AgroLife Scientific Journal - Volume 4, Number 2, 2015
ISSN 2285-5718; ISSN CD-ROM 2285-5726; ISSN ONLINE 2286-0126; ISSN-L 2285-5718

COMPARATIVE RESEARCH ON SEVERAL WHEAT (*Triticum aestivum* L.) GENOTYPES GROWN UNDER THE CONDITIONS OF DÂLGA- CĂLĂRAȘI

Bogdan-Alexandru GUȚĂ[1,2], Doru Ioan MARIN[2], Pierre-Louis CARRIER[3]

[1]Saaten Union Romania SRL,1-5 General Praporgescu Street, 4th floor, Ap. 8, District 2, 020965, Bucharest, Romania, Phone: +4021 318.67.14, Fax: +4021318.67.13,
Email: bogdan.guta@saaten-union.ro
[2]University of Agronomic Sciences and Veterinary Medicine of Bucharest, 59 Mărăști Blvd, District 1, 011464, Bucharest, Romania, Phone: +4021.318.25.64, Fax: + 4021.318.25.67,
Email: bogdan.guta@yahoo.com
[3]Saaten-Union France, 163 ter Avenue de Flandre, 60190, Estrées-Saint-Denis, France, Phone: +33 698 757 042, Fax: +33 344 914 848, Email: pierre-louis.carrier@saaten-union.com

Corresponding author email: bogdan.guta@yahoo.com

Abstract

Research was carried out between 2012 and 2014, under the soil-climate conditions of the Dâlga area, Călărași County, and included a comparative study of several winter wheat genotypes of foreign and local origin, as follows: four winter wheat varieties (Dropia, Glossa, Katarina, Mulan) and eight winter wheat hybrids (Hystar, Hyfi, Hywin, Hylux, Hyspeed, Hyland, Hybery, Hybiza).
The experiment was established according to the randomized blocks method including three repetitive stages. The main goal of our research was the identification of the most competitive winter wheat varieties for the soil-climate conditions specific to the Romanian Plain.
During our research, we performed phonological observations and determinations concerning plant density in autumn (plants/m^2), plant density in spring (stems/m^2), head density at harvesting time (ear/m^2), grains weight per ear at harvest maturity (g), grain moisture (%) at harvesting time, the grain yield related to the area unit (kg/ha); we also carried out determinations concerning the main physical quality indices of grains: thousand grain weight and hectolitre weight.
Sowing density was 500 germinable kernels/m^2 for the winter wheat varieties and 200 germinable kernels/m^2 for the winter wheat hybrids.
The analysis of the average data for the two experimental years showed that the number of harvestable ears ranged between 545 ears/m² (Glossa) and 696 ears/m² (Katarina) in the winter wheat varieties, while the wheat hybrids varied between 559 ears/m² (Hybery) and 656 ears/m² (Hyspeed). Regarding their tillering capacity, the hybrids under study proved to be highly superior to the varieties.
The analysis of the grain yields for the 12 winter wheat genotypes indicated that the recorded benefit values varied between 5623 kg/ha (Dropia) and 7291 kg/ha (Hystar), and that the tested hybrids were superior in productivity terms, as they recorded increased yields comprised between 316.2 Kg/ha and 1163.2 kg/ha, compared with the average of the average of the varieties, i.e. the control. The results obtained showed that the wheat hybrids had a high tillering capacity of forming fertile tillers, as six of the analysed hybrids recorded higher yields than the varieties.

Key words*: Triticum aestivum L., wheat, varieties, hybrids, yield, quality indices.*

INTRODUCTION

The increasingly frquent evolution of climate change latelt has demanded the updating of the technological links by using new winter wheat varieties as genotypes characterized by high tolerance to drought and heat stress.
In Romania, research concerning the development of new winter wheat varieties with high yield potential and high baking value has made significant progress, resulting in more early varieties with good tolerance to extreme conditions (Săulescu, 2007, 2010; Ittu, 2012).
The issues generated by the diversification of the winter wheat assortment and their vulnerability to evironmental conditions, were partly solved out by the research performed both in Romania (Mustăţea et al., 2008; Lupu et al., 2010; Melucă et al., 2011; Neacşu, 2012) and other countries (Egesel, 2012), so that the

research concerning yield stability and quality balance are current topics.

