Genetic Variation in Nut and Kernel Quality Characteristics of Walnut Selected from District Budgam of Kashmir Valley

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An intensive survey of walnut tree was conducted in Budgam district of Kashmir valley during 2006. Forty three bearing trees of walnut were selected across the district and nuts from selected seedling trees have been characterized for different in-shelled and shelled characters in laboratory. Most of the accession were round in shape, medium smooth in shell texture and light medium in shell colour whereas, rest of in-shelled characters had varied response. Regarding kernel characters only fourteen genotypes had well filled kernels and most of the accession had light to dark kernel colour. Kernel percentage was recorded highest in accession QCL6W-39 (58.00%) and lowest of 25.00% in the accession QCL6W-5 and recorded highest (21.8%) contribution towards diversity as compared to other metric traits. Highest coefficient of variation was observed for Kernel Weight (133.37%) followed by Nut Weight (54.59%) and Kernel percentage (35.54%). The variation for Nut Length, Diameter at Cheek and Suture were 16.65, 15.15 and 11.86 respectively. From this survey, it is concluded that the accession no. QCL6W-7, QCL6W-8, QCL6W-16, QCL6W-18, QCL6W-23, QCL6W-35, QCL6W-36, QCL6W-38, QCL6W-39 and QCL6W-44 can be earmarked for utilization in future breeding programme for development of walnut varieties having better qualitative and quantatives characters.

Key Words: Characterization, Evaluation, Kernel, Nut, Walnut

Walnut is principal nut crop of Jammu and Kashmir as it accounts for 80 per cent of total walnut production of country with an average productivity of 1.4 t/ha (Bhat and Ahmad, 2001), which is very low as compared to Iran (3.2 t/ha) and USA (2.64 t/ha). Indian walnut occupied a special position which have 5 per cent share in the international market and rank among five top producing countries in the world (Ahmad and Simnani, 2001). Almost all existing plantation of walnut in North-West Himalaya are of seedling origin which posing problem of late bearing, giant size of tree and variation in the shape, size, colour and quality characters of nut and kernel that ultimately hampers the grading of nut and kernel for export (Ahmad *et al.* 2007). The North-West Himalayan region of India is endowed with very rich genetic diversity in walnut. Nevertheless, the propagation techniques have not been standardized yet. As a result farmers prefer to raise walnut sapling through seed which does not give true-to-type planting material (Iqbal *et al.*, 2004) and leads to the variability in nut and kernel characters. Bhat *et al.* (2000) reported that all walnut plantations in Jammu and Kashmir owe their origin from non-descriptive type of seedling and therefore, are extremely heterogeneous in important quality attributes like nut size and colour of kernel. Under All India Co-ordinated Improvement Programme on Nut Crops, various walnut accession were collected which ultimately resulted in release of two varieties of walnut, namely, Sulaiman and Hamdan from SKUAST-K, Shalimar (Bhat and Ahmad, 2001). In order to further increase the varietal spectrum of walnut for different objectives, an intensive survey was conducted in district ‘Budgam’ where almost all plantation of walnut are existed on *karawa* land (upland plateau) and is totally rainfed. Keeping in view the above fact, an attempt was made to exploit the existing genetic diversity of walnut for having desirable yield and superior kernel quality attributes for use in future breeding programme.

Materials and Methods

Survey of walnut tree was conducted in Budgam district of Kashmir valley during August to September 2006, situated at altitude ranges from 1700 to 2300 msl. Forty-three bearing trees of walnut were selected across the district and individual tree was assigned separate accession number as QCL6-W-1 to QCL6-W-44. Nut samples from every accession have been evaluated for different in-shelled and shelled characters in laboratory. The collected samples were dehulled properly, washed and dried in shade for 20 days. Random sample of 10 nuts were selected from each accession for study of unshelled and shelled traits, namely, nut shape, shell texture, shell

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colour, shell strength, shell seal, shell integrity, kernel filling, kernel colour and ease of kernel removal as described in the descriptor of walnut provided by IPGRI (Anonymous, 1994). The dried sample from each accession was randomly taken for study of various metric nut traits, namely, shell thickness (mm), diameter at cheek (mm), diameter at suture (mm), nut length (mm) and kernel length (mm) by the use of Vernier Caliper and nut weight (g) and kernel weight (g) work out by highly sophisticated digital balance. The kernel colour was recognized as per the classification chart (Anonymous, 1999) and kernel percentage was calculated as per the method given by Hendricks *et al.* (1985). The data was analyzed in R-software as suggested by Gomez and Gomez (1984).

