

GERMINATION ABILITY OF ACHENES OF *Helianthus* genus WILD SPECIES INTERSPECIFIC HYBRIDS¹

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SUMMARY

The authors considered three interspecific hybrids between wild *Helianthus* species and the cultivated sunflower (*H. annuus* x *H. argophyllus*, *H. annuus* x *H. bolanderi*, *H. annuus* x *H. debilis*); moreover, an inbred line ("C") was used as tester. Achene germination was studied at different temperature levels (5, 10, 15, 20, 25 and 30°C). Germination percentage and germination energy were determined. The wild genotypes germinate better than line "C" at 10 and 29°C. Germination energy increases from low to high temperatures for all the accessions, particularly we can say that *H. annuus* x *H. argophyllus*, *H. annuus* x *H. debilis* (at 10 and 29°C) and *H. annuus* x *H. bolanderi* (at 25°C) have a lower medium germination time than line "C".

INTRODUCTION

Nowadays researchers and plant breeders are interested in wild *Helianthus* species as sources of important genes to improve sunflower crop.

Diseases and pests resistance characters (Leclerq, 1971; Zimmer and Kinman, 1972; Vear, 1974; Pustovoit, 1978; Fick and Auwater 1981; Fick and Auwater 1982), male sterile cytoplasm sterility (Leclerq, 1971; Fick et al., 1974; Škorić et al., 1978; Dominguez et Fernandez, 1980; Serieys, 1980) were discovered in wild germoplasm.

Unfortunately, wild species possess many unsatisfactory agronomic characters like a lower achene germination rate than cultivated sunflower (Vannozi et al., 1982; Škorić et al., 1983; Škorić, 1984; Chandler et al., 1985).

To secure better germination, several methods were attempted: e.g., exposing achenes to varying temperatures, including alternate freezing and thawing, or wetting and drying, washing in several changes of water, and/or soaking for several days.

Interspecific hybrids may combine useful agronomic characters (absence of branching, high oil content, achene yield, good germination ability) with biotic and abiotic stress resistance characters (Zimmer and Hoess 1978; Vannozi et al., 1984b; Škorić, 1984); in fact, interspecific hybridization (wild x cultivated) had proved to be the best way of transferring such useful characters from wild species to cultivated sunflower (Alba, 1978; Vannozi et al., 1982; Vannozi et al., 1984b; Škorić, 1984).

Germination percentage and germination energy (expressed as medium germination time) are very important agronomic characters; in fact, high levels of them, at lower temperatures, allow an earlier sowing of the crop, avoiding contemporaneity between

¹ Presented at the F.A.O. Sunflower Meeting helded in Sindos (Greece), July 1986.

reduction of soil water in summer and the critical flowering period of sunflower. Thus, a good germination ability is required in different environmental conditions, particularly temperatures; minimum germination is 4°C in sunflower, but temperatures of at least 8 to 10°C are required for a satisfactory germination (Rollier, 1974; Rollier, 1977; Robinson, 1978; Benvenuti et al., 1978; Macchia et al., 1985).

Our work regards the behaviour of three interspecific hybrids tested at different laboratory temperatures and in field conditions with the aim of evaluating their germination percentage and comparing the germination energy on with cultivated sunflower.

MATERIALS AND METHODS

The trial regarded three interspecific hybrids between cultivated sunflower (Line "A" PI661) as male parent, and *H. argophyllus*, *H. bolanderi*, *H. debilis* as female parents, coming from a collection of hybrids gathered at the Experiment Farm of Torretta (Pisa, Italy) in 1985. Achenes of these interspecific hybrids had been directly sown in field on 15th May 1985 and gathered in October.

Germination tests were carried out at the Seed Testing Laboratory of Pisa University, in early 1986, and the following characters were recorded:

- a) germination percentage (at the end of the trial, 15 days);
- b) germination percentage after 7 days (standardized time for germination requirements of *Helianthus* "seed" in Italy adopted by MAF (Agriculture and Forestry Ministry);
- c) germination energy, expressed as medium germination time (days) (Scott et al., 1984):

$$\text{MGT} = \frac{\sum(N_i \times T_i)}{\sum(N_i)}$$

where N_i = number of achenes germinated at the (i)th day;

T_i = ordinal number of the (i)th day.

The tests were conducted for the following temperatures: 5, 10, 15, 20, 25 and 30°C with three replications/hybrid/temperature; 50 achenes/replication were put in Petri dishes (10 cm ϕ) with a wet double filter paper layer. Line "C", developed and selected in PISA Agronomy Institute, was used as tester. Germination percentage and AGT were measured by a daily count of achenes germinated in each sample and by recording the number of normal seedlings (with normal root development and cotyledon emerged from integument).

