Assessment of Genetic Diversity Using Quantitative and Qualitative Traits in Hazelnut

KA Zargar[1], KK Srivastava[2], Gul Zaffar[3], SK Bhat[4] and SR Singh[2]

[1]*Division of Pomology, Sher-e-Kashmir University of Agricultural Sciences and Technology (SKUAST), Shalimar, Srinagar-190007, Jammu and Kashmir*

[2]*Central Institute of Temperate Horticulture, Old Air Field, Rangreth-190007, Srinagar, Jammu and Kashmir.*

[3]*Division of Plant Breeding and Genetics, SKUAST-K, Shalimar-190007, Srinagar, J&K*

[4]*Research Associate, Central Institute of Temperate Horticulture, Old Air Field, Rangreth-190007, Srinagar, Jammu and Kashmir*

(Received: 01 June, 2012; Revised: 08 August 2012; Accepted: 09 August 2012)

The study conducted on to assess the genetic diversity on hazelnut in Kashmir valley, the results indicate genetic diversity with regard to morphological, yield, yield attributing and quality attributes. Maximum nut weights were recorded in SKAU-H-0035 whereas, kernel per cent registered maximum in SKAU-H-0003 and early nut maturity was recorded in SKAU-H-0041. Highest kernel weight (0.69g/kernel) were found in SKAU-H-0041 whereas lowest (0.43 g/kernel) in SKAU-H-0034 genotype. Highest yield were found in SKAU-H-0014. Crude fat content was recorded highest in SKAU-H-0020, whereas, highest crude protein content was noted in SKAU-H-0012.

Key Words: ***Corylus colurna,*** **Flowering, Kernel, Maturity, Nut, Variability**

Introduction

The Himalayan hazelnut botanically known as *Corylus colurna* L. considered as *C. jacquemontii* Decne (Kasapligil, 1963) (family Corylaceae) is typically a temperate zone nut crop (Westwood, 1993). It is locally known as "Virin" in Kashmir (Wanchoo, 2000). Hazelnuts are deciduous trees or shrubs scattered over the temperate region of Northern Hemisphere, extending from Japan, China, Turkey, India and Europe to North America Spain (Sharma, 1991). *Corylus colurna,* occurs in mixed temperate forest from Hindukush Mountain in Northern Afganistan through Pakistan and Indian Himalayan region to western Nepal. *C. ferox* Wall., the Himalayan hazel occurs at high elevations (1700-3500m) in the eastern part of the Himalayan in India, Nepal, and NW Yunnan province of China.

In USA hazelnut is so popular that it has been declared as Oregon States state nut. The nuts are small in sized and hard shelled. The flesh (kernel) of the hazelnut is highly nutritious and contains about 12.6% proteins, 62.4% `fats. Himalayan species *Corylus colurna* which is naturally available in Kashmir could not be exploited due to poor yielding behaviour of trees and having hard nuts considering the aforementioned fact an exploration programme was carried out to exploit the genetic variability of the natural habitats of Jammu and Kashmir.

Materials and Methods

An extensive exploration programme for identification, selection and evaluation of hazelnut was carried out at Dachigam Wildlife Sanctuary during 2006 to 2008 which is situated at an elevation of 16,00-4,250 m between 34°-10'N and 74°-50' to 75°-10'E altitudinal range . During course of study 41 trees were indentified and earmarked and named with prefix SKAU-Hazelnut (SKAU-H) with serial of genotypes to record data on foliage on various vegetative, nut and kernel characters. Leaf shape was recorded by measuring the leaf length and breadth with scale and ratio was worked out (Mir, 2002), staminate catkins per cluster and their appearance period, pistillate colour was recorded, quantitative traits like tree height, tree spread were recorded by measuring tape, tree volume was calculated using the formula, Volume= $4/3л\ ab^2$ or $4/3л\ a^2b$ and trunk cross sectional area was calculated by (Diameter) 2/ 4 л as suggested by Westwood (1983). Data on all the features pertaining to descriptive characteristics was recorded as per the "Descriptor of Hazelnut Bioversity" FAO (2008) standard format.

