

INFLUENCE OF SOME MIXTURES BETWEEN RETARDANTS AND ANTIBROADLEAVED HERBICIDES ON THE GRAIN YIELD AND GRAIN QUALITY OF DURUM WHEAT

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ABSTRACT

The research was conducted during 2010 - 2012 on pellic vertisol soil type. A field experiment was carried out with durum wheat cultivar Progress (*Triticum durum* var. *leucurum*). Factor A included no treated check and 3 retardants – Cycocel extra (chlormequat + cholinechloride) – 1.5 l/ha, Vivax (chlormequat + ethephon) – 1.7 l/ha, Terpal (ethephon + mepiquat) – 3 l/ha. Factor B included weeded no treated check and 4 antibroadleaved herbicides – Granstar 75 DF (tribenuron-methyl) – 20 g/ha, Granstar super 50 SG (tribenuron-methyl + tiphensulfuron-methyl) – 40 g/ha, Laren 20 SG (methsulfuron-methyl) – 30 g/ha, Ally max SG (methsulfuron-methyl + tribenuron-methyl) – 35 g/ha. All of retardants, antibroadleaved herbicides and their tank mixtures were treated in tillering stage of the durum wheat. The weak adhesion of Granstar, Granstar super, Laren and Ally max required its application with adjuvant Trend 90 – 0.1 %.

Herbicide Granstar super cannot be mixed with retardants containing chlormequat - Cycocel extra and Vivax. There is antagonism at mixtures of retardant Terpal with herbicides containing methsulfuron-methyl – Laren and Ally max. The lowest durum wheat grain yields are obtained by these tank mixtures. The grain yield decrease by these tank mixtures is due to the decrease in the grain number per spike and the grain weight spike. The 1000 grain weight, test weight and vitreousness are increased by influence of the investigated retardants, antibroadleaved herbicides and their tank mixtures. Retardants Cycocel extra, Vivax and Terpal, antibroadleaved herbicides Granstar, Granstar super, Laren and Ally max increase the protein quantity, wet and dry gluten quantities. Protein quantity wet and dry gluten quantities by tank mixtures Cycocel extra + Granstar super, Vivax + Granstar super and Terpal + Granstar super are lower than these quantities by the alone application of these preparations.

Key words: *durum wheat, retardants, herbicides, grain yield, structural elements of the yield, grain quality*

INTRODUCTION

The application of pesticides, including herbicides, is a part of plant protection systems in the cultivation of all cultures. For weed control in winter cereals are widely used foliar-applied herbicides from the group of the sulfonylureas (Bassi et al., 2002; Kieloch et al., 2008).

The cereals with confluent surface area are crops with high risk cultures if account is taken losses from weeds. The summarized data of many studies show that at average level of weed infestation, yield of the cultivation of winter cereals with confluent surface area decreases from 15 % to 35%. To be obtained stable yields and incomes by the cultivation of winter cereals, weed control is accomplished by applying different herbicides (Soukup et al., 2000; Zewdie and Rungsit, 2005; Gupta et al., 2011; Sangi et al., 2012). Kubines (1990), Arends and Pegg (1990), Lancikova (1992) establish cultivar sensitivity to some herbicides. It must therefore investigate the effect of herbicides on the crop before they register to use (Grundy et al., 1996; Stashinskis, 2001, Brzozowska and Brzozowski, 2002; Cacak-Pietrzak et al., 2008).

The purpose of this investigation was to investigate the influence of some retardants, antibroadleaved herbicides and their tank mixtures on grain yield of durum wheat, its structural elements and grain quality.

MATERIALS AND METHODS

The research was conducted during 2010 - 2012 on pellic vertisol soil type. A field experiment was carried out with durum wheat cultivar Progress (*Triticum durum* var. *leucurum*). Two factors experiment was conducted under the block method, in 4 repetitions; the size of the crop

plot was 15 m². Factor A included no treated check and 3 retardants – Cycocel extra (chlormequat + cholinechloride) – 1.5 l/ha, Vivax (chlormequat + ethephon) – 1.7 l/ha, Terpal (ethephon + mepiquat) – 3 l/ha. Factor B included weeded no treated check and 4 antibroadleaved herbicides – Granstar 75 DF (tribenuron-methyl) – 20 g/ha, Granstar super 50 SG (tribenuron-methyl + thifensulfuron-methyl) – 40 g/ha, Laren 20 SG (methsulfuron-methyl) – 30 g/ha, Ally max SG (methsulfuron-methyl + tribenuron-methyl) – 35 g/ha.

