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WHEAT EFFICIENCY USE OF CLIMATE RESOURCES IN GĂVANU-BURDEA PLAIN

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Abstract

The maximum efficiency use of climate resources in plant culture technology is the principal aim of agriculture adapted to climate change. In this paper, there are presented the results of experimental research concerning the maximizing effect of climatic factors on the yield of wheat in the Găvanu-Burdea Plain.
The research was carried out within 2011-2012 and 2012-2013 in the SC Polirom Prod SRL experimental field, situated inside Găvanu-Burdea Plain, Scurtu-Mare locality, Teleorman County, on the ground of preluvosol reddish type. Within the trial, there have been used 3 wheat Romanian varieties and 10 foreign varieties, belonging to the precocious/half-precocious varieties, with increased resistance to drought, heat, and wintering. The applied technology was that specific to minimum system works.
In terms of climate, crop year 2011-2012 has been a dry year. From sowing to harvesting 370.0 mm precipitation fell, and during the growing season, after leaving winter there was a precipitation quantity of 248.0 mm. Instead, 2012-2013 crop year was characterized by high pluviometric regime: 478.6 mm from sowing to harvesting and 261.8 mm during the spring-summer growing season.
Specific consumption of climate resources in the vegetation period is averaging 79 mm/t of grains and 423^{o}C/t of grains. Varieties with water specific consumption below average are: Izvor (68 mm/t), Felix (69 mm/t), Renata (75 mm/t) Kalasz (76 mm/t), Csillag (77 mm/t), Glosa (78 mm/t), Akratos (78 mm/t). The highest specific water consumption from precipitation were registered in the varieties: Quebon (102 mm/t), Genius (93 mm/t), and Mulan (86 mm/t).
Precipitations and temperature recovery efficiency, expressed through the annual average unit yield, recorded the following values: 13 kg grains/mm precipitation during the growing season; 2.4 kg grains/^{o}C active temperature in the vegetation period. Varieties with specific minimum levels of water consumption had the highest recovery efficiency (15 kg grains/mm for Izvor, 14 kg grains/mm for Felix, 13 kg/mm for Renata, Kalasz, Csillag, Petur, Glosa varieties etc.).
Among all the experienced varieties, Izvor Romanian variety is to be remarked, this one achieving the highest recovery efficiency of climate resources. Almost similaris the Romanian Glosa variety as well as some foreign varieties: Felix and Renata (originating in Croatia), Kalasz, Csillag and Petur (from Hungary). Quebon, Mulan and Genius German varieties are not recommended.

Key words: *climate, consumption, efficiency, precipitations, temperature.*

INTRODUCTION

The genotypes used in technologies adapted to climate change is characterized by high resistance to drought and high temperatures. This characteristic implies achieving high yields with lower specific costs of climate resources (water, temperature) and with greater efficiency in achieving yields. There are also appreciated the varieties which ensure the stability of the production under contrastant environment conditions, namely as well under favourable as unfavourable water regime. (Mustăţea et al., 2008; Voica, 2009; Melucă et al., 2011; Marinciu, 2013; Voinea, 2013).

Within the research whose results are presented in this paper, there has been studied the effect of climate resources (precipitation and air temperature) for the production of a range of wheat varieties in the specific conditions of Găvanu-Burdea Plain during 2011-2013.

