

The Effect of Climatic Changes – Hail and Storm on Sunflower Hybrids – Constanta County, Dobrogea Area, Romania.

Dumitru Manole^{1*}, Ana Maria Giumba¹, Laurentiu Luca Ganea² and Viorel Ion²

¹S.C. SPORT AGRA S.R.L. – Amzacea, Constanța County, Romania.

²University of Agronomic Sciences and Veterinary Medicine of Bucharest, Faculty of Agriculture, Romania.

*Correspondence author

Dumitru Manole

S.C. SPORT AGRA S.R.L. – Amzacea, Constanța County, Romania

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Abstract

Constanta County had the largest area cultivated with sunflower crop in Dobrogea region in South-East Romania in 2019 (23%), 2020 (20.8%), and 2021 (23.4%). Dobrogea is the most drought area in Romania (average rainfall of 464 mm in the period 1961-1990) and the year 2020 was one of the driest year, with rainfall of 348.5 mm. Sometimes, in this region it's possible to have extremely climatic dangerous factors, such as hail and storm. This was happened in the year 2021, when twenty-three sunflower hybrids in an experimental field of S.C. SPORT AGRA S.R.L. in Amzacea Village, Constanta County from Dobrogea region (South-East of Romania) were damaged in 2021, June 12th, by a rainfall with hail and storm, registered in 35 minutes 71 mm rainfall. The sunflower hibryds had 12-14 leaves. The aim of this study is

- to see the behavior of the sunflower hybrids in the unbelievable hail and storm conditions,
- to find out the yield and the tolerance to hail storm the hybrids have,
- to know how the sunflower hybrids behavior to the main pathogens under such severe conditions.

The results of the performed research are showing that there are sunflower hybrids that tolerate the hail storm, this being able to realize good yields even under such severe conditions.

Keywords : sunflower, hybrids, hail and storm, tolerance, grain yield.

Introduction

Constanta County (Dobrogea region, in South-East of Romania) had the largest area regarding the surface cultivated in Romania with sunflower crop - 11% from arable land in 2021, and 23.40% in 2021 from Constanta arable land (according to General Direction of Agriculture and Development Constanta, 2021).

Referring to the market offer for sunflower hybrids we can say it's a large number of hybrids, from different companies. In order to decide which are the most suitable hybrid for every region, it should exist experimental fields not only for sunflower but for other important crops related to a specific region. The hybrids must be from different seed companies eliminating any suspicions regarding the results. In Dobrogea. such experiments were made over the years (Jinga et al., 2016; Manole et al., 2018, 2019) which provided results for grain yield in very dry conditions due to the climatic changes.

Hail is one of the dangerous meteorological phenomena facing society (Angearu et al., 2021), causing significant damages to agricultural crops. The damage with hails is determined by the size ranges and the number of hailstones that fall per unit area

during a hailfall, wind force during the event and the property of the crop canopy: for instance, studies have concluded that most property damage begins when hailstone diameters are 20 mm or greater (Bal et al., 2014).

The results of several scientific researches show a close relationship between yield reduction at sunflower crop and the defoliation levels, respectively the higher the defoliation level, the higher the yield reduction (Erbas & Baydar, 2007; Schreiner et al., 1987). The yield response depends on the growth stage at which the defoliation is experienced and on the extent of the damage (Muro et al., 2001; Bal et al., 2014; Polat et al., 2011). Sunflower can compensate for defoliation damage at certain growth stages by increasing leaf area or delaying senescence (Polat et al., 2011). Moreover, some recovery may occur even if leaf loss is not replaced (Moriondo et al., 2003).

The aim of this study is

- to see the behavior of the sunflower hybrids in the unbelievable hail and storm conditions,
- to find out the yield and the tolerance to hail storm the hybrids have

- to know how the sunflower hybrids behavior to the main pathogens under such severe conditions.

Materials and Methods

The experimental plots were organized in 2021 in the field of S.C. SPORT AGRA S.R.L. Amzacea Village, Constanta County, in Dobrogea region (South-East of Romania) (Figure 1). The number of sunflower hybrids taken into account have



Figure 1: The experimental field organized in 2021 at S.C. SPORT AGRA S.R.L. Amzacea Village, Constanta County in Dobrogea region (South-East of Romania).

The area of each plot was 560 m². The proceeding crop was winter wheat. Sowing was performed on April 4th at a density of 64,250 seeds/ha, 70 cm row spacing and 5.6 cm depth. The hybrid ES Genesis CLP is the only hybrid that was sown at two dates, respectively on April 4th (ES Genesis CLP), as all the other hybrids, but also on April 15th (ES Genesis CLP).

