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Integrated Pre and Post-Harvest Technologies for Extending Shelf Life and Freshness of Tuberose

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Tuberose (*Polianthes tuberosa* L.) is an economically important ornamental crop in India, widely used as loose flowers, cut flowers, and in the perfume industry. However, its commercial value is often reduced due to its highly perishable nature and short shelf life. Rapid aging, high respiration rate, water loss, and sensitivity to ethylene lead to considerable post-harvest losses. This paper emphasizes the significance of integrating pre- and post-harvest technologies to enhance shelf life and maintain freshness of tuberose flowers. Pre-harvest aspects such as climatic conditions, variety selection, planting material, nutrient supply, irrigation, and pest and disease management contribute to the development of strong spikes with better carbohydrate reserves. Post-harvest practices including conditioning, pre-cooling, pulsing, modified atmosphere packaging, and cold storage help in slowing down respiration, delaying senescence, and preserving flower quality. A well-coordinated approach linking field management with scientific post-harvest handling is essential for improving vase life, reducing losses, and increasing the market value of tuberose flowers.

Keywords: Tuberose; Shelf life; Post-harvest management; Pre-harvest technology; Conditioning; Pre-cooling; Modified atmosphere packaging; Vase life

Introduction

Tuberose (*Polianthes tuberosa* L., earlier known as *Agave amica* Medik.) is a commercially significant ornamental crop cultivated widely in tropical and subtropical regions. It is admired for its waxy white florets and strong, pleasant fragrance, making it an essential component of loose flower trade, cut flower industry, and perfumery sector. Tuberose flowers are extensively used in garlands, decorations, religious offerings, and essential oil extraction. Due to its high demand, improving its post-harvest performance has become a major concern for growers and researchers. Despite its economic importance, tuberose is highly perishable with limited shelf life. Rapid quality deterioration after harvest occurs due to high respiration rate, ethylene sensitivity, moisture loss, depletion of carbohydrates, and microbial blockage in stem vessels. These changes result in early floret senescence, wilting, petal browning, fragrance loss, and reduced market value. Therefore, maintaining freshness and extending shelf life should be considered a continuous process that begins before harvest in the field (Bindiya et al., 2018; Finger et al., 2021).

Importance of Shelf-Life Extension in Tuberose

Extending shelf life is crucial for tuberose due to its high perishability. Flower freshness directly influences market price, consumer preference, and export potential. Longer shelf life allows safe transportation over long distances, minimizes post-harvest losses, and provides flexibility in marketing. It also enables farmers and traders to avoid distress selling and obtain better returns (Verma et al., 2018).

Pre-Harvest Factors Affecting Shelf Life of Tuberose

1. Environmental Conditions

Environmental factors significantly influence growth and post-harvest behavior of tuberose. Temperature plays a key role in metabolic activity and carbohydrate accumulation. An optimum range of 20–30°C supports balanced growth, stronger spikes, and delayed floret senescence. Tuberose grows best under warm and humid conditions, which promote uniform floret development and better fragrance retention. Extreme temperatures can negatively affect spike quality and shelf life. Well-drained sandy loam soil with pH 6.5–7.5 is ideal, as it prevents waterlogging and bulb rot. Varieties such as Prajwal, Shringar, Suvasini, and Vaibhav perform reasonably well even in slightly alkaline soils (Singh, 2014).

2. Genetic (Varietal) Factors

Varietal differences strongly influence post-harvest longevity. Based on flower structure, tuberose varieties are grouped into single, semi-double, double, and variegated types.

Single-flowered types like Prajwal, Phule Rajani, and Shringar have fewer petals, lower respiration rate, and better carbohydrate utilization, resulting in longer shelf life (6–8 days under ambient conditions). These varieties are also highly fragrant and commercially preferred (Bhattacharjee & De, 2010). Double-flowered varieties such as Calcutta Double, Pearl Double, and Hyderabad Double have more petals, which increases metabolic activity and water loss, leading to faster senescence and shorter shelf life (4–6 days).

3. Planting Material, Time, and Spacing

Healthy, disease-free bulbs of 2–2.5 cm diameter and 25–35 g weight are recommended for better spike quality and shelf life. Proper curing of bulbs through shade drying for 7–10 days after lifting reduces physiological disorders. February–March is the best planting time, ensuring favorable conditions for spike development. Proper spacing of 30 × 20 cm or 20 × 20 cm reduces competition for nutrients and light, resulting in longer spikes and better vase life (Singh, 2014).

4. Nutrient Management

Balanced fertilization enhances spike quality and post-harvest performance. Application of FYM @ 20 t/ha improves soil health and plant vigor. Recommended NPK dose of 200:50:70 kg/ha supports optimal growth. Split application of nitrogen prevents excessive soft growth. Phosphorus improves floret development, while potassium enhances cell membrane stability and reduces wilting (Kabir et al., 2012).

Integrated Pre-Harvest Technologies

Integrated nutrient management using a combination of organic and inorganic fertilizers improves both field performance and post-harvest quality. Application of 80% RDF with Jeevamruta (500 L/ha) enhances shelf life (Aal et al., 2024). Use of neem cake, vermicompost, Azotobacter, and PSB along with reduced chemical fertilizers improves spike durability (Meena et al., 2015). Humic acid and boron supplementation further increases spike length and floret number (Suseela et al., 2020).

Harvesting Factors Affecting Shelf Life

Harvesting should be done early morning or late evening to minimize water stress. For cut flowers, spikes should be cut when 1–2 pairs of florets have opened. Loose flowers should be plucked when fully open or just before opening. Using sharp, clean tools prevents mechanical damage and microbial infection (Kumar et al., 2015).

Post-Harvest Technologies for Shelf-Life Extension

Conditioning: Freshly harvested spikes are placed in clean water or preservative solution to restore turgidity and reduce stress. This improves floret opening and vase life (Reid & Jiang, 2012).

Pre-cooling: Rapid removal of field heat at 4°C slows respiration and water loss. Forced-air cooling is most effective for commercial handling (Reid, 2009).

Pulsing: Spikes are treated with sugar or chemical solutions (sucrose, citric acid, STS, HQC, salicylic acid) for 12–24 hours to enhance rigidity and delay senescence (Salehi et al., 2016).
Packaging: Modified Atmosphere Packaging (LDPE) reduces respiration and microbial growth, extending vase life by 3–6 days. Corrugated boxes, plastic crates, polyethylene liners, and ethylene absorbers help maintain quality during transport (Singh, 2024; Reddy et al., 2014).
Storage: At ambient conditions (25–30°C), tuberose lasts only 1–2 days. Cold storage at 2–4°C with 90–95% RH extends shelf life up to 7–10 days. Cool chambers (18–22°C) maintain freshness for 3–4 days, while modified atmosphere storage further delays senescence (Halevy & Mayak, 2011; Nowak & Rudnicki, 2014).

Conclusion

Extending the shelf life of tuberose is a continuous process that starts in the field and continues through post-harvest handling and storage. Proper pre-harvest management ensures strong spikes with better carbohydrate reserves, while post-harvest techniques reduce respiration and moisture loss. An integrated approach combining scientific cultivation, careful harvesting, and improved post-harvest practices is the most effective and sustainable way to enhance the commercial value of tuberose flowers.

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