Germination cabinets had an accuracy of $\pm 0.2^\circ\text{C}$ for temperature; moreover, trials were carried out in fluorescent light with 2000 lux lamps.

Data were elaborated according to a two-way analysis of variance scheme (Parker, 1973). Correlation coefficient and regression analysis were conducted for each hybrid. All these elaborations were conducted with a specific software library, on a virtual machine working at CNUCE in PISA.

RESULTS AND DISCUSSION

Table 1. Total germination (%)

Hybrid	Temperature						Mean
	5°C	10°C	15°C	20°C	25°C	30°C	
X argophyllus	76.66	86.66	58.33	93.33	61.66	46.66	70.55
x bolanderi	73.33	86.66	40.00	85.00	41.66	61.66	64.72
x debilis	95.00	85.00	60.00	91.66	58.33	46.66	72.77
Line C	63.33	80.00	86.66	75.00	85.00	90.00	90.00
Mean	77.08	84.58	61.25	86.25	61.66	61.25	
LSD	Hybrid	Temperature		Hybrid x Temperature			
P = 0.05	5.7320	7.02		14.04			
P = 0.01	7.6557	9.37		18.75			

These hybrids seem not to have the dormancy system of their female parents; moreover, they germinate better than line "C" at 10 and 20°C, whereas the latter has major germination at 15, 25 and 30°C (Table 1). Regression analysis reveals that *H. annuus* x *H. debilis* has a higher germination percentage than line "C" at low temperatures (5 and 10°C) and vice-versa for high temperatures (25 and 30°C). The two accessions have the same level of germination at 15°C (Fig. 1).

Germination after 7 days reveals a higher germination rate at 20°C for wild hybrids, at 5°C for *H. annuus* x *H. debilis* and at the other temperatures for line "C" (Table 2).

Table 2. Germination after 7 days (%)

Hybrid	Temperature						Mean
	5°C	10°C	15°C	20°C	25°C	30°C	
X argophyllus	10.00	86.66	48.33	93.33	61.66	46.66	57.77
x bolanderi	8.33	83.33	40.00	85.00	41.66	61.66	53.33
x debilis	30.00	83.33	58.33	91.66	58.33	46.66	61.38
Line C	21.66	80.00	86.66	75.00	85.00	90.00	73.05
Mean	17.50	83.33	58.33	86.25	61.66	61.25	
LSD	Hybrid	Temperature		Hybrid x Temperature			
P = 0.05	5.876	7.196		14.393			
P = 0.01	7.848	9.612		19.224			

Emergence in field is generally very low, but the hybrid *H. annuus* x *H. debilis* (Fig. 2) has a good field germination (44%), whereas the other wild hybrids have a lower rate of it (5.04 and 2.5%, respectively, for *H. annuus* x *H. argophyllus* and *H. annuus* x *H. debilis*).