The weak adhesion of Granstar, Granstar super, Laren and Ally max required its application with adjuvant Trend 90 – 0.1 %. All of retardants, 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. Investigated herbicides have not antigaminaceous effect and the fight against graminaceous weeds in all variants was carried out with herbicide Traxos 045 EK (pinoxaden + clodinafop) in dose 1.2 l/ha.

It was investigated the influence of the retardants, antibroadleaved herbicides and their tank mixtures on durum wheat grain yield and yield components – spike length, spikelets per spike, grains per spike, grain weight per spike. It was investigated and changes who made of the tested factors in the physical properties - 1000 grain weight, test weight and vitreousness – and the biochemical properties – protein quantity, wet and dry gluten quantities. The mathematical processing is made with analysis of variance method.

RESULTS AND DISCUSSION

Data for the influence of retardants, antibroadleaved herbicides and their tank mixtures on grain yield (Table 1) show that the lower yield is obtained in untreated and weed check. The alone application of herbicides Granstar, Granstar super, Laren and Ally max increase grain yield, because destroy existing annual and perennial broadleaved weeds. The alone application of retardants Cycocel extra, Vivax, and Terpal also increases yield because they stimulate the growth and development of durum wheat. The increase was less than its mixtures with herbicides, because available broadleaved weeds neutralize part of its positive effect. At all variants, graminaceous weeds are destroyed with antigaminaceous herbicide Traxos which treated 10 days before the application of the relevant products.

There has been antagonism of combined application of herbicide Granstar super with retardants containing chlormequat - Cycocel extra and Vivax. Antagonism is biggest in 2011, when grain yields by tank mixtures Cycocel extra + Granstar super and Vivax + Granstar super are smaller and mathematically proven than grain yields by the other tank mixtures with 6 – 7%. Tank mixtures of herbicide Granstar super with retardants Cycocel extra and Vivax have not antagonism to grain yield during any of the years of investigation. Grain yields by these mixtures are higher than grain yields by the alone application of the preparations. This means that it is the antagonism between the active substance chlormequat containing in retardants Cycocel extra and Vivax by one hand and the active substance thifensulfuron - methyl containing in herbicide Granstar super by other hand. Herbicides Granstar, Laren and Ally max do not contain thifensulfuron- methyl and their mixtures with chlormequat from retardants Cycocel extra and Vivax have not antagonism. At combined application of retardant Terpal containing ethephon + mepiquat, but not containing chlormequat with herbicide Granstar super antagonism is also missing.

There has been antagonism of combined application of retardant Terpal with herbicides containing methsulfuron-methyl - Laren and Ally max. Antagonism is biggest in 2010, when grain yields by tank mixtures Terpal + Laren and Terpal + Ally max are smaller and mathematically proven than grain yields by the other tank mixtures with 3 - 4%. Tank mixtures of retardant Terpal with herbicides Granstar and Granstar super have not antagonism to grain yield during any of the years of investigation. Grain yields by these mixtures are higher than grain yields by the alone application of the preparations. This means that it is the antagonism between the active substance

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mepiquat containing in retardant Terpal by one hand and the active substance methsulfuron-methyl containing in herbicides Laren and Ally max by other hand. Retardants Cycocel extra and Vivax do not contain mepiquat and their mixtures with methsulfuron-methyl from herbicides Laren and Ally max have not antagonism. At combined use of herbicides Granstar and Granstar super with retardants Cycocel extra and Vivax containing respectively chlormequat + cholinechloride and chlormequat + ethephon, but not containing mepiquat antagonism is also missing.

Table 1: Grain yield and structural elements of the yield (mean 2010-2012)

Variants		Grain yield		Spike length, cm	Spikelets per spike, number	Grains per spike, number	Grain weight per spike, g
Retardants	Herbicides	kg/ha	%				
-	-	4011	100	8,4	19,0	33,6	2,12
	Granstar	4326	107,9	8,2	20,6	43,4	2,46
	Granstar super	4348	108,4	8,2	20,6	43,0	2,24
	Laren	4319	107,7	8,3	19,6	43,0	2,22
	Ally max	4343	108,3	8,4	19,8	43,8	2,46
Cycocel extra	-	4229	105,4	8,4	19,2	40,4	2,38
	Granstar	4378	109,1	8,3	19,6	46,0	2,60
	Granstar super	4300	107,2	8,2	19,2	41,6	2,42
	Laren	4391	109,4	8,3	19,6	46,2	2,62
	Ally max	4418	110,4	8,4	20,0	47,0	2,78
Vivax	-	4223	105,3	8,2	18,8	42,6	2,48
	Granstar	4396	109,6	8,2	19,8	46,4	2,66
	Granstar super	4292	107,0	8,3	19,8	44,0	2,54
	Laren	4410	109,9	8,1	19,6	45,6	2,60
	Ally max	4422	110,2	8,3	20,0	46,6	2,68
Terpal	-	4260	106,2	7,6	18,8	38,4	2,22
	Granstar	4401	109,7	8,3	20,2	44,8	2,54
	Granstar super	4406	109,8	8,4	20,2	43,8	2,52
	Laren	4311	107,5	8,1	19,0	40,2	2,42
	Ally max	4329	107,9	8,1	19,0	44,4	2,44
LSD 5%		167	4,2	1,8	1,6	6,1	0,21
LSD 1%		189	4,7	2,6	2,5	7,3	0,38
LSD 0,1%		215	5,4	3,7	4,2	8,5	0,54

