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CHARACTER ASSOCIATION AND PATH COEFFICIENT ANALYSIS IN ROSE (*Rosa spp.*)

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ABSTRACT

Twenty nine genotypes of roses collected from different places and maintained in Horticulture section were evaluated in RBD replicated twice in 2015, with the objective to estimate the inter relationship among the components for high flower yield and to estimate the direct and indirect influences of the component trails towards flower yield. Observations recorded on plant height, primary branches plant^{-1}, secondary branches plant^{-1}, canopy diameter, stem girth, bud length, bud width, diameter of flower, days taken to anthesis, stalk length, thorn density, fresh weight of flower, flower yield plant^{-1}, flower yield plot^{-1} were used in this study for computing genetical analysis. Flower yield plant^{-1} was significantly and positively correlated with that of plant height (r= 0.841, 0.741), number of primary branches plant^{-1} (r= 0.765, 0.633), number of secondary branches plant^{-1} (r= 0.782, 0.628), canopy diameter (r= 0.901, 0.877), stem girth (r= 0.876, 0.701), bud length (r= 0.800, 0.0717) at both genotypic and phenotypic level. Thorn density recorded negative correlation with all characters and days taken to anthesis showed non significant relationship with all the characters studied. Significant correlation of flower yield plant^{-1} with different traits were due to the high direct effect of stalk length (55.26%), canopy diameter (29.25%), stem length (26.92%) and plant height (19.17%) and due to the indirect effect of bud length (126.32%), fresh weight of flower (102.33%), number of secondary branches plant^{-1} (102.38%), number of primary branches plant^{-1} (98.16%), plant height (80.83%), stem girth (73.08%), canopy diameter (70.75%) and stalk length (44.74%). Stalk length, canopy diameter, stem girth and plant height were identified for primary selection based on positive significant correlation and high direct effect. Considering these characters, the five genotypes Kiss of fire,Peter F, Centenary, Double delight and Veternas honor were identified for further purification and multiplication.

(Key words: Rose, correlation coefficient, path coefficient analysis)

INTRODUCTION

Rose is one of the most economically important ornamental species used as landscape and cut flower plant in the world. Among cut flowers, rose ranks first in terms of trade and popularity. Rose plays a vital role in manufacturing of various products of medicinal and nutritional importance, However, a very peculiar aspects of rose production is to get the cut flowers, which greatly deals with the floricultural business. An effective breeding programme for developing improved quality varieties requires preliminary information on the nature and magnitude of genetic variability, degree of transmission of traits and their inter-relationship. Hence, it is important to have the knowledge of association of vegetative and floral traits among themselves. Correlation coefficient studies are useful in choosing superior cultivars from their phenotypic and genotypic expression. As far as flower yield is concerned it is a complex trait known to be collectively influenced by various polygenically inherited traits. Therefore, correlation studies give an idea about the positive and negative associations of different vegetative and floral traits with number of flowers plant^{-1} and also among themselves. However, using correlation coefficient studies, nature and extent of contribution by these traits towards number of flowers plant^{-1} is not obtained. This difficulty is overcome by path coefficient studies, it facilitates partitioning of correlation coefficients into direct and indirect effects of the different traits on number of flowers plant^{-1} or any other traits and also helps in finding out how these effects influence a particular character to produce a given positive or negative correlation. The information helps in giving proper weightage to various traits during selection or other breeding programme so that the improvement of desirable trait could be achieved effectively. Keeping these points in view, the present studies was carried out to find out the inter-relationship among the component responsible for more number of flowers plant^{-1} i.e., flower yield plant^{-1} and the direct and indirect influences of each of the component trait towards number of flowers plant^{-1}.