Research on hybrid wheat breeding began in the US around 1930. The first CHA (Chemical Hybidization Agent) was created in 1973, but it is only in 1982 that HybriTech started a hybrid wheat breeding programme in the US, with the CHA system named Genesis. In 1992 the Orsan Lafarge company created the company Hybrinova based on their own CHA system named Croisor. In 1993 HybriTeck and Hybrinova obtained authorizations for the distribution of the first wheat hybrids in France. The data represents the beginning of the wheat hybrid business in Europe (***Saaten-Union, 2015). The Hystar variety was the first commercial wheat hybrid launched in Romania (2010).

Recent studies have shown that introducing new wheat hybrids is a possibility to obtain high yields per ha, as the best hybrids wheat record yields of over 1.0 t/ha, compared with the winter wheat line varieties (Gowda et al., 2012; Longin et al., 2012).

Our paper presents the experimental results obtained between 2012 and 2014 for an assortment of Romanian and foreign winter wheat varieties and hybrids grown under the soil-climate conditions specific to the Dâlga area, Călăraşi County.

MATERIALS AND METHODS

In order to identify the winter wheat quality and yield potential, during 2012-2014, we organized a field - located monofactorial experiment according to the randomized complete block design in three replications; the experiment studied 12 wheat genotypes (four varieties: *Dropia, Glossa, Katarina, Mulan*, and eight hybrids: *Hystar, Hyfi, Hywin, Hylux, Hyspeed, Hyland, Hybery, Hybiza).*

The observations and determinations throughout the vegetation period were performed in dynamics and were aimed at measuring: plant density after germination (end of October), at the beginning of winter (December), plant density in spring (April) and before the harvesting time (July), by using the metrical frame method.

After harvesting the trial crop, we determined the grain yield for each genotype and collected grain samples for laboratory determinations for the main physical indices related to crop quality, i.e. thousand grain weight (TGW) and hectolitre weight (HL).

The interpretation of the experimental results was based on variance analysis, with the as control element the averages of the analysed varieties and hybrids considered the control.

The climatic conditions during our research were characterized as follows: in the autumn of 2012 (October-November) precipitations recorded 41 mm, adding 124.5 mm during winter (December-February), 117 mm in the spring of 2013 (March-April) and 99.52 mm in May and June, totalling 382.02 mm during the whole vegetation period (Table 1).

Table 1. Climatic conditions throughout experiments (2012 - 2014) - temperature (^{o}C) and rainfall (mm)

Research year/ Month	2012 - 2013 (^{0}C)	2013 - 2014 (^{0}C)	Multiannual average (^{0}C)	2012 - 2013 (mm)	2013 - 2014 (mm)	Multiannual average (mm)
October	15.8	13.26	12.99	32	45	44.25
November	9.8	10.61	7.45	9	29	39.88
December	0.17	1.28	1.38	70.5	27	40.79
January	1.4	4.6	0.04	15.5	26	40.73
February	4.9	4.62	2.08	38.5	55	26.64
March	7.02	9.72	7.29	22.5	59	32.54
April	13.6	13.2	12.06	94.5	107	34.78
May	20.2	17.65	18.15	28.02	106.2	58.32
June	21.85	20.7	21.38	71.5	34	69.76
July	24	24.6	24.04	34.5	30.5	59.09
August	24.8	26.3	23.17	124.5	74	42.64
September	19.6	21.35	17.47	15.5	26	66.72
Average/Total	**13.59**	**13.99**	**12.29**	**556.52**	**618.7**	**556.14**

The 2013-2014 agricultural year was characterized by a higher pluviometric regime: 488.2 mm from sowing until harvesting and 306.2 during the spring-summer vegetation period, with a pluviometric contribution of 140.2 mm during the water shortage period for winter wheat (May-June).

The daily average temperature throughout the wheat vegetation period (October-December) was 13.59^{0}C for the 2012-2013 agricultural year and 13.99^{0}C for the 2013-2014 agricultural year.

Under those circumstances, the winter wheat hybrids under study achieved yields performances that made them competitive with the best varieties cultivated nowadays in the Romanian Plain, owing to the effective use of the water from rainfalls under conditions of absent irrigation.

