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INTERSPECIFIC HYBRIDIZATION BETWEEN *H. pumilus* nutt. AND *H. annuus* L. AND THEIR POTENTIAL FOR CULTIVATED SUNFLOWER IMPROVEMENT

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SUMMARY

Successful interspecific hybridization was carried out between the wild perennial diploid species *Helianthus pumilus* Nutt., accession GT-M-172, and cultivated *H.annuus* L. The cross compatibility between *H.pumilus* and *H.annuus* was much higher when the wild species was used as the male in the crosses. Insemination (seed set) was very low in both directions. In order to prove the presence of considerable variability in the early F_1 generation, some statistical methods were used for evaluation of morphological traits such as plant height, head diameter, number of disk flowers and insemination. Heterosis was detected for plant height. Cases of partial to complete dominance of the cultivated parent prevailed. A high level of segregation was observed in the F_2 generation, therefore, traits depression and transgression were evaluated for plant height, head diameter, number of florets and seed set. A triple phenotypic correlation appeared between three characters in sunflower and one of them was confirmed on genetic level as well. Resistance to *Plasmopara helianthi*, *Orobanche cumana* and *Phomopsis helianthi* was discovered in different progenies of the interspecific hybrids of *H.pumilus*.

Key words: ***Helianthus pumilus*** **Nutt.,** ***Helianthus annuus*** **L., interspecific hybridization**

INTRODUCTION

The genus *Helianthus* is composed of 50 species and 19 subspecies with 14 annual and 36 perennial species (Seiler and Rieseberg, 1997). Wild *Helianthus* species constitute the basic genetic stock from which cultivated sunflower originated. The diverse species represent considerable genetic variability which can be utilized

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for the improvement of cultivated sunflower. Cultivated hybrid sunflower utilizes an extremely narrow genetic basis leaving the crop vulnerable to disasters as was seen with the southern corn leaf blight epidemic (Tatum, 1971). Genetic variability in the cultivated sunflower may be increased by crossing with the numerous wild *Helianthus* species. Interspecific hybridization in *Helianthus* has been used for many years to integrate genes from the wild species into cultivated sunflower (Whelan, 1978; Jan, 1997; LaFerriere, 1986). Conventional breeding methods have produced many interspecific hybrids between cultivated sunflower and several of the wild species, especially the diploid annuals. Several wild species, especially the diploid perennials, and some of the higher ploidy perennials remain to be explored for agronomically useful traits because they have not been hybridized with cultivated sunflower and their progenies have not been evaluated.

Crossing of diploid perennial *H.pumilus* (2n=34) with cultivated *H.annuus* has been reported by Krauter *et al*. (1991) using a modified embryo culture. However, the authors did not give detailed morphological information about the interspecific hybrids or any evaluation information. The objective of this paper is to describe the interspecific hybrids of cultivated sunflower and *H.pumilus* and their potential for improving cultivated sunflower.

MATERIALS AND METHODS

Figure 1: A plant of Helianthus pumilus Nutt.

Helianthus pumilus is a diploid perennial species (2n=34) belonging to the Section *Ciliares*, Series *Pumili* (Schilling and Heiser, 1981).

The stems are 0.3 to 1.0 m tall, branched, light green, and have a prostrate growth habit. Leaves are ovate, green to ashy-green, opposite and petiolate. Heads are few on rather short peduncles, disk 1.0-1.4 cm in diameter, few ray florets, lemon-yellow, disk-corolla yellow. Achenes are small (3-4 mm long), smooth, gray to light brown, speckled. The original source of the population of *H.pumilus* was obtained from Cheyenne, Wyoming, USA. This population was designated GT-M-172 in the wild species germplasm collection of the Dobroudja Agricultural Institute, General Toshevo, Bulgaria.

Under the environmental conditions at DAI, *H.pumilus* began to grow during the third week of March, depending on the weather. Flower buds appeared about 20 May, approximately 56-64 days after the plants emergence in the spring. It flowered in 81-90 days. Physiological maturity occurred in 102-153 days, with a total vegetation period of 180 days. Seed set under open-pollination averaged 4.49%. When heads of *H.pumilus* were self-pollinated, they did not produce seed due to the high self-incompatibility.

