III. GENETIC RESISTANCE TO SUNFLOWER BROOMRAPE

4th International Symposium on Broomrape in Sunflower

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HELIANTHUS SPECIES AS A SOURCES FOR BROOMRAPE RESISTANCE

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Abstract

Broomrape (*Orobanche cumana*) is an obligate holoparasite and has become one of the most important biotic factors limiting sunflower production in Southern Europe, the Black Sea region, Ukraine and China. For more than 60 years broomrape is present in Serbia and the most affected region is Vojvodina province. The aim of this study was evaluation of resistance of some wild *Helianthus* species to broomrape populations that are highly virulent in Serbia. Experiment was carried out at the Institute of Field and Vegetable Crops, Novi Sad where is one of the biggest collection of wild *Helianthus* species worldwide. Evaluation was done in green house using buckets infested with broomrape seeds collected from naturally infested fields from Bačka region. Plant material for evaluation included 6 annual wild *Helianthus* species and in total 13 populations. Results of the experiment showed that in total 9 populations were resistant. Resistant populations were *H. debilis* 1134, *H. neglectus* 0457, *H. niveus* 0608, *H. argophyllus*, *H. petiolaris* 0338, *H. petiolaris* 1383, *H. petiolaris* 1910, *H. praecox* 1151, *H. praecox* 1340. Susceptible populations were *Helianthus debilis* 1287, 1569, 1566 and *Helianthus praecox* 0380. Further testing of resistant accessions of wild species should indicate possibility of finding source for resistance for more virulent broomrape populations present in Spain, Ukraine and Black Sea region.

Keywords: *broomrape, helianthus species, resistance evaluation*

INTRODUCTION

Being one of the most important oil crop, worldwide, sunflower (*Helianthus annuus* L.) is faced with many biotic factors that are limiting its production. Considering that, sunflower breeders are confronted with difficult tasks, because while breeding for higher seed and oil yield, they are also in constant race for resistance genes to different pathogens and parasites that attack sunflower. Among many of them, sunflower broomrape (*Orobanche cumana*) is considered to be the most important one. Broomrape is an obligate holoparasite and has become one of the most important biotic factor limiting sunflower production in Southern Europe, the Black Sea region, Ukraine and China. Besides sunflower, broomrape parasites many other crops such as tomatoes (*Solanum lycopersicum*), hop (*Humulus lupulus*), tobacco (*Nicotiana tabaccum*), sugar beet (*Beta vulgaris*), carrot (*Daucus carota*), hemp (*Cannabis sativa*), alfalfa (*Medicago sativa*) and others (Dedić et al., 2009; Marinković et al., 2014). It is obligatory and non-photosynthetic root parasitic plant of the sunflower (Louarn et al., 2016). Broomrape is flowering weed that is entomophily pollinated and attacks the root system of sunflower plants (Marinković et al., 2014). Once attached to a host, it reduces the vitality of the affected plants by taking their water and minerals, which in the end, depending on the

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severity of the attack, leads to partial or complete yield reduction. Depending on the susceptibility the infected sunflower plants are smaller, substantial decrease in head diameter is observed and significant yield losses are recorded (Alcántara et al., 2006; Duca, 2015). There are several methods of controlling the broomrape but still the most efficient one is breeding for genetic resistance (Thomas et al., 1998; Mauromicale et al., 2005; Tan et al., 2005; Echevarria-Zomeno et al., 2006; Kaya et al., 2012; Louarn et al., 2016). Valuable source of genetic resistance to broomrape races found in wild *Helianthus* species and introgression of the resistance genes from interspecific crosses was described in previous studies (Dozet and Marinković, 1998; Jan and Fernandez-Martínez, 2002; Velasco et al., 2007; Fernandez-Martinez et al., 2008; Terzić et al. 2010; Seiler and Jan, 2014).

For more than 60 years broomrape is present in Serbia and the most affected region is Vojvodina province. In Vojvodina the severity of attack is in Bačka and diffusion of the parasite is between Bačka Topola and Subotica (Maširević, 2001). Broomrape presence in Serbia was firstly described in early 1950s (Aćimović, 1998). According to Maširević and Medić-Pap (2009) significant damage to susceptible hybrids were recorded in the 1990s. The most dominant race in Serbia is E and it appeared in 1996 (Mihaljčević, 1996). For more than 20 years race E is present in Serbia and according to Miladinović et al. (2014) no new broomrape races have appeared.

The aim of this study was evaluation of resistance of some wild *Helianthus* species to broomrape populations that are highly virulent in Serbia.

MATERIAL AND METHODS

Experiment was carried out at the Institute of Field and Vegetable Crops, Novi Sad where is one of the biggest collection of wild *Helianthus* species, worldwide. Plant material for evaluation included 6 annual wild *Helianthus* species and in total 13 accessions (Tab. 1).

