Review Article

ISAH Indian Journal of Arid Horticulture
Year 2025, Volume-7, Issue-2 ( July-December)

# Optimizing yield and quality in guava through crop regulation: comprehensive review

Raj Kumar[1], Nirmal Singh[1]*, Ashwani Kumar[1], Suresh Kumar[1] and Pratibha Poonia[2]

[1]ICAR-Central Soil Salinity Research Institute, Karnal, Haryana – 132001
[2]ICAR-Indian Institute of Wheat and Barley Research, Karnal, Haryana– 132001

## ARTICLE INFO

Received: 18 June 2025
Accepted: 07 September 2025

**Keywords:** Crop Regulation, Flowering Management, Pruning, Growth Regulators, Yield Enhancement

doi:10.48165/ijah.2025.7.2.3

## ABSTRACT

Guava (*Psidium guajava* L.) is a prominent tropical and subtropical fruit crop valued for its high nutritional content, economic returns, and adaptability to diverse agro-climatic conditions. However, its productivity and fruit quality are often challenged by irregular flowering, excessive fruit set, and off-season bearing, which lead to small fruit size, poor market value, and high management costs. Crop regulation in guava is a critical agronomic strategy aimed at synchronizing flowering and fruiting, improving fruit quality, and enhancing overall profitability. This review consolidates existing knowledge on the various crop regulation techniques employed in guava cultivation, including mechanical methods (pruning and deblossoming), chemical treatments (application of growth regulators such as NAA, ethrel, and urea), and cultural practices (water stress, root exposure, and nutritional management). Each method is discussed with respect to its physiological basis, effectiveness under different environmental conditions, and impact on flowering intensity, fruit set, yield, and quality attributes. The role of innovative approaches such as the use of bio-regulators and precision horticulture is also explored to address emerging challenges in climate-resilient guava production. Comparative evaluation of crop regulation strategies across different seasons—particularly in tropical regions where guava tends to bear multiple crops—provides insights into season-specific recommendations. Emphasis is also placed on integrating crop regulation with canopy management and varietal selection for maximizing resource-use efficiency. The review identifies key research gaps, including the need for region-specific standardization of practices, development of environmentally safe chemical alternatives, and deeper understanding of the molecular and hormonal mechanisms governing floral induction and abscission. This article aims to serve as a comprehensive reference for researchers, extension workers, and growers seeking sustainable solutions to enhance guava productivity and fruit quality through effective crop regulation practices.

Corresponding author's Email: nirmalsingh@hau.ac.in (Dr. Nirmal Singh)

# Introduction

Guava (*Psidum guajava* L.) is one of the most favourable fruit crops in India and is considered to be a well-executed, nutritionally valuable and profitable crop. Recently, guava has secured higher demand within the global trade because of its nutritional value and processed products (Kumar *et al.*, 2017). The fruit is an excellent source of ascorbic acid, pectin, minerals like phosphorus, iron and calcium etc. as well as vitamins like vitamin A, thiamine, riboflavin, pantothenic acid and niacin (Sharma, 2010). It is a hardy, prolific bearer and produces a fairly remunerative fruit crop (Mishra *et al.*, 2025). It is mainly cultivated on a large commercial scale. Guava fruit bears three bahar seasons, *viz*., Ambe bahar, Mrig bahar, and Hasth bahar. Among the three bahar seasons, the heaviest flowering is observed in the Ambe bahar, but the fruit quality of this season is rough, watery, insipid in taste, poor in quality, less nutritive and is heavily attacked by many insects, pests and diseases. The fruit quality of winter season crops is excellent, nutritive, and escaped from the attack of fruit flies. Therefore, the crop regulation practice is to force the tree for rest and produce profuse blossoms and fruits throughout any one of the two or three flushes. It is necessary to reduce the fruit set during the rainy season and subsequently increase the fruit set during the winter season through the use of various chemicals like NAA, ethereal, urea etc. to regulate the guava crop (Kumar *et al*., 2014).

Crop regulation in guava is a horticultural practice aimed at optimizing the productivity and quality of guava fruit while ensuring a more predictable and even yield throughout the year (Dongre and Choudhary, 2023). This is particularly important for commercial growers who need to manage large orchards for maximum efficiency and profit. The purpose of crop regulation is to force the tree to rest and produce profuse blossoms and fruits (Kumar *et al*., 2021). It can be achieved through with holing irrigation water, root exposure, root and shoot pruning, de-blossoming, spray of chemical and other plant growth regulators. Several crops that bloom more than once a year do not produce a good yield and quality of fruit throughout the year.

