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Research Article

Genetic analysis of variability, heritability and genetic advance in F_3 populations of sunflower *(Helianthus annuus* L.)

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Abstract
The field experiment was carried out by using 46 sunflower progenies of two cross combinations (COSF6B x CMS 335B and COSF7B x 343 B) of F_3 generation at Department of Oilseeds, CPBG, TNAU, Coimbatore during *kharif* 2018 to study the genotypic coefficient of variation, phenotypic coefficient of variation, heritability and genetic advance. The analysis of variance imparted significant differences for all the characters. In the B (maintainer) line development programme, the characters like head diameter, percent disease index (PDI), seed yield per plant, 100 seed weight, volume weight and oil yield in both the populations recorded high heritability associated with high genetic advance, whereas the traits; days to flowering and days to maturity showed low values of GAM in both the populations. The results indicated that the characters with high heritability and high or moderate genetic advance can be further improved with individual plant selection, whereas characters with high heritability and low genetic advance indicated little scope for further improvement through individual plant selection.

Keywords
Sunflower, heritability, genetic advance, genotypic coefficient of variation, phenotypic coefficient of variation.

Introduction

Oilseeds play an important role in human diet as a source of vitamin E, which is the primary fat–soluble antioxidant. Among the oilseeds crop, sunflower is highly preferred by consumers due to the presence of Poly Unsaturated Fatty Acids (PUFA) – 55 to 60% linoleic acid and 25 to 30% oleic acid, which is good for heart patients to reduce the risk of cardiac arrest. Sunflower *(Helianthus annuus* L.) is commonly called as "golden girl of American Agriculture", which belongs to the family Asteraceae with chromosome number (2n = 34). The total area under sunflower in the world is about 25.82 million hectares and the production is about 48.01 million metric tonnes with yield of 1.86 metric tonnes / ha. In India, it occupies area of about 0.39 million hectares with production of 0.32 million metric tonnes and along with yield of 0.82 metric tonnes/ha Anonymous (2019). Even though, the sunflower is the second most potential oilseed crop, the exploitation of genetic variability is an important tool for any successful breeding programme for further genetic upgradation of a crop. The presence of variability in the crop species is indirectly measured by using the magnitude of variability. And the study of heritability helps in partitioning the heritable and non – heritable components, which is needed for effective selection. In addition, genetic advance paves the way for noble selection in segregating generation. Hence, instead of estimating the heritability alone, heritability along with genetic advance as percent of mean is quite useful in predicting the precise value of gene action responsible for valuable selection. The variability found for various characters is compared with the support of genotypic co-efficient of variation (GCV) and phenotypic co-efficient of variation (PCV). Hence, the present study has been carried out to study PCV, GCV, heritability and genetic advance.

Materials and Methods

The experimental material comprised of 46 progenies of two cross combinations (for B line development) of F_3 population along with four parents (COSF6B, COSF7B, CMS 335B, 343B) and four checks (Morden, COSV5, TNAU CO2 Hybrid and COH3). The experiment was conducted by using Augmented Design-I with the progenies, which were raised in single progeny row along with four replications of checks in Department of Oilseeds, CPBG, TNAU, Coimbatore during *kharif* 2018. Being a self-incompatible crop, the selfing was done by covering the individual head with

muslin cloth on previous day of flower opening to maintain the seed set for F_4 generation. Hand rubbing has been done every day while opening of every whorl of flower head for promising seed set. Biometrical characters like; days to first flowering and powdery mildew percent disease index were recorded during flowering stage. During maturity stage characters like; days to maturity, plant height and head diameter were recorded. The other characters such as 100 seed weight, volume weight, seed yield per plant, oil content and oil yield were recorded after harvest. Statistical analysis of data was performed to determine the significant effect and genetic variability. The analysis of variance was worked out as per Sharma (2006). Heritability and genetic advance was calculated as per Allard (1960).

Results and Discussion

The results obtained were presented in Table 1 to 3. The analysis of variance imparted the significant differences for all biometrical characters contributing to yield, which has been observed from their mean sum of squares in two cross combinations (Table 1 and 2). This revealed that the sufficient variation was present in the experiment material taken for study. Adequate amount of variability has been found for selection of desirable type. The estimation of mean, range, variability parameters, heritability and genetic advance as percent of mean were assessed for ten characters were presented in the Table 3.