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. Another elite cultivated *cms* line designated as l.1234 developed by the sunflower program at DAI was also used.

Techniques for wide hybridizing in sunflower have been described by Georgieva-Todorova (1976) and Christov (1990). Initial crosses between *H.pumilus* and *H.annuus* were made according to a full scheme, *i.e.*, including reciprocal crosses. Cytoplasmic male sterile inflorescences sterilized with gibberellic acid (0.0033%) were used in hybridization. Heads were bagged just before anthesis; the pollination was made as soon as the stigmas were exerted. The heads were then re-bagged 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 fresh pollen from cultivated plants during the flowering period of *H.pumilus*. The hybrid seeds from crosses cultivated × wild were planted in field. The seeds from the reciprocal crosses were planted under greenhouse conditions and then seedlings were planted in the experimental field. The number of inseminated disk florets (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.

After self-pollination of F_1 plants and backcrossing with pollen from cultivated sunflower, F_2 and BC_1, F_3-F_9 generations were produced.

Morphological and phenological characterization was done of the wild *H.pumilus*, cultivated inbred lines and their hybrid progenies. The observations were made on 10 plants at least, grown under 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, length/width ratio 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 technological maturity.

Statistical estimation of the experimental data included the following genetic characteristics: hypothetical and true heterosis (Omarov, 1975), heritability d/a (Gentchev *et al.*, 1971), genetic (H^2) heritability (Gentchev *et al.*, 1971), depression $D=(F_1-F_2/F_1) \times 100$ (%), transgression in degree (Tc) and frequency (Tr) (Voznesenskaya and Shpota, 1967), variation coefficient VC (Mather and Jinks, 1971), mean (x) and mean squared (x_q), the differences were compared according to the Student t_{crit} (Mather and Jinks, 1971), phenotypic (Rp) and genotypic (Rg) correlation coefficient (Snedecor, 1961). Statistical estimations were performed by Biostat, version 5.1., Statistica for Windows 95 and Microsoft Excell, version 7.0.

The evaluation of the material for downy mildew resistance (*Plasmopara helianthi* Novot.) was made under greenhouse conditions according to the standard method (Vear and Tourvieille, 1987). The evaluation of the material for broomrape resistance (*Orobanche cumana* Wallr.) was carried out under greenhouse conditions according to the standard method (Panchenko, 1975). The inoculation for Phomopsis resistance (*Phomopsis helianthi* Munt.-Cvet *et al.*) was made according to the method of Encheva and Kiryakov (2002), in an infection plot with additional irrigation. The testing was performed for 6 years. Twenty plants were tested from each progeny.

RESULTS AND DISCUSSION

The cross compatibility between *H.pumilus* as the female parent and cultivated *H.annuus* as the male parent was low (8.51%) (Table 1). When *H.pumilus* was used as the male, the compatibility was significantly higher, with 34.5%. Number of inseminated disk florets or seed set in the interspecific hybrids was very low in crosses in both directions (Table 1).

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

Hybrid combination	Inflorescence pollinated			Seeds produced		Hybrid plants	
	Polli-nated	No. with seeds		Total	Seeds set		Total seeds in % to seeds
	No.	No.	(%)	No.	(%)	No.	(%)
M-172 × *H.annuus*	47	4	8.51±0.236	14	0.61±0.411	0	0±0
H.annuus ×M-172	58	20	34.48*±0.453	204	0.39_{HP}±0.135	61e	29.90**±1.065
	t stat=2.31>t crit.=2.06, at P=0.005%			t stat=0.50<t crit.=2.00		t stat=2.86>t crit.=2.09, at P=0.001%	

A total of 14 seeds were obtained from all cross combinations *H.pumilus* M-172 × *H.annuus* and 204 from the reciprocal crosses. The percentages were 0.61 and 0.39%, respectively, and no significant difference was detected between the two types of crosses. The number of hybrid plants, presented as percent of the total number of produced seeds, gave another view on the viability and germinating ability of the hybrid seeds (Table 1). No hybrid plants could be grown from the 14 seeds in the combinations wild × cultivated. The seeds either could not germinate or the plantlets died in early stages of development. Only interspecific hybrid plants were produced from the cultivated × *H.pumilus*. Sixty-one plants were produced, which represented about 30% of the total number of 204 seeds.

