INHERITANCE OF SELF-FERTILITY IN SUNFLOWER

Gabriela SOARE and Alexandru Viorel VRÂNCEANU
Research Institute for Cereals and Industrial Crops,
Fundulea 8264 - Călărași (Romania)

Abstract

Studies have been carried out in 1991-1993, using 17B and Rf inbred lines (LC) and 200 experimental hybrids representing the F_1, F_2, BC_1 and BC_2 populations obtained from the crossing of the 17 LC. The degree of self-fertility was investigated in lines and their crosses, and correlations between the degree of self-fertility in the lines and F_1 hybrids, were calculated. The total variance and its components were also calculated, together with gene action types and the number of the gene pairs involved in the genetic control of sunflower self-fertility. As a result of this study, it was demonstrated that between the degree of self-fertility of the lines and their hybrids was a positive and significant correlation. In the F_1, a dominance effect for self-fertility was determined.
Additivity and nonallelic gene effects were also proven. Heritability of this character was moderate (h_n^2 = 0.11-0.67) and the number of gene pairs involved in genetic control of self-fertility was 5-12.

Key words: sunflower, self-fertility, heritability.

Introduction

The self-fertility of sunflower lines as well as hybrids is one of the most important traits in breeding programmes. It is a decisive factor for yield, especially under less favourable weather conditions, during flowering and in areas where the number of pollinators is reduced.
Several papers identified the importance of the subject. According to **Vrânceanu et al., (1978)** the genetic influence on self-fertility is complex and environmental factors have a large share in its expression. **(Fick 1978)** reported a high level of variability among sunflower lines from completely self-fertile to zero self-fertility. **Segala et al., (1980),** using the regression between parental forms and hybrids, found a low heritability for this trait (0.26). **Burlov and Krutko (1986)** found basic differences in inheritance of the expression of self-fertility by autogamy and geitonogamy. **Skaloud and Kovacik (1994)** showed that a hybrid obtained from

the cross of self-fertile lines was generally more self-fertile than the parental forms.

The object of this study was to establish the relationship between self-fertility of lines and their crosses, and to clarify some aspects concerning the genetic control of this trait.

Materials and methods

For this study, 17 inbred lines possessing different degrees of self-fertility were used. From the crosses of 17 inbred lines, 200 hybrid populations F_1, F_2, BC_1 and BC_2 resulted.

Together with the parents, the hybrid populations F_1, F_2, BC_1 and BC_2 were studied under field conditions for two years (1992, 1993).

The design of the experiment utilized the randomized block with three replications.

The degree of self-fertility was determinated over 15 sunflower heads / variant.

The type of gene action has been calculated by the method proposed by **Gamble (1962).**

Total, genotypic and environmental variances have been calculated using the formula proposed by **Brewbacker (1964).**

The heredity coefficient in the wide sense has been calculated using the formula proposed by **Mahmud and Kramer (1951).**

The determination of the estimated number of gene pairs involved in the genetic control of self-fertility has been estimated using the formula proposed by **Weber (1950).**

Results, discussions and conclusions

In practice the level of hybrid self-fertility is highly dependant on the self-fertility of the inbred lines. The results, with their positive and significant correlation, $r = 0.54$ (Figure 1), emphasise that to obtain a hybrid with high degree of self-fertility, it is necessary to increase the selection pressure on the inbred lines for this character.

The inbred lines used for genetic study of self-fertility in sunflower were significantly different in this respect (Table 1). Based on mean differences, according the Duncan test, the lines were classified into three groups: self-fertile (SF) - RHA-270, V-1304, T-66-8712, SVM-8791, medium self-fertile (MSF) - ISS-14699, MD-4634, ND-1416, and self-sterile - O-7657, V-3281, SP-4559 (Table 2). The hybrids from diallel crosses have shown the presence of dominance for self-fertility.

Figure 1

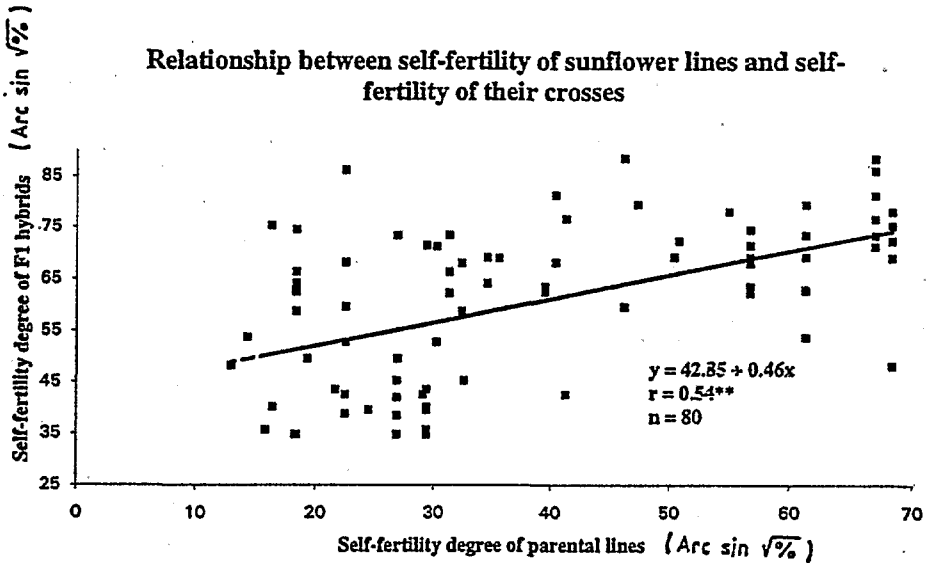

Table 1

Self-fertility degree of B and Rf sunflower lines used in genetic study of self-fertility (Fundulea - 1992-1993)

