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Helianthus GENUS WILD SPECIES INTERSPECIFIC HYBRIDS: MORPHOLOGICAL AND TECHNOLOGICAL CHARACTERS[1]

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Summary

The authors considered three interspecific hybrids between wild *Helianthus* species and the cultivated sunflower (*H.annuus Line A* x *H.argophyllus, H.annuus Line A* x *H.bolanderi, H.annuus Line A* x *H.debilis*.) with the aim of examining their morphological, biometrical, biological and technological characters. An AN.O.VA. and path coefficients were made. Results show that these hybrids maintain several characters of wild types although the trend is to get to the cultivated ideotype. A normal desaturation activity is present; moreover, path analisys reveals that oleic acid may be increased by flowering height in *H.annuus* x *H.argophyllus*, by leaves number in *H.annuus* x *H.bolanderi* and leaf surface in *H.annuus* x *H.debilis*. Finally oil content may be increased by unsaturated acids in *H.annuus* x *H.argophyllus* and is not influenced by environmental conditions in all three hybrids.

INTRODUCTION

Wild species of *Helianthus* genus represent very important sources of genes to improve sunflower crop. In fact cultivated sunflower has now a narrow genetic variability for many important resistance and other characters. This had been done in the past, by selection, in order to obtain plants with better agronomic features. For such reasons researchers began to study and collect new sources of germplasm to resolve the problems of the crop (Heiser, 1978; Rogers et al., 1982; Škorić, 1983; Škorić, 1984a).

Wild species are interesting sources of many useful characters such as, for example, disease and drought resistance and tolerance (Rogers et al., 1982), oil quality, oil content, protein content and protein quality (Thompson et al., 1981; Dorrel and Whelan, 1987), transferrable to cultivated sunflower by interspecific hybridization (Škorić and Vannozzi, 1984).

Considering oil content, *H.argophyllus* possesses a low level of it, with a range going from 16% to 26% (mean 20-22%) in different populations (Thompson et al., 1981; Vannozzi and Paolini, 1984b; Seiler, 1985); *H.bolanderi* goes from 20% to 30% with a mean of 25-27%, and *H.debilis* has a better mean level (about 30%) with a peak of 36%.

If we consider acid composition we can see that *H.argophyllus* and *H.debilis* have good levels of oleic acid (40% and 35%, respectively), whereas *H.bolanderi* may have high amounts of linoleic acid (74.5% +/- 9.1); moreover, palmitic and stearic acid too maintain high levels (4-5% on average).

1 (Presented at the F.A.O. Sunfl. Meeting, Thessaloniki, Greece, July 1986)

Our work has been aimed at evaluating interspecific hybrids between three wild annual species and cultivated sunflower for morphological, biometrical, biological and technological characters and interrelations among them, already done in a few wild species (Seiler, 1983; Seiler et al., 1985; Vannozzi and Megale, 1986).

MATERIALS AND METHODS

Achenes of three interspecific hybrids between:
H.annuus Line A PI661 (male)[1] x *H.argophyllus* (female)[2];
H.annuus Line A PI661 (male)[1] x *H.bolanderi* (female)[2];
H.annuus Line A PI661 (male)[1] x *H.debilis* (female)[2];
were directly sown in field at the Experiment farm of Torretta (PI) of the Agronomy Institute, on 15th May 1985, in a randomized block design. Each hybrid had 5 replications; each plot had a surface of 5.5 x 0.8 m (4.4 sq.mt.).

Each plot was sowed by plot drill with 100 seeds/replication. Fertilization was by 100 Kg/ha of N, P_2O_5 and K_2O.

The biological characters examined were:
1) flowering date (days from the beginning of year);
2) flowering height (cm);
3) leaves number;
4) leaf length (cm);
5) leaf width (cm);
6) achene weight (basing on 100 "seed" lots).
The technological characters examined were:
7) dry achene oil content (%) (determined with Soxlet method);
8) palmitic acid content (%) (with gas cromatography);
9) stearic acid content (%)
10) oleic acid content (%)
11) linoleic acid content (%)
12) stearic desaturation ratio (S.D.R.) (Cherif et al., 1975);
13) oleic desaturation ratio (S.D.R.) (Cherif et al., 1975).

