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RESEARCH ARTICLE

Phenotypic variability in the shape of nuts recorded in the seedling raised walnut (*Juglans regia* L.) population in the Kashmir valley

■ **IMTIYAZ AHMAD LONE**

SUMMARY

The present investigation entitled phenotypic variability in the nut shape in the seedling raised natural population of walnut (*J. regia*) in the Kashmir valley was carried out in order to document the available genetic variability in walnut germplasm and to select elite walnut genotypes possessing superior attributes and quality traits. During the survey, data was recorded on one hundred fifty two (152) walnut trees growing in different areas of Kashmir valley. Remarkable variability was observed in seedling walnut trees for different morphological, nut and kernel characters. Similarly, variations were also reported for other characters *viz.*, tree vigour, growth habit, branching habit, leaflet shape, shoot colour, nut shape, shell texture, shell colour, shell seal, shell strength, shell integrity, kernel shrivel and kernel colour. Studies on nut shape revealed nut shape varied from round to cordate. Majority of the genotypes (56) that represented 36.85 per cent population had round nut shape followed by 36 genotypes (23.69%) that had ovate nut shape; 8 genotypes (5.27%) had triangular nut shape; 10 genotypes (6.58%) had broad ovate nut shape; 7 genotypes (4.60%) had short trapezoid nut shape, 3 genotypes (1.97%) had long trapezoid nut shape, 16 genotypes (10.52%) had broad elliptic nut shape and the remaining 13 genotypes (8.55%) had elliptic nut shape.

Key Words : Walnut, Variability, Nut shape

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The Persian walnut (*Juglans regia* L.), known as the English walnut, belongs to the family Juglandaceae. English walnut has its origin in the eastern Europe, Asia minor and points eastward to Himalayan mountains. The native habitat of walnut extends from the Carpathian mountains to Europe across Turkey, Iraq, Afghanistan, South Russia and further eastward into the foot hills of the Himalayas. In India walnuts are usually grown in the mid hill areas of Jammu and Kashmir, Himachal Pradesh, and upper hills of Uttarakhand and Arunachal Pradesh. The soil most suitable for its cultivation should be well-drained and deep

AUTHOR FOR CORRESPONDENCE

IMTIYAZ AHMAD LONE, Division of Pomology, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, SHALIMAR (J&K) INDIA

silt loamy containing organic matter in abundance. It should not have a fluctuating water level, hard pan and/or sandy sub-soil with alkaline reaction. A soil 2.5 to 3.0 m deep gives best results because the roots can penetrate deep and utilize residual soil moisture during dry spell and also make available sufficient nutrients. Furthermore, availability of sufficient moisture in the leaves can reduce the damage due to sun burning of leaves, shoots and young fruits. Walnut is grown commercially in about 48 countries with an area of 66, 58, 966 hectares. The world walnut production is about 16, 70, 109 MT. The chief walnut producing countries are China (22%), USA (20%), Iran (12%) and Turkey (10%) (Anonymous, 1984 and 2007). India accounts for about 2.0 per cent of the world production. In India, Jammu and Kashmir is leading both in area as well as in production with an area of 82.04 thousand ha and production of 146.78 thousand tonnes. However, the productivity level of 1.79 t ha^{-1} is far below than other countries. Himachal Pradesh has an area of 6.54 thousand ha with a production of 1.24 thousand tonnes and productivity level of 0.19 t ha^{-1}; while Uttarakhand has an area of 19.26 thousand ha with a production of 8.73 thousand tonnes and productivity level of 0.45 t/ha and Arunachal Pradesh has an area of 2285 ha with a production of about 51 tonnes and productivity level of 0.022 t/ha.In the state of Jammu and Kashmir, Anantnag is the leading district both in area as well as production corresponding to an area of 13647 ha and production of 41180 tonnes with a productivity level of 3.01 t ha^{-1}, followed by the Kupwara district that covers an area of 8175 ha with 22103 tonnes production and a productivity level of a 2.70 t ha^{-1}. Kulgam ranks 6^{th} in area and 3^{rd} in production in the J&K state and has the highest productivity of 3.52 t ha^{-1}, which is even higher than that of USA. This indicates that the state has the right type of agro-climatic conditions and vast potential to produce export quality walnut and kernels. In Jammu and Kashmir walnut cultivation is mainly based upon conventional methods, with the result all the plantations own their origin to non-descript seedling and therefore, are extremely heterozygous in tree behaviour and quality attributes like nut size, colour and protein contents of kernels (Bhat *et al.*, 1999). The success of any genetic breeding programme depends on the presence of sufficient genetic variability to make effective selection. It is important to assess the relative magnitude of components of genetic variability in order to use such information, together with other selection parameters for improvement of the plant type through adoption of effective, breeding methods (Johnson *et al.*, 1955; Hanson *et al.*, 1956; Williams, 1964; Briggs and Knowles, 1967 and Li *et al*., 1991). Micro propagation studies in walnut are not so well established nor any fool proof protocol is yet developed for efficient and faster multiplication of superior plants. The presence of phenolic compounds and entophytic bacteria are still the main limiting factors for establishing plant micro propagation in walnuts. The use of young vegetal material is the usual technique for *in vitro* set up of walnut (Driver and Kuniyuki, 1984 and Jay-Allemand *et al.*, 1993). Quality in regeneration of *in vitro* plant material is correlated with maintenance of mother plants in the controlled environments, with regular hormone application and proper choice of physiological stage for collecting materials. The correct temperature in growth chambers is essential for a proper regeneration as well for subsequent multiplication (Dolcet-Sanjuan *et al.*, 1993). The addition of PVP to the culture medium as well as the substitution of agar by gelrite are the main factors reported for the control of phenolic compounds.

