

SUNFLOWER INBRED LINES DERIVED FROM INTERSPECIFIC HYBRIDS

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SUMMARY

A total of 230 hybrids have been introduced in a sunflower breeding program as initial material and submitted to selection for the following traits: earliness, size of head, position of head related to the stem, stay green, tolerance to *Sclerotinia sclerotiorum*, tolerance to *Phomopsis* sp., CMS-Rf ability.

Some interspecific hybrids were promoted through advanced generations of selfing, such as *H. annuus* x STR, ARG x *H. annuus*, RIG x *H. annuus*, (ANN x DEB) x *H. annuus*, the others were tested for CMS and restoration ability by crossing and offspring evaluation.

The new CMS source ANT-1 is the most promising source for a new CMS-pollen fertility restoration system in sunflower hybrid production. Interspecific hybrids are important as donors and crosses for introgressing new favorable alleles to parent inbred lines.

Key words: interspecific hybrids, CMS, restorers

INTRODUCTION

The first attempt at using interspecific hybridization in sunflower was made in Russia in 1916. After many years, the interest in interspecific hybridization is renewed, as a tool to achieve disease resistance, stress resistance, CMS sources, oil quality, biochemical compounds.

The usefulness of many species of wild *Helianthus* is limited by their poor crossability and high degree of F₁ sterility in interspecific hybrids. These impediments are overcome by using different populations of a single species in hybridization experiments. The pollen of such populations has different degrees of potential pollen fertility (Seiller, 1984; Altagić, 1990). Interspecific pollen competition plays an important role in controlling the formation of hybrids between two species and

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may partially account for patterns of differential cytoplasm versus nuclear introgressions in *Helianthus* (Rieseberg *et al.*, 1995).

The wild *Helianthus* species, especially *H. annuus* L., represent the basic genetic stock from which the cultivated sunflower originated. They possess considerable variability for most of the economic, agronomic and seed quality traits, resistance to insects and disease pathogens (Thompson *et al.*, 1981; Rogers *et al.*, 1982) and survival environmental mechanisms (Turner, 1979). Miller in 1992 and Seiller in 1997 have provided excellent overviews of the potential use of wild germ-plasm and interspecific hybrids in sunflower.

This paper presents a part of the results of a trial with interspecific hybrids performed at Fundulea and reviews their potential usefulness for breeding and selection.

PLANT MATERIAL AND METHODS

A total of 25 wild sunflower species have been crossed with pollen from one hundred inbreds available at Fundulea. The species were typically used as mother parent, but we also used CMS PET1 in many crosses. Embryo rescue 3-4 days after fertilization has been used in the case of hybrids with *H. rigidus*. The F₁ hybrids were backcrossed one to three times with valuable inbreds in order to obtain fertile plants and "gene pool" genotypes with introgressions from the wilds.

All descendants were submitted to a strong selection in order to produce the best material for breeding. During 5-6 generations of selfing and selection for agronomic values and new traits, several inbreds were saved. Flowering period, 1000-seed weight, oil content, stay green, head position, diseases resistance, drought tolerance and maturity period data were recorded for all entries each year. After additional 1-2 generations, the best selected inbreds will be analyzed for genetic distance using RAPD and pedigree data will be used for characterization of the inbreds and prediction of good hybrid combinations.

RESULTS AND DISCUSSIONS

The number of interspecific hybrids obtained in the period of 1980 and 1989 was quite low compared with the large number of crosses performed. Only those plants which were capable of growing in the field were taken into account (Table 1, Figures 1-3; Iuoras, 1991).

Most of the F₁ hybrids were sterile, from flowerless plants to plants with small heads that contained pollen. The degree of sterility in the case of hybrids *H. rigidus* x *H. annuus* is shown in Table 2 (Iuoras and Vranceanu, 1988).

A total of 230 hybrids were introduced in the sunflower breeding program as initial material and submitted to selection for the following traits: earliness, size of

head, position of head related to the stem, stay green, tolerance to *Sclerotinia sclerotiorum*, tolerance to *Phomopsis* sp., CMS-Rf ability.



Figure 1: Interspecific hybrids between *H. argophylus* and *H. annuus* L.



