Variability studies in walnut (*Juglans regia* L) genotypes for different horticultural traits

SAMRITA SHARMA, RK DOGRA, DP SHARMA and KAPIL KALSI

Department of Fruit Science, Dr YS Parmar University of Horticulture and Forestry Nauni, Solan 173230 Himachal Pradesh, India
Email for correspondence: dogra_rk@rediffmail.com

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ABSTRACT

The present investigations were carried out at the experimental farm of Department of Fruit Science, Dr YS Parmar University of Horticulture and Forestry, Himachal Pradesh during 2015-2017 to study the variability in different walnut genotypes. Analysis of variance showed significant differences among all the genotypes for the plant growth, flowering, yield and nut characteristics. The genotype Wilson Wonder recorded highest yield and performed better for other important horticultural traits among other studied genotypes viz Hartley, Kainthal Selection, Kashmir Budded, Kinnaur Selection, Montignac, Pieral Lara, Shimla Selection, Sirmour Selection and Solan Selection. Kainthal Selection was found to be the earliest and Montignac was latest for flowering. Therefore Wilson Wonder and Kainthal Selection can be future candidate genotypes for commercialization under mid-hills of northwestern Himalayas.

Keywords: Walnut; genotype; variability; horticultural traits; yield

INTRODUCTION

Persian walnut (*Juglans regia* L) is a nut crop that belongs to family Juglandaceae. The genus *Juglans* contains twenty species producing edible nuts and is characterized by a monoecious and heterodichogamous habit. It is also commonly known as Carpathian walnut or English walnut. It is a highly nutritious nut crop and is a good source of carbohydrates, protein and minerals. It is native to Iran. It is cultivated mainly in the northern hemisphere between 30º to 50º of latitude and at an altitude of 1200-2150 meter amsl. Its chilling requirement ranges from 700 to 1500 hours and well distributed rainfall of about 80-90 cm is sufficient for its cultivation. It can tolerate as low as -11ºC during deep dormancy without serious damage. The temperature even 2 or 3ºC below freezing point (0ºC) kills leaves, shoots and flowers thus resulting in crop failure. High temperature more than 38ºC causes sun burning of hulls and shrivelling of kernels resulting in blank nuts. In India it is commercially grown in Jammu and Kashmir which is ranked first in production followed by Uttarakhand and Himachal Pradesh. Testing of the available varieties for suitability and adaptability with respect to different horticultural traits is of prime importance. The present study was undertaken to assess the variability among walnut genotypes. It is the variation which if heritable could be used for crop improvement as varieties are the backbone of any orchard system. Therefore prior to recommendation of new cultivars they should be tested and extent of variability present in them must be adequately assessed so that they perform consistently over a long period of time.

MATERIAL and METHODS

The present investigations were carried out at the experimental farm of Department of Fruit Science, Dr YS Parmar University of Horticulture and Forestry, Nauni, Solan, Himachal Pradesh located at 30° 51´ North latitude and 77° 88´ East longitude for two consecutive years 2015-2016 and 2016-2017. The location is 1320 m amsl and climate of the area is typically sub-temperate. The experimental material consisted of ten walnut genotypes viz Hartley, Kainthal Selection, Kashmir Budded, Kinnaur Selection, Montignac, Pieral Lara, Shimla Selection, Sirmour

Selection, Solan Selection and Wilson Wonder. Three uniform trees of each genotype were taken for recording the observations. Comprehensive observations on various plant growth, flowering, fruiting, nut and kernel characters were recorded as per the IPGRI descriptors (Anon 1994).

The plant growth, flowering, yield and nut characteristics such as tree height, tree spread, tree volume, trunk girth, trunk cross sectional area, shoot length, time and duration of male flowering, time and duration of female flowering, flower density, fruit set, fruit yield, nut weight, nut length, nut width, shell thickness, kernel weight, kernel width and kernel percentage were observed by using standard methods. The two year data were pooled and subjected to the analysis of various traits as described by Gomez and Gomez (1983). The variability parameters were calculated as per the methods suggested by Burton and DeVane (1953) and Johnson et al (1955).

