A CORRELATION BETWEEN SELF-FERTILITY AND THE MELLIFEROUS INDEX IN SUNFLOWER

A.V.Vranceanu, F.M.Stoenescu, and Monica Iuoraş
Research Institute for Cereal and Industrial Crops,
8264 Fundulea, Romania

Abstract

A significant negative correlation coefficient was found between self-fertility and the melliferous index, indicating that sunflower adaptation to insect pollination is associated with nectar production. A breeding strategy is discussed accordingly.

Introduction

The expansion of sunflower cultivation in regions with low frequency of pollinating insects or with unfavourable meteorological conditions for their activity as well as the intensification of chemical pest control in blooming time, have determined the development of breeding works for obtaining high self-fertile sunflower hybrids (Fick, 1978; Vranceanu et al., 1978; Roath and Miller, 1980; George et al., 1980). The selection pressure on this character has been greatly increased by selfing without artificial pollination under bag followed by discarding all self-compatible individuals.

In order to study the implications of the increased level of self-fertility on the melliferous value of sunflower, adequate investigations were conducted at the Research Institute for Cereal and Industrial Crops of Fundulea, Romania, and the first results are presented in this paper.

Materials and Methods

A set of 53 sunflower single (SH) and three-way hybrids (TH) and 3 open-pollinated varieties (OPV) representing both domestic and foreign selections was used in this study. The genotypes under study were those experimented at Fundulea in 1982 and 1983 within the FAO Research Network on Sunflower (trial no.1 with early and medium-early hybrids and trial no.2 with medium-late hybrids), and in one local competitive trial (trial no.3). The randomized block design for trials no.1 and 2 and the rectangular lattice design for trial no.3 were used, both with five replications. Four plants per plot were chosen at random and isolated with

light cotton bags with orifices of o.1-o.2 mm^2 size. No artificial pollination was carried out inside the bags.

The degree of self-fertility was defined as the ratio between the mean number of filled seeds on the bagged heads and the mean number of filled seeds on the open-pollinated heads. Arcsine transformation of data was used prior to statistical analysis.

The melliferous index was considered as the product of the nectar content and its sugar concentration. The nectar content was determined by its extraction with capillary glass tubes weighed before and after nectar extraction and sugar concentration was established by means of a portable refractometer. Ten tubular flowers in the pistillate stage (Free et al., 1976) situated in different zones of the head were analysed and the mean melliferous index of each entry was estimated on the basis of ten head determinations.

Results

Data presented in tables 1, 2 and 3 show a large variation of the present sunflower hybrids as concerns their self-fertility degree which ranged from o.3 % in the case of the Yugoslav hybrid NS-H-3 to 66.3 % for the Hungarian hybrid IH-56. The melliferous index also varied from o.14 (the Hungarian hybrid Citosol-2) to o.62 (the Romanian hybrid RO-15o). The analysis of variance (Table 4) showed that the genotypes differed greater among them for self-fertility degree than for the melliferous index. In both cases the fluctuations due to years were large and distinct significant but they didn't exceed the differences among genotypes.

The values of the genotype x year interaction indicate that the cultivars reacted significantly to each year, especially in respect of the melliferous index.

Examining the trend of variation of the two analysed traits, it is quite obvious that, as a general rule, the increase of one trait is accompanied by the decrease of the other one. After statistical interpretation, a significant negative correlation was found between the degree of self-fertility and the melliferous index, indicating that sunflower adaptation to insect pollination is associated with nectar production. The coefficients of

Table 1. FAO trial no.1 with early and medium-early sunflower cultivars (Fundulea, 1982 and 1983)

