



USING LINE X TESTER ANALYSIS FOR EARLINESS AND PLANT HEIGHT TRAITS IN SUNFLOWER (*HELIANTHUS ANNUUS* L.)

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Abstract

Line x tester analysis, involving four lines and four testers were made in sunflower for four parameters. The variance due to GCA and SCA showed that gene action was predominantly additive for days to first flowering (DFF), days to hundred percent flowering (DH%F) and plant height (PH), whereas predominance of non-additive genetic effect was discovered for days to maturity (DM). Both additive and non-additive genetic interaction was important for morpho-physiological characters in sunflower. The line TS-18 was the best general combiner for characters like DFF and PH, whereas line TS-17 was the best general combiner for DH%F and DM. The tester R-25 proved to be the best general combiner for DFF, DH%F and DM, whereas the tester 291RGI proved to be the best general combiner for PH. The SCA estimates were highest in cross TS-335 x TR-9 for DFF, TS-18 x R-25 for DH%F and DM. For PH, the best SCA cross was TS-18 x 291RGI. The best GCA parents as TS-17, TS-18, R-25 and 291RGI are recommended, which may be exploited for varietal improvement in different cross combination especially in synthetic production, whereas the three best SCA crosses are recommended to be the best hybrids for cultivation and be included in the national uniformity yield trial for its exploration in multilocation. Additive type of gene action was observed for DFF, DH%F and PH. These characters may further be improved through simple selection method in early generation, whereas non-additive type of gene action was observed for DM, which is desirable for heterosis breeding and may be exploited in hybrid seed production.

Key Words: GCA; SCA; Gene action; Line x Tester Analysis; Sunflower; Pakistan.

Introduction

The success of any hybridization program largely depends on selection of suitable parental lines. Information regarding different types of gene action, relative magnitude of genetic variance and combining ability estimates for important parameters is essential for the improvement of sunflower crop. This important information could prove an essential tool to the sunflower breeders in the choice of better parental combination for further improvement. The present study was conducted with the aim of understanding the nature of such characters. The inferences drawn here, in a strictly statistical sense apply only for these specific sunflower hybrids involved. However, since these lines comprise a representative sample of the material available for our breeding work, so findings may be viewed in a broader sense.

Singh and Singh (2000) and Adefris *et al* (2001) reported significant general and specific combining ability

effects for days to flowering. Burli *et al* (2001) and Ashok *et al* (2000) found significant general and specific combining ability estimates for days to maturity. Yadav *et al* (2004), Gill *et al* (2003), Nehru and Manjunath (2003) and Dagustu (2002) reported significant general and specific combining ability magnitude for plant height.

In the present study parents and hybrids produced from line x tester mating were evaluated. The objectives of this study were to estimate GCA and SCA of parents so as to identify though superior combiners for desired plant height in sunflower which is an important parameter in sunflower.

Materials and Methods

Eight genetically diverse genotypes of Sunflower (*Helianthus annuus* L.) were crossed in Line x Tester mating design. Four (Lines) were used as a female (TS-

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17, TS-18, TS-228 and TS-335) and four (Testers) as male parents (291RGI, R-25, TR-9 and TR-6023).

All these parents were sown on September 7, 2006 at Agricultural Research Institute (ARI), Tarnab, Peshawar. Crosses were made in line x tester design at flowering stage in November. In this way sixteen F₁ hybrids were obtained, which were TS-17 × 291RGI, TS-17 × R-25, TS-17 × TR-9, TS-17 × TR-6023, TS-18 × 291RGI, TS-18 × R-25, TS-18 × TR-9, TS-18 × TR-6023, TS-228 × 291RGI, TS-228 × R-25, TS-228 × TR-9, TS-228 × TR-6023, TS-335 × 291RGI, TS-335 × R-25, TS-335 × TR-9, TS-335 × TR-6023. These F₁ hybrids along with their parents were evaluated in September 2007. Parents and F₁ hybrids are arranged in randomized complete block design (RCBD) with three replicates. Each hybrid and parental line was sown in five-meter long rows with inter and intra row space of 0.3m and 0.75m in each plot. A basal fertilizer dose of 120 kg nitrogen ha⁻¹ and 60 kg phosphorus ha⁻¹ were applied. The sources of fertilizer were urea for nitrogen and Diammonium Phosphate (DAP) for phosphorus. Full dose of DAP and half dose of nitrogen was applied at the time of sowing. While the remaining half dose of nitrogen was applied just before head initiation.

Ten plants were selected at random from each plot to record the data on days to first flowering, days to 100 % flowering, days to maturity and plant height. The data was subjected to analysis of variance according to Steel and Terrie (1980). The estimates of combining ability effects were made following Kempthorne (1957).

Results and Discussion

Days to First Flowering

Analysis of variance showed that mean squares due to hybrids, lines, testers and line x tester interaction were significant for days to first flowering (Table-I).

