

The spreading of high-virulent *O. cumana* races, affecting sunflower in the South of Russian Federation

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ABSTRACT

- In many countries where the sunflower is cultivated the obligate parasite broomrape (*Orobancha cumana* Wallr.) which refers to the higher floral plants, is considered to be the one of the most dangerous pathogen of this crop. During the last years in the South of Russian Federation, the biotypes of broomrape have appeared and propagated, overcoming rapidly the immunity of the local sunflower varieties as well as the foreign hybrids. Their racial belonging needs to be identified. The nomenclature of designation of *O. cumana* races in Russian Federation did not coincide with that of other countries since USSR period, and should be adjusted due to free exchange of sunflower sowing material between the countries. The purpose of the present research was to estimate the degree of virulence of the populations and racial belonging of *O. cumana* in different regions of the South of Russian Federation.
- The seeds of broomrape were collected in Rostov and Volgograd regions, Stavropol and Krasnodar areas. To identify the races of *O. cumana* there were used Romanian differentials, resistant to races D, E, F, G, the Spanish line P 96, resistant to race F under control of two recessive genes *or6or7* and two local sunflower lines: VK 623 and VT 62, resistant to local broomrape.
- The Rostov region is weed-covered by the broomrape mostly. Some populations of *O. cumana* are represented there by the mix of races: C, D, E, F, G, in other populations – the race F or the mix of E and F. Several populations from 5 districts of Rostov region have a high concentration of biotype (race H, presumably), overcoming the resistance to race G of the differential, resistant to that race in Romania. The populations of broomrape in Volgograd region are less virulent and are represented mostly by the mix of races E and F. However, in one of the areas the biotype, affecting the differential resistant to race G in Romania, was found. The race F prevails in the populations of Stavropol region. The studied populations of broomrape from Krasnodar region are represented by the mix of races C, D, E, but in the northern districts of this area bordering on Rostov region, the biotypes of a parasite affecting differential resistant to races F and G were found.
- Thus, in the South of the Russian Federation high virulent *O. cumana* races overcoming action of known sunflower resistance genes: *Or5*, *Or6*, *Or7*, *or6o7* have spread. In Rostov region there are populations of *O. cumana* which are the most virulent, with prevalence of high-virulent biotypes in 5 areas (race H, presumably) with high degree of affection of all studied sunflower genotypes. 15 areas of Rostov region are mapped, according to the occurrence of broomrape biotypes of different virulence.
- This research is the first attempt of identification *O. cumana* races in the Russian Federation according to their nomenclature in other countries. The obtained data show areas of dissemination of high-virulent *O. cumana* biotypes in the South of the Russian Federation.

Key words: sunflower - broomrape - races - virulence - identification - dissemination areas

INTRODUCTION

A harmful obligate sunflower parasite *O. cumana* is considered to be one of the most important constraints in production of this crop in many countries. During last 15 years the efforts of scientists and breeders to introduce the genetic sources of resistance to that plant-parasite in sunflower hybrids, were attended by the appearance of new virulent races of broomrape, which had quickly overcome all known genes of resistance (Fernandez-Martinez et al., 2008).

In Russia the broomrape in the course of centenary period of parasitism on sunflower had exposed this crop to the danger of disappearance thrice. Sunflower cultivation became unprofitable because of the strong affection of plants by broomrape.

The latest epiphytotic situation occurred in the fields of USSR in the beginning of 70ies, when the biotype of broomrape had appeared for the first time in Moldova, called the Moldavian race, and began to affect the varieties, which were previously resistant, and had spread in all regions of sunflower cultivation. However, the successful development and cultivation of varieties and hybrids, resistant to that race, had lead to destruction of parasite's main seed stocks in fields, as they germinated in the presence of the roots of sunflower of both susceptible and resistant genotypes.

Since the middle of 80ies until the end of 90ies, the problem of broomrape on sunflower in Russia hadn't arisen. It was even difficult to find and to collect the necessary quantity of the seeds of that plant-parasite to test the resistance of the breeding material to it. Never the less, in recent years in southern regions of Russian Federation, especially in Rostov region, all local assortment, as well as the hybrids of foreign breeding, get strongly affected by the broomrape.

Eight races of *O. cumana* on sunflower are known, designated by the letters of latin alphabet: A, B, C, D, E, F, G, H. The last 3 of them ,the most virulent, were found in the course of the last ten years at first in Romania, then in Spain and in Turkey (([Molinero-Ruiz and Melero-Vara, 2005; Fernandez-Escobar et al., 2008; Fernandez-Martinez et al., 2008; Păcureanu-Joita, 2008; . Kaya et al., 2004). The nomenclature of designation of *O. cumana* races in Russian Federation did not coincide with that of other countries since USSR period, and should be adjusted due to free exchange of sunflower sowing material between the countries.