MATERIALS AND METHODS

This experiment was undertaken during the year 2015-2016 at farm of Horticulture section, College of Agriculture, Nagpur. The experimental material consisted

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of 29 rose genotypes collected and maintained by Horticulture Section. The 29 rose genotypes were planted in 4.5 m x 4.5 m plot of flat bed with a spacing 0.9 m x 0.9 m in randomized block design with two replications and maintained by Horticulture Section, College of Agriculture, Nagpur. The plants were time to time supplemented with nutrient mixture along with RDF (recommended dose of fertilizer) for the proper growth and development of flower bud. Irrigation was given to the rose plants at proper interval. Weeding, earthing up, plant protection, irrigation, etc. were adopted as and when found essential. Pruning in rose was done twice in a year, first pruning done in 1^{st} fort night of June and second in 1^{st} fort night of October. Generally moderate pruning was done with the help of sharp shear. Half dose of N and full dose of P and K were provided after pruning for proper growth and development of plants. Data were recorded on five competitive plants for fourteen characters like plant height, number of primary branches plant^{-1}, number of secondary branches plant^{-1}, canopy diameter, stem girth, bud length, bud width, diameter of flower, days taken to anthesis, stalk length, thorn density, fresh weight of flower, flower yield plant^{-1}, flower yield plot^{-1}. The data recorded were subjected to various statistical and biometrical analysis *viz.,* Analysis of variance (Panse and Sukhatme, 1954), estimation of correlation co-efficient (Sharma, 1998) and estimation of path co-efficient (Wright ,1921; Dewey and Lu,1959).

RESULTS AND DISCUSSION

The analysis of variance for experimental design (Table 1) revealed that the mean squares due to genotypes were highly significant for all the characters studied except for bud width and diameter of flower. This indicates that the rose genotypes had substantial genetic variability among themselves for flower yield and most of the yield components except for bud width and diameter of flower which allows the further estimation of different parameters for the twelve traits. Similar to this result wide variability for flower yield plant^{-1} and yield contributing characters were also observed by Sezari and Ahmet (2004), Susek *et al.* (2005), Babaei *et al*. (2008), Verma *et al.* (2008), Zeinali *et al.* (2009) and Atram *et al*. (2015) in rose.

Interrelationship of flower yield plant^{-1} with component traits

Since rose is grown for its ornamental and landscape characteristics, therefore, apart from its flower yield, other traits, *viz.,* stalk length, neck length, intermodal length, bud length, flower diameter, flower weight, number of petals flower^{-1}, prickle density etc., which contribute to its ornamental value, are also of paramount importance. Correlation coefficient analysis measures the mutual relationship between various plant characters and determines the component characters on which selection is based for genetic improvement for a particular character like flower yield plant^{-1} in our study. The genotypic and phenotypic correlation coefficients were computed in all possible combinations for eleven characters and are presented in table 2.

In the present study, genotypic correlation coefficients were found to be higher than phenotypic correlation coefficients for all the characters, indicating a strong inherent association between various characters. The difference between genotypic and phenotypic correlation for each pair of trait studied indicated that there is environmental influence which mask the actual genotypic correlation. The higher genotypic correlation in magnitude than the phenotypic correlation coefficient indicating that there is strong association between various vegetative and floral traits studied. This association is mainly because of genetic and environmental sources of variation which affected the trait through different physiological mechanisms, pleiotropy, linkage and environmental effects being more common. Similar to this results Zeinali *et al.* (2009) and Panwar *et al*. (2012) also reported higher genotypic correlation coefficient than the phenotypic correlation coefficient in rose.

The results of correlation studies shows that flower yield plant^{-1} was significantly and positively correlated with that of plant height (r= 0.841, 0.741), number of primary branches plant^{-1} (r= 0.765, 0.633), number of secondary branches plant^{-1} (r= 0.782, 0.628), canopy diameter (r= 0.901, 0.877), stem girth (r= 0.876, 0.701), bud length (r= 0.788, 0.623), stalk length (r= 0.896, 0.708) and fresh weight of flower (r= 0.8000, 0.0717) at both genotypic and phenotypic level. Thorn density was found to be significant but negatively correlated (r= -0.497, -0.382) with flower yield plant^{-1}. Days taken to anthesis recorded negative nonsignificant association with flower yield plant^{-1}. Interestingly in this study most of the characters were found to be positively associated with one another except for thorn density and days taken to anthesis. Thorn density recorded negative correlation with all the characters studied either significantly or nonsignificantly, and days taken to anthesis was found to show no significant relationship with all the characters studied.

