EFFECTS OF CERTAIN FACTORS ON THE CHEMICAL COMPOSITION OF SUNFLOWER SEEDS IN CONNECTION WITH THE EVALUATION OF THE BREEDING MATERIAL

Y. STOYANOVA and P. IVANOV
(Bulgaria)

The evaluation of sunflower oil content in selection and seed production is performed with seeds taken from free-pollinated plants. No seeds from self-pollination or sib-pollination are used because of two reasons. Firstly, for maintaining the genetic purity, paper bags are used in the selection nurseries. They influence the microclimate of the head during the seed development period connected with certain changes in the biochemical processes. As sunflower self-fertility under induced selfing and sib-pollination is low, it results in small amounts of seeds which are often insufficient for analysis and reproduction. Secondly, sunflower bugs damage the seeds and this also leads to chemical composition changes and should be kept in mind while selecting.

The above pointed facts forced us to evaluate the rate of influence of the different factors and seek for a precise answer about the method to be used for chemical analysis of the seeds. Studies were made during 1970—1973 with very uniform lines in sixth and seventh inbred generations. The oil content was determined by *Rushkovsky* method (1957) and the fatty acid composition — with a gas chromatograph. The quantity of protein was determined by Kjeldahl method and the coefficient used for converting the total nitrogen into protein was 6,25.

The effect of the paperbags was observed in three inbred lines of about 100 plants each (table 1) and in 46 lines representing seed samples from 40 plants which were either selfed or sib pollinated or open pollinated (table 2).

The results obtained from the two series of experiments confirm one another. Under the influence of the paperbags the relative part of kernel decreased in the two cases with 2.8 and 2.6 per cent respectively. The kernel oil content decreased more drastically — 5.1 and 6.99% fort the two groups of analyses. The values of this index in

Table 1

Paperbag effect

Indices	Inbred number	Under bag		Without bag
		selfing	sib	free-pollination
Kernel in seed %	1510	73.2	73.1	76.5
	1715	73.1	74.0	76.3
	1756	73.1	73.8	75.1
	$\overline{M}$	73.1	73.6	75.9
			+ 0.5	+ 2.8
Oil in kernel %	1510	52.7	51.9	57.2
	1715	51.7	53.3	58.6
	1756	54.7	55.2	58.6
	$\overline{M}$	53.1	53.4	58.2
			+ 0.3	+ 5.1
Oil in seed %	1510	38.3	38.0	43.7
	1715	38.0	40.2	44.8
	1756	39.4	40.8	44.1
	$\overline{M}$	38.6	39.3	44.2
			+ 0.7	+ 5.6

Table 2

Paperbag effect. Mean analysis values of 46 lines

Indices	Seeds obtained under bag	Seeds obtained by free-pollination	Difference
% kernel	67.7	70.3	+2.6
% oil in kernel	45.62	52.61	+6.99
% protein in kernel	33.2	29.7	—3.5
% oil in seed	32.4	37.1	+4.7
% protein in seed	22.4	20.7	—1.7
% linoleic acid	58.2	58.3	+0.1
% oleic acid	25.8	27.5	+1.7

the seeds obtained from selfing and sib-pollination are quite the same, at which no doubt contributed the fairly good uniformity of lines.

Having in mind the negative correlation between the oil and protein content in the kernel, the data concerning the proteins are a logical consequence. The protein content in seeds from free-pollination is 3.5 per cent lower in kernel and 1.7 per cent in seed.

The fatty acid composition analysis of oil seed from controlled and free-pollinated plants shows that in the latter the quantity of linoleic acid has slightly increased.

This way of comparison does not differenciate the effect of the controlled pollination as a factor influencing the seed formation and development process from the importance of the genome of the embryo on one hand and from the effect of the female plant on the other.

