Madras Agric. J., 104 (4-6): 114-117, June 2017

Genetic Variability and Association Studies in RIL Population of Sunflower (*Helianthus annuus* L.)

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The present investigation was carried out to study variability and association among yield and its component traits in RIL population of sunflower. The investigation was carried out at Tamil Nadu Agricultural University, Coimbatore. Observations were recorded for nine characters *viz*., plant height, head diameter, volume weight, 100 seed weight, seed yield per plant, oil content, oleic acid content, linoleic acid content and oil yield per plant. Variability studies revealed high PCV for Plant height, head diameter, 100 seed weight, seed yield per plant, oleic acid content, linoleic acid content and oil yield per plant. High GCV was observed for plant height, 100 seed weight, seed yield per plant, oleic acid content, linoleic acid content and oil yield per plant. High heritability and high genetic advance as percentage of mean were recorded for the traits plant height, volume weight, 100 seed weight, seed yield per plant, oleic acid content and linoleic acid content. Oil yield per plant showed positive correlation with plant height, head diameter, volume weight, 100 seed weight, oil content, seed yield per plant. Seed yield per plant had significant and positive correlation with plant height, head diameter, volume weight, 100 seed weight and linoleic acid content. Plant height, head diameter, 100 seed weight and seed yield per plant are important selection indices for oil yield improvement programme.

Key words : Sunflower, Variability, Correlation, Path analysis.

Sunflower (*Helianthus annuus.* L) is one of the important oilseed crop in the world. It is native to North America and belongs to the family Asteraceae (Compositae). The genus name *Helianthus* is derived from two Greek words namely *Helios* means “sun” and *anthos* means “flower”. It is successfully grown over a widely scattered geographical area and considered as a crop adapted to a wide range of environmental conditions (Ekin *et al.* 2005). Sunflower is the third major source of vegetable oil in the world after soybean and groundnut. Seeds of the oilseed varieties are rich source of edible oil (40 to 45%), it is considered as good from health point of view due to high concentration of polyunsaturated fatty acids (PUFA), 55 to 60 per cent linoleic and 25 to 30 per cent oleic acid. They are known to reduce the risk of coronary disease by regulating the cholesterol content in blood plasma. It also acts as good source of vitamin E, lecithin and carotenoids. Sunflower production is lagging behind in terms of supply because of increasing population and lack of high yielding cultivars. To meet the demand there is a need to increase the production without increase in the acreage. The Best way to meet out the increasing demand is to develop high yielding cultivars. Variability helps in better understanding of breeding behaviour of various traits and to assess the character of importance for choosing best cultivars. It is also essential to know type and magnitude of association of yield and yield contributing traits. Correlation studies help in knowing type of association between the characters. Path analysis helps in knowing magnitude of association and divides effects of various traits into direct and indirect effects (Wright, 1921).

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Material and Methods

The present investigation was carried out with 129 recombinant inbred lines (RIL) in F_{11} generation of a cross 17B x 7-1B. The parent 17B has low oil content (30 - 33%) with medium brown seed color and prominent stripes on both the seed surfaces. The parent 7-1B has high oil content (35 - 38%) with black seed color and non striped seed surface. The hybrids *viz.,* Sunbred 275, Hybrid CO 2, DRSH 1 and a variety COSFV 5 were used as checks. These RILs were evaluated along with checks in augumented block design I. The field experiment was carried out at the Department of Oilseeds, Centre for Plant Breeding and Genetics, Tamil Nadu Agricultural University, Coimbatore during *kharif* 2016. Observations were recorded for plant height(cm), head diameter(cm), volume weight(g/100m), 100 seed weight(g), seed yield per plant(g), oil content(%), oleic acid content(%), linoleic acid content(%) and oil yield per plant(g). The oil content was estimated using BRUKER MATRIX-I NIR spectrometer.

Results and Discussion

Genetic variability

Analysis of variance (Table 1) revealed high

significant difference among all genotypes for all characters. This indicated presence of high variability among all genotypes for all traits. Variability helps to choose a potential cross since it indicates the extent of recombination for initiating effective selection procedures. The genetic parameters were presented in the Table 2. High PCV was observed for plant height(23.23), head diameter(22.33), 100 seed weight (31.24), seed yield per plant(58.38), oleic acid content(24.33), linoleic acid content(35.26).

