

RESULTS ON THE VIRULENCE OF THE *OROBANCHE CUMANA* WALLR. POPULATIONS IN DOBROGEA, ROMANIA

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ABSTRACT

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, Ialomita, Buzau and Calarasi counties, with a tendency of spreading toward the sunflower crops in the West of Romania. In the last two decades, the population virulence has increased significantly, causing a loss of seeds and oil production.

Experiments for testing *Orobanche cumana* Wallr. infestation were carried out in 2009 and 2010 in fields with sunflower monoculture at ARDS Valu lui Traian and at Cogealac, Constanta county, and also in open fields of *Orobanche* at ARDS Valu lui Traian to determine seed and oil production in conditions without infestation. We identified races more aggressive than race E, as the hybrid Favorit (race F resistant) showed infestation. We also identified some populations more aggressive than the race G, but these new populations were present with a lower frequency; the attack degree of the hybrid PR64E71 (race G resistant) had very low values, without a negative influence on yield. The yield losses reported for the hybrid Performer (without resistance genes) were up to 37%. Hybrids with genetic resistance to race F (Favorit) can be cultivated in Dobrogea, provided the areas that have been strongly affected by broomrape are avoided.

Key words: *Orobanche cumana* Wallr., physiological broomrape races, virulent, differential host assortment.

INTRODUCTION

Broomrape (*Orobanche cumana* Wallr.) is a holoparasitic sunflower parasite that reduces the seed and oil production, the parasite being attached on the sunflower's root system and it can cause severe damages, that can reach up to 100%, depending on the virulence of the populations and on the physiological races of the parasite in the area cultivated with sunflower.

Vrânceanu et al. (1980) identified five pathogenic races named A through E with a set of sunflower differentials carrying the dominant resistance genes *Or*₁ through *Or*₅, which provide cumulative resistance to the five successive races.

In 1995, a new race named F, overcoming all the known resistance genes *Or*₁ through *Or*₅, was identified in Spain (Alonso et al., 1996; Dominguez, 1999).

In 1996, virulent races overcoming the resistance gene *Or*₅ were identified in Romania (Păcureanu et al., 2004) and in Turkey where the new races were more

virulent than the races present in other countries (Kaya et al., 2004).

In 2005, in Spain, Molinero-Ruiz and Melero-Vara identified a new race, named G, which attacked sunflower genotypes resistant to race F.

In 2006, in Russia, *Orobanche cumana* populations that were more virulent than race E were identified (Tatiana Antonova, personally communication).

In Romania, the research carried out by Păcureanu et al. (2009) identified the race G in some experiments in the SE of the country, using a differential host assortment made up of inbred lines and commercial hybrids available in Romania and presented by the authors as being resistant to *Orobanche* races more aggressive than race E.

The aim of the study was to identify the broomrape species populations (*Orobanche cumana* Wallr.) in Dobrogea area, the parasite population virulence and their influence on yield under conditions of moderate and high natural infestation. The results are intended to

offer the farmers information regarding sunflower hybrids zoning in Dobrogea.

MATERIAL AND METHODS

The testing methodology consisted in using a differential host assortment to identify broomrape species structure and their virulence, the assortment consisting of sunflower hybrids with known reaction against *Orobanche cumana* Wallr. parasite. The hybrids that were used are commercial ones and were described by the producers regarding the reaction to the parasite published in trade catalogs or existing data in literature. Research concerning broomrape species (*Orobanche cumana* Wallr.) was conducted in fields with natural infestation at ARDS Valu lui Traian and Cogealac, Constanta County. Research regarding the parasite influence on seed and oil production was conducted at ARDS Valu lui Traian in sunflower monoculture fields for testing the reaction to *Orobanche cumana* Wallr. and also in open field with broomrape at ARDS Valu lui Traian.

The differential host assortment consisted of 4 hybrids mentioned below:

Variant 1: Performer – without resistance genes (NARDI Fundulea);

Variant 2: PR64A89 – resistant to race E (Pioneer Hi-Bred Seeds Agro Romania, 2008 seed catalog);

Variant 3: Favorit – resistant to race F (NARDI Fundulea);

Variant 4: PR64E71 – resistant to race F+ (Păcureanu et al., 2009; Pioneer Hi-Bred Seeds Agro Romania, 2009 seed catalog).

The variant without resistance to *Orobanche cumana* Wallr., the hybrid Performer, was additionally included as sensitivity control to verify the uniformity of infestation in the experimental field.

The trial design was randomized blocks and plant population was 48,500 pl./hectare.