## Why crop regulation?

The rainy season crop of guava is poor in terms of consumer acceptance quality and crop is affected by many biotic and abiotic stresses as compared to winter season crop (Zaid *et al.*, 2024). The environmental factors which are more supporting in obtaining winter season quality fruit production include diurnal variation during winter and also reduction in temperature facilities, higher total soluble solids content in guava fruits. The winter season crops which ripen from second fortnight of October to first fortnight of January are superior in quality, free from diseases and pests and fetch higher income. This requires regulation of flowering to obtain most profitable crop by withholding irrigation, root exposure, pruning and thinning of flowers. The flowering is more in guava during summer season because of heavy new flushes that lead to more fruit production in rainy season. In this season, duration of fruit harvesting is reduced to 30 days due to high temperature and rainfall and it causes glut in the market which lead to poor price and less demand in the market. Winter season crop is superior in quality which fetches higher prices than rainy season crop. In rainy season there is a serious attack of fruit flies which deteriorates its quality and fruits become unfit for human consumption. So far getting the quality fruits in guava only winter season crop should be taken and rainy season crop should be avoided. Water availability is also a big issue in Maharashtra, Rajasthan and Gujarat during summer season for guava grower. Farmers always avoid taking ambe bahar crop and regulate this crop to mrig bahar concurrent with the onset of monsoon and crop is harvested during winter.

## Principle of crop regulation

The basic principle of crop regulation is to manipulate the natural flowering behaviour of the guava plant in desired season which contributes to increased fruit yield, quality and profitability. This concept is based on the fact that guava flowers are borne only on new, succulent, vigorously emerging vegetative growths. These new growth flushes can be either on new emergences of lateral bud on older stems or extensions of already established spurs of various size and vigour.

## Objectives of crop regulation

The main objective of crop regulation is to force the tree for rest and produce profuse blossom and fruits during any one of the two or three flushes. The advantage is to regulate a uniform good quality of fruits with rise in the production as well as augmented profit to the growers. The prime benefit is to reduce cost of cultivation because uninterrupted continuous blossom would produce light crops over the whole year and requires a high cost for the monitoring and marketing.

# Methods of crop regulation in guava

## Withholding irrigation method

In guava, the induction of water stress by withholding irrigation after harvesting of the winter crop results in the shedding of flowers and the trees go to rest. The operations of withholding water exhibit feeding roots and also prune

the fibrous roots to force blossom in the desired season. June flowering is inspired to get a winter crop; for that, the basin of the tree is dug up, manured, and irrigated in June. After 20-25 days of fertigation, the tree offers profuse flowering in July and fruiting in the winter season. Water stress may be induced by practices like root exposure and root pruning. It has been suggested that withholding of water and removing the earth from around the upper roots by 10th June and again covering it with soil and manure mixture (Howes *et al*., 1955). Two irrigations were also suggested before a normally heavy one when the rains did not start. Likewise, it has also been suggested that the root pruning practice is done along with withholding irrigation in heavier soils during December or January (Singh, 1963). In guava the operations of withholding water, expose of feeder roots and pruning of fibrous roots to force blossom in the desired season are practiced in Maharashtra and Deccan plateau growing belt of guava in India. Some researchers recommended withholding of water for those areas of the western India where soils were lighter in texture.

## *B*ending of shoots

The bending method is very much dependent on the training of guava branches. On the basis of the calculation of expected flowering, the branches of guava plants are bent down about 45-60 days before the expected date of flowering to produce fruits in the off season. Initially, bending of branches of guava plants ought to be done at the age of two years of the plant. Before bending the leaves, small shoots, flowers, and fruits from the branch are removed or cut off, keeping 10-12 inches of terminal twigs intact. During autumn (September-November), the new shootlets take 20-25 days to emerge. Bent branches ought to be untied once the new shootlets are about 1 cm in length. Flowering occurs in the new shootlets at 4-5 pairs of leaf stage after 45-50 days of summer and 60-65 days of autumn bending. Manures and fertilizers should be applied 15 days before the bending of branches and again at the peak stage of fruit growth followed by irrigation (Singh, 2013).

