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Heterosis for oil content and oil quality in sunflower (*Helianthus annuus* L.)

MOHD SHAMSHAD*, SK DHILLON and GURPREET KAUR

Department of Plant Breeding and Genetics, Punjab Agricultural University, Ludhiana-141 004, Punjab, India
*Email of corresponding author: shamshad.rattan@gmail.com

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ABSTRACT

The present study was aimed to estimate heterosis for oil content and oil quality of the newly developed hybrids of sunflower (*Helianthus annuus* L.) using selected parental lines. For this purpose five cytoplasmic male sterile lines CMS 11A, CMS 47A, CMS 67A, CMS 68A and CMS 234A and eight restorer lines 95 C-1, P 93R, P 103R, P 124R, P 134R, P 145R, P 167R and RCR 8297 and their forty F_1 hybrids along with commercial check PSH 569 were evaluated in randomized complete block design with three replications at Ludhiana during 2014. For oil content the magnitude of mid-parent heterosis ranged from -5.25% (CMS 11A x 95 C-1) to 21.40% (CMS 234A x P167R). The value for heterobeltiosis varied from -12.45% (CMS 11A x 95C-1) to 13.25% (CMS 11A x P 103R). The standard heterosis ranged from -22.77% (CMS 11A x P 145R) to 1.73% (CMS 67A x P 134R) over PSH 569. Mid, high and standard heterosis estimates for oil quality i.e. fatty acid composition of F_1 hybrids ranged from -27.94% to -28.57%, -22.81% to -37.18%, -2% to -44% for palmitic acid ($C_{16:0}$); from -47.73% to -18.03%, -50.98% to -2.27%, -44.74% to -13.16% for stearic acid ($C_{18:0}$); from -35.06% to -36.91%, -49.15% to -16.44%, -59.86% to -8.17% for oleic acid ($C_{18:1}$) and from -26.12% to -55.03%, -35.93% to -34.28%, -4.52% to -115.81% for linoleic acid ($C_{18:2}$), respectively. In the present investigation, fourteen out of the forty experimental hybrids recorded significantly positive heterosis over mid parent, whereas twenty hybrids recorded significant positive heterosis over better parent for oleic acid. The range of standard heterosis over check hybrids PSH 569 was from -59.86% to 8.17%. Among the hybrids, only one CMS234A x 95 C-1 had significantly positive heterosis (8.17%) over standard check hybrid PSH 569. Thus the hybrids showed significant standard heterosis for both oil content and quality, therefore, these parental lines may further be used for improvement of oil content and quality.

Key words: Heterosis, Oil content, Oil quality, Sunflower

The cultivated sunflower ranks fourth after soybean (*Glycine max* L.), rapeseed (*Brassica campestris* L. and *B. napus* L.) and peanut (*Arachis hypogaea*) as one of the most important annual crops in the world grown for edible oil. Sunflower is known for rich source of good quality edible oil. It can be successfully grown in many parts of India due to its wider adaptability and photo and thermo-insensitive plant type. Being a cross pollinated crop heterosis can easily be exploited for better oil content and oil quality traits. The cytoplasmic male sterility discovery (Leclercq, 1966) in France and fertility restoration (Kinman, 1970) in America has provided the desirable mean for the development of hybrids through heterosis breeding. Oil contentis an important trait to be considered in hybrid selection. Utilization of heterosis has allowed sunflower to become one of the major oilseeds in many countries. Presently grown sunflower hybrids have oil content ranging from 35.0 to 40% and 18-20% protein. Sunflower oil is of good quality as it contains high proportion of linoleic acid which is a polyunsaturated fatty acid. It is also a good source of calcium, phosphorus, nicotinic acid and vitamin E. The new market requirements regarding the product safety lead to the necessity of resistant oils to high temperatures, less saturated, which resist longer to oxidation. Solving this issue is possible through releasing new sunflower oil type, with low linoleic acid and with high oleic acid content.Since oil content and qualityare important objectives in sunflower breeding programme, therefore the experiment was designed to study the commercial heterosis in sunflower hybrids developed from selected desirable improved lines and testers. Heterosis for oil content and quality are the driving forces behind the hybrid seed industry in cultivated sunflower (Cheres *et al*., 2000).