The study regarding the parasite influence on seed and oil production was carried out in 2009 and 2010 at ARDS Valu lui Traian in the following manner: 3 replications; 2 rows/plot; 5 m plot length; 17 plants/row; 2 harvested rows; 7 square meters sown

area/plot; 6.58 square meters harvested area/plot. The harvested seed weight of the plot was calculated under conditions of infestation at Valu lui Traian and Cogealac and was compared to that obtained under conditions of free infestation at Valu lui Traian.

During the vegetation period, observations were made regarding the evolution of the parasite and the hybrids' reaction to its attack. The frequency, the intensity and the attack degree at the end of flowering and before harvest, was determined by counting the parasite on each plant. The number of sunflower plants per plot, the plant height, the calatidium diameter, the number of plants attacked by broomrape, the average number of broomrape stalks per host plant and the production per plot at harvest were recorded.

RESULTS AND DISCUSSION

The accuracy of the research results regarding the parasite-host plant system studied in conditions of natural infestation depends on the homogeneity of the experimental field infestation and on the studied genetic material. The experimental results were obtained in 2009 and 2010 at ARDS Valu lui Traian and at Cultivar Testing Center Cogealac, Constanta County. Infestation with broomrape was high at both locations, Valu lui Traian and Cogealac; however the infestation level and the uniformity of the infestation were higher at Cogealac (Tables 1 and 2).

The race structure was evaluated on the basis of hybrids' reaction from a differential assortment, mentioning that the parasite's aggressiveness was higher at Cogealac because of the frequency (Figure 1), intensity (Figure 2) and attack degree that recorded higher values and hence a more drastic yield reduction (Figure 3).

In both experimental years, 2009 and 2010, the hybrid Performer, without resistance genes, presented higher infestation at Cogealac, where the attack degree was 7.2% in 2009 and 8.6% in 2010 (Table 2). The attack degree at Valu lui Traian was 2.8% in

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2009 and 3.4% in 2010, while the variant values for the determination of the homogeneity infestation were 4.1% in 2009 and 5.3% in 2010. At this level of the attack degree, the yield reduction was significant, being of 13-15% for the hybrid Performer at Valu lui Traian in the two experimental years (Table 1). The yield loss was higher at Cogealac, of 36% in 2009 and of 35% in 2010, because of a stronger infestation (Table 2).

The hybrid PR64A89, resistant to race E, recorded lower values of frequency, intensity and attack degree than the control. The attack degree had values of 0.8-1%

at Valu lui Traian in 2009 and 2010 and the yield reduction was of 3-4% (Table 1), while at Cogealac the attack degree was 2.5-2.6% leading to a yield reduced by 30% in 2009 and 27% in 2010 (Table 2). This could be explained by the fact that the resistance mechanism is complex and the simple count of broomrape stalks that appeared on the soil surface is not enough to elucidate this phenomenon. On the other hand the differential host assortment used to identify the races, may have not fully covered the spectrum of the parasite's virulence.

Table 1. Results on the identification of *Orobanche cumana* Wallr. populations in 2009 and 2010 at Valu lui Traian

Year	<i>Orobanche cumana</i> Wallr. race	Experimental variants - resistance gene	Frequency = [(no. of infested sunflower plants/total no. of plants) x 100]	Intensity = (no. of <i>Orobanche</i> plants/no. of infested sunflower plants)	Attack degree = [(F x I) / 100] (%)	Average yield reduction (%)
2009	A, B, C, D, E, F, G	V ₁ : Performer – without resistance genes	100%	2.8	2.8	13
	E, F	V ₂ : PR64A89 – gene for race E	69%	0.8	0.8	3
	F, G	V ₃ : Favorit – gene for race F	73%	1.2	1	0
	G, G+	V ₄ : PR64E71 – gene for race F+	0%	0.07	0.01	0
	A, B, C, D, E, F, G	Ctrl: Performer – without resistance genes	100%	4.1	4.1	13
2010	A, B, C, D, E, F, G	V ₁ : Performer – without resistance genes	100%	2.9	3.4	11
	E, F	V ₂ : PR64A89 – gene for race E	67%	1	1	4
	F, G	V ₃ : Favorit – gene for race F	68%	1.4	1.6	0
	G, G+	V ₄ : PR64E71 – gene for race F+	3%	0.03	0.02	0
	A, B, C, D, E, F, G	Ctrl: Performer – without resistance genes	100%	5.3	5.3	15

The hybrid Favorit, having resistance gene for race F, had the attack degree of 1-1.6% in 2009 and 2010 at Valu lui Traian, without influence on yield (Table 1). At Cogealac, the attack degree was of 2.5% in 2009 and 2010, but the yield reduction was of 19% in 2009 and 16% in 2010 (Table 2).