The purpose of the present research was to estimate the degree of virulence of the populations and racial belonging of *O. cumana* in different regions of the South of Russian Federation.

MATERIALS AND METHODS

The seed samples of broomrape were collected in different fields in 15 areas of Rostov region and 6 of Volgograd region, also in 3 areas of Stavropol region and 5 in Krasnodar region. To identify their racial belonging the Romanian differentials were used, resistant to races D, E, F, G: LC1002, LC1003, LC1093, 16x25, and also the Spanish line P 96 with resistance to race F under control of joint action of 2 recessive genes *or6or7*. Also lines: VK 623 and VT 62, developed in VNIIMK and resistant to local broomrape were used. The variety VNIIMK 8883 was used as the susceptible control.

Sunflower plants were grown in greenhouse conditions in flower pots, filled with a mix of soil and sand, with the seeds of broomrape, every sample separately. Broomrape seeds were applied in an amount of 200 mg for 1 kg of soil. After 30 days since germination, the sunflower plants were dug out, their roots washed with water, the quantity of tubercles and the developed broomrape shoots was counted.

RESULTS

The broomrape biotype, affecting the hybrid combination 16x25, resistant to race G in Romania, was not found only in Salskiy, Tselinskiy and Sholokhovskiy areas of Rostov region. Though, in populations from Belokalitvinskiy, Egorlikskiy, Konstantinovskiy, Tatsinskiy areas its concentration was very high (the degree of affection was 36,31,34 and 35, respectively) (table 1). Calling this type the race H, it should be mentioned, that in some areas there are the samples of broomrape with even higher virulence, which overcome the immunity of the line VT 62.

The resistance of the Spanish line P 96 is overcome by broomrape from Belokalitvinskiy and Tatsinskiy areas with the degree of affection 15 and 12, accordingly. That proves the existence of the race

G, which singular samples occur in other areas. The broomrape from Azovskiy, Aksaiskiy, Morozovskiy and Tatsinskiy areas affects in a significant degree the Romanian line LC 1093, resistant to the race F in Romania. To a lesser degree this line is affected by broomrape from Belokalitvinskiy, Konstantinovskiy, Millerovskiy, Oblivskiy areas. Singular affection of this line is shown by broomrape also from other areas, except Salskiy one. The broomrape from Salskiy area doesn't affect also the differentials resistant to races E and D. Similarly, it is not affected by the broomrape form Tselinskiy, Sholokhovskiy areas in comparison with high degree of affection of the control VNIIMK 8883 (72 and 55, respectively). Therefore, the virulence of the broomrape from these populations do not overcome the gene of resistance for the race D (*Or4*). Analyzing the indices of affection of these lines in other areas, in comparison with the control, we come to conclusion, that the majority of the studied populations of broomrape have a mix of races and in the areas, mentioned previously there are the races G and H in considerably high concentration (table.1).

Table 1. Affection degree* of sunflower differentials by *O.cumana* from different areas of Rostov region

Areas of broomrape gathering	Sunflower differentials to broomrape races							
	VNIIMK 8883 susceptible	LC1002 D**	LC1003 E	BK 623 E	LC1093 F	P 96 F	16x25 G	BT 62 H
		<i>Or4</i>	<i>Or5</i>	<i>Or5</i>	<i>Or6</i>	<i>or6, or7</i>	?	?
Azovskiy	36	42	18	27	21	3	2	0
Aksaiskiy	76	57	15	21	36	4	3	0
Belokalinvinskiy	68	18	21	13	12	15	36	1
Egorlikskiy	82	18	13	4	3	1	34	1
Konstantinovskiy	119	57	36	23	15	7	31	0
Kuibishevskiy	97	10	13	4	4	1	4	0
Millerovskiy	86	29	34	3	12	1	6	0
Morozovskiy	118	94	34	21	52	6	3	3
Oblivskiy	83	67	30	26	10	2	1	1
Rodionovonesvetaiskiy	76	6	23	8	1	2	6	0
Salskiy	72	0	0	1	0	7	0	0
Tatsinskiy	82	76	35	43	21	12	35	1
Tselinskiy	55	0	0	0	2	0	0	0
Tsimlyanskiy	66	22	9	16	2	3	8	0
Sholokhovskiy	85	3	0	1	1	0	0	0

* Affection degree – mean of tubercles and shoots of broomrape on one affected sunflower plant;

** Letter designation of broomrape race against which differential is resistant

One of the most unfavorable area because of the broomrape infestation is Belokalitvinskiy one, situated in the central part of Rostov region (fig. 1). The broomrape from all populations from this area overcomes the action of the genes *Or4*, *Or5*, *Or6* and the mutual action of *or6 or7* (table 2). The immunity of the hybrid combination 16x25, resistant to race G in Romania, is overcome with the high degree. The table 2 shows, that in the fields of this area there is a mix of races D, E, F, G, H with considerably high concentration.