Data were elaborated with an analysis of variance, comparing hybrids themselves, and each hybrid with its parents.

Correlation coefficients were determined for hybrids, and path coefficient analysis was developed (Dewey and Lu, 1959; Bhatt, 1973).

Statistical analysis was conducted, basing on a software library, with a virtual machine working at CNUCE in Pisa.

1 Pollen of male parents had been bulked and gathered in 1984, from three plants of line A, selected for uniformity, morphological and technological characters; the bulked pollen was divided in 3 parts, each one of them for breeding with female parents;

2 5 plants/species, selected for uniformity of morphological and technological characters (excluding off-types).

RESULTS AND DISCUSSION

All these hybrids (Table 1, 2) had a quite longer sowing-flowering period than cultivated sunflower, particularly *H.annuus* x *H.argophyllus* (113.33 days), whereas the others had similar levels to H.annuus.

Table 1. Wild species hybrids: comparing some phenologycal and technologycal characters

Character	*H.annuus* x *H.argophyllus*	*H.annuus* x *H.bolanderi*	*H.annuus* x *H.debilis*	Line A PI661
Flowering date (days from the beginning of the year)	248.33a	216.00b	212.66b	211.55b
Flowering height (cm)	196.66a	146.00b	118.33c	100.55c
Leaves number	N.S.	N.S.	N.S.	N.S.
Leaf length	N.S.	N.S.	N.S.	N.S.
Leaf width	N.S.	N.S.	N.S.	N.S.
Achene weight (mg)	19.54d	39.93c	50.09b	70.74.a
Dry achene oil content (%)	25.41c	34.87b	36.05b	53.72a
Palmitic acid (%)	9.86a	5.56b	6.83b	7.25a
Stearic acid (%)	N.S.	N.S.	N.S.	N.S.
Oleic acid (%)	13.46c	32.63a	26.73b	36.41a
Linoleic acid (%)	70.50a	56.00b	61.10ab	52.20b
Other (%)	N.S.	N.S.	N.S.	N.S.
S.D.R. (stearic desaturation ratio) %	94.32 N.S.	95.27 N.S.	95.89 N.S.	95.65 N.S.
O.D.R. (oleic desaturation ratio) %	83.96a	63.18bc	69.56b	59.09c

Values not followed by the same latters are different for P 00.5
N.S. = not significant differences

Considering biometrical characters, flowering height is very high in *H.annuus* x *H.argophyllus* (196 cm), shorter in *H.annuus* x *H.bolanderi* (146 cm) and *H.annuus* x *H.debilis* whose level (118 cm) is not different from the test (A Line PI661). These hybrids do not show any statistical difference among them and the test for leaves number, lenght and width.

Achene weight is lower in *H.annuus* x *H.argophyllus* (19.5 g), than in *H.annuus* x *H.bolanderi* (39.9 g); *H.annuus* x *H.debilis* (50.5 g) is near the test value(70 g).

Oil content is lower in *H.annuus* x *H.argophyllus* (25.4 %) than in *H.annuus* x *H.bolanderi* (34.8 %); *H.annuus* x *H.debilis* (36 %) is quite far from test (53 %), so that these accessions maintain a low and unfavourable oil content, typical of wild parents.

Acid composition reveals that palmitic acid has different levels among hybrids, but not significantly different from the test wheras stearic acid does not show any difference, as indirectly confirmed by the S.D.R. (stearic desaturation ratio, Cherif et al., 1975).

Linoleic acid reveals a peak only in *H.annuus* x *H.argophyllus* (70.5%) whereas no very important differences in other acids are noted. The level of O.D.R. (oleic desaturation ratio) in the test is lower than the wild hybrids.