Results and Discussion

Genetic Variability in Hazelnut Genotypes with Regard to Quantitative and Qualitative Traits.

**Author for Correspondence: E-mail:* kanchanpom@gmail.com

The data on growth and yield characteristics of identified hazelnut genotypes are presented in Table 1. Tree height varied from 6.50 to 22.46 m, the genotype SKAU-H-0014 was found to be tallest (22.46 m), whereas, SKAU-H-0041 was smallest (6.50 m). Tree spread was found to be in the range of 3.20 to 10.40 m, the maximum spread was recorded in SKAU-H-0012 (10.40 m) whereas; the lower tree spread was recorded in SKAU-H-0041 (3.20 m). The maximum volume was recorded in SKAU-H-0014 (122.89 m^3) whereas, the minimum volume was noted in SKAU-H-0041(34.83 m^3). Maximum Trunk Cross Sectional Area (T.C.S.A.) was registered in SKAU-H-0014 and SKAU-H-0023 (0.38 m^2) respectively, whereas, the minimum (0.06 m^2) in SKAU-H- 0038 (Table 1).

Remarkable variations in morphological characters were noted in identified hazelnut genotypes. Leaf length was found maximum (15.53 cm) in SKAU-H-0037, and lowest (13.53 cm) was in SKAU-H-0041 genotypes. Leaf width and petiole length was found highest in SKAU-H-0031 (11.34 cm) and SKAU-H-0037 (4.35 cm) and minimum was in SKAU-H-0023 (9.26 cm) and SKAU-H-0003 (3.41 cm) respectively. Maximum leaf area was found in SKAU-H-0020 (131.77 cm^2) and minimum in SKAU-H-0008 (112.33 cm^2). The leaf shape factor was ranged between 1.30 to 1.57, leaf shape varied from round to ovate to elongated, nine genotypes viz., SKAU-H-0004, SKAU-H-0012, SKAU-H-0016, SKAU-H-0017, SKAU-H-0020, SKAU-H-0029, SKAU-H-0031, SKAU-H-0032, and SKAU-H-0034 were found with round shape, whereas two genotypes SKAU-H-0023 and SKAU-H-0027 were having elongated leaf shape and rest of the genotypes produce ovate shaped leaves (Table 1).

Maximum (5.53) number of catkins per cluster were noted in SKAU-H-0012 and minimum in SKAU-H-0029, rest genotypes were in between. Maximum length of catkins (11.66 cm) was recorded in SKAU-H-0040, shortest (7.66 cm) in SKAU-H-0019. Catkins appear earliest in SKAU-H-0040 and SKAU-H -0041 and late in SKAU-H-0001, SKAU-H-0002, SKAU-H -0003, SKAU-H -0004, SKAU-H 0005, SKAU-H -0022, SKAU-H -0023, SKAU-H 0024 and SKAU-H-0025. Maximum pistillate flowers per cluster (7.53) were noted in SKAU-H-0008; while as minimum (4.20) were found in SKAU-H-0024. Very early stigmatic styles were appeared in SKAU-H-0040 and SKAU-H-41 and very late in SKAU-H-0006, SKAU-H-0007, SKAU-H-0019, SKAU-H-0020 and SKAU-H-0021 (Table 2).

SKAU-H-0019, (3.54), was found with maximum nuts/cluster followed by SKAU-H-0034, andSKAU-H-0035 with 3.53 each whereas minimum (2.13) was in SKAU-H-0041. Large nut size (16.50mm) and small (14.84 mm) was recorded in SKAU-H-0041 and SKAU-H-0001 respectively.