In case of bending of branches of guava wood tension of branch is increased and phloem formation decreased. As a result, photosynthetic assimilates pass slowly from the shoots of bent branch to the other parts, maintaining increased C: N ratio and induce more flowering and fruit set. Bending forces dormant reproductive buds into active growth. Shoot bending is one of the ways to produce better quality fruits in the off-season of guava (Sarker *et al*., 2005). The upright branch produces fewer flowers and fruits than the bent branch (Ito *et al*., 1999). Bending induces profuse flowering and fruiting, as well as fetches greater returns and regulate flowering by bending of shoots (Mitra *et al*., 2008). Bending consistently increased the lipid, tryptophan, proline, polyphenol oxidase, catalase, and peroxidase levels in leaves, bark, and fruits, but decreased phenolics (Eassa *et al*., 2012). Shoot bending increased the fruit set per plant during off-season was also reported by Sarker and Ghosh (2006). Shoot bending increased the fruit yield per plant and quality fruit during off-season (Sarkar *et al*., 2005). Samant *et al*. (2016) has also shown the positive effect of shoot bending in guava.

## Thinning

Thinning is part of an integrated approach to crop regulation in guava that balances the tree's energy expenditure between growth and fruit production. By implementing a thoughtful thinning regime, growers can significantly improve fruit quality and tree health, thereby enhancing the overall productivity of orchards (Figure 1). This practice involves selectively removing a portion of the fruit or flowers from a tree. Thinning can be done manually or chemically and offers several benefits, including reducing the risk of branch breakage due to heavy fruit loads, ensuring better nutrient

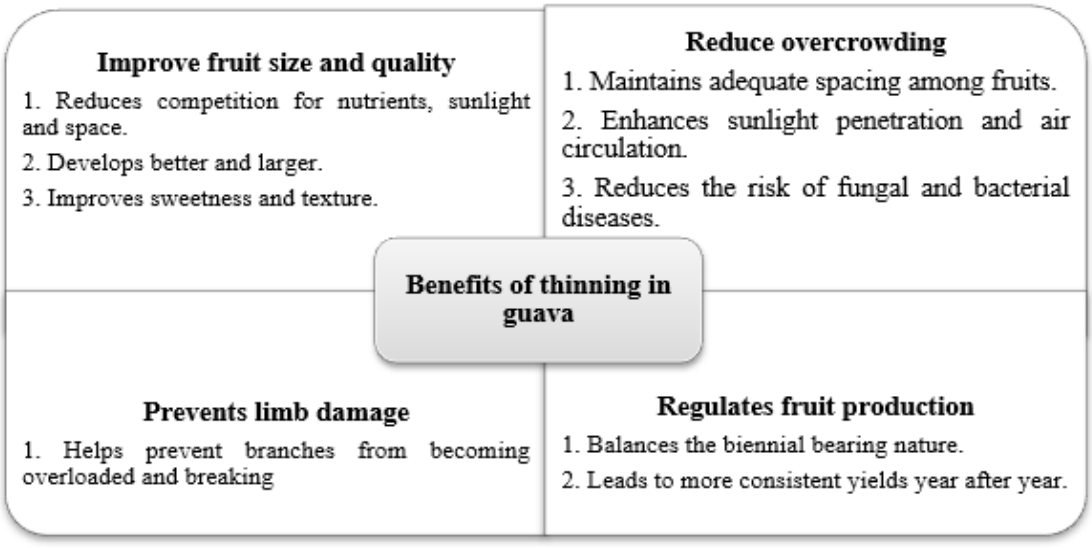


**Fig. 2.** Various benefits of thinning management practices in guava

allocation to remaining fruits, and potentially reducing the incidence of certain diseases by improving air circulation within the canopy. Mamun *et al*. (2012) conducted an experiment to check out effect six different management practices viz., (i) control (no shoot bending + no fruit thinning); (ii) shoot bending; (iii) 25% fruit thinning; (iv) 50% fruit thinning; (v) 75% fruit thinning and (vi) 100% fruit thinning and found out that 50% fruit thinning treatment showed the highest fruit yield (20.46 kg/plant) and 75% fruit thinning treatment performed lowest fruit yield (10.06 kg/ plant) during on-season. Additionally, they found that highest fruit retention in both seasons (on-season 89.28 % and off-season 90.47 %) was observed in 50 % fruit thinning treatment. Similarly, Rahman *et al*. (2017) also revealed that thinning practice in guava crop is helpful in increasing fruit weight.

## Methods of thinning in guava

**Manual thinning:** This is the most common method and involves physically removing flowers or young fruits by hand. It allows for selective removal based on size, location, and health.

### Best practices for manual thinning

**Timing:** The best time for thinning guava fruits is when they are small, usually pea to marble size. Early thinning is more effective as it prevents the tree from wasting resources.

