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INCIDENCE, GROWTH AND HERBICIDE CONTROL OF BROOMRAPE (Orobanche cernua) IN SUNFLOWER: A REVIEW

L. García-Torres, M. Castejón-Muñoz and F. López-Granados,
Institute of Sustainable Agriculture, CSIC,
Apartado 240, Córdoba-14080, SPAIN (Fax: 57/202721)

Abstract

Studies to determine the geographical incidence, growth and herbicide control of broomrape in sunflower were conducted in Southern Spain. The aim of this paper is to outline this research. Orobanche cernua Loefl. infests areas where confectionary cultivars are commonly grown; infections have also recently extended to areas with oil cultivars. Evidence of diverse O. cernua populations were determined through isoenzyme techniques. Broomrape attachment to sunflower began when it had 6 to 7 leaves and continue throughout the vegetative and flowering period. Broomrape infections generally occur less with very early sunflower sowings than with late ones. Several herbicide treatments, all applied preemergence to sunflower efficiently control O. cernua; among them, imazethapyr at 20 to 40 g/ha, imazapyr at 12 to 25 g/ha and chlorsulfuron at 4 to 6 g/ha.

Key words: parasitic weeds, biology/ecology of weeds, herbicides.

Introduction

O. cernua (O. cumana Wallr.; broomrape) is an obligate parasitic weed of the sunflower (Helianthus annuus L.) root system. It is extensively found in Southern and Eastern Europe and in the Middle East. Crop yield loss caused by broomrape varies according to the infection severity, which is mainly a result of the seed bank and of the susceptibility cultivar.

The objective of this paper is to briefly report the research which has been conducted in Spain from 1986 to 1991 on the following topics: a) geografical incidence of the parasite in Spain; b) seeds/ infestations dispersal; c) phenology and growth and d) herbicide control.

a) *Geographical incidence in Spain*

O. cernua was first observed in Spain in 1958 in the province of Toledo (Diaz-Celayeta, 1958). In 1976 Sackston (1978) observed broomrape infestations in oil sunflower in the province of Cuenca and González-Torres et al. (1982) surveyed the broomrape infestations in that province and in the province of Málaga, reporting high infection severity of confectionary cultivars and to a much lesser degree of some oil cultivars. During the 1980's, broomrape spread to wide areas of Sevilla and Cádiz (Castejón-Muñoz et al., 1989 a & b), where slight infestation in some oil cultivars were repeatedly observed clearly intensified in the last two years (García-Torres, 1991; data not published).

b) *Seed - Infestation dispersal*

It was reported that growing broomrape-susceptible sunflower cultivars in a broomrape infested farm in suscesive years is a key factor to increases in the infection severity in the same farm and neighbouring areas. Furthermore, broomrape infections in oil cultivars were also higher after confectionary sunflower cultivars had been grown in the same farm (Castejón-Muñoz, 1989).

The spread of broomrape infestations is mainly due to the dispersal of broomrape seeds through the sunflower seeds (aquenes) and the wind. It has been determined that between 2% and 9% of the sunflower seeds (aquenes) from an infested field carry broomrape seeds adhered to the kernel (Castejón-Muñoz et al., 1991b). This can be easily explained by the microscopic size of the broomrape seeds (0.2-0.3 mm) which made very hard to see with the human eye.

It has been determined that broomrape seeds move from the mother plant to the head of sunflower plants before mechanical harvesting takes place. This explains the previously commented infestation of the sunflower aquenes by broomrapes seeds. Furthermore, if the wind is obviously the driving factor for short distances (between the mother plant and the sunflower head) it is forseeable that they also play an important role is broomrape seed disemination for long distances, especially in windy areas.

c) *Phenology and development*

The germination of broomrape seeds and subsequent attachment to sunflower roots occur at the early stages of the crop development, in response to the estimulants from the crop root exudates. Parasitic weed attachment was first observed in sunflower plants with 6-7 leaves, 18-22 cm high and coinciding with mean soil temperatures of 15-23 ºC (Castejón-Muñoz et al., 1992).

Parasitic attachment was also found throughout the vegetative and flowering period of the crop, therefore coexisting broomrapes at different stages of development. Figures 1 and 2 show the evolution of the infection (number and dry weight of broomrapes attached to sunflower plants) as affected by the crop sowing date (Castejón-Muñoz et al., 1992). Broomrape attachments follow an exponential pattern. Broomrape emergence from the soil surface began at early flowering of sunflower and lasted 4 to 6 weeks.

