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BROOMRAPE (*Orobanche cumana* Wallr.) IN BULGARIA - DISTRIBUTION AND RACE COMPOSITION

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SUMMARY

Broomrape presents serious problems to sunflower production in Bulgaria. This leads to considerable losses expressed, on the one hand, in yield decrease, and on the other in lower quality of the obtained produce. Furthermore, the parasite forms new, more virulent races which overcome the resistance of the varieties and hybrids commonly used in production. With a view of limiting the parasite's distribution and decreasing the losses it causes, it would be preferable to know the distribution area of the individual races, and the rate and percent of broomrape attack. The results from this investigation showed that at the present moment there are three races of the parasite in Bulgaria - races D, E and F. Race E had the widest area of distribution among them. It was widespread in all sunflower production regions of the country. Three *Orobanche* sources, Morava, Tsarevets and Byala-2, overcame the resistance of the line P-1380 (*Or-5*), *i.e.*, this is a new race for Bulgaria - race F (Bulgaria). It was registered during the growing seasons of 2003 and 2004 and it had limited distribution in individual fields of central-northern Bulgaria. An insignificant portion in the *Orobanche* population belonged to race D which was isolated from two samples only.

Key words: broomrape, race composition, sunflower

INTRODUCTION

Broomrape (*Orobanche cumana* Wallr.) is a parasite of sunflower roots. It causes serious damages to sunflower production in a number of countries. It is characterized by a high propagation coefficient allowing it to breed fast, to expand its distribution area and increase its attacking rate. According to Kaya *et al.* (2004), about 80% of sunflower areas in Turkey (Trakia region) are infested with the seeds of the parasite. According to these authors, epiphytotic occurrence of broomrape is registered in this region each 20 years. Furthermore, the parasite forms new, more

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virulent races which overcome the resistance of the varieties and hybrids commonly used in production (Kaya *et al*., 2004; Pacureanu-Joita *et al*., 1998; Alonso, 1996; Fernandez-Martinez *et al*., 2000). This impedes effective control of broomrape.

Broomrape presents serious problems to sunflower production in Bulgaria. It keeps expanding its distribution area, forming new and more virulent races (Shindrova, 1994). This leads to considerable losses expressed, on the one hand, in yield decrease, and on the other in reduced quality of the obtained produce (Shindrova *et al.*, 1998). With a view of limiting the parasite's distribution and decreasing the losses it causes, it would be preferable to know the distribution area of individual races, and the rate and percent of broomrape attack. These were the aims of the present study.

MATERIAL AND METHODS

Broomrape race composition was determined through the reaction of the lines from the standard differential set enriched with lines developed at Dobroudja Agricultural Institute. During the period 2000 - 2004, samples (seeds) of the parasite were collected from different locations in the main sunflower production regions:

- 2000 - southeastern Bulgaria (Bourgas, Radnevo, Boyanovo), central-northern Bulgaria (Selanovtzy, Pordim, Byala), northeastern Bulgaria (Silistra, Dobrich, IWS- General Toshevo, Granichar, Krushary, Durankulak) (Table 1).
- 2001 - southeastern Bulgaria (Bourgas, Radnevo, Yambol), central-northern Bulgaria (Selanovtzy, Pordim, Iskar, Byala), northeastern Bulgaria (Dulovo, Silistra, Dobrich, Krushary, Durankulak, Shoumen) (Table 2).
- 2002 - southeastern Bulgaria (Bourgas, Radnevo Zimnitza), central-northern Bulgaria (Slavianovo - 1, Slavianovo - 2, Pordim, Ovcha mogila), northeastern Bulgaria (Shoumen, Dobrich, Spasovo, Durankulak) (Table 3).
- 2003 - southeastern Bulgaria (Radnevo), central-northern Bulgaria (Selanovtzi, Pordim, Tsarevets), northeastern Bulgaria (Gradiny, General Toshevo, Spasovo Durankulak) (Table 4).
- 2004 - southeastern Bulgaria (Bourgas, Radnevo, Beronovo, Zimnitsa), central-northern Bulgaria (Selanovtzy, Pordim, Morava, Byala - 1, Byala - 2, Tsarevets), northeastern Bulgaria (DAI - General Toshevo, Krushary Spasovo, Durankulak). During vegetation, three samples with origin from Hungary (Marton Vashar region), Serbia - Montenegro (Novi Sad region) and Turkey (Odrin region) were also collected (Table 5).