The areas of Volgograd region, where the seeds of broomrape were collected, are situated in southern and northern part of the region (fig. 1). From the populations of these 6 areas of Volgograd region only Gorodishenskaya broomrape with the degree 11 affects the hybrid combination, resistant to the race G in Romania. (table 3). In other areas the occurrence of such a biotype is singular or is absent. The Spanish

line P 96, resistant to the race F in Spain, is affected insignificantly. Though, the Romanian line LC 1093, resistant to the race F in Romania, is affected by the broomrape from all areas, except Surovikinskiy. The degree of affection by broomrape of this line from Elanskiy and Rudnyanskiy areas is the highest (25 and 47, respectively). That indicates the presence of biotype, similar to the race G in Spain and Romania, in these areas. Practically the same degree of affection by broomrape from Elanskiy area of the lines LC 1093, LC 1002 and the control VNIIMK 8883 indicates the high concentration of the race F there. In Novoanninskiy area – the mix of races E and F. The sample of the broomrape seeds from Surovikinskiy area is less virulent and is represented mostly by the race E.

Table 2. Affection degree* of sunflower differentials by *O.cumana* from different populations of Belokalitvinskiy area of Rostov region

№ of field	Name of farm	Hybrid, variety on which broomrape seeds where gathered	Sunflower differentials to broomrape races							
			VNIIMK 8883	LC1002 D**	LC1003 E	BK623 E	LC1093 F	P 96 F	16Ax25 G	VT 62 H
				Or4	Or5	Or5	Or6	or6, or7	?	?
1	Drujba	Garant	72	76	26	30	55	17	7	0
2	Drujba	Signal	148	75	40	49	38	39	13	0
3	Drujba	Garant	87	20	58	90	65	39	11	1
4	Necrest and K	Master	68	18	21	13	12	15	36	1
5	Сагунн	PR64A83	106	78	38	35	19	12	8	0
6	Smetvinovka	Flagman	79	32	34	22	45	19	6	0

* Affection degree – mean of tubercles and shoots of broomrape on one affected sunflower plant;

** Letter designation of broomrape race against which differential is resistant

In Stavropol region the population from Grachevskiy area overcomes the resistance of hybrid combination 16×25 with degree of affection 12. That indicates the presence of more virulent biotype than the race G in Romania, that is the race H. It has to be also mentioned that the broomrape from Petrovskiy area overcomes the resistance P 96 with the degree 6 and LC 1093 – with the degree 31, which indicates the significant concentration of the race G there. All studied populations from Stavropol region represent the mix of races D, E, F, G, in which the race E prevails (table 3).

In the populations from Krasnodar region the races D and E prevail with the admixture of the race F. Though, in the populations from Kushevskiy and Novopokrovskiy areas there is already an admixture of race G, as the resistance of both lines is overcome: the Romanian LC 1093 and the Spanish P 96. The degree of their affection is 9 and 9, respectively - in Kushevskiy area, 12 and 7 – in Novopokrovskiy (table 3).

DISCUSSION

High profitability of production of sunflower seeds in Russian Federation during 90ies had led to disorder in crop rotations occurring everywhere, especially in Rostov region, where the sunflower was often returned to the former place in 1-3 years. As a result of such intensification of production of seeds of this culture in many areas of Rostov region the broomrape biotypes had appeared and propagated, they had quickly overcome the immunity of both local assortment of sunflower and foreign hybrids. In the central part of Stavropol region the frequent return of the sunflower to the previous field, as in Rostov region, is observed. The presence of broomrape biotypes, similar to the race H from Romania is most likely to be related with this fact. The samples of broomrape seeds from Volgograd region were considerably less virulent, than from Rostov region, though, in Gorodishenskiy area, situated in the south part, there already exists the biotype, similar to the race H.

In Krasnodar region the situation is more favourable. However, if we look on the map (fig. 1), it could see the spreading of the high virulent biotypes of broomrape from Rostov area to frontier areas of

Krasnodar region. Thus, one of the most unfavorable in this respect area of Rostov region – Egorlikskiy, borders on Beloglinskiy and Kushyovskiy areas of Krasnodar region. In these areas there already exists the biotype, similar to the race G from Romania. In areas, more remoted from Rostov region, Viselkovskiy and Eyskiy, the populations of broomrape consist mostly of race D (or even less virulent biotype) with some admixture of races E and F.

