductive performance in dairy cows,IXth International Conference on Production Diseases in Farm Animals, Sept.11 – 14, Berlin, Germany, p. 302 (Abstr.).

Thesis:

Penkov D, 2008. Estimation of metabolic energy and true digestibility of amino acids of some feeds in experiments with muscus duck (Carina moshata, L). Thesis for DSc. Agrarian University, Plovdiv, 314 pp.

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Studies performed on experimental animals should be carried out according to internationally recognized guidelines for animal welfare. That should be clearly described in the respective section “Material and methods”.

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