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Estimates of genetic variability, heritability and genetic advance in strawberry

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Abstract

Phenotypic and genotypic coefficients of variability, heritability along with genetic advance as percent of mean were estimated in strawberry accessions for 16 characters. The fruit length showed high coefficient of variation (104.56%). The percent of plant flowering showed maximum PCV and GCV followed by fruit volume, number of flower, trusses per plant and flower disk diameter. The characters, fruit weight, plant height, length of leaf petiole, percent of plant flowering, fruit volume, showed high heritability coupled with high genetic advance as percent of mean, which indicated that selection can be made for improvement. The genotypic correlation coefficients were larger than phenotypic correlations. This indicated little role of environment in expression of genetic relationship. The number of fruits per plant was positively and significantly correlated with the fruit volume, fruit weight, flower disk diameter, percent of plant flowering and number of runners per plant.

Key words: Variability, heritability, genetic advance, strawberry, breeding

Introduction

Strawberry (*Fragaria vesca* L.), a perennial herb, belongs to the family Rosaceae and native of America (Galletta and Himelrick, 1990). In any crop improvement programme, a knowledge of various variability parameters and association among different traits in the base population is a pre-requisite to initiate and execute properly the selection for yield. Since most of the economic plant characters are polygenic in nature and highly influenced by environment, the knowledge of genetic association between yield and its components under different production conditions will improve the efficiency of breeding programme by preparing appropriate selection indices for developing suitable varieties. The aim of this work was to estimate the genetic variability, heritability coefficients, and the relative genetic gains for the yield traits of strawberry in order to obtain information necessary for choosing the most appropriate methods of breeding/ selection.

Materials and methods

The investigation was carried out with 17 germplasm of strawberry collected from different parts of India and maintained in the field gene bank at the National Bureau of Plant Genetic Resources Regional Station, Bhowali. The experiment was laid out in randomized block design with three replications in 1997 at Bhowali (29^{o}N latitude and 70^{o}E longitude) an altitude of 1600 msl. The climate of this site is sub-temperate with minimum and maximum temperature ranging between –7 ^{o}C to 37 ^{o}C with an annual rainfall around 1600 mm. All cultural management applied as per Joolfka *et al.* (1986). The observation were recorded on plant height (cm), number of runners per plant, number of plantlets per plant, length of runners (cm), length of petiole (cm), terminal leaf length (cm), percent of plant flowering, number of flower trusses per plant, number of flower per trusses, flower diameter (cm), flower disk diameter (cm), fruit length (cm), fruit width (cm), fruit weight (g), fruit volume (ml) and number of fruit per plant. The genotypic and phenotypic coefficients of variation was calculated as per method suggested by Burton and Devane (1953). Heritability in broad sense was estimated as suggested by Allard (1960), expected genetic advance as percent of mean and correlation were worked out by the method of Johnson *et al.* (1955) and Aljibouri *et al.* (1958), respectively.

Results and discussion

Mean data of different characters are presented in Table 1. The results with regard to different parameters of variability for different traits have been presented in Table 2. The analysis of variance for sixteen characters indicated that there is considerable variation in respect to all the characters studied. However, absolute variability in different characters is showing the highest degree of variability. Maximum variation was observed in percent of plant flowering followed by plant height, length of leaf petiole, fruit weight, length of runners and number of fruits per plant. Low variation was observed for flower disk diameter, fruit width, flower diameter and fruit volume.

In the present study (Table 2) genotypic coefficient of variation (GCV) was less as compared to phenotypic coefficients of variation for all the characters indicating a considerable influence of environment on their expression. The number of fruits per plant ranged from 3.66-9.00, fruit volume, fruit weight, fruit width, fruit length and number of flower trusses per plant ranged from 0.83-2.26 ml, 6.00-19.46 g, 1.03-1.88 cm, 1.08-2.08 cm and 1.00-2.00, respectively. Fruit length showed maximum phenotypic coefficient of variation (104.56%). Fruit length showed maximum PCV followed by percent of plant flowering followed by fruit volume (56.35%). Per cent of plant flowering and fruit volume exhibited

