

**INFLUENCE OF THE CLIMATIC STRESS
ON QUANTITATIVE TRAITS IN WHEAT GENOTYPES
RECOMMENDED FOR CROPPING
IN THE MOLDAVIAN ZONE**

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ABSTRACT – Investigations conducted at the Agricultural Research and Development Station of Podu-Iloaiei, during 2003-2007 (years with very different climatic conditions) had as aim to point out the influence of the climatic stress on some quantitative traits in wheat varieties: Flamura 85, Eliana, Iași 2, Beti, Boema, Dropia, Faur, Crina, Gabriela and Moldova 83. The studied quantitative traits were number of spikes/m², number of grains in spike, weight of grains/spike, weight of one thousand grains and grain yield. During the five years of testing, 2003 and 2007 were the unfavourable years for wheat growing in the region of Moldavia. In 2003, the number of spikes/m² was the most affected trait with high influence on yield diminution. It had values comprised between 14 spikes/m² in Faur variety and 73 spikes/m² in Beti and Gabriela varieties. In 2007, drought has highly affected the weight of grains in spike, with values comprised between 0.42 g/spike in Dropia variety and 0.94 g/spike in Gabriela. The average on trial for this trait, in 2007, represented only 50% of the average of the year 2006, which was the most favourable one for wheat growing from all the five testing years. On the average of five years, for the trait number of grains in spike, Iași 2 variety had higher statistically ensured values, as compared with Flamura 85 control variety. On the average of five years, the weight of one thousand years had higher values in varieties Dropia (42g), Crina (41 g), Iași 2 (40.6 g), Eliana (40.4 g) and Faur (40.2 g), as compared with the control Flamura 85. The production capacity has varied between high limits, determined by genotype and its interaction with the environment conditions. In 2006, the yield obtained was comprised between 54.6 q/ha in Moldova 83 variety and 36.8 q/ha in Flamura 85. In 2003, the limits of the production variation were of 10.1 q/ha in Boema and 4.2 q/ha in Moldova 83. As compared with the average on trial, the lowest production was achieved in 2003 (7.1 q/ha), followed by year 2007 (14.2 q/ha). On the average of five experiencing years, the yield increase (compared to the control) was between 31% in Eliana variety and 13% in Faur variety, excepting Dropia

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and Moldova 83 varieties. The obtained results showed that the diversity of climatic conditions in the growing area, with frequency of drought periods, had determined a high phenotypic variability of all the quantitative traits in the studied wheat genotypes. Yield losses were high in all the varieties, representing 86% in 2003 and 71% in 2007, as compared with the yield obtained in 2006.

Key words: climatic stress, genotype, quantitative traits, genetic potential, phenotypic variability, water deficit

