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## Recent advances of high density planting in apple

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### Abstract

The requisite for preliminary production of fruit crops viz., Apple, Peach, Pear, Apricot, and Cherry has become censorious as the compactness of the plants over the past half century has raised with the ameliorated management systems. For apple cultivation, dwarfing rootstocks are the pointers to alter the size of the trees, spacing and preliminary production. The other development methods which involve feathered trees, minimal pruning techniques and good knowledge on limb angle also resulted in drastic alteration in the density of apple trees. The pruning techniques and tree forms have been advanced with the knowledge on light interception and light distribution through the canopy. Dwarfing rootstocks benefit was full in case of apple and pear than the rest of the fruit crops. Even though the advanced techniques for high density planting were followed in other fruit crops, the density of the plants have not raised. Without disturbing the quality of the fruit, the concept of high density planting has increased the productivity of many fruit crops, majorly Apple. The preliminary yields of fruits will be obtained with the implementation of high density orchard planting. Even though the investment for high density orchard planting was bit high compared to conventional orchard development, the returns obtained were enormously high. This technique has the record of A Grade fruits with respect to quality as well price. Thus high density planting was recommended to improve the production, productivity and quality of the fruits.

**Keywords:** canopy, dwarfing rootstocks, high density planting

### Introduction

India stood next to china in the production of fruits worldwide. But the productivity was a bit low in the country compared to many other countries. The reasons behind low productivity are lack of knowledge on orchard management, poor canopy management, and low yielding varieties. Cultivation of apple throughout the world experienced drastic alterations since the past half century from traditional cultivation of large spaced trees to high density, closely spaced trees. In the past, the orchards were established with 70-100 trees/ha. In the recent times, the orchard plant density has been raised as 1000-6000 trees/ha (Robinson, 2003) [24]. Since the past 60 years, a lot of changes have been made in the planting of trees in orchards and the advancements involve dwarfing rootstocks, High density planting, pruning strategies as well as plant growth regulators which ultimately result in high preliminary yields and good quality of fruits. The dense planting of trees in the orchard was controlled by managing the size of the trees.

In the ancient times, the people used to believe high density orchard as the orchard with greater than 150-180 trees per acre. But, at present the normal orchards are maintained with 150-180 trees per acre and the high density planting contains the number greater than this. The dwarfing rootstocks used for high density planting yields better in the third year of planting for early production. Selection of good dwarfing rootstocks for early fruit production is very crucial. The interception of light and the distribution of light will be at greater extent for high density planting. The pruning strategies should be followed timely as the fruit production starts so early. The preliminary production of fruits is very crucial to conquer the investments on establishment of the trees. To magnify the production in the high density orchards, there is a need to alter the training and pruning techniques from the start of fruit establishment.

### Benefits of high density planting

- Expansion of yields and product quality improvement naturally.
- Expenses on the work and labour are minimised.
- Efficient use of manures, water, solar radiation, fungicides, weedicides and pesticides.
- Minimized structural branches and increased fruiting branches.

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- Based on the propagation methods, dwarfing rootstocks as well spacing.
- Vertical growth is minimised with horizontal lateral growth of the trees.
- Maintains the growth and development of the fruiting spurs along with the whole branch.
- The lateral branches are more, rigid and self-supportive.
- Maintenance of fruiting branches at a single position.

### Categories of high density orchard

High density orchards are categorised as follows

#### Low density planting (LDP)

Low density planting gives room for almost 100 plants per hectare without the use of dwarfing rootstocks, minimised training and pruning. Commercial production will be attained after 10-15 years and yields low during the early years.

#### Medium density planting (MDP)

Medium density planting provides room for 250-500 plants per hectare with the use of pruning. Yields more quality fruits with long productive life.

#### High density planting (HDP)

High density planting provides room for more than 1000 plants per hectare. High density planting needs more training and pruning, dwarfing rootstocks with growth promoting chemicals. Yield as well expenses are more in this case.

#### Ultra high density planting (UHDP)

It accommodates more than 2000-5000 plants /ha. The planting needs more pruning and training with better canopy management and proper growth promoting chemicals and nutrients as well technical back up too.

#### Super high density planting (SHDP)

It accommodates more than 10,000-40,000 plants/ha. Needs greater level of top pruning, huge application of growth regulators and judicious canopy management. Trees start yielding after 1 or 2 years after planting.

### Components of high density planting (HDP)

#### Dwarfing rootstocks

Dwarfing rootstocks are the basic components to alter the size of the trees, spacing and preliminary yields drastically. In 1920's, the Malling series of apple rootstocks were released. The canopy of the trees was maintained at 50cm from the ground, therefore, animal grazing was not allowed in the apple orchards. The labour efficiency was determined by the dwarfing rootstocks. These rootstocks help to maintain high density of trees within the orchard and also maintain the expenses at a low scale. Most of the rootstocks improve the size of fruits and their tolerance to several diseases like fire blight, Phytophthora, crown gall etc., and also tolerance to various insects like woolly apple aphid as well as tolerance to several abiotic stresses. The very famous rootstocks in the present times are M.9, M.26, budagovsky etc. The availability of dwarfing rootstocks for high density planting is very low, but numerous selections are going on with proper evaluation. Various breeding programmes are under process continuously to develop tolerant rootstocks to numerous biotic and abiotic stresses.

