# PARASITE–HOST PLANT INTERACTION OF *OROBANCHE CUMANA (OROBANCHE CERNUA)* WITH *HELIANTHUS ANNUUS*

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**Abstract**

Broomrape (*Orobanche cumana* Wallr. [syn. *Orobanche cernua* Loefl.]) is one of the important factors limiting sunflower (*Helianthus annuus* L.) yield in Europe. The use of resistant sunflower varieties is the most reliable way to fight this parasite. The actual spectrum of the broomrape races in Europe has changed. The study of the sunflower differential set for the broomrape races in Romania under natural and artificial infestation demonstrated the existence of a new spectrum of the races. We assigned the new race to be F and the corresponding gene for resistance Or6. The Chi-square test has shown the inheritance of resistance to be controlled by a single dominant gene. Five *Orobanche* populations were studied: one from Turkey, one from Spain, one from Yugoslavia and two from Romania (Călăraşi and Constanţa). The behaviour of the differentials for races 5 and 6 (races E and F) shows that there are some differences between the races of broomrape in Turkey and Constanţa, Romania. The races in Yugoslavia and Călăraşi (Romania) are totally different from races in Spain, Romania and Turkey.

## Introduction

Sunflower broomrape (*Orobanche cumana* Wallr./*Orobanche cernua* Loefl.) has become one of the most important parasites of this oleaginous crop in Russia, Ukraine, Moldavia, Romania, Turkey, Bulgaria, Yugoslavia and Spain but it has also been reported in other countries. Broomrape is an important problem because of the large area sown to sunflower in infested zones (Joel, 1988). Breeding programmes for the incorporation of resistance genes to broomrape in sunflower were started many years ago in Eastern Europe. At present, the parasite is controlled mainly by the use of resistant cultivars. The appearance of more virulent broomrape types in Ukraine and Russia (Tolmacev, 1990), Bulgaria (Shindrova, 1994), Yugoslavia (Mihaljcevic, 1996, Dozet and Marinkovic, 1998), Romania (Păcureanu-Joiţa et

al., 1998), Turkey (Bulbul et al., 1991) and Spain (Alonso et al., 1996) is an indication of the possible danger of an epiphytotic attack on sunflower crops in all European countries. Much information has been accumulated about the mechanism and genetic control in sunflower resistance to broomrape. However, there is a need to systematically determine the interdependence between the virulence of different broomrape biotypes and sunflower resistance. The goal of this work is to present the situation of broomrape races in Romania and to show the interdependence of the virulence of different biotypes and sunflower resistances.

**Materials and Methods**

*Orobanche* was collected on infested sunflower in several geographic regions. Two Romanian populations, one Yugoslavian, one Turkish and one Spanish were studied. Seeds of *Orobanche* plants were collected in one field, in the same area on different sunflower genotypes. A differential set of sunflower for broomrape races in Romania was used. Two sunflower genotypes (the differentials for broomrape races E and F) were used for infestation with *Orobanche* seeds from each region of Europe. For an in vitro experiment, *Orobanche* seeds were surface sterilized for 5 min in sodium hypochlorite (3.61%) and rinsed five times with distilled water. They were preconditioned at 21C for a week on glass fibre filter paper moistened with 5 ml sterile distilled water in a Petri dish. Sunflower seeds were surface sterilized in the same way, before being sown in vials containing glass beads (2 mm diameter) moistened with sterile distilled water. Preconditioned broomrape seeds were stimulated for germination with GR 24, then placed on the roots of 10-day-old sunflower seedlings. After infestation, broomrape development was observed weekly under a binocular microscope. The presence and number of necrotic broomrapes was noted. Mean values of the fixation of *Orobanche* on the root (stage 1), formation of *Orobanche* tubercles (stage 2), formation of tubercles with adventive roots (stage 3) and *Orobanche* on the stem (stage 4) were calculated.