**Technique:** Gently twist and pull the fruit or use small shears to cut them off. Be careful not to damage the branch or the remaining fruits.

**Selection Criteria:** Remove fruits that are misshapen, damaged, or diseased first. Then, thin the fruits based on spacing, leaving the healthiest and best-positioned fruits.

**Flower thinning:** Removing a portion of the flowers can reduce the number of fruits that set, which is particularly useful if a high fruit set is expected.

**Fruit thinning:** Typically done at the early stage of fruit development, usually a few weeks after fruit set. The goal is to space out fruits adequately, often leaving them about 4-6 inches apart on each branch.

**Chemical thinning:** This method can be less labour-intensive but requires careful handling and precise application to avoid damaging the tree or affecting unintended parts of the crop.

**Growth regulators:** Substances like gibberellic acid (GA) and naphthalene acetic acid (NAA) can be used because they affect the hormonal balance in the plant, which can reduce the initial fruit set.

**Monitoring and management:** It is crucial to monitor the tree's response after thinning by noticing signs of new growth and general tree health. Tree may need less water and nutrients than before thinning due to the reduced fruit load and water and nutrient supply should be adjusted.

## Pruning and exposure techniques

Pruning is essential in fruit culture for long-term guava production. It helps in shaping the tree, removing dead or diseased branches, and promoting better air circulation and sunlight penetration, which are essential for fruit development. The orchard's life and harvesting period are extended by proper pruning. It is typically done after the harvest to prepare the tree for the next cropping season. Pruning is a critical technique used in the crop regulation of guava trees, helping to enhance both fruit quality and yield by influencing the growth and productivity of the tree. Effective pruning practices can also aid in controlling the harvest period and ensuring that the trees remain healthy and productive over time. Annual pruning is used as a cheap and effective culture technique for regulating the cropping pattern and increasing fruit yield and quality in guava" (Bhagawati *et al*., 2015). It has been reported that the maximum number of fruits in a winter crop is found from guava trees when three-fourths of the shoot length is pruned during May (Singh, 2013). The practice is popularly known as elicit treatment and is achieved by root exposure and root pruning or exposure to hot sun before the onset of monsoon. Root pruning, however has a harmful effect on the longevity of trees". It has been studied that the effect of pruning on vegetative growth, flowering, and fruiting in Sardar guava favoured the production of more flowers in the July-August flush thereby more fruits in the winter season. In addition, 50% shoot pruning of guava cv. L-45 (Sardar) in May produced the highest fruit yield of any winter crop (Sharma, 2006).

Objectives of Pruning in Guava

- To regulate fruit production
- To improve fruit quality
- To maintain tree health
- To manage tree size and shape

## *T*ypes of pruning in guava

**Formative pruning**: It is done in the early years of a guava tree's life to shape the structure of the tree. This type of pruning establishes a strong framework of branches that can support fruit production in later years. It usually involves selecting 3-4 well-spaced branches as the main scaffold limbs.

**Maintenance pruning**: This is carried out annually to remove unwanted growth, maintain shape, and encourage the development of new fruiting wood. It includes thinning out branches to improve light penetration and air flow within the canopy.

**Rejuvenative pruning:** This is more severe pruning used to revitalize older trees that have become less productive. It involves cutting back a significant portion of the tree to

stimulate new growth and can help in managing diseases and pests.

T**echnique:**

- Remove all diseased, broken, or dead branches.

Cut back overly vigorous, vertical branches (water sprouts) that typically do not bear fruit.

- Thin out the centre of the tree to enhance sunlight penetration and air circulation.
- Maintain the desired shape and height for easier harvesting.

**Precautions**: Sharp pruning shears/scissors or secateurs should be used to prune the plant (Pilania *et al.*, 2010), so that branches are not damaged. These tools should be sterilized with alcohol to prevent spread of disease. No branch should touch the ground. Pruning should not be performed during intense high temperatures (May, June, July), as it may cause wilting, and also not on rainy days, which may lead to fungal attack. Fungicide must be sprayed in case of misty weather. Meena *et al*. (2017) found that just after pruning, a spray of copper oxychloride stopped disease attack.

