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Agronomy performance of new triticale varieties (*xTriticosecale* Wittm.) grown under different regions

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ABSTRACT

In three years of field trials (2009-2011) carried out in parallel in the experimental fields of the Dobroudja Agricultural Institute - General Toshevo (DAI) and the Department of Crop Science, Agronomy Faculty at the Agricultural University - Plovdiv (AU) tested two new varieties of triticale - Kolorit and Accord. Experiments are included after predecessor sunflower, using the fractional plots in four replications. The size of the experimental area is 10 m^2. In the investigation fertilization is in the ratio N:P:K=12:6:6 and $N_0P_0K_0$ (control). Analyzed the influence of fertilization and environment of the region on the formation of grain yield (GY) and some quality parameters - mass of 1000 grains (TKW) and specific weight (TestW) in the new triticale varieties. Studied triticale varieties Kolorit and Accord are formed higher productivity for the environment in the region of Dobroudja Agricultural Institute - General Toshevo. The mineral fertilization in the ratio N:P:K=12:6:6 has a greater effect on agro-environmental conditions in the area of the Department of Crop Science, Agronomy Faculty at the Agricultural University – Plovdiv and results in a greater increase in the productivity of Kolorit and Accord. The new triticale variety Kolorit is characterized with maximum values of the studied parameters – grain yield (GY), mass of 1000 grains (TKW) and specific weight (TestW) in the environment of Plovdiv and under environment of DAI Kolorit has a high grain yield (GY), mass of 1000 grains (TKW) and Accord – with a maximum specific weight (TestW).

Keywords: *triticale – region – yield – fertilization.*

INTRODUCTION

DAI - Dobroudja Agricultural Institute - General Toshevo
AU - the Department of Crop Science, Agronomy Faculty at the Agricultural University – Plovdiv
GY – grain yield
TKW – 1000 grain weight
TestW - specific weight

In 1967 the first Bulgarian 42-chromosome triticale variety T-AD (2n=42) was developed and thus Bulgaria became the seventh country in the world to develop this crop. Five cultivars were developed, four of them for grain and one for green mass (Panayotov and Rachinsky, 2001).

Triticale was introduced in production at the beginning of the 1980s, when many countries officially registered newly released cultivars and thus triticale, previously a crop for pure theoretical investigations, became a crop for mass production. The interest to this crop is becoming greater, especially in regions with low-fertility soils. The testing of new triticale cultivars under variable conditions is important for higher yields with good quality (Vassileva, 2005; Gibson, 2007; Marton, 2008; Clapham, 2008).

Similar to wheat, triticale is an intensive and highly productive crop which has high requirements to the agronomy practices used for its cultivation to realize its production potential. The investigations on the biological and economic properties of the

new triticale cultivars under variable soil and climatic conditions and agronomy factors would contribute to their proper distribution and improvement of the technology for their growing (Gibson, 2008; Fisher, 2009; Kolev, 2010).

The aim of this investigation was to: i) study the behavior of the new triticale cultivars according to the environment; ii) to analyze the effect of the mineral fertilization and the agro-ecological conditions of the growing region for formation of grain yield and some quality indices (1000 grain weight and test weight).

MATERIAL AND METHODS

During the 3-year period of study (2009 – 2011), two parallel field trials were carried out: one at the trial fields of Dobrudzha Agricultural Institute – General Toshevo (DAI), and one at the Agrarian University – Plovdiv (AU). The trials were sown after previous crop sunflower and were designed according to the split plot method, in 4 replications, the size of the trial plot being 10 m^2. Two new triticale cultivars were subjected to investigation, Colorit and Accord, both of them developed at DAI ((Baychev, 2006; Baychev and Petrova, 2009). The investigated cultivars were grown with the same technology in two agro-ecological regions. Sowing was performed with a plot seeder within the appropriate sowing dates (depending on the autumn conditions and the possibility for harvesting of the previous crop), the sowing norm being 550 germinating seeds/m^2. Soil tillage included single disking (10-12 cm) after harvesting of the previous crop and double disking after the main fertilization. Treatment with nitrogen, phosphorus and potassium was done manually; phosphorus and potassium were introduced prior to sowing, before the first soil tillage, and nitrogen was used as a single application for early spring nutrition. The phosphorus fertilizer was triple super phosphate at fertilization norm 60 kg.ha^{-1} P_2O_5, and potassium chloride was applied as potassium fertilizer at the same norm (60 kg.ha^{-1} K_2O). Ammonium nitrate was used as nitrogen fertilizer (120 kg.ha^{-1}). Control of weeds, diseases and pests was done when necessary applying suitable chemicals. Harvesting was at stage full maturity.

