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The Virulence of Broomrape (Orobanche cumana Wallr.) in Sunflower Crop in Braila Area, in Romania

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Abstract: Broomrape *(Orobanche cumana* Wallr.) is an important parasite in sunflower crop in Europe, some Asian countries and Australia. The parasite has spread in sunflower crop from south Russia and Ukraine. In Romania this was identified for the first time in 1940–1941 year, the most infested area being in central and south Moldavia, south Dobrogea and eastern Baragan. The negative impact of broomrape on sunflower could be found on the cultivated as well as on wild sunflower. For broomrape controlling there have been created resistant sunflower hybrids to different races of the parasite. This paper presents the results obtained by testing sunflower differential set for broomrape races A to F as well as some commercial hybrids for races more virulent than F. Using this differential set and hybrids it has been done testing in different locations from Braila county, in 2014 and 2015 years. We found that in Braila area there are present all races of the parasite which have been identified up to now in sunflower crop in Romania, having important differences between different locations. So, in some locations there is present, as the most virulent, race E, in other locations race F, in some other locations having the most virulent races, more than F. In some locations the parasite is very aggressive, having around one hundred broomrapes per one sunflower plant. We have identified the new races of the parasite in areas were one year before these have not been present.

Keywords: sunflower, broomrape, races, resistant genotypes

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Introduction

The parasitic plant broomrape (*Orobanche cumana* Wallr.) is the most important biotic constraint to the production of sunflower crop, in all countries where sunflower is grown, except North and South America. The parasitism of *O. cumana* on sunflower dates back to the first half of nineteenth century in Russia, (Saţâperov, 1913) expanding to Moldova and Romania by the beginning of twentieth century and later in others like Turkey, Spain, Serbia, Bulgaria and Ukraine. Currently, *O.cumana* is present in all countries in Southern Europe and areas around Black See, as well as in many countries in Asia (Molinero-Ruiz *et al.*, 2015).

There are many *Orobanche* genus species (around 50), in Romania being identified three species paraziting different crops: *O. cumana* on sunflower, *Orobanche (Phelipanche ramosa*) on tobacco and *O. aegiptiaca*, on tomato (Buia, 1961; Iliescu, 1974).

The damage (seed yield losses) produced by broomrape to sunflower crop is high, from 5% to 90%, depending by infestation degree, sunflower genotype and climatic conditions (Vrânceanu, 2000). Sunflower plants attacked by broomrape are small, with thin stems, small heads and empty kernels. One sunflower plant can be parazited by 40–100 broomrape plants, when the attack is very high.

Broomrape is one parasitic plant which attach its radicles or germ tubes, on the sunflower roots (Vranceanu, 2000). It must to pass around 50–60 days from the moment of broomrape fixation on the sunflower roots to the broomrape apparition on the soil surface (Teryokhin and Anisimova, 1980).

The first broomrape races on sunflower crop (races A and B) it have been identified in Russia (Placek, 1930). Russian breeders have developed sunflower varieties genetically resistant to races A and B (Placek, 1930; Pustovoit, 1966). Later (1970–1980) in Romania it have been identified other three races: C, D, E as well as a set of sunflower genotypes, each of them carrying one single major gene of resistance (Vrânceanu *et al.*, 1980). Races A to E were effectively controlled through genetic resistance for some decades, until race F have been identified (Păcureanu Joiţa, 1998).

Along the last decades, a new break of the genetic control of *O. cumana* has occurred in Turkey, Romania, Bulgaria, Russia, Spain, as a consequence of the crop intensification and short crop rotation, together with the use of genetic material from foreign breeding programs. There have been identified new highly virulent races, the hybrids carrying the resistance gene *Or6*, being attacked in high percent (Păcureanu Joiţa *et al.*, 2008).

Important efforts of breeders have been devoted to the search of effective resistance against the increasingly virulent parasite populations and, as a result, resistant genotypes have been released (Păcureanu Joița *et al.*, 2012).

For obtaining new sunflower hybrids, resistant to the new broomrape races, to be cultivated in different areas, it needs to know the distribution of the parasite races. For this reason it must to be done testing of different sunflower genotypes resistant to different races of the parasite, in different areas cultivated with this crop.

Our paper presents the results obtained by testing different sunflower genotypes in Braila area, compared with some results obtained in Ialomita, Constanta and Tulcea areas, in 2014 and 2015 years.

Material and method

Our experiments have been made in infested fields (natural infestation) as well as in the artificial infestation conditions, with broomrape parasite.

In field, each sunflower genotype was planted on 4 rows, in 3 randomized replications. We used different experimental and commercial sunflower hybrids, with different level of resistance to the broomrape parasite, as well as the sunflower differential set for the broomrape races (C to F). Some of used sunflower hybrids have the resistance to the broomrape races, more than F. The experiments have been placed in different locations in Braila area, having soil infested with different races of broomrape.

