Genetic structure of two sunflower populations

Maria Regina Gonçalves Ungaro (1,2) & José Branco de Miranda Filho (3)

(1) Seção de Oleaginosas, IAC, Cx.Postal 28, 13001-970, Campinas, SP, Brazil
(2) With research grants from National Research Council, CNPq.
(3) Instituto de Genética, ESALQ/USP, Cx.Postal 26, Piracicaba, SP, Brazil

SUMMARY

The work included the evaluation of two sunflower population (A and B) after the second and third cycle of intrapopulational recurrent selection based on half-sib families. The following traits were studied: FL- days to 50% flowering; PH- plant heigh; HD- head diameter; Y- yield in g/plant; Ah- resistance level to *Alternaria* disease; OL- oil content.

The highest heritability coefficients were obtained for days to 50% flowering (A= 78.96 and 91.94; B= 72.95 and 83.85) and for plant height(A= 48.64 and 74.23; B= 56.54 and 72.35, respectively for second and third selection cycle) wich also presented the highest b value, thus indicating a very good chance for selection effectiveness. The additive genetic variance found for A and B were, respectively: FL= 25.59 and 12.98; PH= 265.12 and 178.53; HD= 32.88 and 34.59; Y= 53.24 and 67.20; Ah= 0.017 and 0.012 for the second cycle. For the third cycle the values were: FL= 26.20 and 12.01; PH= 395.78 and 392.96; HD= 2.93 and 3.86; Y= 359.25 and 336.99; Ah= 0.052 and 0.035.

Key words: sunflower, recurrent selection, heritability.

INTRODUCTION

The genetic base of quantitative traits in sunflower populations, as in many other species, must be known in order to maximize the effectiveness of selection. SINGH et al. (1977) studied eight traits in 18 open-pollinated varieties and found that yield and plant height showed the higher variability among populations, with genotypic coefficient of variation of 19.4% and 10.7%, respectively. FICK (1978) concluded that the genetic variability for grain yield is very high in sunflower. Nevertheless, as a complex trait, grain yield is highly affected by environmental factors so that its heritability is low in general, eventhough heritability coefficients as high as $h^2 = 0.57$ has been reported (PATHAK ,1974).

VARSHNEY & SINGH (1978) also reported on high genetic coefficient of variation for yield (15.0%) and plant height (12,9%) among 32 open-pollinated sunflower populations. However, the genetic variability for head diameter was relatively low among populations.

MOUTOUS & ROATH (1985) concluded that nonadditive genetic effects is an important source of variation for plant height, as indicated by the high heterosis in F_1 crosses. MILLER et al. (1940) estimated that 50.0% of the total variation was explained by oil content in a multivariate analysis, indicating the high heritability of the trait, largely based on additive effects, although dominance for high oil has been reported (FICK, 1975).

The effectiveness of recurrent selection based on half-sib families was reported by ORTEGON & SCOBEDO (1985) for grain yield and oil content in three populations, and by ESCOBEDO et al. (1988) for grain yield, after three cycles in four populations.

Induced mutations in sunflower has been of restricted use, and altough some succesfull results have been reported, as the increase in seed weight (SAVIN & STEPANENKO, 1988) , oil content (CUETKOVA , 1970; SAADAT et al., 1974) and higher resistance to rust (LOFGREN & RAMARAGE URS, 1982). In Brasil, SILVEIRA (1988) observed a higher variability in a subpopulation submitted to gamma ray irradiation, as compared with the control subpopulation.

MATERIAL and METHODS

Two samples (subpopulations A and B) were taken from the French germplasm named PIGB, a population characterized by intermediate plant height, early flowering, high variability for head diameter and plant cycle, with small and black akenes. The subpopulation A was recombined in an open-polinated isolated block, from wich half-sib families were obtained. The seeds of the subpopulation B were irradiated (18kr gamma rays) and submerged in water before planting in isolated block, from wich half-sib families were obtained. Results of the first cycle of recurrent selection based on half-sib progenies were reported by SILVEIRA (1988) for both subpopulations A and B.

