

Tall Spindle – Apple orchard planting system for the future

The apple farming in India has changed significantly over the last 3 decades. During the late 80's, apple orchards were characterized by standard type 'Red Delicious' plantings on seedling rootstocks trained mostly on open vase system pollinized mainly with 'Golden Delicious'. In early 90's with the introduction of spur type 'Red Delicious' varieties and semi-dwarf rootstocks such as MM.106 and MM.111 apple planting density has increased from 156 (8 m × 8 m) to 800 trees/ha using Open Centre, Delayed Open Centre and Central Leader training system mainly in square design at a spacing of 5 × 5 (400 tree/ha) and 4 × 4 (625 tree/ha), whereas, some grower's adopted rectangular design with spacing of 6 × 4 m (416 trees/ha) or 5 m × 3 m (666 trees/ha) and 5 m × 2.5 m (800 trees/ha). However, after 12-15 years of orchard life many of these orchards had excessive vigor with permanent upper tier branches that were too strong resulting in shading of the lower and inner canopy which compromise fruit quality and in some cases return bloom. Later with the introduction of dwarfing rootstocks (M-9), there is a strong trend towards denser orchards (2,200 or more trees/ha) by adopting flat planner orchard planting system like Espalier and vertical planner orchard planting system like Vertical Axis and modified form of Vertical Axis. Now from last 5-6 years, Tall Spindle orchard planting system is gaining popularity among the Indian apple growers.

EVOLUTION towards more competitive apple orchard systems has taken place to improve orchard efficiency in term of yield, quality and profitability with efficient use of inputs. Efforts to modify tree form and develop new apple orchard planning systems began in the middle of the 20th century. Both researchers and apple growers began to search for more efficient shapes and system. The journey started with Spherical-shaped canopy form and reached to vertical planner canopy system via conic, flat and V-shaped canopies. Below mentioned research advancement led to development of several orchards planting systems for apple, each with their own merits:

- i. Development of dwarf rootstocks
- ii. Light interception studies
- iii. Light distribution and tree form studies
- iv. Pruning studies
- v. Better understanding to bearing habit of cultivar
- vi. More understanding to the management of branching
- vii. Limb angle studies
- viii. Introduction of feathered plants
- ix. Development of new cultivar with high market price.

Tall Spindle orchard planting system

Tall Spindle is ideally suitable for apple fruit growers in India, particularly in Kashmir region where most of the apple orchard are on plain land with assured irrigation facilities. Instead of relying on strong trunk and big scaffold branches, Tall Spindle trees depend on a trellis system for support. Tall in the name of system denote height of the tree which is about 10-12 feet whereas spindle (thin) is natural growth habit of standard 'Golden Delicious' cultivar which tend to be spreading with wide crotches and frequent branching. The Tall spindle incorporates aspects of the Slender spindle (high tree density), Vertical axis (tree height, limb renewal pruning), Solaxe (pendant limb angle) and Super spindle (simpler and narrow canopy, small diameter fruiting branches, no large scaffold) orchard planting system. The Tall spindle system achieves the goals of early cropping, regular high yield and good fruit quality. In addition to this it also maximizes the profitability by utilizing the optimum tree density, moderate investment and simplified management technique. Therefore if done properly it will be the most profitable system for apple growers of Kashmir valley.

Basic Principle and merits of Tall Spindle orchard planting system

Tree management in Tall spindle system is relatively very simple than other systems and very easy to manage by growers. The basic elements of mature Tall Spindle system is a single dominant trunk with height limited to 90% of the distance between the rows which result in maximum light interception (70-75%). The second principle is that it has no large diameter branches from the base of the tree up to the top. Only those branches are allowed to remain which are smaller than 2.5 cm in diameter. A Tall Spindle trees generally have 15-20 small fruiting branches which produce about 150 high quality fruits. The third principle of the Tall Spindle system is that it maintains a very narrow canopy. The top is narrower compared to base of the tree that allows good light exposure on both sides of the tree. Trees in north to south oriented row receive morning sunshine on one side of the tree and in the afternoon other side of the tree. Since it is very narrow (less than 3 feet deep canopy) almost all fruits receive direct sunlight exposure leading to development of uniform colour and size. Further, this system not only have very narrow tree wall but is also very tall thus it provides an opportunity for partial mechanization for pruning, hand fruit thinning and harvesting in upper part of trees by positioning worker at 6 feet by using platform. Due to possibility of partial mechanization, labour reduction can contribute to the potential positive ability of Tall Spindle. Thus Tall Spindle system not only has a lot of advantages that combine high economic productivity but also tree management is very easy under this system.

