



Studies on Genetic Variability in Sunflower (*Helianthus annuus* L.)

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The success of any plant breeding program largely depends on the presence of sufficient genetic variability within the crop species. Assessing the extent of variability among different cross combinations provides valuable insight into the genetic diversity available for selection. A field experiment had been conducted to obtain information on genetic variability, heritability and genetic advance for seed yield and associated characters by using forty diverse genotypes. The analysis of variance revealed the significant differences among the genotypes for all the traits indicating presence of sufficient variability among the genotypes for various traits. High estimate of genotypic

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and phenotypic coefficient of variation were observed for seed yield per plant, hull content and head diameter. While, high heritability coupled with high genetic advance observed for plant height, head diameter, 100 seed weight, volume weight, seed yield per plant, hull content and oil content indicated that selection may be effective for improving these characters in the studied genotypes. The highest genetic advance in absolute terms was recorded for plant height and seed yield per plant suggesting substantial scope for improvement through selection. High heritability estimates accompanied with high genetic advance as a percentage of the mean were observed for traits such as seed yield per plant, plant height, head diameter, 100 seed weight and oil content.

Keywords: Sunflower; variability; GCV; PCV; heritability; genetic advance.

1. INTRODUCTION

In the Indian agricultural economy, oilseeds are important next to food grains. Among the various oilseed crops, sunflower (*Helianthus annuus* L.) ranks prominently after groundnut, rapeseed-mustard and soybean. It is particularly valued for its production of heart-friendly edible oil, which has led to a consistent commercial demand. In sunflower breeding programs, the primary objective is to develop high-yielding cultivars with improved yield contributing traits. However, seed yield in sunflower is a complex quantitative trait substantially influenced by environmental factors. Therefore, a comprehensive understanding of the nature and extent of variability both genetic and non-genetic is essential for the formulation of an effective and systematic breeding strategy.

In India, sunflower is primarily cultivated in states such as Punjab, Haryana, Karnataka, Gujarat, Maharashtra, Uttar Pradesh, West Bengal, Odisha, Rajasthan, Tamil Nadu and Andhra Pradesh. At present, the crop covers an area of 3,64,000 hectares yielding a total production of 3.63 million tones with an average productivity of 996 kg per hectare. Karnataka, Maharashtra, and Andhra Pradesh together represent 70% of the total area under sunflower cultivation (Directorate of Economics & Statistics, Department of Agriculture & Farmers Welfare, Government of India, 2021).

The success of any plant breeding program largely depends on the presence of sufficient genetic variability within the crop species. Assessing the extent of variability among different cross combinations provides valuable insight into the genetic diversity available for selection. Estimation of heritability plays a crucial role in identifying the proportion of phenotypic variation that is attributable to genetic factors thereby enabling breeders to effectively select superior inbred lines from a genetically diverse population. Moreover, when heritability is

considered in conjunction with genetic advance, it becomes a more reliable predictor of the potential response to selection than heritability alone. In this context, the present investigation was carried out to assess the genetic variability, heritability and genetic advance in a set of forty sunflower (*Helianthus annuus* L.) genotypes.

2. MATERIALS AND METHODS

The present investigation was conducted at the Research farm, Oilseeds Research Station, Latur during the *Kharif* season of 2024-25. The experimental material comprised of advanced interspecific derivatives of *Helianthus* species, along with two check varieties taken from Oilseeds Research Station, Latur. The genotypes sown in a randomized block design with two replications having plot size 1.20x4.5 m² and plant spacing of 60 cm and 30 cm respectively. All the recommended cultural, agronomical and plant protection measures was undertaken during the crop growth period. The data were recorded from five randomly selected plants from each genotype on ten distinct morphological characters viz., days to 50 per cent flowering, days to maturity, plant height (cm), head diameter (cm), seed filling (%), 100 seed weight (g), volume weight (g/100ml), hull content (%), seed yield per plant (g) and oil content (%). Days to 50 per cent flowering and days to maturity observations were recorded on plot basis only once.

