Scientific Papers. Series A. Agronomy, Vol. LX, 2017
ISSN 2285-5785; ISSN CD-ROM 2285-5793; ISSN Online 2285-5807; ISSN-L 2285-5785

STABILITY EVALUATION OF SOME FOLIAR FERTILIZER AND GROWTH REGULATORS FOR THEIR INFLUENCE ON THE GRAIN YIELD OF DURUM WHEAT

Grozi DELCHEV

Trakia University, Faculty of Agriculture, Stara Zagora, 6000, Bulgaria

Corresponding author email: delchevgd@dir.bg

Abstract

In 2010-2012 was studied the influence of some foliar fertilizers and growth regulators on grain yield and its stability of durum wheat cultivar Victoria (Triticum turgidum conv. durum Desf. var. valenciae). Factor A included the years of investigation. Factor B included 5 foliar fertilizers - Vertex high-H34 – 3 l/ha, High-phos – 5 l/ha, Potassium thiosulfate (PTS) – 5 l/ha, Foliar extra – 2.5 l/ha and Trace elements for cereals (TEC) – 1 l/ha, a growth stimulator Amalgerol premium – 3 l/ha, an antitranspirant Pureshade - 20 l/ha and tank mixture Amalgerol premium – 3 l/ha + TEC – 1 l/ha. Foliar fertilizers and growth stimulator were treated during tillering stage of the durum wheat and antitranspirant was treated during ear emergence and grain development stages of durum wheat. The grain yields are increase by foliar fertilizers Vertex high-H34, High-phos, Potassium thiosulfate (PTS), Foliar extra and Trace elements for cereals (TEC) and the growth stimulator Amalgerol premium were treated during tillering stage of the durum wheat and the antitranspirant Pureshade was treated during ear emergence and grain development stages of the durum wheat. Antitranspirant Pureshade is the most unstable for grain yield by treatment in both stages - ear emergence and grain development. Pureshade must be treated during the occurrence of drought, not during special stage of the durum wheat development. Tank mixture Amalgerol premium + TEC, followed by foliar fertilizers Vertex high-H34, High-phos, TEC and stimulator Amalgerol premium are technological the most valuable. They combine high grain yield with high stability with relation to different years. Using of these preparations is being proposed as an element of the technology for growing of durum wheat.

Key words: *durum wheat, foliar fertilizers, growth stimulator, antitranspirant, grain yield*.

INTRODUCTION

Modern agriculture cannot successfully develop, if not more widely applied agro-technical and agrochemical activities aimed at increasing the yields of crops. In modern technologies for growing of field crops increasingly becomes important use of complex fertilizers for foliar application (Yuande et al., 1994; Barraclough and Haynes, 1996; Shuqing et al., 1998; Panayotova and Stoyanova, 2014). The main advantage of foliar application is that it acts directly on the leaves of the plant, and it is proved that they are absorbed by much better and more fully the nutrients. Complex fertilizers contain all necessary for the development of culture nutrients: nitrogen, phosphorus, potassium, several trace elements, amino acids and physiologically active substances connected by special biotech environment.

Foliar fertilization of field crops is essential reserve to supplement and correction of soil fertilization. In specific cases, such as soil drought or soil agrochemical unfitness, the use of foliar fertilization is an important link in the overall technology of cultivation of every crop. The appropriateness and effects of foliar application is an aim of study in works of many authors (El-Naga, 1995; Phillips et al., 1999; Taniguchi et al., 1999).

Growth regulators properly selected and used in appropriate level of fertilization, increase yield and quality of received production where classical methods and tools are less effective or almost exhausted their possibilities (Vildflush and Gurban, 1999; Delchev, 2003). There is data that common and durum wheat respond differently to treatment with the same preparations. According to some authors (Jürgens and Knittel, 1985; Rapparini et al., 1987) durum wheat in its response to some retardants is closer to barley than to common wheat.

