



Regd.no.S/1248 dt 31/01/13  
Area of operation-All India

SOUVENIOR

## Walnut & other Nut fruit Growers Association of India

The **Walnut and Other Nut Fruit Growers Association of India (WANGAI)** was registered on 31<sup>st</sup> Jan 2013 having received clearance from Ministry of Agriculture and Cooperation, Government of India & Ministry of Consumer affairs, for the promotion of nuts in the country.

The major emphasis at present is to bring awareness to the farmers about the benefits of walnut and other nut crops in terms of nutrition and income generation and for the ecology. The WANGAI has a strong mandate to bring at least 10000 farmers as their members in next three years of time and will try to solve the major crises of unavailability of planting material of both walnut & other nut crops.

WANGAI is bringing the information and technology from CITH, Srinagar, UHF Nauni and other state universities, NGO's, farmers groups working on research and development of walnut to the walnut growers doorstep. WANGAI has signed a Material Transfer Agreement (MTA) with CITH Srinagar, J & K.

WANGAI is assisting the producers for:

1. Continuity in Plantations
2. Mechanization of product and collect tools
3. Control of the quality and of the environmental impact
4. Communication – for latest technology and development

### Growers / Members

WANGAI has already identified Walnut Growers in Uttarakhand & Himanchal who have shown willingness to grow walnut & take up plantation. In a short span of time about 232 Growers have taken WANGAI Membership.

### Technology Transfer Plantation and Varieties

The advisory panel (technical) of WANGAI is providing assistance in all the production steps, from plantation to the harvest.

### The Plantation

Area identification, selection of farmer, rope in as member in association, soil survey and varieties selection.

The grafted plants from known traditional varieties and focus is on lateral bearing new more productive varieties like Franquittee, Ferner, Lara, Chandler, Tulare, Pyne etc.

### The orchard Management

Help and recommendations in the following process

- Availability of grafted plants
- Production Technology
- Fertilization & Irrigation
- Plant Protection

### Our commitment

- Quality approach
- Following of regulations
- Environment friendly practices
- Training of growers and nurserymen

# NATIONAL SEMINAR

on

## Prospects of Walnut in Himalayan States-Impact on Environment and Sustainable Livelihood

24-25 October, 2013

Organised by



Walnut & other Nut fruit Growers Association of India

in collaboration with



Horticulture Mission for North East And Himalayan States  
Uttarakhand

Village & Post Bayeri, Block Tarikhet, District Almora-263663, Uttarakhand-India  
Regd office: 3/1 Nehru Enclave, Kalkaji Extention, New Delhi - 110019, Tel: 9811107502, 9456544777, Fax: 011-26109651  
Email: [walnutassociation@gmail.com](mailto:walnutassociation@gmail.com) website: [www.wangai.co.in](http://www.wangai.co.in)  
Shri K. C. Pandey, Hon' President (981107502), Dr. N. C. Nainwal, Hon' Gen. Secretary (9971913688)

# NATIONAL SEMINAR

on

## Prospects of Walnut in Himalayan States-Impact on Environment and Sustainable Livelihood

24-25 October, 2013

### Sponsors



National Horticultural Board,  
Govt. of India, Gurgoan



Vivekanand Parvatiya Krishi  
Anusandhan sansthan, Almora  
(Indian Council of Agricultural  
Research)



G. B. Pant Institute of Himalayan Environment  
and Development, Almora (An Autonomous  
Institute of Ministry of Environment and Forests,  
Government of India)

### Supported by



Agriculture & Processed  
Food Export development Authority  
(APEDA) (Ministry of Commerce)



Central Institute of Temperate  
Horticulture (CITH), (Indian Council of  
Agricultural Research)



G. B. Pant University  
of Agriculture & Technology  
Pantnagar



Pepinieres Coulie, Chasteaux,  
France



Javikkala Nursery  
Uttarakhand

Organised by

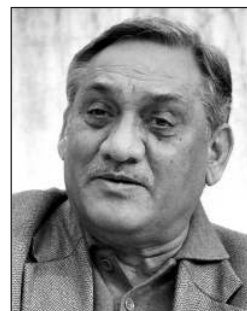


Walnut & other Nut fruit Growers Association of India

in collaboration with



Horticulture Mission for North East And Himalayan States  
Uttarakhand



Shri Vijay Bahuguna  
Chief Minister  
Uttarakhand



उत्तराखण्ड शासन  
Government of Uttarakhand  
Secretariat Annexe  
4, Subhash Road  
Dehradun-248001  
Tel: 0135-2655177  
2650433 (F) 2712827  
E-mail: cm-uk@nic.in



Shri Ashish Bahuguna  
Secretary



Government of India  
Ministry of Agriculture  
Department of Agriculture & Cooperation

## MESSAGE

It is very heartening to know that Walnut And Other Nut Fruit Growers Association of India (WANGAI) in collaboration with HMNEH-Uttarakhand is organizing a two days National Seminar on "Prospects of Walnut in Himalayan State-Impact on Environment and Sustainable Livelihood" from 24 to 25 October, 2013 at G.B Pant Institute of Himalayan Environment and Development Kosi-Katarmal, Almora. As we all are aware that due to global warming, the microclimate is changing fast which is adversely affecting our production base, so there is need to re-look the horticultural scenario in the country in general and Uttarakhand in particular to earmark the areas for different horticulture crops accordingly. Special attention needs to be given to eco-friendly and sustainable management practices for increasing productivity in the changing scenario of shrinking land and water resources. From the last one decade, the production of walnut and other nut cultivation in the country is stable therefore, it is highly imperative to formulate perspective planning to increase the area and production of nut crops especially in Uttarakhand and other Himalayan States.

I hope deliberations of this seminar will help in addressing issues for further development of horticulture especially walnut and other nut crops in the Himalayan States as well as in the country.

I wish the seminar a grand success.

17th Oct. 2013  
New Delhi

VIJAY BAHUGUNA

## MESSAGE

It gives me immense pleasure to learn that Walnut And Other Nut Fruit Growers Association of India (WANGAI) in collaboration with Horticulture Mission for North Eastern & Himalayan States and Government of Uttarakhand, is organizing a National Workshop on "Prospects of Walnut in Himalayan State-Impact on Environment and Sustainable Livelihood" during 24-25, 2013 at G.B Pant Institute of Himalayan Environment and Development, Almora.

In India, an area of 1.57 lakh ha. in the States of Jammu & Kashmir, Himachal Pradesh, Uttarakhand and Arunachal Pradesh, yield approx. 2.8 lakh tones of walnuts. India is major exporter of walnut to countries like Egypt, Germany, France, Netherlands, Spain and UK. There is a growing demand for walnut, both in domestic and international markets. It is expected that all walnut stakeholders will take advantage of the initiatives like NHM, HMNEH, RKVY, NMMI, etc. to improve the production, productivity of walnut.

I compliment the Walnut And Other Nut Fruit Growers Association of India (WANGAI) and the Government of Uttarakhand for organizing this National Workshop for formulating a strategic plan for the promotion of walnut and other nuts in the country and wish them all success in their endeavour.

17th Oct. 2013  
New Delhi

ASHISH BAHUGUNA



Om Prakash, I.A.S.  
Principal Secretary



Principal Secretary (Horticulture),  
Government of Uttarakhand,  
Secretariat, Subhash Road, Dehradun  
0135&2712066

Email: secy-horti-ua@nic.in / om.1962@gmail.com

## MESSAGE

I am happy to learn that Walnut And Other Nut Fruit Growers Association of India (WANGAI) is organizing a National Seminar on Prospects of Walnut Cultivation in Himalayan States - Impact on Environment and Sustainable Livelihood in collaboration with State Horticulture Mission, Uttarakhand on 24-25 October, 2013 at Govind Ballabh Pant Institute of Himalayan Environment and Development, Kosi Katarmal, Almora.

Walnut is very well known for its medicinal and therapeutic properties from the ancient times in India. Uttarakhand is endowed with rich agroclimatic diversity and as such has vast potential for cultivation of various horticulture crops including walnut and other fruit nuts. Uttarakhand happens to be the second largest producer of walnut in the country. Keeping in view the potential for cultivation of walnut in the State, its farming is being promoted under Horticulture Mission scheme.

Organizing this Seminar is, therefore, timely and appropriate and I hope that the deliberations in the Seminar will help in formulating suitable policy regime for promoting the cultivation, marketing and processing of walnut in the country as well as in the State of Uttarakhand.

I wish the Seminar all success.

OM PRAKASH



Ambassador Islam A. Siddiqui  
Chief Agricultural Negotiator  
Office of the U.S. Trade Representative  
Executive Office of the President



Office of the U.S. Trade Representative  
Executive Office of the President  
600 17th St NW, Washington DC 20508

## MESSAGE

I am happy to know that Walnut And Other Nut Fruit Growers Association of India (WANGAI) is organizing a National Seminar on Prospects of Walnut in Himalayan States - Impact on Environment and Sustainable Livelihood, 24-25 October 2013 in Almora, Uttarakhand.

This Seminar is a definite step towards establishing collaborative research programmes and exchange of ideas that will greatly benefit the entire walnut community. A national seminar of this kind with participation from some of the leading specialists will provide the right platform for deliberating on some of the most complex and multidisciplinary topics related to walnut research and development.

Efforts of WANGAI to provide for the participants to exchange views, ideas and experiences for expediting progress and drawing a road-map for future work in this area of walnut production are commendable.

Although I will not be able to attend the event and visit my Matra Bhumi in Uttarakhand due to prior commitments in Washington D.C., I extend my greetings and felicitations to the organizers and the participants and wish the Seminar all success.

20th Oct. 2013  
Washington, D.C.

ISLAM A. SIDDIQUI



Dr. B.S. Negi  
Director,  
Horticulture Mission



Horticulture Mission for North East & Himalayan States  
Department of Horticulture & Food Processing, Uttarakhand  
Government Garden, Circuit House, Dehradun  
@0135 & 2759796 @ 2759799  
Email: missionhortiuk@gmail.com  
Website: www.shm.uk.gov.in



Shri K.C. Pandey



Walnut & other Nut fruit  
Growers Association of India

## MESSAGE

I am delighted to learn that Walnut And Other Nut Fruit Growers Association of India (WANGAI) is organizing a National Seminar on Prospects of Walnut in Himalayan States - Impact on Environment and Sustainable Livelihood in collaboration with State Horticulture Mission, Uttarakhand on 24-25 October, 2013 at Govind Ballabh Pant Institute of Himalayan Environment and Development, Kosi Katarmal, Almora.

In the quest for diversification in Uttarakhand, the fruit sector including walnut and other nuts offers good scope to farmers to take up cultivation of these crops and hence the potential of the State should be capitalized by adopting scientific cultivation and the latest technologies.

Keeping in view its potential for cultivation, walnut has been identified as one of the focused crops under Horticulture Mission. Organizing this Seminar is, therefore, timely and appropriate.

I am sure the Seminar will provide an opportunity to nurserymen, farmers and entrepreneurs of Uttarakhand to better understand the cultivation of walnut & other nuts, so that they could gain from this seminar, besides creating avenues for trade and marketing of their produce.

I wish the Seminar all success.

B.S. NEGI

## MESSAGE

The greatest challenge before the Himalayan states is of ensuring livelihood and livelihood security for all people of working age. Walnut and other nuts are one of the most potentially productive resource, which can provide livelihood to the vast majority of the population in the hills. The promotion of this livelihood will help to retain people through local employment, income generation and to enhance their quality of life in the villages.

Walnut orchards can not only provide full as well as part time employment to family labour but also provide permanent green cover to the soil besides acting as a soil binder preventing soil erosion to a considerable extent. The gross return on walnut comes around Rs. 3, 00, 000 per hectare. This is based on a yield of 1,500 kg. per hectare and farm price of Rs 200 per kg. of walnut in the shell. After deducting the farm expenses assumed to be 40% of the gross return, the net income of the farmer comes to a substantial sum of Rs. 1,80,000 per hectare.

There is a wide scope of walnut based industries like cleaning grading and packaging of nuts grown in the hills for markets in the plains. Keeping this in mind, skills and support for processing and storing the fruits need to be provided along with an initial market support. In fact, it would be prudent to ensure that no walnut and other nut product be allowed to be transported out of the hills in its raw state. It should be go out semi-processed and value added.

Realizing the need for the introduction of new lateral bearing varieties, importance of good quality planting material and latest technology from abroad, WANGAI is motivating stakeholders to take part in this initiative, and recently a collaboration between SANCHAR/JAVIKKALA (Nursery) and one of the best walnut nurseries of the world M/S Pepinieres Coulie of France has been established. Through this collaboration growers will get the necessary information regarding latest varieties, nursery management practices and production technology right at their doorsteps.

I hope the Seminar will stimulate action at all levels. Fusion of political will, professional skill and grower's participation can help us to achieve seemingly difficult tasks. The seminar will serve as the catalyst in bringing about such a fusion.

We are highly indebted to Shri. Ashish Bahuguna, Secretary Agriculture, Ministry of Agriculture & Cooperation who has supported the Seminar on "Prospects of Walnut in Himalayan States-Impact on Environment and Sustainable Livelihood" since inception of the idea. This seminar is very important at the national level, in order to reach a solution for the stability of walnut production and reducing productivity.

I owe sincere gratitude to Shri M K Jain, Additional Secretary Agriculture and Dr Sanjeev Chopra, Joint Secretary Agriculture Govt. of India for their support and cooperation for organizing the Seminar. I sincerely acknowledge the scientific support of an enlightened specialist and top horticulturist Dr. S.K. Melhotra, Horticulture Commissioner, Govt. of India, New Delhi.

I am highly obliged to Shri Alok Jain (IAS), Vice Chancellor, G.B. Pant University of Agriculture and Technology, Pantnagar for his keen interest, guidance and the constant motivation he has given us since the idea of organizing this seminar began taking shape.

I am thankful to Dr. J. C. Bhatt, Director, VPKAS, Almora for his support and cooperation and Dr. P.P. Dhyan, Director, G.B Pant Institute of Environment Development, Kosi, Katarmal for providing the venue and facilities for organizing the Seminar. I thank my teams of WANGAI and HMNEH, Uttarakhand, Himachal Pradesh, Jammu & Kashmir and Arunachal Pradesh and grower members of WANGAI for organizing the seminar successfully.

My sincere thanks and congratulations on the success of this seminar goes to members of the organizing committee Dr. B. S. Negi, Director-HMNEH, Uttarakhand, Dr. N. C. Nainwal, Gen Secretary, WANGAI and Dr. Jagmohan Singh Chauhan, Chief Consultant National Horticulture Board and Advisor WANGAI.

I hope this seminar will not only provide a vision for the future but also a road map for converting the barren and fellow lands of these hills into a thriving cultivation hub of walnut and nuts. This will be a milestone in preserving the environment of this area. The ecological security of the Himalayas is therefore not only essential for the livelihoods of the people but also for the general wellbeing of children, youth and women.

22nd Oct. 2013  
New Delhi

K.C. PANDEY



**Walnut & other Nut fruit  
Growers Association of India**



श्री के. सी. पांडे

## संदेश

हिमालयी राज्यों के सामने सबसे बड़ी चुनौती काम करने वाले उम्र के सभी लोगों के लिए आजीविका एवं आजीविका सुरक्षा सुनिश्चित करना है। अखरोट एवं अन्य गिरीदार फल सर्वाधिक उत्पादक संसाधन हैं, जो पहाड़ियों में अधिकांश जनसमुदाय को आजीविका प्रदान कर सकते हैं। इस आजीविका को बढ़ावा देने से लोगो को स्थानीय रोजगार के जरिए रोके रखने, आय पैदा ध्वंसित करने तथा गांवों में जीवन की गुणवत्ता को बढ़ाने में मदद मिलेगी।

अखरोट के बगीचे परिवार श्रम को न केवल पूर्णकालिक तथा अंशकालिक रोजगार प्रदान करते हैं अपितु, मिट्टी के लिए स्थायी ग्रीन कवर प्रदान करते हैं और काफी हद तक मिट्टी के कटाव को रोकने के लिए मिट्टी बांधने का कार्य भी करते हैं। अखरोट से लगभग 3,00,000 प्रति हेक्टेयर कुल आय होती है। यह 1,500 किलो प्रति हेक्टेयर उपज और खोल, 10मससद्दद्ध में 200 रू0 प्रति किलो पर आधारित है। खेत का खर्च जिसे कुल आय का 40 :माना जाता है, को घटाने के बाद किसान की शुद्ध आय 1,80,000 प्रति हेक्टेयर की पर्याप्त राशि बैठती है।

मैदानी इलाकों के बाजारों के लिए अखरोट आधारित उद्योगों जैसे पहाड़ियों में उगाए गए गिरीदार फलों की सफाई, ग्रेडिंग एवं पैकेजिंग की काफी संभावनाएं हैं। इसे ध्यान में रखते हुए, आरंभिक बाजार के समर्थन के साथ –साथ फलों के प्रसंस्करण (प्रोसेसिंग) एवं भंडारण के लिए कौशल एवं सहयोग प्रदान करने की आवश्यकता है। वास्तव में, यह सुनिश्चित करना विवेकपूर्ण होगा कि किसी भी अखरोट एवं अन्य गिरीदार उत्पाद को कच्ची स्थिति में पहाड़ियों से बाहर जाने की अनुमति न दी जाए। यह अर्द्ध संसाधित तथा मूल्य योजित पर जाना चाहिए।

नई पार्श्व किस्मों, अच्छी गुणवत्ता की रोपण सामग्री तथा विदेश से नवीनतम तकनीक की आवश्यकता को समझते हुए, महत्त्वपूर्ण हितधारकों को इस पहल में भाग लेने के लिए प्रेरित कर रहा है, और हाल में संचार जावीककला (नर्सरी) तथा विश्व की सर्वोत्तम में से एक डै चमचपदपमतमे ब्वनसपम व्थिंदबम के बीच समझौता किया गया है। इस सहयोग से उत्पादक को उनके अपने दरवाजे पर नवीनतम किस्मों, नर्सरी प्रबंधन प्रथाओं तथा उत्पादन तकनीक के बारे में आवश्यक जानकारी प्राप्त करेंगे।

मुझे आशा है कि संगोष्ठी सभी स्तरों पर कार्रवाई को तेज करेगी। राजनैतिक इच्छाशक्ति, व्यावसायिक कौशल तथा उत्पादक की सहभागिता इस प्रतीयमान कठिन कार्यों को प्राप्त करने में हमारी सहायता करेगी। संगोष्ठी ऐसे संलयन (fusion) के लिए उत्प्रेरक के रूप में कार्य करेगा।

हम श्री आशीष बहुगुणा, सचिव कृषि, कृषि एवं सहकारिता मंत्रालय के भी अत्यंत आभारी हैं जिन्होंने विचार उत्पन्न होने के बाद से शहिमालयी राज्यों में अखरोट की संभावनाएं— पर्यावरण पर प्रभाव तथा सतत आजीविका विषय पर संगोष्ठी का समर्थन किया। अखरोट उत्पादन की स्थिरता और कम होती हुई उत्पादकता का समाधान ढूंढने के लिए यह संगोष्ठी राष्ट्रीय स्तर पर बहुत महत्वपूर्ण है।

मैं, गोष्ठी के आयोजन के लिए श्री एम.के.जैन, अपर सचिव कृषि एवं डा0 संजीव चोपड़ा, संयुक्त सचिव कृषि, भारत सरकार को उनके समर्थन और सहयोग के लिए आभार प्रकट करता हूं। मैं प्रबुद्ध विशेषज्ञ एवं शीर्ष बागवानी विशेषज्ञ डा0 एस.के.मेलहौत्रा, बागवानी आयुक्त(कमिश्नर), भारत सरकार, नई दिल्ली द्वारा दी गई वैज्ञानिक सहायता के लिए उन्हें हार्दिक धन्यवाद देता हूं।

मैं, श्री आलोक जैन (आईएएस), कुलपति (वाइस चांसलर), गोविंद बल्लभ पंत कृषि एवं प्रौद्योगिकी विश्वविद्यालय, पंतनगर का भी अत्यंत आभारी हूँ जिन्होंने इस संगोष्ठी को आयोजित करने का विचार बनाने के बाद से इसमें गहरी रुचि दिखाई, हमारा मार्गदर्शन किया तथा निरंतर प्रेरणा दी।

मैं डा० जे.सी.भट्ट, निदेशक, वीपीकेएएस, अल्मोड़ा को उनके द्वारा दिए गए समर्थन एवं सहयोग के लिए तथा डा० पी. पी.ध्यानी, निदेशक, जीबी पंत पर्यावरण विकास संस्थान, कोसी कटारमल को संगोष्ठी के आयोजन के लिए स्थल एवं सुविधाएं प्रदान करने के लिए धन्यवाद देता हूँ। मैं संगोष्ठी के सफलतापूर्वक आयोजन के लिए छल्ल १८ और एचएमएनईएच, उत्तराखंड, हिमाचल प्रदेश, जम्मू एवं कश्मीर तथा अरुणाचल प्रदेश की हमारी टीम तथा छल्ल १८ के उत्पादक सदस्यों का हार्दिक धन्यवाद करता हूँ।

मैं इस संगोष्ठी की सफलता के लिए आयोजक समिति के सदस्य डा० बी. एस. नेगी, निदेशक –एचएमएनईएच, उत्तराखंड, डा० एन.सी.नैनवाल, महासचिव, छल्ल १८ और डा० जगमोहन सिंह चौहान, राष्ट्रीय बागवानी बोर्ड मुख्य सलाहकार, तथा सलाहकार छल्ल १८ को धन्यवाद एवं हार्दिक बधाई देता हूँ।

मुझे आशा है कि यह संगोष्ठी न केवल भविष्य के लिए एक उद्देश्य (विज्ञान) प्रदान करेगी अपितु, इन पहाड़ियों की बंजर और उजाड़ जमीनों को अखरोट एवं गिरीदार फलों की संपन्न खेती के एक हब में परिवर्तित करने के लिए कार्ययोजना (रोड मैप) भी प्रदान करेगी। यह इस क्षेत्र के पर्यावरण को सुरक्षित रखने में एक मील का पत्थर साबित होगी या एक बड़ी उपलब्धि होगी। इसलिए, हिमालय की पारिस्थितिकी सुरक्षा न केवल लोगों की आजीविका के लिए अपितु, बच्चों, युवाओं तथा महिलाओं की सामान्य भलाई के लिए भी आवश्यक है।

22 अक्टूबर 2013  
नई दिल्ली

के. सी. पांडे

## PREFACE



Walnut And Other Nut Fruit Growers Association of India (WANGAI) is the first registered Association of nut growers of its kind in the country, which was the utmost requirement for the promotion of walnut and other nuts. This Association is now becoming a leading Centre for organizing walnut growers, experts, scientists and policy makers for walnut education, training, research and extension in the country. The objectives of the WANGAI are broad to explore the possibility of area expansion for providing nutrition and income to the growers, training of growers, establishment of certified nurseries and promotion of trade of walnut and other nuts in the country.

The Association is playing a pivotal role in ushering the nut revolution. The Association has so far 232 walnut and other nut grower members from Uttarakhand, Himachal Pradesh, Jammu & Kashmir and Arunachal Pradesh which are contributing in country's total walnut production. It is gratifying that the Association is working to address the emerging challenges and issues of walnut and other nuts cultivation and allied industries as the most urgent issue to be taken in present scenario for expansion and promotion in the country.

This seminar is being organised in collaboration with Horticulture Mission for North East & Himalayan States-Uttarakhand sponsored by National Horticulture Board, Ministry of Agriculture, Government of India, which is presided by Dr. Sanjeev Chopra, Joint Secretary-Agriculture & Mission Director Horticulture, Ministry of Agriculture & Cooperation, Government of India, New Delhi whose visionary leadership and precious guidance motivated the organizing committee to take path breaking initiative to undertake the daunting task of organizing this seminar to address the emerging issues of walnut and other nuts among the walnut growers, Government officers and scientific fraternity.

I am delighted at the overwhelming response, the seminar received from various sectors through out the country. Enormous enthusiasm generated by this seminar as evident from huge gathering of growers & stake holders from public and private sectors including 25 invited speakers of national and international fame, about 25 contributed articles from researchers stands a testimony to majestic success of the event. Such symposiums are a vital part of our professional development as they allow interchange and exchange of ideas between growers and scientists from different states and organizations.

In the next two days, there will be an opportunity for all participants to share knowledge and experiences among the present scientific fraternity and enrich themselves with 25 Keynote lectures delivered by renowned experts concerning most outstanding themes on walnut and other nuts of national and international importance. The organizing committee of the symposium took painstaking efforts in scheduling the technical session so as to cover all the domains of walnut and other nuts in today's perspective.

During the seminar, it has been decided to bring out a number of publications such a Souvenir containing the lead lectures, Film on Walnuts and the Website of WANGAI. It earnestly hope that this treasure will prove useful to the students, researchers and professionals working in the field of walnut and other nuts as a detailed compilation covering various thematic areas.

I sincerely acknowledge the support from Ministry of Agriculture & Cooperation Govt. of India, New Delhi. My sincere thanks connected with congratulations on the success of this seminar goes to members of the organizing committee.

I take this opportunity to place on record our sincere and heartfelt gratitude for sponsors and co-sponsors of the seminar who contributed in making the event a grand success. Major assistance came from Government agencies National Horticulture Board, Horticulture Mission for North East & Himalayan States-Uttarakhand, Ministry of Agriculture & Cooperation, and Indian Council of Agricultural Research.

Finally I wish to thank the team of hard working colleagues of WANGAI and HMNEH-Uttarakhand who toiled effortlessly for the successful organization of this seminar. I wish that all the participants will benefit from this great and deep exchange of knowledge and experiences on walnut and other nuts, to let new ideas and projects grow and develop for the benefit of walnut growers.

We rededicate ourselves to take Walnut and other nuts to further heights and work hard to provide leadership in this sector towards becoming top nut producing country in the world.

