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High density planting in Aonla

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Introduction:

High-density planting (HDP) represents an intensive horticultural production methods with significant implications for the food and nutritional security of a growing global population. It is considered a highly advanced technology for enhancing fruit crop productivity in India. The perennial nature of fruit crops makes HDP particularly beneficial, as it facilitates efficient land and resource utilization, improved branch management, farm mechanization, and the effective application of insecticides and pesticides. HDP also allows for precise timing of harvest to optimize yield and quality, leading to higher returns. This fully mechanized approach to fruit crop production involves training, pruning, growth regulation, and the management of irrigation, fertilization, and nutrients to achieve high productivity per unit area. HDP was first introduced in apple, cultivation in Europe (specifically England) in 1962 and was subsequently adopted for mango and guava cultivation in India, and is now widely utilized for various fruit trees.

Aonla (Emblica officinalis Garten. Syn. Phyllanthus emblica L.) is a significant minor fruit crop in India and globally, belonging to the Euphorbiaceae family and known by various names such as amla, amlaki, amali, ambala, amalakamu, and nelli across different regions of India. It thrives in arid and semiarid regions and is a highly profitable crop even with minimal care. The fruit is exceptionally nutritious, being the richest source of vitamin C among fruit crops, second only to Barbados cherry (Asenjo, 1953). Further more, the ascorbic acid content of Aonla fruit surpasses that of guava, tomato, and citrus fruits. Notably, Aonla fruit's ascorbic acid does not oxidize during processing and storage, attributed to the presence of polyphenols or leucoanthocyanins (Sastry *et al.*, 1956), along with containing calcium, phosphorus, iron, Vit-B, and nicotinic acid. With a calorific value of 59% per 100g of fruit, it is esteemed for its diverse medicinal, industrial, and other applications due to its antiscorbutic, diuretic, laxative, alternative (Nadkarni, 1927), and antibiotic properties

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(Ray and Majumder, 1976). Aonla fruits are not typically consumed fresh but are processed into various products such as murabba, sauce, candy, Triphala churan, Chavanprash, pickles, toffees, dried chips, jellies, tablets, and powders. A wide diversity of Aonla exists in India and is distributed across various regions within the country as well as globally in places like Sri Lanka, Cuba, Hawaii, Florida, Iran, Iraq, Pakistan, and the West Indies (Wali *et al.*, 2015). In India, most Aonla orchards are of seedling origin with wider spacing leading to low productivity; thus, there is significant potential for High-Density Planting (HDP) to mechanize the orchards and address the issue of low productivity.

Training and pruning: Basic unit of plant Canopy

Training: Training may be define as- maintaining plant shape & size in the initial stage to produce good frame work of plant canopies**.**

Pruning: Pruning it may be define as – pruning is the art and science, removal of judicious plant part (dead branches, criss-cross branches, weak shoots) to improve the shape, growth, flowering, fruitfulness, produce good quality fruits, and increase production**.**

Types of training: basically 3 types of training systems are fallow

- **Central leader system / closed cantered system**
- **Open Centre system/ vase shaped system**
- **Modified leader system/ delead system**

Central leader system- In this system Central branches are allow to growing upwards with side branches are out of different heights. In this type of system best suited to bear land and resistances again strong winds.

Open Centre system- In this system are allowing side shoots branches in curved shape and giving thinning out cut all branches growing beyond or below a point to develop a tree with open or vase system.

Singh, Gorakh, and Mishra, Rajneesh (2007). Aonla Rejuvenation

Limitations-

- Not suitable frost areas.
- Not bear heavy crop load.

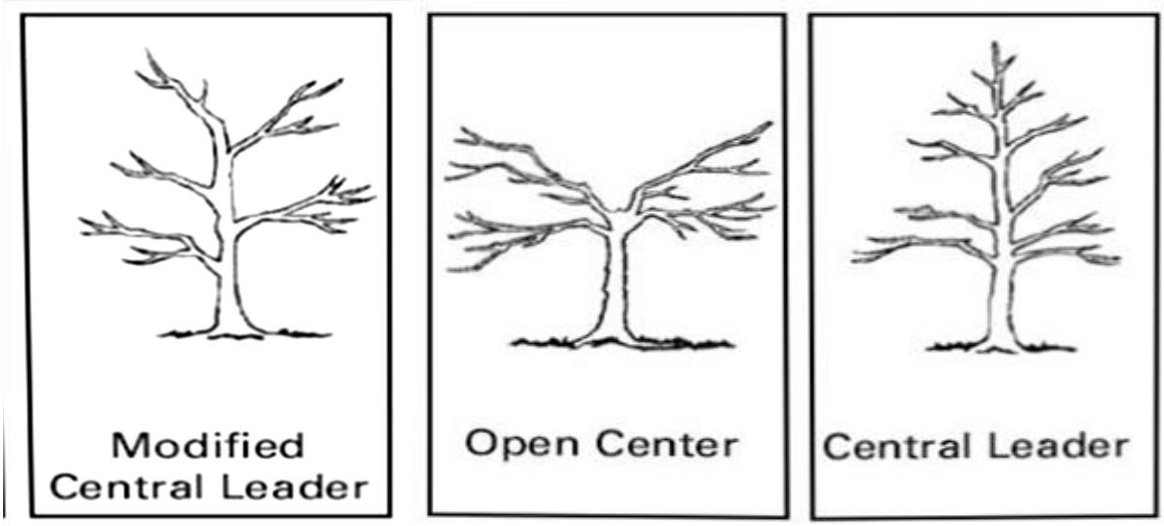
Modified leader system – This system is mostly acceptable and commercially follow in fruits cultivation. In this system branches are allow to growing in 1- 2 years with any restrictions , after 1-2 years tree is trained to have a good framework in which, the branches are well spaced. Modified system are best compared to Central and vase system. In this system easy to intercultural operation, better light interception, and not prone to limb breakage.