In this study flower yield plant^{-1} being the important trait which has to be concentrated and simultaneously improved by improving characters like plant height, number of primary branches plant^{-1}, number of secondary branches plant^{-1}, canopy diameter, stem girth, bud length, stalk length and fresh weight of flower as these traits recorded significant positive correlation with flower yield plant^{-1}. In accordance to this result Babaei *et al.* (2008) reported that flower yield was positively correlated with number of petals and negatively correlated with thorn density. Similarly Zeinali *et al.* (2009) reported that the number of flowers plant^{-1} had the highest correlation with flower yield plant^{-1} (r= 0.95). Correlation between flower yield plant^{-1} and fresh weight of flower (r= 0.57), canopy diameter (r= 0.58), length of receptacle (r= 0.54) and flowering period (r= 0.43) was positive. Panwar *et al.* (2012) observed statistically significant and positive correlation (genotypic and phenotypic) for primary branches with number of flowers plant^{-1}.

Partitioning of correlation coefficient into direct and indirect effects through path coefficient analysis

Correlation studies indicates association pattern of the different component traits with flower yield plant^{-1}. It simply represents the overall influence of particular trait on target without revealing the cause and effect relationship. The knowledge of direct and indirect influence of yield contributing characters is of prime importance in selecting high yielding genotypes. Path coefficient analysis helps in estimating the direct and the indirect effects. The combination of characters for path coefficient analysis was chosen based on two criterias (i) the magnitude of correlation coefficient of different characters with flower yield plant $^{-1}$ and (ii) the residual factor. In order to obtain developmental relationship, the cause and effect relationships between yield and yield contributing parameters were studied in rose through path coefficient analysis. Genotypic path coefficient analysis was carried out by taking flower yield plant^{-1} as a dependent character and are presented in table 3 and 4. The residual effect was found to be 0.3315 which reveals that sufficient characters were included in the analysis of path coefficient and hence, the information drawn can be used.

The partitioning of positive genotypic correlation of flower yield plant^{-1} with different traits into direct and indirect effects revealed that the stalk length (0.495) contributed highest positive direct effect to flower yield plant^{-1} followed by canopy diameter (0.263), stem girth (0.235) and plant height (0.161). In terms of percentage maximum direct effect contributed towards positive significant genotypic correlation were stalk length (55.26%), canopy diameter (29.25%), stem length (26.92%) and plant height (19.17%). However, negative direct effect on flower yield plant^{-1} were attributed by bud length (- 0.207), thorn density (- 0.097) and days taken to anthesis (- 0.049).

This study also reported positive significant correlation of flower yield plant^{-1} with bud length, fresh weight of flower and number of secondary branches plant^{-1} but their direct effects were found to be negative. The positive significant correlation observed for these traits were due to their respective indirect effect contributing to the maximum up to 126.32% (bud length), 102.88% (fresh weight of flower) and 102.38% (number of secondary branches plant^{-1}). Other than these characters number of primary branches plant^{-1} (98.16%) followed by plant height (80.83%), stem girth (73.08%), canopy diameter (70.75%) and stalk length (44.74%) also contributed indirect effect. It was further observed in this study that the per cent indirect effect contribution of all traits except for stalk length and days taken to anthesis were higher than their direct effect contribution towards flower yield plant^{-1}. The major contributors to the indirect effect were stalk length, canopy diameter, stem girth and plant height. These four characters have also contributed maximum direct effect towards flower yield plant^{-1}.