The current methodology of woody crop rooting by a bietapic process is well documented in walnut (Driver *et al.*, 1984) with the use of IBA. Walnut is hard to propagate through micro propagation. Various attempts have been made using different types of explants, media, culture condition and rooting techniques (Driver and Kuniyuki, 1984). Poor proliferation and rooting rate is one of the main obstacles that limit the micro propagation efficiency in walnut. Intensive and well planned research is needed to develop a perfect protocol for micro propagation for this crop. Genotype plays a major role in vegetative propagation, in particular for micro propagation.

In many cases the propagation ratio can be improved by using a stronger cytokinin or increasing its concentration. However, this can sometimes have detrimental effects in the later stages of micro propagation. Micro propagation studies have also been carried out in some other species of nuts and similar trees like hazelnut (Radojevic *et al.*, 1975; Mele and Messeguer, 1983 and Perez *et al.*, 1983); chestnut (Vieter and Vieiter, 1980) and almond (Mehra and Mehra, 1974). But reports on *in vitro* walnut culture are scarce.

MATERIAL AND METHODS

The present investigation entitled diversity for tree

vigour in the natural population of walnut (*Juglans regia* L.) was carried out during the crop seasons of 2013 and 2014. The studies comprised two clusters of germplasm extending over the main geographical distribution of cultivation in the Jammu and Kashmir state. Genetic variability studies and diversity were estimated in the natural walnut population of Kashmir valley forming two cluster populations. Two standard check cultivars (Sulaiman and Hamdaan) were used for comparison (IPGR).

Cluster-I :

Plant materials in this cluster comprised 75 *in situ* earmarked seedling raised plants that were identified after detailed survey of the areas having large concentration of the crop in the districts of Kupwara and Baramulla.

Cluster-II :

In this cluster plant materials also comprised 75 *in situ* earmarked seedling raised plants that were identified after extensive survey of promising materials in the Pulwama and Shopian districts of South Kashmir and Budgam district of central Kashmir. The data of both the clusters (over 2 years) was pooled together for statistical analyses.

Morphological characters were recorded as per the Standard Descriptor of Walnut recommended by IBPGR.

Nut shape :

The selected nuts were scored as per their shape.

Round	-	1
Triangular	-	2
Broad ovate	-	3
Ovate	-	4
Short trapezoid	-	S 5
Long trapezoid	-	6
Broad elliptic	-	7
Elliptic	-	8
Cordate	-	9

RESULTS AND DISCUSSION

The present investigation comprised one hundred fifty (150) seedling genotypes found growing in various regions of Kashmir valley together with two standard checks (Sulaiman and Hamdan). Most of the seedling trees were indigenous of Kashmir valley. Tremendous variation in configuration of land surface, vegetation aspect, meteorology and soil type was encountered during the study. The geographical variation has resulted in sizeable genetic diversity in walnuts. The seedlings identified and catalogued in this study represent a cross section of walnut germplasm available in Kashmir. An attempt has been made to evaluate this germplasm in respect of various descriptive and Perusal of the Table 1 revealed that nut shape varied from round to cordate. Majority of the genotypes (56) that represented 36.85 per cent population had round nut shape followed by 36 genotypes (23.69%) that had ovate nut shape; 8 genotypes (5.27%) had triangular nut shape; 10 genotypes (6.58%) had broad ovate nut shape; 7 genotypes (4.60%) had short trapezoid nut shape, 3 genotypes (1.97%) had long trapezoid nut shape, 16 genotypes (10.52%) had broad elliptic nut shape and the remaining 13 genotypes (8.55%) had elliptic nut shape.

