CLIMATE CHANGE IMPACT ON THE EVOLUTION OF THE MAIN AGRICULTURAL CULTURES IN THE ROMANIAN PLAIN

Anca –Marina Amuzescu
University of Agronomic Sciences and Veterinary Medicine of Bucharest-Romania, 59 Marasti Boulevard, Bucharest, Romania
E-mail: amz.anca@yahoo.com

Abstract
Agricultural production activity is the most vulnerable to the change of exogenous factors among which the climate variables have a direct and long term influence on human health and food security, and in general, on human life quality.
Large agricultural areas in the southern part of the country are affected by the air global warming with cumulative effects such as: extension of desertification; degradation of the natural soil properties; significant changes of the biocenosis pattern, among which the latest ones are the biological risks generated by the appearance of new pathogens, Gaeumannomyces graminis, Septoria nodorum, Aspergillus flavus. In general, culture plants diseases show selective preference for hosts, for this reason when they come in new geographical areas they parasitize the same species/ food resource and under favourable conditions, they spread from a single plot to the whole ecosystem.
A complex research of the agro-meteorological date on long terms, that also includes obvious climate change at the level of the country's agricultural land, shows the evolution trend of aridity and emergence of new plant pathogens in cereal crops (winter wheat and maize) in the Romanian Plain.

Key words: climate variables, desertification, new pests, food security.

1. INTRODUCTION

Against the background of climate change, degradation of habitat resources becomes more and more visible with impact on the evolution of anthropogenic ecosystems. Reduction of favourable climate conditions for cereal crops in the south of the country/Muntenia is weakening plant resistance to exogenous factors [4a.], to new plant pathogens inclusive, as well as the productive potential of cereal plant types/ hybrids.
Knowing the biology of potential pests and the optimal parameters necessary to their development allows one to determine the most vulnerable areas and to elaborate integrated systems for cultures protection in conformity with the food security requirements.

2. MATERIALS AND METHODS

Research was based on the analysis of an uninterrupted row of agro-climatic data (1961-2007) collected from 11 stations as representative examples of agricultural areas in Muntenia: Brăila, Buzău, Călăraşi, Curtea de Argeş, Fundulea, Giurgiu, Piteşti, Ploieşti, Slobozia, Târgovişte and Turnu Măgurele [5b].
Evaluation aimed at the following: mean, minimal and maximal daily air and soil temperatures; phenomenon of "intense heat"; total daily, monthly, seasonal and multi annual precipitations; relative air humidity; water quantity stored in the ground layers 20-50-100cm deep; phenological and production data about the main cereal crops (wheat and maize) [5a].
Climate parameters investigation related to the needs of cultivated plants in different vegetation phases as well as to the ethology of plant pathogens through Emerisc method allowed to quantify vulnerability of agricultural areas in Romanian Plain.
The investigated cereal plants were winter wheat and maize, which led to the identification of 3 risk levels (high, reduced and no risk) that was used to plot GIS maps

regarding the zoning of emergent risk found out in the new pests: *Gaeumannomyces graminis, Septoria nodorum* on wheat and *Aspergillus flavus* on maize.

3. RESULTS AND DISCUSSION

Dynamics of meteorological data evinced a great frequency of risk phenomena in the last decade; thus heat and water deviations were significant in comparison with the multi annual averages characteristic to the concerned zone in the period 2000-2003 as well as in the years 2005 and 2007 when atypical manifestations had a serious impact on the evolution of cultivated plants [1b; 4a].

The annual precipitations quantities registered a decreasing tendency; thus, in the last decade the droughtiest years were 1999-2000, 2000-2001, 2001-2002, 2006-2007 (frequency of 50%), excessive water quantities were registered in 2005 (frequency of 10%).