Genetic variation among characters associated with plant growth and resultant morphological and physiological differences serves as the basis for development of lines and cultivars with improved agronomic traits. Variation in character such as days to first flowering is particularly useful because it allows for development of types adapted to specific environments or agro-climatic region (Putt, 1940). Sunflower hybrids with later flowering tend to have smaller seed weight due to smaller grain filling period. For the trait, days to first flowering negative values of GCA and SCA are desirable.

The general combining ability variances were higher than the specific combining ability variance for days to first flowering, which provides the information that greater amount of genetic variability was due to general

combining ability effects, which indicates additive type of gene action being involved for this parameter (Table-II). This character can be improved by simple selection methods in early generations. Data analyzed for GCA shows that sufficient variation was found in female and male parents. Among the female parents maximum negative GCA effects were indicated by TS-18 (-1.875) while maximum positive GCA estimates were indicated by TS-335 (2.625). Among the male parents maximum positive GCA estimates were expressed by 291RGI (2.125), while maximum negative GCA effects were expressed by TR-25 (-1.625) as depicted in Table-III. If minimum days to first flowering is desirable then two female parents TS-17 and TS-18 and two male parents R-25 and TR-9 were potential parents and their values of general combining ability were -1.375, -1.875, -1.625 and -1.375 respectively and the crosses TS-335 x TR-9, TS-228 x 291RGI and TS-18 x 291RGI were the potential crosses and their significant specific combining ability values were -2.125, -1.625 and -1.125, respectively (Table-IV). These crosses may be exploited in further breeding program. The results are in conformity with the research work of Khurana *et al* (1996), Lande *et al* (1997), Singh and Singh (2000) and Gill *et al* (2003) they reported similar findings.

Days to 100 % Flowering

Analysis of variance showed that mean square due to hybrids, lines, testers and line x tester were significant for days to hundred percent flowering (Table-I).

Variations in days to 100 % flowering are important because it allows for development of types adapted to specific growing regions. Sunflower hybrids with later flowering tend to have smaller seed weight due to smaller grain filling period (Putt, 1940). For the trait, days to hundred percent flowering negative values of GCA and SCA are desirable.

The general combining ability variances were higher than the specific combining ability variance for days to 100 % flowering, which provides the information that greater amount of genetic variability was due to general combining ability effects, which indicates additive type of gene action being involved for this character (Table-II). This character can further be improved through simple selection methods in early generations. All the parents both female and male were significant except TS-18 for this character. Among the female parents maximum negative GCA effect was expressed by TS-17 (-3.250), while among the male parents maximum negative GCA effects was recorded for R-25 (-1.725) (Table-III). Eight crosses expressed significant SCA effects while eleven out of sixteen crosses showed positive SCA magnitude. Maximum negative SCA effects for days to 100 percent

flowering (-4) was exhibited by the cross combination of TS-18 x R-25 followed by TS-335 x TR-9 (-2.750) and TS-335 x 291RGI hybrid with the magnitude of -2 (Table-IV). The results are in agreement with findings of Sakthivel et al (2003 a, b), Burli et al (2001) Ashok et al (2000), Gangappa et al (1997), Khurana et al (1996) and Kandhola et al (1995 b).

Days to Maturity

Analysis of variance showed that mean squares due to hybrids, lines, testers and line x tester were significant for days to maturity (Table-I).

Physiological maturity is the time when maximum seed dry weight accumulation occurs. As sunflower responds to variable photoperiods, therefore, maturity date can be changed with variable day length and intensity of light. Main focus in sunflower breeding is to develop early maturing hybrids and open pollinated cultivars for short growing season (Kinman, 1975). For days to maturity negative values of GCA and SCA are desirable.

Table I. Analysis of variance for Lines x Testers including parents for morpho-physiological characteristics in sunflower genotypes sown at ARI Tamab, Peshawar

Source	Degrees of freedom	Days to first flowering	Days to 100% percent flowering	Days to maturity	Plant height
Replication	2	4.500	4.010	4.389	112.590
Genotypes	23	62.864 **	81.060 **	86.867 **	803.934 **
Parents	7	107.946 **	115.619 **	123.810 **	799.148 *
Crosses	15	21.950 **	33.000 **	22.528 **	444.135
Parents vs Crosses	1	361.005 **	559.667 **	793.357 **	6234.423 **
Lines	3	50.750 **	63.500 **	8.472 **	673.561
Tester	3	39.250 **	51.500 **	38.583 **	819.839
Line x Tester	9	6.583 **	16.667 **	21.861 **	242.425
Error	46	0.413	0.390	0.853	307.469
Total	71				

Significant at 1% level; * Significant at 5% level

The specific combining ability variances were higher than general combining ability variances for days to maturity, which provides information that greater amount of genetic variability was due to specific combining ability effects, which indicate non-additive type of gene action being involved for this character (Table-II). The character is desirable for heterosis breeding and can be exploited in hybrid production. All the parents were significant for GCA magnitude except TS-18 and TS-228 among the female parents and TR-9 among the male parents for days to maturity (Table-III). Maximum negative GCA effects were observed for TS-17 (-1.125) among the female parents. Among the male parents maximum negative GCA estimates were observed for R-25 (-2.205). Eight crosses were significant. Eight out of sixteen crosses expressed negative SCA effects. The highest result regarding the SCA value for this character was observed in the cross combination of TS-18 x R-25 which

possess a negative SCA magnitude of -4.125 followed by TS-335 x 291RGI having a negative SCA magnitude of -3.875 (Table-IV). The results are strongly supported by the previous work of Ashok et al (2000), Khurana et al (1996), Kandhola et al (1995 a, b).