Nut roundness index registered maximum in SKAU-H-0026 (0.95mm) and minimum in SKAU-H-0041 (0.67mm). Out of 41 genotypes, only one SKAU-H-0041 produce oblong-elongated shaped nuts, five genotypes viz., SKAU-H-0004, SKAU-H-0010, SKAU-H-0014, SKAU-H-0020 and SKAU-H-0023 produce roundish-ovate shaped nuts and rest of the genotypes produce flatish shaped nuts.

Maximum nut weight was noted (1.83 g/nut) in SKAU-H-0035, while as minimmum (1.28 g) in SKAU-H-0004. Very thick shell (2.25 mm) was noted in SKAU-H-0037 and thin shelled (1.04 mm) nut was SKAU-H-0041 (Table 3). Highest kernel weight (0.69 g) noted in SKAU-H-0041 whereas least Kernel weight (0.43 g) was in SKAU-H-0034. Maximum kernel percentage (41.70) was found in SKAU-H-0003 and minimum (25.23 %) was in SKAU-H-0037. Further Thompson (1977) found very high heritability for this traits. Genotype SKAU-H-0020 registered maximum crude fat content (54.96 %) whereas, minimum crude fat content was recorded 44.65% in SKAU-H-0040, highest (18.22 %) crude protein content were found in SKAU-H-0012, whereas, lowest in SKAU-H-0026 (11.07%) (Table 3). Sharma and Sharma (2004) registered remarkable variation in different nut and kernel characters in seedling population of hazelnut grown in Pangi, Solong, Sungri and Nichor area of Himachal Pradesh. Sharma and Kumar (2001) recorded sectional variation in hazelnut from Himachal Pradesh. The maturity in Hazelnuts starts from 16th August and completed up to 19th September. Early maturity was observed in SKAU-H-0041 which starts from 16th of August and completed up to 1st week of September,, however, late maturity was observed in three genotypes, namely SKAU-H-009, SKAU-H-0025 and SKAU-H-0028 which starts from 5th September and completed up to 19th September.

The harvesting period of mature nuts in identified genotypes were recorded between 5th to 26th September within the range of 22 days. The mature nuts were first harvested from SKAU-H-0041 on 5th September whereas,

