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Chip budding techniques for walnut (*Juglans regia*): Enhancing propagation efficiency

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The expansion of walnut cultivation in the country is greatly restricted because of the inadequate supply of quality planting stock from improved varieties and the difficulty in determining the right time for collecting scion wood for budding. Therefore, enhancing propagation methods is essential for the potential growth of the walnut industry. Asexual propagation techniques such as chip budding with 81 per cent success rate are effective for propagating walnuts.Chip budding is vital in walnut propagation because it enhances the efficiency, reliability, and quality of new plant production, ensuring that growers can meet the increasing demand for walnuts with superior cultivars. Its ability to produce uniform, superior-quality, and early-bearing walnut trees makes it an essential practice in modern walnut cultivation. To multiply elite cultivars, it is essential to develop high-quality rootstocks since they boost overall yield and promote early fruiting. Ensuring superior rootstock quality is a key factor in meeting production targets in walnut cultivation.

Keywords: Chip budding, Propagation, Rootstock, Scion, Walnut

THE walnut (*Juglans regia* L.) tree is known by various names around the world, with "akhrot" being the most common in Hindi. In India, walnuts are primarily cultivated in the northwest Himalayan region, extending to Sikkim and Darjeeling. Its cultivation spans over 103.55 thousand hectares across Jammu and Kashmir, Himachal Pradesh, Uttarakhand, and Arunachal Pradesh, yielding an annual production of 298.29 thousand metric tonnes (National Horticulture Board 2023). Due to its highly favourable climate for walnut cultivation, Jammu and Kashmir is the leading walnut producing state in the country, followed by Uttarakhand, Himachal Pradesh, and Arunachal Pradesh, with Jammu and Kashmir alone contributing over 85% of the nation's total output.

The walnut tree is a big tree that can grow as tall as 25 m, with a wide spread. It is a deciduous tree, meaning it sheds its leaves in the winter. Walnuts have both male and female flowers on the same tree, but they grow on different branches. The male flowers grow sideways and hang in long bunches called catkins. The female flowers look like small nutlets and grow at the tips of fresh green shoots that come out in the current season. Walnut trees grow well in cool climates at heights 900–3,500 m above sea level. But for farming and commercial nut production, it is not safe to plant walnuts above 2,500 m because late spring frosts can harm the flowers and cause heavy yield loss, or sometimes even the complete failure of the crop.

In India, most walnut orchards have come up from normal seedlings, not from improved varieties. Because of this, many trees do not have the best qualities like high yield, good nut size, or uniform growth. Even though walnuts have huge potential in the country, farmers face problems mainly because there is not enough supply of quality planting material from superior, popular varieties. In other parts of the world, walnut farming is organized and well established. In recent years, walnuts have become more valuable everywhere since people now know more about their high nutrition and health benefits, which has led to a big rise in demand.

Problems limiting large-scale walnut cultivation

- Good quality walnut plants are hard to find in enough numbers.
- Grafting and budding often don't work well, leading to fewer successful plants.

Walnut Tree

Male flowers

Female flower

- There are no special rootstocks available to control tree size or improve yields.
- Not enough mother trees of high-yielding and standard varieties are available for taking scion wood.
- A shortage of trained workers makes walnut propagation difficult.
- Trees often suffer from pests, diseases, and harsh weather conditions.
- High cost of production and limited income create financial struggles for farmers.
- Prices in the walnut market keep changing, making it hard to plan.
- Farmers are not fully aware of the correct time to collect scion wood for budding.

Raising of seedling rootstock

A rootstock is the part of a plant, usually the underground portion that supports new shoot growth above the soil. It plays a key role in influencing how grafted or budded plants grow, flower, bear fruit, and develop fruit quality. Rootstocks also help plants withstand pests, diseases, poor soil, and harsh weather. In walnut cultivation, raising healthy seedling rootstocks is an essential step, as they form the base onto which scions from improved cultivars are grafted. The strength and quality of these rootstocks directly determine the long-term success and productivity of an orchard.

Steps involved in raising of seedling rootstocks

Source of seeds: For raising walnut plants, seeds must be chosen carefully. Collect them only from strong, healthy trees that are free from diseases and pests, and that grow well in the local soil and climate. Good parent trees should also show high vigour and resistance to common problems. In most places, local walnut seedlings are used as rootstocks. But the quality of the seedlings largely depends on the seed. Do not use very hard-shelled or very small walnuts, because they normally germinate poorly and produce weak plants. Soft-shelled walnuts grow better, but they are often sold in the market for a good price, so farmers usually avoid using them for seed. The best choice is to use medium-sized nuts, about 3–4 cm in diameter. These give good germination, produce strong seedlings, and are economical. Very large nuts may give excellent plants but are not cost-effective for seed production.