Table II. Estimates of genetic components for morpho-physiological, seed yield and yield related and oil quality and quantity characteristics in sunflower genotypes (4 females and 4 males), sown at ARI Tamab, Peshawar

Gene action	Days to first flowering	Days to 100 % flowering	Days to maturity	Plant height
Variance due to non-additive type of gene action	2.056	5.425	7.002	41.055
Variance due to additive type of gene action	4.634	5.462	1.399	54.912

Plant Height

Height generally is considered to be a quantitative character. There is considerable interest recently in the use of dominant alleles for the development of semi dwarf hybrids. In some crosses considerable height reduction occurs in the hybrids, while in other crosses little reduction in height occurs. These suggest the complex genetic control of plant height. Tall hybrids were later in flowering in maturity, suggesting focus on selecting short stature sunflower hybrids, which mature early and in shortest period of time (Enns, 1959). For the trait, plant height negative values of GCA and SCA are desirable.

Table III. Estimates of GCA effects for morpho-physiological characteristics in sunflower genotypes (4 females and 4 males) sown at ARI Tamab, Peshawar

Parents	Days to first flowering	Days to 100 % flowering	Days to maturity	Plant height
Females				
TS-17	-1.375 *	-3.250 *	-1.125 *	-1.900
TS-18	-1.875 *	0	-0.125	-9.794
TS-228	0.625 *	1.500 *	0.458	6.335
TS-335	2.625 *	1.750 *	0.791 *	5.358
Males				
291RGI	2.125 *	-0.500 *	0.625 *	-7.866
R-25	-1.625 *	-1.750 *	-2.208 *	-6.408
TR-9	-1.375 *	-0.750 *	-0.458	6.891
TR-6023	0.875 *	3 *	2.041 *	7.383
Standard Error	0.185527	0.18027	0.266615	5.061857
* Significant $p \leq 0.5\%$ if the respective value is greater than twice the Standard Error				

The general combining ability variances were higher than specific combining ability variances for plant height, which provide information that greater amount of genetic variability was due to general combining ability effects, which indicate additive type of gene action being involved for this character (Table-II). This character can be improved through simple selection methods in early

generations. Both male and female mean squares were non-significant for plant height. As minimum plant height is desired therefore the potential parents for GCA effect among the female parents were TS-18 (-9.794) and TS-17 (-1.900). 291RGI (-7.866) as presented in Table-III.

In case of plant height negative GCA effects are more important since more emphasis is given on selection for medium or short stature segregates in the segregating population because they ultimately produce short stature lines which are more responsive to fertilizer and tolerant to lodging. Eight out of sixteen crosses manifested negative SCA magnitude. The highest negative SCA effects for plant height -10.773 were manifested by the cross combination of TS-18 x 291RGI, followed by TS-228 x TR-6023 (-10.019) as presented in Table-IV. The results are in agreement with the work of Radhika et al (2001). Burli et al (2001).

Table IV. Estimates of specific combining ability effects for morpho-physiological characteristics in sunflower genotypes (hybrids), sown at ARI Tamab, Peshawar

Crosses	Days to first flowering	Days to 100 % flowering	Days to maturity	Plant height
TS-17×291RGI	0.375	0	1.375	* -8.166
TS-17×R-25	0.125	0.250	0.875	-2.358
TS-17×TR-9	-0.125	0.250	-2.208	* -0.058
TS-17×TR-6023	-0.375	-0.500	-0.041	10.583
TS-18×291RGI	-1.125	* 1.750	* 2.708	* -10.773
TS-18×R-25	-0.375	-4	* -4.125	* 2.269
TS-18×TR-9	0.375	2	* 0.458	3.725
TS-18×TR-6023	1.125	* 0.250	0.958	4.777
TS-228×291RGI	-1.625	* 0.250	-0.208	14.930
TS-228×R-25	0.125	0.500	-0.041	-1.094
TS-228×TR-9	1.875	* 0.500	1.875	* -3.817
TS-228×TR-6023	-0.375	-1.250	* -1.625	* -10.019
TS-335×291RGI	2.375	* -2	* -3.875	* 4.008
TS-335×R-25	0.125	3.250	* 3.291	* 1.183
TS-335×TR-9	-2.125	* -2.750	* -0.125	0.150
TS-335×TR-6023	-0.375	1.500	* 0.708	-5.341
Standard Error	0.371054	0.38055	0.533229	10.12371

Conclusion

Additive type of gene action was observed for days to first flowering, days to 100 % flowering and plant height. These characters may further be improved through simple selection method in early generation, whereas non-additive type of gene action was observed for days to maturity, which is desirable for heterosis breeding and may be exploited in hybrid seed production.

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