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RESEARCH ON THE IDENTIFICATION OF HIGH PRODUCTIVITY WINTER WHEAT VARIETIES AND LINES, TESTED ON LUVISOL FROM ȘIMNIC IN THE PERIOD 2004-2018

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Abstract

Over the period 2004-2018, on the luvisol from Șimnic were tested 394 varieties and lines of winter wheat of different origins, at least 3 years each, in order to identify those with high productive potential and a high degree of adaptability to the pedoclimatic conditions in the area. The analysis of the results was made in terms of average yields obtained from the varieties and lines of wheat tested. The registered values had extreme limits: 267 kg / ha for the Bancal variety in 2015 and 8420 kg/ha for the Gruia variety in 2004. The average preponderant classes were 4001-5000 kg/ha and 5001-6000 kg/ha, with 25% of the results placed in each of them. The fact that the Glosa variety registered the highest average yield over a period of 15 years (5078 kg/ha) certifies the results of this research, knowing that this variety is the most cultivated and the most stable variety in Romania.

Key words*: wheat, luvisol, yield, correlation, stability.*

INTRODUCTION

Bread wheat is one of the most widely grown and most consumed food crops all over the world. The breeding programs need to produce germplasm capable of maximizing the agricultural potential of specific areas and of minimizing the occurrence of crop failures or very low yields in unfavorable years. The cultivars well adapted confer stability and diminish the risks (Bunta, 2020).

The use of genetic diversity at the territorial level, by cultivating in each area several different varieties, is the simplest and most accessible way to reduce the fluctuation of wheat crops (Săulescu et al., 1980). Also, the cultivation of varieties with wide adaptability to contrasting environmental conditions can reduce the risks of declining yield in unfavorable years (Mustăţea et al., 2008).

Previous research mainly focused on accurate and real-time monitoring of the occurrence and development droughts (Aghakouchack et al., 2015), but very few reports address the impacts of droughts on growing crops and related crop yield (Yu et al., 2018). Droughts with different intensities that occur during different growth stages of crop can have distinctly different impacts on crop yield (Cakir, 2004).

The incipient droughts that occurred during the wintering period of the winter wheat growth helped to increase the winter wheat yield, while the mild droughts that occurred during the maturity stage of winter wheat resulted in a reduction yield. The mild droughts that occurred during the filling and maturity period had a significant effect on the yield of winter wheat (Yu et al., 2018). Along with climate impact a range of regional and global political and economic factors intensify food insecurity and long term vulnerability in certain regions (Paraschivu et al., 2017, 2019).

A study comparing 14 wheat varieties was carried out in Secuieni during 2007-2010. The highest yields were obtained for the varieties: Glosa (8991 kg/ha), Boema 1 (8224 kg/ha), Delabrad 2 (8084 kg/ha), Faur F (8062 kg/ha) and Gruia (7932 kg/ha). Of the three years of experimentation, one year was characterized as a normal year in terms of rainfall and with a uniform distribution during the wheat vegetation period, namely, the year 2007-2008, the year in which the largest wheat yields were also made (Pochișcanu et al., 2011).

All over the world, multi-annual studies have been carried out on the adaptability and stability of wheat varieties. In general, the relatively small yields of wheat can be explained by the negative influence of the lower water supply of the soil in the unfavorable years and the high number of weeds in the case of monoculture and 2-year rotation (Partal and Paraschivu, 2020).
Using data from 1973-2004, Stone and Schlegel (2006) reported that grain yield was correlated with soil water available for the plant at germination but also with rainfall during the growing season. Studies conducted by Xiao et al. (2008) between 1981 and 2005, in the semi-arid area of China, showed that once there were changes in temperature and precipitation, there are also significant changes in the phenology of the plant whose yield is higher at high altitude. In the face of climate change, wheat yield in this region is higher at high altitudes than at low altitudes. By 2030, wheat yield is expected to increase by 3.1% at low altitude and by 4% at high altitude.
For the period 1978-1995, in the southern part of China, Li et al. (2010) found that precipitation variability explains 23-60% of yield variability, while temperature variability justifies 37-41% of yield variability.
The climatic impact on wheat in Picardy (region in northern France) and Rostov (region in southern Russia) was studied by Licker et al. (2015) for a period of 37 years (1973-2010). During this period, the summer precipitation in Rostov decreased by 61% while the summer temperatures increased by 4°C. In Picardy the total precipitations decreased by 9% while the maximum spring temperatures increased by 2.4°C. Wheat yield was strongly correlated with the number of climate variables. The average temperatures in May and June explained 49%, respectively 16% of the variability of yield in Rostov, while the precipitation in November and the minimum summer temperature explain 26%, respectively 23% of the yield.