In parallel with collecting seeds from the parasite, observations were made on the percent and rate of attack in the investigated fields. When reading the attack rate, plots of 100 plants were marked in the crop field, the number of plots depending on the size of investigated field. A rule was observed to mark 5 evenly distributed plots at every 10 ha. The number of shoots per plant was registered. Results were averaged for plots, and consecutively - for the entire field and investigated region. The attack rate registered in the marked plots reflected the percentage of

Table 1: Reaction of broomrape-differential lines to *Orobanche sp.* of different origins in Bulgaria - 2000

Origin of *Orobanche sp.*-2000	Reaction of broomrape-differential lines									Race/ biotype
	AD-66	Kruglik A-41	Jdanov 8281	Record	S-1358	P-1380	7009R	N 4511	N 738	
	Or-0	*Or-1*	*Or-2*	*Or-3*	*Or-4*	*Or-5*	*Or-?*	*Or-?*	*Or-?*	
Southeastern Bulgaria										
Burgas	S	S	S	S	S	R	R	R	R	E
Radnevo	S	S	S	S	S	R	R	R	R	E
Boyanovo	S	S	S	S	S	R	R	R	R	E
Central-northern Bulgaria										
Selanovtzy	S	S	S	S	S	R	R	R	R	E
Pordim	S	S	S	S	S	R	R	R	R	E
Byala	S	S	S	S	S	R	R	R	R	E
Northeastern Bulgaria										
Silistra	S	S	S	S	S	R	R	R	R	E
Dobrich	S	S	S	S	S	R	R	R	R	E
DAI-General Toshevo	S	S	S	S	S	R	R	R	R	E
Granichar	S	S	S	S	S	R	R	R	R	E
Krushary	S	S	S	S	R	R	R	R	R	D
Durankukak	S	S	S	S	S	R	R	R	R	E

R - resistant, S - susceptible

Table 2: Reaction of broomrape-differential lines to *Orobanche sp.* of different origins in Bulgaria - 2001

Origin of *Orobanche sp.*-2001	Reaction of broomrape-differential lines									Race/ biotype
	AD-66	Kruglik A-41	Jdanov 8281	Record	S-1358	P-1380	7009R	N 4511	N 738	
	Or-0	*Or-1*	*Or-2*	*Or-3*	*Or-4*	*Or-5*	*Or-?*	*Or-?*	*Or-?*	
Southeastern Bulgaria										
Burgas	S	S	S	S	S	R	R	R	R	E
Radnevo	S	S	S	S	S	R	R	R	R	E
Yambol	S	S	S	S	S	R	R	R	R	E
Central-northern Bulgaria										
Selanovtzy	S	S	S	S	S	R	R	R	R	E
Pordim	S	S	S	S	S	R	R	R	R	E
Iskar	S	S	S	S	R	R	R	R	R	D
Byala	S	S	S	S	S	R	R	R	R	E
Northeastern Bulgaria										
Dulovo	S	S	S	S	S	R	R	R	R	E
Silistra	S	S	S	S	S	R	R	R	R	E
Dobrich	S	S	S	S	S	R	R	R	R	E
Krushary	S	S	S	S	R	R	R	R	R	D
Durankulak	S	S	S	S	S	R	R	R	R	E
Shoumen	S	S	S	S	S	R	R	R	R	E

R - resistant, S - susceptible

Table 3: Reaction of broomrape-differential lines to *Orobanche sp.* of different origins in Bulgaria - 2002

