BROOMRAPE (*OROBANCHE CUMANA* WALLR.) CONTROL BY DEVELOPING GENETIC RESISTANT GENOTYPES IN SUNFLOWER

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Abstract

Sunflower broomrape (*Orobanche cumana* Wallr.) is a parasitic plant which has a significant negative impact on seed yield. The parasite is spread in large areas of Europe, Asia and it has identified recently, in North Africa. Breeding for resistance is regarded as the most effective, feasible and environmentally friendly solution to control sunflower broomrape. However, breeding for resistance is challenging as new races of the parasite have evolved. The use of resistant hybrids of monogenic resistance type, is followed by the appearance of new more virulent races that overcome the existing resistance genes. So, it is necessary to develop sunflower hybrids which can accumulate qualitative and quantitative resistance in a single one, in order to have a durable resistance. Among this, by developing Clearfield Production System in sunflower it could have an important control strategy and complemented the genetic resistance against the parasite.

Key words: sunflower broomrape, genetic control, qualitative resistance, quantitative resistance, herbicides resistance

The parasitic weed *Orobanche cumana* (sunflower broomrape) is an obligatory and non-photosynthetic root parasitic plant of the sunflower (*Helianthus annuus* L.) and is a substantial threat in Europe, especially in countries around the Black Sea and in Spain (Molinero-Ruiz L. *et al*, 2013, Louarn J. *et al*, 2016). Under favourable conditions, it infects the roots of sunflower plants and connects to the vascular tissue, thus depleting the nutrients and affecting host growth and yield (Heide-Jorgensen H., 2008; Molinero-Ruiz L. *et al*, 2015). Broomrape seeds are very small and individual plants can produce an impressive number of seeds that remain viable in the soil for up to 20 years. They are widely disseminated by water, wind, animals, humans, machinery, or though attachment to sunflower seeds (Parker C., 2013).

A major difficulty for the breeders is the fast development of new races of the parasite, which overcome the resistance of sunflower genotypes. To the present day, more than seven races of sunflower broomrape have been identified (Kaya Y., 2014). Vranceanu A.V. *et al* (1980) identified five races of *O. cumana*, designated as A, B, C, D and E. Later on, more virulent race F was identified in Spain (Alonso L.C. *et al*, 1996; Molinero-Ruiz L. *et al*, 2008, Martin-Sanz *et al* 2016), Romania (Păcureanu-Joita M. *et al*, 1998), Turkey (Kaya Y. *et al*, 2004) and some other counties. Presence of more virulent broomrape races, designated G and H, has been also reported (Shindrova P. and Penchev E., 2012, Antonova L. *et al*, 2014, Kaya Y., 2014).

Current racial situation of broomrape in the main infested areas is unclear, since there is a lack of information on whether races under the same name reported in different countries are the same or differ in terms of virulence (Fernández-Martínez J. *et al*, 2012; Molinero-Ruiz L. *et al*, 2015, Martin-Sanz A. *et al*, 2016).

Breeding for genetic resistance appears to be the most appropriate and reliable measure to control the parasite.

The changes in broomrape race composition have forced sunflower breeders to continuously search for resistance genes to new races and study their genetic control.

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The objective of this study was to identify sources of resistance to the parasite and to develop genetic resistant genotypes to broomrape.

MATERIAL AND METHOD

Six cultivated sunflower inbred lines and two sunflower wild species have been introduced in crossing for obtaining interspecific hybrids, in order to create sunflower populations which will be used for releasing inbred lines with high resistance to broomrape (*Orobanche cumana*).

These hybrids as well as the parental forms (cultivated and wild) have been studied for resistance to the parasite broomrape. There have been analyzed the number of sunflower heads and number of seeds/head, for each crossing.

The crossing between cultivated and wild sunflower was made by emasculation in cultivated inbred lines and making pollination with wild species pollen, as well as making emasculation in wild forms and pollination with pollen of cultivated ones.

The populations which were obtained from interspecific hybrids have been tested for resistance to broomrape. The resistance to broomrape parasite was made in natural and artificial infestation conditions. The testing in the artificial infestation was made in glass house, in pots of 5 liters capacity, having inside a mixture of soil and sand (3/1) as well as broomrape seeds (1 g/pot). It has been collected broomrape from areas very high infested with the parasite.

In natural infestation, the testing was made in two locations situated in areas Constanta and Tulcea, with different virulence of broomrape populations.

