INTERSPECIFIC HYBRIDIZATION BETWEEN *HELIANTHUS ARGOPHYLLUS* AND *H. ANNUUS.* I. CROSS COMPATIBILITY AND FIRST HYBRID GENERATION CHARACTERIZATION

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Abstract

Three accessions of *H. argophyllus,* GT-E-007, GT-E-008, and GT-E-091 were included in reciprocal crosses with cultivated sunflower and gave very good results. The degree of cross compatibility between *H. argophyllus* and *H. annuus* was very high regardless of the differences between the two types of crosses and the three accessions of the wild species. A good number of hybrid seeds was produced in both types of crosses for the three accessions of *H. argophyllus* in almost all different hybrid combinations. Nevertheless, the seed set in the inflorescence was low in the crosses in both directions of hybridization. It could be said as a conclusion that many F1 plants were grown from the reciprocal crosses, but the degree of viability and germinating ability of the hybrid seeds was low in both directions of hybridization and in all accessions of *H. argophyllus* included in the investigation. There was considerable variability among the F1 hybrid progeny. For the plant height superdominance of the higher parent (the wild species) was mainly registered. The heritability (d/a) for head diameter is basically intermediate. For the number of disk florets there was no case of heterosis. The wide sense heritability (H2) had very high values and the d/a showed partial to complete dominance of the wild species. Results were analogous for the number of fertilized disk florets (seed set) of the F1 plants.

Introduction

The method of interspecific hybridization has been used for almost a century already. With the help of different supporting techniques it is becoming increasingly attractive to breeders because of the opportunities that the method provides to introduce desirable genes from the wild sunflower species into cultivated sunflower. These genes could be either resistance to diseases and stress factors, or cytoplasmic male sterility, or fertility restoration. A species that could be used as a source of all of these desirable genes is *Helianthus argophyllus* T. & G. Christov (1990, 1992, 1996b) reported CMS lines developed from interspecific hybrids with *H. argophyllus*. Tsvetkova and Velkov (1976), Skoric (1981), Christov & Petrov (1988), and Christov (1996a, b) observed the presence of Rf genes derived from *H. argophyllus*.

The main interest in the inheritance of different traits should be directed towards the F1 and F2 hybrid generations, considering the role of both parental forms in the transfer of genes controlling these traits. There have been few reports on this topic. Georgieva-Todorova (1976) observed that interspecific hybrids tend to inherit most characters from the wild parent. Bohorova (1977) and Christov (1988) reported that diversity in morphological traits

could be present even in the F1 hybrid generation. According to Atlagic (1991), in the F1 generation all types of inheritance were present.

The aim of this investigation was to follow the mode of inheritance for a few traits, linked to the yield potential of the sunflower plant in the F1 generation and the role of both parental forms, comparing reciprocal crosses. Some negative or undesirable breeder traits, such as branching, anthocyanin coloration, self-fertility and low oil percentage were also studied.

Materials and Methods

Helianthus argophyllus is an annual diploid (2n=34) species belonging to the Section Helianthus (Schilling and Heiser, 1981). Three different accessions of *H. argophyllus* were included in the investigation – GT-E-007, GT-E-008 and GT-E-091. The stems are 110 to 205 cm tall, depending upon the accession, branched, light to medium green, and have a straight growth habit. Leaves are ovate to cordate, green to ashy-green, hairy in some accessions, opposite and petiolate. Heads are many on rather short peduncles, disk 5.0-9.0 cm in diameter, 16 to 30 ray florets, yellow, disk-corolla yellow in some accessions, dark anthocyanin in others. Achenes are small (3-4 mm long). The original source of the population of *H. argophyllus* was from Bushland, Texas, USA. The populations of accessions E-007, E-008 and E-091 have been maintained in the wild species germplasm collection at the Dobroudja Agricultural Institute, General Toshevo, Bulgaria.

