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THE INFLUENCE OF THE *Orobanche cumana* Wallr. ATTACK ON AN ASSORTMENT OF SUNFLOWER HYBRIDS UNDER BRAILA COUNTY CONDITIONS

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Abstract

In infested fields, Orobanche cumana Wallr. causes severe yields and quality losses. In this study, several commercial sunflower hybrids were analyzed. All the tested hybrids presented different levels of infestation, depending on the resistance genes of the used assortment. The hybrid Performer, without resistance genes, presented the highest attack rate, with an average attack rate of 3.09% and the lower attack rate was recorded in case of the hybrid LG 50.635 CLP, with an average attack rate of 0.19%. The highest production (kg/ha) was recorded for the SY BACARDI CLP hybrid, with an average yield per variant of 2493.4 kg/ha (tolerant to Orobanche cumana Wallr. up to breed E), and at the opposite pole, the highest production being registered for the hybrid LG 55.55 CLP, with 3235.3 kg/ha (resistant up to breed G). Regarding the percentage of oil, the lowest values have been recorded in case of hybrids ES JANIS and PERFORMER, with an oil percentage of 44.4%.

Key words*: Orobanche cumana, sunflower, attack degree, oil content.*

INTRODUCTION

Sunflower remains the main plant for obtaining oil in its cultivation area (Chiriac et al., 2018; Arghiroiu et al., 2015). The health status of sunflower culture, seed and oil production are affected by the presence of important pathogens and parasites (Mardare et al., 2015; Mardare et al., 2014; Cristea, 2005).

The yield stability and the agronomic and economic efficiency of sunflower cultivation depend on the influence of genotype, the level of applied technology, and the presence of an important number of diseases caused by the attack of parasitic pathogens. More than 30 diseases have been identified on sunflower (Gulya et al., 1994).

The parasite *Orobanche cumana* Wallr. lives attached on the sunflower's root system and it can cause severe damages that can reach up to 90% depending on the virulence of the populations and physiological races of the parasite in the area cultivated with sunflower and on the attack's intensity (number of broomrape plants formed on one sunflower plant) (Vranceanu, 2000).

Broomrape was described for the first time in Russia at the end of the 19th century. From the southern regions of Russia and Ukraine, the broomrape extended on the same time with the sunflower crops in the other riverside countries, Romania, Bulgaria and Turkey (Vranceanu, 2000).

If we talk about the current situation regarding the spread of broomrape around the world, in addition to Russia, Ukraine, Romania, Bulgaria, Turkey and Spain, as the main sunflower producers, we can also add Serbia, Moldova, Hungary, Greece, Tunisia, Israel, Iran, Kazakhstan, China, Mongolia and Australia because the parasite it has been also reported, and in a few other countries as well (Marinkovic et al., 2014; Gisca et al., 2013; Amri et al., 2012; Pacureanu-Joita et al., 2012; Burlov and Burlov, 2011; Dedic et al., 2009; Molinero-Ruiz et al., 2009).

The aim of the study was to identify the parasite population virulence (O*robanche cumana* Wallr.) in Braila county and the influence on yield and oil content. These results are intended to offer information concerning the sunflower hybrids zoning in this area.

MATERIALS AND METHODS

The testing methodology consisted in using an assortment of sunflower hybrids with known reaction against *Orobanche cumana* Wallr., to identify their virulence. The used hybrids are commercial and were described in trade catalogues by the producer regarding the reaction to the parasite. The research has been carried out over three years (2018, 2019, 2020), but the presence of this parasite was reported only in 2018 as the result of a natural infestation.

Being thought of as an experimental field with several factors, the observations regarding the attack of this parasite were made both in the variant considered as a control and in three other variants where solid and liquid fertilizers were applied. The trial design was randomized incomplete blocks, each variant having three repetitions.

Factor 1 (the assortment of hybrids used): H_1 (ES JANIS) - resistant to race G (Euralis); H_2 (MAS 92. CP) - resistant to race E (Maisadour); H_3 (SY NEOSTAR CLP) - tolerance to race E (Syngenta); H_4 (SY BACARDI CLP) - tolerance to race E (Syngenta); H_5 (LG 50.635 CLP) - resistant to race G (Limagrain); H_6 (LG 55.55 CLP) - resistant to race G (Limagrain); H_7 (PERFORMER) - without resistance genes (NARDI Fundulea); H_8 (FD-15 C27) - tolerance to races F-G (NARDI Fundulea); H_9 (ES GENESIS) - resistant to race G (Euralis).

