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OROBANCHE CUMANA WALLR. RESISTANCE OF COMMERCIAL SUNFLOWER CULTIVARS GROWN IN ARGENTINA

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ABSTRACT

The parasitic weed *Orobanche cumana* Wallr. (broomrape) is one of the major limiting factors in worldwide sunflower production. However, it is absent in the centre of origin and in the sunflower crop areas of América. It has not yet been elucidated if *O. cumana* naturalization in sunflower habitats in Argentina is restricted as a result of either abiotic constraints or resistance in grown commercial cultivars. The aim of the present study was to assess the degree of resistance of commercial sunflower cultivars grown in Argentina to *O. cumana*. More than 95% of the tested sunflower cultivars were, in general, susceptible to broomrape attack. Although three cultivars were found to evidence an acceptable response to broomrape attack, only one of them showed complete resistance to *O. cumana*. This disregards genetic resistance of grown cultivars as being the reason for the absence of broomrape in Argentina. In view of this, future studies should focus on other biotic and abiotic factors affecting broomrape growth and development which could be potentially responsible for the absence of *O. cumana* in Argentina.

Key words: broomrape, incidence, severity.

RESUMEN

La planta parásita *Orobanche cumana* Wallr. (jopo) es una de las mayores limitantes de la producción de girasol en los principales países productores del mundo. Sin embargo, está ausente en el centro de origen y en las áreas de cultivo de girasol en América. No ha quedado claro aún si la naturalización de *O. cumana* en los hábitats de girasol de Argentina está limitada por restricciones abióticas o por la resistencia de los cultivares comerciales. El objetivo de este estudio fue investigar la resistencia a *O. cumana* de los cultivares comerciales de girasol en Argentina. En general, más del 95% de los cultivares probados fue susceptible al ataque de jopo; solamente uno de ellos mostró completa resistencia a *O. cumana*. Esto descarta la posibilidad de considerar a la resistencia genética de los cultivares utilizados como la causa de la ausencia de jopo en Argentina. Por lo tanto, los estudios futuros deberían focalizarse en otros factores bióticos y abióticos que, por afectar el crecimiento y desarrollo del jopo, podrían ser responsables potenciales de la ausencia de este parásito en Argentina.

Palabras clave: jopo, incidencia, severidad.

INTRODUCTION

The parasitic weed *Orobanche cumana* Wallr. (broomrape) is one of the major limiting factors in sunflower production among the principal sunflower-producing countries all over the world. As of the earliest studies initiated in Russia by Dr. V.S. Pustovoit at the beginning of the last century, genetic resistance combined with herbicides has been the best way to control this weed (Eizenberg *et al.*, 2006; Rubiales *et al.*, 2009; Fernández-Martínez *et al.*, 2010). Nonetheless, in spite of the worldwide use of these control strategies, infested areas keep on revealing a significant increase. This parasitic weed, which is native of Russia, is widely distributed in the whole Eurasia continent, including the Black Sea region (Antonova *et al.*, 2009), Serbia (Masirevic and Medic-Pap, 2009), Romania (Pricop *et al.*, 2011), Turkey (Demirci and Kaya, 2009), Spain (Fernández Martínez *et al.*, 2009), Israel (Eizenberg *et al.*, 2003) and Southern areas of France. Broomrape has also been recently detected in Africa (Amri *et al.*, 2012).

Broomrape is absent in the centre of origin of sunflower and in the sunflower crop areas of América. As a result of an intense sunflower seed exchange among regions worldwide and due to the very small size of *Orobanche* seeds, absence of accidental introductions seems to be almost impossible. It has not yet been confirmed if *O. cumana* naturalization in Argentinean sunflower habitats is limited due to abiotic constraints (Miladinovic *et al.*, 2012). The habitats suitable for broomrape invasion in Argentina have been observed to be different from invaded habitats in Serbia particularly in terms of mean temperature during the coolest months. Also, *O. cumana* has been found in some Spanish habitats where winter temperatures are similar to those in Argentina (Cantamutto *et al.*, 2012). Both natural and broad genetic resistance in Argentina sunflowers could be potentially responsible for broomrape absence in Argentina. In view of the above, the purpose of the present study was to assess resistance of Argentine commercial sunflower cultivars to *O. cumana*.

