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# BROOMRAPE (*OROBANCHE CUMANA* WALLR.), THE MOST IMPORTANT PARASITE IN SUNFLOWER

## LUPOAIA (*OROBANCHE CUMANA* WALLR.), CEL MAI IMPORTANT PARAZIT ÎN CULTURA FLORII-SOARELUI

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**Abstract**

**Sunflower broomrape (*Orobanche cumana* Wallr.) is currently regarded as one of the most important constraints in sunflower ( *Helianthus annuus* L.) production. In the last 15 years, efforts to introduce genetic resistance to this parasite in sunflower hybrids were followed by the occurence of new virulent races that promptly overcame all known resistance genes. Due to this situation, most of the research efforts have focused on the development and characterization of new sources of genetic resistance to the most virulent races and also, on the genetic variability of *Orobanche cumana* populations. Different tests for sunflower resistance to the new races of the parasite, have showed that they are present now in different regions of Romania, Russia, Turkey and Spain. Results of evaluation of sunflower germplasm for resistance to different broomrape races have demonstrated that cultivated sunflower near the wild one, constitute an important reservoir of genes conferring resistance to new virulent races.**

**Key words**: sunflower, *Orobanche cumana*, broomrape races, genetic resistance.

## INTRODUCTION

Sunflower is one of the most important annual oilseed crops in the world. *Orobanche cumana* Wallr. (sunflower broomrape ), a holoparasitic angiosperm plant that infects sunflower roots, is regarded as one of the main constraints on sunflower production in Southern Europe, Spain, Black Sea region, Ukraine and China and the Middle East (P a r k e r, 1994).

Broomrape attacks are frequently severe and yield losses can reach up to 50% (D o m i n g u e z, 1996a). Control of this parasite remains extremely difficult, as thousands of tiny seeds produced by a single broomrape plant can

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be easly dispersed by water, wind, animals, humans, machinery or attached to sunflower seeds. Broomrape seeds may remain viable for 15-20 years and will only germinate in the presence of the host plant (Škorić, 1988). In the area infested with broomrape, there has been a progressive development of this parasite in sunflower crops and a rapid appearance of new and more virulent races (Fernandez-Martinez et al., 2008).

Vrânceanu et al. (1980) identified five pathogenic races of this parasite, named A through E, with a set of sunflower differentials, carrying the dominant genes *Or1* through *Or5,* that provided a resistance to the five races of the parasite (A, B, C, D, E). In 1995, a new race named F, overcoming all the known resistance genes, *Or1* to *Or5,* was identified in Spain (Alonso et al., 1996 ). A virulent race overcoming the gene *Or5,* was identified in Romania too, in 1996 (Păcureanu et al., 1998 ). For this new race, was found resistance in both cultivated and wild sunflower (Fernandez-Martinez et al., 2000; Păcureanu et al., 1998 ). However, a more virulent race, designated G, attacking the cultivars resistant to race F, has been identified (Molinero-Ruiz and Melero-Vara, 2005; Păcureanu et al*.,* 2008). In Turkey, the new broomrape races, in sunflower crop, seem to be more virulent than the races present in other countries (Kaya et al., 2004).

Consequently, the survey and understanding of the evolution of broomrape populations and their genetic variability, as well as the identification of new sources of resistance, is essential for the establishment of the efficient breeding programs.

Sources of resistance to recent virulent races have been found in cultivated sunflower, as well as in some sunflower wild species (Perez-Vick et al., 2005; Păcureanu et al*.,* 2008).

The host – parasite system of sunflower – *Orobanche cumana* described for races A through E appears to follow the gene-for-gene model (Vrânceanu et al., 1980). Genetic studies carried out by other authors agreed with monogenic and dominant inheritance of resistance to sunflower broomrape (Pogorletsky and Geshele, 1976; Sukno et al., 1999), although two dominant genes (Dominguez, 1996b) and one recessive gene (Ramaiah, 1987) have also been reported. Genetic resistance to race F, in the germplasm source P-96, derived from cultivated sunflower, was found to be controlled by recessive alleles at two loci (Rodriguez-Ojeda et al., 2001). The race F resistant genotype BR4, derived from wild sunflower, as well as LC-1093, derived from cultivated sunflower, were found to be under the control of one single dominant gene designated *Or6* (Păcureanu et al., 1998; Perez-Vick et al., 2002). However, the results of the evaluation of crosses between different race F resistant lines and different susceptible parental lines, have shown that dominance relationships and genetic control of broomrape resistance in sunflower is highly dependent on the race of broomrape, the source of resistance and also, the susceptible parental line used for the cross (Perez-Vick et al*.,* 2004a).