Thus, the path coefficient analysis indicates that stalk length, canopy diameter, stem girth and plant height are the primary traits for which selections can be exercised for increasing flower yield plant^{-1}. Thorn density as negatively correlated and contributing 19.50 % directly and 80.50 % indirectly on flower yield plant^{-1}, the breeders has to comprise between yield and thorn density. Selection for both cannot be done simultaneously. Similar observation was also reported in rose by Panwar *et al*. (2012) who also reported stalk length and stem girth as the primary traits for selection. Verma *et al.* (2013) and Panwar *et al.* (2012) also reported negative correlation between thorn/prickle density with flower yield.

***Per se* performance for different characters**

The *per se* performance for 14 characters over 29 genotypes are presented in table 5. The genotype Kiss of Fire ranked first for 12 characters *viz.,* plant height (111.90 cm), number of primary branches plant^{-1} (3.90), number of secondary branches plant^{-1} (19.81), canopy diameter (116.40 cm), stem girth (3.61 cm), bud length (4.98 cm), bud width (3.25 cm), diameter of flower (10.48 cm), stalk length (65.39 cm), fresh weight of flower (12.07 g), flower yield plant^{-1} (33.76) and flower yield plot^{-1} (135.05) and was significantly superior over other genotypes.

This was followed by the genotype Peter F, Centenary, Double delight and Veternas honor which were at par with Kiss of fire and significantly superior over other genotypes for 10 characters i.e. plant height (111.00, 104.40, 103.80 and 103.20 cm respectively), number of primary branches plant^{-1} (3.80) in each genotype, number of secondary branches plant^{-1} (17.40, 17.23, 16.82, 16.09 respectively), bud length (4.72, 4.62, 4.52, 4.52 cm respectively), bud width (3.17, 3.15, 3.14, 3.12 cm respectively), diameter of flower (9.71, 9.20, 9.05, 8.95 cm respectively), stalk length (59.77, 55.33, 54.09, 52.31 cm respectively), fresh weight of flower (11.06, 10.36, 10.06, 9.84 g respectively), flower yield plant^{-1} (32.19, 31.18, 29.17, 29.17 respectively) and flower yield plot^{-1} (128.77, 124.75, 116.70, 116.70 respectively). The same four genotypes Peter F, Centenary, Double delight and Veternas honor were at par with each other and next to Kiss of fire but significantly superior over other genotypes for canopy diameter (98.40, 95.90, 93.40, 93.40 cm respectively) and stem girth (2.84, 2.77, 2.73, 2.61 cm respectively).

From the genotypic correlation and path coefficient analysis studied in this experiment four characters i.e., stalk length, canopy diameter, stem girth and plant height were identified for primary selection as they have high positive significant correlation and high positive direct effect. Considering these characters, the five genotypes Kiss of Fire, Peter F, Centenary, Double delight and Veternas honor which showed significantly superior mean were identified for further purification and multiplication.

Table 1. Analysis of variance for various traits in rose

		Mean sum of squares													
Sources of Variation	df	Plant height (cm)	No. of prim. branches plant^{-1}	No. of sec. branches plant^{-1}	Canopy diameter (cm)	Stem girth (cm)	Bud length (cm)	Bud width (cm)	Diameter of flower (cm)	Days taken to anthesis (days)	Stalk length (cm)	Thorn density (No.)	Fresh weight of flower (g)	Flower yield plant^{-1} (No.)	Flower yield plot^{-1} (No.)
Replications	1	96.47	0.43	15.33	12.94	0.13	1.11	0.12	0.85	0.001	118.90	2.60	4.88	25.11	401.83
Genotypes	28	522.98**	0.33*	13.04**	613.29**	0.41**	1.05**	0.19	1.30	0.12**	225.19**	262.63**	8.47**	94.63**	1514.08**
Error	28	48.39	0.12	3.78	35.68	0.04	0.28	0.16	1.06	0.03	37.16	2.59	1.29	10.76	172.17

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

Table 2. Genotypic and phenotypic correlation coefficient of different traits with flower yield plant^{-1}