Origin of *Orobanche sp.*-2002	Reaction of broomrape-differential lines									Race/ biotype
	AD-66	Kruglik A-41	Jdanov 8281	Record	S-1358	P-1380	7009R	N 4511	N 738	
	Or-0	*Or-1*	*Or-2*	*Or-3*	*Or-4*	*Or-5*	*Or-?*	*Or-?*	*Or-?*	
Southeastern Bulgaria										
Burgas	S	S	S	S	S	R	R	R	R	E
Radnevo	S	S	S	S	S	R	R	R	R	E
Zimnitza	S	S	S	S	R	R	R	R	R	D
Central-northern Bulgaria										
Slavianovo-1	S	S	S	S	S	R	R	R	R	E
Slavianovo-2	S	S	S	S	R	R	R	R	R	D
Pordim	S	S	S	S	S	R	R	R	R	E
Ovcha mogila	S	S	S	S	S	R	R	R	R	E
Northeastern Bulgaria										
Shoumen	S	S	S	S	S	R	R	R	R	E
Dobrich	S	S	S	S	S	R	R	R	R	E
Spasovo	S	S	S	S	S	R	R	R	R	E
Durankulak	S	S	S	S	S	R	R	R	R	E

R - resistant, S - susceptible

Table 4: Reaction of broomrape-differential lines to *Orobanche sp.* of different origins in Bulgaria - 2003

Origin of *Orobanche sp.*-2003	Reaction of broomrape-differential lines									Race/ biotype
	AD-66	Kruglik A-41	Jdanov 8281	Record	S-1358	P-1380	7009R	N 4511	N 738	
	Or-0	Or-1	Or-2	Or-3	Or-4	Or-5	Or-?	Or-?	Or-?	
Southeastern Bulgaria										
Radnevo	S	S	S	S	S	R	R	R	R	E
Central-northern Bulgaria										
Selanovtsi	S	S	S	S	S	R	R	R	R	E
Pordim	S	S	S	S	S	R	R	R	R	E
Tsarevets	S	S	S	S	S	S	R	R	R	F
Northeastern Bulgaria										
Gradiny	S	S	S	S	S	R	R	R	R	E
Gen. Toshevo	S	S	S	S	S	R	R	R	R	E
Spasovo	S	S	S	S	S	R	R	R	R	E
Durankulak	S	S	S	S	S	R	R	R	R	E

R - resistant, S - susceptible

parasitic plants per plot. Race composition of broomrape was determined under greenhouse conditions by standard methods (Panchenko, 1973).

The term "race", as used in this study, means the parasite population originating from different geographic locations.

Table 5: Reaction of broomrape-differential lines to *Orobanche sp.* of different origins in Bulgaria - 2004

Origin of *Orobanche sp.*-2004	Reaction of broomrape-differential lines									Race/ biotype
	AD-66	Kruglik A-41	Jdanov 8281	Record	S-1358	P-1380	7009R	N 4511	N 738	
	Or-0	*Or-1*	*Or-2*	*Or-3*	*Or-4*	*Or-5*	*Or-?*	*Or-?*	*Or-?*	
Southeastern Bulgaria										
Bourgass	S	S	S	S	S	R	R	R	R	E
Radnevo	S	S	S	S	S	R	R	R	R	E
Beronovo	S	S	S	S	S	R	R	R	R	E
Zimnitsa	S	S	S	S	R	R	R	R	R	D
Central-northern Bulgaria										
Selanovtsy	S	S	S	S	S	R	R	R	R	E
Pordim	S	S	S	S	S	R	R	R	R	E
Morava	S	S	S	S	S	S	R	R	R	F
Byala-1	S	S	S	S	S	R	R	R	R	E
Byala-2	S	S	S	S	S	S	R	R	R	F
Tsarevets	S	S	S	S	S	S	R	R	R	F
Northeastern Bulgaria										
DAI-General Toshevo	S	S	S	S	S	R	R	R	R	E
Krushary	S	S	S	S	S	R	R	R	R	E
Spasovo	S	S	S	S	S	R	R	R	R	E
Durankulak	S	S	S	S	S	R	R	R	R	E
Hungary	S	S	S	S	S	R	R	R	R	E
Serbia and Montenegro	S	S	S	S	S	R	R	R	R	E
Turkey	S	S	S	S	S	S	S	S	S	?

