IMPACT OF SOME HERBICIDES AND HERBICIDE TANK MIXTURES ON SOWING CHARACTERISTICS OF DURUM WHEAT SEEDS (*TRITICUM DURUM* DESF.)

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Abstract: *The research was conducted during 2015 - 2017 on pellic vertisol 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. Herbicide tank mixtures Scorpio super + Lintur and Traxos + Granstar super do not proven increase germination energy of the durum wheat seeds. Laboratory seed germination do not prove increased by combination of antigraminaceous herbicide Scorpio super with antibroadleaved herbicide Lintur only. Length of coleoptile is decreased by herbicide tank mixtures Scorpio super + Lintur and Traxos + Granstar super. Herbicide tank mixture Scorpio super + Lintur decreases lengths of primary roots and also increases waste grain quantity. Herbicide tank mixture Traxos + Secator lead to obtaining of the highest grain yield. High yields of durum wheat grain also are obtained by herbicide tank mixtures Traxos + Biathlon and Axial + Biathlon.*

Key words: *durum wheat, herbicides, herbicide tank mixtures, grain yield, sowing characteristics*

INTRODUCTION

Herbicides will remain in future agriculture effective means of weed control as part of integrated control therefore there is need for research to optimize their use (BASSI ET AL., 2002; KUDSK AND STREIBIG, 2003; CAMPAGNA AND RUEEGG, 2006; SANGI ET AL., 2012; DELCHEV, 2018 AND 2018A). The experience of their widespread use shows how important it is borne in mind all the factors that determine the effective application of these complex organic compounds. The main accent in the study of herbicides in durum wheat crops is on their performance against the dominant weeds, selectivity in relation of culture and their influence on the grain quality as regards the use as a raw material in the food industry (HALLGREN, 1993; TEWARI ET AL., 1993; ORLANDO, 1994; BAERG ET AL., 1996; PANWAR ET AL., 1996; KUMAR AND SINGH, 1997; RAPPARINI ET AL., 2004; HASSAN ET AL., 2006; BUCZEK ET AL., 2007).

A part of the grain, however, is used as a seed for sowing. The realization of the biological potential of durum wheat is closely related to the creation of well-topped and highly productive crops that require high-quality seeds. The question of the influence of herbicidal use in the seed production on the quality of the obtained durum wheat seeds has not yet been elucidated.

The aim of this investigation was to establish the influence of some antigraminaceous herbicides, antibroadleaved herbicides and their tank mixtures on sowing characteristics of the durum wheat seeds and the quantity of waste grain.

MATERIALS AND METHODS

The research was conducted during 2015 - 2017 on pellic vertisol 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 A included 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 %.

The grain gained after every variant was cleaned through a sieve with holes' size 2.2 mm and the quantity of the waste grain was defined (siftings). All version seeds for sowing were defined for their germination energy and lab seed germination. It was studied intensity of early growth of seeds, expressed by the length of primary roots and coleoptile definite on the eighth day after setting the samples. Each index was determined in two repetitions of the year. Averages in each of the years of experience were used as repetitions in mathematical data processing were done according to the method of analysis of variance.

RESULTS AND DISCUSSION

One of the important conditions for obtaining a normal crop and a good harvest is the use of quality seeds. Apart from the high-yield cultivar which is resistance to diseases and pests, it must have the necessary sowing properties, the main of which are high germination energy

and seed germination. Germination energy is one of the most important characteristics of the sowing properties of the seed. The low germination energy is the reason for slower development of primary roots and coleoptile after seed germination and is associated with later germination in field conditions, less tempering of plants and a higher risk of frost in the winter. Its lead to lower grain yields. The obtained results show that the treatment of the durum wheat with herbicide tank mixtures Scorpio super + Lintur and Traxos + Granstar super during tillering stage of durum wheat lead to the fewest increase in the germination energy (Table 2). Analysis of variance, in which the years have taken for replications, shows that these increases are not mathematically proven.

Table 2

Influence of some herbicides and herbicide tank mixtures on sowing characteristics of the seeds (mean 2015 - 2017)

