



# High Density Planting and Meadow Orcharding in Guava for Higher Return

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## Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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## ABSTRACT

Due to the extensive tree canopy, the traditional method of cultivation has had difficulty achieving the intended levels of productivity. As a result, it became necessary to enhance the current manufacturing system in addition to impressing with its productivity. There is a current tendency for fruit trees to be planted more densely or in meadow orchards to control tree size, keep desired architecture, and make operations like pruning, pest control, and harvesting easier. The meadow orchard system is a novel idea for guava planting, providing densities of 5000 trees per hectare at a spacing of 1 m by 2 m. In contrast to conventional well-branched trees, this system is controlled to

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create a simpler and smaller structured framework starting in the first year. Guava trees are topped and hedged to encourage the development of fruit buds in the first year. Regular topping and pruning helped to reduce the size of the tree canopy. In the first year after sowing, trees produced flowers and fruit.

**Keywords:** *Guava; meadow orcharding, pant prabhat; traditional system; ultra-high density.*

## 1. INTRODUCTION

Guavas are among the most well-known and legendary fruits due to their hardiness, prodigious yielding ability, even on poor soil, high vitamin C content, particularly in the fruit skin when it is mature, and increased yield with little maintenance or effort. In addition to vitamin C, the fruit is a particularly good provider of fibre, vitamin A, vitamin B2, and vitamin B1. The entire guava fruit contains a good amount of iron, a medium amount of phosphorus, and a moderate amount of calcium. All things considered, it is also referred to as "Poor man's apple or Apple of the tropics." It is the fifth most widely grown fruit crop of India and is grown in an area of about 2.85 million hectares, with an annual production of 3.72 MT (NHB, 2020-21). But, of late, this crop has exhibited a paradigm shift in the production system, from subsistence farming to commercial production. Tree spacing is one method used to obtain efficient and profitable land use; its basic function is to confine the exploitation zone of the plant with regard to light, water, and nutrients so the highest total yield position can be reached in the smallest possible area. With ever increasing land costs, and the need for early returns on invested capital, there is a worldwide trend toward high density plantings/meadow orcharding or super intensive or ultra-high-density planting. Although there was increase in area and production of fruits during last decade in the country productivity did not show significant increase. Generally, guava is cultivated through traditional planting system. In which it is very difficult to achieve desirable level of production. Moreover, in this system guava tree takes 4-5 years for coming into commercial bearing and thus maximize the overall cost of production per unit area. There is a global trend towards high density plantings/meadow orcharding or super intense or ultra-high density planting as a result of rising land costs and the requirement for quick returns on investment.

The increasing importance of guava as a commercial tropical fruit crop, both for table purposes and processing, demands its widespread cultivation ensuring regular cropping and higher production. . Guava is often grown

using a traditional planting strategy, which makes it challenging to reach higher level of production because huge trees have low productivity and require a lot of labor. Moreover, large trees take several years before they come into bearing and overall cost of production per unit area is further increased. Therefore, there is an urgent need to enhance the current planting method. Currently, there is a global trend toward permanent high-density fruit tree planting, meadow orchards, and canopy management, which regulates tree growth patterns and tree structure while ensuring high fruit production of the desired size and quality.

"Generally, guava is cultivated using a traditional planting system, under which it is difficult to achieve desired levels of production, because large trees provide low production per unit area and need high labor inputs. Moreover, large trees take several years before they come into bearing and overall cost of production per unit area is further increased. Hence, there is an overriding need to improve the existing planting system. There is currently a worldwide trend to plant fruit trees on permanent high-density planting, meadow orchards and to manipulate tree growth using canopy management to control tree growth patterns and tree shape and maintaining high fruit production of desired size and quality. The available land area for fruit cultivation is shrinking due to rapid urbanization, fragmentation in land holdings and industrialization" (Sharma 2012). Under such circumstances the concept of high density plantation has become extremely significant to increase fruit yield and productivity. The efficient training and pruning can maintain the proper canopy size of the guava tree.