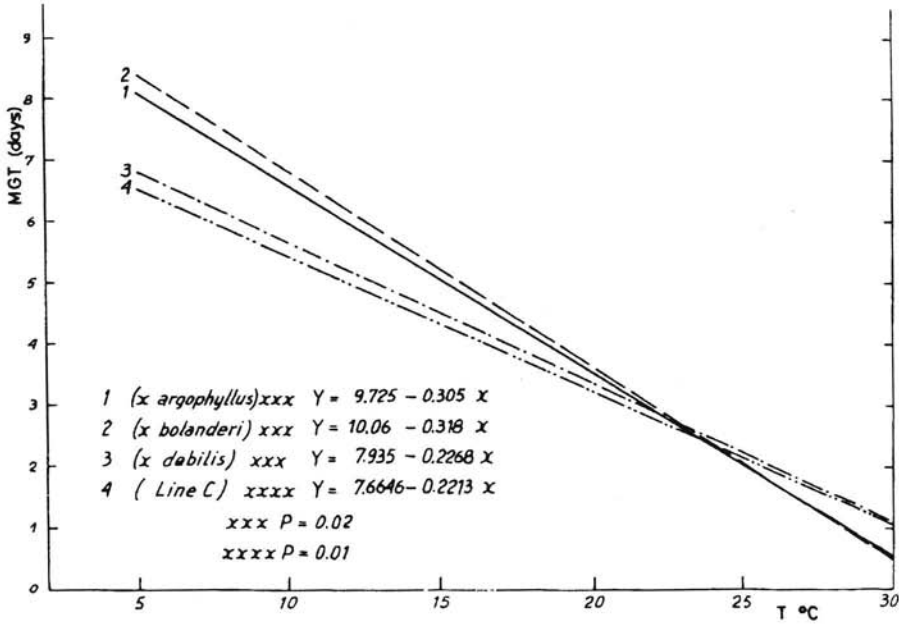


Fig 1. Germination percentage - linear regression

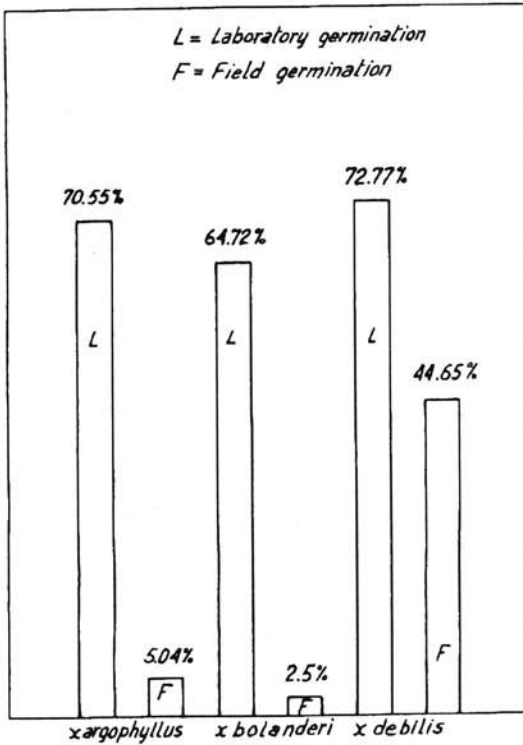


Fig 2. Laboratory germination and field emergence in wild species hybrids

Germination energy is decreasing from low to high temperatures for all the accessions: *H. annuus* x *H. debilis*, *H. annuus* x *H. argophyllus* at 10 and 30°C and *H. annuus* x *H. bolanderi* at 25°C have a lower average germination time than line "C" (Table 3). Regression analysis reveals that line "C" has a higher germination energy than the wilds at low temperatures, whereas *H. annuus* x *H. argophyllus* and *H. annuus* x *H. bolanderi* have a better vigour at 30°C than the cultivated line (Fig. 3).

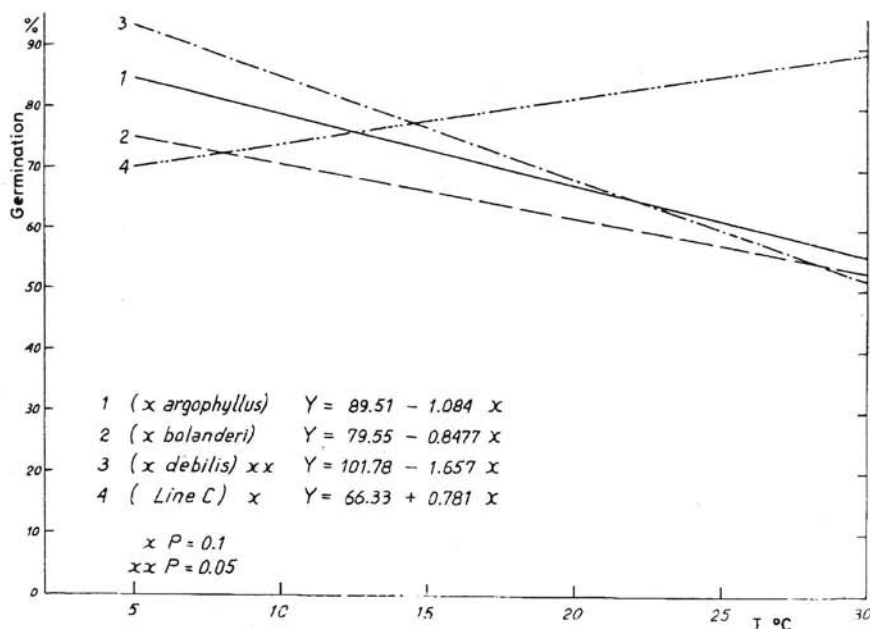


Fig 3. Germination energy (medium gemination time) – linear regression

Table 3. Germination energy (VIGOR) (expressed as medium germination time in days)