MATERIALS AND METHODS

Over the period 2004-2018, on the luvisol from Șimnic were tested 394 varieties and lines of winter wheat of different origins, at least 3 years each, in order to identify those with high productive potential and a high degree of adaptability to the pedoclimatic conditions in the area.
The analysis of the results was done with the help of yield.
The applied technology did not include foliar treatment, only seed and vegetation treatment for pests.
To present the distribution of values from a series of data, the boxplot method was used, which marked the variants with large deviations from the average. Highlighted were those that were clearly detached from the outliers values (exceeded by more than 1.5 to 3 times the interval in which 50% of the values found themselves) and extreme ones (exceeded 3 times or over, same range) (Hawkins, 2009).
The study was performed for each year and on average for cultivars tested for at least 3 years.
The minimum values, the maximum values, the amplitude, the distribution of values and the cultivars that registered yields over 2000 kg / ha regardless of the climatic conditions were highlighted.
The correlations between the average yields and those obtained in the driest year (2007), on the one hand, and in the rainiest year (2018), on the other hand, were calculated.

RESULTS AND DISCUSSIONS

The number of cultivars tested for 15 years varied greatly depending on the year - from 27 in 2004 to 469 in 2016 (Figure 1). The results underlying this study came from cultivars tested for at least 3 years but there were varieties that were tested throughout. These include the Glosa variety.Depending on the number of years of testing, when taking into consideration the yield, the following varieties are leading: Unitar - 5440 kg / ha on average for 3 years; Falado - 6304 kg/ha on average for 4 years; Gabrio - 6442 kg/ha on average for 5 years; Basmati - 5077 kg/ha on average for 6 years; Mv Martina - 5056 kg/ha on average for 7 years; Pajura - 4562 kg/ha on average for 8 years; Bitop - 4058 kg/ha on average for 9 years; Brakes - 4265 kg/ha on average for 10 years; Orion - 4656 kg/ha on average for 11 years; Gruia - 4666 kg/ha on average for 12 years; Cezanne - 4906 kg/ha on average for 13 years; Exotic - 5213 kg/ha on average for 14 years and Glosa - 5078 kg/ha on average for 15 years.

The fact that the Glosa variety recorded the highest average yield over a period of 15 years, certifies the results of this research, knowing that this variety is the most cultivated and the most stable variety in Romania. The study provides valuable information for the wheat breeding program on identifying genetic sources with a high degree of adaptability.

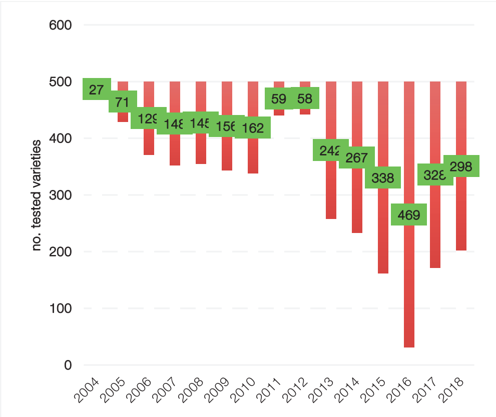

Figure 1. Number of cultivars tested each year

The distribution of yield according to the year of experimentation was much differentiated. In the years 2004 (Figure 2), 2007 (Figure 6), 2008 (Figure 7), 2009 (Figure 8), 2011 (Figure 10), 2012 (Figure 11), 2013 (Figure 12), 2015 (Figure 14), 2017 (Figure 16) and 2018 (Figure 17), most yields were grouped mainly in a single class. In 2005 (Figure 4), 2006 (Figure 5), 2010 (Figure 9), 2014 (Figure 13), 2016 (Figure 15), most yields were grouped into several classes, which indicates that the favorable climatic conditions were their characteristic.

