



ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2023; 12(7): 3620-3623
© 2023 TPI

www.thepharmajournal.com

Received: 17-05-2023

Accepted: 20-06-2023

Megha Raghavan

Department of Horticulture,
College of Agriculture, Kerala
Agricultural University,
Padannakkad, Kerala, India

Ajmal KK

Department of Agronomy,
College of Agriculture, CoA
Kerala Agricultural University
Padannakkad, Kasargod,
Kerala, India

Walnut (*Juglans regia* L.): Morphology and biology for crop diversification

Megha Raghavan and Ajmal KK

Abstract

Walnut (*Juglans regia* L.) a temperate nut crop coming under the family *Juglandaceae* have wide most importance in the diet of people in the past, present and future. Wide variety of study was conducted in walnut till now ranging from phonological to phylogenetic molecular level. Walnuts are rich in protein, fat, carbohydrate and minerals. The storage life of these nuts is longer than that of the other temperate fruits because their fruits are dry and light. Growth habit reflecting with tree trunk, volume and girth are wide variety among the available genotypes and cultivars. The plant being Monoecious in nature starts flowering in the months of April to May. The setting of fruits starts from the last week of May to June and maturing of fruits is over by September to October. Walnuts are dried to remove excess moisture from the shell and kernel. These nuts are of high export value. This review paper gives some primary information about characters of walnut that can be useful for breeding work.

Keywords: Nut, growth, floral character, Kernal, etc.

Introduction

Juglans regia L. commonly named as walnut is one of the oldest food crop among all nut crop. These being cultivated world-wide in temperate areas. It is commonly known as *akhrol* in India, is a native of the North and western parts of Himalayas and is grown in almost all parts of the Himalayan region between an elevation of 1000 to 2200 m above mean sea level. Even though considered as one of the oldest crops, breeding was started in 20th century only. Wide variety of study was conducted in walnut till now ranging from phonological to phylogenetic molecular level character evaluation. The genetic improvement in walnut have succeeded much more than before. This review paper gives some primary information about characters of walnut that can be useful for breeding works. Family in which walnuts belong is *Juglandaceae*. Walnut is grown extensively in France, Italy, Rumania, U.S.A., China and some other adjoining countries in small proportions. India the major walnut growing states are Jammu & Kashmir, hilly areas of Punjab, Himachal Pradesh and Uttar Pradesh. The leading walnut producing state in India is Jammu & Kashmir with 98% of the total walnut production in the country (Chadha, 2009).^[4]

Walnut is exceptionally sensitive to the extremes of summer and winter temperatures as well as to duration of heat or prevailing cold or heat. It requires condition which is free from frost in spring and from extreme summer during growth. Even a low temperature of 2 or 3 degree below freezing point (0 °C) kills leaves, shoots and flowers which results into complete crop failure. High temperature of about 38 °C causes sun burn in walnuts and shrivelling of kernels and even they result in empty kernels. An annual rainfall of about 80 cm is considered an apt condition for the cultivation of walnut which can be grown in drier regions with irrigations, particularly for young plants.

Walnuts are rich in protein, fat, carbohydrate and minerals. The storage life of these nuts is longer than that of the other temperate fruits because their fruits are dry and light. The nuts stand transportation better, hence cultivation of walnut can be taken up in remote and neglected areas of hills where other temperate fruits like apple, pear, and plum cannot be cultivated commercially. A soil rich in organic matter with well-drained and deep sandy loam soil is the most suitable for the cultivation of walnut. Soil depth of 2-3 metres give the best results, because walnut roots penetrate up to a depth of about 3 metres and it requires a soil pH of neutral range i.e. 6 to 7 (Chadha, 2009)^[4]. The nuts are in great demand abroad and thus have a high potential of earning foreign exchange. Presently walnuts are exported to 22 countries fetching nearly Rs. 20 crores as foreign exchange and even more.