Results and Discussion

The data pertaining to various unshelled and shelled traits of seedling walnut trees showed wide variation for all the studied traits (Table 1). The nut shape of walnut accession of district Budgam ranged from round to broad elliptical. Most of the accession were round in shape, whereas accession QCL6W-1, 2, 14, 20, 21, 22, 37, 39 and 44 were broad elliptical. Seven accessions QCL6W-6, 8, 13, 33, 34, 38 and 42 were ovate shaped, three accessions QCL6W-18, 25 and 36 having long

Table 1. Qualitative characters of walnut genotypes from district Budgam

Accession Number	Nut shape	Shell Texture	Shell Colour	Shell Strength	Shell Seal	Shell Integrity	Kernel Filling	Kernel Colour	Ease of Removal
QCL6-W-1	Broad Elliptic	Rough	Light	Weak	Weak	Incomplete	Moderate	Light	Moderate
QCL6-W-2	Broad Elliptic	Medium	Medium	Intermediate	Intermediate	Intermediate	Moderate	Medium	Difficult
QCL6-W-3	Round	Medium	Medium	Intermediate	Intermediate	Intermediate	Moderate	Light	Difficult
QCL6-W-4	Round	Rough	Dark	Intermediate	Intermediate	Incomplete	Well	Medium	Difficult
QCL6-W-5	Round	Smooth	Light	Intermediate	Strong	Intermediate	Moderate	Light	Moderate
QCL6-W-6	Ovate	Medium	Medium	Intermediate	Strong	Intermediate	Well	Medium	Difficult
QCL6-W-7	Round	Medium	Medium	Weak	Weak	Complete	Well	Medium	Easy
QCL6-W-8	Ovate	Smooth	Medium	Weak	Weak	Intermediate	Well	Light	Easy
QCL6-W-9	Round	V. Rough	Medium	Intermediate	Very Strong	Incomplete	Poor	Medium	Difficult
QCL6-W-10	Round	Smooth	Medium	Intermediate	Intermediate	Complete	Well	Dark	Moderate
QCL6-W-11	Round	Rough	Light	Intermediate	Intermediate	Complete	Moderate	Dark	Difficult
QCL6-W-12	Round	V. Rough	Dark	Strong	Very Strong	Incomplete	Moderate	Medium	Difficult
QCL6-W-13	Ovate	Rough	Medium	Strong	Strong	Intermediate	Moderate	Light	Difficult
QCL6-W-14	Broad Elliptic	Medium	Light	Intermediate	Strong	Intermediate	Moderate	Light	Moderate
QCL6-W-15	Cordate	Rough	Medium	Intermediate	Strong	Intermediate	Poor	Medium	Difficult
QCL6-W-16	Elliptic	V. Smooth	Medium	Intermediate	Weak	Complete	Moderate	Light	Moderate
QCL6-W-17	Round	Medium	Medium	Intermediate	Strong	Intermediate	Well	Medium	Moderate
QCL6-W-18	Long Trapezoid	Medium	Medium	Intermediate	Weak	Intermediate	Well	V. Light	Easy
QCL6-W-19	Round	Medium	Light	Strong	Very Strong	Intermediate	Moderate	Light	V. Difficult
QCL6-W-20	Broad Elliptic	Rough	Dark	Intermediate	Intermediate	Incomplete	Moderate	Medium	Moderate
QCL6-W-21	Broad Elliptic	Medium	Medium	Strong	Strong	Intermediate	Moderate	V. Light	V. Difficult
QCL6-W-22	Broad Elliptic	Medium	Dark	Strong	Strong	Intermediate	Moderate	V. Light	Difficult
QCL6-W-23	Short trapezoid	Smooth	Medium	Intermediate	Intermediate	Intermediate	Well	Light	Moderate
QCL6-W-24	Round	Medium	Light	Intermediate	Intermediate	Intermediate	Moderate	V. Light	Difficult
QCL6-W-25	Long Trapezoid	Medium	Medium	Intermediate	Weak	Intermediate	Moderate	Medium	Difficult
QCL6-W-26	Round	V. Rough	Medium	Weak	Very Strong	Intermediate	Moderate	Dark	Easy
QCL6-W-27	Round	Medium	Dark	Strong	Very Strong	Incomplete	Moderate	Amber	Moderate
QCL6-W-28	Round	Smooth	Medium	Intermediate	Very Strong	Intermediate	Moderate	Medium	Easy
QCL6-W-29	Round	V. Rough	Dark	Strong	Strong	Intermediate	Moderate	Medium	Difficult
QCL6-W-31	Round	Smooth	Light	Weak	Very Weak	Complete	Moderate	Dark	Easy
QCL6-W-32	Round	Medium	Medium	Papery	Intermediate	Complete	Moderate	Light	Moderate
QCL6-W-33	Ovate	Smooth	Light	Intermediate	Strong	Intermediate	Moderate	Dark	Difficult
QCL6-W-34	Ovate	Rough	Medium	Strong	Very Strong	Incomplete	Well	Light	Moderate
QCL6-W-35	Round	Medium	Medium	Weak	Strong	Intermediate	Well	Light	Moderate
QCL6-W-36	Long Trapezoid	Medium	Light	Weak	Weak	Intermediate	Well	V.Light	Moderate
QCL6-W-37	Broad Elliptic	Medium	Light	Intermediate	Strong	Intermediate	Moderate	V.Light	Difficult
QCL6-W-38	Ovate	Rough	Light	Weak	Weak	Intermediate	Well	V.Light	Easy
QCL6-W-39	Broad Elliptic	Smooth	Dark	Intermediate	Intermediate	Complete	Well	Light	Moderate
QCL6-W-40	Round	Rough	Medium	Strong	Intermediate	Incomplete	Moderate	Medium	Difficult
QCL6-W-41	Short Trapezoid	Smooth	Light	Strong	Strong	Intermediate	Moderate	Light	Difficult
QCL6-W-42	Ovate	Medium	Dark	Intermediate	Very Strong	Intermediate	Moderate	Medium	Moderate
QCL6-W-43	Round	Medium	Light	Intermediate	Intermediate	Complete	Moderate	Light	Moderate
QCL6-W-44	Broad Elliptic	Smooth	Medium	Weak	Weak	Intermediate	Well	Medium	Moderate

