World Journal of Agricultural Sciences 2 (3): 340-345, 2006
ISSN 1817-3047

Variability, Heritability and Genetic Advance in Some Genotypes of Roselle (*Hibiscus sabdariffa* L.)

M.M. Ibrahim and R.M. Hussein

Genetics and Cytology Department, National Research Centre (NRC), Dokki, Cairo, Egypt

Abstract: Information on genetic variability, heritability and genetic advance is derived from data on 5 yield related characters (plant height, number of branches, number of bolls/plant, seed weight and dry sepals weight) in 16 genotypes of roselle grown during 2003 and 2004 seasons. Significant differences between genotypes were observed for most studied characters in both seasons which indicate that there is a sufficient variability available to have an effective selection. Genotypic and phenotypic variance were highest for dry sepals weight trait, followed by dry seed weight and number of branches/plant. Whereas the maximum genotypic coefficient of variability was found in dry sepals weight and dry seed weight in both seasons. Broad sense heritability estimates ranged from low to high. Maximum heritability was 96% in plant height in 1st season and 89.9% in sepals weight in 2nd season. High heritability for plant height, dry sepals weight and dry seed weight coupled with high genetic advance values, that is could be improved through mass selection. In both season, dry sepals weight had a significant positive correlation with seed weight. In second season, no. of bolls/plant had a positive significant correlation with no. of branches and plant height. Other characters had low correlation values and had a negative significant correlation. These correlated yield components suggested that it may be a good selection criteria to improve seed and yield of roselle crop.

Key words: *Hibiscus sabdariffa* · genetic variability · genetic advance · heritability · correlation

INTRODUCTION

Roselle (*Hibiscus sabdariffa* L., Fam. Malvaceae), is an annual crop native to tropical Africa [1]. Actually, the crop is cultivated extensively in India, Sudan, Egypt, Senegal and Thailand for its pleasant red colored calyxes which are used for making jam, jelly and soft drinks [2, 3].

Roselle is one of the most medicinal plants which has a many applications in folk medicine in different countries of the world: in China is used for treatment hypertension, pyrexia and liver damages and the recent studies demonstrated that the phenolic compounds of its sepals water extracts can use as a effective treatment against leukemia [4]. Moreover, water and fat extracts of Roselle sepals and seeds present a high antioxidant capacity which may protect the cell against free radicals damages [5, 6]. Furthermore, the water extract of Roselle sepals may have a considered effects on high blood pressure lowering [7].

In Egypt, Roselle is considered to be one of the most famous folk medicinal plants due to its sepal colored materials which used for pharmaceutical, food and cosmetic industries [8, 9]. However, the cultivation of Roselle plants is concentrated in Upper Egypt, where the old (clay) lands and the suitable conditions [10, 11].

As a result of the importance of Roselle in Egypt, the cultivation area is increasing gradually for local utilization and exports; however, the interest of many investigators is to find out the most favorable conditions to get the best yield components [12, 13].

Generally the success of any crop improvement programs largely depends on nature, magnitude of genetic variability, genetic advance, characters association, direct & indirect effects on yield and yield attributes. Correlation studies are useful in most of breeding programs. Genetic diversity is important for selection parents to recover transgressive segregates [14].

In this study on genetic variability in Roselle, we are undertaken to evaluate the range of variation for a number of characters in 16 selected genotypes through studying of several genetic parameters (Phenotypic coefficient of variation (PCV), Genotypic coefficient of variation (GCV), Heritability and genetic advance), which may contribute to the plant yield components, to facilitate the formulation of suitable selection indices.

Corresponding Author: Dr. M.M. Ibrahim, Genetics and Cytology Department, National Research Centre (NRC), Dokki, Cairo, Egypt

MATERIALS AND METHODS

The present study was carried out during two successive growth seasons of 2003 and 2004 at the experimental station of National Research Centre, Shalakan, Kalubia governorate. 16 Roselle genotypes were collected from a different Roselle farmers at Quena governorate and sown on April of 2003 and 2004. Complete Randomized Block Design with three replications was used and each replicate had 3 lines.