## 2. MEADOW ORCHARD SYSTEM

The meadow orchard is a contemporary fruit-cultivation technique that makes use of tiny or dwarf trees with altered canopies. This is a modern method of fruit growing that uses small or dwarf trees with a modified canopy. Better light distribution within the tree canopy is accepted as a result of pruning more than twice/year. This condition induces a high rate of canopy photosynthesis that leads to high yield

**Table 1. Comparison between traditional and meadow orchard systems of guava growing**

Attributes	Traditional system	Meadow systems
Bearing	After two year	From first year
Production	Average yield is 12-20 t ha <sup>-1</sup>	Average yield 40-60 t ha <sup>-1</sup>
Management	Difficult to manage due to large trees sizes	Easy to manage due to small tree size
Labour requirement	Require more labour	Require less labour
Production cost	Higher cost of production	Lower cost of production
Harvesting	Difficult	Easy
Quality	Large canopy, poor sunlight penetration and poor quality fruits	Small canopy, better air and sunlight penetration, minimises disease incidence and high quality fruit with good colour development

per unit area however; no attempt has been made to develop a meadow orchard system in India for guava production despite its apparent and imminent advantages. Scientific advances in physiology and horticulture are critical for this transformation but the principal factor that makes this transformation possible is topping and hedging for dwarfing. In fact, guava responds well to canopy architecture, which embodies pruning and training, and is one the most suitable for meadow orcharding system Singh et al., 1995. To meet this challenge, CISH, Lucknow has developed a meadow orchard system for guava for the first time in India which accommodates 5000 plants per hectare (1mx2m) with regular topping and hedging, particularly during the initial stage. The modern system of fruit growing which has been developed over the years for temperate fruit production can be employed for guava fruit production with certain modifications. In these systems, small trees are essentially planted at high density, with height controlled only by stocking and hedge trimming. The reason for this was the need to obtain an early harvest with high regular yields and low labor to cover the ever-increasing production costs.

A comparison is drawn between the meadow orchard system and the traditional system of fruit growing as given in Table 1.

### 3. ESTABLISHING MEADOW ORCHARD

“The meadow orchard system is a novel idea of guava planting that has been developed for the first time in India at CISH, Lucknow and GBPUAT, Pantnagar. In this system, planting is done at 2m (row to row) x 1m (plant to plant), which gives a density of 5000 plants ha<sup>-1</sup>. Initially, the trees are pruned and trained to allow maximum production of quality fruits during the

first year. A single trunk tree with no interfering branches up to 30-40 cm from the ground level is desired to make dwarf tree architecture. After a period of 1-2 months of planting, all the trees are topped at an uniform height of 30-40 cm from the ground level for initiation of new growth below the cut ends. No side shoot or branch should be left after topping. This is done to make a single trunk straight up to 40 cm in height. After 15-20 days of capping, new shoots are formed. In general, 3-4 shoots remain below the cut after cutting. As the shoots mature, which usually occurs after a period of 3- 4 months, they are shortened by 50 of their total length so that new shoots emerge below the cut. This is done to attain the desired tree canopy architecture and strong framework. Shoot pruning in high density orchards is prerequisite to maintain the desired canopy of this fast-growing guava plant” [1]. The emerged shoots are allowed to grow 3-4 months before they are again pruned by 50 per cent. After pruning new shoots emerge on which flowering takes place.

“Under natural conditions, these crops produce flowers thrice in a year i. e. February-March (AmbeBahar), June-July (MrigBahar) and October-November (HasthBahar) with the corresponding harvest during rainy, winter and spring seasons, respectively” [2,3]. “The choice of bahar at a particular location is determined by prevailing production constraints like availability of irrigation water, quality of produce, market demand and extent of damage by insect-pests and diseases” [3]. “The principle behind crop regulation is to induce flowering and fruiting in the desired season of the year that contribute to the increased fruit yield, quality, profitability and sustainability of the environment by reducing the frequency of application of pesticides” [3].