**Results**

Starting in 1996, the differentials for the race E of broomrape in Romania lost resistance in the regions of Constanta, Brăila and Tulcea (Table 1). The results of the mean values in stage 1 to stage 4 of broomrape infestation (Figures 1 and 2) showed that the isolates from these regions of Europe displayed differences. In the case of sunflower differential, for the race E, broomrape in Turkey seems to be more virulent than broomrape in Constanța, Romania. These results are presented in the photos in Figure 3. Broomrape in Yugoslavia is different than broomrape in Romania, Turkey and Spain (less virulent). Twenty-one days after infestation, only the stage 1 attachment of broomrape was observed for sunflower differentials for race 6 (race F). The number of the fixations was greater for the broomrape populations from Spain and Yugoslavia. The behaviour of the broomrape in Turkey and Constanta, Romania was similar in this case. There was no attachment of broomrape on sunflower in both situations. There was no infestation of broomrape from Călărași, Romania on the differentials for race E and the differentials for race F. The results after 56 days of in vitro infestation (Table 2) confirmed the differences between the isolates of broomrape, especially on sunflower differentials for race E. The weight of the aerial part and the roots of the

sunflower plant was very small in the case of differentials for race E broomrape in Turkey. The results of an in vivo experiment (Table 3) show differences for the virulence of broomrape on the sunflower differentials for the race E (male sterile A line and the maintainer B line). All cases (Romania, Turkey and Spain) display this difference, but especially broomrape in Constanta, Romania (number of emergences) on the maintainer.

Table 1. Reaction of sunflower differentials to broomrape attack in Romania (populations of different sources), under artificial infestation (1995 – 2003).

| Differentials | Year | Reaction to broomrape races | Source of broomrape seeds and infestation index (I%) | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Constanța | Tulcea | Brăila | Vaslui | Ialomița | Teleorman |
| LC-1093 | 1995 | E-A | 0 | 0 | 0 | 0 | 0 | 0 |
| P-1380-2 | | E-A | 0 | 0 | 0 | 0 | 0 | 0 |
| S-1358 | | D-A | 15.7 | 9.2 | 16.8 | 4.9 | 9.7 | 0 |
| Record | | C-A | 30.1 | 26.5 | 37.7 | 26.4 | 25.2 | 0 |
| Jd-01 | | B-A | 51.7 | 47.7 | 55.2 | 44.9 | 47.1 | 42.2 |
| K-A41 | | A | 69.1 | 63.5 | 62.5 | 62.4 | 64.1 | 62.1 |
| AD-66 | | suscept. to all races | 77.2 | 72.5 | 69.5 | 62.7 | 69.7 | 62.9 |
| LC-1093 | 1996 | E-A | 0 | 0 | 0 | 0 | 0 | 0 |
| P-1380-2 | | E-A | 3.8 | 2.6 | 3.9 | 0 | 0 | 0 |
| S-1358 | | D-A | 17.2 | 10.5 | 14.7 | 5.9 | 12.4 | 0 |
| Record | | C-A | 29.4 | 24.2 | 41.4 | 29.2 | 27.5 | 7.7 |
| Jd-01 | | B-A | 47.4 | 50.8 | 48.3 | 47.2 | 38.5 | 35.5 |
| K-A41 | | A | 57.2 | 49.4 | 59.2 | 67.5 | 59.5 | 61.3 |
| AD-66 | | suscept. to all races | 78.5 | 68.7 | 71.7 | 65.4 | 60.3 | 60.5 |
| LC-1093 | 1998 | F-A | 0 | 0 | 0 | 0 | 0 | 0 |
| P-1380-2 | | E-A | 5.4 | 4.3 | 5.5 | 0 | 4.7 | 0 |
| S-1358 | | D-A | 18.3 | 11.2 | 14.7 | 11.4 | 22.3 | 0 |
| Record | | C-A | 28.4 | 14.7 | 24.5 | 21.3 | 29.8 | 5.2 |
| Jd-01 | | B-A | 48.2 | 38.5 | 50.4 | 55.4 | 58.3 | 43.3 |
| K-A41 | | A | 49.1 | 57.6 | 61.3 | 60.7 | 57.4 | 62.7 |
| AD-66 | | suscept. to all races | 69.2 | 77.7 | 70.9 | 64.8 | 78.5 | 68.7 |
| LC-1093 | 2001 | F-A | 0 | 0 | 0 | 0 | 0 | 0 |
| P-1380-2 | | E-A | 7.5 | 9.2 | 15.7 | 0 | 8.7 | 0 |
| S-1358 | | D-A | 19.1 | 15.4 | 18.4 | 11.0 | 19.8 | 5.2 |
| Record | | C-A | 29.2 | 17.1 | 23.2 | 22.4 | 33.1 | 9.4 |
| Jd-01 | | B-A | 46.7 | 33.2 | 49.5 | 57.4 | 55.1 | 41.3 |
| K-A41 | | A | 47.2 | 44.1 | 59.7 | 61.4 | 57.2 | 66.3 |
| AD-66 | | suscept. to all races | 71.2 | 69.4 | 71.8 | 68.2 | 75.4 | 78.7 |
| K-078 | 2003 | F-A | 0 | 0 | 0 | 0 | 0 | 0 |
| LC-1093 | | F-A | 0 | 0 | 0 | 0 | 0 | 0 |
| P-1380-2 | | E-A | 8.1 | 8.9 | 15.9 | 0 | 9.3 | 0 |
| S-1358 | | D-A | 18.9 | 15.0 | 19.2 | 10.8 | 18.5 | 6.7 |
| Record | | C-A | 31.0 | 15.7 | 25.3 | 20.8 | 31.5 | 8.9 |
| Jd-01 | | B-A | 45.8 | 34.1 | 47.7 | 52.9 | 56.2 | 44.5 |
| K-A41 | | A | 47.4 | 44.3 | 63.7 | 58.4 | 57.0 | 63.9 |
| AD-66 | | suscept. to all races | 77.2 | 70.4 | 68.2 | 68.0 | 77.3 | 75.5 |