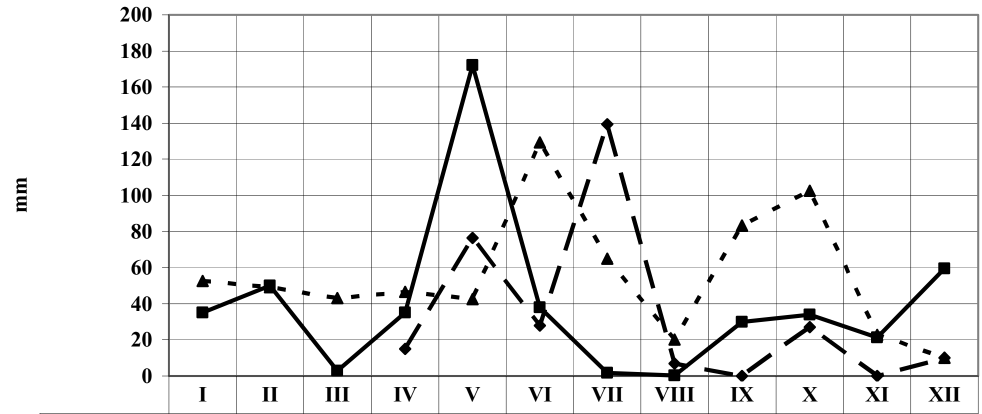
MATERIALS AND METHODS

Research was effected during 2011-2012 and 2012-2013 agricultural years in the experimental field from SC Polirom Prod SRL, located in Scurtu Mare locality, Teleorman county.

The soil where the research was effected is reddish preluvosoil, characteristic to the areas of Găvanu-Burdea Plain.

General climate. Related to climate, the yearly amount of precipitations is of 530-580 mm, and the year average temperature is of 10.0-10.5°C.

Experimental period climate. Crop year 2011-2012 has been a dry year (Figures 1 and 2).



	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
2011				15.0	76.5	28.0	139.5	7.0	0	27.0	0	10.0
2012	35.0	50.0	3.0	35.0	172.0	38.0	1.6	0.4	30.0	34.0	21.4	59.6
2013	52.6	49.2	43.2	46.6	42.6	129.4	65.0	20.0	83.2	102.6	22.6	10.0

Figure 1. Precipitations regime from the experimental field during 2011-2013

In the autumn of 2011 (October-November) fell only 27 mm precipitation. To these have been added 95 mm in the winter (December-February), 89.8 mm in the spring 2012 (March-April) and 210.0 mm for the rest of the months (May-June).

It appears that from sowing to harvesting it fell only 370.0 mm precipitation. Although the pluviometric regime was generally found to be ineffective (248.0 mm during the spring-summer growing season, compared to a minimum of 350-450 mm, which would ensure the daily water consumption of about 4 mm/day during this period), precipitations during May and June have ensured the average consumption of 3.5 mm/day in the last two months of the growing season.

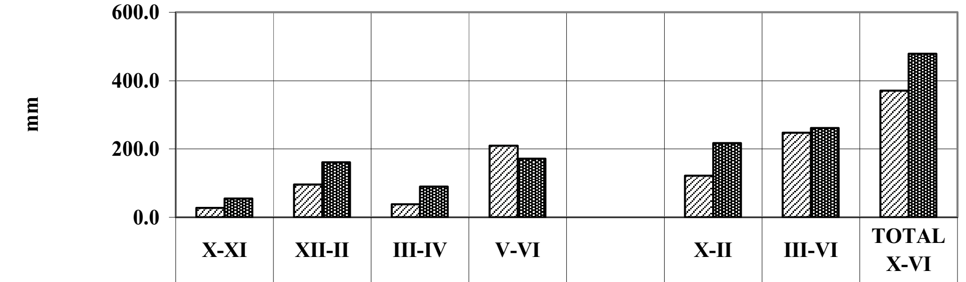
In exchange, 2012-2013 crop year was characterized by a higher pluviometric regime: 478.6 mm from sowing to harvesting (29% more than in the previous year) and 261.8 mm during the vegetation period in the spring-summer period (5% in addition to 2012). However, if we refer to the critical period for wheat (May-June) we note that in 2013 only 170 mm rainfall shall be recorded, which represents 38 mm less than 2012.

In this situation, the water intake in 2013 from rainfall during the period of grain filling and it was averaging only 2.8 mm/day, specific to a dry year. The average daily temperature during the growing season of wheat during the crop year 2012-2013 was of 8.6°C (X-VI) and 10°C (X-VII).

