DEPENDANCE OF SELF-FERTILITY OF INBREDS ON SOME CHEMICAL PROPERTIES OF POLLEN

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INTRODUCTION

The variance in the degree of self-fertility among sunflower genotypes depends on genetic and environmental factors (day length, precipitation, temperature, relative air humidity, etc. for the latter). Pollinizing insects, particularly the bees, play an important role in the pollination of sunflowers. A number of authors has found the correlation between pollination and environmental factors. Most recent results from this field were reported by Low et al. (1978).

The phenomenon of self-fertility gained prominence after the introduction of hybrids based on cytoplasmic male sterility. The degree of self-fertility is particularly important in regions in which pollinizers are scarce and the weather conditions during the stage of flowering are unfavorable.

A number of authors has studied the genetic control of self-fertility, i.e., self-incompatibility in sunflowers. Habura (1957) found the relationship between pollen and the pistil to be determined by two pairs of dominant alleles (S).

Vranceanu et al. (1978) the correlation between the degree of self-fertility on one side and major morpho-physiological characters of the plant and pollen on the other. They also stated that the heritability of self-fertility in F_1 and F_2 generation are controlled by different major genes as well as that it depends on the degree of heterozygosity and the type of pollination. Furthermore, they found

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the dependance of self-fertility on day length and temperature at the time of pollination.

Fernández-Martínez and Knowles (1978) found that the self-incompatibility, the phenomenon opposite to self-fertility, is controlled by five different dominant alleles (S) in various wild species of *Helianthus annuus* L.

Especially large differences in the degree of self-fertility are expressed during selfing. Fick (1978) reported of a high variability in this character among sunflower inbreds, pointing to the necessity of developing inbreds with a high degree of self-fertility in order to be able to produce high-yielding hybrids.

There are not much data on the dependance of self-fertility on the biochemical composition of sunflower pollen (nucleic and amino acids, biogenic elements). On the other hand, such data are numerous for other plant species, especially the corn (Britikov et al., 1964; Jelinic et al, 1965; Pfahler, 1965; Marsalek, 1972; etc.).

The objective of this study was to examine the composition of amino acids and biogenic elements in the pollen of sunflower inbreds with different degrees of self-fertility in order to determine eventual dependance of the level of self-fertility on the biochemical composition of pollen.

MATERIAL AND METHOD

Sunflower inbreds in S_{12} generation, of different genetic origins, were used. The inbreds differed in the degree of self-fertility, as determined in earlier studies. The experiments in 1979 included: A-9343-11, Pr-17, A-3497-47, and V-1640-23. One hundred plants of each line were grown in isolation. At the stage of full flowering, pollen was gathered from 20 plants per inbred, in two turns, for chemical analyses. The remaining 80 plants per inbred, divided into four replications of 20 plants, were selfed. After the maturation, filled and empty seeds were counted to determine the percentage of self-fertility. Amino acid composition in pollen was determined after Moore and Stein (1951), on a Biocal amino-analyser, model BC-20. Nitrogen content was determined by the method of Kjeldahl, phosphorus by spectrophotometry, potassium by flamephotometry, and calcium, magnesium, iron, manganese, zinc, and copper by atomic absorption spectrophotometry.

The obtained values were calculated statistically.

RESULTS AND DISCUSSION

The examined inbreds differed in the degree of self-fertility. A-3497-47 had the smallest number of fertile seeds per head, i.e., the lowest percentage of self-fertility —only 2.7%. V-1640-23 had the largest degree of self-fertility —38.4%, i.e., the average number of fertile seeds was 29. The remaining two inbreds had intermediate values. The obtained results show that the highest average had the inbred which had the largest difference between the maximum and minimum number of fertile seeds per head, but a small number of heads with a low percentage of self-fertility (Table 1).

The examined inbreds differed both in the contents of individual amino acids and in their total content. V-1640-23, which had the highest percentage of self-fertility, also had significantly higher contents of lysine, glutamic acid, leucine, isoleucine and phenylalanine than the other inbreds. The pollen of V-1640-23 had increased contents of other amino acids, too. Besides, this inbred had the highest total amino acid content. The amino acid contents in the pollen of the other inbreds did not follow any regularities which might give indications on the degree of self-fertility.