Herbicides		**Germinative energy, %**	**Germination, %**	**Length, cm**		**Waste grain, %**
Antigraminaceous	**Antibroadleaved**			**Coleoptile**	**Root**	
-	-	77.5	88.0	8.08	14.14	14.2
	Biathlon	91.0	96.5	10.73	18.89	13.0
	Lintur	91.5	96.0	10.65	18.87	13.4
	Granstar super	91.5	96.0	10.65	18.92	13.5
	Secator	91.0	97.0	10.85	18.82	13.0
Axial	-	91.0	96.5	10.98	18.06	13.4
	Biathlon	94.0	97.0	11.56	18.56	11.9
	Lintur	94.5	96.5	11.60	18.50	12.1
	Granstar super	96.0	98.0	11.56	18.21	11.3
	Secator	95.0	98.0	11.50	18.18	10.4
Topic	-	89.5	95.5	10.74	18.36	13.7
	Biathlon	92.5	98.0	11.09	18.96	11.1
	Lintur	93.0	98.0	11.82	18.86	12.2
	Granstar super	93.0	97.0	11.32	18.93	11.2
	Secator	94.0	97.5	11.05	18.00	11.9
Traxos	-	89.0	95.0	10.69	18.93	13.6
	Biathlon	94.0	97.5	11.89	19.16	11.5
	Lintur	94.0	96.0	11.16	19.34	12.2
	Granstar super	92.5	95.0	9.93	17.90	13.0
	Secator	96.5	97.0	11.58	19.70	11.3
Scorpio super	-	88.5	95.0	10.86	18.35	13.2
	Biathlon	94.0	97.5	11.60	19.15	11.2
	Lintur	92.0	93.0	9.74	16.44	16.3
	Granstar super	93.5	98.0	11.65	19.92	13.9
	Secator	94.5	98.5	10.20	19.93	11.8
LSD 5 %		6.3	5.4	2.0	3.2	1.9
LSD 1 %		8.4	7.1	4.7	5.8	4.7
LSD 0.1 %		10.6	9.3	6.1	8.0	6.8

Germination is the most important index who characterizing the sowing properties of the seed. At low laboratory germination sowing should be done with higher sowing rate, which increases the cost production. Laboratory germination of the seeds at all variant during the three years of study above the requirements of the standard for over 85% germination, although in different years account for some variation of its values. This is the positive effect of their use, because it is not necessary to increase the sowing rate (in kg/ha) and the cost of necessary seeds. At herbicide tank mixtures Scorpio super + Lintur seed germination is lower than alone treatments of herbicides Scorpio super and Lintur and unproven higher than untreated control. The durum wheat seeds germinate normally by influence of the herbicide tank mixture Traxos + Granstar super, although the initial rate of development is lower due to lower germination energy. Other antigraminaceous herbicides, antibroadleaved herbicides and their tank mixtures increase the indexes germination energy and seed germination. This means that they help for joint and fast germination of the durum wheat sowing-seeds.

The obtained results for germination energy and seed germination are a prerequisite continue to investigate the effect of herbicides and their tank mixtures on initial intensity of the growth of seeds, expressed by the length of roots and coleoptiles. It was found that the length of coleoptiles of durum wheat is decreased by herbicide tank mixtures Scorpio super + Lintur and Traxos + Granstar super. The length of primary roots of durum wheat is decreased by herbicide tank mixture Scorpio super + Lintur only. These decreasing are proven by analysis of variants. Combination of antigraminaceous herbicide Traxos with antibroadleaved herbicide Granstar super does not influence on length of primary roots. The herbicide tank mixtures Scorpio super + Lintur and Traxos + Granstar super difficult young plants developments, reduces their resistance to cold and increase risk of frost damages during winter months. Other tank mixtures between investigated antigraminaceous and antibroadleaved herbicides stimulate the growth of the length of primary roots and coleoptiles of the durum wheat and recommended for use in seed production crops of durum wheat.

At the evaluation of the sowing characteristics we have to consider not only the characteristics of the sowing seeds but also the quantity of the waste grain (siftings) which are gained at the preparation of these seeds. Bigger quantity screenings lead to higher cost of the seed and reduce the economic effect of seed production of durum wheat. Tank mixture of antigraminaceous herbicide Scorpio super with antibroadleaved herbicide Lintur lead to are mathematically proven increase in the quantity of waste grain. Other antigraminaceous herbicides, antibroadleaved herbicides and their tank mixtures lead to decreasing in the quantity of waste grain. Differences between them and untreated control are mathematically proven.

Decreases in the values of germination energy and laboratory seed germination, changes in the intensity of the initial growth, expressed by the length of the root and coleoptile at germination and changes in the quantity of waste grain by the influence of the herbicide tank mixtures Scorpio super + Lintur and Traxos + Granstar super are explained by the depressing effects on growth and development of the durum wheat during its vegetative period.

To done a full evaluation of the sowing characteristics needed to establish not only the quality of seeds, but also the quantity of grain which will be received this seeds. Data for the influence of antigraminaceous herbicides, antibroadleaved herbicides and their tank mixtures on grain yield (Table 3) show that the lower yield is obtained in untreated control. At alone application of antibroadleaved herbicides Biathlon, Lintur, Granstar super and Secator increases grain yield average for the period from 113.8 % to 116.1 %. These herbicides cannot control annual graminaceous weeds. Herbicides Biathlon, Granstar super and Secator are ineffective against *Convolvulus arvensis*. This is due to the fact that the massive emergence of this

perennial broadleaved weed is late and occurs after the herbicide treatment during the tillering stage of durum wheat. Only herbicide Lintur, besides foliar action, also has soil action. Thus, this herbicide can control the shoots до *Convolvulus arvensis* during stem elongation stage of durum wheat.

