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COMBINING ABILITY OF SOME INBRED SUNFLOWER (*H. ANNUUS* L.) LINES

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ABSTRACT

The general and specific combining ability of seven inbred sunflower lines, and gene effects for kernel content, oil content in seed, and seed yield per plant were tested. Additive and nonadditive gene effects had important function in the inheritance of all three traits. However, the genes with additive effect are predominant in the inheritance of kernel content and oil content in seed, while genes which have nonadditive effect are predominant in the inheritance of seed yield per plant. The best general combiners for kernel content, oil content in seed, and seed yield/plant are the inbred lines L-3 and L-4.

Key words: Sunflower, inbred lines, combining ability, additive and nonadditive gene effect.

Sunflower hybrids, introduced in large scale production, significantly increased the average productivity of sunflower. According to many authors [1–6], the sunflower hybrids produced from self-pollinated lines give higher seed yield. Therefore, the inbred lines need to be analysed not only for their agronomic characteristics but also for combining ability.

MATERIALS AND METHODS

Seven inbred lines were mated in diallel system without reciprocals. The seeds were sown in randomized block design replicated thrice at Rimski Sancevi. Row-to-row and plant-to-plant distances were 70 cm and 30 cm, respectively. The tested traits were: kernel content, oil content, and seed yield per plant. The analysis of variance for general and specific combining ability was done as per standard procedure [7].

RESULTS AND DISCUSSION

Kernel content. Kernel content in seed significantly differed between inbred lines and their crosses. The highest and lowest kernel content was recorded in the inbred lines L-3

(76.4%) and L-6 (70.2%). In F_1 hybrids, the highest and the lowest mean kernel content was shown by the crosses L-1 x L-3 (76.7%) and L-6 x L-7 (69.8%) (Table 1), respectively.

Highly significant values of combining abilities indicated large variations in the genotypes studied (Table 2). The higher magnitude of additive component ($\sigma^2A = 2\sigma g =$

Table 1. Mean kernel content, oil content, and seed yield of parents (in bold) and their F_1 hybrids in a 7 x 7 diallel cross of sunflower

Parent	Character	L-1	L-2	L-3	L-4	L-5	L-6	L-7
L-1	Kernel content (%)	**74.9**	74.9	76.7	74.9	73.4	74.7	73.6
	Oil content (%)	**44.4**	44.6	48.7	44.9	42.6	44.7	46.0
	Seed yield/plant (g)	**51.2**	67.6	62.7	81.0	87.9	80.3	72.4
L-2	Kernel content (%)		**75.6**	75.6	76.0	74.6	73.7	73.5
	Oil content (%)		**41.5**	49.3	44.3	39.6	44.9	45.3
	Seed yield/plant (g)		**37.3**	70.4	75.2	63.1	66.9	82.8
L-3	Kernel content (%)			**76.4**	75.5	74.3	75.8	75.0
	Oil content (%)			**46.6**	49.1	46.5	48.9	48.4
	Seed yield/plant (g)			**44.0**	101.1	77.7	79.9	90.0
L-4	Kernel content (%)				**73.1**	75.6	75.0	73.5
	Oil content (%)				**40.8**	45.8	43.7	43.0
	Seed yield/plant (g)				**56.7**	83.5	107.7	101.1
L-5	Kernel content (%)					**73.0**	75.6	74.8
	Oil content (%)					**40.1**	41.8	42.5
	Seed yield/plant (g)					**38.5**	71.8	82.
L-6	Kernel content (%)						**70.2**	69.8
	Oil content (%)						**36.9**	35.2
	Seed yield/plant (g)						**44.3**	36.4
L-7	Kernel content (%)							**70.8**
	Oil content (%)							**40.2**
	Seed yield/plant (g)							**36.3**

Table 2. Analysis of variance for general (gca) and specific combining ability (sca) effects in sunflower

Source	d.f.	Kernel content in seed			Oil content in seed			Seed yield per plant		
		SS	MS	F	SS	MS	F	SS	MS	F
Gca	6	17.8	2.97	16.0**	63.5	10.58	13.6**	1750.4	291.7	6.0**
Sca	21	12.9	0.62	3.3**	50.0	2.38	3.1**	9557.6	455.1	9.4**
Error	54	10.0	0.19		42.1	0.78		2618.2	48.5	

0.52) than the dominant component ($\sigma^2D = \sigma^2S = 0.43$) shows that the genes with additive effect are more important in the expression of this character, as observed earlier [8].

Five inbred lines had the positive and two negative gca values (Table 3). The inbred line L-3 had highest gca value (0.84). However, this inbred line showed low variance of the specific combining ability (sca) ($\sigma^2S_i = 0.07$) and can be successfully used as a component of synthetic varieties (Table 4). In contrast, line L-6 may be used to make hybrid combinations with kernel content in seed (Table 5).