Table 2. Comparing hybrids with their parents

Character / Hybrid	Transplanting flowering date period (days)	Flowering height	Dry achene oil content	Achene weight	Linoleic acid
H.annuus x *H.argophyllus*	105.33b	196.66b	25.41b	19.54b	70.5a
H.argophyllus	140.65a	234.33a	25.36b	4.73c	56.5b
Line Al PI 661	61.33c	100.05c	53.50a	70.70a	52.10b
H.annuus x *H.bolanderi*	73.00a	145.00a	34.87c	39.93b	56.00b
H.bolanderi	59.00b	91.66b	26.93b	2.00c	74.50a
Line Al PI 661	61.33b	100.05b	53.50a	70.70a	52.10b
H.annuus x *H.debilis*	69.66	118.33a	36.05b	50.09b	61.1
H.debilis	62.33	65.00b	31.3b	4.53c	52.7
Line Al PI 661	61.33	100.05a	53.50a	70.70a	52.10

Values not followed by the same letters are different for P 0.05

Regarding path coefficient analysis, interesting significant relationships in *H.annuus* x *H.argophyllus* are flowering height-oleic acid (+0.9993) and leaf width-oleic acid (+0.9635) showing that a reduction of height may give low levels of this acid as much as leaf width. Such situation is confirmed by the path analysis (Table 3); in fact the most important vector for an increment of oil content is the height of the plant, whereas the other factors have no great influence. In *H.annuus* x *H.bolanderi* the most effective relationships are leaf number-oleic acid (+0.9828), leaf number-linoleic acid (-0.9975), oleic acid-oil content (-0.9997), linoleic acid-oil content (+0.9901); so an increment in oil content could be unfavourable for oleic acid. Path coefficient analysis (Table 4) confirms the light positive effects of leaf number on oleic acid, whereas a great positive flow is on linoleic acid content. In *H.annuus* x *H.debilis* flowering height-oil content (+0.9869), oleic acid-leaf lenght (+0.9908), linoleic acid-leaf lenght (-0.9915), oleic acid-leaf width (+0.9868), linoleic acid-leaf width (+0.9859), are the most important relationships. Path coefficient analysis (Table 5) reveal that the flowering height has a negative influence (-1.078) on oil content, and confirms that leaf area has a negative influence on linoleic, and positive on oleic acid content.

Finally, oil content (Table 6) seems to be highly positively influenced by oleic and linoleic, and negative by stearic acid in *H.annuus* x *H.argophyllus,* whereas a negative influence of the unsaturated fatty acids is in *H.annuus* x *H.debilis*.

Table 3. Path coefficient analysis in *H.annuus* x *H.argophyllus*

Character	Dry seed oil content	Linoleic acid content	Oleic acid content
Flowering time	–0.0088	–0.1330	–0.0020
Flowering height	–0.2651	+0.8693	+1.0357**
Leaves number	+0.9138	–1.0156	–0.0813
Leaf length	–0.0577	–0.0503	–0.0127
Leaf width	–0.0833	+0.1677	–0.0184**
Seed weight	+0.3655	+1.1505	+0.0806
Residual factors	+0.3050	+0.8316	+0.0670

** : significant patterns P 0.01

Table 4. Path coefficient analysis in *H.annuus* x *H.bolanderi*

Character	Dry seed oil content	Linoleic acid content	Oleic acid content
Flowering time	+0.0309	–1.9057	+0.0027
Flowering height	–3.8780	–11.3211	–2.0032
Leaves number	+2.2658	+14.0240**	+0.3181**
Leaf length	+12.2269	–33.4670	+11.2227
Leaf width	–0.6751	+21.2690	+0.1127
Seed weight	–11.3348	+7.9525	–10.5751
Residual factors	+0.0742	+1.6930	+0.0661

** : significant patterns P 0.01

Table 5. Path coefficient analysis in *H.annuus* x *H.debilis*

Character	Dry seed oil content	Linoleic acid content	Oleic acid content
Flowering time	–2.5016	–0.000009	+0.0418
Flowering height	–1.0786**	–0.1092	+0.3857
Leaves number	–0.0068	–0.0005	+0.0012
Leaf length	–2.0484	–0.3563	+0.0435**
Leaf width	–0.1984	–0.7351	+0.2376**
Seed weight	–1.5482	–0.00004	+1.0552
Residual factors	+0.0100	+0.0051	+0.0077

