Current situation of sunflower broomrape over the world

Maria Joita-Pacureanu

4th International Symposium on Broomrape in Sunflower

2 – 4 July 2018, Bucharest, Romania

Aim of the presentation

- To have a view of broomrape (*Orobanche cumana*) parasite in sunflower crop, mostly in the main cultivated area with sunflower, over the world

- Sunflower ⇨ important crop in the modern agriculture
- In more than 150 years ⇨ 4 important steps
  - ✓ Local populations resistant to broomrape (25-28%)
  - ✓ Varieties (30-35%)
  - ✓ Varieties (45-50%)
  - ✓ Hybrids (more than 50%) – 80% of cultivated area

over all steps of sunflower crop developing:

broomrape parasite - very important negative factor for the seed yield

Seed yield losses: up to 90%


CANADA
UNITED STATES
BRAZIL
RUSSIA
CHINA
INDIA
AUSTRALIA
ALGERIA
LIBYA
MALI
NIGER
CHAD
SUDAN

Europe: 70 % of cultivated area

60% of the seed production

EUROPE
0 miles 400 800 1,000 miles
©Academia Maps, GeoAtlas®
Copyright 2012, All rights reserved.
LEGEND
SPAIN COUNTRY
MADRID FED. CAPITAL
Naples LARGE CITY
Vigo CITY
MAIN ROAD
BORDER
MOUNTAIN
RIVER
LAKE
DRY SALT LAKE
SALT LAKE
Land Elevation/ Sea Depth
GREENLAND
Kalaallit Nunaat
(Denmark)
Denmark Strait
ICELAND
Vatnajökull
REYKJAVIK
Jan Mayen
(Norway)
NORWEGIAN SEA
North Cape
Faroe Islands
(Denmark)
Shetland Islands
(U.K.)
Orkney Islands
NORTH ATLANTIC OCEAN
British Isles
SCOTLAND
UNITED KINGDOM
IRELAND
DUBLIN
ENGLAND
WALES
LONDON
CELTIC SEA
English Channel
NORTH SEA
Scandinavia
Lapland
NORWAY
OSLO
SWEDEN
STOCKHOLM
FINLAND
HELSINKI
Gulf of Bothnia
Gulf of Finland
Skagerrak
DENMARK
COPENHAGEN
BALTIC SEA
Gotland
Oland
ESTONIA
TALLINN
LATVIA
RIGA
LITHUANIA
VILNIUS
KALININGRAD
(RUSSIAN FED.)
BELARUS
MINSK
POLAND
WARSAW
NETHERLANDS
AMSTERDAM
BELGIUM
BRUSSELS
LUX.
GERMANY
BERLIN
FRANCE
PARIS
Bay of Biscay
Massif Central
SWITZ.
BERNE
LIECHT.
AUSTRIA
VIENNA
CZECH REP.
PRAGUE
SLOVAKIA
BRATISLAVA
HUNGARY
BUDAPEST
SLOVENIA
LJUBLJANA
CROATIA
ZAGREB
BOSNIA & H.
SARAJEVO
SERBIA
BELGRADE
MONTENEGRO
PODGORICA
KOSOVO
F.Y.R.O.M.
SKOPJE
ALBANIA
TIRANA
ROMANIA
BUCHAREST
Carpathians Mts.
MOLDOVA
CHISINAU
UKRAINE
KIEV
Dnieper
Krimea
Sea of Azov
BULGARIA
SOFIA
Danube
BLACK SEA
Bosporus
TURKEY
ANKARA
Anatolia (Asia Minor)
GREECE
ATHENS
Peloponnesus
AEGEAN SEA
Crete
CYPRUS
NICOSIA
SYRIA
LEBANON
BEIRUT
DAMASCUS
IRAQ
BAGHDAD
IRAN
TEHRAN
ITALY
ROME
VAT.
Alps
Mt Blanc
Corsica
Sardinia
Sicily
Gulf of Lions
SPAIN
MADRID
Pyrenees
AND.
Sierra Morena
Balearic Is.
PORTUGAL
LISBON
Azores
(Portugal)
Strait of Gibraltar
MOROCCO
RABAT
ALGERIA
ALGIERS
TUNISIA
TUNIS
MALTA
VALLETTA
MEDITERRANEAN SEA
RUSSIAN FEDERATION
MOSCOW
St Petersburg
Lake Ladoga
Lake Onega
Kola Peninsula
WHITE SEA
Cape Kanin Nos
Chesha Bay
Kolguyev I.
Kara Strait
New Zemlya
Ural Mountains
Volga
Don
Caspian Depression
CASPIAN SEA
Caucasus
Elbrus
GEORGIA
TBILISI
ARMENIA
YEREVAN
AZERBAIJAN
BAKU
KAZAKHSTAN
UZBEKISTAN
TURKMENISTAN
ASHGABAT
Kara-Kum
Aral Sea
Salt Desert
ARCTIC CIRCLE