R - resistant, S - susceptible

RESULTS AND DISCUSSION

The results of the investigation showed that *Orobanche* is widespread in almost all sunflower production regions in the country. Exception were some regions in northwestern Bulgaria, a part of central-northern Bulgaria (the regions of Veliko Tarnovo and Targovishte), and parts of south Bulgaria (the regions of Stara Zagora, Sliven and Plovdiv) (Figure 1).

Significant differences were determined in index percentage and attack rate by region. Highest percentages of attack were registered in northeastern Bulgaria, or more specifically along the border with Republic of Romania. Attacks up to 80% were observed in individual fields. Here, too, highest values of the attack rate were

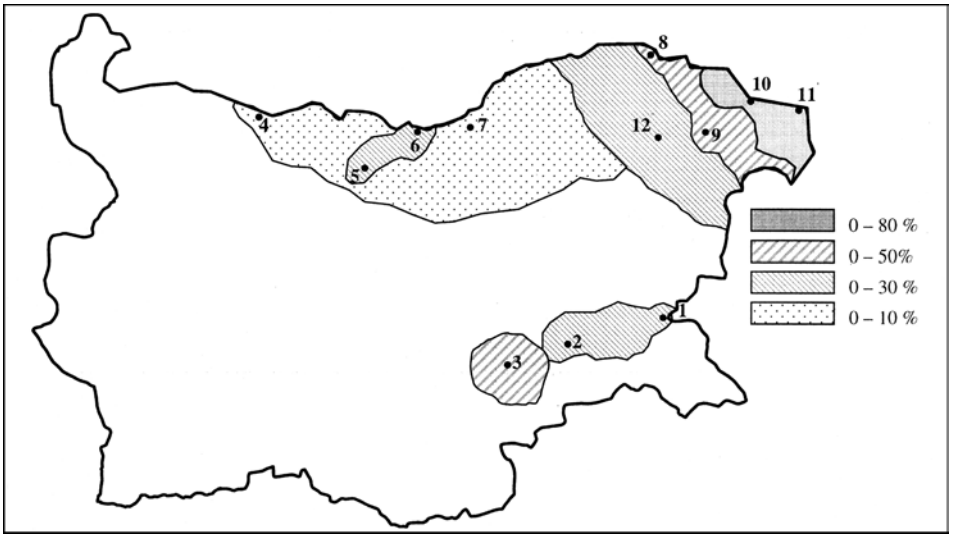

Figure 1: Areas and percentage of distribution of broomrape in Bulgaria – 1) Burgas; 2) Yambol; 3) Radnevo; 4) Selanovtsy; 5) Pordim; 6) Tsarevets; 7) Byala; 8) Silistra; 9) Dobrich; 10) Spasovo; 11) Durankulak; 12) Shoumen

