SUNFLOWER DOWNY MILDEW, IN YEAR 2021, IN EAST OF THE ROMANIAN PLAIN

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Abstract

Seed yield decrease at sunflower genotypes infected with pathogen *Plasmopara halstedii* because the plants remain small and the seeds are dry. In last years, sunflower downy mildew has developed new races and it is important to identifying which races is present. In year 2021, in Fundulea location we tested a differential set for sunflower downy mildew and identified 12 races of pathogen *Plasmopara halstedii:* 300, 304, 310, 314, 330, 334, 700, 703, 704, 710, 714, 731. New races present in Fundulea location, in year 2021 are 703, 704 and 731.

Key words: sunflower, downy mildew, races, differential set

Nowadays, the pathogen *Plasmopara halstedii* develops new races (Gontcharov S.V., Goloschapova N.N., 2020) and is present all over the world where is cultivated sunflower (Spring O., 2019; Bán R. *et al*, 2021).

Sunflower downy mildew causes low seed yield when environmental conditions (temperature and precipitations) allow the development of this pathogen (Andreeva K.K. *et al*, 2020).

Seed treatment against pathogen *Plasmopara halstedii* with fungicides and pesticides, show good results (Humann R. *et al*, 2019; Doshi P. *et al*, 2020).

MATERIAL AND METHOD

In 2021, on April 14, 2021, we sowed in natural conditions, a differential set with eleven sunflower genotypes, to identify races of downy mildew present in Fundulea location (*table 1, 2*).

Table 1

Differential set used for determination of pathotype of downy mildew
(adapted after Gascuel Q. *et al*, 2015, 2016; Martín-Sanz A., 2019; Trojanova Z. *et al*, 2016)

Differential genotype			Pathotypes of *Plasmopara halstedii*													
		100	300	304	307	314	330	334	700	703	704	707	710	714	730	774
D1	LC985	S	S	S	S	S	S	S	S	S	S	S	S	S	S	S
D2	RHA265	R	S	S	S	S	S	S	S	S	S	S	S	S	S	S
D3	RHA274	R	R	R	R	R	R	R	S	S	S	S	S	S	S	S
D4	PMI3	R	R	R	R	S	S	R	R	R	R	R	S	S	S	S
D4	DM2	R	R	R	R	S	S	R	R	R	R	R	S	S	S	S
D4	DM3	R	R	R	R	S	S	R	R	R	R	R	S	S	S	S
D7	HAR4	R	R	R	S	R	R	R	R	S	R	S	R	R	R	R
D8	QHP1	R	R	R	S	R	R	R	R	S	R	S	R	R	R	R
D8	HAR5	R	R	R	S	R	R	R	R	S	R	S	R	R	R	R
D9	HA335	R	R	S	S	S	R	S	R	R	S	S	R	S	R	S
D15	RHA419	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R

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Table 2

***Pl* genes of differential genotypes used in identification of races of pathogen *Plasmopara halstedii* in Fundulea location, in year 2021 (adapted after Gascuel Q. *et al*, 2015, 2016; Martín-Sanz A., 2019; Trojanova Z. *et al*, 2016)**

Differential genotype		Origin	Gene *Pl*
D1	LC985	Fundulea, Romania[1]	no *Pl* gene
D2	RHA265	Fundulea, Romania[1]	Pl_1
D3	RHA274	Novi Sad, Serbia[2]	Pl_2/Pl_{21}
D4	PMI3	Novi Sad, Serbia[2]	Pl_{PMI3}
D4	DM2	PI 552947, USA[3]	$Pl_5/Pl_{11}/Pl_{12}$
D4	DM3	PI552948, USA[3]	*Pl????*
D7	HAR4	Novi Sad, Serbia[2]	*Pl???*
D8	QHP1	PI 66418, USA[3]	Pl_{15}/Pl_{16}
D8	HAR5	PI 650763, USA[3]	Pl_{13}
D9	HA335	PI 518773, USA[3]	Pl_6
D15	RHA419	PI 619204, USA[3]	Pl_{Arg}
Additional	RHA340	PI 518778, USA[3]	Pl_8
Additional	HA288	Novi Sad, Serbia[2]	*Pl???*

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[3] North Central Regional Plant Introduction Station (NCRPIS), part of United States National Plant Germplasm System (NPGS)

We tested three experimental sunflower hybrids with resistance at sulfonylurea herbicide (tribenuron-methyl active substance) and three experimental sunflower hybrids with resistance at imidazolinone herbicide (imazamox active substance) to see behavior regarding downy mildew. This experimental sunflower hybrids, was were sown in four rows of seven meters long in three repetitions, on April 14, 2021, in natural conditions in Fundulea location (*table 3*). Pre-seeding treatment of sunflower seeds of experimental hybrids was performed with two fungicides: Maxim® XL (active ingredients, mefenoxam and fludioxonil) and Apron® XL (active ingredient, mefenoxam).

