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Genetic variability in quality and yield parameters of early ripening grape genotypes

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Abstract

Phenotypic and genotypic coefficients of variability, heritability along with genetic advance were studied in 14 early maturing genotypes for yield and quality characters. The differences among the genotypes were highly significant (p=0.05) for all the characters (except bunchlength) studied. A wide range of variation was recorded in bunch width, number of berry per bunch, 100-berry weight, 100-seed weight, juice content, TSS, reducing sugar, organic acid content and berry yield. Based on coefficient of variation, broad sense heritability and expected genetic advance it can be concluded that berry yield, 100-berry weight, 100-seed weight and organic acid content provides greater scope for selection of superior genotypes. Among fourteen genotypes Flame seedless produced highest (17.6 t/h) berry yield, Cardinal registered highest (275.6 g) 100-berry weight with high (6.5g) 100-seed weight and Pusa Navrang showed highest organic acid content and 100-seed weight (6.7g). The characters studied are quantitatively inherited and non-additive effects were detected with organic acid.

Key words: Grape, early varieties, phenotypic, genotypic, coefficients of variability, heritability, yield, quality

Introduction

In northern India, pre-monsoon showers during ripening of grape spoil the crop. High temperature prevailing during ripening of grapes in north India do not allow grape to store high sugar. The desirable total soluble solids: acid blend for wine making is never attained in the grapes grown in north India. Thus, breeding for early maturity is one of the main objectives of grape improvement in north India. In grape, most of the characters of interest are polygenic in nature and inheritance of some of the important traits like yield and yield components (number of berries per branch, berry weight, number of bunches per vine, bunch weight and volume of bunches) are under the control of many genes. Therefore, a better knowledge about variation in these traits among different genotypes and assessment of genetic variability, heritability and genetic advance are useful while fixing selection criteria for early maturity in grape. The present study was undertaken to estimate the magnitude of genetic parameters to determine breeding strategy and select superior genotypes of early ripening grape.

Materials and methods

Fourteen genotypes of grape (Table 1) were grown in randomized block design with five replications at the experimental orchard of Central Institute for Sub-tropical Horticulture, Lucknow. The application of fertilizers and other agro-practices were carried out as per normal recommendations. Physical and biochemical examination of the fruits of different varieties were made during 2000-2001. The observations on quantitative characters *viz.,* bunch length, bunch width, number of berry per bunch, 100-berry weight, total soluble solids, 100-seed weight, juice content, reducing sugar, organic acid and berry yield were recorded by selecting five random bunches from each genotypes in each of replication. Total soluble solids were measured by hand refractometer. Reducing sugar and titratable organic acid content of the fruits was determined as per A.O.A.C. (1990).

The analysis of components of variance for these character was carried out by adopting standard procedure for the estimation of genetic constant as suggested by Johnson *et al*. (1955), Panse (1957) and Gomez and Gomez (1984). The heritability in broad sense and genetic advance were also calculated for these characters (Allard, 1960 and Singh and Chaudhary, 1985) as follows:

$$h^2 = \sigma^2_g / \sigma^2_p$$

$$GA = ih^2 \sigma_p$$

Where, h^2 is heritability in broad, σ^2_g and σ^2_p are the genotypic and phenotypic variances, respectively, and i is the standardized selection differential at selection intensity of 5%.

Results and discussion

The genotypes exhibited significant variation indicating very high magnitude of variability with respect to all the characters studied, except the length of bunch (Table 1). Bunch width was highest with Beauty Seedless, which was significantly at par with Pusa Seedless, New Perlette, Pusa Urvasi, Pusa Navrang Delight, Flame Seedless and BA x Per-75-32 while lowest with Perlette and Gold. Number of berry per bunch was significantly higher in Beauty Seedless followed by Pusa Seedless, BA x Per-75-32, New Perlette, Flame seedless, Delight and Pusa Navrang, whereas comparatively lesser in Pusa Urvasi followed by Cardinal, Kishmish Beli and Gold.

The genotypes showed significant variation in 100-berry weight., which ranged from 104 g in Pusa Navrang to 275g in Cardinal, while the juice content varied from 52.16 to 67.2% lowest in Pusa Urvasi and highest in Beauty Seedless. Among the genotypes, Cardinal, Pusa Navrang, Gold and BA x Per-75-32 were seeded while rudimentary seeds were also observed in seedless varieties *i.e*. Pusa Urvasi, Kishmish Charani and Flame Seedless in second year of experiment. It might be due to environmental effect.