NAVIN NAINWAL  
(Organizing Secretary)

# Contents

	Page No.
<b>Present Status and Future Strategies for Commercial Production of Walnut in Uttarakhand</b> Dr. B.S. Negi, Dr. Surabhi Pandey & Dr. Ratan Kumar	
<b>Status of Walnut in Himachal Pradesh</b> Dr. I. D. Gupta	
<b>Status of Walnut in Arunachal Pradesh, Govt. of Arunachal Pradesh Department of Horticulture, Chimpu, Itanagar</b> Sh. Mardo Ninu	
<b>Walnut</b> Sh. K.K. Pramanick	
<b>Propagation and quality nursery production of walnut (Juglans regia L.)</b> Sh. J S Chandel	
<b>An overview of Walnut rootstocks, cultivars and propagation in California</b> Sh. Gurreet Brar	
<b>Usefulness of Walnut</b> Dr. DP Sharma and Sh. Kishore Kumar Thakur	
<b>Status of Walnut cultivation in Himachal – Problems and future strategies</b> Sh. B.S. Thakur	
<b>Improving the Efficiency of Walnut Industry In India: Lateral Bearing Varieties and Improved Post Harvest Practices</b> Sh. Navin Chandra Nainwal and Smt. Kanchan Nainwal	
<b>Selection of unique walnut and its cultivation</b> Sh. K.K. Pramanick, Sh. D.K.Kishore, Sh. Y.P. Sharma and Sh. Santosh Watpade	
<b>Present Status and Future Strategies for Walnut Production in India</b> Sh. Nazeer Ahmed, Sh. S.R. Singh, Sh. J.I. Mir and Sh. Abid Mir	
<b>Prospectus of Walnut Growing in Himalayan Region of India and Future Plan of Action</b> Dr Jagmohan Singh and Dr. Rajesh Thakur	
<b>Pest Management in Walnut</b> Dr M C Pandey	
<b>Organic Walnut Cultivation</b> Sh. S.P. Ghulati	
<b>V.S.T Tillers Tractors Ltd (VTTL)</b> Sh. Chandramouli Sharma	



# National Seminar on Prospects of Walnut in Himalayan States-Impact on Environment and Sustainable Livelihood

24-25 October, 2013

## Steering Committee

Dr. Sanjeev Chopra, Joint Secretary, Agriculture & Mission Director Horticulture, National Horticulture Mission	Chairman
Dr. Mathew Prasad, Vice Chancellor, Uttarakhand University of Horticulture & Forestry, Bharsar, Pauri, Uttarakhand	Vice Chairman
Dr. J. Kumar, Dean, Agriculture, G. B. Pant Uni. of Agril. & Tech. Pantnagar, Uttarakhand	Member
Dr R. C. Sharma, Dean, Y.S. Parmar University of Horticulture & Forestry, Nauni, Solan, Himachal Pradesh	Member
Dr. J. C. Bhatt, Director, Vivekananda Parvatiya Krishi Anusandhan Sansthan, (Indian Council of Agricultural Research), Almora	Member
Dr. P. P. Dhyani, Director, G. B. Pant Institute of Himalayan Environment and Development (Ministry of Environment and Forests, Government of India), Kosi-Katarmal, Almora	Member
Shri N. C. Mistry, Additional Managing Director, National Horticulture Board	Member
Dr. Nazir Ahmad, Director, Central Institute of Temperate Horticulture, Srinagar, Jammu & Kashmir	Member
Shri A. S. Rawat, General Manager, APEDA, Govt. of India, New Delhi	Member
Dr. I. A. Khan, Director, Horticulture, Directorate of Horticulture & Food Processing, Ranikhet, Uttarakhand	Member
Shri K. C. Pandey, President, Walnut and Other Nut Fruit Growers Association of India (WANGAI), Bayeri, Ranikhet	Secretary

## Organizing Committee

Dr. B. S. Negi, Director, HMNEH, Dehradun, Uttarakhand	Chairman
Shri K. C. Pandey, President, Walnut and Other Nut Fruit Growers Association of India (WANGAI), Bayeri, Ranikhet	Vice Chairman
Dr. I. D. Gupta, Director, HMNEH, Shimla, Himachal Pradesh	Member
Dr. B. S. Thakur, Associate Director, Horticulture Research Station Masobhra, YSPUHF, Nauni, Solan, H.P.	Member

Dr. Jambo Ratan, Director Horticulture, Itanagar, Arunachal Pradesh,	Member
Shri Gunjan Jain, President Exporters Association of Walnut, J&K	Member
Shri Parikshit Thakur, Joint Secretary, WANGAI, Solan, HP	Member
Er. Krit Kumar, Group Head-SWC, G. B. Pant Institute of Himalayan Environment and Development, Almora	Member
Dr. S. K. Nandi, Group Head. Bio Chemistry, G. B. Pant Institute of Himalayan Environment and Development, Almora	Member
Dr. N. K. Hedau, Senior Scientist, VPKAS, Almora	Member
Dr. Ranjan Joshi, Deputy Director, Horticulture, Bhowali, Nainital	Member
Dr. Ratan Kumar, Deputy Director, HMNEH, Dehradun	Member
Shri Dayalu Ram, District Horticulture Officer, Almora	Member
Dr. Rameshwar Singh, District Horticulture Officer, Nainital	Member
Dr. N. C. Nainwal, Assistant Director, AIHSR, Amity University, Noida, Uttar Pradesh	Organizing Secretary

## Souvenir / Proceedings Publishing Committee

Dr. Jagmohan Singh Chauhan, Former, Vice Chancellor, YSPUHF, Nauni, Solan, HP & Advisor WANGAI	Chairman
Dr. K. K. Pramanick, Head Regl. Station, IARI, Shimla	Member
Dr. J. C. Chandel, Proffessor, YSPUHF, Nauni, Solan	Member
Dr. D. C. Dimri, Professor, Horticulture, G.B.PU.A.T. Pantnagar	Member
Dr. Surabhi Pandey, Coordinator, HMNEH Uttarakhand, Dehradun	Member
Shri V. P. Kukreti, HMNEH Uttarakhand, Dehradun	Member
Dr. N. C. Nainwal, Assistant Director, AIHSR, Amity University Uttar Pradesh, Noida	Convenor

# Present Status and Future Strategies for Commercial Production of Walnut in Uttarakhand

**\*Dr. B.S. Negi, Mission Director, Dr. Surabhi Pandey, Coordinator  
& Dr. Ratan Kumar, Deputy Director**

Horticulture Mission, Uttarakhand

## INTRODUCTION

Walnuts are the oldest tree food known to man, dating back to 7000 B.C. The Romans called walnuts *Juglans regia*, "Jupiter's royal acorn." Early history indicates that English walnuts came from ancient Persia, where they were reserved for royalty. Thus, the walnut is often known as the "Persian Walnut." Walnuts were traded along the Silk Road route between Asia and the Middle East. Caravans carried walnuts too far off lands and eventually through sea trade, spreading the popularity of the walnut around the world. English merchant marines transported the product for trade to ports around the world and they became known as "English Walnuts." England, in fact, never grew walnuts commercially. The outer shell provided a natural protective layer helping to maintain the quality of the nut. Today the nut trade continues to be a well-established, ordered, and structured business, and the California walnut is well known as the top quality walnut for the world.

## ECONOMIC AND MEDICINAL VALUE OF WALNUT

- Walnut (*Juglans regia* L.) is extensively used in traditional systems of medicine for treatment of various ailments. Walnuts are the only nut that contain a significant amount (2.5 grams per ounce) of alpha-linolenic acid (ALA), the plant-based form of omega-3 fatty acid, and also contain fiber (2g) and protein (4g). It is described as an anticancer, antidiabetic, tonic, blood purifier and detoxifier agent.
- Walnut helps lower breast cancer risk.
- Walnuts are great source of Omega-3 fatty acids. It helps improve brain health.
- Brain health dramatically improves by intake of omega-3 fatty acids.
- Omega-3 fatty acids boost bone density in men, prevent heart disease, inflammatory diseases and slow aging process.

## STATUS OF WALNUT CULTIVATION IN UTTARAKHAND:

Uttarakhand is bestowed with wide range of agro climatic conditions, ranging from hot Tarai & Bhabar to cold Snow bound mountains and enjoy an enviable position for growing diversified horticultural crops, i.e. fruits, vegetables, flowers, spices, mushroom, medicinal and aromatic plants, tea and sericulture. The climatic conditions are also favourable for cultivation of various nut fruits including walnut. Shorter winters and more sunshine provides perfect growing and fruiting conditions for the English walnut or Persian walnut (*J. regia*), which is being cultivated for many years in some districts of Uttarakhand both as an ornamental and for local as well as commercial nut production. Walnut tree produces fine-quality nuts only on fertile, well-drained soils of medium-heavy texture. The round-tipped leaflets have smooth margins, and the terminal leaflet is the largest. The leaflets of native North American walnuts are largest toward the centre of the leaf, and have toothed margins. The tree grows 25 to 35 metres with a trunk 2 metre in diameter in 60 years. Besides, annual supply of nuts, it also provides valuable timber for various uses.

Uttarakhand stands second in the production of walnut in India (21.8 thousand MT) after Jammu & Kashmir. In Uttarakhand, walnut is cultivated in all the 11 hilly districts viz. Nainital, Almora, Bageshwar, Pithoragarh and Champawat districts of Kumaon region and Dehradun, Pauri, Tehri, Chamoli, Rudrapur and Uttarkashi districts of Garhwal region. During recent years, State Horticulture Mission has given more thrust on cultivation of walnut in the State.

## EFFORTS MADE FOR PROMOTION OF WALNUT IN UTTARAKHAND

In order to increase the production and productivity of walnut in the State, Department of Horticulture had taken various initiatives in the past few years. Details are as under:

### Establishment of Mother Nurseries & multiplication of Walnut plants in Uttarakhand:

In order to increase the production and productivity of walnut in the State, thrust was given to improve the quality planting material by establishing progeny orchards. In this direction, Department of Horticulture had imported 4,453 numbers of plants of eight varieties of walnut in 2007-08 from France. Most of them were lateral bearing varieties. Details of imported plants are as under:

S No	Varieties	No of Plants
1	Lara	1000
2	Fernor	1000
3	Chandler	860
4	Franquette	345
5	Parisienne	100
6	Fernette	48
7	Meylanaise	100
8	Pronkwit	1000
	Total	4453

These walnut plants were planted in the following State Government Gardens and Nurseries to establish Mother Block and multiply them for large scale distribution among the farmers:

SN	Garden/Nursery	No of Plants Planted
1	Government Garden, Soni, Almora	460
2	Government Garden, Chaubattia, Almora	3653
3	Government Garden, Jarmola, Uttarkashi	100
4	Government Garden, Barotha, Dehradun	240

The performance of these varieties in terms of adaptability, production and productivity is still under observation.

Besides, Mother Blocks of walnut have also been established in Kumaon and Garhwal region in the following Government Gardens by sourcing mother plants of latest varieties of walnut developed by Central Institute of Temperate Horticulture (CITH), Srinagar, J&K.

S. No.	Garden	Varieties								
		W7	W10	W13	W16	W19	W21	W23	W24	Total
1	Government Garden Koti, Chamoli	5	30	5	30	3	2	20	5	100
2	Government Garden, Tehri-Gahrwal	5	5	5	0	2	3	5	0	25
3	Government Garden, Chaubatia, Almora	5	5	5	10	2	3	10	10	50
4	Government Nursery Patan, Champawat	5	-	5	-	3	2	5	5	25
	<b>Total</b>	<b>20</b>	<b>40</b>	<b>20</b>	<b>40</b>	<b>10</b>	<b>10</b>	<b>40</b>	<b>20</b>	<b>200</b>

## 2. AREA EXPANSION PROGRAMME OF WALNUT

Under Horticulture Mission for North East & Himalayan States (HMNEH), there is provision for providing assistance to farmers for development of new fruit orchards including walnut. For this purpose, assistance is provided to farmers @ of 75% of cultivation cost of Rs. 40,000 per ha for normal density planting and Rs. 80,000 per ha for high density planting. The assistance is provided over a period of 3 years in the ratio of 60:20:20. Besides, assistance is also provided for rejuvenation and re-planting of old and senile orchards @ 50% of cost subject to maximum of Rs. 15,000 per ha.

Due to intervention under HMNEH in past one decade, area under walnut has substantially increased. While in 2002-03 area under walnut was 3230 ha, in 2011-12 it had increase to 19,644 ha by registering an increase of more than 5 times. However, the productivity of the walnut is still very low (1.11 MT/ha) in the State, which is a cause of concern. To increase the productivity, it has been decided to supply only grafted plants to the farmers under HMNEH.

## 3. CAPACITY BUILDING AND AWARENESS PROGRAMMES

Under HMNEH, there is provision for raising awareness and also capacity building of various stakeholders including farmers about latest technological advancement in the field of horticulture. In this direction, many workshops and seminars were organized. Training programmes of officials and farmers were organized through State Agriculture / Horticulture Universities and ICAR Institutes, especially through Central Institute of Temperate Horticulture (CITH), Srinagar, J&K. The technology developed by concerned Institutes / Universities for cultivation of walnut is being provided to the farmers through extension brochures. Some of the technical aspects of walnut cultivation are described as under:

### TIPS FOR SUCCESSFUL CULTIVATION OF WALNUT:

#### a) Propagation -

**Cuttings.** Walnuts are difficult to raise from cuttings as rooting is poor.

**Grafting.** Walnut cultivars are propagated by wedge grafting or T-budding on one-year old seedlings of *Juglans nigra* (black walnut) or *J. regia* (common or English walnut).

**Seed.** Fresh seed from which all the green fibrous husk has been removed, is sown 3cm (1¼in) deep in pots, containing well-drained soil or gritty compost. In the following August, seedlings should be ready to T budding using fresh wood or wedge grafts may be made later in the year.

#### b) Cultivation

Walnut is grown in all soils, but prefer well-drained, fertile, moisture-retentive and alkaline loam (a soil that is not very clayey or sandy) soil.

Strong winds and spring frosts can damage foliage and flowers. Therefore, frost pockets and exposed sites to be avoided.

Young trees, less than 3m (10ft) tall are easiest to establish and care must be taken to prevent damage to the tap root, so, pot-bound plants should be avoided.

Light shade is tolerated at the early stages of development but full sunlight is ideal

Walnuts are partially self-fertile – but production is improved through cross-pollination

Trees should be planted in autumn or winter with spacing of 08-10m apart.

Balanced fertiliser to be applied.

Newly-planted trees need to be staked and watered during dry spells in the spring and summer to encourage good establishment. A mulch of well-rotted compost around the base of the tree helps to retain moisture.



Walnut tree



Male flower



Female flower



Fertilized flower

c) **Pruning and Training** - Walnut trees should be grown with a central leader. Alternatively, needs to be pruned to encourage the production of side shoots by removing the leader - This also restricts the size of the tree. The side shoots should be pinched at the fifth or sixth leaf to encourage the tree to bush. Regular pruning is unnecessary but, if required, dead or crossed branches to be removed. Pruning should be undertaken between mid-summer and early autumn as walnuts are prone to 'bleeding' (sap oozing from the pruning cut). Hard pruning is not tolerated.



Fruits

d) **Harvesting, Drying and Storing**- In cooler areas, the nuts may not fully ripen. These can be picked at the green stage but before the outer casing begins to toughen. The nuts develop in a pitted shell surrounded by a fibrous, leathery casing which splits when the nuts ripen in autumn. Nuts can be eaten at this stage but tend to have a rubbery texture. Harvesting walnuts at the later stage when their outer husks have softened and blackened is not recommended as this can taint the flavour of the inner nut. Nuts to be harvested daily as they are very vulnerable to birds and squirrels. Usually it is better to dry them to keep well. Remove all traces of the fibrous casing with a wire brush before storage to prevent mould development. Dry the nuts in a cool oven at no more than 40°C (104°F). Once fully dried, store them in a cool dry place.



Seed

#### e) Management of Insect and Pest

Walnuts are largely pest and disease free but may suffer from the following;

- Grey squirrels can devastate the entire crop. Wrapping the trunk with plastic tree guard that squirrels cannot grip and raising the lower branches to 1.8-2.5m (6-8ft) can deter attack
- Walnut leaf blotch and anthracnose can affect the leaves. Chemical control for these diseases should be followed by spraying suitable fungicide. Collection and disposal of the diseased leaves can break the life cycle of the infection.

### WAY FORWARD:-

1. To bring more area under walnut cultivation in cluster mode in the State by adopting an end-to-end approach involving production, protection, post harvest management, processing and marketing.
2. To enhance the production and productivity of walnut more number of new model nurseries with state of art facilities will be setup in the State.
3. To ensure quality of planting material, all existing nurseries and new nurseries to be setup in the public and private sector will be got accredited through National Horticulture Board and SAUs.
4. To facilitate easy harvesting, dwarf and lateral bearing cultivars will be promoted in the State. The suitable cultivars will be imported for establishment of mother block in the State.
5. To promote new high yielding cultivars of walnut developed by CITH in the state after observing their performance in the field.
6. ICAR Institutes and State Agriculture / Horticulture Universities to take up research work towards conservation of indigenous germplasm of walnut and develop new cultivar through selection.
7. To promote organic cultivation of walnut in the State.

## Status of Walnut in Himachal Pradesh

Dr. I. D. Gupta

Mission Director (HMNEH), Himachal Pradesh, Shimla-2

Walnut (*Juglans regia* L.) is a native to North-West Himalayas and grown at an elevation of 1200 to 2150 Mtrs a.m.s.l in Himachal Pradesh. Persian walnut is the most important temperate nut grown in India. It is mainly grown in Jammu & Kashmir, Himachal Pradesh, Uttar Pradesh, Arunachal Pradesh and other Himalayan States. Walnut is grown in some of the districts of Himachal Pradesh viz. Mandi, Kullu, Shimla, Solan, Sirmour, Kinnaur, Chamba etc. The total area under Walnut in Himachal Pradesh is about 4720 hectare with the production of around 1500 MT annually. As such, the productivity of walnut in the State is around 0.32 MT per ha. In the past, efforts have been made in Himachal Pradesh to help develop and adapt technologies to promote walnut cultivation on commercial lines. The germplasm of walnut trees is limited to a few varieties in the state and most of the walnut trees being grown are of seedling origin and are terminal bearing. Most plantations are in scattered form that produces nuts of variable quality. Breeders over the years have exploited the variation amongst these seedling trees to select superior genotypes with desirable traits. Besides this, the improved cultivars were introduced from other countries and after evaluation, some recommendations have been made. Extreme summer heat, if temperature rises above 40°C, accompanied by low humidity affects the production. On the whole, walnut has remained a low priority crop in otherwise apple dominated regions. Walnut growing suffers from lack of suitable methods of propagation, inadequate number of vegetatively propagated plants, lack of standard rootstocks/ cultivars, problems of re-establishment of nursery plant in the orchard, specific climatic requirements, pollination behavior and lack of suitable Pollinizers, long juvenile period and harvesting of fruits.

The nursery production work of walnut trees is confined to few nurserymen in the State. The walnut trees are being grown by these nurserymen in general as seedling stock, which has long gestation period and low productivity. The promising cultivars of walnut in the state are Gobind, Pratap and Soldling Selection, Kashmir Budded, Eureka, Placentia, Wilson, Franquette etc. & most of them are terminal bearing.

There is a need to improve the existing germplasm of by introduction of lateral bearing varieties like Chandler, Fernette, Howard, Tehama, Sunland, Tulare etc. along with their pollinizing cultivars such as Cisco, Payne Pedro, Franquette etc, which have higher fruit productivity and a better nuts and kernel ratio, large ecological adaptability to variable climatic and edaphic conditions of the State. This will certainly help farmers in taking up walnut cultivation on commercial scale and can be an important step in improving their economic status.

## Status of Walnut in Arunachal Pradesh

Govt. of Arunachal Pradesh  
Department of Horticulture, Chimpur, Itanagar

No. Hort/TM/WS/2002-03

Dated 16th September 2013

Among the nut crops, walnut is the only crop that is grown commercially in Arunachal Pradesh though other crops are also there but not grown commercially.

**Area and production of Walnut in the table given below:**

Area, Production and Productivity of Major Horticultural Crops During 2012-13				
Component		Total		
		Area	Production	Prdty(mt/ha)
A	Fruit Crops			
1	Apple	14066	30945.2	2.20
2	Walnut	4805	574	0.12
3	Kiwi	3452	4720.5	1.37
4	Citrus	39396	175707	4.46
5	Pineapple	12280	66780	5.44
6	Banana	6132	18186	2.97
7	Others	6727	13288	1.98
	<b>Total</b>	<b>86858</b>	<b>310200.7</b>	

Yours faithfully,

Sd/-  
Mardo Ninu  
Hort Development Officer, Itanagar

# WALNUT

**K.K. PRAMANICK**

HEAD & PS, IARI REGIONAL STATION (CHC),  
AMARTARA COTTAGE, SHIMLA-171004 (H.P.)

## INTRODUCTION

Walnut (*Juglans regia*) is a native of the North-western Himalayas and is grown in all parts of the Himalayan region between the elevation of 1,200 to 2,150 m above mean sea level. It belongs to the family Juglandaceae. Walnut is grown extensively in France, Italy, Rumania, U.S.A. and China. The major walnut growing states in India are Jammu & Kashmir, hilly areas of Punjab, Himachal Pradesh and Uttarakhand. Jammu & Kashmir is the leading walnut producing state in India with 98% of the total production in the country. There are no regular orchards of walnuts in India because the existing plantations are generally of seedling origin. The seedling trees attain giant size and start bearing nuts of variable sizes and shapes after 10-15 years, whereas vegetatively propagated plants are true-to-type and remain within manageable size. Low success rate is a major constraint in vegetative propagation. Limited availability of scion material from desired trees results in very few vegetatively propagated plants. Walnuts are rich in protein, fat, carbohydrate and minerals. 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. The nuts are in great demand in abroad and thus have a high potential of earning foreign exchange.

## CLIMATE AND SOIL

Walnut is highly sensitive to the extremes of winter and summer temperatures as well as to its duration. It requires a climate which is free from frost in spring and from extreme heat in summer. A temperature of even 2 or 3 degree below freezing point (0°C) kills leaves, shoots and flowers and thus resulting into a crop failure. High temperature of about 38°C causes sun-burning of hulls and shriveling of kernels resulting sometimes in empty nuts. Hot summers with low humidity result in blank nuts. An annual rainfall of about 80 cm is considered sufficient for the cultivation of walnut which can be supplemented drier regions with irrigations, particularly for young plants.

A well drained, deep silt loam soil containing an abundance of organic matter is the most suitable for walnut cultivation. Walnut requires a fertile and well drained top soil and the sub-soil should be free from solid rock, impervious clay or gravel layers which restrict root growth. A soil depth of 2-3 metres give the best results, because walnut roots penetrate up to a depth of about three metres. It requires a soil pH of neutral range i.e. 6 to 7.

## UNFAVOURABLE CLIMATE

Pollination in walnut is carried out by wind. It is self fertile but pollination is not satisfactory in certain varieties mostly because these varieties fail to mature their pollen at the time when the female flowers are receptive. Hot spring weather hastens the development of catkins and makes them shed their pollen quickly. It does not have great effect on the development of pistillate flowers. The pollination difficulty in the established orchards can be overcome temporarily by bringing catkins from the neighboring plantations and hanging them in the trees. It can be permanently overcome by top working certain limbs with the desirable varieties. The new plantations of walnuts should be located near the existing bearing trees. Snowfall or very cold weather at the time of flowering causes poor setting of the crop.

## FLOWERING AND FRUITING

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 seasons 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.

## VARIETIES

### Leading Varieties For Cultivation

Walnut (*Juglans sp.*) is the most important temperate nut fruit of the country. Walnut in India are found in different sizes and shapes. The Indian walnuts are categorized into 4 categories viz., paper-shelled, thin-shelled, medium-shelled and hard-shelled. Walnuts flourished at altitudes of 900 to 3000.

Walnut varieties grown in different states of India are:	
Jammu and Kashmir	Lake English, Drainovsky, Opex Caulchry and CITH Selections
Himachal Pradesh	Gobind, Eureka, Placentia, Wilson, Franquetfe, Kashmir Budded and Pusa Khor
Uttarakhand	Chakrata Selections

Source: APEDA, 2013

### 1. Hartley

It is one of the most popular commercial cultivars of California. It is a selection from a seedling. The nuts are large with broad flat base and pointed tip. The shell is light coloured, thin and seals well. The variety is tolerant to codling moth and blight disease.

### 2. Payne

It is the second leading cultivar of California which originated as a seedling. Nut is medium to small in size with a good seal. Trees are moderately vigorous, round in shape and require heavy pruning to maintain vigour.

### 3. Franquette

It is an old and leading cultivar of France. Nut is small, good shell seal and kernel is light in colour. Tree is large and upright in nature and is known for its late bud break thus escaping injury from frost during late spring.

### 4. Serr

It was evolved from a cross of Payne X PI 159568. It is heavy yielding and well adapted to warm conditions. The tree is very vigorous and gives poor yield on very fertile soils. The kernel is light in colour and good in quality. It is susceptible to codling moth and blight disease.

### 5. Ashley

It is a high yielding, early bearing cultivar which requires heavy pruning to keep the tree vigorous. Kernel is of high quality, good in flavour and light tan in colour. This variety is unsuitable for high rainfall areas due to blight problem.

### 6. Sunland

It is a mid-season variety obtained from a cross of Lompoc X PI 159568 in California. The nut is very large, long, oval with good seal and kernel colour is good. It is susceptible to blight-and late spring frost.

### 7. Chico

It is evolved from a cross of Sharkey and Marchetti. The variety is fruitful on lateral buds and the nut is small but excellent in quality with light coloured kernel. Heavy pruning is required to maintain nut size.

### **8. Vina**

It was evolved from a cross of Franquette and Payne. The kernels are light in colour, high in quality and shelling percentage is 48. It requires good pruning to maintain its vigour and nut size.

### **9. Howard**

Howard is a lateral fruiting and high yielding cultivar. Nuts are large, round and smooth with a good seal. Kernel is light in colour and shelling percentage is 50. Tree is small, semi upright and tolerant to blight.

### **10. Pedro**

It is an early bearing variety due to which it has become popular cultivar in many walnut growing regions. The nuts are large shell heavy and seal fair. It sheds its pollen over a long period becoming a good pollinizer.

### **11. Chandler**

It is a very promising cultivar which has been evolved from a cross of Pedro X VC 56 -224. The nut is large, oval, smooth with a good seal and excellent colour. Kernel percentage is 49. Tree is moderately vigorous and semi-upright.

### **12. Tehama**

It is a heavy yielding midseason and lateral fruiting cultivar evolved from a cross of Waterloo and Payne. Nut size is large but shell seal is not so good because sometimes it cracks at the suture exposing the kernel to damage. Kernel colour is good with 50% shelling. Tree is large and vigorous and mainly serving as a pollinizer.