The seeds have been treated against *Plasmopara halstedii* using the fungicide Apron XL 350ES (350 g/l metalaxyl-M (mefenoxam)) at a rate of 3 l/t. The seeds weren't treated with any insecticides against *Tanymecus dilaticollis* Gyll, the studying area was one of the most infested area in Romania with this pest. Therefore, after plant emergence there was needed to be used the insecticide Lamdex Extra (lambda-cyhalothrin 25 g/kg) at a rate of 0.3 kg/ha applied two times in order to ensure the crop protection.

For controlling the pathogens during the vegetation period, two fungicides were applied, respectively: Mirage 45 EC (prochloraz 45%) applied in a rate of 1 l/ha at the growth stage of the sunflower plant of 6-8 leaves, and Pictor (200 g/l dimoxystrobin + 200 g/l boscalid) applied in a rate of 0.5 l/ha after hail storm at June 25th.

For controlling the weeds, the following herbicides were used: Taifun 360 SL (glyphosate 360 g/l), in a rate of 3 l/ha applied in autumn 2020; Efica 960 EC (S-metalachlor 960 g/l) in a rate of 1.5 l/ha and Racer 25 EC (fluorochloridon 250 g/l) in a rate of 2.5 l/ha, mixed up and applied after sunflower sowing; Pulsar Plus (imazamox 25g/l) used only for the imazamox resistant hybrids in a rate of 2 l/ha and at the growth stage of the sunflower plant of 6 leaves; Express 50 SG (tribenuron-methyl

been twenty-three, among which eight sulfonylurea resistant hybrids, respectively RGT Vollter SU, Suomi HTS, P64LE25, P64LE99, P64LE137, ES Aromatic SU, FD15E27, FD19E42, and fifteen imazamox resistant hybrids, respectively Charlotte CL, RA8125647 CL, RA1033711 CL, SY Odessa CLP, SY Onestar CLP, Fergus CLP, Loris CLP, Acordis CLP, Aluris CLP, ES Genesis CLP, ES Janis CLP, ES Anthemis CLP, ES Terramis CL, FD20CL70, HS8566 CL.

500 g/kg) used only for the sulfonylurea resistant hybrids in a rate of 30 g/ha and at the growth stage of the sunflower plant of 6 leaves.

The fertilization was performed in the same time with sowing using a complex chemical fertilizer (Granoro-NP 10.20.0+20SO₃+4Ca+0.5B+0.3ZnO+7.5C-org+Humic Acid) in a rate of 250 kg/ha. Ammonium nitrite (34% nitrogen) was applied in vegetation before hail storm, using 150 kg/ha. Also, a complex foliar fertilizer was applied using Dr.Green product: (145SO₃+5MgO+100B+2Cu+25Fe+50Mn+0.5Mo+20Zn) in a rate of 2 kg/ha at the growth stage of the sunflower plant of 6 leaves.

Phytosanitary assessments were performed on July 27th only for 11 hybrids (the rest of them have been destroyed by the hail) for *Sclerotinia sclerotiorum* (Lib.) de Bary and *Orobanche cumana* Wallr. The degree of attack (DA%) was calculated using the following formula:

$$DA = \frac{F \times I}{100}$$

Where F is the frequency of the attacked plants (%) and I is the intensity of plants attack (%).

The soil where the field experiment was organized is a cambic chernoziom with a deeper profile than other chernozioms and a blackish-brown layer of 40-50 cm thickness, with the following characteristics: medium texture; nitrogen index of 4; phosphorus content of 72 mg/kg; potassium content of 200 mg/kg; humus content of 3.11%; neutral pH (7.2 value).

Constanta County has temperate continental climate. Average annually air temperature is between 11 and 13°C. The absolute minimum temperature of -25°C was registered in 1929, February 10th, and the absolute maximum temperature of 38.5°C was registered in 2007, July 25th.

Rainfall in 2021 (period from January to August) in Amzacea area was of 563.5 mm, the highest between 15 meteorological

stations from all over Dobrogea region which include counties Constanta and Tulcea (Tables 1 and 2). In June 2021, in Amzacea area, the rainfall registered 270 mm, but in June 12th, in 35 minutes, there was registered 71 mm rainfall with hail and storm (Figure 2), in this respect being issued a Warning for Hazardous Meteorological Phenomena for Constanta County, including Amzacea Village (Figure 3). The diameter of hailstone was around 20 mm, and stand of plants vegetation between 12 and 14 leaves, near the bud stage.