Plant records: Plant records were considered on individual plants basis, they included:

- Plant height
- Number of branches
- Number of fruits (bolls)
- Total seed weight g/plant
- Total dry sepals weight g/plant

Statistical procedures: The experimental design was complete randomized blocks with three replicates. The general s tatistical procedures was practiced according to standard methods given by Steel and Torrie [15]. The analysis of variance (ANOVA) and broad sense heritability (h^2_b) were generally assigned for the data of each season according to Robinson *et al.* [16]. The phenotypic coefficients of variance (PCV%) and genotypic coefficients of variance (GCV%) were computed according to Burton [17]. The expected genetic advance from selection ΔGA% was computed according to Johnson *et al.* [18].

RESULTS AND DISCUSSION

Analysis of variance: Sixteen genotypes of roselle assessed for plant height, number of branches, number of bolls, seed and dry sepals weight to evaluate genetic variability.

The significant variation among different genotypes revealed considerable amount of variation in both seasons. In first season, the genotypes differed significantly for all traits, while in the second season, all genotypes significantly differed except number of branches trait (Table 1). These results is in conformity with the finding of Gandhi *et al.* [19] and Mostofa *et al.* [20].

Mean performance: Differences in mean yield performance of 16 genotypes of roselle in first and second season are presented in Tables 2 and 3. In the first season, the results indicated that genotypes No. 12, 13

Table 1: Mean squares of five characters studied in two seasons (2003 & 2004) of sixteen genotypes of Roselle

S.O.V	D.f	Plant height cm Season I	Plant height cm Season II	No. of branches Season I	No. of branches Season II	No. of bolls/plant Season I	No. of bolls/plant Season II	Dry seed weight g/plant Season I	Dry seed weight g/plant Season II	Dry sepals weight g/plant Season I	Dry sepals weight g/plant Season II
Rep.	2	15.4375	76.333	0.0625	0.1875	0.7500	5.6458	1.1327	0.7452	0.7365	0.0694
Genotypes	15	1011.8444**	890.0653**	2.6444**	1.0222	30.8389**	32.4542**	25.4391**	32.8543**	20.4546**	22.6045**
Error	30	13.6153	51.2444	0.9069	0.87648	2.7056	2.0458	1.3036	1.4123	0.7413	0.8287

*, ** Significant at 0.05 and 0.01 levels, respectively

Table 2: Mean performance of five characters in the first season (2003) data analysis of sixteen Roselle genotypes

Genotypes		Plant height (cm)	No. of branches	No. of bolls/plant	Seed weight (g/plant)	Sepals weight (g/plant)
1		164.33	5.66	26.00	05.33	05.50
2		183.00	5.00	19.33	12.20	09.53
3		177.66	5.66	20.00	07.10	05.93
4		148.33	5.00	19.66	13.17	11.53
5		163.66	5.66	16.66	05.83	04.34
6		160.00	5.00	21.66	06.83	13.00
7		124.00	5.66	16.33	06.26	05.18
8		185.33	5.66	17.66	06.33	05.30
9		176.00	9.00	25.00	06.03	06.36
10		180.66	5.33	17.00	05.66	05.33
11		192.33	6.00	18.00	14.00	09.60
12		198.00	5.33	15.00	06.33	04.93
13		190.00	6.33	16.00	07.96	07.40
14		180.00	5.33	17.00	06.10	05.60
15		178.66	5.66	22.00	05.10	05.20
16		170.00	5.66	17.33	05.27	05.17
L.S.D	0.05	6.155	1.589	2.744	1.905	1.436
	0.01	8.285	1.138	3.693	2.564	1.933

Table 3: Mean performance of five characters in the second season (2004) data analysis of sixteen Roselle genotypes