In the given circumstances, the majority of tested wheat varieties, characterized by superior precocity in comparison with the older varieties, valorized with efficiency the water from precipitations falling and they realized as it will be seen further on, under non-irrigated production performances, which make them competitive with the most intensive culture technologies.

For the calculation of climate resources indices there were used the rainfall amount and the sum of daily average temperatures exceeding 5^0C (active temperatures) along certain periods during the growing season (Figure 2 and 3): along the vegetation period in autumn-sowing (October-November), cripto-vegetation period (December-February), the period of vegetation from spring until the heading-flowering (March-April), the period of formation and filling of the grains (May-June).

The sum of daily average temperatures exceeding 5^oC (biologically active temperature for plant, vegetation wheat) throughout the growing season of the crop year 2012-2013 was 2379.3^oC, and that corresponding to the period of vegetation after the winter was 1749.2^oC.



	X-XI	XII-II	III-IV	V-VI		X-II	III-VI	TOTAL X-VI
2011-2012	27.0	95.0	38.0	210.0		122.0	248.0	370.0
2012-2013	55.4	161.4	89.8	172.0		216.8	261.8	478.6

Figure 2. Precipitations amount from wheat vegetation period
(Scurtu Mare, Teleorman county, 2011-2013)

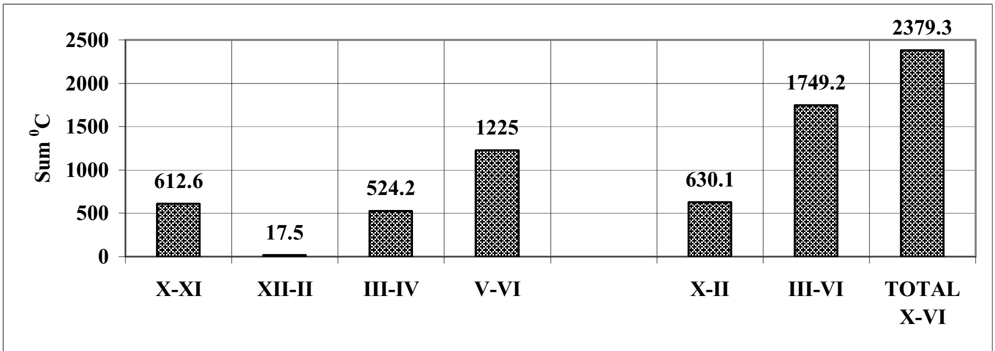


Figure 3. Active temperatures amount ($t>5^oC$) from wheat vegetation period
(Scurtu Mare, Teleorman county, 2012-2013)

The efficiency of climate resources use for wheat culture was expressed by the following indices: the specific contribution (specific use) water from precipitation (mm/t), specific warmth air (^oC/t), the unit of production (kg/1mm precipitation and kg/1^oC active temperature).

Experimental variants. Within trials, there have been used 3 Romanian varieties and 10 foreign varieties of wheat, from very early varieties half-precocious category, with increased resistance to drought, heat and wintering. The technology applied was the one specific to minimum works.

Before sowing, there were made fertilizations with complex fertilizers (20-20-0) in the dose de N60 P_2O_5-60, and in the spring, at the beginning of vegetation, N100 has been applied in the form of urea.

Sowing was carried out between 1st and 20th of October, the optimal period for research area.

There have been also used chemical treatments to fight against weeds, diseases and pests.

RESULTS AND DISCUSSIONS

The genotype influence on the production. Table 1 shows that the higher level of precipitations in the crop year 2012-2013 has contributed to an average increase of production reaching 11% in 2013 (5620 kg/ha) compared to 2012 production (5081 kg/ha). Hence, it results that the relationship between the relative increase of precipitation and the relative increase of production has been averaging 3:1.

