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GENETICS

Characterization of Walnut (*Juglans Regia* L.) Genotypes in Ladakh Region of India

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Abstract

Ladakh region includes Leh and Kargil districts of Jammu and Kashmir in India. The region is cold and arid limiting the growing of fruit crops. The study aims to characterize walnut diversity in the region which would be resourceful in the near future for various purposes and boost up walnut cultivation. Four genotypes are selected from various walnut growing areas of Ladakh *viz.* G_1 from Skara, G_2 from Nurla, G_3 from Temisgam and G_4 from Dhomkhar. It was evident that majority of the genotypes exhibited intermediate tree vigour with spreading nature of growth habit, glabrous shoot pubescence and leaf and rachis pubescence, strong shell seal and shell strength with good nut diameter and nut length, satisfactory kernel flavor, well filled kernel and easy removal of kernel halves. Leaflet shape observed was elliptic, leaflet margin was entire, green leaf and rachis colour, brown shoot colour, complete shell integrity and kernel plumpness was moderate in all the four genotypes. The branching habit was dense in genotypes G_3 and G_4, intermediate in G_1 and intermediate to dense in G_2. In general, the highest value of leaf length and kernel percentage was recorded in G_2. G_3 exhibited the maximum width of leaf, number of leaflets, inshell nut weight and kernel weight. The nut shape was broad to ovate in G_2 and G_3, while G_1 was broad ovate and G_4 was broad elliptic in shape. The shell texture of G_2 and G_4 was medium while G_3 was medium to rough and G_1 was rough. The shell colour of G_1 was light, medium in G_2, light to medium in G_3 and medium to dark in G_4. The shell thickness recorded the maximum in G_4. The kernel colour was light in G_2 and G_4, while extra light and light to amber was observed in G_1 and G_3 respectively.

Highlights

- Four genotypes are selected from various walnut growing areas of Ladakh.
- Characterization and evaluation of the genotypes are carried out.
- The genotypes exhibited variability in the leaf, shoot, nut, shell and kernel characters.
- G_2, G_3 and G_4 are supreme in several characters and can be used for various crop improvement programmes.

Keywords: Characterization, genotypes, Ladakh, walnut

English or Persian walnut (Juglans regia L.), the only species cultivated widely for nut production is deciduous in nature and belongs to the family Juglandaceae. Walnuts are one of the several high nutrient density foods. Nuts are rich in oil, and are widely eaten both fresh and in cookery, as well as for flavouring and confectionery. Walnut are also excellent source of omega-3 fatty acids, vitamins and minerals, and valued as healthy snack food (Rana *et al.* 2007). Unlike most nuts that are high in

monounsaturated fatty acids, walnuts are composed largely of polyunsaturated fatty acids, particularly apha-linolenic acid and linoleic acid. The beneficial effects of this unique fatty acid profile has been a subject of many studies and discussions (Deirdre and Frank 2009). This alpha-linolenic acid has substantial cardio protective effects as it surges the ratio of high-density lipoprotein cholesterol to total cholesterol, thereby, plummeting the inflammation and mending arterial function (Hu *et al.* 1999, Diousse *et al.* 2001, Patel 2005). Walnut provides a number of nutrients and there is some evidence that eating walnuts after a meal high in unhealthy fats can reduce the damaging effects of such fats on blood vessels (Cortes *et al.* 2006). The Jammu and Kashmir State of India alone accounts for >98% of India's total production (Sharma 2012). Ladakh includes Leh and Kargil districts of Jammu and Kashmir. The region is cold, arid with harsh climates, and the choice of growing fruits is very limited due to poor adaptability of fruit plants. The growing season is also limited to five to six months only. The collection and characterization of walnut diversity and their careful evaluation would prove valuable in the near future for crop improvement programmes and boost up walnut cultivation. In general, information on the genetic diversity within and among closely related crop varieties is essential for a rational use of genetic resources (Singh *et al.* 2015a) and characterization of genotypes also helps in finding out the ideal one which is resistant to diseases (Singh *et al.* 2015b). Furthermore, Sharma *et al.* (2014) also stresses on the importance of selection from the existing seedling population for increasing the nut production, better export quality and supply of quality planting material to walnut growers. So, in the present study, efforts were made to investigate and characterize the different genotypes of walnut growing in Ladakh for phenological and pomological characters and find out the superior genotype (s) which would be important commercially.

