HIGH DENSITY PLANTING

• Pioneered for temperate fruits in Europe.

• First planted in Europe at the end of 1960.

• HDP is defined as planting at a density in excess of that which gives maximum crop yield at maturity if the individual tree grows to its full natural size.

• In other words, it is the planting of more number of plants than optimum through manipulation of tree size.
• HDP is one of the improved production technologies to achieve the objective of
  – enhanced productivity of fruit crops.
• Yield and quality of the produce - two essential components of the productivity.
• HDP aims to achieve the twin requisites of productivity by
  – maintaining a balance between vegetative and reproductive load without impairing the plant health.
• In India, HDP has been proved useful in many fruit crops e.g. Pineapple, banana, mango, apple and citrus.
Principle of HDP

• To make the best use of vertical and horizontal space per unit time and

• To harness maximum possible returns per unit of inputs and resources.
Advantages of HDP

- Induces precocity, increases yield and improves fruit quality.
- Reduces labour cost resulting in low cost of production.
- Enables the mechanization of fruit crop production.
- Facilitates more efficient use of fertilizers, water, solar radiation, fungicides, weedicides and pesticides.
Plant Architecture in HDP

• Fruiting branches-more and structural branches-minimum

• Arrangement – minimum shade on other branches.

• Plant architecture is influenced by
  – the method of propagation,
  – rootstock and
  – spacing.
Desirable Architecture of Temperate Fruit Plants

- Prevent upright growth and develop horizontal laterals.
- Space small laterals along the central leader.
- Develop and maintain fruiting spurs along entire branch as it develops.
- Develop rigid, strong, self supporting laterals.
- Maintain fruiting branches in one position.
- Develop fruiting spurs along the sides rather than top or bottom of lateral branches.
Factors Affecting HDP

• Cultivar
• System of Planting
• Planting material
• Nutrition and moisture
• Economics of production
Methods of HDP

• Control of tree size
• Planting systems
Tree Size Control

- Use of genetically dwarf scion cultivars
- Use of dwarfing rootstocks and interstock
- Training and Pruning
- Use of growth retardants
- Induction of viral infection
- Use of incompatible rootstock
## Use of genetically dwarf scion cultivars

<table>
<thead>
<tr>
<th>Crop</th>
<th>Genetically dwarf cultivars</th>
<th>Desirable features</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mango</td>
<td>Amarpalli</td>
<td>Precocious &amp; tend to bear regularly</td>
</tr>
<tr>
<td>Papaya</td>
<td>Pusa Nanha</td>
<td>Dwarf &amp; tend to bear at lower height</td>
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<tr>
<td>Banana</td>
<td>Dwarf Cavendish (AAA)</td>
<td>High yielding with dwarf stature</td>
</tr>
<tr>
<td>Apple</td>
<td>Spur varieties like Red Chief, Oregon Spur</td>
<td>Bear on short stem, spurs; grow to 60-70% of standard cultivars in vigour and bear more spurs and yield more</td>
</tr>
<tr>
<td>Cherry</td>
<td>Compact Lambert, Meteor and North Star</td>
<td>High yielding, self fruitful Dwarf</td>
</tr>
<tr>
<td>Peach</td>
<td>Redheaven</td>
<td>Dwarfing &amp; high yielding</td>
</tr>
<tr>
<td>Sapota</td>
<td>PKM1, PKM3</td>
<td>Columnar tree shape, Dwarf tree stature</td>
</tr>
</tbody>
</table>
# Use of Dwarfing Rootstock