Table 3

Experimental sunflower hybrids tested in Fundulea location, in year 2021for resitance/tolerance at pathogen *Plasmopara halstedii*

Number	Experimental sunflower hybrid	Combination between cytoplasmic androsterile line (line A) and fertility restoration line (line C)	*Pl* gene
1	H1SU	2018A SU-CL+ x 2019C SU-CL+	Pl_2/Pl_6
2	H2SU	2019A SU-CL+ x 2019C SU-CL+	Pl_2/Pl_6
3	H3SU	2019A SU-CL+ x 2018C SU-CL+	Pl_2/Pl_6
4	H4CL+	2020A-IMI+ x 2017C SU-CL+	$Pl_2/Pl_6/Pl_{???}$
5	H5CL+	2020A-CL+ x 2019C SU-CL+	$Pl_2/Pl_6/Pl_{???}$
6	H6CL+	2020A-CL+ x 2018C SU-CL+	$Pl_2/Pl_6/Pl_{???}$

RESULTS AND DISCUSSIONS

The average temperature in month April (9.7°C) in year 2021, was very low and because of that, the emergence of sunflower genotypes was much delayed. Under normal temperature conditions (15°C), sunflower emerge ten days after sowing, but in 2021 it emerge after 24 days. The average temperature in May (17.2°C) and June (21.1°C) was suitable for the development of the pathogen *Plasmopara halstedii* (*figure 1*).

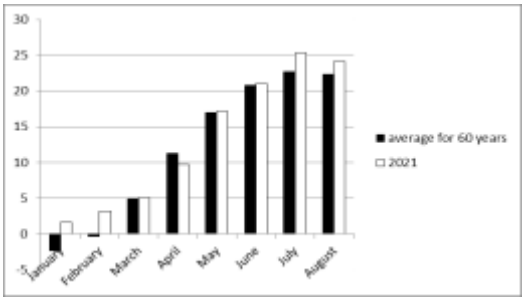

Figure 1 **Temperature (°C) registered in Fundulea location, in year 2021**

The average precipitations in year 2021, in months May (57.6 mm) and June (135 mm) was suitable for the development of the pathogen *Plasmopara halstedii* (*figure 2*). In Fundulea location, annual average rainfall is 571 mm. (https://www.incda-fundulea.ro/informatii_en.htm)

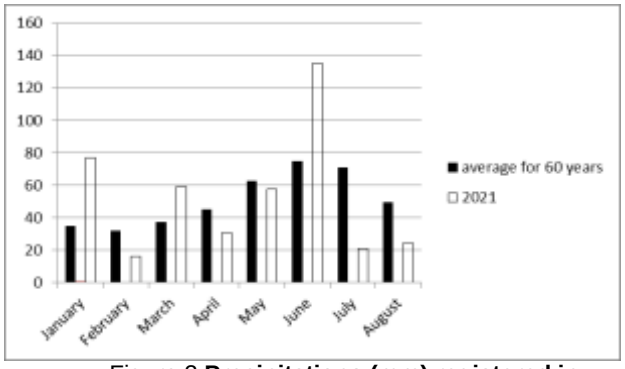

Figure 2 **Precipitations (mm) registered in Fundulea location, in year 2021**

At phenophase of ten true leaves, we note in natural field, in location Fundulea, about plants of differentials set with sporulated leaves for determined races of pathogen *Plasmopara halstedii* (*table 4*), to identifying races of sunflower downy mildew present in this area.

