Genetic variability and correlation studies in some drought-resistant sunflower *(Helianthus annuus L.)* genotypes

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Abstract

Five sunflower hybrids (Albena, Super Start, Zora, Santafe and San Luka) and their parental lines (2607, 1234, 1607, 147 R, RW-666, RF-673 and 19R) were tested on a block design in four replication in the course of two years. The highest phenotypic and genotypic coefficients of variation were recorded for seed yield per plant followed by the number of seeds per plant and 1000 seed weight, while the lowest value was observed at 50% flowering. The heritability coefficients in a broad sense were high in all characters and ranged from 69.74 % to 96.96 %. Correlation between the main quantitative characters found a positive correlation with the seed yield per plant. Oil content was lower but not significantly correlated concerning the head diameter, the 1000-seed weight, the plant height, the stem diameter and the days to 50% flowering.

Keywords: correlation, genetic variability, genotypes, sunflower

Introduction

Sunflower (*Helianthus annuus* L.) is considered to be the most important source of oil in Bulgaria and other developing countries. Any progress in a breeding program depends on the magnitude of genetic variability in the genotypes and on the extent of heritability of the desirable characters. Variability analysis has been found useful for getting information about the characters that are expected to response to selection. Phenotypic and genotypic variances were estimated by El-Ahmer et al., 1989. They studied the differences among eighteen sunflower genotypes concerning variance components and heritability where a great difference is observed. They found that days to 50% flowering, 1000-seed weight and plant height gave the highest values of heritability - 97.9, 86.4 and 84.5% respectively. Petakov, 1994 determined the heritability and he found that plant height gave the highest value of heritability - 96.0%.
The investigations of many authors showed that there is a positive correlation between the yield and some morphological and agricultural characters such as: plant height, head diameter, seed number per plant and 1000-seed weight (El-Ahmer et al., 1989; Petakov., 1994; Mogali and Virupakshappa, 1994; El- Hosary et al., 1999; Naderi A., 1998; Narayana et al., 1998).

The present work was conducted to study the genetic variability and correlation for 12 sunflower genotypes grown under condition in South Bulgaria.

Materials and Methods

Five sunflower hybrids (Albena, Super Start, Zora, Santafe and San Luka) and their parental lines (2607, 1234, 1607, 147 R, RW-666, RF-673 and 19R) were tested in trials conducted by a block method in four replications. The studied characters were: days to 50% flowering, plant height, stem diameter, number of leaves per plant, head diameter, 1000-seed weight, seed yield per plant, number of filled seeds per plant, seed filling (%), kernel percentage (%) and oil content (%). Analysis of variance for individual and combined seasons was done in accordance with Snedecar and Cochran (1967). Genotypic (σ^2_g) and Phenotypic (σ^2_{ph}) variations of seasons and Combined (σ^2_G and σ^2_{PH}) were calculated by EMS as follows:

Source of Variation	degrees of freedom	Mean square	Expected mean squares
1- For the individual seasons:			
Replications	(r-1)		
Genotypes	(g-1)	M_1	$\sigma^2_e + r\sigma^2_g$
Error	(r-1)(g-1)	M_2	σ^2_e
2- For both seasons combined:			
Years	(y-1)		
Rep.,/years	y(r-1)		
Genotypes	(g-1)	M_3	$\sigma^2_E+r\sigma^2_{GY}+ry\ \sigma^2_G$
GxY	(g-1)(y-1)	M_4	$\sigma^2_E+r\sigma^2_{GY}$
Pooled error	y(g-1)(r-1)	M_5	σ^2_E

Thereafter the phenotypic and genotypic variances were calculated as follows:

$\sigma^2_g = (M_1 - M_2) / r$

$\sigma^2_{ph} = \sigma^2_g + \sigma^2_e/r$ where $\sigma^2_e = M_2$

$\sigma^2_G = (M_3 - M_4)/ry$

$\sigma^2_{PH} = \sigma^2_G + \sigma^2_{GY}/y + \sigma^2_E/ry$

where $\sigma^2_E = M_5$ $\sigma^2_{GY} = (M_4 - M_5)/r$

Thereafter, broad sense heritability (h^2) was estimated as follows: $\sigma^2_g / \sigma^2_{ph} \times 100$
where:
σ^2_g = Genotypic variance.
σ^2_{ph} = Phenotypic variance.
Genotypic and Phenotypic coefficient of variation of the studied characters were calculated as follows:

$$P.C.V = \frac{\sigma^2_{ph}}{X_G} \times 100$$

$$G.C.V = \frac{\sigma^2_G}{X_G} \times 100$$

Where: Xg = General mean
A simple correlation coefficients between all studied traits were estimated, as well.