MATERIALS AND METHODS

A representative sample of commercial Argentine sunflower germplasm including a hundred of commercial hybrids from 22 private seed companies and one old open pollinated variety (Impira INTA) from a national institution (breeders) was analyzed. Sunflower cultivars were grouped as i) traditional (TRAD; n=68), ii) imidazolinone resistant or Clearfield® (CL; n=23), and iii) high oleic (SQ; n=10) varieties. Ninety-six of the sampled hybrids were included in the sunflower network of experimental analyses carried out by the *Instituto Nacional de Tecnología Agropecuaria* (INTA) during the 2010-2011 growing season.

Samples of sunflower cultivars grown in Argentina were carefully cleaned and treated with 1.05 mg/g seed of metalaxyl-m. Treated seeds were sent to the Institute of Field and Vegetable Crops, in Novi Sad, Serbia, following phytosanitary regulations from Argentina and Serbia.

Broomrape resistance screening was performed as described by Terzic *et al.* (2010). Ten-litre pots were filled with a mixture of sand: perlite: peat in a 1:1:1 ratio and 70 mg of *O. cumana* seed, race E. Ten sunflower plants per pot were grown in the greenhouse at 25°C - 16:8 h photoperiod during six weeks. After seven weeks, the plants were completely cleaned and broomrape attack incidence and severity were determined. Incidence (INC) was calculated as the ratio attacked plants: total plants (n=10); Severity was calculated as broomrape attachment number per sunflower plant (TSPL).

For severity values, ANOVA was done using InfoStat (2008) where each sunflower plant was treated as one replication (n=10) in a completely randomized design, factorial arrangement with three factors: cultivar, breeder and group. *O. cumana* incidence was determined considering cultivars as replicates (n=68, 23, 10) and two factors: breeder and group. Each cultivar was identified by a letter for the breeder and a number corresponding to the variety. Due to commercial implications, identification of the cultivars analyzed is restricted but available to each breeder upon request.

RESULTS AND DISCUSSION

In general, sunflower cultivars grown in Argentina were found to show a high incidence of *O. cumana* attack, with no differences among the above-mentioned three groups (Table 1). Mean attack severity corresponded to susceptible cultivars (Terzic *et al.*, 2010) and no effect of breeder either on incidence or on attack severity was observed (Data not shown). In the most susceptible subgroup among traditional cultivars, severity reached more than eight broomrape attachments per plant and complete incidence (Fig. 1). The open variety Impira INTA (coded as L3) was included in this category. On the other hand, in four cultivars from this group broomrape emergence was lower than two attachments per plant. Furthermore, two traditional cultivars showed a good resistance level as no emergence of broomrape was observed. However, broomrape nodules were found on their roots. The I3 cultivar was observed to have only one infested plant with seven broomrape nodules. Due to the hybrid nature of I3 cultivar, this unusual response to inoculation could be attributed to an unintentional seed contamination.

On the other hand, high severity of broomrape attack was observed in all Clearfield cultivars, with two or more broomrape tassels per plant and complete parasitic incidence (Fig. 2). The high susceptibility of Clearfield cultivars to broomrape could be the consequence of a breeding process on account of the fact that as in Clearfield cultivars less attention is paid to genetic resistance to this parasite since broomrape could be chemically controlled in Clearfield crops (Kaya *et al.*, 2012). Among high oleic sunflowers, W15 cultivar showed complete resistance to broomrape attack, with no root attachments (Fig. 3). The remaining nine high oleic cultivars showed complete incidence, with more than two broomrape attachments per plant.

In general, more than 95% of the tested sunflower cultivars grown in Argentina were susceptible to broomrape attack. Although three cultivars showed an acceptable response to broomrape attack, only one of them showed complete resistance to *O. cumana*. This is indicative of a general vulnerability to *O. cumana* diffusion in Argentina.

Findings from the present study reveal that the majority of the commercial sunflower cultivars grown in Argentina are susceptible to broomrape. The possibility of considering genetic resistance of grown cultivars to *O. cumana* as the reason for broomrape absence in Argentina is therefore discarded. Future studies should therefore be conducted on other biotic and abiotic factors affecting broomrape growth and development which could be potentially responsible for the absence of this parasite in Argentina.

Group	TSPL	INC (%)
Traditional	4.5 ± 0.3	97.2 ± 1.7
Clearfield	4.8 ± 0.3	100.0 ± 0.0
High Oleic	6.2 ± 1.0	90.0 ± 10.0
ANOVA	ns	ns

Table 1. Severity (TSPL= *Orobanche* attachments per sunflower plant) and Incidence (INC=attacked plants/total inoculated plants) mean ± SE for the three groups of Argentine sunflower cultivars inoculated with *O. cumana*, race E.