For optimal results, select well-sealed, medium-sized nuts from the current season's crop. Seeds can be purchased or gathered from the field in September or October. The following factors should be kept in mind during collection of seeds:

- Pick seeds from strong and healthy trees that give good harvests and quality nuts.
- Collect seeds from several trees in the same area, not just one tree.
- Always use fully ripe and healthy fruits to take out seeds.
- Handle the seeds gently while removing them so they don't get damaged.
- Make sure the seeds are alive, fresh, and suitable for planting.
- Mark or label the seeds properly so you can recognize and use them later.

Seed preparation: After collecting walnut seeds, they must be cleaned properly so that no disease spreads to the new plants. First, soak the seeds in water to remove the outer husk and any sticky pulp. After cleaning, if needed, treat the seeds with a fungicide to protect them from fungal attacks during storage or planting.

Preparation of nursery beds: In places where the soil is light sandy or sandy loam and there is no danger of waterlogging, nursery beds for walnuts are best prepared during spring and summer when rains are less likely. The land should be prepared well by mixing in well-rotted farmyard manure (about 5–6 kg/m^2) to improve soil fertility. Once the soil is ready, divide the field into small, equal-sized plots using ropes and measuring tape, as per the need. Make control irrigation channels between every two rows of beds so that water can reach all beds properly and uniformly. This ensures good and controlled watering for healthy seedling growth.

Sowing of seeds in the nursery beds: Nuts can be sown directly or after stratification in well-prepared nursery beds, enriched with manure, at a depth of 2–3 inches with enough spacing of 10–15 cm between seeds and 20 cm between rows to allow for adequate growth and root development. Mulching may be applied to retain moisture and suppress weeds.

Methods of seed sowing:

- **Direct Sowing:** Direct sowing

One year old walnut seedlings

is commonly used in regions with snowfall from December to March. In these areas, seeds are typically sown from late November to early December, depending on weather conditions. The seeds are planted in nursery beds, and the natural snowfall provides the necessary cold treatment for stratification. However, this method can pose risks, such as seed spoilage and damage from birds and rodents, especially in certain soil types.

- **Stratification:** Stratification is an alternative method that involves storing seeds in pits, boxes, or other structures for cold treatment. For large-scale stratification, seeds are layered in moist sand within a pit, alternating between sand and seed layers. To enhance germination, seeds can be soaked in running water or water that is changed daily for 5–8 days in December. After soaking, seeds are stratified at 2–5°C for 60–100 days. Additionally, treating seeds with GA_3 (100–200 ppm) after stratification can further increase germination rates.

Fertilizer application: Seedlings should be fertilized with balanced nutrients to promote strong growth, using either organic or inorganic fertilizers based on soil conditions. Proper feeding, especially with well-decomposed organic matter, is crucial for rapid growth and the overall success of the nursery.

Weeding: Weeds pose a significant threat to young seedlings, as they grow quickly and can overshadow the seedlings if not controlled. Shallow hoeing is an effective method for weed control, which also improves soil aeration. Weeds should also be cleared from paths and irrigation ditches to prevent their spread. Regular weeding is essential to reduce competition for nutrients and water. Mulching and manual weeding are common practices.

Irrigation: Consistent and adequate watering is crucial for the development of a robust root system. Young seedlings require precise watering. Light irrigation should be done every 7–10 days in summer and every 15 days in winter to maintain the necessary turgor pressure for optimal growth. After sowing, seed beds are lightly irrigated and covered with a 10 cm layer of dry grass mulch to prevent the seeds from drying out.

Seed germination: Once seedlings begin to germinate, the mulch is removed. Seedlings are then carefully transplanted to nursery beds when they reach 5–6 cm in height and have 3–4 leaves.

Pre-grafting care: Before grafting, the rootstocks should be properly watered and fertilized to ensure they are in optimal condition. The stem diameter should be appropriate for the type of grafting technique to be used, such as chip budding.

One-year-old seedlings ready for chip budding: After one year in the nursery, walnut seedlings are kept for another six months following chip budding. They are ready for planting after this additional six-month period, making the total time from seedling to planting-ready about two years.

Collection of scion wood for chip budding

For successful chip budding in walnuts, choosing the right scion (budwood) is very important. The scion should come from the current

Collection of scion wood from current season growth

season's healthy growth and must have well-developed, mature buds. Do not use rough, brown buds because they mostly produce male flowers (catkins), which are not useful for budding. Remember, walnut trees have both male and female flowers on the same tree but in different places. Female flowers grow in small bunches at the tips of fresh leafy shoots from the current season, while male flowers come from simple buds on older one-year wood. For budding, always select scions with female buds from the tip area, as these will produce fruit-bearing branches.

In open fields, walnuts are commonly propagated using chip budding, which is especially effective in the mid-hills of the northwest Himalayas, with the best results achieved between mid-May and early June. Chip budding has a high success rate of 89 per cent, compared to around 50 per cent for patch budding.