The genotypes exhibited significant variation in the biochemical constituents of the fruits. The total soluble solids was comparatively low in BA x Per-75-32, while higher in Pusa Navrang, Kishmish Beli, Perlette and Kishmish Charani. Similar trend in reducing sugar content in these genotypes was observed with a range of 4.3% in BA x Per-75-32 to 11.73% in Pusa Navrang. The organic acid in fruits showed a range of 0.32% in Flame Seedless to 0.75% in BA x Per- 75-32. In case of berry yield, Flame Seedless registered highest (17.6 t/h) followed by Pusa Navrang (16.18 t/h) while BA x Per-75-32 showed lowest (2.02 t/h).

Number of berry per bunch ranged from 88.40 to 215.80 with a mean 150.03 showed maximum CV (34.02%), coefficient of environmental and phenotypic variation being 2605.018 and 4185.86, respectively while 100-berry weight varied from 104.0g to 275g with a mean of 166.014, indicating maximum (1915.227) genotypic variation in fruits. Table 2 revealed that high genotypic coefficient of variation was noticed for 100-seed weight (169.331) followed by berry yield (83.655), organic acid (30.673), number of berry per bunch (26.501) and 100-berry weight (26.361). The character showing low gcv indicated that they were highly influenced by the environmental components.

From Table 2 it is quite clear that 100-seed weight recorded highest phenotypic coefficient of variation (171.848) followed by berry yield (84.654), number of berry per bunch (43.124) and organic acid (33.139). The coefficient of variation indicated high magnitude of variability in the genotypes. Selection may, therefore, be effective for these characters. Juice content exhibited low genotypic and phenotypic coefficient for this character. A comparatively low pcv was shown for juice content and TSS. This low variation indicated the highly stable nature of these characters among genotypes studied and are indicative of less scope for improvement, which is similar to the findings of Adebola *et al*. (2002) in Kola (*Cola nitida*).

The estimates of gcv were lower in magnitude than pcv. The results are in conformity with the reports of Vijulan Harris *et al.* (1994) in cashew (*Anacardium occidentale* L.), Sharma and Chandrababu (1997) in almond [*Prunus dulcis* (Miller) D.A.Webb] and Kulkarni *et al.* (2002) in banana indicating that a large environmental influence in the manifestation of the traits occured as reflected by the differences in the values between phenotypic and genotypic variances.

The estimate of heritability ranged from 0.11 (bunch length) to 0.98 (berry yield). The heritability in broad sense of berry yield, 100-seed weight, organic acid, total soluble solids, 100-berry weight and sugar content was very high indicating greater genetic component and marginal influence of environment. A computed

Table 1. Physico-chemical characteristics of different genotypes of grapes

Genotypes	Bunch length(cm)	Bunch width(cm)	No. of berry/ /bunch	100-berry weight(g)	100-seed weight(g)	Juice content (%)	TSS (%)	Reducing sugar(%)	Acidity (%)	Yield (t/ha)
Beauty Seedless	19.30	12.60	215.80	164.00	0.00	67.20	13.70	7.03	0.63	2.08
Cardinal	14.50	8.60	89.60	275.60	6.50	59.40	13.94	7.64	0.39	9.34
Pusa Navrang	15.80	10.50	151.20	104.00	6.74	64.40	18.04	11.73	0.85	16.18
Kishmish Beli	14.30	7.78	94.80	128.60	0.00	58.80	18.04	11.61	0.52	2.30
Kishmish Charani	14.60	9.50	110.60	148.00	3.70	58.20	16.84	10.92	0.42	9.16
Pusa Urvasi	15.40	11.00	88.40	183.00	3.60	52.16	15.24	9.39	0.45	1.32
Pusa Seedless	17.90	11.40	198.40	183.00	0.00	56.40	15.40	9.36	0.46	5.02
Gold	12.90	7.40	96.00	178.40	6.50	56.40	15.00	9.31	0.38	8.88
Flame Seedless	17.64	10.10	182.00	154.80	5.24	58.40	16.72	10.82	0.32	17.60
Delight	15.30	11.00	168.80	167.40	0.00	50.80	15.28	9.49	0.52	2.70
New Perlette	17.80	11.20	184.80	118.00	0.00	58.00	14.72	8.51	0.33	4.28
Perlette	15.20	7.40	143.40	146.40	0.00	58.80	17.38	11.30	0.49	3.24
BA x Per-75-32	19.10	10.30	196.40	140.00	6.10	64.00	9.72	4.30	0.75	2.02
CD (p=0.05)	NS	2.81	64.72	29.40	0.59	7.38	1.34	1.45	0.078	1.42