The purpose of this investigation was to establish the selectivity and stability of some foliar fertilizers, growth stimulator Amalgerol premium and antitranspirant Pureshade 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 two factor experiment as a block method in 4 repetitions, on a 15 m^2 harvesting area, after sunflower pre-crop. Under investigation was Bulgarian durum wheat cultivar Victoria, which belongs to *Triticum durum* var. *valenciae* Desf. Factor A included years of investigation. Factor B included 5 foliar fertilizers – Vertex high-H34 – 3 l/ha, High-phos – 5 l/ha, Potassium thiosulfate (PTS) – 5 l/ha, Foliar extra – 2.5 l/ha and Trace elements for cereals (TEC) – 1 l/ha, a growth stimulator Amalgerol premium – 3 l/ha, an antitranspirant Pureshade - 20 l/ha and a tank mixture Amalgerol premium – 3 l/ha + TEC – 1 l/ha. Foliar fertilizers and growth stimulator Amalgerol premium were treated during tillering stage of the durum wheat EC21-EC29, with quantity of 200 l/ha solution. Anti-transpirant Pureshade was treated during ear emergence EC70 and grain development stages of durum wheat EC80. During early spring was carried out fertilizer with 120 kg N/ha as form of ammonium nitrate. All of variants are treated on the main level: Akurat 60 WG - 10 g/ha (against broadleaved weeds) + Foxtrot 69 EB – 1 l/ha (against graminaceous weeds) + Impact 25 SC - 500 ml/ha (against diseases) which applied as tank mixture in tillering stage of durum wheat.

The efficacy of foliar fertilizers and growth regulators has been established with their influence on grain yield. The statistically 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 and growth regulators 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 for the influence on grain yield of preparations included in experience (Table 1) show that all investigated fertilizers have proven mathematically increase on grain yield. Compared to untreated control this increase varies from 254 kg/ha or 5.0 % by Potassium thiosulfate (PTS) to 420 kg/ha or 8.3 % by Vertex-high-H34.

Table 1. Grain yields, kg/ha

Variants	2010		2011		2012	
	kg/ha	%	kg/ha	%	kg/ha	%
Control – no treated	5360	100	5073	100	4539	100
Amalgerol premium – 3 l/ha	5597	104.4	5455	107.5	4950	109.1
Vertex high-H34 – 3 l/ha	5657	105.5	5493	108.3	4998	110.1
High-phos – 5 l/ha	5567	103.9	5417	106.8	4839	106.7
PTS – 5 l/ha	5573	104.0	5327	105.0	4800	105.7
Foliar extra – 2.5 l/ha	5563	103.8	5377	106.0	4804	105.8
TEC – 1 l/ha	5587	104.2	5397	106.4	4829	106.4
Amalgerol premium – 3 l/ha + TEC – 1 l/ha	5760	107.4	5667	111.7	5103	112.4
Pureshade - 20 l/ha – ear emergence	5573	104.0	5487	107.8	4566	100.6
Pureshade - 20 l/ha – grain development	5657	105.5	5407	106.6	4506	99.3

LSD, kg/ha:

F.A	p≤5%=67	p≤1%=90	p≤0.1%=117
F.B	p≤5%=123	p≤1%=164	p≤0.1%=213
AxB	p≤5%=213	p≤1%=284	p≤0.1%=370

The nitrogen fertilization of durum wheat gives the highest results especially in wet years. The highest yield Vertex-high-H34 is due to the fact that this foliar fertilizer is characterized by a high content of nitrogen (34 %) and contains a combination of different forms of nitrogen - amide, ammonium and nitrate. It contains also magnesium, which is a basic building element for chlorophyll, and minor amounts of copper, which is important for the processes of

flowering. Not high rate of soil fertilization with ammonium nitrate during the tillering stage (120 kg N/ha) is the reason for this high effect of this foliar fertilizer. Other fertilizers included in the study contain less nitrogen. High-phos is a foliar fertilizer with phosphorus, potassium and magnesium plus trace elements. Potassium thiosulfate (PTS) is potassium fertilizer containing sulfur. Foliar extra is a combination of nitrogen, phosphorus, potassium, magnesium and trace elements. Trace elements for cereals (TEC) contain the most necessary for cereals trace elements.

Growth stimulator Amalgerol premium contains an extract of seaweed, distilled paraffin oil, vegetable oils, distilled herbal extracts. This stimulator is rich in hydrocarbons and natural plant growth hormones and increasing microbial soil activity. The use of Amalgerol premium increases grain yield of durum wheat average for period with 382 kg/ha or 7.5 %.

Combined application of trace elements for cereals (TEC) with stimulator Amalgerol premium in tillering stage of durum wheat leads to the highest increase in grain yield - with 594 kg/ha, or 11.%. Combination of trace elements cereals (TEC) with Amalgerol premium not only leads to increased quality and quantity of yield but also increases and resistance to durum wheat to adverse weather conditions.

