AGROMETEOROLOGY – A PROSPECT SCIENCE IN THE EUROPEAN AGRICULTURE

AGROMETEOROLOGIA ŞTIINŢĂ DE PERSPECTIVĂ ÎN AGRICULTURA EUROPEANĂ

MARIA ZĂPÂRŢAN*, OLIMPIA MINTAŞ*, ANA MOZAI*, ELIZA AGUD*

**Environmental Protection Faculty, University of Oradea, Romania*

Abstract: *The climate, together with all factors contained, influences the life of plants, imposing the development of a distinctive study of these relations assumed by agrometeorology. Outside considerations of a theoretical general manner, we took into account the fact that the temperate climate conditions from Romania, the plants, have adapted their life cycle to the season rhythm, responding to the influences of external factors, in relation to their reaction norm, as a result of the interaction between the genetic information and the factors of the external environment. The agrometeorology, as a science, analyzes the permanent interaction between the weather factors and the vegetable organisms, their positive or negative influence on the physiological processes and on their life phases. The agrobiometeorology has three study directions: the physiological one, the phenological one, and the species' pathology, analyzing the weather conditions and their implications in the morpho-physiological conditions, following the evolution of relations between weather* ***– climate – plant – production****.*

Rezumat: *Clima, cu toţi factorii pe care îi cuprinde influenţează viaţa plantelor, impunând dezvoltarea unui studiu distinct al acestor raporturi pe care l-a asumat agrometeorologia. În afara unor consideraţii de ordin teoretic general, am avut în vedere că, în condiţiile de climă temperată de la noi, plantele şi-au adaptat ciclul de viaţă la ritmul sezonier, răspunzând la influenţele factorilor externi, în funcţie de norma de reacţie a lor, ca rezultat al interacţiunii dintre informaţia genetică şi factorii mediului exterior. Agrometeorologie, ca ştiinţă, analizează interacţiunea permanentă dintre factorii de vreme şi organismele vegetale, influenţa pozitivă sau negativă a acestora asupra proceselor fiziologice şi asupra etapelor lor de viaţă. Agrobiometeorologia are trei direcţii de studiu: al fiziologiei, al fenologiei, şi al patologiei speciei, analizând condiţiile meteorologice şi implicaţiile acestora în procesele morfo-fiziologice şi patologice, urmărind evoluţia relaţiilor dintre* ***vreme – climă – plantă – producţie****.*

Key words**:** *agrometrology, environmental factors, lasting agriculture, relation weather – climate – plant – harvest, climate – ground – plant – technology, biological watch, thermic periodicity.*

Cuvinte cheie: *agrometeorologie, factori de mediu, agricultura durabilă, relaţia vreme – climă – plantă – recoltă, climă – sol – plantă – tehnologie, ceas biologic, termoperiodism*

INTRODUCTION

The agrometeorology studies the environmental factors in the entire agroecosystem, its climate functions, with influence on the relation between *weather – climate – plant – harvest*. More than half of the surface of the Earth is not fitted for agriculture. For the development of a „*lasting agriculture*", in unfavourable meteorological and climate conditions, it is compulsory to increase the agricultural profitability rate, getting to know the weather and the multi-annual line of the meteorological phenomena, as well as of their deviations in comparison to regular values.

The second technical revolution of mankind meant a development of agriculture, but also a step of degradation of the equilibrium of natural ecosystems. It is necessary that mankind set as objective, among the main economic objective, also the one to maintain the ecologic

systems in a state of equilibrium, in order to ensure the renewability of necessary raw material and energy resources, objective achievable through the adoption and putting into practice of the concept of *lasting development*, which takes into account the complexity of biological interactions, the improvement of the environmental conditions, the reasonable capitalization of the environmental conditions, the reasonable capitalization of economic resources on a global scale.

STUDY METHOD

The study is intended to be an instrument to inform on the relations between the environmental factors and the vegetative organism; the objective is represented by the elaboration of models for a general system, *climate– soil – plant – technology*, microclimate systems, hydric regime, photoperiodicity, photosynthesis etc., models which allow the scientific research of the phenomenon, discovery of new aspects which contribute to obtaining high quality agricultural harvests.