## Deblossoming techniques

Some of the plant growth regulators (NAA, NAD, 2, 4-D, carbaryl and ethrel) or certain chemical compounds have been found very effective in thinning of flowers, increasing the winter crop as well as manipulating the cropping season under different agro-climatic conditions. Post-bloom application of NAA @ 80- 100 ppm has been useful in reducing fruit set. This treatment can reduce more than 80% of the rainy season crop and also increase flowering of the winter crop. The spray of 2, 4-D @ 30 ppm was also found to be effective for de-blossoming in summer flowers. Manual deblossoming of rainy season flowers at small scale, kitchen garden and early age of the plant is very effective as compared to large commercial plantation. Flower thinning by using naphthalene acetic acid (NAA), naphthalene acetamide (NAD), 2,4-dichlorophenoxy acetic acid (2,4-D), potassium iodide (KI), ethephon, 4,6-dinitro-ocresol (DNOC) and urea has been tried with varying degrees of success. This variation may be due to cultivars, tree condition, soil type, and environment. Most of the workers are of the opinion that chemical thinning is economical, as it increases the winter yield and also helps in improvement of fruit quality. In guava, deblossoming with NAA @ 600 ppm prevents flowering and cropping during the rainy season in order to augment cropping in the winter season. It has been found that 15 per cent urea at 50 per cent bloom stage showed the most effective in deblossoming during the rainy season guava crop (Choudhary *et al*., 1997). Similar results have been reported by Tiwari and Lal (2007). Khan *et al*. (2013) studied 3–4-year-old guava cv. Gola plants and found that 50% de-blossoming without defoliation resulted in uniform and better sized fruit with high organoleptic properties, reducing sugars, ascorbic acid, and TSS. However, more than 50% de-blossoming causes low yield. One of the previous studies conducted by Thakre *et al*. (2016) revealed that one-leaf-pair pruning achieved the maximum cost–benefit ratio as compared to flower bud thinning by hand, retaining one leaf pair at the top, removal of all leaves and flowers by hand, and one leaf-pair shoot pruning in guava cv. Pant Prabhat.

## Nutrient Management

Balanced and timely application of nutrients, especially nitrogen, phosphorus, potassium, and essential microelements, is crucial for the healthy growth of guava trees and optimal fruit production. Soil tests can help determine the necessary fertilizer requirements. Nutrient management in guava cultivation is crucial for ensuring the health and productivity of the trees. Proper fertilization helps regulate growth, enhances fruit quality, and increases yields. Understanding the specific nutrient needs of guava trees at different stages of their growth cycle is key to effective nutrient management.

## Controlled Irrigation

Water management is vital in guava cultivation (Figure 2). Controlled irrigation can help manage flowering and fruiting cycles. For instance, a period of water stress followed by adequate irrigation can stimulate flowering. This method is often used to schedule harvests according to market demand. Controlled irrigation is a crucial aspect of guava cultivation, significantly impacting both fruit yield and quality. Guava trees are relatively drought tolerant, but for optimal fruit production, they require specific watering strategies. The goal of controlled irrigation is to regulate water supply in a manner that optimizes the tree's growth phases, from flowering to fruit set and maturation. Here's how controlled irrigation can be effectively used for crop regulation in guava.

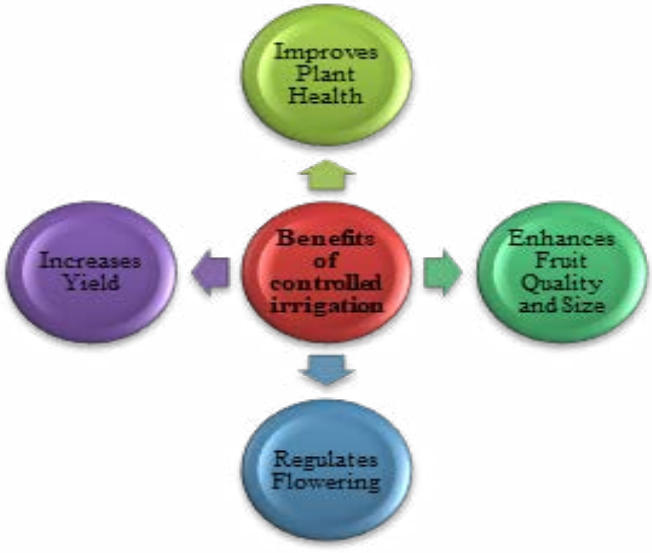


**Fig. 3.** Benefits of controlled irrigation in guava

# Strategies for controlled irrigation

## Water stress and regulated deficit irrigation (RDI)

It involves applying less water than the crop evapotranspiration demands during certain phases of the growth cycle (usually post-harvest and pre-flowering stages) to save water and control vegetative growth, focusing the tree's energy on fruit development. Temporary water stress before the onset of flowering can stimulate the flowering process. This is useful for synchronizing and inducing flowering, particularly for off-season production.