Field experiments conducted in Andalusia (Southern Spain) showed less broomrape incidence as sunflower crop sowing was anticipated. Certainly, the number of final attached and/or emerged brommrapes was less in early crop sowing (late January; early February) than in late sowing (late March; early April) (Figures 1, 2 and 3). Moreover, the positive effect of anticipating sunflower sowing under mild winter conditions as a mean to escape from the high temperatures and dryness of

Mediterranean climates in July and August is also well-known.

d) *Diversity of populations*

The existence in different countries (Ukrania, Moldavia, Rumania, Turkey, etc) of different "strains", "races" or "populations" of O. cernua, showing different degree of agressiveness to certain sunflower cultivars it is known for decades . Melero-Vara et al. (1988) studied the aggressiveness of the O. cernua races from Spain, concluding that some of them were different to others previously found in Eastern Europe.

Differences between O. cernua populations from diverse geographical areas, type of cultivars (confectionary or oil) and fields with diverse infection severity in a given area were determined in Spain with isoenzymatic techniques (Castejón-Muñoz, 1989; Castejón-Muñoz et al., 1991a). Generally, the isoenzymatic pattern varied widely within a given population and between populations. Less variability occur in young populations which come from a few plants.

The variability and evolution of broomrape populations previously commented is a serious difficulty for the introduction of genetic resistance against this parasitic weed in sunflower. Similarly, it can also make the selection and development of biotypes resistant to a given herbicide possible if it is used extensively for many years.

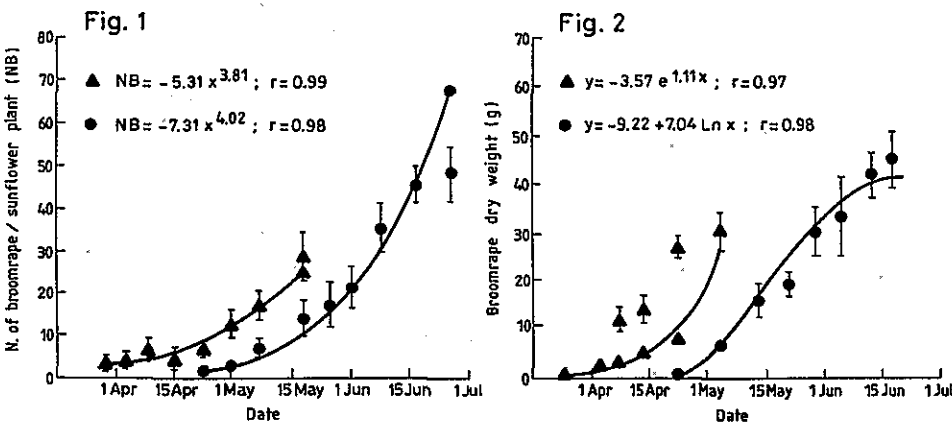
e) *Herbicide control*

Due to the serious spread of O. cernua in several regions of Spain, a research program to develope new herbicides treatments for its control began in 1986. In collaboration with transnational agrochemical companies over 30 new molecules, most of them not yet commercialized, were selected as potential herbicides for broomrape control according to one of the following modes of action: a) absorbed by the leaves of the host crop and translocated via phloema to the roots and b) active in the soil and with medium persistance (García-Torres et al., 1988). The selected herbicide were assayed for several years in different locations, its efficacy or broomrape control determined (the number of parasite plants emerged from the soil surface) and through the phytotoxity or crop response to the herbicide under weed-free conditions. The most interesting results found are as follows.

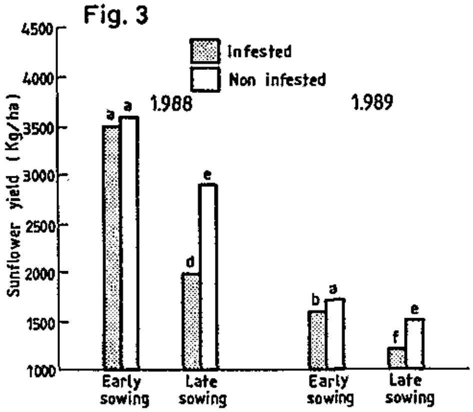
Glyphosate applied to sunflower plants with about 22 leaves effciently controlled the broomrapes of about .5 to 1 cm attached to the roots. However, glyphosate treatments should not be recommended (Castejon-Muñoz et al., 1990) due to the low crop tolerance or phytotoxicity to the herbicide, which makes sunflower yields from glyphosate treatments lower that those from untreated infested or non-infested checks.