Antitranspirantat Pureshade protects plants from harmful ultraviolet and infrared radiation, while allowing for flow of photosynthesis. The product forms a protective film on the durum wheat leaves, which acts as a reflective barrier against harmful effects of sunlight. Reducing harmful solar influence, Pureshade limits transpiration from the stomata of the plant and improve the use of water quantities available in soil. This antitranspirant enhances the plants growth during hot and dry weather.

During 2011, the treatment of durum wheat with antitranspirant Pureshade during ear emergence stage give a better effect on grain yield in comparison to treatment during grain development stage. The increase in yield was respectively 414 kg/ha or 7.8 % during ear emergence stage and 334 kg/ha or 6.6 % during grain development stage. During to ear emergence stage of durum wheat weather was hot and dry and there were days with strong winds - dry winds. The preparation limited the adverse effects of drought and lead to better pollination of spikelets.

During 2010 Pureshade gave better results in the treatment during grain development stage, though the differences in yields between two stages of application are not big. It is in the range of 1.5 % or only 84 kg/ha. The reason for the small difference is less spring drought during this harvest year.

During 2012, as a result of wet weather during May, with rainfall of 142 l/m^2, use of antitranspirant not had an influence on grain yield. These results indicate that the introduction of Pureshade should not be linked with the development stage of crop and should be linked with weather conditions. This antitranspirant must be applied during drought when Pureshade limits transpiration from the plants leaves and assists to more economical use of limited water quantities in soil.

Analysis of variance for grain yield (Table 2) shows that investigated variants have proven influence on grain yield – 86.6 %. The years have the highest influence on grain yield – 72.5 % on the variants. The reason is the large differences in the meteorological conditions during the three years of investigation.

The strength of influence of investigated preparations is 10.0 %. The influence of variants, years and preparations is very well proven at $p \leq 0.01$. There is an interaction between preparations and meteorological conditions of years (AxB) – 4.1 %. They are proven at $p \leq 0.5$. That means that weather conditions over the three years of experience have influenced the degree of influence of foliar fertilizers and growth regulators. The largest differences are accounted for in antitranspirant Pureshade. Its effectiveness is changed the most depending on temperate and rainfalls during the years.

Based on proven preparation 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.

Table 2. Analysis of variance for grain yield

Source of variation	Degrees of freedom	Sum of squares	Influence of factor, %	Mean squares
Total	89	142964	100	-
Tract of land	2	9198	6.5	4599.0***
Variants	29	123878	86.6	4271.7***
Factor A - Years	2	103620	72.5	51810.0***
Factor B – Preparations	9	14356	10.0	1595.1***
AxB	18	5902	4.1	327.9*
Pooled error	58	9888	6.9	170.5

*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
Control – no treated	4991	186.4	336.0*	198.5	-6
Amalgerol premium – 3 l/ha	5334	191.2	-9.8	366.2	9+
Vertex high-H34 – 3 l/ha	5383	220.5	-9.8	413.2	11+
High-phos – 5 l/ha	5274	6.8	-6.6	71.3	8+
PTS – 5 l/ha	5233	48.1	113.7	137.4	3
Foliar extra – 2.5 l/ha	5248	-15.2	-3.4	36.1	4
TEC – 1 l/ha	5270	-11.1	0.3	42.5	7+
Amalgerol premium – 3 l/ha + TEC – 1 l/ha	5510	147.4	54.6	2962	13+
Pureshade - 20 l/ha – ear emergence	5208	861.1**	423.7	1438.1	-6
Pureshade - 20 l/ha – grain development	5186	1484.0**	-6.7	2434.8	-7

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.

On this basis, using the first three parameters of stability, it is found that the most unstable are variants of antitranspirant Pureshade which is treated during ear emergence and grain development stages of durum wheat, followed by no treated control. 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. At Pureshade instability is a linear type - proven values of σ_i^2, the values of S_i^2 are not proven. The reason for this high instability is greater variation in grain yields during years of experience as weather conditions affect those most. At no treated control instability is a nonlinear type - proven values of S_i^2, the values of σ_i^2 are not proven. Other variants exhibit high stability because they interact poorly with the conditions of years.

