

Innovative eco-safe technologies for residue free fruit production

Producing good-quality fruits with minimal residue load is crucial for securing better prices in domestic and international markets. Pre-harvest fruit bagging in mango and guava has been standardized as cost-effective and eco-friendly practice for improving fruit quality. Fruits are covered with double-layer non-woven bags (28 × 20 cm, 80 gsm for mango; 18 × 24 cm, 55 gsm for guava). Bagging is done 28–35 days after fruit set in mango and 35–40 days in guava, and bags remain until harvest. The bag mouth should be closed to prevent pest entry, with perforations to exchange air circulation. Bagging enhances fruit colour, firmness, and shelf life, and significantly reduces pest and disease damage (thrips injuries, fruit fly, physical scratches of fungal spot, etc). Consequently, bagged mango and guava fruits fetch higher market prices and are widely adopted by farmers.

Keywords: Eco-friendly practices, Fruit bagging, Pest and disease management, Pre-harvest fruit bagging, Shelf life enhancement

MANGO (*Mangifera indica* L.) is one of the most important fruit crops in the tropical and subtropical regions of India. It is cultivated over an area of 2.4 million ha, with an annual production of 22.42 million metric tonnes and an average productivity of 9.34 t/ha. Both the peel and pulp contain numerous bioactive phytochemicals, such as phenolics, carotenoids, and flavonoids, which are proven antioxidants. However, the quality of mango fruits is deteriorating due to various existing and emerging biotic and abiotic factors. Climatic aberrations, such as sudden rises in temperature, humidity fluctuations, and unseasonal rainfall, are significant abiotic challenges. Such adverse climatic conditions not only affect the external appearance of the fruit but also exacerbate pest and disease incidence. Furthermore, the excessive use of pesticides to counter biotic stresses can lead to the rejection of fruits for export due to chemical residues. Long-term application of pesticides and fungicides also

negatively impacts both soil health and fruit quality. To mitigate losses caused by biotic and abiotic factors, several good agricultural practices (GAP) are becoming increasingly popular worldwide.

Guava (*Psidium guajava* L.) is another important fruit crop in tropical and subtropical regions of India. It ranks as the fifth most important fruit in the country based on acreage and has gained popularity due to its prolific and precocious bearing habit and wide adaptability to various agro-climatic conditions. Guava trees bear fruit mainly during the rainy and winter seasons. However, during the rainy season, although bumper fruiting occurs, more than 90% of the fruits are infested with fruit fly, rendering them unsuitable for table consumption or marketing.

Importance of fruit bagging

Fruit bagging is one of the important GAP and an alternative technique for enhancing the quality of mango



Fruit bagging in *Dashehari*



Mature and ripe fruit with double layer brown black colour bag (*Dashehari*)



Economic gain with bagging in mango

Sold to	Gross return (₹/t)			Bagging and packaging cost (₹/t)	Gross margin over bagging and packaging cost (₹/t)		
	Bag	Non-bag	Difference		Bag	Non-bag	Difference
Delhi market	1,00,000	45,000	55,000	15,000	85,000	45,000	40,000
Local market	75,000	36,000	39,000	15,000	60,000	36,000	24,000

and guava production. In this method, individual mango and guava fruits are bagged on the tree for a specific period. The bag acts as a physical protective barrier, reducing the incidence of fruit damage caused by various biotic and abiotic stresses. Studies have shown that bagging improves fruit colour and quality by increasing the temperature and humidity inside the bag. Moreover, the micro-environment within the fruit bag can enhance the physical appearance of the fruit by promoting peel coloration. Bagging has been widely used in several fruit crops to improve skin colour and to reduce the incidence of diseases, pests, mechanical damage, sunburn, and agrochemical residues. Some countries, such as Mexico, Chile, and Argentina, do not import fruits unless they are bagged. Therefore, bagging enables the production of high-quality fruits that are free from chemical residues and possess no external or internal defects. Against this background, the present study was undertaken to optimize bagging time and bagging material for high-quality mango and guava production under subtropical conditions.

Standardized bagging techniques for mango and guava

The field experiment was conducted at ICAR-Central Institute for Subtropical Horticulture, Rehmankhera, Lucknow, during 2022–2025. Four types of fruit bag

materials were evaluated: Double-layer brown/black bags, White single-layer bags, Blue single-layer bags, and Black single-layer bags. Fruits without bagging served as the control. Bagging was performed 28–35 days after fruit set in mango and 35–40 days in guava. The selection of bag types was based on their durability under varying climatic conditions.

Quality and economic gain with bagging

The double-layer brown-black bag performed best in terms of fruit colour, firmness, and shelf life in both mango and guava. Postharvest diseases, such as shoulder browning (SB) and anthracnose (AN), were observed in mangoes. However, bagging with the double-layer brown-black bag completely protected the fruits from these postharvest diseases.

Institute efforts in bag production through incubate

The extension of bagging technology began during 2016–17, and by 2023–24, the demand for fruit bags had increased tremendously. The bags were initially procured mainly from Andhra Pradesh, which added significant transportation costs. To address this, the Institute provided mentorship and technical support to a local entrepreneur to produce these bags locally, thereby reducing costs for farmers. M/S Meta Agritech Pvt. Ltd., an incubatee of ICAR-CISH, produced the bags in Lucknow and sold approximately 1 crore bags throughout Uttar Pradesh in 2025.



Fruit bagging in Amrapali



Mature and ripe fruit with double layer brown black colour bag (Amrapali)

CONCLUSION

Pre-harvest fruit bagging using double-layer brown-black bags, applied 28–35 days after fruit set in mango and 35–40 days in guava, significantly improves peel colour, firmness, and shelf life. This eco-friendly practice protects fruits from pests, diseases, and mechanical damage while reducing reliance on chemical pesticides, ensuring residue-free fruits suitable for domestic and export markets. Bagged fruits fetch premium prices, providing economic benefits to farmers. Overall, fruit bagging is a sustainable, practical, and profitable strategy for enhancing the quality and marketability of mango and guava production.

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