SHORT COMMUNICATION

Diversity and Selection of Persian Walnut (*Juglans regia* L.) from Ladakh Region of India

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Investigations were carried out during 2006 on 91 seedling trees of Persian walnut growing at high altitude (more than 300 mamsl.) at various locations of Ladakh region in India. Data were collected on 26 nut and kernel characters. A great magnitude of variability was noticed for various traits. Maximum coefficient of variability was recorded for kernel weight while minimum for nut width. Based upon the existing variability, selection criteria was made and elite genotypes were selected virk Tree No. 1 at Domkhar, Tree No. 1 and 2 at Nurla; Tree No. 4 and 10 at Saspol and Tree No. 4, 6, 9 and 19 at Khalsi. These selected types will be vegetatively propagated and released as cultivars for commercial cultivation in Ladakh region of India in future to boost the cultivation of walnut at high altitudes.

Key Words: Diversity, Seedling trees, Walnut, Nut characters, Kernel, Variability

Persian walnut (*Juglans regia* L.) is one of the most important nut crops grown in temperate climate and belongs to family Juglandaceae. In India mostly walnuts of seedling origin are being grown. However, in last twenty years a lot of work on variability, selection and propagation has been carried out and now the systematic orcharding with superior cultivars has been started but with low pace. Walnut is monoecious and pollination takes place through wind which exhibit a great variability for various nut and kernel characters in the plants raised from seed. Past selection work has resulted to a number of present day cultivars throughout the world. Although walnut is successfully cultivated from 1,200 to 2,200 meters amsl, but also seedling trees of walnut were found growing at more than 3,000 meters above mean sea level (amsl). So, in present study an effort was made to study the extent of diversity and selection of elite genotypes of walnut from Ladakh for future use in high altitudes.

The present investigations were carried out during 2006 in some of the seedling walnut growing in Ladakh region of India. Nut samples were collected from Saspol (34°14.666' N and 77°10.165' E), Nurla (34°17.968' N and 76°59.473' E), Khaltsi (34°19.218' N and 76°52.972' E) and Domkhar (34°24.179' N and 76°45.995' E) area of district Leh in Jammu and Kashmir. These areas are more than 10 kilometers situated at an elevation of 3075, 3005, 3031 and 3045 meters amsl. These places are apart from each other. A sample size of 20 sun dried nuts were randomonly collected from each bearing tree. The samples were taken from 10 bearing seedling trees from Saspol, 13 from Nurla, 26 from Khaltsi and 42 from Domkhar area. Data on various nut and kernel characters were recorded on total 91 seedling trees as per descriptors of UPOV (1988) and IPGRI (1994). Data were analyzed as per Panse and Sukhatme (1985). The criteria used for selection of important traits were as per Sharma and Sharma (2000).

Data on range, mean, standard deviation and coefficient of variability on various metric nut and kernel characters are presented in Table 1. Maximum and minimum values for various characters were recorded from nuts produced by Tree No. 4 at Khaltsi and Tree No. 5 at Nurla, Tree No. 1 at Domkhar and Tree No. 10 at Nurla, Tree No. 19 at Khaltsi and Tree No. 3 at Domkhar,

Table 1. Range, Mean, Standard Deviation and Coefficient of Variability for Various Metric Nut and Kernel Characters

Characters	Range	Mean	Standard deviation	Cofficient of variability (%)
Nut weight (g)	5.61-18.47	11.30	2.65	23.42
Nut width (mm)	21.97-35.61	29.40	2.72	9.26
Nut height (mm)	26.92-47.30	35.98	4.31	11.99
Nut thickness (mm)	20.39-36.40	29.90	2.91	9.74
Index of roundness	0.65-1.00	0.83	0.08	9.93
Pad thickness (mm)	2.69-6.89	4.46	0.89	19.88
Pad width (mm)	1.76-6.91	4.50	1.11	24.29
Shell thickness (mm)	0.97-2.34	1.63	0.34	20.86
Kernel weight (g)	1.83-10.13	4.53	1.43	31.60
Kernel width (mm)	24.25-27.66	20.11	2.44	12.15
Kernel height (mm)	17.34-36.57	26.96	3.69	13.70
Kernel thickness (mm)	15.44-33.44	23.89	3.28	13.72
Kernel percentage	13.51-63.36	39.96	7.87	19.70

