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Foreword

The International Sunflower Association (ISA) and the Argentine Sunflower Association (ASAGIR) are pleased to present this guide to the 18th International Sunflower Conference.

At the time the main objectives for the meeting were defined, organizers aimed to provide a forum for the international sunflower research community with interest in any aspect of science and technology relating to the crop (in its oil-seed and confectionery variants) that would allow all involved to:

- Update knowledge in all fields of sunflower research since the previous conference held at Córdoba, Spain, June 2008;
- Review recent technological advances in sunflower production and identify knowledge gaps that require attention;
- Analyze the status and expectations for current and prospective demands for sunflower products;
- Provide a venue for workshops and special-interest meetings focusing on unresolved research, market, and production issues;
- Provide new generations with an opportunity to interact with global leaders in sunflower research.

The local Program Committee, with the help of the International Steering Committee, has developed a program covering the whole spectrum of relevant topics from genes and genomics through to field agronomy, crop protection, and industry and market issues. The program comprises 14 plenary and 13 invited presentations, 14 short oral presentations, an exhibition of 160 posters that can be visited during each of the first three days of the meeting. In addition, there will be three associated workshops (Bird Damage, Breeding, International Sunflower Genome Initiative), a special-interest presentation of the Global Crop Diversity Trust, and facilities will be available on request for small groups who wish to discuss business or scientific topics.

On the last day of the meeting, the Conference Field Day will be held at the joint INTA-Universidad de Mar del Plata facility in Balcarce. This time the traditional Conference demonstration plots of hybrids from International Sunflower Association member countries and from the host country will be complemented by a broad range of demonstrations of production and management techniques, as well as demonstrations of research techniques in current use by Argentine sunflower research teams.

This Conference has been made possible by the work of many people, by the support of sponsors from both the public and the private sector (sponsors are recognized on the back covers of this guide) and last, but certainly by no means least, those responsible for the lectures, short oral presentations, posters, associated workshops and special interest meetings, and field and laboratory demonstrations that make up the rich and varied bill of fare for this Conference, as reflected in this guide. The Organizing Committee extends their heartfelt thanks to all these individuals and organizations.

ISA and ASAGIR trust that this guide will enable all attendees to have an interesting and fruitful 18th International Sunflower Conference.

Welcome

It has been 27 years since the 11th International Sunflower Conference was held in Mar del Plata, Argentina, March 10-13, 1985. Since then, very many things have changed in the world of sunflower science, technology, and crop production and management. As the global sunflower community reconvenes once again in the same city, its members will have the opportunity to review progress in the last four years, which has been substantial in many areas.

Mar del Plata, a vibrant city located by the sea, with a fishing port, good restaurants, an unusually good choice of golf courses, and kilometers of sandy beaches, together with Balcarce, provide excellent venues for the Conference lectures and Field Day, and will allow attendees to appreciate a unique combination of seas, hills and Pampas. It is a great pleasure for the Organizing Committee to be able to host attendees to this meeting, which we hope will be both enjoyable and fruitful.

Welcome to Argentina, to Mar del Plata and Balcarce, and to the 18th International Sunflower Conference.

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Comparative study of abiotic environmental factors in broomrape (*Orobanche cumana* Wallr.) infested and non-infested sunflower areas of Serbia and Argentina

