

Genetic Variability Studies in Fruit Quality Parameters of Kashmiri Cherry (*Prunus avium* L.)

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ABSTRACT

The experimental study was conducted in the main cherry growing belts of Kashmir viz. Srinagar, Baramulla and Shopian districts during 2013 and 2014. Fruit weight and fruit volume recorded wide range of variability. Three accessions of cherry viz. KC-36, KC-37 and KC-40 recorded highest fruit weight and fruit volume. Most of the accessions were medium in stone weight except five wherein stone weight was small and in six accessions large stone weight was observed. In most of the accessions, the ratio of fruit weight to stone weight was medium, however in three genotypes KC-08, KC -21 and KC-22 the ratio was small and in four genotypes KC-11, KC-36, KC-37 and KC-42 the ratio was large. TSS ranged between 13.2 to 22.0 °Brix and the acidity ranged between 0.33-0.96. Maximum yield efficiency of 1.43 was observed in KC-38. Divergence analysis of the forty five cherry genotypes, using Mahalanobis D² statistics revealed significant results and the genotypes got grouped into seven clusters. Maimum inter-cluster distance was found between cluster-VI and cluster-VII. Cluster-VI recorded maximum mean values for fruit weight (10.79 g), fruit volume (9.27 cm³) and fruit weight to stone weight ratio (22.05), minimum stone weight (0.40 g) was recorded in cluster-V and cluster-II recorded maximum T.S.S. (19.06 °Brix), yield efficiency (1.01) and minimum acidity (0.56 per cent).

Keywords

Cherry, Genetic variability, Fruit quality, Accessions.

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Introduction

Sweet cherry belongs to the genus *Prunus* along with almonds, peaches, plums and apricots. The edible portion consists of the outer layer of the mature ovary wall, the flesh (mesocarp) and the skin (exocarp). The pit (endocarp) encloses the seed. Sweet cherry is a vigorous tree with strong apical control with an erect pyramidal canopy shape; grows up to

18 m in wild but in cultivated form, sweet cherries are maintained up to 4 m in height. Leaves are relatively large, elliptic with acute tips, petiole and strongly veined (1). Sweet cherry trees generally have larger leaves and bear larger fruit than sour cherries and have a markedly sweeter taste. The sweet cherry fruit is described as dark or light according to skin

color. The skin color of dark cherries range from reddish-purple to mahogany; for light cherries, skin color ranges from yellow to yellow with a pink blush.

Cherry cultivation is mainly confined between 35° N and 55°S latitude. However in some exceptional areas like Norway, the main cherry growing areas are located at 60°N latitude (2). The areas having good winter rains and dry cool summers are ideal for cherry cultivation. Southern hill slopes with adequate air drainage are preferable sites. The Jammu and Kashmir State is located in the North most part of India between 32°-17' to 37°-06' latitude, 73°-26' and 80°-38' East longitude and 81° East Greenwich falling in western Himalayas region of the country. The geographical area of 233 lakh square Km comprises mainly of mountainous tract out of which about 24 lakh hectares encompasses agriculture (3).

By virtue of temperate climatic conditions of Kashmir valley, 90 per cent of the total cherry production of India is confined to Kashmir valley of Jammu and Kashmir (4) In India, cherry is mainly grown in the state of Jammu and Kashmir, Himachal Pradesh and a very little acreage in Uttarakhand (5) Under Kashmir conditions, cherries attain market maturity within 60 to 70 days after full bloom and are the first temperate tree fruits to reach the market fetching premium price. In Kashmir valley Bigarreau Napoleon (Double Glass), Bigarreau Noir Gross (Misri), Black Heart (siyah Gol), Pourpera Perceca (Awal Number), Guigne Noir Gross Lucenta (Tontal) and Guigne Noir Hative (Makhmali) are the most common sweet cherry cultivars cultivated in plains, foot hills and upland areas (6). The state of Jammu and Kashmir is bestowed with wide range of agro-climatic conditions that offers tremendous scope for cultivation of both temperate as well as sub-tropical fruits. The valley of Kashmir has a

distinction and is comparable to any other state in the country, producing all kinds of temperate fruits. The favorable agro-climatic conditions and the active involvement of the people in fruit farming have been responsible in the increased production of the fruits since independence. Almost 2-3 million people of the state are directly or indirectly involved with the fruit industry and the annual turnover of about 1500-2000 crore rupees.