RESULTS and DISCUSSION

Plant growth characteristics

The basic requirement of any breeding programme is the variability found within the members of the population. In the present study the walnut genotypes differed significantly for plant growth characteristics (Table 1). Shimla selection registered highest tree height value (6.50 m) which was statistically at par with Sirmour Selection (6.40 m), Wilson Wonder (6.10 m) and Kinnaur Selection (5.50 m) while Kashmir Budded observed lowest (3.60 m) tree height. The maximum tree spread was observed for Shimla Selection (4.72 m) followed by Wilson Wonder (4.60 m) and Sirmour Selection (4.53) while minimum tree spread (2.88 m) was observed for Kashmir Budded. Shimla Selection (73.83 m^3) recorded maximum tree volume which was statistically at par with Sirmour Selection (69.63 m^3) while Kashmir Budded (15.95 m^3) recorded the minimum. The maximum trunk girth was recorded for Sirmour Selection (71.90 cm) followed by Solan Selection (68.28 cm) and minimum (27.95 cm) for Kashmir Budded. Maximum increment in trunk girth was registered in Kashmir Budded (11.57%) and minimum in Montignac (2.73%). Sirmour Selection (0.41 m^2) observed maximum trunk cross sectional area followed by Solan Selection (0.37 m^2) and in Kashmir Budded it was minimum (0.06 m^2). The maximum shoot length was registered for Sirmour Selection (14.73 cm) which was statistically at par with Kinnaur Selection (14.38 cm) and minimum for Solan Selection (10.05 cm). These observations on plant growth characteristics suggested that there were significant variations in various plant growth characteristics. The observations for plant growth characteristics in the present study are in accordance with the findings of Mosivand et al (2013), Attar et al (2014) and Ojaghloo et al (2014).

Flowering characteristics

The observations recorded in Table 2 indicate that there were significant variations among genotypes for time and duration of male and female flowering. During both the years the male flowering initiation was earliest in 1st week of March in Kainthal Selection and latest in Montignac in the 2nd week of April. Whereas the female flowering initiation was earliest in 4th week of March in Kainthal Selection and latest in Montignac in the 3rd week of April during both the years. The variation in time of flowering may be due to the difference in chilling hour requirement to break bud dormancy in various genotypes. The observations for flowering time in the present study are in consonance with the findings of Botu et al (2010), Cosmulescu et al (2010) and Cosmulescu and Botu (2012). The duration of flowering was found to be significantly different in studied genotypes. The duration of male flowering registered short period of 10.50 days (Sirmour Selection) and longest period of 18.00 days (Kainthal Selection and Solan Selection). The duration of female flowering registered short period of 12.00 days (Hartley and Kinnaur Selection) and longest period of 17.50 days (Montignac and Pieral Lara) (Table 2). These results are in accordance with the results recorded by Sharma and Sharma (2004). Flower density was observed maximum (0.46) in genotype Wilson Wonder followed by Pieral Lara (0.42) and minimum (0.20) in Kainthal Selection. The results obtained for flower density are in line with the findings of Hassani et al (2006).

Yield characteristics

In the present study there were significant variations observed in yield characteristics (Table 3). The yield is the main objective in any crop improvement programme and is a complex character and polygenically-controlled. Yield is dependent on many parameters important being age of the tree, trunk girth, flower density, fruit set etc. The maximum fruit set value was observed for Pieral Lara (76.10%) followed by Wilson Wonder (74.00%) and minimum for Kinnaur Selection (50.90%). Wilson Wonder (6.00 kg) registered maximum whereas Kashmir Budded (1.80 kg) the minimum yield. The observations for yield

