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Influence of Some Mixtures between Stimulators 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. Factor A included no treated check and 2 stimulators – Napsil – 500 ml ha^{-1} and Cemofol – 700 ml ha^{-1}. Factor B included weeded no treated check and 4 antibroadleaved herbicides – Derby super WG – 33 g ha^{-1}, Secator OD – 100 ml ha^{-1}, Sunsac – 1 l ha^{-1}, Lintur 70 WG – 150 g ha^{-1}. All of stimulators, antibroadleaved herbicides and their tank mixtures were treated in tillering stage of the durum wheat. Under investigation was Bulgarian durum wheat cultivar Victoria, which belongs to *Triticum durum var. valenciae* Desf. The grain yield was the highest by combined use of stimulators Napsil and Cemofol with herbicides Derby super and Secator. Stimulator Cemofol cannot be mixed with herbicide Lintur. There is antagonism at mixtures of stimulator Napsil with herbicides Lintur and Sansak. 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 stimulators, antibroadleaved herbicides and their tank mixtures. Stimulators Napsil and Cemofol and antibroadleaved herbicides Derby super, Secator, Sunsac and Lintur increase the protein quantity, wet and dry gluten quantities. Protein quantity, wet and dry gluten quantities are the highest by the tank mixtures Napsil + Derby super and Napsil + Secator.

Keywords: durum wheat, stimulators, herbicides, grain yield, structural elements of the yield, grain quality

Introduction

In connection with the increased requirements for environmental safety when using pesticides in modern agriculture in recent years, have a question about the impact of herbicides and their mixtures on growth, development, yield and quality of crops. In modern agriculture herbicides are an effective tool for weed control in wheat. In use it is necessary to know not only their effectiveness against weeds, but their specific effect on the wheat plants (Stevenson et al., 2000; Martin et al. 2001; Domoradzki and Rola, 2002; Senior and Dale, 2002). Very often in research works in parallel with the verification of biological efficacy of herbicides also examine their influence on grain yield and grain quality (Kudsk and Mathiassen, 1995; Adkins et al.,. 1998; Hannan-Jones, 1998; Archambault et al., 2001; Hartzler and Battles, 2001; Misovic et al., 2001).

Growth regulators properly selected and used an appropriate level of mineral fertilization, increase grain yield and grain quality in cases where traditional methods and tools are little effective or nearly exhausted their options

(Taniguchi et al., 1999; Vildflush and Gurban, 1999). In literature, there is evidence that common and durum wheat respond differently to treatment with the same preparations (Rapparini et al., 1984; Pomati, 1987; Stoyanova, 2008; Stoyanova and Petkova, 2010; Stoyanova et al., 2010; Panayotova and Stoyanova, 2014).

The purpose of this investigation was to investigate the influence of some stimulators, 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. Under investigation was Bulgarian durum wheat cultivar Victoria, which belongs to *Triticum durum var. valenciae* 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 no treated check and 2 stimulators – Napsil (chlorofenoxyacetic acid derivatives, naftilacetic acid, phtalamine acid, chlorochlorine chloride, folic acid, trace elements) - 500 ml ha^{-1} and Cemofol (methilphtalamine acid derivatives, chlorochlorine chloride, folic acid, salicylic acid, trace elements, surface active substance) - 700 ml ha^{-1}. Factor B included weeded no treated check and 4 herbicides – Derby super WG (florasulam + aminopyralid) - 33 g ha^{-1}, Secator OD (iodosulfuron + amydosulfuron) - 100 ml ha^{-1}, Sunsac (metosulam + 2.4-D) - 1 l ha^{-1} and Lintur 70 WG (triasulfuron + dicamba) - 150 g ha^{-1}.

All of stimulators, herbicides and their tank mixtures were treated in tillering stage of the durum wheat and are applied in a working solution of 200 l ha^{-1}. Mixing was done in the tank on the sprayer. Investigated herbicides have not antigraminaceous 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^{-1}.

It was investigated the influence of the stimulators, 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 stimulators, antibroadleaved herbicides and their tank mixtures on grain yield (Table 1) show that the lower yield is obtained in untreated and weeded check. The separate uses of herbicides Derby super, Secator, Sunsac and Lintur increase grain yield, because destroy existing annual and perennial broadleaved weeds. The separate uses of stimulators Napsil and Cemofol 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, grassy weeds are destroyed with antigrass herbicide Traxos which treated 10 days before the application of the relevant products.

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
Stimulators	Herbicides	kg ha^{-1}	%				
	-	4600	100	6.1	21.0	43.0	2.02
	Derby super	5000	108.7	6.2	21.6	45.6	2.40
-	Secator	4979	108.2	6.2	21.6	45.8	2.41
	Sunsac	4980	108.3	6.2	21.4	44.8	2.23
	Lintur	4964	107.9	6.2	21.4	44.4	2.22
	-	4868	105.8	6.2	21.4	45.3	2.26
	Derby super	5235	113.8	6.7	22.2	49.8	2.48
Napsil	Secator	5207	113.2	6.6	22.2	48.2	2.46
	Sunsac	4916	106.9	6.6	22.2	48.6	2.45
	Lintur	5165	112.3	6.6	22.0	46.8	2.42
	-	4916	106.9	6.2	21.4	45.4	2.26
	Derby super	5281	114.8	6.8	21.8	48.4	2.47
Cemofol	Secator	5295	115.1	6.9	22.4	51.8	2.48
	Sunsac	5172	112.4	6.6	21.2	46.6	2.43
	Lintur	4876	106.0	6.6	21.4	44.8	2.24
LSD 5%		213	4.6	0.7	0.4	1.3	0.22
LSD 1%		282	6.1	1.6	2.2	2.9	0.44
LSD 0.1%		365	7.9	2.8	4.0	4.3	0.70

Effectiveness of tank mixtures between stimulators and antibroadleaved herbicides depends largely by weather conditions during the growing period. The best results are obtained by combined use of stimulators Napsil and Cemofol with herbicides Derby super and Secator. There is synergism in both years of the investigation by these mixtures. The highest grain yield is obtained by tank mixture Cemofol + Secator - 15.1 % or 695 kg/ha average for the period of investigation.