Table 2. Dry weight of aerial parts and roots of sunflower cultivars 56 days after in vitro infestation by different *Orobanche cumana* populations.

| Races | Constanța (Romania) | | | Turkey | | | Spain | | | Călărași (Romania) | | | Yugoslavia | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sunflower cultivars | AP | R | O | AP | R | O | AP | R | O | AP | R | O | AP | R | O |
| Diff. for race 5 (E) | 1306 | 196 | 79 | 540 | 112 | 405 | 1042 | 147 | 112 | 1105 | 170 | 0 | 1290 | 212 | 0 |
| Diff. for race 6 (F) | 1705 | 282 | 0 | 1310 | 295 | 0 | 1110 | 303 | 0 | 1450 | 230 | 0 | 1256 | 276 | 0 |

AP = aerial parts; R = roots; O = *Orobanche*

Table 3. Number of *Orobanche cumana* emergences on different sunflower hosts 70 days after infestation.

| | *Orobanche cumana* races | | | | |
|---|---|---|---|---|---|
| Sunflower genotypes | Yugoslavia | Romania (Călărași) | Romania (Constanța) | Turkey | Spain |
| 10A-Diff. for race 5 (E) line A | 0 | 0 | 1.3±0.6 | 0.7±0.6 | 2.1±0.6 |
| 10B-Diff. for race 5 (E) line B | 0 | 0 | 6.7±0.6 | 2.3±0.6 | 4.4±0.6 |
| Diff. for race 5 (E) line R | 0 | 0 | 2.7±0.6 | 4±1 | 3.7±0.6 |
| Diff. for race 6 (F) | 0 | 0 | 0 | 0 | 0 |