To explain changes in grain yield were investigated some of the structural elements that determine it. The results of structural analysis show, that the increase in grain yield is due to the greatest extent of the increase in the grain number per spike and the grain weight per spike. The greatest increase in the grain number per spike and the grain weight per spike compared to weed

check is obtained by combination of herbicide Ally max with retardants Cycocel extra and Vivax. The increase of the structural elements are mathematically proven and by mixture of retardants Cycocel extra and Vivax with herbicides Granstar and Laren and by mixtures of retardant Terpal with herbicides Granstar and Granstar super. The differences between these two variants on the one hand, and the alone application of the respective preparations on the other hand, is mathematically proven. The main reason for the large differences in the structural elements of yield between these variants is differences in the efficacy of different herbicides and retardants. Other than mixtures also increase the grain number per spike and the grain weight per spike, but it is less and mathematically unproven. The effect of retardants, herbicides and their tank mixtures on the indexes spike length and spikelets number per spike is significantly less. The investigated preparations influence not proven on these structural elements of yield. It must be borne in mind that the spike length and spikelets number per spike have little influence on the grain yield. The spike can be very long, but lax, with fewer spikelets per spike spindle. More important for the durum wheat are all of spikes to have many grains, well ripened, without sterile spikelets at the base and at the top of the spikes.

Durum wheat is the main raw material for the production of high quality pasta. To meet this requirement, it must be grown in suitable agrotechnology, providing a high-quality grain. From this perspective, the efficient and timely displayed weed control in durum wheat crops and the stimulating with stimulators is important for improving the quality of the durum wheat grain. The high selectivity of the herbicides used in the cultivation of durum wheat also has a positive impact on these indicators.

Treatments with the investigated retardants, herbicides and their tank mixtures have positive effect on the 1000 grain weight (Table 2). The increase of this indicator relative to control was proven in all variants. The at 1000 grain weight the combinations of the retardant Cycocel extra with herbicides Granstar super and Ally max is the biggest. The values of this index are over international standards at all variants.

Test weight characterizes the density of the grain and is one of the important technological parameters. Usually with increasing nitrogen rate specific weight decreases. This is associated with the preparation of a more lax tissue cell at a high nitrogen fertilizer, especially under dry conditions. Use of tank mixtures between retardants and antibroadleaved herbicides not adversely affect the test weight of the grain. It retains its high levels characteristic of durum wheat - all variants except weeded control have test weight over 82 kg.

The use of antibroadleaved herbicides and retardants leads to proven increases vitreousness of durum wheat grain compared weed check, although this was some variation during years. The vitreousness is the highest at tank mixtures of herbicides Granstar and Laren with the retardant Vivax.

The keeping the physics properties of the grain (1000 grain weight, test weight and vitreousness) high and stable guaranteed good mill qualities and high semolina output.

Other indexes included in the investigation characterized the biochemical properties of the grain from the different variants as raw material for the pasta production. The protein quantity and the wet and dry gluten quantities are one of the most important indexes, leading to pasta with a good culinary quality.

The protein quantity is definitely by cultivar, but it varies depending on weather conditions and the agrotechnology. Data shows that it increases proved under the influence of retardants Cycocel extra, Vivax and Terpal, antibroadleaved herbicides Granstar, Granstar super, Laren and Ally max and their tank mixtures. At combinations of herbicide Granstar with retardants Cycocel extra, Vivax and Terpal protein quantity is lower the alone application of the respective preparations and is unproven higher than weed check.

Wet and dry gluten quantities are an important element of the quality characteristics of the

grain. The obtained data show that the retardants, antibroadleaved herbicides and mixtures between them increase the value of wet and dry gluten compared weed check. Wet and dry gluten quantities at combinations of herbicide Granstar super with the three retardants - Cycocel extra, Vivax and Terpal are lower than these ones at alone application of the respective preparations, but these decreasing are not mathematically proven by analysis of variance. All variants are over the standard requirements about the wet gluten quantity - more than 28 %. The ratio between wet and dry gluten (2.5 - 3 to 1) remains unchanged and favorable for producing high quality pasta. The differences in the biochemical properties of the grain are due to the changes in the speed and nature of the physiological and biochemical processes in plants occurring under the influence of different retardants and herbicides.