The agrometeorology and phenology research and study from the National Meteorology and Hidrology Institute were done on crop plants, types and hybrids with various precocities, in order to establish the degree of availability of weather conditions of Romania (2) or of the role of temperature and water factors on the main phenophases at various crops, establishing which is the advance or the delay of the vegetation (8). The research was also focused on thermic, pluviometrical, phenological abnormalities and their implication on the agricultural harvest; the impact of weather phenomena with a high degree of risk on the reduction or calamity of agricultural harvests, a special concern being linked to the vulnerability of the main crops to the action of meteorological risks (9).

DISCUSSION

The relations between the plant – climate – soil is emphasiz the role of the relation in the final harvest of a crop (3). The harvest plants, in their morpho – physiological development, are influenced by the environmental factors, in the middle of which they grow. By improving the environmental conditions, we may achieve an optimum capitalization, duty which has to be fulfilled by all involved in this field(1).

One of the issues highly discussed nowadays and of a big interest for the field of agriculture is to find new energetic resources, exploited with systems that do not have to destroy the calorific balance of the Earth (5). The green plant, by attracting the solar energy, allows the annual synthesis of $1,7 \times 10^{11}$ tons of organic matter. The highly developed countries have already found the systems adapted to bioconversion of solar energy by creating new technologies for the transformation of energy, which are technologies to obtain methane and ethanol from biomass, looking for biosensory systems, which, at th moment, are still in a research phase (15).

In order to develop a "durable agriculture", in unfavourable weather and climate conditions, it is compulsory to increase the profitability rate of agriculture, and, as a consequence, to get to know the weather, the multiannual course of weather phenomena, as well as of their deviations from regular values. The agrometeorology research and values were done on crop plants, types and hybrids with various precocities, in order to establish the degree of favourability of Romania's climate conditions (8,9) and the role of thermic and hydric factors on the main phenophases in various crops, establishing which is the advance or the delay of the vegetation, the thermic, pluviometrical, phenological abnormalities and their implications on the agricultural crop; the impact of meteorological phenomena with a high degree of risk on the reduction or calamitation of harvests represents a special concern, being linked to the vulnerability of the main crops to the action of weather risks.

The meteorological factors do not action of an insulated manner on the biological cycle, but in connection to one another. Among the weather phenomena with an implication in agriculture and of interest for the final purpose of this economic branch, we remind here: the atmosphere as a source of oxygen and carbon dioxide, solar radiation, soil's and air's temperature, atmospheric humidity, atmospheric rainfall, wind, nebulosity and the atmospheric pressure.

The need towards light intensity varies depending upon the species and the vegetation phase. In weak light, the leaves are etiolated (the chlorophyll decreases), and in optimum light, the plants are vigorous and have a green colour. In order to flourish, the plants need a minimum of light (4): thus, the peas requires 11.000 lux, wheat and barley approximately 1.800-1.400 lux, the tobacco 2.200-2.800, and corn 1.800-8.000 lux.

The rotation movement of the Earth and the revolution movement around the Sun is in direct connection with the season modifications and daily modifications of the duration of light interval. The means though which plants control their vital activities with photoperiodical activities is the *„biological clock"*, the internal mechanism of the vegetative organism, which allows to measure the time. The modifications are performed with an exact periodicity, manifested during larger time periods, from one season to another, fact for which these photoperiocal modifications are also called seasonal. In the temperate area, the vegetation goes through several phases of vegetation in one year – phenophases (14).. The species of plants from the temperate area were adapted to daily and seasonal variations of temperature, having different needs in comparison to the temperature values and with season, manifesting also the phenomenon of *thermoperiodicity* (7).

The physiological processes from plants are developed between certain limits of temperature, called biological thresholds, over or under them these processes cease, and only at different values of temperature from the soil (6). The thermic properties of the soil and their degree of heating influence the physical state from the microclimate layer situated on top of the soil. There are agrotechnical measures which can modify the soil's temperature: *breaking up* allows the entrance of air in depth, its temperature increasing or decreasing; *mixing* the soil with coal or with dark foils determines the increase of temperature, or mixing with minced straws determines the decrease of soil's temperature; *the application of organic fertilizers* breaks up the soil and increases its temperature; *the irrigation* influences the soil's temperature, through water's temperature, as well as through the quantity of heat lost in the evaporation process.

The atmospheric humidity has an important role for the development of the crop cycle of plants, in relation to its values intensifies or reduces the vapoperspiration and the water consumption from the soil. Neither the low values, nor high values of humidity are favourable for plant processes. If the humidity is low during blooming, the formation of fruits and seeds, the fertilization and accumulation of reserve substances is hindered. If this is exceeding and if the excess coincides with a hot period, there are conditions which favour the appearance of diseases and pest.