2007 is the year of climate hazard, when highly intensive heat associated with rare precipitations, almost none, that ended up the water stored in the ground. Days of 'intense heat' (ΣT>32ºC) are characteristic to summer months (June-August) and happen rarely in May or September. "Intense heat" above 20 units along 5-7 days in succession is a heat risk factor for plant cultures [2b]. In comparison with the peak years 1987 and 1993 (when there were 20-45 days of 'intense heat'), in 2007 there were 30–60 days of high heat intensity (91-150 "intense heat" units) and even extremely high heat intensity (151-223 units) in the greatest part of Muntenia (figure 1) as against the multi annual average (11-53 units) in the period 1961-2000, figure 2. Moreover, the days of 'intense heat' (ΣT≥32ºC) were accompanied by tropical nights, (ΣT≥17ºC), which reduced the rhythm of substance accumulation in seeds/beans up to a standstill of vegetative processes.

Against the background of high heat regime, precipitations were extremely small in the greatest part of Romanian Plain; the mean water deficit registered a value of -40% and [5a], under those conditions, an extremely intense pedological drought came in affecting the phenological evolution of cereal cultures (wheat and maize) that were in phases of maximal water demand [2a] (gradual degradation in various percentages 50-100%). In the agricultural year September 2006-August 2007, the total precipitations quantity was 428 l/m^2.

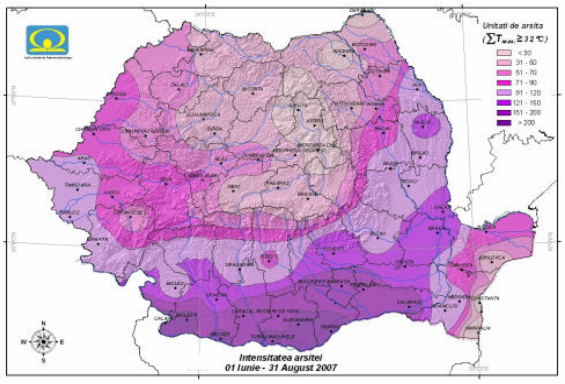

Fig. 1 – Heat intensity 01.06 – 31.08.2007

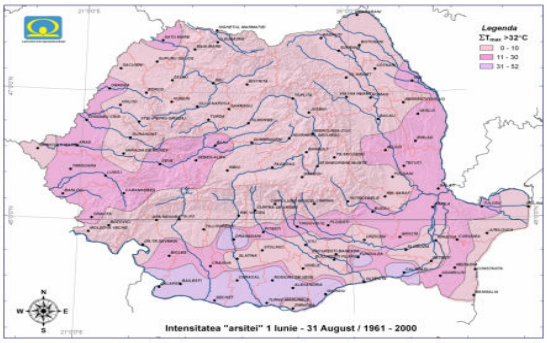

Fig.2 - Heat intensity 01.06 – 31.08/1961-2000

The agricultural year September 2004-August 2005 was predominantly rainy with excessive pluviometric values in the majority of months (January-May, July-September), and the total precipitations were 601-1330 l/m^2/year, figure 3. The rains were torrential, and locally, their registered quantity was over 100 l/m^2 water in 24h (Târgovişte, 137.6 l/m^2 in May) exceeding the maximal values registered over the years (1961-2000), table 2.

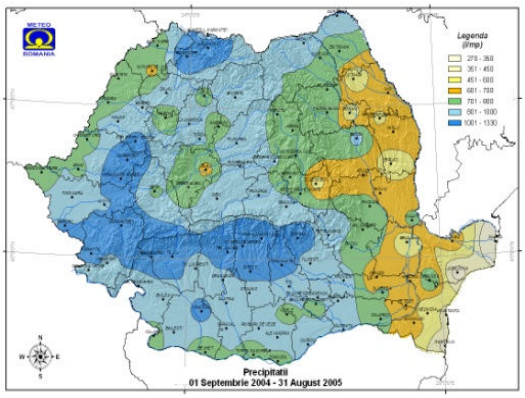

Fig. 3 Precipitations 01.09 – 31.08.2005

Climate variability causes essential changes in the dynamics and structure of plant and animal populations [2c]. The natural mechanisms of the living bodies give birth to a genetic plasticity that is shaped by the interaction between physical and chemical mediums so that at one time, against the background of climate change those living bodies can occupy new areas [2d]. Agro-biocenoses decay caused by plant parasite species coming from other geographical zones is favoured by the reduced phyto sanitary protection applied to cultures in our country in the last years [2g].

