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Genetic Variability and Correlation among Seed Yield and Yield Attributing Traits in RIL Population of Sunflower (*Helianthus annuus* L.)

M. Muthupriya, N. Manivannan* and R. Chandirakala
Department of Oilseeds
Tamil Nadu Agricultural University, Coimbatore - 641 003

A recombinant inbred line (RIL) population was developed with high and low oil content genotypes in sunflower and used in the study. The phenotypic coefficient of variation (PCV) was high for the characters *viz*., oil yield per plant, seed yield per plant, 100-seed weight, head diameter and plant height. The genotypic coefficient variation (GCV) was high for the characters *viz*., oil yield per plant, seed yield per plant and 100-seed weight. Heritability was high for oil yield per plant, seed yield per plant, volume weight, plant height, 100-seed weight and oil content. High genetic advance as a percentage of mean was observed for the traits *viz*., oil yield per plant, seed yield per plant, 100-seed weight, plant height and volume weight. Positive skewness was observed for head diameter and 100-seed weight. No skewness was observed for other traits. In case of kurtosis, the traits *viz*., 100-seed weight and oil yield per plant recorded platykurtic nature. The trait oil content expressed leptokurtic nature. Correlation studies revealed that oil yield per plant had significant positive correlation with head diameter, 100-seed weight, volume weight, seed yield per plant and oil content. Oil content had significant positive correlation with seed colour. Head diameter had positive significant correlation with 100-seed weight and seed yield per plant. Black seed colour and non striped seed surface along with other yield component traits *viz*., head diameter, 100-seed weight, volume weight and seed yield per plant could be considered as selection indices for the development of high oil yielding sunflower genotypes.

Key words: Sunflower, Seed colour, Stripes, Variability, Correlation.

The family Compositae comprise a genetically diverse and ecologically successful plants comprising one tenth of all known flowering species (Heywood, 1978) and including more than 40 domesticated plants and many of the world's worst weeds. Predominant within the Compositae is the cultivated sunflower (*Helianthus annuus* L.), the only major crop plant native of North America (Harter *et al*., 2004) and one of the world's most important oilseed crops. It has now become the third major source of edible oil in the world after soybean and groundnut. The seeds of sunflower can be eaten either fresh or cooked or used to extract oil, which is widely used in cooking. The seeds are commonly harvested for bird seeds. Sunflowers are often grown as ornamental plants due to their large, attractive flower head. Sunflower oil is popular as healthy cooking oil due to its health benefits while the meal is used in animal feed industry. Among sunflower products, meal is the most traded in world market. Two types of sunflower are grown in the world: (1) those for oilseed production and (2) non-oilseed for the home and birdfeed markets. Seeds of the oilseed varieties are rich source of edible oil (32 to 42%), and considered as good from health point of view. The seed yield of sunflower (*Helianthus annuus* L.) is a complex character, which is highly influenced by environmental factors. Information on nature and magnitude of variability present in a population due to genetic and non genetic causes is an important prerequisite for systematic breeding programme. It is necessary to measure the mutual relationship between various plant characters and determine the component characters on which selection can be based for genetic improvement in any character. Thus, it helps to base selection procedure to a required balance where, two opposite desirable characters affecting the principal characters are being selected. It also helps to improve different characters simultaneously.

An attempt was made in the present investigation to assess the variability of quantitative characters and to assess the correlations among various yield attributes on oil yield per plant in a recombinant inbred line (RIL) population of sunflower.

Materials and Methods

The material of the present study comprises of 109 recombinant inbred lines (RILs) of the cross TNHSF239-68-1-1-1 x 17B. The parent TNHSF239-68-1-1-1 has high oil content (40-42%) with black seed colour and non-striped seed surface. The parent 17B has low oil content (< 35%) with brown seed colour and prominent stripes

*Corresponding author email: nmvannan@gmail.com

on seed surface. The field experiment was carried out at Department of Oilseeds, Centre for Plant Breeding and Genetics, Tamil Nadu Agricultural University, Coimbatore during rabi-summer 2015-16. Observations were recorded on five single plants for plant height (cm), head diameter (cm), 100-seed weight (g), volume weight (g/100 ml), seed yield per plant (g), oil content (%) and oil yield per plant (g). The oil content was estimated using BRUKER MATRIX-I NIR spectrometer.