Fruits of sweet cherry are refreshing, diuretic, energetic, anti-infective and have the laxative and detoxifying effect. For this reason maximum portion of cherry fruit is consumed in fresh form, although it is also processed in various forms like confectionary, ice creams, bakery, juice making, syruling and liquors. Cherries are rich source of proteins, sugars, having more calorific value than apple. Fresh cherries contain 78-85 per cent moisture, 0.5 to 1.2 per cent proteins, 0.2 per cent fat and 8.5 to 18.5 per cent sugars. Cherries are good source of vitamins and minerals like potassium, calcium, magnesium, iron and zinc (7). Concerning the fact that the demand for sweet cherry fruits increases from year to year, in perspective, there are real conditions to expand the production, and at the same time to enlarge its economic significance. An increase in production of sweet cherries, as well as profitability of its growing, depends on biological and economic properties of the cultivar and the rootstock.

Materials and Methods

The present investigation was conducted in three districts of Jammu and Kashmir state namely Srinagar, Baramulla and Shopian; located between 34° 05' 24" North Latitude and 74° 47' 24" East Latitude; 34° 0' 34" North Latitude and 74° 0' 45" East Latitude; 33° 43' 06" North Latitude and 74° 50' 01" East Latitude respectively. The districts under survey viz. Srinagar, Baramulla and Shopian

are located at an altitude of 1585, 1593 and 2058.61 m above mean sea level respectively. The survey was conducted for two years 2013 and 2014 and observations were recorded as per the International Union for the Protection of New Varieties of plant standard descriptor (8). The data presented is pooled data of two years 2013 and 2014. Accessions selected during the initial survey at different locations of the three districts were tagged with aluminum labels. The basic material for the experiment consisted of 110 diverse genotypes of cherry selected during the survey on the basis of genetic variability for various morphological and phenological traits as per the International Union for the Protection of New varieties of plants (UPOV) standard descriptor (2006). The final experimental material comprised of 45 genotypes. The fruits were evaluated for different quality parameters. Total soluble solids were recorded by using hand refractometer at room temperature and readings are presented in °Brix. The juice of each genotype was extracted by a blender and preserved in glass beaker separately. The juice was then analyzed for juice content %, acidity (%) using titration method as per the (A.O.A.C., 2000). Tocher's method was used for assigning various varieties to different clusters. The spatial distances between clusters were arrived at by taking square root of average intra and inter cluster D^2 values.

Results and Discussion

Fruit weight is considered to be a very important trait in the fresh-market group; fruit shape is very important for packaging and transportation; fruit size is very important for the canning industry; and sugar content and total soluble solids content are very important for the food industry. Fruit size is an important factor in consumer liking and acceptance as bigger fruits are generally considered to be more attractive to the eye

and therefore sell more easily and usually at a higher price per gram, so varieties yielding larger fruits will be preferred commercially. At the international level, cherry cultivars with large fruits are increasingly valued (9,10). Perusal of the data regarding various quality parameters presented in Table 1, revealed highly significant differences among the genotypes for all the traits under study. The range of variation was highest for fruit weight to stone ratio (9.67-22.68) followed by TSS (13.2-22.0 °Brix), fruit weight (3.15-11.68 g) and fruit volume (2.35- 10.49 cm³). Similar observations have been found (11). Fruit size is expressed in this study by fruit weight which is mainly depended on the cultivar. Its influence was partly connected with the level of fruit set but particular climatic conditions of each year seem to be more important in this respect. Maximum fruit weight (11.68 g) and minimum fruit weight (3.15 g) was recorded in KC-37 and KC-38 respectively.

Fruit volume followed same pattern as that of fruit weight. Maximum fruit volume (10.49 cm³) was recorded in case of KC-37 and minimum (2.33 cm³) in case of KC-30. The diversity in fruit weight and fruit volume of various genotypes may be due to difference in cell size and cell densities. The stone size of the studied cherry genotypes ranged from 0.36–0.77 g, while as fruit: stone ratio was between 9.67 and 22.68.