Table 1. Growth and yield characteristics of hazelnut genotypes

Genotype	Leaf length (cm)	Leaf width (cm)	Leaf area (cm^2)	Leaf shape factor*	Petiole Length (cm)	Tree height (m)	Tree spread (m)	Tree volume (m^3)	Trunk cross-sectional area (m^2)	Maturity period	Harvesting date	Nut yield (kg/tree)
SKAU-H-0001	15.20	10.50	120.01	1.46 b	4.25	11.00	5.40	167.86	0.11	28 Aug.-10 Sep.	15 Sep.	2.5
SKAU-H-0002	15.50	11.06	128.26	1.40 b	3.81	15.50	6.80	375.08	0.26	25Aug.-9 Sep.	14 Sep.	3.5
SKAU-H-0003	15.11	11.00	125.72	1.3 8b	3.41	13.63	7.12	361.33	0.14	1 Sep.-15 Sep.	21Sep.	3.8
SKAU-H-0004	14.50	11.06	116.23	1.30 a	3.85	9.09	5.15	125.54	0.13	23 Aug.-6 Sep.	12 Sep.	3.5
SKAU-H-0005	14.66	10.51	119.77	1.40 b	3.48	19.69	9.39	906.16	0.36	25 Aug.-10 Sep.	16 Sep.	3.5
SKAU-H-0006	14.48	10.16	117.97	1.42 b	3.98	12.50	6.36	264.60	0.10	26 Aug.-10 Sep.	15 Sep.	2.6
SKAU-H-0007	15.23	11.10	127.19	1.37 b	3.93	14.30	5.90	260.50	0.18	29 Aug.-13 Sep.	19 Sep.	2.7
SKAU-H-0008	13.71	9.83	112.33	1.39 b	4.06	13.50	7.60	408.07	0.14	22 Aug.-3 Sep.	9 Sep.	2.5
SKAU-H-0009	14.45	10.40	121.40	1.38 b	4.18	19.25	9.50	908.72	0.33	5 Sep.-19 Sep.	26 Sep.	3.2
SKAU-H-0010	14.71	10.33	118.38	1.42 b	3.60	12.50	7.13	331.62	0.13	25 Aug.-7 Sep.	16 Sep.	2.0
SKAU-H-0011	14.98	10.89	121.03	1.36 b	3.51	18.23	8.74	728.36	0.22	30 Aug.-15 Sep.	23 Sep.	3.5
SKAU-H-0012	14.33	10.83	116.43	1.32 a	3.98	21.16	10.4	1197.73	0.36	24 Aug.-6 Sep.	14 Sep.	4.0
SKAU-H-0013	14.11	10.36	115.28	1.36 b	3.73	20.39	10.3	1131.50	0.31	24 Aug.-6 Sep.	15 Sep.	3.9
SKAU-H-0014	14.00	10.08	114.31	1.38 b	4.13	22.46	10.2	1222.89	0.38	28 Aug.-10 Sep.	19 Sep.	4.2
SKAU-H-0015	14.36	9.76	112.93	1.48 b	3.95	15.31	6.83	369.99	0.22	26 Aug.-10 Sep.	18 Sep.	2.9
SKAU-H-0016	14.76	11.32	123.47	1.30 a	3.88	9.45	5.61	154.92	0.08	29 Aug.-13 Sep.	21 Sep.	2.5
SKAU-H-0017	14.40	10.76	115.95	1.33 a	4.03	17.51	8.50	661.68	0.31	25 Aug.-8 Sep.	15 Sep.	3.8
SKAU-H-0018	14.15	10.38	115.37	1.36 b	3.66	16.39	7.23	446.85	0.24	23 Aug.-6 Sep.	13 Sep.	2.5
SKAU-H-0019	14.20	10.29	118.52	1.37 b	3.63	13.25	7.51	389.75	0.14	23 Aug.-6 Sep.	13 Sep.	3.5
SKAU-H-0020	14.65	10.76	131.77	1.35 a	3.93	18.75	8.03	630.80	0.36	24 Aug.-6 Sep.	14 Sep.	3.6
