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COMBINING ABILITY ESTIMATES IN SOME SALT TOLERANT INBREDS OF SUNFLOWER (*Helianthus annuus* L.)

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SUMMARY

Six sunflowers inbreds were crossed in partial diallel fashion to evaluate their general and specific combining ability for yield, yield components and oil content under saline conditions. Specific combining ability (SCA) variances were higher than general combining ability (GCA) variances for all the plant traits studied which manifested non-additive genetic control. However, substantial amount of additive variance was contributing for plant height and oil content. GIMSUN-459 and GIMSUN-318 were high general combiner while GIMSUN-459 x GIMSUN-477 was a good specific combination for production under saline soil conditions.

Key words: **Sunflower, *Helianthus annuus* L., inbreds, partial diallel, yield and yield components, general and specific combining ability.**

INTRODUCTION

The menace of soil salinity is a global problem. The adaptation of crops to salinity is a formidable challenge for plant breeders and geneticists to meet the increasing food requirements in future. Breeding for salinity tolerance have thus been receiving much attention in the recent years.

Sunflower (*Helianthus annuus* L.) is categorized as low (Fenster *et al.*, 1976) to moderately salt tolerant (Heikal *et al.*, 1980) with a threshold level of EC_e 2.5 dSm^{-1}. Estimation of combining ability is pre-requisite in sunflower breeding whether it is aimed at the development of hybrid or improvement of populations. Combining ability analysis provides information on general and specific combining ability of genotypes for different plant traits. Different researchers studied combining ability for different plant traits by top-cross (Shcherbak and Zazharskii, 1976; Rozhkova, 1978; Cherzhentseva, 1990), poly-cross (Burlov and Buntovskii, 1978) and line x tester methods (Sheriff *et al.*, 1985; Cruz, 1986; Kadkol *et al.*, 1986; Shankara, 1986; Naik *et al.*, 1987). The technique proposed by Griffing (1956) for combining ability analysis also partitions the variation to additive, dominance and environmental components.

Under normal soils (non-saline), achene yield, other related parameters and oil content in sunflower were reported to be controlled by non-additive genes (Alba *et al.*, 1985; Kadkol *et al*, 1986; Ortegonn and Escobedo, 1993). However, some workers (Rincon and Barreda, 1983; Ortegonn and Escobedo, 1993) have reported additive genetic effects for different plant traits.

The present studies were conducted to estimate the combining ability of six salt tolerant inbred lines of cultivated sunflower. It is hoped that information so derived will be useful in designing future programme of breeding sunflower for salinity tolerance.

MATERIALS AND METHODS

The experimental material comprises of six salt tolerant sunflower lines Viz; GIMSUN-318, GIMSUN-342, GIMSUN-459, GIMSUN-477, GIMSUN-686 and GIMSUN-767. The inbred lines were crossed to obtain all possible combinations excluding reciprocals during 1995. Next year (spring, 1996) all the crosses along with the parental lines were sown on raised saline beds in soil having ECe 12 dSm^{-1}, using randomized complete block design with three replications. The plant to plant and row to row distances were 20 and 50 cm, respectively. At maturity data were recorded on five randomly selected guarded plants of each entry per replication on following parameters.

1. Plant height	(cm)	2. Head diameter	(cm)
3. 100-achene weight	(g)	4. Achene yield per plant	(g)
5. Oil content	(%)		

The data were subjected to analysis of variance (Steel and Torrie, 1980) and analysis of combining ability (Griffing, 1956) using method 2, Model-I and II. Test of significance for specific combining ability variance is same in both Models. In Model-I, mean squares for GCA were tested against error mean squares whereas, in case of Model-II, mean squares for GCA were tested against SCA mean squares.

RESULTS AND DISCUSSION

Mean squares for genotypes (Table 1) exhibited highly significant differences for all the plant traits studied. General combining ability (GCA) mean squares were significant in Model-I while non-significant in Model-II. However, specific combining ability (SCA) mean squares were significant and thus presented similar inferences in both Model-I and Model-II.