In the context of the local and general climate change there is the risk of the coming in of new pathogens on winter wheat (*Gaeumannomyces graminis*–plant bending position and wheat seeds withering, *Septoria nodorum*) and maize (*Aspergillus flevus*- dry rot of the corncob); these new organisms are characteristic to agricultural areas from other parts of the world. This process should be analysed within the complex specific relationships that are changing in corelation with the availability of abiotic elements (temperature. precipitations, soil) [3a;3b].

The evaluation of local conditions was carried out in close relationship with the essential factors that influence plant pest's development [3c;3d] and spreading cycle associated with wheat and maize plant phases through EMERISC method:

♦*Gaeumannomyces graminis*: maximal air temperature 20…25 ºC, soil humidity is high because of precipitations or irrigation in the period May-June. The degree of favourable conditions in the pathogen area was characterized into three types: very favourable, at least 2 days of a maximal air temperature of 20…25ºC in May–June and at least 1 l/m^2/day precipitations; favourable, at least one day when the maximal air temperature was 20…25ºC, and precipitations were over 3 l/m^2/day; no risk, when there are no favourable conditions for the development of *Gaeumannomyces graminis*.

There were processed agro climate data over 44years/1961-2004. The analysis of the vulnerability degree of the agro climate conditions in Muntenia at the occurrence and development of *Gaeumannomyces graminis* evinces the following: high risk in 14-24 cases/55-95%; reduced risk 2-16 cases/5-36%, no risk 0-8 cases/0-18%, table 3.

The zoning of the *major risk* related to the occurrence of *Gaeumannomyces graminison* on the winter wheat in Muntenia is presented in figure 4.

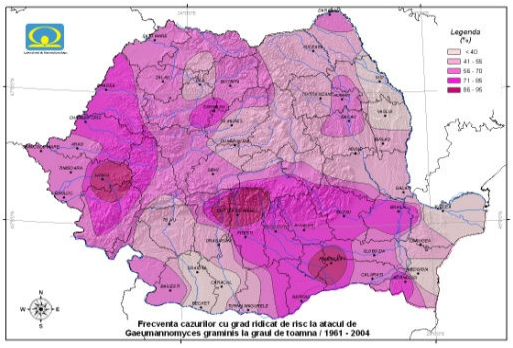

Figure 4

♦*Septoria nodorum*: the optimal temperature is 22…26 ºC and the air humidity is high/precipitations are over 1 l/m^2 in May–June when the wheat passes through the phases of bean shaping and growing.

The results show a high risk in 17-40 cases/ 61-90%; reduced risk 2-13 cases/5-30%; no risk for the *Septoria nodorum* attack 0-4 case/0-9%, table 3.

The frequency distribution of high risk cases related to the occurrence of septoriosis in the winter wheat cultures1 is presented in the GIS map, figure 5.

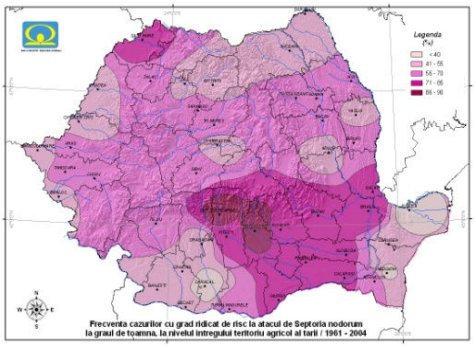

Figure 5

The degree of favourable agro-climate conditions for the occurrence and development of *Aspergillus flevus* is evaluated by the number of "intense heat" units added in the period June-August, when the maize is the blooming phase (divided in relation to the hybrid precocity). Three categories of conditions were established: very favourable, when ΣTmax.≥32ºC registered over 30 intense "heat" units, favourable, when ΣTmax.≥32ºC registered between 10-30 intense "heat" units and no risk, in the years when during summer time the maximal air temperature did not exceed 30ºC.