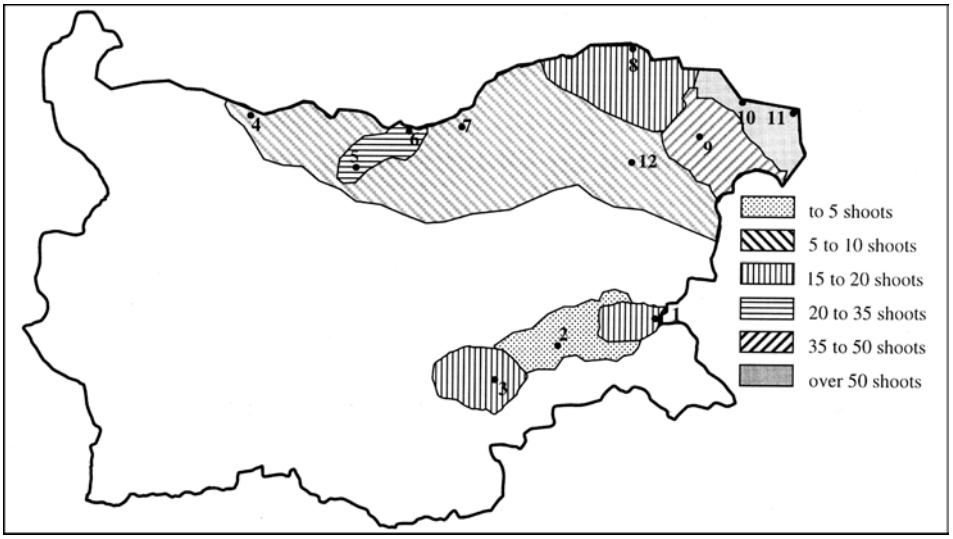

Figure 2: Atack rate of broomrape in Bulgaria – 1) Burgas; 2) Yambol; 3) Radnevo; 4) Selanovtsy; 5) Pordim; 6) Tsarevets; 7) Byala; 8) Silistra; 9) Dobrich; 10) Spasovo; 11) Durankulak; 12) Shoumen

registered - 50-60 parasitic plants per sunflower plant (Figures 2 and 3). The combination of the two indices has often been the reason for strong yield decrease or for complete failure of the crop.

High percentages of attack were registered in southeastern and northeastern regions of Bulgaria - up to 50%, although the loss caused by the parasite was less because the high percentages were not combined with high attacking rate. The results showed that the values of this index were within the range from 15 to 20 parasitic plants per host plant (Figure 4). Broomrape attack of up to 30% was registered in individual fields in southeastern Bulgaria, where the attacking rate of the parasite did not exceed 5 parasitic plants per host plant. Occurrence of broomrape was also established in the region of central-northern and northeastern Bulgaria. In these regions the percentage of attack did not exceed 10% and the number of parasites per host plant was from 5 to 10. There were several exceptions in single fields in the regions of Tsarevets and Pordim, where the percentage of attack and attack rate had higher values - up to 30% and from 20 to 35 parasitic plants per host plant, respectively.

Figure 3: Broomrape attack.

Figure 4: Broomrape attack.

In order to determine the race composition of *Orobanche* during the vegetation period of 2000, seeds from 12 locations in Bulgaria were collected to infect the lines from the standard differential set, enriched with lines from the breeding materials of DAI - General Toshevo (Table 1). Two races of the parasite were isolated - E and

D. The predominant race was E. It was identified in 11 of the collected samples and it was distributed in all sunflower production regions. Race D had a limited distribution. It was isolated from only one sample taken near the village of Krushari in northeastern Bulgaria. Similar results were obtained during 2001 (Table 2). Out of the total of 13 sources of *Orobanche*, 11 were identified as race E and 2 as race D. Race E was again established in all regions, while race D was found only in central-northern and northeastern Bulgaria. From the 11 samples collected in 2002, races E and D were again identified. The ratio between the two races was in favor of race E, which was established in 9 of the samples. The new aspect in this case was that race D was isolated also in Zimnitza, a region in south-eastern Bulgaria. In 1993, race affiliation of 8 *Orobanche* sources was examined. Seven of them were identified as race E. For the first time a more virulent race was established, which overcame the resistance of line P-1380 from the differential set, *i.e.*, it overcame the gene *Or-5*. This implies that race F of the parasite has been identified in Bulgaria as well. It was localized in single fields of central-northern Bulgaria (the Tsarevets source) (Table 4). From the 17 *Orobanche* sources analyzed in 2004, three races of the parasite were isolated: D, E and F. Race D was represented by a single sample from a region in southeastern Bulgaria (Table 5). The results obtained showed that race F expanded its distribution area. It was identified in three samples from a region of central-northern Bulgaria: Morava, Byala 2 and Tsarevets. Race E once again had the widest distribution; it was isolated from a total of 10 samples originating from all sunflower production regions of the country. During the vegetation of 2004, the race affiliation of three samples with origin from Hungary, Serbia and Montenegro and Turkey was also determined (Table 5). The reaction of the differential lines showed that the broomrapes from Hungary and Serbia-Montenegro belonged to race E of the parasite. The population from Turkey was the most virulent one and it overcame the resistance of all lines from the differential set used. It can be concluded that at the present moment there are three races of the parasite in Bulgaria - races D, E and F. Race E had the widest area of distribution among them. It was widespread in all sunflower production regions of the country. Three of the *Orobanche* sources, Morava, Tsarevets and Byala-2, overcame the resistance of line P-1380 (*Or-5*), *i.e.*, this is a new race for Bulgaria - race F (Bulgaria). It was registered during the vegetations of 2003 and 2004 and it had limited distribution in individual fields of central-northern Bulgaria. An insignificant share in the *Orobanche* population belonged to race D.