In 2nd and 3rd cycles of recurrent selection, 100 half-sib families from subpopulations A and B were used. The comercial hybrid DK-180 (intermediate cycle, tall plants and high yield) was used as check. The half-sib families were evaluated in 1991 (2nd cycle) and 1994 (3rd cycle) in 10 x 10 triple lattice experiments, using row plots 4m long and spaced 1m between rows and 0.25m between plants within rows. The following traits were analysed: days to flowering, plant height, head diameter, grain yield, oil content and resistance to *Alternaria* sp.

RESULTS and DISCUSSION

The means of six traits shown in Table I for half-sib families in two cycles of selection indicate little higher values for subpopulation B (irradiated) as compared with subpopulation A (control). In fact, the contrast B vs A, in percent of A, in cycles II and III represents, respectively, 11.8% and 5.0% for grain yield, 0.2% and 2.6% for plant height, 4.4% and 4.7% for head diameter, 7.1% and 11.5% for *Alternaria* notes and 1.0% and 11.0% for days to flowering; the oil conten in subpopulation B decreased 3.1% in relation to A in cycle II. From Table I, the effectiveness of selection from cycle II to cycle III is also evident, particularly for grain yield and head diameter, with realized gain of 38.2% and 16.8% in A and 36.0% and 17.8% in subpopulation B, respectively, in relation to check.

The estimates of coefficient of variation (CV) (Table II) were between 20% and 30% for the two subpopulation in the two years. The lowest CV estimate were for days to flowering. The genetic coefficient of variation (Cvg%) were fairly high for yield, varying from 13.8% to 14.9% (Table II); lower estimates (Cvg% < 7.0) were found for the other traits. The coefficient of heritability on progeny mean basis (h^2_m) varied from 25.2% to 91.9% among traits and subpopulations, sowing good perspectives for recurrent selection within population. ORTEGON & SCOBEDO (1988) also reported a high estimates for heritability in several traits.

The estimates of the additive genetic variances (Table II) were higher in subpopulation B for days to flowering and plant height in both years. For yield, the estimates were apparently equivalent in both years, although the expression of the additive variance were much higher in 1994. In general, there were no evidence of higher variability in the irradiated subpopulation (B), as compared to the control (SILVEIRA, 1988).

The ratio b= Cvg/ Cve showed higher estimates for days to flowering (b> 1) and plant height (0.56< b >0.98) indicating more effective selection for those traits.

The relative yield for both subpopulations and high expression of genetic variability for most of the traits suggest that recurrent selection can be effectively accomplished in both subpopulations.

BIBLIOGRAPHY

CUETKOVA, F. Initial material for breeding by gamma and X irradiation. **Genetics and Plant Breeding**, Sofia, 3: 231-237, 1970.

ESCOBEDO, M.A.; MOLINA GALÁN, J.D.; ORTEGÓN MORALES, A.S. & BUCIO ALANÍS, L. Respuesta a la selección de progenies S1 y familias de medios hermanos en girasol (*Helianthus annuus* L.). (In: ESCOBEDO, A & ORTEGÓN, A. Respuesta de cuatro variedades de girasol (*Helianthus annuus* L.) a la selección recurrente. INTERNATIONAL SUNFLOWER CONFERENCE, 12, Novi Sad, 1988. **Proceedings**, p. 472-477

FICK, G.N. Heritability of oil content in sunflowers. **Crop Science**, Madison, **15**:77-78, 1975.

FICK, G.N. Breeding and Genetics (In: CARTER, J.F. **Sunflower Science and Technology**. American Society of Agronomy, 1978. Madison, USA, p.279-338

LOFGREN, J.R. & RAMARAGE URS, N.V. Chemically induced mutation in sunflower. INTERNATIONAL SUNFLOWER CONFERENCE, **10**, Surfers Paradise, 1982. **Proceedings**. p.264-268.

MILLER, J.F.; HAMMOND, J.J. & ROATH, W.W. Comparison of inbred vs. single-cross testers and estimation of genetic effects in sunflower. **Crop Science**, Madison, **20**: 703-706, 1980.

MOUTOUS, J.E. & ROATH, W.W. Genetica de altura de planta en girasol (*Helianthus annuus* L.) INTERNATIONAL SUNFLOWER CONFERENCE, 11, Mar del Plata, 1985, **Proceedings**, p. 633-638.