Generally, in 2013 all trial varieties achieved gains in production in comparison with 2012, excluding Renata and Akratos varieties. Individual varieties having extra allowances vacillated between 2% (Kalasz) and 33% (Quebon) and the corresponding ratio between relative precipitation increase and relative production increase has been between 2% and 33%.

As an average for two years, the highest yield was obtained from the Romanian variety Izvor (6204 kg/ha). This variety, together with Felix, Kalasz and Renata have achieved very significant production gains (255-853 kg/ha), statistically, in comparison with the average experienced varieties. Genius, Mulan and Quebon varieties were characterized by differences in less than the average, being very significant too (391-1185 kg/ha). Other varieties, among which the Romanian varieties Boema 1 and Glosa achieved average yields.

Varieties with the lowest yields had the weakest recovery efficiency of resources and the greatest climate variability of production from one year to another.

Table 1. Genotype influence on wheat production (2012-2013)

	Variety	2012	2013	2013/2012	Average 2012-2013			
		kg/ha		%	kg/ha	%	Difference (kg/ha)	Signification
1	**Boema 1**	4960	5635	114	5298	99	-54	-
2	**Ilinca**	4563	5887	129	5225	98	-126	-
3	**Glosa**	5151	5775	112	5463	102	112	-
4	**Izvor**	***5952***	***6456***	***108***	***6204***	***116***	***853***	***
5	**Genius**	4166	4935	118	4551	85	-801	ooo
6	**GK Petur**	5158	5454	106	5306	99	-45	-
7	**GK Csillag**	5357	5714	107	5536	103	185	*
8	**Felix**	5952	6320	106	6136	115	785	***
9	**GK Kalasz**	5555	5656	102	5606	105	255	***
10	**BC Renata**	5753	5541	96	5647	106	296	***
11	**Mulan**	4365	5555	127	4960	93	-391	ooo
12	**Akratos**	5555	5367	97	5461	102	110	-
13	**Quebon**	3571	4761	133	4166	78	-1185	ooo
	AVERAGE	**5081**	**5620**	**111**	**5351**	**Control**	**-**	**Control**

LSD 5% =144 kg/ha; LSD 1% =192 kg/ha; LSD 0.1% = 250 kg/ha.

Specific contribution (specific use) of rainfall with production. On average throughout the wheat growing season (October-June) during the two years taken into study and as an average for each variety, one tonne of grain is obtained with 79 mm of rainfall (Figure 4).

The lowest specific water consumptions were recorded with Izvor, Felix, Renata, Kalasz, Csillag, Glosa and Akratos (68-78 mm/t), and the highest with Mulan, Genius and Quebon varieties (86-102 mm/t).

With few exceptions (Ilinca, Quebon), throughout the vegetation period, the specific consumption was higher in 2012-2013, as compared to 2011-2012. If we take into account only the period of vegetation after exiting winter (March-June), it appears that between those two years whether there are practical no differences in respect to the specific water consumption, whether it is higher than in the first year. As an average on years and varieties, during the spring-summer growing season the specific consumption of water from rainfall was of 48 mm/t (Figure 5). The minimum and maximum values of water intake are the same for the varieties specific to the period of October-June.

From these data it appears that 2013 production gains were obtained by increasing the specific water consumption in particular of the water water consumption in particular of the water accumulated from the autumn-winter rainfall.