The following indices were investigated:

- Grain yield (t.ha^{-1})
- 1000 kernel weight (g)
- Test weight (kg)

Statistical analysis of the data was performed with the help of Statistica ver. 7.

RESULTS AND DISCUSSION

The synthetic cereal crop triticale, which took a whole century to reach production stage, still poses a number of problems and challenges to breeders and agronomists dealing with crop technology. To solve such problems, a number of methods are used for developing of new forms, investigation on the behavior of the new genotypes under changeable environments and for study of their production potential and adaptability (Baychev, 2004; Vassileva, 2004; Iliev and Baychev, 2010; Akbarian, 2011; Baychev and Petrova, 2011; Roohi, 2013).

The analysis on the variation revealed the effect of the agronomy factors on the investigated indices in the two regions (Table 1). Grain yield is determined by a number of factors: the genetic production potential of the cultivar, the level of the applied agronomy practices and the combination of the meteorological conditions during the growing season. The effect of the genotype was not significant for the formation of the yield from triticale in neither of the two agro ecological regions. The probable reason for this is the small number of the investigated cultivars. The effect of mineral fertilization on the formation of grain yield was much better expressed in the region of Plovdiv than in the region of DAI, while the year conditions were opposite in direction to fertilization: their effect was much more ostensible under the conditions of DAI.

Grain size (TKW) is a varietal trait and the independent action of the genotype was better expressed in the region of Plovdiv. The effect of mineral fertilization and the year conditions on the formation of 1000 kernels of the investigated cultivars was higher in the region of DAI than in the region of Plovdiv.

Based on the variance analysis, test weight of the investigated triticale cultivars was most affected by the meteorological conditions at DAI. Second in significance was the genotype. Similar results have been reported in our previous studies on the productivity of different genotypes of common and durum wheat in the trial field of DAI (Ivanova and Tsenov, 2009; Ivanova and Tsenov, 2010; Ivanova and Tsenov, 2010). Under the agro-ecological conditions of Plovdiv, test weight of the investigated cultivars was almost equally influenced by the genotype and by the mineral fertilization, and much less – by the year conditions.

Table 1. ANOVA - main effects

Indices	GY, t.ha^{-1}		TKW, g		TestW, kg	
Sourse of variation	DAI	AU	DAI	AU	DAI	AU
Variety	0,61	2,04	10,57**	37,56**	251,61**	7,71**
Fertilization	54,87**	150,67**	23,06**	7,20**	125,22**	7,12**
Year	248,72**	49,45**	34,02**	12,93**	758,34**	4,56**

** Significance at p=0.01

The behavior of the two cultivars varied according to the agro-ecological conditions of growing (Table 2). In the region of DAI the genotypes demonstrated higher productivity; the mean yield formed being 6,27 t.ha^{-1}. The minimum yields obtained were 2,90 t.ha^{-1}, and the maximum – 9,47 t.ha^{-1}. In the region of Plovdiv the mean yield formed was with 1,78 t.ha^{-1} lower. The minimum and maximum values were also lower (1,80 t.ha^{-1} and 8,82 t.ha^{-1}, respectively), and yield variation was greater.

Thousand kernel weight (TKW) is a character directly related to productivity. The triticale cultivars involved in this investigation formed larger and plumper grain under the agro-ecological conditions of DAI (averagely 42,99 g).The variation in the values of this index was also high: the minimum values were 37,12 g, and the maximum values reached 48,96 g. Under the agro-ecological conditions of Plovdiv the mean 1000 kernel weight of the investigated triticale genotypes was 33,55 g. Under these conditions the variation of values was even greater (minimum value 26,21, maximum – 40,10 g).

Test weight (TestW) is an index used for evaluation of grain. The higher the test weight, the higher flour yield is. The new triticale cultivars demonstrated higher values of this index under the agro-ecological conditions of DAI. The variation of the values was very high (minimum value 63,00 kg, maximum – 75,50 kg). The new triticale cultivars had lower test weight under the conditions of Plovdiv (an average of 65,62 kg). Much lower was the difference between the minimal (62,28 kg) and the maximal (70,15 kg) values.