Table 1. Analysis of variance of RIL population of 17B x 7-1B for various characters

Source of variation	Degrees of freedom	Plant height (cm)	Head diameter (cm)	Volume weight (g/100ml)	100 seed weight (g)	Seed yield per plant (g)	Oil content (%)	Oleic acid content (%)	Linoleic acid content (%)	Oil yield per plant (g)
Treatment	132	969.14*	8.87*	21.92*	2.17*	274.32*	8.12*	165.63*	241.14*	33.99*
Checks	3	1171.50 *	4.13	18.70*	3.35*	457.68*	12.15*	380.19*	338.14	69.98*
Test Entry	128	768.84 *	8.64*	17.22*	2.13*	217.28*	6.92*	146.18*	192.56*	24.55*
Checks Vs Test Entry	1	26000.32*	51.68	632.73*	3.71	7025.54*	149.33	2011.26	5528.36	1134.14*
Error	12	87.41	3.99	0.72	0.24	14.60*	0.9	39.23	53.62	2.81
Total	144									

*, - Significance at 5%

and oil yield per plant(58.68). These results were in agreement with Sridhar *et al*. (2006) Mijic *et al*. (2009) and Dhillon *et al*. (2011). Moderate and low PCV was observed for volume weight(12.42) and oil content(7.37). This result was in agreement with the report of Mijic *et al*. (2009), Dhillon *et al.* (2011).

Table 2. Variability parameters of various traits for RIL population of 17B x 7-1B

Traits	Mean	Min	Max	PCV(%)	GCV(%)	h2(%)	GAM(%)	Skewness	Kurtosis
Plant height(cm)	119.34	63.10	198.7	23.23	21.87	88.63	42.42	0.17 *	-0.16
Head diameter(cm)	13.17	6.20	21.40	22.33	16.37	53.76	24.73	0.19 *	0.19 *
Volume weight(g/100ml)	33.40	21.41	50.00	12.42	12.16	95.78	24.51	0.13 *	1.94 *
100 seed weight(g)	4.68	1.52	9.45	31.24	29.39	88.50	56.96	0.87 *	0.86 *
Seed yield per plant(g)	25.25	1.74	81.90	58.37	56.38	93.28	28.32	1.45 *	2.80 *
Oil content (%)	33.27	26.36	40.19	7.91	7.37	86.90	14.16	0.13 *	-2.45
Oleic acid (%)	49.70	26.15	85.28	24.33	20.81	73.16	36.66	0.51 *	0.05 *
Linoleic acid (%)	39.87	5.72	70.12	35.26	30.09	72.86	52.91	-0.30	-0.49
Oil yield per plant (g)	8.44	0.45	28.80	58.68	55.21	88.53	9.03	1.35 *	2.73 *

*, - Significance at 5%

High GCV values were observed for plant height(21.87), 100 seed weight(29.39), seed yield per plant(56.38), oleic acid content(20.81), linoleic acid content(30.09) and oil yield per plant(35.6). These results are in agreement with Makane *et al*. (2011). Moderate GCV values were head diameter(16.37) and volume weight(12.16). Low GCV was observed for oil content(7.37). These results are also in agreement with Tyagi and Tyagi (2011). These result indicated that sufficient level of variability were observed for most of the traits in this population. Hence selection can be carried out for those traits with high and moderate GCV.

The heritability and genetic advance provide the proportion of heritable variation and the genetic gain to be obtained in subsequent generations. High heritability was recorded for plant height(88.63), volume weight(95.78), 100 seed weight(88.5), oil content(86.9), seed yield per plant(93.28), oleic acid content(73.16), linoleic acid content(72.86) and oil yield per plant(88.51). Moderate heritability was observed for head diameter(53.76). These results are also in agreement with Jagadeesan *et al*. (2008). Low heritability value was not observed for any trait. High heritability and high genetic advance as percentage of mean were recorded for the traits plant height(42.42), volume weight(24.51), 100 seed weight(56.96), seed yield per plant(28.32), oleic acid content(36.66) and linoleic acid content(52.91). High heritability and high genetic advance as percentage of mean indicates the presence of additive gene action. Directional selection for these traits would be more effective for desired genetic improvement. These results are also in agreement with Sridhar *et al*. (2006), Sujatha and Vishnuvardhan Reddy (2009), Janamma *et al*.

(2009) and Makane *et al*. (2011), Sudrik *et al*. (2014), Amin *et al*. (2016). High heritability and low genetic advance as per cent of gain was observed for oil yield per plant. Among the traits, all traits showed positive skewness and only linoleic acid showed no skewness indicating normal distribution of population for linoleic acid content. In case of kurtosis the characters *viz.,* volume weight (1.94), seed yield per plant (2.80) and oil yield per plant (2.73) showed leptokurtic nature. This indicated the presence of wider variability for these traits so directional selection may improve per se performance of these traits.

