Indian Farming 76 (01): 07-10; January 2026

An apple a day:

The evolution and impact of apple cultivation in Himachal Pradesh

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The age-old adage, "An apple a day keeps the doctor away", resonates deeply in Himachal Pradesh, fondly known as India's "Apple State". Far beyond a mere health proverb, apples have become the cornerstone of the state's economy, transforming the lives of orchardists and establishing Himachal as a dominant force in India's fruit production landscape. From its modest origins in the 19th century to a thriving industry generating ₹4,000–5,000 crore annually, apple cultivation has not only uplifted over 1.5 lakh families but also woven itself into the cultural and economic fabric of the region. Despite challenges posed by climate change, erratic weather, diseases, and market fluctuations, relentless innovation and adaptive practices have ensured the industry's resilience. This article delves into the rich history, challenges, and groundbreaking advancements in apple cultivation, particularly, the shift toward high-density planting systems that continue to shape Himachal's apple legacy.

Keywords: High density plantation, Kinnaur, Royal Delicious, Seedling rootstock

THE journey of apple cultivation in Himachal Pradesh began in 1870 when Captain R.C. Lee planted the first orchard in Bandrol, Kullu, laying the foundation for what would become a transformative industry. In 1916, Samuel Evans Stokes (Satyanand Stokes) introduced the Red Delicious variety, a cultivar that would become synonymous with Himachal's apple industry. Stokes also introduced the Golden Delicious variety, further enriching Kotgarh's orchards and cementing his legacy as a pioneer. From a modest 400 hectares in 1950, apple orchards have expanded dramatically to 115,680 hectares by 2023. Royal Delicious dominates Kinnaur's apple orchards, representing 90% of all varieties. In the 2022–23 season, the state achieved a substantial production of 672343 metric tonnes of apples, with a productivity of 5.81 t/ha. Shimla, with its favourable climate and terrain, leads production, contributing significantly to the state's annual revenue of ₹4,000–5,000 crore. This growth reflects not only agricultural expansion but also the industry's ability to adapt and innovate in response to evolving challenges.

Navigating challenges: Climate, pest, and markets

The apple industry in Himachal Pradesh faces a complex array of

Ultra high-density plantation on seedling rootstock and fruiting in Kinnaur, Himachal Pradesh

High density plantation established under HPHDP in the year 2016

challenges. Climate change has introduced erratic weather patterns, including unseasonal rains and temperature fluctuations, which disrupt flowering and fruit-setting. Diseases like scab, Alternaria leaf spot, premature leaf fall, root rot and other fungal infections with pest as insects like scale, woolly apple aphid and mites threaten yields, while market volatility driven by fluctuating prices and competition, poses economic risks for farmers. Yet, the industry has shown remarkable resilience through strategic interventions. In 2016, a World Bank-funded project introduced high-density planting and modern varieties like Gala and other colour strains, boosting the productivity and quality. The development of low-chilling varieties enabled cultivation in warmer regions, where rising temperatures due to climate change have opened new opportunities. Additionally, the adoption of universal 20-kg cartons in 2024 has streamlined packaging and marketing, ensuring consistency and enhancing market competitiveness. These innovations have helped farmers navigate challenges while sustaining the industry's economic contributions.

The early days: A trial-and-error approach

When apple cultivation began in Himachal Pradesh, there were no standardised guidelines for planting. Early orchards were haphazard, with trees spaced far apart, allowing them to grow into towering, robust giants. These large trees, while impressive, remained non-productive for extended periods, often staying in a juvenile phase for 15–20 years. During this time, they focused on vegetative growth, developing strong branches and expansive canopies, rather than fruiting. Farmers initially believed that larger trees would yield more fruit, a misconception rooted in the assumption that size equated to productivity. However, this approach led to unintended consequences. While large trees produced substantial quantities of fruit, a significant proportion was of inferior quality, fetching lower prices in the market. The sprawling canopies of these trees intercepted sunlight primarily at their outer edges, with only the top 4 feet of foliage receiving adequate light. The lower and inner parts of the canopy, shrouded in shade, produced smaller, less vibrant fruits that lacked the colour, flavour, and market appeal of their sun-exposed counterparts. This realisation prompted a shift in perspective, as farmers and researchers began to prioritise quality alongside quantity.

Standardising practices: The square system

The Department of Horticulture, Agriculture, and Dr. Y. S. Parmar University of Horticulture and Forestry (YSPUHF), along with its research stations and Krishi Vigyan Kendras (KVKs) developed a package of Practices (PoP) for apple cultivation, standardising planting density to a square system with 7 × 7 m or 6 × 6 m spacing between rows and plants. This system aimed to optimise space and improve fruit quality by ensuring more uniform

Old conventional low-density orchards in Kinnaur

High-density plantation on clonal rootstock at Kalpa

Ultra-high-density orchard on clonal rootstock

growth. Initially, the square system offered improvements over the haphazard plantations of the past. Trees planted at these densities produced better-quality fruit in their early years, as the spacing allowed for adequate light and air circulation. However, as the trees matured and their canopies expanded, the same issue of light interception resurfaced. In a 7 × 7 m layout, each tree could spread up to 3.5 m from its trunk, leaving little space between trees. This resulted in dense orchards where the lower canopy received minimal sunlight, leading to a higher proportion of low-quality fruit. Even with proper canopy management practices, such as pruning, achieving consistent quality and high productivity remained challenging due to the trees' robust nature and limited light penetration.

