HELIA, **28**, Nr. 43, p.p. 25-32, (2005) UDC 633.854.78:631.524.86

REACTION OF SOME SUNFLOWER ACCESSIONS TO *Albugo tragopogonis* AND *Sclerotinia sclerotiorum* INFECTIONS

F. Castaño[1*], T. Gulya[2], J. Ré[3], M. Echeverría[1] and R. Rodríguez[1]

[1]*Sunflower Genetics and Breeding Group, UIB (Unidad Intergrada Facultad de Ciencas Agrarias – Universidad Nacional de Mar del Plata / Estación Experimental Agropecuaria – Instituto de Techologia Agropecuaria)*
[2]*USDA-ARS, P.O. Box 5677, 58105 Fargo, ND, USA*
[3]*Monstanto Argentina SA, Camino Provincial 7, B 7612, Pueblo Camet, Argentina*

Received: September 10, 2004
Accepted: November 22, 2005

SUMMARY

Sunflower is attacked by several pathogens that reduce both the quantity and quality of harvested grains. It is necessary to keep evaluating the germplasm of this oil crop in order to detect new resistance sources to be included in breeding programs. Different accessions from North Central Regional Plant Introduction Office, Ames, IA, were evaluated for reaction to *A. tragopogonis* and *S. sclerotiorum* infections on levaes and capitula, respectively. Under our conditions, statistical analysis showed differential responses to white rust severity, white rot incidence and relative incubation period. Accessions were classified according to their level of resistance to each infection type. A general and favorable association between white rust and white rot performances was absent in the evaluated genetic material. The accession PI 343790 had the highest level of resistance to each quantified variable while the accessions Ames 3224, Ames 4040 and Ames 4050 had the lowest levels of resistance. Applicability of these results in sunflower genetic improvement for resistance to the studied diseases is discussed.

Key words: **breeding, disease resistance, genetic resources, sunflower, white blister rust, white rot**

INTRODUCTION

Sunflower crop suffers frequently biotic stresses produced by attacks of several pathogens (e.g., *Albugo tragopogonis* and *Sclerotinia sclerotiorum*), which can reduce seed yield level and quality in susceptible genotypes.

* Corresponding author, Phone: 54 22 66 43 91 00 ext. 379, Fax: 54 66 43 91 01, e-mail: fcastanio@balcarce.inta.gov.ar

A. tragopogonis produces white blister rust and is characterized by large chlorotic blister-like pustules on the upper side of leaves, which result from localized infections of the pathogen's asexual stage. It has been observed as a common inhabitant in the sunflower crops for more than 20 years in Argentina (Delhey and Kier-Delhey, 1985) and it was recently described in the USA (Gulya *et al.*, 2000).

The white rot produced by *S. sclerotiorum* infections on capitula can be considered as the most extensively studied and thus one of the most important sunflower diseases worldwide, given the higher number of papers published at the last four International Sunflower Conferences held in Europe, Asia and North-America between 1992 and 2004, in relation to those involving other pathogens and diseases (Vear, 2004).

Sunflower resistance to both of these pathogens is of horizontal nature and no resistance commercial hybrids are available (Castaño *et al.*, 2001). For this reason, sunflower breeders have to evaluate periodically different germplasm sources in order to detect the inheritance genetic diversity that allows combining the best resistance to both pathogen infections in new sunflower hybrids.

The aim of this work was to detect variability to disease resistance in some sunflower germplasm evaluated after *A. tragopogonis* and *S. sclerotiorum* infections on leaves and capitula, respectively.

MATERIAL AND METHODS

Thirty sunflower accessions (Table 1) from Regional Central North Plant Introduction Office, Ames, IA, were used. The hybrid 894, released in the 1970s, was used as a white rot resistance check.

All accessions were planted in the UIB's experimental field, following a randomized complete block design with two replications. Plots had at least 15 plants. The hybrid 894 was in adjacent plots following three staggered sowing dates.

The natural infection of *A. tragopogonis* on leaves was recorded by plot when most of plants were in the R1 (Schneiter and Miller, 1981) or E1's (CETIOM, 1992) sunflower developmental stage, also known as “star apical button”. The severity of the pathogen attack on leaf area was assessed according to Siddiqui *et al.* (1975), in two observations. A mean by plot and observation was calculated subsequently.

