YIELD AND SOME AGRONOMIC CHARACTERS OF WINTER WHEAT VARIETIES IN THE YIELD TRIALS AT ARDS TURDA

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Abstract: *The results of our study are about of yield capacity and stability of different winter wheat variety in Transilvanian Plain conditions, as well as an analysis of the main elements of productivity. Under semi-arid conditions wheat genotipe with a longer grain filling duration give lower yields if occur high water and temperature deficiency. The plant genotype and environment both influence the rate and duration of grain filling, which have a directly influence on the grain productivity. Productivity components and some morpho-physiological traits such as number of grains per spike, grain weight per ear, thousand kernel weight , plant size and plant density are closely related to the production of grain. On the other hand,between grain yield and protein content and wet gluten content there are an negative relationship.The experiments were conducted over two years, 2011 and 2012, at Agricultural Research and Development Station Turda, which are characterized with a high rainfall and temperatures favourable for winter wheat crop. The biologic material used in our study is quite varied, consisting of 25 winter wheat varieties of local and foreign origin.On the bases of results obtained it can say that winter wheat genotypes studied had different reactions to the environmental conditions and agro-technological factors apply.Although most elements of productivity studied are under genetic control, but more or less environmental influence that affect negatively the main elements by increasing or decreasing the production.The best results were registered to winter wheat varieties released by ARDS Turda which means that they have a good adaptability and yield stability to the specific environments.The foreign winter wheat varieties had also a very good behaviour recording high yields, which means they have a good adaptability which recommend them for use in this area. Concluding, on the basis of our results, the wheat growers from Transilvania, have large possibilities to choice the best cultivars for their particular environmental and farming conditions.*

Key words: *wheat, yield, thousand-kernel weight; grain weight; number of grains per spike;*

INTRODUCTION

The wheat (*Triticum aestivum*) is the most important cereal grain, beeing the leading source of vegetable protein in human food, having a higher protein content than soybeans or the other major cereals maize and rice. Wheat was a key factor enabling the emergence of city-based societies from the start of civilization because it was one of the first crops that could be easily cultivated on a large scale, and had the additional advantage of yielding a harvest that provides long-term storage as food. In Europe, the winter wheat is more important crop because it meat favorable condition of environment for highest yields. Over time, many winter wheat varieties were using more and less in production giving high or small production depending on environment condition in area they were sowing. Lately, appeared wheat varieties adapted to growing area whit high and good production. This paper deals the results of our study with emphasis on yield capacity and stability of different winter wheat variety in Transilvanian Plain conditions, as well as an analysis of the main elements of productivity.

Under semi-arid conditions wheat genotipe with a longer grain filling period give lower yields if occur high water and temperature deficiency. The plant genotype and environment both influence the rate and duration of grain filling, which direct influences on the grain productivity.

Table 1

Origin of the winter wheat cultivars used in the yield trials at ARDS Turda

Country	Place of origin	Cultivars
Romania	Turda	Apullum ; Arieşan; Dumbrava; T 96-97; T 67-02; Andrada
	Fundulea	Boema; Delabrad; Dropia; Faur; Gruia;
	Lovrin	Lovrin 34
	Albota	Trivale
Hungary	Szeged	GK Othalom; GK Kalasz
	Martonvásár	MV Martina; MV Palotas; MV Mandolin; MV Mariska; Maty; MV 06-02
	Kiskun	Serina
Austria		Josef
France	Limagrain	Renan
Russia		Bezostaia

MATERIALS AND METHODS

The experiments were conducted over two years, 2011 and 2012, at Agricultural Research and Development Station Turda, which are characterized with a high rainfall and temperatures favourable for winter wheat crop. The biologic material used in our study is quite varied, consisting of 25 winter wheat varieties of local and foreign origin.

