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EFFICACY OF SOME HERBICIDES AND HERBICIDE TANK MIXTURES AGAINST WEEDS AND SELF-SOWN PLANTS IN DURUM WHEAT (*Triticum durum* Desf.)

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Abstract

The research was conducted during 2015-2017 on pellicvertisol soil type. Under investigation was Bulgarian durum wheat cultivar Elbrus (Triticum durum Desf.). Factor A included untreated control and 4 antigraminaceous herbicides - Axial 050 EC (pinoxaden) - 900 ml/ha, Topic 080 EC (clodinafop) - 450 ml/ha, Traxos 045 EC (pinoxaden + clodinafop) - 1.20 l/ha and Scorpio super 7.5 EB (fenoxaprop-ethyl) – 1 l/ha. Factor B included untreated control and 4 antibroadleaved herbicides - Biathlon 4 D (tritosulfuron + florasulam) - 55 g/ha, Lintur 70 WG (triasulfuron + dicamba) - 150 g/ha, Granstar super 50 SG (tribenuron-methyl + tiphensulfuron-methyl) - 40 g/ha and Secator OD (amidosulfuron + iodosulfuron) - 100 ml/ha. All of antigraminaceous herbicides, antibroadleaved herbicides and their tank mixtures were treated in tillering stage of the durum wheat.Self-sown plants of Clearfield canola in durum wheat crops are successfully controlled by herbicide Biathlon only. Self-sown plants of Clearfield and ExpressSun sunflower are controlled by herbicides Biathlon, Lintour and Secator. Self-sown plants of coriander are controlled by herbicides Lintur, Granstar super and Secator. Self-sown plants of milk thistle are controlled by herbicides Lintur and Secator. There is synergism in herbicide Traxos and very good efficacy against Bromus arvensis L. There is antagonism in herbicide tank mixture Scorpio super + Lintur and decreasing of the efficacy against Galium aparine L., Chamomilla recutita Rauchert, Myagrum perfoliatum L., Cirsium arvense Scop. and Apera spica-venti P.B. For complete control of all weeds and self-sown plants in durum wheat crops, two herbicides should be combined - both antigraminaceous and antibroadleaved.

Key words*: durum wheat, weeds, self-sown plants, herbicides, herbicide tank mixtures, efficacy, selectivity.*

INTRODUCTION

In Bulgaria, durum wheat is grown mainly in crop rotations with sunflower or canola. The most part of winter oilseed canola is grown by Clearfield technology - about 60%. Oil-bearing sunflower is grown mainly by Clearfield and ExpressSun technologies - between 93% and 95%. 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 the latest years the coriander significantly increased the areas and became the sixth culture in Bulgaria, deferring only to wheat, sunflower, maize, canola and barley. Currently, about 200.000 hectares in the Bulgaria already "are weed infested" with self-sown plants of coriander (Delchev, 2018a). These self-sown plants are destroyed difficult in wheat crops (Vaculík, 2007).

Self-sown plants of milk thistle are an unpleasant weed for next crops, especially for winter cereals (Delchev, 2018b). The seeds maintain their germination ability for a long time and easily spread by wind at harvest. Uneven maturation time of individual anthodia is typical and the achenes tend to fall out from ripe anthodia, so optimal time of harvest must be selected (Spitzová, 1997; Moudrý, 2001).

Seeds from self-sown plants of Clearfield canola, Clearfield sunflower, ExpressSun sunflower, coriander and milk thistle are becoming a big problem in the durum wheat crops (Nakayama et al., 2010; Gupta et al., 2011; Tsyuganov and Potarenko, 2011). Effective weed control is one the important conditions for full realization of the biological potential of the durum wheat (Delchev, 2018).

The purpose of the investigation was to establish the efficacy and selectivity of some antigraminaceous herbicides, antibroadleaved

herbicides and their tank mixtures on durum wheat.