The overall mean values of different characters were subjected to statistical analysis. Analysis of variance was done by subjecting the data to the statistical method on randomized block design (RBD) as described by Panse and Sukhatme (1985). The genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) was computed according to the method suggested by Burton and de Vane (1953). The expected genetic advance (GA) expressed in percentage of mean were calculated by

using the method suggested by Johnson et al. (1955).

3. RESULTS AND DISCUSSION

3.1 Analysis of Variance

The results obtained under the present investigation are presented in (Table 1). Analysis of variance revealed significant differences among the genotypes for all the characters. A wide range of variability was exhibited by most of the traits under study. The wide range of variation noticed in all the characters would offer scope of selection for improvement of desirable types. Similar results were also earlier reported by Makane et al. (2011), Sujatha et al. (2014), Supriya et al. (2016) and Varshitha et al. (2023).

3.2 Mean Performance

The average performance of forty genotypes along with mean, CV (%) and CD (5%) are presented in (Table 2). Seed yield per plant recorded a general mean of 19.85 g and the values ranged from 12.00 g (PB-1231) to 40.70 g (PB-15-20). Out of all forty genotypes evaluated, twenty-four genotypes were below and the remaining sixteen genotypes were above the average value of seed yield per plant. PB-1231 (12.00 g) had the lowest seed yield followed by PB-1457 (12.50 g), PB-1643 (12.70 g) and PB-1349 (12.85 g) whereas PB-15-20 (40.70 g), PB-1 (38.45 g), PB-500 (29.90 g), PB-1627 (29.10 g) and PB-434 (27.75 g) had the higher seed yield. With respect to oil content, the genotypes PB-500, PB-253, PB-1646, PB-1 and PB-304 emerged as promising sources for enhancing oil quality traits. Furthermore, early flowering

genotypes such as PB-1528, PB-1, PB-15-20 and LSF-08 were identified indicating their suitability for cultivation in regions with a short growing season. Similarly, genotypes including PB-1, PB-15-20, LSF-08 and SS-2038 demonstrated early maturity making them favourable candidates for early harvesting and double-cropping systems.

3.3 Genotypic and Phenotypic coefficient of Variation

The range of genotypic coefficient of variation was smaller compared to phenotypic coefficient of variation. At phenotypic and genotypic level, the values of PCV and GCV respectively were provided in (Table 3). The graphical presentation is mentioned in (Fig. 1). The highest value for phenotypic coefficient of variation were noticed in trait seed yield per plant (32.79) followed by hull content (26.45), head diameter (26.16), 100 seed weight (17.50), plant height (16.05), volume weight (14.18), oil content (11.27) and days to 50 per cent flowering (10.13) whereas lower values were noticed in days to maturity (7.17) and seed filling (6.46). The amount of variation among the genotypes can be indicated by genotypic coefficient of variation. Genotypic coefficient of variation was higher in seed yield per plant (32.51) followed hull content (26.06), head diameter (24.59), 100 seed weight (17.35), plant height (15.14), volume weight (13.73), oil content (11.05) and days to 50 per cent flowering (9.38) whereas lower values were noticed in days to maturity (6.60) and seed filling (5.92). Similar results on variability for different characters were reported by Nandini et al. (2017), Mohamed et al. (2018), Vipul et al. (2018), Reena et al. (2019) and Varalakshmi et al. (2019).