Figure 2: Interspecific hybrids between *H. strumosus* and *H. annuus* L.



Figure 3: Interspecific hybrids between *H. rigidus* and *H. annuus* L.

Table 1: Interspecific hybrids between *Helianthus* wild species and cultivated sunflower (no. of viable plants), Fundulea, 1980-1989

Species	<i>H. annuus</i>	<i>H. arg.</i>	<i>H. pet.</i>	<i>H. debilis</i>	<i>H. praec.</i>	<i>H. florid.</i>	<i>H. micro.</i>	<i>H. gig.</i>	<i>H. mollis</i>	<i>H. nutt.</i>	<i>H. gross.</i>	<i>H. max.</i>	<i>H. div.</i>	<i>H. str.</i>	<i>H. rig.</i>	<i>H. tub.</i>	Cultivated sunflower ^x
<i>H. annuus</i>	-	6	8	8	18	2	-	0	0	0	-	1	0	0	15	3	98
<i>H. argophyllus</i>	2	-	3	1	3	-	-	-	-	-	-	-	-	-	0	-	20
<i>H. petiolaris</i>	5	1	-	7	4	-	-	-	-	0	-	-	0	0	1	0	13
<i>H. debilis</i>	28	-	2	-	5	-	-	0	0	0	-	-	-	-	2	0	8
<i>H. praecox</i>	88	3	7	2	-	-	-	0	0	0	-	-	-	1	2	-	30
<i>H. floridanus</i>	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
<i>H. microcephalus</i>	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0
<i>H. giganteus</i>	0	0	0	0	0	-	-	-	-	-	-	-	-	-	-	-	0
<i>H. mollis</i>	0	0	0	0	0	-	-	-	-	-	-	-	-	-	0	-	0
<i>H. nuttali</i>	1	0	1	0	3	-	-	-	-	-	-	-	-	-	0	-	0
<i>H. grosseserratus</i>	2	-	-	-	0	-	-	-	-	-	-	-	-	-	0	-	0
<i>H. maximiliani</i>	0	0	0	0	0	-	-	-	-	-	5	-	-	-	0	-	0
<i>H. divaricatus</i>	0	0	0	0	0	-	-	-	-	-	-	-	-	-	0	-	1
<i>H. strumosus</i>	2	0	0	0	0	-	-	-	-	-	-	-	-	-	5	1	17
<i>H. rigidus</i>	5	-	1	0	3	-	-	-	-	-	-	-	-	1	-	2	310
<i>H. tuberosus</i>	1	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	76
Cultivated sunflower ^x	13	20	12	2	20	0	0	0	1	2	0	0	0	3	81	26	

x) Varieties, hybrids, inbreds

Table 2: Percent of aberrations during meiosis in interspecific hybrids RIG x *H. annuus* in different generations (Vranceanu and Iuoras, 1988)

Generation	Metaphase I		Anaphase I		Telophase I		Tetrads, diads, triads, etc.	
	No. of cells	% of aberration	No. of cells	% of aberration	No. of cells	% of aberration	No. of cells	% of aberration
P ₁ , P ₂	175	0	165	2.0	108	1.5	275	6.5
F ₁	143	84.2	369	92.2	131	82.0	650	85.0
BC ₁	336	94.4	379	95.0	201	96.6	513	65.3
BC ₂	40	90.0	69	93.0	56	88.0	110	64.2

Some interspecific hybrids were promoted through advanced generations of selfing, as *H. annuus* x STR, ARG x *H. annuus*, RIG x *H. annuus*, (ANN x DEB) x *H. annuus*, the others were tested for CMS and restoration ability by crossing and offspring evaluation (Table 3).

The hybrids with ARG showed good tolerance to drought, resistance to *Sclerotinia sclerotiorum* and large heads. Unfortunately these valuable traits were associated with a strong susceptibility to lodging, due to a rigid stem, and low oil

content. The hybrids with PRAE were very early and with a good position of the head, but they were susceptible to diseases.