trapezoid shape and, two accessions QCL6W-23 and 41 were having short trapezoid shape. One accession QCL6W-15 had cordate shape. The variation in the nut shape of walnut is due to its seedling origin, which is highly heterozygous in nature and such type of variation in nut shape has also been reported by various workers namely Panday and Sinha (1984), Bhat *et al.* (1999) and Sharma and Sharma (2001). About 40-60 % of walnut are sold as inshell in India, hence, the smoothness of the shell and its light colour is most important characteristic which attract consumer and farmers get good return from medium smooth to very smooth nuts. In the present finding, the shell texture observed were medium to smooth shell in almost all accession except one accession *i.e*., QCL6W-16 which had very smooth shell. Further, light shell colour was recorded in accessions QCL6W-1, 5, 11, 14, 19, 24, 31, 33, 36, 37, 38, 41 and 43, whereas accessions QCL6W-4, 12, 20, 22, 27, 29, 39 and 42 had dark shell colour and rest of the accessions had medium shell colour. Shell strength rangeds from weak (QCL6W-1, 7, 8, 26, 31, 35, 36, 38 and 42) to strong (QCL6W-12, 13, 19, 21, 22, 27, 29, 34, 40 and 41) whereas rest of the accessions were found to be intermediate. Weak shell seal was observed in accessions QCL6W-1, 7, 8, 16, 18, 25, 36, 38 and 44, whereas strong and very strong seal was observed in QCL6W-5, 6, 13, 14, 17, 21, 22, 29, 33, 35, 37, 41 and QCL6W-9, 12, 19, 26, 27, 28, 34 and 42 respectively. Complete shell integrity was found in accession QCL6W-7, 10, 11, 16, 31, 32, 39 and 43, whereas incomplete shell integrity in accessions QCL6W-1, 4, 9, 12, 27, 34 and 40 and rest of the accessions had intermediate shell integrity. These shell characters of nut crops are of utmost important as they determine crack out quality of nuts, bleaching, insect and pest damage, overall consumers acceptability and their market prize. The consumer acceptability is governed by shell texture and shell colour. Sen and Tekintas (1992) used shell colour as one of the parameters to characterize the superior types while as Bhat *et al.* (1999) suggested that the shell strength constitute an important component of nut character and it determines the cracking out quality of walnut and its market prize. As far as kernel filling is concerned, more than half of the selected genotype of walnut is moderately filled (QCL6W-4, 6, 7, 8, 10, 17, 18, 23, 34, 35, 36, 38, 39 and 44) to poorly filled (QCL6W-9 and 15). The kernel colour "very light to light" is considered desirable for consumer acceptability. In the present study, the kernel colour varied from very light to dark in colour. The accessions QCL6W-18, 21, 22, 24, 36, 37 and 38 had very light kernel colour and accessions QCL6W-10, 11and 27 had amber kernel colour, while rest of the accessions have light to dark kernel colour.

