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# BAHAR MANAGEMENT IN FRUIT CROPS: PRINCIPAL, PRACTICES AND ECONOMIC IMPLICATIONS

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**ABSTRACT**

Bahar management, also known as crop regulation, is a crucial horticultural practice aimed at improving fruit yield, quality, and economic returns by manipulating the flowering and fruiting behavior of fruit crops. This practice is particularly important in tropical and subtropical regions, where perennial fruit crops like guava and acid lime exhibit multiple flowering cycles in a year, often resulting in inferior yield and quality. By understanding the floral biology and bearing habits of crops, farmers can select the most suitable bahar to obtain superior produce. Various techniques such as withholding irrigation, pruning, nutrient management, shoot bending, deblossoming, and the use of plant growth regulators are employed to regulate flowering and ensure a single, high-quality crop. Modern approaches like precision agriculture and genetic engineering further enhance crop regulation efficiency. Overall, bahar management ensures synchronized flowering, improved fruit quality, higher yield, reduced production costs, and better market value, making it an essential practice for sustainable and profitable fruit production.

***Keywords***: Bahar Management, Flowering, Fruit quality, Economic returns, Pruning

## Introduction

Bahar management, also referred to as crop regulation, is an important horticultural practice used to enhance fruit production by regulating the flowering and fruiting cycles of fruit trees. Bahar regulation provides a basis for achieving consistent yield and superior fruit quality. It is also known as "vegetative-reproductive balance management." This practice is particularly useful in tropical and subtropical regions, where many fruit crops flower continuously without a definite rest period, leading to the production of two or three bahar annually which are frequently inferior in both yield and quality. A comprehensive understanding of the floral biology and bearing behavior of fruit crops is essential for selecting the most productive bahar under specific environmental conditions (Kumar *et al.*, 2021). Effective implementation of bahar regulation synchronizes flowering, leading to uniform fruit set, improved fruit size, enhanced quality attributes and greater economic returns.

In guava, three distinct flowering seasons are observed, namely Ambe bahar, Mrig bahar, and Hasth

bahar. Under North Indian conditions, the rainy season crop is generally characterized by poor fruit quality, reduced nutritional value, and higher susceptibility to insect pests and pathogens. Conversely, the winter season crop produces superior quality fruits with minimal pest and disease incidence, thereby offering higher market value. Hence, it is agronomically advisable to regulate flowering to obtain a single, high-quality annual crop (Boora *et al.,* 2016). In Western India, root pruning is commonly employed as an effective technique for seasonal crop regulation in guava.

Acid lime exhibits almost continuous flowering throughout the year, with a pronounced peak during the spring season (February-March) and a lean phase from July to August. Three principal flowering seasons-rainy, winter, and spring, correspond to distinct harvesting periods. However, for optimal yield and quality, only one bahar is generally preferred. Under South Indian agro-climatic conditions, although the rainy season crop may command higher market prices, it is often inferior in quality.

This is accomplished through various approaches such as breeding, nutrient management, pest and disease control, use of plant growth regulators, and direct manipulation of the plant. Direct manipulation of plants to achieve the desired yield involves two main types of horticultural techniques: (1) removal of specific plant parts (e.g. pruning, fruit thinning) and (2) disruption of the movement of assimilates between major plant organs (e.g. ringing, girdling, branch bending which alters the distribution of auxin, etc.) (Dhillon and Das, 2018). Farmers have utilized girdling and allied techniques (Cincturing, frilling, notching, nicking, ringing, scoring, strangulation, stripping, and wiring) for centuries in horticulture to enhance crop productivity.

| Bahar Name | Flowering Period | Harvesting Period | Management starts |
|---|---|---|---|
| Ambe Bahar | January - February | June - August | November /December |
| Mrig Bahar | June - July | November - January | April/May |
| Hasta Bahar | September - October | February - April | August |

## Why need for Bahar Management

Flowering is higher in the summer season as plants recover from winter stress, which leads to increased fruiting in the rainy season. However, high temperature and rainfall during harvesting shorten the harvesting period to nearly 30 days, resulting in a market glut. This oversupply lowers prices and reduces farmers' income (Boora *et al.,* 2016).

The winter season crop is of better quality and commands higher market value than the rainy season crop. In the rainy season, heavy infestation of fruit flies damages the fruits and reduces their suitability for consumption. Therefore, to obtain high-quality guava, it is advisable to promote the winter crop and avoid the rainy season crop (Boora *et al.,* 2016).

## Principle of bahar management

The basic principle of crop regulation is to manipulate the natural flowering pattern of fruit plants so that flowering occurs in the most desirable season, thereby improving fruit yield, quality, and economic returns. This concept is based on the fact that most fruit crops produce flowers on new, actively growing, and succulent vegetative shoots.

These new growth flushes may arise either from the emergence of lateral buds on older branches or from the extension of existing terminal shoots of varying size and vigor. Fruit crops such as guava, citrus, and pomegranate are typical examples where this principle is effectively applied for crop regulation.