Table 1. Analysis of variance for yield and yield attributing traits in Sunflower

Sr. No.	Characters	Mean Sum of Squares		
		Replication (1)	Treatment (39)	Error (39)
1	Days to 50 per cent flowering	0.313	72.818**	5.569
2	Days to maturity	3.613	83.748**	6.946
3	Plant height (cm)	45.451	712.423**	41.477
4	Head diameter (cm)	4.311	18.508**	1.143
5	Seed filling (%)	2.738	43.326**	3.819
6	100 seed weight (g)	0.339	2.244**	0.231
7	Volume weight (g/100ml)	5.995	52.790**	1.708
8	Hull content (%)	0.013	70.750**	1.057
9	Seed yield per plant (g)	0.176	84.021**	0.718
10	Oil content (%)	0.273	27.752**	0.545

* Indicates significance at 5% level ** Indicates significance at 1% level

Table 2. Mean performance of 40 genotypes for 10 quantitative characters

Sr. No.	Genotypes	Days to 50 per cent flowering	Days to maturity	Plant height (cm)	Head diameter (cm)	Seed filling (%)	100 seed weight (g)	Volume weight (g/100ml)	Hull content (%)	Seed yield per plant (g)	Oil content (%)
1	PB-1228	60.00	92.50	124.80	9.75	71.20	5.77	49.05	22.00	16.90	27.61
2	PB-1231	65.50	96.50	115.75	7.80	69.60	4.83	38.95	25.70	12.00	32.16
3	PB-1232	68.00	98.00	122.40	9.85	74.40	5.06	44.05	26.85	18.05	35.75
4	PB-1240	70.50	104.00	138.80	13.48	76.05	4.63	32.65	25.10	21.13	32.19
5	PB-1241	71.00	103.50	133.15	14.35	72.90	4.60	36.10	28.85	20.95	31.71
6	PB-1349	64.50	98.00	150.15	15.79	72.00	6.08	31.95	16.80	12.85	30.10
7	PB-1355(S)	59.50	92.00	118.15	11.25	71.85	6.60	33.20	17.00	14.05	32.62
8	PB-1355(B)	58.50	92.50	115.75	13.90	71.80	6.71	34.40	16.90	13.75	30.99
9	PB-1389	58.50	92.50	97.85	9.20	72.35	5.15	35.10	26.95	16.15	32.58
10	PB-1403	59.50	94.00	126.50	10.50	72.20	4.19	39.30	25.35	15.95	29.32
11	PB-1424	63.50	95.50	117.35	8.90	70.70	5.90	36.10	21.00	15.55	28.73
12	PB-1462	59.50	90.00	89.95	11.58	72.20	5.11	36.65	18.05	17.70	31.93
13	PB-1461	63.50	94.00	118.35	11.17	71.30	4.62	29.90	29.10	15.15	31.62
14	PB-1457	61.00	92.50	100.95	8.22	69.20	5.17	38.75	21.45	12.50	29.97
15	PB-1456	63.00	97.00	105.85	10.06	74.05	5.73	48.10	15.40	19.85	31.90
16	PB-1443	60.50	92.50	118.85	9.95	70.35	4.56	37.40	28.15	13.90	35.66
17	PB-1429	66.50	104.50	111.85	12.00	71.40	3.71	37.05	33.95	17.95	27.77
18	PB-1530	61.50	91.50	124.35	10.60	75.55	4.67	41.95	26.35	19.10	32.76
19	PB-1528	47.00	84.50	126.80	12.40	72.65	3.93	36.55	27.25	18.70	33.31
20	PB-1600	65.50	102.50	135.40	10.65	75.25	4.21	32.65	25.15	23.85	33.72
21	PB-1599	68.50	102.00	124.35	13.55	76.80	6.01	38.45	35.95	24.40	33.26
22	PB-1556	72.00	101.50	121.20	10.95	71.95	6.03	33.05	17.00	16.00	36.31
23	PB-1609	59.00	93.50	120.45	17.25	73.85	5.97	42.15	16.05	20.20	31.60
24	PB-1617	61.50	91.50	122.85	15.90	76.90	4.42	36.30	28.10	22.10	35.10
25	PB-1627	56.50	89.50	86.55	10.95	78.25	4.58	33.55	14.10	29.10	29.94
26	PB-1643	59.00	90.50	99.65	7.05	70.85	5.01	30.90	18.20	12.70	36.35
27	PB-1644	63.50	93.00	100.55	8.20	77.85	6.08	33.30	14.40	16.80	30.09
28	PB-1645	61.50	95.50	109.00	14.60	78.40	4.14	30.15	28.10	21.75	34.20
29	PB-1646	68.00	101.50	116.05	10.35	75.80	5.81	32.35	22.10	14.65	39.62
30	PB-434	69.00	98.50	143.10	13.05	83.65	6.07	39.95	17.70	27.75	39.65
31	PB-500	61.50	90.50	141.85	18.50	84.60	5.94	47.30	17.75	29.90	43.37
32	PB-253	69.50	98.50	119.35	11.40	80.10	3.76	34.45	33.35	23.05	40.33
33	PB-304	68.00	99.50	92.95	11.30	71.05	6.78	37.50	15.80	14.80	38.53
34	PB-243	66.00	100.50	137.95	11.87	76.50	5.20	39.95	23.90	21.65	36.59
35	PB-171	56.50	86.00	129.95	14.00	71.00	5.33	36.30	19.20	16.40	31.21
36	PB-44	58.50	92.50	131.75	10.70	75.80	6.30	43.45	19.80	18.70	34.00
37	PB-1	47.50	78.50	169.15	20.90	87.25	6.80	35.40	16.45	38.45	39.13
38	PB-15-20	50.50	79.50	169.85	17.25	86.70	6.85	41.30	14.75	40.70	35.00
39	LSF-08 (C)	53.50	82.50	92.70	9.50	80.90	6.67	31.40	27.95	24.85	30.02

