International Journal of Forestry and Crop Improvement
Volume **8** | Issue 1 | June, 2017 | 53-57 | ■Visit us : *www.researchjournal.co.in*
e ISSN-2230-9411

RESEARCH ARTICLE

DOI: 10.15740/HAS/IJFCI/8.1/53-57

Diversity for tree vigour in the natural population of walnut (*Juglans regia* L.) in the Kashmir valley

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ABSTRACT : The present investigation entitled diversity for tree vigour in the natural population of walnut (*Juglans regia* L.) 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 tree vigour revealed substantial variability among the seedling raised walnuts genotypes in Kashmir valley. Tree vigour ranged from low to high. Out of 152 genotypes 43 genotypes (28.30%) possessed low tree vigour, 45 genotypes (29.60%) were intermediate and 64 genotypes (42.10%) exhibited high tree vigour.

KEY WORDS : Walnut, Diversity, Tree vigour

HOW TO CITE THIS ARTICLE : Lone, Imtiyaz Ahmad (2017).Diversity for tree vigour in the natural population of walnut (*Juglans regia* L.) in the Kashmir valley. *Internat. J. Forestry & Crop Improv.*, **8** (1) : 53-57, **DOI: 10.15740/HAS/IJFCI/8.1/53-57.**

ARTICLE CHRONICAL : Received : *12.04.2017;* Revised : *08.05.2017;* Accepted : *22.05.2017*

INTRODUCTION

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 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

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16, 70, 109 MT. The chief walnut producing countries are China (22%), USA (20%), Iran (12%) and Turkey (10%) (Anonymous, 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 6th in area and 3rd 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. The variations are dependent on different environmental conditions to whichthe plants are subjected before and after propagation (Chase, 1947; Ibrahim *et al.*, 1978; Awasthi *et al.*, 1982 and Qureshi and Dalal, 1985). Micro propagation studies in walnut are not so well established nor is any full proof protocol 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; 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.

EXPERIMENTAL 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.

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.

Growth rate of seedling trees based on height and stem diameter was recorded and scored as per the descriptor (Anonymous, 1984).

Low	-	3
Intermediate	-	5
High	-	7

EXPERIMENTAL RESULTS AND ANALYSIS

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 quantitative characters and measures their diversity.

Studies on tree vigour revealed substantial variability among the seedling raised walnuts genotypes in Kashmir valley (Table 1). Tree vigour ranged from low to high. Out of 152 genotypes 43 genotypes (28.30%) possessed low tree vigour, 45 genotypes (29.60%) were intermediate and 64 genotypes (42.10%) exhibited high tree vigour. Walnut selections WS-9, WS-23, WS-24, WS-25, WS-26, WS-27, WS-28, WS-29, WS-30, WS-32, WS-33, WS-35, WS-36, WS-37, WS-38, WS-39, WS-40, 148 had low tree vigour; walnut selections WS-08, WS-10, WS-13, WS-15, WS-16, WS-28, WS-31, WS-34, WS-44, WS-49, WS-52, WS-54, WS-57, WS-62, WS-68, WS-71, WS-73, WS-75, WS-76, WS-77, WS-78, WS-79, WS-81, WS-91, WS-92, WS-93, WS-95, WS-98, WS-99, WS-100, WS-101, WS-106, WS-109, WS-110, WS-111, WS-121, WS-122, WS-123, WS-124, WS-134, WS-146, WS-149, WS-150 and Sulaiman were intermediate in tree vigour;

The genotypes in the study exhibited distinct and varied tree growth habits, tree vigour, leaf shape and nut bearing thereby, exhibiting variability for these characters. In the present study 43 genotypes (28.30%) had low tree vigour, 45 genotypes (29.60%) intermediate and 63 genotypes (42.10%) had high tree vigour. In the present study 54 genotypes (35.52%) were erect, another 54 genotypes (35.52%) semi-erect and the remaining 44 genotypes (28.96%) were spreading. This variation observed in the tree vigour and growth habid could be due to age, soil fertility and environmental conditions.

Cultivars of walnut studied by other workers were found to vary tremendously in size and growth habit from erect, upright to spreading and tree vigour ranged from low to high. Similar observations were made by Godeanu and Botu (1997) when they evaluated 16 walnut genotypes from Oltenia (Romania) on the basis of their agro-productive characteristics. Among these genotypes two genotypes were found to be vigorous, six genotypes had intermediate vigour and eight genotypes were found to produce high vigour trees. Solar and Stamper (2006) reported that 'Ramsau' variety had most vigorous growth habit with dense branching habit and majority of genotypes studied over a period of 3 years exhibited semi-errect to semi-spreading growth habit. The exceptions were "Z-62" with markedly erect habit and "C-6/7" with spreading branches.

The Northwestern Himalayan region is one of the richest and most diverse gene pool of the cultivated walnuts. China, Iran and India are extremely rich sub centers of walnut germplasm diversity (Bhat *et al.*, 1992).