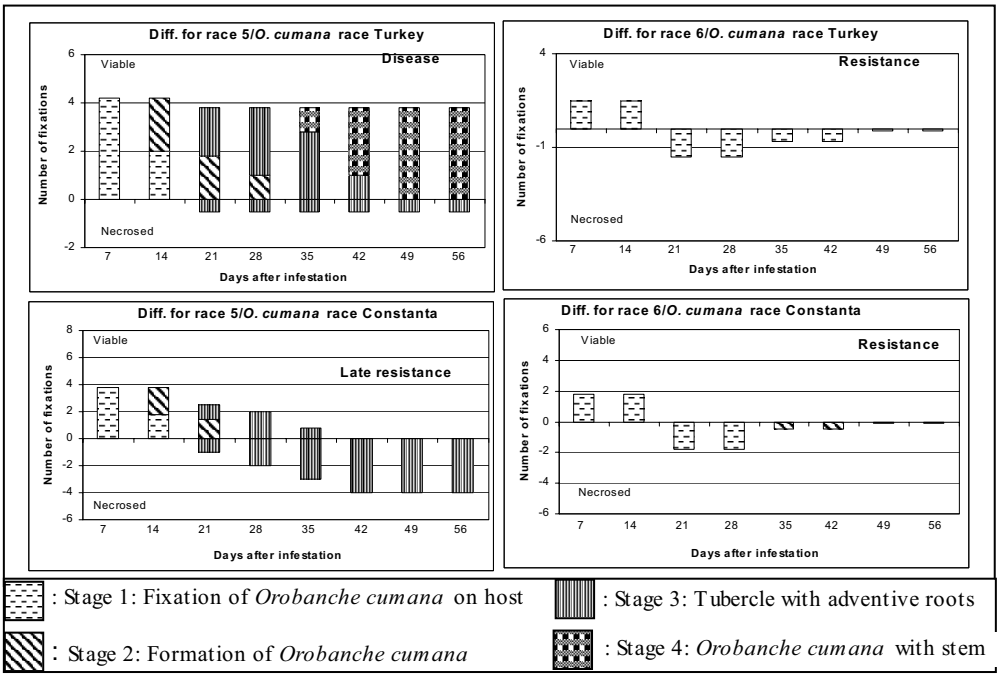


Figure 1. Results of in vitro experiments.

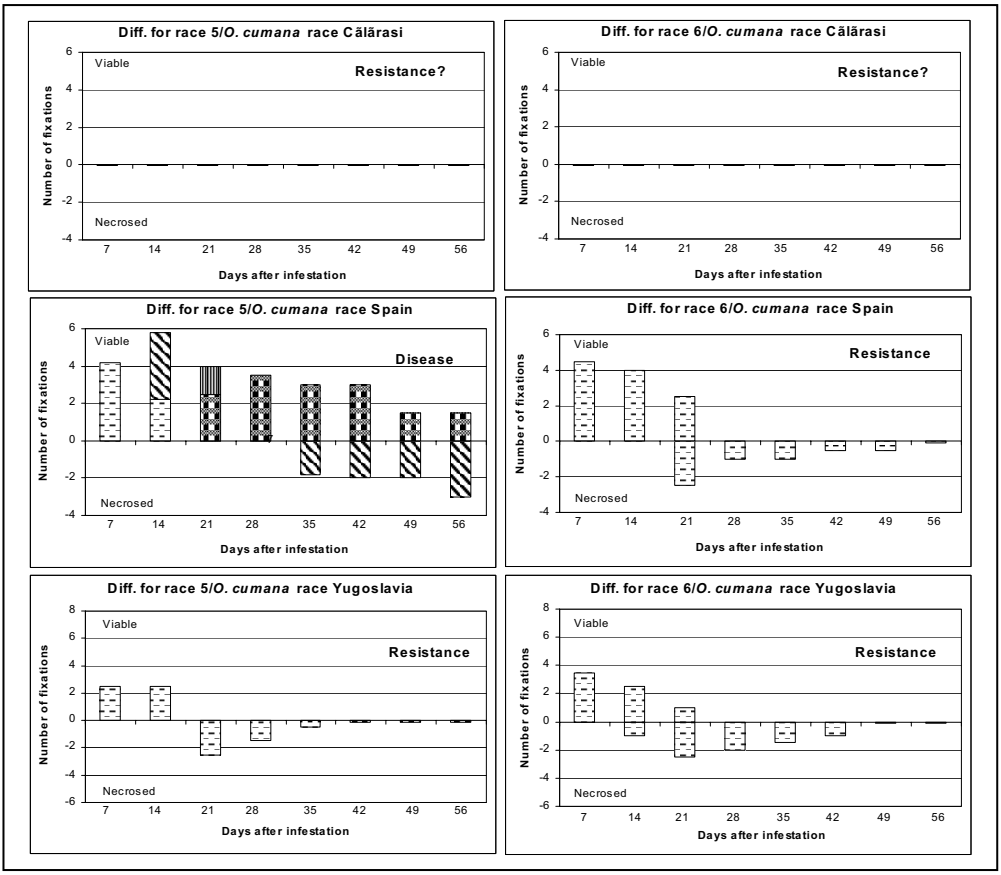


Figure 2. Results of in vitro experiments.


Figure 3. Broomrape attachment on sunflower roots of the differential for race E.

## Discussion

A new race of the parasite *Orobanche cumana* Wallr. has appeared in Romania, starting in 1996. This new race has spread very much in recent years in a large area of sunflower cultivation in the Constanta, Brăila, Tulcea and Ialomița regions. The populations of broomrape attacking sunflower in Europe are very different. The most virulent population is in Turkey, compared to broomrape in Romania, Spain and Yugoslavia. The results of this experiment are not so clear regarding broomrape from Călăraşi, Romania.

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