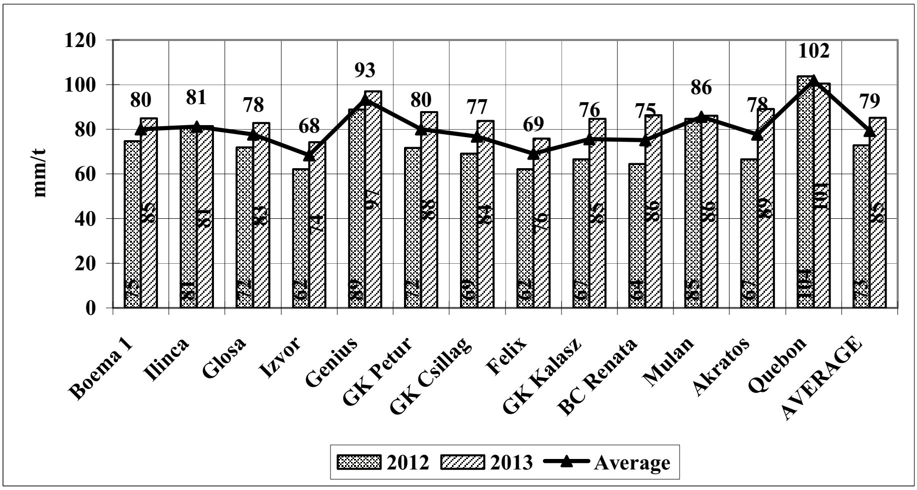


Figure 4. Precipitations specific contribution during the whole growing period (X-VI) when achieving production

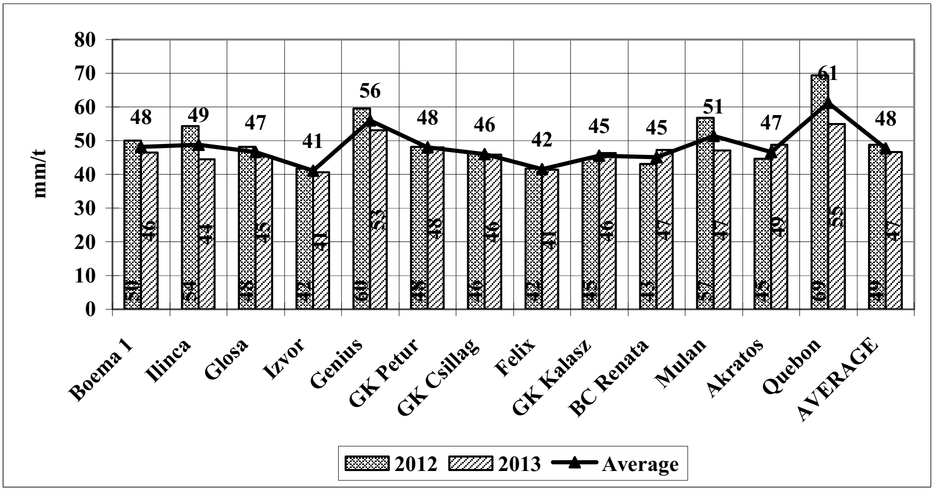


Figure 5. Precipitations specific contribution in the early spring (III-VI) when achieving production

The efficiency of precipitations recovery for the wheat production. The most reliable effectiveness indicator of the climate resources is represented the useful production compared to the assembly of resources (kg/mm, kg/^{o}C). In terms of valorizing the rainfall throughout the growing season, as shown in Figure 6, the average production per unit and varieties was of 13 kg/mm. Varieties which have had the use efficiency of the above-average precipitation have been Izvor (15 kg/mm) and Felix (14 kg/mm). Out of the varieties with the lowest use efficiency of precipitation, we can name: Quebon (10 kg/mm) and Genius (11 kg/mm).

In relation to the research year, the efficiency was higher in 2011-2012 than in 2012-2013. In the year 2012, with a pluviometric regime lower with about 30% in comparison with 2013, there were obtained, however, particularly large productions for an extremely dry year, productions which have oscillated around 5 t/ha. In these conditions, rainfalls in 2012 were capitalized for most varieties with a yield higher than the one of the year 2013 (an extra 1-4 kg/mm).