The data presented in the Table 2 revealed that wide variation in the metric nut traits of all 43 walnut accessions has been observed. The Shell Thickness varies from 1.28 mm in accession QCL6W-36 to 2.56 mm in accession QCL6W-3 with the average of 1.81 mm and least coefficient of variation of 11.09% was observed. Hence, the shell thickness contribution towards genetic diversity is only 0.87%. The present finding is in contrary to the result of Sharma and Sharma (2001) who have reported 3.54% contribution toward diversity indicating that the little bit more variation in shell thickness in walnut genotype of Himachal Pradesh as compared to Budgam district of Kashmir valley. Diameter at Cheek was recorded to be the highest in QCL6W-40 (45.20 mm) followed by QCL6W-11 (40.53 mm) and lowest was recorded in QCL6W-24 (26.51 mm) with mean of 33.74 mm and this character contributes 16.33% toward diversity. Similarly, the minimum diameter at suture was in accession QCL6W-24 (25.98 mm) and maximum of 41.00 mm in accession QCL6W-12 with the mean of 33.58 mm. The maximum nut length (46.75 mm) was observed in accession QCL6W-42, whereas minimum length in accession QCL6W-43 (29.78 mm) with mean of 38.64 mm. These components of nut are important as they determine the overall nut volume. Similar results were also reported by Bhat *et al*. (1999) and Sharma and Das (2003).

The nut weight is the most important character as it determines the yield and kernel percentage. In this survey, the maximum nut weight was recorded in accession QCL6W-40 (22.11gm) and minimum of 7.76gm in the accession QCL6W-32 having a mean weight of 15.54 gm. The highest kernel weight (10.70gm) was recovered from accession QCL6W-39 and lowest weight (3.41 gm) from the accession QCL6W-24. The maximum coefficient of variation was found in kernel weight which constitutes about 133.37% but the percent contribution towards diversity was only 4.18%. Kernel percentage was recorded highest in accession QCL6W-39 (58.00 %) and lowest of 25.00% in the accession QCL6W-5, with the mean of 45.04% and recorded highest (21.81%) contribution towards diversity as compared to other metric traits. The minimum kernel length was observed in accession

Table 2. Analysis of quantative characters of walnut genotypes from district Budgam