** : significant patterns P 0.01

Table 6. Effects of the main fatty acids on dry seed oil contents in the three interspecific hybrids

Fatty acid	*H.annuus* x *H.argophyllus*	*H.annuus* x *H.bolanderi*	*H.annuus* x *H.debilis*
Palmitic	+1.9823	+0.1309	–7.3511
Stearic	–2.1100	–0.00002	+10.2683
Oleic	+2.7884	–0.1071	–36.5516
Linoleic	+2.7333	+0.8556	–33.2504
Residual factors	+0.0301	+0.0216	+0.1013

CONCLUSION

These hybrids have a normal desaturation activity which cause medium-high levels of linoleic acid. Moreover, not very interesting patterns were revealed by path analysis; we can say that a low height may be useful for oil content and a large leaf area for oleic acid increment in *H.annuus* x *H.debilis.*

These selection patterns will be utilized in obtaining progenies with either resistance or good agronomic characters, particularly in *H.annuus* x *H.debilis.*

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HYBRIDES INTERSPECIFIQUES ISSUS D'ESPECES SAUVAGES DU GENRES *Helianthus*[1]

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Les auteurs ont considéré trois hybrides interspécifiques issus du croisement entre des espéces sauvages appartenant au genre *Helianthus* avec du tournesol cultivé (*H.annuus lignée A* x *H.argophyllus, H.annuus lignée A* x H.*bolanderi, H.annuus lignee A* x *H.debilis)*, afin d'examiner leurs caracteristiques morphologiques, biométriques, biologiques et technologiques. Les données ont été traitées par des analyses de variance et des "Path coefficients"

1 (presente au congre "Tournesol F.A.O", Thessalonik, Grece - Juillet 1986).

analysis. Une activité normale de désaturation existe. Cependant la "Parth Analisys" révéle que le contenu en acide oleique est positivement correle a la durée de la floraison pour le croisement *H.annuus* x *H.argophyllus,* au nombre de feuilles pour le croisement *H.annuus* x *H.bolanderi* et à la surface foliaire pour *H.annuus* x *H.debilis.* Le contenu final en huile peut être augmenté par la présence d'acides insaturés pour l'hybride *H.annuus* x *H.argophyllus* et n'est pas soumis aux influences environementales pour les trois hybrides.

CRUCES INTERESPECIFICOS ENTRE DISTINTAS ESPECIES DE *Helianthus.* CONTENIDO EN ACEITE Y ACIDOS GRASOS

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Se estudiaron tres híbridob interespecificos entre *H.annuus Línea A* y las trés especies *H.argophyllus, H.bolanderi* y *H.debilis.* Se examinaron sus características biológicas y tecnológicas y se hicieron análisis de la varianza, de correlación y se calcularon los coeficientes de sendero para varias características.

Los resultados revelaron una gran variabilidad entre los hibridos para altura de la planta, peso de las semillas, contenido en aceite y contenido en acido oleico. Los análisis de correlación y los de coeficiente de sendero mostraron como el contenido en aceite está altamente influenciado por el número de hojas, peso de las semilla y altura de la planta en el híbrido *H.annuus* x *H.argophyllus* en el que el contenido en ácido oleico podria ser incrementado selecionando plantas con menos hojas, mas tempranas y mas altas. En el híbrido *H.annuus* x *H.bolanderi* los coeficientes de sendero muestran que el contenido de aceite está positivamente influenciado por el número de hojas y longitud de estas, y negativamente por la altura de la planta y peso de la semilla. El contenido de ácido oleico se puede incrementar seleccionando para plantas mas bajas, con mas hojas y éstas mas grandes. En el híbrido *H.annuus* x *H.debilis*, los coeficientes de sendero revelan que el contenido de aceite de la semilla esta negativamente correlacionado por todos los caracteres estudiados. El contenido de ácido oleico esta positivamente correlacionado con el peso de semilla altura de la planta y anchura de la hoja.