REZUMAT- *Influența stresului climatic asupra caracterelor cantitative la genotipuri de grâu recomandate pentru cultură în zona Moldovei.* Cercetările efectuate la S.C.D.A.Podu-Iloaiei, în perioada anilor 2003-2007, ani cu condiții climatice foarte diferite, au avut drept scop evidențierea influenței stresului climatic asupra unor caractere cantitative la soiurile de grâu; Flamura 85, Eliana, Iași 2, Beti, Boema, Dropia, Faur, Crina, Gabriela, Moldova 83. Caracterile cantitative luate în studiu au fost; numărul de spice/m², numărul de boabe în spic, greutatea boabelor/spic, masa a 1000 de boabe și, în final, producția de boabe. Anii 2003 și 2007 sunt considerați cei mai nefavorabili pentru cultura grâului în zona Moldovei. În anul 2003, caracterul cel mai afectat, cu influență puternică în diminuarea producției a fost numărul de spice/m², acesta având valori cuprinse între 14 spice/m² la soiul Faur și 73 spice/m² la soiurile Beti și Gabriela. În anul 2007, condițiile de secetă accentuată au afectat în cea mai mare măsură greutatea boabelor în spic, aceasta având valori cuprinse între 0.42 g/spic la soiul Dropia și 0.94 g/spic la soiul Gabriela. Media experienței pentru acest caracter, în anul 2007, a reprezentat doar 50% din media anului 2006, considerat a fi cel mai favorabil pentru cultura grâului din seria celor cinci ani de experimentare. Pentru caracterul numărul de boabe în spic, în medie pe cinci ani, s-a remarcat cu valori superioare, asigurate statistic față de soiul martor Flamura 85, soiul Iași 2. Masa a 1000 de boabe, în medie pe cinci ani, a avut valori superioare la soiurile Dropia (42g), Crina (41g), Iași 2 (40.6g), Eliana (40.4g), Faur (40.2g), comparativ cu soiul martor Flamura 85. Capacitatea de producție a oscilat în limite mari, determinate de genotip și de interacțiunea acestuia cu condițiile de mediu. În anul 2006, producția realizată a fost cuprinsă între 54,6 q/ha la soiul Moldova 83 și 36,8 q/ha la soiul Flamura 85. În anul 2003, limitele de variație a producției realizate au fost de 10.1q/ha la soiul Boema și 4.2q/ha la soiul Moldova 83. Comparativ cu media experienței, cea mai scăzută producție s-a realizat în anul 2003 (7,1 q/ha), urmată de anul 2007 (14,2 q/ha). În medie pe cinci ani de experimentare, sporurile de producție față de martor au fost cuprinse între 31% la soiul Eliana și 13% la soiul Faur, excepție făcând soiurile Dropia și Moldova 83. Rezultatele obținute au aratat că diversitatea condițiilor climatice în zona de cultură, cu frecvență a perioadelor de secetă, a determinat o variabilitate fenotipică ridicată a tuturor caracterelor cantitative la genotipurile de grâu studiate. Pierderile de producție au fost mari la toate soiurile, acestea reprezentând 86% în anul 2003 și 71% în anul 2007, comparativ cu producția realizată în anul 2006.

Cuvinte cheie: stres climatic, genotip, caractere cantitative, potențial genetic, variabilitate fenotipică, deficit hidric

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INTRODUCTION

The creation of wheat cultivars, which achieve high and stable yields, is a very complex process, because of the polygenic determinism of quantitative traits and of the complexity of interactions between genotype and environment factors (Ceapoiu, 1984). The production of a variety is the effect of the interaction between genotype and its expression opportunities, given by the environment conditions of the year (Mureşan, 1967). As influenced by different factors, the genetic structure of varieties may be changed (Bîlteanu et al., 1983).

Because wintering and drought resistance are hereditary traits, with a high variability, the continuous process of creating new varieties requires their testing under different ecological areas. The quantitative traits (number of spikes/m², number of grains/spike, weight of grains/spike and weight of one thousand grains), which contribute to the achievement of the general productivity trait, polygenically determined, are greatly affected by ecological and technological factors (Ceapoiu, 1972; Ioan, 2001).

The paper presents the mean values obtained during 2003-2007, for some quantitative traits in the wheat genotypes recommended for cropping in the Moldavian zone.

MATERIALS AND METHODS

At the Agricultural Research and Development Station of Podu-Iloaiei, wheat varieties Flamura 85, Eliana, Iaşi 2, Beti, Boema, Dropia, Faur, Crina, Gabriela and Moldova 83 were tested during 2003-2007, in competition comparative crops. The effect of climatic stress was investigated on some quantitative traits. The experiment was situated on a Cambic Chernozem, according to the method of Latin rectangle with three replicates. The predecessor plant was a legume, and the density at sowing was of 550 germinable grains/m². From each replicate, 30 plants were harvested, in which they determined the values of the following traits: number of spikes/m², number of grains/spike, weight of grains/spike, weight of one thousand grains, and they calculated the respective means. We have also used the yields obtained in the genotypes studied at the same period with very different climatic conditions. As control, we used Flamura 85, for estimating the differences obtained in the studied traits, as well as for the comparison between the years with high climatic stress (2003 and 2007) and 2006, the most favourable year for wheat growing of the five years of experiencing.

