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# High density plantation in apple – A highly remunerative enterprise

**High density planting (HDP) refers to increasing the plant population per unit area of land to increase the fruit production, overcome low productivity and long gestation period for early returns, which is achieved by using suitable scion varieties grafted on dwarfing/semi dwarfing rootstocks. High density orchards were first planted in Europe at the end of the 19th century and since then there is decline in traditional orchards with low densities. The underlying principle of HDP is to make the best use of vertical and horizontal space per unit time and to harness maximum possible return per unit of output. Standard apple plants raised on seedling rootstocks are planted at a spacing of 6×6 m to 7×7 m with a planting density of 204-278 trees/ha and spur varieties on seedling rootstocks are planted at a spacing of 5.0×5.0 m with a planting density of 400 plants/ha. The average productivity of these orchards is approximately 10 to 12 MT/ha, which is much below the productivity obtained in high-density orchards (60-80 MT/ha). High-density planting of apple varieties grafted on dwarf/semi-dwarf clonal rootstocks can accommodate approximately 3,333 plants/ha to improve productivity without affecting the quality of the produce.**

HIGH-DENSITY orchards can be laid on flat and fertile lands with assured irrigation are trained to modern methods of training systems, viz.espalier, vertical axis, slender spindle, tall spindle etc. The technology is helpful in best utilization of land resources, ease in orchard inter-culture operations, plant protection, harvesting and to obtain export quality of the produce. Canopy management has paramount importance in high-density planting to control vigour of trees and harvest of quality fruits. Apple is an important temperate fruit crop and is currently grown in Jammu and Kashmir, Himachal Pradesh and Uttarakhand. Apple cultivation is also extended to Nagaland, Sikkim, Arunachal Pradesh and Meghalaya. In Himachal Pradesh, farmers are currently in a fight to save their apple orchards that have been hit by climate change. They are adopting the new method of high density apple plantation being promoted by the state government. In Jammu and Kashmir, government is promoting high density apple plantation by phasing out old orchards that have completed their economic life, giving farmers a subsidy on re-plantation with new varieties grafted on dwarfing rootstock like M9. The commonly used apple varieties in high density planting are Jeromine, King Roat, Scarlet Spur-II, Super Chief, Red Velox, Gala's, Mema Master, Golden Delicious Reinders, Granny Smith, Adams and Gala Redlum.

Espalier system in apple

Tall spindle system in apple

**Advantages of HDP**

- High density planting facilitates better utilization of available resources i.e. solar radiation, land, water, labour, dwarf rootstocks, spur cultivars, human skill etc.
- High density orchards are more precocious thus result in earlier return on investment, which is key for investment.
- High density planting results in higher productivity and harvest index due to increase in bearing surface per unit area.
- High density planting produce better quality fruits due to high light interception and distribution of light within plant canopy.
- High density planting facilitate easy picking with less injury to fruit which result in better post-harvest life during storage.
- High density orchards have better acceptance to modern input saving fruit production technique such as drip irrigation, fertigation, mechanical harvesting, mechanical pruning etc.
- High density orchards increase effectiveness and reduce cost involved in horticultural operation like inter-cultural operation, pruning, plant protection measures etc.

**Limitation/constraints**

- High initial establishment costs, mainly due to the increased tree cost per unit area and tree support structure.
- Need more professional and scientific approach in management.

**Recommended HDP models in apple by ICAR-CITH, Srinagar**

High density planting system recommended in apple by ICAR-CITH, Srinagar (Model 1 and Model 2) having potential for enhancing productivity from 10-15 t/ha under traditional orcharding to 50-60 t/ha under HDP system. Under this system, varieties have been identified with better fruit quality and thus having more consumer acceptability and market value. Since this technology has been standardized on M-9 rootstock, which needs support and assured irrigation, therefore drip irrigation for assured irrigation and trellis system for proper support is being recommended. This support system provides the scope for development of designer tress using suitable canopy architectures like Espalier or/and Tall Spindle systems. Both these canopy architectural systems provide the scope for proper light penetration and diffusion responsible for optimum colour development and secondary metabolism in apple. Apples harvested through this technology are of better quality with optimum size, colour, secondary metabolites and uniformity in quality.

**Recommended Model 1**

- Planting spacing: 3.0 × 1.5 m (Plant to plant 3.0 m and row to row spacing 1.5 m)
- Planting density: 2222 plants/ha
- Canopy architecture: Espalier system
- Yield/productivity: Approx. 60 t/ha
- Varieties evaluated and recommended: Oregon Spur, Gala Mast, Coe Red Fuji, Granny Smith, Silver Spur, Spartan and Red Chief
- Rootstock: M-9.

