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STABILITY VALUATION OF SOME MIXTURES BETWEEN FOLIAR FERTILIZERS AND ANTIGRAMINACEOUS HERBICIDES FOR THE GRAIN YIELD 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 Deyana (Triticum durum var. valenciae Desf.). Factor A included the years of investigation. Factor B included no treated check and 3 foliar fertilizers - Humustim - 1 l/ha, Lactofol O - 8 l/ha, Masterblend (20-20-20) – 3.5 kg/ha. Factor C – included weeded, no treated check and 4 antigraminaceous herbicides - Foxtrot 69 EB (fenoxaprop-ethyl) – 1 l/ha, Axial 050 EC (pinoxaden) - 900 l/ha, Topic 080 EC (clodinafop) - 450 l/ha, Traxos 045 EC (pinoxaden + clodinafop) – 1.2 l/ha. All of foliar fertilizers, antigramunaceous herbicides and their tank mixtures were treated in tillering stage of the durum wheat.

There is antagonism of combined use by antigraminaceous herbicide Foxtrot with three foliar fertilizers Humustim, Lactofol O and Masterblend. The grain yield increase in compared to self-use of the preparations is only 0.6 - 0.9%. There is an additive effect by tank mixtures of fertilizers Humustim, Lactofol O and Masterblend with antigraminaceous herbicides Axial, Topic and Traxos. The highest grain yields are obtained by these tank mixtures. Tank mixtures of herbicide Foxtrot with foliar fertilizers Humustim, Lactofol O and Masterblend are the most unstable for grain yield. Tank mixtures of herbicides Axial, Topik and Traxos with organic foliar fertilizer Humustim and complex foliar fertilizers Lactofol O and Masterblend are technological the most valuable. They combine high grain yield with high stability with relation to different years. Self-use of foliar fertilizers Humustim, Lactofol O and Masterblend without herbicides have low estimate and do not be used in the durum wheat crops.

Key words: *durum wheat, foliar fertilizers, herbicides, grain yield, selectivity, stability.*

INTRODUCTION

Mixed treatment of foliar fertilizers with herbicides is essential for agricultural production. Mixed treatment reduces phytotoxicity to the culture and increases the herbice efficacy (Shaban, 2007; Gupta et al., 2011). Foliar fertilizers help to overcome the plants stress by treating with herbicides (Pavlova, 2004). The introduction of more herbicides and complex fertilizers for foliar feeding necessitates research on their combination, in order to create optimal conditions for the growth and development of the durum wheat (Grundy et al., 1996; Rola et al., 1999; Kolev and Gorbanov, 2000; Brzozowska and Brzozowski, 2002; Sangi et al., 2012).

Continuous and repeated use of the herbicide of the same active base leads to the emergence of resistant biotypes weeds (Hartmann et al., 2000; Labrada, 2000). Competitive interaction between crops and weeds are complex and dynamic, depend on many factors and are amended as during the growing season and from year to year (Montemurro, 1998; Bell, 1999; Scursoni and Satorre, 2005; Guillen et al., 2006).

A prerequisite for the introduction of herbicides in agricultural practices has been studying their influence on the culture. Reduction in yield in winter cereals as a result of phytotoxic effects of various herbicides have proven by many authors (Lyubenov, 1987; McMullan, 1993; Orr, 1996; Derylo and Szynankiewicz, 1996; Derylo, 1997; Tonev et al., 2001; Dimitrova et al., 2003; Delchev and Stoychev, 2009; Stoyanova and Georgiev, 2014; Styanova et al., 2015).

The purpose of this investigation was to establish the selectivity and stability of some foliar fertilizers, antigraminaceous herbicides

and their tank mixtures on the durum wheat by influence of different meteorological conditions.

MATERIALS AND METHODS

The research was conducted during 2010 - 2012 on pellic vertisol soil type. It was carried out a three factor experiment as a block method in 4 repetitions, on a 20 m^2 harvesting area, after sunflower predecessor. Under investigation was Bulgarian durum wheat cultivar Deyana (*Triticum durum var. valenciae*). Factor A included the years of investigation. Factor B included untreated check and 3 foliar fertilizers - Humustim – 1 l/ha, Lactofol O – 8 l/ha, Masterblend (20-20-20) – 3.5 kg/ha. Factor C included weeded untreated, weeded check and 4 antigraminaceous herbicides - Foxtrot 69 EB (fenoxaprop-ethyl) – 1 l/ha, Axial 050 EC (pinoxaden) - 900 l/ha, Topic 080 EC (clodinafop) - 450 l/ha, Traxos 045 EC (pinoxaden + clodinafop) – 1.2 l/ha.