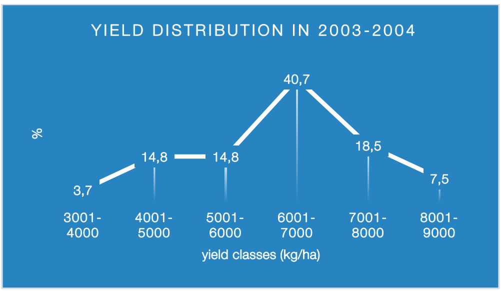

Figure 2. Yield distribution in the agricultural year 2003-2004

The values of the registered yields had extreme limits between 267 kg/ha for the Bancal variety in 2015 and 8420 kg/ha for the Gruia variety in 2004 (Figure 3). The limits (minimum and maximum yield) of each year were totally different from each other. The only variety that appeared twice was Apache but as a lower limit in 2012 (3156 kg/ha) and as an upper limit in 2006 (5450 kg/ha).

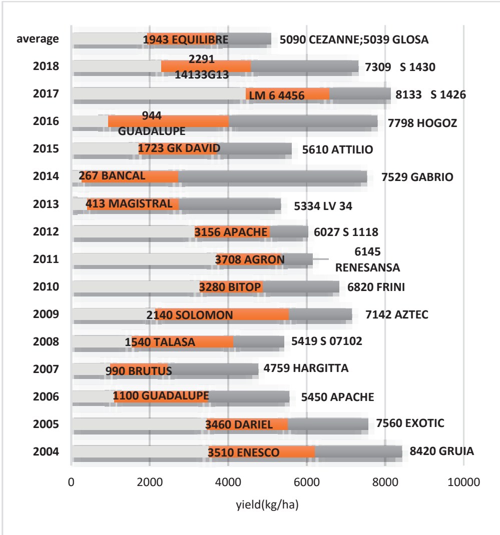

Figure 3. Extreme limits of yield obtained in each year of testing

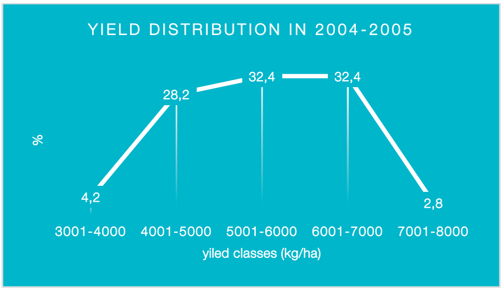

Figure 4. Yield distribution in the agricultural year 2004-2005

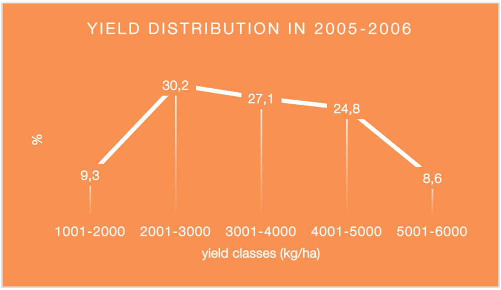

Figure 5. Yield distribution in the agricultural year 2005-2006

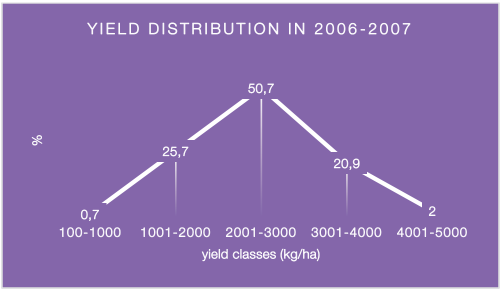

Figure 6. Yield distribution in the agricultural year 2006-2007

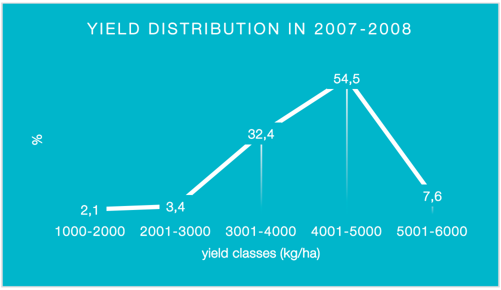

Figura 7. Yield distribution in the agricultural year 2007-2008

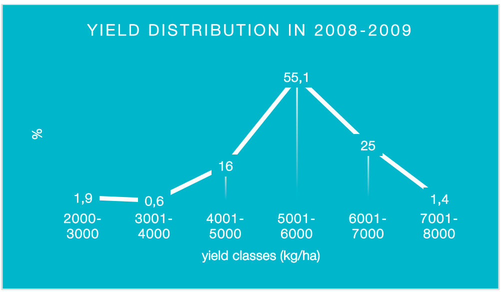

Figure 8. Yield distribution in the agricultural year 2008-2009

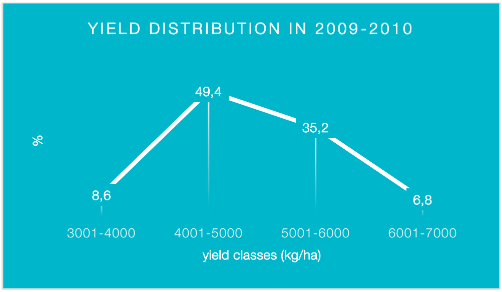