The climatic conditions during the testing years showed a great diversity, with high frequency of drought periods and extreme temperatures, which made that the yields obtained in tested varieties be below their genetic potential.

From the climatic point of view, 2003 and 2007 are extremely unfavourable years for wheat growing. In the crop year 2002/2003, since autumn, because of abundant rainfall from the first and the second decade of October, sowing was done out of the optimum period. After sowing, minimum temperatures decreased below 0⁰ since November 1, 2002 (-1.5⁰C), being also accompanied by snowfall, so that wheat did not

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sprout totally in winter. The minimum temperatures were of -18.8°C in December, -27.6°C in January and -18.1°C in February. Spring was dry, the rainfall deficit reaching 43.4 mm in May and 58.7 mm in June, and the mean temperature of the month exceeded the multiannual mean with 5.7°C and 3.2°C in May and June.

The crop year 2006/2007 was dry, with temperatures exceeding with 2.1°C the mean multiannual temperature of September, October, November and December, while the water deficit registered in that period was of 72.6 mm, compared to the multiannual mean. Winter was characterized by higher temperatures with 5.8°C against the multiannual mean.

During May-June, the water deficit was of 106.2 mm, as compared with the normal rainfall amount for this period, and the maximum temperatures reached values of $35.5 - 38^{\circ}\text{C}$ in air and 66°C in soil. These conditions, accompanied by strong winds, have determined the appearance of plant fading and fastened plant ripeness, with negative influences on all the quantitative traits, which are determinant for plant productivity.

The crop year 2003/2004 was dry in spring, a rainfall deficit of 30.8 l/m^2 being registered in April and of 38.6 l/m^2 in May, with maximum temperatures of 28.8°C in May.

In the crop year 2004/2005, the rainfall amounts exceeded the multiannual mean by 38.8 l/m^2 in April and by 47.4 l/m^2 in May, accompanied by high temperatures with great differences from day to night; these conditions favoured the appearance of a leaf disease complex in plants, which affected the grain yield.

The climatic conditions of the crop year 2005/2006, from sowing until plant physiological ripeness, were characterized by values of mean temperatures close to the multiannual average of the area. The rainfall amounts from that period were of 482 mm, with uneven spreading. The minimum temperatures from January and February (-23.1°C and -18.7°C) did not result in losses of plants, which were covered by a protecting snow layer.

RESULTS AND DISCUSSION

The diversity of climatic conditions in the cropping area, with high frequency of drought periods, has determined a high phenotypic variability of quantitative traits in all the studied wheat genotypes.

Number of spikes/m²

On the average of five years of testing, low values were registered in all tested genotypes (*Table 1*). Positive differences against the control Flamura 85 were found in most of the varieties, being between 25 spikes/m² in Moldova 83 and 42 spikes/m² in Iași 2. Negative differences were found in Eliana, Boema (4 spikes/m²) and Faur (11 spikes/m²), compared to the control. By comparing the values obtained every year within the same genotype, we assess that the low temperatures from the winter of the crop year 2002/2003, as well as the drought from the spring of the same year, have highly affected the number of spikes/m², which were between 14 spikes/m² in Faur and 73.0 spikes/m² in Beti and Gabriela.

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Table 1 - Mean values of the number of spikes /m² (2003-2007)

Genotype	Year					Mean of spikes/m ²	Mean %	Dif	Signif
	2003	2004	2005	2006	2007				
Flamura 85	26	431	384	448	227	303	100	0	
Eliana	36	427	318	531	185	299	99	-4	
Iași 2	56	433	536	499	199	345	114	42	
Beti	73	530	488	461	168	344	114	41	
Boema	66	408	426	430	163	299	99	-4	
Dropia	26	399	495	445	190	311	103	8	
Faur	14	433	361	447	206	292	96	-11	
Crina	33	447	358	518	243	320	106	17	
Gabriela	73	393	499	532	184	336	111	33	
Moldova 83	66	523	392	496	161	328	108	25	
Mean on trial	spikes/m ²	47	442	426	481	193	318	105	15
	%	10	92	89	100	40	66		