## Supplemental irrigation

During dry periods, supplemental irrigation ensures that guava trees do not suffer from moisture stress, especially during critical phases like fruit setting and ripening. This can be particularly crucial in regions with seasonal rainfall where dry spells may occur during these critical growth phases.

## Drip irrigation

Drip irrigation delivers water directly to the base of the tree, minimizing evaporation and runoff. It's highly efficient for conserving water and allows for the addition of fertilizers directly into the irrigation system (fertigation). The irrigation schedule can be adjusted based on the season, tree age, soil type, and local climate. For instance, younger trees require frequent, smaller amounts of water, while mature trees benefit from less frequent but deeper irrigation to encourage root growth. Using sensors or tensiometers helps in monitoring the moisture levels in the soil, thus allowing precise control over irrigation based on actual soil moisture status. Regular checking of soil moisture by feeling the soil can also guide irrigation needs, although it is less precise than using sensors. In areas with high evaporation rates, more frequent irrigation may be necessary. Sandy soils require more frequent irrigation than clayey soils, which hold water longer. Larger, older trees have deeper root systems and can access water from deeper soil layers, potentially reducing the frequency of irrigation required. Controlled irrigation, when done correctly, not only optimizes the productive output of guava orchards but also enhances the sustainability of water resources. It is a vital tool in the management of crop production, particularly in water-scarce areas, and can significantly affect the profitability of guava cultivation.

## Use of growth regulat*ors*

Growth regulators are chemical substances that influence the growth and development of plants. In guava cultivation, these regulators are used to manage and enhance various aspects of plant growth, from flowering and fruit set to fruit size and ripening. Besides, all available high production technologies such as use high yielding varieties, high density orcharding, the use of PGR's has been proved as a powerful tool to meet demand of guava fruits to the increasing population of the country by influencing fruit production directly or indirectly (Bhardwaj and Mishra, 2005).

## Common growth regulators used in guava

**Gibberellic Acid ($GA_3$):** $GA_3$ promotes cell elongation and division, which help in increasing fruit size and improving fruit quality. It can also delay fruit maturation, allowing for an extended harvest period.

**Naphthaleneacetic acid (NAA):** A synthetic auxin used to promote fruit set and reduce fruit drop. It can also be used to enhance the uniformity of fruit ripening.

**Ethephon (Ethrel):** It encourages the ripening of fruit by releasing ethylene, which is a natural plant hormone involved in the ripening process. Ethephon treatment can help synchronize fruit ripening, making harvest more manageable and timely.

**Paclobutrazol (PBZ):** It inhibits gibberellin synthesis, thus controlling excessive vegetative growth and promoting more reproductive growth, leading to improved fruit yields. It can also help induce uniform flowering and manage tree size, which is beneficial for mechanical harvesting.

## Applications of growth regulators in guava

### Inducing flowering

**Gibberellic acid and Paclobutrazol:** These can be used to manipulate the flowering stages of guava trees. For example, applications of paclobutrazol during the post-harvest period can induce more uniform and synchronous flowering, which is crucial for off-season production.

### Enhancing fruit set and size

**Naphthaleneacetic acid:** Spraying NAA shortly after flower bloom helps improve fruit set and reduces premature fruit drop. It can also assist in achieving a more uniform fruit size.

**Gibberellic acid:** Application during the early stages of fruit development can enhance fruit size by promoting cell division and elongation.

### Regulating fruit development and ripening

**Ethephon:** If it is applied during the later stages of fruit maturity, ethephon can accelerate fruit ripening, which is particularly useful for synchronizing harvest and improving the colour and quality of the fruits for market (Kumar *et al*., 2016).

### Defoliation

Defoliation, the deliberate removal of leaves from a plant, can be a strategic tool in guava crop regulation. In guava cultivation, defoliation is primarily used to manage and synchronize flowering, which can help in stabilizing the production cycle and enhancing fruit quality and yield.

In some cases, artificial defoliation (removal of leaves) is practiced to induce stress and promote uniform flowering. This technique, however, must be used cautiously as it can lead to reduced vigour if not managed properly. The timing of defoliation is critical and varies based on the desired outcomes and climatic conditions. It is usually done after the harvest of the main crop, before the onset of the next flowering period. In tropical climates, where guava can have multiple flowering periods, defoliation might be timed to encourage off-season flowering.

### Purpose of defoliation in guava

**Inducing uniform flowering:** Defoliation can trigger a stress response in guava trees that leads to uniform and synchronized flowering. This is particularly useful for producing off-season crops.