It was evident that V-1640-23 had increased contents of some macro- and micro-elements. This inbred had the highest contents of N, P, and Mg, increased contents of micro-elements Mn and Zu, but the lowest content of K in pollen. The other three inbreds had different contents of individual macro- and micro-elements. It was characteristic, however, that the inbred with the lowest degree of self-fertility, A-3497-47, had the lowest contents of P, Ca, Fe, Mn, and Cu in pollen.

TABLE 1

Degree of self-fertility in sunflower inbreds

No.	Inbred	Average no. of filled seeds per one plant	Average self-fertility	Extreme values for no. of filled seeds	
				Min.	Max.
1	A-9343/11	84	7,6	13	160
2	Pr-17	148	14,5	20	263
3	V-1640-23	297	38,4	45	344
4	A-3497-47	25	2,7	2	127

For the number of filled seeds per head: LSD 5% = 44 seeds/head, 1% = 59 seeds/head

This study, dealing with the composition of pollen of sunflower inbreds with differents degrees of self-fertility, should be considered as preliminary. It should be continued and extended to include a larger number of inbreds with both high and low degrees of self-fertility in order to discern a regularity and try to find a link between the contents of individual elements or amino acids on one side and the degree of self-fertility on the other. Further studies should also deal with the composition of nucleic acids in sunflower pollen. If proved to be valid, the hypothesis stating that the degree of self-fertility may be predicted on the basis of the biochemical composition of pollen will

TABLE 2

Content of aminoacids in pollen of sunflower inbreds (gr/100 gr of dry matter)

No.	Aminoacid	A-9343-11	Pr-17	A-3497-47	V-1640-23
1	Lysine	2,00	2,07	2,07	*2,83*
2	Histidine	1,26	1,70	1,35	1,78
3	Arginine	1,11	1,11	1,01	1,19
4	Aspartic acid	1,78	2,75	2,24	2,83
5	Thereonime	0,88	1,08	1,12	1,17
6	Serine	0,93	1,12	1,19	1,39
7	Glutamicacid	2,83	3,01	3,21	*3.70*
8	Proline	1,00	1,10	*1,31*	1,17
9	Glycine	1,03	1,21	1,38	1,60
10	Alanine	1,39	1,64	1,77	1,87
11	Valine + cystine	0,79	0,85	0,96	1,01
12	Methionine	0,41	0,47	0,35	0,49
13	Isoleucine	0,47	0,58	0,76	*0,98*
14	Leucine	1,26	1,40	1,51	*1,84*
15	Tyrosine	0,72	1,27	0,77	0,86
16	Phenylalanine	0,96	1,02	1,06	*1,36*
17	NH_3	0,43	0,27	0,25	0,37

LSD — 5% = 0,25%
1% = 0,32%

TABLE 3

Contents of macro and microelements in pollen of sunflower inbreds

No.	Inbred	mg/%					ppm (mg/kg)			
		N	P	K	Ca	Mg	Fe	Mn	Zn	Cu
1	A-9343-11	4578	455	652	142	146	204	49	82	33
2	Pr-17	5063	472	590	188	135	198	50	74	30
3	V-1640-23	*5117*	*563*	498	136	*158*	115	*58*	*96*	33
4	A-3497-47	4899	424	596	119	134	112	45	78	28

gain practical importance in the development of inbred lines as well as in the evaluation of the degree of self-fertility in sunflower hybrids.

ABSTRACT

Pollen of sunflower inbres with different degrees of self-fertility was analysed for the composition of amino acids, contents of macro-elements N, P, K, Ca, and Mg, and contents of micro-elements Fe, Mn, Zn, and Cu. The following conclusions were drawn:

The inbred V-1640-23, which had the highest percentage of self-fertility (38.4%), had significantly higher contents of lysine, glutamic acid, isoleucine, and phenylalanine as well as the total amino acid content than the other inbreds.

V-1640-23 also had increased contents of the following macro and micro-elements: N, P, Mg, Mn, and Zn.

The other inbreds varied in the contents of individual amino acids but the variations could not be associated with the degree of self-fertility. These inbreds also varied in the contents of individual macro- and micro-elements in pollen.

The obtained results should be considered as preliminary. Further studies should be extended to include a larger number of inbreds in order to become capable of predicting the degree of self-fertility in sunflower inbreds and hybrids on the basis of the biochemical composition of their pollen.

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