## **PROPAGATION AND ROOTSTOCK**

Walnut can be propagated either by seed or by vegetative methods. Both of these methods are described here.

### **A. Seed Propagation**

Walnut seedlings are generally used as rootstock. Healthy and disease free walnuts procured from current season's crop should be sown directly in well-prepared seed beds during November. If land is not ready for sowing and inclement weather prevails, nuts can be stratified in moist sand till soil becomes workable. They may be sown in lines 50 cm apart and the seed to seed distance should be kept at 25 cm. The big nuts should be selected with bright brown colour having good cracking quality of the shell, good taste and flavour of the kernel. The beds should be covered with grasses after sowing and irrigation. While preparing the beds, proper drainage facilities should be provided.

## **B. VEGETATIVE PROPAGATION**

Walnut can be propagated vegetatively by grafting, budding and stooling.

### **1. Grafting**

Tongue or whip grafting, cleft and veneer grafting during February and early March have given good results. Epicotyl grafting has also given encouraging success in the propagation of walnut. The best period for grafting is January -February. For propagating the plants through veneer grafting, 5-6 month old scion wood of 15 cm is grafted on the rootstock of same thickness. The selected scion wood should be defoliated 15 days prior to its detachment from the scion cultivars. The optimum time for veneer grafting under mid -hill condition is July -August. One year old seedlings of hard shelled walnut or black walnut can be used as rootstock. Scion for tongue grafting should always be selected from the tree which has already started fruiting.

### **2. Budding**

Patch budding is generally practiced to propagate walnut plants vegetatively. The best period for budding is July/August. Scion should always be selected from the tree which has already started fruiting.

### **3. Stooling**

Stool layering is a suitable method of walnut propagation and is useful for the multiplication of true to type rooted plants from a rootstock bed. One year old seedlings of a known cultivar are planted in a nursery bed at 1 sq. m. distance and headed back from 6.8 cm above the ground in March before bud swelling. All the cut ends are painted with Chaubatia paste. In April, buds start swelling and 3 -4 shoots come out from the stock. In July, 2 -5 cm bark is removed and the ringed portion is treated with IBA 6000 ppm in lanolin base. After a week the upper end of the ringed part swells and development of root primordia is initiated. The treated shoots are then earthed up, covering the shoot even beyond the ringed portion. Fortnightly irrigation is given to the stool bed to keep the moisture constant. During the second fortnight of February the shoots are unearthed. These shoots show rooting and are detached from the mother plant and planted in the main field in the month of March.

### **Top Working**

Top working is a very useful choice for walnut production in the hilly tracts of India since a large number of young seedling trees are found producing inferior quality of nuts. Top -working is usually carried out by modified cleft grafting or bark grafting late in the spring season or when new growth occurs. The dormant scion wood should be removed from the parent tree in advance and stored in refrigerator after proper packing. Bleeding is a problem in walnut top-grafting especially when it is done in early spring which can be avoided by heading back the stock two weeks before actual operations. After grafting, the open wounds must be covered by grafting wax and if required rewaxing may be done. White washing of the stem may be done to protect them from sunburn. As the rootstock is already well established, the scion makes rapid growth and bears earlier than the transplanted trees.

Most of the existing plantations in the country are of seedling origin and there is varying success in vegetative propagation by different methods and at different timings of the year. However, temperature of 25<sup>o</sup> +/- 10-20 and 75 +/- 5% relative humidity are required for scion take.

### **Planting**

Square system of planting is commonly adopted in walnut because it is easy to layout and convenient for cultural operations and tree thinning. Pits of 1.25 X 1.25 x 1.25 m size at a distance of 10 X 10 m should be dug during September. The pits should be filled up with orchard soil mixed with 50 kg well rotten FYM, 150 g Aldrin dust, 150 g urea, 500 g each of superphosphate and muriate of potash. The best season for walnut plantation is December to January. The plant should be well fixed in the soil and the adjoining portion of scion and stock union should be at least 15 cm above the ground surface. Watering should be done soon after plantation. To protect the plant from collar rot it should be treated with Dithane Z- 78 before planting.

### **Manures And Fertilizers**

Walnut tree has a very extensive root system and vigorous growth, thus it requires heavy feeding. A balanced nutrition of nitrogen, potassium and phosphorus should be applied for the proper vegetative and reproductive growth. A one year old seedling requires 500 g urea and 750 g each of superphosphate and muriate of potash. The doses of fertilizer may be increased with the increase in the age of the tree. The full dose of superphosphate and muriate of potash and half dose of urea should be applied in October after picking the fruits and the remaining half dose in the month of February every year. These fertilizers should be well mixed with the soil and applied at least 30 cm away from the main stem of the plant. Every year in the month of October, 50 kg of well decomposed farmyard manure should be applied as a normal feed. Foliar application of all the micronutrients like zinc, copper, manganese, boron, iron and magnesium may be done in the month of March. For correcting Zinc deficiency, 0.4 % zinc sulphate should be applied as a foliar spray.

### **Irrigation**

Watering is very essential for the establishment of grafts and young plants. The water requirement, however, decreases with the development of roots in adult trees. When the trees start bearing, irrigation should be given from the time of fruit set till its maturity to reduce the fruit drop and for better filling of nuts. When the trees are grown under rainfed conditions and when the rainfall is not sufficient and well distributed, irrigation is essential for walnut cultivation. The common irrigation systems

followed are flood, furrow, sprinkler and drip irrigation.

### **Training And Pruning**

Walnut is both terminal and lateral bearer. It bears fruits on one year old wood which is produced either terminally or both terminally and laterally. Terminal bearing cultivars are thinned, but not headed back because vegetative growth keeps on increasing in absence of early fruiting. On the other hand, lateral bearing cultivars are both thinned and headed back in order to encourage shoot growth which gets suppressed due to early fruit production. Modified leader system of training (refer booklet No. 18 on "Horticultural Practices") is followed in walnut. After the first year's growth the plant is headed back above 2 m of its height. All lateral shoots on the leader are removed leaving one or two shoots at lower level on the trunk.

The primary objective of pruning of mature walnuts is to obtain regular and high production of quality nuts which is often hampered by overcrowding of branches, insufficient production of new wood and inadequate availability of sunlight. Selective thinning out of limbs in the top and sides of the tree should be done to avoid overcrowding. The pruning operations are carried out in the dormant season but early spring is preferable. Further delay causes excess bleeding. All the cut surfaces should be treated with a tree wound dressing.

### **Weed Control**

The herbicides such as Simazine and Diuron have been successfully used to control weeds in young and established walnut grooves. Simazine and Diuron @ 2-4 lb/acre have effectively controlled annual weeds throughout the season.

### **Harvesting And Yield**

Harvesting at proper maturity is of prime importance in the production of quality nuts. Any delay in picking after maturity of kernels deteriorates the quality and increases the incidence of mould and pests. Two indices for maturity are commonly used. A thick hull covering the nut splits on maturity causing the fall of the nut on the ground. Sometimes, kernel matures earlier than hull splitting. In such cases, proper maturity is assessed by observing the packing tissue between and around the kernel halves which turns brown on maturity.

Walnuts are ready for harvesting in August, September and October. In Himachal Pradesh harvesting commences from August and extends up to last week of September, whereas in J&K walnuts are harvested in September –October. Some nuts fall on the ground after splitting of the hull while others are forced to drop down by beating with long poles. The nuts are collected from the ground, cleaned, washed and dried in the sun by spreading them on a canvas sheet or floor. The dried nuts are graded according to the cultivar, size and colour, Sometimes in order to improve the appearance of nuts, these are bleached either with acid or alkali solution.

Yield of walnut varies depending on the age, size and variety of trees. A 40-year old large tree can produce as much as 175 kg nuts while an average yield is around 40 kg/tree. Full commercial bearing starts after 18 -20 years in seedling trees and 8 -10 years in grafted trees.

### **Drying, Storage And Marketing**

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 stored 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.

### **Future Steps:**

A unique walnut plant is being evaluated at the IARI regional station, Shimla. It was collected from Chamba region of Himachal Pradesh which came into bearing in the second year of its grafting. The known varieties of walnut normally take 10 to 15 years to come into bearing. Sometimes it takes even more. The fruit appears to be borne in lateral position as well as terminally. This is a characteristics of newly evolved early, good quality and heavy bearing walnut cultivars. However, no such cultivar is reported

in India so far. The leaf size and annual shoot increment is also much more than other walnut plants collected during the same survey. They are also not yet in bearing stage. The fruit weight with husk was 58.85gm; where as, without husk (nut) weight recorded 23.5gm. The length of the fruit with husk (nut) it was 43.85cm. The nut is thin shelled and kernel colour of light yellow and good in taste. This is christened as "Pusa Khor".

According to Ramos et al.(1984) selection of clones that produce pistillate flowers on lateral buds has resulted in Persian walnut, *Juglans regia* lateral bearing Persian walnut cultivars tend to be more precocious and are better suited to high yielding, high density plantings.

High development costs for establishing a walnut orchard demand the crops at an early age. Cultivars displaying lateral bud fruitfulness generally come into production well in advance of non-lateral bearing cultivars. Shell thickness and structure are the most important determinant of percent kernel and nut crack-ability. The highest quality walnuts have a thin outer shell with no internal convolutions protruding into the nut meat. The inner shell partition between Kernel halves should be very thin to allow easy removal of Kernel pieces. The nuts of the tree collected from Chamba appear to meet this standard.

# Propagation and Quality Nursery Production of Walnut (*Juglans Regia L.*)

**J.S. Chandel**

Professor, Department of Fruit Science,  
Dr Y S Parmar University of Horticulture and Forestry, Nauni, Solan (Himachal Pradesh)  
E-mail: [chandeljs@yahoo.co.in](mailto:chandeljs@yahoo.co.in)

## INTRODUCTION

Walnut (*Juglans regia L.*) is one of the important nut fruit of the world, cultivated mostly in semi-cold regions. It is grown extensively in USA, China, France, Italy, Turkey, Poland, Yugoslavia, Rumania and Iran. In India, walnut is mainly grown in the state of Jammu and Kashmir and to a limited scale in Himachal Pradesh and Uttarakhand. It occupies an area of 137000 ha. with a production of 233400 MT (Anonymous, 2010). Although there is tremendous scope for its cultivation in entire Himalayan region between elevation of 1200 to 2500 m a.m.s.l., yet its commercial has remained in a state of neglect particularly in Himachal Pradesh and Uttarakhand. At present, the walnut is grown as scattered trees and not in the form of well laid out regular plantation or orchard. The majority of trees are of seedling origin, which has a long gestation period and are highly variable producing nuts of inferior quality with low shelling. The development of walnut industry in north western Himalayas has been constrained due to:

- The non-availability of vegetatively propagated plant material of known pedigree with desirable nut attributes
- Low transplanting survival in the orchard due to strong tap root system
- Non availability of lateral bearing and high yielding superior cultivars
- Long gestation period, low productivity and low planting density etc.

Some efforts have been made on the standardization of propagation techniques in the state of Himachal Pradesh and Jammu and Kashmir with a bud take success of 40-50 per cent in tongue grafting to as high as 70-80 per cent with hot callusing cable and 90 per cent in chip budding. These improved methods/techniques should be adopted on commercial scale for mass multiplication of nursery plants of walnut to cater the need of farmers. The advances / techniques made in walnut propagation by the University of Horticulture and Forestry, Solan is as under.

## ROOTSTOCK AND PROPAGATION:-

In India, seeds of hard shell walnut known as katha walnut are generally used to raise seedlings rootstocks. Although, walnut germinates without stratification under some conditions, yet proper stratification is desirable for good seed germination and growth of seedlings. The seeds are stratified for 90-110 days in alternate layers of moist sand during December to February. Soaking of seeds in 750- 1000 ppm GA3 or 1000 ppm etherel solution for 24 hours after stratification is very effective in stimulating seed germination and growth of seedlings. The stratified seeds are sown in nursery beds in line 30 cm apart at a distance of 15-20 cm and at a depth of 5-6 cm in March. The rootstock attain graftable or budable size in a year, which are grafted or budded in next year, thus takes two or three years to produce grafted or budded nursery plants. However, a technique has been developed by sowing stratified seeds either in polybags or in nursery beds under polyhouse conditions in the month of Mid February and these seedlings attain budable size in July.

## ESTABLISHMENT AND MANAGEMENT OF BUD-WOOD BANK

For the production of quality nursery plants, bud wood bank or mother tree orchard of improved high yielding varieties should be established near the nursery for the supply of scion wood in bulk for further grafting and budding. Mother trees are planted at close spacing of 3m x 3m and proper record of variety is made by making maps in the nursery register. Trees are hard pruned

every year to develop hedges for the production of scion-wood in bulk. Trees are frequently irrigated and higher doses of nitrogen fertilizers is applied to make more vegetative growth. Rigorous plant protection measures are followed for the control of insect-pests and diseases. Separate tools like secature, pruning saw, knife and pick axe etc are kept to use in mother tree orchard, which are also sterilized before their use.

## PROPAGATION OF SCION

Walnut is propagated through grafting and budding techniques.

### GRAFTING:

In grafting, generally tongue, cleft and side veneer methods are used. Tongue and cleft methods are performed during the month of February and March and graft success in these methods depend upon the climatic conditions particularly the temperature at the time of grafting and subsequent healing of graft union. A good bud-take success is obtained in tongue and cleft methods of grafting if the temperature remain around 24- 25oC during grafting time. However, poor success is obtained if the temperature remain less than 20oC at the time of healing of graft union. The average graft success in these methods generally ranged from 40 to 55 per cent. In Jammu and Kashmir, some refinement has been made with the use of hot callusing cables at graft union by which the temperature is maintained around 25oC at graft union. They obtained about 77 per cent graft take success by using this technique. Better success with these grafting methods are obtained when grafting is done in green house having 25-28oC temperature and 80-90 % relative humidity. The best time for veneer grating under mid hill conditions has been found in August with a success rate of about 60-65 per cent.

### SUMMER BUDDING METHODS (CHIP, PATCH AND ANNULAR):

A significant achievement in the propagation of walnut has been made with the summer budding methods particularly chip budding by the University of Horticulture and Forestry, Solan (HP). The studies were conducted on the standardization of time and methods of summer budding viz. chip, patch, annular and shield at 10 days intervals from Mid of May to last week of August at Solan in Himachal Pradesh for four years. Among these methods, chip method was found superior and gave as high as 87 - 92 per cent bud take success during last week of May to first week of June. The best time for Patch and Annular budding methods was found Mid of June to Mid of July under mid hill conditions. However, time of budding should to standardized in different agro-climatic conditions as the best time for chip budding at higher elevation of Himachal Pradesh was found in Mid of June.

### PRODUCTION OF BUDDED PLANTS IN A YEAR UNDER PROTECTIVE CONDITIONS:

Generally it takes 2 to 3 years to produce grafted and budded plants, however, an agro-technique has been standardized to produce budded plants in a year. The seeds are put for stratification in alternate layers of moist sand in first week of December and stratified seeds are sown in well prepared nursery beds in polyhouse during mid February. The seedling rootstocks attain budable size in July and budded with chip and patch methods from mid July to first week of August with a bud-take success of 80-87 per cent. The budded plants become saleable by December.

### TOP-WORKING TECHNIQUE:

Large number of young seedling trees producing inferior quality nuts are abundant in the hills of north-west Himalayas, which can be top-worked by scion of some superior varieties using budding methods. Top-working technique with dehorning has been standardized for higher bud-take success. In this technique, the seedling trees are dehorned by heading back main branches in dormant season (December-January). New branches will emerge from dehorned branches in spring season and these new branches are budded with chip method in second week of May and annular method in first week of July. Chip method gave 85 per cent bud-take success in second week of May and annular budding also registered more than 80 per cent bud-take success. This technique can be adopted for changing the seedling trees with some superior cultivars.





Chip budding



Bud-take success in chip budding(92%)



Dehorned walnut seedling tree with summer budding on current season's forced shoots



At the time of Bud Sprouting



At the end of season

**Top worked walnut tree with chip budding**

## An Overview of Walnut Rootstocks, Cultivars and Propagation in California

### Gurreet Brar

Assistant Extension Advisor-III  
University of California Cooperative Extension,  
550 E Shaw Ave, Suite 210 B, Fresno, 93710, CA

Walnuts have been grown in California for more than 200 years. During the late 1700's, Spanish missionaries brought English or Persian walnut (*Juglans regia*) to California. Earlier plantings consisted of seedling trees of English walnut varieties selected for better vegetative growth as well as better nut quality. Later in the 19th century, budding or grafting the desirable varieties onto different rootstocks became a preferred way of growing and propagating walnut trees. The rootstocks were selected based on their ability to adapt to different soil and climatic conditions as well as for their vigor and disease resistance. In the early 20th century, Northern California Black Walnut (*Juglans hindsii*) became a widely used rootstock based on its high vigor and characteristics like salinity and disease resistance. Since the 1950s, Paradox hybrid is being extensively used as a major rootstock in California walnut industry. Paradox is a hybrid of Northern California Black walnut (*J. hindsii*) and English walnut (*J. regia*).

### ROOTSTOCKS:

Rootstocks are selected and developed on the basis of their vigor, ability to provide good anchorage, ability to grow under various soil conditions and to resist or tolerate soil borne pathogens. Among the commonly used walnut rootstocks in California, different rootstocks are known for their different characteristics. Therefore, rootstock selection should be made according to specific soil and climatic conditions of a particular orchard site. Traditionally, two rootstocks have been used as industry standard in California- Northern California Black walnut and Paradox hybrid. Apart from these two, own-rooted English cultivar seedlings are also used in some situations where walnut blackline disease is prevalent, as English walnut is known to resist this disease.

**Northern California Black walnut (*Juglans hindsii*):** This was the preferred rootstock during early to mid-twentieth century. This rootstock was more vigorous than own-rooted Englishwalnut. It was an old standard, which is still used in some plantings. Black walnut is less vigorous than Paradox and less susceptible to crown gall, but is more susceptible to phytophthora crown and root rot.

**Paradox hybrid:** It is a hybrid of Black walnut and English walnut. Traditionally, Paradox hybrid seedlings have been produced by sexual propagation by collecting seeds from black walnut trees pollinated by English variety. However, more recently many clonal Paradox rootstocks have become popular- Vlach, RX1, and VX211. Each of these clonal rootstocks has their own merits. For example, Vlach is more tolerant to crown gall than Paradox seedlings, VX211 is more tolerant to nematodes while RX1 shows some resistance to Phytophthora spp. Paradox hybrid rootstock has been a standard in California walnut industry for a few decades now.

**English walnut:** English walnut was used as rootstock in early plantings during late 19th century. English walnut generally shows poor performance as compared to later rootstocks, therefore it has limited commercial use. However, there is a renewed interest in this rootstock mainly due to its tolerance to walnut blackline disease. Since both Black walnut and Paradox hybrid do not show any tolerance to blackline disease, English walnut cultivars are grown on their own roots, in areas where this disease is prevalent.

### CULTIVARS:

**Chandler:** This is the most commonly used cultivar in recent plantings in California. It is a lateral bearing cultivar with moderately vigorous growth and strong yields. It is a thin shell cultivar with oval, smooth and light colored shell, which becomes stronger in older trees. Kernels have excellent color and are easily removed in halves. Chandler is harvested relatively late in the season.

**Howard:** It is a moderately vigorous cultivar but often less vigorous than Chandler. It is a lateral bearing variety with strong yield. Nut size is large with strong shell-seal, while the kernel color is light. This is often marketed as in-shell variety.

**Ivanhoe:** This is a new early variety with strong yields and precocious bearing. It is harvested early in the season, almost a month earlier than Chandler. It has thin, smooth shell with excellent kernel color. However it tends to be susceptible to walnut blight.

**Serr:** Serr is a very vigorous cultivar, which is moderately fruitful on laterals. It has a thin, well-filled shell with good seal and excellent kernel quality. It has a high quality and high production potential but can exhibit flower drop if it is exposed to excess pollen. It is often planted without pollinizer varieties.

**Tulare:** This cultivar has an upright canopy and vigorous growth with lateral bearing habit. It is a mid-season variety, which is a little more susceptible to low temperatures during fall and winter seasons. It is also grown without pollinizers.

### PROPAGATION:

Walnut trees are propagated using different methods of propagation. While rootstock seedlings are produced by sexual propagation, vegetative propagation methods like budding or grafting can be used to produce finished trees with desirable scion cultivars. More recently, micropropagation techniques are also being used extensively to produce clonal seedlings of walnut rootstocks.

### SEXUAL PROPAGATION:

Sexual propagation is mainly used for producing walnut rootstock seedlings. Seeds of commonly used rootstocks, Black walnut and Paradox hybrid are sown in fall to grow seedlings, which would then be budded or grafted with desired cultivars during the next season. Seeds are collected by shaking nuts off the trees. To avoid contamination with *Agrobacterium tumefaciens* (which causes crown gall disease), nuts are collected on tarps and are not allowed to be in contact with the ground. In walnuts, the dormant embryo is the major constraint in sexual propagation and the seeds need to go through cold stratification (moist pre-chilling at 3-50 C for 3-4 months) to ensure germination. Sowing seeds in fall can also break dormancy, as temperature conditions for seed stratification are met during winter months.

### VEGETATIVE PROPAGATION:

**Micro-propagation:** This method is being used increasingly for the production of clonal rootstock. When compared to traditional propagation methods, the advantage of micropropagation is that we can produce genetically identical individuals in large numbers in a short period of time. Micropropagation in walnuts consists of following steps:

- i). Preparation of aseptic cultures by surface-sterilization of stem segments.
- ii). Shoot multiplication by culturing these explants on agar medium with added plant growth regulators, sugars and other nutrients.
- iii). The clonal microshoots thus produced are rooted in-vitro. Plant growth regulator indole-3-butyric acid (IBA) has been used to obtain higher root proliferation.
- iv). Acclimatization and hardening of these microplants is achieved by transferring them to polystyrene trays in peat-based growing medium in greenhouse conditions. After hardening, these plants are transferred to the nursery.

**Budding:** Budding is a preferred method for propagating walnut trees asexually, by inserting buds from desired cultivars onto the rootstock seedlings. When the rootstock seedlings are well established and develop girth matching the budwood, buds from English varieties are budded onto them. Patch budding is the most commonly used budding method, resulting in good budding success. Traditionally, the rootstock seedlings are fall-budded from late August to Mid-September and a finished tree is produced by next fall. However, a more recent technique called June budding is being adopted by commercial nursery operations in California. In June-budding, the seedlings sown in fall are pushed hard to achieve buddable size in June, which will coincide with the development of current season scion buds. The rootstock seedlings are budded in June, which typically provides the finished tree within the cycle of a year. Patch budding is performed using a double bladed knife (see Figure 1). A square piece of bark is removed from the rootstock seedling and the same size patch containing a well-developed bud is cut from the scion. The patch of bud is placed on the rootstock and tied with a budding tape. Generally, the bud is kept naked while the rest of the patch is tied thoroughly with the tape. The bud union is usually formed in a couple of weeks, after which the tape is removed. Buds are usually pushed by topping off the rootstock seedlings a couple of feet above the inserted bud.

Some nurseries also use T-budding, where a T-shaped cut is made on the rootstock and a shield-shaped bud cut from the scion

is inserted into the T-cut.

**Grafting:** Whip or tongue grafting is the technique used to graft walnut seedlings. Scion wood is collected during dormant season and the grafting is performed during spring season. For performing tongue grafting, first a slanting cut is made on both rootstock and scion and then the second vertical cut is made in the middle. The scion is inserted in the tongue-like cuts in the rootstock as they lock each other. The graft union is tied with a tape. Grafting is considered more labor-intensive and time-consuming than budding, therefore budding is usually a preferred method.

**Cutting:** Walnut is a difficult-to-root species. Conventionally, semi-hardwood and hardwood cuttings have been used in walnut propagation by cutting. Depending on the type of genotype being rooted, the rooting success varies profoundly. Currently, research is being conducted to further improve this method.

### GUIDE TO ROOTSTOCK AND CULTIVAR SELECTION:

The choice of rootstock and cultivar depends on the soil and climatic conditions of the proposed orchard site. Based on the description of different characteristics of various rootstocks and cultivars, the most suitable types can be selected for a given site. Rootstock selection should be based on characteristics like-

- Resistance to environmental stresses like cold injury, soil conditions like high salinity.
- Resistance to pests and diseases like blackline disease, root rot/crown rot, crown gall and root lesion nematodes.
- In areas where blackline disease is prevalent, English walnut trees are grown as own-rooted trees because English walnut is resistant to blackline disease.

Scion selection depends on a variety of factors like available chilling hours, local climatic conditions and severity of some pests and diseases in a given area. Walnut trees require exposure to certain number of chilling hours during dormant winter months in order to break dormancy. Different cultivars vary regarding their chilling requirements and this can be judged from their relative leaf-out dates. Among the cultivars described earlier in this article, Ivanhoe and Serr varieties leaf out relatively early, signaling that they have lower chilling requirement as compared to Chandler, Tulare and Howard, which leaf out relatively later. Another consideration is climatic conditions. For example, in areas of high precipitation, cultivars like Ivanhoe should be avoided because of its susceptibility to walnut blight.



Figure 1: Steps in Patch-budding in walnuts. (Photos: GurreetBrar)

### Literature cited:

- McGranahan, G. (1995). Walnut fact sheet. Retrieved September 10, 2013 <http://fruitsandnuts.ucdavis.edu/>
- Payghamzadeh K. and Kazemitabar S. K. (2011). In vitro propagation of walnut - A review. African Journal of Biotechnology, 10(3), pp. 290-311.
- Ramos, D. E. (1998). (Ed.) Walnut production manual. University of California, Division of Agriculture and Natural Resources, Oakland, CA.

# Usefulness of Walnut

**Dr. DP Sharma and Kishore Kumar Thakur**

Department of Fruit Science  
Dr. YS Parmar University of Horticulture and Forestry,  
Nauni Solan, HP

## INTRODUCTION

Walnut (*Juglans regia* L.) is the most widespread tree nut in the world. The tree is commonly called as the Persian walnut, white walnut, English walnut or common walnut. It belongs to family juglandaceae and has the scientific name *Juglans regia*. The point of origin for the Persian walnut (*Juglans regia*) lies in Central Asia, where the tree grows in a wild and semi-cultivated state. In pre-historic times, it spread to western China, the Caucasus, Persia, and Europe. At present, walnut is cultivated commercially throughout southern Europe, Northern Africa, Eastern Asia, USA and Western South America. China is the leading world producer, followed by the Iran, USA, Turkey, Ukraine, Mexico, France, India Romania, and Chile (FAO, 2011).