**Improving fruit quality:** By reducing the leaf mass, more resources (like nutrients and carbohydrates) are redirected towards fruit development, potentially improving fruit size and quality.

**Pest and disease management:** Removing older leaves may help reduce the incidence of certain leaf-borne diseases and pests (Kumar *et al.*, 2025).

## Conclusion

Crop regulation in guava is a vital horticultural practice that plays a key role in managing flowering behavior, improving fruit quality, and ensuring synchronized harvesting for better market returns. The integration of mechanical, chemical, and cultural methods offers a flexible and effective approach to control excessive fruiting, manage crop load, and optimize yield. Among these, techniques like strategic pruning, application of growth regulators, and regulated water and nutrient management have shown promising results across various agro-climatic zones. However, the success of these practices largely depends on factors such as cultivar, season, and local environmental conditions. With the increasing demand for quality produce and the challenges posed by climate change, there is a growing need to refine existing crop regulation strategies through region-specific research and promote the use of eco-friendly and sustainable methods. Future advancements in molecular biology and plant physiology can further enhance our understanding of guava's flowering mechanisms, paving the way for more precise and innovative regulation practices. Ultimately, adopting an integrated and scientific approach to crop regulation will be essential for improving productivity, profitability, and sustainability in guava cultivation.

## Acknowledgements

The authors express their sincere grateful to the authorities of ICAR-CSSRI, Karnal for providing the support to compile the information.

## Conflict of Interest

The authors declare no conflict of interest.

## Data Sharing

This review article did not generate any supplementary data.

## Reference

Bhagawati, R., Bhagawati, K., Choudhary, V.K., Rajkowa, D.J. and Sharma, R. 2015. Effect of pruning Intensities on the performance of fruit plants under mid-hill condition of Eastern Himalayas: case study on Guava. *International Letters of Natural Sciences*, 46: 46-51.

Bhardwaj, D.R. and Mishra, V.K. 2005. Vegetative propagation of Ulmus villosa: effects of plant growth regulators, collection time, type of donor and position of shoot on adventitious root formation in stem cuttings. *New Forests*, 29(2): 105-116.

Choudhary, R., Singh, U.P. and Sharma, R.K. 1997. Deblossoming of rainy season crop of guava. *Horticultural Journal*, 10(1): 93-95.

Dongre, R. and Choudhary, B. 2023. Effect of foliar application of biofertilizers on productivity and quality of guava (*Psidium guajava* L.). *Indian Journal of Arid Horticulture*, 5(1-2):75-78. https://doi.org/10.48165/ijah.2023.5.1.13

Eassa, K.B., Gowda, A.M. and El-Taweel, A.A. 2012. Effect of $GA_3$, hand pollination and branch-bending on productivity and quality of banati guava trees grown in sandy soils. *Journal of Plant Production*, 3(2): 241-251. https://doi.org/10.21608/jpp.2012.84048

Howes, F.N., Cheema, G.S., Bhat, S.S. and Naik, K.C. 1955. Commercial Fruits of India: With Special Reference to Western India. *Kew Bulletin*, 10(3): 370. https://doi.org/10.2307/4109228

Ito, A., Yaegaki, H., Hayama, H., Kusaba, S., Yamaguchi, I. and Yoshioka, H. 1999. Bending shoots stimulates flowering and influences hormone levels in lateral buds of Japanese pear. *HortScience*, 34(7): 1224-1228. https://doi.org/10.21273/HORTSCI.34.7.1224

Khan, A.S., Khan, M.R.G., Malik, A.U., Rajwana, I.A., Shaheen,

T. and Bakhsh, A. 2013. Influence of defoliation and deblossoming on fruit quality of guava (*Psidium guajava* L.) cv. Gola. *Pakistan Journal of Botany*, 45(2): 563-570.

Kumar, R., Kaur, G., Mann, A., Lata, C., Singh, A. and Kumar, A. 2016. Biochemical changes in guava (*Psidium guajava*) cv. Allahabad Safeda fruits as a function of maturity stages. *Indian Journal of Agricultural Research*, 86(12): 1595-1600.