Chemical composition aspects of fruits like total soluble solids and acidity provide important information to the consumers in terms of recognizing a more nutritious fruit (Fig. 1). The data is presented in Table 1. Perusal of the pooled data from two years of study showed a considerable variability on TSS. The maximum TSS (22.6 °B) was recorded in KC-37 whereas; minimum TSS (13.1°B) was recorded in KC-39. Environmental factors such as temperature, light (duration and intensity), rainfall/supply

of water and locations have a pivotal role on the TSS (12). Trees with high moisture availability showed less TSS compared to scarce water supply with higher contents of soluble solids in fruits. This indicates that the variability in fruit characteristics especially in fruit composition was not only genetic factor

but also influenced by climatic factors. Maximum acidity (0.96%) was recorded in KC-9, while lowest acidity (0.33%) was recorded in KC-16. The variation in fruit acidity may be due to different rates of conversion of organic acids into soluble sugars by different genotypes.

Fig.1 Mean values for fruit quality parameters of Kashmiri cherry accessions

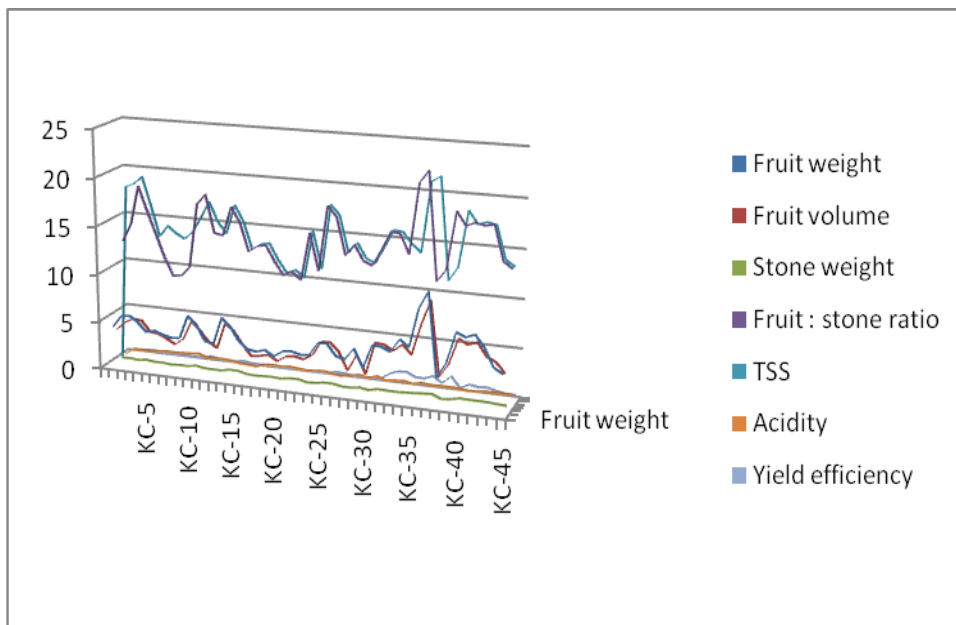


Fig.2 Cluster means for various traits in different clusters of Kashmiri cherry accessions