Table 1. Mean performance of strawberry accessions

Accessions	PH	NRP	NPP	LR	LLP	TLL	PLF	FTP	NFT	FD	FDD	FL	FW	FWe	FV	NFP
NIC-18091	21.73	2.00	2.66	21.50	13.80	7.03	11.66	1.00	2.66	1.46	0.24	1.70	1.06	13.53	1.40	4.33
NIC-18092	22.26	3.66	3.00	23.43	16.56	7.60	8.00	1.33	5.00	1.80	0.46	1.83	1.37	17.20	1.13	5.33
NIC-18093	23.66	3.33	3.66	18.50	15.63	7.20	11.66	1.33	5.66	1.73	0.60	1.95	1.88	20.30	1.80	7.00
NIC-18095	21.33	3.00	2.33	19.33	15.56	7.60	25.00	1.66	6.33	1.80	0.53	2.08	1.40	18.33	1.46	6.00
NIC-18096	16.50	3.33	2.00	21.00	10.90	6.73	35.00	1.33	4.33	2.03	0.70	1.73	1.53	19.46	1.46	6.00
NIC-18097	15.33	3.00	2.00	18.66	10.90	7.50	35.00	1.66	6.00	1.83	0.63	1.21	1.05	15.00	2.26	6.00
NIC-18098	17.40	4.00	3.00	19.66	12.00	6.73	15.00	1.33	5.00	2.03	0.56	1.45	1.05	14.16	1.46	7.00
NIC-18099	17.56	3.00	3.00	18.16	11.00	4.66	21.66	2.00	5.66	1.60	0.46	1.24	1.20	11.66	1.26	9.00
NIC-18100	15.63	3.66	3.00	16.83	14.73	6.36	9.33	1.33	3.33	1.36	0.36	1.35	1.17	14.73	1.20	5.33
NIC-18101	13.26	4.33	3.08	21.16	16.40	7.16	55.00	1.33	5.33	1.60	0.46	1.28	1.10	11.13	0.93	6.00
NIC-18102	14.86	4.00	2.00	18.50	20.86	7.13	15.00	2.00	6.00	2.00	0.56	1.41	1.26	10.66	0.98	5.33
NIC-18103	15.80	4.33	1.66	25.00	12.73	6.83	45.00	1.33	5.00	1.40	0.30	1.37	1.21	12.00	1.46	7.00
NIC-18111	25.00	2.66	3.00	21.00	23.83	8.53	15.00	1.00	5.00	1.70	0.43	1.64	1.13	7.16	0.90	6.66
NIC-18112	24.90	4.00	3.33	19.50	19.66	9.33	25.00	1.33	7.33	1.56	0.43	1.69	1.32	11.13	1.20	5.00
NIC-18113	28.13	3.00	3.00	25.00	19.93	8.90	25.00	1.66	5.66	1.76	0.46	1.08	1.03	8.00	0.83	4.33
NIC-18114	28.33	3.00	3.66	17.33	19.66	8.33	10.00	1.33	5.00	2.13	0.50	1.36	1.07	7.26	1.00	3.66
NIC-18115	27.10	3.33	3.33	17.06	25.16	8.30	8.33	1.33	5.00	1.50	0.56	1.25	1.11	6.00	0.96	4.66
SEM+	1.22	0.71	0.49	1.46	1.31	0.45	4.27	0.37	0.91	0.19	0.10	1.01	0.10	1.04	0.17	0.90

PH - Plant height (cm) NFT- No. of flower/truss LLP- Length of leaf petiole (cm) FW - Fruit width (cm)
NRP- No. of runners/plant FD - Flower diameter (cm) TLL- Terminal leaf length (cm) FWe - Fruit weight (g)
NPP- No. of plantlets/plant FDD- Flower disk diameter (cm) PLF- % of plant flowering FV - Fruit Volume (cm)
LR - Length of runners (cm) FL - Fruit length (cm) FTP- No. of flower trusses/plant NFP - No. of fruit/plant