The artificial infection of *S. sclerotiorum* on capitula was made following the current protocol (Vear and Tourvieille, 1984) used in the UIB. Briefly, every capitula received an aqueous suspension containing approximately 25×10^3 pathogen ascospores when sunflower plants were in the R5.3 (Schneiter and Miller, 1981) or E3's (Cetiom, 1992) development stage. After infection, all capitula were covered with kraft paper bags until the end of the experiment. The disease incidence (I%) was scored per plot, as the proportion of plants showing capitula infected by white rot. The incubation index, i.e., the relationship between the incubation periods of the accessions and that of the hybrid 894, was calculated per infected capitulum. A mean of the incubation index (IND) was then estimated per plot and per replication.

For statistical analysis, data of SEV% were transformed according to the arcsine square root function. Analysis of variance and correlation coefficients were made following Reza-Hosmand (1998). An estimation of genotypic coefficient of variation was provided as suggested by Singh and Chaudhary (1985).

RESULTS AND DISCUSSION

The analysis of variance detected highly significant (P=0.001) differences among the accessions for SEV%. Nevertheless, no effects were detected either by observation or through accession x interaction effects. Therefore, general means by observer were similar and the observations by different persons in the field did not modify the ranking of accessions regarding the *A. tragopogonis* attack on leaves.

Test of comparison among the means (LSD=9) allowed classifying accessions in one of the following three groups: high, intermediate or low level of resistance (Table 1). The accessions were grouped according to their relative disease performance, i.e., whether their values were statistically similar to the maximum or minimum SEV% values in the experiment. Fifteen accessions showed high relative performance; the low and the intermediate resistance groups included 7 and 8 accessions, respectively.

After *S. sclerotiorum* inoculation, the hybrid 894 showed 76% of disease incidence. The analysis of variance detected significant effects (P=0.02) of accessions on both I% and IMD variables. As shown by SEV%, there was significant variability in *S. sclerotiorum* inoculation among the evaluated accessions.

The estimated values of least significant difference among the means for I% (LSD=6%) and IND (LSD=0.17) allowed again to make three groups of genotypes, as shown above for SEV%, regarding their white rot performance. For I%, 5 accessions showed high, 6 intermediate and 19 low performance. Meanwhile, 11 accessions had high, 3 intermediate and 16 low performance regarding the IND variable (Table 1).

The genotypic coefficient of variation (GCV) was calculated to express the genotypic standard deviation as a fraction of phenotypic variability. The estimated values were GCV=44% for SEV%, GCV=28% for I% and GCV=8% for IND. These results indicate that the relative values of genotypic variability in the evaluated accessions for SEV% were 45% and 57% higher than those ones calculated for IND and I%, respectively. Given that estimations were made for fixed environmental conditions, effects of environment and accession x environment interaction may have had some influence on the magnitude of genotypic variability among genotypes and thus on the GCV values.

Table 1: Means of responses of 30 sunflower accessions to white blister rust on leaves and white rot on capitula

Accession No.	Denomination	White rust	White rot	
		Severity (%)	Incidence (%)	Incubation index
Ames 3220	HA 154	22#	49#	1.19#
Ames 3224	GUAYACAN	27	88	0.88
Ames 3234	6 SC U6 L6	15	48	1.11
Ames 3296	CMG-2 (*H. gig.* / Saturn)	9	72	0.91
Ames 3302	GOR 104	22	48	0.96
Ames 3360	VK-32	7	86	1.05
Ames 3365	HS 42 RM	15	92	1.04
Ames 3389	RM 42	15	87	0.97
Ames 3391	ROM SUN V3355	9	84	0.93
Ames 4039	RHA 272	16	95	0.96
Ames 4040	RHA 273	26	95	0.96
Ames 4041	RHA 274	21	70	1.13
Ames 4043	RHA 276	7	93	1.22
Ames 4044	RHA 278	10	90	0.98
Ames 4045	RHA 279	7	77	0.97
Ames 4046	RHA 294	12	25	0.90
Ames 4048	RHA 297	16	97	1.09
Ames 4049	RHA 298	6	43	1.03
Ames 4050	RHA 299	31	81	0.96
Ames 4051	RHA 801	22	38	0.86
Ames 4054	HA 61	9	53	1.15
Ames 4060	HA 224	3	61	1.10
Ames 4109	RHA 310	5	63	1.18
Ames 4110	RHA 311	6	12	1.02
Ames 18923	HA-R2. WIR 3360	2	53	0.95
Ames 18924	HA-R3.WIR 3361	5	88	1.15
PI 343790	TCHERNIANKA SELECT W-9	7	47	1.13
PI 343793	TCHERNIANKA SELECT W-12	13	94	0.85
PI 343797	TCHERNIANKA SELECT W-16	8	78	0.87
PI 552931	RHA 296	7	74	0.83
Mean		13	69	1.01
LSD (p=0.05)		[9]*	36	0.17
CV (%)		[23]*	25	11