The accessibility of water for plants has established that the threshold of 50% from the soil's capacity for water represents the minimum limit of reserve of humidity necessary in order to develop regular vegetative processes in its body. Under 50% the pedological drought is installed, which may have various intensities and consequences, being considered the most dangerous factor of physiological stress.

The drought appears when the annual drought regime is under the necessities of plants, and their fall does not correspond to critical periods for plants. It is caused by an anticyclone regime, maintained for a longer period of time in a region. For agriculture, it is not interesting the annual total of rainfall, but the period of time from the year in which the

rainfalls was missing or were in an insufficient quantity. A year without rainfall or with insufficient rainfall, with low humidity (under 30%), intense perspiration, leads to a lack of balance between the absorbed water and the water lost through perspiration, causing the so called atmospheric drought. *The pedological drought* appear when the cells of plants loose their turgescence, phenomenon which takes place at the beginning in the leaves from the inferior floor of the plant, appears at the middle or at the end of summer. The association of pedological draught with the atmospheric draught results in the mixed draught, which determines the partial or total deterioration of the harvest. *The agricultural drought*, linked to the damaging effects on crops, is a complex phenomenon, in comparison to the meteorological one, which takes into account only the lack of rainfall.

In Romania, the draught is a relatively frequent phenomenon in the field regions. The rarest draught periods are in spring and at the beginning of the summer, and the highest number is encountered at the end of summer and the beginning of fall. Getting to know the weather conditions from various regions of the country allows the *mapping of crops* in relation to the requests of plants towards water. The most droughty regions from Romania are: the seaside, where the medium length of the drought period are of 18-20 days; Dobrogea, Bârlad platform, where the average is of 23 days; in the Romanin Field and along the Danube, where the average decreases to 15-18 days; in the rest of the country the average is of 12-14 days. The number of consecutive days without rainfall reaches the maximum in Bărăgan, decreasing towards West and North.

The wind may cause high variations of temperature and humidity, and a direct mechanic action, on plants, as well as on soil's crumbling (causing the aeolian erosion). The effects of winds can be favourable or non-favourable (11, 12), determining the disappearance or uniformization of weather microrelief factors.

Among all concepts analyzed by *Tromp, S.W.*, that of the *bioclimate index* has a special importance, establishing a complex relationship between the climate sphere and biosphere (10). After *Povară, R.,* 2001 the most important bioclimate indexes are: - the therman index, the hydrothermal index and the humidity index (involved in the phases of thermal and hydric stress of plants);- the thermal and hydric stress (which determines in plants physiological malfunctions, favouring the phytopatogenetic diseases); - thermal and hydric radiative comfort index, typical for each species and even variety of plant.

The resistance of plants to diseases is not a constant, invariable feature, since there is a possibility that they be enhanced, reduced or modified through the action of environmental factors, such as: temperature, humidity, light etc., which influence the parasitical process. Between all environmental conditions, the humidity and high temperature ensure the best conditions of appearance and proliferation of the disease. *The thermal therapy or the treatment with high temperatures* starts to be used very frequently in combating the diseases caused by viruses in plants. Getting to know the *inactivation temperatures* is very important in order to combat the phytopatogenetic viruses located in plants. This temperature varies depending on the type of virus, from 42^0 C to 90^0 C, but the great majority of viruses loose their ability to infect from a temperature ranging from 55^o C to 57^o C.

Heliotherapy represents combating pathogenetic agents by using *solar light.* Thus, some seeds (for example, the beans), by exposing them to the sun for several days, are treated against the bacteria *Xanthomonas phaseoli* and the fungus *Colletotrichum lindemuthianum.* Also, the potato tubers exposed to the sun for approximately 3 – 4 days are chlorophyllated, and, in this manner, they become more resistant to the attack of fungus *Erwinia* and *Fusarium*, which most frequently attack the types of potato.

In combating the pathogenetic agents in plants, the method of *radiotherapy* is also used in plants, which is represented by using various types of radiations with the purpose to

destroy the spores of some fungus and to inhibit bacteria and viruses. Thus, the radiations gama, beta, infrared and ultraviolet have been successfully tested in combating various diseases, rendering inactive or destroying a series of viruses, bacteria and fungus. The irradiation with X rays has proven to be effective in combating bacterial cancer, for the brand which appears at the rice plants and at some species of fruit bearing trees.

