METEOROLOGICAL HAZARDS FOR WHEAT YIELD IN THE WESTERN PART OF ROMANIA

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Abstract *The agricultural production of a country is mainly influenced by social, scientific, technological and climatological factors. By knowing the relationship between the meteorological factors and production rates is, as such, highly important with the agricultural management. The set of agrometeorological conditions in an agricultural year can determine the value of the harvest of a certain crop through the evolution of each meteorological parameter and according to the specific bioclimatic requirements of each phenological phase. As such, each meteorological event might or might not have a positive impact upon culture growth and as they deviate more and more from the optimal need, they can become risk factors, with different degrees of intensity. Wheat is the most important agricultural crop in Romania, both as a cultivated area and as an economic and social value. The ecological plasticity of this plant offers it the possibility to adapt in the most diverse climatic conditions. Apparently resistant to the action of unfavourable factors, offering satisfactory yields, wheat is very vulnerable to extreme values of the crop stress index, which can sometimes become risky and affect in different proportions the crop or even destroy it. The purpose of this paper is to present a short climatological analysis of the western part of Romania and the meteorological hazards imposed by the current climate towards the wheat yields.*

Keywords: wheat yield, agriculture, climatology, weather hazards, risk factors.

INTRODUCTION

Meteorological factors represent the main ecological element with a role in influencing the state of vegetation and the productivity of spontaneous plants and of cultivated ones. Due to unfavourable weather conditions, more than half of the Earth's surface is unsuitable for agriculture. Therefore, increasing agricultural yield, in order to provide food for the whole population, knowing the weather and climate, annual and multiannual variations of meteorological phenomena, their anomalies in relation to normal values, meteorological risks that can affect crops, is a mandatory and priority requirement for the sustainable development of agriculture (BERBECEL & NEACȘA, 1966).

The set of agrometeorological conditions in an agricultural year can determine the harvest value of a certain crop, by the evolution of each parameter in closer or farther limits, depending on the specific bioclimatic requirements of each phenological stage (CEAPOIU, et al.,1984).

In this context, meteorological phenomena can be favourable or adverse for crops, evolving as restrictive factors and as they deviate more and more from the optimal need, it tends in becoming a risk factor, with different degrees of intensity. The final harvest of a crop is thus a result of the complex action of meteorological factors. The great spatial and temporal variability of each meteorological parameter determines in this case the fluctuation of the productions and their deviation from the potential value of each cultivated variety. During the vegetation season of each cultivated plant, its requirements for weather conditions differ from one phenological phase to another, reaching maximum values in critical periods. If during these periods the evolution of meteorological parameters takes place outside the optimum necessary to go through the biological processes, the respective factors become stressful, sometimes even reaching a risk phase, depending on the size of the deviation, persistence and intensity of the disturbing elements. The negative impact on the culture materializes through the gradual deterioration of the vegetation state, the decrease of the harvest, and sometimes the calamity of the culture (BERBECEL, 1983).

Due to its genetic diversity and great ecological plasticity, wheat is grown almost worldwide, in over 70 countries, from the equator to the parallels of 66° north latitude and 45° south latitude, respectively. From the point of view of altitude, the wheat can be harvested at altitudes varying from 400 meters under the mean sea level to about 4000 meters altitude. The multitude of limiting meteorological factors for wheat cultivation include temperature, precipitation and light. From a thermal point of view, it is considered that some wheat varieties can be grown beyond the Arctic Circle, in Alaska, Canada, Norway, Sweden, Finland, the Russian Federation, or further south of the 45 ° parallel, Argentina and South Africa (CEAPOIU et al., 1984).

Wheat develops from a rainfall point of view in the northern hemisphere in sub-arid areas, where the amount of precipitation varies between 250 and 500 mm, in sub-humid areas, where precipitation varies between 500 and 750 m (CIULACHE, 1985). From a rainfall point of view, the most important aspect is the distribution of precipitation during the vegetation season.