Corresponding Author:

Megha Raghavan

Department of Horticulture,
College of Agriculture, Kerala
Agricultural University,
Padannakkad, Kerala, India

Growth

Trunk girth, tree height and tree volume are important characters which reflect the tree strength and yield potential in walnut. Gupta (1999) [8] in his studies on the characterization and evaluation of various indigenous and exotic walnut varieties in Himachal Pradesh reported that only one accession had small trunk girth (31.0 cm), 13 had medium (40-80cm) and 4 had large girth (81.0-97.0 cm) whereas Sharma and Sharma (1997) [25] recorded the trunk girth ranging from 50-497cm among 125 bearing seedling trees of Persian walnut during their studies on variability in walnut selections in Solan district of Himachal Pradesh. While during their studies on the evaluation of walnut cultivars Botu *et al.* (2001) [3] under Romanian condition observed average tree height to range from 3.75 m in cultivar Jupanesti to 5.98m in VL206S, Atefi (1990) [2] studied the correlation between pair characters of more than 250 genotypes of walnuts growing in different productive areas of Iran and concluded that tall cultivars are more productive as yield has a positive correlation with height of the tree.

Leafing out data is a very important character used in the study and descriptor classification of Persian walnuts. Late leafing time is a desired character to avoid the damage from spring frosts. In a French walnut breeding programme about 3450 walnut hybrids were studied by Germain (1990) [7] and 37.2% of these were medium late to very late in leafing and in the progenies resulting from the crosses between French and Californian varieties there were always late leafing trees. Atefi (1990) [2] during their studies on phenological and pomological characters of promising clones of walnut in Iran reported late leafing in the walnut genotypes K144/2, K144/3, K143/7, K114/3 and K135/3.

Some Iranian walnut clones named as Z53 in earliest leafing groups, Serr, Z63 and K72 clones were in the mid leafing group, Z30 and Vina in the late mid group, Hartley and Lara were in very late group in the study of Atefi (1990) [2]. He even concluded that Franquette and Ronde de Montignac were also considered as the late leafing cultivars.

Floral and Fruiting characters

Walnut is a monoecious plant i.e. staminate (male) and pistillate (female) flowers are borne separately on the same tree. Staminate flowers are borne on the previous season's growth and hang in catkins (elongated structures) and pistillate flowers appear in pairs in the form of nutlets in the current season's growth. Walnut trees start flowering from April to May. Fruit bud formation is initiated during summer and the final development occurs shortly before anthesis in the following spring. The setting of fruits starts from the last week of May to June and maturing of fruits is over by September to October (Chadha, 2009) [4].

Rathore (1984) [19] evaluated 22 walnut accessions collected at NBPGR regional station Phagli, Shimla and reported considerable variation with regards to date of male flowering (30 March to 12th April) and female flowering (12th April to 18th May). Riberio da saliva *et al.* (1997) [20] gave reports of early male flowering in cultivars Paynee and Arco on 27th March and late in Franquette on 15th May, the female flowering was recorded first on 3rd April in Chico and last on 28th May in Franquette. Kumar (2000) [11] during his studies on pollination and fruit set in walnut reported highest fruit set (87.50%) in plant No 47 both under natural (open) and self (hand) pollination, fruit retentions was also highest in Plant

No 47 both under natural and self-pollination. Among the cross combinations (Roopa Akhrot × Plant no 46) and (KX Giant × Kandhaghat selection) reported 100% fruit set and retention.

Ozkan and Celep (2001) [15] while investigating some characteristics related to yield of sowalnut cultivars and types grown in Tokat ecological conditions reported protandry in walnut varieties 29/B-4, 170/B-16, 32/B-18 and 198/10. Yarılgç *et al.* (2001) [28] in their studies on some promising walnut selections found eight selections as protandrous, one as protogynous and four selections as homogamous.

Yield

Yield being an important aspect for plant economic analysis, various studies were conducted to increase the productivity. Joolka and Sharma (2006) [10] recorded variation in yield ranging from 5.25-80.73kg in different strains of walnut trees in a study on genetic resources of walnut in some parts of North Western Himalayas. Botu *et al.* (2001) [3] reported that Hartley yielded 1.10kg fruits per tree in the fifth year and varieties Velnita, Ciumesti yielded 0.30. 0.23kg fruits per tree respectively while studying some walnut seedling selections. Paunovic (1990) [17] evaluated 2500 walnut genotypes for yield and other characters out of which genotype T2 was recorded to be highest yielder (196 kg per tree). Sharma (1999) [22] while studying the variability in 229 seedling trees of walnut in Himachal Pradesh recorded, maximum nut yield of 130 kg in Tree No43 from Bharmour district of Chamba while minimum nut yield of 1.5kg in Tree No 7 from Garsa Valley of district Kullu.