Figure 9. Yield distribution in the agricultural year 2009-2010

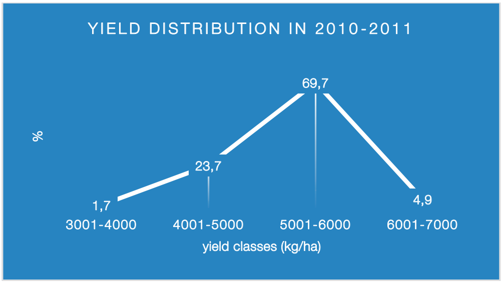

Figure 10. Yield distribution in the agricultural year 2010-2011

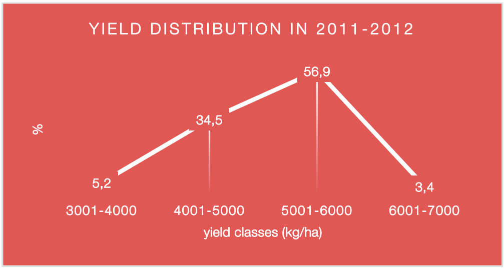

Figure 11. Yield distribution in the agricultural year 2011-2012

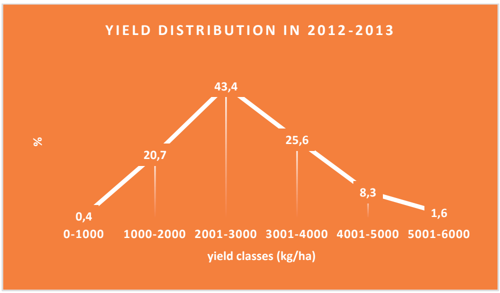

Figure 12. Yield distribution in the agricultural year 2012-2013

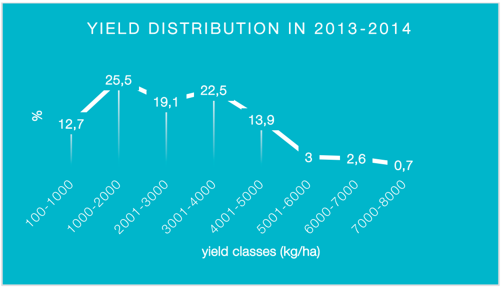

Figure 13. Yield distribution in the agricultural year 2013-2014

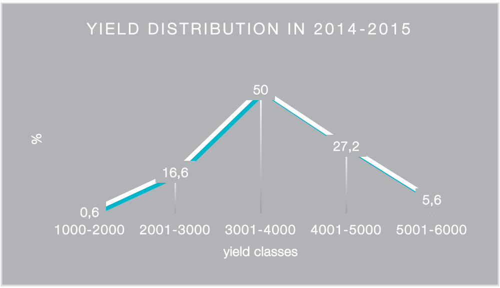

Figure 14. Yield distribution in the agricultural year 2014-2015

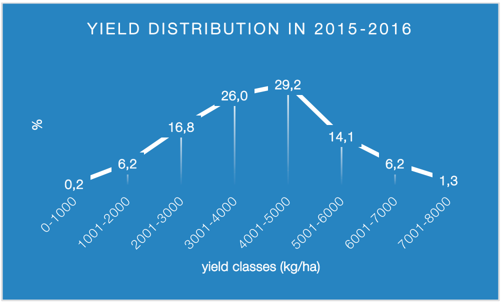

Figure 15. Yield distribution in the agricultural year 2015-2016

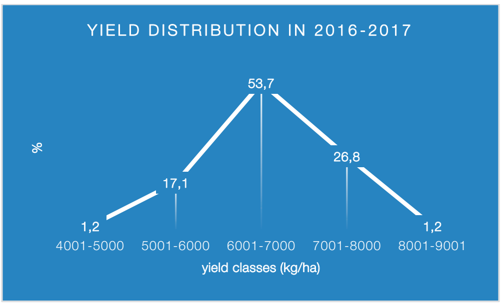

Figure 16. Yield distribution in the agricultural year 2016-2017

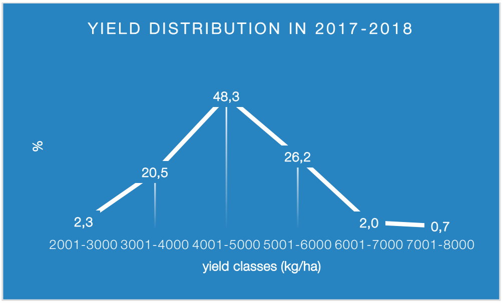

Figure 17. Yield distribution in the agricultural year 2017-2018

The average preponderant classes for the studied period were 4001-5000 kg/ha and 5001-6000 kg/ha, with 25% of the results placed in each of them (Figure 18).

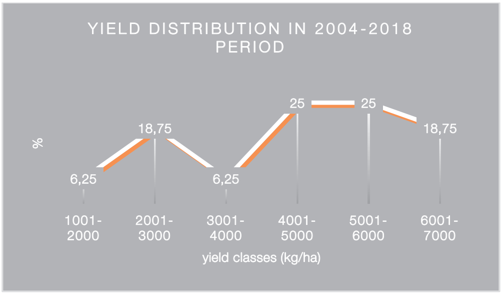

Figure 18. Yield distribution in the agricultural year 2004-2018