This allows us to identify race G of *Orobanche cumana* Wallr. (Table 3). Very low insignificant values were recorded in the hybrid PR64E71, for the frequency, the intensity and the attack degree in both locations, without influence on yield. At Valu lui Traian the attack degree was

of 0.01% in 2009 and of 0.02% in 2010 (Table 1), while at Cogealac the attack degree had higher values, of 0.04-0.05% in both years (Table 2). The hybrid is resistant to race G (Păcureanu et al., 2009) and according to the commercial catalog of Pioneer Hi-Bred Agro SRL Romania 2009 Company it is described as being

resistant to *Orobanche* races that are more aggressive than the race E. The infestation at Valu lui Traian and Cogealac enables us to conclude that in Dobrogea a physiological race that is more aggressive than race G exists (Table 3), but cultivation of hybrids with the corresponding gene can prevent yield losses.

Table 2. Results on the identification of *Orobanche cumana* Wallr. populations in 2009 and 2010 at Cogealac

Year	<i>Orobanche cumana</i> Wallr. race	Experimental variants - resistance gene	Frequency = [(no. of infested sunflower plants/ total no. of plants) x100]	Intensity = (no. of <i>Orobanche</i> plants /no. of infested sunflower plants)	Attack degree = [(F x I) / 100] (%)	Average yield reduction (%)
2009	A, B, C, D, E, F, G	V ₁ : Performer - without resistance genes	100%	7.9	7.2	36
	E, F	V ₂ : PR64A89 - gene for race E	100%	2.5	2.5	30
	F, G	V ₃ : Favorit - gene for race F	100%	2.4	2.5	19
	G, G+	V ₄ : PR64E71 - gene for race F+	19%	0.2	0.04	0
	A, B, C, D, E, F, G	Ctrl: Performer - without resistance genes	100%	7.8	7.9	30
2010	A, B, C, D, E, F, G	V ₁ : Performer - without resistance genes	100%	8.6	8.6	35
	E, F	V ₂ : PR64A89 - gene for race E	100%	2.7	2.6	27
	F, G	V ₃ : Favorit - gene for race F	100%	2.4	2.5	16
	G, G+	V ₄ : PR64E71 - gene for race F+	13%	0.1	0.05	0
	A, B, C, D, E, F, G	Ctrl: Performer - without resistance genes	100%	7.7	7.6	35

Table 3 - Explanations on the identification of broomrape races in the experimental fields

Differential host	Possible situations	Race identification
Hybrid without resistance genes (Performer)	Heavily infested, does not reach blooming	Race above E
Hybrid resistant to race E (PR64A89)	Heavily infested, blooms but the sunflower plants remain small, affected	Race F
Hybrid resistant to race F (Favorit)	Average infestation, the yield is only affected a little, not significant	Race G
Hybrid resistant to race G (Păcureanu et al., 2009) PR64E71	Weakly infested, without influence on yield	Population more virulent than race G

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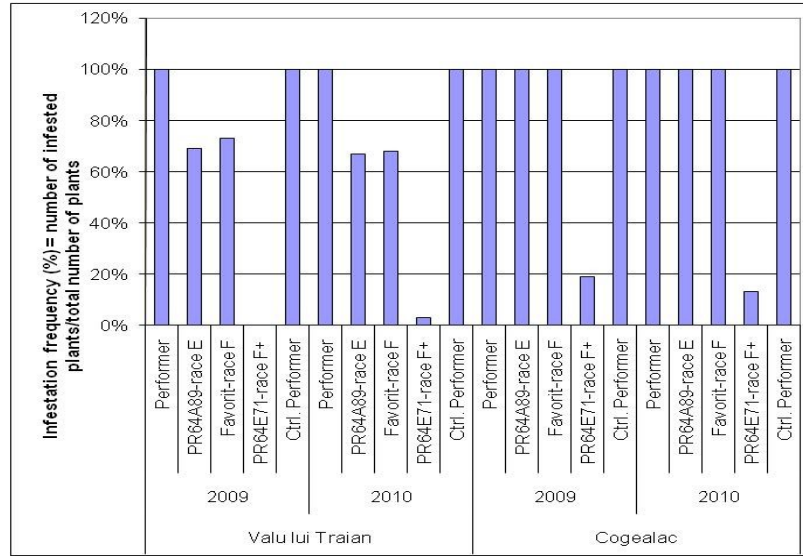


Figure 1. The frequency of broomrape infestation in 2009 and 2010 at Valu lui Traian and Cogealac

