INTRA-POPULATION RECURRENT SELECTION IN SUNFLOWER (Helianthus annuus L.)

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ABSTRACT

An open-pollinated population of sunflower (Helianthus annuus L.) subdivided into two populations (A = original e B = CO^{60} gama irradiated) was studied using the methodology of intra-population recurrent selection based on half-sib families. Three hundred half-sib families of each population were evaluated in three simple lattice experiments at a single location. The traits studied were: capitulum and achene weight, plant and capitulum height and capitulum diameter. Several genetic parameters were estimated and comparisons were made between the A and B populations. The estimates of the additive variance were higher for the population B than for A showing that irradiation caused slight increase in variability. The expected genetic gain was similar for both A and B population. This was due to higher mean and lower genetic variability of the original population when compared to the irradiated population.

INTRODUCTION

The sunflower is an oilseed crop cultivated in several countries due to its phenotipic flexibility and due to its genetic adaptability obtained through the development of improved breeding methods. Among these methods, recurrent selection with mass selection and half-sib progenies selection are recommended (Hallauer & Miranda Filho, 1981). According to Eberhart (1967), recurrent selection could be applied in sunflower, as it is in corn (Zea mays L.). The use of ionizing radiation for plant improvement generates great number of plants with new genics blocks. Understanding of these mutations is important for practical uses. The objective of this experiment was to estimate several genetic parameters through the half-sib progenies method.

MATERIAL AND METHODS

A french population of sunflower (PIGB), subdivided in two subpopulations - A, control, and B, irradiated, to induce mutation throgh gama radiation of CO^{60} with 1.8 Kr (0.056 Kr/min) was evaluated. Each subpoplulation was instaled in isolation plots and three hundred selected progenies were evaluated through the metodology of selection based on half-sib progenies with remanant seed recombination; the lattice experimental design was used with two replications. The single row experimental plots measured 4.0 m length and the plant spacing was 4 plants/m, totalling 40,000 plants/ha; row spacing was 1.0 m. The hybrids cultivars CONTI-112 and CONTISOL were used as controls. Capitulum and achenes

weight, plant and capitulum height, and capitulum diameter were evaluated. For determination of genetic parameters variance analyses (Cochran & Cox, 1957) and models were used to determine expected mean square (Gardiner, 1963):

VF	FG	MS	E(MS)	F
Progenie	g1	Q1	$\sigma^2 + r.\sigma^2_p$	Q1/Q2
Error	g2	Q2	σ^2	

where g1, g2 are the degree of freedom associate to the source of variance and $g1 = k^2 - 1$ e $g2 = (r-1).(k-1)$; Q1 is the progenie mean square; Q2 is the error mean square; σ^2_p is the genetic variance among half-sib progenies; σ^2 is the error variance among progenies; r is the number of replications. The estimated values were obtained through the following formulas:

$$\sigma^2_p = (Q1 - Q2)/r \qquad \sigma^2 = Q2 \qquad \hat{\sigma}^2_A = 4.\hat{\sigma}^2_p \qquad \hat{\sigma}^2_F = Q1/r$$

where $\hat{\sigma}^2_A$ is the additive genetic variance among progenies and $\hat{\sigma}^2_F$ is the phenotypic variance among progenies mean.

The expected gain with selection for increased achenes weight were calculated according to Vencovsky (1978), using the formula:

$$Gs = k \; . \; (1/4).\hat{\sigma}^2_A \; / \; \sqrt{\hat{\sigma}^2_F}$$

where Gs is the expected gain with the selection among half-sib progenies, in both sex; k is the standard selection differential.

RESULTS

The coefficient of variation of the experiment (CVe%) were high for achenes weight (17.65 and 17.40% for the subpopulation A and B, respectively), and lower for plant height (5.74 and 7.03% for the same subpopulation - Table 1). The genetic coefficient of variation was superior for achenes weight trait (13.32 and 15.66% for subpopulations A and B, respectively) and lower for capitulum diameter (6.20 and 6.31% for the same subpopulations). The average of capitulum and achenes weight were not different between the subpopulations, and the yield of the controls were slightly superior compared with irradiated (2387 and 2348, 1319 and 1270 Kg/ha, respectively) (Table 3). The capitulum and plant height presented higher values in the control subpopulation than in the irradiated - 113.44 and 108.48, 136.84 and 131.59, respectively. The capitulum diameter was similar for both A and B populations. The estimates of genetic variance among progenies showed higher values in the irradiated subpopulation when compared to the control. The estimates of additive genetic variances among

progenies for capitulum weight (214.90 and 182.99); achenes weight (94.97 and 70.71); plant height (340.24 and 288.96); capitulum height (313.92 and 289.16); capitulum diameter (3.72 and 3.60) were higher also for the irradiated than for the control populations (Table 2). Using selection intensity (k) for achenes weight 34 plants (k = 11.33%) were selected from population A and 33 plants (k = 11.00%) from population B. In the subpopulation A (Table 4), the production of the selected sample was 27.70% higher than the original, representing an increase of 365 Kg/ha. The expected gain was 199 Kg/ha representing an increase of 15.10% compared with the control subpopulation. An average production of 1518 Kg/ha was observed in the Cycle I. The sample selected in the irradiated material showed an increase of 256 Kg/ha compared with the control which is an expansion of 20.20%. This is equivalent to an expected mean yield of 1526 Kg/ha, in Cycle I.

