

SCREENING WILD SUNFLOWER SPECIES FOR RESISTANCE TO *OROBANCHE CUMANA*

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Abstract

In this study, wild sunflower species were evaluated for resistance to *Orobanche cumana* under artificial conditions. Broomrape seeds were collected in 2024 from seven locations in southern and southeastern Romania (Călărași 1–3, Tulcea 1–2, Constanța 1, Brăila 1) and resistance tests were performed in 2025. The annual species (*Helianthus annuus*, *Helianthus argophyllus*) were the most susceptible to all broomrape populations. *Helianthus grosseserratus*, *Helianthus maximiliani* and *Helianthus nuttallii* subsp. *rydbergii* were infested only by the highly virulent population from Tulcea 2. In contrast, the perennial species (*Helianthus divaricatus*, *Helianthus giganteus*, *Helianthus mollis*, *Helianthus nuttallii* subsp. *nuttallii*, *Helianthus salicifolius*, *Helianthus californicus*, *Helianthus laetiflorus*) showed complete resistance to all tested populations. These results highlight the potential of perennial wild sunflowers as valuable genetic resources for breeding resistant cultivars and ensuring sustainable sunflower production.

Keywords: sunflower, *Orobanche cumana*, wild species, germplasm screening

Broomrape (*Orobanche cumana* Wallr) is a rots parasitic plant who infested sunflower (*Helianthus annuus* L.) in many countries around the world and causes low seed yield. The most aggressive races of broomrape are localized in basin of Black Sea, in countries such as Romania, Moldova, Turkey, Bulgaria, Ukraine (Kiliç Y., Goksoy A.T., 2024; Duca M., Bivol I., 2022; Nenova N., 2023; Maklyak E. *et al*, 2018). In Romania was reported all races of broomrape, from A up to I (Anton F.G., 2023; Anton F.G. *et al*, 2023, Rîșnoveanu L. *et al*, 2016; Skoric D. *et al*, 2021). In Turkey are present races F, G, H and I of sunflower broomrape (Akar H., Kaya Y., 2021). In Ukraine, is present races G and H (Khablak S.H. *et al*, 2025).

In Russia where reported races E, F, G and H of sunflower broomrape (Antonova T. *et al*, 2020, 2022, 2023; Savichenko D. *et al*, 2023; Skoric D. *et al*, 2021). In Moldova where reported races G and H of broomrape (Clapco S., 2021, Clapco S. *et al*, 2020; Duca M. *et al*, 2020, 2022, 2024).

In Serbia is present race E of broomrape (Cvejić S. *et al*, 2020; Ivanović Z. *et al*, 2021; Jocković J. *et al*, 2023). In Greece are present races of broomrape G and G+ (Kaundun S.S. *et al*, 2024).

In Spain, are present races of sunflower broomrape, F and G (Fernández-Aparicio M. *et al*, 2022; Fernández-Melero B. *et al*, 2024; Calderón-González Á., *et al*, 2024). In China was reported races E, F, G and G+ (Duca M. *et al*, 2021; Shi B.X. *et al*, 2019; Shi B., Zhao J., 2020; Bao T.T. *et al*, 2023). In Morocco, in North Africa are present races E and G (Nabloussi A. *et al*, 2023).

Orobanche cumana Wallr was reported in Iran (Nosratti I. *et al*, 2020), Tunisia (Amri M. *et al*, 2012; Jebri M. *et al*, 2017; Khamassi K. *et al*, 2023), Portugal (González-Cantón E. *et al*, 2019), Bolivia (Barea G. *et al*, 2025), Kazakhstan (Antonova T., 2014), France (Jestin C. *et al*, 2014), Israel (Eizenberg H. *et al*, 2004), Hungary (Onișan E. *et al*, 2023).

Wild *Helianthus* species represent a gene pool for sunflower breeding for parasite *Orobanche cumana* (Chabaud M. *et al*, 2022; Seiler G.J., Jan

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C.C., 2014; Jocković J. *et al*, 2023; Velasco L., Perez -Vich B., 2023).

MATERIAL AND METHOD

In year 2024, we collected broomrape seeds from seven locations from southern and southeastern Romania (Călărași 1–3, Tulcea 1–2, Constanța 1, Brăila 1) and in year 2025 we screening resistace/tolerance at *parasite Orobanche cumana*, of some wild species of genus *Helianthus* in artificial conditions, in Fundulea.