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ABSTRACT

- In several main sunflower producing regions, the parasitic weed *Orobanche cumana* (Broomrape) is the most serious biotic crop constraint. This weed, native of the Caucasus region, has progressively migrated to all Eurasia. It causes high economic losses in the Black Sea region, Serbia, Spain, Turkey and Israel territories, where severely infested patches occur in close proximity of non-infested areas. Broomrape is absent in the extended sunflower crop area of Argentina in South America. The difference between invaded and not invaded areas could be related to agriculture practices or to environmental factors. It is widely accepted that abiotic environment parameters determine the geographic plant invader distribution. It is unknown if this could be the case of this noxious sunflower parasitic plant.
- The influence of 14 environmental factors on the geographical distribution of broomrape was studied. We collected geographic, climatic and edaphic information from 15 sunflower habitats of Serbia with different natural infestation levels and 25 Argentine habitats without infestation. The latter group was constituted by nine natural habitats of ruderal *H. annuus* and 16 sites of sunflower cultivar field trials.
- In Serbia, altitude, latitude, mean hottest month temperature, mean coolest month temperature, soil texture and soil chemical composition of infested habitats were no different to non infested habitats. Argentina habitats differed from Serbia invaded habitats only in latitude, mean coolest month temperature, soil pH and soil clay content. In spite of these differences the compared habitats showed remarkable overlaps in the range of the two latter micro environmental parameters. Considering 11 abiotic factors in multivariate analysis, which explained more than a half of the total variability, three clusters were found. Serbia invaded and non invaded habitats showed a semi-coincident distribution, but were clearly separated from non invaded habitats of Argentina. Mean month temperatures and latitude were the most related with this separation.
- It is known than temperature regulates the weed seed dormancy and this parameter is one of the main differences found between regions. Day length (latitude dependant) and winter temperature could adjust the germination time of the weed. Due to the existence of invaded areas at hottest and lower latitudes (i.e. Spain) these facts need to be confirmed before assessing Argentina vulnerability.
- These results pointed to the importance of environment characterization in sunflower crop areas invaded with broomrape in order to develop tools to limit the spread and crop losses caused by this noxious weed.

Key words: parasitic weed, plant invasion, geographic distribution.

INTRODUCTION

The broomrape family Orobanchaceae comprises more than a hundred parasitic plants mostly native to temperate zones of the Old World (Mitich, 2011). *Orobanche cumana* Wallr. is the most serious constraint of sunflower crop in several main producer countries in the world. This weed, native to the Caucasus region, has progressively migrated to all Eurasia. The invasion comprises the Black Sea region, Serbia, Spain, Turkey, and Israel territories. Breeding against this weed was initiated in Russia by Dr. V.S. Pustovoit, early in the last century. In spite of the discovery of several resistance genes, genetic resistance has shown low durability due to the continuous emergence of new weed races (Fernandez-Martínez et al., 2010). Chemical control is also possible (Eizenberg et al., 2006), but integrated strategies could minimize herbicide usage (Rubiales et al., 2009).

At macro and micro geographical scale broomrape shows an irregular distribution, with severely infested patches near non-infested areas (Gonzáles-Andújar et al., 2001). The weed is absent in important sunflower regions of America. In spite of the careful phytosanitary control, because of its small seed size and the intense seed exchange between regions, avoidance of intentional or non-intentional introductions seems to be almost impossible. The intensity of international trade is highly associated with plant invasions (Nuñez and Pauchard, 2010). Boomrape could belong to the 90% plants that fail to invade a new ecosystem because of biotic and abiotic habitat limitations (Kolar and Lodge, 2001).

Several biogeographical scales should be used to predict plant invasions (Hierro et al., 2005; Radosevich et al., 2005; Jones, 2011). Biotic and abiotic microhabitat factors modulate the dynamics and success of a plant invasion (McGone et al., 2011). Soil biota (Reinhart and Callaway, 2006) and texture could determine the vegetal community composition (Dodd et al., 2002). Temperature fluctuations during a warm wet period are required for broomrape seed germination (Song et al., 2005). The development of *O. cumana* on sunflower is a highly temperature-dependent process (Ephrath and Eizenberg, 2010).

There is no available information about biotic and abiotic factors related with the *Orobanche*-sunflower complex geographic distribution in the modern literature. In a previous explorative study we fail to explain *Orobanche* absence in some habitats of Serbia and Argentina through abiotic factors (Miladinović et al 2011). From a biological invasion standpoint, this could mean a high vulnerability of all considered regions. The goal of this study was to broaden our understanding about the environmental dissimilarity between broomrape invaded and non invaded habitats in Serbia and Argentina.