Under the environmental conditions at DAI, *H. argophyllus* began to grow the third week of April. It flowered in 90-98 days after plant emergence in the spring, depending upon the accession. Physiological maturity occurred after 118-124 days. Plants stayed green and vigorous till the first autumn frosts (25 Sept.-10 Oct.). Seed set under open-pollination averaged from 7.41 to 92.59% for the different accessions. When heads of *H. argophyllus* were self-pollinated, their seed set averaged 0-1.19% for E-007, 0-0.66% for E-008 and 0-26.32% for E-091.

The elite cultivated lines used in the study were cytoplasmic male sterile lines (CMS HA-300 and HA-821) developed and released by the USDA-ARS. Other elite cultivated CMS lines designated as L.1607, L.2607, L.1234 and L.3064 developed by the sunflower program at DAI were also used. The elite open-pollinated variety Peredovik, developed by VNIIMK, Russia was also used.

Techniques for wide hybridizing in sunflower have been described by Georgieva-Todorova (1976) and Christov (1990). Initial crosses between *H. argophyllus* and *H. annuus* were made according to a full scheme; i.e., reciprocal crosses. In the present investigation heads were bagged just before anthesis; the pollination was made as soon as the stigmas were exerted. The heads were then rebagged and after approximately four to five weeks the seeds were harvested. Planting dates for cultivated sunflower were extended and performed several times in order to ensure flowering cultivated plants and fresh pollen during the flowering period of *H. argophyllus*. The hybrid seeds from crosses of cultivated x wild were planted in the field. The seeds from the reciprocal crosses were planted in greenhouse conditions and seedlings were planted to the experimental field. The seed set was calculated as a ratio between the seeds obtained and the total number of tubular florets in the inflorescence. The germination and vitality of the hybrid seeds was determined as a ratio between the grown hybrid plants and the total number of produced seeds in the corresponding combination.

Morphological and phenological characterization of the wild *H. argophyllus*, the

cultivated sunflower inbred lines and the hybrid progenies was done. The observations were made on at least 10 plants grown in field conditions. The following traits were studied: plant height (cm), number of branches, head diameter (cm), head thickness (cm), number of bract leaves, number of ray florets, ratio of length/width of leaves, length of the leaf petiole (cm), length of the longest branch (cm), stem thickness (cm), seed size (length, width and thickness [cm]), color of the stigma, germination, button formation, flowering period, physiological and technical maturity.

Seed oil content of the parental forms and hybrid combinations was estimated according to the nuclear magnetic resonance method. The kernel oil content of the wild species was estimated according the Rushkovski (1957). Fatty acid composition was evaluated according to the gas chromatographic techniques on a "Perkin Elmer" gas chromatograph.

Statistical estimation of the experimental data included the following genetic characteristics: hypothetical (Hhyp) and true heterosis (Htrue) (Omarov, 1975), heritability d/a (Gentchev et al., 1971), genetic (H2) heritability (Gentchev et al., 1971), variation coefficient VC (Mather & Jinks, 1971), mean (x) and mean squared (xq), and the differences were compared according to the Student t-test (Mather & Jinks, 1971). Statistical estimations were performed by BIOSTAT, version 5.1., Statistics for Windows 95 and Microsoft Excel version 7.0.

Results and Discussion

Three accessions of *H. argophyllus,* E-007, E-008, and E-091 were included in reciprocal crosses with cultivated sunflower and gave very good results. The cross compatibility between *H. argophyllus* as the female parent and cultivated *H. annuus* as the male parent was high (68% for accession E-007, 61.76% for E-008 and 44.44% for E-091) (Table 1). When *H. argophyllus* was used as the male, the compatibility was lower for accessions E-007 and E-008 with 48.28 % and 56.14 % respectively.

Table 1. Cross compatibility between *Helianthus argophyllus* and *H. annuus* (1993-1996).