Complex fertilizers Lactofol O and Masterblend contain nitrogen in amide, ammonium and nitrate forms, easily absorbable phosphorus and potassium, trace elements, amino acids, physiologically active substances, and organic fertilizer Humustim - potassium salts of humic acids and fulvia acids. Both complex foliar fertilizers differ mainly in the nature of the complexing agent – in Lactofol O it is lactic acid, and in Masterblend it is ethylene-diamine-tetra-acetic acid (EDTA).

All of foliar fertilizers, 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 spray tank. Due to investigated herbicides have not antibroadleaved effect the control of broadleaved weeds in all variants was done with the herbicide Secator OD at 100 ml/ha.

The selectivity of herbicides has been established through their influence on grain yield. The math processing of the data was done according to the method of analyses of variance (Shanin, 1977; Barov, 1982; Lidanski, 1988). The stability of foliar fertilizers, herbicides and their tank mixtures for grain yield with relation to years was estimated using the stability variances σ_i^2 and S_i^2 of Shukla (1972), the ecovalence W_i of Wricke (1962) and the stability criterion YS_i of Kang (1993).

RESULTS AND DISCUSSIONS

The data showed that the lowest grain yield is obtained in weeded and untreated check (Table 1). At self-use of herbicides Foxtrot, Axial, Topic and Traxos grain yield increases because the weeds are destroyed. The increase is at least by Foxtrot - 6.9%, and the highest by Traxos - 8.5%. The increasing of grain yield is greatest at the herbicide Traxos because it is controlled at a large number of graminaceous weeds including *Bromus arvensis*. The reason for the effective control of *Bromus arvensis* at Traxos is synergism in combination of active substances - pinoxaden and clodinafop. Herbicides Axial and Topic which containing respective only pinoxaden and clodinafop cannot control this grassy weed. Herbicide Foxtrot except against *Bromus arvensis* is ineffective against *Lolium multiflorum* and *Lolium temulentum*.

Self-use treatment of organic foliar fertilizer Humustim and complex foliar fertilizers Lactofol and Masterblend increases grain yield because they stimulate the growth and development of durum wheat. The increase ranged from 4.4% by Humustim to 5.7% by Masterblend. The self-use of fertilizers lead to less increase than self-use of antigraminaceous herbicides due to available graminaceous weeds neutralize some of the positive effects. At all of variants, the fight against annual and perennial broadleaved weeds is done with antibroadleaved herbicide Secator which was treated 10 days after treatment of the investigated preparations.

It is established manifestations of antagonism by concurrent use of antigraminaceous herbicide Foxtrot with three foliar fertilizers Humustim, Lactofol and Masterblend. The grain yields are unproven higher than those in the self-use of these preparations. The increase in grain yield is only 0.6% to 0.9%. The mixing of fertilizers Humustim, Lactofol and Masterblend with the other three antigraminaceous herbicides Axial, Topik and Traxos not lead to antagonism. They have an additive effect. At these tank mixtures grain yield and herbicidal effect is equal to the

aggregate effect of these fertilizers and antigraminaceous herbicides. The increase of grain yield is the bigger in tank mixture Humustim + Traxos. The increase is 10.4% or 445 kg/ha average for the investigated period.