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Figure 6. Precipitations valorization efficiency during the whole growing period (X-VI) for wheat production

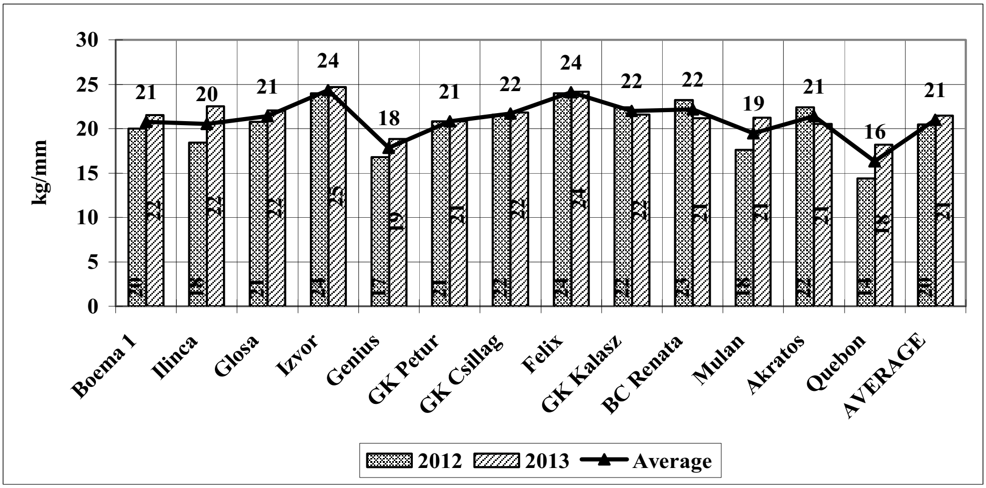

Figure 7. Precipitations valorization efficiency in the early spring (III-VI) for wheat production

If production is compared only to the period of vegetation in the spring-summer (III-VI), the average unit yield obtained reaches 21 kg/mm (Figure 7), with a variability, depending on the tried variety similar to the one recorded throughout the period of vegetation. The influence of the pluviometric regime of trial years during the vegetation period after winter plant output is almost identical. In Figure 7, however, there is observed a higher efficiency in 2013 from the varieties throughout the period of the growing season there were differences from one year to another, or they were insignificant: Ilinca, Genius, Mulan, Quebon.

Specific contribution (specific use) of temperature to achieve production.

The amount of biologically active temperatures (daily average temperatures exceeding $5^{o}C$) throughout the period of vegetation (X-VI), acquired for the production of grain in the year 2013, was $423^{o}C/t$, an average of all trial varieties (Figure 8). Similarly, the specific contribution of the precipitation minimum temperature recorded has been active in the most productive varieties (Izvor and Felix), and the maximum for the varieties with the lowest yields (Quebon and Genius).

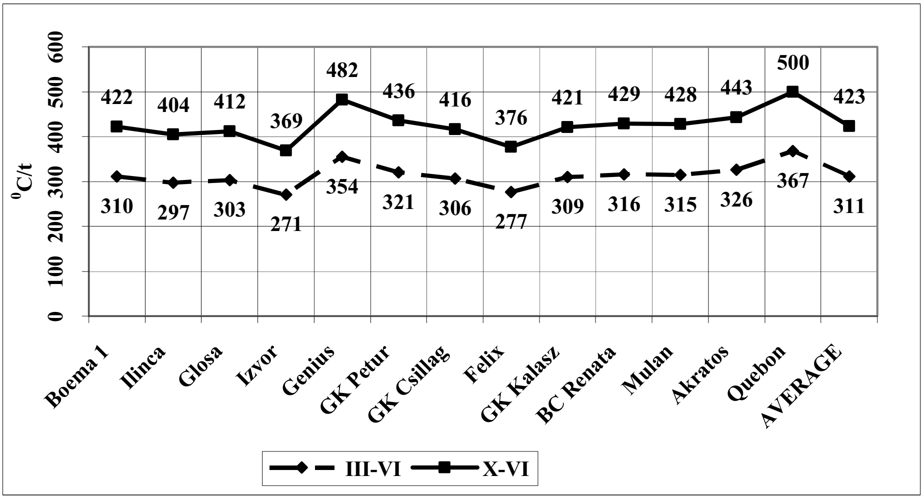

Figure 8. Temperature specific contribution when achieving production (2012-2013)