Light intensity and spectrum are factors that influence the distribution of wheat around the globe. It is observed that Romania, through its entire territory and especially in the plain area, meets the particularly favourable pedoclimatic conditions for the cultivation of wheat. The long duration of sunlight of approximately 2000-2400 hours/year reflects together with the humus-rich chernozems beneficial factors for the development of wheat crops in Romania.

In Romania, preoccupations in the field of agrometeorology have existed since the beginning of the 19th century, even before the establishment of the National Meteorological Institute. The training of specialists in the field of agrometeorology and implicitly the research in this field started in 1973, when the Agrometeorology Laboratory was established.

The territory of Romania is characterized by a wide variety of climatic nuances determined by the complexity and fragmentation of the terrain and the diversity of atmospheric processes, conditioned by the geographical location of the country and its position in relation to the main components of the general atmosphere. These genetic factors of the climate act in close connection and are mutually conditioned, their interaction being very obvious throughout the agricultural territory.

The invasions of cold and humid air from the northwest and west towards the intra-Carpathian areas are slowed down or blocked by the mountain range of the Carpathians, which causes a forced ascent of the air masses (ION-BORDEI, 1983). Thus, during the warm period of the year the decrease in temperature, as an effect of the advection of cold air, is intensified on the northern and western slopes of the Carpathian chain, by cooling processes and high heat consumption required for evaporation of fallen precipitation. Under these conditions, the ratio between the components of the caloric balance changes significantly, which is reflected in the vertical distribution of soils and vegetation.

When the invasions from the northwest and west are more active, and the humid and cold air masses have a great vertical development, they exceed the Carpathians, causing on the sheltered slopes (eastern and southern) the appearance of Foehn processes, materialized by the increase of air temperature and the appearance drought periods. Such processes are characteristic of the Mureș corridor (CIULACHE & POVARĂ, 1997).

In winter, the cold air moving from the east of the European continent to the Balkan Peninsula often invades Câmpia Română area and is blocked by the peaks of the Carpathians. These invasions are related to the development of an anticyclonic ridge that causes a sharp drop in air temperature by stagnating for a long time above the plain, and consequently, the installation of thermal inversions.

During the period when cyclonic activity is developing in the Mediterranean Sea basin, the intense transport of hot and humid air from the southwest causes abundant precipitation in the southern part of the territory in the form of blizzards (ŞERBAN, 2010).

In the absence of the cold anticyclonic ridge from the northeast of the continent, the penetration of tropical air from the southwest causes sudden increases in air temperature in Câmpia Română, as such melting snow and the excess water from the soil surface leads to asphyxiation of crops.

It is worth noting the invasion of tropical air from the southwest during the summer, which produces a strong and rapid rise in air temperature. This phenomenon is accompanied by accentuated rainfall deficits, by the decrease of the relative humidity of the air below the critical threshold and finally by the installation of the agricultural drought phenomenon.

MATERIALS AND METHODS

The present study aims to investigate some of the meteorological factors that produce dangerous meteorological phenomena for wheat crops in western Romania. The methodology applied to this paper, although reduced in terms of extent, falls within the requirements of the World Meteorological Organization and complies with the standards imposed for operational meteorological research.

To determine the meteorological phenomena dangerous for wheat crops, archive data are used from four meteorological stations in operation or for which there is a meteorological archive (CRISTEA, 2004).

The main parameters that guide this paper are the minimum and maximum amounts of precipitation, the number of events with torrential rain and the amount of precipitated water and the number of incidents with acid rain. Due to the extent in time of some data, it is not possible to identify, with the help of modern atmospheric remote sensing means, the characteristics of some cellular systems to establish the advanced characteristics of those convective systems.

The data presented in the following sections derives both from analysis data and from published bibliographic archives (STOENESCU, 1962) by the National Institute of Meteorology and Hydrology (STOENESCU, 1966).