Table 3. Estimates of general combining ability effects for three economic traits in sunflower

Parent	Kernel content in seed	Oil content in seed	Seed yield per plant
L-1	0.24	0.61	-0.35
L-2	0.29	-0.06	-6.30
L-3	0.84	2.05	1.37
L-4	0.10	0.04	11.75
L-5	0.01	-0.81	-1.50
L-6	-0.62	-1.17	-2.84
L-7	-0.86	-0.66	-2.12
(gi-gj)	0.20	0.42	3.28

Table 4. Estimates of specific combining ability effects for kernel content, oil content, and seed yield per plant in sunflower

Parent	Character	Sca effects					
		L-2	L-3	L-4	L-5	L-6	L-7
L-1	Kernel content	-0.28	0.48	-0.02	-0.87	-0.63	0.18
	Oil content	0.35	0.06	-0.15	-0.56	1.10	-1.16
	Seed yield/plant	4.56	-8.03	-0.05	20.04	13.84	5.16
L-2	Kernel content		-0.32	0.71	-0.22	-0.15	-0.16
	Oil content		1.10	0.22	-1.60	1.78	1.32
	Seed yield/plant		5.68	0.10	1.23	6.39	21.56
L-3	Kernel content			-0.23	-0.48	0.68	0.48
	Oil content			0.89	0.05	1.90	1.18
	Seed yield/plant			18.31	8.20	11.67	21.05
L-4	Kernel content				0.57	0.85	0.18
	Oil content				1.87	1.02	0.10
	Seed yield/plant				3.59	29.18	21.82
L-5	Kernel content					1.50	1.25
	Oil content					0.67	0.76
	Seed yield/plant					6.47	16.78
L-6	Kernel content						-0.70
	Oil content						-3.00
	Seed yield/plant						-28.23
	Standard errors:	Kernel content		Oil content		Seed yield	
	SE ($S_{ij} - S_{ik}$)	0.58		1.18		9.28	
	SE ($S_{ij} - S_{kj}$)	0.54		1.10		8.68	

Oil content in seed. Oil content in the seeds of the inbred lines tested ranged from 36.9% (L-6) to 46.6% (L-3). The hybrids of the inbred lines also differed in oil content in seed. The lowest oil content in seed was recorded in the hybrid L-6 x L-7 (35.2%) while the hybrids L-2 x L-3 (49.29%) and L-3 x L-4 (49.2%) had highest oil content (Table 1).

The ANOVA for the combining ability displayed presence of highly significant gca and sca variances. However, transformation of variance components to genetic components showed that the additive component ($\sigma A = 2\sigma g = 1.82$) is higher than the dominant one ($\sigma D = \sigma S = 1.6$), which is in confirmity with earlier findings [2, 8–12].

The gca estimates for oil content were positive for three inbred lines (L-1, L-3 and L-4), and negative for four (L-2, L-5, L-6 and L-7) (Table 3). The high gca effect and relatively low sca variance in the line L-3 ($\sigma^2S = 0.537$) indicates that this line transfers its ability for high oil content to all of its F_1 hybrids. Although the inbred lines L-6 and L-7 had negative gca

Table 5. Estimates of general and specific combining ability variances in sunflower

Parent	Character	σ^2g_i	σ^2S_i	Individual basis (σe)	Mean (σ^2)
L-1	Kernel content	0.04	0.10	30.09	0.19
	Oil content	0.30	- 0.12	126.27	0.78
	Seed yield/plant	- 46.06	78.50	7854.75	48.49
L-2	Kernel content	0.06	- 0.02	30.09	0.19
	Oil content	- 0.07	0.84	126.27	0.78
	Seed yield/plant	- 6.49	54.34	7854.75	48.49
L-3	Kernel content	0.73	0.07	30.09	0.19
	Oil content	4.14	0.54	126.27	0.78
	Seed yield/plant	44.30	140.69	7854.75	48.49
L-4	Kernel content	0.01	0.12	30.09	0.19
	Oil content	- 0.07	0.27	126.27	0.78
	Seed yield/plant	91.97	240.26	7854.75	48.49
L-5	Kernel content	- 0.02	0.71	30.09	0.19
	Oil content	0.59	0.61	126.27	0.78
	Seed yield/plant	- 43.90	95.40	7854.75	48.49
L-6	Kernel content	0.37	0.57	30.09	0.19
	Oil content	1.29	2.45	126.27	0.78
	Seed yield/plant	- 38.09	304.16	7854.75	48.49
L-7	Kernel content	0.72	0.24	03.09	0.19
	Oil content	0.36	1.72	126.27	0.78
	Seed yield/plant	- 41.69	375.82	7854.75	48.49

effects, they are superior to the inbred line L-3 in hybrid production for increased oil content as both have high gca variances (σ^2S = 2.451 and 1.716) (Table 5).

Seed yield. The higher estimates of genetic dominant component ($\sigma^2D = \sigma^2S$ = 406.6) than the additive component ($\sigma^2A = 2\sigma g$ = –0.36) indicated that the genes with nonadditive effects played predominant role in the expression of seed yield in sunflower, which is in agreement with previous findings [6, 8, 13].

The line L-4 had significantly higher gca effects than the other inbred lines (Table 3). Unlike inbred line L-3, which was the best general combiner for kernel and oil content with relatively low sca variance, the inbred line L-4 had relatively high sca variance (σS_i = 240.3).

Five out of the six hybrids with the inbred line L-4 had positive sca values, the highest being in the hybrid L-4 x L-6.

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