CONCLUSIONS

1. The requests of plants towards the air volume from the atmosphere is different and is conditioned by the age of plants, their vigour, the intensity of their respiration, nature or type of plant, plant's physiology etc.
2. Obtaining energy „via photosysnthesis" represents the basis of life on Earth, being the force which keeps alive the metabolic processes from the biosphere, the energy ensured by coal, petroleum, natural gas having the same biological origin.
3. The physiological and biochemical processes from the plant are influenced by the air's temperature, as well as by the soil's temperature. Considered as a limit factor of the distribution of species on the globe, the temperature also establishes the degree of thermal favourability for different regions. A complex of measures is necessary in order to improve the thermal regime in some species, such as: choosing resistant types, plantation on southern exposition, protection against winds etc.
4. For the agricultural practice, it is important to know the *thermal-physical properties of the soil*, in order to create conditions favourable to elevate and develop types and hybrids, by applying the corresponding agrotechnical measures.
5. *The soil's humidity* in excess or missing leads to a metabolic lack of balance in plants, with influence on the final production, as well as on the edaphic biochore.
6. *Combating the effects of the drought* may be achieved through the creation of types resistant to drought, using adequate agrotechnical and the application of irrigations. Thus, types resistant to drought were created, whose critical period coincides with the periods right in rainfall.
7. *Combating the unfavourable effects of the wind* can be done by massive cutting of protection curtains, of woods, bushes, with unfavourable effects on agrosystems.
8. All weather elements which generate the climate, in certain situations, may act as *risk factors*, for agricultural plants, as well as for the spontaneous ones (8). The plants prefer a moderate circulation of air masses, the violent ones may compromise the crops (severed plants, uprooted plants, destroyed at the end). For the agricultural sectors it is important to know the main direction of the wind in order to place the plots of seed crops, in order to avoid the biological impurity of species and types which form these lots.
9. *The sunstroke and night radiation* are reduced by the clowds, which diminish the daily and yearly amplitude of the atmosphere temperature and of the soil's temperature. The combined effect between the sunstroke and nebulosity is beneficial for the life on Earth in general and favourable to plants in special (13).
10. *The atmospheric pressure* exercises an indirect influence on plants, the variations of atmospheric pressure being insignificant, at a low pressure takes place a slow activation of the process of vapoperspiration in plants.

LITERATURE

1. BURROUGHS J,W, and col., I libri dela natura „*METEOROLOGIA*", Edizione italiana a cura di Luca Mercalli, Istituto Geografico D^e^AGUSTINI, Studio Booksystem, Novara; 1998
2. BERBECEL O., *Agrometeorology*, Ed., CERES, Bucureşti, 1992, 1999
3. CAPORALI F., 1991 *„Ecologia per agricoltura"*, UTET, Libreria, Torino

4. CRIVEANU H., *„ Agrometeorology”*, Risporint Publishing House, Cluj –Napoca, 2001
5. DEBROIS A, SEINANDRE E., 2003, *Petit atlas des phénomènes naturales*, Petit Encyclopédie, Larousse, Imprimé en France , septembre 2003
6. DRAGOMIRESCU E., ENACHE L., *„Agrometeorology”*, Didactical and Pedagogical Publishing House R, A., Bucharest, 1998
7. GEORGESCU, B., 2006, *”Course of ecology and environmental protection”* Risoprint Publishing House, Cluj – Napoca
8. POVARĂ P., „M*eteorological risk in agriculture*”, Fall wheat, Economica Publishing House, Bucharest, 2000
9. POVARĂ R., „*Biometeorology and climatology”*, Du Goéland Publishing House, Bucharest, 2001
10. TROMP S., W., „*Progress în biometeorology*”, Swets et Zeitlinger Publishing House, B.V., Amsterdam, 1974
11. ZĂPÂRȚAN M., BUZAȘIU O., *„Agrometeorology,* Studia Publishing House, Cluj- Napoca, 2002
12. ZĂPÂRȚAN M,“ *Vegetal biometeorology”* Dacia Publishing House, Cluj – Napoca 2005
13. ZĂPÂRȚAN M., „*Environmental factors and alive organisms”* SAGA Publishing House, Cluj – Napoca, 2007
14. *** *„Atlanti Scientifici Giunti., Meteorologia”* Giunti Gruppo Editoriale, Firenze, prima edizione decembre, 2002
15. *** L’Atlas environnement « *Analyses et solutions* » in Monde Diplomatique, 2007