Table 3 - Affection degree* of sunflower differentials by *O. cumana* from some areas of Volgograd, Stavropol and Krasnodar regions

Area	Sunflower differentials to broomrape races							
	VNIIMK 8883	LC1002 D**	LC1003 E	VK 623 E	LC1093 F	P 96 F	16x25 G	VT62 H
	susceptible	Or4	Or5	Or5	Or6	or6, or7	?	?
Volgograd region								
Surovikinskiy	81	84	10	0	0	1	3	0
Gorodischenskiy	74	24	20	5	7	2	11	0
Novoanninskiy	102	115	28	57	12	2	0	0
Kikvidzenskiy	96	67	24	8	17	2	1	0
Elanskiy	77	78	72	46	25	6	1	1
Rudnyanskiy	69	23	11	5	47	1	0	0
Stavropol region								
Grachevskiy	79	68	23	12	16	3	12	1
Ipatovskiy	92	98	23	10	15	2	0	0
Petrovskiy	111	81	30	17	31	6	2	0
Krasnodar region								
Beloglinskiy	83	59	24	18	8	2	0	0
Viselkovskiy	91	22	16	12	5	2	0	0
Eiskiy	76	12	4	2	0	0	0	0
Kushyovskiy	109	46	17	21	9	9	0	1
Novopokrovskiy	97	53	19	23	12	7	0	1

* - Affection degree– mean of tubercles and shoots of broomrape on one affected sunflower plant

** - letter designation of broomrape race against which differential is resistant

On the whole, the mixed character of the virulence of broomrape in different areas of the studied regions is observed. The broomrape from different fields of one and the same area can be different in virulence. This indicates the recent emergence of high virulent biotypes and is important for placing the sunflower assortment, characterized by different genes of the resistance.

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Figure 1. The spreading of *O. cumana* high virulent biotypes (▲ - F, ✦ - G, ★ - H) in regions of the South of the Russian Federation.

Areas of Krasnodar region: 1 – Viselkovskiyi, 2 – Novopokrovskiyi, 3 – Beloglinskii, 4 – Kushyovskiyi, 5 – Eiskiyi.

Areas of Rostov region: 6 – Azovskiyi, 7 – Aksaiskiy, 8 – Rodionovonesvetaiskiy, 9 – Kuibishevskiy, 10 – Egorlikskiy, 11 – Tselinskii, 12 – Salskiy, 13 – Konstantinovskiy, 14 – Tsimlyanskiy, 15 – Belokalitvinskii, 16 – Tatsinskii, 17 – Morozovskiy, 18 – Millerovskiy, 19 – Oblivskiy, 20 – Sholohovskiy.

Areas of Volgograd region: 21 – Novoanninskii, 22 – Kikvidzenskiy, 23 – Elanskiy, 24 – Rudnyanskiy, 25 – Gorodischenskii, 26 – Surovikinskii.

Areas of Stavropol region: 27 – Ipatovskiy, 28 – Grachevskiy, 29 – Petrovskiy.

REFERENCES

- Fernandez-Martinez J.M., Dominguez J., Perez-Vich B. and L.Velasco. 2008. Update on breeding for resistance to sunflower broomrape. *Helia*. 31: 73-84.
- Molinero-Ruiz M.L. and J.M. Melero-Vara. 2005. Virulence and aggressiveness of sunflower broomrape (*Orobanche cumana*) populations overcoming the *Or5* gene. p. 165-169. In: Proc. Int. Sunflower Conf., Fargo, ND, USA.
- Fernandez-Escobar J., Rodriguez-Ojeda M. I and L.C. Alonso. 2008. Distribution and dissemination of sunflower broomrape (*Orobanche cumana* Wallr.) race F in Southern Spain. p. 231-236. In: Proc. 17th Int. Sunfl. Conf. Cordoba. Spain.
- Păcureanu-Joita M., Raranciuc S., Procopovici E., Sava E. and D.Nastase 2008. The impact of the new races of broomrape (*Orobanche cumana* Wallr.) parasite in sunflower crop. p. 225-230. In: Proc. 17th Int. Sunfl. Conf. Cordoba. Spain.
- Kaya Y., Evci G., Pekcan V. and T. Gucer. 2004. Determining new broomrape infested areas, resistant lines and hybrids in Trakya region of Turkey. *Helia*. 27:211-218.