Materials and Methods

The investigation on the various nut and kernel parameters was carried out at the laboratory of the Department of Horticulture, Institute of Agricultural Science, University of Calcutta, West Bengal, India, during the year 2011-2013. The genotypes (G) are selected from various walnut growing areas of Ladakh *viz.* G_1 from Skara (34° 9.907′ N and 77° 33.437′ E), G_2 from Nurla (34° 17.968′ N and 76° 59.473′ E), G_3 from Temisgam (34° 19.242′ N and 76° 59.260′ E) and G_4 from Dhomkhar (34° 24.179′ N and 76° 45.995′ E) with an altitude of 3360, 3005, 3231 and 3045 meters above sea level respectively. The maximum and minimum temperature recorded at the time of investigation was 32 °C and 10 °C respectively with an average relative humidity of 63% and 15 mm rainfall. A sample size of 15 sun dried nuts was collected from each bearing trees for kernel and nut characters. The genotypes were characterized for various characters following Biodiversity International Walnut Descriptor (1994). The characters selected for characterization were tree vigour, growth habit, branching, leaf length (cm), leaf width (cm), number of leaflets, leaflet shape, leaflet margin, leaf colour, rachis colour, shoot pubescence, shoot colour, leaf and rachis pubescence, nut shape, nut diameter (mm), nut length (mm), shell texture, shell colour, shell seal, shell strength, shell integrity, shell thickness (mm), inshell nut weight (g), kernel weight (g), kernel percentage (%), kernel flavor, kernel fill, kernel plumpness, ease of removal of kernel halves and kernel colour. Analysis was done by one-way ANOVA technique. Duncan's test at 5% was also followed by comparing genotypic means if significant. All analysis was done following SPSS. 17.0 software.

Results and Discussion

It is evident from the data presented in the table 1, that tree vigour under all the genotypes (G_1, G_2, and G_4) of walnut tree was observed intermediate except in G_3 which was intermediate to high in nature. The growth habit of G_1 was semi-erect while other genotypes were spreading in nature. Sharma *et al.* (2014) also observed the spreading growth habit in the elite clones of walnut with medium tree vigour. The growth habit of walnut cultivars have been categorized into erect, semi-erect and spreading

types (UPOV 1988, Gupta 1997, Solar *et al.* 2002). Solar *et al.* (2002) found semi-erect growth habit with majority of the walnut strength in Slovenia. A wide variation in pomological and phenological character similar to the present investigation was also reported by Akca and Sen (2001). The branching habit was dense in genotypes G_3 and G_4, intermediate in G_1 and intermediate to dense in G_2. Leaflet shape observed was elliptic, leaflet margin was entire and leaf colour was green in all the four genotypes. The green colour of the fully expanded leaves was in confirmative with the findings of Sharma *et al.* (2014). The highest value of leaf length was recorded in G_2 and G_4, whereas, G_3 recorded the maximum in width of leaf and number of leaflets (Table 3). Similar to the present findings, a significant difference in foliage characters were also reported by Sharma *et al.* (2010). Rachis colour was observed green and shoot colour was brown in all the genotypes and shoot pubescence and leaf and rachis pubescence was glabrous in all the genotypes except G_3 which was slightly pubescent. Sharma *et al.* (2014) however observed slightly pubescent in shoots of elite clone 'GL0109' of walnut which are green and brown in colour.

The nut shape was broad to ovate in G_2 and G_3, while G_1 was broad ovate and G_4 was broad elliptic in shape. The shell texture of G_2 and G_4 was medium rough while G_3 was medium to rough and G_1 was rough. The shell colour of G_1 was light, medium in G_2, light to medium in G_3 and medium to dark in G_4. The shell seal and shell strength was observed strong in the genotypes except G_2 which was weak to intermediate. Shell integrity of all genotypes of walnut was complete shell, no holes was recorded. The kernel flavour was satisfactory and kernel plumpness was moderate in all the genotypes. The kernel fill was however moderate to well in G_3 and well in nature in other three genotypes. Ease of removal of kernel halves was very easy in G_2 and easy in other three genotypes. The kernel colour was light in G_2 and G_4, while extra light and light to amber was observed in G_1 and G_3 respectively. (Table 2). The maximum nut diameter and nut length was observed in the genotypes excluding G_2. This is higher than the value observed by Sharma *et al.* (2014) in clone 'GL0109'. The shell thickness and inshell nut weight recorded the maximum in G_4 and G_3 respectively. The kernel weight was highest in G_3 (Figure 1), while kernel percentage was found to be highest in G_1 and G_2 (Table 3). The variability in kernel characters in the present result is in confirmative with the findings of Sharma *et al.* (2010) and Dogan *et al.* (2005).

Table 1. Qualitative traits of tree morphological, leaf characters, rachis and shoots of different genotypes of walnut.