<table>
<thead>
<tr>
<th>Crop</th>
<th>Dwarfing Rootstock</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apple</td>
<td>M9, M26, M27, Bud.9, P22 &amp; Ottawa3</td>
</tr>
<tr>
<td>Pear</td>
<td>Quince C</td>
</tr>
<tr>
<td>Peach</td>
<td>Siberian C, St Julien X, Prunus besseyi and Rubira</td>
</tr>
<tr>
<td>Plum</td>
<td>Pixy</td>
</tr>
<tr>
<td>Cherry</td>
<td>Colt and Charger</td>
</tr>
<tr>
<td>Ber</td>
<td>Zizyphus rotundifolia</td>
</tr>
<tr>
<td>Citrus</td>
<td>Citrangequat, Feronia and Severinia buxifolia</td>
</tr>
<tr>
<td>Guava</td>
<td>Psidium friedrichsthalianum, P. pumilum</td>
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</tbody>
</table>
• Standard plantation on standard apple rootstocks (MM106) at 5x5 m accommodate 400 plants/ha,

• Non spur type cultivar on dwarf rootstock M9 spaced at 2 x 2 contain 2500 plants /ha.

• Spur apple cultivar on standard rootstock MM111 at 4 x 4 m and semi dwarf MM106 and M7 at 3x3m accommodate 1111 plants/ha.
Training and Pruning

• Pruning - dwarfing effect on the tree.

• Slow growing trees respond more favourably to pruning and training and can be maintained at a given size and shape without sacrificing yield.

• Removal of apical portion - compact and bushy tree

• Mango, guava, litchi and most of the other fruit crops in India are evergreen and are seldom pruned.
• Pruning -to regulate crop in guava, ber and fig, and rejuvenation of old orchards in mango.

• Tree size control through pruning - limited to grape, apple and some other temperate fruits.

• Spindle bush raised on M9, M7 and M4 rootstocks -promising training system for HDP.
Use of Growth Retardant

- Commercially adopted are CCC, Ancymidal, Paclobutrazol, B-9 (Phosphon D) and chloramquat.
- Paclobutrazol - gained commercial application in crop regulation in mango
Induction of Viral Infection

- Not adopted commercially,
  - tree size can be reduced by inducing viral infection e.g. Citrus, apple.
- In apple, virus free rootstock series East Malling Long Ashton (EMLA) are vigorous than their infected counterparts.
Use of Incompatible Rootstocks

• Use of graft incompatible scion and stock also induces dwarfness.
  – not commercially exploited for this end.

• In ber, cultivars on *Zizyphus rotundifolia*, *Z. nummularia* induces dwarfness due to graft incompatibility
Planting Systems

• Aimed to achieve high assimilated production for its conversion into economic yield.

• Various planting systems adopted in fruit crops
  – square, triangular, quincunx, rectangular, hexagonal, hedgerow (single & double), paired planting and cluster planting.

• Square and triangular systems are followed
  – for HDP in mango, Kinnow, banana, papaya and

• Hedge row system in apple and pineapple in India.
Impact of HDP

• In mango,
  – Amrapali at 2.5x 2.5m in triangular system accommodation of 1600 and
  – Dashehari at 3.0 X 2.5 m in square system -1333 plants per hectare,

• Increase in yield per hectare was 2.5 times in Amrapali than that of the low density orchards of vigorous cultivar.

• In Dashehari mango, the average yield in high density is reportedly 9.6 tonnes compared to 0.2 tonnes in low density planting.

• This yield can further be improved in alternate bearing cultivars like Dashehari, Chausa and Bombay Green through the application of growth retardant like Paclobutrazol.
• In Citrus, Kinnow on Troyer Citrange and Karna khatta rootstocks could be planted at 1.8 x1.8.m and 3x3 m to accommodate 3000 and 1088 plants per hectare, respectively.

• In pineapple, population density of 63758 per hectare coupled with improved package of agrotechniques result in increase in yield from 15-20 to 70-80 tonnes/ha.
Constraints of HDP

• Lack of standardization of production technology and extension of technical- know how to the farmers.
• High initial establishment cost.
• Lack of promising dwarfing rootstock in mango, guava, sapota, peach, sweet cherry etc.
• In apple, commercial utilisation of dwarf rootstocks for tree size control in HDP is restricted due to their poor anchorage, occurrence of sloppy, shallow and rainfed lands and low fertility.
• High incidence of some diseases in HDP e.g. Sigatoka leaf spot & finger tip in banana.
High Density Apple Plantation
High density planting in Mango