DISCUSSION AND CONCLUSION

The plant and capitulum height were strongly affected by ionizing radiation. The lack of variation of the capitulum diameter between control and irradiated materials suggests than the effects to induce mutation over this trait was low or cannot be avaluated with precision during this period of improvement of the population. The additive genetic variances were consistently higher in subpopulation B for all studied traits. Thus, it can be concluded that irradiation resulted in sensitive increase of genetic variability. The expected gain confirm higher genetic variability in irradiated progenies; otherwise, it was observed lower mean of supbpopulation B traits than A. Thus, the lower expected progress in control population is compensated by the higher original mean, resulting in improved populations derived from the control and irradiated populations with similar means. Therefore, it is concluded that the mutation process using ionizing radiation increased the variability for all traits, and it was evident a considerable increase in the capitulum and achenes weight and a small increase of the capitulum diameter. The experimental error had the tendency to be higher in materials affected by the radiation, except the achenes weight. The control and irradiated subpopulations were useful for the intrapopulation improvement program based on the expected progress. Due to the small change in the mean and variability of the irradiated population it was concluded that the contribution for selection process is small in short run. However, better genotypes could be obtained in the coming generations after recombination.

Table 1: Mean ($\bar{x}$), experimental variation coefficient (CVe %) and genetic variation coefficient (CVg%), for capitulum weight, achenes weight, plant height, capitulum height and capitulum diameter. EMBRAPA/CNPSo, Londrina, PR-Brazil. 1992.

Genetic material	Capitulum weight			Achenes weight			Plant height			Capitulum height			Capitulum diameter		
	$\bar{x}$	CVe %	CVg %	$\bar{x}$	CVe %	CVg %	$\bar{x}$	CVe%	CVg%	$\bar{x}$	CVe%	CVg%	$\bar{x}$	CVe%	CVg%
Subpop. A	835,60	15,00	11,55	461,70	17,65	13,32	136,84	5,74	6,37	113,44	9,29	7,51	15,31	9,57	6,20
Subpop. B	821,70	17,25	12,61	444,30	17,40	15,66	131,59	7,03	7,23	108,48	10,03	8,37	15,44	10,24	6,31

Weight: g/3,5 m^2; Height and diameter: cm.

Table 2: Estimates obtained calculated for plants (g/plant) for capitulum weight (CW), achenes weight (AW), plant height (PH), capitulum height (CH) and capitulum diameter (CD) for genetic variance among progenies ($\hat{\sigma}^2_p$), experimental error variance among plots ($\hat{\sigma}^2$), additive genetic variance among progenies ($\hat{\sigma}^2_A$) and associated standard error, and phenotypic variance among progenies mean ($\hat{\sigma}^2_F$). EMBRAPA/CNPSo, Londrina, PR - Brazil. 1992.

Genetic material	$\hat{\sigma}^2_p$					$\hat{\sigma}^2$				
	CW	AW	PH	CH	CD	CW	AH	PH	CH	CD
Subpop. A	45,7465	17,6771	72,24	72,29	0,90	83,9882	37,1132	69,19	111,95	2,18
Subpop. B	53,6007	23,7432	85,06	78,48	0,93	105,5264	32,6077	85,06	78,48	0,93

Genetic material	$\hat{\sigma}^2_A$					$\hat{\sigma}^2_F$				
	CW	AW	PH	CH	CD	CW	AH	PH	CH	CD
Subpop. A	a 182,9859	70,7084	288,96	289,16	3,60	87,7406	36,2337	106,84	128,27	1,99
	b 54,7600	22,9200	63,20	78,76	1,28					
Subpop. B	a 214,4029	94,9728	340,24	313,92	3,72	106,3639	40,0470	133,80	142,12	2,20
	b 66,8400	24,3200	79,76	87,64	1,44					

a,b: Estimates of variance and respective associated standard error.

Table 3: Capitulum weight and achenes weight (Kg/ha), plant height and capitulum height, and capitulum diameter (cm), mean values grouped, for the progenies (prog) and selected samples (samp) in the subpopulation A (control) and B (irradiated) and control cultivars (check 1 = CONTISOL and check 2 = CONTI-112). EMBRAPA/CNPSo, Londrina, PR - Brazil. 1992.

Genetic material	Capitulum weight				Achenes weight			
	prog	samp	check1	check2	prog	samp	check1	check2
Subpop. A	2387	2914	4474	2051	1319	1684	1989	1351
Subpop. B	2348	3009	4349	2026	1270	1690	1957	1234

Genetic material	Plant height				Capitulum height				Capitulum diameter			
	prog	samp	check1	check2	prog	samp	check1	check2	prog	samp	check1	check2
Subpop. A	136,84	145,64	191,33	162,40	113,44	121,37	155,97	116,83	15,31	16,85	19,50	13,00
Subpop. B	131,59	142,64	195,93	163,40	108,48	116,80	155,70	113,67	15,44	16,83	19,37	13,17

Table 4: Mean productivity of the achenes weight progenies in the subpopulation A (control) and B (irradiated) for selected sample, control cultivars and selection expected gain. EMBRAPA/CNPSo, Londrina-PR-Brazil. 1992.

Elements	Subpopulation A		Subpopulation B	
	Kg/ha	%	Kg/ha	%
Original	1319	100,00	1270	100,00
Sample (selected)	1684	127,70	1690	133,00
Gain (expected)	199	15,10	256	20,20
Cycle I (expected)	1518	115,10	1526	120,20
Checks				
Contisol	1989	150,80	1957	154,10
Conti-112	1351	102,40	1234	97,20

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