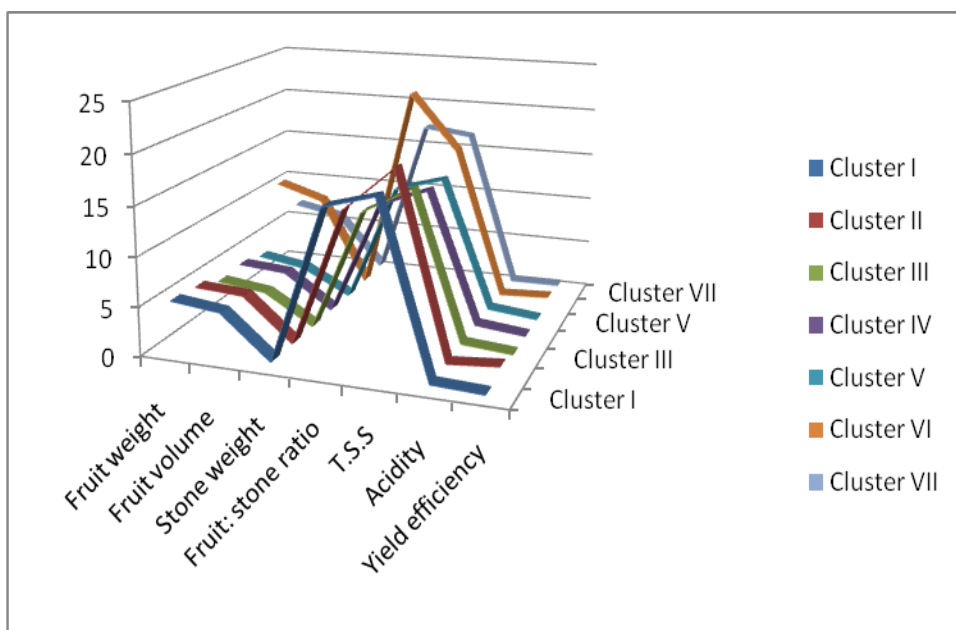


Fig.3 Dendrogram based on quality parameters of forty five cherry (*Prunus avium* L.) accessions

