MODE OF INHERITANCE OF LAI IN F_1 GENERATION OF DIFFERENT SUNFLOWER INBREDS

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Abstract

Eleven inbred lines of different genetic origin were diallelly crossed excluding reciprocals, to study the mode of inheritance of leaf area index (LAI) in F_1 generation.

In F_1, LAI was most frequently inherited superdominantly (38 combinations). Dominance was found in 14 combinations, partial dominance and intermediacy in only a few combinations.

In other words, high-intensity heterotic effect for LAI was frequent in F_1.

The lines L-4, L-5, and L-9 had high GCA values for LAI.

Highly significant SCA values were found in 14 hybrid combinations, significant SCA values in two combinations.

The analysis of the components of genetic variance showed that the inheritance of LAI was governed by the non-additive component as well as that the expression of that character was governed by more dominant genes.

The analysis of regression showed that at least three of the examined lines stimulated interallelic interaction regarding the inheritance of LAI.

It was concluded on the basis of the obtained results that the minimum LAI for breeding purposes is 2.5 m^2/m^2. However, it was not elucidated which values of LAI in the inbreds would secure the LAI of 3-4 in the hybrids.

Introduction

To develop good sunflower hybrids, it is important not only to have good parent lines but also to know how certain characters are inherited in F1. That knowledge accelerates the process of breeding. Since we cannot know beforehand either the combining ability of certain lines or the mode of inheritance of certain characters, we must resort to diallel crossing.

Seed yield depends largely on the photosynthetic efficiency of the leaf and the intensity of translocation of assimilates into the seed at the time of seed forming and filling. It is thus essential to secure the optimum leaf area, both per plant and per unit area.

Leaf number and size per plant determine the total or assimilation leaf area.

According to Morozov (1947), F1 hybrid combinations surpassed their parental inbred lines in the number of leaves and the total leaf area on account of heterosis in the inheritance of these characters.

Sindagi et al. (1980) analysed diallel crosses of eight sunflower inbreds and found superdominance in the inheritance of leaf number. Marinković (1981) studied the mode of inheritance of leaf number and total area by diallel crossing and found that the non-additive genic action was significant.

There are scarce literature data on the mode of inheritance of LAI in F1 generation. We decided to study combining ability, mode of inheritance in F1, components of genetic variabilit, and genic effect for LAI in several sunflower inbreds.

Material and Method

The analysis of the inheritance of LAI included 11 inbreds from different varietal populations. All of them were in S_{12} generation but they differed in most of their characters. The inbreds were diallely crossed, excluding reciprocals, in the course of 1982 growing season. The plants serving as mothers were made male sterile by gibberellic acid.

The trial including all F1 hybrid combinations and their parents was established in 1983 at the experimental field of the Institute of Field and Vegetable Crops in Novi Sad. Plant materials were planted after the system of random blocks in three replications. Each block had 20 plants at harvest. Leaf area (only the lamina) was determined by the method of leaf parameters at the stage of full flower, i.e., at the time of maximum leaf area. For each variant we calculated the average value of five plants in three replications. LAI, in m^2/m^2, was calculated on the basis of total leaf area per plant.

The diallel crosses were analysed for combining ability, after Griffing (1956),method 2, model 1, in order to obtain full information on the components of genetic variance and genic effect for the examined character. The analyses of the components of genetic variance and regression were conducted after the method developed by Jinks (1954), Hayman (1954), and Mather and Jinks (1971).

For the sake of easier reading, the examined lines are referred to ordinal numbers.

The examined inbred lines and their hybrid combinations differed significantly in their values of LAI. The highest value was found in L-3, the lowest in L-9: 3.9 and 1.9 m^2/m^2, respectively.

Among the F1 combinations, the highest average LAI was found in L-4 x L-9, the lowest in L-3 x L-7: 7.6 and 2.9 m^2/m^2, respectively (Table 1).

Tab. 1 - Results of diallel crossing for LAI (m^2 leaf area/m^2)

PARENT	L-1	L-2	L-3	L-4	L-5	L-6	L-7	L-8	L-9	L-10	L-11
L-1	2,7	3,3^{pd}	4,1^d	4,1^h	5,8^h	3,9^h	4,1^h	3,4^d	3,1^d	3,0^d	3,6^h
L-2		3,5	4,4^d	3,8^d	3,9^d	5,2^h	4,4^d	4,2^h	6,6^h	3,3^d	4,5^h
L-3			3,9	4,4^d	4,3^d	3,1^d	2,9^d	4,6^h	5,2^h	6,5^h	4,6^h
L-4				2,3	4,9^h	4,9^h	5,3^h	5,7^h	7,6^h	4,7^h	4,9^h
L-5					2,9	5,8^h	4,4^h	5,6^h	3,7^h	6,2^h	6,2^h
L-6						2,9	3,6^h	3,8^d	4,2^h	4,0^h	6,4^h
L-7							2,6	4,3^d	7,3^h	4,1^h	4,5^h
L-8								3,5	6,2^h	5,1^h	3,4^d
L-9									1,9	4,5^h	3,6^h
L-10										2,1	4,4^h
L-11											2,2

LSD $\begin{matrix} 0.05 = 0.59 \\ 0.01 = 0.79 \end{matrix}$

It was concluded on the basis of the obtained results that the heterotic effect for LAI was frequent (in 38 combinations), as well as that the intensity of heterosis was high. Dominace for LAI was found in 14 combination while partial dominance and intermediacy were present in a few combinations only (Table 1).