SKAU-H-0021	15.33	10.43	119.32	1.49 b	3.66	11.30	5.91	205.85	0.11	23 Aug.-6 Sep.	14 Sep.	2.3
SKAU-H-0022	14.60	10.48	121.33	1.39 b	4.23	13.36	7.15	356.43	0.14	29 Aug.-13 Sep.	20 Sep.	2.6
SKAU-H-0023	14.51	9.26	120.54	1.57 c	4.03	19.82	9.41	916.51	0.38	30 Aug.-15 Sep.	23 Sep.	3.0
SKAU-H-0024	15.31	11.00	128.66	1.38 b	3.51	15.53	6.82	377.77	0.31	31 Aug.-16 Sep.	21 Sep.	3.6
SKAU-H-0025	14.20	10.33	118.30	1.37 b	3.83	9.50	5.53	151.48	0.10	5 Sep. – 19 Sep.	24 Sep.	3.5
SKAU-H-0026	14.51	10.40	117.07	1.40 b	3.86	14.50	7.30	404.38	0.23	3 Sep. – 16 Sep.	21 Sep.	2.3
SKAU-H-0027	14.31	9.58	113.08	1.51 c	4.01	12.36	5.82	219.10	0.14	4 Sep. – 16 Sep.	23 Sep.	2.2
SKAU-H-0028	14.75	10.06	124.75	1.47 b	4.18	18.50	8.36	676.64	0.30	5 Sep. – 19 Sep.	25 Sep.	3.4
SKAU-H-0029	14.65	10.86	131.60	1.34 a	3.60	15.73	7.60	475.17	0.22	30 Aug. – 15 Sep.	23 Sep.	3.6
SKAU-H-0030	14.15	10.41	114.43	1.36 b	3.96	13.75	7.30	383.18	0.14	30 Aug. – 15 Sep	21 Sep.	3.1
SKAU-H-0031	15.30	11.34	114.27	1.34 a	4.06	19.50	7.90	636.89	0.35	28 Aug. – 10 Sep	18 Sep.	3.3
SKAU-H-0032	14.36	10.90	125.80	1.31 a	3.85	14.50	7.25	109.87	0.19	2 Sep. – 15 Sep.	21 Sep.	2.9
SKAU-H-0033	14.25	9.86	123.17	1.46 b	3.60	12.50	7.50	367.96	0.11	24 Aug. – 6 Sep	15 Sep.	2.8
SKAU-H-0034	14.73	10.93	121.53	1.35 a	3.88	8.69	4.50	91.98	0.08	28 Aug. – 10 Sep	17 Sep.	2.3
SKAU-H-0035	14.53	10.51	115.52	1.39 b	3.71	17.50	8.32	633.96	0.32	26 Aug. – 10 Sep	18 Sep.	2.9
SKAU-H-0036	15.23	11.01	129.65	1.38 b	3.73	13.64	7.14	363.9	0.16	24 Aug. – 6 Sep	15 Sep.	3.5
SKAU-H-0037	15.53	10.76	120.00	1.46 b	4.35	13.50	6.39	287.57	0.13	27 Aug. – 10 Sep	16 Sep.	2.5
SKAU-H-0038	14.03	9.98	118.55	1.40 b	3.98	7.38	4.21	68.12	0.06	30 Aug. – 15 Sep	20 Sep.	2.3
SKAU-H-0039	14.60	10.63	118.18	1.36 b	3.50	9.53	5.68	160.73	0.13	30 Aug. – 15 Sep	21 Sep.	3.5
SKAU-H-0040	15.15	10.33	119.57	1.47 b	3.98	10.81	6.50	238.74	0.14	20 Aug. – 3 Sep	10 Sep.	3.4
SKAU-H-0041	13.53	9.81	121.17	1.37 b	4.18	6.50	3.20	34.83	0.07	16 Aug. – 1 Sep	5 Sep.	0.5
L.S.D (0.05)	**1.66**	**1.57**	**20.43**	**0.21**	**0.80**	-	-	-	-	-	-	-
± S.E. $_{diff.}$	**0.83**	**0.79**	**10.27**	**0.10**	**0.40**	-	-	-	-	-	-	-