The F_1 hybrids all had an annual growth habit. There was considerable variability among the progeny, with common traits including branched stems, different types of branching - basal, apical, both basal and apical and along the entire stem; anthocyanin coloration in disk florets, leaf petioles, and stems, and inflorescence with long peduncles. In some interspecific hybrids, the leaves were erect, a characteristics not typically seen in cultivated sunflower. Many of these traits are typical for the wild species parent.

Figure 2: F_1 H. annuus × H. pumilus.

Figure 3: F_1 H. annuus × H. pumilus.

Most F_1 hybrid plants sprouted on about 14-30 May. Anthesis started about 50 to 60 days after germination. Physiological maturity occurred 67 to 87 days after germination. The vegetation period of the hybrids varied between 102 and 121 days.

In order to prove the presence of considerable variability in this early F_1 generation, some statistical methods were used for the evaluation of several morphological traits: heritability (d/a), variance coefficient (VC), genetic (H^2) heritability and hypothetical and true heterosis (H_{hyp} and H_{true}). Data on F_1 hybrid combinations l.1234 × M-172 and l.HA-300 × M-172 are given in Table 2. The characteristics of the parental forms were also included.

The F_1 plants in both crosses were considerably and significantly higher than the higher parent, i.e., lines 1234 and HA-300. The investigation of heritability (d/a) showed superdominance of the cultivated parent with regard to **plant height**. This fact was also confirmed by the high values of genotypic heritability (H^2), H_{hyp} and H_{true}, proving the presence of true heterosis. The variance coefficient of plant height was very high - 71.12% in the first combination and 58.41% in the second one.

The **head diameter** in the *H.pumilus* plants proved significantly smaller (an average of 1.2 cm) in comparison with the cultivated sunflower plants. This fact had a definite influence on the forming of the inflorescence in the hybrid plants. All studied hybrid plants in both crosses had significantly smaller inflorescences than those of the cultivated parent. The heritability (d/a) was intermediate in the combination l.HA-300 × M-172, while in the first one it showed dominance of line 1234. The variation for this trait was also high - 97.5%. No heterosis was observed (Table 2).

Table 2: Genetic parameters, characterizing the initial parental forms and their F_1 progenies

Hybrid combination	P_1		P_2		F_1					
	x	VC	x	VC	x	d/a	VC	H^2	Hhyp.	Htru
					Plant height (cm)					
1234 × M-172	112.8	1.92	43.0 c	10.91	195.0 c	4.46	71.12	0.97	148.41	71.05
HA-300 × M-172	159.4	3.93	43.0 c	10.91	201.0 c	3.44	58.41	0.99	123.71	26.10
					Head diameter (cm)					
1234 × M-172	20.4	12.78	1.2 c	15.59	14.0 a	0.91	97.50	0.91	29.63	-
HA-300 × M-172	20.2	6.45	1.2 c	15.59	11.5 c	-0.11	97.47	0.93	-25.57	-
					Total number of disk florets					
1234 × M-172	1714.0	7.80	49.0 c	22.68	1806.8 -	1.11	98.96	0.88	104.97	5.41
HA-300 × M-172	1520.3	5.95	49.0 b	22.68	1240.8 -	0.62	106.77	0.71	58.13	-
					Number of inseminated disk florets/seed set/					
1234 × M-172	1171.3	4.62	2.2 c	87.43	448.2 -	-0.12	165.59	0.46	-23.61	-
HA-300 × M-172	837.0	16.21	2.2 c	87.43	159.7 c	-0.62	179.95	0.82	-61.94	-

The analysis of the results for the **number of disk florets** showed a high variation (99 - 107%) in the progenies of every studied combination. Cases of partial to complete dominance of the cultivated parent prevailed. The number of disk florets in the F_1 plants from the combination l.1234 × M-172 averaged to 1807, compared with the cultivated parent (1714), confirming the presence of a slight heterosis effect (5.4%).

