INHERITANCE OF OIL PERCENT IN SUNFLOWER SEEDS

SALEM ABD-ELKREEM [1], **BADR A. ELAHMAR** [2], **HASAN GALAL** [1], **and MOHAMMAD ABOU GAZALA** [2] (Egypt)

INTRODUCTION

Sunflower *(Helianthus annuus* L.) is one of the four most important annual crops grown for edible oil. It stands in the second position after soybean. There is an increasing interest in sunflower over the world, due to its wide adaptability and high percent of excellent oil. So that information pertaining to the genetic control of oil content is of special importance for sunflower breeder.

Unrau (1947) had tested the hybrid progenies of six sunflower inbred lines and the variety Sunrise. He observed an improvement in oil content. Weber (1952) found that oil percentage had moderate heritability values. Putt (1956) suggested that additive was more important than non-additive gene action in controlling oil content. Nicolić-Vig et al. (1971) reported that heritability values for oil content were high. Fick (1975) studied the inheritance of oil content in two crosses of sunflower. The narrow and broad sense heritability were 27% and 61% respectively. Haikal (1976) found a relatively high heritability values for oil content (93.7% to 99.3%). Miller et al. (1977) found that heritability values of oil content in sunflower were sufficient high for selection in early generations to improve the oil content. After three cycles of simple recurrent selection, oil content increased by 12.4%. Hammad (1980) indicated that additive gene action was important for oil percent, with moderate heritability value.

MATERIALS AND METHODS

Two varieties (Giza 1 and Mayak) and two inbred lines (N. A. 468 and N. A. 510) were used to study the inheritance of oil content in sunflower seed. Those parents were chosen to represent low (Giza 1) $17.74 \pm 1.11\%$, medium (N. A. 468 and N. A. 510) $30.0 \pm 1.0\%$ and $24.05 \pm 1.15\%$ and high oil content (Mayak) $41.59 \pm 1.2\%$.

The parents were arranged into three crosses representing low × medium (Giza 1 × N. A. 468), medium × medium (N. A. 510 × N. A. 468) and high × medium oil content (Mayak × N. A. 468).

The hybridization had been done in the summer of 1979. F_1 and F_2 populations, along with parents were sown at Sakha Research Station, Agriculture Research Centre, in the Middle of Delta, Egypt.

Oil content was determined following the technique mentioned by Comstock and Culbertson (1958).

The data were statistically analysed and the number of genes was estimated by using Castle and Wright's (1921) and Wright's (Burton, 1951) formulae. Heritability value in broad sense was calculated by applying the equation

$$H = \frac{VF_2 - \dfrac{VF_1 + VP_1 + VP_2}{3}}{VF_2}$$

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[1] Genetic Department, Faculty of Agriculture, Tanta University, Kafr El-Sheikh.

[2] Oil Crops Research Section, Field Crops Research Institute, Agricultural Research Centre, Giza.

RESULTS AND DISCUSSION

The oil percentage of sunflower seed was studied in three crosses, arranged into three groups according to their oil content :

A. low × medium (Giza 1 × N. A. 468)

B. medium × medium (N. A. 510 × N. A. 468)

C. high × medium (Mayak × N. A. 468).

The frequency distributions, means, variances and coefficient of variability of the parents, F_1 and F_2 of the three crosses are given in Table 1. The actual F_1 means of A and B crosses (18.6 ± 1.7% and 25.4 ± 1.9%) were approximately equal to their calculated arithmetic (20.90 and 27.080) and geometric (20.66 and 26.91%) means within the scope of significance. The actual F_1 mean (25.8±1.8%) of C cross was significantly lower than its arithmetic (32.82%) and geometric (31.63%) means.

This comparison indicated the absence of dominance in the former groups and partial dominance of medium oil content over high oil in the latter. Both arithmetic and geometric means of each group of crosses were similar within the scope of significance, so that the nature of gene action could not be determined in these crosses (Table 2). These results differ from those mentioned by Putt (1966) and Hammad (1980).