To evaluate the complete efficacy of each foliar fertilizer and growth regulator 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 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 differrences 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 only of untreated control and antitranspirant Pureshade, characterizing them as the most unstable and low yields. According to this criterion, the most valuable technology appears tank mixtures Amalgerol premium + TEC, followed by alone application of foliar fertilizers Vertex high-H34, High-phos, Trace elements for cereals (TEC) and stimulator Amalgerol premium. These variants combine high levels of grain yield and high stability of this index during the years. Variants with alone application of foliar fertilizers Foliar extra and Potassium thiosulfate (PTS) get low ratings and them to be avoided.

CONCLUSIONS

The grain yields are increase by foliar fertilizers Vertex high-H34, High-phos, Potassium thiosulfate (PTS), Foliar extra and Trace elements for cereals (TEC) and the growth stimulator Amalgerol premium were treated during tillering stage of the durum wheat and the antitranspirant Pureshade was treated during ear emergence and grain development stages of the durum wheat.

Antitranspirant Pureshade is the most unstable for grain yield by treatment in both stages - ear emergence and grain development. Pureshade must be treated during the occurrence of drought, not during special stage of the durum wheat development.

Tank mixture Amalgerol premium + TEC, followed by foliar fertilizers Vertex high-H34, High-phos, TEC and stimulator Amalgerol premium are technological the most valuable. They combine high grain yield with high stability with relation to different years.

Using of these preparations is being proposed as an element of the technology for growing of durum wheat.

REFERENCES

Barov V., 1982. Analysis and schemes of the field experience. NAPO, Sofia, p. 668.

Barraclough P., Haynes J., 1996. Effect of foliar supplements of potassium nitrate and urea on the yield of winter wheat. Fertilizer Research, 44 (3) 217-223.

Delchev Gr., 2003. Use of growth regulators and complex fertilizers of different fertilization rates of durum wheat. PhD Dissertation.

El-Naga S., 1995. Influence of micronutrients (Co, Mo, Fe, Mn and Zn) on growth and nitrogen fixation in clover and wheat plants in calcareous soil. Journal of Agricultural Research, 20 (2) 803-826.

Jürgens G., Knittel H., 1985. Durum-Weizen: die Produktionstechnik ansfeilen. DLG - Mitteilunger. BRD, 100 (4), 184-186.

Kang M., 1993. Simultaneous selection for yield and stability: Consequences for growers. Agronomy Journal, 85: 754-757.

Lidanski T., 1988. Statistical methods in biology and agriculture, Sofia, p. 376.

Panayotova G., Stoyanova A., 2014. Influence of universal liquid fertilizer MaxGrow on yield and quality of durum wheat (*Triticum durum* Desf.) cultivar Progress. Science and Technology, Vol. 6, No 1, pp. 50 – 56.

Phillips S., Chen J., Raun W., Johnson G., Cossey D., Murray D., Westerman R., 1999. Winter wheat and seed response to foliar nitrogen applications. Journal of Plant Nutrition, 22 (10) 1541-1549.

Rapparini G., Benussi D., Bassi F., 1987. Verifica dell'utilita d'impiego di fitoregulatori di crescida sui cereali vernini. Informatore Agrario, 43 (5), 29-35.

Shanin Yo., 1977. Methodology of the field experience. BAS, p. 384.

Shukla G., 1972. Some statistical aspects of partitioning genotype - environmental components of variability. Heredity, 29: 237-245.

Shuqing J., Shuzhang Zh, Fengrong L., 1998. Effect of nitrogen application under different conditions at late growth stage of wheat. Acta Agronomica Sinica, 24 (6) 884-888.

Taniguchi Y., Fujita M. Sasaki A., Ujihara K., Ohnushi M., 1999. Effect of top dressing at booting stage on crude protein content of wheat in Kyushu district. Japanese Journal of Crop Science, 68 (1) 48-53.

Vildflush I.R. and Gurban K.A., 1999. Yield and quality of spring wheat in an integrated application of mineral fertilizers, trace elements and new growth regulators. In: International scientific conference. Minsk, Belarus, 16-19. 02; 84-85.

Wricke G., 1962. Über eine Methode zur Erfassung der ekologischen Strekbreitein Feldersuchen. Pflanzenzuecht, 47: 92-96.

Yuande Q., Peichang Y., Weimin Y., 1994. Yield increasin efficacy of multiple elements micronutrient liquid fertilizers on wheat. Agricultural Science, №6 268-270.