Nut and Kernel characters

For the nut and kernel, a high quality is essential in Persian walnuts. The desired nut size is 12-14g and 9-11g for kernels. Nut quality depends upon the colour, shell thickness, kernel percentage, kernel colour and ease of kernel removal. The kernel of walnut which is the edible portion is much rich in protein, fat and minerals and is a high source of energy for consumption. The walnut can be eaten as dry nut or as a dessert or can be added in confectionery or for the oil extraction process. Even the immature fruits of walnut can be used for making pickles, chutneys, marmalades, juice, syrups, jams and biscuits. Oil of walnut is having application in various arenas. It can be used as a healthy alternative of edible oil, oil color for painting works, varnishes or soap making. Even walnut shell flour is used as an ingredient in plastic pillers, battery cases, moulding resin forms, industrial tile and as insecticide spreader. Timber of walnut is used for furniture, carving and making butts of guns (Chadha, 2009) [4].

Nut characters

The natural dehiscence of hull has been considered as the period most suitable for mechanical harvesting. PTB stage is considered as the time of maturity in walnut. Rathore (1984) [19] reported the harvested dates to vary from 11th August in cultivars 'Japan' and 'Orth' to 5th September in cultivars Blackmore, Tutle-16, Tutle-31 and Neilson of walnut during his studies on the evaluation of the genetic resources of walnut in Himachal Pradesh. Ferhatoglu (1993) [5] while describing the characteristics of walnut cultivars obtained through selection reported that the cultivars, Sebin, Bilecik, Yalova3, KR-1, KE-25 are last ones to harvest while Kalpan

86 is the earliest variety to ripen.

The maturity period in newly registered varieties Fernor and Fernette was found to be in late October by Germain 1990 [7] while studying the behaviour of some precious walnut types in France. Sharma and Sharma (1998) [24] studied the variability on 125 seedling trees of walnut in the Jaunaji area of district Solan and reported nut weight ranging from 6.3 to 18.6 grams and shell thickness from 0.07 to 0.5 centimeters. Nine promising walnut strains in Chakarta hills of Uttar Pradesh were studied by Lal and Singh (1978) and in their study average nut weight varied from 5.0 g (Chakarta Lehman Kagzi) to 17.6g (Hanaul Kagzi) whereas shell thickness varied from 0.20 cm (Chakarta Lehman Kagzi) to 0.28 cm (Kuna Kagzi).

A study was conducted by Rana *et al.* (2008) [18] in the Western Himalaya region of India comprising of the states of Jammu & Kashmir, Himachal Pradesh and Uttarakhand to analyse the range and patterns of phenotypic diversity in walnut and in the study the nut weight ranged from 7.1-22.5g, shell thickness varied between 1.0-2.0mm and shell colour varied from quite dark to light tan dusted with white.

Gautam (2000) [6] conducted surveys in four important localities of shimla district chirgaon, Jubbal, Kotkhai and Theog and selected the most promising types, the nut weight and shell thickness in various selected superior selections ranged from 8.2-2.4gram and 1.3-2.8mm respectively. Shell colour of the selected types varied as amber, light amber and dark amber. Sharma and Chauhan (1980) [23] studied variability in 14 seedlings growing at stayanand strokes Horticultural complex, Oachaghat and recorded nut weight to range from 6.73-14.76 grams and shell thickness to range between 0.12-0.35cm respectively.

Kernel characters

Kernel characters are extremely important marketing attributes in view of the fact that in the international market increasing quantities of produce is sold as kernel rather than in shell nut. The main kernel characters include kernel weight, kernel size, and ease of kernel removal. Akca and Sen (1994) [1] studied various selections of walnut in Gurun region of Turkey and recorded variation in kernel weight from 5.77 grams (Type No.16) to 9.41grams (Type No.1), kernel percentage from 46.1 percent (Type No.56) to 64.2 percent (Type No.40) and light-yellow kernel colour varied from 50-100 percent. Kernel characteristics are seen diverse in many types. In Parvati valley in kullu district Singh (1993) [27] studied genetic variability in 102 seedling walnut and observed considerable variation in seedling trees with respect to kernel weight (3.06-8.06g) kernel width (1.6- 22.85 cm), kernel length (1.88- 43 cm), kernel percentage (45-52%).