Source of variation		Degrees of freedom	Sum of square	Mean square	Observed F	Tabular F	
						5%	1%
Lines	(A)	16	14,916	932.30	316.2***	1.97	2.62
Error	(A)	32	94	2.94			
Years	(B)	1	43	43.23	6.64*	4.13	7.44
Lines x Years	(A x B)	16	9,643	602.71	92.66***	1.95	2.58
Error	(B)	34	221	6.50			

Table 2

Self-fertility degree of B and Rf sunflower lines (significations according *DUNCAN test*)
1992-1993

RHA 270	V 1304	T-66-8712	SVM 8791	O 7493	ISS-14699	MD 4634	A 1566	ND-1416	V 1633	OS-13338	H 73-6874	S-1358	O-7657	O-7869	V 3281	SP 4559	*Std. int* (DUN CAN) 5 %	*Std.* int Sx (Sx= 0.98)
64.8	61.8	52.7	48.9	42.8	37.9	35.8	33.4	31.3	28.5	28.1	25.4	20.4	17.8	17.3	17.0	13.6		
	3.0	12.1	15.9	22.0	26.9	29.0	31.4	33.5	36.3	36.7	39.4	44.4	47.0	47.5	47.8	51.2	2.89	2.83
		9.1	12.9	19.0	23.9	26.0	28.4	30.5	33.3	33.7	36.4	41.4	44.0	44.5	44.8	48.2	2.89	2.83
			3.8	9.9	14.8	16.9	19.3	21.4	24.2	24.6	27.3	32.3	34.9	35.4	35.7	39.1	2.97	2.91
				6.1	11.0	13.1	15.5	17.6	20.4	20.8	23.5	28.5	31.1	31.6	31.9	35.3	3.03	2.96
					4.9	7.0	9.4	11.5	14.3	14.7	17.4	22.4	25.0	25.5	25.8	29.2	3.2	3.14
						2.1	4.5	6.6	9.4	9.8	12.5	17.5	20.1	20.6	20.9	24.3	3.35	3.28
							2.4	4.5	7.3	7.7	10.4	15.4	18.0	18.5	18.8	22.2	3.56	3.49
								2.1	4.9	5.3	8.0	13.0	15.6	16.1	16.4	19.8	3.6	3.53
									2.8	3.2	5.9	10.9	13.5	14.0	14.3	17.7	3.79	3.71
										0.4	3.1	8.1	10.7	11.2	11.5	14.9	3.8	3.72
											2.7	7.7	10.5	10.8	11.1	14.5	3.8	3.72
												5.0	7.6	8.1	8.4	11.8	3.95	3.87
													2.6	3.1	3.4	6.8	4.15	4.07
														0.5	0.8	4.2	4.3	4.21
															0.3	3.7	4.45	4.36
																3.4	4.55	4.46
		SF						MSF						SS				

Whilst the overall variance was large, the genetic variance was clearly the most important (Table 3).

In the genetic control of self-fertility, the effects for additivity were significant (Table 4).

Effects for dominance and nonallelic interactions were also present (V-1304 x O-7493; OS-13338 x S-1358, RHA-270 x T-66-8712).

With reference to the relationship between genetic variance (Vg) and the total variance (Vp), and with the genetic variance for additivity to the genetic variance, the heritability of self-fertility was moderate (h_n^2 = 0.11-0.67)(Table 5).

Table 3

Phenotypic (Vp), genotipic (Vg) and environmental variance (Ve) for self-fertility in sunflower

CROSS	1992					1993				
	Vp	Vg	$\frac{Vg}{Vp}x100$	Ve	$\frac{Ve}{Vp}x100$	Vp	Vg	$\frac{Vg}{Vp}x100$	Ve	$\frac{Ve}{Vp}x100$
V-1304 x O-7493	17.5	8.7	50	8.8	50	16.3	8.3	51	8.0	49
V-1304 x V-3281	59.3	47.8	81	11.5	19	28.9	17.9	62	11.0	38
OS-13338 x S-1358	10.5	5.9	56	4.6	44	9.9	2.8	28	7.1	72
RHA-270 x T-66-8712	21.7	7.4	34	14.2	66	16.7	2.4	14	14.3	86
RHA-270 x O-7869	56.8	46.8	82	10.0	18	39.9	28.6	72	11.3	28

Table 4

Genes action type involved in genetic control of sunflower self-fertility (1992-1993)