Essential component of Tall Spindle orchard planting system

Optimum tree density

Planting density is single most important factor which determines the yield of orchard particularly in early years. However, proper selection of tree density for Tall Spindle system depends on consideration of vigor of rootstock and variety, bearing habit of variety, soil fertility (determine in row spacing) and land slope (determine between row spacing). The proper tree density can vary from as many as 3,700 trees/ha (0.9 × 3 m) to 2,300 trees/ha (1.2 × 3.6 m). For weak or moderate growing cultivars the recommended row spacing is 0.9 m whereas for vigorous and tip bearing cultivar the recommended row spacing is 1.2 m. The recommended spacing between rows is 3 m and 3.6 m for plain and sloppy land respectively.

Fully dwarf rootstock

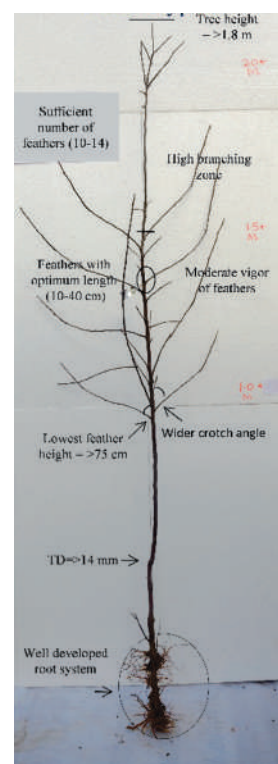
The trees in Tall Spindle should be dwarfing and precocious. Till date most successful Tall Spindle orchards were established on M.9 and B.9 rootstocks. Within rootstock, however, there are vigor differences. Weaker clones (M.9-T337, B.9, G.11 and G.41, etc.) are recommended for vigorous cultivars or virgin soils, whereas, more vigorous clones (M.9 Pajam 1&2, M.9 Nic29, M.9 EMLA G.16 etc.) should be used with weak scion cultivars or weak soils.

Cultivar selection

Certain cultivar perform better in some areas than others therefore, care should be taken to ensure suitability of cultivars to the particular growing region. Further, when choosing cultivar to grow, it is important to consider the market price of the cultivar, because market price has the greatest effect on the potential profit of orchard planting system. In most cases the market price is very high when the new variety is introduced in market but as production increased the price dropped. The high density planting systems are more sensitive to price fluctuation than the low density. This means that when the market prices are less, they suffer the most and when the market prices are more they benefit the most.

Feathered nursery trees for planting

A high density apple orchard should be precocious to overcome the high early investment costs. Therefore, whip or small caliper plants are not suitable for establishment of the Tall Spindle orchard planting systems. If apple grower's use such type of nursery plants, the plants do not bear fruits until 4 or 5 year. High quality apple nursery trees suitable for Tall Spindle orchard planting system should be at least 6 feet tall with dominant straight leader to achieve desired height after planting and have at least 14 mm trunk diameter to produce significant yield during second year. Further, it should have 6-8 feathery branches which are induced at desirable height (more than 70 cm from ground) and distributed along the leader at regular intervals, with appropriate length (10-40 cm) and crotch angle (> 45°). Moreover, it should have an abundance of healthy roots to support plant canopy during first year.



Feathered nursery tree is essential component of Tall Spindle system



Ideal planting depth - just covers roots with soil



Graft / bud union should be 10-15 cm above ground



Remove feather/s competing with central leader at the time of planting

High planting depth

Deep planting always comes with a risk and can hurt the tree. Keep the nursery soil line above the ground and just cover roots with soil. This provides proper oxygen to roots and roots work better. Graft/bud union needs to be 10 to 15 cm above ground to avoid scion rooting, graft union rot and to regulate the stionic effect.

Minimal/no pruning at planting

Pruning of tree at the time of planting is a most common practice with most orchard planting systems to maintain shoot to root ratio and to encourage vegetative

growth to form canopy as soon as possible to fill allotted space in orchard. However, under Tall Spindle system, plants are planted at closer spacing. Therefore very little space is needed to fill and very little pruning is needed. In this system leader as well as feather is not pruned at planting to achieve targeted height and to get crop in second year. In the Tall Spindle orchard planting system, following precautions should be taken:

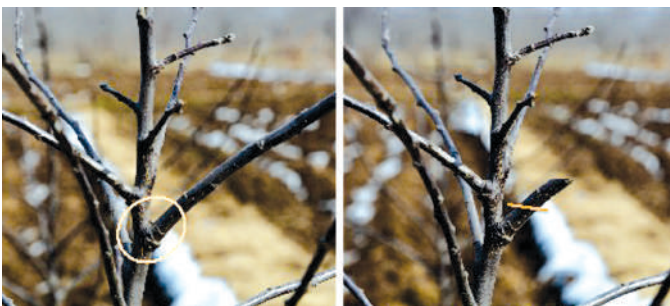
- Do not head back tree at the time of planting.
- Remove low branches (below knee height) and any feather/s that are larger than 2/3 of the diameter of the leader.
- Leave as many feathers as possible without compromising growth of leader.