Hybrid combination	Inflorescence pollinated				Seeds produced			Hybrid plants		
	No. pollinated	No. with seeds			Total No.	Seeds set %		No.	in %	
		No	%			%			of seeds	
E-007 x *H. annuus*	25	17	68.00	± 0.389	238	8.35	± 2.715	67	28.15	± 3.346
H. annuus x E-007	29	14	48.28	± 0.297	776	2.87	± 1.165	139	17.91	± 4.750
	t stat = 1.48 < t crit.= 2.12				t stat = 1.86 < t crit.= 2.07			t stat = 0.71 < t crit.= 2.16		
E-008 x *H. annuus*	34	21	61.76	± 0.420	164	5.14	± 1.603	21	12.80	± 1.603
H .annuus x E-008	57	32	56.14*	± 0.217	3305	4.81	± 0.975	458	13.86**	± 1.813
	t stat = 2.95 > t crit.= 2.20 at P =5 %				t stat = 0.18 < t crit.= 2.03			t stat = 3.78 > t crit.= 2.09 at P =1 %		
E-091 x *H. annuus*	36	16	44.44	± 0.221	183	5.67	± 1.865	41	22.40	± 1.822
H. annuus x E-091	56	40	71.43	± 0.149	5124	6.83	± 1.319	506	9.88 ***	± 2.003
	t stat = 0.64 > t crit.= 2.10				t stat = 0.51 < t crit.= 2.03			t stat = 5.12 > t crit.= 2.06 at P =0.1 %		

It was higher, though not significant for accession E-091. Almost no significant difference could be found in the results for the three accessions in both directions of hybridization with cultivated sunflower (Table 2). Only one exception was observed between

accessions E-007 and E-091 in the crosses of wild x cultivated, where the difference between 68% (E-007) and 44.44% (E-091) was significant at P=5%. A conclusion could be made that the degree of cross compatibility between *H. argophyllus* and *H. annuus* was very high regardless of the differences between the two types of crosses, and the three accessions of the wild species.

Table 2. Significance of differences between the three accessions of *H. argophyllus* in cross compatibility, seed set and number of hybrid plants.

	Cross compatibility			Seeds produced			Hybrid plants		
	E-007	E-008	E-091	E-007	E-008	E-091	E-007	E-008	E-091
Crosses (wild x cultivated)									
E-007	68.00			8.35			28.15		
E-008	-	61.76		-	5.14		*	12.80	
E-091	*	-	44.44	-	-	5.67	-	-	22.40
Crosses (cultivated x wild)									
E-007	48.28			2.87			17.91		
E-008	-	56.14		-	4.81		-	13.86	
E-091	-	-	71.43	*	-	6.83	-	-	9.88

A good number of hybrid seeds were produced in both types of crosses for the three accessions of *H. argophyllus* in almost all different hybrid combinations. It is apparent from Table 1 that the number of hybrid seeds was much lower in the crosses of wild x cultivated than that in the opposite ones. Nevertheless, the seed set in the inflorescence was low in the crosses in both directions of hybridization (Table 1). Significant differences between the seed set of the reciprocal crosses were not found for the three accessions. Comparing the accessions in seed set, only one significant difference was found and it was between the low value of E-007 (2.87%) and the higher one of E-091 (6.83%) in the crosses of cultivated x wild (Table 2).

First hybrid generation plants obtained from crosses wild x cultivated were considerably less in number than these from the opposite types of crosses. There were no differences between the accessions of *H. argophyllus* in this respect (Table 1). It could be seen from the results that 506 F1 plants were grown from crosses *H. annuus* x (E-091), 458 from *H. annuus* x (E-008), and 139 from *H. annuus* x (E-007). The number of hybrid plants, presented as a percentage of the total number of the produced seeds gives another view on the vitality and germinating ability of the hybrid seeds (Table 1). It was much higher in crosses of wild x cultivated than in the opposite ones for accessions E-007 and E-091, and vice versa for accession E-008 (13.86**>12.80). The only significant difference between the three accessions of *H. argophyllus* was found in the crosses of wild x cultivated between E-007 (28.15 %) and E-008 (12.80 %)(Table 2). It could be said as a conclusion that many F1 plants were grown from the reciprocal crosses, but the degree of viability and germinating ability of the hybrid seeds was low in both directions of hybridization and in all accessions of *H. argophyllus* included in the investigation.

