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## **PRODUCTIVITY OF FOREIGN COMMON WINTER WHEAT CULTIVARS (*Triticum aestivum* L.) UNDER THE CONDITIONS OF DOBRUDZHA REGION**

### **ABSTRACT**

One of the main directions in common winter wheat breeding is toward achieving high results with regard to yield and production potential. An important prerequisite for this is the including in breeding of new gene plasma with variable origin adequate to the growing environments and the desired goal.

The aim of this investigation was to study the productivity and the elements of yield of foreign winter wheat cultivars under the conditions of Dobrudzha region.

The investigation was carried out during 2011 – 2013 in the trial field of Dobrudzha Agricultural Institute (DAI). Twenty-four cultivars of foreign origin were tested. Their yield was compared to two standards: Enola and Sadovo 1. The cultivars were planted in harvest plots each of 10 m<sup>2</sup> in two replications. The structural elements of yield were analysed, as well as some traits and properties characterizing the variation of the separate wheat cultivars. The following traits related to productivity were investigated: vegetation period, plant height yield, number of productive tillers, grain weight per spike, number of grains per spike and 1000 kernel weight. Cultivars Kantata, Sonata, Sixtus and Podoima demonstrated highest production potential realizing a yield of more than 8 t/ha, averaged for the three years of investigation. Highest variation was observed in the traits grain weight per spike and number of grains per spike. The above mentioned genotypes are suitable cultivars which can be successfully involved in the breeding program of DAI with regard to the index yield.

**Keywords:** winter wheat, productivity, elements of yield.

### **INTRODUCTION**

Breeding of common winter wheat is a process related to the development of new cultivars with optimal combination of different valuable biological and economic properties (Panayotov, 1992; Panayotov, 2013).

One of the most important directions is toward higher grain yield (Tsenov et al., 2009). The use of initial breeding material of variable origin is a

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good prerequisite for achieving the set goals. The investigations on the productivity of foreign bread wheat cultivars would give important information whether they could be involved in the breeding programs of Dobrudzha Agricultural Institute (DAI) (Stoeva *et al.*, 2009; Tsenov, 2013). Grain yield is a value, which is not only genetically determined but also dependent to a high degree on the growing conditions (Tsenov *et al.*, 2006; Tsenov *et al.*, 2014; Sabaghnia *et al.*, 2013). Many materials need to be preliminary adapted before they could be included in the process of hybridization. Measuring the separate elements, which influence the formation of productivity and their variation during the different years, would help to make the proper selection of parental forms (Chamurlyiski *et al.*, 2012).

The aim of this investigation was to study the productivity and the elements of yield of foreign common winter wheat under the conditions of Dobrudzha region.

### MATERIAL AND METHODS

The experiment was carried out during 2011 – 2013 in the trial field of DAI. Twenty-four varieties of foreign origin were tested (Table 1). Their biological and economic properties were compared to two standards, Enola and Sadovo 1, which are national models for quality group B within the system of the Bulgarian Executive Agency of Variety Testing, Field Inspection and Seed Control.

Table 1. Common winter wheat cultivars used in this investigation

Varieties	Origin	Varieties	Origin
Dobropolka	Balti, Moldova	Lilyana	Novi Sad, Serbia
Liman	Balti, Moldova	Dragana	Novi Sad, Serbia
Podoima	Balti, Moldova	Kantata	Novi Sad, Serbia
Livada	Balti, Moldova	Sonata	Novi Sad, Serbia
Harry	USA	Kiria	Odessa, Ukraine
Wesley	USA	Vesta	Odessa, Ukraine
Cougar	USA	Zmina	Odessa, Ukraine
Yuamar	USA	Kolumna	Odessa, Ukraine
New Sky	USA	Cornelius	Austria
Prowers	USA	Sixtus	Austria
Jerry	USA	Faur	Fundulea, Romania
<b>Sadovo 1</b>	<b>BG - check</b>	Glosa	Fundulea, Romania
<b>Enola</b>	<b>BG - check</b>	Boema	Fundulea, Romania

The cultivars were planted in harvest plots each of 10 m<sup>2</sup> in two replications, according to the Latin square method, at sowing norm 500

germinating seeds/m<sup>2</sup>. Planting was done within the optimal dates after previous crop grain pea.