“It is emphasized that shoot pruning should be done thrice a year” (Singh et al. 1995). “This leads to desired canopy development. Though fruiting starts in the same year, one can’t expect fruits on each and every shoot. Pruning is continued so that plants remain dwarf. After a year, pruning operation is done especially in April, July and October and height maintenance in month of January- February. The efficient training and pruning can maintain the proper canopy size of the guava tree, improve fruit quality and provide opportunity to increase the number of trees per unit area” [4]. Nautiyal et al. [5] had also observed that “the interaction between plant spacing and pruning severity had also effect on total annual yield per plant for both the experimental year”.

Generally, harvesting of fruits is done in August from the April pruned shoots (first pruning). After harvesting, pruning is done (second time). After pruning the shoots in July-August, new shoots appear. Flowering takes place on these shoots and the fruits are harvested in October-November. After harvesting, the third pruning takes place in October and the fruits are harvested in December-January. After that, the height of the orchard is kept at 1 m in the first year and 1.25 m in the second year. This is primarily for better management of the tree canopy. This is the technique to maintain an orchard for optimal production and dwarf tree size. “An average production of 4-6kg fruits plant<sup>-1</sup> is obtained every year. As harvesting is easy in a meadow orchard, there is no damage to the fruits” [6]. One guava variety i.e. Pant Prabhat. Is evaluated under meadow orchard system. The positive impact of pruning has been witnessed in this variety.

#### 4. FERTILIZATION

The amount of manures and fertilizers to be applied in high density /meadow orchard of

guava depends on the age of tree, condition of plant and type of soil. Based on the research trials done in Pantnagar for proper growth and higher yield, fertilizer doses should be applied according Table 2.

#### 4.1 Use of Micronutrients

In addition to macronutrients, guava is also deficient in micronutrients. Boron deficiency results in dark brown coloration of the flesh and, in severe deficiency, fruit hardening and bursting. Spraying twice or three times with Borax @ 0.6-0.8% can minimize the effects. Borax @ 250 g per plant can be applied to the soil in December/January.

It also shows zinc deficiency. Zinc deficiency causes reduced leaf size and fruit number. Spraying of ZnSO<sub>4</sub> @ 0.5 % twice or thrice can minimize the effect.

#### 4.2 Irrigation

“Withholding watering of trees from February to middle of May results in the shedding of flowers and trees go to a rest period during which accumulation of food materials takes place in branches” [7].

#### 4.3 Weed Control

To control weeds and undesirable growth in guava plantations with high plant density, we can use a pre-emergence weed killer called oryzalin. Oryzalin is a weedicide that used for prohibiting the unwanted growth. “It is used to control annual grasses, broadleaf weeds, woody shrubs and vines in grapes, berries and many orchard crops, including both fruits and nuts. (1.6 liter/ha), And we also use simazine (1.6 kg/ha) or atrazine (1.6 kg/ha)” [8].

**Table 2. Amount of manures and fertilizers to be applied in high density /meadow orchard of guava**

Age of plant (year)	FYM (kg)	N (g)	P (g)	K (g)
1	10	75	65	50
2	20	150	130	100
3	30	225	195	150
4	40	300	260	200
5	50	375	325	250
6 and above	60	450	400	300

#### 4.4 Production

In this system, production starts in the first year. In the first year of meadow orchard system, an average yield of about 13 tons/ha is approximately obtained, which doubles the next year and gradually increases from year to year. This clearly shows that the orchard meadow system is the most beneficial compared to other systems.

#### 5. COST OF CULTIVATION

The cost of cultivation of guava increased day by day. They depend on the production. However, they vary in different Indian states and in different state agricultural universities. The high density or scattered orchard allows higher production and quality of fruit. "The meadow orchard is a modern method of fruit growing that uses dwarf stems with a modified canopy. Better light distribution in the canopy increases the number of well-lit leaves. This also increases the photosynthetic rate, resulting in a high yield per unit area. Planting guavas at high density will revolutionize the guava industry by increasing productivity while reducing production costs. The meadow orchard system of guava accommodates 5000 plants/ ha, planted at 2.0m x 1.0m spacing and managed with regular topping and hedging, especially during initial stages. Topping and hedging in guava are helpful in controlling tree size and extending fruit availability" [9].