CROSS	Year	Statistic parameter	M	Genes action type				
				A	D	AA	AD	DD
V-1304 x O-7493	1992	$\bar{x}$	55.7***	15.2*	77.1**	45.2*	4.8	-23.1
		Vp	17.5	28.7	410.5	395.0	32.3	801.5
	1993	$\bar{x}$	50.2***	37.0***	31.8	16.4	28.3***	-10.1
		Vp	16.3	25.1	376.4	361.2	28.0	723.2
V-1304 x V-3281	1992	$\bar{x}$	42.8***	22.1*	54.8	39.0	2.8	47.2
		Vp	59.3	82.3	1304.7	1277.5	84.6	2374.1
	1993	$\bar{x}$	68.4***	3.7	50.4	14.6	-16.8*	-86*
		Vp	36.8	56.7	837.9	815.5	60.2	1509.7
OS-13338 x S-1358	1992	$\bar{x}$	34.5***	9.8*	-7.6	-21.7	7.6	32.7
		Vp	10.5	16.1	242.9	231.8	17.2	469.8
	1993	$\bar{x}$	31.5***	14.1**	44.3*	33.4*	8.6	-75.4**
		Vp	9.9	17.4	237.5	226.2	20.7	482.2
RHA-270 x T-66-8712	1992	$\bar{x}$	60.8***	-1.3	67.2*	53.8*	-6.75	-100.5**
		Vp	16.7	31.5	414.7	393.0	38.6	858.1
	1993	$\bar{x}$	65.4***	13.2*	52.6	42.0	6.6	-65.9
		Vp	21.7	36.6	517.8	493.4	42.7	1030.5
RHA-270 x O-7869	1992	$\bar{x}$	60.2***	11.1	42.0	19.0	-10.4	186.5***
		Vp	39.9	56.3	884.4	864.4	61.0	1559.2
	1993	$\bar{x}$	61.2***	28.8**	37.6	11.6	2.8	-32.6
		Vp	56.8	76.2	1230.9	1214.6	80.1	2202.0

, * = significant for P > 0.01 and P > 0.001 respectively

Table 5

Wide (h^2_W) and narrow sense (h^2_n) heredity coefficients for self-fertility of sunflower (1992-1993)

CROSS	Heredity coefficients			
	h^2_W		h^2_n	
	1992	1993	1992	1993
V-1304 x O-7493	0.50	0.51	0.36	0.46
V-1304 x V-3281	0.80	0.49	0.67	0.46
OS-13338 x S-1358	0.54	0.28	0.46	0.25
RHA-270 x T-66-8712	0.34	0.14	0.31	0.11
RHA-270 x O-7869	0.82	0.71	0.66	0.59

Table 6

Estimated number of pair genes involved in genetic control of sunflower self-fertility

CROSS	Number of gene pairs	
	1992	1993
V-1304 x O-7493	9.44	9.15
V-1304 x V-3281	8.59	11.70
OS-13338 x S-1358	5.42	7.64
RHA-270 x T-66-8712	6.54	7.12
RHA-270 x O-7869	7.94	9.31

As the results have already demonstrated, the self-fertility of sunflower is estimated as a complex phenomenon, and polygenically, inherited. The number of gene pairs involved was 5.42-11.7 (table 6).
It is clear that to obtain hybrids possessing a good level of self-fertility, the presence of higher level of self-fertilty in the cross of inbred lines is required.

References

1 - **Brewbacker, J.L., 1964** - Agricultural genetics. Printice Holl N.Y. Cap. IV.

2 - **Burlov, V.V., Krutko V.I., 1986** - Projavlenije priznata samosovmestimosti u padpasolnetnika. Nauc-techn. bjull. VSGI, No 2/60. pp 45-50.

3 - **Fick B.N., 1978** - Selection for self-fertility and oil percentage in development of sunflower hybrids, 8-th Int. Sunfl. Conf. Minneapolis, p. 418-422.

4 - **Gamble E.E., 1962** - Gene effects in corn (*Zea mays*). Separations and relative importance of gene effects for yield. Canadian Journal of Plant Science, 42, 2, pp. 339-248.

5 - **Mahmud Imam and Kramer H.H., 1951** - Segregation for high yield and maturity following a soybean cross. Agr. J. 1: 605-609.

6 - **Skaloud V., and Kovacik A., 1994** - Findings on sunflower self-fertility in connection with line hybridization. HELIA, 17, Nr. 20, pp 13-20.

7 - **Segala A., Segala M., Piquemal G., 1980** - Recherches en vue d'améliorer le degré d'autogamie des cultivars de tournesol. Ann. Amelior. Plantes, 30(2), p 151-174.

8 - **Vrânceanu A.V., Stoenescu F.M., Scarlat A., 1978** - The influence of different genetic and environmental factors on pollen selfcompatibility in sunflower. Proc. 8th. Int. Sunfl. Conf. Minneapolis, p. 453-465.

9 - **Weber C.R., 1950** - Inheritance and interrelation of some agronomic and chemical characters in an interspecific cross in soybeans Glicine max. x Glicyne ussuriensis. Iowa Agr. Sta. Res. Bull. 374: 767-816.