Table 1: Mean squares for genotypes, general and specific combining ability for different plant traits in sunflower

Source of variation	d.f.	Plant trait				
		Plant height (cm)	Head diameter (cm)	100-achene weight (g)	Achene yield/ plant (g)	Oil content (%)
Genotype	20	234.4222**	1.1431**	0.6525**	1.8114**	12.6613**
Error	40	8.6515	0.0198	0.0344	0.0203	0.7520
GCA (M-I)	5	150.7586**	0.4293**	0.2085**	0.8190**	7.5882**
GCA (M-II)	5	150.7586^{NS}	0.4293^{NS}	0.2085^{NS}	0.8190^{NS}	7.5882^{NS}
SCA	15	53.9269**	0.3660**	0.2205**	0.5333**	3.0913**
Error	42	2.7465	0.0063	0.0109	0.0065	0.2387

Estimates of general combining ability effects (Table 2) showed that GIMSUN-459 and GIMSUN-318 were more promising as these lines showed better general combining ability effects for achene yield per plant and head diameter. GIMSUN-477 exhibited highest GCA effects for oil content however, its performance for other yield components was poor. GIMSUN-767 showed promise for high oil content and 100-achene weight with additional advantage of short stature. Different crosses demonstrated highest capability for different plant parameters. Estimates of specific combining ability effects (Table 3) revealed that hybrid combination GIMSUN-459 x GIMSUN-477 was more promising as it expressed highest specific combining ability effects for greater achene yield per plant and larger head diameter. In addition, its performance for high oil content was also good. The same combination divulged maximum SCA effects for plant height. It was followed by a combination GIMSUN-342 x GIMSUN-477 which was good for achene yield and also showed promise for high oil content. There were two other crosses, GIMSUN-459 x GIMSUN-477 and GIMSUN-318 x GIMSUN-767, which exhibited high potential for achene yield however, both flaunted negative SCA effects for oil content and achene weight.

Table 2: Estimates of general combining ability effects for different plant traits for six inbreds in sunflower

Genotype	Plant trait				
	Plant height (cm)	Head diameter (cm)	100-achene weight (g)	Achene yield/ plant (g)	Oil content (%)
GIMSUN-342	-0.6183	0.1654	-0.0392	-0.1958	0.3888
GIMSUN-459	6.6729	0.2504	-0.1867	0.1817	-0.2313
GIMSUN-318	3.4204	0.1954	-0.1492	0.5092	-1.7175
GIMSUN-477	-3.6108	-0.1421	0.0221	0.0792	1.0188
GIMSUN-686	-1.0108	-0.1646	0.1096	-0.2158	-0.1788
GIMSUN-767	-4.8533	-0.3046	0.2433	-0.3583	0.7200
SE(g_i)	0.5349	0.0256	0.0337	0.0260	0.1577
SE(g_i-g_j)	0.8286	0.0397	0.0522	0.0403	0.2443

Table 3: Estimates of specific combining ability effects for different plant traits for fifteen crosses in sunflower

Hybrid	Plant trait				
	Plant height (cm)	Head diameter (cm)	100-achene weight (g)	Achene yield/ plant (g)	Oil content (%)
GIMSUN-342 x GIMSUN-459	-1.8924	0.4904	-0.0546	0.6004	-1.7589
GIMSUN-342 x GIMSUN-318	-0.6374	0.4654	-0.0921	0.0229	1.0473
GIMSUN-342 x GIMSUN-477	5.3339	0.1729	0.0966	0.9529	1.1211
GIMSUN-342 x GIMSUN-686	-7.8661	0.1754	0.6791	0.0179	0.4586
GIMSUN-342 x GIMSUN-767	-8.0236	-0.3146	-0.6846	-0.5696	0.4498
GIMSUN-459 x GIMSUN-318	2.0714	-0.5096	0.1154	-0.8446	0.6973
GIMSUN-459 x GIMSUN-477	14.4426	1.4879	-0.8559	1.0454	1.5811
GIMSUN-459 x GIMSUN-686	7.6426	0.1704	-0.1734	0.9504	-2.8014
GIMSUN-459 x GIMSUN-767	-0.1849	-0.4696	0.2629	-0.2171	0.0398
GIMSUN-318 x GIMSUN-477	2.3551	0.1629	-0.4534	-0.5021	2.1173
GIMSUN-318 x GIMSUN-686	-6.9049	-0.1146	0.1191	-0.8671	2.6048
GIMSUN-318 x GIMSUN-767	-1.5324	0.8254	-0.2446	0.8154	-1.0739
GIMSUN-477 x GIMSUN-686	-5.1436	-0.1471	0.6879	0.0029	-1.1414
GIMSUN-477 x GIMSUN-767	-2.7011	-0.3771	0.3141	0.0054	0.9198
GIMSUN-686 x GIMSUN-767	0.6989	-0.1546	-0.0334	0.2204	0.7473
SE (S_{ij})	0.7003	0.0335	0.0441	0.0341	0.2065
SE (S_{ij} - S_{ik})	2.1923	0.1050	0.1381	0.1067	0.6463
SE (S_{ij} - S_{kj})	2.0297	0.0972	0.1279	0.0987	0.5984