Days	Month								Sum
	Jan	Feb	March	April	May	June	July	Aug	
The growing season 2020: Rainfall (mm) for 10-day periods									
1-10	0	20	0	0	18	4	29	2	73
11-20	0	0	0	4	0	10	0	0	14
21-31	2	8	16	6	14	0	0	0	46
Sum	2	28	16	10	32	14	29	2	133
The growing season 2021: Rainfall (mm) for 10-day periods									
1-10	23	6	14.5	19	0	72.5	15.5	0	150.5
11-20	63.5	27	21	16	2.5	150	3	0	283
21-31	36	1	26	0	19.5	47.5	0	0	130
Sum	122.5	34	61.5	35	22	270	18.5	0	563.5
Average 1961-1990: monthly values of rainfall (mm)									
1-31	27.7	24.0	29.1	31.8	37.7	47.1	38.9	37.4	273.7


Table 1: Rainfall during 2020 and 2021 (period from January to August) in Amzacea area, Constanta county from Dobrogea region.

No	County	Meteorological Station	Month								Total I-VIII
			Jan	Feb	March	April	May	June	July	Aug	
1	CT	Adamclisi	82.3	29.7	75.2	45.0	56.4	171.2	90.6	11.6	562.0
2	CT	Cernavoda	72.5	19.3	45.5	34.8	61.2	111.0	96.3	6.1	446.7
3	CT	Constanta	74.8	22.8	52.3	64.1	53.6	129.5	36.0	5.3	438.4
4	CT	Constanta Dig	61.5	9.3	48.5	76.7	66.0	180.3	40.1	8.3	490.7
5	CT	Harsova	72.2	12.0	59.4	45.0	59.2	184.6	90.2	13.8	536.4
6	CT	Mangalia	101.2	17.2	26.3	38.0	24.4	131.2	52.1	71.1	461.5
7	CT	Medgidia	66.7	29.3	39.9	38.0	59.8	149.8	29.2	3.4	416.1
8	TL	Corugea	45.0	27.2	29.3	30.7	45.9	89.6	59.8	5.2	332.7
9	TL	Jurilovca	33.0	8.3	27.3	30.3	34.9	101.5	35.7	8.0	279.0
10	TL	Gorgova	86.0	25.8	36.2	40.7	33.6	105.3	17.8	10.7	356.1
11	TL	Gura Portitei	46.3	10.4	19.4	37.4	12.8	124.8	23.0	22.8	296.9
12	TL	Mahmudia	67.0	18.2	19.8	35.2	34.0	149.2	18.4	19.4	361.2
13	TL	Sf. Gheorghe	64.2	8.0	30.0	38.0	11.1	119.3	50.6	32.8	354.0
14	TL	Sulina	43.3	4.9	17.7	28.2	32.8	74.5	20.2	7.8	229.4
15	TL	Tulcea	66.7	14.3	32.6	34.6	52.8	95.8	23.2	24.6	344.6

Table 2: Rainfall during 2021 (period from January to August) at the meteorological stations in Dobrogea region (Constanta county – CT; Tulcea county – TL).







Figure 2: The experimental field on June 12th, 2021, Amzacea Village, Constanta County in Dobrogea region (South-East of Romania), after the rainfall with hail and storm.




MINISTRY OF ENVIRONMENT,
WATERS AND FORESTS

NATIONAL METEOROLOGICAL ADMINISTRATION

METEO



ROMANIA

DOBROGEA REGIONAL METEOROLOGICAL CENTRE

WARNING FOR HAZARDOUS METEOROLOGICAL PHENOMENA

RED CODE

Issued: 12 June 2021	Time: 13:11 L.T.	No. 93
Ministry of Environment, Waters and Forests, Department for Emergency To: Situations, General Inspectorate for Emergency Situations, River Basin Administrations, Inspectorate for Emergency Situations and Constanta County Prefecture		
Warned phenomena:	Torrential rain showers that will accumulate over 40...50 mm, frequent thunder, hail, squalls. More than 40-50mm have accumulated in the warned area.	
Concerned areas:	- Constanta county: Tuzla, Negru Vodă, Topraisar, 23 August, Limanu, Chirnogeni, Albești, Amzacea , Pecineaga, Mereni, Costinești, Comana, Cerchezu, Mangalia.	
Validity interval:	12 June 2021 13:15 L.T. to 12 June 2021 14:00 L.T.	

Figure 3: The Warning for Hazardous Meteorological Phenomena issued for Constanta county, including Amzacea Village, on June 12th, 2021.

Results and Discussion

The sunflower plant emergence took place after 17 days from sowing for all the hybrids, and the stand density varied between 5 and 7 plants on square meter (Table 3). On May 25th, the sunflower plants had between 6 and 10 leaves. With just two days before the rainfall with hail and storm, respectively on June 10th, the sunflower plant height varied between 108 cm (ES Anthemis CLP hybrid) and 86cm (Aluris CLP).