A survey was conducted in Uttaranchal by Pandey *et al.* (2006) to find out the existing variability amongst the naturalized walnut seedling trees and to identify the superior genotypes with better kernel weight and good kernel percentage. A total of 103 genotypes were collected and evaluated for important nut and kernel characteristics. Based on preliminary evaluation approximately 15 genotypes were identified and compared with exotic and indigenous varieties and found to have better kernel weight and kernel percentage. Highest kernel oil was recording GP/ ANT-133 (78.065) followed by GP/ANT-128 and GP/ANT-156/. Similarly highest kernel protein was recorded in GP/ANT-61 followed by GP/ANT -55. The kernel colour varied from light-to-light

amber.

Mehta *et al.* (2005) [13] conducted a survey in the Himalayan ranges to select superior and promising strains of walnut and assess variability in the seedling trees of Persian walnut. In the promising strains selected by them the kernel weight varied from 3.0-8.0 grams to 48.28% respectively.

Sharma and Sharma (2001) [26] carried out studies on the genetic divergence in seedling trees of Persian walnut for various metric nut and kernel characters in Himachal Pradesh and observed a wide range of variation in nut and kernel characters from different locations. Kernel weight, kernel percentage varied from 1.02-9.16 grams, 11.02-62.50 percent and 6.08-21.67 percent respectively in various walnut trees. Considerable variation for nut and kernel characters was recorded in seedling trees of walnut in Jammu & Kashmir by Sharma and Das (2003) [21] and they reported the kernel weight to vary from 2.60 to 11.50 g among various genotypes of walnut.

Sharma and Sharma (2001c) reported considerable variation in nut and kernel characters during their studies on seedling walnut trees in Garsa and Jogindernagar areas of Himachal Pradesh, the mean kernel weight varied from 1.50 to 7.10 grams, kernel width from 13.79 to 33.77mm, kernel length from 21.94 to 36.31mm and kernel percentage from 12.0 to 62.5 percent.

Mitrovic *et al.* (2007) studied major biological and pomological properties of walnut selections from the region of central and Eastern Serbia and found that the fruits ripen in the third decade of September, the kernel is light coloured or yellow of good or very good taste, with high kernel percentage (45.1-50%). Jookla and Sharma (2005) selected 10 superior strains out of the total population of walnut growing in the Kinnaur district of Himachal Pradesh and reported the kernel weight, length, breadth, kernel percentage varied from 4.33 to 10.33 g, 2.58 to 3.65cm, 2.23 to 3.05cm and 43.29 to 66.26 percent respectively.

Walnuts are dried to remove excess moisture from the shell and kernel. Drying prevents deterioration in kernel quality, makes bleaching efficient and prolongs the storage life. The nuts are dried up to 8% moisture level. The drying of fruits can be done in mild sunlight or by a dehydrating machine at 44.5 °C temperature. They are then gathered and kept in gunny bags in small ventilated rooms free from excessive humidity. Packing cases are used to send produce to distant markets. The boxes are lined with paper on all sides to avoid shaking and breaking of walnuts. The nuts which fall on tile ground with their husk intact should be stored and marketed separately as otherwise they will lower the price of the whole lot.

Reference

1. Akca Y, Sen SM. Studies on selection of walut (*Juglans regia* L.) in Gurun. In: Progress in temperate fruit breeding (eds. H. Schmidt and Kellerhals). Netherland: Kulwer Academic Publishers; c1994. p. 179-181.
2. Atefi J. Preliminary research of Persian Walnut and correlation between pair characters Acta Horticulture, 1990;284:97-104.
3. Botu M, Godeanu I, Baeiu A. Behaviour of some walnut cultivars and selections in the first years after planting. Acta Horticulturae. 2001;544:141-145.
4. Chadha KL. Handbook of Horticulture. Indian Council of Agricultural Research (ICAR), New Delhi; c2009. p. 76-