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Tree No. 10 at Nurla and Tree No. 2 at Nurla, Tree No. 11 at Nurla and Tree No. 8 at Domkhar, Tree No. 19 at Domkhar and Tree No. 28 at Domkhar, Tree No. 4 at Khaltsi and Tree No. 29 at Domkhar and Tree No. 7 at Domkhar and Tree No. 31 at Domkhar, respectively. Kernel weight, kernel width, kernel height, kernel thickness and kernel percentage varied between 1.83 g (Tree No. 5 at Nurla) to 10.13g (Tree No. 4 at Khaltsi), 14.25 mm (Tree No. 10 at Nurla) to 27.66 mm (Tree No. 4 at Khaltsi), 17.34 mm (Tree No. 10 at Nurla) to 36.57 mm (Tree No. 2 at Nurla), 15.44 mm (Tree No. 10 at Nurla) to 33.44 mm (Tree No. 36 at Domkhar) and 13.51% (Tree No. 2 at Khaltsi) to 63.36% (Tree No. 1 at Saspol) with their mean and coefficient of variability at the tune of 4.53 g and 31.60%, 20.11 mm and 12.15%, 26.96 mm and 13.70%, 23.98 mm and 13.72% and 39.96% and 19.70 %, respectively. The coefficient of variability extremes between 9.26% (nut width) to 31.60% (kernel weight).

Nut shape in longitudinal section perpendicular to suture and through suture on various locations were circular, triangular, broad ovate, ovate, short trapezoid, long trapezoid, broad elliptic and obovate. The percentages of trees at different locations were different. Most of the nuts produced at various locations were circular and broad elliptic for nut shape in cross section except one tree at Nurla which produced nuts having narrow elliptic shape in cross section. Shapes of nut base and apex also varied at various location as pointed, rounded, truncate and emarginated with varied frequencies at various places. The prominence of pistil point was weak, medium and strong at various location with varied number of trees while the position of pad on suture extremes as up to upper half, upper 2/3 and whole length of the fruit. The structure of shell surface was slightly grooved, moderately grooved, strongly grooved and embossed while grooves along pad on suture were shallow, medium and deep at various locations with different frequencies of trees falling in each category. Similarly adherence of two shell halves observed was weak, medium, strong and very strong while inner dividing primary and secondary membranes were thin, medium and thick at various locations with varied percentage of trees in each category. The kernel recovery was very easy, easy, medium, difficult and very difficult while the intensity of brown colour on kernel was very light, light, medium, dark and very dark.

Based on the existing variability for various nut and kernel characters in the region, 9 seedling trees were found elite trees. The various nut and kernel characters of selected types are presented in Table 2. The number of selected types at different locations is one at Domkhar (Tree No. 1), 2 at Nurla (Tree No. 1 and 2), 2 at Saspol (Tree No. 4 and 10) and 4 at Khaltsi (Tree No. 7, 6, 9 and 19). All the selected types produced nuts having nut weight more than 15 g. Tree No. 4 at Khaltsi and Tree No. 1 at Domkhar had maximum nut weight (18.47 g) and nut width (35.61 mm, respectively. Similarly Tree No 19 at Khaltsi and Tree No 2 at Nurla produced nuts with maximum height (47.30 mm) and thickness (36.40 mm), respectively. Minimum pad thickness 3.84 mm), pad width (1.76 mm) and shell thickness (1.05 mm) among selected types was found in Tree No. 9 at Khaltsi, Tree