Genotypes		Plant height (cm)	No. of branches	No. of bolls/plant	Seed weight (g/plant)	Sepals weight (g/plant)
1		166.00	6.33	27.00	06.50	06.17
2		190.00	6.00	21.00	12.80	09.30
3		185.67	6.66	21.00	07.90	06.70
4		161.00	5.33	21.00	13.96	13.00
5		175.66	7.33	17.66	06.27	06.40
6		177.00	6.00	22.00	07.67	13.96
7		135.00	6.33	18.33	04.80	05.96
8		185.66	6.33	18.66	04.73	06.13
9		181.00	7.66	26.33	06.43	07.00
10		190.00	6.33	18.33	05.00	05.60
11		205.00	7.66	19.33	15.23	11.63
12		206.66	6.33	16.33	06.20	05.87
13		195.00	6.66	17.33	08.63	07.33
14		185.00	6.00	17.66	06.80	06.20
15		178.33	7.33	25.33	05.47	06.17
16		178.66	6.66	19.00	05.77	05.67
L.S.D	0.05	11.941	1.562	2.386	1.982	1.519
	0.01	16.073	2.102	3.212	2.668	2.044

Table 4: Range, Mean, phenotypic coefficient of variation (PCV%), genotypic coefficient of variation (GCV%), Broad sense heritability (h^2_b) and expected genetic advance (GA%) for five characters in two seasons of sixteen Roselle genotypes

Characters	Season	Range	Mean	Phenotypic variation (PCV)	Genotypic variation (GCV)	Heritability (h^2_b)	Genetic Advance GA%
Plant height	I	124.00-198.00	173.25	10.74	10.52	0.961	51.572
	II	135.00-206.66	180.97	10.06	9.24	0.845	43.014
No. of branches	I	5.00-9.00	5.75	21.20	13.23	0.390	1.154
	II	5.00-7.66	6.49	14.81	3.41	0.530	0.107
No. of bolls/plant	I	15.33-26.00	19.12	18.18	16.01	0.776	7.410
	II	16.33-27.00	20.39	17.12	15.62	0.830	8.100
Seed weight	I	5.10-14.00	7.47	36.16	32.78	0.861	7.390
	II	4.73-15.23	7.69	36.98	35.04	0.881	8.600
Sepals weight	I	5.16-13.00	6.87	39.36	37.32	0.899	6.900
	II	5.60-13.97	7.69	36.98	35.04	0.898	7.240

and 8 had the highest plant height (cm) with mean of 198.00, 190.00 and 185.00, respectively. However in the second season, genotypes No. 12, 11 and 13 had the highest values (cm) of plant height with the mean of 206.66, 205.00 and 195.00, respectively (Table 3). The mean of genotypes No. (9, 13) and (11, 15 and 5) revealed that the highest values of number of branches in first and second season, respectively (Tables 2 and 3).

Means number of bolls/plant showed that genotypes (1, 9 and 15) had the highest values in first and second season with means of (26.00, 25.00 and 22.00) and (27.00, 26.33 and 25.33), respectively. However, genotypes No. 6, 4 and 11 showed the highest values of dry sepals weight in the first and second season with means of (13.00, 11.53 and 9.60) and (13.96, 13.00 and 11.63), respectively.

For seed weight, genotypes No. 11, 4 and 2 expressed significantly the highest values in first and second season with values (14.00, 13.17 and 12.20) and (15.23, 13.96 and 12.80), respectively which suggest the existence of significant variation among genotypes. These results support the selection programs for better seed and sepals weight. Similar pattern of variability in germplasm evaluation have been earlier reported by Koorse [21], Thirthamallappa & Sherif [22] and Zayed [23].

Genetic parameters: Analysis of genetic parameters of 16 roselle genotypes of five characters illustrated in the first and the second season in Table 4. Range, means, phenotypic & genotypic variations, heritability and genetic advance were compared for all studied characters in both seasons.