Remove branch/cs below knee height at the time of planting

Bending feathers and branches below horizontal at planting

In the Tall Spindle system instead of very high vegetative growth only optimum growth is needed. Moreover, this system utilizes highly feathered nursery trees, therefore no lateral growth is needed but only central leader growth is needed to attain anticipated tree height. To limit extension growth and get early



Remove dead or damaged end of feather/s or remove completely at the time of planting



Bending of feathers at the time of planting



Bending of branches due to crop load during second year

yield, branches should be tied down below horizontal in a pendant position at planting. This also prevents them from developing into large lower scaffolds and prevent severe limb removal pruning in early age. Thus this simple method of branch management in early age allows for long-term fruiting in many branches and little intensive pruning for first 4-8 years at very close in-row tree spacing. After the initial tying or weighing down of branches at planting, new lateral branches that arise along the central leader do not need to be tied down. In most climates, if moderate vigor shoots are not headed back, often fruit load in the third year will bend them down below horizontal and a natural balance between growth and fruiting will be established without additional branch management. Thus with the Tall Spindle branch tying is needed only at the time of planting. However, in vigorous climates or where winter chilling is insufficient, branches often become too large before they set sufficient crop loads to bend the branches down. In these climates, tying down to all vigorous branches must be done annually for the first 3-5 years until the tree settles down or begins to crop heavily.

Limb renewal pruning

In Tall Spindle orchard planting system, trees are spaced very close within the row thus there should be no permanent limbs within the tree. Therefore, when scaffolds grow too large they should be renewed by complete removal for available space. Renewal cuts are made using the “bevel cut” method (removal of large branch at the point of origin leaving about 2-2.5 cm long



Renewal pruning using bevel cut

beveled stub) which encourages new shoots to form as replacement fruiting limbs.

Leader management

Maximum leader growth during first 2-3 years is critical in a Tall Spindle apple orchard planting system to obtain desired yield. The tree should reach the top wire (10 feet) by the end of the third year. To achieve targeted growth of leader in expected time, maintaining good leader growth is critical. Growers need to intensively manage the trees in the first 3 years to achieve desired growth.

1. Remove the buds around the leader and cut back top shoots competing with leader at the time of planting.
2. Quickly install the trellis and irrigation lines after planting.



During first 2-3 years, remove branch/es that compete with central leader

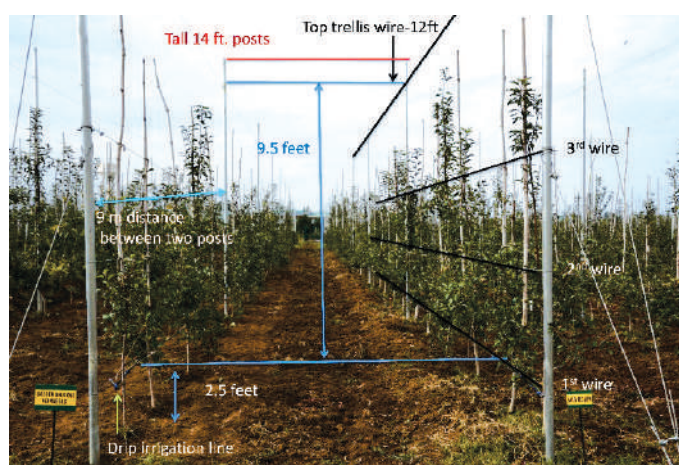


Choose replacement leader if leader get damaged before reaching to top wire

- Water (when needed) should be supplied by drip irrigation with low doses per tree (8-10 litre) but frequently (2-3 times per week).
- The best tree growth response can be achieved by injecting liquid nitrogen fertilizer (fertigation) with each irrigation (100 ppm = 0.1 g / litre of irrigation water).
- The new trees should grow healthy, without weed competition, and biotic and abiotic stress.
- The leader should be attached to the trellis with a rubber band or a wire loop as soon as it reaches successive wire.
- In first 2-3 years, remove branches that compete with central leader (early growing season or during dormant season) or rub off the second and third shoots below the central leader at 5-8 cm of growth.
- If leader gets damaged before reaching to top wire, choose replacement leader from the strong upright branch, tied to the trellis or stalk and remove competing branches.

Superior support system

Support system is an essential component of Tall Spindle orchard planting system as this system utilizes dwarf rootstock to manage vigor and induce early cropping. The orchard support system is crucial factor for achieving targeted tree growth during the early age of orchard, early high yield and to support crop load on weak fruiting branches. There are two types of support systems available i.e. individual tree stakes and post and wire. However, post and wire trellis have several advantage over individual tree stakes i.e. the trellis is more economical at higher tree density, the wire attachment allow less twisting in the wind with fever broken graft union. Further, wire gives more option for branch positioning and support fruit load on weak fruiting branches.