Table 2. Nut and kernel characteristics of some elite walnuts of Ladakh

Characters	Locations and Tree Number								
	Domkhar	Nurla		Saspol		Khaltsi			
	Tree	Tree No. 1	Tree No. 2	Tree No. 4	Tree No. 10	Tree No. 4	Tree No. 6	Tree No. 9	Tree No. 19
Nut weight (g)	16.64	15.44	17.63	15.28	15.21	18.47	15.42	15.22	16.66
Nut width (mm)	35.61	31.58	34.02	33.15	31.01	35.21	25.05	31.38	35.21
Nut height (mm)	37.54	42.62	44.43	41.65	45.88	45.01	32.86	35.32	47.30
Nut thickness (mm)	36.39	33.73	36.40	33.70	30.93	35.30	28.23	32.79	36.10
Shell thickness (mm)	1.74	1.07	1.29	1.18	2.21	1.09	1.58	1.45	1.05
Kernel weight (g)	6.14	5.89	6.94	7.13	5.97	10.13	5.64	6.57	8.78
Kernel percentage	36.90	38.15	39.36	46.66	39.25	54.85	36.58	43.17	52.70
Structure of shell surface	Strongly grooved	Slightly grooved	Slightly grooved	Moderately grooved	Slightly grooved	Moderately grooved	Embossed	Embossed	Slightly grooved
Adherence of two halves	Strong	Medium	Medium	Strong	Very strong	Strong	Very strong	Medium	Strong
Kernel removal	Medium	Easy	Easy	Very easy	Easy	Very easy	Medium	Very difficult	Very easy
Intensity of brown colour	Very light	Very light	Very light	Very light	Light	Medium	Medium	Medium	Light

No. 4 at Khaltsi, and Tree No. 19 at Khaltsi, respectively. Maximum kernel weight (10.13g) and kernel percentage (54.85%) was found in nuts produced by Tree No. 4 at Khaltsi. All the selected types have medium, strong and very strong adherence of two shell halves; very easy, easy and medium ease of kernel removal. The intensity of brown colour on kernel in selected types was medium, light and very light. Only two trees (Tree No. 10 at Saspol and Tree No. 9 at Khaltsi) had value of shell thickness (2.21 mm) and ease of kernel removal (very difficult) beyond the desirable limits but they have other all characters superior, hence they were selected.

In the present study a great range of variability was observed for various nut and kernel characters. Similar variations for these characters were recorded by various workers in seedling trees (Sharma and Sharma, 1998; 2001a and Mehta *et al.*, 2005). The nut shapes observed were as per UPOV (1988) description. Besides, one more shape "obovate" has been observed. The existence of this shape has been earlier reported in seedling trees in Himachal Pradesh by Sharma (1999) and Mehta *et al.* (2005). Similar type of diversity for various non metric nut and kernel traits was also observed by Sharma and Sharma (2000). The existence of variability is the pre requisite for any breeding program. To evolve a cultivar through hybridization is a long process in the fruit crops like walnut. As the cultivar requirement of every region differ and cultivar in one region may not do well in another place. So, the most easy and fast method of improvement is selection of superior types from the existing variability. In the present study nine elite types of walnuts were selected from Ladakh region of India. Similar types of selection work from the existing variability were carried out Sharma and Sharma, 2000; 2001b; Sharma and Sharma, 2005 and Mehta *et al.*, 2005) in Himachal Pradesh. Although criteria used in present study slightly differed from earlier studies because selection was made from the existing population at very high altitudes (more than 3000 meters amsl.) As growing of walnuts was not reported at such height, so the cultivar requirements of this region might be totally different from elsewhere. Although among the selected, one type had more shell thickness than the criteria fixed and other had very difficult kernel removal but these were selected because they were superior in all other characters. The continuous cross pollination and seed propagation has resulted to this variability for various nut and kernel characters. These selected types can be used as cultivars to boost walnut production in the region in future.

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