Table 1. Plant growth characteristics of different walnut genotypes

Genotype	Tree height (m)			Tree spread (m)			Tree volume (m^3)		
	2016	2017	Pooled	2016	2017	Pooled	2016	2017	Pooled
Hartley	3.70	3.90	3.80	3.90	4.03	3.97	28.17	32.50	30.33
Kainthal Selection	3.90	4.10	4.00	3.33	3.53	3.43	22.67	26.97	24.82
Kashmir Budded	3.50	3.70	3.60	2.77	3.00	2.88	14.33	17.57	15.95
Kinnaur Selection	5.30	5.60	5.50	3.80	4.05	3.93	40.47	48.57	44.52
Montignac	4.90	5.10	5.00	3.77	4.23	4.00	38.67	50.57	44.62
Pieral Lara	4.40	4.60	4.50	3.93	4.10	4.02	35.69	40.56	38.12
Shimla Selection	6.30	6.60	6.50	4.57	4.87	4.72	69.35	78.30	73.83
Sirmour Selection	6.30	6.50	6.40	4.33	4.73	4.53	62.83	76.43	69.63
Solan Selection	5.10	5.30	5.20	3.97	4.17	4.07	42.28	49.75	46.02
Wilson Wonder	5.80	6.30	6.10	4.30	4.90	4.60	56.95	68.17	62.56
$CD_{0.05}$	0.95	0.97	1.68	0.59	0.61	0.57	9.13	7.97	7.73

Table 1. contd.....

Genotype	Trunk girth (cm)				Trunk cross sectional area (m^2)			Shoot length (cm)		
	2016	2017	Pooled	Increment (%)	2016	2017	Pooled	2016	2017	Pooled
Hartley	46.50	48.07	47.28	3.44	0.17	0.18	0.18	11.15	10.75	10.95
Kainthal Selection	40.43	42.07	41.25	4.03	0.13	0.14	0.13	10.68	11.27	10.98
Kashmir Budded	26.47	29.43	27.95	11.57	0.06	0.07	0.06	11.83	12.05	11.94
Kinnaur Selection	46.17	47.83	47.00	3.64	0.17	0.18	0.17	14.27	14.50	14.38
Montignac	48.17	49.47	48.82	2.73	0.18	0.19	0.19	12.13	12.53	12.33
Pieral Lara	49.67	52.67	51.17	5.99	0.19	0.22	0.21	10.77	11.07	10.92
Shimla Selection	46.17	49.53	47.85	7.23	0.17	0.19	0.18	12.17	12.20	12.18
Sirmour Selection	70.10	73.70	71.90	5.18	0.39	0.43	0.41	14.80	14.67	14.73
Solan Selection	66.90	69.67	68.28	4.05	0.35	0.38	0.37	10.23	9.87	10.05
Wilson Wonder	58.00	61.87	59.93	6.63	0.27	0.30	0.28	11.27	11.50	11.39
$CD_{0.05}$	7.02	7.45	7.20	3.52	0.06	0.07	0.06	1.67	1.55	1.40

Table 2. Flowering characteristics of different walnut genotypes

Genotype	Time and duration of male flowering								
	Opening time		Peak time		End of flowering		Duration (days)		Pooled
	2016	2017	2016	2017	2016	2017	2016	2017	
Hartley	4.04	10.04	15.04	16.04	19.04	21.04	16.00	12.00	14.00
Kainthal Selection	6.03	15.03	16.03	24.03	23.03	1.04	18.00	18.00	18.00
Kashmir Budded	24.03	26.03	6.04	2.04	10.04	6.04	18.00	12.00	15.00
Kinnaur Selection	3.04	31.03	15.04	3.04	18.04	10.04	16.00	11.00	13.50
Montignac	14.04	15.04	22.04	20.04	30.04	27.04	17.00	13.00	15.00
Pieral Lara	1.04	3.04	10.04	11.04	15.04	18.04	15.00	16.00	15.50
Shimla Selection	18.03	17.03	30.03	26.03	3.04	2.04	17.00	17.00	17.00
Sirmour Selection	23.03	26.03	29.03	31.03	2.04	4.04	11.00	10.00	10.50
Solan Selection	17.03	16.03	28.03	27.03	3.04	2.04	18.00	18.00	18.00
Wilson Wonder	27.03	27.03	5.04	4.04	10.04	12.04	15.00	17.00	16.00
$CD_{0.05}$							2.94	2.48	1.92

Table 2. contd.....