The variation in number of **inseminated disk florets (seed set)** of the F_1 plants was highest (166-180%), as compared with the other three studied traits (Table 2). The values of wide-sense heritability (H^2) were comparatively low (0.46-0.82), which demonstrated the distance between the two parents. The barriers of incompatibility were difficult to overcome and these results were also confirmed by the values of heritability (d/a) and H^2 of this trait. The number of inseminated disk florets was intermediate between that of the wild and cultivated parents and no heterosis was detected in the plants.

Some F_1 hybrids obtained from the cultivated *cms* × *H.pumilus* were fertile, while others were sterile. The perennial 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 indicated that gene(s) for fertility restoration of the *cms* PET-1 cytoplasm were present in the original wild perennial population. F_1, F_2, and F_3 progenies of *H.pumilus* had fertility restoration varying from 40 to 100%.

The self-compatibility of the F_1 plants varied from 0% to 40.2%. Seeds of different colors were observed - gray, brown, particolored, black with or without stripes. Seed length was usually 0.7-0.8 cm, width 0.3-0.4 cm, and seed thickness 0.2 cm.

A high level of segregation was observed for several traits in the F_2 and BC_1F_1 progenies. Short and tall plants were obtained with varying head diameter, branching type, coloration of stem, petiole, disk florets, and seed color. Some plants inherited predominantly wild traits such as long peduncles, anthocyanin coloration of disk florets, seed shattering, and strongly pubescent plants.

Anthesis of the F_2 progenies began as early as 41 to 44 days after germination, similar to a corresponding early flowering in *H.pumilus*. Insemination (seed set) in the F_2 generation varied from 2.4 to 64.7%, depending on the combination. This trait had a very high variance coefficient (98.09 to 112.57%). There was a significant trait depression for plant height (13.08***) in F_2 progenies (Table 3).

Table 3: Variation, depression and transgression in some traits in F_2 plants

Hybrid combination	VC	Depression		Transgression					
		%	t	In degree			In frequency		
				min.	max.	total	min.	max.	total
Plant height (cm)									
1234 × M-172	13.23	-5.64	0.66	-	81.25	81.25	-	100.00	100.00
HA-300 × M-172	14.67	13.08	4.31***	-	28.36	28.36	-	80.95	80.95
Head diameter (cm)									
1234 × M-172	14.85	1.43	0.06	-	-	-	-	-	-
HA-300 × M-172	35.89	-43.48	2.31*	-	1.01	1.01	-	4.76	4.76
Total number of disk florets									
1234 × M-172	49.19	-58.04	1.43	-	64.54	64.54	-	100.00	100.00
HA-300 × M-172	14.63	-101.56	3.71**	-	141.43	141.43	-	85.71	85.71
Number of inseminated disk florets/seed set/									
1234 × M-172	98.09	-187.40	1.20	-	100.03	100.03	-	50.00	50.00
HA-300 × M-172	112.57	-331.00	1.16	-	87.10	87.10	-	33.33	33.33

Trait transgression was observed in F_2 progenies for plant height, head diameter, number of disk florets and insemination (seed set). The data in Table 3 indicates a high transgression in both degree and frequency. All transgressive traits in the F_2 progenies of *H.pumilus* were positive. The lack of depression with regard to head diameter, number of disk florets and seed set was confirmed also by the absence of negative transgressive forms for these traits. Sunflower breeding programs are interested in improving seed set and number of florets. Both traits had high positive transgressive values (64.5-141.4%). The fact that plants overcome the distance between the species as early as in F_2 generation and the fertility and insemination of these plants considerably increase, is of great importance for breeding. The wild species *H.pumilus* possesses a small number of disk florets and low self-compatibility, but the interspecific hybrids of the species overcome these negative characters in F_2 generation, which shortens the breeding process and leads to faster cultivation of the hybrid material. Hybrid progenies showed transgression for two, three, and four traits simultaneously.