MATERIALS AND METHODS

The materials consist of five cytoplasmic male sterile (CMS) lines, viz. CMS 11A, CMS 47A, CMS 67A, CMS 68A and CMS 234A, which were used for synthesis of hybrids with eight restorer lines, viz. 95C-1, P93R, P103R, P124R, P134R, P145R, P167R and RCR 8297. The experimental material consisting of 54 entries, viz. 40 hybrids, 13 parents and one recommended hybrid, viz. PSH 569 were evaluated in randomized complete block design (in a plot of 1.2 x 3 m^2) with three replications during spring season of 2014 at Punjab Agricultural University, Ludhiana. The crop was raised by following recommended package of practices for Punjab State. The oil content was estimated using a benchtop pulsed nuclear magnetic resonance (NMR)–MQC-5 analyser (oxford, London) supplied with preloaded "easy cal" software which was calibrated by reference data obtained by soxhlet method. Before construction of calibration curve and sample analysis, seeds were dried by keeping them at 80° C for 8 hours. The analysis was performed with 40 mm diameter sample probe; 5 MHz operating frequency, 4 scans and 1s recycle delay and 40° C magnetic box temperature. NMR room temperature was maintained at 23° C ± 2. The gas liquid chromatography (GLC) was used for fatty acid estimation.

RESULTS AND DISCUSION

The hybrid combinations which exhibited significant differences from the mean values of the parents and the average values of the parents were analyzed for the heterosis of oil content and fatty acids i.e. oleic acid ($C_{18:1}$), linoleic acid ($C_{18:2}$), palmitic acid ($C_{16:0}$) and stearic acid ($C_{18:0}$). Highly significant genetic differences (p<0.01) observed among parents and hybrids for oil content, oleic acid ($C_{18:1}$), linoleic acid ($C_{18:2}$), palmitic acid ($C_{16:0}$) and stearic acid ($C_{18:0}$) revealed considerable diversity in the breeding material for these traits (Table 1).

Oil content

The magnitude of heterosis over mid-parent ranged from -5.25% (CMS 11A× 95C-1) to 21.40% (CMS 234A x P167R). A total of 37 hybrids recorded positive heterosis over mid parent, of which 35 had significant positive heterosis. The range of heterobeltiosis varied from -12.45% (CMS 11A x 95C-1) to 13.25% (CMS 11A x P 103R). A total of 28 hybrids recorded positive heterosis over better parent; twenty one of these recorded significant positive heterosis. The standard heterosis ranged from -22.77% (CMS 11A x P145R) to 1.73% (CMS67A x P134R) over PSH 569. The hybrid CMS 67A x P 134R shows positive heterosis (1.73%) over standard check PSH 569. A varying degree of negative heterosis for oil content was also noticed over mid parent, better parent and standard check PSH 569. Since oil content improvement is one of the important breeding objectives, the parental lines involved in the hybrids showing higher heterosis may be used for improving of oil content of the hybrids. Similar results of getting higher heterosis for oil content in experimental hybrids has earlier been reported by Kaya (2005) and Sujatha and Reddy (2009).

Palmitic acid ($C_{16:0}$)

The *per se* performance of hybrids for palmitic acid ranged from 4.9% (CMS 11A x RCR 8297) to 7.2% (CMS68A x P103R). The range of heterosis over mid parent was from -27.94% (CMS 11A x P 167R) to 28.57% (CMS68A x P 103R) and the number of hybrids with negative heterosis were 19, of which, all were significant, while the standard check heterosis over PSH 569 ranged from -2% (CMS 11A x P 167R) to 44% (CMS 68A × P 103R). Among forty hybrids evaluated only one had significant negative heterosis over the standard check PSH 569. The range of heterobeltosis was from -37.18% (CMS 11A × P 167R) to 22.81% (CMS 68A × P 93R). Twenty four hybrids recorded significant negative heterosis over better parent. Heterosis for palmitic acid has been recorded by Giriraj and Nagaraj (2003). As palmitic acid belongs to unsaturated group of fatty acids, lot of health risks are involved with higher concentration of this fatty acid. In present study hybrids CMS 11A x P167R exhibited significantly low levels of palmitic acid and these might serve as potential hybrids, which can be used in future breeding programme.

Stearic acid ($C_{18:0}$)

The F_1s studied varied in their stearic acid content from 2.1% (CMS 67A x P167R) to 4.3% (CMS 234A x P134R). The heterosis over mid parent for stearic acid content ranged from -47.73% (CMS 47A x P124R) to 18.03% (CMS 234 A x P167R). Similar to palmitic acid, negative heterosis for this fatty acid is considered to be desirable. Most of the experimental hybrids recorded highly significant negative heterosis over mid-parent, better parent and standard check PSH 569. The standard heterosis ranged from -44.74% (CMS 67A × P167 R) to 13.16% (CMS 234A x P134R). Heterobeltosis ranged from -50.98% (CMS 67A x 95C-1) to -2.27% (CMS 234A x P134R). Most of the hybrids had negative heterosis over standard check PSH 569. Negative heterosis for stearic acid in sunflower has also been reported by Singh *et al*. (2002).