Hybrid	Temperature						Mean
	5°C	10°C	15°C	20°C	25°C	30°C	
X argophyllus	11.03	3.90	4.35	3.20	2.10	1.638	4.373
x bolanderi	11.40	5.20	3.05	3.16	1.93	2.210	4.496
x debilis	9.20	3.54	3.31	3.15	2.88	1.691	3.965
Line C	8.12	4.72	3.36	2.15	2.33	2.053	3.729
Mean	9.94	4.34	3.52	2.91	2.31	1.898	
LSD	Hybrid		Temperature		Hybrid x Temperature		
P = 0.05	0.2619		0.320		0.6415		
P = 0.01	0.3498		0.428		0.8569		

Regarding correlation coefficients we can say that a negative relationship is between temperature and germination in wild accessions whereas a positive is in cultivated as confirmed by a few authors (Macchia et al., 1985); moreover, germination energy is increasing from low to high temperatures, in all the accessions.

Table 4. Interspecific hybrids: correlation coefficients (between temperature and the following characters)

Hybrid	Temperature germination %	Temperature germination after 7 days	Temperature germination energy (expressed as medium germination time)
x argophyllus	-0.5643	+0.2698	-0.8356 ^{xxx}
x bolanderi	-0.3851	+0.3397	-0.8328 ^{xxx}
x debilis	-0.7649 ^{xx}	+0.09723	-0.8016 ^{xxx}
Line C	+0.7518 ^x	+0.70799 ^x	-0.8801 ^{xxxx}

x = P 0.01

xx = P 0.05

xxx = P 0.02

xxxx = P 0.01

CONCLUSIONS

The interspecific hybrids have a good germination at low and medium temperatures, better than wild parents and line "C"; moreover they revealed themselves more vigorous than the line at medium-high temperatures, although their germination energy is lower at low temperatures (MGT is higher). In spite of this, they have a higher germination energy (a lower MGT) at low and high temperatures, than a few sunflower cultivars (Romsun HS 52, Airelle, Gianni, Ala, Argentario) according to Macchia et al., 1985.

Wild species interspecific hybrids reveal a good behaviour about germination and germination energy, sometime better than cultivated sunflower; so that interspecific progenies will be further evaluated for these characters, together with stress resistance and others, with the aim of obtaining progenies with good agronomic and resistance characters.

BIBLIOGRAPHY

- Alba E., Carrozzo G. (1987) - Considerazioni sull'utilità dell'incrocio interspecifico nel genere *Helianthus* (Utility of interspecific hybridization in *Helianthus* genus). Convegno sugli aspetti genetici, agronomici e patologici del girasole e sulle caratteristiche industriali, alimentari e commerciali del prodotto (in Italian) PISA, 1978.
- Anachenko A. B. (1979) - Filogeneticeskija svyhazi v rode *Helianthus* L. trudi po prikladnoi botanika, genetike, selekcii. Tom. 64, vipusk 2/Leningrad.
- Benvenuti A., Paolini R., Vannozzi G. P. (1978) - Analisi delle esigenze del girasole ai fini di una più rispondente tecnica di coltivazione. Convegno sugli aspetti genetici, agronomici e patologici del Girasole e sulle caratteristiche industriali, alimentari e commerciali del prodotto (in Italian), PISA, 1978.