* Results obtained by using arcsine % transformed data

Relative performance Higher (light grey) Intermediate (dark grey)

Although the infected accessions do not represent the total variability of sunflower, and according to the level of genotypic diversity detected for each disease resistance, it seems that *S. sclerotiorum* infection should be evaluated with more precision in this genetic material than *A. tragopogonis* infection if we wish to select for white rot resistance as effectively as for the white blister rust.

There were no significant correlations between SEV% and I% (r=0.18) and IND (r=-0.21). Therefore, a general relationship between the infections of *A. tragopogonis* on leaves and of *S. sclerotiorum* on capitula was absent: this agrees with the results of Arana *et al.* (1997) who assessed a series of commercial hybrids for the same two infection types.

Nevertheless, the accession PI 343790 should be pointed out as the only genotype having a high relative disease performance regarding SEV%, I% and IND (Table 1); therefore, it seems safe to consider Tchernianka Select W-9 as a source of resistance in breeding programs for *A. tragopogonis* and *S. sclerotiorum* resistances. Conversely, the accessions Ames 3224, Ames 4040 and Ames 4050 had the poorest reactions to both pathogens.

Although genotypic variability for disease performance was detected in only one experiment, it is nevertheless possible to propose some actions to be carried out while breeding for *A. tragopogonis* and *S. sclerotiorum* resistance.

Hybridization of different accessions could be used to form sunflower populations with genetic variability for resistance characters, either to map QTL's conferring disease resistance to both pathogens or as a first step in a hybrid development program.

In this sense, a cyclic selection method for the white blister rust and white rot resistances could be developed. However, the lack of relationship between these two diseases, and the need to combine resistance genes from all selected parents into all the members of the population, suggests that it is not easy to carry out simultaneous selection for both diseases.

In that way it would be possible to reduce the period of time spent in selecting inbred lines with high combining ability needed to produce hybrids with a moderate level of resistance to white blister rust and white rot.

ACKNOWLEDGEMENTS

The authors acknowledge valuable help from Mrs. Mary Brothers, curator of sunflower collection at the Regional Central North Plant Introduction Office, Ames, USA. This work was partially financed by the UIB, Argentina, and the National Sunflower Association, USA.

REFERENCES

Arana, D., Castaño, F., Rodríguez, R., Pereyra, R. and Escande, A., 1997. Roya blanca de girasol: evaluacíon de comportamiento de híbridos comerciales. Visión Rural 28: 32-35.

Castaño, F., Vear, F. and Tourvieille, D., 2001. Horizontal resistances in sunflower: a review of a workshop at the 15^{th} International Sunflower Conference. OCL – Oléagineux Crops Gras Lipides 8: 211-215.

Cetiom (ed.), 1992. Guide Cultural du Tournesol. PROLEA-CETIOM.
Delhey, R. and Kier-Delhey, M., 1985. Symptoms and epidemiological implications associated with oospore formation of *Albugo tragopogonis* on sunflower in Argentina. Proceedings of 11th International Sunflower Conference, 10-13.03.1985., ASAGIR-ISA (Eds.), Mar del Plata, Argentina, II: 455-457.
Gulya, T., van Wyk, P. and Viljoen, A., 2000. Resistance to white rust (*Albugo tragopogonis*) and evidence of multiple genes. Proceedings of 15th International Sunflower Conference, 12-15.06.2000., ISA (Ed.), Toulouse, France, II: J26-J30.
Reza-Hoshmand, A., 1998. Statistical Methods for Environmental and Agricultural Sciences. 2nd Ed., CRC Press, Boca Raton.
Schneiter, A. and Miller, J., 1981. Description of sunflower growth stages. Crop Science 21: 901-903.
Siddiqui, M., Brown, J. and Allen, S., 1975. Growth stages of sunflower and intensity indices for white blister and rust. Plant Disease Reporter 59: 7-11.
Singh, R.K., Chaudhary, B.D., 1985. Biometrical Methods in Quantitative Genetic Analysis. Kalyani Publishers, New Delhi–Ludhiana, India, pp. 1-318.
Vear, F., 2004. Breeding for durable resistance to the main diseases of sunflower. Proceedings of 16th International Sunflower Conference, 29.08.-02.09.2004., ISA-NSA (Eds.), Fargo, USA, I: 15-28.
Vear, F. and Tourvieille, D., 1984. *Sclerotinia sclerotiorum* sur tournesol: differences de sensibilité variétale at méthodes de sélection. INRA (Ed.), CRA, Clermont Ferrand.