Characters		No. of pri. branches	No. of sec. branches	Canopy diameter	Stem girth	Bud length	Days taken to anthesis	Stalk length	Thorn density	Fresh weight of flower	Flower yield plant^{-1}
Plant height	G	0.716**	0.850**	0.895**	0.837**	0.851**	-0.011	0.813**	-0.463*	0.855**	0.841**
	P	0.626**	0.770**	0.795**	0.757**	0.781**	-0.006	0.711**	-0.312	0.716**	0.741**
No. of pri. branches	G		0.726**	0.824**	0.690**	0.716**	-0.046	0.792**	-0.437*	0.834**	0.765**
	P		0.641**	0.722**	0.512**	0.614**	-0.017	0.619**	-0.543**	0.724**	0.633**
No. of sec. branches	G			0.837**	0.811**	0.824**	-0.088	0.777**	-0.430*	0.804**	0.782**
	P			0.720**	0.724**	0.749**	-0.013	0.632**	-0.383*	0.720**	0.628**
Canopy diameter	G				0.913**	0.822**	-0.056	0.859**	-0.462*	0.903**	0.901**
	P				0.844**	0.717**	-0.026	0.712**	-0.392*	0.867**	0.877**
Stem girth	G					0.819**	-0.038	0.845**	-0.386*	0.786**	0.876**
	P					0.729**	-0.014	0.714**	-0.330	0.605**	0.701**
Bud length	G						0.038	0.865**	-0.413*	0.756**	0.788**
	P						0.012	0.713**	-0.345	0.622**	0.623**
Days taken to anthesis	G							-0.049	-0.045	0.010	-0.083
	P							-0.036	-0.024	0.082	-0.017
Stalk length	G								-0.433*	0.752**	0.896**
	P								-0.398*	0.617**	0.708**
Thorn density	G									-0.517**	-0.497**
	P									-0.494**	-0.382*
Fresh weight of flower	G										0.800**
	P										0.717**

* Significant at 5 % level ** Significant at 1 % level $r_{(5\%)} = 0.367$ $r_{(1\%)} = 0.471$

Table 3. Genotypic path coefficient matrix for flower yield plant^{-1}

Characters	Plant height (cm)	No. of pri. branches plant^{-1}	No. of sec. branches plant^{-1}	Canopy diameter (cm)	Stem girth (cm)	Bud length (cm)	Days taken to anthesis (days)	Stalk length (cm)	Thorn density (No.)	Fresh wt. of flower (g)	**Genotypic correlation with flower yield plant^{-1}**
Plant height (cm)	**0.1612**	0.0101	-0.0158	0.2360	0.1974	-0.1765	0.0006	0.4030	0.0449	-0.0197	**0.841****
No. of pri. branches plant^{-1}	0.1156	**0.0141**	-0.0135	0.2173	0.1629	-0.1487	0.0023	0.3924	0.0424	-0.0192	**0.765****
No. of sec. branches plant^{-1}	0.1371	0.0102	**-0.0186**	0.2208	0.1913	-0.1709	0.0043	0.3850	0.0417	-0.0185	**0.782****
Canopy diameter (cm)	0.1444	0.0116	-0.0156	**0.2635**	0.2154	-0.1705	0.0028	0.4255	0.0448	-0.0208	**0.901****
Stem girth (cm)	0.1350	0.0097	-0.0151	0.2407	**0.2358**	-0.1699	0.0019	0.4186	0.0374	-0.0181	**0.876****
Bud length (cm)	0.1372	0.0101	-0.0153	0.2167	0.1931	**-0.2074**	0.0027	0.4285	0.0401	-0.0174	**0.788****
Days taken to anthesis (days)	-0.0019	-0.0007	0.0016	-0.0148	-0.0090	0.0113	**-0.0493**	-0.0246	0.0044	-0.0002	**-0.083****
Stalk length (cm)	0.1312	0.0112	-0.0145	0.2265	0.1994	-0.1795	0.0024	**0.4951**	0.0420	-0.0173	**0.896****
Thorn density (nos)	-0.0748	-0.0062	0.0080	-0.1219	-0.0911	0.0857	0.0023	-0.2146	**-0.0969**	0.0119	**-0.497****
Fresh weight of flower (g)	0.1380	0.0117	-0.0150	0.2381	0.1855	-0.1568	-0.0005	0.3726	0.0501	**-0.0230**	**0.800****