RESULTS AND DISCUSSION

1. Drought

Drought is a temporary meteorological phenomenon in the climate scenario of areas with high variability of precipitation, by duration, intensity, frequency, spatial-temporal distribution and its direct and indirect effects, affects not only agriculture but the entire economic activity of a region (POVARĂ, 1990).

The immediate impact of drought in agriculture is manifested by the deterioration of plant vegetation, due to the imbalance between absorption and perspiration, and as the moisture deficit in the air and soil worsens from day to day, until the limits of wilting are reached. When the phenomenon of drought sets in over a longer period, it causes a decrease in plant production, produces damage to pastures and natural grasslands and considerable reduction of water resources can even lead to changes in land use (LOMAS & SHASGOUA, 1988).

There are also several types of droughts, of which atmospheric drought is the lack of rainfall and is characterized by a low moisture content in the air. Pedological drought represents the decrease of the accessible water content from the soil to the limit of the withering coefficient. Atmospheric drought causes pedological drought, but can equally occur independently of it. This happens when the air temperature is very high and the relative air humidity is low. Thus, the evapotranspiration process, that exceeds the root absorption power, is increased (CIULACHE & POVARĂ, 1997).

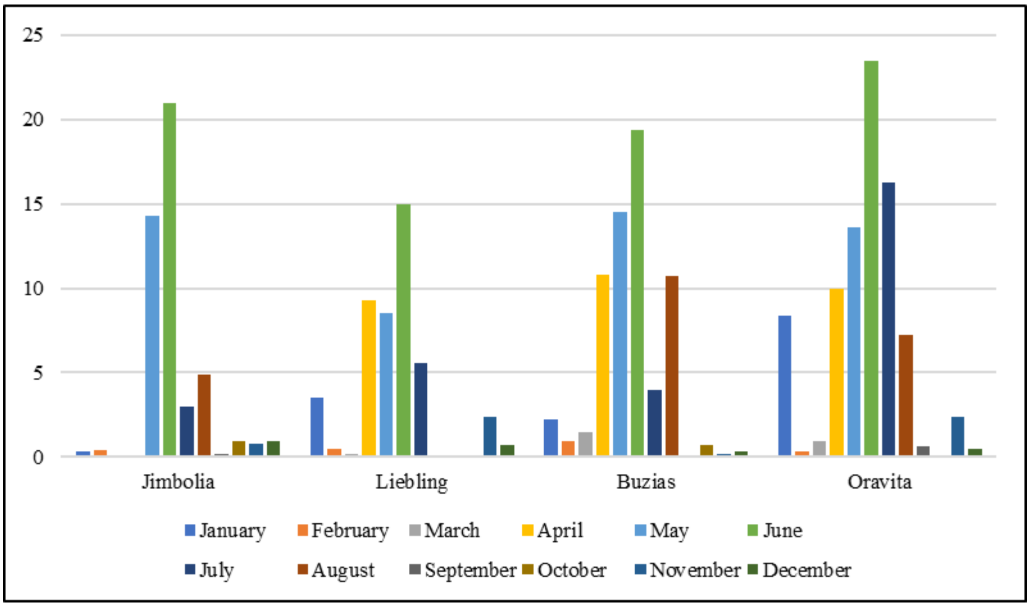

Fig. 1. Minimum precipitation quantities for the timescale 1950 - 2010

The differentiation of the precipitation in both size and location is also highlighted when presenting the minimum monthly quantities. For many of these stations, this value did not exist, that means that practically no precipitation was reported.

Rainfall was absent in March and April at Jimbolia and in August, September and October at Liebling station. In September, there was no rainfall in Buziaș.

The lack of precipitation in time and space generates dryness phenomena, and if this persists, severe drought sets in. The dryness period is characterized by the absence of precipitation in 5 consecutive days, during which time it did not rain at all, or if it rained, the rainfall did not exceed the daily average (BOGDAN & NICULESCU, 1999).