MATERIALS AND METHODS

The research was conducted during 2015-2017 on pellicvertisol soil type. A field experiment was carried out with Bulgarian durum wheat cultivar Elbrus (*Triticum durum* Desf.). Two factors experiment was conducted under the block method, in 4 repetitions; the size of the crop plot was 15 m^2. Factor Aincluded untreated control and 4 antigraminaceous herbicides - Axial 050 EC, Topic 080 EC, Traxos 045 EC and Scorpio super 7.5 EB. Factor B included untreated control and 4 antibroadleaved herbicides - Biathlon 4 D, Lintur 70 WG, Granstar super 50 SG and Secator OD. The active substances and doses of the investigated herbicides are given in Table 1.

Table 1. Investigated variants

№	Herbicide	Active substance	Dose
		Antigraminaceous herbicides	
1	Control	-	-
2	Axial 050 EC	pinoxaden	900 ml/ha
3	Topic 080 EC	clodinafop	450 ml/ha
4	Traxos 045 EC	pinoxaden + clodinafop	1.20 l/ha
5	Scorpio super 7.5 EB	fenoxaprop-ethyl	1 l/ha
		Antibroadleaved herbicides	
1	Control	-	-
2	Biathlon 4 D	tritosulfuron + florasulam	55 g/ha
3	Lintur 70 WG	triasulfuron + dicamba	150 g/ha
4	Granstar super 50 SG	tribenuron-methyl + tiphensulfuron-methyl	40 g/ha
5	Secator OD	amidosulfuron + iodosulfuron	100 ml/ha

Herbicide Biathlon was used in addition with adjuvant Dash HC - 500 ml/ha and herbicide Granstar super - with adjuvant Trend 90 - 0.1%.

All of antigraminaceous herbicides, antibroadleaved herbicides and their tank mixtures were treated in tillering stage of the durum wheat, with working solution 200 l/ha. Mixing was done in the tank on the sprayer. Due to of low adhesion of the herbicide Biathlon it was used in addition with adjuvant Dash HC - 500 ml/ha and herbicide Granstar super - with adjuvant Trend 90-0.1 %.

It was investigated efficacy and selectivity of herbicides and their tank mixtures. Efficacy of herbicides against weeds and self-sown plants was appointed according to 100% scale of EWRS (European Weed Research Society). Selectivity of herbicides to durum wheat plants was followed according to the 9 - rate scale of EWRS (rating 1 - without damages, rating 9 - crop is completely destroyed).

RESULTS AND DISCUSSIONS

Annual broadleaved weeds in the experience are represented by *Anthemis arvensis* L., *Chamomilla recutita* Rauchert, *Galium aparine* L., *Sinapis arvensis* L., *Raphanus raphanistrum* L., *Capsella bursa-pastoris* L., *Falopia convolvulus* Leve, *Lithospermum arvense* L., *Papaver rhoes* L., *Consolida regalis* Gray, *Viola tricolor* L., *Myagrum perfoliatum* L., *Lamium purpureum* L., *Veronica hederifolia* L., *Stellaria media* Cyr.

Perennial broadleaf weeds are established *Cirsium arvense* Scop., *Convolvulus arvensis* L., *Cardaria draba* L., *Sonchus arvensis* L.

Graminaceous weeds are reported *Avena fatua* L., *Avena ludoviciana* Durien., *Alopecurus myosuroides* L., *Apera spica-venti* P.B., *Lolium*

temulentum L., *Lolium multiflorum* L., *Bromus arvensis* L.

Self-sown plants in experience are from Clearfield canola (*Brassica napus* L.), Clearfield and ExppessSun sunflower (*Helianthus annuus* L.), coriander (*Coriandrum sativum* L.) and milk thistle (*Silybum marianum* Gaertn.). They are sown manually when sowing durum wheat.

Antibroadleaved herbicides Biathlon and Secator have high efficacy against represented in the experience annual broadleaved weeds (Table 2). Herbicide Lintur is less effective only against *Consolida regalis* Gray - 45%. It destroys mainly less developed plants. Herbicide Granstar super has satisfactory efficacy against *Falopia convolvulus* Leve, but the efficacy against *Galium aparine* L. is unsatisfactory.

