Orobanche ramosa L.: a new pest on rapeseed in the Western part of France

Gibot-Leclerc S.[1], Pinochet X.[2], Tuquet C.[1] and Sallé G.[1]
(1) Laboratoire de Parasitologie Végétale, Université Pierre et Marie Curie, 4 Place Jussieu, case courrier 155, 75252 Paris Cedex 05, France, E-mail: gibotl@ccr.jussieu.fr
(2) Direction Scientifique, service Innovations, CETIOM, Centre de Grignon, BP 4, 78850 Thiverval Grignon, France, E-mail: pinochet@cetiom.fr

ABSTRACT

Orobanche ramosa L. is an obligate root parasite which causes considerable yield losses on several major crops, especially in the Mediterranean area. For a few years, *O. ramosa* has been extending in rapeseed (*Brassica napus* L.) fields from the Western part of France, becoming a real agronomic threat. Since mid 1999 research have been developed on the pathosystem *O. ramosa*/rapeseed to get a better understanding of the spread of broomrape and on the effects of the main environmental factors on preconditioning and germination of parasite seeds. Studies include field observations and surveys to estimate the parasitized areas and to identify weeds present in rapeseed cultures. Surveys performed over four years (1999-2002) indicated a significant extension of the parasite. Field observations showed that, among 22 weeds having a high affinity to rapeseed, 11 were parasitized by broomrape and 4 were strongly attacked (*Aphanes arvensis, Crepis foetida, Geranium dissectum* and *Picris echioides*). Greenhouse co-cultures confirmed these results. On the contrary, 3 species studied in *in vitro* co-cultures provocked "suicidal germinations" of *O. ramosa* seeds. The preconditioning treatment of *O. ramosa* seeds was effective from 5 to 35°C. At the optimal temperature (20°C), the treatment was effective even when performed under a low water potential medium (-2 MPa) or under a low oxygen containing atmosphere (1% oxygen). On the other hand, preconditioned *O. ramosa* seeds germinated in a narrower range of temperatures (10-25°C) than rape seeds (5-35°C), only under atmosphere containing at least 3% oxygen and under a potential medium of –3 MPa. Rape seeds sown in different kinds of artificially infested soils, from Saint Jean d'Angely area, were parasitized by broomrape under greenhouse conditions.

These data indicate that, besides the obligatory presence of susceptible crops, development of *O. ramosa* does not require specific conditions. Possible causes of the spread of the broomrape in France are discussed taking into account data presented here.

Key words : Rapeseed, *Orobanche ramosa* L., parasitism, weeds, environnemental factors

INTRODUCTION

Orobanche ramosa L. (broomrape) is known as a root holoparasite damaging many cash and food crops in the Mediterranean region (Musselman, 1980; Parker and Riches, 1993; Sallé *et al.*, 2000). Since several years it has been extending in rapeseed (*Brassica napus* L.) fields in the Western part of France (Charente Maritime) (Gibot-Leclerc *et al.*, 2001). To get a better understanding of *O. ramosa* spread, field observations and surveys were carried out in the area of Saint Jean d'Angely with an emphasis on the behaviour of the parasite and of the weeds developed in the crop. Moreover, the effects of the main environnemental factors (temperature, oxygen availability, water potential and soil pH) were studied *in vitro* (Corbineau and Côme, 1995).

MATERIALS AND METHODS

To estimate the behaviour of *O. ramosa* in rapeseed in the Western part of France, surveys were carried out over four years (1999-2002) in the area of Saint Jean d'Angely (Charente Maritime) immediately after the harvest. During these surveys, rapeseed weeds were also identified and their susceptibility to broomrape established.

For rapeseed weed species presenting a high affinity to the culture, their susceptibility to *O. ramosa* was estimated through field observation and greenhouse and *in vitro* co-culture conditions.

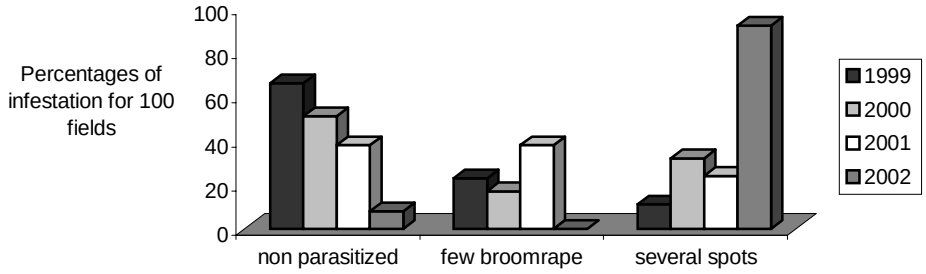
To study the effects of environmental factors on *O. ramosa* seed preconditioning and germination, seeds of broomrape parasitizing rapeseed were collected from 1999 to 2001. Broomrape seeds were surface sterilized and preconditioned according to Gibot-Leclerc *et al*. (2001). Preconditioning was performed at different temperatures, under various conditions of oxygen tensions (Côme and Tissaoui, 1968) or in PEG-8000 solutions (Michel and Kaufmann, 1973). Germination of *O. ramosa* was studied in the presence of a synthetic stimulant, GR24 (1ppm) (Zwanenburg *et al*.,1986; Gibot-Leclerc *et al*., 2001) at different temperatures, under various oxygen tensions or in different water potentials. Germination ability of rape seeds was tested in the same conditions as above.