Table 3

Influence of some herbicides and herbicide tank mixtures on grain yield of durum wheat (mean 2015 - 2017)

Herbicides		**2015**		**2016**		**2017**		**Mean**	
Antigraminaceous	**Antibroadleaved**	**kg/ha**	**%**	**kg/ha**	**%**	**kg/ha**	**%**	**kg/ha**	**%**
-	-	4200	100	3483	100	4550	100	4078	100
	Biathlon	4611	109.9	4500	129.9	5090	111.9	4736	116.1
	Lintur	4507	107.3	4375	125.6	5066	111.3	4649	114.0
	Granstar super	4500	107.1	4400	126.3	5016	110.3	4639	113.8
	Secator	4566	108.7	4550	130.6	5000	109.9	4706	115.4
Axial	-	4560	108.6	4133	118,7	5066	111.3	4586	112.5
	Biathlon	4914	117.0	4772	137.0	5260	115.6	4982	122.2
	Lintur	4906	116.8	4598	132.0	5283	116.1	4928	120.8
	Granstar super	4914	117.0	4694	134.7	5090	111.9	4899	120.1
	Secator	4933	117.4	4694	134.7	5273	115.9	4967	121.8
Topic	-	4550	108.3	4133	118.7	5016	110.3	4567	112.0
	Biathlon	4883	116.3	4766	136.8	5216	114.6	4956	121.5
	Lintur	4882	116.2	4605	132.2	5283	116.1	4923	120.7
	Granstar super	4500	107.1	4402	126.4	5016	110.3	4939	121.1
	Secator	4933	117.4	4694	134.7	5183	113.9	4937	121.0
Traxos	-	4580	109.0	4200	120.6	5090	111.9	4623	113.4
	Biathlon	4914	117.0	4705	135.1	5333	117.2	4984	122.2
	Lintur	4882	116.2	4605	132.2	5283	116.1	4923	120.7
	Granstar super	4662	111.0	4465	128.2	5183	113.9	4770	117.0
	Secator	4914	117.0	4750	136.4	5324	117.0	4996	122.5
Scorpio super	-	4466	106.3	4016	115.3	5050	111.0	4511	110.6
	Biathlon	4767	113.5	4705	135.1	5183	113.9	4885	119.8
	Lintur	4444	105.8	4033	115.8	4833	106.2	4437	108.7
	Granstar super	4866	115.9	4666	133.9	5111	112.3	4881	119.7
	Secator	4700	111.9	4750	136.4	5333	117.2	4928	120.8
LSD 5 %		273	6.5	307	8.8	346	7.6		
LSD 1 %		353	8.4	394	11.3	455	10.0		
LSD 0.1 %		466	11.1	495	14.2	587	12.9		

Herbicide Biathlon has insufficient efficacy against self-sown plants of coriander and milk thistle. Herbicides Lintur and Secator have fewer efficacies against self-sown plants of Clearfield canola only. Herbicide Granstar super is not efficacy against self-sown plants of Clearfield canola, Clearfield and ExpressSun sunflower and milk thistle.

At alone application of antigraminaceous herbicides Axial, Topic, Traxos and Scorpio super increases grain yield average for the period from 110.6 % to 113.4 %. These herbicides cannot control annual and perennial broadleaved weeds, and also self-sown plants of Clearfield canola, of Clearfield and ExpressSun sunflower, of coriander and of milk thistle.

The herbicide tank mixtures between antigraminaceous herbicides Axial, Topic, Traxos and Scorpio super on the one hand and the antibroadleaved herbicides Biathlon, Lintur, Granstar super and Secator on the other hand lead to higher yields than the alone application of respective herbicides during the three years of the investigation. Herbicide combinations provide good control over a large number of annual and perennial broadleaved weeds, annual graminaceous weeds and self-sown plants of cultural species in durum wheat crops. The highest grain yield is obtained by herbicide tank mixture Traxos + Secator – 122.5 % over untreated control, followed by Traxos + Biathlon and Axial + Biathlon - 122.2 %. This is due to their very good efficacy against graminaceous and broadleaved weeds and against self-sown plants of cultural species.

There is antagonism at the combination of antigraminaceous herbicide Scorpio super with antibroadleaved herbicide Lintur. Grain yield is less than the grain yields of alone applications of herbicides Scorpio super and Lintur.