Table 2: Physical and biochemical properties of the grain (mean 2010-2012)

Variants		1000 grain weight, g	Test weight, kg	Vitreousness, %	Protein, %	Gluten	
Retardants	Herbicides					Wet, %	Dry, %
-	-	50,0	80,2	81,2	11,94	30,3	11,3
	Granstar	50,6	82,9	86,4	12,81	33,0	12,4
	Granstar super	50,8	82,7	87,4	12,76	34,2	12,4
	Laren	50,4	82,2	86,8	12,87	33,8	12,8
	Ally max	50,8	82,6	87,4	12,76	34,4	12,6
Cycocel extra	-	50,2	82,7	85,8	12,42	33,1	12,9
	Granstar	50,4	82,5	86,8	12,70	33,8	14,6
	Granstar super	51,6	83,2	86,4	12,53	32,9	13,2
	Laren	50,4	83,0	87,2	12,65	33,4	13,9
	Ally max	51,8	83,4	86,6	12,63	33,8	14,0
Vivax	-	50,0	83,2	86,8	12,40	32,1	13,3
	Granstar	50,2	83,4	88,8	12,45	32,8	14,8
	Granstar super	50,8	82,7	87,8	12,50	32,2	13,2
	Laren	49,2	83,0	88,8	12,55	33,8	14,8
	Ally max	50,4	83,7	87,2	12,78	33,1	14,4
Terpal	-	49,6	82,2	86,4	12,45	33,2	14,2
	Granstar	50,6	82,7	87,8	12,70	34,5	14,9
	Granstar super	50,8	82,7	87,6	12,84	32,6	13,5
	Laren	50,0	82,2	87,4	12,66	34,0	14,3
	Ally max	50,2	82,4	87,6	12,70	34,1	14,4
LSD 5%		1,2	3,1	3,3	0,62	3,2	2,8
LSD 1%		2,3	4,0	5,4	0,70	4,7	4,1
LSD 0,1%		3,5	5,4	7,5	0,97	5,0	5,9

Wet and dry gluten quantities are an important element of the quality characteristics of the

grain. The obtained data show that the retardants, antibroadleaved herbicides and mixtures between them increase the value of wet and dry gluten compared weed check. Wet and dry gluten quantities at combinations of herbicide Granstar super with the three retardants - Cycocel extra, Vivax and Terpal are lower than these ones at alone application of the respective preparations, but these decreasing are not mathematically proven by analysis of variance. All variants are over the standard requirements about the wet gluten quantity - more than 28 %. The ratio between wet and dry gluten (2.5 - 3 to 1) remains unchanged and favorable for producing high quality pasta. The differences in the biochemical properties of the grain are due to the changes in the speed and nature of the physiological and biochemical processes in plants occurring under the influence of different retardants and herbicides.

In the evaluation of the physical and biochemical properties of the grain should be borne in mind that their increase by Granstar, Granstar super, Laren and Ally max not due to the direct stimulatory effects of used antibroadleaved herbicides. The increase compared to the untreated, weed check is indirectly and is due to good herbicide efficacy against weeds and good selectivity of herbicides to durum wheat in its growing period. Used herbicides liquidated negative influence of weeds enable durum wheat to realize its high quality and productive potential, based on the genetic traits of the using cultivar Progress and other units of the cultivation technology, especially of soil fertilization with mineral fertilizers. The use of retardants Cycocel extra, Vivax and Terpal has a direct stimulating effect on durum wheat.

CONCLUSION

Herbicide Granstar super cannot be mixed with retardants containing chlormequat - Cycocel extra and Vivax. There is antagonism at mixtures of retardant Terpal with herbicides containing methsulfuron-methyl – Laren and Ally max. The lowest durum wheat grain yields are obtained by these tank mixtures.

The grain yield decrease by these tank mixtures is due to the decrease in the grain number per spike and the grain weight spike.

The 1000 grain weight, test weight and virteousness are increased by influence of the investigated retardants, antibroadleaved herbicides and their tank mixtures.

Retardants Cycocel extra, Vivax and Terpal, antibroadleaved herbicides Granstar, Granstar super, Laren and Ally max increase the protein quantity, wet and dry gluten quantities.

Protein quantity wet and dry gluten quantities by tank mixtures Cycocel extra + Granstar super, Vivax + Granstar super and Terpal + Granstar super are lower than these quantities by the alone application of these preparations.

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