Tatura trellis - The Tatura trellis system is also known as "V" shape training system. This system was developed by Chalmers and van den Eude at Irrigation research Institute from Tatura, Australia, in 1973. This system is main purpose to produce a continuous canopy of fruiting wood half a meter deep to maximize yield and at the same time to facilitate intercultural/mechanical operation. Each tree has only two limbs growing East and West at the angel 60^0 to horizontal position. The secondary arm / branches are developed across the arm .V shaped tree in N-S row. In trellis system tying down of branches to horizontal positions causes a gravemorpic response (the movement or growth of a plant in response to gravity). This response improves to premature terminal bud formation and sometimes to improve flower intention.

- The canopy is open to provide good ventilation, aeration & low disease incidence.
- Trellis canopy results in precocious and profuse fruiting in many subtropical and temperate tree.

Limitations-

- It shows some problems during intercultural operation like spraying during in the inner canopy



Utilization of Hormones in High-Density Planting

In high-density planting systems for aonla cultivation, the application of auxins and cytokinins is crucial for promoting root and shoot development, respectively.

Auxins (e.g., Indole-3-Butyric Acid - IBA):

Role: Auxins are synthesized in the shoot tip region of young leaves, primarily originating from the precursor Tryptophan. They facilitate rapid plant growth and maintain apical dominance by inhibiting the growth of lateral buds. Additionally, auxins stimulate cell division, enlargement, and elongation in the apical zone, as well as promote enzyme activity and differentiation of xylem cells. Furthermore, auxins enhance root formation and growth, increase RNA synthesis, and aid in cell expansion, all of which are essential for establishing a well-developed root system in high-density planting systems.

Application: IBA, a synthetic auxin, is commonly used as a rooting hormone to encourage root development in cuttings or planting sites. In Aonla cultivation, foliar spray application of plant growth regulators such as Gibberellic acid (GA3) and IBA can mitigate the adverse effects of soil sodicity on seed germination and promote root and shoot growth.

Cytokinins (e.g., Kinetin):

Role: Cytokinins play a pivotal role in cell division and shoot growth. Their interaction with auxins influences the ratio between cell division and differentiation. Cytokinins also contribute to DNA synthesis, mitosis division, cytokinesis, and cell enlargement. Moreover, they affect seed germination and can stimulate or inhibit root development. In the context of high-density planting, cytokinins facilitate the production of compact and well-branched plants, optimizing space utilization.

Application: Kinetin, a type of cytokinin, is often used to promote shoot initiation and development while also regulating apical dominance and suppressing lateral bud growth. It can be applied as a foliar spray or incorporated into the soil. Application methods and concentrations of these hormones may vary based on specific crop requirements, growth stages, and environmental conditions. It is essential to adhere to recommended guidelines and seek advice from agricultural experts for precise hormone application in cultivation practices.

Rejuvenation:

It is a crucial process in horticulture, particularly for fruit plants, as they experience a decline in both the quality and quantity of produce over time. This decline leads to orchards becoming economically nonviable and unproductive. In India, a significant

proportion of fruit crop areas are occupied by old, dense, and diseased affected orchards, which are unproductive and uneconomical. Traditional rehabilitation strategies involving uprooting and replacing large-scale plants are time-consuming and expensive. Therefore, there has been a focus on developing a technology called Rejuvenation, to overcome the unproductive potential of existing plantations. The process involves specific steps for rejuvenating old trees, including pruning and applying certain pastes to stimulate new shoot growth. A similar need for rejuvenation exists in Aonla orchards due to the decline in fruit quality and production capacity over time. Rejuvenation and top working practices have been found to be effective in increasing fruit quality and production in Aonla orchards, with specific cultivars showing improvements in fruit length, breadth, and vitamin C content after undergoing these practices.

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