The high PCV was recorded for head diameter (29.02%), percent disease index (34.99%), seed yield per plant (34.74%), 100 seed weight (36.77%), volume weight (23.43%) and oil yield (40.41%) and high estimate of GCV was recorded for head diameter (28.61%), percent disease index (34.59%), seed yield per plant (32.88%), 100 seed weight (35.76%), volume weight (21.81%) and oil yield (38.55%) in F_3 population of COSF6B x CMS 335B suggesting that these characters were under genetic control. The high estimate of PCV was recorded for percent disease index (20.24%), seed yield per plant (25.02%), 100 seed weight (24.93%), volume weight (28.48%) and oil yield (30.46%), whereas high GCV was noticed for seed yield per plant (23.15%), 100 seed weight (23.89%), volume weight (27.15%) and oil yield (28.53%) in F_3 population of COSF7B x 343 B indicated presence of variability, suggesting that these traits were under genetic control. Mijić *et al.* (2009) found that the values of PCV and GCV were found high for grain yield and oil yield. Similar results of high PCV and GCV were reported for seed yield per plant and 100 seed weight by Neelima *et al.* (2012), Rani (2016), Supriya *et al.* (2016) and Chandirakala *et al.* (2017) for seed yield, while oil content by Adare (2014) and Baraiya and Patel (2018).

High heritability was recorded for days to first flowering (98.22%), days to maturity (99.10%), plant height (97.35%), head diameter (97.21%), percent disease index (97.73%), seed yield per plant (89.62%), 100 seed weight (94.59%), volume weight (86.62%), oil content (80.68%) and oil yield (91%) in F_3 population of COSF6B x CMS 335B. Similarly, high heritability was recorded for days to first flowering (96.05%), days to maturity (99.56%), plant height (94.90%), head diameter (89.16%), percentage of disease incidence (95.80%), seed yield per plant (85.57%), 100 seed weight (91.85%), volume weight (90.88%), oil content (90.95%) and oil yield (87.76%) in F_3 population of COSF7B x 343B, indicating the genetic ability to transmit genes to their progenies with less influence of environment on these traits. Similar results of high heritability was reported for days to 50% flowering, 100 seed weight and days to maturity by Neelima *et al.* (2012); for plant height, volume weight, test weight, days to 50% flowering, oil content, seed yield per plant, head diameter and days to maturity by Supriya *et al.* (2016), for plant yield, oil yield, oleic acid content,100- seed weight and plant height by Chandirakala *et al.* (2017) and high heritability was imparted by other characters like plant height,1000-seed weight and oil yield reported by Khan *et al.* (2007).

High genetic advance was recorded for plant height (25.03%), head diameter (58.11%), percent disease index (70.45%), seed yield per plant (64.13%), 100 seed weight (71.65%), volume weight (41.81%) and oil yield (75.75%) in F_3 population of COSF6B x CMS 335B. High heritability was recorded for head diameter (23.23%), percent disease index (39.94%), seed yield per plant (44.11%), 100 seed weight (47.17%), volume weight (53.32%), oil content (23.27%) and oil yield (55.06%) in F_3 population of COSF7B x CMS 343B. This suggested that more effectiveness for selection and improvements expected for these traits in future breeding programme as estimated from GAM. This results of high GAM was confirmed with the findings of Chandirakala *et al.* (2017) for oil yield, single plant yield, 100-seed weight and oleic acid content. Rani (2016) noticed that the value of genetic advance as percent of mean was reported as high for seed yield per plant, plant height, head diameter, 100- seed weight, seed filling percent, hull content and protein content.

The traits *viz.*, head diameter, percent disease index, seed yield per plant, 100 seed weight, volume weight and oil yield in both the populations

recorded high heritability associated with high genetic advance which indicated that heritability is due to the effect of additive gene and these traits were least influenced by environmental effects and selection based these characters would be rewarding. The results were in line with the findings of Iqbal *et al.* (2013) for total leaf area and achene yield per plant; Adare (2014) for days to maturity, plant height, yield and oil content; Supriya *et al.* (2016) for plant height, head diameter, test weight, seed yield per plant and volume weight and Rani (2016) for seed yield per plant, plant height, stem girth, seed filling percentage and 100 seed weight.

The results indicated that among the ten characters studied for variability, the characters *viz*., days to flowering and days to maturity showed low values of GAM for both the crosses, hence, selection for these characters are not effective, whereas the traits plant height, head diameter, percent disease index, seed yield per plant, 100 seed weight, volume weight and oil yield in both the populations recorded high heritability associated with high genetic advance. Hence, the characters with high heritability and high or moderate genetic advance can be further improved with individual plant selection whereas the characters with high heritability and low genetic advance (non-additive gene action) indicated little scope for further improvement through individual plant selection.