Table 2. Means of the investigated parameters by regions

Indices / Regions	GY, t.ha^{-1} $\overline{X}$	t	TKW, g $\overline{X}$	t	TestW, kg $\overline{X}$	t
DAI	6,27±0,34	18,71**	42,99±0,56	76,77**	69,60±0,63	109,62**
Min-Max	2,90 – 9,47		37,12 – 48,96		63,00 – 75,50	
AU	4,49±0,33	13,90**	33,55±0,59	56,64**	65,62±0,33	196,08**
Min-Max	1,80 – 8,82		26,21 – 40,10		62,28 – 70,15	

The main criterion determining the economic properties of a cultivar is its productivity. Figure 1 presents the grain yield averaged for the three years of investigation for the two triticale cultivars depending on fertilization under the agro-ecological conditions in the studied regions.

Higher yields were formed in the region of DAI, and cultivar Colorit demonstrated higher productivity than cultivar Accord regardless of the fertilization and the environment. Comparing the behavior of the two cultivars at both locations, greater variations of productivity were observed in the check variants at Plovdiv, while under the same conditions in the region of DAI the two cultivars demonstrated almost equal yields. Comparing their behavior under fertilization, the opposite tendency was observed: the differences between the two cultivars were greater in the region of DAI, while under the same conditions in the region of Plovdiv almost equal yields were obtained from the two cultivars.

Under conditions without fertilization the variation in the formed grain yield from cultivar between the two regions was 2,27 t.ha^{-1}, and for cultivar Accord the variation was even greater: 2,87 t.ha^{-1}.Under mineral fertilization the variation changed: it became higher with cultivar Colorit (1,11 t.ha^{-1}) and decreased for cultivar Accord (0,88 t.ha^{-1}).

Comparing the productivity of the two triticale cultivars within the regions, higher effect of fertilization was observed in the agro-ecological region of Plovdiv. The use of mineral fertilization at ratio N:P:K=12:6:6 in the region of Plovdiv increased the productivity of cultivar Colorit with about 76%, and for cultivar Accord the increase exceeded 100%. Under the agro-ecological conditions of DAI, high yields were obtained even with the check variants of the tested triticale cultivars. Under the same conditions, the applied mineral fertilization increased the productivity of cultivar Colorit with about 25%, and of cultivar Accord – with about 18%.

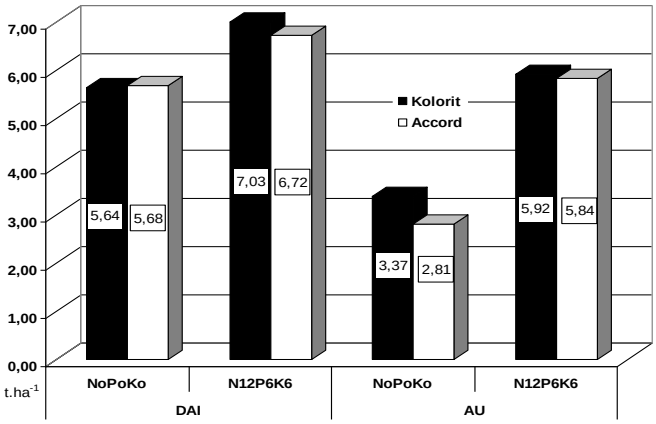

Figure 1. Grain yield by region

Figure 2 shows 1000 kernel weight averaged for the three years of study on the two triticale cultivars according to the applied fertilization under the agro-ecological conditions of the respective regions.

Thousand kernel weight in the region of DAI was with averagely 9,44 g higher than 1000 kernel weight obtained in the region of Plovdiv. Again cultivar Colorit demonstrated higher values of this index, regardless of the fertilization and the environment. In the check variants 1000 kernel weight of cultivar Colorit was with 9,88 g higher in the region of DAI, and in the variants with fertilization – with 6,62 g. With cultivar Accord these variations increased and the index was with 13,64 g higher in the check variants at DAI, and in the variants with fertilization – with 7,63 g higher.

Mineral fertilization under the agro-climatic conditions of DAI did not increase grain size of the investigated triticale cultivars but on the contrary – decreased it. Similar regularity has been established in our previous studies as well which were related to 1000 kernel weight of common wheat (Ivanova, 2007; Ivanova and Tsenov, 2010). The fertilization norm decreased absolute grain weight of cultivar Colorit with 1,58 g, and of cultivar Accord – with 3,95 g.