## HISTORICAL VIRTUES OF WALNUT

Walnuts were likely an important food gathered by early humans. The last glacial epoch greatly restricted the extent of Persian walnuts in Western Europe, but archaeologists have found their remains in southern France dating to 17,000 thousand years ago. Neolithic peoples cultivated walnuts by 7,000 years ago, but they were not widely cultivated in the Mediterranean until ancient Roman and Greek times, when economic factors contributed to their dispersion throughout Europe. Walnuts were an item of trade and amphora filled with walnut residue has been salvaged in sunken Roman ships in the Mediterranean.

The walnut was the most important nut from a health standpoint in the ancient Mediterranean world. Its medicinal virtues were detailed in many Greek and Roman medical writings. Dioscorides, a Greek physician esteemed walnuts for medicinal purposes. He believed that when they were eaten with rue and figs, the nuts counteracted poisons. Walnuts along with honey and rue helped with “inflammation of the breasts, abscesses and dislocations.” With onions, salt, and honey, walnuts would heal those bitten by dogs or men. When burnt, they assuaged colic. He also wrote that if walnut kernels were burned, ground with wine and oil, and applied to an infant's head, the child's hair would grow abundantly and bald spots would disappear. Walnut if chewed and laid on as a plaster cures gangrene, carbuncles, style in the eye, and hair loss. They were also mixed with garlic and applied as a poultice to remove bruises on the body. Many of these recommendations would appear in subsequent medical works for almost two thousand years.

## EUROPEAN HERBALS

The early-seventeenth-century physician Daniel Sennert, claimed that walnuts, ground up and combined with dates, raisins, egg yolks, and wine, could be employed as a plaster to heal carbuncles. It may have been the carbuncle's resemblance to the walnut that inspired this treatment. Schroder believed that candied walnuts aided digestion, which is why they were usually included among desserts. The Bolognese herbalist Baldassare Pisanelli, in an early-seventeenth-century treatise on diet and health, pointed out that walnut candied with sugar or honey were good “to use in cold weather to heat the stomach.” He also reported that they “offer much nutrition, increase the brain, and cooked with honey heal an old cough, and roasted and eaten with pepper.”

The herbalist John Gerard proclaimed in 1597 that walnuts consumed with rue prevented infection of the plague which had devastated Europe for centuries. When the plague hit England again in the mid-seventeenth century, walnuts (combined with other ingredients) were often recommended for those wishing to avoid “this pestilence.” Another source recommended combining rue, salt, garlic, and a walnut to prevent the plague. Ralph Austen, one of the authors of *A Treatise on Fruit-Trees* (1653), verified this, writing that walnuts “distilled and drunk with vinegar,” were thought to be a “preservative against the Pestilence.”

The English physician Robert James, in his *Pharmacopoeia Universalis*, noted that candied nuts were “gently emetic.” The nuts were also used to cure colic and counteract diarrhea, and to prevent “contagious Distempers,” while the tree's leaves were recommended for treating gout, ulcers, and even cancer. Walnuts even cured hiccups, “perhaps more effectually, than any other Medicine”—or so reported Robert James.

## CULINARY ENJOYMENT

Walnuts were readily available, cheap, and easily preserved, and during the eighteenth and nineteenth centuries they were incorporated into a vast array of recipes from salads, sauces, and soups to pickles, preserves, and pies. The unripe fruits are pickled in vinegar. Among the more common uses were in salads—in combination with apples, bananas, cherries, chicken, cream cheese, dates, or pineapple—culminating in the highly popular Waldorf salad. One favorite way of preserving walnuts was to make ketchup from them. For the past half millennium, cooks and chefs in the western world have used walnuts and walnut products in every imaginable type of dish. The seed part of the fruit (kernel) is consumed fresh, toasted, or mixed with other confectionaries. In the Middle East walnuts are added alone or along with almonds, date, and raisin as a special pastry preparation called Ma'moul.

## WALNUT NUTRITIONAL AND NON FOOD USAGE

Walnut has been used globally in human nutrition since ancient times. The high protein and oil contents of the kernels of *Juglans regia* L. (*Juglandacea*) make this fruit indispensable for human nutrition. Therefore, the walnut is classified as a strategic species for human nutrition and is included in the FAO list of priority plants (Gandev, 2007). Nutritional assets and medicinal benefits of the walnut include omega-3 fatty acids, antioxidants, fiber, and numerous vitamins and minerals. Researchers have shown the diverse benefits of the walnut through many clinical studies. Because of the strong evidence of the walnut's potential role in cardiovascular health, the U.S. Food and Drug Administration approved one of the first qualified health claim for a whole food in March of 2004: “Supportive but not conclusive research shows that eating 1.5 ounces of walnuts per day, as part of a low saturated fat and low cholesterol diet, and not resulting in increased caloric intake, may reduce the risk of coronary heart disease.” In addition to heart health, studies have shown walnut consumption to benefit people with diabetes and cancer, promote bone health, assist with weight management, improve cognitive performance, and counteract some effects of aging. The husk yields valuable oil and a yellow dye when pressed; the oil is used in soaps, paints, and dyes. The oil from walnut kernels is high in unsaturated fats and can be used in cooking. The wood is heavy and fine-grained and is used mostly for furniture and gum stocks.

Walnuts are nutrient-rich food due to high contents of fats, proteins, vitamins and minerals as depicted in Table 1. They are also good source of flavonoids, sterols, pectic substances, phenolic acids and related polyphenols. The nutritional contents differ from a cultivar to another which can be influenced by genotype, different ecology and different soil (Martinez et al., 2010). **The major components of walnut oil are triacylglycerols (980 g/kg oil), in which monounsaturated fatty acids (FAs) (mainly oleic acid) and polyunsaturated FAs (PUFAs; linoleic and  $\alpha$ -linolenic acids) are present in high amounts in all genotypes (Table 1).** Walnuts have high amount of omega-6 and omega-3 PUFA, which are essential dietary fatty acids. Clinical studies suggest that omega-3 PUFA have significant role in prevention of coronary heart disease (Davis et al., 2007). Oil rich in oleic acid displays greater oxidative stability therefore; it could be widely used as frying oil.

**Table 1: Comparison of nutrient profile of English and Black walnuts**

Nutrient (per 100 gram)	English walnut seed	Black walnut seed
Carbohydrates (g)	13.7	9.9
Protein (g)	15.2	24.1
Unsaturated fatty acids (g)	56.1	50.1
Poly to mono unsaturated fatty acids ratio	47:9	35:15
Fiber (g)	6.7	6.8
Calcium (mg)	98	61
Iron (mg)	2.9	3.1
Zinc (mg)	3.1	3.4
Vitamin B-6 (mg)	0.54	0.58

Walnut cultivars analyzed have recorded rich mineral composition, especially potassium, magnesium, and calcium. Walnuts contain high levels of potassium, phosphorus and magnesium and lower sodium. These elements play an important role for many enzymes activity especially as cofactor.

### **ETHNO BOTANICAL USE**

Across the world the leaves of *Juglans regia* have been used mostly in traditional medicines as antimicrobial, antihelmintic, astringent, keratolytic, antidiarrhoeal, hypoglycaemic, depurative, tonic, carminative, and for the treatment of sinusitis, cold and stomach ache. Curing with folk medicine in Turkey, fresh leaves applied on the naked body or forehead to reduce fever or on swelled joint to alleviate the rheumatic pain. *Juglans regia* kernel has been used for the treatment of inflammatory bowel disease in Iranian traditional medicine. In Palestine, it is used for treatment of diabetes and asthma and to treat prostate and vascular disturbance. The plant is used as a topical remedy for dermal inflammation and excessive perspiration of the hands and feet. It is also a common home remedy for the treatment of chronic eczema and scrofula. The leaves of this plant is used topically to treat scalp itching and dandruff, sunburn and superficial burns as well as an adjunctive emollient in skin disorders. It also has high anti-atherogenic potential and a remarkable osteoblastic activity that adds to the beneficial effect of a walnut enriched diet on cardio-protection and bone loss. The bark, branches and exocarp of the immature green fruit of this medicinal plant have been used to treat gastric, liver and lung cancer a long time in China. It is used by traditional healer in northeastern region of Mexico to protect against liver damage. The bark is used as miswaks for teeth cleaning. In Nepal the bark paste is useful in arthritis, skin diseases, toothache, and hair growth. Seed coat is used for healing wounds. The shell of *Juglans regia* is used in Calabria folk medicine to heal malaria.

### **ANTIBACTERIAL ACTIVITY**

Broad spectrum antibacterial activity of hot and cold solvent and aqueous extract of leaves, barks, fruits and green husks of *J. regia* has been reported from different countries against gram-positive and gram-negative bacteria viz. *Bacillus cereus*, *Bacillus subtilis*, *Staphylococcus aureus*, *Pseudomonas aeruginosa*, *Escherichia coli*, *Klebsiella pneumoniae*, *Staphylococcus epidermidis*, *Micrococcus luteus*, *Salmonella typhimurium*, *Enterococcus faecalis*, *Bacillus thuringiensis*, *Protomonas extroquens*, and *Proteus sp.* using agar streak method, disc diffusion method and microplate alamar blue assay. Over 45% of Iranian clinical isolates of *Helicobacter pylori* strain were inhibited by *J. regia* aqueous and equal mixture of methanol, diethyl ether and petroleum benzene extract.

### **ANTIFUNGAL ACTIVITY**

The fruits, leaves and bark aqueous and solvents extract of *J. regia* exhibited antifungal activity against wide range of fungi using disc diffusion method, agar dilution method, agar streak dilution and Raddish method. It has been reported that all the walnut varieties exhibited antifungal activity against *Candida albicans* and *Cryptococcus neoformans* when soxhleted with light petroleum ether (b.p. 40-60°C). Cold extraction of fruit, leaves and bark inhibited the growth of *Microsporum canis*, *Trichophyton mentagrophytes*, and *Trichophyton violaceum*. The bark extract prepared in methanol, acetone, chloroform and ethyl acetate revealed antifungal activity against *A. niger*, *Alternaria alternata*, *Trihoderma viresn*, *fusarium solani*, *Pichia guiliermondii*, *Pichia jadinii* and all *Candida* species tested.

### **ANTIVIRAL ACTIVITY**

A concentration of about 95% ethanol and ethyl acetate leaves extract of *J. regia*, inhibited tobacco mosaic virus (TMV) (Mei-zhi et al., 2007). The methanol extract of *J. regia* inhibited Sindbis virus at a minimum concentration of 1.5 µg/ml (Mouhajir et al., 2001).

### **ANTICANCER ACTIVITY**

Ellagic acid is found in walnut leaves and fruits; it is being studied for use as a cancer therapy drug, in addition to having many other biological effects. Shells are ground and used as antiskid agents for tiers, blasting grit, activated carbon, and sometimes an adulterant of spices.

Juglone has been reported to inhibit intestinal carcinogenesis induced by azoxymethane in rats and might be a promising chemo-preventive agent in human intestinal neoplasia. Walnut methanolic extracts obtained from *J. regia* seed, green husk and leaf showed concentration dependent growth inhibition against human renal cancer cell lines A-498, 769-P and the colon cancer cell line Caco-2. Concerning A-498 renal cancer cells, all extracts exhibited similar growth inhibition activity, walnut leaf extract showed higher antiproliferative efficiency than green husk or seed extracts (Carvalho et al., 2010).

### **CLINICAL STUDY**

A daily intake of 43 to 57g of walnuts incorporated into Japanese diet for 4 weeks to 40 healthy Japanese men and women lowered blood cholesterol, particularly in women (Iwamoto et al., 2000). In double-blind case with either plasma triglyceride (TG) concentration more than 350 mg/dl or total cholesterol concentration more than 250 mg/dl were randomized into two groups, group A subject were administered 6 capsules, each filled with 500 mg of the extracted walnut oil, per day for 45 days, group B individual serve as control and received placebo for 45 days. The result of this lowered plasma triglyceride level by 19 to 33% (Zibaenezhad et al., 2003). Ros et al. (2004) reported that substituting walnuts for monounsaturated fat in a Mediterranean diet improves endothelium-dependent vasodilation (EDV) in hypercholesterolemic subjects. A daily intake of 8-13 walnuts for 4 weeks significantly improves the EDV of 21 hypercholesterolemic males and females. On the other hand, walnut-enriched meals effectively prevented post prandial lipidemia where triacylglycerol was significantly reduced (Bellido et al., 2004).

### **TOXICITY**

Walnuts have some toxic properties also. Juglone is excreted by the roots of black walnut and other walnuts and is toxic to many other plants (i.e., it is allelopathic). Even dead roots can release juglone for years after the tree is gone. Black walnuts should be kept away from most other plants, particularly vegetable gardens. The most susceptible plants include asparagus, cabbage, eggplant, pepper, tomato, potato, apple, pear, blueberries, bacberries, azaleas and rhododendrons, some pines, silver maple, ornamental cherries and crabapples, crocus, some chrysanthemums, columbine, lilies and petunia. The 95% ethanol, petroleum ether and ethyl acetate extract of green walnut hull have obvious anti-feeding effect on armyworm and the small vegetable-moth (Me-zhi et al., 2006).

### **USES OF WALNUT BARK:**

Juglone from black walnut fruits and bark acts against dermatomycosis (skin fungi), being first used for this purpose by Greeks and Romans. *Juglans insularia* is used in Cuba as an herb decoction in bath water to treat various skin diseases of children. Walnut bark is used as a dentifrice in Pakistan. Black walnut tincture, an extract made with grain alcohol, is derived from fresh green hulls of the black walnut tree. It is said to kill adult and developmental stages of at least 100 parasites. It is touched as a great antiseptic that is high in iodine, and excellent for the treatment of any kind of fungal condition. It is good vermifuge for pineworm, ringworm, and other parasites, and it even removes warts and treats psoriasis. The tincture is generally used in conjunction with wormwood and cloves as part of a complete parasite-eradication program. The benzene, methanol and ethanol soxhlet extracts of *J. regia* stem bark on adult Indian earthworm, *Pheretima posthuma* exhibited significant anthelmintic activity as comparable to that of standard drug Piperazine citrate (Upadhyay et al., 2010a).

### **OTHER USES**

The seeds contain unusual fatty acids which are industrially important, as they are used in protective coatings, dispersants, pharmaceuticals, cosmetics, soaps and a variety of synthetic intermediates as stabilizers in plastic formulations. The wood is of very high quality, and is used to make furniture, and gunstocks. The dye is used as a coloring and tonic for dark hair.

### **REFERENCES**

Bellido C, Lopez-Miranda J, Blanco-Colio LM, Perez-Martinez P, Muriana FJ, Martin-Ventura JL, Marin C, Gomez P, Fuentes F, Egido, Perez-Jimenez F (2004). Butter and walnuts, but not olive oil, elicit postprandial activation of nuclear transcription factor KB in peripheral blood mononuclear cells from healthy men. *Am. J. Clin. Nutr.*, 80: 1487-1491.

Carvalho M, Ferreira PJ, Mendes VS, Silva R, Pereira JA, Jenimo C. Silva BM (2010). Human cancer cell antiproliferative and

antioxidant activities of *Juglans regia* L. *Food Chem. Toxicol.*, 48: 441-447.

Davis L, Stonehouse W, Loots DT, Mukuddem-Petersen J, Van Der Westhuizen F, Hanekom SJ, Jerling JC (2007). The effects of high walnut and cashew nut diets on the antioxidant status of subjects with metabolic syndrome. *Eur. J. Nutr.*, 46: 155-164.

FAO (2011). Production with walnut with shell by countries. Retrieved 2013-08-26.

Gandev, S (2007). Budding and grafting of the walnut (*Juglans regia* L.) and their effectiveness in Bulgaria (Review). *Bulgar. J. Agri. Sci.*, 13:683-689.

Iwamoto M, Sato M, Kono M, Hirooka Y, Saka K, Takeshita A, Imaizumi K (2000). Walnuts lower serum cholesterol in Japanese men and women. *J. Nutr.*, 130: 171-176.

Martinez ML, Labuckas DO, Lamarque AL, Maestri DM (2010). Walnut (*Juglans regia* L.): genetic resources, chemistry, by-products. *J. Sci. Food. Agric.*, 90: 1959-1967.

Mei-zhi Z, Bing-nian J, Cai-xia J, Chao-bin L (2007). Study on Extraction Conditions of Active Antiviral Substance from Walnut Leaves. *Chemistry and Industry of Forest Products*. 02 [Abstract].

Mei-zhi Z, Feng-yun Z, Hua W, Wei W (2006). A Study on the Bioactivity of Secondary Metabolites from Walnut Green Gull University. *Journal of Northwest Forestry University-01* [Abstract].

Mouhajir F, Hudson JB, Rejdali M, Towers GHN (2001). Multiple antiviral activities of endemic medicinal plants used by Berber people of Morocco. *Pharm. Biol.*, 39: 364-374.

Ros E, Nnez I, Perez-Heras A, Merce S, Gilabert R, Casals E, Deulofeu R (2004). Walnut diet improves endothelial functions in hypercholesterolemic subject. *Circulation* 109: 1609-1614.

Taha NA and Mohammed A Al-wadaan (2011). Utility and importance of walnut, *Juglans regia* Linn: A review. *African Journal of Microbiology Research* Vol. 5(32), pp. 5796-5805.

Upadhyay V, Kambhoja S, Harshaleena K, Veeresh, Dhruva K (2010a) Anthelmintic activity of the stem bark of *Juglans regia* Linn. *Res J. Pharm. Phytochem. (RJPP)* 2: 465-467

Zibaeenezhad MJ, Rezaiezadeh M, Mowla A, Ayatollahi SMT, Panjehshahin MR (2003). Antihypertriglyceridemic effect of walnut oil. *Angiology.*, 54: 4.

## Status of Walnut cultivation in Himachal – Problems and future strategies

**B.S. Thakur**

Associate Director (Res.&Extn.)  
Regional Horticultural Research Station,  
Dr YS Parmar University of Horticulture and Forestry, Mashobra, Shimla (HP)- 171 007

The walnut (*Juglans regia* L) popularly known in English as Persian walnut is a native of the North-Western Himalayas and is found growing between the elevations of 1200 to 2200 m above mean sea level. At present about 4625 ha area is under walnut with a production of about 1700 metric tones. In fact, there has been a rapid development in the cultivation of temperate fruits in the state, however cultivation of walnut on scientific lines has remained neglected due to several reasons like non availability of vegetatively propagated planting material, long Juvenile period, raising of plantations on marginal lands, large tree size, lack of suitable varieties, pollination problems, lack of proper cultivation practices etc. There are no established walnut plantations in the state, however, seedling trees are found growing scattered in the districts of Kinnaur, Shimla, Kullu, Mandi, Chamba, Sirmour, Solan and Kangra. By far, great majority of trees in Himachal are of seedling origin that have a long Juvenile phase, are highly variable in vigour, quality with low yields. In certain parts of the state, the planting of walnut tree is not considered to be auspicious and no serious attempt seems to have been made to plant budded or grafted trees. Any seedlings that come up in nature are allowed to grow which has resulted in the preponderance of inferior trees.

There is still a great potential for bringing more area under this fruit in the form of regular plantations where large areas of wasteland are lying vacant. Besides, the demand for walnut kernel is increasing both in the Indian and International market due to its high nutritive value especially the omega -3-fatty acids which has been reported to reduce the risk of cardiac arrest.

No doubt, some selections (Gobind Pratap, Solding, Kainthla, Roopa etc.) have been made in the recent past but still there is a great scope for new selections with desirable traits as the genetic variability of walnut in the state has not been fully harnessed. Efforts are required to be made to explore the niche area of walnut and identify potential seedlings from the germplasm that could be released as a cultivar or seedling selections. The following characters should be taken into consideration while selecting a new cultivar/selection.

- 1) The nuts should be medium to large in size.
- 2) The nuts should be smooth and light coloured.
- 3) Should be medium shelled with good shell seal.
- 4) High kernel to shell ratio.
- 5) The most important character is the colour of kernel which should be preferably white.
- 6) Should separate easily from the shell.
- 7) Should have good taste and flavour.

### PROBLEMS

The walnut production in Himachal is beset with the problems of;

- a) Low productivity.
- b) Lack of suitable root stocks and superior scion cultivars.
- c) Non availability of vegetatively propagated planting material in sufficient number.
- d) Inadequate knowledge of cultural practices (Training, Pruning, Fertilization, irrigation etc.).
- e) Existence of dichogamy - pollination problems.

- f) Ignorance about the knowledge of insect pests and diseases.
- g) Improper harvesting and handling techniques.
- h) Inadequate knowledge about processing and marketing.

#### FUTURE STRATEGIES

In order to popularize walnut cultivation on a commercial scale the following points need to be taken care of;

- 1) Extensive survey of walnut growing areas to identify promising strains with desirable traits.
- 2) Introduction of new varieties with lateral bearing habit. These varieties achieve fruit set more quickly and have an elevated level of productivity. Some of the lateral bearing cultivars that needs to be imported are Chandler, Chico, Gillet, Payne, Tulare, Fernor. These varieties have all the desirable traits as mentioned above.
- 3) Production of sufficient planting material of improved strains for supply to the orchardists.
- 4) Strengthening of research on the standardization of rootstock, training and pruning, standardization of harvesting stage for quality kernel production.
- 5) Strong coordination among different walnut growing states for exchange of germplasm to study their performance under different agro climate zones in the country.
- 6) Top working of inferior seedling trees with improved scion cultivars on a large scale.
- 7) Development of protocol for micro-propagation of walnut.

## IMPROVING THE EFFICIENCY OF WALNUT INDUSTRY IN INDIA: LATERAL BEARING VARIETIES AND IMPROVED POST HARVEST PRACTICES

**Navin Chandra Nainwal 1 and Kanchan Nainwal 2**

**1** Assistant Director, Amity Institute of Horticulture Studies & Research, Amity University Uttar Pradesh, Noida-201303, Gautam Budha Nagar, Uttar Pradesh, India  
**2** Assistant Professor, Department of Agronomy, G.B. Pant University of Agriculture and Technology, Pantnagar-263145, Uttarakhand, India

#### ABSTRACT

There is a huge demand for walnuts in the country because of its immense use in food, pharmaceutical and cottage industries. To expand the area the availability of grafted plants of walnuts is a primary requirement; and especially introduction of new and improved and high yielding lateral bearing varieties having quality kernels for getting good economic returns to the farmers. The recommended varieties are Chandler, Serr, Howard, Pedro, Ashley, Tahma and Lara, Hartley, Franquette, Meylanaise, Ronde de Montignac, Fernor, Fernette, as per the soil and climatic condition of the region.

Emerging technological innovations will provide greater opportunity for more rapid communication and the benefits of increased exchange of ideas as we address the walnut problems of the future. Walnut growing suffers from lack of suitable methods of propagation, inadequate vegetatively propagated plants, lack of standard rootstocks/ cultivars, problems of re-establishment of nursery plant in the orchard, specific climatic requirements, pollination behaviour and lack of suitable pollinizers, long juvenile period and harvesting. The progress made in the recent years to overcome the above cultivation problems with a view to revive the walnut industry with export potential has been discussed (Sharma & Kumar, 2001).

The Himalayan State i.e. Arunachal Pradesh, Himachal Pradesh and Uttarakhand have massive scope of expansion of area under walnut by convincing and motivating farmers, by providing them good quality grafted plants, by establishing nurseries and mother orchards of lateral bearing high yielding varieties. The walnut growers also have to come forward united in a form of walnut grower associations to formulate strategy with government to get incentives under some scheme or mission.

The emphasis should be given on identification of areas for expansion in these states, establishment of Mother Nurseries for preparation of good quality lateral bearing disease free grafted plants. The cultivation and production of walnut certainly improve the nutrition status, employment and economy of the rural farmers of Himalayan states in India.

#### INTRODUCTION

Walnuts (*Juglans regia*) are plants in the family Juglandaceae. These are light demanding species that benefit from protection from wind, and are also drought-tolerant. Walnut is believed to have originated in Iran and the areas surrounding it. The army of Alexander the Great brought it to Europe. Then it moved from Italy to Spain, France, etc to the southern USSR and went to China from Tibet. In India, walnut production was earlier confined to Jammu & Kashmir and it appears that it spread to Himachal Pradesh and Uttarakhand states of the country. Some limited variability may also exist in eastern and north-eastern regions, viz. Darjeeling, Sikkim and Arunachal Pradesh. The most common vernacular name for walnut in the region is akhrot, but other names are also known, such as dun in Kashmir and khod in parts of Himachal Pradesh and Uttarakhand.

Jammu and Kashmir is a major walnut producing state contributing more than 85 per cent of total production of the country. Around 30,800 hectares is under walnut cultivation in the country, with the annual production at 36,000 tonnes (Nainwal et al, 2004). The domestic and external demand has been increasing over the years and is projected to 75,000 tones by 2020. Therefore, it is necessary to bring additional area to meet the projected demand.

Presently production of walnut in India is around 1.2 tonne per hectare which is very low in comparison to 3-5 tonne/hectare in advanced countries. India exports walnut to more than 40 nations with earnings of more than Rs 300 crores (USD 54 Million/ EUR 43 Million) of foreign exchange annually. The top importers of Indian walnut include Egypt, UK, China, Germany, France, Netherlands, UAE, Greece, US, Kuwait, Australia, Hong Kong and Spain.

Walnuts are rich in proteins, fats and minerals and are a concentrated source of energy. These contain a good amount of vitamin B group and are the richest in vitamin B6 among all the nuts. Walnut is having very high nutritive values and good for curing heart diseases. Immature fruits of walnut can be utilised for preparing various products like pickles, chutneys, fresh juices and syrups. The fruit has excellent flavour and is mainly consumed as a dry fruit. Commercially, it is used for preparation of bakery products, chocolates, ice-creams, ornaments, oils, and confectionary and salad products. Shells are used in glue and plastics and for making solutions for cleaning and polishing surfaces.

### WORLD PRODUCTION

The major walnut growing countries are China, Iran, USA, Turkey, Ukrain, Mexico, France and India. Table I shows world production of walnuts and it is evident that China stands first followed by Iran, USA, Turkey, Ukrain, etc. India stands eighth in production.