The success of any breeding programme depends on the presence of sufficient genetic variability to pursue effective selection. It is necessary to assess the relative magnitude of the existing genetic diversity in order to use such information together with other selection parameters for the improvement of fruit yield and other quality parameters of any fruit crop through adoption of an effective breeding approach (Williams, 1964). The extent of genetic variability indicates the potential of exercising selection of a particular genotype, whereas, heritability (h^2) along with genetic advance (% of mean) are more useful in predicting the resultant effect of selection of the best genotypes. Knowledge of the extent of genetic variation and diversity for fruit phenology, quality, maturity and yield component traits in walnut populations (seedling origin) and subsequent identification of adapted superior genotypes/cultivars as potential donors for yield,

Table 1 : Tree vigour revealed substantial variability among the seedling raised walnuts genotypes

+ '/\]Descriptor*	Score*	Accession number	Total	% of the population
Low	3	WS-09, WS-23, WS-24, WS-25, WS-26, WS-27, WS-29, WS-30, WS-32, WS-33, WS-35, WS-36, WS-37, WS-38, WS-39, WS-40, WS-42, WS-43, WS-45, WS-47, WS-50, WS-56, WS-59, WS-60, WS-65, WS-67, WS-69, WS-83, WS-84, WS-102, WS-103, WS-107, WS-108, WS-118, WS-119, WS-120, WS-131, WS-135, WS-136, WS-140, WS-142, WS-143 and WS-148	43	28.30
Intermediate	5	WS-08, WS-10, WS-13, WS-14, WS-15, WS-16, WS-28, WS-31, WS-34, WS-44, WS-49, WS-52, WS-54, WS-57, WS-62, WS-68, WS-71, WS-73, WS-75, WS-76, WS-77, WS-78, WS-79, WS-81, WS-91, WS-92, WS-93, WS-95, WS-98, WS-99, WS-100, WS-101, WS-106, WS-109, WS-110, WS-111, WS-121, WS-122, WS-123, WS-124, WS-134, WS-146, WS-149, WS-150 and Sulaiman	45	29.60
High	7	WS-01, WS-02, WS-03, WS-04, WS-05, WS-06, WS-07, WS-11, WS-12, WS-17, WS-18, WS-19, WS-20, WS-21, WS-22, WS-41, WS-46, WS-48, WS-51, WS-53, WS-55, WS-58, WS-61, WS-63, WS-64, WS-66, WS-70, WS-72, WS-74, WS-80, WS-82, WS-85, WS-86, WS-87, WS-88, WS-89, WS-90, WS-94, WS-96, WS-97, WS-104, WS-105, WS-112, WS-113, WS-114, WS-115, WS-116, WS-117, WS-125, WS-126, WS-127, WS-128, WS-129, WS-130, WS-132, WS-133, WS-137, WS-138, WS-139, WS-141, WS-144, WS-145, WS-147 and Hamdan	64	42.10

*As per the IBPGR Descriptor for Walnut

quality improvement, nut weight, kernel weight, kernel colour, kernel recovery percentage, extension of harvest period, etc. is therefore, essential. Potent variability is the result of prolonged natural and artificial selection, which is heritable and accumulation of the significant magnitude of variability for economic traits leads to the genetic diversity, which is important for creation of new genetic variability through hybridization and reorganization of new gene constellation.

In the valley of Kashmir the walnut cultivation is concentrated in some important pockets. Though, of course, individual seedling raised plants are scattered throughout the length and breadth of the valley in sub-tropical (Uri, Ramban, Karnah etc.) to temperate conditions (valley basin), growing successfully from 1000 to 2000 m a.m.s.l. Being highly cross-pollinated because of unisexual flowers, each seedling raised plant is therefore, a distinct genotype due to their highly heterozygous nature of genotype. The magnitude of cross pollination together with diversity at allelic level for most of the genes results in formation of new gene groups and constellations in the resultant seed. Thus, tremendous genetic variability is created which on the outer play of environmental conditions produce some excellent genotypes (possessing many desirable traits in a single plant).

Keeping in view the importance of biodiversity of walnut genotypes, it is important to survey these populations and identify superior genotypes for their use in the future breeding programme through *in situ* conservation and subsequent use in the hybridization. The study was accordingly taken up to characterize and catalogue the local gene pool and identify some promising genotypes for future improvement of this fruit crop species. In the present study 150 seedling genotypes growing in and adapted to different areas of the Kashmir valley were evaluated for the Phonological, quantitative and qualitative traits and the results obtained. Mother plants of two checks *viz.,* (Hamdan and Suleiman) growing *in situ* in their original locality and identified in the previous studies were used for comparison. The study of each tagged plant was carried over two years and the observation data pooled for interpretation of the results. Morphological characters were recorded as per the Standard Descriptor of Walnut recommended by IBPGR.

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