Genotype	Time and duration of female flowering									Flower density (%)		
	Opening time		Peak time		End of flowering		Duration (days)			2016	2017	Pooled
	2016	2017	2016	2017	2016	2017	2016	2017	Pooled			
Hartley	14.04	13.04	19.04	17.04	0.27	0.27	0.27	12.00	12.00	0.27	0.26	0.26
Kainthal Selection	27.03	25.03	3.04	2.04	0.18	0.18	0.18	17.00	15.50	0.18	0.22	0.20
Kashmir Budded	5.04	3.04	13.04	11.04	0.23	0.23	0.23	14.00	13.50	0.23	0.28	0.25
Kinnaur Selection	12.04	10.04	16.04	16.04	0.28	0.28	0.28	12.00	12.00	0.28	0.27	0.28
Montignac	21.04	19.04	2.05	28.04	0.24	0.24	0.24	17.00	17.50	0.24	0.25	0.25
Pieral Lara	8.04	12.04	20.04	25.04	0.42	0.42	0.42	18.00	17.50	0.42	0.41	0.42
Shimla Selection	9.04	5.04	14.04	13.04	0.22	0.22	0.22	15.00	14.50	0.22	0.26	0.24
Sirmour Selection	29.03	1.04	5.04	7.04	0.34	0.34	0.34	13.00	12.50	0.34	0.33	0.34
Solan Selection	31.03	30.03	5.04	6.04	0.32	0.32	0.32	16.00	14.00	0.32	0.30	0.31
Wilson Wonder	30.03	3.04	8.04	9.04	0.43	0.43	0.43	13.00	13.50	0.43	0.48	0.46
$CD_{0.05}$	2.64	2.07	1.94	0.08	0.07	0.06						

Table 3. Yield characteristics of different walnut genotypes

Genotype	Fruit set (%)			Fruit yield (kg/tree)		
	2016	2017	Pooled	2015	2016	Pooled
Hartley	52.90	54.80	53.80	2.20	2.50	2.40
Kainthal Selection	64.00	65.20	64.60	1.70	2.30	2.00
Kashmir Budded	51.60	53.50	52.50	1.50	2.10	1.80
Kinnaur Selection	50.50	51.40	50.90	3.10	3.60	3.40
Montignac	52.10	57.50	54.80	1.80	2.30	2.00
Pieral Lara	74.30	77.80	76.10	4.30	4.80	4.50
Shimla Selection	60.20	60.50	60.30	1.90	2.30	2.10
Sirmour Selection	71.50	72.10	71.80	4.00	4.20	4.10
Solan Selection	66.90	69.90	68.40	3.60	4.20	3.90
Wilson Wonder	72.20	75.80	74.00	5.90	6.10	6.00
$CD_{0.05}$	10.97	7.85	8.80	0.60	0.65	0.61

characteristics in the present study are in conformity with the findings of Kong et al (2008), Attar et al (2014) and Ojaghloo et al (2014).

Nut and kernel characteristics

The observations on nut and kernel characteristics are presented in Table 4a and 4b which reveal significant variations among various characters under study. The maximum nut weight was recorded for Shimla Selection (13.10 g) followed by Kainthal Selection (12.80 g) and minimum for Montignac (7.20 g). Wilson Wonder (43.33 mm) registered maximum nut length which was statistically at par with Sirmour Selection (40.03 mm) and Kashmir Budded (30.71 mm) obtained the minimum. The maximum nut width was obtained for Kainthal Selection (36.33 mm) which was statistically at par with Shimla Selection (34.35 mm) and it was minimum for Solan Selection (27.98 mm). Hartley (1.88 mm) recorded maximum shell thickness followed by Wilson Wonder (1.76 mm) and Kashmir Budded (1.50 mm) observed the minimum. Maximum kernel weight was registered in Shimla Selection (6.30 g) which was statistically at par with Kainthal Selection (5.90 g) and was minimum in Montignac (3.38 g). The kernel width was maximum (28.20 mm) in Kainthal Selection followed by Shimla Selection (27.58 mm) and Kinnaur Selection (26.39 mm) whereas minimum kernel width (19.14 mm) was observed in Hartley. Pieral Lara (49.87%) registered maximum kernel percentage value followed by Kashmir Budded (49.48%) whereas Hartley (40.63 %) recorded minimum value. The present results are in consonance with the findings of

