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RESEARCHES ON THE MAIN FIELD CROPS YIELDS VARIATION IN THE BURNAS PLAIN BETWEEN THE DRY YEARS 2000 AND 2012

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Abstract

In this paper an objective synthesis is made on the productions obtained from wheat, barley, maize, sunflower and rapeseed crops in a quite long period of time, during which at least 4 years may be considered as being dry and extremely dry (2000, 2003, 2007 and 2012). To achieve the established objective we chose Burnas Plain as case study, part of the Romanian Plain, well known for its agricultural importance in Romania. Also, within this subdivision we will make a brief analysis of the meteorological phenomena produced on the territory of Teleorman County, the place where we conducted our field researches and for which we collected information regarding the evolution of temperatures and precipitations. Based on all these results we have calculated the impact of thermo-hydric stress on the agriculture in the territory. The data used for maps, tables and graphs creation were taken from the Statistical Yearbooks of the National Institute of Statistics and from the National Institute of Meteorology and Hydrology database, while those for 2012, which weren't centralized and disclosed yet, are obtained from our own experimental fields and from others big agricultural producers in the area. In this way we will be able to emphasize the important role of climatic conditions for agricultural yield in the south part of Romania, currently with poor irrigation possibilities, and the necessity of finding solutions to this problem through research.

Key words: *Burnas Plain, drought, temperature, rainfall, production.*

INTRODUCTION

For worldwide agriculture the drought became one of the determinant factors of productivity, until now being impossible to find any ways to combat it or control it. Research has shown that the amelioration of varieties in order to resist to drought leads, in the same time, to a decrease in productive yield (Blum, 2005), which is a contradiction with the growing food demand. One solution could be the irrigation process, but it is difficult to achieve, involving excessive costs and water resources that are not available to everyone. Also, if to the lack of water are added high temperatures and strong winds, which increase the water evaporation, even irrigations become ineffective. Weather changes noticed lately, with pronounced drought and with a trend of climate aridisation in the Romanian Plain, led to an increased frequency of the years without rainfalls (Meluca et al., 2011).

MATERIALS AND METHODS

As it will be seen from the analysis of statistical data collected, regardless of the period in which is installed, the thermo-hydric stress negatively affects the crops, in a greater or lower extent (Puiu, 2006).

To reach the results that we have proposed, namely to demonstrate the influence of heat and water on agricultural productivity of field crops, we realized conclusive maps, tables and figures, based on which we were able to draw the final conclusions.

We started with the establishment of the geographical area for which we conducted the research and for which we used the information concerning the evolution of temperature and precipitation. The graphs that show the annual productions were made individually for each crop so as to be more clearly visible the differences from one year to another.

Having the combined graph of precipitation and temperatures and the one of the annual productions for the 5 crops taken into study we can overlap them, thus obtaining the actual effect of drought on agricultural yield.

RESULTS AND DISCUSSIONS

Intervals with prolonged droughts existed in Romania over the years, the most notable being those from 1894-1907, 1945-1951, 1983-1994. Berbecel et al. (1981) make a classification of agricultural droughts, which he divides into 3 categories that succeed each other – atmospheric drought, soil drought and mixed drought.

We will start by making a short presentation of the region. Benefiting from a large surface of arable land (Figure 1) – 437,727 ha out of the total of 487,171 ha – Teleorman County manages to be on the second place at national level in terms of vegetal production.

Another plus is the high quality of soils. Of the total arable land surface, about 65% is placed in the 1st and 2nd class of fertility.

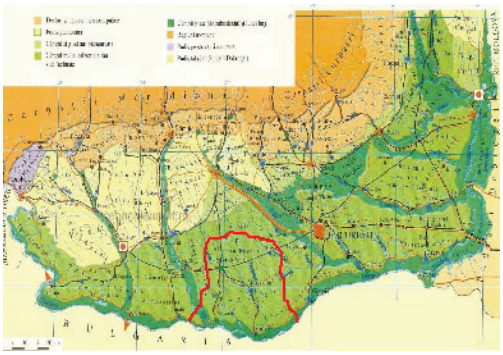

Figure 1. Teleorman County delimitation on the map of Romanian Plain

With all these strengths that we have mentioned till now, the analyzed territory, as well as the entire Romanian Plain, should obtain some record yields at European and even global level. However, this doesn't happen so that the reasons have been and are still in the attention of researchers.

One of the aspects is represented by climatic conditions, that vary from year to year and that have the capacity to reduce the agricultural productivity for all crops. Of almost half a century began the interest of everyone concerning the climate change occuring around the world, the intensification of aridity phenomen, the loss of land surfaces to the detriment of seas and oceans water etc.