The evolution study regarding the conditions for *Aspergillus flevus* in the maize cultures in Muntenia shows the following aspects: *high risk* in 1-11 cases/ 2-25%; *reduced risk* in 6-19 cases / 14-43% and *no risk* in 2-37 cases/ 41-48%, table 4.

The analysis of the frequency distribution of high risk cases related to the occurrence and development of *Aspergillus flevus* in Romanian plain shows the following; below 10% in the north of Muntenia and 11- 25 % in the south of the region.

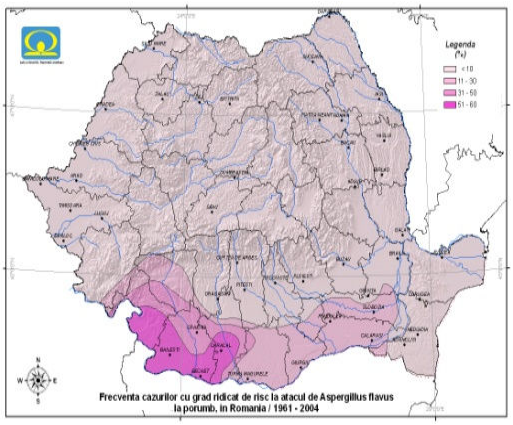

Figure 6

Table 1. Optimal precipitations demand (l/m^2) in the period April- July for the main cereal cultures compared to the precipitations registered in the same period of the year 2007

	OPTIMAL PRECIPITATIONS DEMAND (l/m^2)			
	IV	V	VI	VII
WINTER HEAT	50	80	80	50
MAIZE	50	90	80	120
MEAN QUANTITIES (l/m^2) REGISTERED IN MUNTENIA				
2007	16	72	57	47

Table 2. Extreme pluviometric values (l/m^2) registered in 24 and 48 hours at the meteorological stations in the period 1961-2000

1961-1990		1991-2000	
24 h	48 h	24 h	48 h
ALEXANDRIA			
98.2/iul.1970	105.2/iul.1970	56.7/mai 1995	73.6/iul.1991
VIDELE			
85.6/iun.1969	116.6/iul.1970	60.5/iul.1991	71.5/iul.1991
132.4/iul.1970	138.2/iul.1970	107.3/iul.1999	113.4/iul.1999

Table 3. Results of the risk degree related to the *Gaeumannomyces graminis* and *Septoria nodorum* attack on wheat cultures in Muntenia

AGROMETEOROLOGICAL STATIONS	HIGH RISK %		REDUCED RISK %		NO RISK %	
	Gaeumannomyces graminis	*Septoria nodorum*	*Gaeumannomyces graminis*	*Septoria nodorum*	*Gaeumannomyces graminis*	*Septoria nodorum*
Braila (1974-2004)	81	84	16	13	3	3
Buzau	84	77	9	20	7	3
Calarasi	73	64	18	18	9	18
Curtea de Arges	90	95	5	5	5	-
Fundulea	75	86	18	9	7	5
Giurgiu	75	82	20	11	5	7
Pitesti	77	77	18	18	5	5
Ploiesti	84	73	11	20	5	7
Slobozia (1981-2004)	71	58	29	34	-	8
Targoviste	89	82	11	16	-	2
Turnu Magurele	61	55	30	36	9	9

Tabelul 4. Results of the risk degree related to the *Aspergillus flevus* attack on the maize cultures in Muntenia

AGROMETEOROLOGICAL STATIONS	HIGH RISK		REDUCED RISK		NO RISK	
	NR. CASES	%	NR. CASES	%	NR. CASES	%
Braila (1974-2004)	3	10	10	32	18	58
Buzau	2	5	16	36	26	59
Calarasi	6	14	18	40	20	46
Curtea de Arges	1	2	7	16	36	82
Fundulea	5	11	19	43	20	46
Giurgiu	11	25	15	34	18	41
Ploiesti	1	2	9	21	34	77
Pitesti	1	2	7	16	36	82
Slobozia (1981-2004)	5	21	10	42	9	37
Targoviste	1	2	6	14	37	84
Turnu Magurele	9	20	17	39	18	41

4. CONCLUSIONS

Kinetics and complexity of the arid conditions forming: severe and frequent forms of soil drought (50% of cases are drought); fertility reduction; degradation of the physico- chemical properties and biological composition; biodiversity reduction asks for a correct approach individualized for the agricultural areas in the south of the country.