Table 1. Grain yield, kg*ha^{-1}

Variants		2010		2011		2012	
Foliar fertilizers	Herbicides	kg*ha^{-1}	%	kg*ha^{-1}	%	kg*ha^{-1}	%
	-	4300	100	4106	100	4567	100
	Foxtrot	4584	106.6	4393	107.0	4891	107.1
-	Axial	4618	107.4	4439	108.1	4932	108.0
	Topic	4623	107.5	4434	108.0	4941	108.2
	Traxos	4644	108.0	4459	108.6	4969	108.8
	-	4472	104.0	4303	104.8	4767	104.3
	Foxtrot	4605	107.1	4069	99.1	4946	108.3
Humustim	Axial	4752	110.5	4439	108.1	5015	109.8
	Topic	4739	110.2	4434	108.0	5033	110.2
	Traxos	4773	111.0	4476	109.0	5074	111.1
	-	4506	104.8	4320	105.2	4814	105.4
	Foxtrot	4644	108.0	4114	100.2	4987	109.2
Lactofol O	Axial	4696	109.2	4483	109.2	4955	108.5
	Topic	4709	109.5	4521	110.1	4969	108.8
	Traxos	4739	110.2	4480	109.1	5024	110.0
	-	4494	104.5	4295	104.6	4928	107.9
	Foxtrot	4687	109.0	4196	102.2	4942	108.2
Masterblend	Axial	4801	111.6	4488	109.3	5015	109.8
	Topic	4730	110.0	4480	109.1	4992	109.3
	Traxos	4700	109.3	4444	108.3	4956	108.5

LSD, kg*ha^{-1}:

F.A	p≤5%=128	p≤1%=137	p≤0.1%=148
F.B	p≤5%=132	p≤1%=143	p≤0.1%=155
F.C	p≤5%=136	p≤1%=148	p≤0.1%=164
AxB	p≤5%=156	p≤1%=174	p≤0.1%=195
AxC	p≤5%=163	p≤1%=183	p≤0.1%=207
BxC	p≤5%=172	p≤1%=196	p≤0.1%=224
AxBxC	p≤5%=226	p≤1%=266	p≤0.1%=314

Analysis of variance for grain yield (Table 2) shows that the years have the highest influence on grain yield – 53.9% on the variants. The strength of influence of foliar fertilizers is 1.0% and the strength of influence antigraminaceous herbicides is 9.6%. The reason is the large differences in the meteorological conditions during the three years of investigation. The influence of years and of herbicides is very well proven at p≤0.01. The influence of foliar fertilizers is well proven at p≤0.1. There is a well proven interaction between foliar fertilizers and meteorological conditions of years (AxB) – 1.0%, between antigraminaceous herbicides and meteorological conditions of years (BxC) – 1.7% and between foliar fertilizers and antigraminaceous herbicides (BxC) – 1.7%. They are proven at p≤0.1. The interaction between three experiment factors (AxBxC) is not proven.

Based on proven foliar fertilizer x year interaction and antigraminaceous herbicide x year interaction, it was evaluated stability parameters for each variant for grain yield of durum wheat with relation to years (Table 3). It was calculated the stability variances σ_i^2 and S_i^2 of Shukla, the ecovalence W_i of Wricke and the stability criterion YS_i of Kang.

Stability variances (σ_i^2 и S_i^2) of Shukla, which recorded respectively linear and nonlinear interactions, unidirectional evaluate the stability of the variants. These variants which showed lower values are considered to be more stable because they interact less with the environmental conditions. Negative values of the indicators σ_i^2 and S_i^2 are considered 0. At high values of either of the two parameters - σ_i^2 and S_i^2, the variant are regarded as unstable. At the ecovalence W_i of Wricke, the higher are the values of the index, the more unstable is the variant.

Table 2. Analysis of variance for grain yield

Source of variation	Degrees of freedom	Sum of squares	Influence of factor, %	Mean squares
Total	179	175104	100	-
Tract of land	2	45240	25.8	22620.0***
Variants	59	122732	70.1	2080.2***
Factor A – Years	2	94348	53.9	47174.0***
Factor B – Foliar fertilizers	3	1744	1.0	581.3**
Factor C – Herbicides	4	16836	9.6	4209.0***
AxB	6	1820	1.0	303.3**
AxC	8	2964	1.7	370.5**
BxC	12	2936	1.7	244.7**
AxBxC	24	2094	1.2	86.8
Pooled error	118	7132	4.1	60.4

*p≤5% **p≤1% ***p≤0.1%

Table 3. Stability parameters for the variants for grain yield with relation to years