Aluris CLP86 cm.



Anthemis CLP 108 cm.



The hybrid FD20CL70 after the hail and storm – 09.07.2021



Anthemis hybrid after the storm and hail – 09.07.2021 – The best hybrid

No crt.	Sunflower hybrid	Sowing date	Date of emergence	Stand density (plants/m ²)	No of leaves per plant, May 25 th	Plant height, June 10 th (cm)
1	RGT Vollter SU	04.04	21.04	6	8	105
2	Suomi HTS	04.04	21.04	7	8	107
3	P64LE25	04.04	21.04	7	8	115
4	P64LE99	04.04	21.04	7	8	100
5	P64LE137	04.04	21.04	7	10	108
6	ES Aromatic SU	04.04	21.04	7	8	105
7	FD15E27	04.04	21.04	7	8	110
8	FD19E42	04.04	21.04	7	6	95
9	Charllote CL	04.04	21.04	6	8	105
10	RA8125647 CL	04.04	21.04	7	10	102
11	RA1033711 CL	04.04	21.04	6	10	110
12	SY Odessa CLP	04.04	21.04	6	8	107
13	SY Onestar CLP	04.04	21.04	7	8	105
14	Fergus CLP	04.04	21.04	6	8	102
15	Loris CLP	04.04	21.04	6	10	104
16	Acordis CLP	04.04	21.04	6	10	112
17	Aluris CLP	04.04	21.04	5	8	86
18	ES Genesis CLP I	04.04	21.04	6	8	108
19	ES Genesis CLP II	04.04	21.04	6	6	88
20	ES Janis CLP	04.04	21.04	6	8	103
21	ES Anthemis CLP	04.04	21.04	6	8	108
22	ES Terramis CL	04.04	21.04	6	8	114
23	FD20CL70	04.04	21.04	6	6	95
24	HS8566 CL	04.04	21.04	7	8	90

Table 3: The sunflower plant status according to the hybrid before the rainfall with hail and storm registered in June 12th, 2021, in Amzacea area, Constanta country from Dobrogea region.

The hail damages consisted in the fell down of the sunflower plants, total or almost total defoliation and stem injuries (Figures 4 and 5).

Among the twenty-three sunflower hybrids only eleven have managed to survive the severe rainfall with hail and storm from June 12th, among which three sulfonyleurea resistant hybrids and eight imazamox resistant hybrids (Table 4). Reported to the initial number of sunflower hybrids taken into study, 37.5% sulfonyleurea resistant hybrids and 53.3% imazamox resistant hybrids survived the hail and storm. Thus, the sulfonyleurea resistant hybrids were much more affected by the hail and storm then the imazamox resistant hybrids.



Vollter SU



Figure 4: The effects of the hail and storm on sunflower(sulfonylurea) plants at the hybrids strong affected by the hail, on June 12th, 2021, in Amzacea area, Constanta County from Dobrogea region (South-East of Romania).

On 26th of July, among the eleven survived hybrids, seven were flourished and four were in the grain filling phase. At full maturity, on 15th of September, the number of plants/m² of the survived hybrids varied between 2 and 5 and the grain yield at 9% moisture content varied between 587 kg/ha (RA8125647 CL hybrid) and 2232 kg/ha (ES Anthemis CLP hybrids) (Table 4).

Grain yields higher than 2000 kg/ha were registered at the hybrids ES Anthemis CLP and Aluris CLP, respectively at the hybrids that tolerated best the hail and storm and that managed to have at maturity 5 plants/m². Grain yields between 1000 and 2000 kg/ha were registered at the hybrids FD20CL70, SY Onestar CLP, HS8566 CL, and ES Genesis CLP, respectively at the hybrids that managed to have at maturity 3-4 plants/m². The hybrids with best yields under the effect of the severe hail and storm were those least affected by hail, the plants being less defoliated and the remaining standing.

Analyzing the situation registered at the hybrid ES Genesis CLP sown at two dates, it can be seen that the sunflower plants more advanced in vegetation in the case of sowing on April 4th (ES Genesis CLP) were less affected by the hail and storm compared with the younger plants in the case of later sowing, respectively on April 15th (ES Genesis CLP). Thus, the grain yield for ES Genesis CLP I was of 1160 kg/ha, while for ES Genesis CLP II it was of 700 kg/ha.