**Leaf Shape: a= round, b = ovate and c =elongated*

Table 2. Staminate and pistillate inflorescence characteristics of hazelnut genotypes

Genotype	Staminate catkins / cluster(no.)	Catkin length (cm)	Appearance period of staminate catkins	Pistillate flowers/ cluster(no.)	Appearance period of stigmatic styles
SKAU-H-0001	4.00	8.33	Late-July	4.90	Mid-March
SKAU-H-0002	4.33	8.93	Late-July	5.70	Mid-March
SKAU-H-0003	4.53	9.00	Late-July	6.50	Mid-March
SKAU-H-0004	4.60	8.33	Late-July	5.53	Mid-March
SKAU-H-0005	4.00	8.73	Late-July	5.00	Mid-March
SKAU-H-0006	5.06	9.26	Mid-July	5.73	Late-March
SKAU-H-0007	3.66	9.76	Mid-July	4.86	Late-March
SKAU-H-0008	4.06	8.56	Late-June	7.53	Mid-February
SKAU-H-0009	3.66	8.13	Late-June	6.03	Mid-February
SKAU-H-0010	3.86	9.86	Late-June	6.20	Mid-February
SKAU-H-0011	4.00	9.70	Late-June	5.13	Mid-February
SKAU-H-0012	5.53	8.16	Late-June	6.46	Mid-February
SKAU-H-0013	4.86	10.10	Late-June	5.93	Mid-February
SKAU-H-0014	4.20	8.83	Early-July	6.86	Late-February
SKAU-H-0015	3.46	10.50	Early-July	6.70	Late-February
SKAU-H-0016	3.80	8.70	Early-July	5.66	Late-February
SKAU-H-0017	3.53	10.43	Early-July	5.23	Late-February
SKAU-H-0018	4.33	7.90	Early-July	5.00	Late-February
SKAU-H-0019	3.13	7.66	Mid-July	5.23	Late-March
SKAU-H-0020	4.33	10.10	Mid-July	5.73	Late-March
SKAU-H-0021	5.40	8.03	Mid-July	6.20	Late-March
SKAU-H-0022	3.46	9.40	Late-July	6.36	Mid-March
SKAU-H-0023	4.86	8.66	Late-July	5.90	Mid-March
SKAU-H-0024	4.26	8.33	Late-July	4.20	Mid-March
SKAU-H-0025	4.53	9.16	Late-July	5.90	Mid-March
SKAU-H-0026	5.26	10.06	Mid-July	5.53	Early March
SKAU-H-0027	4.46	9.00	Mid-July	4.46	Early March
SKAU-H-0028	4.46	9.66	Mid-July	6.03	Early March
SKAU-H-0029	3.00	8.40	Mid-July	5.56	Early March
SKAU-H-0030	4.86	8.56	Mid-July	5.13	Early March
SKAU-H-0031	4.40	8.60	Early-July	5.90	Mid-March
SKAU-H-0032	4.26	10.40	Early-July	5.80	Mid-March
SKAU-H-0033	4.00	9.43	Early-July	5.10	Mid-March
SKAU-H-0034	3.93	9.06	Early-July	6.23	Mid-March
SKAU-H-0035	5.33	8.06	Early-July	5.53	Mid-March
SKAU-H-0036	5.06	8.33	Late-June	5.66	Late-February
SKAU-H-0037	4.40	8.83	Late-June	5.80	Late-February
SKAU-H-0038	4.20	8.50	Late-June	6.60	Late-February
SKAU-H-0039	5.00	8.00	Late-June	5.20	Late-February
SKAU-H-0040	4.60	11.66	Mid-June	6.00	Early- February
SKAU-H-0041	3.20	8.00	Mid-June	5.10	Early- February
L.S.D (0.05)	**2.85**	**2.85**	–	**2.76**	–
± S.E. $_{diff.}$	**1.44**	**1.43**	–	**1.40**	–