Cultivars	Genetic type	Country of origin	Nectar mg/fl/ 24 h	Sugar concentr. (%)	Melliferous index	Self-fertility degree (%)
H9/P2	TH	France	o.5o	51.6	o.26	5o.1
H9/P1	SH	"	o.72	5o.8	o.37	41.1
G-9/76	SH	Germany,F.R.	o.54	5o.o	o.27	8.8
G-19/77	SH	"	o.69	46.1	o.32	6.5
G-24/77	SH	"	o.73	47.4	o.35	9.3
Citosol-3	SH	Hungary	o.44	42.8	o.19	39.1
Koflor-1	SH	"	o.71	33.5	o.24	53.3
HNK-81	SH	"	o.8o	44.5	o.36	21.6
HNK-84	SH	"	o.92	42.4	o.39	19.5
RO-7o	SH	Romania	o.8o	4o.8	o.33	26.3
RO-59A	SH	"	1.oo	42.1	o.42	12.2
RO-25	SH	"	o.91	47.o	o.43	28.2
NS-H-4	SH	Yugoslavia	o.7o	45.8	o.32	15.4
NS-H-5	SH	"	o.8o	42.2	o.34	51.9
NS-H-3	SH	"	o.91	43.8	o.4o	o.3
Tcherneanka	OPV	U.S.S.R.	o.58	35.4	o.21	3.1
L.S.D. 5 %			o.o8	3.7	o.o5	6.2

Table 4. Analysis of variance for self-fartility and melliferous index to 56 sunflower cultivars (Fundulea, 1982 and 1983)

Source	df	Mean squares for	
		Self-fertility	Melliferous index
Replications	4	8.11	5.22
Genotypes	55	919.o3^{xx}	316.o2^{xx}
Genotypes x Replications	22o	4.88	4.33
Years	1	1o9.7o^{xx}	98.5o^{xx}
Genotypes x Years	55	48.34^{xx}	27.41^{xx}
Pooled error	33o	5.83	4.29

xx Significant at the o.o1 probability

Table 2. FAO trial no.2 with medium-late sunflower cultivars (Fundulea, 1982 and 1983)

Cultivars	Genetic type	Country of origin	Nectar mg/fl/ 24 h	Sugar concentr. %	Melli-ferous index	Self-fertility degree (%)
HB-783	SH	Bulgaria	o.67	55.6	o.37	7.8
H9/P4	TH	France	o.48	61.9	o.3o	12.4
Citosol-2	SH	Hungary	o.38	38.o	o.14	41.4
IH-56	SH	"	o.65	49.o	o.32	66.3
IH-155	SH	"	o.7o	48.6	o.34	31.8
Gahib-7	SH	"	o.78	52.8	o.42	6.3
RO-134	SH	Romania	o.53	4o.8	o.22	29.3
RO-44	SH	"	o.45	63.8	o.29	23.7
RO-131	SH	"	o.69	43.6	o.3o	58.1
RO-141	TH	"	1.11	43.8	o.49	16.1
RO-15o	SH	"	1.32	37.4	o.49	14.9
Pemir	OPV	Spain	1.19	39.4	o.47	9.7
Cargill-2o5	SH	U.S.A.	o.85	29.o	o.25	48.2
Sunbred-254	SH	"	1.o1	41.4	o.42	28.6
Seedtec-S-315	SH	"	1.o6	4o.4	o.43	45.o
Stauffer-31o1	SH	"	1.92	3o.6	o.59	57.9
Peredovik	OPV	U.S.S.R.	o.98	44.8	o.44	8.8
NS-H-42	SH	Yugoslavia	o.86	32.4	o.28	39.7
NS-H-4o	SH	"	o.81	38.6	o.31	11.2
NS-H-43	SH	"	1.o8	41.2	o.44	18.7
L.S.D. 5 %			o.11	4.2	o.o6	5.3

correlation for each of the three trials were -o,49^{xx}, -o,6o^{xx}, and -o,59^{xx} respectively. The general correlation coefficient of -o,57^{xx} for the whole set of cultivars (Table 5) is yet not very high, indicating the existence of some exceptions. Thus, there are hybrids with high self-fertility degree and high or medium melliferous index, such as Stauffer-31o1, IH-56, NS-H-5, Seedtec-S-315, Sorem-82, RO-131, RO-942, and hybrids with a low level of self-fertility and a low to medium melliferous index, as for instance G9/76, NS-H-4o, RO-134. The three open-pollinated varieties Tcherneanka, Pemir and Peredovik, used as checks in the FAO trials no.1 and 2, exhibited a very low degree of self-fertility