LSD 5% = 59 spikes/m²; LSD 1% = 79 spikes/m²; LSD 0.5% = 105 spikes/m²

The water deficit registered during 2006/2007 has negatively influenced the number of spikes /m² in all the tested varieties, having values between 161 spikes/m² in Moldova 83 and 243 spikes/m² in Crina. As concerns the mean on trial, we found that the lowest values of the number of spikes/m² were obtained in 2003, when the mean was only of 10%, compared to the mean in 2006; in 2007, the values of this trait represented 40% of the average in year 2006. The mean values achieved in other experiencing years were close to the values of year 2006. The obtained results showed that the low number of spikes on the unit area resulted in the high yield diminution in those years.

Number of grains in spike

On the average of five testing years, we have noticed Iași 2 variety, with statistically assured values, as compared with Flamura 85 control variety (*Table 2*). The other tested genotypes did not register significant differences, but, on the average of five years, most of them had higher values than the control variety, excepting Crina variety, with a minus difference of two grains/spike and Moldova 83 variety, with a difference of three grains/spike. As compared to the mean on trial, the lowest value of the number of grains in spike was obtained in 2007, representing 74% , compared to the average in 2006; in 2003, the value of this trait represented 77% of the value of year 2006. In 2004, they achieved the highest value of the number of grains in spike, statistically equal to the one obtained in 2006. In 2003 and 2007, at equal mean values in all the varieties (27 and 26, respectively), a different reaction was found in some genotypes towards the same environment conditions. Greater differentiations were found in Faur

variety (with six grains in spike more in 2007 than in 2003) in Flamura 85 and Beti (with five grains in spike more in 2003 than in 2007).

Table 2 - Mean values of the number of grains/spike (2003-2007)

Genotype	Year					Mean of spikes/m ²	Mean %	Dif	Signif
	2003	2004	2005	2006	2007				
Flamura 85	28	31	28	34	23	29	100	0	
Eliana	28	30	32	34	27	30	105	1	
Iași 2	34	34	32	34	32	33	115	4	X
Beti	29	34	34	35	23	31	107	2	
Boema	31	31	31	39	28	32	112	3	
Dropia	27	29	29	34	26	29	101	1	
Faur	23	35	29	36	29	30	106	2	
Crina	22	32	28	33	20	27	94	-2	
Gabriela	27	31	35	35	27	31	107	2	
Moldova 83	16	33	30	31	19	26	90	-3	
Mean Grains/ on trial spike	27	32	31	34	26	30	104	10	
%	77	93	90	100	74	86			

LSD 5% = 4 grains/spike; LSD 1% = 5 grains/spike; LSD 0.5% = 6 grains/spike

Weight of grains in spike

On the average of five years of testing, this indicator was highly influenced by environment conditions, different values being registered from one year to another within the same variety (*Table 3*). No significant differences were found compared to Flamura 85 control variety. The variation limit of the mean values for this trait was of 1.28 g/spike in Boema and 1.1 g/spike in Beti.

Table 3 - Mean values of the weight of grains in spike (2003-2007)

Genotype	Year					Mean (g)	Mean %	Dif	Signif
	2003	2004	2005	2006	2007				
Flamura 85	0.95	1.36	1.08	1.56	0.93	1.18	100.00	0	
Eliana	1.16	1.46	1.13	1.55	0.72	1.20	102	0.02	
Iași 2	1.15	1.39	0.83	1.40	0.76	1.10	93.20	-0.08	
Beti	1.06	1.32	0.90	1.34	0.66	1.06	89.80	-0.12	
Gabriela	0.90	1.30	1.34	1.59	0.94	1.21	102.50	0.03	
Boema	1.02	1.53	1.19	1.80	0.85	1.28	108.50	0.10	
Dropia	1.17	1.08	1.04	1.63	0.42	1.07	90.70	-0.11	
Faur	1.10	1.59	1.09	1.54	0.84	1.23	104.00	0.05	
Crina	1.65	1.39	0.99	1.40	0.65	1.22	103.40	0.04	
Moldova 83	1.10	1.70	0.94	0.96	0.65	1.10	93.20	-0.08	
Mean g/spike on trial	1.13	1.41	1.05	1.48	0.74	1.16	98.70	-0.15	
%	76.00	95.00	71.00	100.00	50.00	78.00			

LSD 5% = 0.22 g; LSD 1% = 0.30 g; LSD 0.5% = 0.40 g

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Compared to the mean on trial, it was found that in 2007, the weight of grains in spike was the most affected trait by the climatic stress.