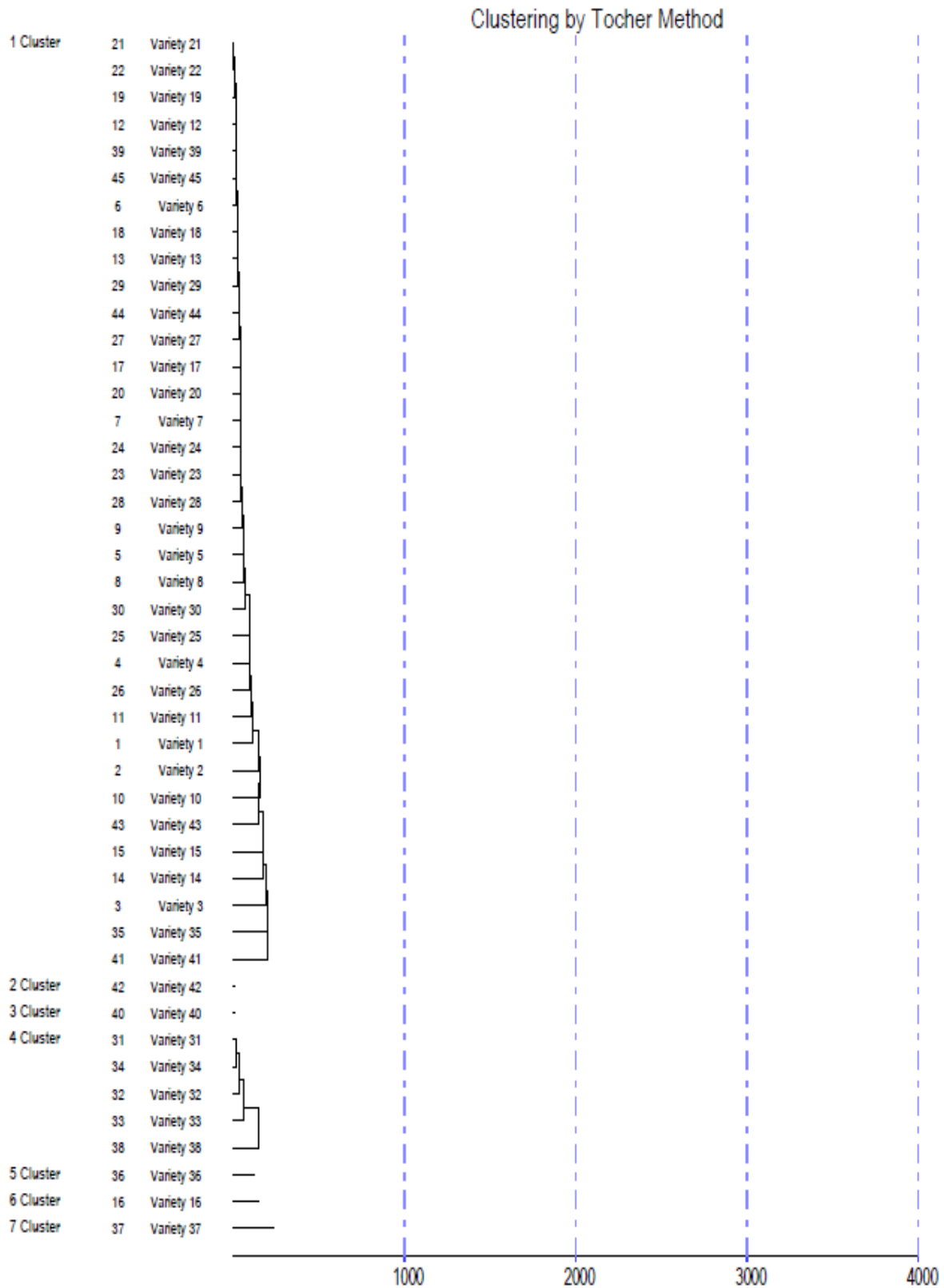


Table.1 Mean values for fruit quality parameters of Kashmiri cherry accessions

Accession Name	Fruit weight	Fruit volume	Stone weight	Fruit : stone ratio	TSS (⁰ B)	Acidity (%)	Yield efficiency
KC- 1	4.50	3.98	0.56	12.86	18.3	0.64	0.24
KC-2	5.70	4.79	0.59	14.68	18.7	0.62	0.34
KC-3	5.83	5.24	0.51	18.72	19.5	0.55	0.38
KC-4	5.27	5.15	0.63	16.25	16.6	0.70	0.29
KC-5	4.33	4.06	0.52	13.90	13.4	0.79	0.23
KC-6	4.56	3.95	0.54	11.54	14.6	0.77	0.24
KC-7	4.23	3.54	0.45	9.67	13.9	0.81	0.22
KC-8	4.01	3.03	0.52	9.78	13.4	0.87	0.24
KC-9	4.10	3.73	0.51	10.76	14.2	0.96	0.21
KC-10	6.50	5.66	0.67	17.39	15.8	0.64	0.48
KC-11	5.75	4.82	0.51	18.47	17.5	0.66	0.33
KC-12	4.12	3.72	0.49	14.58	15.5	0.70	0.25
KC-13	3.92	3.19	0.48	14.40	14.4	0.63	0.24
KC-14	6.71	5.91	0.68	17.41	17.4	0.45	0.39
KC-15	5.92	5.15	0.67	15.88	15.8	0.42	0.27
KC-16	4.50	3.86	0.45	13.00	13.0	0.33	0.25
KC-17	3.75	2.76	0.39	13.65	13.6	0.65	0.27
KC-18	3.64	2.89	0.43	13.80	13.8	0.71	0.23
KC-19	3.90	3.13	0.48	12.23	12.2	0.65	0.24
KC-20	3.35	2.56	0.41	10.91	10.9	0.74	0.22
KC-21	3.99	3.17	0.56	11.35	11.3	0.64	0.24
KC-22	4.11	3.27	0.58	10.63	10.6	0.57	0.23
KC-23	3.85	3.08	0.36	15.50	15.5	0.65	0.21
KC-24	3.92	3.60	0.42	11.72	11.7	0.72	0.23
KC-25	5.27	5.09	0.56	18.36	18.3	0.52	0.43
KC-26	5.34	5.17	0.56	17.39	17.3	0.44	0.37
KC-27	4.15	4.27	0.39	13.61	13.6	0.62	0.23
KC-28	3.92	2.48	0.37	14.76	14.7	0.77	0.22
KC-29	5.14	4.22	0.51	13.20	13.2	0.58	0.31
KC-30	3.25	2.33	0.36	12.82	12.8	0.87	0.25
KC-31	5.67	5.63	0.58	14.52	14.5	0.52	0.89
KC-32	5.65	5.58	0.55	16.39	16.3	0.63	1.27
KC-33	5.25	5.04	0.52	16.26	16.2	0.71	1.35
KC-34	6.60	5.78	0.58	14.31	15.1	0.52	0.91
KC-35	5.91	4.87	0.62	21.42	14.3	0.73	0.88
KC-36	9.90	8.05	0.71	22.68	21.4	0.63	1.24
KC-37	11.68	10.49	0.77	11.85	22.0	0.66	0.62
KC-38	3.15	2.96	0.38	13.11	11.8	0.65	1.43
KC-39	4.78	4.34	0.47	18.96	13.2	0.64	0.33
KC-40	7.94	7.03	0.67	17.60	18.9	0.49	0.81
KC-41	7.53	6.51	0.65	17.99	17.6	0.52	0.65
KC-42	7.90	6.85	0.65	17.79	17.9	0.64	0.73
KC-43	6.71	5.55	0.63	17.96	17.7	0.65	0.48
KC-44	4.86	5.09	0.57	14.48	14.4	0.63	0.33
KC-45	4.33	4.07	0.51	13.83	13.8	0.66	0.31
Mean	5.23	4.57	0.53	14.79	14.79	0.64	0.45
Range	3.15-11.68	2.33-10.49	0.36-0.77	9.67-22.68	13.1 –22.0	0.33 – 0.96	0.21-1.43
CV	2.42	3.77	1.71	2.88	0.73	3.14	4.39