* Values in bold are the direct effect   Residual effect = 0.3315

Table 4. Estimates of direct and indirect effect of different traits on flower yield plant^{-1} in rose in terms of percentage

Characters	**Genotypic correlation with flower yield plant^{-1}**	**Direct effect**	**% Direct effect**	**Total indirect effect**	**% indirect effect**	**Major contributing characters with their percentage towards total indirect effect**			
						Plant height (cm)	Canopy diameter (cm)	Stem girth (cm)	Stalk length (cm)
Plant height (cm)	0.841**	0.161	19.17	0.680	80.83	-	34.716	29.038	59.282
No. of pri. branches plant^{-1}	0.765**	0.014	1.84	0.751	98.16	15.395	28.939	21.694	52.257
No. of sec. branches plant^{-1}	0.782**	-0.019	-2.38	0.801	102.38	17.125	27.579	23.895	48.089
Canopy diameter (cm)	0.901**	0.264	29.25	0.638	70.75	22.651	-	33.788	66.745
Stem girth (cm)	0.876**	0.236	26.92	0.640	73.08	21.087	37.598	-	65.386
Bud length (cm)	0.788**	-0.207	-26.32	0.995	126.32	13.783	-	-	43.048
Days taken to anthesis (days)	-0.083**	-0.049	59.40	-0.034	40.60	-	43.917	26.706	72.997
Stalk length (cm)	0.896**	0.495	55.26	0.401	44.74	32.726	56.498	49.738	-
Thorn density (nos.)	-0.497**	-0.097	19.50	-0.400	80.50	18.695	30.467	22.769	53.637
Fresh weight of flower (g)	0.800**	-0.023	-2.88	0.823	102.88	15.395	34.716	29.038	59.282