RESULTS AND DISCUSSIONS

The experimental results concerning the average plant density for the two years of research highlighted that after emergence, in the varieties, the indicator ranged between 468 and 495 plants/m^2, with Mulan recording the highest number of plants per unit area. At the beginning of winter, after the varied between 531 stems/m^2 in the Dropia and Mulan varieties, and 573 stems/m^2 in Katarina (Table 2).

For the varieties under study, plant density measured in spring varied between 898 stems/m^2 in Glosa and 1086 stems/m^2 in Mulan, the latter showing the best tillering capacity.

The productive tillering specific to each studied genotype resulted in a number of harvestable ears ranging between 545 ears/m^2 in Glosa and 696 ears/m^2 in Katarina, the latter recording the highest number of fertile tillers on plant.

Table 2. Influence of wheat genotypes on plant density, average 2012 – 2014

No.	Genotype	Density at sowing time (plants/m²)	%	Density at the beginning of winter (stems/m²)	%	Density in spring (stems/m²)	%	Harvestable ears (ears/m²)	%
1	GLOSA	476	99.2	547	100.2	898	90.1	545	87.3
2	DROPIA	468	97.6	531	97.3	956	95.9	592	94.8
3	KATARINA	479	99.8	573	105.4	1048	105.1	696	111.5
4	MULAN	495	103.2	531	97.3	1086	108.9	663	106.2
VARIETY AVERAGE (Ct. 1)		***479.50***	***100***	***545.50***	***100***	***997.00***	***100***	***624.00***	***100***
5	HYSTAR	193	102.7	309	106.1	975	103.9	653	105.6
6	HYFI	187	99.5	276	94.6	956	101.9	597	96.6
7	HYWIN	185	98.4	268	91.9	1042	111.1	629	101.7
8	HYLUX	186	99.0	312	107.0	931	99.2	618	100.0
9	HYSPEED	190	101.1	339	116.2	861	91.7	656	106.1
10	HYLAND	185	98.4	269	92.2	919	97.9	606	98.1
11	HYBERY	194	103.2	298	102.2	813	86.6	559	90.4
12	HYBIZA	183	97.4	261	89.5	1009	107.5	626	101.3
HYBRID AVERAGE (Ct. 2) Ct.= Control		***187.87***	***100***	***291.5***	***100***	***938.25***	***100***	***618.00***	***100***

Analysing plant density as the average of the hybrids for the two experimental years, we noticed that, at sprouting, the indicator varied between 183 and 194 plants/m^2 in the Hybery hybrid. Plant density ranged between 261 and 339 stems/m^2 at the beginning of winter, betweeen 813 and 1042 stems/m^2 in spring, and the number of harvestable ears varied between 559 and 656 ears/m^2 at the harvesting moment. Thus, we may conclude that the tested hybrids proved a higher quality for their density per area unit and yielding tillering capacity, compared with the wheat varieties under analysis.

As the average for the two experimental years, the results concerning the tillering capacity of the varieties and hybrids grown within the experiment, emphasized the clear superiority of the winter wheat hybrids as they formed a double number of tillers on each plant (Table 3). Thus, we noticed that the number of tillers on the plant varied from 1.07 to 1.19 at the beginning of winter, with the Katarina variety showing the highest tillering capacity during

that stage of determinations; the tested hybrids varied between 1.42 and 1.78 tillers/plant, with the Hyspeed hybrid showing the highest tillering capacity at the beginning of winter. In the tested hybrids, the number of tillers formed on a plant in spring ranged between 4.19 tillers/plant (Hybery) and 5.63 tillers/plant (Hywin), with the other hybrids exceeding all the varieties under study, in which the number of tillers varied between 1.88 tillers/plant (Glosa) and 2.26 tillers/plant (Mulan, which showed the best tillering capacity during that stage of determinations).

We recorded the same situation when we analyzed the number of fertile tillers at harvesting time, as the hybrids proved their superiority to the winter wheat varieties again. During that stage of determinations, in the varieties, the indicator ranged between 1.14 fertile tillers/plant (Glosa) and 1.45 fertile tillers/plant (Katarina, which proved the best in terms of productive tillering capacity, compared with the other analyzed varieties).