**Recommended Model 2**

- Planting spacing: 3.0 × 1.5 m or 3.0 × 1.0 m (row to row spacing 3.0 m and plant to plant distance 1.5 m)
- Planting density: 2222 plants/ha (3 m × 1.5 m spacing) or/and 3333 plants/ha (3 m × 1 m spacing)
- Canopy architecture: Tall Spindle System
- Yield/productivity: Approx. 50-60 t/ha
- Varieties evaluated and recommended: Super Chief, Red Velox, Gala Redlum, Golden Delicious Reindeers, Golden Delicious Clone-B etc
- Rootstock: M-9.

In apple, high density plantation with modern canopy management system has been developed by the

**Table 1.** Comparison of high density plantation with traditional orchard system in apple

| Parameter | Traditional orcharding | HDP (Recommended) |
|---|---|---|
| Planting density | 100-278 plants | 2222-3333 plants |
| Training system | Centre leader, open centre, modified central leader system | Tall Spindle and Espalier |
| Precocity | Bearing starts after 6-8 years of plantation | Highly precocious (bearing starts after second year of plantation) |
| Productivity | Low (<20 t/ha) | High (>60 t/ha) |
| Yield potential | Low | High |
| Fruit quality | Low; due to low photosynthetic photon flux density (PPFD) and less penetration and diffusion of photosynthetically active radiation (PAR) | High; due to high photosynthetic photon flux density (PPFD) and more penetration and diffusion of photosynthetically active radiation (PAR) |
| Input use efficiency | Low | High |
| Disease incidence | High; this is due to dense canopy and low air circulation through canopy | Low; which is due to sparse canopy and more leaf area index |
| Mechanization | Difficult | Easy and cost effective |

**New generation high value apple varieties commercialized under HDP**

Super Chief

King Roat

Mema Gala

Jeromine

Gala Redlum

Gala Schnico Red

Red Velox

Golden Delicious Reindeers

Institute which increases the productivity of apple from 15 t/ha to 60 t/ha. This technology was taken as the base during 2016-17 and 2017-18 by the Government of India for initiating the High Density Mission of apple in Jammu and Kashmir. The spur and standard type cultivars like Oregon Spur, Super Chief, Silver Spur, Well Spur, Starkrimson, Scarlet Spur, Red Velox etc have potential to yield up to 60 t/ha under HDP on M-9 rootstock against the existing productivity of 15 t/ha on traditional orchards. Use of clonal rootstocks like M-9 induces precocity and plants bear fruits 2 years after plantation. Thus use of spur type apple cultivars grafted on clonal rootstocks like M-9 not only increases the productivity and quality but also induces precocity. Increase in productivity from 15 t/ha to 60 t/ha can increase the returns from 6 lakh/ha to 24 lakh/ha (@ Rs 40/kg). Under HDP, total planting density is about 2222 plants/ha and therefore requirements of planting material is huge. ICAR-CITH, Srinagar in addition to development of HDP technology in apple has also commercialized the identified elite apple varieties in the region. Institute is multiplying approximately 20,000 plants of elite varieties covering an area of about 10 ha annually. Entrepreneurship and employment generation has increased manifolds after the introduction of HDP in apple and other crops. At present, most of the youth are involved in HDP in apple due to better returns and quality produce. ICAR-CITH, Srinagar has identified new spur type and coloured varieties in apple which have been recommended for HDP in the regions. Due to better yield and quality, these varieties have better market value and consumer acceptance and hence play important role in enhancing employment generation and entrepreneurship. The varieties identified and technology developed can be commercialized in other states for enhancing the income of the farmers in the region.

**Economic advantage of HDP (Per ha)**

**Cost of establishment (₹ in lakh)**

| Component | Estimated estab. cost (Approx.) |
|---|---|
| Cost of plant material (5 feathered and above) for 3333 trees (1×3 m) | 16.00 |
| Cost of 4-wire trellis system (with installation) | 12.00 |
| Cost of micro-irrigation system | 2.00 |
| Annual maintenance including nutrition and plant protection | 1.20 |
| **Total** | **31.2** |
| Additional cost may be incurred on anti hail net, land development etc., based on location. | |

**Economic returns**

- Input cost per year ₹ 1.20 – 1.50 lakh/year/ha and returns on 60 t/ha at ₹ 50/kg are ₹ 30 lakh/ha/year. Therefore two-year return after commercial bearing (₹ 60 lakh) will cover establishment cost in addition to significant benefit to the farmer. Thereafter benefit of more than ₹ 28 lakh/ha/year is assured up to the age of at least 25 years.
- If we compare traditional orcharding system where productivity is about 10 t/ha with HDP orchard where productivity can go up-to 60 t/ha and therefore can increase the economic returns from existing (10,000 × 50 = ₹ 5 lakh /ha) to (60,000 × 50 = ₹ 30 lakh/ha).
- The quality of fruit under HDP is better (Grade A) due to proper canopy management system which leads to good fruit size and colour.
- The varieties which are being recommended for HDP are better in quality and have higher consumer acceptability.
- Orchards come into commercial bearing early due to better precocity.

**Regions recommended:** Temperate region including Jammu and Kashmir, Uttarakhand, Arunachal Pradesh, Himachal Pradesh, other North Eastern states.

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