emergence of new broomrape populations (races) has been observed in the past 20 years in several countries (Romania, Moldova, Ukraine, Russia, Turkey, Bulgaria, Spain, Serbia, and China)

- France – 2007 (South – West)

  In 2013 (CETIOM data): 156 plots with sunflower broomrape

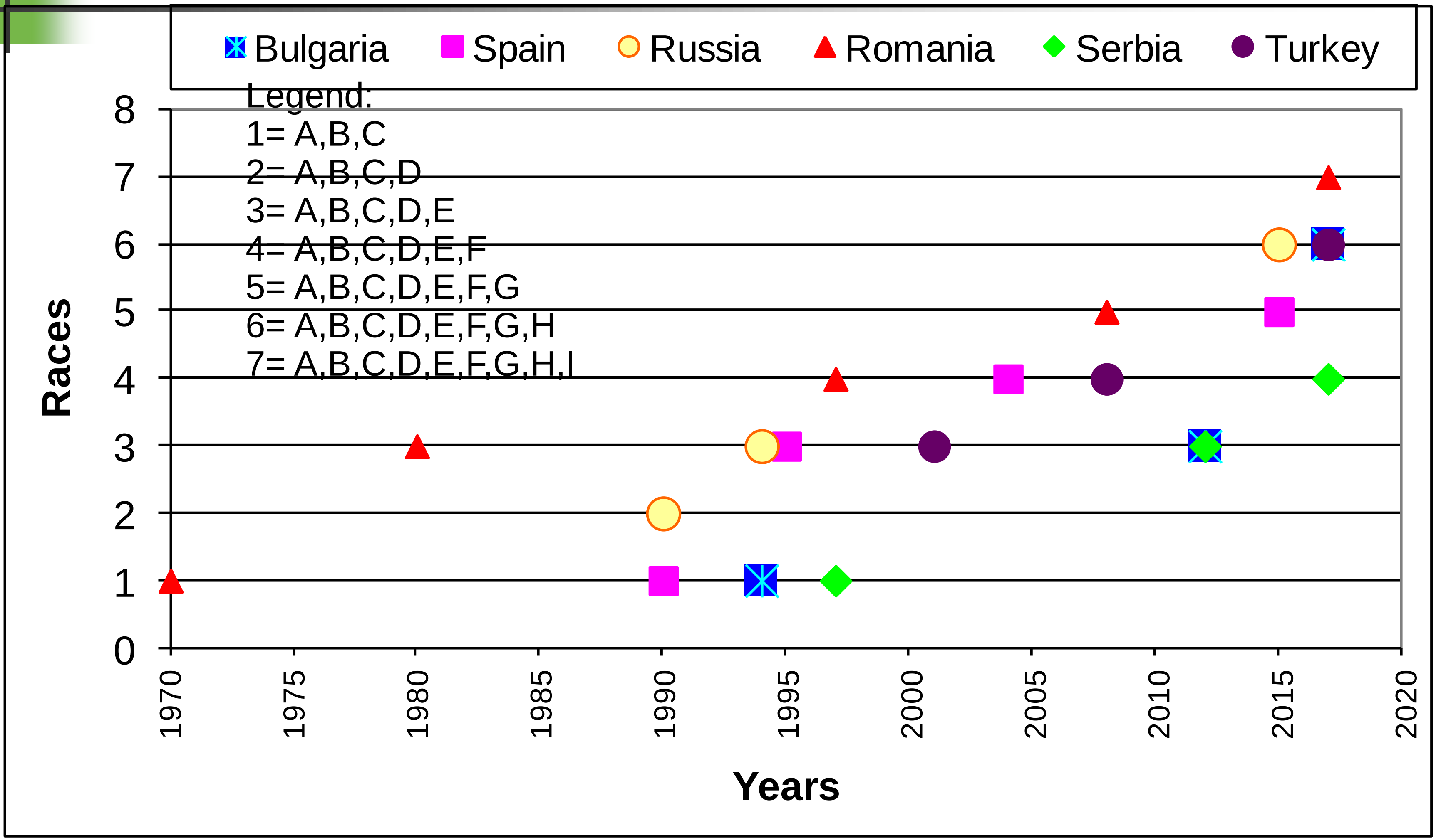
- Management
  - ✓ Prophylaxis: eradicating broomrape, harvesting healthy plots before the infested, cleaning the equipments after use, do not introduce sunflower in infested plots, for long time)
  - ✓ Resistant genotypes
  - ✓ Chemical methods