- 82.
5. Ferhatoglu Y. The characters of walnut cultivars obtained through selection. *Acta Horticulturae*. 1993;311:31-46.
 6. Gautam DR. Selection of Persian walnut (*Juglans regia* L.) Varieties in Shimla district of Himachal Pradesh. *Indian Journal of the plant genetic resources*. 2000;13(3):294-297.
 7. Germain A. Inheritance of late leafing and lateral bud fruitfulness in Walnut (*Juglans regia* L.) Phenotypic correlations among some traits of the trees. *Acta Horticulturae*, 1990;284:125-134.
 8. Gupta SK. Characterization and evaluation of walnut (*Juglans regia* L.) germplasm accessions. MSc Thesis, Dr Y.S Parmar University of Horticulture and forestry, Nauni, solan (H.P), India; c1999.
 9. Jookla NK, Sharma MK. Selection of superior persian walnut (*Juglans regia* L.) strains from a population of seedling origin. *Acta Horticulturae*. 2005;696:75-78.
 10. Joolka NK, Sharms MK. Studies on the genetic resources of walnut (*Juglans regia* L.) in some parts of north western Himalayas. *Haryana Journal of Horticulture Sciences*. 2006;33(1&2):6-8.
 11. Kumar A. Studies on flowering, pollination and fruit set in Persian walnut. M.Sc Thesis Dr. Y.S Parmar University of Horticulture and Forestry, Nauni, Solan (H.P), India. 2000.
 12. Lal H, Singh RD. Some promising walnut strains in Chakarta hills of Uttar Pradesh. *Progressive Horticulture*. 1978;10:61-65.
 13. Mehta K, Sharma OC, Kashyap AS, Thakur BS. Variability for various nut and kernel characters in some promising seedling walnuts (*Juglans regia* L.) in Himachal Pradesh *Acta Horticulturae*. 2005;696:85-89.
 14. Mitrovic M, Miletic M, Rakicevic M, Blagojevic, Glistic I. Biological and pomological properties of some walnut selections from the native population. *Genetika*, 2007;39(1):39-46.
 15. Ozkan Y, Celep C. Investigation of some characteristics related to yield of some walnut cultivars and types (*Juglans regia* L.) grown in Tokat ecological conditions. *Acta Horticulturae*, 2002;544:100-108.
 16. Pandey G, Tripathi AN, Mandal S, Singh Achal. Promising Genotypes of Persian walnut (*Juglans regia* L.) from Uttaranchal. *Indian journal of Horticulture*. 2006;63(3):155-158.
 17. Paunovic SA. The walnut cultivars selected from indiginous population of *Juglans regia* L. in SR Serbia. *Acta Horticulturae*, 1990;284:135-141.
 18. Rana JC, Singh D, Yadav SK, Verma MK, Kumar K, Pradheep K. Genetic diversity collected and observed in Persian Walnut (*Juglans regia* L) in the Western Himalaya region of India. *Plant Genetic resources Newsletter*. 2008;151:63-68.
 19. Rathore DS. Evaluation of genetic resources of walnut. *Advances in genetic resources of temperature fruits*; c1984. p. 47-49.
 20. Ribeiro da silva MJ, Neves N, Crispim JM. Behaviour of some walnut tree (*Juglans regia*) Varieties in 'Regiao Agraria Da Belra Litoral'. *Acta Horticulturae*. 1997;442:209-212.
 21. Sharma AK, Das B. Genetic variation study on nut and kernel characters of walnut seedlings. *Progressive Horticulture*. 2003;35(1):11-13.
 22. Sharma OC. Studies on the variability of superior Persian walnut (*Juglans regia* L.) seedling trees in Himachal Pradesh. Ph.D Thesis Dr YS Parmar University of Horticulture and Forestry, Solan; c1999.
 23. Sharma SD, Chauhan JS. A note on the variability in nut characters of walnut seedlings. *Punjab Horticultural Journal*. 1980;20(1-2):78-79.
 24. Sharma SD, Sharma OC. Studies on variability in nut of seedling walnut in relation to the tree age. *Fruit varieties Journal*. 1998;52(1):20-23.
 25. Sharma SD, Sharma OC. Variability in seedling trees of Persian walnut in Himachal Pradesh, western Himalaya IGPRI Newsletter for Asia, The pacific and Oceania. 1997;23:25-26.
 26. Sharma SD, Sharma OC. Studies on variation in nut and kernel characters and selection of superior walnut seedlings (*Juglans regia*. L) from Garsa and Jogindernagar areas of Himachal Pradesh. *Acta Horticulturae*. 2001;544:47-49.
 27. Singh D. Genetic variability in bearing seedling walnut (*Juglans regia* L.) in kullu valley M.Sc Thesis Dr Y S Parmar University of Horticulture and Forestry, Nauni, Solan (H.P), India; c1993.
 28. Yartilgac T, Koyuncu F, Koyuncu MA. Some promising walnut selections (*Juglans regia* L.). *Acta Horticulturae*, 2001;544:93-95.