In buckets of 10 l with mixed soil:sand in percent of 3:1 and broomrape seeds from each location. In date of April 1 st, 2025, we sown more differential genotypes for determining broomrape races present in all seven locations and on date March 27 th, 2025, we sown annual species and perennial wild species (*table 1* and *2*).

Table 1

Sunflower differential genotypes for *Orobanche cumana* races

No.	Genotype	Gene Or	Race
1	KA41	Or1	A
2	J8281	Or2	B
3	Record	Or3	C
4	1002A	Or4	D
5	1003A	Or5	E
6	1093A	Or6	F
7	P96	or6, or7	F
8	1010B XA2DEB	Or?	G
9	0305CX P9MO	Or Mol Or Mol	H
10	Neagra De Cluj	Or?	G,H,I
11	Performer Sensitive Check	No Or	-
12	BR4	Or ₆ ; Or ₆ , Or ₇	F

Table 2

Sunflower annual and perennial wild species

Plant name	Wild species of genus <i>Helianthus</i>	Annual/perennial	Chromosome number
CAL2383	<i>H. californicus</i>	Perennial	2n= 6x = 102 (hexaploid)
CAL2798	<i>H. californicus</i>	Perennial	2n= 6x = 102 (hexaploid)
APS/HD/2017/038/297	<i>H. divaricatus</i>	Perennial	(2n=2x=34) diploid
GIG2015	<i>H. giganteus</i>	Perennial	(2n=2x=34) diploid
GIG- IRW	<i>H. giganteus</i>	Perennial	(2n=2x=34) diploid
GRO2027	<i>H. grosseserratus</i>	Perennial	(2n=2x=34) diploid
MAX2049	<i>H. maximiliani</i>	Perennial	(2n=2x=34) diploid
MAX2284	<i>H. maximiliani</i>	Perennial	(2n=2x=34) diploid
MOL880	<i>H. mollis</i>	Perennial	(2n=2x=34) diploid

NUT2749	<i>H. nuttallii</i> subsp. <i>nuttallii</i>	Perennial	(2n=2x=34) diploid
NUT2286	<i>H. nuttallii</i> subsp. <i>rydbergii</i>	Perennial	(2n=2x=34) diploid
SAL2666	<i>H. salicifolius</i>	Perennial	(2n=2x=34) diploid
SMI2592	<i>H. smithii</i>	Perennial	(2n=2x=34) diploid
LAET2643	<i>Helianthus laetiflorus</i> x	Perennial	2n= 6x = 102 (hexaploid)
ANN 0340	<i>H. annuus</i>	Annual	(2n=2x=34) diploid
ANN 1526	<i>H. annuus</i>	Annual	(2n=2x=34) diploid
ARG 13	<i>H. argophyllus</i>	Annual	(2n=2x=34) diploid

In flowering time we note number of broomrape at sunflower differential genotypes and at sunflower wild species to establish resistance/tolerance at broomrape populations from all seven locations.

RESULTS AND DISCUSSIONS

In stage of flowering of differential sunflower genotypes, between June 10 - June 15 2025, we take of sunflower roots from soil and we noticed with Sensible if are underground tubercles and multiple shoots of broomrape and with Resistant if is not present.

Race A of broomrape is present in Romania, in year 2024 in locations Călărași 1 and 3, Tulcea 1 and 2, Constanța 1, Brăila 1 because genotype KA 41 was sensible, except location Calarasi 3 because genotype KA 41 (gene *Or₁*) was resistant (*table 3*).

Race B of broomrape is present in Romania, in year 2024 only in location Tulcea 1, because genotype J8281 (gene *Or₂*) was sensible.

Races C, D, E, F and G of broomrape is present in Romania, in year 2024 in all seven locations Călărași 1 -3, Tulcea 1 - 2, Constanța 1, Brăila 1, because genotypes Record (gene *Or₃*), 1002A (gene *Or₄*), 1003A (gene *Or₅*), 1093 A (gene *Or₆*), BR4 (genes *Or₆*; *Or₆*, *Or₇*) was sensible

Differential genotype P96 (*or6*, *or7*) resistant at race F from Spain according to Cvejić S. *et al* (2020), was resistant at Calarasi 1 broomrape population, but differential genotypes 1093 A and BR4 who is differential genotypes for race F of broomrape was sensible. That means is difference between race F from Romania and race F from Spain.