"Shoot pruning is also helpful in reducing the tree size and improving the fruit quality and provide opportunity to increase the number of trees per unit area" [1]. Kundu [10] reported that "high density planting in guava may be adopted as it increased the yield significantly per unit area with insignificant or less reduction in fruit weight and quality". "The fruit diameter significantly increased with the decreasing plant population per unit area" [11]. Maximum plant height and highest yield per hectare was recorded in double hedgerow system of planting [12]. Work done by Singh (2010) at CISH Lucknow on meadow orchard of guava revealed that apical growth controlled within the first year of planting for better architecture by topping to a uniform height of 60-70 cm from the ground level and further 50 per cent new emerged shoot were pruned for enhanced production.

Singh et al. [13] observed "in high density of guava that after harvesting, trees pruned and headed back small branches to a length of 50 cm

favoured horizontal shoots and maintained tree dwarfness without excessive growth". Experiment on guava conducted by Singh (2010) revealed that "new emerged shoots of guava reduced by 50 per cent of their total length so that new shoots emerge below the cut point". "The emerged shoots were allowed to grow for 3-4 months before they were again pruned by 50 per cent. Regular pruning of guava was done for maintaining meadow orchard for optimum production and dwarf size" [6]. "Gaur [14] reported that pruning the top half of the current season's growth of Allahabad Safeda guava improved the fruit size during both rainy and winter season crop. The maximum number of flower buds per branch, the maximum fruit-set percentage and the minimum per cent flower bud abscission were found with one leaf pair pruning treatment for winter season crop" [15]. Dalal et al. [16] studied "the effect of severity of pruning on growth and quality of fruits of 25 year old guava tree cv. Sardar and they found that pruning increased fruit yield per tree".

Lal et al. (2000) study "the effect of plant spacing and pruning intensity on fruit yield and quality of guava and found that winter season crop was maximum with one leaf pair shoot pruning". Thakre et al. [17] observed that "the maximum number of fruits and total yield for winter season were recorded with the one leaf pair pruning, while minimum in control. During rainy season, the reverse trends were observed". Pratibha et al. [18] concluded that "one leaf pair pruning in guava cv. Sardar planted under square system was useful to maximize yield in winter season crop under *terai* regions". Joshi et al. [19] reported that "the maximum fruit yield per hectare during winter season can be obtained at 2.0m X 1.0m plant spacing with three fourth (3/4<sup>th</sup>) shoot pruning during last week of April". "It was also observed that the reducing sugar percentage of fruits increased with wider spacing which might be due to lesser competition among plants for nutrients and better penetration of sunshine for photosynthesis" [20], (Pal et al. 2017). Joshi et al. [21] concluded that "physico-chemical qualities of the guava fruits were found superior at 2m x 2m spacing".

Singh et al. [6] reported that "from economic point of view, it is desirable to take a sole winter crop instead of three crop in a year". Tiwari and Lal [15] reported that "on the basis of yield and net returns during both the seasons, for regulating the cropping pattern in guava and obtaining maximum winter season yield of

superior quality fruits, one leaf pair shoot pruning should be done in the first week of May". Nautiyal et al. [4] observed that "as pruning severity increased, there was a reduction in fruit set and increased the flower/ fruit drop percentage for rainy season crop which ultimately increased the fruit set for winter season crop". Nautiyal et al. [22] observed that "plant growth fruit yield and profitability of guava can be influenced by pruning severity. Fruit yield per hectare increased with increase in plant population per unit area. The maximum benefit: cost ratio was found with the treatment complete removal of non-fruiting shoots followed by one leaf pair shoot pruning due to high winter season fruiting".

## 6. CONCLUSION

Certain important strategies have been identified for enhancing guava production in India to be competitive in domestic and international markets. They include the use of modern, innovative and high-tech methods. One of these strategies is high density planting (HDP) and meadow orcharding. These include the adoption of appropriate planting density, canopy management, high quality planting material, and a promotion and management system with appropriate inputs. Given the popularity of these technologies and their associated benefits, it is now high time to encourage the adoption of these technologies by the guava growers.

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## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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