Romania wasn't spared by any of the environmental effects mentioned above, since the beginning of the XXIst century becoming obvious that droughts, floods, storms and frosts are succeeding in a much faster rhythm.

Analysing the climate map of the studied territory we chose to use the values from the meteorological and hydrological stations in Alexandria, Turnu Magurele and Teleorman (INS, 2008, 2009, 2010, 2011, 2012; SCDA Teleorman) in order to elaborate graphs showing the temperatures and precipitations evolution. In Figure 2 are presented the annual average temperatures for Burnas Plain, being evident their increase compared to the reference period, which is 1961-2000.

The only return to normal was in the years 2010 and 2011, when there was an annual decrease of 0.5°C from one year to another.

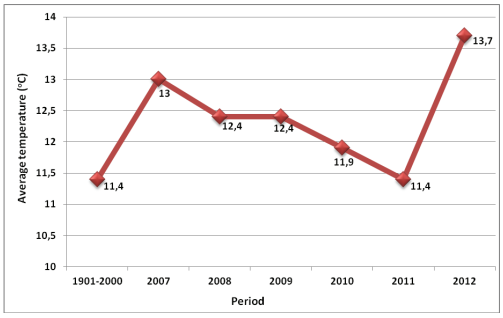

Figure 2. The values of annual average temperatures registered in Burnas Plain (Turnu Magurele and Teleorman meteorological stations)

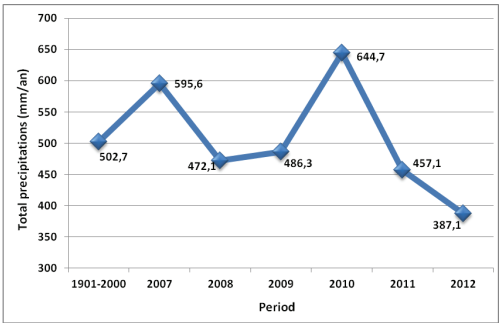

Figure 3. The values of total annual rainfall recorded in Burnas Plain during periods 1901-2000 (average) and 2007-2012 (total yearly)

Also based on the chart we note that the average of 2012 grew by 2.3°C, even exceeding the one recorded in 2007. The difference was, however, limited by low temperatures in the first part of the year, the winter 2011-2012 being very frosty and with a lot of snow, which provided the resources of water in the ground for a few months. Then, the year didn't seem to be a dry one.

From the two graphs above (Figure 2 and Figure 3) we can conclude that temperatures and rainfall are not fully consistent with each other. 2007, for example, was one of the driest years, but although the annual average temperature grew by more than 1°C compared to the normal values, rainfall have increased in the same measure.

The explanation comes from the fact that the two indicators are not uniformly distributed per months.

It is shown (Figure 4) that heat factor was higher in 2007 only in a few months, January, February, May, June and July, the rest of the months being in the normal range for the southern part of Romania. Most probably yields were affected by additional degrees from spring and summer, more than 2°C in May, almost 3°C in June and 4°C in July.

Similarly, we can see the chart for 2012, with higher temperatures starting with June and continuing till October.

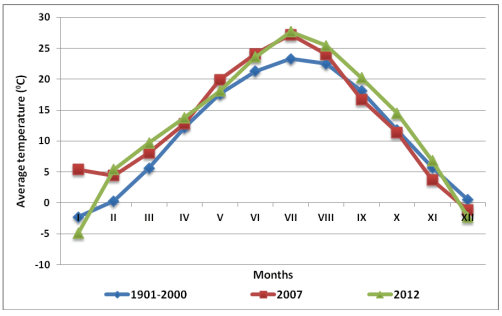

Figure 4. Monthly average temperatures for Burnas Plain in 1901-2000, 2007 and 2012

Can't be made the same analysis based on Figure 5, which presents large differences in rainfall volume recorded in 2007 and 2012 compared to the average for 1901-2000.

Looking at the red line (2007) we conclude that April was a month without rainfall, and in January, June and July, water from rains not even reached 30-40% of necessary. The green line (2012) is, on the contrary, extremely high in April, but after that is followed by a 7 months period with low precipitation (May-November).

While the reduced amount of water in January or February wasn't a calamity, the lack of rainfall from other months, in which take place the most important stages of plant growth, was what led to disastrous productions in those two years.

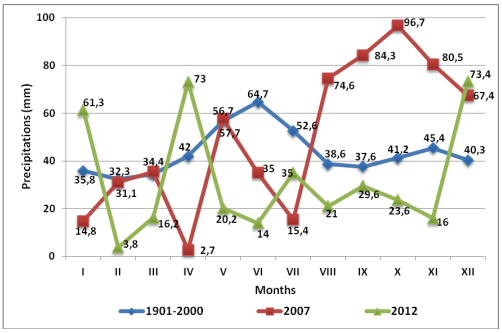

Figure 5. Monthly average rainfall for 1901-2000 period, 2007 and 2012

Instead, the rainfall volume was very high in autumn and winter through massive snow falls, also accompanied by temperatures lower than the average, so bt severe frosts.