Table 4: Phenotypic and genotypic (above the diagonal) correlations between traits in F_3 generation of cross combination l.1234 × *H.pumilus* (M-172)

	Plant height	Head diameter	Head thickness	Number of bract leaves	Number of ray florets	Ratio length to width of leaves	Length of leaf petiole	Length of longest branch
	1	2	3	4	5	6	7	8
				F_3 l.1234 × *H.pumilus* (M-172)				
1		0.202	0.212	0.239	-	-0.127	0.235	0.237
2	0.52		0.145	0.050	-	**-0.349***	-0.007	**0.940*****
3	0.33	0.46		0.243	-	-0.040	0.196	0.190
4	0.43	**0.96***	0.33		-	-0.090	0.229	0.219
5	-	-	-	-		-	-	-
6	0.16	0.68	0.87	0.54	-		-0.168	-0.177
7	0.80	0.59	0.79	0.41	-	0.67		0.246
8	-0.19	**-0.94***	-0.43	**-0.92***	-	-0.74	-0.38	

Phenotypic and genotypic correlations between different morphological traits were studied in F_2 and F_3 progenies of *H.pumilus*. Table 4 presents the results for an F_3 combination, l.1234 × *H.pumilus* (M-172). A negative phenotypic correlation was observed between head diameter and length of longest branches (r=-0.94*). The genotypic correlation for these traits was highly significant and positive (r=0.94***). The phenotypic correlation between head diameter and number of bract leaves was positive (r=0.96*), while the correlation between number of bract leaves and length of longest branch was negative (r=-0.92*). Another significant negative genotypic correlation was found between head diameter and length/width ratio of leaves. These results allow to conclude that head diameter correlates with traits like number of bract leaves (+), length/width ratio of leaves (-) and length of longest branches (-), while the last trait correlates with number of bract leaves and head diameter. A triple phenotypic correlation was determined between these three characters in sunflower and one of them was confirmed on the genetic level as well.

Phytopatological studies were performed on the parental forms and interspecific progenies in different generations for their resistance to various sunflower pathogens and parasites. No susceptibility to mildew, phomopsis or broomrape was registered on the *H.pumilus* plants maintained in the collection of DAI. All tested inbred sunflower lines were found to be susceptible to the mentioned pathogens. Various results were obtained for the hybrid progenies. Second and third hybrid generation plants were produced after a process of selection, performed in the F_1 generation according to different traits, one of which was resistance to diseases (where enough seeds were available). Therefore, the resistant F_1 plants gave resistant F_2 or F_3 plants, demonstrating that dominant gene(s), controlling these resistances, were retained in the next hybrid progeny. The backcross progenies were tested in BC_1F_1 at the earliest. Some of the results are reported in Table 5.

Table 5: Resistance of hybrid material to *Plasmopara helianthi*, *Orobanche cumana*, *Phomopsis helianthi*, *Phoma macdonaldii*

Hybrid combination	Generation		Resistance (%)		
			Pl. helianthi	*O. cumana*	*Ph. helianthi*
HA-300A × M-172	F_2	736/96	-	-	100
HA-300A × M-172	F_3	1033/97	32.5	0	-
(1234A × M-172) × 1234	BC_1F_1	1423/97	77.8	0	-
HA-300A × M-172	F_3	1035/97	0	70	-
1234A × M-172	F_3	1324/97	-	-	100
(1234A × M-172) × 1234	BC_1F_2	2136/98	95	-	-
(1234A × M-172) × 1234	BC_1F_4	700/01	86.5	-	-
(1234A × M-172) × 1234	BC_1F_5	735/02	100	0	-
(HA-300B × M-172) × HA-300	BC_1F_5	731/02	75	0	-

Figure 4: BC_1F_4 (l.1234 × M-172) × 1234.