Considerable variability was observed among the F1 hybrid progeny, with common traits including branched stems, anthocyanin coloration in disk florets, leaf petioles, and stems, and heads with long peduncles. Many of these traits are characteristic of the wild species parent. In some interspecific hybrids, the leaves were erect, a characteristic not typically seen in cultivated sunflower. Three types of branching were observed: basal, axial, and branching both at the base and the apical part of the stem. Branches in some plants were situated above

the central head of the plant. Similar results and observations were reported by Saciperov (1961), Georgieva-Todorova (1976) and Christov (1988).

Most F1 hybrid plants sprouted about 20-24 April with anthesis starting about 69 to 78 days after germination. The vegetation period of the hybrids varied between 96 and 117 days.

Data about the genetic parameters of some morphological traits are presented in Tables 3 and 4. Several hybrid combinations of wild x cultivated are characterized for the three accessions of *H. argophyllus* in Table 3; and in Table 4 the same combinations (as far as it was possible) in the opposite crosses of cultivated x wild. The characteristics of the parental forms are also included.

Table 3. Genetic parameters, characterizing the initial parental forms and their F1 progenies in crosses of wild x cultivated.

Hybrid	P_1		P_2		F_1					
combination	x	VC	x	VC	x	d/a	VC	H^2	H hyp.	H true
Plant height (cm)										
E-007 x 1607	133.3	21.32	116.0 -	7.53	176.7 a	6.02	28.63	0.72	41.76	52.33
E-008 x 1607	155.0	27.94	116.0 b	7.53	153.3 -	0.94	24.47	0.63	13.14	32.16
E-091 x 1607	145.0	9.12	116.0 -	7.53	134.2 -	0.26	37.67	0.25	2.84	15.69
E-007 x 2607	133.3	21.32	129.4 -	7.36	117.5 -	-7.13	3.01	0.84	-10.58	-9.20
E-008 x 2607	155.0	27.94	129.4 -	7.36	116.0 a	-2.05	39.84	0.30	-18.42	-10.36
E-091 x 2607	145.0	9.12	129.4 a	7.36	193.3 c	7.19	5.38	0.93	40,89	49,38
E-007 x 1234	133.3	21.32	114.0 a	8.32	155.0 a	3.23	8.53	0.79	25,30	35,96
E-091 x 1234	145.0	9.12	114.0 c	8.32	153.3 -	1.54	8.21	0.87	18,38	34,47
Head diameter (cm)										
E-007 x 1607	6.33	36.46	17.1 b	32.83	4.7 -	1.30	26.96	0.70	-59,83	-72,51
E-008 x 1607	5.67	20.38	17.1 b	32.83	9.7 -	0.30	5.97	0.62	-14,91	-43,27
E-091 x 1607	5.67	20.38	17.1 b	32.83	8.2 -	0.56	25.00	0.72	-28,07	-52,05
E-007 x 2607	6.33	36.46	15.7 c	19.63	9.5 -	0.32	22.33	0.77	-13,64	-39,49
E-008 x 2607	5.67	20.38	15.7 c	19.63	5.0 -	1.14	32.66	0.89	-53,27	-68,15
E-091 x 2607	5.67	20.38	15.7 c	19.63	13.3 b	-0.52	35.44	0.74	24,30	-15,29
E-007 x 1234	6.33	36.46	16.4 b	30.54	11.5 -	-0.02	4.35	0.58	0,88	-29,88
E-091 x 1234	5.67	20.38	16.4 b	30.54	11.3 -	-0.06	5.09	0.62	2,73	-31,10
Total number of disk florets										
E-007 x 1607	167.7	32.21	1474.0 c	5.50	243.0 -	0.88	39.10	0.98	-70,40	-83,51
E-008 x 1607	151.7	31.64	1474.0 c	5.50	220.7 -	0.90	58.46	0.97	-72,85	-85,03
E-091 x 1607	190.0	25.92	1474.0 c	5.50	421.3 b	0.64	16.98	0.98	-49,36	-71,42
E-007 x 2607	167.7	32.21	1787.0 c	5.71	526.3 a	0.56	37.46	0.95	-46,15	-70,55
E-008 x 2607	151.7	31.64	1787.0 c	5.71	233.2 -	0.90	56.86	0.98	-75,94	-86,95
E-091 x 2607	190.0	25.92	1787.0 c	5.71	442.5 -	0.68	35.00	0.97	-55,24	-75,24
E-007 x 1234	167.7	32.21	1714.0 c	7.80	298.7 -	0.83	50.80	0.96	-68,25	-82,57
E-091 x 1234	190.0	25.92	1714.0 c	7.80	720.5 a	0.30	40.92	0.91	-24,32	-57,96
Number of fertilized disk florets / seed set										
E-007 x 1607	22.0	65.56	1006.0 b	36.60	175.3 -	0.69	56.92	0.72	-65,89	-82,57
E-008 x 1607	123.3	33.33	1006.0 b	36.60	146.3 -	0.95	76.74	0.70	-74,09	-85,46
E-091 x 1607	118.7	64.63	1006.0 b	36.60	158.5 -	0.91	136.92	0.67	-71,82	-84,24
E-007 x 2607	22.0	65.56	1163.7 c	2.27	199.0 -	0.69	100.44	0.91	-66,44	-82,90
E-008 x 2607	123.3	33.33	1163.7 c	2.27	103.2 -	1.04	143.65	0.95	-83,96	-91,13
E-091 x 2607	118.7	64.63	1163.7 c	2.27	361.0 -	0.54	51.32	0.93	-43,70	-68,98
E-007 x 1234	22.0	65.56	1171.3 c	4.62	53.0 -	0.95	155.58	0.98	-91,12	-95,48
E-091 x 1234	118.7	64.63	1171.3 c	4.62	664.5 a	-0.04	35.01	0.89	3,02	-43,27