RESULTS AND DISCUSSIONS

The results regarding the crosses between wild and cultivated sunflower are presented in *table 1*. In case of using cultivated sunflower as pollen receptor, the number of seeds/head is high, comparing with case of using the wild sunflower as pollen receptor, when the number of seeds/head is very low. In this case the number of heads is high, taking into consideration that the wild sunflower is high branched, so, there are many small heads.

Table 1

Results regarding the crosses between wild and cultivated sunflower

Helianthus annuus	*H. tuberosus*	*H. agrestis*	LC 1001	LC 985	LC 1015	LC 1066	LC 1085	LC 1088
	Hybridization: number of heads and seed/heads							
LC 1001 B	3/640	3/250						
LC 985 B	3/520	3/120						
LC 1015 B	3/390	3/360						
LC 1066 C	3/150	3/150						
LC 1085 C	3/280	3/250						
LC 1088 C	3/130	2/110						
Helianthus tuberosus			25/15	25/7	25/5	25/14	25/23	25/12

In *figure 1* are presented the results regarding the resistance to broomrape for sunflower populations obtained from interspecific hybrids. Comparing the results obtained in two locations situated in Tulcea and Constanta areas, these are showing that some populations are full resistant in Tulcea area, having a low attack degree in Constanta area.

The sunflower differential line, for the race E which was used as check for sensitivity, has a high infestation degree, in both locations. This it means that in these locations the parasite has developed races more virulent.

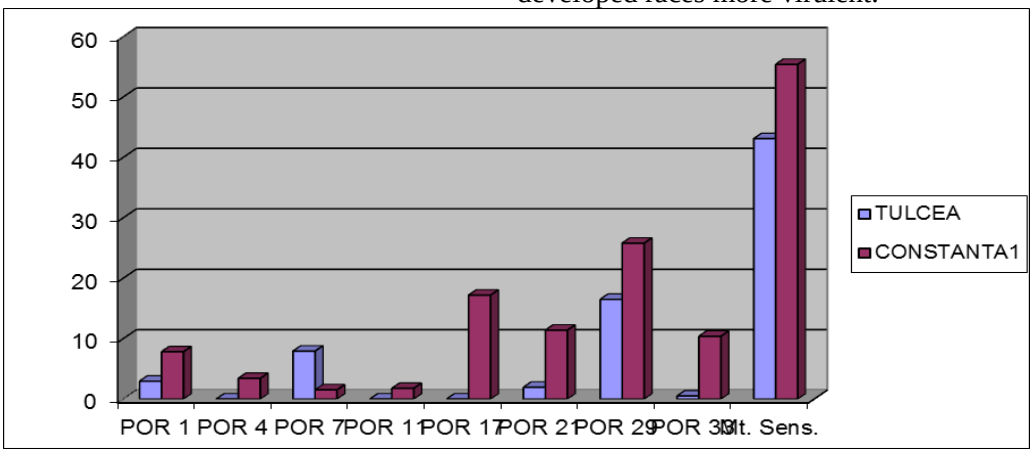

Figure 1 **Results regarding the resistance of some sunflower populations obtained from interspecific hybrids, to the broomrape parasite, in the natural infestation conditions, in two areas in Romania**

In *figure 2* is presented the scheme used for introducing the genes for resistance to the parasite broomrape, in the valuable sunflower inbred lines. In this process of the genes transferring it needs a number of 3-4 backcross generations, followed by 1-2 generation of self-pollination.