Table 3. Tillering capacity of wheat genotypes, average 2012-2014

No.	Genotype	At the beginning of winter (November) tillers/pl	%	In spring (April) tillers/pl	%	At harvesting (July) fertile tillers/pl	%	Grains weight/ear (g)	%
1	GLOSA	1.14	100.9	1.88	89.9	1.14	88.4	1.10	110
2	DROPIA	1.13	100.0	2.04	97.6	1.26	97.7	0.95	95
3	KATARINA	1.19	105.3	2.18	104.4	1.45	112.4	0.95	95
4	MULAN	1.07	94.7	2.26	108.1	1.33	103.1	1.02	102
VARIETY AVERAGE (Ct. 1)		***1.13***	***100***	***2.09***	***100***	***1.29***	***100***	***1.00***	***100***
5	HYSTAR	1.60	103.9	5.05	101.2	3.38	103.1	1.20	104.3
6	HYFI	1.47	95.4	5.11	102.4	3.19	97.2	1.22	106.1
7	HYWIN	1.44	93.5	5.63	112.8	3.40	103.6	1.07	93
8	HYLUX	1.67	108.4	5.00	100.2	3.32	101.2	1.10	95.6
9	HYSPEED	1.78	115.6	4.53	90.8	3.45	105.2	1.08	93.9
10	HYLAND	1.45	94.1	4.96	99.4	3.27	99.7	1.18	102.6
11	HYBERY	1.53	99.3	4.19	83.9	2.88	87.8	1.28	102.6
12	HYBIZA	1.42	92.2	5.51	110.4	3.42	104.2	1.14	99.1
HYBRID AVERAGE (Ct. 2)		***1.54***	***100***	***4.99***	***100***	***3.28***	***100***	***1.15***	***100***

The hybrids under study formed a double number of fertile tillers on each plant, exceeding the wheat varieties in all cases. Thus, we noticed that the number of fertile tillers in the hybrids varied between 2.88 fertile tillers/plant (Hybery) and 3.45 fertile tillers/plant (Hyspeed). Although the Hybery hybrid recorded the weakest yielding tillering capacity, it nevertheless exceeded all the tested varieties in terms of productivity index, compared with the rest of the hybrids.

Ear weight was superior in the hybrids, compared with the varieties, recording values of the productivity index varying between 1.07 g (Hywin) and 1.28 g (Hybery, which proved superior to the other genotypes), while in the varieties, ear weight ranged between 0.95 g (Dropia and Katarina) and 1.10 g (Glosa, inferior to all hybrids).

Analysing the yield potential of the 12 wheat genotypes as the average for the two years (Table 4), we noticed the superiority of the hybrids, compared with the varieties for which the grain yields decreased significantly (o) in Dropia and recorded an insignificant increase in Katarina and Mulan (222.2 kg/ha and 418.2 kg/ha). Mulan was the most productive of the winter wheat varieties, compared with the average of the varieties considered as control. Analyzing the yields obtained from the varieties, compared with the average of the hybrids, we noticed a very significant decrease (ooo) in the grain yields, i.e. 839 kg/ha in Glosa and 1208.1 kg/ha in Dropia.

The hybrids under study were characterized by a high yielding potential, compared with the variety average (Ct 1) as the production increase was statistically assured as very significant (***) in Hystar and Hyfi. The yield of hybrids increase ranging between 316.2 kg/ha and 1163.2 kg/ha.

Table 4. Grain yield (kg/ha) in winter wheat genotypes, under the conditions of the Dâlga area - Călăraşi County, average 2012-2014