Factor 2 (fertilization): unfertilized plot (control); urea fertilizer 46% N (90 kg/ha active substance); liquid fertilizer Last N (250 g/l N in one dose: 15 l/ha in 200 l water); liquid fertilizer Last N (250 g/l N in two doses: first application 15 l/ha in 200 l water and the second application, with the same dose, 14 days after).

Regarding the evolution of the parasite and the hybrids reaction, observations were made during the vegetation period. The frequency (F%), the intensity (I%) and the attacking rate (AR%) ware evaluated at the end of flowering, by counting the parasite on each plant (Kaya Y. et al., 2004).

The frequency of the attack was calculated using the formula: $F(\%) = \frac{N}{Nt} \cdot 100$, where: N = the number of the infested sunflower plants; N_t = the total number of analyzed plants.

The intensity of the attack is represented by the number of broomrape plants formed on one sunflower plant and was calculated using the formula: $I\ (\%) = \frac{a}{N}$, where: a = the number of *Orobanche cumana* Wallr. plants; N = the number of infested sunflower plants. Attack rate (AR) was calculated using the formula: $AR(\%) = \frac{F(\%) \cdot I(\%)}{100}$, where: F (%) = frequency, I (%) = intensity.

The percentage of oil was determined using the Infratec 1241 Grain Analyzer. To determine the percentage of seed oil, sunflower seeds were scanned using the infrared spectrometer for grain, Infratec 1241 Grain Analyzer, which is intended for whole seeds, using embedded infrared transmission technology to analyze a wide range of parameters (moisture, protein, oil, etc.)

RESULTS AND DISCUSSIONS

Broomrape (*Orobanche cumana* Wallr.) is the primary parasite of sunflower in the SE area of Romania and it is especially spread over Constanta, Tulcea, Braila, Ialomița, Buzau and Calarasi counties, with a tendency of spreading toward the sunflower crops in the West of Romania (Pricop et al., 2011).

The broomrape's virulence increased significantly in the last two decades due to a short crop rotation and the use of non-resistant sunflower hybrids, causing a loss of yield and oil production (Pricop and Cristea, 2012).

Heavy infestations can cause >50% reduction in yields and severe quality losses (Duca and Glijin, 2013). Mean attack severity corresponds to susceptible cultivars (Terzic et al., 2010).

The parasite-host plant system studied in conditions of natural infestation depends on the homogeneity of the field infestation and on the genetic material had in the study.

The most important economic traits in sunflower are the productions obtained per hectare and the percentage of oil (Hladni et al., 2010; Marinković, 1992).

The experimental results were obtained in 2018 in Braila, Braila County. All the tested hybrids presented different levels of infestation with broomrape. The race structure was evaluated depending on the hybrids reaction and the results regarding the parasite frequency, intensity and attack rate are presented in Table 1.

Table 1. Results on the identification of *Orobanche cumana* Wallr. populations in 2018 in Braila