As compared with year 2006, the obtained values represented only 50%, and in 2003, they were found at 76.0%. In 2004, the average of this trait was 95.0% of the value of year 2006, to which was statistically equal.

Weight of one thousand grains

As compared with Flamura 85 control variety, on the average of five years, no significant differences were registered. The genotypes Dropia (42.0 g), Crina (41.0 g), Iași 2 (40.6 g), Eliana (40.4 g) and Faur (40.2 g) were superior (*Table 4*).

Table 4 - Mean values of the weight of one thousand grains (2003-2007)

Genotype	Year					Mean (g)	Mean %	Dif	Signif
	2003	2004	2005	2006	2007				
Flamura 85	37.1	45.7	37.5	44.0	34.3	39.7	100.0	0	
Eliana	39.1	45.1	49.0	39.5	29.3	40.4	101.8	0.7	
Iasi 2	37.0	45.0	49.0	41.4	30.5	40.6	102.3	0.9	
Beti	31.9	41.5	37.5	39.7	30.2	36.2	91.2	-3.5	
Boema	31.6	44.2	45.5	44.0	29.3	38.9	98.0	-0.8	
Dropia	42.0	46.6	45.0	44.0	32.6	42.0	105.8	2.3	
Faur	41.1	42.9	41.0	45.2	30.8	40.2	101.2	0.5	
Crina	47.8	42.0	37.5	43.5	34.3	41.0	103.3	1.3	
Gabriela	32.1	44.7	41.0	44.2	35.2	39.4	99.2	-0.3	
Moldova 83	33.4	40.6	41.5	30.7	38.5	36.9	90.7	-2.8	
Mean g	37.3	43.8	42.5	41.6	32.5	39.5	99.3	-1.7	
on trial %	90.0	105.0	102.0	100.0	78.0	95.0			

LSD 5%=5.0; LSD 1%=6.7 g; LSD 0.1%=8.9 g

As compared to the mean on trial, the lowest value of the weight of one thousand grains was obtained in 2007, representing 78% of the average on year 2006, and in 2003, it represented 90%. In 2004 and 2005, they registered the highest values, statistically equal to the average of year 2006.

Production capacity

In all the ten tested varieties, production has varied within high limits, determined by genotype and its interaction to the environment conditions during testing. The response of different genotypes to the variation of climatic conditions results from comparing the production results, obtained in the experiencing years, which have a diversified thermal-rainfall regime (*Table 5*). Thus, in the most favourable year (2006), the variation limits of the obtained productions were between 54.6 q/ha in Moldova 83 and 36.8 q/ha in Flamura 85; in the year with difficult climatic conditions (2003), yield has varied between 10.1 q/ha in Boema and 4.2 q/ha in Moldova 83. In the unfavourable year 2007, yield was much diminished, having values between 21.1 q/ha in Flamura 85 and 8.7 q/ha in

Dropia. On the average of five years, none of the studied genotypes has achieved statistically assured yield increases, as compared to Flamura 85 control variety. However, yield increases were comprised between 31% in Eliana and 13% in Faur. Negative differences to the control were obtained in Dropia (0.1 q/ha) and Moldova 83 (0.4 q/ha).