There is antagonism by combined use of Napsil and Cemofol with antibroadleaved herbicides Sansak and Lintur. The antagonism is strongest by tank mixture Cemofol + Lintur during 2010 and 2012. Grain yield at this combination was lower than their self-use and almost equal to that of the untreated check. There is not antagonism during 2011. This year there is an additive effect - grain yield and herbicide effect is equal to the sum effect of the use of stimulator Cemofol and herbicides Lintur. The antagonism is established only in 2012 by tank mixture Napsil + Sansak, when the yield of grain was higher than that of the untreated check only 3.9 %. Grain yield during 2010 and 2011, by combined use of stimulator Napsil and herbicide Sunsac are unproven higher than the self-use of these preparations. The antagonism is established only in 2010 by tank mixture Napsil + Lintur; there is not antagonism during 2011 and 2012. During those two years, even there is synergism by combination Napsil + Lintur. The increase of grain yield is 17.6 % and 12.4 % respectively, compared to weeded check. These differences can be explained by the large differences in temperature and rainfalls during the period after treatment in the three years of the investigation.

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 weeded check is obtained by combination with the stimulators Napsil and Cemofol with herbicides Secator and Derby super. The increase of the structural elements are mathematically proven and by mixture of stimulator Napsil with herbicide Lintur and by mixture of stimulator Cemofol with herbicide Sunsac. The differences between these two variants on the one hand, and the self-use 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 stimulators. Other thank mixtures also increase the grain number per spike and the grain weight per spike, but it is less and mathematical unproven. The effect of stimulators, herbicides and their thank 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.

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

Variants		1000 grain weight, g	Test weight, kg	Vitreous-ness, %	Protein, %	Gluten	
Stimulators	Herbicides					Wet, %	Dry, %
-	-	49.2	75.8	80.8	12.84	23.8	8.1
	Derby super	50.4	77.0	85.2	13.57	28.0	9.4
	Secator	50.4	76.7	85.4	13.58	28.0	9.4
	Sunsac	50.2	76.6	85.0	13.59	28.0	9.2
	Lintur	50.4	76.5	85.2	13.49	28.5	9.5
Napsil	-	50.0	76.4	88.4	13.49	28.0	9,6
	Derby super	50.4	76.0	89.6	14.36	30.5	11.0
	Secator	50.8	76.2	89.8	14.33	30.6	11.0
	Sunsac	50.8	76.4	88.8	13.97	30.0	10.8
	Lintur	50.4	76.2	89.0	13.77	28.5	10.0
Cemofol	-	50.0	76.5	87.2	13.77	28.0	9.6
	Derby super	51.6	77.0	88.8	13.95	28.6	10.5
	Secator	51.6	76.8	88.9	13.97	28.8	10.6
	Sunsac	51.6	76.6	88.8	13.93	29.5	10.6
	Lintur	50.8	76.1	89.0	13.84	28.0	10.2
LSD 5%		3.0	2.8	4.1	0.33	4.0	1.2
LSD 1%		4.1	3.5	5.8	0.44	5.5	1.8
LSD 0.1%		5.2	4.9	7.3	0.56	7.8	2.6

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 stimulators, herbicides and their tank mixtures have positive effect on the of 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 stimulator Cemofol with herbicides Derby super, Secator and Sunsac 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 stimulators 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 85 kg.

The use of antibroadleaved herbicides and stimulators leads to proven increases vitreousness of durum wheat grain compared weeded check, although this was some variation during years. The vitreousness is the highest at tank mixtures of herbicides Secator and Derby super with the stimulator Napsil.

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 tank mixtures of stimulator Napsil with antibroadleaved herbicides Derby super and Sacator. At other tank mixtures protein quantity is proven higher than the self -use of the preparations and weeded check.

Wet and dry gluten quantities are an important element of the quality characteristics of the grain. The obtained data show that the stimulators, antibroadleaved herbicides and mixtures between them increase the value of wet and dry gluten compared weeded check. Wet and dry gluten quantities are the highest by combination of herbicides Derby super and Secator with stimulator Napsil. 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 stimulators and herbicides.

In the evaluation of the physical and biochemical properties of the grain should be borne in mind that their increase by Derby super, Secator, Sunsac and Lintur not due to the direct stimulatory effects of used antibroadleaved herbicides. The increase compared to the untreated, weeded 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 Victoria and other units of the cultivation technology, especially of soil fertilization with mineral fertilizers. The use of growth regulators Napsil and Cemofol has a direct stimulating effect on durum wheat.

Conclusion

The grain yield was the highest by combined use of stimulators Napsil and Cemofol with herbicides Derby super and Secator.

Stimulator Cemofol cannot be mixed with herbicide Lintur. There is antagonism at mixtures of stimulator Napsil with herbicides Lintur and Sansak. 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 stimulators, antibroadleaved herbicides and their tank mixtures.

Stimulators Napsil and Cemofol and antibroadleaved herbicides Derby super, Secator, Sunsac and Lintur increase the protein quantity, wet and dry gluten quantities.

Protein quantity, wet and dry gluten quantities are the highest by the tank mixtures Napsil + Derby super and Napsil + Secator.

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