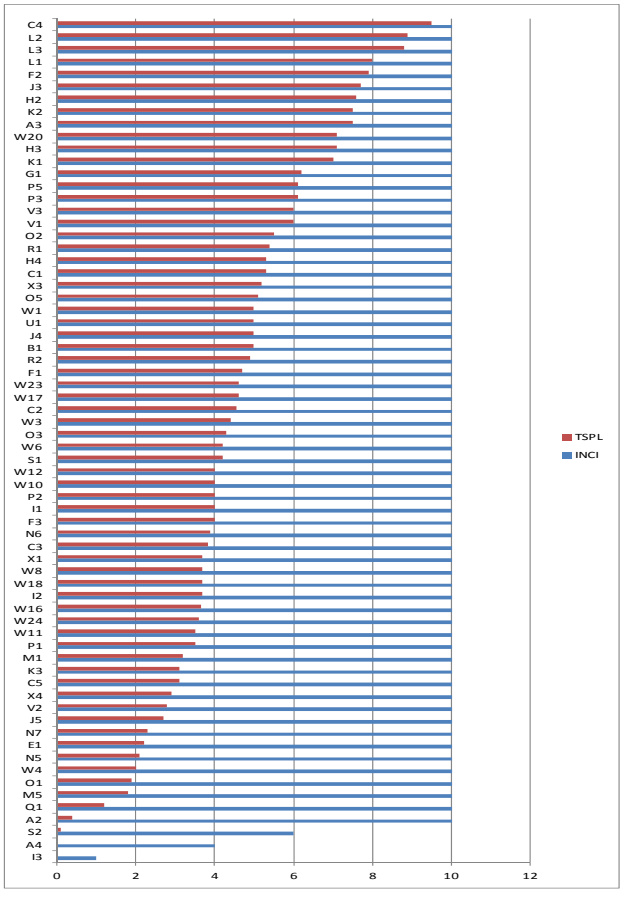

Figure 1. Broomrape (*O. cumana* Race E) severity (as broomrape attachments per plant = TSPL, LSD = 2.5) and incidence (attacked plants per ten plants = INC) of traditional Argentine sunflower cultivars.

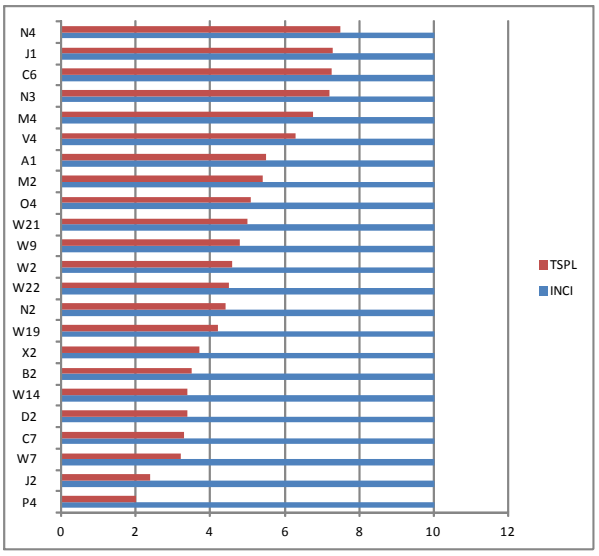

Figure 2. Broomrape (*O. cumana* Race E) severity (as broomrape attachments per plant = TSPL. LSD = 2.6) and incidence (attacked plants per ten plants = INC) of Argentine Clearfield (CL) sunflower cultivars.

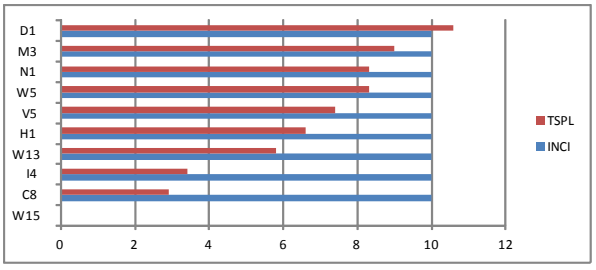

Figure 3. Broomrape (*O. cumana* Race E) severity (as broomrape attachments per plant = TSPL, LSD = 3.3) and incidence (attacked plants per ten plants = INC) of Argentine high oleic sunflower cultivars.

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