The structural elements of yield were analysed, as well as some traits and properties characterizing the variation of the individual wheat cultivars. The vegetation period (DH) was represented as number of days from January 1<sup>st</sup> till the date to heading. Plant height (PH, cm) was recorded at stage milk maturity. The following traits related to productivity were investigated: yield (t/ha) – GY; number of productive tillers (number of stems per m<sup>2</sup>) – NPT; 1000 kernel weight (g) – TKW. The following indices were calculated: grain weight per spike (g) – WGS, number of grains per spike – NGS.

The mathematical processing of data was done with EXCEL 13. Dispersion, variation, correlation and PC analyses were the applied statistical approaches, using the software SAS 9.1, XLSTAT 7.5.2 and BioStat 6.0.

Year 2013 was most favourable for the development of common wheat with respect to the meteorological conditions. The investigated materials realized to a large extent their production potential in spite of the lower-than-the-norm precipitation during April-June. The rainfalls, however, were sufficient during a stage optimal for the development of the plants. The results related to productivity of wheat in 2011 and 2012 were lower, especially during 2011. On the whole, the conditions during these two years had some negative effect on the development of the crops and the formation of yield.

## RESULTS AND DISCUSSION

The results from the trial, averaged for the three years, are summarized in Table 2. Concerning the vegetation period, none of the investigated cultivars differed significantly from the standards Enola and Sadovo 1. Maximum levels of plant height (PH) were recorded in the wheat varieties Sixtus, Jerry, New Sky and Cougar – over 100 cm. The obtained values of this parameter showed that the tested genotypes with origin from USA exceeded the standards. A similar tendency was observed also for the trait number of productive tillers per m<sup>2</sup> (NPT). Highest values were read in the cultivars New Sky and Yuamar. With regard to weight of grains per spike (WGS), cultivar Podoima exceeded the rest of the varieties with weight of 1.5 g. The investigated accessions formed lower weight of grains per spike in comparison to the standard Enola, approximating more the standard Sadovo 1. Highest number of grains per spike (NGS) was recorded in cultivar Vesta, and Sadovo 1 demonstrated maximum absolute weight (TKW); none of the investigated materials exceeded the standard by this index. Most of the wheat cultivars were at the level of Enola. In general, the fourteen cultivars exceeded the standards by grain yield (GY) at the highest level of significance. Maximum results with regard to productivity were recorded in the Serbian accessions Kantata and Sonata which realized 8.65 t/ha and 8.54 t/ha, respectively. The other two cultivars, which exceeded all other investigated varieties, were the Austrian Sixtus and the Moldovian Podoima. The calculated variation coefficient showed that there was highest variation in the traits weight

of grains per spike (WGS), number of grains per spike (NGS) and plant height (PH). This variation was due to the fact that the materials involved in this investigation were of various origins and their response to the environment was most clearly expressed in these parameters.