Table 2. Variability in some quantitative traits for strawberry

Characters	Range	Mean	Variance		Coefficient of variation			Heritability	GA	GA as %
			σg	σp	PCV	GCV	ECV	(%)		of mean
Plant height (cm)	13.26-28.33	20.51	28.53	24.06	26.03	23.90	10.30	84.32	9.27	45.19
No. of runners/plant	2.00-4.33	3.39	1.40	0.11	34.96	10.00	36.36	8.18	0.20	5.89
No. of plantlets/plant	1.66-3.66	2.80	0.86	0.11	33.07	11.97	30.83	13.10	0.25	8.92
Length of runners (cm)	17.03-25.00	20.09	10.78	4.30	16.33	10.32	12.66	39.92	2.70	13.43
Length of leaf petiole (cm)	10.90-25.16	16.41	23.28	18.12	29.39	25.93	13.83	77.85	7.73	47.10
Terminal leaf length (cm)	4.66-9.33	7.46	1.32	0.69	15.43	11.19	10.62	52.58	1.24	16.62
% of plant flowering	8.00-55.00	21.80	225.98	171.09	68.94	59.99	33.97	75.71	23.44	107.52
No. of flower trusses/plant	1.00-2.00	1.43	0.36	0.06	42.21	17.46	45.68	17.11	0.21	14.68
No. of flower/trusses	2.66-7.33	5.19	2.83	0.33	32.42	11.09	30.46	11.70	0.40	7.70
Flower diameter (cm)	1.36-2.13	1.72	0.13	0.01	21.07	7.10	19.84	11.34	0.08	4.65
Flower disk diameter (cm)	0.26-0.70	0.49	0.03	0.00	38.37	8.23	37.48	46.05	0.01	2.02
Fruit length (cm)	1.08-2.08	1.64	2.96	0.12	104.56	21.26	106.70	4.13	0.14	8.53
Fruit width (cm)	1.03-1.60	1.21	0.04	0.01	18.26	10.01	15.27	30.07	0.13	10.74
Fruit weight (g)	6.00-19.46	12.80	20.93	17.65	35.71	32.80	14.12	84.36	7.95	62.10
Fruit Volume (cm)	0.83-2.26	1.10	0.38	0.29	56.35	49.26	27.34	76.44	0.97	88.18
No. of fruit/plant	3.66-9.00	5.68	3.18	0.70	31.40	14.78	27.70	22.75	0.81	14.26

higher GCV values. The lowest variability (15.43 and 11.19%) and (16.33 and 10.32%) was noted for the terminal leaf length and length of runners, respectively.

Fruit weight showed maximum heritability (84.36%) with high genetic advance (62.10) as percent of mean. Verma *et al.* (2002) reported similar results. Robinson (1966) has categorized the estimates of heritability as low (5-10%), medium (10-30%) and high (30 and above). Following this classification, the heritability estimates obtained high for maximum characters except number of runners per plant, number of plantlets per plant, number of flower trusses per plant, number of flower per trusses, flower diameter, fruit length and number of fruit per plant. Such high heritability estimates have been found to be helpful in making selection of superior genotypes on the basis of phenotypic performance with respect to quantitative characters. However, the heritability estimate along with genetic advance is more useful than the heritability values alone for selecting the best individual. In present study, the characters fruit weight, plant height, length of leaf petiole, percent of plant flowering, fruit volume showed high heritability coupled with high genetic advance as percent of mean. Number of fruit per plant, number of flower trusses per plant and number of plantlets per plant, showed medium heritability coupled with low genetic advance as percent of mean.

The characters which exhibited high heritability with high genetic advance as percent of mean are genetically controlled by additive gene action (Panse, 1957) and can be improved through mass selection, family selection, or any other modified selection procedure. In case where the characters exhibited high heritability

Table 3. Genotypic (G) and phenotypic (P) correlations among 16 characters in strawberry