## Objective of bahar management

The main objectives of bahar management are to obtain a suitable crop during the desired season and to improve flowering and fruit set, particularly in situations where yields are sub-optimal. It helps in regulating the production of uniform and high-quality fruits while maximizing overall yield and profitability for the grower. Bahar management also aids in reducing excessive crop load, ensuring better market prices, and producing superior quality fruits, such as winter guava. Additionally, it maintains a proper balance between vegetative and reproductive phases for the subsequent cropping cycle. This practice further helps in minimizing flower and fruit drop and reducing the cost of cultivation, as continuous and unregulated flowering leads to scattered, low-yielding crops throughout the year, increasing expenses related to monitoring and marketing.

## The practices of bahar at a location is mainly determined by

- Availability of irrigation water
- Quality of the produce
- Incidence and severity of pests and diseases
- Market demand
- Climatic conditions of the area

- Availability of fruits in the market
- Comparative yield potential

**Techniques of Bahar management:**

To obtain a crop in the desired season, it is essential to regulate flowering. The following practices can be adopted to ensure fruit production during the preferred season:

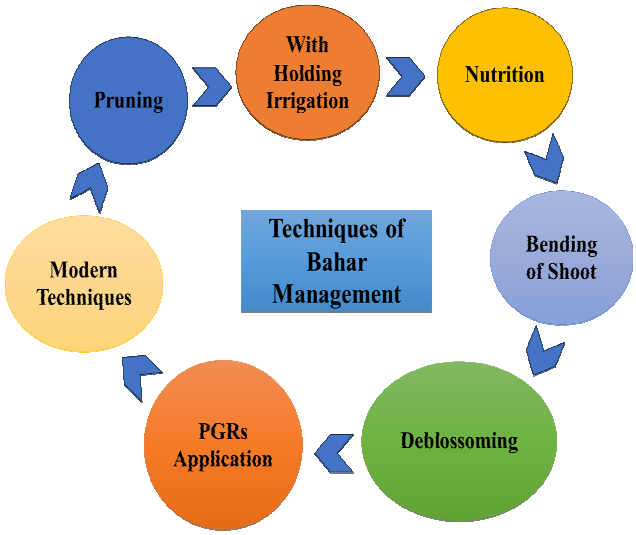


**Fig. 1:** Techniques of Bahar Management

**Withholding irrigation:**

In the northern plains, irrigation is withheld after harvesting the winter crop, which induces flower drop and allows the trees to enter a rest period. The tree basin is then dug, manured, and irrigated in June. After about 20-25 days, the trees produce profuse flowering, and the fruits mature during winter. Inducing water stress by withholding irrigation from December to June, or until the onset of the monsoon depending on local conditions, is recommended for effective crop regulation (Cheema *et al.,* 1954; Teaotia and Pandey, 1968). Water stress may be induced by techniques such as root exposure and root pruning to check the rainy season crop and encourage a superior winter crop (Cheema *et al.,* 1954).

**Pruning**

The terminal portion of shoots, measuring about 20-30 cm in length, should be pruned between 20th and 30th April, while avoiding severe pruning in guava. Pruning of the current season's spring flush growth has been recommended to suppress the rainy season crop (Singh, 1980). This practice has also been advocated in the northern regions of the country to avoid rainy season flowering (Tiwari and Lal, 1984). Additionally, pruning 25-50% of the shoots during late April to May (20 April, 10 May, or 30 May) has been found effective in preventing rainy season flowering and promoting winter season flowering in 'Sardar' guava (Dhaliwal *et al.,* 1998). Light pruning increased the number of productive branches and enhanced the number of fruits per branch in guava cv. Paluma (Serrano *et al.,* 2008).

**Nutrition**

To enhance the magnitude of the winter crop, the fertilizer application schedule should be shifted from April-May to May-June, as this promotes increased vegetative growth and subsequently improves winter fruiting (Boora *et al.,* 2016). Gupta and Nijjar (1978) also recommended the application of NPK at the rate of 40:100:40 g, respectively.

**Bending of shoot**

Shoot bending is an effective technique for improving fruit quality during the off-season in guava (Sarker *et al.,* 2005). Bending of branches increases mechanical tension and reduces phloem development, which slows the translocation of photosynthates from the shoots to other plant parts. This leads to a higher carbon to nitrogen (C:N) ratio, thereby promoting enhanced flowering and fruit set. The practice also stimulates dormant reproductive buds to grow. Compared to upright branches, bent branches produce a greater number of flowers and fruits (Ito *et al.,* 1999). Furthermore, shoot bending induces profuse flowering and fruiting, resulting in higher economic returns (Ghosh, 2003), and serves as an effective method for regulating flowering (Mitra *et al.,* 2008).

**Deblossoming**

Manual removal of flowers (deblossoming) is an effective practice for regulating fruiting, as it directs the plant's energy towards producing a smaller number of fruits with improved quality. Ikhlaq *et al.* (2022) reported significant deblossoming in the summer guava crop. In the cultivar Sardar, deblossoming of the rainy season crop through the application of NAA @ 800 ppm has been found to enhance winter crop production (Mishra and Singh, 2021). Various chemicals have been used for flower thinning with varying levels of effectiveness, including naphthalene acetic acid (NAA), naphthalene acetamide (NAD), 2,4-dichlorophenoxy acetic acid (2,4-D), potassium iodide (KI), 2-chloroethyl phosphonic acid (ethephon), 4,6-dinitro-o-cresol (DNOC), and urea.