Table 2. Grain yield, vegetation period and structural elements of yield

Cultivars	DH	PH	NPT	WGS	NGS	TKW	GY
Dobropolka	135,5	73,8	574,3	1,32	28,7	46,3	7,50***
Liman	137,7	78,3	610,7	1,20	24,8	49,2	7,32
Podoima	136,0	89,3	553,3	1,50	31,1	48,4	8,16***
Livada	139,2	81,8	549,3	1,44	28,9	49,8	7,76***
Harry	138,0	89,7	634,7	1,11	27,7	40,1	6,93
Prairie red	131,8	84,3	747,7	0,93	21,8	43,2	6,95
Cougar	135,7	104,3	708,3	0,95	21,0	46,0	6,73
Yuamar	134,5	87,5	771,0	0,95	26,3	37,1	7,39
New Sky	136,5	106,3	781,3	0,87	24,4	35,7	6,67
Jerry	136,7	108,8	656,7	1,01	22,3	46,0	6,70
Cornelius	139,0	98,0	581,3	1,29	28,0	46,3	7,44***
Sixtus	140,7	109,8	651,3	1,29	29,6	43,7	8,26***
Lilyana	133,3	87,0	619,7	1,05	21,7	48,9	6,53
Dragana	133,3	91,7	708,7	1,05	20,2	52,3	7,45***
Kantata	136,2	87,8	651,7	1,32	29,2	45,7	8,65***
Sonata	134,8	85,7	744,3	1,14	23,7	48,6	8,54***
Kiria	135,7	72,0	656,7	1,20	24,1	50,3	7,94***
Vesta	136,3	81,2	535,0	1,47	31,4	47,0	7,99***
Zmina	134,8	79,5	518,7	1,31	28,9	45,8	6,84
Kolumna	135,3	96,3	636,7	1,19	25,6	47,2	7,60***
Faur	135,5	80,2	597,3	1,28	26,7	47,9	7,59***
Glosa	133,5	81,8	597,7	1,31	25,3	52,2	7,85***
Boema	134,8	81,0	604,0	1,28	27,1	47,7	7,71***
<b>Sadovo 1 BG check</b>	<b>133,8</b>	<b>92,5</b>	<b>596,0</b>	<b>1,20</b>	<b>22,1</b>	<b>54,3</b>	<b>7,02</b>
<b>Enola BG check</b>	<b>132,2</b>	<b>77,2</b>	<b>530,0</b>	<b>1,35</b>	<b>28,0</b>	<b>48,9</b>	<b>7,15</b>
<b>Mean</b>	135,6	88,2	632,7	1,2	25,9	46,7	7,5
<b>Standard Error</b>	0,43	2,13	15,16	0,03	0,65	0,86	0,12
<b>VC%</b>	1,58	12,05	11,98	14,42	12,50	9,24	7,94

\*\*\* -  $p \leq 0,01$

LSD5% - 0,14; LSD1% - 0,19; LSD0,1% - 0,24

The dispersion analysis was performed according to the following model:

$$Y_{ijk} = Y_{..} + G_i + Y_j + (GY)_{ij} + E_{ijk},$$

where G and Y were the factors genotype and climatic conditions, and E was the error of the model.

The results are presented in Table 3. All interactions were significant. Highest was the effect of the year on the vegetation period (DH), the number of productive tillers per m<sup>2</sup> (NPT) and productivity (GY). The effect of the genotype was clearly expressed only on plant height (PH). The interaction between the genotype and the environment was very strong in the parameters number of grains per spike (NGS) and weight of grain per spike (WGS), which explains the results in Table 2 and is the reason for their strong variation. It can be concluded that the above structural elements of yield in the tested materials varied over years under the effect of the respective meteorological conditions; in some of the indices a constant regularity prevails which is genetically determined. This is a normal response because the investigated materials are not adapted to the environment in which the experiment was carried out.

Table 3. Two-factor dispersion analysis

Index	Genotype			Year			Genotype*Year		
	MS	F-value	F%	MS	F-value	F%	MS	F-value	F%
<b>DH</b>	27,4	37,1	10,0	2882,9	3895,8	<b>87,7</b>	2,0	2,7	1,5
<b>PH, cm</b>	678,2	<b>40,9</b>	60,8	3891,5	235,0	29,1	30,8	1,9	5,5
<b>NPT</b>	34489,8	10,7	33,5	497022,6	154,4	<b>40,2</b>	8563,5	2,7	16,6
<b>WGS, g</b>	0,2	13,8	44,7	1,1	85,7	23,1	0,1	3,4	<b>22,1</b>
<b>NGS</b>	63,1	7,2	31,8	797,4	90,7	33,5	20,8	2,4	<b>20,9</b>
<b>TKW, g</b>	111,9	30,5	53,6	774,1	211,1	30,9	10,4	2,8	10,0
<b>GY, t/ha</b>	2,1	32,0	12,8	152,6	2313,1	<b>77,0</b>	0,7	11,3	9,0

Table 4 summarizes the correlation coefficients of yield with the structural elements which form it. The productivity of the investigated foreign common winter wheat varieties was formed mainly by the weight of grains per spike (WGS) and the number of grains per spike (NGS). A non-significant negative correlation was observed between productive tillering (NPT) and yield (GY). This is not a typical correlation, but its negativity is in this case caused by the cultivars with origin from the USA, which had high number of spike-bearing stems per m<sup>2</sup> but formed low yield because low values of the index weight of grains per spike (WGS) were observed in them. Another explanation could be the significant high negative correlation ( $r = -0.85$ ) between productive tillering (NPT) and weight of grains per spike itself (WGS). Such an approach for investigating the production potential of foreign materials in Bulgaria has been applied to other crops as well (Georgiev et al, 2009).

