HAIL - PHENOMENA OF RISK FOR AGRICULTURE

Mioara ŞIŞU[1], V. D. MIRCOV[2], Simona NITA[2]

[1]CMR Banat – Crişana, Timişoara, str. Gheorghe Adam, nr. 15
[2]Universityof Agricultural Science and Veterinary Medicine of the Banat, Timisora, Romania
E-mail: vlad_mircov@yahoo.com

Abstract: *One of the phenomena associated with atmospheric instability and a negative impact both in daily life, and in pursuit of activities related to agriculture, is the hail. As a type of rainfall, hail consists of ice particles with a diameter of between 5 and 50 mm, sometimes even larger. It emerges from Cumulonimbus clouds and it is usually accompanied by rain showers, lightning and wind gust. Hail is a characteristic phenomenon for the warm period of the year and is formed especially in cold front passage (very active ones) over overheated surfaces. Thermal non-homogeneity in the lower layers of air, or roughness of underlying surfaces, generate upward movement of air, lead to the formation of so-called "convection cells", whose characteristics are essential in hail occurrence. Since in many cases damages are significant and it is difficult to say in the short-range forecasts which areas will be affected by this phenomenon, forecast for the immediate meteorological phenomena and anti-hail measures have a particularly important role. This work presents two synoptic situations that have led to hail in the Western Plain area and which resulted in serious damage. For each of the two cases, a presentation of the synoptic and mesoscale settings (with image examples for some important parameters), followed by a description of the general appearance of the weather, the context in which there were severe weather phenomena, in this case - the production of hail and an estimation of damage. In the end of the work, there is a short presentation of anti-hail methods that can be taken both in our country and at European level.*

Key words: *hail, Cumulonimbus clouds, updrafts, atmospheric instability, anti-hail systems*

INTRODUCTION

Hail is the phenomena associated with atmospheric instability which constitutes a negative impact both in daily life, and in pursuit of activities related to agriculture. As a type of rainfall, hail consists of ice particles with a diameter of between 5 and 50 mm, sometimes even larger ,it can reach 15 cm. Hail is a characteristic phenomenon for the warm period of the year and is formed especially in cold front passage, very active ones, over overheated surfaces. Thermal non-homogeneity in the lower layers of air, or roughness of underlying surfaces, generate upward movement of air, lead to the formation of so-called "convection cells", whose characteristics are essential in hail occurrence.

Since in many cases damages are significant and it is difficult to say in the short-range forecasts which areas will be affected by this phenomenon, forecast for the immediate meteorological phenomena and anti-hail measures have a particularly important role.

MATERIALS AND METHODS

To study the frequency of hail occurrence data from five weather stations in the Western Plain were taken into account. The monthly and annual average number of days with hail was calculated in the period 1961-2009 and the maximum monthly and annual number of days with hail occurrence was identified for each of these stations.

Also, two synoptic situations are presented that have led to hail in the studied area and that have resulted in serious damage. For each of the two cases, a presentation of the synoptic and mesoscale settings (with image examples for some important parameters), followed by a description of the general appearance of the weather, the context in which there were immediate harmful weather phenomena, in this case - the production of hail and an estimation of damage.

RESULTS AND DISCUSSIONS

Hail is formed in Cumulonimbus type clouds. Ideal conditions for its formation are: the presence of very strong upward currents in the cloud, the existence of a large amount of over-cooled water as well as dust particles to constitute the condensation nuclei.

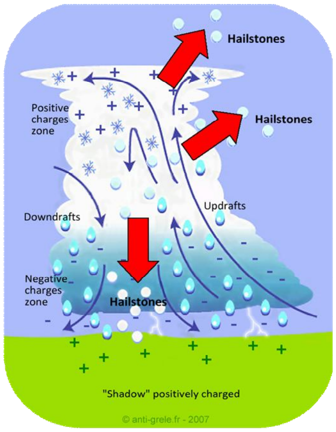

Figure 1. Hail formation process

The most dangerous hail occurrences are the ones in which the presence of an atmospheric front is associated with strong convective developments within the pre-existent air mass. This is reflected in data on the occurrence of hail at the stations considered for the study. A brief look at the monthly and annual average number of days with hail reveals that this meteorological phenomenon is specific for the warm season, namely the period from April to September.