The drought period sets in if for 14 consecutive days in the cold season, as such during October and March, and at least 10 consecutive days in the warm season (April - September), there was precipitation that totalled a minimum of 10 mm.

2. Torrential rain

Torrential rains occur in the warm half of the year, and due to their large amount of water and their intensity, they can generate excessive moisture. They are due to the uneven warming of the earth's surface and the very active dynamics of tropical humid air. Often, rains can be torrential, becoming a climate risk for the environment.

The genetic causes of torrential rains may be frontal in nature, due to the activity of oceanic and Mediterranean cyclones, especially those of retrograde character (DONEAUD, 1958).

The consequences of these rains can be serious in terms of soil erosion and nutrient washing as well as in terms of slope modelling by processes of runoff, landslides and of accumulation of excess moisture (BORONEANȚ & VANCEA, 1986).

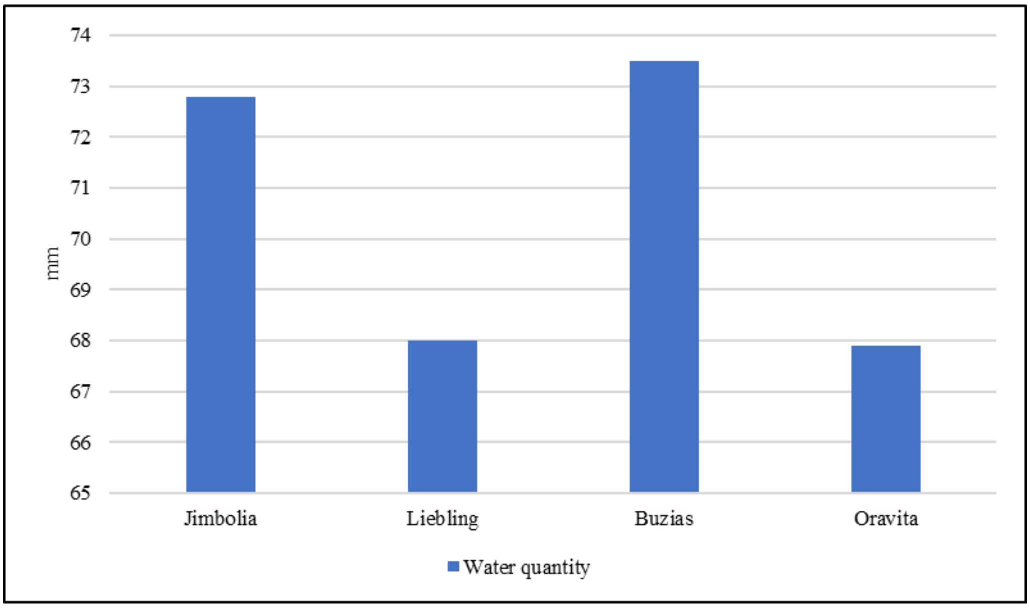

Fig. 2. Torrential precipitation quantities recorded in the timescale 1950 - 2010

The favourable season for recording torrential rains is the warm one, especially between June and August. The destructive effect of torrential rains depends not only on the intensity, duration and amount of precipitable water. It is amplified by many characteristics of the active surface such as the slope, the lithospheric substrate, the absence of the vegetal carpet and the time of year when they occur.

3. Acid rain

Acid rain is one of the most important environmental pollutants, contaminating, on the surfaces where they fall, all environmental factors at the same time and with different degrees of intensity. As a result, surface and groundwater, soil, wildlife and flora are degraded. Acid rain is the result of emissions of sulphates and nitrates, substances that, released into the atmosphere, can be transported by wind at different distances and reach the ground in the form of liquid precipitation, solids or acid dust. If they are not neutralized, they cause great damage with undesirable consequences.