Table 3. Romanian competitive trial no.3 with sunflower medium-late hybrids (Fundulea, 1982 and 1983)

Hybrids	Genetic type	Nectar mg/fl/ 24 h	Sugar concentr. %	Mellife-rous index	Self-fer-tility degree (%)
RO-131	SH	o.63	37.2	o.23	57.6
RO-176	TH	o.69	42.6	o.29	58.4
RO-157	SH	o.68	43.6	o.3o	12.3
RO-68	SH	o.6o	5o.2	o.3o	16.9
RO-954	SH	o.76	42.o	o.32	34.7
RO-174	TH	o.56	42.4	o.32	18.1
RO-25	SH	o.57	58.2	o.33	22.o
RO-154	TH	o.85	4o.2	o.34	8.4
RO-177	TH	o.92	39.4	o.36	6.5
SOREM-82	SH	1.o7	36.8	o.39	46.9
RO-155	SH	o.99	39.8	o.39	7.7
RO-942	SH	o.74	53.6	o.4o	45.9
RO-29	TH	o.88	47.4	o.42	3o.3
RO-152	TH	1.oo	42.o	o.42	23.9
RO-933	SH	o.72	6o.6	o.44	5.9
RO-173	TH	1.18	37.8	o.45	2.4
RO-1o9	SH	1.19	39.8	o.47	2.4
RO-153	SH	1.31	36.4	o.48	35.5
RO-175	TH	1.38	37.4	o.52	2.7
RO-15o	SH	1.42	43.6	o.62	2.4
L.S.D. 5 %		o.1o	4.7	o.o8	6.4

Table 5. Mean values for self-fertility and melliferous index and the correlation between the two traits estimated for 56 sunflower cultivars

Traits	Mean values	L.S.D. 5 %	Correlation coefficient (r) Tr.1	Tr.2	Tr.3	Total	C.V. %
Self-fertility	24.9	6.o	-o.49^{xx}	-o.6o^{xx}	-o.59^{xx}	-o.57^{xx}	26
Melliferous index	o.36	o.o6					

xx Significant at the o.o1 probability

(3.1 - 9.7 %) and a low to medium values of the melliferous index (o.21 - o.47).

Discussion and Conclusions

The low degree of self-fertility and the abundant nectar secretion have been developed as a phylogenetic adaptation of sunflower populations to insect pollination so that the selection pressure put on high self-fertility without any concomitent selection for nectar production leads inevitably to the loss of the latter trait which will become of no use for sunflower species. From data presented in this paper, it is evident that sunflower breeding could be performed in two divergent directions, high self-fertility or high melliferous value, depending on the ecological conditions and the frequency of pollinating insects. However the possibility to develop sunflower self-fertile hybrids with good melliferous value exists and in a such direction should be oriented the modern sunflower breeding programmes.

Acknowledgements

We acknowledge with many thanks the valuable contribution of Dr. I.Balana, Elena Grosu and G.Fota from The Research Institute for Apiculture, Bucharest, in determining the nectar content and sugar concentration.

References

FICK, G.N. 1978. Selection for self-fertility and oil percentage in development of sunflower hybrids. Proceedings of the 8th International Sunflower Conference, Minneapolis, U.S.A., 418-422.

FREE, J.B. MUSSEN, E.C., NOETZEL, D.M. and ROBINSON, R.G. 1976. Observation on nectar secretion in sunflower. Proceedings of Sunflower Forum, Fargo, N.D., 1: 11-12.

GEORGE, D.L., SHEIN, S.E. and KNOWLES, P.F. 198o. Compatibility, autogamy and environmental effects on seedset in selected sunflower hybrids and their inbred parents. IX Conferencia Internacional del Girasol, Torremolinos, España, 14o-146.

ROATH, W.W. and MILLER, J.F. 108o. Environmental effects on self-fertility in oilseed sunflower. IX Conferencia Internacional del Girasol, Torremolinos, España, 134-139.

VRANCEANU, A.V., STOENESCU F.M. and SCARLAT, A. 1978. The influence of different genetic and environmental factors on pollen self-compatibility in sunflower. Proceedings of the 8th International Sunflower Conference, Minneapolis, U.S.A., 453-465.