Oleic acid ($C_{18:1}$)

The *per se* performance of hybrids for oleic acid varied from 22.6% (CMS 67A x P 167R) to 60.9% (CMS 47A x 95C-1). The heterosis over mid parent ranged from -35.06% (CMS 47A x RCR 8297) to 36.91% (CMS 234A × P167R). Oleic acid is considered to be important from health point of view, as it belong to unsaturated group of fatty acids and enhances shelf life of oil due to its oxidative stability. Thus, emphasis was given to exploit positive heterosis for oleic acid content in sunflower hybrids. In the present investigation, fourteen of the forty experimental hybrids recorded significant positive heterosis over mid parent, whereas, twenty hybrids recorded significant positive heterosis over better parent. The range of standard heterosis over check hybrids PSH 569 was from -59.86 to 8.17%. Among the hybrids, CMS 47A x 95C-1 had showed significantly positive heterosis (8.17%) over standard check hybrid PSH 569. Heterotic and heterobeltiotic effects of oleic acid were highly significant for all F_1 hybrids noted by Vares *et al.* (2002) and Joksimovic *et al.,* (2006) similar that observed in present study.

Linoleic acid ($C_{18:2}$)

The linoleic acid content of the F_1s varied from as low as 29.6% (CMS 47A x 95C-1) to as high as 66.9% (CMS 67A x P167R). The heterosis over mid parent for linoleic acid content ranged from -26.12% (CMS 234A x P167R) to 55.03% (CMS 47A x RCR 8297). Linoleic acid belongs to unsaturated fatty acid group. Similar to oleic acid positive heterosis is considered to be desirable for this trait also. As many as twenty eight hybrids recorded significant positive heterosis over mid-parent. With respect to standard heterosis thirty nine hybrids recorded significant positive heterosis and standard heterosis over PSH 569 ranged from -4.52% (CMS 47A x 95C-1) to 115.81% (CMS 67A x P167R). The heterobeltosis ranged from -35.93% (CMS 47A x 95C-1) to 34.28% (CMS 11A x P145R). The nineteen hybrids recorded significant positive heterosis over the better parent. The results revealed that the sunflower genotypes have

Table 1. Mean values, heterosis (MPH %), heterobeltosis (BPH %) and standard heterosis (SH %) for oil content (OC) and fatty acid components