F_2 plants from the combination l.HA-300 × M-172 and F_3 plants from l.1234 × M-172 were tested for susceptibility to phomopsis in infection plot under inoculation and were found to be resistant. Different progenies of the combination l.HA-300 × M-172 were studied for their reaction to mildew and broomrape too, and some of them demonstrated partial resistance to mildew (32.5%), others - to broomrape (70%). Plants in BC_1F_1 (1234 × M-172) × 1234 showed 77.8% resistance to *Plasmopara helianthi*. After self-pollination and selection, plants with 95% resistance were obtained in the next year. In the BC_1F_5 generation, progenies with 100% resistance to mildew were already produced. These results support the opinion, based also on an investigation of other interspecific hybrids from different wild

Helianthus species, that a partial resistance to a pathogen could be successfully increased to 100% by means of a very careful study in every progeny after selfing and a precise selection for trait resistance.

CONCLUSIONS

Successful interspecific hybridization was carried out between the wild perennial diploid species *Helianthus pumilus* and cultivated *H.annuus*. The cross compatibility between *H.pumilus* and *H.annuus* was much higher when the wild species was used as the male parent in the crosses. Insemination (seed set) was very low in both directions. A high level of variation was observed in F_1 progenies for plant height, head diameter, total number of disk florets and seed set. Heterosis was detected for plant height. Cases of partial to complete dominance of the cultivated parent prevailed. A high level of segregation for several traits was observed in F_2 generations as well as positive transgressive forms for plant height, head diameter, number of florets and seed set. A triple phenotypic correlation was established between three characters in sunflower and one of them was confirmed on the genetic level as well. Resistance to *Plasmopara helianthi*, *Orobanche cumana* and *Phomopsis helianthi* was discovered in different progenies of the interspecific hybrids of *H.pumilus*.

REFERENCES

Christov, M., 1990. Prouchvane na divi vidove ot rod *Helianthus* s ogled izpolzvaneto im v selekciata na slanchogleda.- Disertacia za prisagdane na nauchnata stepen "Kandidat na selskostopanskite nauki", Sofia, Bulgaria

Encheva, V. and I. Kiryakov, 2002. A method for evaluation of sunflower resistance to *Diaporthe/ Phomopsis helianthi* Munt.-Cvet *et al.*- Bulgarian Journal of Agricultural Science, 8(2002): 219-222

Gentchev, G., E. Marinkov, V. Jontcheva and A. Ognianova, 1975. Biometrichni metodi v rastenievadstvoto, genetikata I selektciata.- Zemizdat, Sofia, pp. 322

Georgieva-Todorova, J., 1976. Me_duvidovi otnoshenia v roda *Helianthus* L. Sofia, Bulgaria.

Jan, C.C. 1997**.** Cytology and interspecific hybridization. *In:* A.A. Schneiter *et al.* (eds.) Sunflower Technology and Production. Agron. Monogr. 35, ASA, CSSA, and SSSA, Madison, WI., pp. 497-558

Krauter, R., Steimetz, A., and Friedt, W. 1991. Efficient interspecific hybridization in the genus *Helianthus via* “embryo rescue” and characterization of the hybrids. Theor. Appl. Genet. 82: 521-525

Laferriere, J.E. 1986. Interspecific hybridization in sunflowers: An illustration of the importance of wild genetic resources in plant breeding. Outlook Agric. 15(3); 104-109

Mather, K. and J. L. Jinks, 1971. Biometrical Genetics. Chapman Hall, London

Omarov, D.S., 1975. K metodike uchota i otsenki geterozisa u rastenii.- Selskohoziajstvennaja Biologia 10(1): 123-127

Pantchenko, A.Ja., 1975. Vestnik selskohoziajstvennoi nauky, No. 2

Schilling, E.E. and Heiser, C.B. 1981. Infrageneric classification of *Helianthus* (*Compositae*). Taxon. 30: 393-403

Seiler, G.J. and Rieseberg, L.H. 1997. Systematics, origin, and germplasm resources of the wild and domesticated sunflower. *In*: A.A. Schneiter *et al.* (eds.) Sunflower Technology and Production. Agron. Monogr. 35, ASA, CSSA, and SSSA, Madison, WI., pp. 21-65