		PH	NRP	NPP	LR	LLP	TLL	PLF	FTP	NFT	FD	FDD	FL	FW	FWe	FV	NFP
PH	G	1.00	-0.87**	0.32	0.03	0.70**	0.89**	-0.56**	-0.29	0.30	0.13	-0.29	0.51	-0.08	-0.48*	-0.63**	-0.82**
	P	1.00	-0.23	0.31	0.01	0.54**	0.57**	-0.48**	-0.16	0.05	0.09	-0.01	0.20	-0.08	-0.36	-0.50	-0.36
NRP	G			-0.14	0.14	-0.44*	-0.37	0.94**	0.78	0.13	-0.17	-0.30	-0.19	0.75**	0.03	-0.23	0.83**
	P			-0.11	0.07	0.17	0.00	0.12	-0.06	0.09	0.00	0.11	0.06	-0.10	0.01	-0.02	0.03
NPP	G				-0.64**	0.79**	0.69**	-0.07	-0.55	-0.27	0.46	0.23	0.42*	-0.73**	-0.48*	-0.93**	-0.28
	P				-0.23	0.14	0.22	-0.01	-0.10	0.12	-0.15	-0.21	-0.32	-0.08	-0.20	-0.28	0.08
LR	G					-0.18	0.20	0.52**	-0.25	-0.10	-0.02	0.10	0.26	0.09	0.04	-0.09	0.09
	P					-0.03	0.11	0.30	-0.08	-0.05	-0.02	0.08	0.25	-0.02	-0.02	-0.05	0.08
LLP	G						0.90**	-0.40	-0.11	0.37	0.05	-0.44*	0.91**	-0.01	-0.76**	-0.89**	-0.84
	P						0.53**	-0.32	-0.11	0.15	-0.10	-0.07	0.15	-0.09	-0.63**	-0.70**	-0.36
TLL	G							-0.12	-0.02	0.86**	0.10	0.18	0.41	-0.17	0.58**	-0.72**	-0.34
	P							-0.12	-0.03	0.25	0.02	-0.04	0.25	0.00	-0.35	-0.58**	-0.24
PLF	G								0.19	0.44*	-0.20	0.03	0.46*	-0.01	0.10	0.18	0.50
	P								0.02	0.18	-0.09	0.25	-0.14	0.00	0.10	0.16	0.22
FTP	G									0.17	0.91**	0.90**	-0.17	0.20	0.04	0.05	0.34
	P									0.16	-0.02	-0.66**	-0.16	0.07	0.00	0.04	0.07
NFT	G										0.10	0.59**	0.17	0.22	-0.16	-0.07	0.34
	P										0.06	0.07	0.13	0.22	-0.04	-0.02	0.13
FD	G											0.58**	-0.17	0.27	0.20	0.20	0.39
	P											0.54**	0.08	0.06	0.13	-0.06	-0.17
FDD	G												0.36	0.23	0.12	0.76**	0.88**
	P												-0.01	0.15	0.11	0.11	0.59**
FL	G													-0.54	-0.80**	-0.12	0.35
	P													-0.04	-0.16	-0.28	-0.12
FW	G														0.58**	0.16	0.16
	P														0.41*	0.11	0.16
FWe	G															0.88**	0.61
	P															0.72**	0.31
FV	G																0.81
	P																0.37

* Significant at 5% level, ** Significant at 1% level

with moderate or low genetic advance as percent of mean can be improved through multiple crosses. The phenotypic as well as genotypic correlations between different pairs of characters are presented in Table 3. In general, the values of correlation at genotypic level were higher than phenotypic correlations. This indicated little role of environment in the expression of genetic relationship on the phenotypes. The number of fruits per plant was positively and significantly correlated with fruit volume, fruit weight, flower disk diameter, percent of plant flowering, number of runners per plant and negatively correlated with plant height and length of leaf petiole. Fruit weight was found significantly correlated with fruit width and negatively correlated with plant height and fruit length. Fruit length was significantly correlated with percent of plant flowering, length of leaf petiole, number of plantlets per plant and plant height. Ardelean *et al.* (1992) reported fruit yield per hectare was significantly correlated (both phenotypic and genotypic) only with mean number of flowers per plant and mean fruit weight. Significant negative correlation between percent fruit set and mean fruit weight was reported. The study revealed that characters *viz.*, number of fruits per plant, fruit volume, fruit weight, flower diameter, number of flower trusses per plant and number of plantlets per plant could be useful for improvement in strawberry through selection.

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