Table 2. Phenotypic and genotypic components of variability and coefficients of variation, broad sense heritability and expected genetic advance in physico-chemical characters and yield of grape

Traits	Range	Grand Mean	CV(%)	σ_g	σ_e	σ_p	GCV	PCV	h^2 (B)	GA
Bunch length	12.9-19.3	16.081	21.072	1.438	11.483	12.921	7.456	22.352	0.111	0.824
Bunch width	7.4-12.6	10.227	21.655	3.004	4.905	7.909	16.948	27.498	0.380	2.201
No. of berry/bunch	88.4-215.8	150.029	34.020	1580.842	2605.018	4185.859	26.501	43.124	0.378	50.334
100-berry weight	104-275.6	166.014	13.964	1915.227	537.418	2452.645	26.361	29.831	0.781	79.665
100-seed weight	0.0-6.74	1.577	29.303	7.132	0.214	7.346	169.331	171.848	0.971	5.421
Juice content	50.8-67.2	68.426	9.965	13.419	33.895	47.313	6.270	11.773	0.284	4.019
TSS	9.72-18.04	15.379	6.880	4.363	1.119	5.452	13.582	15.226	0.796	3.839
Reducing sugar	4.30-11.73	9.336	12.205	3.873	1.298	5.171	21.078	24.357	0.749	3.508
Organic acid	0.32-0.85	0.492	12.544	0.023	0.004	0.027	30.673	33.139	0.857	0.288
Yield	2.02-17.6	6.476	12.967	29.349	0.705	30.054	83.655	84.654	0.977	11.028

heritability value was very low for bunch length (0.11). The rest of the characters showed heritability estimate of 0.28 or more. Similar results were also observed by Chandrababu and Sharma (1999) in almond and Sirisena and Senanayake (2000) in banana.

The genetic advance for 100-berry weight was high (79.67) followed by number of berry per bunch (50.33) and berry yield (11.02). Phenotypic and genotypic coefficient of variation together with heritability estimates revealed that selection would be of more magnitude for 100-seed weight and berry yield.

Estimated heritability in combination with genetic advance is more reliable than heritability alone for predicting the impact of selection (Johnson *et al.* 1955). In the present investigation, berry yield, 100- berry weight, 100-seed weight and organic acid had high heritability accompanied with high gcv which suggested that these four characters provide greater scope for further selection. Kulkarni *et al*. (2002) have reported high heritability with high gcv for characters like bunch weight, number of fingers and fruit weight in banana.

Panse (1957) reported that high heritability associated with high genetic advance is mainly attributed to the action of additive gene. In the present findings, high gcv and heritability estimate associated with greater genetic advance were noticed for 100-berry weight, berry yield and 100-seed weight which revealed that these three characters had additive gene effect and therefore they are more reliable for effective selection. Low genetic advance (0.288) associated with high heritability (0.857), recorded in case of organic acid may be due to non-additive gene action, which might accompany epistasis and dominance. According to Shadakshari *et al*. (1995) a low genetic advance implies that the heritability of a particular character in a specific environment was mainly due to non-additive gene action (dominance and epistasis), whereas if the heritability was due to additive gene effect, it would be associated with high genetic advance. The rest of the characters recorded low scores in all three genetic parameter and therefore offered less scope for selections as they were much more under the influence of the environment and accounted for non-additive gene effect as observed in tomato (Sahu and Mishra, 1995).

Based on coefficient of variation, broad sense heritability and expected genetic advance it can be concluded that berry yield, 100-berry weight, 100-seed weight and organic acid content provide greater scope for selection of superior genotypes. Among fourteen genotypes flame seedless produced highest (17.6 t/h) berry yield, Cardinal registered highest 100-berry weight (275.6 g) with higher 100-seed weight (6.5g) and Pusa Navrang showed highest organic acid content and 100-seed weight (6.7g). The characters studied are quantitatively inherited and non-additive effects were detected with organic acid.

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