Sr. No.	Genotypes	Days to 50 per cent flowering	Days to maturity	Plant height (cm)	Head diameter (cm)	Seed filling (%)	100 seed weight (g)	Volume weight (g/100ml)	Hull content (%)	Seed yield per plant (g)	Oil content (%)
40	SS-2038 (C)	54.50	84.50	115.50	10.65	79.70	6.75	25.40	28.20	24.15	28.64
	Grand mean	61.79	93.94	120.94	11.98	75.12	5.39	36.81	22.66	19.85	33.38
	SE (\pm)	1.67	1.86	4.55	0.76	1.38	0.34	0.92	0.73	0.60	0.52
	CD 5 %	4.77	5.33	13.03	2.16	3.95	0.97	2.64	2.08	1.71	1.49
	CV	3.82	2.81	5.33	8.92	2.60	8.93	3.55	4.54	4.27	2.21

Table 3. Parameters of genetic variability for yield and yield contributing characters

Sr. No.	Characters	Mean	Range	Genotypic variance	phenotypic variance	Environmental variance	GCV (%)	PCV (%)	ECV (%)	Heritability in broad sense (H^2) (%)	Genetic Advance	Genetic Advance as % of mean
1	Days to 50 per cent flowering	61.79	47.00 -72.00	33.62	39.19	5.57	9.38	10.13	3.82	85.79	11.06	17.91
2	Days to maturity	93.94	78.50 -104.50	38.40	45.35	6.95	6.60	7.17	2.81	84.68	11.75	12.51
3	Plant height (cm)	120.94	86.55 - 169.85	335.47	376.95	41.48	15.14	16.05	5.33	89.00	35.59	29.43
4	Head diameter (cm)	11.98	7.05 - 20.90	8.68	9.83	1.14	24.59	26.16	8.92	88.37	5.71	47.62
5	Seed filling (%)	75.12	69.20 - 87.25	19.75	23.57	3.82	5.92	6.46	2.60	83.80	8.38	11.16
6	100 seed weight (g)	5.39	3.71 - 6.85	0.87	0.89	0.01	17.35	17.50	2.25	98.34	1.91	35.44
7	Volume weight (g/100ml)	36.81	25.40 - 49.05	25.54	27.25	1.71	13.73	14.18	3.55	93.73	10.08	27.38
8	Hull content (%)	22.66	14.10 - 35.95	34.85	35.90	1.06	26.06	26.45	4.54	97.07	11.98	52.88
9	Seed yield per plant (g)	19.85	12.00 - 40.70	41.65	42.37	0.72	32.51	32.79	4.27	98.31	13.18	66.40
10	Oil content (%)	33.38	12.00 - 40.70	13.60	14.15	0.55	11.05	11.27	2.21	96.15	7.45	22.32