The Castle and Wright's (1921) and Wright's (Burton, 1951) formulae showed (0.14—0.17), (0.1—0.11) and (0.96—1.27) pairs of genes for A, B and C crosses suggesting that one pair of genes controlled the differences

Table 1

Frequency distributions, actual means, standard deviation, variance and coefficient of variation of oil percentage for the populations of three crosses (A, B and C)

Crosses	Genotype	Class centres										Total	X ± S.E.	S^2	C.V. %
		13	19	25	31	37	43	49	55	61	67				
A. low × medium (Giza 1 × N.A. 468)	P_1	8	7	4								19	17.74±1.11	22.32	26.63
	P_2		8	66	5							19	24.05±1.15	25.05	20.79
	F_1	7	4	2	2							15	18.6 ±1.7	43.54	35.43
	F_2	2	5	3	8	24	38	32	7						
B. medium × medium (N. A. 510 × N. A. 468)	P_1		1	4	12	3						20	30.1 ±1.0	19.99	14.85
	P_2		8	6	5							19	24.05±1.15	25.05	20.79
	F_1		7	3	2	3						15	25.4 ±1.9	53.83	28.90
	F_2		2	5	6	29	30	17	9	4	5	107	43.68±0.98	101.52	23.35
C. high × medium (Mayak × N.A. 468)	P_1					8	5	4				17	41.59±1.2	24.88	11.99
	P_2		8	6	5							19	24.05±1.15	25.05	20.79
	F_1		6	4	2	3						15	25.8 ±1.8	50.74	27.60
	F_2		3	7	20	21	32	19	5	2	2	111	40.24±0.90	90.84	23.68

Table 2

Estimations of actual, arithmetic and geometric means of F_1 and F_2 for oil percentage, heritability estimates and number of genes involved in A, B, and C crosses

Crosses	F_1			F_2			Heritability %	Genes number	
	actual	arith.	geom.	actual	arith.	geom.		1	2
A. low × medium (Giza 1 × N.A. 468)	18.6	20.90	20.66	41.34	19.47	19.72	62.36	0.14	0.17
B. medium × medium (N. A. 510 × N. A. 468)	25.4	27.08	26.91	43.68	26.24	26.23	67.53	0.1	0.11
C. high × medium (Mayak × N.A. 468)	25.8	32.82	31.63	40.24	28.95	29.10	63.06	0.96	1.27

1. Castle and Wright's formulae
2. Wright's formulae

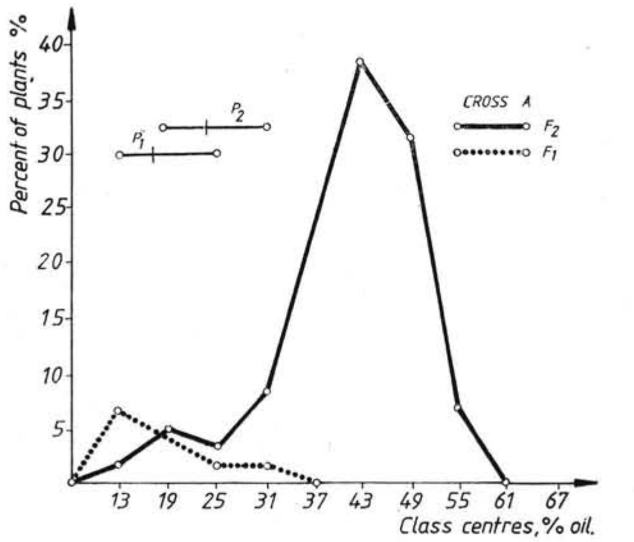

Fig. 1 — Frequency distribution curves for oil percentage for F_1 and F_2 populations of cross A

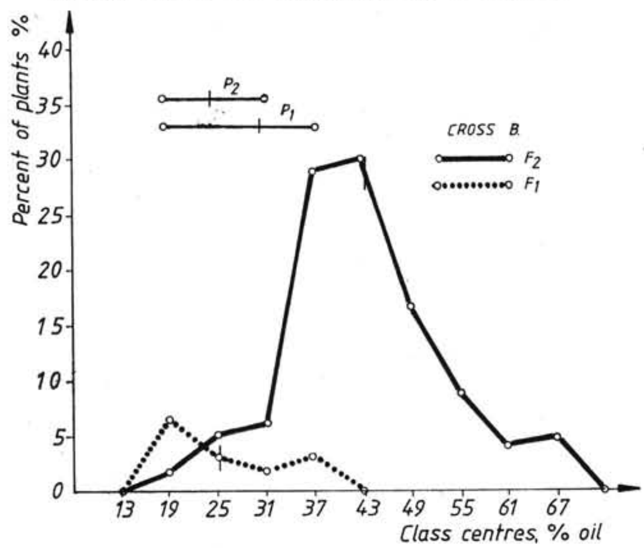

Fig. 2 — Frequency distribution curves for oil percentage for F_1 and F_2 populations of cross B