MATERIALS AND METHODS

The study comprised 40 habitats with active *Helianthus annuus* L. stands during 2009-2011 growing seasons. The sunflower crop habitats in Serbia and Argentina were the stations of sunflower field trials nets from IFVC and ASAGIR-INTA. The presence of *Orobanche cumana* was observed as described by Dedić et al. (2009). The nine habitats from wild *H. annuus* in Argentina, free from the weed, were taken from Cantamutto et al. (2008). Macro-abiotic environmental data comprised latitude, longitude, altitude, mean hottest month temperature, mean coolest month temperature and average annual rainfall (averags for 10 or more years). Habitat micro-abiotic parametersincluded: soil pH, calcareous content, total nitrogen, organic matter, available P, available K, sand content, silt content and clay content. These parameters were analyzed as described in work of Miladinović et al. (2011).

The effect of abiotic variables on broomrape distribution was accomplished by ANOVA and the Kruskal Wallis test considering the invaded and non invaded areas of each country as treatments; then, parameter means were subjected to Tukey test. Overall influence of abiotic parameters on broomrape distribution was estimated by Principal Component Analysis. All analyses were performed with InfoStat (2010).

RESULTS

ANOVA and Kruskal-Wallis test showed coincident results. The 14 abiotic analyzed parameters did not show statistical differences between broomrape-free and invaded habitats of Serbia (Table 1). Generally, broomrape-free habitats in Serbia were situated in higher altitudes, and the soils had higher clay and available K content, as well as lower sand and Ca content compared to the broomrape infested habitats.

The sunflower habitats in Argentina were distributed at lower latitude with higher mean temperature of the coolest month but there were no differences in altitude, mean temperature of hottest month and annual rain with all Serbia habitats. At micro scale level, Argentina habitats showed lower clay content but did not differ from Serbia habitats in the remaining textural fractions. In general, soil fertility of

Argentine habitats was similar to Serbia habitats. Argentina habitat acidity was lower than in Serbia invaded habitats, but not different than Serbia non invaded habitats. In spite of mean differences, the three habitat groups showed a notable overlapping in pH and clay soil content values, but at macro-environmental level a complete separation between countries was observed (Fig. 1).

PCA overall analysis showed high similarity between the invaded and non invaded Serbia habitats, but at macro-environmental level they were clearly separated from Argentina by latitude and cool month mean temperature, the main vectors determining the first PC, which explained near to one third of the total variability (Fig. 2). In a second level, soil clay content and acidity also contributed to separate country habitats.

Table 1. Abiotic parameters of sunflower habitats of Serbia and Argentina invaded or free of *O. cumana* (site number between parenthesis). Letters show Tukey test differences at 0.05 level

Parameter	Acronym				
		Invaded (7)	Free (8)	Free (25)	ANOVA
Geographic variables					
Latitude (degree)	LAT	45.54 a	45.08 a	34.36 b	**
Altitude (m over sea level)	ALT(mosl)	80	99	179	ns
Climatic variables					
Hottest month mean temperature (C°)	HotM°C	23.3	23.0	25	ns
Coolest month mean temperature (C°)	CoolM°C	-1.5 b	-1.4 b	8.3 a	**
Annual rain (mm)	AnRain(mm)	674	671	783	ns
Soil chemistry variables					
Acidity	pH	7.7 a	7.1 ab	6.6 b	*
Available P (ppm)	Pppm	19.8	19.4	26.5	ns
Organic matter content (%)	(%)	3.0	2.7	2.7	ns
Calcareous content (%)	CoCa	8.1	4.0	Sd	ns
N content (%)	N%	0.24	0.21	Sd	ns
K availability (ppm)	Kppm	27.5	31.5	Sd	ns
Soil physic variables					
Clay content (%)	CLAY (%)	23.5 a	28.7 a	13.4 b	**
Loam content (%)	LOAM (%)	24.8	24.6	35.1	ns
Sand content (%)	SAND (%)	51.7	46.7	51.4	ns