Long trapezoid and cordate shaped nuts were the least and found only in 3 genotypes (1.97% each). The walnut selection WS-01, WS-02, WS-03, WS-09, WS-12, WS-20, WS-21, WS-23, WS-24, WS-25, WS-30, WS-37, WS-39, WS-40, WS-41, WS-43, WS-45, WS-47, WS-54, WS-55, WS-56, WS-61, WS-65, WS-66, WS-67, WS-68, WS-76, WS-79, WS-85, WS-86, WS-90, WS-91, WS-93, WS-96, WS-99, WS-100, WS-101, WS-106, WS-107, WS-112, WS-115, WS-121, WS-126, WS-129, WS-130, WS-131, WS-133, WS-135, WS-136, WS-138, WS-139, WS-140, WS-142, WS-145, WS-146 and WS-150 had round nut shape; the selections WS-07, WS-52, WS-69, WS-71, WS-88, WS-98, WS-103 and WS-110 had triangular nut shape; the selections WS-04, WS-05, WS-16, WS-17, WS-31, WS-87, WS-111, WS-128, WS-143 and WS-147 had broad ovate nut shape; while the selections WS-08, WS-11, WS-18, WS-22, WS-28, WS-29, WS-32, WS-33, WS-44, WS-48, WS-49, WS-51, WS-53, WS-57, WS-58, WS-62, WS-63, WS-64, WS-70, WS-74, WS-75, WS-78, WS-80, WS-81, WS-82, WS-89, WS-94, WS-105, WS-109, WS-114, WS-124, WS-127, WS-134, WS-137, WS-148 and Sulaiman had ovate nut shape. quantitative characters and measures their diversity. The genotypes WS-36, WS-77, WS-108, WS-119, WS-120, WS-125 and WS-149 had short trapezoid nut shape; while WS-06, WS-46 and WS-141 had long trapezoid shape. Similarly, the genotypes WS-10, WS-13, WS-14, WS-15, WS-26, WS-34, WS-38, WS-42, WS-73, WS-92, WS-95, WS-117, WS-118, WS-122 and WS-123 had broad elliptic nuts, while WS-19, WS-50, WS-59, WS-60, WS-72, WS-83, WS-84, WS-97, WS-102, WS-104,

Table 1 : Diversity for nut shape in the natural population of walnut (*Juglans regia* L.) in the Kashmir valley