The agriculture is the first affected by weather conditions, plants being the most sensitive regarding the intense effects of thermic and hydric stress, the sudden transitions from hot to cold, from dryness to heavy rains and vice versa.

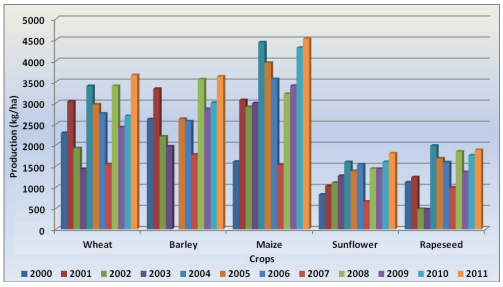

Figure 6. Annual average productions for Romania during 2000-2011

Throughout Romania crops are suffering in adverse weather conditions. The five studied field crops register great differences in

productions from one year to another (Figure 6).

In the XXIst century the years with a yield positive balance of all cultures were only 2004, 2008, 2010 and 2011.

The fact that only 4 of the 13 years have managed to reach to the desired agricultural level is not encouraging at all, especially because of the modernization of inputs, culture technologies, varieties, phytotechnics.

Since dry years begin to reappear more often, research should continue the experiments for finding solutions and these can only come from ecologization and genetics.

By protecting the environment can be stoped or slowed down the process of global warming and desertification, can be adjusted to a certain measure the seasons alternation, the soil ecologization extending their life, productivity and resistance to extreme climatic events.

Genetics' role is to support the production by ameliorating new varieties that can be cultivated in any environmental conditions, but none of them can't be resistant to all abiotic factors.

Another factor that must be taken into account is the zonal one, protected regions (like depressions, intra-mountain plains or hilly areas) are not affected as much by drought.

Teleorman, which is a plain county and almost exclusively agricultural, doesn't succeed, in most cases, to exceed the annual average yields of Romania (Table 1).

Table 1. Annual average productions during 2007-2011 in Romania and Teleorman County

Year / Culture	2007 (kg/ha)		2008 (kg/ha)		2009 (kg/ha)		2010 (kg/ha)		2011 (kg/ha)	
	RO	TR	RO	TR	RO	TR	RO	TR	RO	TR
Wheat	1541	1166	3403	3395	2421	2276	2688	2635	3663	3794
Barley	1772	1281	3564	3672	2858	2874	3003	2895	3628	3306
Maize	1526	618	3215	2247	3409	3899	4309	4948	4525	4428
Sun-flower	654	455	1437	1171	1433	1667	1597	1791	1798	2087
Rapiţă	991	920	1844	2023	1357	1635	1755	2021	1882	2164

With several exceptions (all crops in 2011, rapeseed, sunflower and corn in 2009 and 2010) in Plain Burnas are obtained average annual yields lower than national.

Comparing these data with those of thermic and hydric indicators will point out that unfavorable years led to significant decreases in production.

Detailed for each crop and for the entire period 2000-2012 we made the graphs below (Tempo-online). For 2012 we took partial data, declared by the County Agricultural Departments after a large part of the cultivated area was harvested (www.revista-ferma.ro; http://agroinfo.ro).

Burnas Plain **wheat** production was very poor in 2003 and 2007 (Figure 7), both years having a few months with almost no rainfall. In the other unusual years the production didn't decreased by more than 20-30%, managing to stay above 2000 kg/ha, mentioning that high yields were just in four years (2001, 2004, 2008 and 2011).

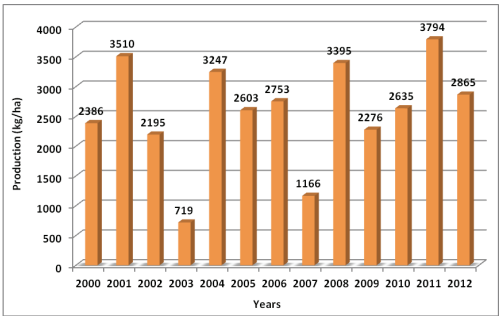

Figure 7. Wheat yields (kg/ha) obtained in Burnas Plain in 2000-2012

Barley harvest, similar to wheat in terms of environmental requirements, still manage to has slightly better yields, but it is necessary to say that productions were major affected in the same years, 2003 and 2007. Exceptionally good were 2001 and 2008 (Figure 8), years that followed after periods with thermo-hydric stress.