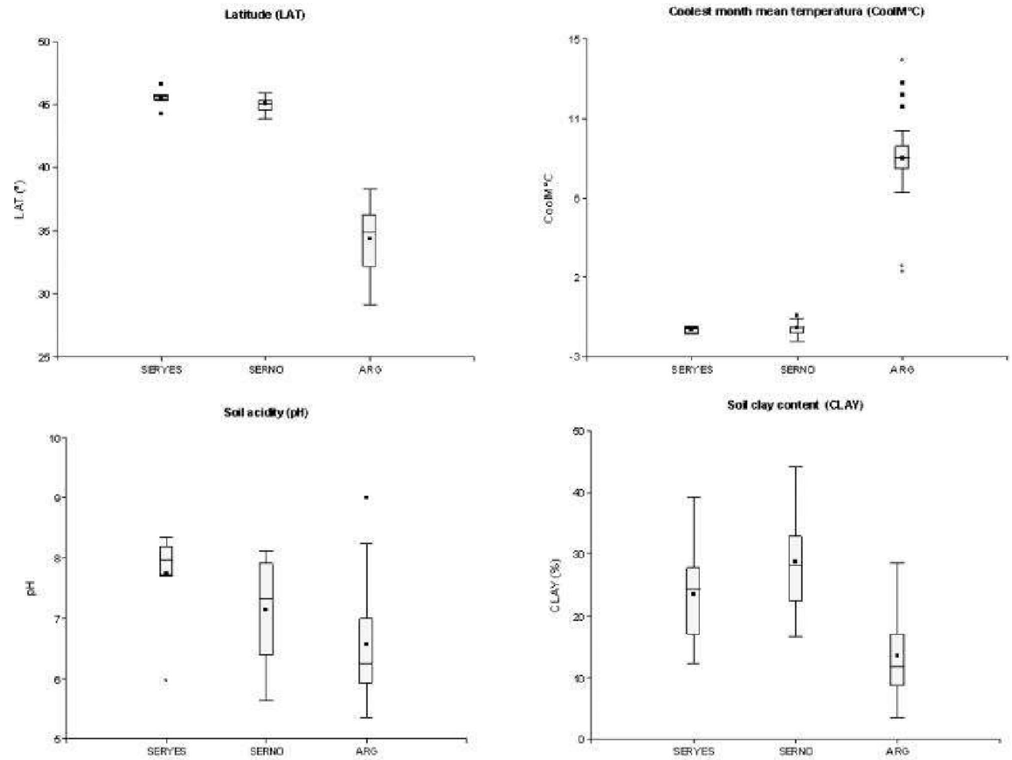

Figure 1. Box-plot of parameters showing ANOVA statistical differences (see Table 1) in invaded and non invaded habitats of Serbia (SERYES, SERNO) and Argentina (ARG).