The experiments in the artificial infestation conditions have been made in the green house, using some pots of 5 l capacity, having inside a mixture of soil and sand (50 % each) as well as broomrape seeds (0.5 g/pot). The broomrape attack was observed on the sunflower plants roots, taking out the plants from soil, after 26 days from the sunflower emergence, in the pots.

The broomrape seeds were collected from infested fields situated in areas cultivated with sunflower, these areas being the most affected by this parasite, in Romania, in 2014 year.

The calculation of the broomrape attack degree was done using the McKinney's formula (Aćimović, 1979):

$$I = \frac{\Sigma(n \times k)}{N \times K} \times 100$$

where: n = the number of broomrapes from one infestation group; k = number of the infestation groups; N = total number of the analized sunflower plants; K = total numbers of the identified infested sunflower plants groups; I = infestation degree;

Results and discussion

The obtained results in 2014 year are presented in the Tables 1–3. Results presented in Table 1 are showing that in Mircea Voda location, in 2014 year, there are races which are overcoming the resistance genes, *Or5* and *Or6*, the race overcoming the gene *Or6*, being present in very low percent, taking into consideration that the genotypes having resistance to the race F are attacked 3% to 7%. The hybrids resistant to the races more virulent than F (type of resistance R7-R8) are not attacked. The seed yield released by hybrids are good, the check for sensibility having a seed yield of 30–40.

Table 1: Results regarding broomrape (*Orobanche cumana* Wallr.) attack, in the field conditions, on some sunflower genotypes, Mircea Vodă, Brăila, 2014.

Genotype	I (%)	Type of resistance	Seed yield (kg/ha)
Favorit	4.2	R6	3,423
CS-D- 1	3.0	R6	3,510
P- L-E-1	7.1	R6	3,487
L-G-5	21.4	R5	3,525
S-G-N-1	5.8	R6	3,423
N-P-CL-3	19.6	R5	3,568
HS 5524	0	R7	3,389
HS 5899	0	R8	3,550
P-L-E-2	0	R7-8	3,688
L-G-1	0	R7	3,326
L-G-2	0	R7-8	3,625
L-G-4	0	R7-8	3,590
M-Y-1	0	R8	3,685
P-L-E-3	0	System 2	3,680
FD15C44	0	R8	3,654
Check	64.4	Sensible	1,540
LSD (P = 5%)			8.43

In Table 2, there are presented results obtained in 2014 year in testing made in Valea Canepii location. No one of the tested differentials or hybrids are resistant. There is only one hybrid which presents kind of resistance or tolerance, this being attacked on the sunflower plants roots, without broomrape plants on the soil surface. The seed yield for all hybrids is quite low, taking into consideration their seed yield potential.

The results presented in Table 3 are showing that in Braila (Research Station) location, in 2014 year, broomrape attacking sunflower has developed

Table 2: Results regarding broomrape (*Orobanche cumana* Wallr.) attack, in the field conditions, on some sunflower genotypes, Valea Cânepii, Brăila, 2014.

Genotype	I (%)	Type of resistance	Seed yield (kg/ha)
Favorit	30.4	R6	3,157
CS-D- 1	25.4	R6	3,055
P- L-E-1	29.0	R6	3,148
L-G-5	42.3	R5	3,070
S-G-N-1	45.1	R6	2,986
N-P-CL-3	47.4	R5	3,076
HS 5524	22.6	R7	3,216
HS 5899	11.3	R8	3,510
P-L-E-2	15.6	R7-8	3,598
L-G-1	27.9	R7	3,109
L-G-2	12.4	R7-8	3,567
L-G-4	8.3	R7-8	3,502
M-Y-1	8.9	R8	3,583
P-L-E-3	0	System 2	1,851
FD15C44	10.7	R8	3,524
Check	83.9	Sensible	347
LSD (P = 5 %)			12.20

Table 3: Results regarding broomrape (*Orobanche cumana* Wallr.) attack, in the field conditions, on some sunflower genotypes, SCDA – Brăila, 2014.

Genotype	I (%)	Type of resistance	Seed yield (kg/ha)
Favorit	0	R6	3,510
CS-D- 1	0	R6	3,576
P- L-E-1	0	R6	3,512
L-G-5	3.7	R5	3,486
S-G-N-1	0	R6	3,395
N-P-CL-3	4.2	R5	3,550
HS 5524	0	R7	3,476
HS 5899	0	R8	3,632
P-L-E-2	0	R7-8	3,566
L-G-1	0	R7	3,298
L-G-2	0	R7-8	3,690
L-G-4	0	R7-8	3,584
M-Y-1	0	R8	3,578
P-L-E-3	0	System 2	3,621
FD15C44	0	R8	3,595
Check	69.8	Sensible	1,647
LSD (P = 5 %)			7.69

only races which do not overcome the resistance gene *Or6*. Sunflower genotypes resistant to the race F are not attacked by broomrape. The hybrids released good seed yield, the check for sensibility having a seed yield of 40 % from its yield potential.