Table 3: Promoted hybrids in breeding program for different traits

Hybrid	Generation	Selfing generation	Character	% of oil, 1999-2000
ARG x <i>H.a.</i>	BC ₃	6	Drought tolerance	24-28
PRAE x <i>H.a.</i>	BC ₂	5	Large, convex head	28-30
<i>H.a.</i> x STR	BC ₃	9	Stay green	35-42
RIG x <i>H.a.</i>	BC ₃	5	Large head, stay green	36-43
ANN x DEB x <i>H.a.</i>	BC ₄	6	Large head, earliness	28-40
ANT x <i>H.a.</i>	F ₁	-	CMS- ANT1	35-40
ANT x <i>H.a.</i>	F ₁	-	Rf- ANT1	38-40

The hybrids *H. annuus* x STR, RIG x *H. annuus* and (ANN x DEB) x *H. annuus* were introduced in a program of crossing with valuable inbreds, in order to obtain competitive hybrids in terms of combining ability and stay green.

The cytoplasmic male sterility in the hybrid ANT x *H. annuus* was different from the "petiolaris" source in Atp DNA pattern (Spasova *et al.*, 1992; Iuoras *et al.*, 1992). This new source is most promising for a new CMS-pollen fertility restoration system in hybrid production. Among hybrid plants, a *Rf* genotype was identified for pollen fertility restoration of CMS-ANT 1 source. CMS-ANT 1 and *Rf*-ANT1 have been introduced in a program for conversion of valuable sunflower inbreds into the new hybrid production system, using embryo culture for generations acceleration.

CONCLUSIONS

Some interspecific hybrids were promoted through advanced generations of selfing, as *H. annuus* x STR, ARG x *H. annuus*, RIG x *H. annuus*, (ANN x DEB) x *H. annuus*, the others were tested for CMS and restoration ability, by crossing and offspring evaluation.

The new CMS source ANT-1 is most promising for a new CMS-pollen fertility restoration system in sunflower hybrid production.

Interspecific hybrids are important as donors and crosses for introgressing new favorable alleles into parent inbred lines.

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LINEAS CONSAGUINEAS DEL GIRASOL DERIVADAS DE LAS INTERSPECIES DE HIBRIDOS

RESUMEN

Como el material inicial en el programa de seleccion eran 230 hibridos seleccionados segun las propiedades siguientes: precocidad, grandeza de cabeza, posicion de cabeza en relacion al tallo, stay green, tolerancia a *Sclerotinia sclerotiorum*, toilerancia a *Phomopsis* sp., capacidad de restauracion de fertilidad, CMS-Rf.

Ciertos hibridos interspecies eran promovidos a traves de varias generaciones de autofecundacion, como *H. annuus* x STR, ARG x *H. annuus*, RIG x *H. annuus*, (ANN x DEB) x *H. annuus*; los otros eran testados a CMS y a la capacidad de restauracion de la fertilidad por el cruce y la evaluacion de descendientes.

La nueva fuente de CMS, ANT-1, promete por lo mas con relacion a la creacion del nuevo sistema de restauracion de la fertilidad en la produccion del girasol hibrido. Los hibridos interspecies son los donadores importantes de los alelos que se introducen por el cruce en las lineas consanguineas paternales.

LIGNES INBRED DE TOURNESOL DÉRIVÉES D'HYBRIDES INTERSPECIES

RÉSUMÉ

Les caractéristiques suivantes ont servi de critères de sélection pour un total de 230 hybrides introduits dans un programme de culture du tournesol: précocité, format de la tête, position de la tête en rapport avec la tige, stay green, tolérance envers la *Sclerotinia sclerotiorum*, tolérance envers le *Phomopsis* sp., aptitude au rétablissement de la fertilité, CMS-Rf.

Quelques hybrides interspecies ont été obtenus par plusieurs générations d'autofécondation, comme *H. annuus* x STR, ARG x *H. annuus*, RIG x *H. annuus*, (ANN x DEB) x *H. annuus*; les autres ont été testés pour CMS et leur aptitude au rétablissement de la fertilité par croisement et évaluation de la descendance.

La nouvelle source CMS ANT-1 est la plus prometteuse pour la création d'un nouveau système de rétablissement de la fertilité dans la production de tournesol hybride. Les hybrides interspecies sont d'importants donneurs qui apportent des allèles favorables aux lignes inbred parentales par croisement.