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Original Article

Propagation of Clonal Apple Rootstocks through Stem Cuttings under Greenhouse Using Soilless Sunken Beds

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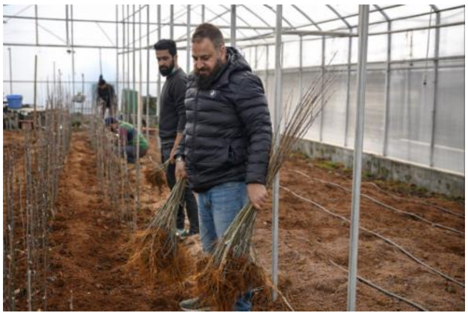
ABSTRACT



A greenhouse-based clonal propagation technology for apple rootstocks was developed and standardized at ICAR–Central Institute of Temperate Horticulture (ICAR-CITH), Srinagar, to enhance domestic production of quality planting material and reduce dependence on imported rootstocks. The technology utilizes one-year-old hardwood stem cuttings prepared from the otherwise discarded aerial portions of stool shoots. Cuttings (30 cm length, 5–6 mm thickness) are treated with fungicide and Indole-3-butyric acid (IBA 2500 ppm) and planted during early March in greenhouse-maintained soilless sunken beds consisting of a lower sand layer for drainage and an upper cocopeat layer for root development. Under protected conditions with regulated humidity and drip irrigation, rooting success ranged from 50 to 84.3% depending on rootstock genotype. More than 75% of the plants attained graftable size (>6 mm stem caliper), and over 50% were suitable for budding within the same season, with budding success exceeding 90%. Approximately 40–45 well-rooted plants were harvested per square meter.

Problem Addressed by the Technology

1.High cost and limited availability of quality clonal apple rootstocks.

2.Heavy dependence on imported planting material

3.Underutilization of aerial portions of stool layers

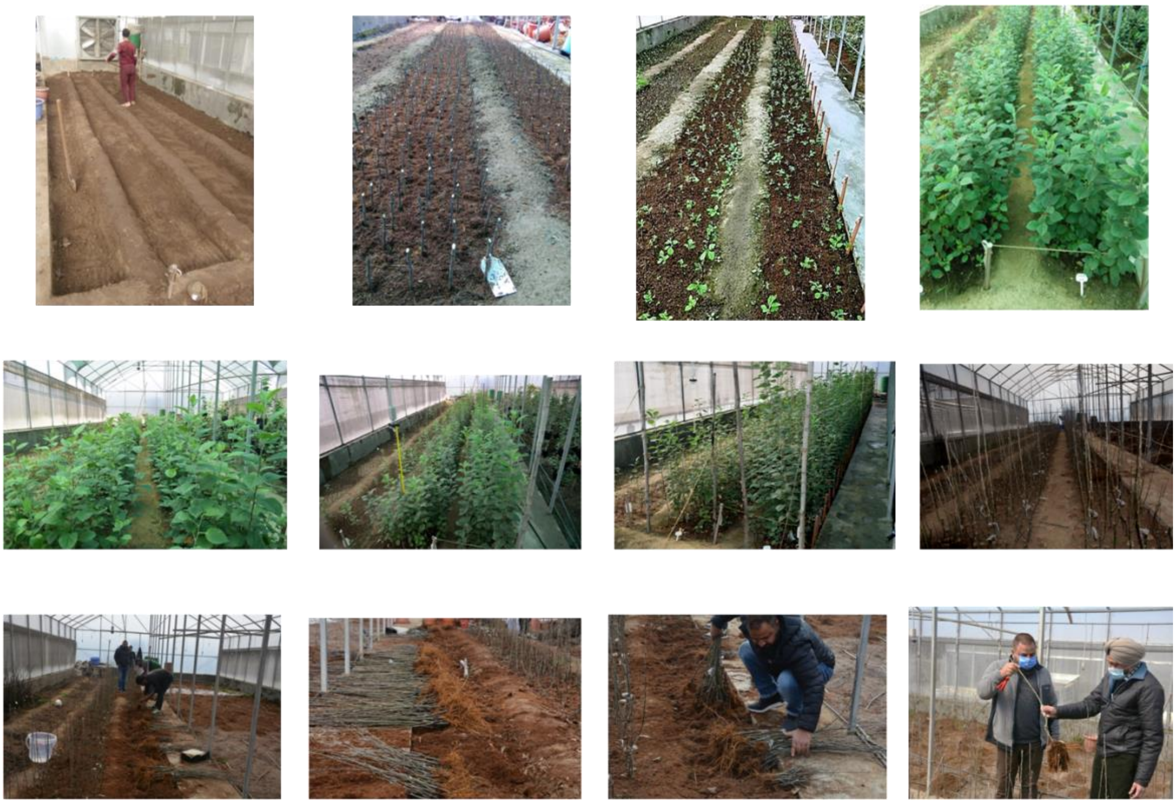
4.High weed incidence and water requirement in conventional nursery beds.