ORTEGÓN, M.A.S. & ESCOBEDO, M.A. Formacción de cuatro variedades de girasol de polinización libre. INTERNATIONAL SUNFLOWER CONFERENCE, 11, Mar del Plata, 1985. Proceedings, p. 761-765

PATHAK, R.S. Yield components in sunflower. University of Nairobi. Department of applied Plant Science, Nairobi, Kenia, p.271-281, 1974.

SAVIN, V.N. & STEPANENKO, O.G. Action of gamma rays from 60Co on sunflower. (In: FERNANDEZ MARTINEZ, J. & DOMINGUEZ GIMENEZ, J. Development of sunflower parental lines after EMS treatments of an inbred line. INTERNATIONAL SUNFLOWER CONFERENCE, **11**, Novi Sad, 1988. **Proceedings**, p. 415-418.

SILVEIRA, J.M. Seleção recorrente intrapopulacional em girassol (*Helianthus annuus* L.) Piracicaba, 1988. 93p. (Mestrado- Escola Superior de Agricultura "Luiz de Queiroz"/ USP.

SINGH, B.; SACHAN, J.N. & SINGH, D. Variability and correlations in sunflower (*Helianthus annuus* L.). **Pantnagar Journal of Research**, New Delhi, 2(1): 27-30, 1977.

VARSHNEY , S.K. & SINGH, B. Correlation and path coefficient analysis in sunflower. **Pantnagar Journal of Research**, New Delhi, 2(2): 147-149, 197

Table I- Mean results obtained for subpopulations A and B and for check , in the 2nd and 3rd cycles of recurrent selection.

Popul.	Year	yield g/plant	plant height	head diameter	oil content	*Alternaria* notes #	*50%* flowering
A	1991	26.55	121.99	15.35	42.50	2.69	59.8
B		29.67	122.25	16.02	41.18	2.88	60.4
T		44.53	137.49	18.61	44.53	2.34	75.9
A	1994	58.95	143.41	20.23		1.57	55.7
B		61.88	147.10	21.19		1.75	61.8
T		60.30	189.20	20.40	45.00	2.00	72.0

Notes: 0 (resistant) to 5 (susceptible)

Table II- Mean estimates of genetic coefficient of variation (Cvg%), environmental coefficient of variation (Cve%), ratio b (CVg%/CVe%), the coefficient of heritability (h^2_m), progenie, aditive and phenotypic variance (σ^2_p, σ^2_A, σ^2_F) for the analysed traits in the two selection cycles.

Popul.	Year	Cve%	Cvg%	b	h^2_m	σ^2_p	σ^2_A	σ^2_F
Days to 50% flowering								
A	1991	3.99	4.18	1.02	76.64	6.40	25.59	8.35
B		3.14	2.98	0.95	72.95	3.24	12.98	4.45
A	1994	2.35	4.60	1.96	91.94	6.55	26.20	7.12
B		2.13	2.80	1.31	83.85	3.00	12.01	3.58
Yield (g/plant)								
A	1991	29.18	13.74	0.47	39.96	13.31	53.24	33.31
B		27.28	13.81	0.51	43.48	16.80	67.20	38.64
A	1994	20.27	16.09	0.79	65.38	89.81	359.25	137.30
B		20.33	14.86	0.73	61.57	84.25	336.99	136.82
Plant height								
A	1991	11.88	6.67	0.56	48.64	66.28	256.12	136.27
B		8.29	5.46	0.66	56.54	44.63	178.70	78.94
A	1994	7.08	6.94	0.98	74.23	98.94	395.78	133.29
B		7.22	6.75	0.92	72.35	98.24	392.96	135.78
Head diameter								
A	1991	13.44	5.91	0.44	36.71	8.22	32.88	2.24
B		13.81	5.80	0.42	34.63	8.65	34.60	2.49
A	1994	7.82	4.23	0.54	46.65	0.73	2.93	1.57
B		7.97	4.64	0.58	50.39	0.99	3.86	1.91
***Alternaria* infection**								
A	1991	9.46	3.35	0.35	27.37	4.2(c)	16.8(c)	15.2(c)
B		8.11	2.73	0.34	25.22	2.9(c)	11.6(c)	11.5(c)
A	1994	10.10	7.28	0.72	61.54	13.0(c)	52.0(c)	22.0(c)
B		10.04	5.32	0.53	45.73	8.7(c)	35.0(c)	19.0(c)