Table 2. Efficacy of some herbicides and herbicide tank mixtures against annual broadleaved weeds at durum wheat according to the 100% visual scale of EWRS (mean 2015-2017)

Herbicides		Weeds								
Antigraminaceous	Antibroadleaved	*Galium aparine*	*Chamomillare cutita*	*Papaver rhoes*	*Consolida regalis*	*Sinapis arvense*	*Raphanus raphanistrum*	*Anthemis arvensis*	*Myagrumperf oliatum*	*Falopia convolvulus*
-	-	0	0	0	0	0	0	0	0	0
	Biathlon	100	100	100	98	100	100	100	100	100
	Lintur	100	100	100	45	100	95	100	100	100
	Granstar super	75	100	100	100	100	100	100	100	92
	Secator	100	100	98	98	100	100	100	100	100
Axial	-	0	0	0	0	0	0	0	0	0
	Biathlon	100	100	100	98	100	100	100	100	100
	Lintur	100	100	100	45	100	95	100	100	100
	Granstar super	75	100	100	100	100	100	100	100	92
	Secator	100	100	98	98	100	100	100	100	100
Topic	-	0	0	0	0	0	0	0	0	0
	Biathlon	100	100	100	98	100	100	100	100	100
	Lintur	100	100	100	45	100	95	100	100	100
	Granstar super	75	100	100	100	100	100	100	100	92
	Secator	100	100	98	98	100	100	100	100	100
Traxos	-	0	0	0	0	0	0	0	0	0
	Biathlon	100	100	100	98	100	100	100	100	100
	Lintur	100	100	100	45	100	95	100	100	100
	Granstar super	75	100	100	100	100	100	100	100	92
	Secator	100	100	98	98	100	100	100	100	100
Scorpio super	-	0	0	0	0	0	0	0	0	0
	Biathlon	100	100	100	98	100	100	100	100	100
	Lintur	98	95	100	45	100	95	100	95	100
	Granstar super	75	100	100	100	100	100	100	100	92
	Secator	100	100	98	98	100	100	100	100	100

Antibroadleaved herbicides Biathlon, Lintur and Secator have very high efficacy against perennial broadleaved weeds *Cirsium arvense* Scop., *Cardaria draba* L. and *Sonchus arvensis* L. (Table 3). Herbicide Granstar super has fewer efficacies against *Cirsium arvense* Scop. compared to herbicide Granstar (Delchev, 2013; 2015). Granstar super controls it at 90%, versus Granstar controlsit at 100%. Obviously, the reduction in the amount of tribenuron-methyl at the expense of the addition of thifensulfuron-methyl at Granstar super increases the efficacy of this herbicide against some annual broadleaved weeds but reduces its efficacy against *Galium aparine* L.

Table 3. Efficacy of some herbicides and herbicide tank mixtures against perennial broadleaved weeds and self-sown plants at durum wheat according to the 100% visual scale of EWRS (mean 2015-2017)

Herbicides		Weeds and self-sown plants								
Antigraminaceous	Antibroadleaved	*Cirsium arvense*	*Convolvulus arvensis*	*Cardaria draba*	*Sonchus arvensis*	*Brassica napus*[1]	*Helianthus annuus*[2]	*Helianthus annuus*[3]	*Coriandrums ativum*[4]	*Silybummaria num*[5]
-	-	0	0	0	0	0	0	0	0	0
	Biathlon	100	0	100	100	100	100	100	70	80
	Lintur	100	86	100	100	65	100	100	100	100
	Granstar super	90	0	90	100	10	15	10	100	0
	Secator	100	0	90	90	82	100	100	100	100
Axial	-	0	0	0	0	0	0	0	0	0
	Biathlon	100	0	100	100	100	100	100	70	80
	Lintur	100	86	100	100	65	100	100	100	100
	Granstar super	90	0	90	100	10	15	10	100	0
	Secator	100	0	90	90	82	100	100	100	100
Topic	-	0	0	0	0	0	0	0	0	0
	Biathlon	100	0	100	100	100	100	100	70	80
	Lintur	100	86	100	100	65	100	100	100	100
	Granstar super	90	0	90	100	10	15	10	100	0
	Secator	100	0	90	90	82	100	100	100	100
Traxos	-	0	0	0	0	0	0	0	0	0
	Biathlon	100	0	100	100	100	100	100	70	80
	Lintur	100	86	100	100	65	100	100	100	100
	Granstar super	90	0	90	100	10	15	10	100	0
	Secator	100	0	90	90	82	100	100	100	100
Scorpio super	-	0	0	0	0	0	0	0	0	0
	Biathlon	100	0	100	100	100	100	100	70	80
	Lintur	95	86	100	100	65	100	100	100	100
	Granstar super	90	0	90	100	10	15	10	100	0
	Secator	100	0	90	90	82	100	100	100	100