No.	Genotype	Yield (kg/ha)	(%)	Difference from Ct. 1 (kg/ha)	Significance	Difference from Ct. 2 (kg/ha)	Significance
1	GLOSA	5992	97.8	- 135.7	-	- 839.1	ooo
2	DROPIA	5623	91.8	- 504.7	o	- 1208.1	ooo
3	KATARINA	6350	103.6	222.2	-	- 481.1	o
4	MULAN	6546	106.8	418.2	x	- 285.1	-
VARIETY AVERAGE (Ct. 1)		***6127.8***	***100***	**-**	***(Ct. 1)***	***-703,3***	**ooo**
LSD 5% = 409 kg; LSD 1% = 665 kg; LSD 0.1% = 768 kg							
No.	**Genotype**	**Yield (kg/ha)**	**(%)**	**Difference from Ct. 2 (kg/ha)**	**Significance**	**Difference from Ct. 1 (kg/ha)**	**Significance**
5	HYSTAR	7291	106.7	459.8	x	1163.2	xxx
6	HYFI	7148	104.6	316.8	x	1020.2	xxx
7	HYWIN	6444	94.3	- 387.1	o	316.2	-
8	HYLUX	6503	95.2	- 328.1	o	375.2	-
9	HYSPEED	6664	97.5	- 167.1	-	536.2	x
10	HYLAND	6837	100.1	5.8	-	709.2	xx
11	HYBERY	6875	100.6	43.8	-	747.2	xx
12	HYBIZA	6887	100.8	55.8	-	759.2	xx
HYBRID AVERAGE (Ct. 2)		***6831.1***	***100***	**-**	***(Ct. 2)***	***703.3***	**xx**
LSD 5% = 287 kg; LSD 1% = 498 kg; LSD 0.1% = 653 kg							

Of the 12 genotypes, Hystar and Hyfi were the most productive, with a yield between 7291 kg/ha and 7148 kg/ha. These hybrids can be recommended for cultivation under the pedo-climatic conditions specific to the Romanian Plain in order to increase productivity per area unit.

As a result of the determinations concerning the main physical indices related to the quality to the winter wheat grains, i.e. the thousand grain weight (TGW) and the dimensional weight (DW), we noticed, on average for the two research years, that even though the tested hybrids were superior in yield, their physical indices were lower compared with the wheat varieties (Table 5). Thus, TGW varied between 34.5 and 45 g, the maximum value being recorded in Dropia which, as we already know, is one of the best quality local varieties.

The thousand grain weight for hybrids varied between 37 g in Hyspeed and 45.5 g in Hyfi, the latter proving a high grain yield and thus being able to succesfully replace any of the varieties tested within the experiment.

The volumetric weight of grains recorded values between 73.5 kg/hl in Hyspeed and 79 kg/hl in Glosa. In this case too, varieties proved their superiority to the hybrids in terms of harvest quality.

Table 5. Physical quality indices in winter wheat, average 2012-2014

No.	Genotype	TGW (g)	(%)	HW (kg/hl)	(%)	Baking value (SR ISO 7971 - 3: 2010)
1	GLOSA	44	106.3	79	101.6	FB
2	DROPIA	45	108.8	78.5	100.9	FB
3	KATARINA	34.5	83.4	77	99.0	B
4	MULAN	42	101.5	76.5	98.4	B
VARIETY AVERAGE (Ct. 1)		**41.37**	**100**	**77.75**	**100**	**B**
5	HYSTAR	42	104.0	76	101.2	B
6	HYFI	45.5	112.7	75	99.8	B
7	HYWIN	38.5	95.4	76	101.2	B
8	HYLUX	38.5	95.4	76.5	101.8	B
9	HYSPEED	37	91.6	73.5	97.8	S
10	HYLAND	40	99.1	75.5	100.5	B
11	HYBERY	41.5	102.8	74	98.5	S
12	HYBIZA	40	99.1	74.5	99.2	S
HYBRID AVERAGE (Ct. 2)		**40.37**	**100**	**75.12**	**100**	**B**

FB = very good; B = good; S=satisfactorily

Analyzing the baking value of the 12 studied genotypes, we may say that they exceeded the minimal value of hectolitre wheight foreseen for milling-baking, i.e. 70 kg/hl, as they are adequate for this purpose.

CONCLUSIONS

The experimental results obtained during the experimental period 2012-2014 showed the following:

On average for the two experimental years, the density of the winter wheat varieties varied between 468 and 495 plants/m^2 after emergence, between 531 stems/m^2 and 573 stems/m^2 at the beginning of winter, 898 stems/m^2 and 1086 stems/m^2 in spring, resulting in about 545 and 696 harvestable ears/m^2; in the tested hybrids, plant density after emergence time ranged between 261 and 339 stems/m^2, in spring density recorded indices varying between 813 and 1042 stems/m^2, and at harvesting time the ears number varied between 559 and 656 harvestable ears/m^2;