Estimates of variance components (Table 4) showed that dominance and environmental variance components remained the same in both Model-I and II. However, the estimates of additive variance were higher in Model-I as compared with Model-II resulting in higher σ^2A/σ^2D ratio. The estimates of dominance variance were greater than their respective estimates of additive and environmental variances for all the plant traits studied (Model-I and II). All the parameters included in the study were predominantly under the control of non-additive type of gene action. Obviously, the contribution of additive variance (σ^2A) was smaller than dominance variance (σ^2D). However, a considerable contribution of additive variance was observed in plant height and oil content. It was also reflected by higher ratio of σ^2A/σ^2D for these two traits than others. Therefore, it is suggested that plant height and oil content were controlled by both additive and dominance type of gene action. Similar results were also reported by Rincon and Barreda (1983), Kadkol *et al.* (1986) and Ortegonn and Escobedo (1993).

Therefore, it concluded from the study that GIMSUN-459 and GIMSUN-318 were good general combiners under saline soils as these lines showed better GCA effects for achene yield per plant and head diameter. Similarly, GIMSUN- 767 showed potential for high oil content and 100-achene weight with additional advantage of short stature. Hybrid combination GIMSUN-459 x GIMSUN-477 manifested

Table 4: Estimates of variance components for different plant traits in sunflower under saline conditions

Component	Plant trait				
	Plant height (cm)	Head diameter (cm)	100-achene weight (g)	Achene yield per plant (g)	Oil content (%)
σ^2E	2.7465	0.0063	0.0109	0.0065	0.2387
σ^2D	51.1804	0.3597	0.2096	0.5268	2.8526
σ^2A (M-I)	37.003	0.1058	0.0494	0.2032	1.8374
σ^2A (M-II)	24.2080	0.0158	0.000	0.0714	1.1242
σ^2A/σ^2D (M-I)	0.7230	0.2941	0.2357	0.3857	0.6441
σ^2A/σ^2D (M-II)	0.4730	0.0439	0.000	0.1355	0.3941

more promise for cultivation under saline conditions as it expressed good specific combining ability effects for greater achene yield per plant and larger head diameter. Similarly, GIMSUN-342 x GIMSUN-477 was another combination which displayed potential for high achene yield and oil content under saline soils. All the plant parameters included in the study were primarily under the control of non-additive gene action however, considerable contribution of additive variance was perceived for plant height and oil content.

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ESTIMACIÓN DE LA APTITUD COMBINATORIA EN ALGUNAS LINEAS DE GIRASOL (*Helianthus annuus* L.) TOLERANTES A SALINIDAD

RESUMEN

Seis l(neas puras de girasol tolerante a salinidad fueron cruzadas de acuerdo con un dialelo parcial para evaluar su aptitud combinatoria general y específica para rendimiento, componentes de rendimiento y contenido de aceite en condicionesde salinidad. Las varianzas de la aptitud combinatoria específia (ACE) fueron mas alta que las de la aptitud combinatoria general para todos los caracteres de la planta estudiados que manifestaron un control genético no aditivo. Sin embargo, hubo una cantidad sustancial de varianza aditiva para altura de la planta y contenido de aceite. GIMSUM-459 y GIMSUM-318 tuvieron buena aptitud combinatoria general, mientras que GIMSUM-459 x GIMSUN-477 mostró una buena aptitud combinatoria específica para producción en condiciones de salinidad en el suelo.

ESTIMATION DE LA VALEUR EN COMBINAISON DE LIGNÉES DE TOURNESOL (*Helianthus annuus* L.) TOLÉRANTES À LA SALINITÉ

RÉSUMÉ

Six lignées de tournesol tolérantes à la salinité ont été croisées selon un dispositif diallèle partiel pour évaluer leur aptitude générale spécifique à la combinaison pour le rendement, les composantes du rendement et la teneur en huile en conditions salines. Les variances d'aptitude spécifique à la combinaison (ASC) sont plus élevées que les variances d'aptitude générale à la combinaison (AGC) pour toutes les caractéristiques étudiées qui obéissent à un contrôle génétique de type additif. Cependant, une partie importante de la variance additive contribue à la taille et la teneur en huile. GIMSUN-459 et GIMSUN-318 présentent une bonne aptitude générale à la combinaison alors que GIMSUN-459 x GIMSUN-477 correspond à une combinaison à bonne aptitude spécifique pour la production en conditions salines.