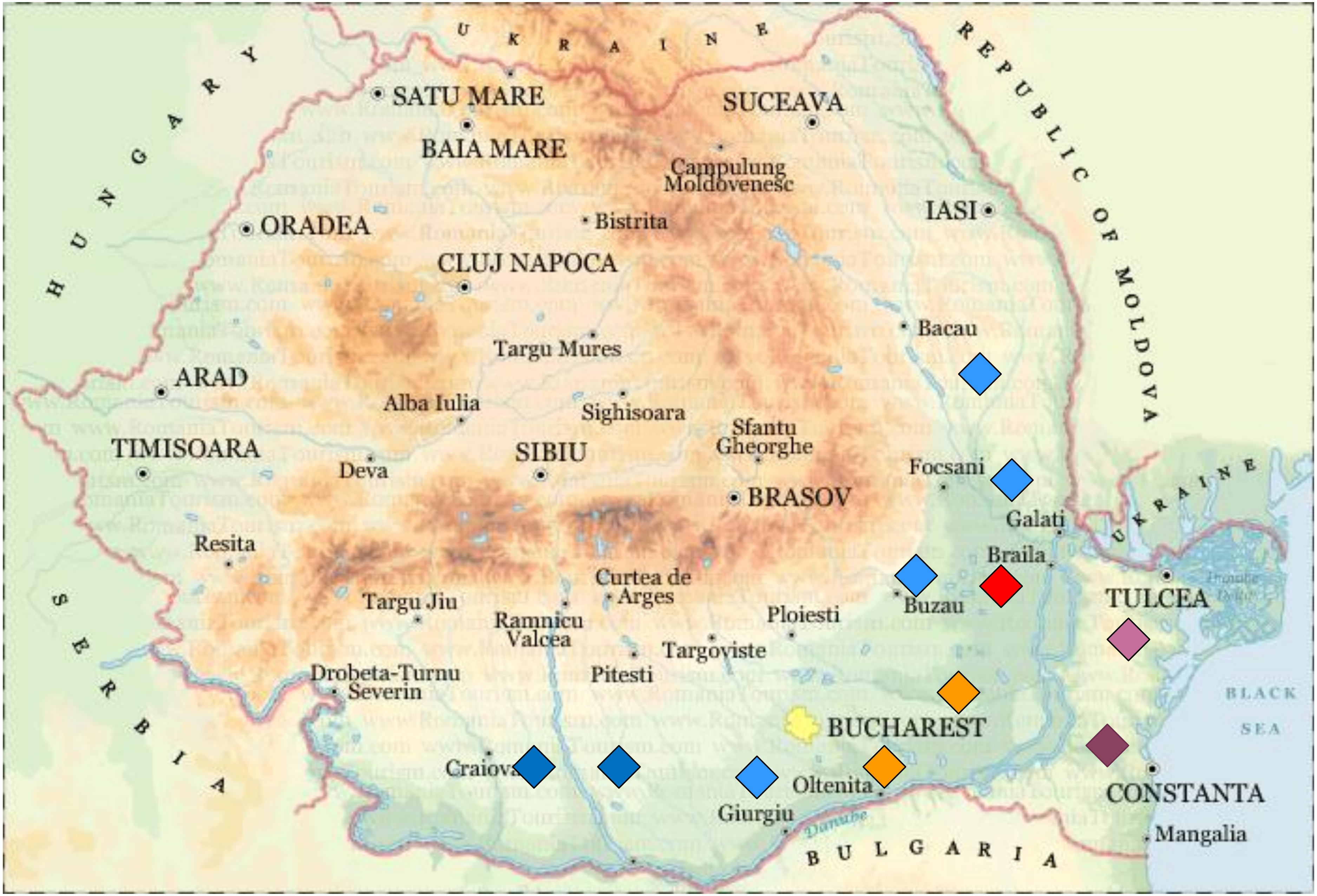
Sunflower differentials	Broomrape races						Resistance type	Resistance genes
	A	B	C	D	E	F		
AD-66	S	S	S	S	S	S	R_0	-
Kruglik A-41	R	S	S	S	S	S	R_1	Or_1
Jdanov 8281	R	R	S	S	S	S	R_2	Or_2
H-8280; Record	R	R	R	S	S	S	R_3	Or_3
S-1358	R	R	R	R	S	S	R_4	Or_4
P-1380-2	R	R	R	R	R	S	R_5	Or_5
LC-1093	R	R	R	R	R	R	R_6	Or_6