For this purpose, the seeds of a male sterile line pollinated by eight pollinators of different oil content (all of them being from controlled plants) were studied. The results in table 3 show that in F_0 the average value for kernel quantity is by 5.9 per cent smaller than that of the pollinators and only 1.6 per cent higher than that of the female

Table 3

Genotype effect

Pollinator number	% kernel			% oil in kernel		
	♂	♀	F_0	♂	♀	F_0
791	73.2		71.0	53.3		48.3
808	74.1		68.9	50.7		49.3
834	76.5		72.6	59.3		48.3
1519	72.2		68.7	51.3		46.3
1520	79.4		69.4	56.5		46.9
1606	79.7		70.3	64.4		47.6
1607	77.5		67.9	61.7		46.1
1721	74.6		71.5	61.5		47.6
$\overline{M}$	75.9	68.4	70.0	58.2	46.3	47.7
♀ 485 ms						
± d from ♂			— 5.9			—10.5
∓ d from ♀			+ 1.6			+ 1.4

form. The difference is more clearly cut in the case of the oil content. The average value of F_0 is very similar to that of the female form and is by 11.9 per cent smaller than that of the pollinators. Variations between different combinations are small, ± 1.6 per cent in comparison with the average value. A special attention deserve the combinations with lines 1519 and 1607 which differ in oil content by 10 per cent but the hybrid seeds being almost equal in this respect. Data conclusively confirm the decisive part of the genotype of the female plant upon the formation of the chemical composition of seeds. Pawlowsky (1964) achieved similar results studying three sunflower varieties.

So it is correct to evaluate the kernel oil and protein content of the selection materials, competitive trials and seed production as well as fatty acid composition of the oil with seeds taken from non-controlled pollination. Change in chemical composition of the seeds due to sunflower bug attack *(Dolycoris baccarum)*, have been observed in Peredovik

variety and 32 inbred lines. We used damaged and non-damaged seeds from free pollinated plants. Thirty of the inbred lines were used to determine the oil content changes in the kernel and the rest of the samples — for fatty acid composition and potein analyses. The studies of Piterskaya — (1963) and Piven (1973) show that according to the rate of bugs'damage the absolute weight and oil content decrease while the acidity value increases simultaneously with some changes in fatty acid composition of the oil.

The results of our studies show that in Peredovik variety the kernel oil content of damaged seeds decreases with 2.3 per cent and the average decrease in the lines is about 3 per cent. A certain change was traced in oil composition of the attacked seeds. The linoleic acid content decreases (3.3 per cent) as well as the quantity of stearic acid, while the content of oleic and palmitic acids increases 1.1 and 2.9 per cent respectively (table 4). Damaged seeds lead to an increase of protein (2.6 per cent on the average) or it is almost the same as the value of the oil content decrease.

Table 4

Effect of the bug attack

Indices	Variety, lines	Peredovik	928/71	928/73	1851	M
Oil in kernel %	healthy	58.5	—	—	—	—
	damaged	56.2	—	—	—	—
Palmitic acid %	healthy	7.8	13.3	7.8	9.0	9.2
	damaged	9.2	13.2	14.7	11.3	12.1
Stearic acid %	healthy	6.8	5.5	5.7	6.3	6.0
	damaged	5.8	5.7	6.1	5.2	5.7
Oleic acid %	healthy	23.5	22.4	26.6	26.7	25.2
	damaged	25.8	24.5	28.3	28.5	26.3
Linoleic acid %	healthy	61.8	58.8	58.2	58.0	59.2
	damaged	59.2	56.6	52.6	55.1	55.9
Protein in defatted kernel	healthy	—	52.5	62.3	58.6	57.8
	damaged	—	56.4	62.9	61.8	60.4

These results show that only non-damaged seeds should be used for objective evaluation of varieties and selection materials concerning oil and protein content.

As we checked the rate of attack of plant bugs on different lines we found that line 2927 possesses full field resistance against these insects.

CONCLUSIONS

1. The use of seeds from free-pollinated plants for evaluation the oil and protein indices of sunflower kernels proved to be correct and leading to precise conclusions.

2. For an objective evaluation of selection materials, varieties and hybrids concerning oil and protein content in seeds, only non-damaged samples should be used.

REFERENCES

Pawlowsky S. H., 1964, *Seed genotype and oil percentage relationship between seeds of a sunflower,* Canad. J. Genet. and Cytol., 6, No. 3.

Piterskaya A. M., 1963, *Vrediteli maslichnih kultur,* Maslichnie i efiromaslichnie kulturi, Moskva.

Piven V. T., 1973, *Posevnie i tovarnie katchestva semian podsolnechnika, povrejdennie klopami,* Biulleten nauchno-tehnicheskoi informatzii po maslichnîm kulturam, vip. II.

Rushkowsky S. V., 1957, *Metodi issledovaniia pri selektzii maslichnih rastenii na soderjanie masla i ego katchestva.* Moskva.