Table.2 Distribution of different cherry accessions into clusters based on D² statistics

Cluster	Number of genotypes in the cluster	Accession No. of the genotypes
I	9	KC-001, KC-002, KC-003, KC-004, KC-011, KC-015, KC-025, KC-026, KC-029
II	6	KC-016, KC-031, KC-032, KC-033, KC-034, KC-038
III	8	KC-012, KC-013, KC-017, KC-019, KC-021, KC-022, KC-027, KC-039
IV	6	KC-005, KC-006, KC-008, KC-009, KC-044, KC-045
V	7	KC-007, KC-018, KC-020, KC-023, KC-024, KC-028, KC-030
VI	2	KC-036, KC-0037
VII	7	KC-010, KC-014, KC-035, KC-040, KC-041, KC-042, KC-043

Table.3 Average inter-cluster (above diagonal) and intra-cluster (diagonal) distance values among different Cherry (*Prunus avium* L.) genotypes

Cluster	I	II	III	IV	V	VI	VII
I	310.23	637.63	759.45	1072.28	1838.59	1228.86	1933.45
II		0.00	32.04	704.95	407.93	1785.77	624.43
III			0.00	643.17	337.92	1756.56	690.60
IV				296.08	945.85	1262.30	2415.80
V					0.00	2776.24	823.53
VI						0.00	4076.06
VII							0.00

Table.4 Cluster means for various traits in different clusters of Cherry (*Prunus avium* L.) genotypes

Clusters	Fruit weight	Fruit volume	Stone weight	Fruit: stone ratio	T.S.S	Acidity	Yield efficiency
Cluster I	5.41	4.84	0.56	16.20	17.64	0.57	0.33
Cluster II	5.13	4.81	0.51	14.53	19.06	0.56	1.01
Cluster III	4.09	3.48	0.48	12.94	15.77	0.64	0.25
Cluster IV	4.36	3.99	0.52	12.38	14.32	0.78	0.26
Cluster V	3.74	2.92	0.40	12.74	14.20	0.75	0.22
Cluster VI	10.79	9.27	0.49	22.05	16.20	0.65	0.93
Cluster VII	7.03	6.05	0.65	17.35	16.72	0.59	0.63

To assess the variability for these quality parameters, a dendrogram was constructed on the basis of mean values of two years data (Fig. 3). Mean, range values and coefficient of variance for each parameter is given in

Table 1. Based on the performance of various genotypes, forty five genotypes got grouped into seven clusters. Cluster-I comprised of maximum genotypes (9), followed by Cluster-III (8), Cluster-V (7), Cluster-VII (7), Cluster-