Differential genotype 1010BxA2De (gene *Or* ??) resistant at race G of broomrape, result from interspecific hybridization with annual wild specie

Helianthus debilis, in F10 generation, was sensible in all seven location.

Differential genotype 0305CxP9Mo (genes *Or Mol Or Mol*) resistant at race H of broomrape, result from interspecific hybridization with perennial wild specie *Helianthus mollis*, in F10 generation, was sensible in Calarasi 1 and 2, Tulcea 1 and 2, Constanta 1. Race H of broomrape was not present only in Calarasi 3 and Braila 1 in year 2024.

Old Romanian variety Neagra de Cluj (gene *Or??*), was resistant at broomrape populations from Calarasi 1 and 3, Tulcea 1 and Braila 1 in year 2024. Races of broomrape G, H and I are present in year 2024, in locations Calarasi 2, Tulcea 2 and Constanta 1.

Conventional sunflower hybrid Performer with no *Or* gene (sensitive check) was infested 100% in all seven locations.

Table 3

Behavior of differential genotypes of parasite *Orobancha cumana* in year 2024, in Romania, in seven locations

Genotype	Broomrape population						
	Calarasi 1	Calarasi 2	Calarasi 3	Tulcea 1	Tulcea 2	Constanta 1	Braila 1
KA41	Sensible	Sensible	Resistant	Sensible	Sensible	Sensible	Sensible
J8281	Resistant	Resistant	Resistant	Sensible	Resistant	Resistant	Resistant
Record	Sensible	Sensible	Sensible	Sensible	Sensible	Sensible	Sensible
1002A	Sensible	Sensible	Sensible	Sensible	Sensible	Sensible	Sensible
1003A	Sensible	Sensible	Sensible	Sensible	Sensible	Sensible	Sensible
1093A	Sensible	Sensible	Sensible	Sensible	Sensible	Sensible	Sensible
P96	Resistant	Sensible	Sensible	Sensible	Sensible	Sensible	Sensible
1010B XA2DEB	Sensible	Sensible	Sensible	Sensible	Sensible	Sensible	Sensible
0305CX P9MO	Sensible	Sensible	Resistant	Sensible	Sensible	Sensible	Resistant
Neagra De Cluj	Resistant	Sensible	Resistant	Resistant	Sensible	Sensible	Resistant
Performer Sensitive Check	Sensible	Sensible	Sensible	Sensible	Sensible	Sensible	Sensible
BR4	Sensible	Sensible	Sensible	Sensible	Sensible	Sensible	Sensible

In period June 13 – October 10, 2025, in flowering time, we observed shoot emergence on sunflower wild species and we noticed *sensible* if are underground tubercles and multiple shoots of broomrape and with *resistant* if is not present (table 4 and figure 1).

Annual species *Helianthus annuus* (ANN 0340), *Helianthus annuus* (ANN 1526) and *Helianthus argophyllus* (A13) was sensible at all seven broomrape population from Romania in year 2024.

Table 4

Screening for resistance of wild species from genus *Helianthus* at parasite *Orobancha Cumana*, in year 2024, in Romania, in seven locations

Plant name	Wild species of genus <i>Helianthus</i>	Broomrape population						
		Calarasi 1	Calarasi 2	Calarasi 3	Tulcea 1	Tulcea 2	Constanta 1	Braila 1
CAL2383	<i>H. californicus</i>	Resistant	Resistant	Resistant	Resistant	Resistant	Resistant	Resistant
CAL2798	<i>H. californicus</i>	Resistant	Resistant	Resistant	Resistant	Resistant	Resistant	Resistant
APS/HD/2017/038/297	<i>H. divaricatus</i>	Resistant	Resistant	Resistant	Resistant	Resistant	Resistant	Resistant
GIG2015	<i>H. giganteus</i>	Resistant	Resistant	Resistant	Resistant	Resistant	Resistant	Resistant
GIG- IRW	<i>H. giganteus</i>	Resistant	Resistant	Resistant	Resistant	Resistant	Resistant	Resistant
GRO2027	<i>H. grosseserratus</i>	Resistant	Resistant	Resistant	Resistant	Sensible	Resistant	Resistant
MAX2049	<i>H. maximiliani</i>	Resistant	Resistant	Resistant	Resistant	Resistant	Resistant	Resistant
MAX2284	<i>H. maximiliani</i>	Resistant	Resistant	Resistant	Resistant	Sensible	Resistant	Resistant
MOL880	<i>H. mollis</i>	Resistant	Resistant	Resistant	Resistant	Resistant	Resistant	Resistant
NUT2749	<i>H. nuttallii subsp. nuttallii</i>	Resistant	Resistant	Resistant	Resistant	Resistant	Resistant	Resistant
NUT2286	<i>H. nuttallii subsp. rydbergii</i>	Resistant	Resistant	Resistant	Resistant	Sensible	Resistant	Resistant
SAL2666	<i>H. salicifolius</i>	Resistant	Resistant	Resistant	Resistant	Resistant	Resistant	Resistant