[1] - self-sown plants of Clearfield canola; [2] - self-sown plants of Clearfield sunflower; [3] - self-sown plants of ExpressSun sunflower; [4] - self-sown plants of coriander;[5] - self-sown plants of milk thistle

Antibroadleaved herbicides Biathlon, Granstar super and Secator are inefficacy against *Convolvulus arvensis* L., although they have high efficacy against *Cirsium arvense* Scop.,

Cardaria draba L. and *Sonchus arvensis* L. This is due to the fact that the massive emergence of the bum is late and occurs after the time of herbicide treatment through the tillering stage of the durum wheat.

From the antibroadleaved herbicides only Lintur has satisfactory efficacy against *Convolvulus arvensis* L. - 86%. This herbicide, besides foliar action, also has soil action. Thus, he can control *Convolvulus arvensis* L. when germinating its shoots through stem elongation stage of the durum wheat.

Herbicide Biathlon successfully controls self-sown plants of Clearfield canola (*Brassica napus* L.) and Clearfield and ExppessSun sunflower (*Helianthus annuus* L.), but has insufficient efficacy against self-sown plants of coriander (*Coriandrum sativum* L.) and of milk thistle (*Silybum marianum* Gaertn.) - respectively 70% and 80%.

Herbicide Lintur has satisfactory efficacy against self-sown plants of Clearfield canola - 65%. This herbicide is efficacy against self-sown plants of Clearfield and ExppessSun sunflower, of coriander and of milk thistle.

Herbicide Granstar super has high efficacy against self-sown plants of coriander, but is inefficacy against self-sown plants of Clearfield canola, of Clearfield and ExppessSun sunflower and of milk thistle.

Herbicide Secator successfully controls self-sown plants of Clearfield and ExppessSun sunflower, of coriander and of milk thistle, but has fewer efficacies against self-sown plants of Clearfield canola - 82%.

Antigraminaceous herbicide Axial is effective against almost all annual graminaceous weeds - *Avena fatua* L., *Avena ludoviciana* Durien., *Alopecurus myosuroides* L., *Apera spica-venti* P.B., *Lolium temulentum* L., *Lolium multiflorum* L. (Table 4). This herbicide is inefficacy against *Bromus arvensis* L. only.

Antigraminaceous herbicides Topicand Traxos have very high efficacy against *Avena*

fatua L., *Avena ludoviciana* Durien., *Alopecurus myosuroides* L., *Apera spica-venti* P.B., *Lolium temulentum* L., *Lolium multiflorum* L. Herbicide Topic can not control *Bromus arvensis* L. only.

The combination of the active substances of herbicides Axial and Topic - respectively pinoxaden and clodinafop - in herbicide Traxos, results in synergism and very good herbicide efficacy against *Bromus arvensis* L. - 96%.

Herbicide Scorpio super has very high efficacy against *Alopecurus myosuroides* L., *Avena fatua* L., *Avena ludoviciana* Durien. and good efficacy against *Apera spica-venti* P.B. This herbicide is inefficacy against *Lolium temulentum* L., *Lolium multiflorum* L. and *Bromus arvensis* L.

There is antagonism in herbicide tank mixture Scorpio super + Lintur. There is reduction in the efficacy of antibroad leaved herbicide Lintur against *Galium aparine* L., *Chamomilla recutita* Rauchert, *Myagrum perfoliatum* L. and *Cirsium arvense* Scop. There is also reduction in the efficacy of antigraminaceous herbicide Scorpio super against *Apera spica-venti* P.B. There is no evidence of antagonism against other graminaceous and broadleaved weeds.