Variants		$\bar{x}$	σ_i^2	S_i^2	W_i	YS_i
Foliar fertilizers	Herbicides					
	-	4324	75.4	2.3	153.7	-2
	Foxtrot	4623	38.7	29.5	87.7	7
-	Axial	4663	53.2	49.0	113.8	10+
	Topic	4666	36.0	41.5	82.9	11+
	Traxos	4691	92.5	99.0	44.4	12+
	-	4513	92.9	37.7	185.2	1
	Foxtrot	4540	978.1**	358.3*	1778.6	-7
Humustim	Axial	4735	14.2	38.5	43.6	18+
	Topic	4735	9.5	8.7	35.1	18+
	Traxos	4774	5.2	1.1	27.5	23+
	-	4547	45.6	35.4	100.2	2
	Foxtrot	4582	563.6**	166.1	1032.1	-3
Lactofol O	Axial	4711	55.1	-6.0	117.3	15+
	Topic	4733	96.1	2.2	194.7	16+
	Traxos	4748	-7.3	-6.1	4.9	20+
	-	4572	196.5	71.5	375.3	1
	Foxtrot	4608	487.8**	454.4**	896.1	-2
Masterblend	Axial	4768	52.4	95.7	112.4	21+
	Topic	4734	11.5	-3.7	38.9	17+
	Traxos	4700	13.7	0.3	42.8	12+

On this basis, using the first three parameters of stability, it is found that the most unstable are tank mixtures of herbicide Foxtrot with foliar fertilizers Humustim, Lactofol O and Masterblend. In these variants values of stability variance σ_i^2 and S_i^2 of Shukla and ecovalence W_i of Wricke are the highest and mathematically proven. The reason for this high instability is greater variation in grain yields during years of experience as weather conditions affect those most. At tank mixtures Humustim + Foxtrot and Masterblend + Foxtrot, instability is linear and nonlinear types - proven values σ_i^2 and of S_i^2. At tank mixture Lactofol O + Foxtrot instability is linear type - proven values σ_i^2, the values of S_i^2 are not proven. Other tank mixtures between foliar fertilizers and antigraminaceous herbicides exhibit high stability because they interact poorly with the conditions of years.

To evaluate the complete efficacy of each tank mixture between foliar fertilizer and antigraminaceous herbicide should be considered as its effect on grain yield of durum wheat and its stability - the reaction of wheat to this variant during the years. Valuable information about the value of technologic value of the variant give the stability criterion YS_i of Kang for simultaneous assessment of yield and stability, based on the reliability of the differences in yield and variance of interaction with the environment. The value of this criterion is experienced that using nonparametric methods and warranted

statistical differences we get a summary assessment aligning variants in descending order according to their economic value.

Generalized stability criterion YS_i of Kang, taking into accounts both the stability and value of yields gives a negative assessment of weeded, untreated control and tank mixtures Humustim + Foxtrot, Lactofol O + Foxtrot and Masterblend + Foxtrot, characterizing them as the most unstable and low yields. According to this criterion, the most valuable technology appears tank mixtures Humustim + Traxos, Masterblend + Axial, Lactofol O + Traxos, Humustim + Axial, Humustim + Topik, Masterblend + Topic, Lactofol O + Topic, Lactofol O + Axial and Masterblend + Traxos. These tank mixtures combine high levels of grain yield and high stability of this index during the years. From the viewpoint of technology for durum wheat growing, high rating also have self-use of herbicides Axial, Topic and Traxos, but without Foxtrot. These herbicides combine relatively good grain yields with high stability during the years of the investigation. Variants with self-use of foliar fertilizers Humustim, Lactofol O and Masterblend without a partner herbicide get low ratings and they to be avoided. In these variants, the positive effect of the foliar fertilizer use is neutralized by the negative effect of the present weeds, because of the absence of effective chemical control against them.

CONCLUSIONS

There is antagonism of combined use by antigraminaceous herbicide Foxtrot with three foliar fertilizers Humustim, Lactofol O and Masterblend. The grain yield increase in compared to self-use of the preparations is only 0.6 - 0.9%.

There is an additive effect by tank mixtures of fertilizers Humustim, Lactofol O and Masterblend with antigraminaceous herbicides Axial, Topic and Traxos. The highest grain yields are obtained by these tank mixtures.

Tank mixtures of herbicide Foxtrot with foliar fertilizers Humustim, Lactofol O and Masterblend are the most unstable for grain yield.

Tank mixtures of herbicides Axial, Topik and Traxos with organic foliar fertilizer Humustim and complex foliar fertilizers Lactofol O and Masterblend are technological the most valuable. They combine high grain yield with high stability with relation to different years.

Self-use of foliar fertilizers Humustim, Lactofol O and Masterblend without herbicides have low estimate and do not be used in the durum wheat crops.

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