Experimental variants		Resistant genes	F (%)	I (%)	**AR (%)**
H_1 (ES JANIS)	unfertilized	resistant to	26.0	1.0	0.26
	urea fertilizer 46% N	race G	24.7	1.0	0.25
	Last N (250 g/l N in one dose)		25.9	1.7	0.44
	Last N (250 g/l N in two doses)		12.5	0.3	0.04
				Average	**0.25**
H_2 (MAS 92. CP)	unfertilized	resistant to	100.0	2.7	2.70
	urea fertilizer 46% N	race E	100.0	1.7	1.70
	Last N (250 g/l N in one dose)		85.0	1.0	0.85
	Last N (250 g/l N in two doses)		68.5	2.1	1.44
				Average	**1.67**
H_3 (SY NEOSTAR CLP)	unfertilized	tolerance to	50.0	1.4	0.70
	urea fertilizer 46% N	race E	46.0	1.3	0.60
	Last N (250 g/l N in one dose)		48.0	2.2	1.06
	Last N (250 g/l N in two doses)		35.2	1.1	0.39
				Average	**0.69**
H_4 (SY BACARDI CLP)	unfertilized	tolerance to	60.0	1.2	0.72
	urea fertilizer 46% N	race E	55.2	1.0	0.55
	Last N (250 g/l N in one dose)		51.0	1.0	0.51
	Last N (250 g/l N in two doses)		61.3	3.2	1.96
				Average	**0.94**
H_5 (LG 50.635 CLP)	unfertilized	resistant to	22.0	1.08	0.24
	urea fertilizer 46% N	race G	20.1	0.9	0.18
	Last N (250 g/l N in one dose)		23.2	0.7	0.16
	Last N (250 g/l N in two doses)		20.2	0.8	0.16
				Average	**0.19**↓
H_6 (LG 55.55 CLP)	unfertilized	resistant to	33.0	1.1	0.36
	urea fertilizer 46% N	race G	30.3	1.2	0.36
	Last N (250 g/l N in one dose)		18.5	1.3	0.24
	Last N (250 g/l N in two doses)		30.8	1.1	0.34
				Average	**0.39**
H_7 (PERFORMER)	unfertilized	without	68.0	5.2	3.54
	urea fertilizer 46% N	resistance	65.9	4.1	2.70
	Last N (250 g/l N in one dose)	genes	72.2	3.8	2.74
	Last N (250 g/l N in two doses)		78.9	4.3	3.39
				Average	**3.09**↑
H_8 (FD-15 C27)	unfertilized	tolerance to	68.0	3.6	2.45
	urea fertilizer 46% N	races F-G	53.1	2.9	1.54
	Last N (250 g/l N in one dose)		50.3	3.5	1.76
	Last N (250 g/l N in two doses)		52.3	2.1	1.10
				Average	**1.71**
H_9 (ES GENESIS)	unfertilized	resistant to	21.0	1.2	0.25
	urea fertilizer 46% N	race G	19.3	1.0	0.19
	Last N (250 g/l N in one dose)		22.7	1.8	0.41
	Last N (250 g/l N in two doses)		18.4	1.5	0.28
				Average	**0.28**

The parasite *Orobanche cumana* Wallr., has become more and more dangerous for sunflower crop in Romania. More than half of area cultivated with sunflower is infested with broomrape. The new populations of this parasite, very virulent, which are spread in areas situated near Black Sea, are changing their virulence in short time, the new sunflower hybrids which are resistant at the beginning of their cultivation in this area, quickly loses their resistance (Pacureanu, 2014).

In the experimental year 2018, all the tested hybrids presented different levels of infestation, depending on the resistance genes of the used assortment (Table 1.). The hybrid Performer, without resistance genes, presented the highest attack rate, with an average attack rate of 3.09% and the lower attack rate was recorded

in case of the hybrid LG 50.635 CLP, with an average attack rate of 0.19%, it justifies this process, the hybrid having resistance genes up to the G breed.

Good results on the attack rate were also recorded in the case of hybrids, ES JANIS with an average attack rate of 0.25% and ES GENESIS, with an average attack rate of 0.28%, both having resistance genes up to the G breed. Pricop et al., 2011, identified race G and some populations more aggressive than the race G, during a study carried during 2009-2010, in fields with sunflower monoculture at ARDS Valu lui Traian and Cogealac, located in Constanța County.

The infestation observed in the experimental field located in Braila, enables us to conclude that in our area a physiological race that is more aggressive than race G, exists (Table 2.), but cultivating hybrids with the corresponding gene, can prevent yield losses.

Table 2. Explanations concerning the identification of *Orobanche cumana* Wallr. races in the experimental field

Differential host	Field status
Hybrid without resistance genes	Heavily infested, the field partially blossomed
Hybrid resistant to race E	The plots were infested, the plants bloomed, but the size being smaller
Hybrid tolerant to race E, F, G	Average infestation, the plants bloomed, smaller size
Hybrid resistant to race G	Weakly infested

The high susceptibility of Clearfield cultivars to broomrape could be the consequence of a breeding process in account of the fact that as in Clearfield cultivars less attention is paid to genetic resistance to this parasite since broomrape could be chemically controlled in Clearfield crops (Kaya et al., 2012).

As it can be seen in Table 3., the highest production was recorded for the SY BACARDI CLP hybrid, with an average yield per variant of 2493.4 kg/ha (tolerant to *Orobanche cumana* Wallr. up to breed E), and at the opposite pole, the highest production being registered for the hybrid LG 55.55 CLP, with 3235.3 kg/ha (resistant up to breed G). Regarding the percentage of oil, the lowest values have been recorded in case of hybrids ES JANIS and PERFORMER, with an oil percentage of 44.4%. The following hybrids stood out with an oil percentage of 45.1%, SY NEOSTAR CLP and FD-15 C27.