Races of *Orobanche cumana* identified -in the past and at present- in several countries were sunflowers are grown and parasite infections are known to occur

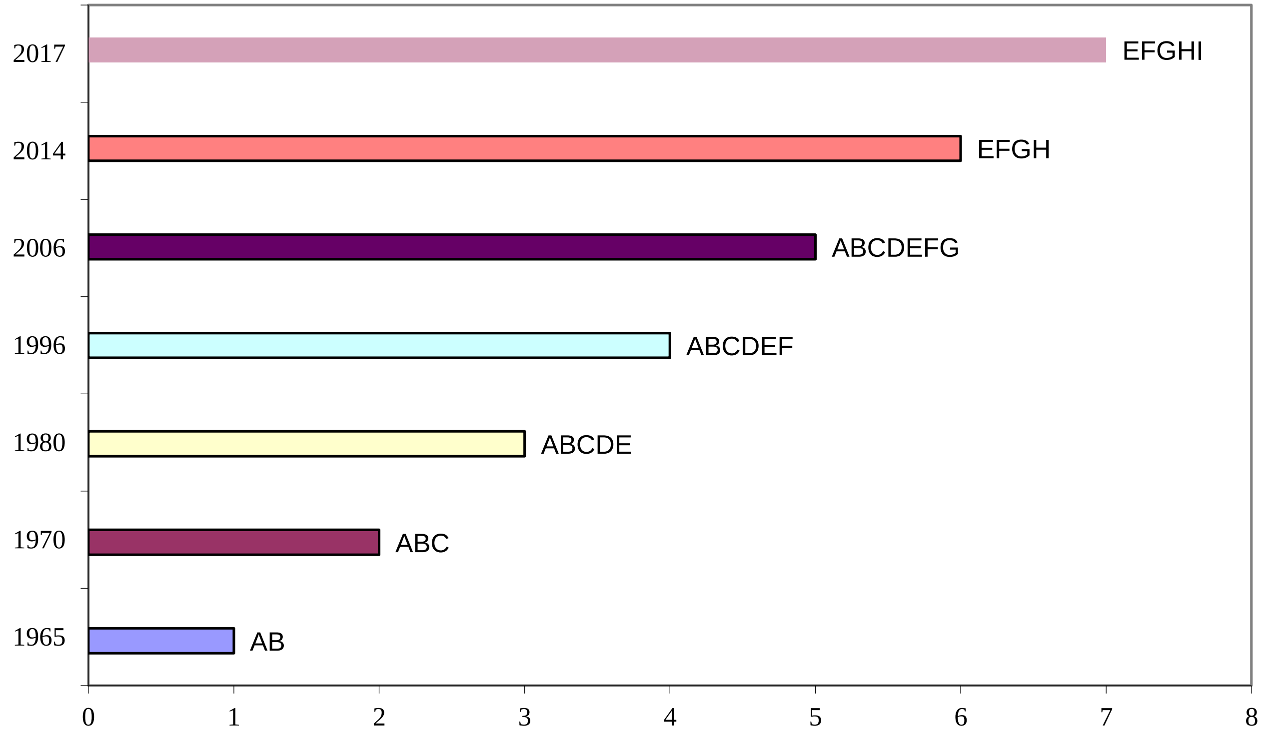
	Races of *O. cumana* identified		
Country	Past	Present	References
Bulgaria	A, B, C, D, E	E, F, G, H	Shindrova, 2006; Batchvarova, 2014, Entcheva, 2018
China	A	A, B, C, D, E, F, G	Ma & Jan, 2014; Shi *et al*., 2015, Zhao, 2018
France	Not present	? [a]	Jestin, 2012; Jestin *et al.*, 2014
Hungary	A, B, C, D	E, F	Zoltán, 2001; Hargitay, 2014; Molinero-Ruiz *et al.*, 2014
Kazakhstan	?	C, G	Antonova, 2014
Moldova	B, C	E, F, G, H	Gisca *et al*., 2013; Duca, 2014, Duca, 2018
Romania	A, B, C, D, E	F, G,H,I	Vrânceanu *et al.*, 1980; Pacureanu-Joita *et al.*, 2008; Pacureanu, 2014, Pacureanu-Joita, 2017
Russia	A, B	E, F, G, H	Antonova *et al*., 2013; Antonova, 2014, Skoric, 2018
Serbia	B, E	E, F	Mihaljčević, 1996; Miladinovic *et al*., 2014, Dedic, 2018
Spain	B, C, D, E	E, F, G	Alonso *et al.*, 1996; Fernández-Escobar *et al.*, 2008; Molinero-Ruiz & Dominguez, 2014; Molinero-Ruiz *et al.*, 2006; 2009
Turkey	?	F, G, H	Kaya *et al.*, 2004; 2012; Molinero-Ruiz *et al.*, 2014, Pers. comm., 2018