For the plant height, super dominance of the taller parent (the wild species) was mainly registered in the crosses of wild x cultivated. This fact was also confirmed by the high values of genotypic heritability (H2) and H true, proving the presence of true heterosis and thus confirming the results of Atlagic (1991). The ratio d/a (heritability) showed intermediary inheritance in only one case (Table 3). The F1 plants in the reciprocal crosses were

considerably taller and superdominance of the higher parent, the pollinator, which means the wild species *H. argophyllus* again, was observed in all studied hybrid combinations. It was confirmed again by the high values of H2, also by the high values of Hhyp and Htrue (Table 4).

The head diameter in the plants of *H. argophyllus* was shown to be significantly smaller than the one of the cultivated sunflower plants. This fact had a definite influence upon the formatting of the inflorescence in the hybrid plants. Almost all hybrid plants studied (with only one exception) in both types of crosses had smaller inflorescences than these of the cultivated parent (Table 3 and 4). The heritability (d/a) was basically intermediate in combinations of wild x cultivated with some cases of dominance of the smaller-headed parent. Results were similar in Atlagic, 1991. No heterosis was observed (Table 3). Results in crosses of cultivated x wild were similar with only one exception of superdominance of the cultivated parent in combination L.1607 x *H. argophyllus* (E-091). This is the only case in all combinations studied in both types of crosses where true heterosis was detected.

Table 4. Genetic parameters, characterizing the initial parental forms and their F1 progenies in crosses of cultivated x wild.