High-density planting: A game-changer

Sunlight is critical for photosynthesis, fruit development, and production of vibrant, high-quality apples. In large trees, only the outer canopy benefits from adequate sunlight, while the inner and lower branches remain shaded, producing inferior fruit. In contrast, shorter trees with well-managed canopies allow light to reach all parts of the plant, resulting in uniform fruit quality and higher yields. This principle has driven the evolution of planting practices, leading to the adoption of high-density planting systems that prioritize light interception and productivity.

High-density planting (HDP) was introduced in India in the 1980s and gained widespread adoption in Himachal Pradesh, Jammu and Kashmir, and Uttarakhand by the 2000s. Unlike traditional orchards, which accommodate 16–23 plants/bigha, HDP allows for significantly more trees per unit area by keeping them short-statured and precocious, reducing the juvenile phase and promoting early fruiting. The success of HDP hinges on the use of clonal rootstocks, such as M9, Malling (M), Malling Merton (MM), Geneva (G), Bud (B) and Polish (P) series, which are dwarf or semi-vigorous compared to the vigorous seedling rootstocks used in traditional orchards. These rootstocks enabled precise orchard designs, higher yields (40–60 t/ha), and compatibility with mechanisation, making them ideal for commercial production. By maintaining smaller trees, HDP ensures that all parts of the canopy receive adequate sunlight, resulting in consistent fruit quality and increased productivity. Clonal rootstocks come with challenges. They require intensive management, including regular irrigation, permanent support systems (e.g. trellises), and careful pruning to maintain their dwarf stature. Their shallow root systems limit their ability to access deep soil moisture, making them less drought-tolerant, and their focus on fruiting over vegetative growth shortens their lifespan. Additionally, their lack of genetic diversity makes them more susceptible to pests, diseases, and environmental stresses compared to seedling rootstocks, which offer greater resilience due to their genetic variability.

Fruiting in high-density orchard of apple on clonal rootstock

Seedling rootstocks in high-density systems: A new frontier

For years, seedling rootstocks were deemed unsuitable for high-density orchards due to their vigorous growth, which led to large, unwieldy trees. However, researchers at YSPUHF Nauni conducted trials that grafted spur cultivars onto seedling rootstocks in high and ultra-high-density systems with 3 × 1 m spacing. These orchards began fruiting in just 3–4 years, a significant improvement over traditional low-density seedling systems, which could take 15–20 years to reach full productivity. This precocity was achieved through meticulous management practices, such as maintaining 90% of row-

Jeromine apple cultivar in fruiting under ultra-high-density orchard system

Laying out ultra-high-density orchard on seedling rootstock at Nako

to-row distance as plant height to keep trees short-statured, adopting modified training systems like dwarf pyramid and mini modified central leader, and implementing regular summer and winter pruning. These techniques ensured that entire canopy intercepted sunlight effectively, resulting in uniform, high-quality fruit. By combining the resilience of seedling rootstocks with the precocity of spur cultivars, these trials demonstrated that seedling rootstocks could be a viable alternative to clonal rootstocks in high- and ultra-high-density systems.

Adapting to Himachal's unique conditions

Himachal Pradesh's climate ranges from dry to wet temperate, and its predominantly rain-fed orchards with low soil fertility present unique challenges and opportunities. While clonal rootstocks have driven the success of HDP, their intensive requirements, regular irrigation, permanent support systems, and high input costs, can be prohibitive in rain-fed regions with limited infrastructure. Seedling rootstocks, with their greater resilience and adaptability, offer a sustainable solution for these conditions. Their ability to thrive in varied soils and climates, coupled with their drought tolerance and stability, makes them an attractive option for farmers seeking to balance productivity and sustainability.

SUMMARY

The apple industry in Himachal Pradesh is a testament to the power of innovation, resilience, and community-driven progress. From Samuel Stokes' pioneering efforts in Kotgarh to the modern adoption of high- and ultra-high-density planting, the state has transformed into India's apple heartland. While challenges like climate change, diseases, and market fluctuations persist, shift toward high-density systems, particularly those using seedling rootstocks, offers a path forward. By prioritizing light interception, precocity, and adaptability, these systems promise to deliver the twin goals of quality and productivity, ensuring that Himachal's apples remain a symbol of economic empowerment and agricultural excellence for generations to come.

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