Ukraine	B	E, F, G, H	Pototskyi, 2014, Makliak, 2018

The evolution of the broomrape (*Orobanche cumana)* races in sunflower crop in Europe




UKRAINE
HUNGARY
REPUBLIC OF MOLDOVA
SERBIA
BULGARIA
UKRAINE
BLACK SEA
SATU MARE
BAIA MARE
SUCEAVA
Campulung Moldovenesc
IASI
ORADEA
Bistrita
CLUJ NAPOCA
Bacau
Targu Mures
ARAD
Alba Iulia
Sighisoara
Sfantu Gheorghe
TIMISOARA
Deva
SIBIU
Focsani
BRASOV
Galati
Braila
Resita
Curtea de Arges
Targu Jiu
Ramnicu Valcea
Buzau
Ploiesti
TULCEA
Targoviste
Drobeta-Turnu Severin
Pitesti
BUCHAREST
Craiova
Oltenita
Giurgiu
Danube
CONSTANTA
Mangalia

The evolution of the broomrape (*Orobanche cumana)* races in sunflower crop in Romania



- no comparative studies have been conducted to test the correspondence of races among countries
- races A to G were or have recently been identified in many countries

very few works ➡ the similarity of those populations from different geographic origin and characterized as belonging to the same race

an universal adoption of the coded triplets system is frequent for many plant pathogens ➡ to ease communication and comparisons of results about characterization of races