GCV = Genotypic coefficient of variation, PCV = Phenotypic coefficient of variation, ECV = Environmental coefficient of variation

3.4 Heritability and Genetic Advance as Per Cent of Mean

The estimates of heritability and expected genetic advance for various characters studied are shown in (Table 3) and (Fig.1). For the ten characters under the investigation heritability ranged from 83.80 % for seed filling to 98.34 % for 100 seed weight. The heritability estimates (broad sense) were high for 100 seed weight (98.34%) followed by seed yield per plant (98.31%), hull content (97.07%), oil content (96.15%), volume weight (93.73%), plant height (89.00%), head diameter (88.37%), days to 50 per cent flowering (85.79%), days to maturity (84.68%) and seed filling (83.80%). Higher estimates of genetic advance were observed for plant height (35.59) followed by seed yield per plant (13.18), hull content (11.98), days to maturity (11.75), days to 50 per cent flowering (11.06), volume weight (10.08), seed filling (8.38), oil content (7.45), head diameter (5.71), while least genetic advance recorded for 100 seed weight (1.91).

High heritability with high genetic advance was reported for plant height, head diameter, 100

seed weight, volume weight, seed yield per plant, hull content and oil content, whereas high heritability accompanied with low genetic advance were found in rest of the characters like days to 50 per cent flowering, days to maturity and seed filling percentage. Similar results were reported by Sujatha et al. (2002) for plant height and seed yield per plant. Arshad et al. (2010) for days to flower initiation, days to maturity, plant height and seed yield. Kalukhe et al. (2010) also reported similar results for seed yield per plant, oil content and plant height.

The perusal of genetic advance as per cent of mean revealed that it ranged from 11.16 % (seed filling percentage) to 66.40 % (seed yield per plant). The result showed that seven attributes namely seed yield per plant (66.40 %), hull content (52.88 %), head diameter (47.62 %), 100 seed weight (35.44 %), plant height (29.43 %), volume weight (27.38 %) and oil content (22.32 %) exhibited high genetic advance as per cent of mean (> 20 %). Although, the traits days to 50 per cent flowering (17.91 %), days to maturity (12.50 %) and seed filling percentage (11.16 %) showed moderate genetic advance as per cent of mean (10 % - 20 %).