Accession Number	Nut length (mm)	Dia. at cheek (mm)	Dia. at suture (mm)	Shell thickness (mm)	Nut weight (gm)	Kernel weight (gm)	Kernel length (mm)	Kernel percentage (%)
QCL6-W-1	36.53	31.97	31.49	1.36	11.61	5.23	29.22	45.00
QCL6-W-2	35.59	31.71	33.38	1.52	12.15	5.63	25.15	46.00
QCL6-W-3	32.35	29.34	29.67	2.56	10.1	4.44	25.48	44.00
QCL6-W-4	36.77	31.66	30.40	1.49	11.48	5.55	27.46	49.00
QCL6-W-5	34.99	32.56	32.39	1.91	17.35	4.53	28.69	25.00
QCL6-W-6	36.53	35.79	33.41	2.09	13.63	6.55	29.17	49.00
QCL6-W-7	43.32	38.56	37.19	1.62	18.21	9.85	35.14	54.00
QCL6-W-8	42.02	30.93	32.49	2.14	13.29	6.50	34.33	49.00
QCL6-W-9	38.61	35.92	37.91	1.71	13.96	6.43	31.69	47.00
QCL6-W-10	34.24	27.98	28.42	1.72	9.83	4.67	25.33	49.00
QCL6-W-11	40.70	39.40	38.04	1.56	19.54	9.29	32.89	48.00
QCL6-W-12	44.95	38.47	41.00	1.96	18.56	7.49	29.86	41.00
QCL6-W-13	43.96	39.34	36.78	1.85	18.18	8.30	31.93	46.00
QCL6-W-14	32.45	30.88	30.41	1.86	10.64	4.80	23.61	45.00
QCL6-W-15	37.33	39.49	35.90	2.14	16.56	5.48	26.57	34.00
QCL6-W-16	45.11	30.10	31.12	1.46	13.72	6.57	34.40	49.00
QCL6-W-17	37.49	37.56	34.91	1.6	15.28	6.92	28.40	46.00
QCL6-W-18	44.80	36.94	35.97	1.69	17.75	8.52	34.13	49.00
QCL6-W-19	40.12	34.47	34.83	2.34	17.89	7.46	29.66	42.00
QCL6-W-20	38.71	29.35	30.29	1.53	11.32	5.71	29.50	51.00
QCL6-W-21	42.45	37.54	36.40	2.15	19.32	7.65	32.89	40.00
QCL6-W-22	37.95	32.08	34.58	2.04	13.62	5.29	29.06	40.00
QCL6-W-23	37.30	33.09	33.77	1.67	13.08	6.54	29.62	50.00
QCL6-W-24	31.15	26.51	25.98	1.78	7.92	3.41	23.77	44.00
QCL6-W-25	40.64	31.91	32.78	1.61	13.62	5.87	29.85	44.00
QCL6-W-26	39.23	40.53	35.51	2.27	16.58	7.88	29.58	47.00
QCL6-W-27	41.34	40.35	39.47	2.13	21.79	9.30	31.88	43.00
QCL6-W-28	33.24	29.95	30.12	1.71	11.07	5.14	25.58	47.00
QCL6-W-29	36.69	35.54	33.65	1.65	13.69	6.18	29.30	46.00
QCL6-W-31	39.97	37.52	34.66	1.80	15.38	7.03	31.52	46.00
QCL6-W-32	31.68	29.73	28.10	1.35	7.76	3.43	23.75	45.00
QCL6-W-33	46.49	35.89	33.38	1.53	15.99	7.25	34.88	45.00
QCL6-W-34	38.10	33.15	34.54	1.72	13.19	6.75	28.95	52.00
QCL6-W-35	37.45	35.33	35.45	1.82	16.68	9.01	29.04	54.00
QCL6-W-36	44.77	37.26	35.46	1.28	17.59	9.04	34.81	52.00
QCL6-W-37	34.73	29.95	30.97	1.83	11.28	4.83	30.01	43.00
QCL6-W-38	40.79	31.69	31.62	1.29	11.47	5.73	30.52	51.00
QCL6-W-39	40.69	34.78	33.19	1.58	18.66	10.70	34.43	58.00
QCL6-W-40	45.00	45.20	39.41	1.80	22.11	10.41	35.62	47.00
QCL6-W-41	33.00	37.64	34.75	1.83	16.26	7.47	27.49	45.00
QCL6-W-42	46.75	35.79	33.32	1.59	15.36	6.20	33.53	40.00
QCL6-W-43	29.78	27.75	26.28	1.41	7.96	3.76	22.69	47.00
QCL6-W-44	37.59	33.43	34.00	0.83	11.69	6.65	31.83	55.00
Range	29.78-46.75	26.51-45.20	25.98-41.00	0.83-2.56	7.76-22.11	3.41-10.41	22.69-35.14	25.00-58.00
Mean	38.64	33.74	33.58	1.81	15.54	8.63	29.51	45.04
SE Mean	0.81	0.77	0.68	0.60	1.48	2.31	.067	1.19
C.V.	16.65	15.15	11.86	11.09	54.59	133.37	11.23	35.54
S.D	4.08	3.89	3.44	0.30	7.39	11.55	3.35	5.96
Percent contribution	18.71	16.33	16.26	0.87	7.52	4.18	14.30	21.81

QCL6W-43 (22.69 mm) and maximum (35.62 mm) was observed in accession QCL6W-40. These results are in conformity with finding of various workers while working with different cultivars and seedling trees of walnut in different region of India (Panday and Sinha, 1984; Sharma and Sharma, 2001; Bhat *et al*., 1999 and Sharma and Das, 2003).

The genotypic variation of metric traits of studied accessions of walnut are concerned, highest coefficient of variation was observed for kernel weight (133.37 %) followed by nut weight (54.59 %) and kernel percentage (35.54 %). The variation for physical nut length, diameter at cheek and suture were 16.65, 15.15 and 11.86 respectively. Sundouri and Sharma (2005) noted that this variation is due to the seedling origin of bearing trees which exhibits lot of heterozygosity among the seedling tree and may also be due to pleotropic gene effect and environment. From the foregoing discussion, it is concluded that the accession no. QCL6W-7, 8, 16, 23, 35, 36, 38, 39 and 44 have been earmarked for utilization in future breeding programme for development of walnut varieties having better qualitative and quantative shelled and inshelled characters in terms of shell strength, shell seal, ease of removal, nut weight, kernel weight and kernel percentage. Tree of these five accession may also be used for clonal propagation and to replace existing seedling origin trees by means of top working that help in further improving the quality of shelled and inshelled characters of walnut and their overall contribution in strengthening the varietal spectrum of walnut germplasm.

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