Table 3. Simple Correlation coefficients between oil yield and yield component characters in RIL population of 17B x 7-1B

Traits	Mean	Min	Max	PCV(%)	GCV(%)	h2(%)	GAM(%)	Skewness	Kurtosis
Plant height(cm)	119.34	63.10	198.7	23.23	21.87	88.63	42.42	0.17 *	-0.16
Head diameter(cm)	13.17	6.20	21.40	22.33	16.37	53.76	24.73	0.19 *	0.19 *
Volume weight(g/100ml)	33.40	21.41	50.00	12.42	12.16	95.78	24.51	0.13 *	1.94 *
100 seed weight(g)	4.68	1.52	9.45	31.24	29.39	88.50	56.96	0.87 *	0.86 *
Seed yield per plant(g)	25.25	1.74	81.90	58.37	56.38	93.28	28.32	1.45 *	2.80 *
Oil content (%)	33.27	26.36	40.19	7.91	7.37	86.90	14.16	0.13 *	-2.45
Oleic acid (%)	49.70	26.15	85.28	24.33	20.81	73.16	36.66	0.51 *	0.05 *
Linoleic acid (%)	39.87	5.72	70.12	35.26	30.09	72.86	52.91	-0.30	-0.49
Oil yield per plant (g)	8.44	0.45	28.80	58.68	55.21	88.53	9.03	1.35 *	2.73 *

*, ** - Significance at 5% and 1%

A study on the nature and degree of association of component characters with oil yield assumes greater importance for fixing up characters that play a decisive role in influencing yield. Simple correlation between oil yield and yield components were presented in the Table 3. Oil yield per plant showed positive and significant correlation with plant height, head diameter, volume weight, 100 seed weight, oil content and seed yield per plant. These results were confirmed with the earlier findings of Sridhar *et al*. (2005), Vidhyavathi *et al.* (2005), Ravi *et al.* (2006), Sowmya *et al*. (2010) and Muthupriya *et al*.(2016). Seed yield per plant had significant and positive correlation with plant height, head diameter, volume weight and 100 seed weight. These results were confirmed with the earlier findings of Manivannan *et al.* (2007), Kalukhe *et al.* (2010), Neelima *et al*. (2012).

Table 4. Path coefficients of oil yield with various traits in RIL population of 17B x 7-1B

Characters	Head diameter (cm)	Volume weight (g/100ml)	100 seed weight (g)	Seed yield per plant (g)	Oil content (%)	Oleic acid content (%)	Linoleic acid content (%)	Oil yield per plant (g)
Plant height(cm)	0.70 **	0.20 *	0.46 **	0.59 **	0.07	0.33 **	-0.11	0.59 **
Head diameter (cm)		0.03	0.57 **	0.61**	-0.35 **	0.48 **	-0.32 **	0.58 **
Volume weight (g/100ml)			0.30 **	0.20 *	0.23**	0.22 *	-0.04	0.22 *
100 seed weight(g)				0.45 **	0.1	0.50 **	-0.31 **	0.46 **
Seed yield per plant (g)					0.11	0.14	0.06	0.98 **
Oil content (%)						-0.16	0.25 **	0.24 **
Oleic acid content (%)							-0.85 **	0.12
Linoleic acid content (%)								0.09

*, ** - Significance at 5% and 1%

Plant height had positive and significant correlation with head diameter, volume weight, 100 seed weight and oleic acid content. These results were similar to the findings of Binodh *et al*. (2008) and Dan *et al*. (2012). Head diameter had positive and significant correlation with 100 seed weight and oleic acid content and it had negative significant correlation with oil content and linoleic acid content. Similar results were reported by Rehman *et al*. (2012), Zia ullah *et al*. (2013) and Sincik *et al*. (2014). Volume weight had positive significant correlation with 100 seed weight, oil content, oleic acid content. These results were confirmed with the findings of Vidhyavathi *et al*. (2005) and Anandhan. (2010). The traits 100 seed weight and oil content had significant and positive correlation with oleic acid content and linoleic acid content respectively. These results were confirmed with findings of Anandhan. (2010) and Tyagi and Khan (2013). From the foregoing discussion on character analysis it might be concluded that the traits *viz.,*

plant height, head diameter, volume weight, 100 seed weight and oil content were important selection indices for both oil and seed yield improvement.

Path analysis

Path coefficient analysis permits the separation of direct and indirect effects by partitioning the simple correlation coefficients. It provides a clear picture of the characters that can be relied upon in a selection programme for improvement. The direct and indirect effects of various traits on oil yield per plant are tabulated in Table 4.

Seed yield per plant recorded highest positive direct effect on oil yield per plant. Oil content had low direct effect as reported by Binodh *et al*. (2008). Head diameter, plant height and 100 seed weight had high indirect effect via seed yield per plant on oil yield per plant. Remaining traits had negligible effects.

From the foregoing discussion on correlation and path analysis, it can be concluded that the traits plant height, head diameter, 100 seed weight and seed yield are important selection indices for oil yield improvement programme.

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Received after revision : April 24, 2017; Accepted : May 19, 2017