Table 5 - Mean values of grain yield (2003-2007)

Genotype	Year					Mean yield q/ha	Relative yield %	Dif	Signif
	2003	2004	2005	2006	2007				
Flamura 85	6.1	37.9	20.7	36.8	21.1	24.5	100	0	
Eliana	7.1	41.9	45.3	52.8	13.4	32.1	131	7.6	
Iași 2	7.4	36.8	37.1	53.8	15.1	30.0	123	5.5	
Beti	7.2	45.6	38.7	48.1	11.1	30.1	123	5.6	
Gabriela	7.5	37.0	40.0	47.0	15.3	29.4	120	4.8	
Boema	10.1	40.7	37.6	51.1	16.2	31.1	127	6.6	
Dropia	5.6	37.0	19.1	51.7	8.7	24.4	100	-0.1	
Faur	7.9	45.9	17.7	48.7	18.8	27.8	113	3.3	
Crina	8.1	38.4	42.9	48.8	11.9	30.0	122	5.5	
Modova 83	4.2	36.4	16.7	54.6	10.5	24.5	100	-0.4	
Mean q/ha	7.1	39.8	31.6	49.3	14.2	28.4	112	38.9	
on trial %	14.0	80.6	64.0	100.0	29.0	57.0			

LSD 5% = 8.2 q/ha; LSD 1% = 11.0 q/ha; LSD 0.5% = 14.6 q/ha

The lowest yield was obtained in 2003 (7.1 q/ha), and represents only 14% against 2006, followed by 2007 (14.2 q/ha) and 29%, respectively. Comparing the yield losses registered in 2003 and 2007 to those of 2006, we found that they were high in all the genotypes, being, on the entire experience, between 86% in 2003 and 71% in 2007. The mean yields of 39.8 q/ha and 31.6 q/ha, obtained in 2004 and 2005, did not reflect the genetic potential of studied varieties. As concerns the testing period (2003 – 2007), we found that the mean yield was between 32.1 and 24.4 q/ha, on the first places being found varieties Eliana, Boema, Beti, Iași 2 and Crina, which achieved yield increases between 31% and 22% against Flamura 85 control variety. Data have shown the importance given to the improvement of the resistance to unfavourable environment factors in wheat genotypes, in order to prevent the diminution of the production potential, as influenced by the climatic stress.

CONCLUSIONS

The means of studied production components (number of spike/m², number of grains/spike, weight of grains/spike and weight of one thousand grains) have shown a greater value diminution in 2003 and 2007, against 2006.

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The most affected traits with influence on yield diminution in 2003 were the number of spikes/m², and in 2007, the weight of grains in spike, followed by the number of spikes/ m² and weight of one thousand grains.

The effect of the climatic stress, present by the dimensional diminution in quantitative traits, has resulted in the increased diminution of grain yield in all the studied genotypes; losses of 86% were registered in 2003 and of 71% in 2007, as compared with the favourable year (2006).

The mean yield of 39.8 q/ha, achieved in 2004, representing 80.6%, compared to the average of year 2006, has been positively influenced by number of spikes/m², weight of grains in spike and weight of one thousand grains. On the average per trial, these traits present the highest values, compared to the values registered in the other testing years.

In the period between 2003 and 2007, most of the tested genotypes have achieved yields higher than Flamura 85 control variety, yield increases being comprised between 13% and 31%.

In years with very favourable climatic conditions, the wheat varieties created at the Agricultural Research and Development Station of Podu-Iloaiei (Eliana, Iași 2 and Moldova 83), have achieved the highest grain yields per ha.

REFERENCES

- Bîlteanu Gh., Fazecaș I., Salontai A., Vasilică C., Birnaure V., Ciobanu F., 1983** – *Fitotehnie*. Edit. Did. și Ped., București
- Ceapoiu N., 1972** – *Citogenetica aplicată în ameliorarea grâului*. Edit. Academiei, București
- Ceapoiu N., 1984** – *Grâul*. Edit. Academiei, București
- Ioan Ionela, 2001** – *Reacția unor soiuri de grâu la stresul climatic din anul 2000*. Cercet. Agron. în Moldova, vol.1-2, Iași
- Mureșan T., 1967** – *Bazele genetice ale ameliorării plantelor*. Edit. Academiei, București