Snedekor, D.U., 1961. Statisticheskie metodi v primenenia k issledovaniam v selskom hoziajstve I biologii.- Moskva, Selhozgiz.
Tatum, L.A. 1971. The southern corn leaf blight epidemic. Science 171: 1113-1117.
Vear, F. and D. Tourvieille, 1987. Test de resistance au Mildiou chez le tournesol. CETIOM. Information techniques 98: 19-20
Voskresenskaja, T.S. and V.I. Shpota, 1967. Transgresia priznakov u gibridov *Brasicae* I metodika kolichestvenogo otcheta.- Dokladi VASHNILL, No. 7, pp. 18-20
Whelan, E.D.P. 1978. Cytology and interspecific hybridization. *In:* J.F. Carter *et al.* (eds.) Sunflower Science and Technology. Agron. Monogr. 19. ASA, CSSA, and SSSA, Madison, WI., pp. 339-370

LA HIBRIDIZACIÓN DE INTERSPECIES ENTRE *H. pumilus* NUTT. Y *H. annuus* L. Y SU POTENCIAL PARA EL ADELANTO DE GIRASOL

RESUMEN

Se realizó una hibridización de interspecies exitosa, entre la especie diplóide perenne silvestre de *Helianthus pumilus* Nutt., designada como GT-M-172, y el girasol cultivado *H. annuus* L. La compatibilidad entre *H.pumilus* y *H. annuus* en el cruzamiento era mucho más alta cuando la especie silvestre fue utilizada como el componente masculino en el cruzamiento. La germinación de la semilla era muy baja en ambos casos. Para probar la presencia de la significante variabilidad en la temprana generación F_1, fueron utilizados algunos métodos estadísticos y las características morfológicas, como la altura de la planta, el diámetro del capítulo, el número de flores acampanadas y la germinación. La heterosis fue determinada para la altura de la planta. Dominaron los casos de dominación parcial hasta completa del progenitor cultivado. El alto nivel de segregación fue notado en las generaciones de F_2. Ello causó la presentación de la depresión y de trasgresión en la altura de la planta, el diámetro del capítulo, número de flores y germinación. La correlación fenotípica triple se presentó entre tres características de girasol, y una de ellas fue confirmada en el nivel genético, también. La resistencia a *Plasmopara helianthi*, *Orobanche cumana* y *Phomopsis helianthi*, fue determinada en diferentes descendencias de las interespecies de híbridos con la especie *H. pumilus*.

HYBRIDATION INTERSPÉCIFIQUE ENTRE *H. pumilus* *NUTT*. ET *H. annuus* L. ET LEUR POTENTIEL DANS L'AMÉLIORATION DU TOURNESOL CULTIVÉ

RÉSUMÉ

Une hybridation interspécifique a été effectuée avec succès entre l'espèce sauvage vivace diploïde *Helianthus pumilus* Nutt., marquée comme GT-M-172 et le tournesol cultivé *H. annuus* L. La compatibilité entre *H. pumilus* et *H. annuus* au cours du croisement était de loin supérieure quand l'espèce sauvage était utilisée comme composante mâle dans le croisement. L'insémination était très faible dans les deux cas. Pour montrer la présence de variabilité importante dans la génération précoce F_1, certaines méthodes statistiques et des paramètres morphologiques ont été utilisées comme la hauteur de la plante, le diamètre de la tête, le nombre de fleurs tubulaires et l'insémination. L'hétérosis a été établi pour la hauteur de la plante. Des cas de dominance partielle à dominance complète du parent cultivé ont prévalu. Un niveau de ségrégation a été observé dans les générations F_2 de sorte que des cas de dépression et de transgression sont apparus dans la hauteur de la tête, le diamètre de la tête, le nombre de fleurs et les germes. Une corrélation phénotypique triple est apparue entre trois caractéristiques de tournesol et l'une d'entre elles a aussi été confirmée au niveau génétique. La résistance à *Plasmopara helianthi*, *Orobanche cumana* et *Phomopsis helianthi* a été confirmée dans différents descendants des hybrides interspécifiques de *H. pumilus*.