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# PROCEEDINGS BOOK



<sup>2<sup>nd</sup></sup>  
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## INFLUENCE OF LATE TREATMENT WITH ANTIBROADLEAVED HERBICIDES DURING STEM ELONGATION STAGE OF DURUM WHEAT ON GRAIN QUALITY

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### Abstract

The research was conducted during 2012 - 2014 on pellicvertisol soil type. Under investigation was Bulgarian durum wheat cultivar Victoria (*Triticum durum var. valenciae*). A total of 20 antibroadleaved herbicides were investigated: Granstar 75 DF, Granstar super 50 SG, Ally max SG, Arat, Biathlon 4 D, Derby super WG, Mustang 306.25 SC, Weedmaster 646 CL, Sunsac, Secator OD, Logran 60 WG, Lintur 70 WG, Akurat 60 WG, Akurat extra WG, Eagle 75 DF, Herbaflex, Starane 250 EK, Sanafen, Dicotex 400 and Herby 675. All herbicides were treated in 1<sup>st</sup>, 2<sup>nd</sup> and 3<sup>rd</sup> stem node stages of durum wheat. During 1<sup>st</sup> stem node stage of durum wheat can to be used the antibroadleaved herbicides Arat, Biathlon, Derby super, Mustang, Weedmaster, Secator, Lintur, Akurat, Akurat extra, Eagle, Starane, Sanafen, Dicotex and Herby. These herbicides do not have negative influence on grain yield. During 2<sup>nd</sup> stem node stage of durum wheat can to be used the herbicides Arat, Biathlon, Derby super, Mustang, Secator, Lintur, Akurat, Akurat extra, Starane, Dicotex and Herby. During 3<sup>rd</sup> stem node stage of durum wheat can to be used only the herbicides Arat, Biathlon, Derby super, Secator, Lintur, Akurat, Akurat extra and Starane. Herbicides Weedmaster, Mustang, Logran, Eagle, Dicotex and Herby decrease of some physical or biochemical properties of grain and should not be used during stem elongation stage of durum wheat crop for commodity production. Herbicides Arat, Biathlon, Derby super, Secator, Lintur, Akurat, Akurat extra and Starane can be applied without the risk of reducing of durum wheat grain quality. These eight antibroadleaved herbicides are economically the most effective.

**Keywords:** Durum wheat, herbicides, late treatment, grain yield, grain quality.

### 1. Introduction

Increased application of herbicides in the agricultural practices raises many open questions about their effect on the quality of obtained products. It has been carried out a number of attempts to establish the efficacy of different herbicides for weed control in durum wheat fields (Alegri, 1998; Montemurro; 1998; Holm et al., 2000). It is still insufficient studies on the reaction of different cultivars to some herbicides (Rapparini et al., 1998; Rola et al., 1999).

At foliar application of herbicides weather conditions in the region are an important condition for the occurrence of the herbicidal effect and establish their influence on cultivated plants (Fetvadzhieva, 1973; Lyubenov, 1987; Kucharski and Sadowski, 2004). Studies show that the quantity and quality of the grain are in direct dependence on weather conditions during the treatment with herbicides and during the period following the treatment (Citron et al., 1998; Stashinskis, 2001; Cacak-Pietrzak et al., 2008; Delchev, 2018).

The purpose of this investigation was to establish the changes on grain yield, its structural elements and grain quality of durum wheat by the influence of 20 antibroadleaved herbicides, which are applied during 1<sup>st</sup>, 2<sup>nd</sup> and 3<sup>rd</sup> stem node stages of durum wheat.

## 2. Materials and Methods

The research was conducted during 2012 - 2014 with Bulgarian durum wheat cultivar Victoria (*Triticum durum* Desf. var. *valenciae*). It was carried out a field experiment as a block method in 4 repetitions, on a 20 m<sup>2</sup> harvesting area, on pellicvertisol soil type, after sunflower predecessor.