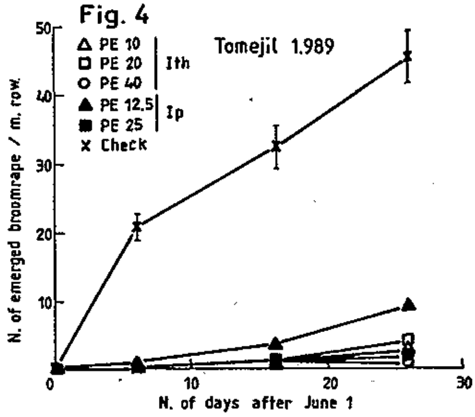
Several herbicides applied preemergence were effective for broomrape control in sunflower (García-Torres & López-Granados, 1991; García-Torres et al., 1992), in particular the herbicide imidazolinones developed by American Cyanamid, and the sulfonylureas by Dupont and other chemical companies. For example, experiments carried out in several locations and years showed that imazethapyr applied preemergence at rates 20 - 40 g/ha and imazapyr at 12.5-25 g/ha were very effective in broomrape control and well tolerated by sunflower (Figures 4, 5 and 6). Chlorsulfuron at about 4 to 6 g/ha also controlled broomrape but was somewhat less effective and variable according to the enviromental conditions present. None of these herbicides are currently registered in Spain for use in sunflower. Imazethapyr is registered in USA and Brazil (commercial name Pursuit or Pivot) as a herbicide for soybean and will probably be registered in Spain as a legume herbicide. Imazapyr is registered in many countries (commercial name Arsenal) as a total herbicide for roadsides and forestry at rates of 0.5 to 2.0 k/ha, therefore 20 to 40 times higher than those recommended in sunflower for broomrape control (from 12.5 to 25 g/ha).

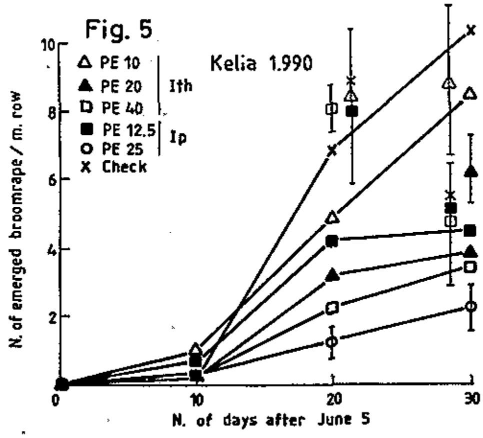
Enviromental conditions, particularly rainfall, generally important role in determining the effectiveness of the preemergence herbicide. This can explain the different results obtained for a given treatment in different years (Figures 4 and 5). Without rainfall, preemergence herbicide are not effective since they are not absorbed by the crop plants. On the contrary, very high rainfall decreases efficacy in broomrape control since under high soil water content herbicide degradation in the soil is enhanced and is not persistant enough throughout the parasite attachment period.



Figures 1 and 2. O. cernua infection evolution as affected by sunflower sowing dates (early ▲ ; late ●). Vertical lines indicate standard errors of the means.







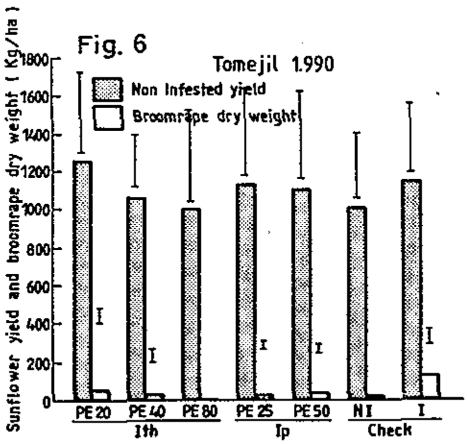


Figure 3. Effect of the O. cernua infestations and sunflower sowing dates on yield. Treatments with the same letter are non significant (P 0.05).

Figures 4 y 5. Effect of the herbicides imazethapyr (Ith) and imazapyr (Ip) on the O. cernua infestation evolution in two locations, 4) Tomejil 1989; 5) Kelia 1990. Numbers indicate herbicide rates in g/ha; and vertical lines indicate standard errors of the means.

Figure 6. Effect of the herbicides imazethapyr (Ith) and imazapyr (Ip) on sunflower yield under a broomrape free situation, and on broomrape dry weight in infested soil. Numbers indicate herbicide rates in g/ha, and vertical lines indicate standard errors of the means.

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