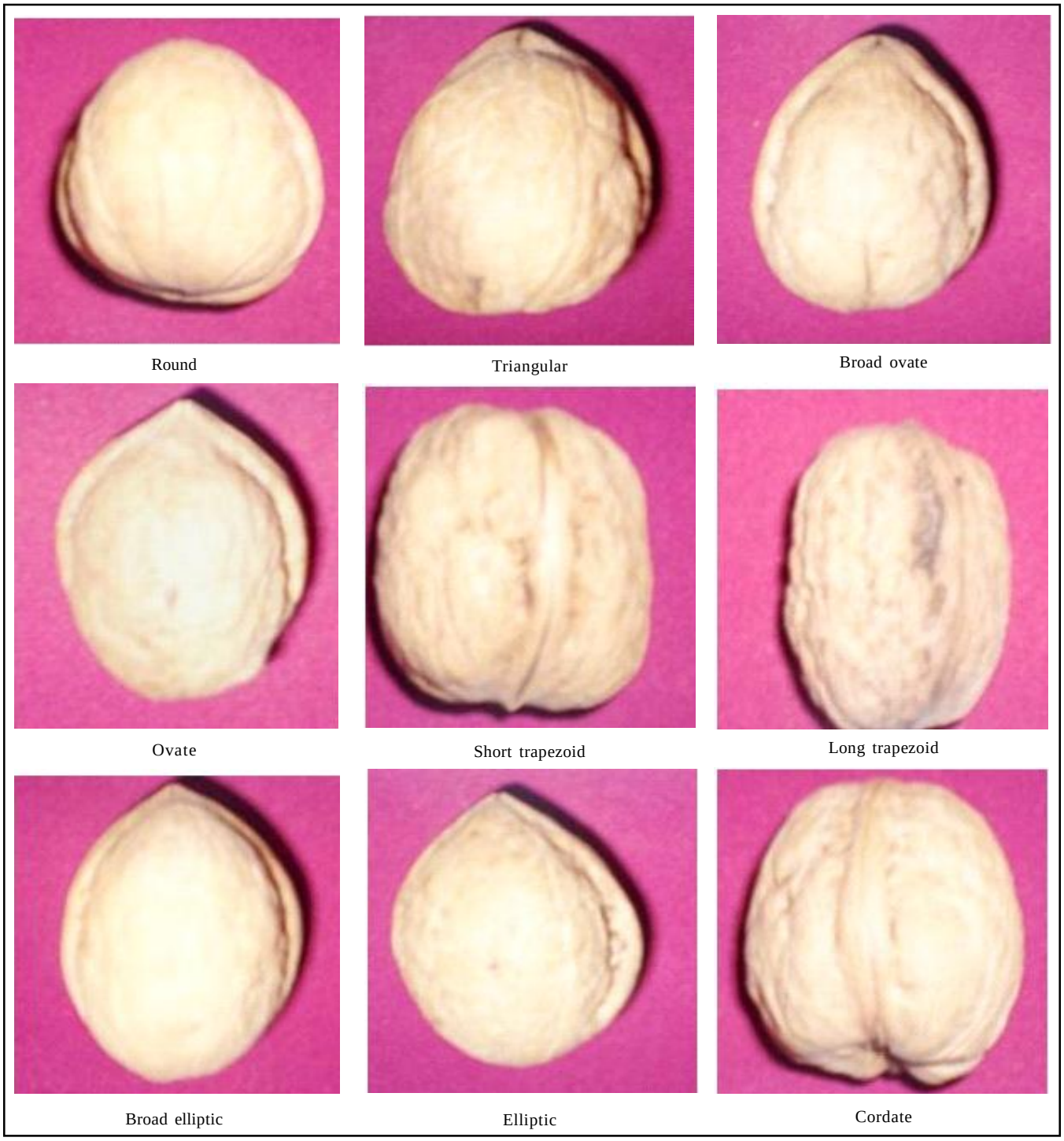
	Score*	Accession numbers	Total	Per cent of the population
Round	1	WS-01, WS-02, WS-03, WS-09, WS-12, WS-20, WS-21, WS-23, WS-24, WS-25, WS-30, WS-37, WS-39, WS-40, WS-41, WS-43, WS-45, WS-47, WS-54, WS-55, WS-56, WS-61, WS-65, WS-66, WS-67, WS-68, WS-76, WS-79, WS-85, WS-86, WS-90, WS-91, WS-93, WS-96, WS-99, WS-100, WS-101, WS-106, WS-107, WS-112, WS-115, WS-121, WS-126, WS-129, WS-130, WS-131, WS-133, WS-135, WS-136, WS-138, WS-139, WS-140, WS-142, WS-145, WS-146 and WS-150	56	36.85
Triangular	2	WS-07, WS-52, WS-69, WS-71, WS-88, WS-98, WS-103 and WS-110	08	5.27
Broad ovate	3	WS-04, WS-05, WS-16, WS-17, WS-31, WS-87, WS-111, WS-128, WS-143 and WS-147	10	6.58
Ovate	4	WS-08, WS-11, WS-18, WS-22, WS-28, WS-29, WS-32, WS-33, WS-44, WS-48, WS-49, WS-51, WS-53, WS-57, WS-58, WS-62, WS-63, WS-64, WS-70, WS-74, WS-75, WS-78, WS-80, WS-81, WS-82, WS-89, WS-94, WS-105, WS-109, WS-114, WS-124, WS-127, WS-134, WS-137, WS-148 and Sulaiman	36	23.69
Short trapezoid	5	WS-36, WS-77, WS-108, WS-119, WS-120, WS-125 and WS-149	07	4.60
Long trapezoid	6	WS-06, WS-46 and WS-141	03	1.97
Broad elliptic	7	WS-10, WS-13, WS-14, WS-15, WS-26, WS-34, WS-38, WS-42, WS-73, WS-92, WS-95, WS-117, WS-118, WS-122, WS-123 and Hamdan	16	10.52
Elliptic	8	WS-19, WS-50, WS-59, WS-60, WS-72, WS-83, WS-84, WS-97, WS-102, WS-104, WS-113, WS-116 and WS-144	13	8.55
Cordate	9	WS-27, WS-35 and WS-132	03	1.97

*As perthe IBPGR Descriptor for Walnut

WS-113, WS-116, WS-144 and Hamdan had elliptic nuts; and three genotypes *viz.*, WS-27, WS-35 and WS-132 had ordate nut shape.