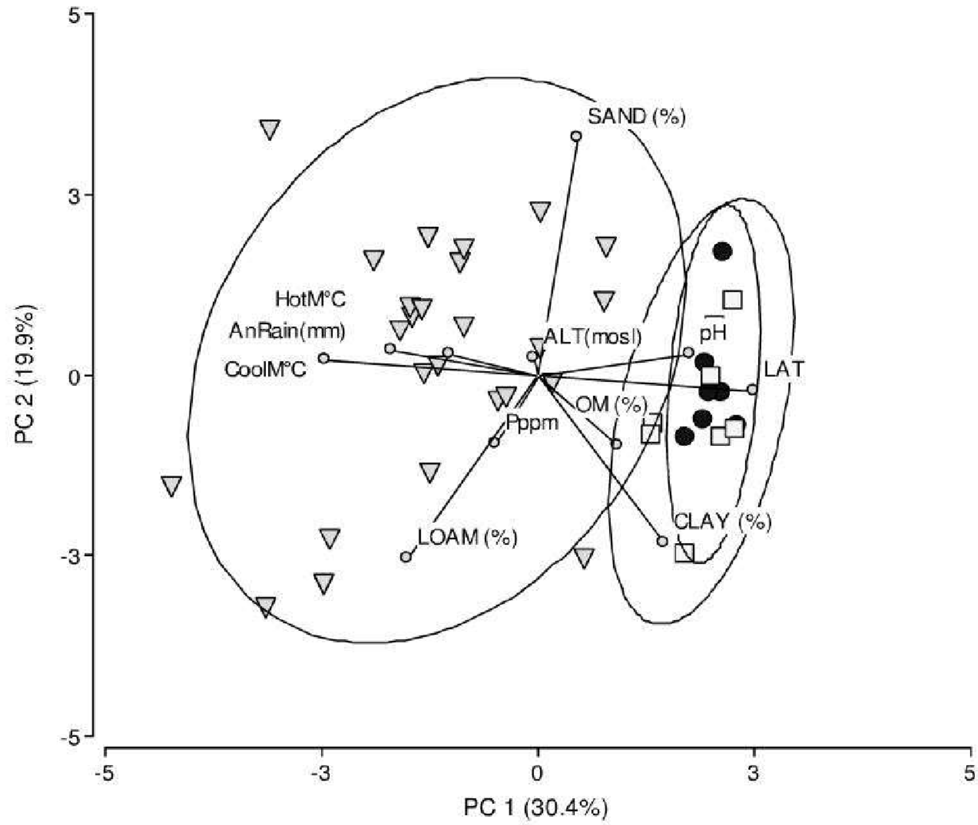

Figure 2. Principal Component Analysis of 11 abiotic variables (see Table 1) of sunflower habitats invaded (squares) or non invaded (circles) by *O. cumana* in Serbia and Argentina (triangles). Confidence ellipses at 90% are shown.

DISCUSSION

It is believed that broomrape generally occurs on poor sandy soils (Dhanapal et al., 1996) and that salinity (Al-Khateeb et al., 2005) and phosphorous availability (Miladinović et al., 2011) could limit its incidence. In the invaded country the data set did not associate soil chemical and physical factors with the weed presence, although some differences were observed. Also chemical and physical soil composition did not clearly separate those habitats from Argentina, considered free of the invader. In this latter country soil K availability tend to be very high, and consequently this parameter is not considered in regular soil fertility tests of the field trial net. The extreme high K availability could be a factor limiting *Orobanche* presence in Argentina.

At macro-environmental level the latitudinal differences between countries is notable. This factor determines the daily sunshine duration, and by this way could be affecting *Orobanche* germination time. The extended invaded areas in Eurasia are mainly distributed in latitudes over 38°. Due to aridity, in Southern America sunflower crop is infrequent over 38° lat. and it is only possible under irrigation. This is the location of the main sunflower seed area in Argentina, with around 9000 ha devoted to this activity in southern Buenos Aires Province, where usually there is an intense seed exchange with countries of the Northern Hemisphere. Due to this risk factor, this region which was not included in the present study should be monitored in future evaluations.

As the coolest month mean temperature clearly differentiated both countries it could explain *Orobanche* absence in Argentina. Soil temperature controls seed dormancy loss, and adjusts weed germination time (Song et al., 2005). To conclude about this parameter reliability as environmental barrier to broomrape presence in Argentina, it would be recommendable to compare this habitat with hottest regions where the parasite is present, as southern Spain (Molinero-Ruiz et al. 2008). Soil management and biota could be other factors related with the *Orobanche* geographic distribution.

The results obtained in our study point to the importance of the further environment characterization in sunflower crop areas invaded with broomrape in order to develop tools to limit the spread of this noxious parasitic weed. Further research should include more broomrape infested and non-infested habitats from Serbia, but also from other countries with similar patchy occurrence of this parasite, such as Spain.

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