Herbicide tank mixtures of antigraminaceous herbicide Scorpio super with antibroadleaved herbicides Biathlon, Granstar super and Secator, as well as of antibroadleaved herbicide Lintur with antigraminaceous herbicides Axial, Topic and Traxos do not exhibit antagonism in their herbicide action.

Antigraminaceous herbicides Axial, Topic and Traksos exhibit excellent miscibility with antibroadleaved herbicides Biatlon, Granstar super and Secator. The herbicides exhibit an additive effect in their herbicide action when they treated as tank mixtures.

The investigated antigraminaceous herbicides - Axial, Topic, Traksos and Scorpio super, antibroadleaved herbicides Biatlon, Lintur, Granstar super and Secator, as well as their tank mixtures exhibit very high selectivity to durum wheat - rating 1 by the scale of EWRS (Table 4).

Visible signs of phytotoxicity to durum wheat were observed only in the herbicide tank mixture Scorpio super + Lintur - rating 2 by the scale of EWRS. It leads to short developmental disorders, resulting in a slight

Table 4. Efficacy of some herbicides and herbicide tank mixtures against annual graminaceous weeds at durum wheat according to the 100% visual scale of EWRS and selectivity according to the 9-rate scale of EWRS (mean 2015-2017)

Herbicides		Weeds							
Antigraminaceous	Antibroadleaved	*Avena fatua*	*Avena ludovicianaa*	*Loliumm ultiflorum*	*Lolium temulentum*	*Alopecurusmyos oroides*	*Apera spica-venti*	*Bromus arvensis*	Selectivity
-	-	0	0	0	0	0	0	0	1
	Biathlon	0	0	0	0	0	0	0	1
	Lintur	0	0	0	0	0	0	0	1
	Granstar super	0	0	0	0	0	0	0	1
	Secator	0	0	0	0	0	0	0	1
Axial	-	100	100	100	100	100	100	0	1
	Biathlon	100	100	100	100	100	100	0	1
	Lintur	100	100	100	100	100	100	0	1
	Granstar super	100	100	100	100	100	100	0	1
	Secator	100	100	100	100	100	100	0	1
Topic	-	100	100	98	99	100	100	0	1
	Biathlon	100	100	98	99	100	100	0	1
	Lintur	100	100	98	99	100	100	0	1
	Granstar super	100	100	98	99	100	100	0	1
	Secator	100	100	98	99	100	100	0	1
Traxos	-	100	100	100	100	100	100	96	1
	Biathlon	100	100	100	100	100	100	96	1
	Lintur	100	100	100	100	100	100	96	1
	Granstar super	100	100	100	100	100	100	96	1
	Secator	100	100	100	100	100	100	96	1
Scorpio super	-	100	100	0	0	100	93	0	1
	Biathlon	100	100	0	0	100	93	0	1
	Lintur	100	100	0	0	100	90	0	2
	Granstar super	100	100	0	0	100	93	0	1
	Secator	100	100	0	0	100	93	0	1

chlorosis on the leaves. Signs of phytotoxicity are overcome by durum wheat for about 4-5 days after treatment.

CONCLUSIONS

Self-sown plants of Clearfield canola in durum wheat crops are successfully controlled by herbicide Biathlon only.

Self-sown plants of Clearfield and ExpressSun sunflower are controlled by herbicides Biathlon, Lintour and Secator.

Self-sown plants of coriander are controlled by herbicides Lintur, Granstar super and Secator.

Self-sown plants of milk thistle are controlled by herbicides Lintur and Secator.

There is synergism in herbicide Traxos and very good efficacy against *Bromus arvensis* L.

There is antagonism in herbicide tank mixture Scorpio super + Lintur and decreasing of the efficacy against *Galium aparine* L., *Chamomilla recutita* Rauchert, *Myagrum perfoliatum* L., *Cirsium arvense* Scop. and *Apera spica-venti* P.B.

For complete control of all weeds and self-sown plants in durum wheat crops, two herbicides should be combined - both antigraminaceous and antibroadleaved.

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