Analyzing Figure 7 and Figure 8 we can draw a first conclusion on the cereals production, for which we have taken as representative wheat and barley, namely that dry years differ greatly among themselves, influencing crop yields in various ways. Very important is the month when the atmospheric drought begins, if it is combined with a hydrological/pedological drought or if plants really need water at that time etc.

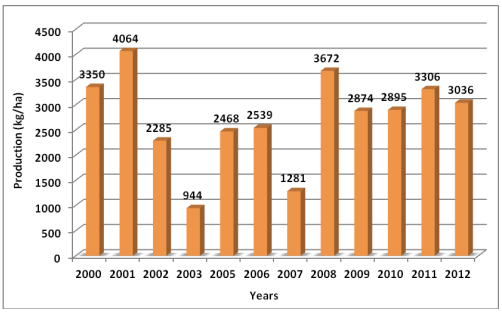

Figure 8. Barley yields fluctuation in Burnas Plain 2000-2012

For **maize** the yields values recorded in the same period stands at the opposite pole, in each of the years considered dry production being significantly affected (Figure 9). Critical were 2000 and 2007, when the production was lost at a rate of 80-95%-only 355 kg/ha in 2000 and 618 kg/ha in 2007.

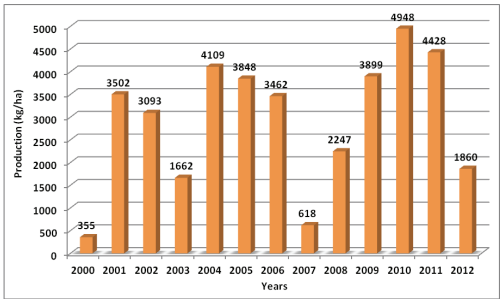

Figure 9. Maize productions in Burnas Plain in the period 2000-2012

Similarly were the years 2003, 2008 and 2012, the maize harvest barely reached 50% of the normal.

The graph shows a periodically gradation, with increases in production for 2-3 years, then sudden drops again.

Sunflower respected the pattern imposed by maize, the less productive years also being 2000 and 2007. In comparison with expected production the losses reached, in this two years, about 70-80%, while in the rest of the period were achieved average yields of 1000-1500 kg/ha.

Exceptions were just 2009-2011, when it went over the threshold of 1600 kg/ha, the maximum being in 2011 – 2087 kg/ha.

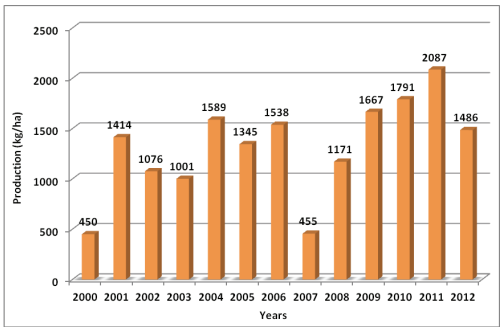

Figure 10. Sunflower production during 2000-2012 in Burnas Plain

Regarding **rapeseed**, it is necessary to note that in 8 of those 13 years graphically represented were obtained yields of over 1600 kg/ha, values that managed to exceed the annual average for the entire country, so we can conclude that Burnas Plain is more favorable to this culture compared to other areas.

Lowest productions were, curiously, in 2002 and 2003, although 2002 was a medium year as temperatures and precipitation (Figure 11). Instead, in 2000, 2001 and 2007 were lost about 50% of the entire productions.

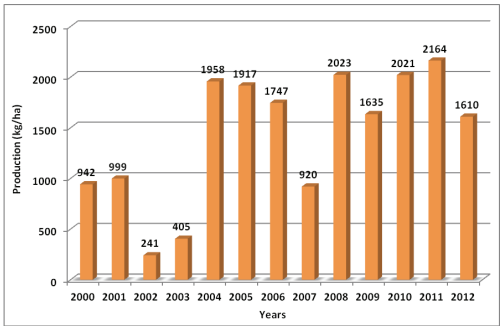

Figure 11. Productions recorded between 2000-2012 in rapeseed crop in Burnas Plain

CONCLUSIONS

Abiotic factors (the temperature and the rainfall) have a very important role in agriculture, largely influencing the yields of all crops, also depending on other characteristics of plants: thermo-hydric stress resistance, the moment of stress installation etc.

The only way to mitigate the effects of extreme weather conditions that succeeding each other during the year (droughts, floods) is currently

represented by soil ecologization and farmers must be trained to do so.

In Burnas Plain dry years have affected crops more than the rainy years done it, in 2007 (dry year) yields being with 50-70% lower than in 2010 (wet year).

Finding some plant varieties resistant to water stress is possible only partially, while the need of water can't be totally eliminated.

It is necessary to be implemented an irrigation system across all the southern part of Romania if we want competitive production at European level.

ACKNOWLEDGEMENTS

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