Result and Discussion

Variability analysis

In crop plants, variability helps to choose a potential cross since variability indicates the extent of recombination for initiating effective selection procedures. Selection for the improvement of quantitative traits can be effective only when segregating generation posses the potential variability.

Table 1. Variability parameters for various traits in RIL population of TNHSF239-68-1-1-1 x 17B in sunflower

Characters	Mean	Minimum	Maximum	PCV (%)	GCV (%)	h^2 (%)	GAM (%)	Skewness	Kurtosis
Plant height (cm)	132.5	84.20	188.43	20.67	19.55	89.42	38.08	0.09	-0.31
Head diameter (cm)	13.32	8.20	21.50	21.61	12.85	35.37	15.74	0.75*	0.04
100-seed weight (cm)	5.09	3.00	8.00	25.39	23.27	84.02	43.95	0.57*	-0.40*
Volume weight (g/100ml)	32.60	20.00	44.00	16.62	15.96	92.26	31.59	-0.22	-0.68*
Seed yield per plant (g)	18.52	3.00	42.67	57.12	55.71	95.14	111.95	0.28	-0.90
Oil content (%)	35.86	30.70	41.78	6.55	5.39	67.57	9.12	0.01	0.60*
Oil yield per plant (g)	6.67	1.15	15.76	58.92	57.62	95.65	116.10	0.20	-1.08*

*Significance at 5% level

The probability of obtaining superior lines can be worked out in early generations through the estimates of first and second order degree of statistics (Jinks and Pooni, 1976).

The phenotypic coefficient of variation (PCV) and genotypic coefficient of variation (GCV) may provide an idea about the magnitude of variability. The phenotypic and genotypic coefficients of variation exhibited wide range for seven characters (Table 1). Seed yield per plant (57.12), oil yield per plant (58.92), head diameter (21.61), plant height (20.61) and 100-seed weight (25.39) had recorded high PCV values. These results were in agreement with Rao *et al*. (2003), Seneviratne *et al*. (2004), Sridhar *et al*. (2006), Mijic *et al*. (2009) Dhillon *et al*. (2011) and Premnath *et al*. (2014). Moderate PCV values were noticed for volume weight (16.62). These results were also in agreement with Sujatha *et al*. (2009), Dhillon *et al*. (2011) and Premnath *et al*. (2014). Low PCV value was observed for oil content (6.55).

The GCV values were high for the characters *viz*., seed yield per plant (55.71), oil yield per plant (57.62) and 100-seed weight (23.27). This was in agreement with Premnath *et al*. (2014). Moderate GCV values were noticed for plant height (19.55), volume weight (15.96) and head diameter (12.85). Low GCV was exhibited for oil content (5.39). These results were also in agreement with Premnath et al. (2014). These results indicated that sufficient level of variability was observed for most of the traits in this population. Hence, selection will be effective for those traits with high or 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 the characters seed yield per plant (95.14), oil yield per plant (95.65), volume weight (92.26), plant height (89.42), 100-seed weight (84.02) and oil content (67.57). Moderate heritability was observed for head diameter (35.37). These results were also in agreement with Jagadeesan *et al*. (2008) and Premnath *et al*. (2014).

High heritability and high genetic advance as percentage of mean were recorded for the traits *viz*., seed yield per plant, oil yield per plant and 100-seed weight. High heritability and high genetic advance as percentage of mean indicated the presence of additive gene action. Directional selection for these traits would be more effective for desired genetic improvement. These results were also in agreement with Sridhar *et al*. (2006), Sujatha and Vishnuvardhan Reddy (2009), Janamma *et al*. (2009), Makane *et al*. (2011) and Premnath *et al*. (2014). Moderate values were recorded for head diameter (35.37). This result was in agreement with Premnath *et al*. (2014). High heritability and low genetic advance as a percentage of mean was observed for oil content (9.12). This result was also in agreement with Sutar et al. (2010) and Premnath *et al*. (2014). High heritability and low genetic advance indicated that the influence of non-additive gene action. Hence, this trait could be improved by heterosis breeding approach. Medium heritability and moderate genetic advance was recorded for head diameter (35.37). This indicated the presence of additive gene action. Hence pedigree or heterosis breeding and directional selection would be effective for the traits that had high or moderate h^2 and GAM.