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EL JOPO DE GIRASOL (*Orobanche cumana* Wallr.) EN BULGARIA – EXTENSIÓN Y CONTENIDO RACIAL

RESUMEN

El Jopo de Girasol causa problemas serios en la producción de girasol en Bulgaria. Eso lleva hasta las significantes pérdidas expresadas por un lado a través del rendimiento reducido, y por otro lado, a través de la disminuida calidad del producto obtenido. Además, el parásito crea nuevas razas, aún más virulentas, que superan la resistencia de las variedades e híbridos que se encuentran en la producción. Con el fin de limitar la extensión de los parásitos y la reducción de pérdidas causadas por él, sería deseable conocer la extensión de las razas particulares, la intensidad y el porcentaje de ataque del Jopo de Girasol. Los resultados de esta investigación han demostrado que en este momento, en Bulgaria, existen tres razas de parásitos - D, E i F. La raza E tiene la extensión más amplia. Ella se puede encontrar en todas las regiones productivas de girasol en Bulgaria. Tres fuentes del Jopo de Girasol, Morava, Tsarevets y Byala-2, han superado la resistencia de la línea P-1380 (*Or-5*), es decir, es una nueva raza de Jopo de Girasol en Bulgaria – la raza F. Ella fue comunicada durante los períodos de vegetación 2003 y 2004, y su extensión es limitada a unos campos individuales en Bulgaria centras y septentrional. Una menor parte de población del Jopo de Girasol pertenece a la raza D, que estaba aislada en sólo dos muestras.

L'OROBANCHE (*Orobanche cumana* Wallr.) EN BULGARIE – DISTRIBUTION DU PARASITE

RÉSUMÉ

L'*orobanche* représente un sérieux problème pour la production du tournesol en Bulgarie. Elle est la cause de pertes considérables d'une part par la diminution du rendement et de l'autre par la pauvre qualité du produit obtenu. De plus, le parasite forme de nouvelles races plus virulentes qui ont raison de la résistance des variétés et des hybrides utilisés dans la production. Dans le but de limiter la distribution du parasite et de diminuer les pertes qu'il cause, il serait souhaitable de connaître la surface de distribution des races individuelles ainsi que le taux et le pourcentage de l'attaque. Cette recherche a montré qu'il y a actuellement trois races du parasite en Bulgarie – les races D, E et F. La race E a la surface de distribution la plus étendue. Elle était répandue dans

toutes les régions de production du tournesol du pays. Trois sources d'*Orobanche*, Morava, Tsarevets et Byala-2 ont eu raison de la résistance de la lignée P-1380 (*Or-5*), il s'agit d'une nouvelle race d'orobanche en Bulgarie – la race F. Elle a été constatée pendant les saisons de végétation de 2003 et 2004 et avait une distribution limitée dans les champs individuels du centre-nord de la Bulgarie. Une partie plus réduite de la population d'*Orobanche* appartenait à la race D qui n'a été isolée que dans deux échantillons.