The average yield for the years of experiment-tation ranged from 2461 kg/ha in 2007 and 6588 kg/ha in 2017. The relationship between the rainfall and the predominant yield class (the yield interval in which most of the tested cultivars were grouped) showed that the latter increases with increasing rainfall but decreases when over 575 mm were recorded.

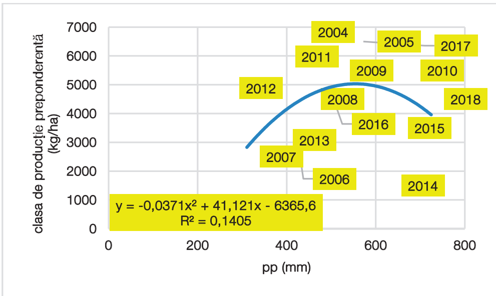

Figure 19. Correlation between rainfall and the predominant yield class in each year of testing

The variability of rainfall explains 14% of the variability of the grouping of yields in the preponderant class (Figure 19).

The correlation between average yield and yield in a dry year showed that the variability of average yield explains 22% of the variability of yield under drought conditions. A variety whose average yield increases by 100 kg / ha, in a dry year registers an increase of only 60 kg / ha, for the studied interval (Figure 20).

The varieties Exotic, Glosa, Mv Martina and Orion stood out as varieties with high average yield (5213 kg/ha, 5078 kg/ha, 5056 kg/ha, respectively 4656 kg/ha) and high yields under drought conditions (4421 kg/ha, 3330 kg/ha, 3380 kg/ha, respectively 3670 kg/ha).