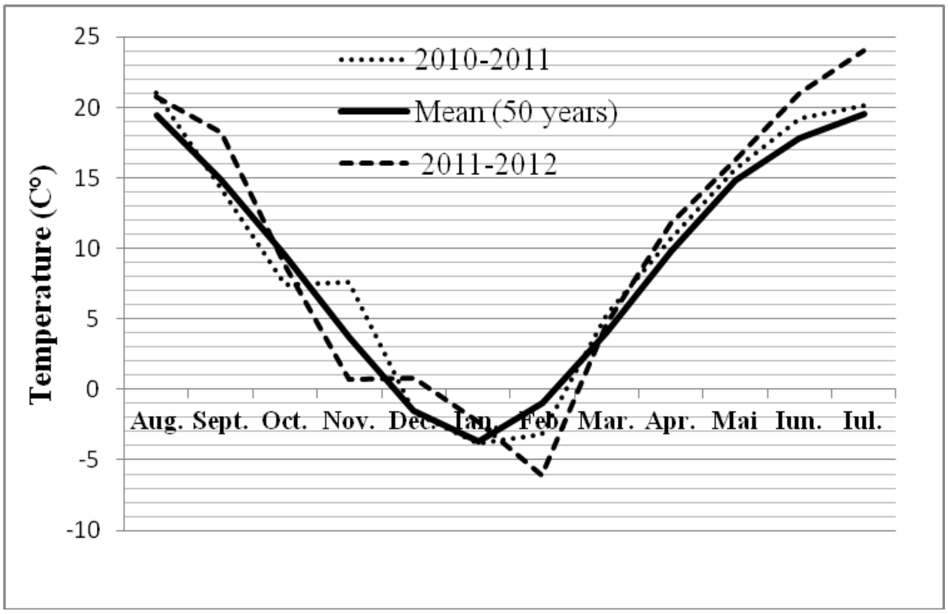

Figure 1.- Monthly temperatures for wheat in the years 2010- 2012 .
(Source: Meteorological station Turda)

The two years was different in terms environment conditions, especially during the grain filling which have a important influence on final grain production and thus the main elements of productivity. So, from the two years, the most favorable conditions for wheat where provides by 2011-2102 growing season.

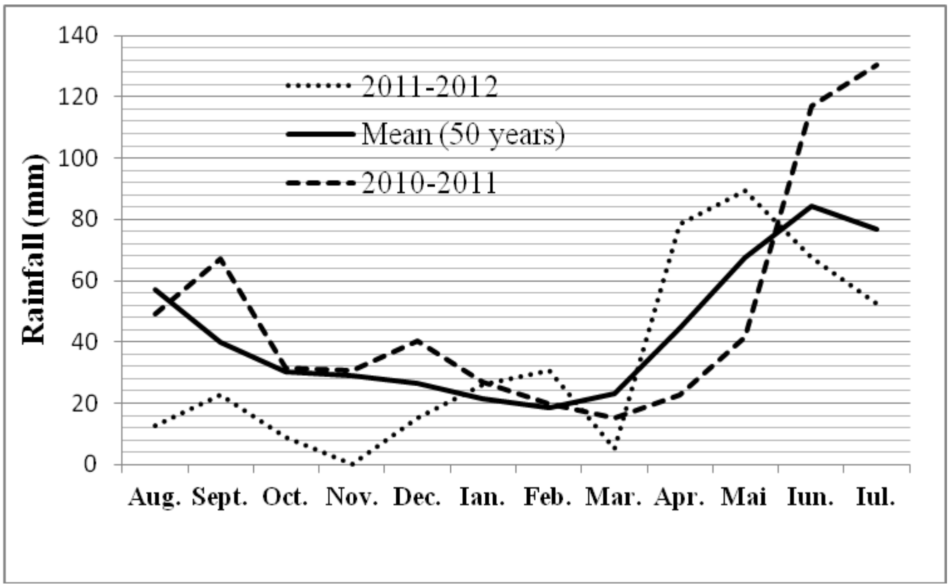

Figure 2- Monthly rainfall regime for wheat in the years 2010- 2012
(Source: Meteorological station Turda)

The seeding rate was adjusted to 550 viable seeds per m^2. The sowing was made at optimal date to our area. The plot size was 7 m^2 (eight rows of 7 m in length and 12,5 cm between rows). Before harvest from each plot have been taken 25 ear to determinate main productivity elements. After frontal elimination of border for remove edge effect, the final plot area were 5 m^2,. Plant high was determinate at full ripening by means of graduated ruler. The density was determined as the number of spikes per m^2 containing grains divided by the total number of stems per m^2. The number of grains per spike was determined as the average spikelet number of 25 spikes randomly selected from the sample. The weight grains per spike have been recorded as the result of dividing total weight of grains by number spike. Thousand-kernel weight (TKW) was also determined for each plot. Plots were mechanically harvested at ripening and yield was expressed at 14% grain moisture content. _To test the ability to capitalize the fertilization, to experimental trials was applied two level of fertilization one level (20:20:0) given to emergence plant and the other level before the anthesis phases (19:19:0). The weed control were made in the spring, at the beginning of stem elongation stage whit a mixture between an herbicide (2,4 D +25 g/l iodosulfuron metil sodiu +10 g/l amidosulfuron + 250 g/l mefenpir dietil) and an insecticid (alfa cipermetrin 100 g/l).