Comparison of these characters revealed that, the mean values for plant height were (173.25-180.97) in first and second season, respectively. It's also noticed the differences between (PCV) and (GCV) values were generally low in both seasons [18]. Among these

Table 5: Phenotypic (above diagonal), genotypic (below diagonal) correlation coefficient among all traits studied of selected genotypes of Roselle in the two seasons

Characters	Plant height (X_1)	No. of branches (X_2)	No. of bolls/plant (X_3)	Seed weight (g) (X_4)	Sepals weight (g) (X_5)
			First season		
X_1	0.000	0.127	-0.101	0.057	-0.099
X_2	0.132	0.000	0.275	-0.084	-0.114
X_3	-0.145	0.501**	0.000	-0.098	0.183
X_4	0.092	-0.269	-0.110	0.000	0.628**
X_5	-0.133	-0.304	0.196	0.740**	0.000
			Second season		
X_1	0.000	0.031	-0.245	0.198	0.001
X_2	0.537**	0.000	0.194	-0.119	-0.317
X_3	-0.267	0.648**	0.000	0.001	0.110
X_4	0.263	-0.804**	0.014	0.000	0.692**
X_5	-0.016	-0.902**	-0.137	0.777**	0.000

* Significant at 5%   ** Significant at 1%

genotypes, the dry sepal weight ranged from 5.16 to 13.00 and 5.60 to 13.97 in first and second season, respectively (Table 4).

A wide range of mean values was observed for seed weight and other characters [24]. Studies on variability of studied characters revealed that PCV values were higher than GCV values. In the first season, GCV values ranged from 10.52 (plant height trait) to 37.32 (dry sepals weight trait), while in the second season, No. of branches trait had the lowest GCV value (3.41), when the seed weight trait which had the highest GCV value (35.04).

Generally, PCV and GCV values were found to be higher in dry sepals weight, number of branches and seed weight on plant which indicate the presence of high level of genetic variability for these characters in both seasons [25, 26]. GCV values only are not enough to determine the genetic variability, this could be done with the help of heritability and genetic advance estimates to assess the heritable portion of total variation and extent of genetic expected gain for selection. Heritability values for studied characters ranged from 39 to 96.1% in No. of branches and plant height, respectively in first season, while in the second season, these values ranged from 53 to 89.8% in No. of branches and dry sepals weight, respectively (Table 4). Low heritability estimates due to larger phenotypic variance indicate the great environmental influence. In both seasons, highest heritability values of plant height (91.1%) and dry sepals weight (89.9%) were observed following by dry seed weight g/plant (88.1%), No. of bolls/plant (77.6%) and No. of branches (53.0%) in the second season, respectively.

Heritability estimates must accompanied with a high genetic advance to be reliable. Therefore, genetic advance was also computed [27, 28]. The results indicated that, maximum genetic advance of (51.57%) and (7.41%) followed by (7.39%) for plant height, no. of bolls/plant and seed weight in the first season, respectively. In the second season, the maximum values were (43.01%) and (8.60%) followed by (7.24%) for plant height, dry seed weight and dry sepals weight, respectively.

High heritability of plant height, dry sepals and seed weight were coupled with high genetic advance which indicate the presence of additive gene effects, hence their importance can be done through the mass selection. Number of branches and bolls showed low to moderate values of heritability and genetic advance, these results may be suggest that these characters were under the control of non additive gene action and environmental effects [21, 29, 30].

Correlation between characters: Phenotypic and genotypic correlation was estimated on genotypes of five studied characters in both seasons between all possible pairs of studied characters (Table 5).

In the first and second season, the results demonstrate that estimates of genotypic correlation coefficients were generally higher than their corresponding phenotypic correlation coefficients, thereby, strong inherent association between various characters at genetic level were be suggested.

At phenotypic level, dry sepals weight showed highly significant positive association with seed weight in both seasons. Other characters showed negative and non significant correlation with dry sepals and seed weight (Table 5).

At the genotypic level, more characters had been showed highly and positive correlation. In first season, no. of branches has highly correlation with no. of bolls/plant also, dry seed weight and dry sepals weight. In the second season, plant height has highly significant correlation with no. of branches, the same result was observed between no. of branches and no. of bolls. Also, dry seed weight was highly correlated with dry sepals weight. The negative and low phenotypic correlation values were observed in the second season in case of seed and dry sepals weight with other studied characters. These relations are influenced by environmental factors limiting the yield [31, 32].