Kumar, R., Krishna, H., Rajan, S., Alizadeh, M. and Barman, P. 2021. Understanding phenological stages of pomegranates vis-à-vis flowering and fruiting regulation. *Journal of Horticultural Research*, 29(2): 1-22. https://doi.org/10.2478/johr-2021-0013

Kumar, R., Singh, N., Kumar, A., Arvind Kumar, A., Barman, P., Haldhar, S.M. and Poonia, P. 2025. Sustainable management of fruit fly infestation in guava for quality fruit production: A review. *Indian Journal of Arid Horticulture*, 7(1): 9-16. https://doi.org/10.48165/ijah.2025.7.1.2

Kumar, R., Tiwari, J.P. and Lal, S. 2014. Effect of zinc and boron on fruit yield and quality of winter season guava (*Psidium guajava* L.) cv. Pant Prabhat. *Annals of Agri-Bio Research*, 19(1): 105-108.

Kumar, R., Tiwari, J.P., Lal, S., Kumar, M., Singh, A. and Kumar. A. 2017. Effect of boron and zinc application on nutrient uptake in guava (*Psidium guajava* L.) cv. Pant Prabhat leaves. *International Journal of Current Microbiology and Applied Sciences*, 6(6): 1991-2002. https://doi.org/10.20546/ijcmas.2017.606.234

Mamun, A.A., Rahman, M.H. Rahim, M.A. 2012. Effect of shoot bending and fruit thinning on productivity of guava. *Journal of Environmental Science and Natural Resources*, 5(2): 167-172. https://doi.org/10.3329/jesnr.v5i2.14808

Meena, K.R., Maji, Sutanu Maji, S.M. and Meena, S.C. 2017. Use of shoot pruning for crop regulation and quality fruit production of guava (*Psidium guajava* L.). *International Journal of Agricultural Science,* 13(2):184–191. https://doi.org/10.15740/HAS/IJAS/13.2/184-191

Mishra, D.S., Yadav, V., Yadav, L.P., Apparao, V.V., Ravat, P., Kumar, P. and Rane, J. 2025. Optimizing guava (*Psidium guajava* L.) breeding programs: The role of genotype selection in enhancing growth, yield and nutrient content. *Indian Journal of Arid Horticulture*, 7(1), 36-44. https://doi.org/10.48165/ijah.2025.7.1.5

Mitra, S.K., Gurung, M.R. and Pathak, P.K. 2008. Sustainable guava production in West Bengal, India. *Acta Horticulturae*, pp. 179-182. https://doi.org/10.17660/ActaHortic.2008.773.25

Pilania, S., Shukla, A.K., Mahawer, L.N., Sharma, R. and Bairwa, H.L. 2010. Standardization of pruning intensity and integrated nutrient management in meadow orcharding of guava (*Psidium guajava*). *The Indian Journal of Agricultural Sciences*, 80(8):673–678.

Rahman, H., Akter, A., Rahman, J., Riad, M.I. and Rahman, M. M. 2017. Effect of fruit thinning and bagging on the yield and quality of guava. *Research & Reviews: Journal of Agricultural Science and Technology*, 6(1): 20-27.

Samant, D., Kishore, K. and Singh, H.S. 2016. Branch bending for crop regulation in guava under hot and humid climate of eastern India. *Journal of the Indian Society of Coastal Agricultural Research*, 34(1): 92-96.

Sarkar, A., Ghosh, B., Kundu, S. and Sukul, P. 2005. Effect of shoot pruning and bending on yield and fruit quality in guava cv L-49. *Environment and Ecology*, 235(3): 621-623.

Sharma, R.R. 2006. Fruit production: Problems and solutions. International Book Distributing Co, Lucknow, Uttar Pradesh, India.

Sharma, S.K. 2010. Postharvest Management and Processing of Fruits and Vegetables: Instant Notes. New India Publishing Agency, New Delhi, India.

Singh, G. 2013. Guava Westuille Publication House. New Delhi, India.

Singh, R. 1963. Fruits. National Book Trust, New Delhi, India.

Thakre, M., Lal, S., Uniyal, S., Goswami, A.K. and Prakash, P. 2016. Pruning for crop regulation in high density guava (*Psidium guajava* L.) plantation. *Spanish Journal of Agricultural Research*, 14(2): e0905. https://doi.org/10.5424/sjar/2016142-7846

Tiwari, J.P. and Lal, S. 2007. Effect of NAA, Flower bud thinning and pruning on crop regulation in guava (*Psidium guajava* L.) cv. Sardar. *Acta Horticulturae*, 735: 311–314. https://doi.org/10.17660/actahortic.2007.735.42

Zaid, A., Singh, A., Srivastava, A.K., Singh, V. and Prajapati, P. 2024. Role of metabolome in enhancing crop resilience to abiotic stress in horticultural crops–A review. *Indian Journal of Arid Horticulture*, 6(1): 11–20. https://doi.org/10.48165/ijah.2024.6.1.2