Hybrid	P_1		P_2		F_1					
combination	x	VC	x	VC	x	d/a	VC	H^2	H hyp.	H true
Plant height (cm)										
1607 x E-007	116.0	7.53	133.3 a	21.32	177.5 c	-6.10	5.98	0.83	42,34	53,02
1607 x E-091	116.0	7.53	145.0 c	9.12	196.0 c	-4.52	9.95	0.95	50,19	68,97
2607 x E-007	129.4	7.36	133.3 -	21.32	185.0 c	-27.49	15.29	0.78	41,02	42,97
2607 x E-008	129.4	7.36	155.0 a	27.94	193.5 c	-4.01	12.84	0.91	36,08	49,54
2607 x E-091	129.4	7.36	145.0 -	9.12	251.6 c	-14.67	21.28	0.93	83,38	94,44
1234 x E-008	114.0	8.32	155.0 -	27.94	205.3 c	-3.45	32.03	0.84	52,64	80,09
1234 x E-091	114.0	8.32	145.0 c	9.12	175.7 c	-2.98	10.39	0.95	35,68	54,12
Head diameter (cm)										
1607 x E-007	17.1	32.83	6.33 b	36.46	7.5 a	-0.78	9.43	0.59	-35,90	-56,14
1607 x E-091	17.1	32.83	5.67 b	20.38	25.4 a	2.46	26.35	0.71	122,81	48,54
2607 x E-007	15.7	19.63	6.33 c	36.46	9.5 a	-0.32	7.44	0.77	-13,64	-39,49
2607 x E-008	15.7	19.63	5.67 c	20.38	11.8 b	0.22	29.84	0.78	10,28	-24,84
2607 x E-091	15.7	19.63	5.67 c	20.38	14.9 -	0.84	37.89	0.65	39,25	-5,10
1234 x E-008	16.4	30.54	5.67 c	20.38	12.1 a	0.20	21.14	0.68	10,00	-26,22
1234 x E-091	16.4	30.54	5.67 c	20.38	10.8 b	-0.04	9.56	0.74	-1,82	-34,15
Total number of disk florets										
1607 x E-007	1474.0	5.50	167.7 c	32.21	630.7 c	-0.29	13.70	0.97	-23,17	-57,21
1607 x E-091	1474.0	5.50	190.0 c	25.92	960.5 a	0.20	19.19	0.91	15,44	-34,84
2607 x E-007	1787.0	5.71	167.7 c	32.21	849.0 b	-0.16	37.20	0.90	-13,14	-52,49
2607 x E-008	1787.0	5.71	151.7 c	31.64	484.8 c	-0.59	77.47	0.85	-49,99	-72,87
2607 x E-091	1787.0	5.71	190.0 c	25.92	889.5 c	-0.12	16.93	0.97	-10,02	-50,22
1234 x E-008	1714.0	7.80	151.7 c	31.64	427.8 c	-0.65	71.62	0.88	-54,14	-75,04
1234 x E-091	1714.0	7.80	190.0 c	25.92	522.5 c	-0.56	45.47	0.92	-45,12	-69,52
Number of fertilized disk florets / seed set										
1607 x E-007	1006.0	36.60	22.0 b	65.56	6.0 b	-1.03	101.38	0.77	-98,83	-99,40
1607 x E-091	1006.0	36.60	118.7 a	64.63	780.5 -	0.49	12.59	0.56	38,78	-22,42
2607 x E-007	1163.7	2.27	22.0 b	65.56	397.7 b	-0.34	88.10	0.79	-32,92	-65,82
2607 x E-008	1163.7	2.27	123.3 b	33.33	218.0 b	-0.82	211.08	0.62	-66,12	-81,27
2607 x E-091	1163.7	2.27	118.7 c	64.63	711.5 a	0.13	25.54	0.93	10,96	-38,86
1234 x E-008	1171.3	4.62	123.3 c	33.33	14.2 c	-1.21	91.20	0.99	-97,81	-98,79
1234 x E-091	1171.3	4.62	118.7 c	64.63	219.5 c	-0.81	127.76	0.83	-64,97	-81,26

The analysis of the results for the number of disk florets showed a high variation in the progenies of every studied combination. The number of disk florets in the F1 plants was smaller than the one of the cultivated parent and bigger than that of the wild parent. This characteristic was typical for the plants of all hybrid combinations from both types of crosses

included in the research (Table 3 and 4). There was no case of heterosis. The wide sense heritability (H2) had very high values and the d/a showed partial to complete dominance of the maternal parent in crosses of wild x cultivated, i.e., the wild species (Table 3); and intermediary inheritance to partial dominance of the pollinator in crosses of cultivated x wild, i.e., the wild species again (Table 4).