The analysis of combining ability displayed significantly high differences for GCA and SCA. As it is considered that GCA indicates the additive genetic variance while SCA indicates non-additive variance, i.e., dominance and epistasis (Griffing, 1956; Falconer, 1967), it ensues that both additive and non-additive component of genetic variance played important roles in the inheritance of LAI by F1 generation of the examined inbreds, the portion of the non-additive component being nevertheless higher (Table 2).

Tab. 2 - Analysis of variance of combining ability for LAI

Source of variation	Degree of freedom	Squares sum	Squares mean	F calcu- lated	F tabular	
					0.05	0.01
GCA	10	9,62	0,96	24,05**	1,97	1,53
SCA	55	76,31	1,39	34,67**	2,59	1,82
E	65		0.04			

GCA/SCA = 0.69

The analysis of GCA for individual inbreds showed significant positive values of GCA for LAI in L-4, L-5, and L-9. Non-significant positive values were found for L-8 and L-3 while the remaining six lines had negative values of GCA for LAI (Table 3).

Tab. 3 - GCA values

No	PARENT	GCA	RANK	LSD	
				0.05	0.01
1	L-1	-0.60	10		
2	L-2	-0.08	7		
3	L-3	0.01	5		
4	L-4	0.25**	3		
5	L-5	0.38**	1		
6	L-6	-0.07	6	0.15	0.22
7	L-7	-0.11	8		
8	L-8	0.12	4		
9	L-9	0.31**	2		
10	L-10	-0.12	9		
11	L-11	-0.08	7		

Hybrid combinations with high SCA usually had one parent with low GCA (L-1 x L-5, L-4 x L-7, L-7 x L-9, etc) and another with high GCA. These results agree with those of Singh and Gupta (1969), Marinković (1981), etc. However, the combinations L-2 x L-6 and L-8 x L-10, with significantly high SCA, had both parents with low SCA. It shows that the combining ability of a specific line depends on the line it is crossed with. (Table 4).

The components of genetic variance were not in full agreement with the analysis of variance of combining ability. The dominant compo- nent (H_1 and H_2) was much larger than the additive (D), indicating the former as the major part of genetic variance (Table 5).

Tab. 4 - SCA values

PARENT	L-2	L-3	L-4	L-5	L-6	L-7	L-8	L-9	L-10	L-11
L-1	-0,32	0.38	0.15	1,72**	0.28	0.52*	-0.42	-0.92	-0.57	-0,01
L-2		0.16	-0.67	-0.70	1.05**	0.30	-0.15	2.06	-0.79	0.37
L-3			-0.17	-0.38	-1,13	-1.28	0.17	0.56*	2.31**	0.37
L-4				-0.03	0.42	0.87**	1.02	2.73**	0.28	0.44
L-5					1.19**	-0.16	0.79**	-1.30	1.64**	1.61**
L-6						-0.51	-0.56	-0.35	-0.10	2.26**
L-7							-0.01	2.80**	0.04	0.41
L-8								1.45**	0.80**	-0.94
L-9									0.01	-0.93
L-10										0.31

LSD 0.05 = 0.51
    0.01 = 0.74

Tab. 5 - Components of genetic variability for LAI

COMPONENT	VALUE
D	0.36
H_1	6.24
H_2	5.23
F	0.94
E	0.04
$H_2/4H_1$	0.210
u	0.70
v	0.30
$\sqrt{H_1/D}$	4.13
K_D/K_R	1.17

The value of F (interaction additive x dominant effect) was positive, indicating the prevalence of dominant over recessive allels in the expression of the examined character, as confirmed by the calculated frequencies of dominant (u) and recessive (v) alleles.

The calculated value of the average degree of dominance, $\sqrt{H_1/D}$, for LAI was larger than one, indicating superdominance if all combinations are taken into consideration (Table 5).

The relationship between the total number of dominant versus recessive alleles (K_D/K_R) shows that the examined parent lines had more

dominant genes for LAI since the calculated value was larger than one (Tab. 5).

The analysis of regression, as a method of studying differences and degree of dependence between phenomena, indicated the presence of interallelic interaction for LAI since the regression VrWr was significantly different from one (b $\pm$ sb = 0.227 $\pm$ 0.105; t (g) = = P > 0.05). (Graph 1).