The cultivars already mentioned in Table 2 which realized higher yield, formed their productivity as a result from optimum combination of productive

tillering (NPT) and 1000 kernel weight (TKW) – this was the case with the first genotype (cultivar Sonata); in cultivar Kantata this was mainly due to the high number of grains per spike (NGS) – 29. These correlations have been confirmed by other authors investigating Serbian breeding (Protic, et al., 2010), too. There is a specific peculiarity observed in the Bulgarian standard cultivars – low number of productive tillers per m<sup>2</sup>, which is compensated for by the high number of plump grains per spike.

Table 4. Correlation analysis

	<i>DH</i>	<i>PH, cm</i>	<i>NPT</i>	<i>WGS, g</i>	<i>NGS</i>	<i>TKW, g</i>	<i>GY, t/ha</i>
<b>DH</b>	1						
<b>PH, cm</b>	0,38	1					
<b>NPT</b>	-0,14	0,43*	1				
<b>WGS, g</b>	0,27	-0,44*	<b>-0,85***</b>	1			
<b>NGS</b>	0,46*	-0,25	-0,60**	<b>0,78***</b>	1		
<b>TKW, g</b>	-0,24	-0,36	-0,50**	0,47*	-0,18	1	
<b>GY, t/ha</b>	0,26	-0,23	<b>-0,11</b>	<b>0,59**</b>	<b>0,50**</b>	0,24	1

\* -  $p \leq 0,05$ , \*\* -  $p \leq 0,01$ , \*\*\* -  $p \leq 0,001$

Figure 1 presents the distribution of yield and its elements as a result from the applied PC analysis. According to the Total Variance Explained, determining were the indices NGS (46.3%) and WGS (25.4%). These results are analogous to the obtained correlations in Table 4. The effect of the indices absolute weight (TKW) and plant height (PH) was insignificant. The indices number of productive tillers per m<sup>2</sup> (NPT) and plant height (PH) had first negative components but the high positive values of their second component implied indirect effect. The indices yield (GY) and vegetation period (DH) had high per cent from the variation, too. The indices NGS and DH had positive first and second components, which proved their positive effect on the formation of productivity (GY).

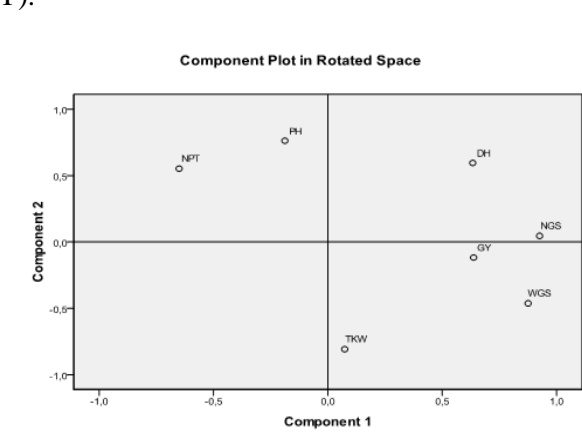


Figure 1. Principal Component Analysis of the grain yield and the elements of productivity.

## CONCLUSIONS

- Highest yield, averaged for the three years of the investigation, was realized by the Serbian cultivars Kantata and Sonata.
- The factor year was determining for the formation of the production potential of the studied foreign wheat cultivars.
- The yield from the investigated materials was formed mainly on the basis of the high number of grains per spike and their high weight.
- Wheat cultivars Kantata, Sonata, Sixtus and Podoima can be successfully included in the breeding programs of DAI with the aim of increasing productivity.

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