II and Cluster-IV (6) and Cluster-VI (2). The names of the accessions in each cluster are given in the Table 2. Nine (KC-001, KC-002, KC-003, KC-004, KC-011, KC-015, KC-025, KC-026, KC-029) accessions fell in cluster I, six (KC-016, KC-031, KC-032, KC-033, KC-034, KC-038) in cluster II, eight (KC-012, KC-013, KC-017, KC-019, KC-021, KC-022, KC-027, KC-039) in cluster III, six (KC-005, KC-006, KC-008, KC-009, KC-044, KC-045) in cluster IV, seven (KC-007, KC-018, KC-020, KC-023, KC-024, KC-028, KC-030) in cluster V, two (KC-036, KC-0037) in cluster VI and seven (KC-010, KC-014, KC-035, KC-040, KC-041, KC-042, KC-043) in cluster VII.

The formation of different clusters with variable number of accessions indicates variability among accessions. Dendrogram illustrated variability at different levels between the accessions of different clusters and relatedness among the accessions within the same cluster. The pattern of group constellation revealed that geographical diversity was not an essential factor for clustering of genotypes from particular origin into a specific cluster. From this it can be concluded that although geographical diversity is very important but not the only criteria in determining the genetic divergence. Thus the grouping of various genotypes from different environments into a particular cluster can be attributed to the admixture or free exchange of plant material from one place to another. The perusal of the results revealed that Cluster-I had the maximum intra cluster distance (310.23) was observed in cluster-I, followed by Cluster-IV (296.08) (Table 3). Maximum inter cluster distance was found between Cluster-VI and Cluster-VII (4076.06), followed by Cluster-V and Cluster-VI (2776.24), Cluster-IV and Cluster-VII (2415.80), Cluster-I and Cluster-VII (1933.45) and Cluster-I and Cluster-V (1838.59).

Cluster means for various quantitative traits are presented in Table 4 (Fig. 2). The perusal of data revealed that Cluster-I had a fruit weight of 5.41 g, fruit volume of 4.84 cm³, stone weight of 0.56 g, fruit: stone ratio of 16.20, T.S.S of

17.64 °Brix, acidity of 0.57 per cent and yield efficiency of 0.33. Cluster-II had a fruit weight of 5.13 g, fruit volume of 4.81 cm³, stone weight of 0.51 g, fruit: stone ratio of 14.53, T.S.S of 19.06 °Brix, acidity of 0.56 per cent and yield efficiency of 1.01. Cluster-III had a fruit weight of 4.09 g, fruit volume of 3.48 cm³, stone weight of 0.48 g, fruit: stone ratio of 12.94, T.S.S of 15.77 °Brix, acidity of 0.64 per cent and yield efficiency of 0.25. Cluster-IV had a fruit weight of 4.36 g, fruit volume of 3.99 cm³, stone weight of 0.52 g, fruit: stone ratio of 12.38, T.S.S of 14.32 °Brix, acidity of 0.78 per cent and yield efficiency of 0.26. Cluster-V had a fruit weight of 3.74 g, fruit volume of 2.92 cm³, stone weight of 0.40 g, fruit: stone ratio of 12.74, T.S.S of 14.20 °Brix, acidity of 0.75 per cent and yield efficiency of 0.22.

Cluster-VI had a fruit weight of 10.79 g, fruit volume of 9.27 cm³, stone weight of 0.49 g, fruit: stone ratio of 22.05, T.S.S of 16.20 °Brix, acidity of 0.65 per cent and yield efficiency of 0.93. Cluster-VII had a fruit weight of 7.03 g, fruit volume of 6.05 cm³, stone weight of 0.65 g, fruit: stone ratio of 17.35, T.S.S of 16.72 °Brix, acidity of 0.59 per cent and yield efficiency of 0.63. These findings are in agreement to those observed by (5), Laciš *et al.*, (13.), Singh *et al.*, (14.), Rai and Mishra (15), Lal *et al.*, (16) and Nagar and Fageria (17) suggested selection of distant parents based on D² analysis. Cluster means coupled with coefficient of variation depict the picture of genetic diversity (18). According to De *et al.*, (19) traits contributing most towards divergence should be given greater emphasis for choosing the clusters for both direct selection as well as prospective hybridization scheme.

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