Comparing the results obtained in 2014 year in Braila area with results obtained in the green house, in the artificial infestation conditions (Table 4), it could to conclude that in Braila area, in Valea Canepii location, we have the new races of the parasite, which have appeared some years ago in Tulcea and Constanta areas. In the other two locations, but specially in Braila (Research Station), the broomrape races are the same like in Ialomita area.

Table 4: Results regarding testing of sunflower differentials for the broomrape races, in the artificial infestation conditions (Fundulea, 2014–2015 year).

Differentials	Broomrape populations			
	Iazu-Ialomiţa	Crucea-Constanţa	Traianu-Tulcea	Valea-Cânepii-Brăila
	I (%)	I (%)	I (%)	I (%)
Record (race C)	47.9	35.7	57.7	63.6
S-1358 (race D)	50.6	33.9	51.9	65.0
P-1380 (race E)	35.4	31.6	53.0	48.4
LC-1093 (race F)	0	21.3	27.4	29.3
PR64LE20 (race G)	0	6.4	7.3	11.9

In Table 5 are the results obtained in 2015 year, in Tufesti location. Here, broomrape has not developed until now, only 5 races more virulent than (A to E), the hybrids carrying the gene of resistance to the race E being not attacked, or having a very low percent of broomrape attack. The hybrids seed yield is quite good. This it means that in this area the parasite is not so aggressive. The hybrids having R6 and R7-R8 types of resistance are full resistant. Their seed yield is high.

The results obtained in 2015 year, by testing in Scarlatesti location (Table 6) are showing that here, there are less 7 races of the parasite has developed races more virulent than race F. No one of the tested hybrids has zero attack. The hybrids carrying resistance genes, more effective than *Or6*, the gene *Or7* have some broomrape, from 13.6 to 21.3 %.

The seed yield is much affected for the hybrids having resistance of R5. The check for sensibility released a very low seed yield (only 877 kg/ha).

Table 5: Results regarding broomrape (*Orobanche cumana* Wallr.) attack, in the field conditions, on some sunflower genotypes, Tufeşti, Brăila, 2015.

Genotype	I (%)	Type of resistance	Seed yield (kg/ha)
Favorit	0	R6	3,585
F911	1.2	R5	3,390
P-L-E-1	2.9	R5-6	3,544
L-G-5	0	R5	3,395
S-G-N-1	0.5	R5	3,287
N-P-C-1	1.3	R5-6	3,645
HS 5654	0	R7	3,510
HS 5899	0	R8	3,588
P-L-E-2	0	R7-8	3,541
L-G-8	0	R7	3,198
L-G-7	0	R7-8	3,445
M-Y-1	0	R8	3,612
FD15IM56	0	R7-8	3,581
FD15C44	0	R7-8	3,496
Check	51.6	Sensible	1,899
LSD (P = 5 %)			6.54

Table 6: Results regarding broomrape (*Orobanche cumana* Wallr.) attack, in the field conditions, on some sunflower genotypes, Scărlăteşti, Brăila, 2015.

Genotype	I (%)	Type of resistance	Seed yield (kg/ha)
Favorit	16.9	R6	3,385
F911	29.3	R5	2,978
P-L-E-1	18.7	R5-6	3,307
L-G-5	33.4	R5	3,165
S-G-N-1	35.2	R5	3,185
N-P-C-1	17.3	R5-6	3,360
HS 5654	13.6	R7	3,445
HS 5899	9.4	R8	3,510
P-L-E-2	12.6	R7-8	3,456
L-G-8	21.3	R7	3,177
L-G-7	10.4	R7-8	3,399
M-Y-1	7.8	R8	3,520
FD15IM56	8.2	R7-8	3,504
FD15C44	9.6	R7-8	3,487
Check	70.4	Sensible	877
LSD (P = 5 %)			10.31

Conclusion

The parasite broomrape is an important limitative factor of sunflower seed yield. In Romania this parasite has developed new races, very virulent, in Tulcea, Constanta and Braila areas. Sunflower hybrids tested in different locations in Braila area released different levels of the seed yield, depending of the type of resistance. In all locations the check for sensibility seed yield, was low.

In Braila area there are different locations with different broomrape races. The most virulent races of the parasite started to be spread in this area from areas where they have been identified ten years ago (Black Sea area).

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