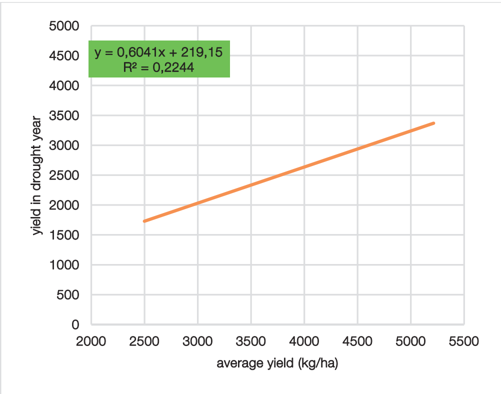

Figure 20. The correlation between average yield and yield in a dry year

The correlation between average yield and yield in a rainy year highlighted the fact that the variability of average yield explains 35% of the variability of yield under water supply conditions. A variety whose average yield increases by 100 kg / ha, in a rainy year registers an increase of only 55 kg/ha (Figure 21). Therefore, a large amount of rainfall does not increase yield.

The basis for the selection of adapted and stable varieties consists of varieties that fall into the group of cultivars with high average yield (at least 4000 kg/ha) and minimum yield of at least 2500 kg/ha.

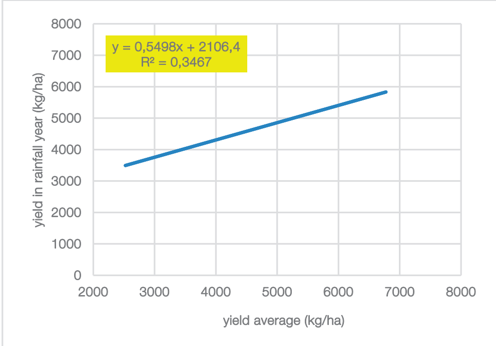

Figure 21. The correlation between average yield and yield in a rainy year

Regarding our testing, cultivars that showed average yields above 4000 kg/ha but minimum yields of at least 2500 kg/ha are shown in the figure below (Figure 22). Of these, as expected, because they are more adapted to the conditions, most of them are local varieties - Glosa, Izvor, Voroneț, Șimnic and Fundulea lines. Among the foreign varieties, the following ones stood out: Nathan (average yields for 6 years) and Cezanne (average yields for 13 years). Since the two variables studied are not correlated (coefficient of determination of only 3.5%), it is very important to make a selection among the large values in their projection.

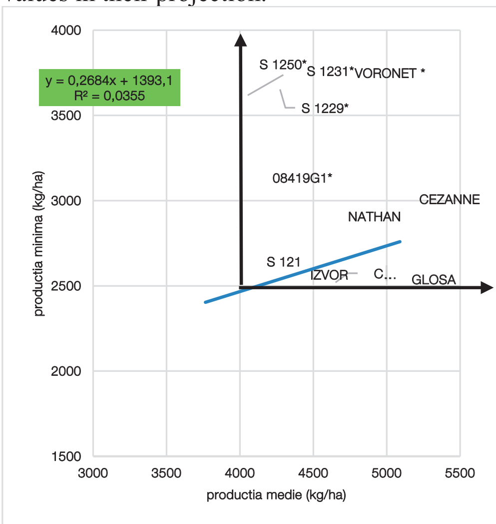

Figure 22. The correlation between average yield and minimum yield with the highlighting of the optimal quadrant (average yields over 4000 kg / ha and minimum yields over 2500 kg / ha).

The results analyzed by the boxplot method are presented in table no.1. Among the varieties tested, the Esquisit, Pegassos, Bhash, Solomom varieties frequently appear with values of deviant or extreme yield.

Varieties recorded as negative outliers or extremes are not recommended for the area because they are inferior to any other variety tested. The probability that those climatic conditions will be repeated exists and it is good that the varieties marked on these positions (outliers or extreme negative) are eliminated from the start so as not to record low yields.

The outliers foreign varieties that stood out and can be successfully cultivated in the area were: Exotic, Hogoz, Gabrio, Hargitta, GK Hattyu, Frini, Orion, GK Petur, Mandolin, Solehio and Falado.