As previously described by Terzić et al. (2010) seed of wild species was firstly dehulled and placed in petri pots containing filter paper moistened with water to promote germination. Petri pots were placed in a growth chamber with a constant temperature of 24°C. After root emergence seedlings were transferred to jiffy 7 pots and grown in the greenhouse at 21°C (day and night), with RH (relative humidity) around 80% and constant light until the phase of two pairs of leaves, after which they were transferred to buckets (10 L). A mixture of sand:perlit:peat in a 1:1:1 ratio which was homogeneously infested with broomrape seeds collected in a Bačka region at a rate of 70 mg/dm3 soil mixture. Plants were grown in the infested soil at a photoperiod of 16/8h day/night until physiological maturity. Broomrape resistance of tested accessions was evaluated at the stage of physiological maturity. Plants with emerged or underground broomrape stalks were considered susceptible and those without a broomrape stalk as resistant (Terzić et al., 2010). Furthermore, roots were thoroughly checked and degree of broomrape nodules was observed. Degree of broomrape attack was calculated as number of broomrape plants/number of sunflower plants.

RESULTS AND DISCUSSION

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Since broomrape appearance at the end of 19th century sunflower breeders were successful in development of resistant genotypes (Seiler and Jan, 2014). Introgression of first resistance genes from wild species, mainly *H. tuberosus*, to cultivated sunflower was described by Pustovoit et al. (1966). Newer studies have also reported resistance to different races of broomrape in many other *Helianthus* species (Nikolova et al., 2000; Fernández-Martínez et al., 2010; Škorić and Pacureanu, 2011; Antonova et al., 2011; Christov, 2013).

Evaluated populations of wild *Helianthus* species showed different reaction to broomrape (Tab. 1). Out of four tested accessions of *H. debilis* only one was completely resistant (DEB1134). This result is in accordance with previous research of Terzić et al. (2010) who also reported resistance in the same population. Accession DEB1287 was found to be the most sensitive accession in experiment with degree of broomrape attack and nodules of 10.75 and 4, respectively. In *H. praecox*, accession PRA0380 was sensitive with intensity of broomrape attack of 7, while PRA1151 and PRA-HIR1340 were resistant. Accessions of *H. petiolaris* PET0338, PET1383 and PET1910, were completely resistant to the broomrape population used in the experiment. Fernandez-Martinez et al. (2008) reported *H. praecox* and *H. petiolaris* to be 100% sensitive to broomrape race F. In a comprehensive study Christov (2013) reported that annual *Helianthus* species, *H. annuus* (wild), *H. argophyllus*, *H. debilis*, *H. petiolaris*, and *H. praecox*, were resistant to broomrape races in Bulgaria. Accession of *H. argophyllus* also showed to be resistant in this study. Petcu and Pacureanu (2011) reported that interspecific hybrid derived from *H. argophyllus* showed resistance to broomrape race F in Romania. *H. neglectus* (NEG0457) and *H. niveus* (NIV0608) showed complete resistance to broomrape population used in this study.

Table 1. Tested wild sunflower accessions and their reaction to broomrape

No	Population (ifvcns)	Species	Broomrape incidence (%)	Degree of broomrape attack	Degree of broomrape nodules
1.	DEB 1134	*H. debilis*	0	0	-
2.	DEB 1287	*H. debilis*	80	10.75	4
3.	DEB 1569	*H. debilis*	25	9	1
4.	DEB 1566	*H. debilis*	40	1	14.5
5.	NEG 0457	*H. neglectus*	0	0	-
6.	NIV 0608	*H. niveus*	0	0	-
7.	ARG	*H. argophyllus*	0	0	-
8.	PET 0338	*H. petiolaris*	0	0	-
9.	PET 1383	*H. petiolaris*	0	0	-
10.	PET 1910	*H. petiolaris*	0	0	-
11.	PRA 1151	*H. praecox*	0	0	-
12.	PRA 0380	*H. praecox*	20	7	-
13.	PRA-HIR 1340	*H. praecox*	0	0	-

CONCLUSIONS

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Bearing in mind narrow genetic background in cultivated sunflower and many constraints in its production, especially evolution of broomrape populations into more virulent races, evaluation of existing germplasm is needed in order to find sources for resistance genes.

Accessions of wild *Helianthus* species showed different reaction to broomrape. Resistant accessions were *H. debilis* 1134, *H. neglectus* 0457, *H. niveus* 0608, *H. argophyllus*, *H. petiolaris* 0338, *H. petiolaris* 1383, *H. petiolaris* 1910, *H. praecox* 1151, *H. praecox* 1340. Susceptible to broomrape were *Helianthus debilis* 1287, 1569, 1566 and *Helianthus praecox* 0380. Further testing of resistant accessions of wild species should indicate possibility of finding source for resistance for more virulent broomrape populations present in Spain, Ukraine and Black Sea region.

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