Brief Description of Technology:-

Clonal propagation of apple rootstocks through stem cuttings is of considerable importance as a supplementary approach to enhance the production of quality rootstock planting material. This technique enables effective utilization of the aerial portion of stool layers above the grafting point, which otherwise remains underexploited. The apical portion of rootstock is generally discarded. However, the remaining portion of the rootstock can be efficiently used as cuttings and successfully converted into rooted plantlets, thereby increasing the multiplication rate of important clonal apple rootstocks. To reduce production costs, simplify nursery operations, and improve the practical feasibility of the technology for nurserymen, an experiment was undertaken using soilless beds for planting the cuttings. One-year-old cuttings were used, and propagation was carried out under greenhouse conditions, as maintaining high humidity around the cuttings—particularly during the early stages—is critical for successful root initiation and establishment.

Bed preparation: - Sunken beds of 2.5 ft (76 cm) width and 1.0 ft (30 cm) depth were prepared inside the greenhouse. The beds were formed by excavating the top 1.0 ft of soil to create a sunken structure. After preparation, the beds were converted into soilless media by filling the lower 6 inches (15 cm) with coarse sand and the upper 6 inches (15 cm) with cocopeat. The use of a soilless medium provided favorable conditions for rooting of cuttings, ensured proper drainage, minimized weed infestation, and significantly reduced water requirements. The coarse sand layer facilitated effective drainage, while the cocopeat layer provided an ideal medium for planting and root development. The width of the beds was maintained at 2.5 ft, while the length varied depending on the available greenhouse space. Narrow bed width facilitated efficient nursery operations such as pinching, weeding, irrigation, and plant protection spray. Hardwood cuttings of 30 cm length and pencil thickness (5–6 mm), each having 8–9 healthy buds, were selected for planting. The basal portion of each cutting was given a straight horizontal cut, followed by light longitudinal cuts on either side to expose additional cambial tissue, thereby enhancing callus formation and rooting. Prior to planting, the cuttings were treated with a fungicide and dipped in Indole-3-butyric acid (IBA) at 2500 ppm for 2–3 minutes. Planting was carried out during the first week of March. The cuttings were planted in the soilless beds at a spacing of 4 inches (10.16 cm) both between rows and between cuttings, accommodating approximately 52 cuttings per square meter. Sprouting commenced within two weeks of planting. Initially, multiple buds sprouted along the length of the cutting; however, when the shoots attained a length of 3–5 cm, only the most vigorous apical shoot was retained, while the remaining shoots were removed to promote strong vertical growth. The results revealed a rooting success of 50%-84.3% depending on rootstock. The average plant height was 115.93 cm (3.77 ft), stem diameter was 8.41 mm, average root length was 32.13 cm, and the average number of adventitious roots per plant was 12.31. The average root fresh weight and dry weight were 17.40 g and 8.80 g, respectively. More than 75% of the produced rootstocks were suitable for grafting, possessing a well-developed root system and a stem caliper greater than 6.0 mm. Furthermore, over 50% of the cuttings attained a stem caliper exceeding 5.0 mm by August–September, enabling budding operations to be carried out on approximately 50% of the rootstocks, with a success rate exceeding 90%. This practice reduced the cost of scion wood and allowed preparation of planting material for the subsequent season. Budding operations inside the greenhouse could be extended by two to three weeks due to prolonged favorable growth conditions under protected cultivation. Using this technology, 20–25 well-rooted plants were harvested per square meter of nursery area. This approach enables the efficient utilization of otherwise discarded plant portions for rootstock production, thereby reducing the cost of planting material and significantly minimizing dependence on imported quality rootstocks.