Genotype	OC (%)	MPH (%)	BPH (%)	SH (%)	$C_{16:0}$	MPH (%)	BPH (%)	SH (%)	$C_{18:0}$	MPH (%)	BPH (%)	SH (%)
Parents												
11A	33.41				5.8				3.7			
47 A	39.89				4.9				4.3			
67 A	38.44				7.2				3.0			
68 A	39.70				5.3				3.8			
234 A	37.57				5.2				3.8			
95- C- 1	39.40				5.9				5.1			
P 93 R	30.62				5.7				4.1			
P 103 R	31.53				5.9				3.5			
P 124 R	32.98				5.7				4.5			
P 134 R	33.34				5.6				4.4			
P 145 R	30.24				5.4				4.5			
P 167 R	30.62				7.8				2.3			
RCR 8297	33.17				6.8				4.4			
Mean	35.17				5.94				4.0			
Hybrids												
11 A × 95C-1	34.49	-5.25**	-12.45**	-17.02**	5.6	-4.27**	-5.08**	12.00**	2.7	-38.64**	-47.06**	-28.95**
11 A × 93 R	37.45	16.97**	12.09**	-9.91**	5.2	-9.57**	-10.34**	4.00**	3.2	-17.95**	-21.95**	-15.79**
11 A × 103 R	37.83	16.52**	13.25**	-8.99**	5.3	-9.40**	-10.17**	6.00**	3.0	-16.67**	-18.92**	-21.05**
11 A × 124 R	35.51	6.99**	6.30**	-14.57**	5.7	-0.87*	-1.72**	14.00**	3.1	-24.39**	-31.11**	-18.42**
11 A × 134 R	34.56	3.56*	3.46*	-16.85**	6.0	5.26**	3.45**	20.00**	3.4	-16.05**	-22.73**	-10.53**
11 A × 145 R	32.10	0.88	-3.91*	-22.77**	5.7	1.79**	-1.72**	14.00**	4.2	2.44**	-6.67**	10.53**
11 A × 167 R	36.80	14.96**	10.16**	-11.46**	4.9	-27.94**	-37.18**	-2.00**	3.0	0	-18.92**	-21.05**
11 A × RCR 8297	32.99	-0.9	-1.26	-20.64**	6.0	-4.76**	-11.76**	20.00**	3.6	-11.11**	-18.18**	-5.26**
47 A × 95C-1	38.04	-4.05**	-4.65**	-8.49**	5.1	-5.56**	-13.56**	2.00**	3.5	-25.53**	-31.37**	-7.89**
47 A × 93 R	40.28	14.24**	0.97	-3.10*	5.1	-3.77**	-10.53**	2.00**	3.8	-9.52**	-11.63**	0
47 A × 103 R	39.48	10.56**	-1.03	-5.02**	6.8	25.93**	15.25**	36.00**	2.6	-33.33**	-39.53**	-31.58**
47 A × 124 R	39.24	7.69**	-1.64	-5.61**	5.8	9.43**	1.75**	16.00**	2.3	-47.73**	-48.89**	-39.47**
47 A × 134 R	38.04	3.89*	-4.64**	-8.48**	5.7	8.57**	1.79**	14.00**	3.3	-24.14**	-25.00**	-13.16**
47 A × 145 R	39.06	11.4**	-2.08*	-6.03**	5.4	4.85**	0	8.00**	3.5	-20.45**	-22.22**	-7.89**
47 A × 167 R	40.01	13.47**	0.29	-3.75**	5.9	-7.09**	-24.36**	18.00**	2.8	-15.15**	-34.88**	-26.32**
47 A × RCR 8297	40.24	10.16**	0.88	-3.19*	6.2	5.98**	-8.82**	24.00**	2.8	-35.63**	-36.36**	-26.32**
67 A × 95C-1	39.31	1.00	-0.23	-5.44**	6.1	-6.87**	-15.28**	22.00**	2.5	-38.27**	-50.98**	-34.21**
67 A × 93 R	40.48	17.22**	5.29**	-2.62*	6.7	3.88**	-6.94**	34.00**	3.6	1.41**	-12.20**	-5.26**