Results and Discussion

The results (tables 1, 2) showed Range, Mean, Phenotypic and Genotypic variance, Phenotypic and Genotypic Coefficient of variation and Heritability in broad sense values for the studied characters in both seasons, as well as, in the combined ones.
Data in table (1, 2) showed that traits differed widely in the P.C.V and G.C.V estimates. The highest P.C.V and G.C.V estimates were observed in seed yield per plant 35.59 % and 35.41 % respectively, for the 2008 season; 36.0% and 35.3 % for the 2009 season and in the combined one -35.58 % and 34.15 %, followed by the number of filled seed per plant and 1000-seed weight in the two seasons and in the combined ones. Therefore, the characters of high P.C.V. and G.C.V. values appeared to have wide range. This means that P.C.V. and G.C.V. for a given fruit was proportionally agreed with its range of mean performance. These results in general, agreed with those found by (El-Ahmer, 1989; Demurin at al. 2006) in sunflower. The low values for P.C.V. and G.C.V. can be found for days to 50% flowering, kernel (%), seed filling and oil content (%). The low variability for these traits emphasizes the need for generating higher variability. Low variability for these characters was also reported by (Suma et al. 1994). The value of heritability estimates high for all characters in both seasons as well as in the combined ones. This indicated that the greatest genotypic variability was observed for these traits and that variability could be utilized in breeding programs. This suggests a definite scope for improvement of these characters through direct selection.
Simple correlation coefficient between the studied characters was calculated in the seasons of 2008 - 2009. Data in tables (3, 4) showed that seed yield per plant was significantly and positively correlated with plant height, stem diameter, the number of leaves per plant, the head diameter and seed filling for both seasons and for 2009 – only with the number of seeds per plant. Oil content in the seeds was negatively but not

significantly correlated with head diameter, 1000-seed weight and kernel (%) for both seasons, while for 2008 it was correlated with days to 50 % flowering, plant height and stem diameter. As for the kernel content in the seed, this character was in a negative correlation with all traits, except for the 1000-seed weight in 2008. For 2009 there is correlation in the following traits: days to 50 % flowering, plant height, head diameter, 1000-seed weight and seed yield per plant.

Table 1. Range, Mean, Phenotypic and Genotypic Variance, Phenotypic and Genotypic Coefficient of Variation and Heritability for the seasons of 2008 and 2009

Characters	2008							2009						
	Range	Mean	Phenot., variance	Geno., variance	PCV (%)	GCV (%)	h^2 (%)	Range	Mean	Phenot, variance	Genot varian	PCV (%)	GCV (%)	h^2 (%)
Days to 50% flowering	52.7-64.3	61.1	11.3	11.19	5.49	5.47	99.4	62.0-71.3	69.7	6.46	6.39	3.7	3.6	98.8
Plant height (cm)	83.5-185.5	143.0	1083.1	1068.97	23.01	22.86	98.7	68.7-148.6	122.3	686	672.5	21.4	21.2	98.0
Stem diameter (cm)	1.52-2.40	2.1	0.07	0.067	12.65	12.24	93.6	1.31-1.77	1.54	0.23	0.20	9.8	9.3	88.6
No. of leaves/plant	24.1-34.7	29.9	13.2	12.80	12.13	11.96	97.2	19.8-31.7	26.5	18.1	17.08	16.1	15.6	94.5
Head diameter (cm)	106-21.4	17.5	14.5	14.23	21.73	21.51	98.0	8.5-16.6	12.9	6.52	6.34	19.9	19.6	97.2
1000 seed weight (g)	22.3-77.3	49.2	261.7	257.81	32.86	32.61	98.5	23.2-54.1	38.5	86.0	79.72	24.1	23.2	92.7
Seed yield/plant (g)	34.7-98.2	65.3	540.1	534.76	35.59	35.41	99.0	23.0-56.0	37.8	185.3	177.9	36.0	35.3	96.1
No. of filled seeds/plant	670-1952	1427	248878	246092	34.90	34.77	98.9	491-1504	1001	104945	98001	32.4	31.3	93.4
Seed filling	64.9-99.3	89.9	140.24	140.09	13.17	13.60	99.9	85.2-99.3	95.3	19.7	18.32	4.7	4.5	93.0
Kernel (%)	67.9-76.7	72.6	7.65	5.92	3.81	3.35	77.4	60.1-73.1	67.9	16.27	14.69	5.9	5.6	90.3
Oil content (%)	41.4-50.3	46.38	9.05	8.56	6.49	6.31	94.6	40.9-51.9	46.32	9.30	8.85	6.28	6.42	95.2