In varieties, the number of tillers formed on a plant varied between 1.07 and 1.19 tillers/plant at the beginning of winter, between 1.88 tillers/plant (Glosa) and 2.26 tillers/plant (Mulan) in spring; the number of fertile tillers number ranged between 1.14 (Glosa) and 1.45 (Katarina, which proved the best in terms of yielding tillering capacity);

The tested hybrids formed a number of tillers varying between 1.42 and 1.78 tillers/plant at the beginning of winter, the number of tillers ranged between 4.19 tillers/plant (Hybery) and 5.63 tillers/plant (Hywin) in spring, while the number of fertile tillers at harvesting time varied between 2.88 (Hybery) and 3.45 (Hyspeed);

Concerning the yield potential of the 12 studied winter wheat genotypes, the hybrids recorded higher values, compared with the average of the varieties (6127.8 kg/ha);

Hyspeed, Hyfi, Hyland, Hybery, Hybiza and Hystar hybrids recorded a significant grain yield, compared with the varieties that ranged between 536.2 and 1163.2 kg/ha;

The quality physical indices (thousand grain weight and hectolitre weight) were normal both for the varieties, i.e. 41.37 g - TGW and 77.75 kg/hl - HW, and the hybrids 40.37 g - TKW and 75.12 kg/hl - HW;

All winter wheat genotypes tested within the experiment exceeded the minimal value of the hectolitre weight foreseen for milling-baking purposes.

REFERENCES

Egesel Cem Ömer, Kahrıman Fatih, Tümer Ali İhsan. Çolak Çağla, 2012. Yield and quality characteristics of some foreign bread wheat (*Triticum aestivum* L.) varieties in Turkey. Romanian Agricultural Research. No. 29, p. 31-38.

Gowda Manje, Longin C., Friedrich H., Volker Lein, and Jochen C. Reif, 2012. Relevance of specific versus general combining ability effects in wheat. Crop Sci. 52: p. 2494-2500.

Ittu Gh., 2012. Soiuri de grâu create la INCDA Fundulea, recomandate pentru 2011-2012. Profitul agricol, Nr. 44.

Longin C.F.H., Mühleisen J., Maurer H.P., Zhang H., Gowda M., Jochen Christoph, 2012. Hybrid breeding in autogamous cereals. Theoretical and Applied Genetics, October 2012, Vol. 125, Issue 6, p. 1087-1096.

Lupu Cornelia, 2010. Influenţa lucrării de bază a solului asupra producţiei de grâu şi a unor însuşiri ale solului în condiţiile de la SCDA Secuieni. An. I.N.C.D.A. Fundulea, Vol. LXXVIII, Nr. 2, p. 79-87.

Melucă Cristina, Sorina Cernat, Tudorina Nistor, 2011. Comportarea unor soiuri de grâu de toamnă în condiţii de stres hidric şi termic în Câmpia Burnasului. An. I.N.C.D.A. Fundulea, Vol. LXXIX, Nr. 2, p. 201-210.

Mustăţea P., Săulescu N., Ittu Gh., Gabriela Păunescu, Leliana Voinea, Ioana Stere, Sorina Mîrlogeanu, Constantinescu E., Năstase D., 2008. Comportarea unor soiuri de grâu de toamnă în condiţii contrastante de mediu. An. I.N.C.D.A. Fundulea, Vol. LXXVI, 2008, p. 7-14.

Neacşu Amalia. 2012. Cultivar and environment effects on dough strength in a set of winter wheat varieties grown in diverse environments and management practices. Romanian Aagricultural Rresearch, No. 29, p. 23-29.

Săulescu N. Nicolae, Gheorghe Ittu, Mariana Ittu, Pompiliu Mustăţea, 2007. Cinci decenii de ameliorare a grâului la Fundulea. Analele INCDA. Fundulea, Vol. LXXV, Volum jubiliar, p. 55-72.

Săulescu N. Nicolae, Gheorghe Ittu, Aurel Giura, Matilda Ciucă, Pompiliu Mustăţea, Mariana Ittu, Gabriela Şerban, Florentina Amalia, 2010. Diversificarea bazei genetice ca fundament al progresului în ameliorarea grâului. An. I.N.C.D.A. Fundulea, Vol. LXXVIII, Nr. L, p. 7-20.

***Saaten-Union, 2015. The hybrid wheat website [online] http://www.hybridwheat.net. (30 April 2015).