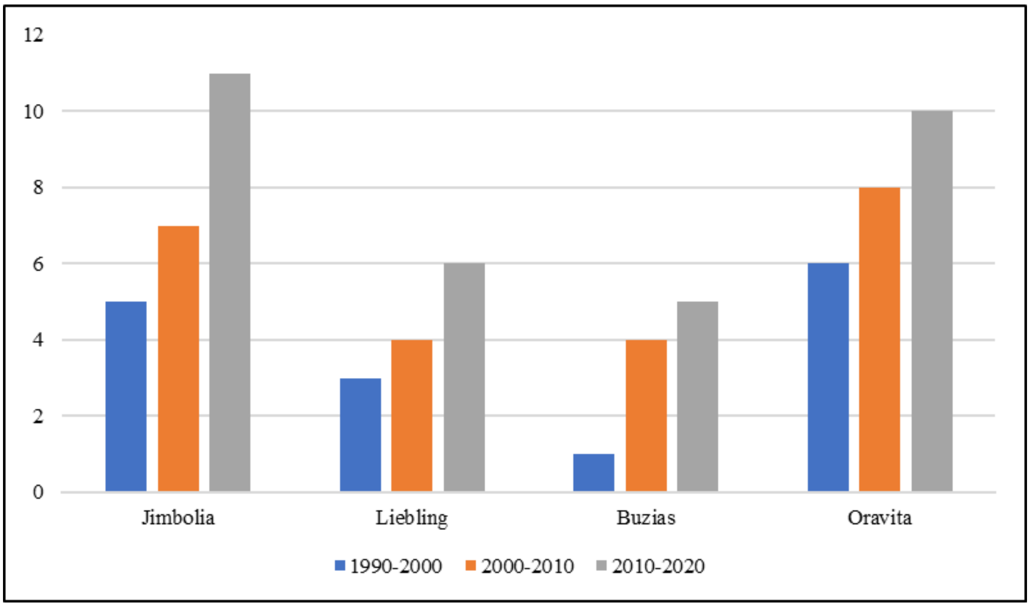

Fig. 3. Number of acid rain events in the timescale 1950 – 2010

The main sources of emissions that have caused acid rain are sulphates and nitrates. Sulphates come from coal-powered power plants and solid-fuel power plants. Depending on the local circulation of the atmosphere and the baric characteristics of the synoptic or mesoscale situation, the sulphites are transported over longer distances to other areas of the western region of Romania. The effects on wheat cultivation can be observed by drying wheat crops in the affected area and by drying grass vegetation. A decrease in production can also be observed for the affected areas.

CONCLUSIONS

The dangerous meteorological phenomena that endanger the wheat harvest in the western part of Romania are, first of all, due to the climate that influences the researched area. The southwest part of the country benefits from a moderate temperate-continental climate with oceanic and sub-Mediterranean influences, as a result of the action of genetic climate factors. Under the action of the atmospheric circulation that transports maritime air masses from western and southwestern Europe, because of the orographic dam of the Carpathians, the continental influences from the east, characterized by special contrasts, are felt very little in the studied area. A significant role in characterizing the dangerous meteorological phenomena for wheat harvest is given by the study of rainfall, through the average annual amounts of rainfall is higher than in the south-southeast regions of the country, through the low number of extreme values regarding the amount and intensity of rains.

In general, from the point of view of operational meteorology, it is taken into account that the dangerous meteorological phenomena registered in the researched area consisted in the occurrence of periods of drought, periods of heavy rains (due to atmospheric blockages) and episodes of hail storms.

The abundance of precipitation in the western part of Romania is caused by the extension of the ridge of the Azores anticyclone, which favours the penetration of wetter air masses from Western Europe. Upon contact with the warmer and drier air from the eastern part of the continent, there is an increase in nebulosity and, as such, the appearance of Cumulonimbus and Nimbostratus clouds with significant rainfall.

The importance of agrometeorological and agroclimatology studies for areas with significant potential for agriculture must be a priority in agronomic research in the conditions of sustainable development and global population growth.

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