**Table-1 TOP PRODUCTION WALNUT WITH SHELL (FAO-2011)**

Rank	Area	Production (Int \$1000)	Flag	Production (MT)	Flag
1	China	2570386	*	1655510	
2	Iran (Islamic Republic of)	753023	*	485000	F
3	United States of America	649326	*	418212	
4	Turkey	284503	*	183240	
5	Ukraine	174825	*	112600	
6	Mexico	149791	*	96476	
7	France	59536	*	38346	
8	India	55894	*	36000	*
9	Romania	54455	*	35073	
10	Chile	54 341	*	35000	F
11	Greece	46268	*	29800	
12	Serbia	37166	*	23938	
13	Egypt	28551	*	18389	Im
14	Italy	27591	*	17771	Im
15	Belarus	24798	*	15972	Im
16	Uzbekistan	23929	*	15412	Im
17	Germany	23418	*	15083	Im
18	Spain	22710	*	14627	
19	Afghanistan	21584	*	13902	
20	Republic of Moldova	21517	*	13859	

\*: Unofficial figure; [ ]: Official data; F: FAO estimate; Im: FAO data based on imputation methodology

### INDIAN SCENARIO

In India, walnuts are grown in Jammu & Kashmir, Arunachal Pradesh, Himachal Pradesh and Uttarakhand. Jammu & Kashmir contributes around 98 per cent of the country's output. In Jammu & Kashmir walnut cultivation is common in Badrawah, Poonch, Kupwara, Baramulla, Bandipora, Gandarbal Budgam, Srinagar, Anan-tanag and other hilly areas. Walnut is grown in Himachal Pradesh and Uttarakhand to a limited extent.

**Table-2 STATEWISE AREA & PRODUCTION REPORT OF ALMONT/WALNUT**

S.No.	Year	State	Area ('000'MT.)	Percentage of Total Area	Production ('000'HA.)	Percentage of Total Production	Productivity
1	2007-2008	Arunachal Pradesh	3.800	33.333	0.100	33.333	0.026
		Jammu & Kashmir	98.900	32.373	156.800	29.981	1.585
		Uttarakhand	18.600	33.333	16.300	33.333	0.876
		H.P.	11.000	33.233	3.300	32.039	0.300
2	2008-2009	Arunachal Pradesh	3.800	33.333	0.100	33.333	0.026
		Jammu & Kashmir	103.000	33.715	152.500	29.159	1.481
		Uttarakhand	18.600	33.333	16.300	33.333	0.876
		H.P.	11.100	33.535	3.700	35.922	0.333
3	2009-2010	Arunachal Pradesh	3.800	33.333	0.100	33.333	0.026
		Jammu & Kashmir	103.600	33.912	213.700	40.860	2.063
		Uttarakhand	18.600	33.333	16.300	33.333	0.876
		H.P.	11.000	33.233	3.300	32.039	0.300
	<b>Total</b>		<b>405.8</b>	<b>400.000</b>	<b>582.5</b>	<b>400.000</b>	<b>2.925</b>

NHB Data 2012

### VARIETIES GROWN IN DIFFERENT STATES

Significant increases in walnut production can be expected in many countries where local selections and new cultivars are being evaluated which will require expanded market development. Those engaged in production research must become more closely aligned with the processing and marketing industry to ensure that the quality aspects of walnuts are considered in relation to commercial demand and processing technology (Ramos, 1997).

In India the seedling populations exhibit tremendous genetic variation in tree and phenological traits, colour, shell sealing and in hardness of nuts as well as quality and percentage of kernel. Therefore, systematic evaluation of this genetically diverse germplasm needs to be taken up immediately for selecting superior genotypes to build gene repository. Fortunately the selection for most of the traits, being highly heritable, can be accomplished easily (Sharma & Kumar, 1994).

The several varieties of walnuts grown in different states of India are:

<b>Jammu &amp; Kashmir</b>	Lake English, Drainovsky and Opex Caulchry
<b>Himachal Pradesh</b>	Gobind, Eureka, Placentia, Wilson, Kashmir Budded
<b>Uttarakhand</b>	Chakrata Selections

The Black More, Hartley, Tutle-31, Franquette, Serr, Ashley, Vina, Howard and Tutle-16 are some of the varieties grown in India. The planting distance recommended for area expansion of lateral bearing varieties are 8 X 6 Meter and a grower can plant 200 trees per hectare of grafted walnut. Walnuts produced in India have different sizes and shapes and are categorized into paper-shelled, thin shelled, medium-shelled and hard-shelled (APEDA-website-[www.apeda.org](http://www.apeda.org)).

Walnuts in India are found in different sizes and shapes. The Indian walnuts are categorized into 4 categories viz., paper-shelled, thin-shelled, medium-shelled and hard-shelled.

These are classified on the basis of their size and shell cracking rate also. The main grades are:

1. Indian special light half
2. Indian light broken
3. Indian light pieces

4. Indian light crumbs
5. Indian light my-fire
6. Indian light amber halves
7. Indian light amber broken
8. Indian light amber pieces

As a whole, the walnut crop in India has cyclical production with year-to-year fluctuations ranging from 5 to 20 per cent depending on the weather.

#### HARVESTING

Nuts are collected from the ground between the months of September and October. After collecting nuts, these are cleaned, washed and dried by spreading them on sheets or floor. Sometimes in order to improve the appearance of nuts, these are bleached with either alkali or acid solution. Nuts which fall down with their husks intact are generally second-grade. After removal of the husks, cleaning and drying, they should be stored and marketed separately to fetch a higher price. Delay in drying causes rapid loss in nut quality and makes walnuts susceptible to the mold. Drying of nuts stabilizes the product's weight and prolongs storage life.

Kernels are considered mature when oil accumulation is complete. This is generally indicated by browning of the internal packing tissue. However harvest should not begin until the husk is well split and separated from the shell. Low temperature and high Relative Humidity advance dehiscence.

The edible kernel is surrounded by a husk that dehisces as the kernels near maturity. The husk, which should be well split and relatively dry at harvest, is generally lost when the nuts fall to the ground. Harvested nuts (the shell and kernel) may be 35% or more water. Nuts are quickly swept from the orchard floor to avoid damage to the fragile nut, and are then dehydrated in forced air dryers to 8% water content. The temperature of the drying air is kept low at < 43oC to avoid damage leading to kernel rancidity.

#### Production, Supply and Demand Data Statistics:

Walnuts, Inshell Basis India	2011/2012 Market Year Begin: Oct. 2011		2012/2013 Market Year Begin: Oct. 2012		2013/2014 Market Year Begin: Oct. 2013	
	USDA Official	New Post	USDA Official	New Post	USDA Official	New Post
Area Planted	0	36,600	0	36,600		36,600 (HA)
Area Harvested	0	31,000	0	31,000		31,000 (HA)
Bearing Trees	0	1,400	0	1,400		1,400 (1000 TREES)
Non-Bearing Trees	0	200	0	200		200 (1000 TREES)
Total Trees	0	1,600	0	1,600		1,600 (1000TREES)
Beginning Stocks	350	625	750	5,905		4,375 (MT)
Production	35,000	40,000	37,000	36,000		40,000 (MT)
Imports	0	0	0	0		1,000 (MT)
Total Supply	35,350	40,625	37,750	41,905		45,375 (MT)
Exports	12,800	12,720	15,000	12,530		13,000 (MT)
Domestic Consumption	21,800	22,000	22,000	25,000		29,000 (MT)
Ending Stocks	750	5,905	750	4,375		3,375 (MT)
Total Distribution	35,350	40,625	37,750	41,905		45,375 (MT)
TS=TD		0		0		0

\*: Unofficial figure; [ ]: Official data; F: FAO estimate; Im: FAO data based on imputation methodology

#### WALNUT KERNELS

The major quality characteristic of kernel is a high oil content (55 to 65% dry weight) that is free from bad flavors caused by oxidation of polyunsaturated fatty acids. The important criterion is maintaining kernel water content below 4%. It retards the progressions of events that leads to rancidity and also prevents mold growth and maintain the kernel's crispness.

The skin covering the kernel contains chemicals that protect fatty acids in the kernel from becoming rancid. Light colour kernels earn a higher price because the light colour indicates that the kernel still has a relatively long shelf life (Hendricks et al., 1998). Retention of light colour influenced by the integrity of the seal between the two halves of the shell, because the shell is an important barrier to O2 entry.

The walnut kernels are an ideal source of nutrition and add a rich taste to any dish. The inclusion of walnuts in the diet is recommended as a dietary source of polyunsaturated fatty acids and other nutrients, and to improve the lipid profile in hyperlipidemic individuals. Cardiac benefits of walnut consumption are described. Walnuts have also been studied in metabolic syndrome with limited benefit demonstrated.

#### GRADE, SIZES AND PACKAGING

In shell and shelled grades exist and are primarily determined by size, degree of kernel fill, colour and freedom from defects and foreign material. Freedom from off-flavors (rancidity) is important. Shelled kernels held for a long period are particularly susceptible. Packaging should be moisture proof. Shelled products should be packaged in airtight, moisture proof, opaque or foil packages to maximize shelf life (Mate et al., 1996).

#### STORAGE

Low water content and high fat content of the kernel make it relatively metabolically stable and able to tolerate low temperatures. The primary objectives of the storage are to maintain the low water content attained after preliminary drying (for enzyme activity suppression, retention of texture and reduction of microbial activity) and limit exposure to O2 to minimize rancidity. The optimum temperature range of storage is 0 to 10oC with the lower temperature being better. Within this temperature range, a 50 to 65% Relative Humidity will maintain walnuts at 4% moisture (Beuchat, 1978). The low water content of properly stored walnuts makes them relatively inert metabolically.

Walnuts are stored in gunny bags in a small ventilated room free from excess humidity. For export purpose, these are packed in double gunny bags. Walnuts are consumed in the winter season, so the problem of their shelf life is seldom felt. The quality of nut meat, however, deteriorates due to darkening and rancidity which are affected by air, moisture, heat and light.

#### MARKETING

Walnuts are marketed as nuts or kernels. These arrive into the market from September onwards and the kernels follow two to three weeks afterwards; the peak arrival season being from November to January. Walnuts produced in Himachal Pradesh and Uttarakhand are consumed almost locally, whereas in Jammu & Kashmir the produce is brought to the assembly market in Jammu, which is the biggest market for walnuts in India. Efforts have been made to assemble quality nuts in Shahia market of Chakrata hill (Dehradun) and send to Delhi market. The nuts in the market are roughly sorted out and empty, stony, highly blighted, shriveled, moldy and darkened nuts removed. Thin shelled nuts are packed in wooden boxes, while medium-shelled nuts are packed in gunny bags. The product then moves either to the commission agents or the exporters' godowns.

#### India: Commodity, Walnut, Price Table



### India: Commodity, Walnut, Price Table

#### Production, Supply and Demand Data Statistics:

Prices Table			
Country	India		
Commodity	Walnuts, Inshell Basis		
Prices in	Rupees	Per uom	100 Kg
Year	2012	2013	% Change
Jan	15,000	17,000	13
Feb	12,000	17,200	42
Mar	12,000	17,200	42
Apr	10,000	17,500	70
May	12,000	17,500	46
Jun	12,500	18,000	44
Jul	12,500	18,000	44
Aug	13,500	17,000	31
Sep	15,000		-100
Oct	15,000		-100
Nov	17,500		-100
Dec	18,000		-100
Exchange Rate	Rs. 65.96	Local Currency/US \$	
Date of Quote	9/9/2013	MM/DD/YYYY	

Source: Trade and Industry sources (average week-end prices in the Delhi Wholesale Market); GAIN Report, India, Tree Nut Annual, 2013

### India: Walnut Prices

PRICE	UNITS	2012/13	2011/12	2010/11
<b>Wholesale Price of FAQ Walnut in Kashmir</b>	<b>(Rs/Kg)</b>	<b>130-175</b>	<b>100-150</b>	<b>80-150</b>
<b>Export Price (C &amp; F Europe)</b>				
Light Halves	US\$/MT	8,000- 9,000	10,500 7,500-	4,000- 11,000
Light Broken/Amber Halves	US\$/MT	6,500- 8,000	9,000 6,800-	6,800- 10,000
Amber Broken	US\$/MT	4,000- 7,000	7,100 6,000-	4,500- 9,300

Source: Market Sources; GAIN Report, India, Tree Nut Annual, 2013

### Exports

The country has exported 11800 MT of Walnuts to the world during the year 2012-13. The major importing countries of walnut from India are United Kingdom, Egypt Arab Republic, Netherlands, Germany, United States, China, Australia and Taiwan.

As far as the world trade in walnuts is concerned, it is traded in two forms, viz, shelled and in-shell. USA is a major exporter of both shelled and in-shell walnuts. In shelled walnut exports, USA is followed by Chile, Mexico, China, Republic of Moldova, India and others. Whereas in inshell walnut exports, USA is followed by France, Mexico, Chile, China, Ukraine, etc. In shelled walnut imports, Germany ranks first followed by Japan, Spain, Turkey, France and the UK. While for inshell walnuts, Italy is the major buyer followed by Spain, Mexico, Germany, Turkey and the Netherlands. As a whole, walnut exports from India have increased over the years. However, this is insufficient as normally 45-50 per cent of the production is consumed domestically.

### India: Commodity, Walnut, Export Trade Matrix

Export Trade Matrix			
Country	India		
Commodity	Walnuts, In Shell Basis		
Time Period Exports for:	April-March 2011	Units:	Metric Tons 2012
United States	233	United States	730
'Others'		'Others'	
Spain	1,785	United Kingdom	2,278
Germany	1,658	Egypt	1,705
Netherland	1,438	China	1,178
Egypt	1,405	Germany	1,038
United Kingdom	1,355	Netherlands	1,013
France	1,078	France	708
Denmark	473	Australia	598
UAE	375	Taiwan	493
Kuwait	342	Spain	463
Australia	335	Hong Kong	418
Sweden	295	Cyprus	345
Greece	283	Denmark	305
Total for 'Others'	10,822		10,538
Others not Listed	1,665		1,262

**Note: MY 2011 refers to Indian Fiscal Year (IFY) 2011/12 (April-March) as most exports happen during October through March**

Source: MY 2011 – Trade sources and Global Trade Atlas; MY 2012 – Provisional Trade Estimates

Even though the domestic and external demand for walnut has increased over the years, in India walnut cultivation could not develop rapidly due to a number of constraints including insufficient scientific research, improper and random classification, long gestation period and low free density. Apart from these, there are several pre-harvest and post-harvest problems in this sector. Constraints in walnut trade include awareness of maturity indices, method of harvesting and non-scientific dehulling.

There is lack of orchard management facility, lack of grading practices, awareness about hygienic protocols and integrated handling system to manage the nuts. There is non-adoption of international standards on grades as well and lack of storage and drying, processing, storage facilities. There is increased competition from overseas suppliers i.e. California, Mexico, China and other countries which are competing with India especially in the EU market.

The domestic and external demand has been increasing over the years. As per the projected demand, we need to expand walnut production in the states like Uttarakhand, Himachal Pradesh and Arunachal Pradesh which have suitable agro-climatic conditions for growing walnut. Other steps to be taken are:

1. Promotion of nurseries in private sector to fulfill the huge demand of grafted plants of walnut.
2. Introduction of new and improved and high yielding lateral bearing varieties having quality kernels for getting good economic returns to the farmers.
3. Linking of Institutions and Universities would be a great help support in this direction. The U C Davis is one of best University in the world working on walnut and other nuts, California Walnut Board, Walnut Club UK etc.
4. Promotion of drip irrigation system in the walnut orchards to increase the yield and improve the nut quality.
5. Dissemination of latest production technology among walnut growers through distribution of package and Practices
6. Training and skill up-gradation of nursery men on efficient methods and providing those facilities for vegetative propagation.
7. Rejuvenation of old and sick walnut orchards
8. Establishment of walnut processing units consisting of pre-cooling and storage facilities
9. Create technical awareness among farmers for plantation of walnut
10. Overcome the problem of pests and diseases

#### Reference:

1. Beuchat, L.R. 1978. Relationship of water activity to moisture content in tree nuts. J. Food Sci. 43:754-755, 758.
2. Hendricks, L.C., W.C. Coates, R.B. Elkins, G. H. McGranaham, H. A. Phillips, D.E. Ramos, W.O. Reil and R.G. Snyder, 1998. Selection of varieties. In: Walnut Production Manual, D.E. Ramos(ed) Univ. of Calif., Div. Agric. Nat.Res., Pub.No.3373, pp. 84-89
3. Mate, J.I., M.E. Saltveit and J.M. Krochta. 1996 Peanut and walnut rancidity: Effects of oxygen concentration and RH. J. Food Sci. 61:465-468, 472.
4. Ramos D.E. (1997), Walnut industry in the world: prospects for research and production, ISHS Acta Horticulturae 442: III International Walnut Congress
5. APEDA-website: [www.apeda.gov.in](http://www.apeda.gov.in)
6. Nainwal N. C. 2004, Development of Temperate fruits in Uttarakhand
7. S. D. Sharma, K. Kumar, Present Status and Problems of Walnut cultivation in India, ISHS Acta Horticulture 544:IV International Symposium, 2001
8. S. D. Sharma, K. Kumar, Genetic diversity and scope of walnut improvement in India, H. Schmidt and M. Kellerhats (Eds.), Progress in Temperate Fruit Breeding, 447-449@1994 Kluwer Academic Publishers.

## Selection of Unique Walnut and its Cultivation

**K.K.Pramanick, D.K.Kishore, Y.P. Sharma and Santosh Watpade**

Indian Agricultural Research Institute  
Regional Station (Cereals & Horticultural Crops), Amartara Cottage,  
Cart Road, Shimla-171004 (H.P.) Tel/Fax:0177-2655305/2808766  
E-mail: [head\\_shimla@iari.res.in](mailto:head_shimla@iari.res.in) and [head\\_iarismil@yahoo.com](mailto:head_iarismil@yahoo.com)

#### ABSTRACT:

Walnut (*Juglans regia*) is a nutritious crop and its kernel (the edible portion) is very rich in protein, fat, minerals and is a concentrated source of energy. Walnut oil is used for edible purposes as it contains Omega-3 fatty acid, antioxidants and vitamins. However, the cultivation of walnut is not very popular because of its late bearing characteristics. This problem has been overcome by the identification and evaluation of a unique walnut at the IARI Regional station, Shimla. This selection came into bearing in the second year of its grafting. The fruits on this walnut are borne in lateral as well as terminal position. Actually it has multiple bearing habit. The kernel is of good quality with the shelling per cent of 45-50. This unique walnut can increase the production in India which have very good quality for export potential also. There is a great demand for this walnut material to be fulfilled in near future.

#### INTRODUCTION:

Nut trees are a promising food resource but this potential is not adequately utilized world-over. However, they are rich in protein and fat as well as in mineral and some vitamins. Nut trees also yield valuable timber when they are old. At present the productivity of the nuts is low or on a decreasing side as they come into bearing at a very late stage.

Although the walnut has been appreciated since ancient times, commercial walnut orchards only started to be planted at the end of the last century. Californian farmers are pioneers in modernizing and technifying this crop and now China is the main walnut producer in the world. During the last ten years an important change has been detected in walnut producing countries: the use of grafted plants with highly productive and well adapted cultivars in new orchards and the search for nut quality through an adequate orchard, harvest and post harvest managements.

A unique walnut plant is being evaluated at the IARI regional station, Shimla. It was collected from Chamba region of Himachal Pradesh which came into bearing in the second year of its grafting. The known varieties of walnut normally take 10 to 15 years to come into bearing. Sometimes it takes even more. The fruit appears to be borne in lateral position as well as terminally. This is a characteristic of newly evolved early, good quality and heavy bearing walnut cultivars. However, no such cultivar is reported in India so far. The leaf size and annual shoot increment is also much more than other walnut plants collected during the same survey. They are also not yet in bearing stage. The fruit weight with husk was 58.85gm; where as, without husk (nut) weight recorded 23.5gm. The length of the fruit with husk (nut) it was 43.85cm. The nut is thin shelled. Kernel colour of light yellow and good in taste

According to Ramos et al. (1984) selection of clones that produce pistillate flowers on lateral buds has resulted in Persian walnut, *Juglans regia* lateral bearing Persian walnut cultivars tend to be more precocious and are better suited to high yielding, high density plantings.

High development costs for establishing a walnut orchard demand the crops at an early age. Cultivars displaying lateral bud fruitfulness generally come into production well in advance of non-lateral bearing cultivars.

#### AREA AND PRODUCTION

The total area under walnut in India is 149.5 thousand hectares with an annual production of 284.4 thousand MT. The country has exported 58,41,556 MT of Walnuts to the world for the worth of Rs.231 crores during the year 2011-12.

**Table 1: Area and Production of walnut in India**

STATES	2011-12		(estimated) for 2012-13	
	A	P	A	P
Jammu & Kashmir	120.5	260.8	128.94	254.02
Uttarakhand	19.6	21.8	19.64	21.81
Arunachal Pradesh	4.8	0.6	4.78	0.57
Himachal Pradesh	4.6	1.2	4.61	0.44

Source: NHB, 2013

**MAJOR EXPORT DESTINATIONS (2011-12):**

The major importing countries of walnut from India are Spain, Egypt Arab Republic, Germany, Netherlands, United Kingdom, France, and Taiwan.

**USES AND COMPOSITION:**

Walnut kernel (the edible portion) is very rich in protein, fat and minerals and is a concentrated source of energy. The walnut kernels are used for dessert purposes in confectionery and for extraction of oil and as a dry fruit. Immature fruits are used for making pickles, chutneys, marmalades, juice and syrups. Walnut oil is used for edible purposes as it contains Omega 3 and 6 fatty acid, artist oil colours, varnishes and soap making. Walnut shell flour is used as ingredient in plastic pillers, battery cases, moulding resin forms, industrial tile and as insecticide spreader. Walnut timber is used for furniture, carving and making butts of guns. Composition of walnut is given in tile table 2.

**Table 2: Composition of Walnut**

Content	Amount/100g
Water	3.5 %
Protein	14.8 g
Fat	64.0 g
Carbohydrate	15.8 g
Fibre	2.1 g
Ash	1.9 g
Calcium	99 mg
Phosphorus	380 mg
Iron	3.1 mg
Sodium	2 mg
Potassium	450 mg
Magnesium	131 mg
Vitamin A	30 I.U
Thiamine	0.33 mg
Riboflavin	0.13 mg
Niacin	0.9 mg
Vitamin C	2 mg

Source: NHB, 2013

**CONSTRAINTS FOR WALNUT CULTIVATION:**

Since the entire walnut plantation is of seedling origin, there is considerable variation in nut crop production. The development of walnut cultivation has in addition faced a number of constraints, including:

- non-availability of plant material of known pedigree and characteristics produced by vegetative propagation
- an absence of proper classification of local varieties
- non-availability of good rootstock
- a long gestation period
- low tree density per hectare
- low productivity.

**LEADING VARIETIES FOR CULTIVATION**

Walnut (*Juglans* sp.) is the most important temperate nut fruit of the country. Walnut in India are found in different sizes and shapes. The Indian walnuts are categorized into 4 categories viz., paper-shelled, thin-shelled, medium-shelled and hard-shelled. Walnuts flourished at altitudes of 900 to 3000.

**VARIETIES:**

**Walnut varieties grown in different states of India are:**

Jammu and Kashmir	Lake English, Drainovsky and Opex Caulchry
Himachal Pradesh	Gobind, Eureka, Placentia, Wilson, Franquetfe, Kashmir Budded and Pusa Khor
Uttaranchal	Chakrata Selections

Source: APEDA, 2013

**Table 3: Fruit Characteristics of the walnut selection (Pusa Khor)**

With Husk			Without Husk			Dry Nuts		
On 04-09-12			On 04-09-12			On 22-09-12		
Weight (g)	Length (mm)	Width (mm)	Weight (g)	Length (mm)	Width (mm)	Weight (g)	Length (mm)	Width (mm)
59.97	61.48	44.35	23.59	43.78	32.87	12.19	43.20	34.65

**Table 4: Vegetative and Kernel Characteristics (Pusa Khor)**

Growth in Height (cm)	Growth in Tree Spread (cm)	New Growth (cm)	Shelling (%)	Oil (%)
427	295-290	65	45-50	55

The walnut is considered as one of the oldest tree species and is very valuable for food, economy and culture. Because of its importance, many researchers have tried to find the best method for improving the quality and quantity aspects.

## ROOTSTOCKS IN INDIA

Paradox (Juglans hindsii x J. regia hybrid); Dwarfing and precocious rootstock, tolerant to drought

## PROPAGATION

Walnut can be propagated either by seed or by vegetative methods. Both of these methods are described here.

### A. Seed propagation

Healthy and disease free seeds should be selected for sowing. They may be sown in lines 50 cm apart and the seed to seed distance should be kept at 25 cm. Sowing is done during mid-November to mid-January depending on the altitude and temperature. The big nuts should be selected with bright brown colour having good cracking quality of the shell. Good taste and flavour of the kernel. Higher germination rates in walnut have been achieved by sowing seed in a vertical position at a depth of 7 cm. The beds should be covered with grasses after sowing and irrigation. While preparing the beds, proper drainage facilities should be provided. However, it is advisable to avoid propagation by seed because the plants which are grown by this method take a very long time (10 to 12 years) to begin fruiting and the plant characteristics may also not be true to type.

### B. Vegetative propagation

Walnut can be propagated vegetatively by grafting, budding and stooling.

#### 1. Grafting

Tongue or whip grafting, cleft and veneer grafting during February and early March have given good results. Epicotyl grafting has also given encouraging success in tile propagation of walnut. The best period for grafting is January -February. For propagating tile plants through veneer grafting, 5-6 month old scion wood of 15 cm is grafted on the rootstock of same thickness. The selected scion wood should be defoliated 15 days prior to its detachment from the scion cultivars. The optimum time for veneer grafting under mid -hill condition is July -August. One year old seedlings of hard shelled walnut or black walnut can be used as rootstock. Scion for tongue grafting should always be selected from the tree which has already started fruiting.

#### 2. Budding

Patch budding is generally practiced to propagate walnut plants vegetatively. The best period for budding is May -June. Scion should always be selected from the tree which has already started fruiting.