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Table 1. ANOVA for ten characters in 11 progenies in F_3 generation (COSF6B x CMS 335B)

Source of Variation	D. F.	Days to flowering (days)	Days to maturity (days)	Plant height (cm)	Head diameter (cm)	PDI (%)	100 seed weight (g)	Volume weight (g/100 ml)	Seed yield (g/plant)	Oil content (%)	Oil yield (g/plant)
Treatments	14	30.9366**	13.1209**	688.7857**	9.2181**	581.6254**	2.0577**	118.1866**	68.1248**	21.6832**	10.2674**
Checks	3	136.314	34.0358	2240.116	5.1102	1661.381	3.329	35.0411	21.3806	61.3105	1.2247
T. Entry	10	2.2139**	4.3761**	279.9453**	8.4979**	96.9169**	1.8811**	134.6659**	74.3866**	9.2011**	13.8702**
CHK *vs* TEST	1	2.0318	37.8245	123.1986	28.7436	2189.444	0.0101	202.8309	145.7401	27.6223	1.3674
Error	12	0.0181	0.0025	5.6675	0.47	1.4804	0.0729	2.6005	2.3953	1.1431	0.9656

** Significant at 1% level of probability

Table 2. ANOVA for ten characters in 35 progenies in F_3 generation (COSF7B x 343 B)

Source of Variation	D. F.	Days to flowering (days)	Days to maturity (days)	Plant height (cm)	Head diameter (cm)	PDI (%)	100 seed weight (g)	Volume weight (g/100 ml)	Seed yield (g/plant)	Oil content (%)	Oil yield (g/plant)
Treatments	38	12.4739**	14.9283**	381.2824**	4.7936**	99.4595**	1.4422**	82.7495**	203.0606**	21.8225**	37.3246**
Checks	3	146.5223	57.9556	3145.363	21.7216	647.4693	2.4961	100.1447	1006.248	41.62	190.7177
T. Entry	34	0.998**	9.0394**	145.5694**	2.1857**	52.2727**	1.249**	81.6847**	53.5077**	19.653**	10.193**
CHK *vs* TEST	1	0.5084	86.0709	103.2845	42.6779	59.7815	4.8477	66.7696	2878.296	36.1947	499.6193
Error	12	0.0394	0.0394	7.4279	0.2369	2.1957	0.1018	7.4485	7.7188	1.7781	1.2481

Table 3. Mean, Range, variability parameter, heritability and genetic advance as percent mean for ten characters

Characters	Cross	Mean	Range	Minimum	Maximum	GCV (%)	PCV (%)	Heritability (%)	GA	GAM (%)
Days to	1	56.98	4.17	55.67	59.83	2.59	2.61	98.22	3.01	5.28
Flowering (days)	2	56.63	3.83	55.00	58.83	1.73	1.76	96.05	1.98	3.49
Days to	1	87.05	7.33	84.17	91.50	2.39	2.40	99.10	4.27	4.91
Maturity (days)	2	85.54	11.83	80.17	92.00	3.51	3.51	99.56	6.17	7.21
Plant height	1	134.07	57.67	105.00	162.67	12.31	12.48	97.35	33.55	25.03
(cm)	2	143.21	56.40	112.10	168.50	8.21	8.42	94.90	23.59	16.47
Head diameter	1	10.05	9.33	7.67	17.00	28.61	29.02	97.21	5.84	58.11
(cm)	2	11.69	6.97	9.53	16.50	11.94	12.65	89.16	2.72	23.23
PDI (%)	1	28.14	37.65	0.00	37.65	34.59	34.99	97.73	19.82	70.45
	2	35.73	26.17	23.33	49.51	19.81	20.24	95.80	14.27	39.94
Seed yield (g/plant)	1	24.83	29.66	9.57	39.23	32.88	34.74	89.62	15.92	64.13
	2	29.23	29.73	15.32	45.04	23.15	25.02	85.57	12.89	44.11
100 seed weight	1	3.73	4.24	2.62	6.86	35.76	36.77	94.59	2.67	71.65
(g)	2	4.48	4.91	2.43	7.34	23.89	24.93	91.85	2.11	47.17
Volume weight	1	33.24	24.61	17.89	42.50	21.81	23.43	86.62	13.31	41.81
(g/100ml)	2	31.74	39.62	12.50	52.12	27.15	28.48	90.88	16.92	53.32
Oil content (%)	1	36.50	10.74	32.26	43.00	7.46	8.31	80.68	5.04	13.81
	2	35.70	28.53	16.37	44.90	11.84	12.42	90.95	8.31	23.27
Oil yield (g/plant)	1	9.22	12.22	3.44	15.66	38.55	40.41	91.00	6.98	75.75
	2	10.48	11.68	5.40	17.08	28.53	30.46	87.76	5.77	55.06

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