For exploration the possibilities to fight with secondary weed infestation with broadleaved weeds in durum wheat fields for processing 20 antibroadleaved herbicides were investigated: Granstar 75 DF, Granstar super 50 SG, Ally max SG, Arat, Biathlon 4 D, Derby super WG, Mustang 306.25 SC, Weedmaster 646 CL, Sunsac, Secator OD, Logran 60 WG, Lintur 70 WG, Akurat 60 WG, Akurat extra WG, Eagle 75 DF, Herbaflex, Starane 250 EK, Sanafen, Dicotex 400 and Herby 675. The active substances and doses of the investigated herbicides are given in Table 1.

**Table 1. Investigated Variants**

№	Herbicide	Active substance	Doses
1	Check	-	-
2	Granstar 75 DF	tribenuron-methyl	25 g/ha
3	Granstar super 50 SG	tribenuron-methyl + tifensulfuron-methyl	40 g/ha
4	Ally max SG	metsulfuron-methyl + tribenuron-methyl	35 g/ha
5	Arat	tritosulfuron + dicamba	200 g/ha
6	Biathlon 4 D	tritosulfuron + florasulam	55 g/ha
7	Derby super WG	florasulam + aminopyralid	33 g/da
8	Mustang 306.25 SC	florasulam + 2.4-D	800 ml/ha
9	Weedmaster 646 CL	2.4-D + dicamba	1 l/ha
10	Sunsac	metosulam + 2.4-D	1 l/ha
11	Secator OD	iodosulfuron + amydosulfuron	100 ml/ha
12	Logran 60 WG	triasulfuron	37.5 g/ha
13	Lintur 70 WG	triasulfuron + dicamba	150 g/ha
14	Akurat 60 WG	metsulfuron-methyl	10 g/ha
15	Akurat extra WG	metsulfuron-methyl + tifensulfuron-methyl	50 g/ha
16	Eagle 75 DF	chlorsulfuron	15 g/ha
17	Herbaflex	beflubutamid + isoproturon	2 l/ha
18	Starane 250 EK	fluroxypyr	1 l/ha
19	Sanafen	2.4-D	2 l/ha
20	Dicotex 400	2M-4X	4 l/ha
21	Herby 675	2.4-D + 2M-4X	1.4 l/ha

The weak adhesion of herbicides Granstar, Granstar super and Ally max required their application with adjuvant Trend 90 - 0.1%. The weak adhesion of herbicides Arat and Biathlon required their application with adjuvant Dash HC - 500 ml/ha.

All herbicides were treated during 1<sup>st</sup>, 2<sup>nd</sup> and 3<sup>rd</sup> stem node stages of durum wheat. All variants are applied with working solution consumption 200 l/ha. To examine only the influence of herbicides and eliminate the negative influence of weeds they are removed by hand weeding during the growing period.

It was investigated the influence of the herbicides 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.

### 3. Results and Discussion

Data about the influence of investigated antibroadleaved herbicides on grain yield are showed that herbicides Arat, Biathlon, Derby super, Mustang, Weedmaster, Sunsac, Secator, Lintur, Akurat, Akurat extra, Eagle, Starane, Dicotex and Herby, applied during 1<sup>st</sup> stem node stage of durum wheat have not proved decrease on grain yield (see Table 2).