Proposal for characterization of populations of *Orobanche cumana* using the coded triplets system, and its correspondence with the traditional method based on the use of consecutive capital letters

Ruiz-Molinero, 2015

	Coded races of *O. cumana*							
Line of sunflower	100	300	700	710	730	770	771	773
AD66	S	S	S	S	S	S	S	S
K A-41	R	S	S	S	S	S	S	S
J8281	R	R	S	S	S	S	S	S
Record	R	R	R	S	S	S	S	S
S1358	R	R	R	R	S	S	S	S
P1380	R	R	R	R	R	S	S	S
LC1093	R	R	R	R	R	R	S	S
P96	R	R	R	R	R	R	R	S
Historical race	A	B	C	D	E	F	F or G?	F or G?

genetic studies of the parasite ⇨ to bring the knowledge on the parasite genetics to the same level as what is known for genetics of sunflower

studies on the inheritance of avirulence genes in *O. cumana* have confirmed the gene-for-gene interaction in the *O. cumana*-sunflower, parasitic system for races E/F and the dominant sunflower gene Or_5 (Rodríguez-Ojeda *et al*.,2013)

the appearance of new races ⇨ considerably reduced the available sources of resistance in the germplasm of cultivated sunflower

a continuous search for sources of resistance for these new races has been carried out ⇨ for the populations overcoming race F resistance, named as races G and H

a high level of resistance was

found in wild *Helianthus* spp.

defining broomrape races on the global level ⇨ more difficult ⇨ non-existence of differential lines for new broomrape races

most of the molecular research for characterizing resistance to *O. cumana* ⇨ mapping the Or_5 or Or_6 genes conferring resistance to races A to F (Pérez-Vich *et al*., 2004; Imerovski *et al*., 2013)

sunflower resistance to *O. cumana* is controlled by a combination of qualitative race-specific resistance controlling the presence or absence of broomrape and quantitative non-race-specific resistance affecting the number of broomrape stalks per plant

breeding programs focused on the development of hybrids of sunflower carrying resistance to *O. cumana* are mainly based on single dominant *Or* genes

alternative breeding strategies are required to increase the durability of genetic resistance to *O. cumana*

the most significant results are achieved by interspecific hybridization in which wild species of genus *Helianthus* are used as donor of the gene of resistance

alternative breeding strategies involving vertical resistance should incorporate gene pyramiding (Molinero-Ruiz et al., 2015)

in addition to the development of broomrape resistance genes ⇨ developing new mechanisms of resistance, genetics of virulence ⇨ to understand the dynamics of broomrape populations and race evolution

- ✓ Clearfield system is an alternative and efficient control method with the use of imidazolinone (IMI) herbicide plus resistant hybrids
- ✓ combining resistance to herbicides with genetic resistance could provide a more horizontal and durable resistance and successful improvement of broomrape control in the future

other chemical options ⇨ inducers of seeds germination leading to suicidal germination of the parasite in the absence of sunflower (Lachia *et al*., 2014)

CONCLUSIONS

The parasitic weed *O. cumana* poses a risk to sunflower oil production in countries of Southern and Eastern Europe, also in China and causes as an average, 50% sunflower seed losses when susceptible hybrids are grown

CONCLUSIONS

Understanding the biology of the interaction between the parasite and its host is a necessary step toward the development of selective control methods

CONCLUSIONS

Breeding for resistance is a recurrent, feasible and effective alternative for controlling *O. cumana*.

CONCLUSIONS

Different races of the parasite have been identified in all the countries where sunflower oil production is affected and important breeding works have been devoted to the search for effective genetic resistance against the increasingly virulent local parasite population

CONCLUSIONS

On the other hand, breeding sunflowers for resistance to the AHAS-inhibiting herbicides has appeared as another alternative for the control of *O. cumana* together with other weeds of the crop, and irrespective of parasite races

Thank you
for your attention!