This paper presents the results obtained in the new broomrape races spreading, as well as new indentified sources of resistance.

## MATERIAL AND METODS

Several sunflower genotypes (hybrids, lines, populations) have been tested in fields (naturally infestation with broomrape), in three locations, as well as in the green house (artificial infestation conditions). In fields have been tested sunflower hybrids (Fundulea hybrids as well as some foreign companies hybrids). In the green house, have been used ten broomrape populations and three sunflower genotypes, as differentials for the race F (LC 1093 ) and for the new races too (the inbred line LC 009 and the Pioneer company hybrid, PR64A71). It has been used the same, some sunflower populations and inbred lines, in order to identify new sources of resistance to the new races of the parasite.

The testing was performed under the artificial inoculation, using broomrape seeds collected from the fields in Romania, Russia, Spain and Turkey. Each sunflower genotype was planted in five pots (5 liters capacity), for each broomrape population.

## RESULTS AND DISCUSSION

The parasite *Orobanche cumana* has developped very fast, new virulent populations in sunflower crop in Romania. So, in the last 12 years, there were identified two or three new races of the parasite , taking into consideration that there are not the differentials for each new race developped by this (Figure 1).

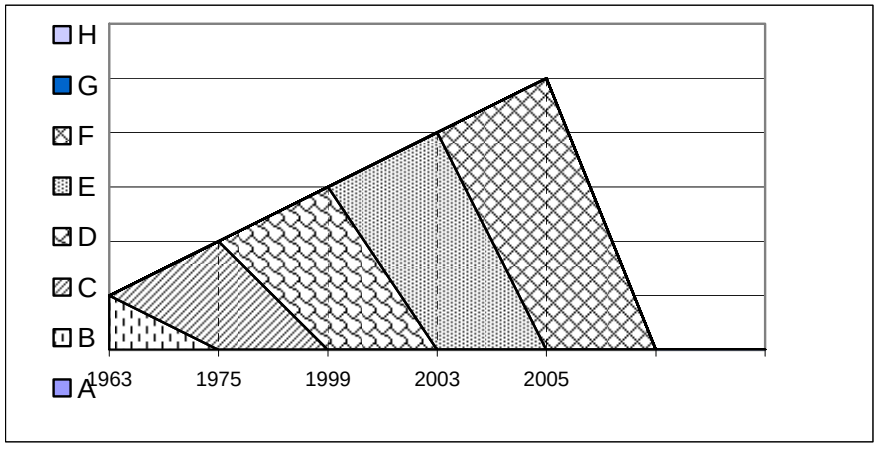


***Fig. 1*** – The evolution of the broomrape (*Orobanche cumana*) races, in sunflower, in Romania

In Romania, more than 60% of the sunflower cultivated area is infested with broomrape. There are three important areas, as the presence of the broomrape races and infestation degree, situated in Braila, Constanța and Tulcea locations. The sunflow er hybrids testing has been performed each year in these areas to have the information about the parasite races spreading.

In the figure 2, it can be observed that in Brăila area, the new virulent populations of the parasite are not present, the hybrids having as mother the inbred line resistant to the race F, being full resistant to the attack of this.