The attack degree of pathogen *Plasmopara hastedii*, was calculate after formula, where AD is attack degree, F is frequency of attack (number of plants attacked) and I is intensity of attack (depending on the size of the surface of the sunflower plant infected with the pathogen *Plasmopara halstedii*):

$$AD = \frac{FxI}{100}$$

In following of notation about degree of infection with pathogen *Plasmopara halstedii*, we identifying twelve races of this pathogen: 300, 304, 310, 314, 330, 334, 700, 703, 704, 710, 714, 731.

Table 4

Attack degree of differential genotypes used in identification of races of pathogen *Plasmopara halstedii*, in Fundulea location, in year 2021

Differential genotype		Sunflower plants sporulated / *total number of sunflower plants (average of three repetitions)*	Attack degree of pathogen *Plasmopara halstedii (average of three repetitions)*
D1	LC985 no *Pl* gene	58 /60	96%
D2	RHA265 Pl_1	7 /60	11.6%
D3	RHA274 Pl_2/Pl_{21}	22 /60	36.6%
D4	PMI3 Pl_{PMI3}	7 /60	11.6%
D4	DM2 $Pl_5/Pl_{11}/Pl_{12}$	12 /60	20%
D4	DM3 *Pl??*	18 /60	30%
D7	HAR4 Pl_{16}/Pl_{16}	4 /60	6.66%
D8	QHP1 *Pl??*	20 /60	33.3%
D8	HAR5 Pl_{13}	0 /60	0%
D9	HA335 Pl_6	36 /60	60%
D15	RHA419 Pl_{Arg}	0 /60	0%
Additional	RHA340 Pl_8	6 /60	10%
Additional	HA288 *Pl???*	0 /60	0&

According to Trojanova Z. *et al* (2016), gene Pl_8 is effective against all currently known races in Europe, but according to Martín-Sanz A. *et al*, (2019), two sunflower hybrids who has incorporate gene Pl_8 from line RHA 340, was affected by downy mildew.

In our field with sunflower with natural infection with downy mildew, from location Fundulea, in year 2021, differential line RHA340 has an attack degree with pathogen *Plasmopara halstedii* of 10%.

Differential line HAR5 (gene Pl_{13}), has 0% attack degree with pathogen *Plasmopara halstedii*

and according to Trojanova Z. *et al* (2016), gene Pl_{13} is effective against races 100, 300, 310, 330, 700, 710, 730, 731 and 770.

Differential line RHA419 (Pl_{Arg}), has 0% attack degree with pathogen *Plasmopara halstedii* and according to Trojanova Z. *et al* (2016), gene Pl_{Arg} is effective against all currently known races.

Additional, line HA288 (*Pl???*), has 0% attack degree with pathogen *Plasmopara halstedii*, in year 2021, in Fundulea location.

From all six experimental sunflower hybrids tested in natural condition, in Fundulea location, in year 2021, only H4CL+, has a better tolerance at downy mildew with 5% attack degree of pathogen Plasmopara halstedii (*table 5*).

Table 5

Experimental sunflower hybrids tested for resitance/tolerance at pathogen *Plasmopara halstedii*, in Fundulea location, in year 2021

Number	Experimental sunflower hybrid	*Pl* gene	Sunflower plants sporulated */ total number of sunflower plants (average of three repetitions)*	Attack degree of pathogen *Plasmopara halstedii* *(average of three repetitions)*
1	H1SU	Pl_2/Pl_6	6/60	10%
2	H2SU	Pl_2/Pl_6	*8/60*	13.3%
3	H3SU	Pl_2/Pl_6	*8/60*	13.3%
4	H4CL+	$Pl_2/Pl_6/Pl_{???}$	*3/60*	5%
5	H5CL+	$Pl_2/Pl_6/Pl_{???}$	*4/60*	6.66%
6	H6CL+	$Pl_2/Pl_6/Pl_{???}$	4/60	6.66%

CONCLUSIONS

In year 2021, in Fundulea location, new races of pathogen *Plasmopara halstedii* appear (races 703, 704 and 731) and pre-seeding treatment of sunflower seeds with fungicides no assure protection against downy mildew if is many precipitations in first stages of developing.

For creating new resistance sunflower hybrids resistant to downy mildew, we must introduce gene *Pl* in maintainer of fertility line (line B) and restorer of fertility line (line C), from differential lines HAR5 (gene Pl_{13}), RHA419 (gene Pl_{Arg}) and HA288 (*Pl???).*

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