For the five weather stations taken in the study, monthly and annual average number of days with hail calculated for the period 1961-2009 is as follows:

Table 1

Monthly and annual average number of days with hail

Stations	Months												Annual
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	
Timisoara	0,02	0	0,04	0,24	0,24	0,3	0,18	0,04	0,08	0,08	0,02	0,02	1,26
Arad	0,00	0,02	0,16	0,20	0,37	0,37	0,12	0,06	0,04	0,06	0,02	0,00	1,43
Sannicolau Mare	0,00	0,00	0,08	0,20	0,29	0,10	0,22	0,04	0,02	0,00	0,00	0,00	0,96
Oradea	0,00	0,04	0,04	0,14	0,27	0,29	0,12	0,10	0,02	0,02	0,02	0,00	1,06
Chisineu-Cris	0,00	0,02	0,04	0,31	0,24	0,22	0,12	0,06	0,06	0,02	0,00	0,00	1,10

It can be seen from the representations above that the average monthly number of days with hail increased significantly starting with April, reaches its top value in May-June, and then decreases to August - September. The exception is Sannicolau Mare, where the top values are recorded in May and July. The most favorable interval in which hail occurs is between May and July.

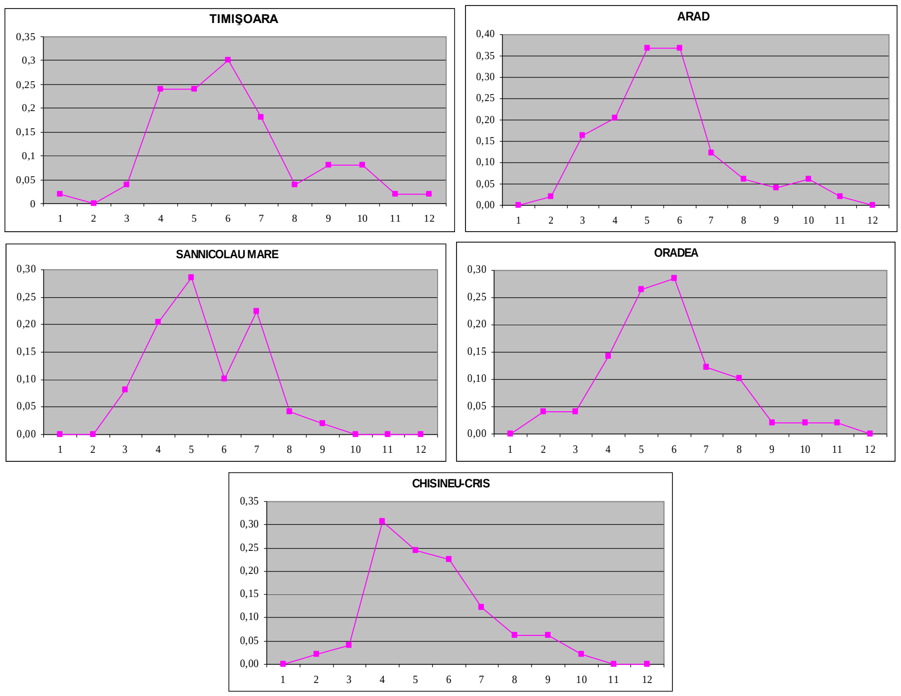

Figure 2. Monthly average number of days with hail

The maximum number of days with hail, monthly and annually for each station is represented in the table below.

Table 2

The maximum number of days with hail, monthly and annual

Stations	Months												Year
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	
Timsoara	1	0	1	2	2	2	1	1	2	1	1	1	4
	1977		1980	1982	1990	1963	1961	1965	1996	1984	1983	1989	1982
Arad	0	1	2	2	3	2	1	1	1	1	1	0	5
		1973	1980	1966	1971	1994	1971	1965	1971	1964	1977		1971
Sannicolau Mare	0	0	1	2	2	1	1	1	1	0	0	0	4
			1968	1966	1964	1980	1965	1968	1972				2009
Oradea	0	1	1	1	2	2	1	1	1	1	1	0	3
		1989	1983	1965	1965	2001	1975	1970	1966	1982	1984		1965
Chisineu-Cris	0	1	1	3	2	3	2	1	1	1	0	0	4
		1989	1966	1985	2008	1979	1978	1968	1963	1966			1979

It can be seen in tables 1 and 2 that the maximum number of days with hail is 2-3 times higher than the average annual number - which is around 1 - and was generally recorded in April-June, some stations also have recorded maximum values in September, March or July. For the studied stations, the maximum monthly number of days with hail was 3: Arad and Chisineu-Cris, and the maximum annual number of days with hail was 5 (Arad).