- Chandler J. M., Jan C. C. (1985) - Comparison of germination techniques for wild *Helianthus* seeds. *Crop Sci.*, 25, 75-79.
- Dominiguez J., Fernandez J. M., Gimenez V. (1980) - *H. exilis* y *H. argophyllus* fuentes de restauracion de la endrosterilidad citoplasmatica en girasol. Proc. 9th Int. Sunfl. Conf. Torremolinos, 306-310.
- Fick G. N., Zimmer D. E., Dominiguez J., Redher D. A. (1974) - Fertility restoration and variability for plant and seed characteristics in wild sunflowers. Proc. of the 6th Int. Sunfl. Conf. Bucharest, 333-339.
- Fick G. N., Auwarter G. E. (1981) - A new race of downy mildew affecting sunflower. Proc. Sunfl. Forum and Res. Workshop, Fargo, 15-16.
- Fick G. N., Auwarter G. E. (1982) - Resistance to a new race of sunflower downy mildew. Proc. 10th Int. Sunfl. Conf., Surfers Paradise (Australia) 175-177.
- Leclercq P. (1969) - Une sterile male citoplasmique chez les tournesol. *Ann. Amelior. Plantes* 19, 2, 99-106.
- Leclercq P. (1971) - La sterilité male citoplasmique du tournesol. Premieres etudes sur la restauration de la fertilité. *Ann. Amelior. Plantes*, 21, 45-54.
- Macchia M., Benvenuti A., Baladezi M. (1985) - Temperature requirements during germination in sunflower. Proc. 11th Int. Sunfl. Conf. Mar del Plata (Argentina), 1, 93-97.
- Pustovoit G. V., Skuronet Z. (1978) - Imunitet u dikih vidov *Helianthus*. Vrediteli i bolezni maslichnich kultur. Sbornik, VNIIMK, Krasnodar.
- Robinson R. G. (1978) - Production and Culture. In *Sunfl. Sci. and Techn.* ASA-CSSA-SSSA, Madison (Wisc.) (Ed. Carter).
- Rollier M. (1974) - Investigation on the penalization of sunflower germination. Proc. 6th Int. Sunfl. Conf. 473-480.
- Rollier M. (1977) - Etudies de la germination des semences de tournesol. *Inf. Techn.*, CETIOM, 54, 3-28.
- Serieys H. (1980) - Utilization des especes sauvages d'*Helianthus* pour l'amelioration du tournesol culture. Proc. of the 9th Int. Sunfl. Conf., Torremolinos, 107-112.
- Škorić D., Cuk L., Mihaljević M., Marinković R. (1978) - New sources of fertility restoration (Rf genes) and downy mildew resistance (Pl genes) in sunflowers. Proc 8th Int. Sunfl. Conf., Minneapolis, (USA), 423-426.
- Škorić D. (1983) - Possibilities of overcoming current problems in sunflower production by developing new hybrids. *Uljarstvo* 1, 25-33, Beograd.
- Škorić D., Vannozzi G. P. (1984) - Genetic resources in *Helianthus* genus. Int. Symposium on Science and Biotechnology for an Integral Sunflower Utilization, Bari (Italy).
- Vannozzi G. P., Paolini R. (1982) - Taking advantage of variability in the genus *Helianthus* for sunflower breeding. Present research in Italy. Workshop on sunflower, Athens, 1982.
- Vannozzi G. P., Paolini R. (1984)a Maintenance of wild species: collection, evaluation and conservation of wild species and their use in sunflower breeding programmes. Progress Report, Novi Sad, 3-12.
- Vannozzi G. P., Paolini R. (1984)b Specie spontanee del genere *Helianthus*: fenologia e caratteristiche dell'achene (in italian); *Agric. Ital.*, 5/6, 170-191.
- Vear F. (1974) - Studies on resistance to downy mildew in sunflower. Proc. of the 6th Int. Sunfl. Conf., Bucharest, (Romania), 297-302.
- Zimmer D. E., Kinnan M. L. (1972) - Downy mildew resistance in cultivated sunflower and its inheritance. *Crop Sci.*, 12, 749-751.
- Zimmer D. E., Hoes J. A. (1978) - Diseases: in *Sunf. Science and Technology* ASA-CSSA-SSSA, Madison (Wisc.), 225-262.

POUVOIR GERMINATIF DESACHENES D'HYBRIDES INTERSPECIFIQUES ISSUS DE TOURNESOLS SAUVAGES

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Les auteurs ont étudié trois hybrides interspécifiques entre des *Helianthus* sauvages et le tournesol cultivé (*H. annuus* x *argophyllus*, *H. annuus* x *bolanderi*, *H. annuus* x *debilis*), de plus une lignée "C" et un hybride commercial (Gloriasol) ont été utilisés comme controle. La germination des graines a été étudiée à différents niveaux de températures (5, 10, 15, 20, 25 et 30°C). Le pourcentage de germination, l'énergie germinative, l'index de germination et le coefficient de rapidité ont été retenus comme paramètre d'étude.

Les génotype sauvages germent mieux que la lignée "C" et "Gloriasol" à 10 et 20°C. L'énergie germinative augmente des basses aux hautes températures pour l'ensemble du matériel étudié.

RESPUESTA GERMINATIVA DE TRES HIBRIDOS INTERSPECIFICOS DE GIRASOL EN TRES REGIMENES DIFERENTES DE TEMPERATURA

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Le semilla de tres hibridos interspecificos entre *H. annuus* y *argophyllus*, y *bolanderi* y *debilis*, mas la de una línea pura de girasol y un híbrido comercial (Gloriasol) fue estudiada para ver su germinacion a diferentes regímenes de temperatura (5, 10, 15, 20, 25 y 30°C). El porcentaje de germinación, la energía germinativa, el índice de germinación y el coeficiente de velocidad fueron estudiados. Los genotipos silvestres germinaron mayor que la línea pura y el híbrido comercial a 10 y 20°C. La energia germinativa aumentó desde las temperaturas mas bajas a las mas altas en todas las muestras,