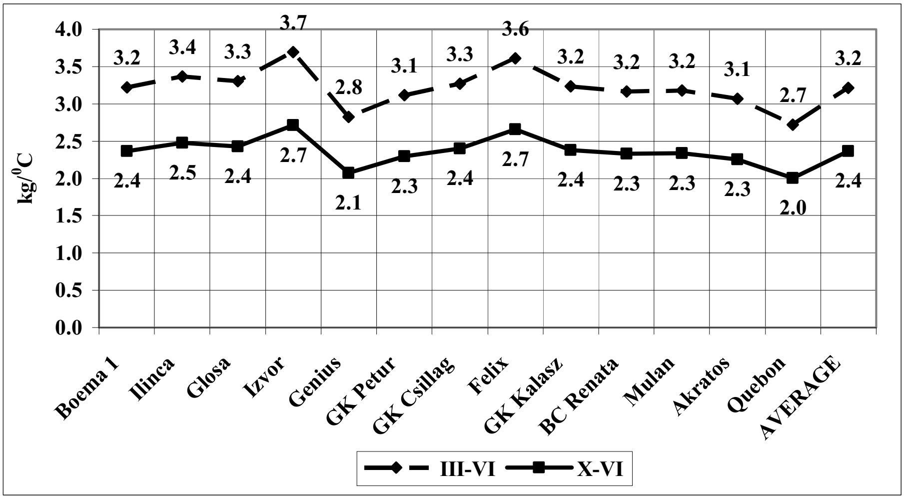

Figure 9. Temperatures valorization efficiency for wheat production (2012-2013)

During the spring-summer growing season (III-VI) the intake of air temperature reached the average amount of 311°C/t, with the same variations before, depending on the grown variety.

The effectiveness of the recovery temperature for production. The production, which moved back to the active temperature 1°C, reached an average of 2.4 kg for the whole period of vegetation and 3.2 kg for the period March-June (Figure 9). Maximum efficiency of temperature use is recorded with Izvor and Felix varieties (2.7-kg/°C), and the smallest with Quebon and Genius varieties (2.0-2.1 kg/°C).

CONCLUSIONS

In specific conditions of Găvanu-Burdea Plain, during two agricultural years, one dry (2011-2012) and another close to the normal period (2012-2013), the early and half-precocious varieties of wheat have valorized with higher efficiency the area climate resources.

On average per year, and all wheat growing season (October-June), 1 tonne of grain is obtained with 80 mm of precipitation, and with 423°C.

The lowest specific rainfall consumptions (precipitation intake) were recorded with the following varieties :Izvor, Felix, Renata, Kalasz, Csillag, Glosa and Akratos (68-78 mm/t), and the highest for Mulan, Genius and Quebon varieties (86-102 mm/t).

The efficiency of basic climate resources, expressed by unitary benefit was 13 kg/mm precipitations and 2.4 kg/°C.

Climate resources low consumption varieties achieved unity gains of 13-15 kg/mm and 2.4-2.7 kg/°C, and the ones with high consumptions of 10-12 kg/mm and 2.0-2.3 kg/°C.

Among the experimented varieties, the highest valorization of basic climate resources is found with: Izvor (RO), Felix (HR), Renata (HR), Kalasz (HU), Csillag (HU), Petur (HU), Glosa (RO) and Akratos (DE). These varieties are productive and they have the capacity to adjust the climate resources specific consumptions but also the development and growing process, so that it ensures the production stability under variable climate conditions.

Quebon (DE), Mulan (DE) and Genius (DE) varieties are characterized by low valorization efficiency sof climate resources and production important dependency on climate regime of the agricultural years.

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