Conclusion :

The present investigation entitled the Kashmir valley was carried out in the phenotypic variability in the natural population of walnut (*Juglans regia* L.) in the Kashmir valley in order to formed a part of the overall population improvement of walnut crop in the state of Jammu and Kashmir. The investigation was carried out to characterize morphological, phonological, maturity, yield and yield component and qualitative traits in this crop species. The study was carried over a period of 2 years on earmarked *in situ* natural seedling raised trees in different pockets and agro-ecological conditions of Kashmir valley. International Standard Descriptor of IBGPR on walnut was used as guide for characterization of characters, besides recording of quantitative data for estimation of variability and different genetic parameters. Maturity and harvesting of the nuts was completed in about 20-22 weeks after full bloom of pistil late flowers and this period extended from 29th August to 17th September over both the years. The variation in maturity resulted from topographical conditions, attitude, climatic conditions, etc. The seedlings identified and catalogued in this study represent a cross section of walnut germplasm available in Kashmir. An attempt has been made to evaluate this germplasm in respect of various descriptive and Perusal of the Table 1 revealed that nut shape varied from round to cordate. Majority of the genotypes (56) that represented 36.85 per cent population had round nut shape followed by 36 genotypes (23.69%) that had ovate nut shape; 8 genotypes (5.27%) had triangular nut shape; 10 genotypes (6.58%) had broad ovate nut shape; 7 genotypes (4.60%) had short trapezoid nut shape, 3 genotypes (1.97%) had long trapezoid nut shape, 16 genotypes (10.52%) had broad elliptic nut shape and the remaining 13 genotypes (8.55%) had elliptic nut shape. Long trapezoid and cordate shaped nuts were the least and found only in 3 genotypes (1.97% each). The. This variation observed in the nut shape habit could be due to age, soil fertility and environmental conditions. *In situ* seedling raised walnut populations in different agro-climatic conditions of the Kashmir valley revealed that maturity of nuts is governed by the topography, climatic conditions and altitude. Characteristics of the cultivars as per the International Standard Descriptor of walnuts (IBPGR) revealed Shape of the nuts in natural population studied varied from round to cordate. Round nut shape was more frequent (36.85%) followed by ovate (23.69%), broad elliptic (10.52%), elliptic (8.55%), broad ovate (6.58%), triangular (5.27%), short trapezoid (4.60%) and long trapezoid and cordate (1.97each).



Diaz *et al.* (2006) studied genetic variation and genetic x environment interaction in walnuts (inter - and intra - populations) and reported magnificent genetic variability for all the traits. Casal *et al.* (1996) studied the performance of three seed sources of *Juglans regia*, three seed sources of *Juglans nigra* and four *Juglans* commercial hybrids (NG23 x RA, NG38 x RA, NGMB3 x HD and MJ209 x RA) at two planting sites in Galicia (Spain). The performance was monitored over eight consecutive years (starting 1996) for traits *viz.*, height, diameter,shape increment and growth habit (apical dominance, stem form and number of branches). The

Juglans commercial hybrids were most vigorous taxon. Significant differences were found among seed sources within taxa for vigour. The Gondomur site had better plant growth but with no significant differences among taxa. At Cartelos site highly significant differences were found among taxa for plant growth (Nauriyal *et al.*, 1969). Thaper (1969) is of the opinion that at present there are no regular plantations of walnut in our country but in many areas trees are growing in large numbers having lot of variation in their nut and kernel characteristics. There is an urgent need to survey the existing varietal potential and create the valuable germplasm pool for propagation of the superior walnut strains for further distribution and future use in breeding programme (Lal and Singh, 1978). The importance of nut and kernel traits of walnut in the international market has promoted the search for attributes such as nut size, nut thickness, nut colour and its smoothness, shelling percentage and other qualitative traits like kernel colour, fat content and protein percentage. Yarilgac *et al*. (2001) identified some promising walnut types on the basis of their morphological, phenological and pomological traits and created a valuable genetic resources on the basis of the fruit characteristics like nut weight, nut diameter, kernel colour, kernel percentage and shell thickness. Bhat *et al*. (2002) studied the genetic variability in natural seedling originated walnut population of Kashmir valley. Most of the nuts were round in shape, had smooth shell surface, light shell colour, intermediate shell seal and intermediate shell strength with light kernel colour. They observed that the natural walnut population of Kashmir valley has great variability in nut shape, shell strength and kernel colour.

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