67 A × 103 R	39.04	11.58**	1.55	-6.09*	6.8	3.82**	-5.56**	36.00**	2.8	-13.85**	-20.00**	-26.32**
67 A × 124 R	39.35	10.20**	2.37*	-5.33**	5.9	-8.53**	-18.06**	18.00**	3.5	-6.67**	-22.22**	-7.89**
67 A × 134 R	42.29	17.82**	10.00**	1.73	6.3	-1.56*	-12.50**	26.00**	3.2	-13.51**	-27.27**	-15.79**
67 A × 145 R	40.93	19.20**	6.48**	-1.53	5.2	-17.46**	-27.78**	4.00**	2.5	-33.33**	-44.44**	-34.21**
67 A × 167 R	40.14	16.25**	4.42*	-3.43*	6.9	-8.00**	-11.54**	38.00**	2.1	-20.75**	-30.00**	-44.74**
67 A × RCR 8297	40.53	13.19**	5.42**	-2.50*	5.6	-20.00**	-22.22**	12.00**	3.2	-13.51**	-27.27**	-15.79**
68 A × 95C-1	41.33	4.51**	4.12*	-0.57	6.3	12.50**	6.78**	26.00**	3.2	-28.09**	-37.25**	-15.79**
68 A × 93 R	40.10	14.06**	1.02	-3.52*	7.0	27.27**	22.81**	40.00**	2.7	-31.65**	-34.15**	-28.95**
68 A × 103 R	38.35	7.67**	-3.40*	-7.75**	7.2	28.57**	22.03**	44.00**	2.5	-31.51**	-34.21**	-34.21**
68 A × 124 R	40.86	12.44**	2.92*	-1.71*	6.5	18.18**	14.04**	30.00**	2.7	-34.94**	-40.00**	-28.95**
68 A × 134 R	39.90	9.25**	0.50	-4.02*	5.4	-0.92*	-3.57**	8.00**	3.0	-26.83**	-31.82**	-21.05**
68 A × 145 R	40.02	14.46**	0.82	-3.72*	6.2	15.89**	14.81**	24.00**	3.2	-22.89**	-28.89**	-15.79**
68 A × 167 R	38.42	9.28**	-3.21*	-7.57**	6.5	-0.76*	-16.67**	30.00**	2.5	-18.03**	-34.21**	-34.21**
68 A × RCR 8297	40.60	11.43**	2.27*	-2.33*	6.9	14.05**	1.47*	38.00**	3.3	-19.51**	-25.00**	-13.16**
234 A × 95C-1	39.22	1.92**	-0.44	-5.64**	5.0	-9.91**	-15.25**	0	2.8	-37.08**	-45.10**	-26.32**
234 A × 93 R	40.58	19.02**	8.01**	-2.37*	6.9	26.61**	21.05**	38.00**	3.2	-18.99**	-21.95**	-15.79**
234 A × 103 R	41.19	19.20**	9.62**	-0.91	5.9	6.31**	0	18.00**	2.8	-23.29**	-26.32**	-26.32**
234 A × 124 R	41.24	16.9**	9.76**	-0.79	6.2	13.76**	8.77**	24.00**	2.4	-42.17**	-46.67**	-36.84**
234 A × 134 R	39.06	10.15**	3.95*	-6.04**	5.7	5.56**	1.79**	14.00**	4.3	4.88**	-2.27**	13.16**
234 A × 145 R	38.93	14.83**	3.62*	-6.34**	5.8	9.43**	7.41**	16.00**	3.7	-10.84**	-17.78**	-2.63**
234 A × 167 R	41.39	21.4**	10.17**	-0.42	5.2	-20.00**	-33.33**	4.00**	3.6	18.03**	-5.26**	-5.26**
234 A × RCR 8297	40.89	15.6**	8.82**	-1.64	6.5	8.33**	-4.41**	30.00**	2.8	-31.71**	-36.36**	-26.32**
Check PSH 569	41.57				5.0				3.8			
Mean	39.0				5.98				3.07			
LSD (P=0.05)	1.74				0.63				0.38			
LSD (P=0.01)	4.49				1.61				0.97			