Table 4a. Nut characteristics of different walnut genotypes

Genotype	Nut weight (g)			Nut length (mm)			Nut width (mm)			Shell thickness (mm)		
	2015	2016	Pooled	2015	2016	Pooled	2015	2016	Pooled	2015	2016	Pooled
Hartley	9.20	9.30	9.30	32.57	33.17	32.87	29.70	29.87	29.78	1.92	1.85	1.88
Kainthal Selection	12.80	12.70	12.80	37.89	38.03	37.96	36.22	36.43	36.33	1.62	1.64	1.63
Kashmir Budded	7.70	7.30	7.50	30.68	30.73	30.71	28.00	28.70	28.35	1.52	1.49	1.50
Kinnaur Selection	10.50	10.70	10.60	37.43	37.90	37.67	32.73	32.93	32.83	1.68	1.70	1.69
Montignac	7.00	7.30	7.20	31.75	31.95	31.85	31.40	31.58	31.49	1.64	1.61	1.62
Pieral Lara	9.20	9.50	9.40	30.78	30.87	30.82	31.70	31.97	31.83	1.59	1.55	1.57
Shimla Selection	13.00	13.20	13.10	36.65	36.90	36.78	34.33	34.37	34.35	1.60	1.65	1.63
Sirmour Selection	9.70	9.90	9.80	39.80	40.27	40.03	31.53	31.63	31.58	1.53	1.57	1.55
Solan Selection	8.30	8.50	8.40	31.13	31.27	31.20	27.77	28.20	27.98	1.55	1.59	1.57
Wilson Wonder	10.20	10.40	10.30	43.28	43.37	43.33	32.20	32.53	32.37	1.81	1.72	1.76
$CD_{0.05}$	1.42	1.64	1.32	4.51	5.69	4.36	5.45	5.65	3.65	0.25	0.28	0.18

Table 4(b). Kernel characteristics of different walnut genotypes

Genotype	Kernel weight (g)			Kernel width (mm)			Kernel percentage		
	2015	2016	Pooled	2015	2016	Pooled	2015	2016	Pooled
Hartley	3.88	3.80	3.84	19.38	18.90	19.14	40.57	40.70	40.63
Kainthal Selection	5.88	5.93	5.90	28.17	28.23	28.20	44.73	44.90	44.82
Kashmir Budded	4.01	3.90	3.95	23.64	23.57	23.61	49.30	49.67	49.48
Kinnaur Selection	4.99	5.31	5.15	26.12	26.67	26.39	43.17	43.11	43.14
Montignac	3.43	3.33	3.38	19.69	19.70	19.70	44.28	44.53	44.41
Pieral Lara	4.37	4.38	4.37	24.23	24.34	24.29	49.73	50.00	49.87
Shimla Selection	6.23	6.37	6.30	27.30	27.87	27.58	41.64	41.57	41.61
Sirmour Selection	4.51	4.96	4.73	19.80	23.23	21.52	45.10	44.23	44.67
Solan Selection	4.36	4.53	4.45	22.86	23.21	23.03	48.00	48.20	48.10
Wilson Wonder	5.01	5.25	5.13	23.18	22.18	22.68	48.62	48.95	48.78
$CD_{0.05}$	0.83	0.95	0.65	3.69	4.46	2.83	5.04	5.09	5.04

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