Table 5. Mean performance of 29 rose genotypes for different traits

Sr. No.	Varieties	Plant height (cm)	No. of primary branches plant^{-1}	No. of secondary branches plant^{-1}	Canopy diameter (cm)	Stem girth (cm)	Bud length (cm)	Bud width (cm)	Diameter of flower (cm)	Days taken to anthesis (days)	Stalk length (cm)	Thorn density (No.)	Fresh wt. of flower (g)	Flower yield plant^{-1} (No.)	Flower yield plot^{-1} (No.)
1	Ace of heart	73.60	3.20	12.07	66.00	1.84	3.01	2.52	7.71	2.30	32.69	15.08	7.39	17.12	68.50
2	Forever	93.90	3.60	15.08	80.90	2.32	4.02	2.86	8.65	2.50	42.25	20.62	9.39	23.03	92.15
3	Queen elizabeath	99.30	3.60	15.57	85.00	2.55	4.32	2.92	8.85	2.80	45.27	19.11	9.54	25.75	103.02
4	Centenary	104.40	3.80	17.23	95.90	2.77	4.62	3.15	9.20	2.20	55.33	7.24	10.36	31.18	124.75
5	Doudle Delight	103.80	3.80	16.82	93.40	2.73	4.52	3.14	9.05	2.60	54.09	5.73	10.06	29.17	116.70
6	Kiss of fire	111.90	3.90	19.81	116.40	3.61	4.98	3.25	10.48	3.00	65.39	13.07	12.07	33.76	135.05
7	Peter F.	111.00	3.80	17.40	98.40	2.84	4.72	3.17	9.71	3.10	59.77	9.85	11.06	32.19	128.77
8	Veternas honor	103.20	3.80	16.09	93.40	2.61	4.52	3.12	8.95	3.00	52.31	11.06	9.84	29.17	116.70
9	Gold Medallion	91.60	3.40	14.08	76.80	2.16	3.82	2.72	8.25	2.80	39.23	7.04	8.84	21.12	84.51
10	Wall street	78.90	3.20	12.57	66.60	2.03	3.21	2.57	7.85	3.20	34.20	10.55	8.04	18.10	72.43
11	Bridges Dream	95.70	3.60	15.39	81.50	2.51	4.32	2.92	8.75	3.00	45.26	8.04	9.45	24.14	96.58
12	Just Joey	102.70	3.70	16.02	92.40	2.60	4.47	3.05	8.95	2.90	48.70	6.03	9.75	27.16	108.65
13	Paradise	93.90	3.60	15.29	81.50	2.38	4.02	2.92	8.75	2.80	44.26	3.54	9.45	23.13	92.50
14	Black Lady	93.30	3.50	14.08	80.40	2.25	3.93	2.76	8.29	3.10	42.05	8.61	9.15	22.12	88.53
15	Wild Fire	89.90	3.30	13.58	75.60	2.14	3.68	2.72	8.25	3.00	38.23	11.06	8.84	20.11	80.48
16	Toro	101.40	3.60	15.69	85.40	2.56	4.42	3.02	8.86	3.30	48.29	6.50	9.75	26.15	104.62
17	Whisper	87.80	3.30	13.07	75.40	2.08	3.61	2.67	8.19	2.90	38.29	12.07	8.55	20.11	80.48
18	Landora	75.90	3.20	12.07	66.20	1.96	0.01	2.52	7.85	2.80	33.19	11.06	7.84	18.10	72.43
19	Gladiator	79.10	3.20	12.57	69.90	2.03	3.41	2.62	7.95	3.10	34.75	3.34	8.14	19.01	76.05
20	Sugandha	92.40	3.50	14.08	79.40	2.23	3.82	2.76	8.26	3.00	40.01	25.50	8.95	21.42	85.71
21	Chardoni	67.30	2.80	10.56	50.50	1.81	2.84	2.38	7.45	3.00	29.17	17.63	5.13	13.08	52.35
22	Kum kum	87.00	3.30	13.07	74.50	2.06	3.57	2.62	7.95	2.80	38.09	27.26	8.44	19.91	79.68
23	Taj mahal	70.10	2.80	10.76	57.20	1.82	2.86	2.41	7.55	3.00	30.18	30.57	5.33	14.58	58.34
24	Dr. M. S. Randhawa	65.70	2.70	10.05	49.50	1.79	2.71	2.38	7.32	2.80	25.88	59.95	4.70	8.84	35.41
25	Bonnint	43.40	2.40	9.05	38.10	1.29	2.51	2.10	6.76	3.00	22.25	30.58	3.68	7.24	28.97
26	Birendranath	64.80	2.50	10.03	45.40	1.74	2.61	2.21	7.14	2.80	25.14	11.28	4.43	7.94	31.79
27	Whimala	7290	3.10	11.96	60.80	1.84	2.91	2.43	7.61	2.90	31.18	16.09	6.73	17.09	68.41
28	Sun Bright	86.60	3.20	12.68	73.70	2.05	3.45	2.62	7.95	2.90	35.21	14.08	8.34	19.11	76.46
29	Maronia	71.00	2.90	11.86	58.70	1.82	2.91	2.41	7.57	2.80	30.83	11.06	6.43	16.09	64.38
	S E ±(m)	**4.92**	**0.35**	**1.94**	**4.22**	**0.14**	**0.37**	**0.29**	**0.73**	**0.13**	**4.31**	**1.14**	**0.80**	**2.32**	**9.28**
	C D (5%)	**14.25**	**0.71**	**3.98**	**12.23**	**0.40**	**1.08**	**-**	**-**	**0.37**	**12.48**	**3.30**	**2.33**	**6.72**	**26.87**

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