CONCLUSIONS

Herbicide tank mixtures Scorpio super + Lintur and Traxos + Granstar super do not proven increase germination energy of the durum wheat seeds.

Laboratory seed germination do not prove increased by combination of antigraminaceous herbicide Scorpio super with antibroadleaved herbicide Lintur only.

Length of coleoptile is decreased by herbicide tank mixtures Scorpio super + Lintur and Traxos + Granstar super.

Herbicide tank mixture Scorpio super + Lintur decreases lengths of primary roots and also increases waste grain quantity.

Herbicide tank mixture Traxos + Secator lead to obtaining of the highest grain yield.

High yields of durum wheat grain also are obtained by herbicide tank mixtures Traxos + Biathlon and Axial + Biathlon.

BIBLIOGRAPHY

BAERG, R., GRONWALD, J., ELERLEIN, C., STUCKER, R., 1996 – Antagonism of diclofop control of wild oat by tribenuron. Weed Science, 44 (3): 461-468.

BASSI, A., LODI, G., MASSASSO, W., TURCHIARELLI, V., CUNSOLO, D., 2002 – Compatibility between carfentrazone and commercial formulations of tribenuron - fenoxapron and clodinafop [*Triticum durum* Desf. - *Triticum aestivum* L. - Italy]. Atti delle Giornate Fitopatologiche, 1: 189-196.

BUCZEK, J., TOBIASZ-SALACH, R., SZPUNAR-KROK, E., BOBRECKA-JAMRO, D., 2007 – Assessment of the effectiveness of application of selected herbicides on spring wheat. Fragmenta Agronomica, 24 (94): 48-57.

CAMPAGNA, C.. RUEEGG, W.. 2006 – Pinoxaden: new herbicide for post emergence application in wheat and barley [*Triticum aestivum* L.; *Triticum durum* Desf.; *Hordeum vulgare* L.; Italy; France; Germany], Atti delle Giornate Fitopatologiche, 1: 285-290.

DELCHEV, GR., 2018 – Mixability of herbicides with growth regulators and foliar fertilizers. Monograph, ISBN: 978-613-6-64820-0, LAP LAMBERT Academic Publishing, Saarbrücken, Germany, pp. 329.

DELCHEV, GR., 2018 – Late use of herbicides in durum wheat crop (*Triticum durum* Desf.). Monograph, ISBN: 978-613-8-26945-8, LAP LAMBERT Academic Publishing, Saarbrücken, Germany, pp. 141.

HALLGREN, E. 1993 – Effects of some herbicides or mixtures of herbicides on annual dicots as a whole and grain yield at different doses, development stages, and weed densities. Vaxtotling Sveriges Landbruksuniversitet, 46: 28-30.

HASSAN, G., KHAN, I., BIBI, S., SHAH, N., 2008 – To investigate the efficacy of different herbicides alone or in mixtures for controlling weeds in wheat. Pakistan Journal of Plant Sciences, 14(1): 59-65.

KUDSK, P., STREIBIG, J., 2003 – Herbicides - a towed-get sword. Weed Research, 43 (2): 90-102.

KUMAR, S., SINGH. G., 1997 – Efficacy and selectivity of tralkoxydim alone or in combination with isoproturon in wheat. Indian Journal of Agronomy, 42 (2): 306-309.

ORLANDO, D., 1994 – Pendiron (chlorotoluron + pendimethalin) and Pronto (fluroxypyr + metosulam): new mixed herbicides for cereal crops, herbicide tolerance of soft wheat varieties. Perspectives Agricoles, 193: 89-95.

PANWAR, R., MALIK, K., BALYAN, R., RATHI, S., 1996 – Influence of tank mixture of isoproturon and fluroxypyr on the control on weeds in wheat. Indian Journal of Agronomy, 41 (4): 577-580.

RAPPARINI, G., PACI, F., BARTOLINI, D., ROMAGNOLI, S., 2004 – Further study of miscibility between clodinafop-propargyl and tralkoxydim with broadleaf herbicides applied in post-emergence of wheat [*Triticum aestivum* L.; *Triticum durum* Desf.; Emilia-Romagna], Atti delle Giornate Fitopatologiche, 1: 357-362.

SANGI, A., ASLAM, M., JAVED, S., KHALID, L., 2012 – Efficacy and economics of mixing different herbicides for controlling broad and narrow leaved weeds in wheat. Journal of Agricultural Research, 50(1): 79-87.

TEWARI, S., SINGH, G., VERMA, B., 1993 – Weed control efficacy of fluroxypyr and its combinations with 2.4-D and isoproturon in wheat. Indian Society of Weed Science, 3: 68-70.