Table 3. Nut and kernal characteristics of hazelnut/genotypes

Genotype	Nuts/ cluster (no.)	Nut roundness index (mm)	Nut size index (mm)	Nut Shape factor*	Nut weight (g)	Shell thickness (mm)	Kernel weight (g)	Kernel percentage (%)	Special Characters	
									Crude Fat contents (%)	Crude Protein contents (%)
SKAU-H-0001	3.39	0.89	14.84	0.93b	1.32	1.65	0.48	36.35	49.22	14.37
SKAU-H-0002	3.44	0.87	15.04	0.96b	1.38	1.69	0.50	36.49	54.01	17.93
SKAU-H-0003	3.43	0.86	14.88	0.96b	1.33	1.71	0.55	41.70	53.20	13.78
SKAU-H-0004	3.39	0.87	15.24	0.97b	1.28	1.71	0.50	39.44	47.76	17.03
SKAU-H-0005	3.43	0.89	15.15	0.94b	1.50	1.58	0.45	30.24	48.84	16.19
SKAU-H-0006	3.45	0.91	15.00	0.91b	1.37	1.63	0.47	34.79	47.04	15.78
SKAU-H-0007	3.49	0.85	14.86	0.90a	1.43	1.67	0.47	32.90	47.40	14.85
SKAU-H-0008	3.52	0.89	15.40	0.95b	1.52	1.74	0.46	30.60	51.63	15.73
SKAU-H-0009	3.49	0.88	15.76	0.96b	1.55	1.62	0.53	34.03	48.69	16.23
SKAU-H-0010	3.43	0.89	15.36	0.97b	1.48	1.64	0.55	37.70	49.44	16.34
SKAU-H-0011	3.49	0.88	14.96	0.96b	1.47	1.58	0.46	31.91	49.97	17.55
SKAU-H-0012	3.46	0.92	15.06	0.91b	1.67	1.77	0.54	32.18	48.37	18.22
SKAU-H-0013	3.51	0.88	15.37	0.95b	1.52	1.71	0.50	33.65	48.79	13.39
SKAU-H-0014	3.42	0.88	15.33	0.97b	1.45	1.92	0.48	33.62	49.33	15.67
SKAU-H-0015	3.45	0.89	15.12	0.96b	1.48	1.78	0.44	29.81	48.99	16.82
SKAU-H-0016	3.45	0.89	15.27	0.93b	1.71	2.01	0.53	31.09	53.67	13.13
SKAU-H-0017	3.49	0.92	15.12	0.91b	1.61	1.78	0.51	31.78	48.30	15.14
SKAU-H-0018	3.48	0.91	15.40	0.92b	1.50	1.75	0.54	36.82	49.62	12.85
SKAU-H-0019	3.54	0.89	15.32	0.96b	1.44	1.65	0.44	30.62	48.54	14.99
SKAU-H-0020	3.45	0.87	15.27	0.97b.	1.43	1.71	0.52	36.43	54.96	17.55
SKAU-H-0021	3.47	0.88	15.26	094b	1.68	1.97	0.45	27.13	48.35	16.99
SKAU-H-0022	3.45	0.91	15.68	0.90a	1.64	2.18	0.52	32.47	49.22	14.60
SKAU-H-0023	3.48	0.87	15.48	0.98b	1.77	1.94	0.51	29.40	50.34	13.85
SKAU-H-0024	3.41	0.89	15.40	0.96b	1.65	2.05	0.47	29.31	45.20	16.05
SKAU-H-0025	3.45	0.89	15.39	0.94b	1.67	1.81	0.48	29.65	52.02	11.61
SKAU-H-0026	3.47	0.95	15.65	0.88a	1.81	1.95	0.50	27.98	49.62	11.07
SKAU-H-0027	3.45	0.92	15.38	0.92b	1.59	2.17	0.44	27.93	50.86	14.28
SKAU-H-0028	3.51	0.90	15.30	0.92b	1.69	2.13	0.54	32.51	47.74	13.72
SKAU-H-0029	3.50	0.92	15.33	0.90a	1.67	2.09	0.46	28.25	52.16	14.10
SKAU-H-0030	3.46	0.90	15.31	0.94b	1.55	1.96	0.45	29.85	48.61	15.16
SKAU-H-0031	3.47	0.90	15.56	0.93b	1.49	2.12	0.53	37.04	50.30	15.25
SKAU-H-0032	3.51	0.92	15.63	0.91b	1.44	2.09	0.45	32.95	48.75	14.76
SKAU-H-0033	3.41	0.87	15.41	0.96b	1.63	2.10	0.46	28.52	51.48	13.44
SKAU-H-0034	3.53	0.90	15.20	0.93b	1.57	1.89	0.43	27.29	48.96	14.37
SKAU-H-0035	3.53	0.90	15.55	0.92b	1.83	1.99	0.53	29.76	50.29	14.35
SKAU-H-0036	3.43	0.89	15.07	0.94b	1.49	2.08	0.46	31.84	51.68	13.74
SKAU-H-0037	3.46	0.91	15.26	0.92b	1.79	2.25	0.45	25.23	48.11	15.90
SKAU-H-0038	3.41	0.90	15.47	0.92b	1.59	1.91	0.46	30.92	46.89	15.00
SKAU-H-0039	3.40	0.92	15.38	0.92b	1.70	1.96	0.45	26.42	50.55	14.85
SKAU-H-0040	3.43	0.94	15.63	0.89a	1.80	2.06	0.48	26.83	44.65	16.49
SKAU-H-0041	2.13	0.67	16.50	1.35c	1.71	1.04	0.69	40.34	45.01	11.94
L.S.D (0.05)	**0.15**	**0.08**	**0.75**	**0.09**	**0.26**	**0.38**	**0.10**	**9.07**	**9.20**	**6.16**
± S.E. $_{diff.}$	**0.10**	**0.04**	**0.38**	**0.05**	**0.13**	**0.19**	**0.05**	**4.60**	**4.63**	**3.10**