**PGRs application**

Plant growth regulators (PGRs) are used in bahar regulation to control flowering and crop load in guava. They help suppress unwanted rainy season flowering and promote the desired winter crop. Chemicals like

NAA, urea, ethephon, and 2,4-D are commonly used for deblossoming and thinning, resulting in improved fruit quality, uniform yield, and higher profitability. In Hasta bahar flowering (September-October) of acid lime, two sprays of cycocel @ 1000 ppm applied at one-month intervals prior to flowering (during August and September) resulted in maximum yield in terms of number and weight of fruits per tree. This treatment also improved fruit quality parameters, including juice percentage, total soluble solids (TSS), acidity, ascorbic acid content, as well as peel and pomace percentage (Mahalle *et al.,* 2010).

**Fig. 2:** Application of Plant Growth Regulators

**Modern techniques of crop regulation**

Precision agriculture and genetic engineering have greatly enhanced guava cultivation by improving crop management practices and plant characteristics. The adoption of sensor-based technologies in precision agriculture allows farmers to monitor environmental conditions and apply water and nutrients more accurately, thereby improving flowering and fruiting performance. Moreover, genetic engineering has led to the development of disease-resistant guava varieties with improved flowering and fruiting traits, which further increases yield and fruit quality. Overall, these advancements contribute to more efficient and productive guava cultivation (Huang *et al.,* 2021).

**Benefits of Bahar Treatment**

**Improved Fruit Quality:** Bahar treatment regulates the timing of flowering and fruiting, resulting in uniform fruit size and better quality. Synchronized fruit development enhances the appearance and marketability of the produce, enabling farmers to obtain higher prices and meet consumer preferences. In pomegranate, bahar treatment applied from February to June reduced fruit cracking and improved quality traits such as juice content and total soluble solids.

**Higher Yield:** Properly timed bahar treatment synchronizes fruiting, leading to increased overall yield. It minimizes the production of off-season fruits, which are often of inferior quality, thereby enhancing total productivity and farmer income.

**Reduced Cost of Cultivation:** Managing off-season crops requires continuous monitoring and higher labour input. Bahar treatment reduces such requirements by aligning the fruiting period, thereby lowering expenses related to labour, transportation, and marketing.

**Efficient Resource Utilization:** Bahar treatment ensures optimal use of resources such as water and nutrients. This promotes sustainable farming practices and improves long-term crop productivity and plant health.

**Lower Pest and Disease Incidence:** Bahar treatment has been found to reduce pest and disease problems. For instance, it significantly decreases nematode infestation in pomegranate, resulting in lower nematode population density.

**Economic Implications of Bahar Regulation:**

Bahar regulation has significant economic advantages in fruit crop production by improving yield quality, market value, and overall profitability. One of the major benefits is the production of fruits in the most favorable season, which ensures better quality and higher market prices. For example, in guava, the winter season crop is superior in quality compared to the rainy season crop and fetches premium prices in the market due to higher consumer preference and lower pest incidence (Boora *et al.,* 2016).

Regulating flowering to obtain a single crop, bahar management reduces the production of off-season fruits, which are usually of inferior quality and have lower market demand. This helps in avoiding market glut and stabilizing prices, thereby increasing farmers' income. Additionally, synchronized flowering and fruiting lead to uniform harvests, making marketing, grading, and transportation more efficient and cost-effective (Kumar *et al.*, 2021).

Bahar regulation also reduces the cost of cultivation. Continuous flowering throughout the year requires frequent monitoring, pest and disease management, and multiple harvesting operations, which increase labor and input costs. By concentrating production in one season, farmers can minimize these expenses and optimize the use of resources such as water, fertilizers, and labor (Dhillon and Das, 2018).

Furthermore, reduced pest and disease incidence during the preferred cropping season lowers the need

for chemical control measures, thereby decreasing input costs and improving net returns. Studies have shown that appropriate bahar treatment can significantly enhance yield and fruit quality, ultimately increasing the benefit-cost ratio in fruit crops (Singh and Kingsly, 2007)

## Conclusion

Bahar management plays a vital role in regulating flowering and fruiting in fruit crops, thereby ensuring improved yield, superior fruit quality, and higher economic returns. By manipulating the natural growth cycle of plants through various cultural, mechanical, and chemical methods, farmers can effectively obtain a single, desirable crop in the most suitable season. This practice not only helps in avoiding poor-quality and low-value off-season produce but also reduces pest and disease incidence and cultivation costs. Additionally, the integration of modern technologies such as precision agriculture and genetic improvement further strengthens the effectiveness of bahar regulation. Therefore, adopting appropriate bahar management practices is essential for achieving sustainable production, efficient resource utilization, and enhanced profitability in fruit cultivation.

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