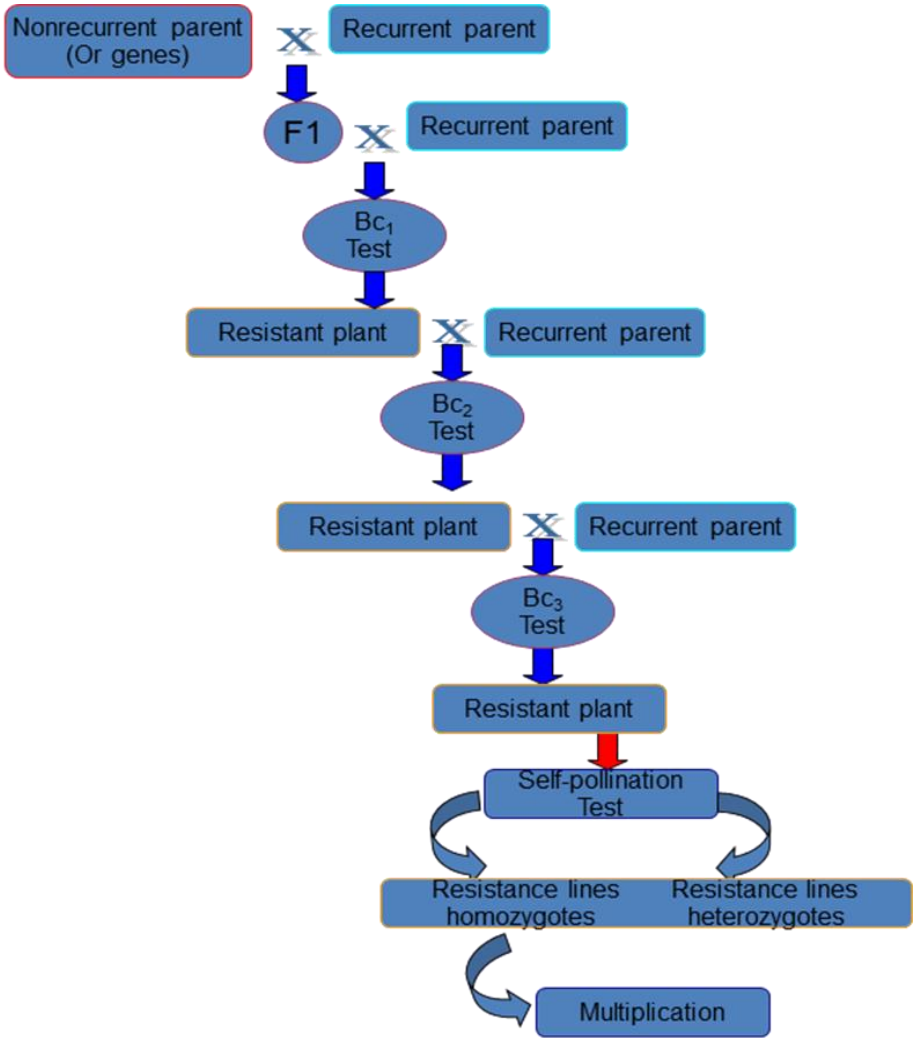

Figure 2 - **Scheme used for the genes for resistance transferring, in the valuable inbred lines**

In *figure 3* are presented the results regarding the behavior of some lines in different generations of the genes transfer, using many broomrape populations, from the most infested areas in southeastern Romania.

The testing was done in the artificial infestation conditions. It can be seen that for some lines, the resistance is increasing after each generation of selection, taking into consideration that it is made one generation per year.

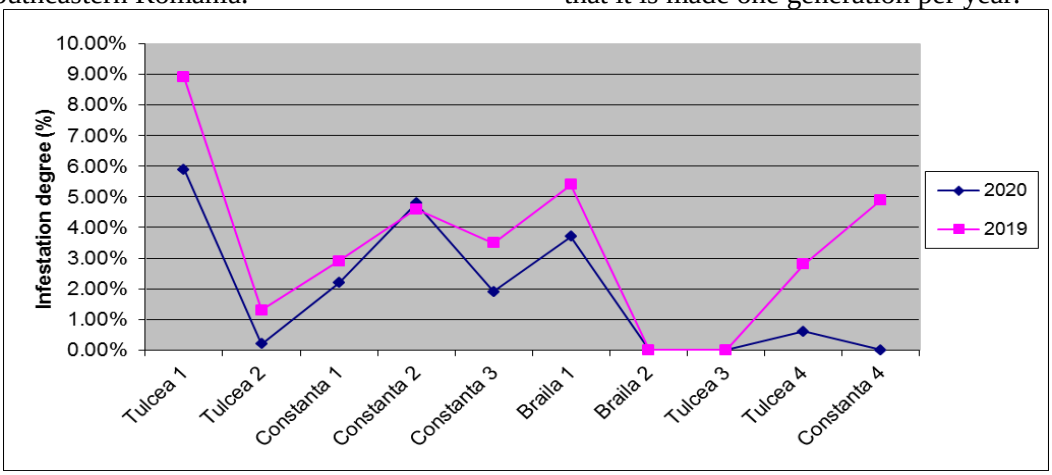

Figure 3 **Results regarding the behavior of sunflower lines, in different generations of selection, in two years**

CONCLUSIONS

The broomrape parasite has become very dangerous for sunflower crop in almost all areas cultivated with sunflower in Europe. It is of a great importance to identify sources of resistance to the new races of broomrape. For this, the sunflower wild species are very important, they being the best source of genes for resistance.

Some sunflower populations obtained by crossing sunflower wild species with cultivated genotypes have good resistance to the broomrape races which are spread in the most important areas cultivated with sunflower in Romania.

Using a scheme efficient for transferring the genes for resistance to broomrape parasite, in some valuable sunflower inbred lines, there has been obtained high resistant genotypes

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