CONCLUSIONS

Depending on the number of years of testing and regarding the yield, the varieties that stood out were the following: Unitary - 5440 kg/ha on average for 3 years; Falado - 6304 kg/ha on average for 4 years; Gabrio - 6442 kg/ha on average for 5 years; Basmati - 5077 kg/ha on average for 6 years; Mv Martina - 5056 kg/ha on average for 7 years; Pajura - 4562 kg/ha on average for 8 years; Bitop - 4058 kg/ha on average for 9 years; Brakes - 4265 kg/ha on average for 10 years; Orion - 4656 kg/ha on average for 11 years; Gruia - 4666 kg/ha on average for 12 years; Cezanne - 4906 kg/ha on average for 13 years; Exotic - 5213 kg/ha on average for 14 years and Glosa - 5078 kg/ha on average for 15 years.

The fact that the Glosa variety recorded the highest average yield over a period of 15 years, certifies the results of this research, knowing that this variety is the most cultivated and the most stable variety in Romania.

The relationship between the rainfall and the predominant yield class (the yield range in which most of the tested cultivars were grouped) showed that the latter increases with the increasing amount of precipitation but decreases when over 575 mm were recorded. The variability of precipitation explains 14% of the variability of the grouping of yields in the preponderant class.

The varieties Exotic, Glosa, Mv Martina and Orion stood out as varieties with high average yield and high yields under drought conditions.

The correlations showed that 22% of the variability of the average yield of a variety is associated with the variability of the variety's yield in a dry year and 35% in a rainy year. The varieties with a minimum yield of over 2500 kg / ha regardless of the year of experimentation and average yields over 4000 kg/ha were: Glosa, Cezanne, Izvor, Nathan.

The foreign varieties that stood out and can be successfully cultivated in the area were: Exotic, Hogoz, Gabrio, Hargitta, GK Hattyu, Frini, Orion, GK Petur, Mandolin, Solehio and Falado.

The study provides valuable information for the wheat improvement program regarding the identification of genetic sources with a high degree of adaptability and stability.

Table 1. The results of the yield analysis by the box-plot method

YEAR	THE LIMITS OF 50% OF THE VALUES	INTER QUARTIL	1,5*INTER QUARTIL	3*INTER QUARTIL	MAXIMUM	MINIMUM	OUTLIERS	EXTREMES
2004	5270-7110	1840	2760	5520	8420	3510	-	-
2005	4960-6280	1320	1980	3960	7560	3460	-	-
2006	2460-4380	1920	2880	5760	5450	1100	-	-
2007	2910-1940	970	1455	2910	3896	990	HARGITTA GK HATTYU EXOTIC	-
2008	3857-4605	748	1112	2244	5419	3000	ESQUISIT Mv SUGEVES PEGASSOS SOLOMON BHASH	TALASA
2009	5247-6029	782	1173	2346	7142	4180	CORNELIUS DEFENCE	BHASH SOLOMON

							LADA ESQUISIT MASSON RHEIA PEGASSOS	
2010	**4440-5270**	**830**	**1245**	**2490**	**6510**	**3280**	**FRINI ORION**	-
2011	**4981-5754**	**773**	**1160**	**2319**	**6145**	**4429**	-	-
2012	**4767-5498**	**731**	**1097**	**2193**	**6027**	**4009**	**AGRON KISKUN G. APACHE**	-
2013	**2046-3289**	**1243**	**1865**	**3729**	**4991**	**413**	**LOVRIN 34 MANDOLIN GK PETUR**	-
2014	**1495-3819**	**2324**	**3486**	**6972**	**6925**	**267**	**GABRIO SOLEHIO**	-
2015	**1723-4172**	**1003**	**1505**	**3009**	**5610**	**1723**	-	-
2016	**3098-7553**	**1782**	**2673**	**5345**	**7798**	**944**	**HOGOZ**	-
2017	**6161-7044**	**883**	**1324**	**2648**	**8133**	**4456**	**AS 5 LM 6**	-
2018	**4082-5080**	**1012**	**1518**	**3036**	**7309**	**2291**	**S 1430 S 1431 S 1426 S 1429 FALADO**	-
							FRUMENTO 14133G13	-

Legend

(yellow)	**Positive variants**
(red)	**Negative variants**

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