#### 3. Stooling

Stool layering is a suitable method of walnut propagation and is useful for the multiplication of true to type rooted plants from a rootstock bed. One year old seedlings of a known cultivar are planted in a nursery bed at 1 sq. m. distance and headed back from 6 .8 cm above the ground in March before bud swelling. All the cut ends are painted with Chaubatia paste. In April, buds start swelling and 3 -4 shoots come out from the stock. In July, 2 -5 cm bark is removed and the ringed portion is treated with IBA 6000 ppm in lanolin base. After a week the upper end of the ringed part swells and development of root primordia is initiated. The treated shoots are then earthed up, covering the shoot even beyond the ringed portion. Fortnightly irrigation is given to the stool bed to keep the moisture constant. During the second fortnight of February the shoots are unearthed. These shoots show rooting and are detached from the mother plant and planted in the main field in the month of March.

#### 4. Top working

Top working is a very useful choice for walnut production in the hilly tracts of India since a large number of young seedling trees are found producing inferior quality of nuts. Top -working is usually carried out by modified cleft grafting or bark grafting late in the spring season or when new growth occurs. The dormant scion wood should be removed from the parent tree in advance and stored in refrigerator after proper packing. Bleeding is a problem in walnut top-grafting especially when it is done in early spring which can be avoided by heading back the stock two weeks before actual operations. After grafting, the open wounds must be covered by grafting wax and if required rewaxing may be done. White washing of the stem may be done to protect them from sunburn. As the rootstock is already well established, the scion makes rapid growth and bears earlier than the transplanted trees.

## C. MASS MULTIPLICATION

The walnut micropropagation is one of the methods largely studied (Driver and Kuniyuki, 1984; Gruselle et al., 1987; Gruselle and Boxus, 1990; Marques Silva and Dias 1997; Navatel and Bourrain, 2001; Lopez, 2004; Britton et al., 2007; Vahdati et al., 2009). Driver and Kuniyuki (1984) demonstrated the feasibility of the tissue culture approach for mass propagation of Paradox (J. hindsii x J. regia) and to apply this process on a larger scale sufficient to satisfy commercial requirements. They obtained a good rate of shoot multiplication by using DKW medium with 1.0 mg/l benzyladenine (BA) and 0.001 mg/l indolilbutyric acid (IBA).

A properly proliferation rate of walnut shoot was obtained by using of MS modified medium with 1 mg/l BAP and 0.03 mg/l IBA (Gruselle et al., 1987; Gruselle and Boxus, 1990). Marques Silva et al. (1997) have obtained good results in shoots multiplication rate with DKWC medium and 1 mg/l BAP. Navatel and Bourrain (2001) have used DKW medium with BA (0.2 mg/l) and IBA (0.05 mg/l) for establishment of cultures. For shoot multiplication they have increased the concentration of BAP to 1 mg/l and have decreased the IBA concentration to 0.01 mg/l. Vahdati et al. (2009) studied the micropropagation of some dwarf and early mature walnut genotypes and for shoot multiplication was used DKW medium with 4.4 µM BAP and 0.05 µM IBA. In addition, acclimatization of in vitro grown shoots from mature walnut trees was realised (Vahdati et al., 2004).

## PLANTING

Square system of planting is commonly adopted in walnut because it is easy to layout and convenient for cultural operations and tree thinning. Pits of 1.25 X 1.25 x 1.25 m size at a distance of 10 X 10 m should be dug during September. The pits should be filled up with orchard soil mixed with 50 kg well rotten FYM, 150 g Aldrin dust, 150 g urea, 500 g each of superphosphate and muriate of potash. The best season for walnut plantation is December to January. The plant should be well fixed in the soil and the adjoining portion of scion and stock union should be at least 15 cm above the ground surface. Watering should be done soon after plantation. To protect the plant from collar rot it should be treated with Dithane Z- 78 before planting.

## MANURES AND FERTILIZERS

Walnut tree has a very extensive root system and vigorous growth, thus it requires heavy feeding. A balanced nutrition of nitrogen, potassium and phosphorus should be applied for the proper vegetative and reproductive growth. A one year old seedling requires 500 g urea and 750 g each of superphosphate and muriate of potash. The doses of fertilizer may be increased with the increase in the age of the tree. The full dose of superphosphate and muriate of potash and half dose of urea should be applied in October after picking the fruits and the remaining half dose in the month of February every year. These fertilizers should be well mixed with the soil and applied at least 30 cm away from the main stem of the plant. Every year in the month of October, 50 kg of well decomposed farmyard manure should be applied as a normal feed. Foliar application of all the micronutrients like zinc, copper, manganese, boron, iron and magnesium may be done in the month of March.

## IRRIGATION

Watering is very essential for the establishment of grafts and young plants. The water requirement, however, decreases with the development of roots in adult trees. When the trees start bearing, irrigation should be given from the time of fruit set till its maturity to reduce the fruit drop and for better filling of nuts. When the trees are grown under rainfed conditions and when the rainfall is not sufficient and well distributed, irrigation is essential for walnut cultivation. The common irrigation systems followed are flood, furrow, sprinkler and drip irrigation.

## TRAINING AND PRUNING

Walnut is both terminal and lateral bearer. It bears fruits on one year old wood which is produced either terminally or both terminally and laterally. Terminal bearing cultivars are thinned, but not headed back because vegetative growth keeps on increasing in absence of early fruiting. On the other hand, lateral bearing cultivars are both thinned and headed back in order to encourage shoot growth which gets suppressed due to early fruit production. Modified leader system of training is followed in walnut. After the first year's growth the plant is headed back above 2 m of its height. All lateral shoots on the leader are removed leaving one or two shoots at lower level on the trunk.

The primary objective of pruning of mature walnuts is to obtain regular and high production of quality nuts which is often

hampered by overcrowding of branches, insufficient production of new wood and inadequate availability of sunlight. Selective thinning out of limbs in the top and sides of the tree should be done to avoid overcrowding. The pruning operations are carried out in the dormant season but early spring is preferable. Further delay causes excess bleeding. All the cut surfaces should be treated with a tree wound dressing.

### **FLOWERING AND FRUITING**

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 seasons 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.

### **UNFAVOURABLE CLIMATE**

Pollination in walnut is carried out by wind. It is self fertile but pollination is not satisfactory in certain varieties mostly because these varieties fail to mature their pollen at the time when the female flowers are receptive. Hot spring weather hastens the development of catkins and makes them shed their pollen quickly. It does not have great effect on the development of pistillate flowers. The pollination difficulty in the established orchards can be overcome temporarily by bringing catkins from the neighboring plantations and hanging them in the trees. It can be permanently overcome by top working certain limbs with the desirable varieties. The new plantations of walnuts should be located near the existing bearing trees. Snowfall or very cold weather at the time of flowering causes poor setting of the crop.

### **HARVESTING AND YIELD**

Harvesting at proper maturity is of prime importance in the production of quality nuts. Any delay in picking after maturity of kernels deteriorates the quality and increases the incidence of mould and pests. Two indices for maturity are commonly used. A thick hull covering the nut splits on maturity causing the fall of the nut on the ground. Sometimes kernel matures earlier than hull splitting. In such cases proper maturity is assessed by observing the packing tissue between and around the kernel halves which turns brown on maturity.

Walnuts are ready for harvesting in September and October. Some nuts fall on the ground after splitting of the hull while others are forced to drop down by beating with long poles. The harvesting is repeated 2 to 3 times at intervals to collect the whole crop. The nuts are collected from the ground, cleaned, washed and dried in the sun by spreading them on a canvas sheet or floor. The dried nuts are graded according to the cultivar, size and colour, Sometimes in order to improve the appearance of nuts. These are bleached either with acid or alkali solution.

Yield of walnut varies depending on the age, size and variety of trees. A 40-year old large tree can produce as much as 175 kg nuts while an average yield is around 40 kg/tree. Full commercial bearing starts after 18 -20 years in seedling trees and 8 -10 years in grafted trees.

### **WEED CONTROL**

The herbicides such as Simazine and Diuron have been successfully used to control weeds in young and established walnut grooves. Simazine and Diuron @ 2-4 lb/acre have effectively controlled annual weeds throughout the season.

### **DISEASE CONTROL**

There are a number of diseases found attacking walnut tree. Description of these diseases along with their control measures is given below.

#### **1. Walnut blight**

This is a common bacterial disease found all over the world wherever walnut is grown. The bacterium enters all the tissues of leaves, catkins and nuts. Brown to black spots with yellowish green perimeter develop on the leaves. Florets die in the infected

catkins. Early infection causes nut drop, while late infection results in nut shriveling and discolouring.

#### **Control**

This disease can be controlled by spraying copper containing chemicals and Bordeaux mixture. The first spray is done on the opening of the female flower followed by subsequent sprays at 7 to 14 days interval depending on the weather conditions. Metallic copper is sprayed at the rate of 4.5 kg/hectare.

#### **2. Anthracnose**

This fungal disease is found in the Kashmir valley. The fungi attacks leaves, young shoots and fruits. Small, circular light brown spots develop into large blotches which further affect the whole lamina.

#### **Control**

- a. Fallen leaves should be collected and burnt.
- b. Spray Zineb or Captan fungicides (0.01 %) on leafing followed by another two or three sprays at an interval of a fortnight.

#### **3. Downy leafspot**

It is a serious fungal disease found in Kashmir. White patches of the mould appear on the ventral side of the leaves which coalesce into large irregular shapes.

#### **Control**

It can be controlled by spraying twice systemic fungicide Bavistin 50 WP (0.03%) in June at an interval of 15 days.

#### **4. Walnut canker or die back**

The canker is found affecting walnut in Jammu and Kashmir and Uttar Pradesh hills. The swollen or sunken areas of various sizes rupture the bark of branches and trunk.

#### **Control**

- a. Scrap the affected tissues and apply a paste of 50% copper oxychloride (WP) on the diseased portion.
- b. A foliar spray of copper oxychloride (0.2%) is also effective,

#### **5. Phytophthora root and crown rot**

This is also a fungal disease. The common symptoms are small chlorotic leaves, premature defoliation, decreased yield, die back of terminal shoots and finally death of the tree. Crown rot girdles the tree causing its death. Root rot infects the small and large roots which later destroy the entire root system.

#### **Control**

- a. Use resistant rootstock such as Paradox.
- b. Avoid tree injury contamination during cultural operations.
- c. Provide better drainage facilities.
- d. Grafted union should be kept high while planting.

### **PEST CONTROL**

Important insect pests of walnut along with suitable control measures are described here.

#### **1. Codling moth (Cydia pomonella)**

This is a serious pest of apple which also attacks the early blooming walnuts. The larva of the moth enters the growing fruit through the blossom end and damages immature fruit which falls down from the tree. The larvae also enter the nuts through the

side of the husk and make them unmarketable.

#### **Control**

- a. Spray Diazinon or Carbaryl (0.2%) to control the pest.
- b. Synthetic pheromone traps can be put in the month of May.

#### **2. Nav~1 orange worm (Paramyelois transitella)**

Several larvae are found attacking the nut. They attack damaged and mummified (dead and mummified) nuts during spring" and summer and cause serious damage to nuts on splitting of husks.

#### **Control**

- a. Remove dead and shriveled nuts.
- b. Control codling moth and walnut blight as they become breeding sites.
- c. Harvest the nuts after husk splits.

#### **3. Walnut husk fly (Rhagoletis cingulata)**

Generally mid and late season cultivars are damaged by husk fly which feeds on the fleshy tissues of the husk and the nut shell gets stained making the nut in the shell unfit for sale. The infested nuts do not split. making harvest a problem. An early infestation of husk fly damage the kernel which shrivels and turns brown.

#### **Control**

The fly can be controlled by timely spray of insecticides.

#### **4. Walnut weevil (Atcidodes porrectirostris)**

The female insect lays eggs on the fruits which on hatching bore deeper and feed on kernels causing premature fruit drop. The adult weevils emerge from fruits and feed on petioles and tender shoots.

#### **Control**

The pest can be controlled by spraying Carbaryl (0.2%) twice, at an interval of seven days from the first attack.

#### **5. Indian gypsy moth (Lymantria obfuscata)**

The caterpillars of this moth are very destructive. They feed on buds and leaves. The moth over winters in egg stage. They are nocturnal in habit and attack the foliage after sunset resulting in complete defoliation.

#### **Control**

Application of Endosulfan (0.05%) and Fenvalarate (0.03%) can effectively reduce the pest population.

#### **6. Walnut aphid (Chromaphis juglandicola)**

Aphids are found in abundant number on the underside of leaves and tender shoots where they suck the sap. On severe infestation, leaves fall, kernels shrivel and sooty mould develops on honeydew.

#### **Control**

- a. Mix Disulfotall (5%) granules thoroughly in the soil around the tree trunk.
- b. Spray insecticides such as Phosphomidon (0.03%) or Dimethoate (0.03%) to control the pest.
- c. Biological control can be achieved by the parasitic wasp (*Trioxys pallidus*)

#### **7. Long horned beetle (Batocera horsfield)**

The bark boring beetle is an important pest in India. The grub eats the inner side of the bark making zig-zag tunnels reaching the

centre of the heartwood. The infested tree becomes unfit for timber purpose.

#### **Control**

The grubs and adults can be hand picked and destroyed by treating the holes with carbon disulphide or chloroform creosote.

#### **SUMMARY**

The establishment cost of walnut orchard is so high that the fruiting at an early stage is very much required. Lateral bearing cultivars generally come into production well in advance of non-lateral bearing cultivars. Shell thickness and structure are the most important determinant of percent kernel and nut crack-ability. The highest quality walnuts have a medium-thin outer shell with no internal convolutions protruding into the nut meat. The nuts of the tree collected from Chamba District of Himachal Pradesh appear to meet this standard. This selection (Pusa Khor) can meet the increasing demand for an early bearing, high yielding of good quality which could be suited to high density walnut orchard in India.

#### **REFERENCES:**

- **APEDA. 2013.** [www.apeda.gov.in/](http://www.apeda.gov.in/)
- **National Horticulture Board. 2013.** [www.nhb.gov.in/](http://www.nhb.gov.in/)
- Rodica Gotea, Ionuț Gotea, Radu E. Sestras, Kourosh Vahdati. 2012: In vitro Propagation of Several Walnut Cultivars, Bulletin UASVM Horticulture, 69(1)/2012 .
- Svetlana M. Paunovic, Rade Miletic, Milisav Mitrovic and Dragan Jankovic 2011. Effect of callusing conditions on grafting success in walnut (*Juglans regia* L.). J. Fruit Ornament. Plant Res. vol. 19(2): 5-14.
- Hackett, W.P., Leslie, C. and McGranahan, G. 2009. Acclimatization of in vitro derived plantlets of walnut rootstock clones. Acta Hort. (ISHS) 812:427-430.
- Gande S. 2007. Budding and Grafting of the Walnut (*Juglans regia* L.) and their Effectiveness in Bulgaria (Review). Bulgarian Journal of Agricultural Science, 13, 683-689.
- Jafari Mofid Abadi, A`li; Sa`adat, Yusef A`li; Javid Tash, Iraj 2006. Micropropagation of Mature Persian Walnut (*Juglans regia* L.) Trees. Research Institute of Forest and Rangeland, Karaj (Iran).
- Kaur R., Nirmal Sharma, K. Kumar, D.R. Sharma, S.D. Sharma 2006. In vitro germination of walnut (*Juglans regia* L.) embryos. Scientia Horticulturae 109(4):385-388.
- Vahdati, K., Jariteh, M., Niknam, V., Mirmasoumi, M. and Ebrahimzadeh, H. 2005. Somatic embryogenesis and embryo maturation in persian walnut. Acta Hort. (ISHS) 705:199-205.
- Michler, C.H.; Pijut, P.M.; Van Sambeek, J.W.; Coggeshall, M.V.; Seifert, J.; Woeste, K.; Overton, R.; Ponder, F., Jr., eds. 2004. Black walnut in a new century, proceedings of the 6th Walnut Council research symposium
- Ramos. D.E. 1984. Walnut orchard management. Publication no. 21410. UC. Davis. 178pp.

## Present Status and Future Strategies for Walnut Production in India

**Nazeer Ahmed, S. R. Singh, J. I. Mir and Abid Mir**

Central Institute of Temperate Horticulture (ICAR), Old Air Field, Rangreth,  
Srinagar -190007 (J&K). Email: dnak59@rediffmail.com

Walnut (*Juglans regia*) is one of the important nut crop of India being exported to more than 42 countries with earnings of more than Rs. 300 crores annually. The area under walnut in India is about 1,49,502 ha with production and productivity of 2,84,409 tones, 1.90 t/ha respectively. It is grown mainly in Jammu & Kashmir, Himachal Pradesh, Uttarakhand and Arunachal Pradesh. However Jammu & Kashmir is the major walnut producing state contributing 80.58% of total area and 91.16% total production of the country. The most important walnut growing districts in Kashmir are Anantnag, Pulwama, Kupwara, Budgam, Baramulla and Srinagar while in Jammu region Doda, Kistwar, Poonch, Udhampur are important with minor quantity in Rajouri and Kathua. In Himachal Pradesh Kullu, Mandi, Shimla, Kinnaur, Sirmour, Chamba are important with a productivity of 2.70t/ha. While in Uttarakhand Nainital, Dehradun, Pauri, Tehri, Chamoali, Almora and Pithoragarh are major growing areas with productivity of 1.10t/ha (Table 1). The major importing countries of walnut from India are Spain, Egypt Arab Republic, Germany, Netherlands, United Kingdom, France, and Taiwan (APEDA-2011-12).

The worldwide production of walnut has been increasing rapidly in recent years, with most increase coming from Asia. World production of walnut is 3.42 million tonnes from 9.65 lakh ha. China is the world's leader in area (4.0 lakh ha) with a total harvest of 1.65 million metric tonnes the other major producers are United States, Iran, Turkey, Ukraine, Mexico, France, India and Romania. Though India is sixth and eighth in area and production in the world but in productivity it ranked 34th among walnut producing countries. Romania have highest productivity (24.44 t/ha) followed by Pakistan (8.6 t/ha), Ukraine (8.13), Egypt, Iran and Czechoslovakia. (Table 2)

**Table 1: Area production and productivity of walnut in India.**

States	Area (Ha)	Production (MT)	Productivity (t/ha)	% share in Area	% share in Production
Arunachal Pradesh	4780	573	0.12	3.19	0.20
Himachal Pradesh	4607	12420	2.70	3.07	4.30
Jammu & Kashmir	120471	260782	2.16	80.58	91.16
Uttarakhand	19644	21812	1.11	13.18	4.63
Total	149502	284409	1.90	100	100

(Source-NHB-2012)

**Table 2: Top ten walnut producing countries of the world**

Area		Production		Productivity				
Rank	Country	Area (lakh ha.)	Rank	Country	Production (Lakh Tones)	Rank	Country	productivity (t/ha)
1	China	4.00	1	China	16.55	1	Romania	24.44
2	USA	0.99	2	USA	4.18	2	Pakistan	8.71
3	Turkey	0.95	3	Iran	4.18	3	Ukraine	8.10
4	Mexico	0.68	4	Turkey	1.83	4	Egypt	7.33
5	Iran	0.64	5	Ukraine	1.12	5	Iran	6.53
6	India	0.30 (1.49)	6	Mexico	0.96	6	Czech Republic	6.33
7	Poland	0.27	7	France	0.38	7	Afghanistan	6.00
8	France	0.19	8	India	0.36 (2.84)	8	Uzbekistan	4.54
9	Chile	0.16	9	Romania	0.35	9	Kyrgyzstan	4.33
10	Ukraine	0.14	10	Chile	0.35	10	USA	4.22
	<b>World</b>	<b>9.655</b>		<b>World</b>	<b>34.18</b>		<b>World</b>	<b>3.54</b>

(Source-NHB-2012)

Productivity of walnut is much less in India. Lack of systemic orcharding with high yielding cultivars and dwarfing root stock, non responsiveness to the pruning, non availability of easy clonal propagation techniques and production technologies which makes it difficult to improve the yield and quality of walnut. To improve production and productivity of walnut in India research institutions and developmental departments have initiated work on development of varieties, propagation techniques and production technologies and are able to make some progress.

### 1. Varietal Development

More than 95 percent of walnut plantations in India are of seedling origin and are being grown since ancient time. Being a cross pollinated crop each growing plant in walnut is a different genotype. Likewise most of the varieties even in other countries of the world are of seedling selection except few in USA, which are developed through hybridization. The varieties grown in India are mostly selected from indigenous material or introduced from abroad like Lake English, Colby Blackmore, Franquette, Opex Caulchery, Turtle 16, Turtle 31, Nielson etc. Few seedlings with high shelling percentage, better kernel quality and soft shell have been identified and released for cultivation such as Gobind, Eureka, KS-1, Sarawari, K-2, SH-23 and SR-11, Roopa, Ratna, Pratap in HP; Chakrata No-2, 4, 6, 13 and 14, in Uttarakhand; Sulaiman, Hamdan, CITH-W-1,2,3,4,5,6,7,8,9 and 10. Lake English, Opex Caulchery, Drainovsky, Franquette in J & K are very promising. In countries like USA, France, Spain etc a quite number of commercial cultivars of walnut are commonly grown having good qualitative traits. Out of which only few of exotic cultivars like Opex Culchery, Tutle, Nugget, Franquette and Chenovo have been introduced and planted in the field gene bank of CITH, Srinagar to see their comparative performance with more than 400 indigenously selected genotypes. More than 50 selections were found superior than top world leading varieties like Chandler and Opex Caulchry, out of which ten have been released by Institute Variety Release Committee which now are being multiplied and supplied in large quantity for growing in entire temperate region.

**Promising selections released by different institutions.**

Varieties	Year of release	Source
Hamdan	2001	SKUAST (K), Srinagar
Sulaiman	2001	SKUAST (K), Srinagar
Sarwari	2007	Dr. YSPUHF , Solan
K-12	2007	Dr. YSPUHF , Solan
KN-5	2007	Dr. YSPUHF , Solan
SH-23	2007	Dr. YSPUHF , Solan
SR-11	2007	Dr. YSPUHF, Solan
CITH-W-1,2,3,4 and 5	2009	CITH, Srinagar
CITH-W-6, 7,8,9 and 10	2012	CITH, Srinagar

**Varieties identified /released from CITH, Srinagar**

**CITH-W-1.** Variety released in 2009 by institute variety release committee. It is suitable for export as well as domestic market, having light kernel colour, bold nut (28g), and large kernel size (14.21g), good kernel recovery (50.75%), light shell colour, intermediate shell seal, intermediate shell strength, long trapezoidal in shape and very easy to remove kernel halves.

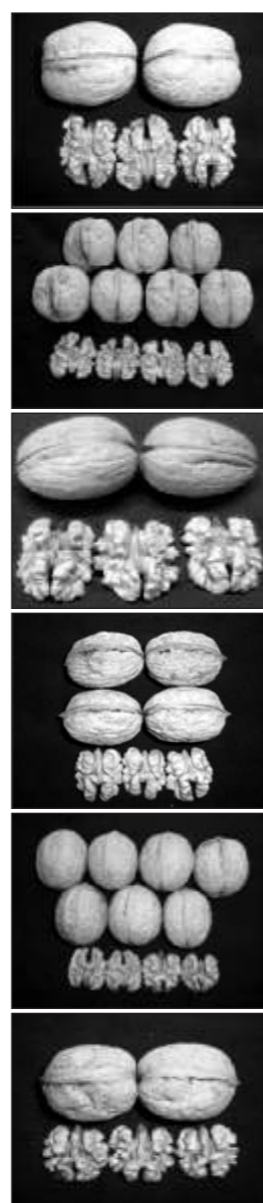
**CITH-W-2.** Variety was identified in 2009 by institute variety release committee. Nuts are large, ovate, medium shell texture, medium shell colour, strong shell seal, intermediate shell strength, complete shell integrity, satisfactory kernel flavor, well filled kernel, plummy, easy to remove kernel halves and light kernel colour. It has average nut weight 16 g and average kernel weight 8 g.

**CITH-W-3.** Variety was released in 2009 by institute variety release committee. Nuts are attractive, large, long trapezoidal in shape, rough shell texture, medium shell colour, strong shell seal, strong shell strength, complete shell integrity, satisfactory kernel flavor, well filled kernel, plummy, difficult to remove kernel halves and light kernel colour. It gives nut weight (19.3 g) and kernel weight (9.8 g).

**CITH-W-4.** Variety released in year 2009 by institute variety release committee. Nuts are large, ovate, rough shell texture, light shell colour, strong shell seal, intermediate shell strength, complete shell integrity, thin, satisfactory kernel flavor, well filled kernel, moderately plummy, very easy to remove kernel halves and light kernel colour. It gives average nut weight 19.08g and kernel weight 10.09 g

**CITH-W-5.** Variety released in 2009 by institute variety release committee. It is a high yielder, having extra light kernel colour, suitable for export market, bigger nut (19.5) and kernel (10.16 g), good kernel recovery (48.9%), and light shell colour, ovate in shape, moderate to remove the full kernel halves.

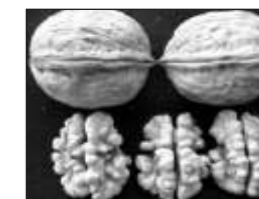
**CITH-W-6.** Variety released in year 2012, by institute variety release committee. Nuts are medium in size, ovate in shape ,light shell colour , intermediate shell seal, and shell strength, satisfactory kernel flavor, well filled kernel, moderate plummy and easy to remove kernel halves. It has average nut weight 24 g and kernel weight 12.2 g with kernel recovery 50.8 %.



**CITH-W-7.** Variety released in year 2012 by institute variety release committee. Nuts are large, elliptic, rough shell texture, medium shell colour, strong shell seal with good shell strength, complete shell integrity, satisfactory kernel flavor, well filled kernel, plummy, easy to remove kernel halves and light kernel colour. It has average nut weight 24.7 g and kernel weight 12.4 g with kernel recovery 50.2%.



**CITH-W-8.** Variety released in 2012 by institute variety release committee. Nuts having light kernel colour with average weight 20.4g, and kernel weight 11.01g, with shelling percentage of 54%, light shell colour, long trapezoidal in shape, very easy to remove kernel halves, rough shell texture, strong shell seal and strong shell strength



**CITH-W-9.** Variety released in 2012 by institute variety release committee. Nuts are large in size, ovate in shape, rough shell texture, light colored shell, strong shell seal, intermediate shell strength, satisfactory kernel flavor, well filled kernel, plummy, easy removal of kernel halves. It gives in shell nut weight 21.2 g, kernel weight 10.7g with 50.5 % kernel recovery.