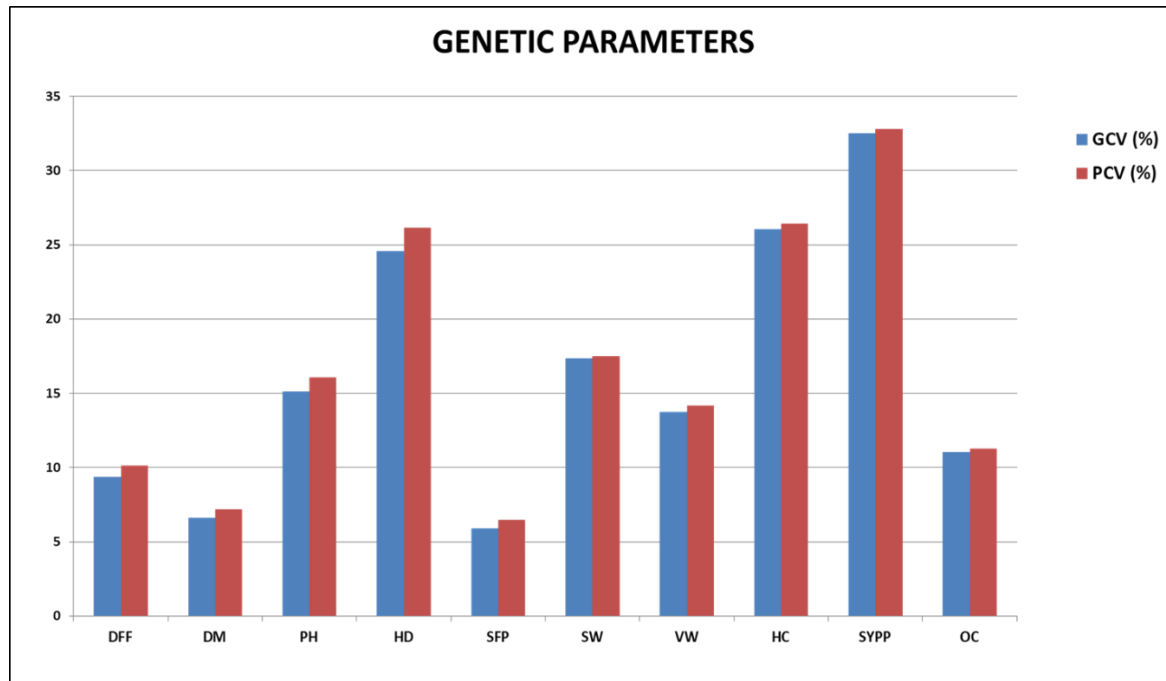


Fig. 1. Genotypic and phenotypic coefficient of variation for ten characters in sunflower

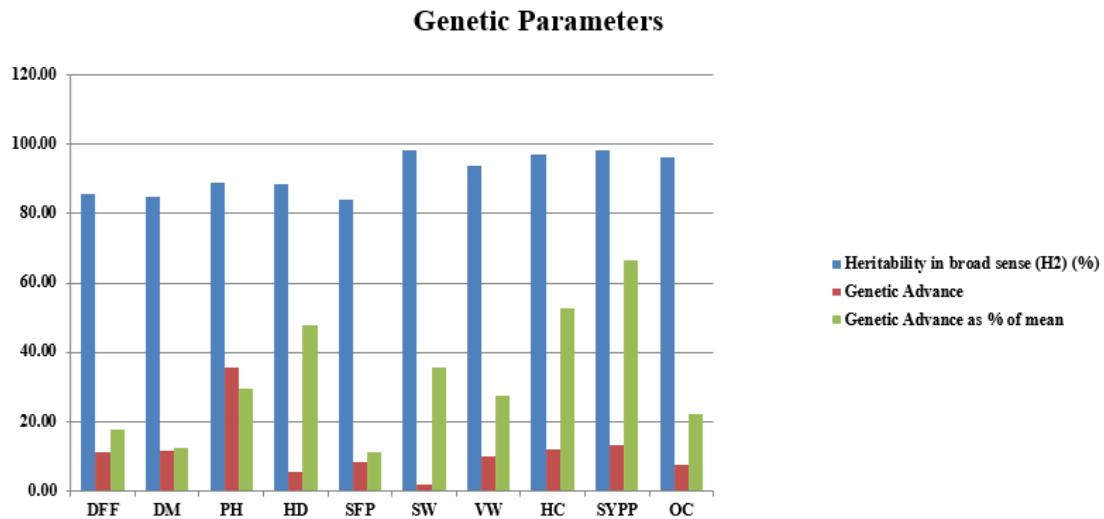


Fig. 2. Heritability and Genetic advance as per cent of mean for ten characters in sunflower

4. CONCLUSION

The results of the present study indicate that there was considerable genetic variability among the genotypes for most of the traits examined. Considerable variation was observed in the heritability estimates across all the traits under investigation. The highest genetic advance in absolute terms was recorded for plant height and seed yield per plant suggesting substantial scope for improvement through selection. High heritability estimates accompanied with high genetic advance as a percentage of the mean were observed for traits such as seed yield per plant, plant height, head diameter, 100 seed weight and oil content. This combination suggests that the expression of these traits is primarily governed by additive gene effects. Consequently, selection based on these traits is likely to be effective leading to significant genetic improvement in subsequent generations.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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