The perpetuation of water shortage regime in the south of the country makes the agricultural land areas reduce their biological productivity or even lose it; the improvement of this resource, especially, water regime, can be achieved through making farming works adequate to the soil types by using different variants such as minimal farming (minim-tillage) or by sowing directly in the stubble (no tillage), by carrying superficial tilling to bury plant remains, to aerate and crumble soil.

The high degree 55-95% (the average being 75%) of favourableness of the conditions in the area of Romanian Plain regarding the occurrence and development of *Gaeumannomyces graminis* and *Septoria nodorum* on the wheat cultures proves the need to continuously monitor the climate parameters and the evolution of all adjacent biocenoses in order to detect in due time natural tendencies to form ecological/ food niches.

Sustainable management in agriculture involves permanent interdisciplinary knowledge to be able to harmonize natural environment with the anthropic environment, to assure ecosystems stability, to reduce any types of pollution and to stop the decay.

5 REFERENCES

[1] a. Hera C., A.Canarache-Seceta şi deşertificarea, probleme actuale majore ale omenirii, Revista „Agricultura României" nr. 27/2000, p. 1–7.
b. Mateescu E.–Sub semnul desertului, articol Jurnalul National, 5 aug. 2005, Bucuresti;

[2] a. Biltenu Gh.-Fitotehnie, volumul I si II. Ed. Ceres, 2003, Bucuresti;
b. Berbecel O., Vlahuta Gh.-Zonarea ecologica a plantelor agricole. Ed. Academiei, 1960, Bucuresti;
c. Berca M.-Planificarea de mediu si gestiunea resurselor naturale, Ed. Ceres, 2006, Bucuresti;
d. Berca M.-Teoria gestiunii mediului si a resurselor naturale, Ed. Fermierul Roman, 1997, Bucuresti;
e. Budoi Gh., Penescu A.-Agrotehnica. Ed. Ceres, 1996, Bucuresti;
f. Deacon Jim-The Microbial World: Biology and control of take-all disease *Gaeumannomyces graminis*.,1973;
g. Oancea I.-Tehnologii agricole performante, editia a doua actualizata si completata. Ed. Ceres, 2005, Bucuresti;
h. Povara R.-Riscul meteorologic in agricultura. Graul de toamna, Ed. Economica, 2000, Bucuresti

[3] a. Babadoost, M., Herbert, T.T.-Factors affecting infection of wheat seedlings by *Septoria nodorum*. *Phytopathology*, 1984.74: 592-595
b. Mori, T., M. Matsumura, K. Yamada, S. Irie, K. Oshimi, K. Suda, T. Oguri, M. Ichinoe.-Systemic aspergillosis caused by an aflatoxin-producing strain of *Aspergillus flavus*. Med Mycol, 1998, 36:107-112.
c. Rajaram, S., Dubin, H.J.-Avoiding genetic vulnerability in semi-dwarf wheats, 1977, *Ann. N.Y. Acad. Sci.*, 287: 243-254.
d. Shaner, A.L., Krupinsky, J.M.-Cultural and inoculation studies of *Septoria nodorum*, caused of glume blotch of wheat, 1970, *Phytopathology*.

[4] a. Geicu A.-Causes and effects of drought in Romania, Proceedings of the Central and Eastern Workshop on Drought Mitigation, 12–15 April 2000, Budapest.

[5] a. Arhiva de date climatice din perioada 1961-2007 – INMH/ANM, Bucuresti
b. Arhiva Laboratorului de Agrometeorologie, Registre Agroclimatice ale culturilor agricole, 1991-2007, INMH/ANM, Bucuresti .