**CITH-W-10.** Variety released in 2012 by institute variety release committee. Nuts are medium in size, round in shape, light in colour, strong shell seal, intermediate shell strength, well filled kernel, plummy, moderate to remove the kernel halves. It has average nut weight 24.5 g and kernel weight 12.5 g with kernel recovery 51 %.



Most of the released varieties have internationally acceptable quality, standard nut size, shell softness, kernel color and flavor. Lateral bearers have smaller nut size but suitable for hedge row planting system. The CITH has started hybridization programme for developing the hybrids having lateral bearing with larger size nut for hedge row planting to enhance the productivity.

**2. Pollination management**

Walnut is monoecious in nature where male and female appear on same tree at different locations. Walnut is self and cross fruitful the pollen of Juglance regia variety is capable to fertilize the eggs of same variety or any variety of other species. The walnut flowers are anemophilous representing all characteristics of wind pollination. (Chauhan and Julka, 1997). Dichogamy is major problem in walnut pollination where many cultivars shed pollen before the stigma becomes receptive (protandry) and in others stigma maturity precedes the pollen dehiscence (protogyny) coupled with short period of pollen viability and stigma receptivity. CITH has rigorously screened the Pollinizer for elite varieties to maximize the pollination and fruit set. Late blooming genotypes have also been identified for frost prone areas.



**Promising selections released by different institutions.**

1	CITH-W-1	CITH-W-2, CITH-W-3, CITH-W-4, CITH-W-5 CITH-W- 6 CITH-W-7. CITH-W-8 CITH-W-9, CITH-W10, Hamdan, Sulaiman.
2	CITH-W-2	CITH-W-3, CITH-W-4, CITH-W-5, CITH-W-6 CITH-W-7. CITH-W-8, CITH-W-9, CITH-W-10
3	CITH-W-3	CITH-W-2 CITH-W-3, CITH-W-4, CITH-W-5 CITH-W-6 CITH-W-7. CITH-W-7 Hamdan, Sulaiman, Opex Caulchery
4	CITH-W-4	CITH-W-1, CITH-W-2, CITH-W-3, CITH-W-4, CITH-W-5 CITH-W-6 ,Hamdan, Sulaiman,
5	CITH-W-5	CITH-W-3, CITH-W-4, CITH-W-7, CITH-W-8, CITH-W10, Hamdan, Sulaiman, Opex Caulchery, Nugget Franquette
6	CITH-W-6	CITH-W-1, CITH-W-2, CITH-W-3, CITH-W-4, CITH-W-6, CITH-W-7, Hamdan, Sulaiman, OpexCaulchery, Nugget Franquette
7	CITH-W-7	CITH-W-1, CITH-W-2, CITH-W-3, CITH-W-4, CITH-W-5 ,CITH-W-6, CITH-W-7. CITH-W-8, Hamdan, Sulaiman Cheinova, Tutle
8	CITH-W-8	CITH-W-1, CITH-W-2, CITH-W-3, CITH-W-4, CITH-W-5 ,CITH-W-6, Hamdan, Sulaiman
9	CITH-W-9	CITH-W-1, CITH-W-2, CITH-W-3, CITH-W-4, CITH-W-5 CITH-W-6 CITH-W-7, Hamdan, Sulaiman
10	CITH-W-10	CITH-W-1, CITH-W-2, CITH-W-3, CITH-W-4, CITH-W-5 CITH-W-6 CITH-W-7. Opex Caulchery, Nugget Cheinova, Tutle

**3. CLONAL PROPAGATION**

In walnut, vegetative propagation is more difficult compared to other fruits therefore the work on new reliable propagation technologies are being tried world-wide including micropropagation for production of quality planting material. The propagation methods of budding and grafting such as patch budding, chip budding, bench grafting, whip, tongue and cleft are highly successful under specific environmental conditions along with new techniques of Hot Cable Callusing and hypocotyls grafting as walnut graft union requires specific temperature (26 +\_ 2 0C) and humidity (80 -90%) for 4-6 weeks for graft success. Hot cable callusing method evaluated under Kashmir conditions gave 60-65 % graft success as compared to open environmental conditions (25-30%). To improve grafting success a major work on propagation of walnut was initiated at CITH, Srinagar and standardized different factors responsible for maximum graft success. Among the grafting techniques, wedge grafting and among types of scion wood middle portion recorded maximum graft success in all environmental conditions (open, poly house and poly trench). Among the interaction effects wedge grafting with middle portion of graft wood under low cost poly house conditions recorded highest graft success (90.00%) and plant growth (201.33 cm) grafted on 15th of March (Ahmed et al., 2012). Varieties, rootstock and scion girth also showed significant variations for maximum graft success under poly house conditions. Wedge grafting performed in mid of March on CITH-Walnut-1 recorded highest grafting success (86.7%) and plant growth as compared to other varieties. Among three root stock girths ( 25-30 mm, 20-25 mm and 15- 20 mm ) and three scion girths (15-20 mm, 10-15 mm, 5-10 mm.) evaluated under poly house conditions the highest graft success(93.30%) was recorded with 25-30mm root stock girth and 15-20 mm scion girth. Due to scarcity of scion material budding is preferred over the grafting as budding have capacity to produce three to four time more plant than grafting from same scion material. The experiment on standardization of different budding methods, timings and environmental conditions indicated that among three budding methods (Patch, Annular and Chip budding), two environmental conditions (open field and net house) and four time of budding (mid May, mid June, mid July and mid August), the patch budding gave better success than annular or chip budding. Mid July was best time for maximum bud success. Patch budding under net house conditions performed in mid July recorded maximum budding success of 51.17%.

**4. PLANTING DENSITY**

Low planting density is another factor for lower productivity. Long juvenile period seedling planting material, vigorous growing

habit of terminal bearing varieties are major cause of lower density. Lateral bearing varieties which are shy in vigour and more responsive to pruning can enhance the planting density and productivity of walnut. Because of slower growth walnut takes several years to cover allotted area. In initial years, planting density can be increased to get maximum yield /unit area. Later on limb thinning or tree thinning can be practised whenever required.

**5. PRUNING**

Pruning in walnut trees is not practised in our country resulting in unmanageable tree size and shading in lower branches which becomes unfruitful in long run. The pruning of walnut trees is done by thinning out in case of terminal cultivars and by heading back and thinning out in lateral bearing cultivars. It is done for maximum sun light penetration to the lower branches which improves the bearing capacity of the tree. CITH has started the work on pruning and thinning of walnut to standardize the quantum of removal of braches to get maximum fruiting.

**6. NUTRITION**

In India, generally no fertilizer is added and no work has been done on nutrition because of non existence of systematic walnut plantations. Deficiency of major and micronutrients may be responsible for poor growth, flowering, fruit set and poor yield. There is need to initiate work on standardization of nutrient dose for walnut on the basis of nutrient removal and plant age.

**7. IRRIGATION**

Walnut is grown as rain fed crop in our country. During summers, plants suffer from drought. Inadequate soil moisture results in poor plant growth and yield coupled with low nut quality. A water stress during the beginning of fruit growing period results in production of small size nuts poor kernel fill and ultimately low yield. Yield of Fraquette walnut on Juglance regia root stock was found double under sprinkler irrigation as compared with un-irrigated one (Charlot, 1990). Nut size and nut weight increased with irrigation in Serr cultivar from 7.6g to 9.6 g (Ramos et al, 1978) . The work on water requirement is very much essential and is being carried out at CITH on newly released varieties.

**8. PLANT PROTECTION.**

Walnut industry in India suffers due to walnut weevil, leaf roller, defoliating beetle and bacterial blight due to unmanageable large tree size and smaller holding, which calls upon cost effective eco-friendly control strategies.

**9. FUTURE STRATEGIES**

It is clear from fore going discussion, a very little work has been done on walnut in India and as such its production potential is yet to be harnessed. Productivity of walnut is much less than other fruit crops due to lack of lateral bearing cultivars and intensive production technologies. There is a need to develop high yielding lateral bearing varieties with better kernel characters with matching production and protection technologies involving dwarfing rootstocks and hedge row orcharding or HDP to improve the productivity. Clonal propagation techniques especially budding need to be standardized for easier multiplication of elite varieties. Introduction of lateral bearing germplasm from China, USA and Russia may be helpful in strengthening the breeding programme. Post harvest handling for shelled walnut packaging and export needs to be standardized for better economic returns of the farming community.

## REFERENCES

- APEDA (2012). Export import report of agricultural commodities.2012  
[www.apeda.gov.in/apedawebsite/SubHead\\_Products/Walnuts.htm](http://www.apeda.gov.in/apedawebsite/SubHead_Products/Walnuts.htm)
- Charlot, G (1990). Irrigation of walnut. Infos.Paris.62.6-10.
- Chauhan JS and NK Julka. (1997).Walnut and pecan. In fruit crop pollination (Ed.L.R.Verma and KK Jindal) Kalyani publisher Ludhiana India. 175-187.
- FAO (2011). [www.faostate.com](http://www.faostate.com)
- NHB (2012). Indian horticulture data base National Horticulture Board, Gurgaon.
- N Ahmed, SR Singh, KK Srivatava, PA Shagoo and Shazia Hayat (2012). Effect of different environments, grafting methods and times on sprouting, graft success and plant growth of walnut (Juglans regia). Indian Journal of Agricultural Sciences. 82(12):1022-6.
- Ramos DE, Brown LC, Uriu, K and Maragoni, B (1978). Walnut irrigation.Calif.Agri.32:5-6.

## Prospectus of Walnut Growing in Himalayan Region of India and Future Plan of Action

**Dr Jagmohan Singh\* and Dr. Rajesh Thakur \*\***

\*Former Vice Chancellor, Dr. YS Parmar, University of Horticulture and Forestry, Nauni, Solan, H.P

\*\*SMS, KVK, Reckong Peo, Kinnaur, H.P

Walnut (*Juglans regia*) commonly known as Akhrot in India, is a native of North-western Himalayas and is grown in all parts of the Himalayan region between the elevation of 1,200 to 2,150 m above mean sea level. It belongs to the family Juglandaceae. This Persian walnut is the most important temperate nut fruit crop grown in our country. It is mainly grown in Jammu and Kashmir, Himachal Pradesh, Uttarakhand and Arunachal Pradesh. Total area under walnut is 30,800 ha and annual production is over 36,000 M.T. (2011). Jammu and Kashmir is the major walnut growing state contributing more than 85 per cent of total production. Most of the plantations are of seedlings origin and are in scattered form which produce nuts of variable qualities. At present no regular orchards of walnut exist in the Himalayan region. The productivity of walnut in our country is about 1.2 MT per ha which is very low as compared to other countries like USA, China, Iran, Turkey, France, Mexico etc. where it ranges from 3 to 5 MT per ha.

The production and productivity of walnut in our country are on a decreasing side and seedling trees also come into bearing at very late stage. The present production of walnut in our country is unable to meet the domestic demand and export potential. Thus, there is a need to introduce new varieties/cultivars of walnut which produce pistillate flowers on lateral buds, tends to be more precocious and are better suited to high density plantings and give more yield per unit area

However, breeders of our country over the year have exploited various strains amongst these seedling trees to select superior genotypes with desirable traits and some cultivars/varieties have been selected/evolved and recommended for growing in J&K, H.P. and Uttarakhand. Besides some cultivars were also introduced from other countries and after evaluation some recommendations have also been made. The varietal status of walnut growing states in our country is as under:

J&K: Lake English, Drainovsky, Opex Caulchry, Sulaimaan and Hamdan, CITH Walnut Selections 1 to 10.

Himachal Pradesh: Gobind, Wilson Wonder, Franquette, Kashmir budded, Pratap, Solding Selection, Kotkhai Selection-I and Kainthal Selection

Uttarakhand: Chakrata Selections.

On the whole, walnut has remained low priority crop in otherwise apple dominated region. Walnut growing suffers from lack of suitable methods for vegetative propagation of plants, lack of standard rootstocks/cultivars, problems in re-establishing of the nursery plants in the orchard, specific climatic requirements, pollination behaviour and lack of suitable pollinizer, long juvenility period and difficulty in harvesting of huge trees.

So, there is a need to take some initiatives for over coming above mentioned problems by adopting new technologies developed both in India and abroad for growing this valuable crop in the hilly regions of the country. This will raise the socio-economic conditions of the farmers living in Himalayan region. The initiatives required to be taken are:-

1. Introduction of high yielding new cultivars from USA, France and other countries like UK, Italy, Spain, Bulgaria, Romania, Iran and China for the establishment of bud wood bank and for mass propagation. The walnut varieties which are high yielding and some of them bear fruits laterally are:

USA:

Chandler (L), Howard (L), Tulare (L), Cisco (P), Hartley (T)

New varieties under patent are Sexton, Gillet and Forde which are precocious and high yielder at young stage.

France:

Franquette (T),Lara (L),Fernor (L),Meylannaise (P),Fernette (P),Ronde de montignac (P)

Italy: Walnuts of Sorrento (T)

Bulgaria: Izvor-10 (T)

Romania: Germisara, Orastie and Sarmis

British Columbia : Broad view

Holland: Buccaneer

L = Lateral bearing

T = Terminal bearing cultivars

Most of these cultivars require 700-800 chilling hours below 7o c during winter months.

**Top ten walnut producing countries (2011) are:**

**Promising selections released by different institutions.**

Production (Tonnes)		
1.	China	1,655,508
2.	Iran	4,85,000
3.	United State	4,18,212
4.	Turkey	1,83,240
5.	Ukraine	1,12,600
6.	Mexico	96,476
7.	France	38,314
8.	India	36,000
9.	Romania	35,073
10.	Chile	35,000

World's Walnut annual production is 3,259,550 (MT)

Two most common species of walnut which are grown for their seeds/ nuts are :- the Persian walnut or English walnut (J. regia) originated in Persia, and the Black walnut (J. nigra) is a native to eastern North America. The black walnut is of high flavour, but due to its hard shell and poor hulling characteristics, it is not grown commercially for the production of nuts. The commercially produced walnut varieties are nearly all hybrids of the English walnut. Our country exported 5.292 thousand MT of walnuts to the world worth of about 200 crores rupees during 2012-13. The major export destination are UK Arab, Republics, Netherlands, Germany, USA, Australia and Taiwan. Other species include J. californica, the California black walnut (often used as a roostock for commercial breeding of J. regia, J cinerea (butter nuts) and J. major, Arizona walnut.

The average world wide walnut seed yield was about 3 M.T. per hectare in 2010. Among the major producers, eastern European, countries have the highest yield. According to FAO the most productive walnut seed farms in 2010 were in Romania with yields above 23 metric tones per hectare. The United State is the world largest exporter of walnut seeds. The Sacramento and San joaquin valleys of California produce 99 per cent of USA commercial English walnut seeds.

Nutritive value of walnut:

The walnut is a rich source of fat, protein, carbohydrates and minerals. The storage life of these nuts is longer than that of other

temperate fruits because nut fruits are dry and light. It is a high value low volume crop. The nuts stands transportation better, hence cultivation walnuts can be taken in remote and in accessible areas of hills. The walnut nuts are in great demand in our country as well as in abroad and thus has a high potential of earning foreign exchange. The walnut also provide high quality timber wood for furniture.

Freshly harvested raw walnut seeds with water content between 2 to 8 per cent offer the best colour, flavour and nutrient density. Walnuts are high nutrient density food. 100 g of walnut contains 15.2 g of protein, 65.2 g fat and 6.7 g dietary fibre. The protein in walnuts contains essential amino acids. The walnut contains the highest total level anti-oxidants including both free anti-oxidants and anti-oxidants bound to fibre. It is a rich source of heart healthy more unsaturated fats and excellent source of omega-3-fatty acids.

1. Expansion of area under walnut cultivation with elite varieties:

The agro climatic conditions of J&K, H.P., Uttarakhand, Arunachal Pradesh and some parts of Sikkim are suitable for growing walnut. It requires climate which is free from frost in spring and from extreme heat in summer. It is highly sensitive to extremes of winter and summer temperature. The temperature should not go below 2 to 3oC in winter and above 35oC in summer. Annual rainfall of about 80 cm is considered sufficient for cultivation of walnut which can be supplemented with irrigation in drier regions, particularly for young plants. It requires soil pH of neutral range having good organic matter and proper water drainage.

There is need to expand walnut plantations in the states like Himachal Pradesh, Uttarakhand, Arunachal Pradesh, J&K and some part of Sikkim having suitable agro-climatic conditions. Small and marginal farmers have to be motivated to adopt new technologies of walnut cultivation which will not only improve the socio-economic conditions of the farmers but will be helpful in conserving the environment of the areas. At the initial stages emphasis is required to be given on the establishment of mother blocks of international varieties, developing good nurseries and training and skill up-gradation of a farmers and capacity building of other stakeholders. The selection of farmers/entrepreneurs should be on the basis of his interest and past experience having suitable land with irrigation facilities and keenness to grow walnut plants with a mandate of raising grafted and budded nursery plants.

3 Vegetative Propagation

Walnut is difficult to propagate species and does not responds to vegetative propagation as favourably as other temperate fruits. The success rate of different budding and grafting methods varies not only from year to year but also from one location to another depending upon the agroclimatic conditions. Commercially, Side veneering grafting, tongue grafting, wedge grafting and annular budding are employed, however patch and chip budding can also be used to propagate the walnut trees under open conditions.

i) Rootstocks

Majority of the walnuts growing in the country are of seedling origin however walnut varieties should be propagated on rootstocks by vegetative methods to maintain their distinctive characteristics and to maintain desirable traits such as uniform, vigour, disease resistance and quality nuts and kernel. The following rootstocks can be used under different conditions.

J. regia: Persian walnut is most common rootstock because of its availability, besides being fully compatible, resistant to crown rot and tolerant to black line disease.

J. hindsii: It is resistant to root oak fungus, root rot nematode, but susceptible to phytophthora, root lesion nematode and black line disease. Plants on this rootstock donot perform well due to low absorbing capacity of Phosphorus and Zinc and poor performance under water logged soils.

J. nigra: more tolerant to crown gall, phytophthora, oak, root fungus, and induce precocity. Also control the tree size to some extent. It is susceptible to black line disease and has low yielding capacity.

Paradox: (J. hindsii x J. regia) cross, it is tolerant to both nematode and phytophthora species. Makes more growth than J. hindsii under poor soil conditions. Susceptible to black line disease.

J. microcarpa: The rootstock is suitable for soil having high chloride, pH and boron where it perform better than J. regia and J. nigra rootstocks.

#### ii) Selection of Scion/Budwood

The scion wood should be selected from vigorous growing branches/trees in the month of December and January. The scion wood should have minimum of three and maximum of five to seven active buds. If the selected scion wood has male flower buds, they should be removed on the spot. Preference should be given to scion wood in which male flower buds are absent. The scion wood should be 2.5 to 3.0 cm in thickness. After selection and collection of the scion wood should be buried in the soil to avoid dryness until they are used for grafting and chip budding purposes in spring. Alternately the scion wood can also be stored in cold storage at 2-3°C having 80-85 per cent humidity. For patch and annular budding during July and August fresh scion wood should be used for achieving better success. Only vegetative buds, which are round, plump and well developed, should be used. It is better to irrigate both rootstock seedlings and budwood trees 3-5 days before budding so that bark slips easily. In grafting, the efficient and suitable methods are wedge and whip grafting which are performed in the last week of February to mid March.

#### iii) Propagation Environment

##### a). Hot Cable Callusing system

In this system an insulated cable which is covered by adhesive strips increase the temperature around the graft union. To maintain the desired temperature around the union, wrapped graft is covered with aluminium foil. The thermostat is connected with the sensor which is inserted between the cables. When the temperature in the cable rises above the fixed (26+2°C) the thermostat get off. This system maintain only temperature however, the maintenance of desired humidity (80 to 90 %) is not possible. This system (HCC) is power dependent thus, method is in practised in countries like Italy and Spain.

##### b). Zero energy polyhouse system

Under this indigenous system, higher success has been recorded. Construction is also cheaper. The wooden structure is covered with UV protected polythene. The temperature in this system rise automatically during February-March and humidity can be maintained by water sprays under polyhouse without any involvement of electric energy. During May-June onwards when temperature rises, polythene can be removed. The multiplication cost per plants is lower than HCC system.

#### Top working

Young seedling trees producing inferior quality nuts should be top worked with better scion cultivar for the production of better quality nuts. Top working is usually carried out by cleft and bark grafting in spring season and chip budding in summer season. The dormant scion wood for spring grafting should be cut from the parent tree quite in advance and be stored in refrigerator/cold storage after proper packing. Bleeding is a problem in walnut top working which can be avoided by heading back the stock before two weeks of actual operation. In top working of grown up trees, the frame working or grafting of branches is desirable for quicker healing of wounds and to obtain large yield early. The open wounds should be covered with grafting wax and the stem portion needs white washing for protecting from sun.

#### iv) Selection of Varieties/Cultivars

The selection of walnut variety (cultivar) is one of the most important decisions a walnut grower must make. The varieties which are highly fruitful on laterals and are very productive require intensive management and best of growing conditions. A grower must evaluate a climate, soil, availability of suitable irrigation water and management ability. One must have the knowledge of available varieties, their characteristics and needs.

The climate of area in general and micro-climate in particular at the site are important consideration. Pollen shedding and pistillate flower receptivity must coincide with pistillate bloom is the first step toward adequate pollination. Most of varieties do not shed pollen at proper time for pollination of pistillate flower, therefore, second variety needs to be planted for pollination, the flowering of which coincides with main variety there should be pollinizer and is planted at 5 per cent level.

##### a) Leaf bud fruitfulness

The varieties with high (80-90%) lateral bud fruitfulness bear more heavily during early years than varieties with a low (0-10%)

lateral bearing habit. Variety with 90 per cent lateral bud fruitfulness is not always more precocious than one with 70 per cent lateral bud fruitfulness. The number of lateral buds that actually grow and produce nuts and number of nuts per shoots are important factors in determining the yield. Lateral bearing habit has little effect upon yielding ability of a mature orchard where cultural practices are effective.

##### b) Pollination

Walnut is a monoecious plant i.e. male & female flowers are borne separately on the same tree. Though walnut plant is self fertile, yet pollination is not satisfactory in certain varieties mostly because their pollens do not mature at the time when the female flowers are receptive. Two or three varieties are therefore, required to be planted for adequate pollination at 5 per cent level.

##### c) Nut quality

Characteristics of nut are important consideration when choosing a variety. Light coloured kernels have traditionally command a high price in the market. It is of prime importance in a new variety. The market favours a large nut with large well developed kernel. Kernel should be easily removable from the shell and it should yield a high percentage of large halves. Shell strength and shell integrity are also important to avoid insect damage. A weak shell seal can be a problem in harvesting, hulling and processing.

d) Harvesting: Budded/grafted walnut trees should be sprayed with 1000 ppm ethepon 3 weeks before normal harvest time. Nuts can also be dipped in 1500 ppm ethepon for 10-15 minutes after harvesting 15 to 20 days before normal picking date. This facilitates easy and early hull dehiscence, superior shell and kernel colour with good taste.

The strength of Himalyan Region for growing elite varieties of walnut is:-

i) The states of HP, Uttarakhand, Jammu and Kashmir, Arunachal Pradesh and some parts Sikkim have suitable agroclimatic condition where high quality walnut can be grown.

ii) The new varieties having desirable traits and characteristics like dwarf stature, shorter juvenile period, earliness, better nut kernel ratio and lateral bearing are available which can be used as planting material instead seedling which lack such desirable traits.

iii) Walnut is less perishable commodity and thus has good storability it can be transported easily to distant places and it is a good commodity for export.

iv) Now, the package of practices for growing walnut has been standardized and made available to the farmers by various State Agricultural Universities and institutes in India.

v) Walnut has both ailmentary and industrial uses. The kernel is rich in fat, protein and minerals and is concentrated source of energy. Walnut is a high energy food, rich in oil (including the preferred omega3 fatty acids), Vitamins and minerals. The tree produces high quality timber wood.

#### FUTURE PLAN OF ACTION

##### 1. Import of planting material from abroad

Identification of high yielding varieties which can be planted as high density orchards and import of their planting material is required to be done in a phased manner. These cultivars are Chandler, Howard, Tulare, Cisco (P) from USA and Franquette, Lara, Fernor Firjean, Fernette (P), Meylanaise (P) and Ronde de Montignue (P) from France, Izvor-10 from Bulgaria, Sorrento walnuts from Italy, Broad view, Buccaneer from Germisara, Orastice and Sormis from Romania. Some of these varieties mentioned above are lateral bearer and some of them are terminal bearers but are good yielder having excellent quality.

2. Identification of sites/location and farmers for the establishment of mother plant orchards and nurseries of walnut in Himachal Pradesh, Uttarakhand and Arunachal Pradesh etc for mass propagation of planting material.

3. Survey to find out the availability of then shelled good quality walnuts in all the Himalayan States for direct use as scion wood for grafts and their utilization in breeding work to select, develop and evolve new varieties with lateral bearing habit.

4. Study the problems and prospectus of new exotic in proved cultivars in our agroclimatic for their commercial exploitation.
5. Standardization of production technologies for growing organic walnuts in collaboration with State Agricultural Universities and ICAR institutes.
6. Sharing of knowledge and information on growing of walnuts and its post harvest management with premier nurseries, Institutes and Universities in India and abroad.

The productivity of walnut in our country is around 1.2 metric tonne which is very low in comparison to 3-5 MT/ha in advance countries. During 2011, in our country total area under walnut was 30800 ha with a production of 3600 MT having the productivity of 1.16 MT per ha. Whereas, world's production was 34,23,447 MT from 9,68,596 ha land having the productivity of 3.53 MT/ha. The low production in our country is due to the non-availability good quality grafted plants of international varieties with efficient methods and facilities for vegetative propagation are lacking. The productivity can be increased if regular orchards are planted with grafted plants of high yielding lateral bearing varieties with a 5 per cent provision of pollinizer varieties and good cultural practices. Domestic and external demand is increasing over the years and is expected to increase 75,000 by 2020 so there is a need bring additional area under walnut growing in Himalayan states of the country which at present is 30800 ha with a production level at 36000 MT.