Qualities of an ideal rootstock for chip budding

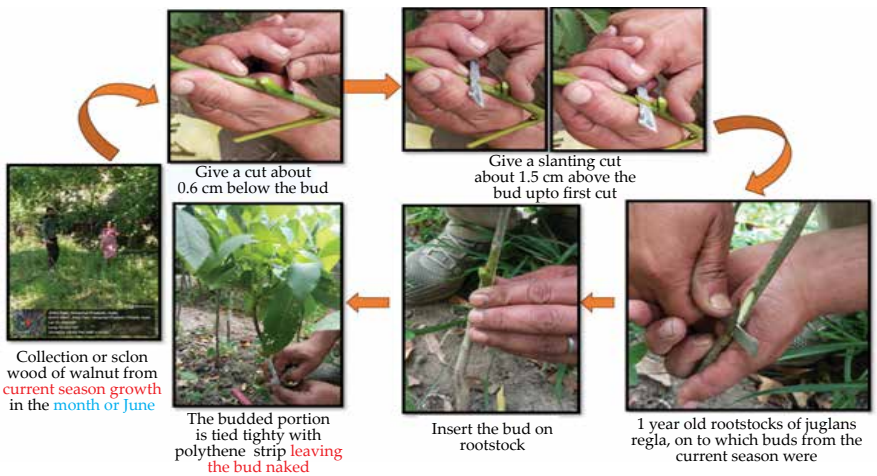
- ***Strong roots:*** The plant should have a deep and healthy root system so it can absorb nutrients well and support the grafted plant. It should also be easy to multiply.
- ***Straight stem:*** The stem should be straight and healthy, making it easy for grafting or budding.
- ***Local adaptability:*** It should grow well in the local soil and climate conditions.
- ***Resilient plant:*** It must be able to tolerate difficult weather and resist diseases and insect pests.

Rootstock requirements

Use seedlings that are 1–2 years old that are at least 50 cm tall. At the budding point, the stem should be more than 12 mm thick, and at the collar (base) it should be at least 20 mm thick.The seedling must be used only as rootstock, not for fruit production. It should also be free from common problems like root rot, crown rot, and walnut aphids.

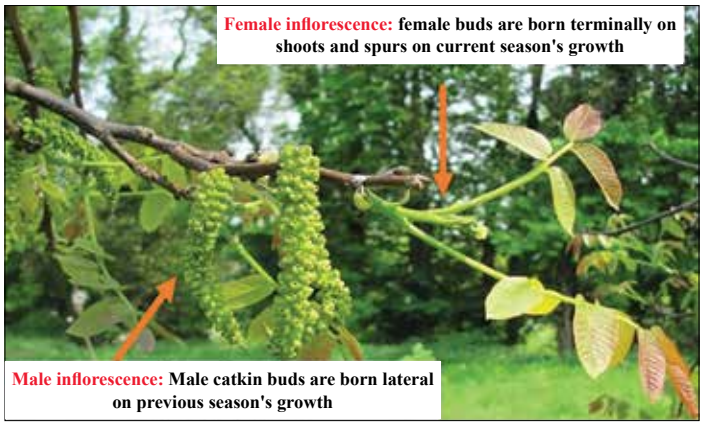
Method of chip budding

- From the rootstock, cut out a small chip of bark along with a little wood from a smooth part between two nodes.
- Take a similar chip, of the same size and shape, from the selected scion wood (of the desired variety).
- On the rootstock, make a downward cut about 2–3 cm long, going slightly into the wood. Then make a second cut of



Procedure of chip budding in walnut

Male catkin bud



Flowering behaviour of the tree

about 2.5 cm length at an angle of 30–45°, so that both cuts meet.

- Insert the bud chip from the scion into this cut, making sure that the inner green layers (cambium) of the stock and scion touch each other closely.
- Wrap the grafted area firmly with a polythene strip to prevent drying. Remove the strip after 3–4 weeks when the bud starts sprouting.

Aftercare

During the hot summer months, irrigation should be provided based on the soil moisture level. Regularly remove suckers or shoots from the rootstock below the grafting point, ideally once a week, to prevent side growth that could hinder the scion's development. Encourage the plant to grow on a single stem without branching to ensure healthy and strong growth.

SUMMARY

In recent years, the vegetative propagation of walnut has attracted increasing attention, driven by the rising demand for planting superior cultivars. Compared to many other fruit species, grafting walnuts presents greater difficulties because their tissues contain high levels of phenolic compounds, which oxidize when damaged. To supply orchards with planting material, the walnut nursery sector employs multiple propagation methods such as seed propagation (rootstocks), micro-propagation, cuttings, budding, and grafting. In countries like India, where walnut cultivation is restricted by a shortage of quality planting stock, chip budding emerges as a highly effective approach. This method is noted for its high success rate, its capacity to produce uniform, vigorous trees, and its efficient use of limited scion wood. By improving propagation outcomes, chip budding addresses key constraints in walnut production, including poor availability of planting material and frequent propagation failures. Ultimately, this technique holds significant importance in expanding walnut cultivation, improving orchard productivity, and fulfilling the growing global demand for walnuts.

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