Among the traits, positive skewness was observed for head diameter (0.75) and 100-seed weight (0.57). Other traits recorded no skewness. It indicated that normal distribution was present in the RIL population for all traits except head diameter and 100-seed weight. In case of kurtosis, the character oil content (0.60) recorded leptokurtic nature. Due to narrow variability, selection might not improve the per se performance for this trait. The trait oil yield per plant and 100-seed weight had platykurtic nature. Due to wider variability, directional selection could improve the per se performance of these traits.

Correlation among characters

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. Selection would therefore be more effective, if it is based on component characters rather than directly on yield. Correlation coefficient analysis measures the mutual relationship between various characters. It is used to determine the component characters on which selection can be done for improvement in yield. Chikkadevaiah *et al*. (2002), Nehru and Manjunath (2003), Binodh *et al*. (2008), Premnath *et al*. (2014) and Abirami *et al*. (2016) had reported positive associations of seed yield with various yield components.

Table 2. Simple correlation among yield contributing characters in RIL population of TNHSF239-68-1-1-1 x 17B in Sunflower

Characters	Seed colour	Presence of stripes	Plant height (cm)	Head diameter (cm)	100-seed weight (g)	Volume weight (g/100ml)	Seed yield per plant (g)	Oil content (%)	Oil yield per plant (g)
Seed colour	1.00								
Presence of stripes	-0.49*	1.00							
Plant height (cm)	-0.01	-0.08	1.00						
Head diameter (cm)	-0.11	0.06	0.37*	1.00					
100-seed weight (g)	-0.05	0.09	0.17	0.32*	1.00				
Volume weight (g/100ml)	-0.04	0.18	0.15	0.13	0.17	1.00			
Seed yield per plant (g)	0.01	0.03	0.11	0.27*	0.25*	0.24*	1.00		
Oil content (%)	0.22*	-0.13	-0.08	-0.11	-0.05	0.03	0.12	1.00	
Oil yield per plant (g)	0.02	0.03	0.10	0.25*	0.25*	0.25*	1.00*	0.20*	1.00

*Significance at 5% level

In the present investigation, oil yield per plant had significant and positive correlation with head diameter, 100-seed weight, volume weight, seed yield per plant and oil content (Table 2). These results were confirmed with the earlier findings of Sridhar *et al*.(2005), Ravi *et al*. (2006), Sowmya *et al*. (2010), Premnath *et al*. (2014) and Abirami *et al*. (2016).

Seed yield per plant had significant and positive correlation with volume weight, 100-seed weight and head diameter. These results were confirmed with the earlier findings of Premnath *et al.* (2014) and Abirami *et al*. (2016). Seed colour had significant positive and negative correlation with the oil content and presence of stripes respectively. It indicated that black colour seed was associated with high oil content and non stripe on seed surface. Considering the inter relationship, plant height had positive and significant correlation with head diameter. Similar results were reported by Chikkadevaiah *et al.* (2002), Ravi *et al*. (2006). Head diameter had positive and significant correlation with 100-seed weight as reported by Anandhan *et al.* (2010). Strong and positive association of head diameter with yield and oil related traits suggested that increased head diameter would lead to higher seed yields and greater oil yield. This type of association might be due to the presence of higher source and sink capacities. Hence head diameter can serve as a good selection criterion to increase the above traits. These findings were in accordance with that of Premnath *et al.* (2014). Presence of stripes had a negative significant association with seed colour.

From the foregoing discussion on correlation analysis, it might be concluded that head diameter, 100-seed weight, volume weight, seed yield per plant and oil content were important selection indices for oil yield per plant. Though the seed colour had association with oil content, the presence of stripes had no association with oil content. However the interrelationship between seed colour and presence of stripes was observed. This indicated that the traits seed colour and presence of stripes were important selection indices for oil content improvement. Hence, black seed colour and non striped seed surface along with other yield component traits *viz*., head diameter, 100-seed weight, volume weight and seed yield per plant could be considered as selection indices for the development of high oil yielding sunflower genotypes.

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