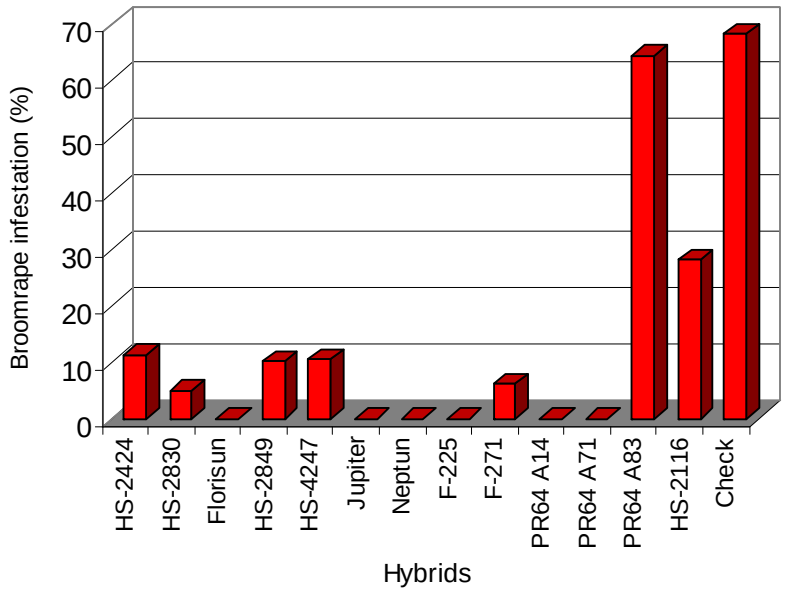


***Fig. 2 –*** The behaviour of some sunflower hybrids, in the infested field with *Orobanche cumana,* in Brăila area, 2008 year

In Tulcea area (Figure 3) all the hybrids are attacked, including the Pioneer company hybrid, PR64A71, which has a not high attack (less than 5%). In Constanța area (Figure 4), the new virulent populations of the parasite have spread in 2008, before being not present. All the hybrids which have been infested in Tulcea area, are now infested in Constanța area too, the infestation degree being smaller (less than 12%, for the hybrids resistant to the race F of the parasite).

The experiment performed in the green house, using the ten populations of the parasite (Table 1) has showed that there are six broomrape populations (two in Romania, two in Russia, one in Turkey and one in Spain), which are very virulent, no one hybrid being full resistant. There is one inbred line (LC 009) full resistant, this being identified in the sunflower germplasm in Fundulea institute collection. For this line we still have not studied the inheritance of the resistance.

*Table 1*

**The infestation with ten populations of broomrape (*Orobanche cumana* Wallr.) for the three sunflower genotypes. Fundulea, 2008-2009**

| ***Orobanche* population** / **Sunflower genotypes** | **Romania** | | | | **Russia** | | | | **Turkey** | **Spain** |
|---|---|---|---|---|---|---|---|---|---|---|
| | **Tulcea** | **Brăila** | **Constanța** | **Călăraşi** | **Krasnodar** | **Stavropol** | **Rostov 1** | **Rostov 2** | | |
| LC 1093 | 5/9 | 0/10 | 3/10 | 0/9 | 0/7 | 2/10 | 6/10 | 7/10 | 4/10 | 3/9 |
| | 4/10 | 0/8 | 4/9 | 0/10 | 0/9 | 0/10 | 5/10 | 4/8 | 5/10 | 5/10 |
| | 7/10 | 0/9 | 4/10 | 0/7 | 0/8 | 1/9 | 5/9 | 6/10 | 3/9 | 4/10 |
| | 5/10 | 0/10 | 3/10 | 0/10 | 0/10 | 1/7 | 7/9 | 7/10 | 4/8 | 3/8 |
| | 5/9 | 0/10 | 3/9 | 0/9 | 0/6 | 2/10 | 6/10 | 6/10 | 5/10 | 4/8 |
| LC 009 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PR64A71 | 1/10 | 0 | 0 | 0 | 0 | 0 | 1/9 | 1/10 | 2/10 | 1/9 |
| | 0/10 | 0 | 2/10 | 0 | 0 | 0 | 0/9 | 0/10 | 6/9 | 0/8 |
| | 2/10 | 0 | 0 | 0 | 0 | 0 | 0/10 | 1/10 | 1/10 | 1/10 |
| | 0/9 | 0 | 1/9 | 0 | 0 | 0 | 2/10 | 0/9 | 0/10 | 2/10 |
| | 2/10 | 0 | 0 | 0 | 0 | 0 | 0/10 | 0/10 | 1/8 | 0/9 |