Anthemis CLP



Genesis CLP 1



Genesis CLP 2





Figure 5: The effects of the hail on sunflower plants at the hybrids(Aluris) tolerating best the hail and storm, on June 12th, 2021, in Amzacea area, Constanta County from Dobrogea region (South-East of Romania)

No crt.	Sunflower hybrid	Plant development phenophase, July 26 th	No of plants/m ² , September 15 th	Grain yield (kg/ha) at 9% moisture content
1	P64LE137	Flourished	2	677
2	ES Aromatic SU	Flourished	2	601
3	FD15E27	Flourished	2	595
4	RA8125647 CL	Flourished	3	587
5	SY Odessa CLP	Grain filling	3	952
6	SY Onestar CLP	Grain filling	4	1339
7	Aluris CLP	Grain filling	5	2099
8	ES Genesis CLP I	Grain filling	3	1160
9	ES Genesis CLP II	Flourished	2	700
10	ES Anthemis CLP	Grain filling	5	2232
11	FD20CL70	Flourished	4	1628
12	HS8566 CL	Flourished	3	1313

Table 4: The sunflower hybrids which survived the severe rainfall with hail and storm from June 12th, 2021, in Amzacea area, Constanta county from Dobrogea region (South-East of Romania) and the plants development and grain yield.

No crt.	Sunflower hybrid	Hibryd potential	Yield/ha	% of losses	Constanta County Average yield/ha	Diference kg/ha	Price/ T October 26th CPT Constanta 670 USD
1	P64LE137	3850	677	82,42	3003	2326	-1558
2	ES Aromatic SU	4000	601	84,98	3003	2402	-1609
3	FD15E27	4120	595	85,56	3003	2408	-1613
4	RA8125647 CL	3500	587	83,23	3003	2416	-1618
5	SY Odessa CLP	3430	952	72,25	3003	2051	-1374
6	SY Onestar CLP	3780	1339	64,58	3003	1664	-1114
7	Aluris CLP	3800	2099	46,61	3003	904	-605
8	ES Genesis CLP I	4500	1160	74,23	3003	1843	-1234
9	ES Genesis CLP II	4500	700	84,5	3003	2303	-1543
10	ES Anthemis CLP	4000	2232	44,2	3003	771	-516
11	FD20CL70	3880	1628	58,05	3003	1375	-921
12	HS8566 CL	3970	1313	66,93	3003	1690	-1132

Table 5: Economical data – Losses – 2021
1 dollar = 4.2587 Lei

The degree of attack of *Sclerotinia sclerotiorum* was very low, the highest value being registered to the hybrid P64LE137 (0.4%). Hybrid FD20CL70 has been affected to the stem starting from internode 2-3, where the plants developed branches, and later on the button of the head. All the hybrids registered no attack of *Orobanche Cumana* (Table 6).

No crt.	Sunflower hybrid	Degree of attack (DA) - %	
		Sclerotinia sclerotiorum	Orobanche cumana
1	P64LE137	0,4	0
2	ES Aromatic SU	0	0
3	FD15E27	0,2	0
4	RA8125647 CL	0,3	0
5	SY Odessa CLP	0,2	0
6	SY Onestar CLP	0,3	0
7	Aluris CLP	0	0
8	ES Genesis CLP I	0	0
9	ES Genesis CLP II	0	0
10	ES Anthemis CLP	0	0
11	FD20CL70	0	0
12	HS8566 CL	0,2	0

Table 6: Degree of attack of pathogens at the sunflower hybrids which survived the severe rainfall with hail and storm from June 12th, 2021, in Amzacea area, Constanta county from Dobrogea region (South-East of Romania).

Conclusions

Under sever rain with hail and storm when the sunflower plants had 12-14 leaves, eleven hybrids out of twenty-three, respectively 47.8% of them managed to survive producing grain yields between 587 kg/ha (RA8125647 CL hybrid) and 2232 kg/ha (ES Anthemis CLP hybrids).

The highest yields were registered by the hybrids with plants less defoliated and the remaining standing.

The sunflower plants more advanced in vegetation were less affected by the hail and storm compared with the younger plants.

The results of the performed research are showing that there are sunflower hybrids that tolerate the hail storm, this being able to realize good yields even under such severe conditions.

Looking to the Table number 5 wich showing economical data, sunflower hybrids resistant to hail and storm minimize the losses from 587 kg/ha (RA8125647 CLP) to 2099 kg/ha (Aluris CLP) – 2232 kg/ha (Anthemis CLP). Converting the yield/ha in USD/T – 670 USD/T CPT Constanta the biggest losess RA8125647 CLP (1618 USD/ha) and the lower Anthemis CLP (516 USD/ha) and Aluris CLP (605 USD/ha).

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