Discussion

The presence of interallelic interactions imposed the need for elliminating methods by which we could discover lines that caused the interactions. The analysis showed that at least three lines caused them. We did not pursue the matter to the end and identify the lines because we would then also have to elliminate their hybrid combinations from the analyses of combining ability and

Graph.1. Regression analysis VrWr for L.A.I.

b = 0.227 $\pm$ 0.105

a = -0.38

$\overline{Vr}$ = 1.44

$\overline{Wr}$ = -0.05
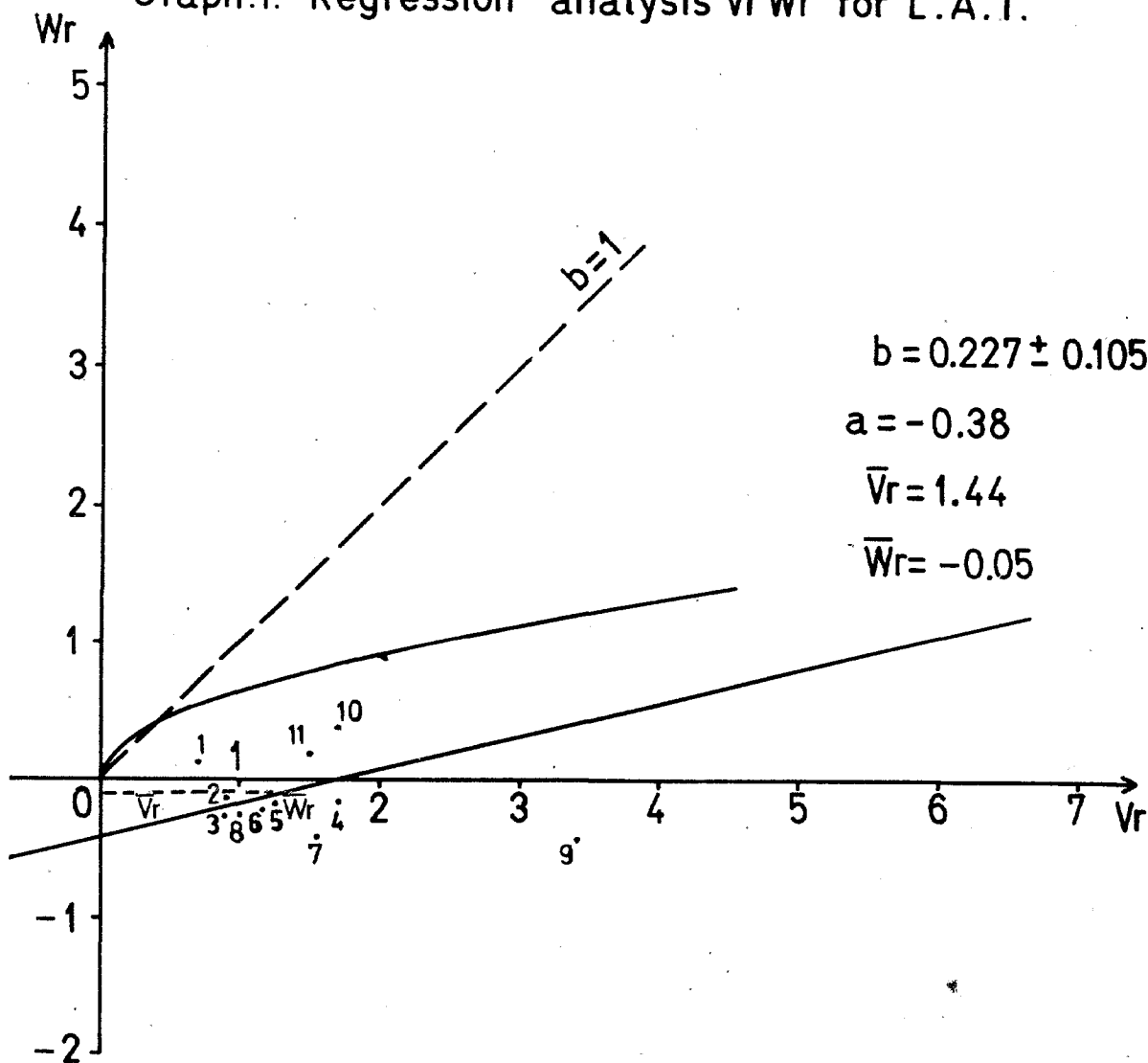
components of genetic variability and we could not fulfill the research objective, i.e., to evaluate combining ability for and mode of inheritance of LAI in F1 generation of the eleven genetically and agronomically diverse inbred lines.

The obtained results did not supply a definite answer as to the optimum LAI in inbred lines serving as the basis for estimating LAI in their F1 generation. It is certain that the heterotic effect will be manifested frequently but its intensity will depend on SCA of the lines in question.

If we accept the results of Vasiljević (1980) which place the optimum LAI between 3 and 4, then the majority of the examined hybrid combinations had too high LAI. However, we cannot evaluate realistically the photosynthetic activity of leaves of a genotype on the basis of LAI alone but we must also take into consideration leaf area duration (LAD). The two parameters studied parallelly make an efficient tool for sunflower breeding.

In this experiment, the inbreds with low LAI (2.5, in L-9, L-10, L-11, and L-4) frequently produced hybrid combinations with high heterosis for LAI (Table 1), no matter if crossed with the other inbreds or with each other. It ensues that we should not go for inbreds with low LAI ($<2,5$) if we want to achieve optimum LAI (3-4) in SC hybrids.

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