RESPUESTAS A LAS INFECCIONES DE *Albugo tragopogonis* Y DE *Sclerotinia sclerotiorum* EN DIFERENTES INTRODUCCIONES DE GIRASOL

RESUMEN

El cultivo de girasol es atacado por diversos patógenos que, desafortunadamente, actúan en detrimento de la cantidad y/o de la calidad de los granos cosechados. Se hace, por lo tanto, necesario evaluar continuamente germoplasma de dicha oleaginosa a fin de detectar posibles fuentes de resistencia. En este sentido, en este trabajo es evaluó una serie 30 entradas, provenientes del "North Central Regional Plant Introduction", de acuerdo a sus respuestas a las infecciones naturales de *A. tragopogonis* en hojas y las inoculaciones de *S. sclerotiorum* en capítulo: para ello, se cuantificó la severidad de ataque de roya blanca así como la incidencia y el período de incubatión relativo de la podredumbre blanca del capítulo. Los análisis estadísticos permitieron, por un lado, detectar respuestas diferenciales de las introducciones a cada varible medida y, por el otro, agrupar a las entradas de acuerdo a su nivel alto, medio o bajo de resistencia a cada tipo de infección, bajo nuestras conditiones de experimentación. No fue posible, sin embargo, encontrar una asociación general y, a su vez. Favorable entre las respuestas a infecciones de *A. tragopogonis* en hojas y de *S. sclerotiorum* en capítulos. A pesar de ello, se puede mencionar que la introducción PI 343790 (denominada Tchernianka Select W-9) fue la única de comportamiento superior a la roya blanca y la podredumbre de capítulos. Mientras que Ames 3224 (Guayacán), Ames 4040 (RHA 273) y Ames 4050 (RHA 299) tuvieron en cambio, comportamientos inferiores a ambas enfermedades. Se discute la utilización de estos resultados en los programas de mejoramiento por resistencia a estos patógenos en girasol, tendientes a la obtención de líneas progenitoras de híbridos on buen comportamientos a ambas enfermedades.

RÉPONSES AUX INFECTIONS D'*Albugo tragopogonis* ET DU *Sclerotinia sclerotiorum* CHEZ DE GERMPLASME DU TOURNESOL

RÉSUMÉ

La culture tournesol suble l'infection de plusieurs pathogènes qui produisent une réduction de la quantité ainsi que de la qualité de graines récoltées sur des plantes malades. Il est alors nécessaire d'évaluer souvent de germplasme de cette oléagineuse au bout de détecter de nouvelles sources de résistance. Trente introductions d'après le "North Central Regional Plant Introduction" ont été cultivées puis évaluées selon leurs performances face aux infections d' *A. tragopogonis* sur feuilles et *S. sclerotiorum* sur capitules. Des analyses statistiques ont montré des réponses différentielles, parmi le matériel génétique évalué, à la sévérité d'infection de la rouille blanche et à l'incidence et la période d'incubation de la pourriture blanche des capitules. Ces introductions ont été classifiées selon leurs niveaux de résistance. La corrélation entre les réponses à chaque infection n'a pas été significative. Malgré ce résultat, l'introduction PI 343790 (connue comme Tchernianka Select W-9) a montré un haut niveau de résistance aux deux infections, tandis que celles codifiées comme Ames 3224 (Guayacán), Ames 4040 (RHA 273) et Ames 4050 (RHA 299) en avaient un bas niveau de résistance. L'utilisation de ces résultats dans l'amélioration génétique du tournesol pour la résistance à la rouille blanche en feuilles et la pourriture blanche en capitules est discutée.