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RESEARCH PAPER

Estimation of variability and genetic parameters for nut yield in the seedling raised natural walnut (*Juglans regia* L.) population in the Kashmir valley

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Abstract : The present investigation on estimation of variability and genetic parameters for nut yield (kg tree^{-1}) in the seedling raised natural walnut (*Juglans regia* L.) population 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 were 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. In order to reduce the variation in the nut yield the entire population of the seedling raised walnut trees in the present study were put into different age groups *viz.*, 15-30, 31-50, 51-70 and above 70 years age on the basis of information from the owner and visual estimate (tree girth and canopy).Mean dried nut yield of 20.92 ± 1.95; 31.35 ± 2.35; 42.02 ± 2.67 and 63.24 ± 3.10 kg tree^{-1} was recorded for 15-30, 31-50, 51-70 and above 70 year age groups, respectively. The magnitude of variability recorded was 10.2- 55.5; 19.5-68.0, 30.3-165.5 and 37.5-185.o kg tree^{-1}, respectively.

Key Words : Walnut, Variability, Nut yield

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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 16, 70, 109 MT. The chief walnut producing countries are China (22%), USA (20%), Iran (12%) and Turkey (10%) (Anonymous1984 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; 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()anoyomes984).

Cluster-I:

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

Cluster-II :

In this cluster plant materials also comprised of 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) were pooled together for statistical analyses.

Nut yield :

The nut yield was obtained by taking weight of all the harvested nuts. The nuts were cleaned and all the hulls removed before weighing and then dried to a moisture content of 8-10 per cent. The total nut yield per tree was expressed in kg. The yield/tree was grouped into different age groups to minimize the variation.

RESULTS AND DISCUSSION

The present investigation 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. In order to reduce the variation in the nut yield the entire population of the seedling raised walnut trees in the present study were put into different age groups *viz.*,15-30, 31-50, 51-70 and above 70 years age on the basis of information from the owner and visual estimate (tree girth and canopy). Estimation of nut yield (kg/tree) was worked out for different age groups of trees so as to minimize the variation in yield arising due to age of trees,

Table 1: Estimation of variability and genetic parameters for nut yield (kg tree^{-1}) in the seedling raised natural walnut (*Juglans regia* L.) population in the Kashmir valley (Pooled values over 2 years)

Parameters estimated	Yield (kg tree^{-1}) under different age groups			
	15-30 yr	31-50 yr	51-70 yr	Above 70 yr
Population mean	20.92±1.95	31.35 ±2.35	42.02±2.67	63.24±3.10
Range	10.2- 55.5	19.5-68.0	30.3-165.5	37.5- 185.0
Phenotypic variance (σ^2p)	133.66	146.11	171.98	762.05
Genotypic variance (σ^2g)	65.83	74.87	77.08	396.52
Environmental variance (σ^2e)	67.83	71.24	94.90	365.53
Phenotypic co-efficient of variation (PCV)	55.26 %	38.56 %	31.21 %	43.65 %
Genotypic co-efficient of variation (GCV)	38.78 %	27.60 %	20.89 %	31.48 %
Heritability broad sense (h^2)	49.25 %	51.24 %	51.81 %	52.03 %
Expected genetic gain (% of mean) at 5% selection intensity (k = 2.06)	56.07	40.69	45.70	46.78

vigour, spread, soil condition and management practices etc. Accordingly, the population in the present study was divided into four age groups on the basis of visual observation like stem diameter, canopy spread, vigour etc, together with the information collected from the owners about approximate age of the tree. Estimation of variability parameters for the age group of 15-30 years revealed a population mean of 20.9 kg tree^{-1} and range of 10.2 to 55.5 kg tree^{-1} (Table 1). The maximum yield was recorded in the walnut selection WS-001 (55.5 kg tree^{-1}) and the minimum yield (10.2 kg tree^{-1}) was recorded in the walnut selection WS-20. Estimation of components of variance revealed a phenotypic variance of 133.66, genotypic variance of 65.83 and environmental variance of 67.83. Estimation of phenotypic and genotypic co-efficients of variation were to the extent of 55.26 and 38.78 per cent, respectively, Heritability (broad sense) was 49.25 per cent and the expected genetic gain (% of the mean) was to the extent of 56.07.

Estimation of variability parameters for the age group of 31 to 50 years revealed a population mean of 31.35 kg tree^{-1} with a range of 19.5 to 68.0 kg tree^{-1}. The maximum yield (68kg tree^{-1}) in this group was recorded in the walnut selection WS-13 and the minimum yield (19.5 kg tree^{-1}) was recorded in the walnut selection WS-119. Estimation of components of variance revealed a phenotypic variance of 146.11, genotypic variance of 74.87 and environmental variance 71.24. Estimation of phenotypic and genotypic co-efficients of variation were to the extent of 38.56 and 27.60 per cent, respectively. Heritability (broad sense) was 51.24 per cent and expected genetic gain to the extent of 40.69 (% of the mean). Estimation of the variability parameters for the age group of 51-70 years revealed a population mean of 42.02 kg tree^{-1} with a range of 30.30 to 165.50 kg tree^{-1}. The maximum yield was recorded in the walnut selection WS-139 (165.5 kg tree^{-1}) and the minimum (30.3 kg tree^{-1}) was recorded in the walnut selection WS-008. Estimation of the components of variance revealed a phenotypic variance of 171.98, genotypic variance of 77.08 and the environmental variance of 94.90. Estimation of phenotypic and genotypic co-efficients of variation were to the extent of 31.21 and 20.89 per cent, respectively. Heritability (broad sense) was 51.81 per cent and expected genetic gain was 45.70 per cent of the mean.

Estimation of the variability parameters in the age group of above 70 years revealed a population mean of 63.24 kg tree^{-1} and range of 37.50-180 kg tree^{-1}. The maximum yield (185.0 kg tree^{-1}) was recorded in the walnut selection WS-46 and the minimum (37.5 kg tree^{-1}) was recorded in the walnut selection WS-60. Estimation of the components of variance revealed phenotypic variance of 762.05, genotypic variance of 396.52 and the environmental variance of 365.53. The phenotypic and genotypic co-efficients of variation were 43.65 and 31.48 per cent, respectively. Heritability (broad sense) was 52.03 per cent and expected genetic gain (per cent of the mean) was 46.78. Lal *et al.* (1993) evaluated different cultivars of walnuts and found highest yield of 654 kg tree^{-1}. Ozkan and Cellepe (2001) evaluated some walnut varieties for nut yield over several years. The average yield per year ranged from 40.8 to 129.0 kg tree^{-1}. A positive correlation was found between the yield and vegetative growth. Similar findings regarding the positive correlation between nut yield and age, canopy, vigour etc have been reported (Olez, 1971; Germain, 1990; Ozkan, 1993 and Cellepe, 1996). Kaushal and Sharma (2004) found similar type of variation in Pecan nut yield tree^{-1} due to age, canopy and vigour of the tree and this yield ranged from 0.20 to 22 kg tree^{-1}. Sharma (1991) reported that filberts vary in yield greatly according to the age and vigour of the tree, planting distance, soil cultural practices and many other factors. However, Wertheim (1997) reported that the walnut yield in mature orchards fluctuates from year to year even from the same tree. Lone (2017) studied on estimation of variability and genetic parameters for nut characters in the seedling raised natural walnut population in the Kashmir valley.

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