We are now presenting two hail occurrence situations in the Western Plain area:

The first situation refers to 18-19 May 2008 and it is part of a longer episode of increased instability, due to both the synoptic context as well as the convective movements which in some cases amplified the effects of atmospheric instability.

As for the synoptic context, at a level of 500 hPa in 18.05.2008 h 12 GMT, we are situated on the upward slope of the geopotential thalweg. The relative topography map shows a hot penetration, especially the southern half of country .On the ground, the south movement was caused by a low-pressure area extended all over Europe, running North – South, with multiple nuclei whose cloud systems affected consecutively the west of the country.

The Western area remained under the influence of the low-pressure field shifted in the South/West to North /East direction and its associated frontal systems for five days. Since May 18, the weather became unstable; rainfalls were signalled, electrical discharges and intensification of wind up to 80-90 km/h.

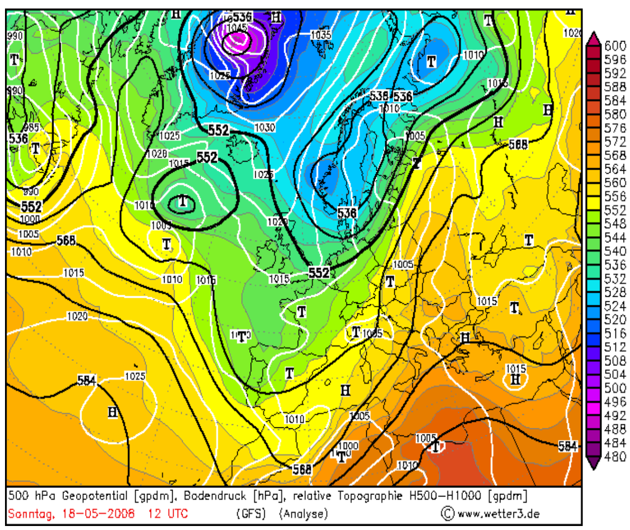

Figure 3. Geopotential at 500 hPa and ground pressure in 18.05.2008 h 12 GMT

Monitoring the evolution and movement of the cloud systems with the help of the Doppler radar indicates, through images and data like the ones in Figure 4, a high probability of hail occurrence in the immediately following period, in the moving direction of the marked cloud systems.

Quantities of precipitation up to 72 l/m^2 and numerous reports of hail were recorded in: Timisoara, Arad, Utvinis, Pischia, Baile Herculane, Chisineu-Cris, Sagu. In the Chisineu-Cris area, the hail pieces were up to 5 cm in diameter. Many crops in the area have been affected, and between Chisineu-Cris and Sintea Mare a 2.5 hectares orchard was totally destroyed. In the Adea area the villagers' gardens and about 200 hectares of land with different crops have been compromised by hail.

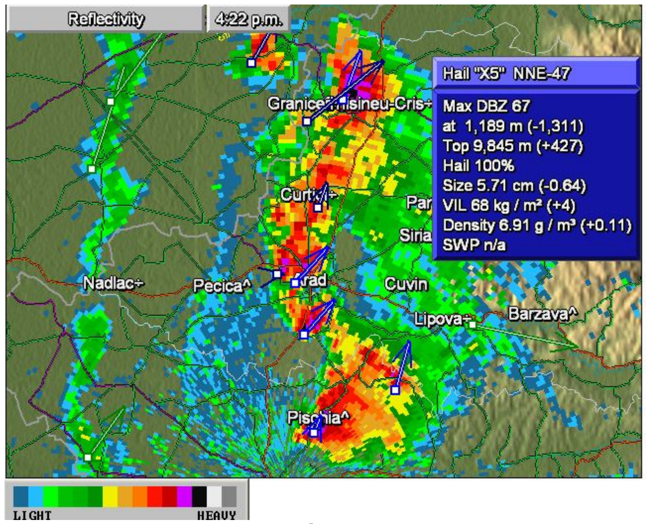

Figure 4. Radar parameters

Figure 5. Crops destroyed by hail

On 10-11 June 2009 another episode of increased instability took place. Phenomena intensity was higher in the evening and the night of 10/11 June.