Different kinds of soils, usually used for rapeseed cultivation in the Charente Maritime area, with pH ranging from 6.1 to 8.3 and artificially infested by broomrape, were tested for greenhouse co-culture of the pathosystem rapeseed/*O. ramosa*.

RESULTS

Field survey. Figure 1 showed that, in 2002, more than 90% of cultivated surfaces with rapeseed were highly infested with *O. ramosa*. In 1999 only 35% of fields were attacked. Whatever the year, a high proportion of plots was infested by broomrape.

Figure 1. Evolution of parasitized rapeseed fields by broomrape in the area of Saint Jean d'Angely over a four year period.



Rapeseed weeds and their behaviour to *O. ramosa*. According to the CETIOM weed data base and our field observations, 22 species from a list of 82 rapeseed weeds, presented a high affinity to this crop, including *O. ramosa*. Among them, 11 were attacked by broomrape and 4 were highly parasitized (*Aphanes arvensis*, *Crepis foetida*, *Geranium dissectum* and *Picris echioides*). This susceptibility was confirmed by greenhouse co-culture experiments. These species can be considered as host plants. Also, other species non attacked in fields (*Capsella bursa-pastoris, Polygonum aviculare* and *Raphanus raphanistrum*) showed a certain level of susceptibility to broomrape when grown in greenhouse conditions. On the contrary, *in vitro* co-cultures showed that root systems of *Anthriscus caucalis*, *Reseda lutea* and *Sinapis arvensis* stimulated the germination of *O. ramosa* seeds more or less highly (in a range of 50 to 98%) and rapidely (from 8 days to 3 weeks). However, when broomrape seeds germinated, they developed swollen radicles wich were unable to attach on host root systems and died by starvation. They were giving rise to "suicidal germinations".

Preconditioning and germination of *O. ramosa* seeds ; germination of rape seeds. The preconditioning treatment of *O. ramosa* seeds was effective from 5 to 35°C. At the optimal temperature (20°C), it required at least 1% oxygen in the atmosphere and remained effective at water potential of the medium of -2MPa.

Preconditioned *O. ramosa* seeds germinated more slowly and in a narrower range of temperatures (10 to 25°C) than rape seeds (5-35°C). Also, the optimal temperature of germination was lower for the parasite (20°C) than for the host (25-35°C). Germination of seeds

of both species occurred in atmospheres containing at least 3% oxygen. *Orobanche ramosa* were less sensitive to water potential of the medium (-3MPa) than rape seeds (-1.5MPa).

Germination of *O. ramosa* seeds and broomrape development were obtained on all kinds of soils from the area of Saint Jean d'Angely, whatever the pH. So, soil pH is not a limiting factor for the broomrape infestation in rapeseed fields.

DISCUSSION

In the area of Saint Jean d'Angély, rapeseed is more and more frequently attacked by *O. ramosa*. Non-parasitized plots are becoming rare and the general level of infestation is increasing. This observation suggests that the soil seed bank of *O. ramosa* is big enough to infest fields, years after years. There is no reason for a natural regression of the infestation.

The spread of the parasite could result of some changes in agronomic management but also of an increase in rapeseed cultivated surfaces during the 90s. Since four years, farmers and people from extension services have been aware of the orobanche problem and, are now able to detect it more easily.

The soil seed bank of *O. ramosa* could also increase *via* several weeds showing a strong affinity to rapeseed and a high susceptibility to the parasite. They are true host plants. On the other hand, only a few weed species (*Anthriscus caucalis, Reseda lutea* and *Sinapis arvensis*) are able to stimulate, *via* their root exudates, germination of broomrape but without any attachment. In this, case they are leading to "suicidal germinations" and, then can be considered as real false hosts, able to decrease the soil seed bank of *O. ramosa*. Therefore, they should be protected as long as possible to allow a massive germination of *O. ramosa* seeds.

All data concerning the effects of environmental factors on preconditioning and germination of *O. ramosa* seeds clearly show that all parameters tested never behave as limiting factors. The best to control the parasite should be to give up cultivating susceptible crops in fields. Unfortunately, this agronomic management has no chance to be taken into account by the rural world.

ACKNOWLEDGEMENTS

These results are part of a "Thèse de l'Université Pierre et Marie Curie" granted conjointly by CETIOM and the Poitou-Charente region.

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