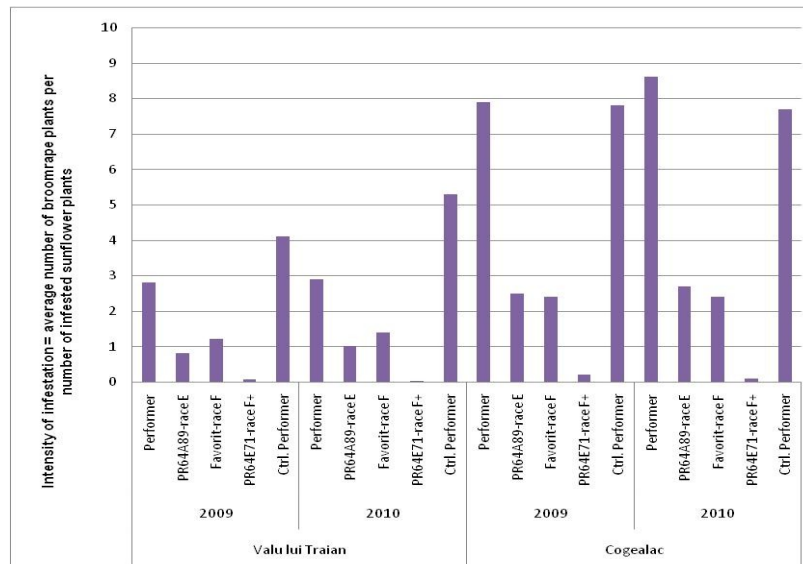


Figure 2. The intensity of broomrape infestation in 2009 and 2010 at Valu lui Traian and Cogealac

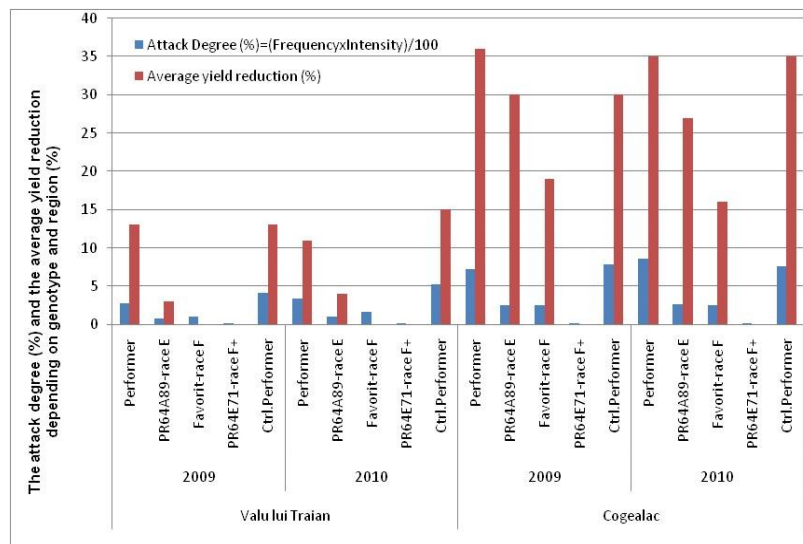


Figure 3. The attack degree and the average yield reduction, depending on genotype in 2009 and 2010 at Valu lui Traian and Cogealac

CONCLUSIONS

The identification of physiological races of the *Orobanche cumana* Wallr. parasite was done by using a differential host assortment that consisted of sunflower hybrids: Performer, PR64A89, Favorit and PR64E71. These hybrids have different genes resistant to the parasite: without resistance genes, resistance to race E, resistant to race F and resistant to race G respectively. The assortment was established based on literature data and descriptions of seed trade catalogs.

The study proved that the parasite is present in the territory in „hearth” of infestation, the structure of *Orobanche cumana* Wallr. populations being more aggressive than race E, a race stable until the year 2000.

We identified race G and also some populations more aggressive than the race G. These new populations are present with a lower frequency; the attack degree of the hybrid PR64E71 had very low values, without a negative influence on yield. The hybrids with genetic resistance to race F (Favorit) can be cultivated in Dobrogea, provided the areas that have been strongly affected by broomrape are avoided. This hybrid proved to be suitable for Valu lui Traian region, but suffered yield losses at Cogealac.

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The results accuracy depends on the structure of the differential host assortment that is used to cover the whole spectrum of the parasite as completely as possible, and also on the homogeneity of infestation with *Orobanche cumana* Wallr. in the experimental field where the identification of physiological races is done.

The race identification must be a continuous process to support farmers, by recommending sunflower hybrids based on the information concerning the parasite spread and virulence throughout the territory. The identification of the parasite physiological races also supports breeders to develop strategy for improvement programs.

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