LAET2643	<i>Helianthus laetiflorus</i> x	Resistant	Resistant	Resistant	Resistant	Resistant	Resistant	Resistant
ANN 0340	<i>H. annuus</i>	Sensible	Sensible	Sensible	Sensible	Sensible	Sensible	Sensible
ANN 1526	<i>H. annuus</i>	Sensible	Sensible	Sensible	Sensible	Sensible	Sensible	Sensible
ARG 13	<i>H. argophyllus</i>	Sensible	Sensible	Sensible	Sensible	Sensible	Sensible	Sensible

Figure 1 Screening of wild species of genus *Helianthus* in artificial conditions for resistance at sunflower broomrape

In location Tulcea 2, in Romania, in year 2024, there is the most virulent race of *Orobanche cumana* because perennial wild species *Helianthus grosseserratus* (GRO2027), *Helianthus maximiliani* (MAX2284), *Helianthus nuttallii* subsp. *rydbergii* (accession NUT2286) and annual species *Helianthus annuus* (ANN 0340), *Helianthus annuus* (ANN 1526), *Helianthus argophyllus* (A13) was sensible at broomrape population from this location.

Annual wild species *Helianthus anomalus* provide resistance at race G of broomrape by gene *Or^{Anom1}* (Fernández-Melero B. *et al.*, 2024), *Helianthus debilis* ssp. *tardiflorus* by gene *Or^{Deb2}* (Velasco L. *et al.*, 2012), *Helianthus praecox* by gene *Or^{pra1}* (Sayago A. *et al.*, 2018).

Jocković J. *et al.* (2023) find different degree of resistance at parasite *Orobanche cumana* in sunflower perennial wild species such as in *Helianthus grosseserratus*, *Helianthus tuberosus*, *Helianthus divaricatus*, *Helianthus mollis*, *Helianthus maximiliani*, *Helianthus niveus*, *Helianthus nuttallii* and in sunflower annual wild species *Helianthus petiolaris*, *Helianthus debilis*, *Helianthus deserticola*, *Helianthus neglectus*, *Helianthus argophyllus*., *Helianthus bolanderi*, *Helianthus praecox*.

CONCLUSIONS

In Romania, in year 2024, race A of broomrape is still present in six locations from seven, such as Calarasi 1 and 2, Tulcea 1 and 2, Constanta 1, Braila 1, excepting Calarasi 3. Race B of broomrape is still present only in location Tulcea 1 and races from C, up to G is present in all seven locations. Race H of broomrape is present in five locations such as Calarasi 1 and 2, Tulcea 1 and 2, Constanta 1, excepting Calarasi 3 and Braila

1. Race I of parasite *Orobanche cumana* is present in locations Calarasi 2, Tulcea 2 and Constanta 1 excepting locations Calarasi 1 and 3, Tulcea 1 and Braila 1.

Wild perennial species *Helianthus californicus* (CAL2383 accession PI 664635, CAL2798 accession PI 673295), *Helianthus divaricatus* (APS/HD/2017/038/297 accession Ames 34086), *Helianthus giganteus* (GIG2015 accession PI 547177, GIG-IRW accession PI 673312), *Helianthus maximiliani* (MAX2049 accession PI 547206), *Helianthus mollis* (MOL880 accession), *Helianthus nuttallii* subsp. *nuttallii* (NUT2749 accession PI 673236), *Helianthus salicifolius* (SAL2666 accession PI 664773) and *Helianthus x laetiflorus* (LAET2643 accession PI 664747) from gene bank from Ames, Iowa, USA, Regional Plant Introduction Station, Iowa State University, North Central Regional Plant Station, represented a valuable source for resistance to most aggressive races of sunflower broomrape (*Orobanche cumana*) from Romania.

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