The walnut is known for its nutritious and healthy food, the regular consumption of which prevents from many ailments. The tree produces a high quality valuable timber and its nuts have multiple usage which are in great demand therefore, the cultivation of walnut in Himalayan region is required to be encouraged and given priorities for the benefits of farmers of hilly states.

## Pest Management in Walnut

**Dr M C Pandey**

Excel Crop Care Limited, 802, Surya Kiran Building  
19, Kasturba Gandhi Marg, New Delhi – 1

Walnut (*Juglans* sp.) is an important temperate nut fruit of India. The major growing area is Jammu and Kashmir, Uttarakhand, Himachal Pradesh and Arunachal Pradesh, with Jammu & Kashmir occupying the largest share in total area and production. The total area under walnut in India is 149.5 thousand hectares with an annual production of 284.4 thousand MT in 2011-12. (Source: [http://www.apeda.gov.in/apedawebsite/SubHead\\_Products/Walnuts.htm](http://www.apeda.gov.in/apedawebsite/SubHead_Products/Walnuts.htm)). Walnut is grown in North America, Iran, France, Italy, China, India, Turkey, Romania, and Yugoslavia.

Walnut is highly sensitive to the extremes of winter and summer temperatures as well as to its duration. It requires frost-free spring and free from extreme heat in summer. A well drained soil rich in organic matter is the most suitable for walnut cultivation.

Walnut tree requires heavy feeding. A balanced nutrition of nitrogen, potassium and phosphorus should be applied for the proper vegetative and reproductive growth. A one year old seedling requires 500 g urea and 750 g each of superphosphate and muriate of potash. The doses of fertilizer may be increased with the increase in the age of the tree. The full dose of superphosphate and muriate of potash and half dose of urea should be applied in October after picking the fruits and the remaining half dose in the month of February every year. Every year in the month of October, 50 kg of well decomposed farmyard manure should be applied as a normal feed. Foliar application of all the micronutrients like zinc, copper, manganese, boron, iron and magnesium may be done in the month of March. (Walnut Booklet No. 189 Nuts Production: NPS- 6 [www.inseda.org/.../56-Nuts%20Production%20\(NPS\)/Walnut-189.doc](http://www.inseda.org/.../56-Nuts%20Production%20(NPS)/Walnut-189.doc)).

Walnut trees grow very fast. It takes 10 years for most trees to produce mature fruit. Walnuts should be stored in cool and dark environments for better shelf life.

There are a number of diseases and insect-pests associated with walnut tree.

**Walnut blight:** This is a common bacterial disease. Brown to black spots with yellowish green perimeter develop on the leaves. Early infection causes nut drop, while late infection results in nut shriveling and discoloring. The disease can be managed by spraying Copper oxychloride (COC) and Bordeaux mixture. The first spray is done on the opening of the female flower followed by subsequent sprays at 7 to 14 days interval.

**Anthraxnose:** The fungus attacks leaves, young shoots and fruits. Small, circular light brown spots develop into large blotches which further affect the whole lamina. The disease can be managed by collecting and burning fallen leaves and spraying plant with Zineb or Captan fungicides (0.01 %) two or three sprays at an interval of a fortnight.

**Downy leafspot:** White patches of the mould appear on the ventral side of the leaves which coalesce into large irregular shapes. The disease can be managed by spraying Bavistin 50 WP (0.03%) in June at an interval of 15 days.

**Die back:** The swollen or sunken areas of various sizes rupture the bark. Scrap the affected tissues and apply a paste of 50% copper oxychloride (WP) followed by foliar spray of copper oxychloride (0.2%).

**Phytophthora root and crown rot:** Symptoms include small chlorotic leaves, premature leaf fall, die back of terminal shoots and finally death of the tree. Crown rot girdles the tree causing its death. Root rot infects the small and large roots which later destroy the entire root system. Use resistant rootstock. Avoid tree injury contamination during cultural operations. Do not use farm implements to clean the area around tree. Go for chemical mowing (use Excel Mera 71). Provide better drainage facilities. Grafted union should be kept high while planting.

**Codling moth (*Cydia pomonella*):** Attacks the early blooming walnuts. The larva enters the growing fruit through the blossom end and damages immature fruit which falls down. The larvae also enter the nuts through the side of the husk. Spraying plant with Profenophos or Trizophos (2 ml/L) will manage the pest.

**Orange worm (*Paramyelois transitella*):** Larvae attack the damaged and mummified nuts during spring and summer and cause

serious damage to nuts on splitting of husks. Remove dead and shriveled nuts. Manage codling moth and walnut blight as they encourage this pest. Harvest the nuts after husk splits.

Walnut husk fly (*Rhagoletis cingulata*): Feeds on the fleshy tissues of the husk and the nut shell gets stained. The infested nuts do not split. An early infestation of husk fly damage the kernel which shrivels and turns brown. Insecticides mentioned for codling moth take care of this pest.

Walnut weevil (*Ateciodes porrectirostris*): Eggs are laid on the fruits which on hatching bore and feed on kernels causing premature fruit drop. The adult weevils emerge from fruits and feed on petioles and tender shoots. Use Trizophos (2ml/L) twice, at an interval of seven days from the first attack.

Indian gypsy moth (*Lymantria obfuscata*): The caterpillars feed on buds and leaves. The moth is nocturnal. Attack is noticed on the foliage after sunset resulting in complete defoliation. Spraying foliage with Profenophos (2ml/L) will manage the pest.

Walnut aphid (*Chromaphis juglandicola*): Aphids suck sap on the underside of leaves and tender shoots. Severe infestation leads to leaf fall, kernels shrivel and sooty mould on honeydew. Pest can be managed by spraying Imidacloprid (200 ml/500 L water).

Long horned beetle (*Batocera horsfield*): The grub eats the inner side of the bark making zig-zag tunnels reaching the centre of the heartwood. The grubs and adults can be handpicked and destroyed by treating the holes with Chlorpyrifos.

Mite: Feed on cell contents and scrap the plant tissue. Mites reproduce very fast. Females lay up to 80 eggs in a month. Adult's life span is about one month with several generations in a year. Hot, dusty conditions encourage a rapid population build up. Spray on walnut foliage with a force of water. It will wash off mites and dust. If the mite is confined on few branches, prune and destroy infested portions. Spraying Fenpyroximate (Pyromite) with 0.75 ml/L water will control this pest.

- Walnuts require a deep, fertile soil with a near-neutral or slightly acidic pH. Plant the tree in deep, well-drained soil enriched with well decomposed manure using “Madhyam” and “Tricho-XP”. New plants should be protected from Termite and Whitegrub therefore, soil should be drenched with termiticide like Chlorpyrifos (Tricel).
- Water, Walnut trees regularly. Young plants need more water than old one. Drip is the best alternative for economic utilization of water.
- Clean-up around the Walnut tree with a suitable herbicide, safe to environment like Excel Mera 71. Weeds compete for nutrients, water and sunlight with the main crop. They also harbor pathogens and insect-pests.
- Plant spacing is very important for trees to receive proper sunlight and aeration. Trees should be placed at least 50 feet apart from one another.
- Harvesting of nuts is critical, especially if you don't want to deal with having to pick-up fallen nuts.

## Organic Walnut Cultivation

S.P. Ghulati

### Introduction

Walnut (*Jug/ansregili L.*) is one of the important nut fruits of India being exported to more than 23 countries with earnings of more than Rs 120 crore of foreign exchange annually. It is mainly grown in Jammu & Kashmir, Himachal Pradesh, Uttarakhand and Arunachal Pradesh. However Jammu & Kashmir is the major walnut producing state contributing more than 85% of total production of the country. In this state walnut is grown on more than 81393 hectares which accounts for 22% of the total area under fruits with production of about 1.15 lakh MT. It is the principle walnut growing state having monopoly in the production of export quality nuts. However the current level of production does not meet the requirements of domestic and export markets. The productivity per unit area is very low in comparison to other walnut growing countries of the world.

The two most common major species of walnuts are grown for their seeds — the Persian or English Walnut and the Black Walnut. The English Walnut (*J. regia*) originated in Persia, and the Black Walnut (*J. nigra*) is native to eastern North America. The Black walnut is of high flavor, but due to its hard shell and poor hulling characteristics it is not grown commercially for nut production. The commercially produced walnut varieties are nearly all hybrids of the English walnut.

Other species include *J. californica*, the California Black Walnut (often used as a root stock for commercial breeding of *J. regia*), *J. cinerea* (butternuts), and *J. major*, the Arizona Walnut.

To grow walnuts organically one has to start with the digging of the pits for planting the stock of walnut plants. Plants obtained from a reliable source should be planted in the previously dug 1x1x1m size pits in a square system of layout at 6-8 m distance. The bottom of the pit up to 10 inches should be filled with stinging nettle (Biccho Grass). Top 25cm soil should be placed over the biccho grass while refilling it. This soil should be mixed with 20% vermi compost/well rotten FYM. Rest of the soil should be mixed with well rotten FYM in the ratio of 50% of the soil.

After planting the plant should be headed back 40 to 50 cm above the graft union by leaving at least four to six active buds. This will help in establishing the balance of the top of the tree with root system. After planting, irrigate the plants. The plants may take 4-7 years to fully mature, before production of nuts. During this period the field can be kept weed free by growing crops/vegetables organically in it.

### Organic farming of crops/vegetables etc.:

Organic farming is a system of crop and livestock production which is not merely stopping the use of synthetic chemicals, genetically modified organisms, antibiotics, and growth hormones in agriculture, but emphasizes on converting the soil into a living entity by optimizing conditions for biological activity within the soil and maintaining biological diversity within the system. Organic Farming aims at protecting the environment, minimizing soil degradation and erosion, reducing pollution, providing attentive care that promotes the health and meets the behavioral needs of livestock.

On the one hand there is an increasing consciousness about conservation of environment as well as health hazards associated with excessive use of pesticides, fertilizers and other chemicals being used in the agriculture production system and consumers' preference to safe and hazard-free food on the other, are the major factors leading to the growing interest in alternate forms of agriculture in the world. A major eco-friendly community subscribes to the philosophy that a successful organic system begins with the soil - a healthy soil produces healthy plants and, in turn, healthy livestock and people. They regard soil as a living organism of inter-dependent processes and life forms. Organic farming promotes the use of crop rotations, cover crops, and encourages balanced host/predator relationships.

India has emerged as one of the largest potential markets for organic food consumption globally, owing to the fact that organic food or products are healthy, contain no chemical or preservatives and are completely natural.

Climate change has become a great concern and attracted the attention of all nations in the world. Under erratic rainfall and extreme events like floods, drought, cyclone, higher temperature higher land productivity can only be obtained by crop

diversification including alternate land uses. For sustaining the subsistence agriculture, a holistic multifarious self reliant farming system knitted to land productivity is the present day need. Terrestrial carbon sequestration is an effective mitigation option because it combines mitigation with positive effects on environmental conservation and soil fertility.

Recent studies have highlighted the substantial contribution of organic agriculture to climate change mitigation and adaptation.

#### ORGANIC FARMING

The FAO's Codex Alimentarius Commission (June 1999) states:

“Organic Agriculture is a holistic production management system which promotes and enhances agro ecosystem health, including biodiversity, biological cycles and soil biological activity”.

The founder of Cuba's Organic Farming Association has beautifully described Organic Farming. “Many people think that farming is a simple and mundane act, but they are wrong. It is the soul of any great culture, because it requires not only a great deal of accumulated knowledge but also putting this knowledge to use every single day. Knowledge of the weather, the soil, plants, animals, the cycles of nature: all of this is used every day by a farmer to make decisions that have to be made in order to produce the food that we eat. To us it may seem like food comes from a factory, but in reality it comes from a culture that generations has created to produce that food”.

#### TRADITIONAL SYSTEM:

Organic Farming is based on the traditional system of Indian Agriculture. This is the system which has sustained and fed us for centuries. Hundreds of manuscripts since ancient times have been written on or contain chapters on Organic Farming.

To illustrate:

RIG VEDA(7000 BC);ARTHSHAstra(after 326 BC);BIRHAT SAMHITA(6 century);VRIKASH AUyURVEDA(6 century)SARNGADHARA PADDHATI(13 century);BAHARNAMA(15 century); JAHANGIR'S MEMOIRS(16 century); DARA SHIKOH'S Book on Agriculture (17 century).

These manuscript cover the entire gamut of Agriculture including prediction and measurement of rainfall; soil improvement; Non chemical fertilizers and pest control, seeds preservation, growth promotion of plants, better farming implements etc.

Very few of these ancient manuscripts have been translated into modern Indian languages. The tradition has been passed on through generations by word of mouth. Women and Balladeers formed a major force in this.

Even today in our villages many farmers follow this system.

#### ORGANIC FARMING AND ENVIRONMENT:

Organic Farming is basically Farming without the use of chemicals. In India- after Power- Agriculture (19%) is the second highest emitter of Green house gases.

Organic Farming is totally environmental friendly

Organic Farming reduces carbon emission by 40 to 60 percent compared to farming with chemical fertilizers and pesticides

As Organic Farming does not pollute the environment with chemicals it preserves biodiversity of animal, plant, insects and micro-organism species

Conserves water and enhances moisture retention in fields.

Organic Farming ensures sustainable soil health and reduces soil erosion.

Organic Farming reduces use of non-renewable energy :-

#### ORGANIC FARMING HEALTHIER AND CHEAPER OPTION

##### ADDITIONAL BENEFITS TO FARMERS WITH ORGANIC FARMING:

- A. Organic Farming produce has a longer shelf life.
- B. Organic farming also empowers women as they form the main labour force in their fields and carry forward the knowledge through generations.
- C. To manufacture one kg of Urea over 13 KW of electricity are required along with a large quantity of water. This non-renewable energy and water will also be saved. Of course, there is reduction of carbon emission to the extent of 40 to 60 percent.
- D. The Supreme Court has, in a recent judgment ordered that for every 2 kg of urea sold; the seller has to sell 1 kg of Organic Manure. This order, if implemented rigorously-as it should be- ensure further mitigation of carbon emission.
- E. Over 60 percent of our farmland is rain-fed and over 8 crore of our farmers are small and marginal farmers. In both these cases use of chemical fertilizers is not possible Chemical fertilized fields require water fixed periodicity, which is a dicey proposition in rain-fed
- F. For the small and marginal farmers the cost of urea and chemical pesticides is also very high whereas organic farming can be developed at nil or minimal cost. It also requires much lesser water.

##### SCIENCE AND TECHNOLOGY INPUTS:

In SANCHAR, we have evolved organic farming protocols and best cultural practices for each phase of agricultural production. The Protocols have been evolved with three main objectives:-

1. Achieving a minimum of 25 to 50 % increase in production of agricultural produce.
2. This to be achieved at 'No cost basis' to the farmers by using in-farm organic inputs.
3. The Protocols evolved should be applicable to all aspects of agriculture production including crops, vegetables, medicinal plants, floriculture and fruits etc.

The protocols evolved are on:-

Soil preparation

Seed preparation

Growth promotion

Pest control

Enhanced flowering

Protection of Seeds and produce from pests

Improved cultural practices.

A. Soil Preparation :-

These include using:

- a. Green manuring with crops and leaf manure
- b. Mulching
- c. Amrit Pani serves the dual purpose of increasing microbial activity and moisture retention-both vital for increased production in rain-fed areas. It is a 24 hours fermented preparation of animal dung,butter-milk, milk, ghee and honey. This is sprayed on the soil.

- d. Preparation and use of compost – Animal dung compost, NADEEP, Vermi-Compost, Gobar Gas plant slurry compost, etc.
  - e. Cow horn bio-dynamic inoculums for increasing microbial activity and moisture retention. This is bio-dynamic preparation of cow dung put in cow horns and buried underground for about 6 months. The inoculums are sprayed on the soil.
  - f. Cow urine collected overnight from stables for use in fields.
  - g. Bio-Fertilizers
  - h. Biomass plantation on bunds
- B. Seed Preparation :-

This ensures enhanced sprouting of seeds, pest control and cent per cent transplantation of seedlings. It involves:

- a. Seeds Selection. Poor seeds, which float on water, are rejected.
- b. Bio-fertilizer
- c. Bio-gas slurry
- d. Amrit Pani
- e. Butter Milk
- f. Neem Leaf and other plant materials.
- g. Seed treatment with bio-agents

The seeds are dipped in a mixture of Amrit Pani, Neem leaves or Persian Lilac leaves extract, butter milk and cow urine. They are dried in shade and then planted.

C. Growth Promotion :-

This involves weekly spraying of organic foliar sprays:

- a) Manure Tea is a filtered extract of compost soaked overnight in water. This is sprayed on the plants.
- b) Vermi spray is earth-worm water extract sprayed on plants.
- c) Bio-gas slurry spray
- d) Panchgavya Liquid Manure Spray is prepared with organic inputs like cow dung, dry leaves, green leaves, leaves of Persian Lilac or Neem, Bichuu grass, Mulberry leaves, Papaya leaves, Custard Apple leaves, Peach leaves, Walnut leaves, Milk, butter milk, Gur etc. It is fermented for 15 days. The filtrate diluted with water is sprayed once a week on the plants.

D. Pest Control :-

1. Preventive Pest Control :-

- a) Panchgavya Liquid Manure Spray acts as a growth promoter as well as a preventive pesticide.
- b) Natural pest control methods includes attracting birds with yellow coloured rice balls. Greased yellow plates to attract white flies, these get attracted and stuck on the plates. Perches for dragon flies in rice fields, etc.
- c) Use of Phonemes
- d) Bio control methods
- e) Crop Rotation
- f) Rodent Control methods.
- g) Spray of cow urine fortified with neem leaf

2. General Pesticides :-

- 1. Panchgavya re-inforced with additives like cow urine, turmeric powder, hing and extracts of green chillies, neem leaves and garlic pods along with khadi soap powder. This mixture is diluted with water and sprayed on the plants

E. Enhanced Flowering :-

Butter Milk Spray

Enhanced Flowering is achieved with the help of once week butter milks Sprays re-enforced with Botanical inputs sprayed on the plants.

Once the walnut plants grow up it would not be possible to grow any crops etc in the field. However by this time the field will be rich with organic micro organisms conducive toward optimal walnut production.

IRRIGATION:

Nuts grow most rapidly during the 5 or 6 weeks after the blossoming. Moisture shortage during this period may result in large proportion of small sized nuts Walnut shells of most of the varieties begin to harden from mid June .. Mid summer or late irrigation will not increase nut size after the shells harden. Moisture stress during summer results in poor nut quality due to lack of plumpness of the kernels and the yield is reduced considerably .

Rain water Harvesting should be done by digging shallow pits round the plants. It should be noted that as the drip line of rainfall increase with the growth of the plant fresh series of pit should also be dug along the dripp line so that the roots ca easily absorb moisture.

MANURING:

For achieving higher yields of quality crop, manuring is very important. Two weeks before expected bloom each plants should be given 40 kgs of vermi compost. Another 10 kgs should be applied three weeks after fruit set and another 10 kgs during early July. Fully grown plants (10 years onward) should be given an additional dose of 50% at each stage.

Pest Control:

The Panchgavya spray will normally control all pests of walnuts. Once a week sprays 4-6 times with the last spray ending just after setting up fruit will ensure pest control.



## V.S.T Tillers Tractors Ltd. (VTTL)

**Mr. Chandramouli Sharma,**  
Vice President- Marketing, Bangalore

V.S.T Tillers Tractors Ltd (VTTL) was incorporated in the year 1967 in Bangalore, India. It was promoted by the V.S.T Group, a well-known business house in South India, in technical collaboration and joint venture with Mitsubishi Heavy Industries and Mitsubishi Corporation, Japan for the manufacture of Power Tillers and Diesel Engines. The plant went into production in the year 1970.

In the year 1985, the company entered into a technical collaboration with Mitsubishi Agricultural Machinery Company Ltd, Japan for the manufacture of 18.5 HP, 4 wheel drive mini Tractor.

The manufacturing plant is located in Whitefield Industrial area near Bangalore. It has 75,000 Sq. metres. Of land and a built up area of 15,000 Sq. metres (approx.) The Manufacturing capacity of the company, presently is 48,000 Power Tillers, 12000 Tractors.

A new plant is being set up in Hosur in Tamilnadu to manufacture Tractors with a manufacturing capacity of 36000 Tractors per annum on two shift operations

VTTL has in-house Design and Development section for upgrading the level of technology in line with current requirements. It also upgrades existing products and develops new products demanded by market from time to time. VTTL has ISO-9001 certification for Quality Management System since January 1998. VTTL follows ISO 9001-2008 Quality System requirements to satisfy all customer needs.

The company is also into trading of agricultural machinery, such as Paddy Transplanter, Power Weeder and Power Reaper

The main products of the Company namely Power Tillers and Tractors are used in the agricultural sector all over India. Power Tillers and Tractors are exported to African countries. The Tractors are exported to Middle East, Russia, Turkey, Korea and Indonesia.

The Company has a nation-wide network of Dealers supported by Sales and Service. This is supported by imparting regular training to Dealers' personnel as well as end users namely the farmers. Apart from Bangalore the company has set up a Training Centre in Bhubaneswar in association with Directorate of Agriculture, Government of Odisha is some of the effective steps taken by the Company towards customer satisfaction.

The company is expected to achieve a Turnover of Rs 650 crores by the end of fiscal year 2014-15.

### Brief Write Up on Products and Application

A reality which we face today is that it is economically unviable to cultivate agricultural produce. The reason among many is the lack of man power to do the manual work in the fields and the fragmenting of land.

Majority of the land holdings are small and getting more fragmented with average land holding size becoming less than 3 acres.

With increase in urbanization there is an increased need to increase output of food grain and horticultural produce.

The answer to this is to mechanise and find machinery that is cost effective and can do almost all the work one would need in the farm with the least amount of manpower thereby getting more output of work, more yield, and more profits.

What is important is to adopt appropriate technology which is primarily targeting the farmer requirement in terms of cost, ease of operation, low maintenance and requirement of availability of spare parts and service.

Power Tillers as a concept was introduced in the country over four decades back. The product has been accepted in most of the states over the last one decade as the most cost effective machinery for doing multiple farming operations.

The products available are many but the most extensively used and preferred by farmers.

The Mitsubishi VST Shakti Power Tiller. A walk behind tractor which is the next step from the bullock and can do everything a tractor can and fits where a tractor cannot, being perfect for small land holdings.

This power tiller is available in three models VWH 120, 130DI and 150DI with a standard implement of Rotavator from 540mm to 600mm and tilling depth of 150mm, which is very much preferred for soil preparation as the Rotavator cuts soil and weeds, pulverisers, mixes the green matter with soil, aerates and levels all in one operation. The power tiller is used primarily for soil preparation with Reversible mould board plough used for soil with moisture content.

Field coverage is 1 to 1.25 acres per day with a tilling depth of 8 to 10 inches.

Dry tilling for dry soil with less moisture, for deweeding, for intercultivation, field coverage is 2 to 2.5 acres per day at 5 to 8 inches depth. Ridging is used to making ridges for row crops such as sugarcane earthing up, potato etc.

5 Tyne cultivators can serve as a secondary tillage and deweeding implement. Spraying, power generation, haulage, water pumping for domestic applications are other applications of possible use. It is easy to maintain and also serve the purpose of creating livelihood through custom hiring services

Low acquisition cost, easy manoeuvrability and multiple applications makes it an ideal choice for difficult hill regions in the country. The Mitsubishi Shakti MT 180 D 18.5 HP four wheels drive TRACTOR WITH ROTARY. This small sized Tractor with a width of 1025 mm and weight of 770 kgs is the next step from the Power Tiller as being slightly bigger in size but with a lot of comfort features such as electric self -start, seat, hydraulically activated Rotovator and a four wheel drive to use the tractor in soft and wet soils.



This Tractor like the Power Tiller has Standard fitment of Rotovator of 900 mm /1100mm (approx 3/ 3.7 ft) tilling width and 150mm Tilling Depth which is used in almost all type of soil preparations. For less moisture soils straight or sickle type of tynes are used and for higher moisture bent tynes are used.

For orchards in the hill region it can effectively serve multiple applications at a low acquisition and maintenance cost.

With low turning radius the corners are not left out and effectively conduct all the operations required for the farmer.

The products offered are a complete solution to the farmers and will prove to be an effective solution for today's horticulture field requirements.



# Come Nurture the Green Revolution!



**VST MITSUBISHI SHAKTI**  
MT 180D



**VST MITSUBISHI SHAKTI**  
VT 224-1D



## THE BEST IN THE FIELD

**VST SHAKTI**  
Weeder 558



**VST SHAKTI**  
Weeder 450



**VST SHAKTI 130-DI**  
Power Tiller



### VST TILLERS TRACTORS LTD



Post Box No. 4801, Whitefield Road, Mahadevapura P.O., Bangalore - 48.

Phone: +91-80-67141418/23 / 67141111 | Fax: +91-80-28510221 | Email: sales@vsttillers.com

[www.vsttillers.com](http://www.vsttillers.com)

## Horticulture Mission for North-East and Himalayan States Mini Mission-I (Uttarakhand)

The state of Uttarakhand is bestowed with an array of agro-climatic conditions and suitable for growing different horticultural crops. For Uttarakhand, Vivekananda Parvatiya Krishi Anusandhan Sansthan (VPKAS), Almora is the Nodal Centre for HMNEH (MM-I) from 2004-05.

The project objectives include "Seed and planting material-Production and supply of parental lines, quality seeds, root stocks, mother-stocks (scion blocks)", "Technology Standardization/ refinement and dissemination" and "imparting training through on farm trials/front line demonstrations". The project activities are carried out at VPKAS (Almora), GPPUA&T (Pantnagar), UUFH (Bharsar), CITH Rg. Station (Mukteshwar), NBPGR Rg. Station (Bhowali) and the KVKS.

So far more than 2 lakhs fruit plants (temperate & sub-tropical), 0.47 lakh kg vegetable seed, 1 lakh flowering plants, 2.7 q seed of different flowers and 0.86 lakh aromatic plants have been produced and provided to stakeholders. Moreover, more than 5100 farmers got benefited through the trainings/field days/farm schools and 2735 demonstrations conducted under the project. Besides, Budwood and root stock bank establishment were initiated at five locations (Pantnagar, Mukteshwar, Bhowali, Chaubattia and Bharsar) of Uttarakhand.



Superior clone of Litchi



Kiwi plantation



Marigold seed production



Mushroom Production



Protected Cultivation



Training on Drip-irrigation