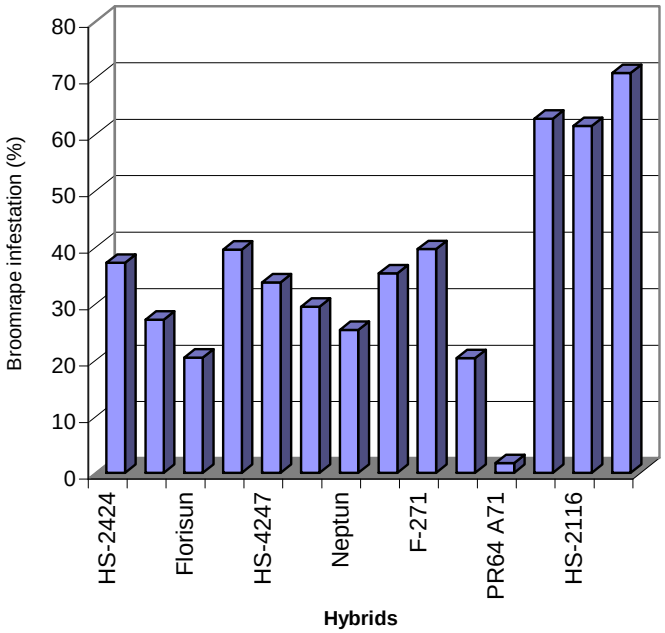


***Fig. 3 –*** The behaviour of some sunflower hybrids in the infested field, in Tulcea area, 2008 year

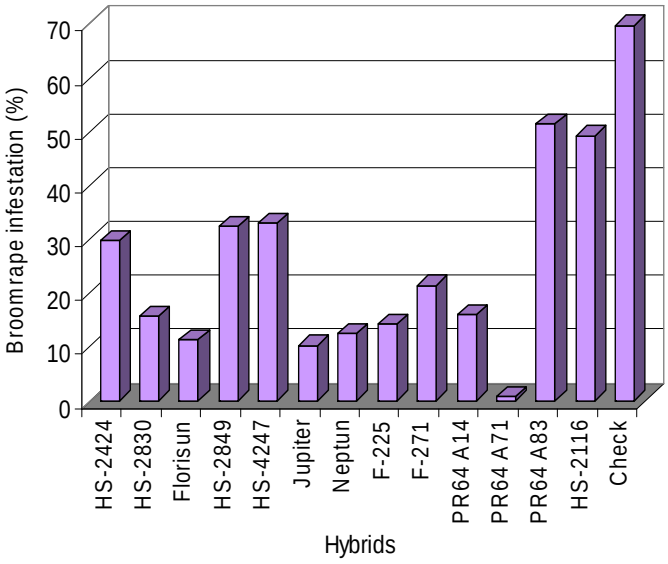


***Fig. 4 –*** The behaviour of some sunflower hybrids in the infested field, in Constanța area, 2008 year

In table 2, it is presented the testing for identifying new sources of resistance to the new races of the parasite. We have been identified two sunflower genotypes, resistant to both (new race in Romania and race G in Spain) populations of the parasite. After identifying the type of inheritance of resistance genes in these genotypes, they could be used for the genes transfering in the inbred lines with good agronomic traits or directly in the commercial hybrids obtaining.

*Table 2*

**The reaction of sunflower genotypes to the two populations of broomrape (artificial infestation conditions). Fundulea, 2008-2009**

| Sunflower genotypes | Boomrape from Romania ( New race ) | Broomrape for Spain (Race G ) |
|---|---|---|
| P-1380-2 (diff. for race E) | Sensitive | Sensitive |
| LC-1093 (diff. for race F) | Sensitive | Sensitive |
| RO 655 | Sensitive | Sensitive |
| CM 477 | Sensitive | Sensitive |
| LC 009 | Resistant | Resistant |
| AO-548 | Resistant | Resistant |
| AD-66 (Check) | Sensitive | Sensitive |

## CONCLUSION

- The rapid evolution of *Orobanche cumana* populations, leading to the occurence of new virulent races requires a continuous search for new resistance sources.
- The new virulent races of this parasite have spread rapidly in some regions in Romania, as well as in Russia, Turkey and Spain.
- Results of evaluation of sunflower germplasm for resistance to the new races have demonstrated that the cultivated sunflower, near the wild one is a good reservoir for the resistance sources to the parasite.
- Taking into consideration that in the new sources of resistance to broomrape it could to have different type of the resistance genes action, for the future, is better to be incorporated in the same hybrid, vertical and horizontal resistance, as well as, resistance to IMI herbicides.

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