Table 2. Range, mean, phenotypic and genotypic variance, phenotypic and genotypic coefficient of variation and heritability in the low seasons of 2008-2009 combined

Characters	Range	Mean	Pheno., variance	Geno., variance	P.C.V(%)	G.C.V(%)	h^2 (%)
Days to 50% flowering	57.3-67.5	65.40	7.74	6.63	4.26	3.94	85.56
Plant height (cm)	76.1-167.0	132.65	858.43	832.33	22.09	21.75	96.96
Stem diameter (cm)	1.42-2.09	1.83	0.04	0.03	10.94	9.85	81.28
No. of leaves/plant	21.9-33.2	28.18	14.70	13.77	13.61	13.17	93.68
Head diameter (cm)	9.5-19.0	15.40	7.43	6.48	17.70	16.52	87.16
1000-seed weight (g)	22.7-58.8	43.85	138.44	103.03	26.83	23.15	74.42
Seed yield/plant (g)	29.7-77.1	51.54	336.24	309.81	35.58	34.15	92.14
No. of filled seeds/plant	662.8-1676.9	1220.00	162336.00	144559.00	33.03	31.16	89.05
Seed filling (%)	75.0-99.3	92.61	64.80	49.64	8.69	7.61	76.59
Kernel (%)	65.6-74.6	70.26	9.18	6.40	4.31	3.60	69.74
Oil content (%)	41.4-49.1	46.35	7.72	6.27	5.99	5.40	81.22

Table 3. Simple correlation coefficients for economic traits in sunflower genotypes during the season of 2008 (n-2=10)

Characters:	1	2	3	4	5	6	7	8	9	10	11
1-Days to 50% flowering		0.216	0.324	0.339	0.196	-0.110	0.004	0.290	-0.067	-0.078	-0.515
2-Plant height (cm)			0.918**	0.805**	0.817**	0.323	0.952**	0.492	0.687*	-0.521	-0.051
3-Stem diameter (cm)				0.684*	0.840**	0.410	0.847**	0.385	0.505	-0.361	-0.077
4-No of leaves/plant					0.472	0.186	0.766**	0.779**	0.799**	-0.732**	0.033
5-Head diameter (cm)						0.747**	0.778**	0.018	0.213	-0.112	-0.413
6-1000-seed weight (g)							0.298	-0.606*	-0.325	0.335	-0.483
7-Seed yield/plant (g)								0.527	0.687*	-0.539	0.034
8-No of seeds/plant									0.741**	-0.730**	0.283
9-Seed filling (%)										-0.629*	0.536
10-Kernel (%)											-0.160
11-Oil content (%)											

* , ** = Least significant difference at levels 5% and 1%, respectively.

Table 4. Simple correlation coefficients for economic traits in sunflower genotypes during the season of 2009 (n-2=10)

Characters:	1	2	3	4	5	6	7	8	9	10	11
1-Days to 50% flowering		0.688*	0.498	0.570	0.501	-0.021	0.329	0.530	0.343	0.073	0.196
2-Plant height (cm)			0.840**	0.929**	0.876**	0.232	0.885**	0.829**	0.739**	0.112	0.245
3-Stem diameter (cm)				0.835**	0.739**	0.041	0.814**	0.824**	0.737**	-0.258	0.369
4-No of leaves/plant					0.770**	0.067	0.831**	0.859**	0.853**	-0.091	0.425
5-Head diameter (cm)						0.560	0.909**	0.569	0.474	0.371	-0.129
6-1000-seed weight (g)							0.436	-0.294	-0.123	0.628*	-0.447
7-Seed yield/plant (g)								0.709**	0.698*	0.198	0.136
8-No of seeds/plant									0.838**	-0.198	0.475
9-Seed filling (%)										-0.275	0.656*
10-Kernel (%)											-0.515
11-Oil content (%)											

Conclusion

Seed yield per plant could be increased by selection of plant height, stem diameter and number of seeds per plant, because they had high positive correlation with seed yield per plant and they also showed high heritability estimates.
The value of heritability estimates high for all characters; therefore, the genotypic variability prevails over the general phenotypic variability in all studied characters.
This indicated that the greatest genotypic variability was observed for these traits and that variability could be utilized in breeding programs. This suggests a definite scope for improvement of these characters through direct selection.

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