These results are agreement with the results of Aruna *et al.* [28], Banerjee *et al.* [33], Gondane *et al.* [34] and Ottai *et al.* [35].

This study concluded that plant height, number of branches and dry sepals weight with high heritability should be taken in consideration during selection for higher yield of roselle.

REFERENCES

1. Akobundu, I.O., 1987. Weed in the tropics: principles and practices. New York: Wiley.
2. Al-Wandawi, H., K. Al-Shaikhaly and M. Abdu-Rahman, 1984. Roselle seeds: a new source of protein. J. Sci. Food Agric., 32: 510-512.
3. Balami, A., 1998. The effect of prcessing conditions packaging and storage on selected quality attributes of *Mungza Ntusa.* M.Sc. Thesis, University of Ibadan, Nigeria.
4. Tseng, T., T. Kao, C. Chu, F. Chou, W. Lin and C. Wang, 2000. Induction of apoptosis by *Hibiscus* Protocatechuic Acid in Human Leukemia Cells via Reduction of Retinoblastoma (RB) Phosphorylation and Bcl-2 Expression. Biochem. Pharmacol., 60: 307-315.
5. Pin-Der, D. and Y. Gow-Chin, 1997. Antioxidative activity of three herbal water extracts. J. Food Chem., 60: 639-645.
6. Hussein, R.M., 2003. Bioprospección de capacidad antioxidante y análisis bioquímico de la biosíntesis de la vitamina E en plantas. Ph.D. Thesis, University of Córdoba, Spain.
7. Haji Faraji, M. and A.H. Haji Tarkhani, 1999. The effect of sour tea (*Hibiscus sabdariffa*) on essential hypertension. J. Ethnopharmacol., 65: 231-236.
8. Omer, E.A., M.E. Khattab and M.E. Ibrahim, 1997. Effect of pinching and foliar application of some growth regulators on two new early mature varieties of *Hibiscus sabdariffa* L. Egypt. J. Hort., 24: 117-130.
9. Shalan, M.N., T.A. Abd-Ellatif, S.G.I. Soliman and E.O. El-Gaawwas, 2001. Effect of some chemical and biofertilizer treatments on Roselle plants *Hibiscus sabdariffa* L. Egyptian J. Agric. Res., 79: 587-606.
10. Shalaby, A.S. and A.M. Razin, 1989. Response of Roselle plant (*Hibiscus sabdariffa* L.) to irradiation treatments. Indian J. Hort., 46: 103-106.
11. Das, N.R. and A.K. Das, 2000. Effect of variety and land situation, on biomass yield of rainfed mesta (*Hibiscus sabdariffa* L.). Advances in Agricultural Research in India, 10: 53-56.
12. Eraki, M.A., M.M. Mazrou and M.M. Afify, 1993. Influence of Kinetin and indole-3-acetic acid (IAA) on the growth, drug yield and essential oil content of *Salvia officinalis* L. plants. Zagazig J. Agric. Res., 20: 1323-1334.
13. Talaat, I.M. and A.A. Youssef, 1998. Response of Roselle plants (*Hibiscus sabdariffa* L.) to some growth regulators substances. Egypt. J. Phisiol. Sci., 22: 327-338.
14. Kiran Patro, T.S. and C. Ravisankar, 2004. Genetic variability and multivariate analysis in okra (*Abelmoschus esculentus* (L.) Moench). Tropical Agric. Res., 16: 99-113.
15. Steel, R.G. and J.H. Torrie, 1980. "Principles and Procedures of Statistics." 2nd Ed. McGraw-Hill, Inc., New York.
16. Robinson, H.F., R.E. Comstock and P.H. Harvey, 1951. Genotypic and phenotypic correlation in corn and their implications to selection. Agron. J., 43: 282-287.
17. Burton, G.W., 1952. Quantitative inheritance in grasses. Proc. 6th Intl. Grassland Cong., pp: 277-283.
18. Johnson, H.W., H.F. Robinson and R.E. Comstock, 1955. Estimates of genetic and environmental variability in soybean. Agron. J., 47: 314-318.
19. Gandhi, H.T., M.D. Yadav and P.A. Navale, 2001. Studies on variability in okra (*Abelmoschus esculentus* L. (Moench). J. Maharashtra Agricultural Univ., 26: 146-148.
20. Mostofa, M.G., M.R. Islam, A.T.M. Morshed Alam, S.M. Mahbub Ali and M.A.F. Mollah, 2002. Genetic variability, Heritability and Correlation studies in kenaf (*Hibiscus cannabinus* L.). Online J. Biol. Sci., 2: 422-424.
21. Koorse, K.V., 1987. Genetic variability studies in Roselle (*Hibiscus sabdariffa* L.). J. Agric. Sci., 21: 90-91.
22. Thirthamallappa and R.A. Sherif, 1991. Genetic variability studies in roselle. Current research, Univ. Agricultural Science, Bangalore, 20: 257-258.