*, ** heterotic, heterobeltioic and standard heterotic effects significant at P=0.05 and P=0.01 probability levels, respectively; MPH mid parent heterosis, better parent heterosis BPH and standard heterosis SH

Table 1. Conti…..

Genotype	$C_{18:1}$	MPH (%)	BPH (%)	SH (%)	$C_{18:2}$	MPH (%)	BPH (%)	SH (%)
Parents								
11A	51.5				38.8			
47 A	59.0				28.7			
67 A	36.2				51.1			
68 A	40.1				47.8			
234 A	43.8				44.6			
95- C- 1	40.1				46.2			
P 93 R	40.8				48.0			
P 103 R	32.9				50.7			
P 124 R	39.9				48.5			
P 134 R	38.3				49.2			
P 145 R	53.8				33.5			
P 167 R	30.7				56.1			
RCR 8297	41.4				43.8			
Mean	42.2				45.2			
Hybrids								
11 A × 95C-1	45.4	-0.87*	-11.84**	-19.36**	45.2	6.35**	-2.16*	45.81**
11 A × 93 R	39.0	-15.49**	-24.27**	-30.73**	50.6	16.59**	5.42**	63.23**
11 A × 103 R	37.0	-12.32**	-28.16**	-34.28**	53.6	19.78**	5.72**	72.90**
11 A × 124 R	34.2	-25.16**	-33.59**	-39.25**	55.1	26.23**	13.61**	77.74**
11 A × 134 R	36.3	-19.15**	-29.51**	-35.52**	53.4	21.36**	8.54**	72.26**
11 A × 145 R	35.4	-32.76**	-34.20**	-37.12**	52.1	44.12**	34.28**	68.06**
11 A × 167 R	43.1	4.87**	-16.31**	-23.45**	47.7	0.53	-14.97**	53.87**
11 A × RCR 8297	30.9	-33.48**	-40.00**	-45.12**	57.9	40.19**	32.19**	86.77**
47 A × 95C-1	60.9	22.91**	3.22**	8.17**	29.6	-20.96**	-35.93**	-4.52**
47 A × 93 R	46.5	-6.81**	-21.19**	-17.41**	42.5	10.82**	-11.46**	37.10**
47 A × 103 R	30.0	-34.71**	-49.15**	-46.71**	59.3	49.37**	16.96**	91.29**
47 A × 124 R	36.4	-26.39**	-38.31**	-35.35**	54.1	40.16**	11.55**	74.52**
47 A × 134 R	38.7	-20.45**	-34.41**	-31.26**	51.1	31.19**	3.86**	64.84**
47 A × 145 R	47.4	-15.96**	-19.66**	-15.81**	41.4	33.12**	23.58**	33.55**
47 A × 167 R	41.2	-8.14**	-30.17**	-26.82**	49.2	16.04**	-12.30**	58.71**
47 A × RCR 8297	32.6	-35.06**	-44.75**	-42.10**	56.2	55.03**	28.31**	81.29**
67 A × 95C-1	39.4	3.28**	-1.75*	-30.02**	51.7	6.27**	1.17*	66.77**
67 A × 93 R	41.9	8.83**	2.70**	-25.58**	45.7	-7.77**	-10.57**	47.42**
67 A × 103 R	33.7	-2.46**	-6.91**	-40.14**	52.8	3.73**	3.33**	70.32**
67 A × 124 R	43.9	15.37**	10.03**	-22.02**	42.7	-14.26**	-16.44**	37.74**
67 A × 134 R	35.1	-5.77**	-8.36**	-37.66**	55.7	11.07**	9.00**	79.68**
67 A × 145 R	37.4	-16.89**	-30.48**	-33.57**	51.1	20.80**	0	64.84**
67 A × 167 R	22.6	-32.44**	-37.57**	-59.86**	66.9	24.81**	19.25**	115.81**
67 A × RCR 8297	38.5	-0.77	-7.00**	-31.62**	50.5	6.43**	-1.17*	62.90**
68 A × 95C-1	27.9	-30.42**	-30.42**	-50.44**	60.9	29.57**	27.41**	96.45**
68 A × 93 R	42.2	4.33**	3.43**	-25.04**	45.1	-5.85**	-6.04**	45.48**
68 A × 103 R	30.8	-15.62**	-23.19**	-45.29**	56.4	14.52**	11.24**	81.94**
68 A × 124 R	38.5	-3.75**	-3.99**	-31.62**	49.5	2.80**	2.06*	59.68**
68 A × 134 R	41.7	6.38**	3.99**	-25.93**	46.3	-4.54**	-5.89**	49.35**
68 A × 145 R	44.1	-6.07**	-18.03**	-21.67**	43.6	7.26**	-8.79**	40.65**
68 A × 167 R	41.1	16.10**	2.49**	-27.00**	46.7	-10.11**	-16.76**	50.65**
68 A × RCR 8297	39.4	-3.31**	-4.83**	-30.02**	47.1	2.84**	-1.46*	51.94**
234 A × 95C-1	43.4	3.46**	-0.91*	-22.91**	45.4	0	-1.73*	46.45**
234 A × 93 R	46.0	8.75**	5.02**	-18.29**	41.2	-11.02**	-14.17**	32.90**
234 A × 103 R	40.5	5.61**	-7.53**	-28.06**	48.2	1.15*	-4.93**	55.48**
234 A × 124 R	45.3	8.24**	3.42**	-19.54**	43.5	-6.55**	-10.31**	40.32**
234 A × 134 R	39.8	-3.05**	-9.13**	-29.31**	47.8	1.92*	-2.85**	54.19**
234 A × 145 R	54.1	10.86**	0.56	-3.91**	33.7	-13.70**	-24.44**	8.71**
234 A × 167 R	51.0	36.91**	16.44**	-9.41**	37.2	-26.12**	-33.69**	20.00**
234 A × RCR 8297	28.6	-32.86**	-34.70**	-49.20**	59.5	34.62**	33.41**	91.94**
Check PSH 569	56.5				31.0			
Mean	39.55				49.21			
LSD (P=0.05)	0.8				0.85			
LSD (P=0.01)	2.05				2.18			

*, ** heterotic, heterobeltioic and standard heterotic effects significant at P=0.05 and P=0.01 probability levels, respectively; MPH mid parent heterosis, better parent heterosis BPH and standard heterosis SH

sufficient genetic variability for linoleic acid which can be used for the improvement of the linoleic acid. Khalil *et al.* (2000) evaluated ten sunflowers for oil content and fatty acid composition recorded similar results.

Study based on mean performance and mid parent, high parent and standard heterotic effects for oil content and quality traits, parent of these eight hybrids are suggested for use in sunflower breeding program. Thus, finally concluded that the hybrids for the quality traits showed non-additive gene action is the causes of the heterosis most tested hybrids and require more intensive breeding for improvement of these traits. The hybrids and parents, which low in palmitic acid, stearic acid and high oleic acid, may be further use in the development of new improvement good quality inbreds and hybrids.

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