RESULTS AND DISCUSSION

On the bases of results obtained it can say that winter wheat genotypes studied had different reactions to the environmental conditions and agro-technological factors applied (Table 2). From the table 2 can be seen that the yield results and environments influence on this also the difference between basic fertilisation and additional fertilisation. Thus, comparing the yield grain in the two experimental years it can notice the year influence of favourable condition. Characters like number of grain per spike and grain weight per spike have a well-established genetic determinism, the latter being the product of the rate and duration of grain filling (Gebeyehou *et. al.*, 1982; Van Sanford and Mackown, 1985; Bruckner and Frohberg, 1987). Grain filling duration is defined as the period between flowering and physiological maturity (Przuli and Mladinov, 1999), also, in wheat, has been reported to be significantly affected by temperature and light (Wardlaw, 1970; Sofield *et. al*., 1977; Wiegand and Cuellar, 1981) and hence could be an important trait in terminal heat stress environments. Under unfavourable conditions of the year 2011 the two characters with direct action on the yield grain were negatively influenced through increase the sterile spikelets instead of those fertile. Thousand-kernel weight is a genetically determined character whose variability substantial depends on environment conditions and is also influenced by grain filling period. Biometrical analyses were performed independently for each year to determine the relationships between yield and its components.The influence of environment conditions and fertilization level on grain yield and the other traits related to production was different for the two experimental years (table 2). So in 2011 level production of the 25 genotypes was 2654 kg/ha at basic fertilization and 4003 kg/ha at additional fertilization, while in 2012 this was 5117 kg/ha at basic fertilization and 6312 at additional fertilization. Also for the number of grain per spike in 2011 was obtain a mean of 24.65 grains per spike, while in 2012 under favourable condition the mean was 33.0 grain per spike. Grain weight per spike is a dependent character by the number of grain per spike and the grain filling period. Grain weight in 2011 had means values since 1.057 g and 1.471 g per ear in 2012. Small differences between the two years for TKW suggest that the natural conditions have low influence on this character which is mainly under genetic control, as well as plant height.

Table 2

Yield and yield components for the group at two years and two fertilization levels

Years	Basic fertilization	Additional fertilization	Average
Grain Yield (kg. ha $^{-1}$)			
2010-2011	2654	4003	3328,5
2011-2012	5117	6312	5714,5
Grains per spike			
2010-2011	23,1	26,2	24,65
2011-2012	31,7	34,3	33,0
Grain weight per spike			
2010-2011	0,982	1,131	1,057
2011-2012	1,392	1,550	1,471

Thousand-kernel weight (g)

2010-2011	42,6	43,3	42,95
2011-2012	44,0	45,4	44.7

Plant height

2010-2011	68.6	77.2	72.9
2011-2012	77.3	79.2	78.3

Number of spikes per m^2

2010-2011	371.6	419.3	395.5
2011-2012	421.7	448.9	435.3

From table 3, there are compared the grain yield and main components of these on each year it can be seen the differences from each to other. So all characters obtain in 2011 are lower than 2012 which strengthens the idea of yearly favorability conditions. Thus the differences between 2012 and 2011 were 33.9 % for number of grain per spike, 39.2 % for grain weight per spike and 71.7 % yield gain respectively. The other characters studied have little differences from year to year, as it can be seen from the table 3 data.

Table 3

Mean values of yield and yield components of winter wheat genotypes

	2010-2011		2011-2012		Difference	
	Average	Range	Average	Range	a-b	(a-b) /a x 100 (%)
Yield (kg. ha^{-1})	3328,5	1942- 4575	5714,5	3977- 7210	-2386	-71.7
Number of grains per spike	24,65	19.2- 30.5	33,0	26.7- 40.9	-8.35	-33.9
Grain weight per spike (g)	1,057	0.751- 1.339	1,471	1.155- 1.794	-0.414	-39.2
Thousand-kernel weight (g)	42,95	38.4- 46.9	44.7	35.8- 49.7	-1.75	-4.07
Number of spikes per m^2	395.5	309.3- 468.0	435.3	342.0- 510.7	-39.8	-10.1
Plant height (cm)	72.9	61.0- 94.3	78.3	63.3- 95.3	-5.4	-7.41

Analyses of variance (ANOVA) have allowed the influence of factors years, variety and fertilization on production and the interaction between them (Table 4). Thus, testing the significance of the calculated values of F- test shows the existence of significant differences within the graduation of each factor and interactions of certain factors.