Results were analogous with regard to the number of fertilized disk florets (seed set) of the F1 plants. The number was smaller in all hybrid combinations, compared to the seed set of cultivated sunflower (Tables 3 and 4). The d/a heritability in crosses of wild x cultivated proved partial to complete dominance of the wild parent (only one case of intermediary inheritance was observed), comparatively high values of H2 and a big variance coefficient (Table 3). The opposite crosses contained one case of intermediary inheritance. Partial, complete or super dominance of the wild parent was observed in the prevailing number of investigated combinations (Table 4). Seed set had a high variance coefficient in both types of F1 combinations. Heterosis was not found.

Some F1 hybrids obtained from the cultivated CMS x *H. argophyllus* were fertile, while others were sterile. The wild species was maintained as a population, so there would be segregation for fertility restoration genes, even in the F_1 hybrids. The presence of fertile plants indicates that gene(s) for fertility restoration of the CMS PET1 cytoplasm were present in the original wild population. F1, F2, and F3 progenies of *H. argophyllus* had fertility restoration varying from 40 to 100%. Tsvetkova and Velkov (1976), Christov and Petrov (1988) and Christov (1996a) reported similar results.

The self-compatibility of the F1 plants varied from 19.3% in combination E-008 x L.2607 to 61.2 % in E-007 x L.2607. Seeds of different colors were observed, white, gray, variegated, and black with or without stripes. Seed length was usually 0.6-0.7 cm, 0.3-0.4 cm wide, and 0.2 cm thick.

The final step of the investigation of the F1 progenies was the study of the 1000-seed weight, the kernel percentage in the seed, the kernel and seed oil content and fatty acid composition of the oil. The 1000-seed weight had low values for both accessions of *H. argophyllus* (11.4 - 14.6 g) and was much higher in the cultivated sunflower lines. The same trait had intermediate values for the F1 hybrid combinations, varying from 28.4 to 36.0 g, confirming data, reported by Christov (1988). The kernel percentage in the seeds was also low for the wild species accessions and intermediate in the hybrid progenies. Values were analogous for the seed oil content. No significant differences were detected in the fatty acid composition of the oil between the parental forms and their hybrid combinations.

Table 5. Seed weight, kernel % in the seed, kernel and seed oil content and fatty acid composition of the oil in hybrid combinations and their parental forms.

Material	1000-seed weight, g	Kernel %	Kernel oil content %	Seed oil content %	Linoleic acid %	Oleic acid %	Stearic acid %	Palmitic acid %
E-007	11.4	52.6	56.6	29.8	67.4	20.4	5.9	6.3
E-091	14.6	52.1	54.5	28.4	71.3	22.8	3.8	2.1
L.1234	62.5	72.0	48.8	35.1	48.3	40.7	3.8	7.2
L.3064	77.5	80.6	45.4	36.6	63.9	25.8	4.9	5.9
E-007 x 1234	36.0	55.6	53.6	29.8	65.0	22.9	4.9	7.2
E-007 x 3064	30.4	59.2	50.8	30.1	64.7	22.6	5.5	7.2
E-091 x 1234	28.4	57.7	54.8	31.6	65.9	21.7	5.0	7.4
E-091 x 3064	33.0	60.6	53.0	32.1	63.1	24.7	5.7	6.5

Conclusions

The degree of cross compatibility between *H. argophyllus* and *H. annuus* was very high regardless of the differences between the two types of crosses, and the three accessions of the wild species. The seed set in the inflorescence was low in the crosses in both directions of hybridization. The degree of viability and germinating ability of the hybrid seeds were low in both directions of hybridization and in all accessions of *H. argophyllus*, included in the investigation.

There was considerable variability among the F1 hybrid progeny. For the plant height, superdominance of the taller parent (the wild species) was mainly registered. The heritability (d/a) for head diameter is basically intermediate. For the number of disk florets there was no case of heterosis. The wide sense heritability (H2) had very high values and the d/a showed partial to complete dominance of the wild species. Results were analogous for the number of fertilized disk florets (seed set) of the F1 plants.

The 1000-seed weight, the kernel percentage in the seeds and the seed oil content were low values for the wild parent and were intermediate percentage for the hybrid plants.

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