Nut shape: a = flatish, b =roundis ovate, c =oblong elongated

SKAU-H-0009 was harvested very late (26th September). The maximum yield was noted in SKAU-H-0014 (4.2 kg) and the minimum yield of 0.5 kg in SKAU-H-0041. Variation in yield might be due to factors governing pollination and genetic make up of individual genotypes, Rana (2004) reports that hazelnut starts commercial bearing late and average yield registered 2.0 to 2.5 kg per tree.

The nut weight is highly heritable character, therefore larger nut size can be used in selection of better types

for commercial as well as for further improvement programme. The major emphasis in this investigation was given to identify the best genotypes, which are superior in yield, yield attributing, nut and kernel quality characters. The extent of genetic variability in studied genotypes indicates the scope of exercising exploration programme in Kashmir valley for proper exploitation of available population for identification of better types.

References

FAO (2008). Descriptor for the Hazelnut (*C. avellana* L.). Bioversity International, Rome, Italy, FAO of UN, International Centre for Advanced Mediterranean Agronomic Studies, Zoragoza, Spain.

Mir MS (2002) Survey and Screening of apsicol in 'Ladhak, PhD Thesis, Sher-e-Kashmir University of Agricultural Sciences and Technology, Srinagar, Jammu and Kashmir.

Kasapligil B (1963) *Corylus colurna* and its varieties. *California Journal of Horticultural Society*, **24**: 95-104.

Rana SS (2004) Hazelnut. In: Recent Trends in Horticulture in the Himalayas, KK Jindal and RC Sharma (eds.) Indus Publishing Co., New Delhi, India, pp 186-196.

Sadsivam S and A Monickom (1992) In: Biochemical Methods for Agricultural Science, Wiley Eastern Limited, New Delhi, pp 26-27.

Sharma SD (1991) Filberts, In: SK Mitra, DS Rathore and TK Bose (eds.) Temperate fruits, Horticulture and allied Publishers Chakrabaria Lana Calcutta, India, pp 473-497.

Sharma SD and K Kumar (2001) Preliminary evaluation of hazelnut seedling trees native to India. *Acta Horti*. **556**: 29-35.

Sharma SD and VK Sharma (2004) Studies on the variability in metric traits of nut and kernel in seedling Hazelnut trees in different locations of Himachal Pradesh. *Prog. Hort.* **36(2):** 211-215.

Thompson MM, HB Lagerstedt and SA Mehlenbachler (1996) Hazelnuts. In: Fruit Breeding, Vol. III: Nuts J Janick and J Moore (eds). John Wiley and Sons, Inc., pp 125-184.

Thompson MM (1977) Inheritance of nuts traits in filberts (*C. avellana* L.). *Euphytica.* **26:** 465-474.

Wancho PN (2000) Fruit Culture and Science : Pomes, Drupes, Nuts, Berries, Mangoes, Citrus, Grapes and all relevant to the regions. Horticulture in Himalayas "Principles and Practices", 386 p.

Westwood MN (1993) Fruit and nut species. Tree nuts, Filbert. pp. 63, Chapter 3. In: (ed.) SW Wilshire, Temperate-Zone Pomology. Timber, Press, Portland, Oregon.