**Table 2. Grain Quality of Durum Wheat at Treatment during 1<sup>st</sup> Stem Node Stage (2012 - 2014)**

Herbicides	Grain yield, kg/ha	1000 grain weight, g	Test weight, kg	Vitreousness, %	Protein, %	Gluten	
						Wet %	Dry %
Check	5227	48.8	82.3	95.0	18.13	39.6	14.9
Granstar	4906	48.0	82.7	94.8	18.31	39.2	14.7
Granstar super	4929	48.0	82.7	94.5	18.16	39.6	14.9
Ally max	4929	48.1	82.7	94.5	18.17	32.4	14.7
Arat	5070	48.7	82.6	94.6	18.20	39.5	14.5
Biathlon	5034	48.6	82.6	94.6	18.21	39.5	14.6
Derby super	5188	48.2	82.5	94.4	18.16	39.8	14.9
Mustang	5060	48.4	82.5	94.4	17.98	39.0	14.7
Weedmaster	5102	46.8	82.8	95.4	17.63	38.2	14.6
Sunsac	4979	48.0	82.3	93.4	17.37	39.8	14.6
Secator	5207	48.6	82.1	94.4	18.17	39.8	14.7
Logran	4605	47.4	82.0	93.8	18.13	39.6	14.9
Lintur	4978	48.2	82.2	94.4	18.12	39.2	15.2
Akurat	4976	48.4	82.0	94.5	19.00	40.6	15.2
Akurat extra	4976	48.7	81.9	94.5	18.98	40.4	15.2
Eagle	4984	47.8	82.3	95.2	18.56	39.2	15.2
Herbaflex	4832	47.6	82.2	94.2	17.71	37.6	14.1
Starane	5125	46.4	82.4	94.2	17.19	36.8	13.7
Sanafen	4932	48.2	82.1	93.8	18.14	36.8	13.8
Dicotex	5058	48.4	82.2	93.4	19.04	40.4	15.2
Herby	5125	48.2	82.0	94.6	18.48	41.6	15.6
LSD 5%	333	1.5	1.4	1.9	0.30	0.7	0.4
LSD 1%	430	2.4	2.0	2.4	0.37	1.9	1.0
LSD 0.1%	561	3.2	3.4	4.2	0.44	2.8	1.5

Herbicides Granstar, Granstar super, Ally max and Weedmaster cannot be used during stem elongation stage of durum wheat. During 2013 herbicides Granstar, Granstar super and Ally max has not proved decrease of grain yield. During 2013 herbicide Weedmaster leads to grain yield equal to this one from untreated check. This is due to different weather conditions in the particular years. Herbicides Logran, Herbaflex and Sanafen also cannot to be used during 1<sup>st</sup> stem node stage, because they have high phytotoxicity to durum wheat.

Herbicides Arat, Biathlon, Derby super, Mustang, Sunsac, Secator, Lintur, Akurat, Akurat extra, Starane, Dicotex and Herby, applied during 2<sup>nd</sup> stem node stage of durum wheat have not proved decrease on grain yield (see Table 3).

With the advancement of stem elongation stage (from 1<sup>st</sup> to 2<sup>nd</sup> stem node stage), herbicides Granstar, Granstar super, Ally max and Weedmaster have enhanced their phytotoxicity with regard to the durum wheat, which is especially strongly expressed at Weedmaster. It is established that the herbicide of base 2M-4X (Dicotex) has better expressed selective action on durum wheat in comparison with that one of base 2.4-D (Sanafen). Herbicide Herby due to its lower content of 2.4-D and lower dose per hectare also has better selectivity to durum wheat. From 2<sup>nd</sup> stem node stage herbicide Eagle has high phytotoxicity during each year of investigation.