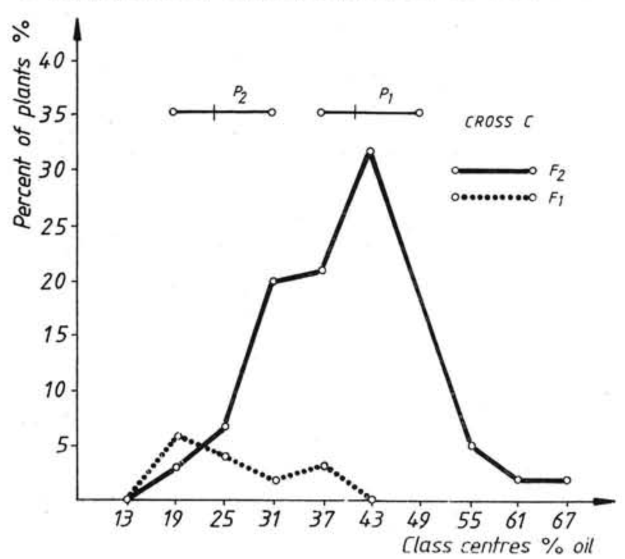

Fig. 3 — Frequency distribution curves for oil percentage for F_1 and F_2 populations of cross C

in A and B crosses and one to two pairs of genes governed the differences in C cross (Table 2). The distribution of F_2 plants of the three crosses was continuous (Table 1, Fig. 1, 2 and 3). There were 101, 65 and 9 plants, higher than the class of high oil percent of A, B and C crosses respectively (Table 1). This transgressive segregations indicated that low and medium oil content parents carried in their genotypes minor genes for high oil percentage and the F_2 segregation accumulated these genes together and resulted in this transgressive segregation, so it could be suggested that one to two pairs of major genes accompanied by minor genes governed the difference in oil content between parents.

Heritability values in broad sense for the three crosses were 62.36%, 67.53% and 63.06% respectively (Table 2). The high heritability values indicated that significant improvement could be made in increasing oil content through individual plant selection in early generations. These results agree with those obtained by Unrau (1947), Weber, (1952), Putt (1966), Fick (1975), Miller et al. (1977) and Hammad (1980).

CONCLUSIONS

Investigations on inheritance of oil content in sunflower carried out under the climatic conditions of the Middle of Delta, Egypt, revealed the absence of dominance in two crosses and partial dominance in one cross. One to two pairs of genes accompanied by minor genes are responsible.

The high heritability values in addition to the small number of genes that control the oil content in sunflower seeds, enable the breeders to conduct successful breeding works for increasing seed oil content.

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L'HÉRÉDITÉ DE LA TENEUR EN HUILE DANS LES GRAINES DU TOURNESOL

Résumé

Les études sur le déterminisme génétique de la teneur en huile des graines de tournesol réalisées dans les conditions arides de l'Egypte, ont mis en évidence l'absence d'une dominance totale chez deux des croisements ainsi qu'une dominance partielle chez un seul croisement. La teneur en huile des graines semble être contrôlée par une ou deux paires de gènes. Les valeurs elevées du coefficient d'hérédité aussi bien que le nombre réduit de gènes qui contrôlent la teneur en huile des graines de tournesol, permettent aux améliorateurs de créer rapidement des génotypes valeureux sous cet aspect.

HERENCIA DEL PORCENTAJE DE ACEITE EN LAS SEMILLAS DE GIRASOL

Resúmen

Las investigaciones concernientes al determinismo genético del contenido de aceite en las semillas de girasol, efectuadas en las condiciones climáticas áridas de Egipto, han puesto de relieve la ausencia de una dominante total en dos de los cruces, así como de una dominante parcial dentro de un cruce único. El contenido de aceite en las semillas parece estar controlado por uno o dos pares de genes. Los valores elevados que controlan el contenido de aceite en las semillas de girasol permiten a los amelioradores crear más rapidamente unos genotipos valiosos desde este punto de vista.