### Intensive planting systems

#### Light interception

Cain (1970) <sup>[3]</sup> concluded that the light interception is necessary throughout the lifetime of the orchard and also

noticed that lifetime of a tree canopy increased with decrease in tree size and increased plant density. The light interception helps in improvement of yields that too in the beginning years of orchard. Leaf area index also plays a role in the light interception along with the size of the trees. Numerous mathematical models were made for the estimation of light interception through various shapes of canopy and planting systems. (Jackson 1981) <sup>[12]</sup>. Light interception is the major consequence of tree shape and arrangement.

### Canopy management

The canopies of the orchards irrelevant to the other crops are discontinuous in apple due to maintenance of orchard machinery. This results in the utilisation of large area uncovered with trees. Therefore high density planting maintains the canopy perfect with proper training and pruning allowing the proper light interception. Maintaining the short height of the trees helps the development of lateral branches thus maintaining the perfect canopy within a small space.

### Feathered trees

The feathered trees is one of the component in the high density planting which helps in promoting the yields early. Previously, the strong branching of the trees was effected severely by the single shoot whips at the nursery stage. This has resulted in the delayed development of strong branches for years and delayed yields for several years. The feathered trees these days provided a strong framework of branches in the early stages itself. The number of feathers at the time of planting and the early yields are directly proportional to each other. More the number of feathers more the yields we get at the early years itself. (Ferree *et al.*, 1987) <sup>[7]</sup>. Pruning plays a key role in the growth and development of the trees since planting. Delaying the pruning in the early stages leads to the poor growth and development of the trees in the normal conditions. But, with the use of feathered trees, the need of pruning was less and the growth and development of the tree will be attained in the early years of planting. Nitrogen and carbohydrates also shows their effect on the development of the trees after transplanting. Therefore, the reserves of nitrogen and carbohydrates are to be maintained to increase the ability of the tree to grow faster after transplanting.

### Limb angle

For the development of small gardens, branch angle of many fruit trees has been altered since many years. Manipulation of branches has become key component in the management of trees in the early stages of development. Huge growth and less flowering is developed by maintaining the branch angle at 45° but the branch angle from 45° down to horizontal leads to the maintenance of less growth meanwhile large flowering, large size of the fruits with good quality of the fruits. The angles below the horizontal leads to development of more number of spurs but with reduced size of the fruits. Therefore, limb angle has become important in maintaining the high densities of the trees in the orchards. The limb angles are manipulated according to the type of orchard that we establish and according to the growth that we need. In the present days the apple growers are interested in manipulated in the branch angle accordingly to gain more fruit yields with large size and good quality.

### Pruning

The studies related to pruning were started in the past from many years. Most commonly used system for pruning using heading cuts with central leader system. Development of tiers of branches was done with the help of heading cuts of the

leader. Upper tiers of the branches were designed in such a way to be permanent. But, as the tree ages these branches will be large enough to shade the below portions of the tree. Considering the natural growth of the tree types of various plants, Lespinasse (1977)<sup>[13]</sup> had developed the concept called renewal pruning. Vertical Axis system proposed by him is so useful to avoid shading of the lower portions by the upper tiers of branches by considering the natural growth habit. Proper distribution of the light throughout the tree canopy was made possible with pruning techniques. The timely pruning of the trees when needed helps in obtaining faster growth coupled with more yields in the early years and with good quality of the fruits.

### New cultivars

Since a century, numerous cultivars have been developed throughout the world and introduced into the world market of apple. Pink lady, Gala, Granny smith, Jonagold, Empire are some of the important varieties worldwide. In the initial days of the release of cultivar the cost of the fruits was a bit high compared to the later days. Efforts are being made throughout the world to develop new cultivars of apple.

### Plant growth regulators

Utilization of the plant growth regulators is more in the production of apple throughout the world. The initial use of the plant growth regulators was made for thinning of the fruits. Naphthalene acetic acid (NAA) has become popular in fruit thinning in apple and then numerous synthetic plant growth regulators were developed and used in fruit thinning. The yearly profit of the fruit depends on the thinning of the fruits. Induction of the lateral branches in the nursery as well as orchard was done using plant growth regulators, Promalin, Maxcel and Tiberon. For controlling the shoot growth, Regalis, Apogee, Prohexadione-Ca were used and for preventing the drop of the fruits before harvest, NAA, Retain, Harvista are used. The softening of the fruits was reduced by using Smart fresh in the storage.

### Conclusion

The development of high density orchards has become so popular these days throughout the world. The use of dwarfing rootstocks, feathered trees, branch angles, minimised pruning, canopy management and use of plant growth regulators made the High density planting very advance. The early production of the fruits within three years of planting was made possible with the implementation of high density orchards. The size and quality of the apple fruits also improved with this technique. The tolerance levels of the trees towards various biotic and abiotic stresses also been increased.

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