Table 3. Results concerning the influence of the *Orobanche cumana* Wallr. attack on sunflower medium production per hectare (kg/ha) and oil content (%), 2018

Experimental variants		Resistant genes	**AR (%)**	**Medium production per hectare (kg/ha)**	**Oil content (%)**
H_1 (ES JANIS)	unfertilized	resistant to	0.26	2913.1	44.2
	urea fertilizer 46% N	race G	0.25	2857.4	44.4
	Last N (250 g/l N in one dose)		0.44	3030.0	44.5
	Last N (250 g/l N in two doses)		0.04	3171.7	44.1
		Average	**0.25**	**2993.0**	**44.4**
H_2 (MAS 92. CP)	unfertilized	resistant to	2.70	2395.3	45.0
	urea fertilizer 46% N	race E	1.70	2832.7	44.8
	Last N (250 g/l N in one dose)		0.85	2953.7	45.1
	Last N (250 g/l N in two doses)		1.44	2858.0	44.9
		Average	**1.67**	**2759.9**	**45.0**
H_3 (SY NEOSTAR CLP)	unfertilized	tolerance to	0.70	2293.5	45.1
	urea fertilizer 46% N	race E	0.60	2992.3	45.2
	Last N (250 g/l N in one dose)		1.06	2382.0	45.0
	Last N (250 g/l N in two doses)		0.39	3110.0	44.9
		Average	**0.69**	**2694.5**	**45.1**
H_4 (SY BACARDI CLP)	unfertilized	tolerance to	0.72	1575.1	45.2
	urea fertilizer 46% N	race E	0.55	2806.7	45.1
	Last N (250 g/l N in one dose)		0.51	2812.3	45.0
	Last N (250 g/l N in two doses)		1.96	2779.7	44.8
		Average	**0.94**	**2493.4↓**	**45.0**

H_5 (LG 50.635 CLP)	unfertilized	resistant to	0.24	2922.0	44.3
	urea fertilizer 46% N	race G	0.18	3033.0	44.5
	Last N (250 g/l N in one dose)		0.16	2913.7	44.5
	Last N (250 g/l N in two doses)		0.16	3351.0	44.7
		Average	**0.19**↓	**3054.9**	**44.5**
H_6 (LG 55.55 CLP)	unfertilized	resistant to	0.36	3217.2	45.2
	urea fertilizer 46% N	race G	0.36	3206.7	45.0
	Last N (250 g/l N in one dose)		0.24	3273.0	44.7
	Last N (250 g/l N in two doses)		0.34	3244.3	44.6
		Average	**0.39**	**3235.3**↑	**44.9**
H_7 (PERFORMER)	unfertilized	without	3.54	2801.6	44.2
	urea fertilizer 46% N	resistance	2.70	3177.0	44.5
	Last N (250 g/l N in one dose)	genes	2.74	2617.0	44.7
	Last N (250 g/l N in two doses)		3.39	2878.7	44.3
		Average	**3.09**↑	**2868.6**	**44.4**
H_8 (FD-15 C27)	unfertilized	tolerance to	2.45	2283.3	45.3
	urea fertilizer 46% N	races F-G	1.54	2403.7	44.9
	Last N (250 g/l N in one dose)		1.76	2398.3	45.0
	Last N (250 g/l N in two doses)		1.10	2996.0	45.2
		Average	**1.71**	**2520.3**	**45.1**
H_9 (ES GENESIS)	unfertilized	resistant to	0.25	3027.9	44.3
	urea fertilizer 46% N	race G	0.19	3624.3	44.6
	Last N (250 g/l N in one dose)		0.41	3180.7	44.5
	Last N (250 g/l N in two doses)		0.28	2937.3	44.2
		Average	**0.28**	**3192.6**	**44.4**

CONCLUSIONS

The study proved that the parasite is present in the territory, the populations of *Orobanche cumana* Wallr. being aggressive. All the tested hybrids presented different levels of infestation, depending on the resistance genes of the used assortment. The hybrid Performer, without resistance genes, presented the highest attack rate, with an average attack rate of 3.09% and the lower attack rate was recorded in case of the hybrid LG 50.635 CLP, with an average attack rate of 0.19%.

The highest production was recorded for the SY BACARDI CLP hybrid, with an average yield per variant of 2493.4 kg/ha (tolerant to *Orobanche cumana* Wallr. up to breed E) and at the opposite pole, the highest production was registered for the hybrid LG 55.55 CLP, with 3235.3 kg/ha (resistant up to breed G).

Regarding the percentage of oil, the lowest values have been recorded in case of hybrids ES JANIS and PERFORMER, with an oil percentage of 44.4%.

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