Character	Genotypes			
	G_1	G_2	G_3	G_4
Tree vigour	Intermediate	Intermediate	Intermediate-high	Intermediate
Growth habit	Semi-erect	Spreading	Spreading	Spreading
Branching	Intermediate	Intermediate-dense	Dense	Dense
Leaflet shape	Elliptic	Elliptic	Elliptic	Elliptic
Leaflet margin	Entire	Entire	Entire	Entire
Leaf colour	Green	Green	Green	Green
Rachis colour	Green	Green	Green	Green
Shoot pubescence	Glabrous	Glabrous	Slightly pubescent	Glabrous
Shoot colour	Brown	Brown	Brown	Brown
Leaf and rachis pubescence	Glabrous	Glabrous	Slightly pubescent	Glabrous

Table 2. Qualitative characters of nut, shell and kernel characters in different genotypes of walnut

Character	Genotypes			
	G_1	G_2	G_3	G_4
Nut shape	Broad ovate	Broad-ovate	Broad-ovate	Broad elliptic
Shell texture	Rough	Medium	Medium-rough	Medium
Shell colour	Light	Medium	Light- medium	Medium-dark
Shell seal	Strong	Weak-intermediate	Strong	Strong
Shell strength	Strong	Weak-intermediate	Strong	Strong
Shell integrity	Complete shell no holes	Complete shell no holes	Complete shell no holes	Complete shell no holes
Kernel flavour	Satisfactory	Satisfactory	Satisfactory	Satisfactory
Kernel fill	Well	Well	Moderate-well	Well
Kernel plumpness	Moderate	Moderate	Moderate	Moderate
Ease of removal of kernel halves	Easy	Very easy-easy	Easy	Easy
Kernel colour	Extra light	Light	Light-amber	Light

Table 3. Quantitative traits of leaf, nut, shell and kernel characters in different genotypes of walnut

Character	Genotypes				Total		F	Sig.
	G_1	G_2	G_3	G_4	Mean	SE		
Leaf length (cm)	32.50 c	49.00 a	38.33 b	48.50 a	42.40	2.32	28.467	0.001
Leaf width (cm)	26.50 b	27.00 ab	29.00 a	27.50 ab	27.60	0.54	1.106	0.417
Number of leaflets	7.00 a	5.00 b	8.33 a	7.00 a	6.80	0.47	12.700	0.005
Nut diameter (mm)	49.50 a	45.33 b	48.67 a	49.50 a	48.00	0.70	5.135	0.043
Nut length (mm)	55.50 a	48.67 b	55.00 a	56.00 a	53.40	1.26	4.306	0.061
Shell thickness (mm)	4.00 ab	3.33 b	3.30 b	5.00 a	3.80	0.25	6.400	0.027
Kernel percentage (%)	32.39 a	42.37 a	37.62 ab	34.32 ab	37.32	1.62	3.172	0.106

*Different small letters reflects significant differences according to the Duncan Multiple Range Test at the level of significance, *P*=0.05.

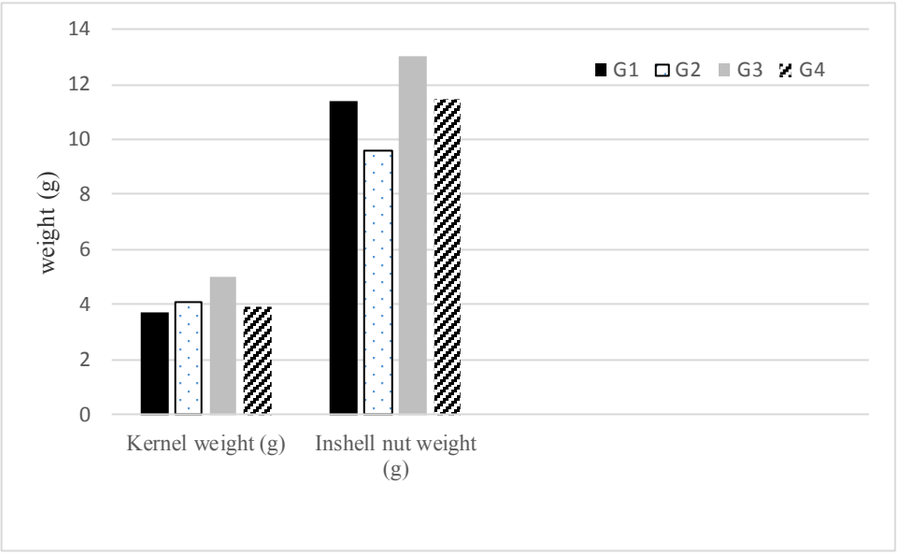

Figure 1. Kernel weight and inshell nut weight in different genotypes of walnut

Conclusion

The present study indicated that the genotypes exhibited variability in the leaf, shoot, nut, shell and kernel characters. The genotypes G2, G3 and G4 are supreme in several characters in the present findings. These can be used for various crop improvement programmes.

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