The synoptic context in which the mentioned phenomena occurred favored instability: the Western part of our country was situated on the upward slope of the geopotential thalweg, and on the ground, the area has been crossed, in a very short time, by a nucleus that was separated from the large low pressure area that included west and north-west Europe.

The radar parameters were indicating a very high probability of hail occurrence, as it is seen in Figure 7.

Precipitation amounts of up to 62 l/m^2 were recorded (Timis County), as well as wind gusts up to 70 km/h. There were hail falls in Banloc (10 mm in diameter) and Timisoara - the Airport area.

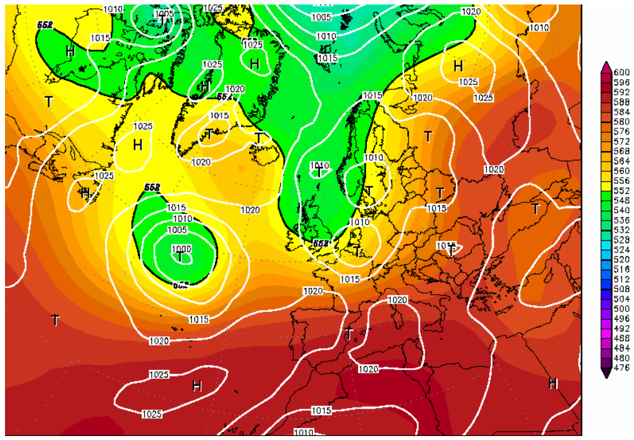

Figure 6. Geopotential at 500 hPa and ground pressure in 11.06.2009 h 00 GMT

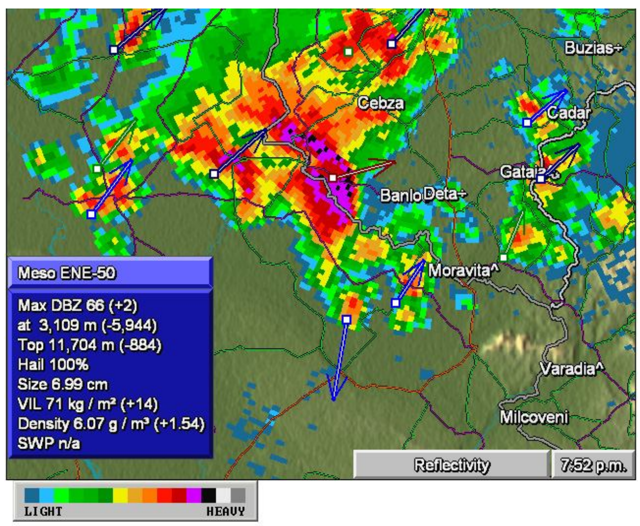

Figure 7. Radar parameters

According to data processed by specialized institutions in Bihor County and Caras-Severin County, in June, hundreds of hectares of farmland were affected by hail, partially or entirely.

Given the extent of damage in many hail occurrence cases, it is useful to know that anti-hail protection systems exist. One of them is the **anti-hail cannon.** This is a shockwave generator. The principle behind the antihail cannon is to prevent the damage cost by hailstones by eviting thier formation and growth by melting all together.

Another protection system is the **anti-hail net.** This system is a rather sure mean of protection against hail but it also has disadvantages: installation and handling costs are quite high, aproximately 5000 Euro/ha, and on the other hand, anti-hail nets are not efficient in the event of very strong hail storms.

A system that is more often used is the **silver iodide anti-hail rocket.** With a molecular structure identical to that of water, it serves as artificial seed in the hail-bearing cloud. In Romania, a national anti-hail program has been initiated, whose implementation will run over 14 years, with costs exceeding 3 milion Euro. The implementation of this protection system is wanted in 5 centers in the following counties: Prahova, Iasi, Vrancea, Timis and Mures. There counties were selected in the wake of the statistics on the frequency and intensity of this phenomenon throughout the country.

CONCLUSIONS

Hail is one of the phenomena that present a particular risk to agriculture. Being typical for the hot season, it can affect crops of vegetables, cereals, fruit trees and vines in various stages of development.

To reduce or prevent damage caused by hail, protective measures can be taken, both at the level of individual farms, as well as regionally. If they are based on an efficient method to detect hail-bearing clouds and their trajectory, these measures can prevent the destruction of crops and other properties, and, why not, they can save lives.

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