A different effect of mineral fertilization on the formation of 1000 kernel weight was observed under the agro-ecological conditions of Plovdiv. The fertilization norm in this case increased the values of this index of both cultivars. The increase was with 2,06 g for cultivar Accord and 1,68 g for cultivar Colorit.

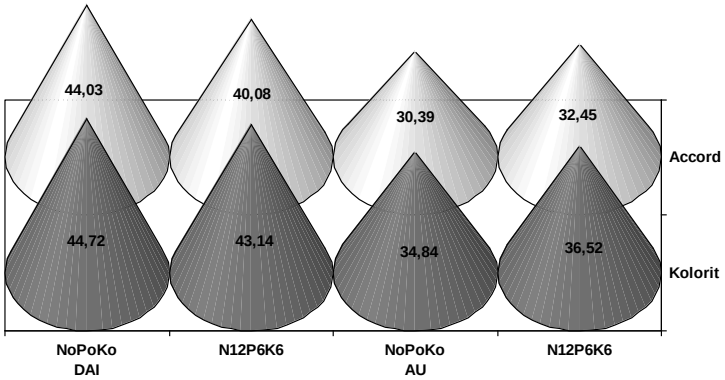

Figure 2. Thousand kernel weight by region

Figure 3 shows test weight of the two triticale cultivars depending on the fertilization applied at the two regions. Both genotypes demonstrated higher values of this index under the agro-ecological conditions of DAI. Under the same conditions cultivar Accord demonstrated higher test weight, while cultivar Colorit performed better under the conditions of Plovdiv region.

Under the agro-ecological conditions of DAI the used mineral fertilization decreased test weight of Colorit (with 2,17 kg) and Accord (with 1,66 kg). Under the agro-ecological conditions of Plovdiv the applied fertilization norm increased the values of the index. The increase was with 1.08 kg for cultivar accord and with 1,78 kg for cultivar Colorit.

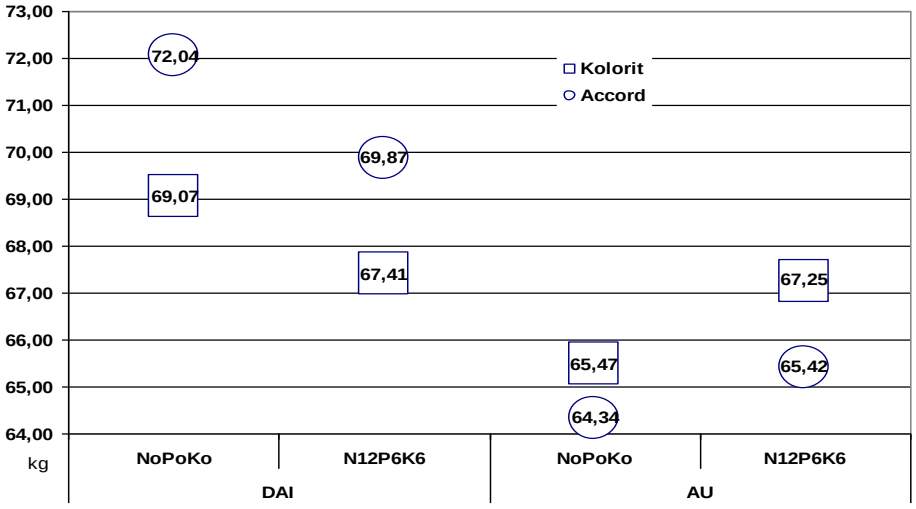

Figure 3. Specific weight by region

The investigated triticale cultivars Colorit and Accord had higher productivity under the agro-ecological conditions in the region of Dobrudzha Agricultural Institute – General Toshevo.

Mineral fertilization at ratio N:P:K=12:6:6 had better effect under the agro-ecological conditions in the region of Plovdiv and lead to higher increase of the productivity of these cultivars.

The triticale cultivar Colorit demonstrated maximum values of the investigated indices (grain yield, 1000 kernel weight and test weight) under the agro-ecological conditions of Plovdiv, and under the conditions of DAI this cultivar had higher grain yield and 1000 kernel weight, while cultivar Accord had maximum test weight.

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