Water Management

Drip irrigation system is more suitable for Tall Spindle as it enhances water use efficiency and is useful in providing optimum amounts of irrigation water (and fertilizer) consistently throughout the season for good fruit development. The growers should install drip irrigation soon after planting with high density orchards that use large feathered nursery trees.

Under the Tall Spindle orchard, developed on M-9 rootstock the area beneath the canopy of the tree should be wet to a depth of 45 cm at each irrigation. In bearing or mature Tall Spindle orchard adequate soil moisture is critical during fruit set and fruit development but more critical period is early growing season i.e. cell divisional period. Irrigation should be done using 4 micro-tube type emitters (1.5 L per hour discharge capacity) per tree in every direction for equal distribution of water around the tree. It helps in proper root distribution and mineralization of nutrients.

Nutrient management

Highly feathered nursery trees have limited ability to take up nutrients from soil just after planting due to damaged root system as well as during planting year due to limited root to shoot ratio. Therefore, increased nitrogen application to support growth in feathered young trees may be needed during the first 1-2 years. After planting, apply low doses of nitrogen at 3-4 days interval through fertigation during first 3-4 month to increase uptake of Nitrogen and achieve good tree growth during the first year. After first two years, low nitrogen application is desirable to keep the trees calm with a balance between vegetative growth and fruiting. Under drip irrigation system only a portion of the soil volume around each plant is wetted and thus conventional method of fertilizer application is not so effective. The limited root zone and the reduced amount of mineralization in the restricted wetted zone are the main reasons for the reduced nutrient availability to the plant with traditional method of fertilizer application under drip irrigation.

Crop load management

Crop load management is best way to produce quality apples and to get good return bloom. Avoid over-cropping by removing excessive fruit load in early summer. In young tree, hand thinning is preferable over chemical due to unpredictable response of chemical thinner. Thin fruit after early drop as un-pollinated fruit naturally fall down on ground at this time. The correct crop load can be determined by tree size and it is usually measured at trunk diameter 10 cm above graft union.

Table 1. Optimum number of fruits to be retained on the tree at different caliper (mm-10 cm above graft/bud union) in Tall Spindle orchard planting system

Caliper (mm)	No. of fruit
12	7
14	9
16	12
18	15
20	19
22	23
24	27
26	32
28	37

Maintain conic shape of the tree

Good light exposure is critical for fruiting and fruit quality in any orchard planting system. Therefore it is important to keep the tree narrower at the top than at the bottom for maintaining a conic shape to the tree. This can be achieved by annual removal of large one or two upper branches completely by “bevel cut” so that small stub of the lower portion of branch remains which often result in flat, weak replacement branch. When such type of pruning is repeated annually, the top of the tree can be composed completely with young fruitful branches.

Advantages

- Most profitable system (compared to other commercial orchard planting systems)
- High early yields (due to high tree density and feathered trees, bear fruit in second year, with a full harvest by 4th year)
- High mature yields (due to continuous renewal of fruiting area)
- High quality produce (due to increased light interception and distribution in the tall and thin tree's foliage)
- Highly efficient (minimum labour for training, pruning and harvesting)
- Simple and easy to establish and maintain.
- Use natural tree growth control (natural branch bending due to fruit load)
- Better spray coverage (due to narrow canopy)
- Adaptable to partial mechanization (pruning, thinning and harvesting)
- Pedestrian orchard (70% of work from the ground).

SUMMARY

The fruiting potential of the apple tree largely governed by its architecture, canopy density and photosynthetic efficiency. With the research advancement many orchard planting system have been developed in apple to optimize production and quality of produce.



Tall Spindle orchard planting system at ICAR-CITH, Srinagar

The Tall Spindle orchard planting system is new apple orchard planting system which is gaining popularity around the world and is ideally suitable for Indian condition particularly for the Kashmir region. This system utilizes the concept of optimum tree density planting with high quality feathered nursery tree and minimal pruning at planting to get high early yield and sustained mature yield of high quality fruits while reducing and simplifying mature tree pruning and other management costs. The system achieves high light interception by growing tree to a height of 90% of row spacing and good light distribution throughout the canopy by keeping the tree canopy thin. Moreover, this system also provides opportunity of partial mechanization of training, pruning, fruit thinning and harvesting using platforms.

For further interaction, please write to:

*Kishan Lal Kumawat (Scientist), ICAR-Central Institute for Arid Horticulture, Bikaner; J I Mir (Senior Scientist) ICAR-Central Institute of Temperate Horticulture, Srinagar, Jammu and Kashmir 191 132. Corresponding author e-mail: kishan84hort@gmail.com

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– Editor