**Table 3. Grain Quality of Durum Wheat at Treatment during 2<sup>nd</sup> Stem Node Stage (2012 - 2014)**

Herbicides	Grain yield, kg/ha	1000 grain weight, g	Test weight, kg	Vitrousness, %	Protein, %	Gluten	
						Wet %	Dry %
Check	5227	48.8	82.3	95.0	18.13	39.6	14.9
Granstar	4806	48.2	82.3	94.0	18.73	39.2	14.7
Granstar super	4835	48.3	82.3	94.0	18.70	39.1	14.6
Ally max	4830	48.5	82.2	94.0	18.69	39.0	14.6
Arat	5044	48.6	82.2	93.8	18.67	39.2	14.5
Biathlon	4997	48.6	82.2	93.8	18.67	39.2	14.4
Derby super	5069	48.4	82.2	93.8	18.80	39.9	14.9
Mustang	4966	48.7	82.3	93.7	17.88	39.4	14.8
Weedmaster	4750	46.4	82.6	94.4	16.86	37.6	14.6
Sunsac	4979	48.2	82.5	93.2	17.88	40.0	14.5
Secator	5025	48.6	82.2	93.6	18.71	39.9	14.8
Logran	4120	46.2	82.2	93.6	17.79	39.6	14.9
Lintur	4924	48.7	82.2	93.4	18.14	40.0	14.0
Akurat	4948	48.8	82.2	93.6	19.19	40.4	14.6
Akurat extra	4927	48.7	82.4	93.5	18.22	40.4	14.2
Eagle	4742	48.2	82.3	95.0	18.05	38.8	15.0
Herbaflex	4832	48.0	82.1	94.6	18.31	38.2	14.6
Starane	5038	47.2	82.3	94.6	17.79	38.0	14.2
Sanafen	4787	48.4	82.1	93.4	18.39	40.4	14.6
Dicotex	4929	48.8	82.4	93.6	18.14	38.8	14.6
Herby	4982	48.6	82.4	93.4	18.14	40.4	14.2
LSD 5%	320	2.0	1.6	2.1	0.28	1.0	0.5
LSD 1%	422	3.2	2.3	2.9	0.32	2.1	1.3
LSD 0.1%	551	4.4	3.6	4.5	0.40	3.3	2.4

Herbicides Arat, Biathlon, Derby super, Secator, Lintur, Akurat, Akurat extra and Starane, applied during 3<sup>rd</sup> stem node stage of durum wheat have not proved decrease on grain yield (see Table 4).

The decrease of the grain yield by treatment with herbicides Granstar, Weedmaster and Sunsac during 3<sup>rd</sup> stem node stage is proven during each year, regardless of weather conditions. At herbicides Granstar super, Ally max and Mustang decrease of the yield is reported only during certain years. Herbicides Sanafen, Dicotex, Herby, Logran, Eagle and Herbaflex also have phytotoxicity on the durum wheat. The biggest is the negative effect at the herbicide Logran where the decrease of grain yield in relative to the control is up to 1525 kg/ha or 29.2 %.

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 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.

The lowest values of 1000 grain weight are accounted in use of herbicides Weedmaster, Logran, Herbaflex and Eagle when they applied during early stem elongation stage. The delay in treatment of herbicides - from 1<sup>st</sup> to 3<sup>rd</sup> stem nodes of durum wheat - leads to a small increase of 1000 grain weight at herbicides Granstar, Granstar super, Ally max, Eagle, Starane, Herbaflex, Dicotex and Herby. The reason for this increase is the smaller number of grains in the spike of main tiller. The indicator values are not changed by use of herbicides Arat, Biathlon, Derby super, Mustang, Sunsac, Secator, Akurat, Akurat extra, Lintur and Starane. Only herbicides Weedmaster and Logran by treatment in stem elongation stage of durum wheat always lead to mathematically proven decrease of 1000 grain weight.

**Table 4. Grain Quality of Durum Wheat at Treatment during 3<sup>rd</sup> Stem Node Stage (2012 - 2014)**

Herbicides	Grain yield, kg/ha	1000 grain weight, g	Test weight, kg	Vitreousness, %	Protein, %	Gluten	
						Wet %	Dry %
Check	5227	48.8	82.3	95.0	18.13	39.6	14.9
Granstar	4635	48.6	82.0	93.4	19.76	46.0	16.1
Granstar super	4647	48.7	82.0	93.4	19.77	46.0	16.1
Ally max	4642	48.8	82.0	93.4	19.78	46.0	16.1
Arat	4987	48.6	82.2	93.3	18.55	39.8	15.0
Biathlon	4945	48.6	82.2	93.3	18.55	39.8	15.0
Derby super	5003	48.6	82.2	93.6	18.97	39.6	14.9
Mustang	4913	48.7	82.1	93.5	17.80	39.6	14.7
Weedmaster	4564	46.2	82.6	94.4	16.85	35.6	13.4
Sunsac	4630	48.2	82.0	93.0	18.05	41.2	15.5
Secator	4982	48.8	82.2	93.6	18.99	39.8	14.9
Logran	3702	48.8	82.3	95.0	18.13	39.6	14.9
Lintur	4929	46.0	82.4	93.2	17.36	39.6	14.9
Akurat	4913	48.8	82.0	93.2	17.80	38.8	14.6
Akurat extra	4903	49.0	82.3	94.4	19.42	43.6	15.3
Eagle	4687	49.0	82.3	93.4	17.82	38.8	14.1
Herbaflex	4578	48.8	82.3	95.0	17.62	38.8	14.6
Starane	4941	49.0	82.1	94.6	18.82	40.8	15.3
Sanafen	4798	48.0	82.0	94.8	18.13	40.8	14.8
Dicotex	4793	48.6	82.0	94.4	19.42	43.6	15.3
Herby	4817	49.0	82.3	93.2	17.80	38.8	14.6
LSD 5%	340	2.9	1.9	2.0	0.22	1.2	0.6
LSD 1%	434	3.8	3.1	2.8	0.31	2.4	1.5
LSD 0.1%	567	5.0	4.5	4.2	0.43	3.6	2.7