23. Zayed, A.A., I.A. Abo Elfadle and E.H. Hussein, 1996. Estimates of variability, heritability and correlation coefficient among some characters of roselle (*Hibiscus sabdariffa* L.). Egyptian J. Appl. Sci., 11: 26-33.
24. Panda, P.K. and K.P. Singh, 1997. Genetic variability, heritability and genetic advance for pod yield and its contributing traits in okra hybrids. Madras Agric. J., 84: 136-138.
25. Reddy, K.R., K.P. Singh and A.K. Rai, 1985. Variability and association analysis in okra. Madras Agric. J., 72: 478-480.
26. Vijay, O.P. and M.S. Manohar, 1990. Studies on genetic variability, correlation and path analysis in okra (*Abelmoschus esculentus* L. (Moench). Indian J. Hort., 47: 97-103.
27. Yadov, D.S., 1986. Variability and inter relations between yield and its components in okra (*Abelmoschus esculentus* L. (Moench). Indian J. Hort., 43: 274-277.
28. Aruna, C., D. Subramanyam, P.V.R. Kumar and G. Satyanarayana, 1989. Correlation and path analysis in Roselle (*Hibiscus sabdariffa* L.). J. Res. APAU., 17: 65-67.
29. Shreshtha, V.S., 1991. Genetic variability, correlation and path analysis studies in jute (*C. capsularis* L.). M.Sc. (Ag.) Thesis. Rajendra Agril. Univ., Bihar, Pusa.
30. Subramayan, D., P.V.R. Kumar, B. Krishnamurthy and S. Islam, 1995. Heritability and correlation studies in Kenaf (*Hibiscus cannabinus* L.). Indian J. Genet. Plant Breed., 55: 279-282.
31. Malik, M.A., A.S. Khan, Saifullah, M.A. Khan, B.R. Khan and S.M. Mahmood, 2000. Study of correlation among morphological parameters in different Varieties/accessions of Brassica Species. Pak. J. Biol. Sci., 3: 1180-1182.
32. Khan, A.H., T. Mahmood and S.A. Shah, 1992. Path coefficient analysis of morphological parameters with seed yield in Raya. Pak. J. Agric. Res., 3: 334-337.
33. Banerjee, R., M.K. Sinha and M.K.G. Roy, 1988. Correlation and Path coefficient analysis of yield components in *Hibiscus sabdariffa* L. Jute Development Journal, 8: 643.
34. Gondane, S.U., G.L. Bhatia and P.S. Partap, 1995. Correlation studies of yield components in okra (*Abelmoschus esculentus* L. (Moench). Haryana J. Hort. Sci., 24: 146-148.
35. Ottai, M.E.S., A.S.H. Abdel-Moniem and R.A. El-Mergawi, 2003. Effect of variety and location on growth and yield components of roselle (*Hibiscus sabdariffa* L.) and its infestation with the spiny bollworm *Earias insulana* (Boisd). Archives of Phytopathology and Plant Protection, 37: 215- 231.