Table 4

ANOVA for the experiment Year × Genotypes × Fertilization in wheat at ARDS Turda

Source of variation	Sum of square (SS)	Degree of freedom (DF)	Mean square (MS) (s^2)	Test F
A (year)	50092,9	1	50092,9	952,91**
B (genotypes)	2344,67	24	97,69	14,83**
A X B	1674,95	24	69,79	10,59**
C (fertilization)	12919,78	1	12919,78	1839,1**
A X C	73,25	1	73,25	10,43**
B X C	345,15	24	14,.38	2,05

A X B X C	188,94	24	7,87	1,12
Error A	105,14	2	52,57	
Error B	632,42	96	6,59	
Error C	702,49	100	7,02	
Total	69114,78	299		

Analyzing r^2 from the linear regression equation between yield and yield components as well as other phenological traits from 2011 which was a stressful year because of environment conditions can be seen as the variation of grain yield is largest influenced by the variability of number of grain per spike and number of spikes per square meter with 24.4 %, respectively 24.1 % (table 5).

In 2012 the main elements of productivity which have a high influence on these were grain weight per spike with 57.5 % and number of grain per spike with 24.3 % at additional fertilization, while to basic fertilization the main important characters was the same but in a lower percent (table 6). Moragues and all. (2006) have obtained for varieties of durum wheat, that for the northern dispersal group TKW was the only trait that was significant, explaining 37% of variations in grain yield, whereas for the southern group the number of spikes per m^2 explained the largest percentage of variation in grain yield (24%).

Table 5

Linear regression equations for the relationship between yield (Y) as dependent variable and yield components and phenological traits as independent variables (X), in 2011

Independent variable (x)	Regression coefficient (b)		Intercept (a)		Coefficient of determination (r^2)	
	Basic. f.	Add. f.	Basic. f.	Add. f.	Basic. f.	Add. f.
Number of grains per spike	- 0.001	36.35	23.19	-0.0021	0.01	0.244
Grain weight per spike (g)	4.05	0.001	0.876	0.9182	0.015	0.041
Thousand-kernel weight (g)	0.0016	0.001	38.29	39.268	0.0506	0.0278
Number of spikes per m^2	0.0249	949.95	305.55	7.283	0.0809	0.241
Plant height (cm)	0.0036	0.0005	59.01	79.359	0.0365	0.0007

Table 6

Linear regression equations for the relationship between yield (Y) as dependent variable and yield components and phenological traits as independent variables (X), in 2012

Independent variable (x)	Regression coefficient (b)		Intercept (a)		Coefficient of determination (r^2)	
	Basic. f.	Add. f.	Basic. f.	Add. f.	Basic. f.	Add. f.
Number of grains per spike	74.88	0.003	2745.1	15.161	0.2054	0.2429
Grain weight per spike (g)	2283	3126.9	1938.5	1466.3	0.3806	0.5752
Thousand-kernel weight (g)	0.0014	0.0012	36.756	37.591	0.0581	0.0505
Number of spikes per m^2	-0.0035	-0.0116	439.48	521.97	0.0022	0.0343
Plant height (cm)	26.176	32.797	3093.8	3714.4	0.17	0.2

CONCLUSION

The grain yield, of cereals culture, is the result of complex interaction genotype-environment, which generates a high degree of variability of this character. Interventions by elements of technology can reduce the unpredictable influence of environmental factors.

In the experimental series with cereal grain varieties (year x variety x fertilizer) production differences from one year to another or from one level of fertilization to another, as well those existing between variety are large enough. Also, there are substantial differences at level of double interaction between experimental factors.

BIBLIOGRAPHY

1. BRUCKNER, P.L. AND R.C., FROHBERG, 1987, Rate and duration of grain filling in spring wheat. Crop Sci., 27: 451–5.
2. GEBEYEHOU, G., D.R. KNOTT AND R.J. BAKER, 1982, Rate and duration of grain filling in durum wheat cultivars. Crop Sci., 22: 337–40.
3. MORAGUES, M., GARCIA DEL MORAL, L.F., MORALEJO, M., ROYO, C., 2006, Yield formation strategies of durum wheat landraces with distinct pattern of dispersal within the Mediterranean basin. I: Yield components, Field Crops Research 95, 194–205.
4. PRZULI, N., AND MLADENOV, N., 1999, Inheritance of grain filling duration in spring wheat. Plant Breed 118:517-521.
5. SOFIELD, I., L.T. EVANS, M.G. COOK I.F. WARDLAW, 1977, Factors influencing the rate and duration of grain filling in wheat. Australian J. Plant Pysiol., 4: 785–97.
6. VAN SANFORD, D.A., AND MACKOWN, C.T., 1985, Cultivar differences in nitrogen remobilization during grain-fill in soft red winter wheat. Crop Sci 27:295-300.
7. WARDLAW, I.F., 1970, The early stages of grain development in wheat: Response to light and temperature in a single variety. Aust J. Bio. Sci. 23:765-744.
8. WIEGAND, C.L., J.A. CUELLER, 1981, Duration of grain filing and kernel weight of wheat as affected by temperature. Crop Sci., 21: 95–101.