The technology involves large-scale clonal propagation of apple rootstocks through stem cuttings under greenhouse conditions using soilless sunken beds filled with sand and cocopeat. The method utilizes the otherwise discarded portion of stool shoots, ensuring efficient resource use. High humidity under protected conditions, combined with optimized rooting hormone treatment and shoot regulation, results in high rooting success, uniform plant growth, and graftable-quality rootstocks within a single season.



Pic: - Different stage of Nursery development from bed preparation to harvesting by employing cuttings in soilless beds under protected conditions.

After care: - Irrigation was carried out once or twice a week depending on the prevailing greenhouse temperature inside the GH. Water was applied using a drip pipes at low pressure to avoid disturbance of the cuttings and growing medium. Up to June, once-weekly irrigation was sufficient; thereafter, daily irrigation was provided through drip to mitigate the effects of high temperatures inside the greenhouse. Shade nets were installed to protect the cuttings and tender foliage from desiccation. Weed incidence was minimal; however, any emerging weeds were manually removed along with their roots without disturbing the cuttings. Insect pests such as aphids and larval fungal gnats, as well as diseases like powdery mildew, were effectively managed using appropriate plant protection measures. At the end of the growing season, after leaf fall, key parameters including percentage of rooted cuttings, plant height, root length, root diameter, number of adventitious roots, root fresh weight, and root dry weight were recorded.

Technology Salient Features

a. Uses discarded portions of stool shoots
b. Soilless sunken bed system (sand + cocopeat)
c. High rooting success (50-80%)
d. Profuse and healthy root zone formation.
e. Produces graftable rootstocks (>70%)
f. Low weed incidence and reduced water use.
g. Suitable for commercial nurseries under protected cultivation

Advantages over Existing Technologies

Parameter	Conventional Method	Present Technology
Rootstock source	Stool layers only	Stool layers + discarded shoots
Rooting medium	Soil	Soilless (sand + cocopeat)
Weed problem	High	Minimal
Water requirement	High	Low
Rooting success	Moderate	High (>84%)
Graftable plants	Limited	>90%
Production cost	High	Reduced
Import dependence	High	Significantly reduced

Target Beneficiaries

a. Commercial fruit nurseries
b. Private entrepreneurs
c. Progressive apple growers
d. State horticulture departments
e. Farmer Producer Organizations (FPOs)
f. Startup ventures in nursery sector

Scale of Production

a. Up to 20–25 graftable rootstocks per m²
b. Suitable for small to large-scale commercial nurseries
c. Scalable under polyhouse/greenhouse systems

Economic Benefits

a. Reduction in cost of rootstock production

b. Additional income through utilization of discarded plant material
c. Early budding and extended growing window
d. Reduced scion wood requirement
e. Faster nursery turnover and higher profitability

Environmental Benefits

a. Reduced water consumption
b. Minimal chemical weed control
c. Efficient use of planting material
d. Sustainable nursery production system

Expected Impact

a. Self-reliance in quality apple rootstock production
b. Reduction in import of planting material
c. Employment generation in nursery sector
d. Enhanced income for nurserymen and growers
e. Strengthening of domestic horticulture value chain

The standardized propagation technology developed by ICAR–Central Institute of Temperate Horticulture represents a cost-effective, scalable, and sustainable addition to conventional stool bed multiplication of apple rootstocks. By efficiently utilizing otherwise discarded stool shoot portions and integrating a soilless sunken bed system under protected conditions, the technology enhances rooting success, lowers input costs, reduces weed incidence and water use, and produces graftable-quality rootstocks within a single growing season. Its wider adoption has the potential to significantly reduce dependence on imported rootstocks, strengthen domestic nursery production systems, and create employment opportunities across the temperate horticulture sector.

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