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. Uses of investigated 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 does not lead to proven decreases vitreousness of durum wheat grain, although this was some variation during years.



The keeping the physics properties of the grain (1000 grain weight, test weight and virtuousness) 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. In this sense it is necessary to note that later treatment -from 1<sup>st</sup> to 3<sup>rd</sup> stem nodes of durum wheat - with herbicides Granstar, Granstar super, Ally max, Sunsac, Derby super, Secator, Starane, Herbaflex and Sanafen leads to prove increase of protein quantity. At herbicides Granstar, Granstar super, Ally max, Sunsac, Herbaflex and Sanafen this increase can be explained by the significantly lower grain yields, which are obtained by these variants, as a result of the existing negative correlation between quantity and quality of yield. At herbicides Arat, Biathlon, Derby super, Secator, Akurat and Starane protein quantity has increased, although the yield of grain does not change proven by treatment with these herbicides during stem elongation stage. Other herbicides included in investigation - Mustang, Weedmaster, Logran, Lintur, Akurat extra, Eagle, Decotex and Herby - decrease protein quantity.

Wet and dry gluten quantities are an important element of the quality characteristics of the grain. The obtained data show that late treatment with herbicides Sunsac, Starane, Herbaflex and Sanafen leads to increase of wet and dry gluten quantities. These quantities decreased by treatment with herbicides Weedmaster, Mustang, Eagle, Dicotex and Herby. Herbicides Arat, Biathlon, Derby super, Secator and Logran do not change wet and dry gluten quantities. Herbicides Granstr, Granstar super, Ally max and Akurat do not change wet and dry gluten quantities at treatment during 1<sup>st</sup> and 2<sup>nd</sup> stem node stages, but increase these quantities at treatment during 3<sup>rd</sup> stem node stage of durum wheat. 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 herbicides.

#### **4. Conclusions**

During 1<sup>st</sup> stem node stage of durum wheat can to be used the antibroadleaved herbicides Arat, Biathlon, Derby super, Mustang, Weedmaster, Secator, Lintur, Akurat, Akurat extra, Eagle, Starane, Sanafen, Dicotex and Herby. These herbicides do not have negative influence on grain yield.

During 2<sup>nd</sup> stem node stage of durum wheat can to be used the herbicides Arat, Biathlon, Derby super, Mustang, Secator, Lintur, Akurat, Akurat extra, Starane, Dicotex and Herby.

During 3<sup>rd</sup> stem node stage of durum wheat can to be used only the herbicides Arat, Biathlon, Derby super, Secator, Lintur, Akurat, Akurat extra and Starane.

Herbicides Weedmaster, Mustang, Logran, Eagle, Dicotex and Herby decrease of some physical or biochemical properties of grain and should not be used during stem elongation stage of durum wheat crop for commodity production.

Herbicides Arat, Biathlon, Derby super, Secator, Lintur, Akurat, Akurat extra and Starane can be applied without the risk of reducing of durum wheat grain quality.

These eight antibroadleaved herbicides are economically the most effective.

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