

## Vegetable grafting: An innovative trend in olericulture

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### Abstract: -

Grafting, an ancient horticultural practice, has been integral to agriculture for thousands of years, with its use dating back to around 1560 BC in China. It involves joining two plant segments the rootstock and the scion allowing for the transfer of beneficial traits from one to the other. This method has historically improved crop resilience and yield, significantly impacting horticulture and agriculture. In modern times, vegetable grafting has gained renewed importance as an alternative to chemical soil fumigation, especially following the phase-out of methyl bromide. Grafting helps manage soil-borne diseases and pests while enhancing crop quality and yield. This article explores the history, benefits, and crops suitable for grafting, as well as the modern-day applications and challenges of this age-old technique.

### Introduction

Grafting has been practiced for centuries, playing a pivotal role in the cultivation of various fruit and nut crops. Its early documentation can be traced back to ancient Chinese texts around 1560 BC, where it was used to enhance crop production and improve plant varieties. Renowned philosophers such as Aristotle and

Theophrastus also discussed grafting in their writings, contributing to the understanding of plant propagation during ancient times. The agricultural treatise "Qi Min Yao Shu," written by Si-xie Jia between 386 and 543 AD, provides a detailed account of grafting techniques for pears, emphasizing methods to improve crop yields and plant health. The early history of vegetable grafting reveals that

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it was a common practice in East Asia. Shengzhi Fan, around 100 BC, described grafting Opo squash, and Si-xie Jia later expanded on these techniques. His recommendations included sowing seeds in a circular pattern and bundling the growing vines, allowing the best vine to be selected for cultivation. The recorded history of grafting in Korea during the early 18th century also highlights its significance and cross-cultural exchange of agricultural knowledge.

The modern era of vegetable grafting began in 1927 in Japan, when a watermelon farmer used it to combat Fusarium wilt. The technique quickly spread throughout Japan and Korea by the late 1920s and 1930s, helping

farmers overcome the challenges of intensive agriculture on small plots of land. By the 1990s, grafting had become common in East Asia, with nearly all fruit vegetables in Japan and South Korea being grafted by 2000. The practice reached Europe and North America in the late 20th century, where it is now an essential tool in greenhouse vegetable production.

### Benefits of Grafting in Vegetables

The phase-out of methyl bromide, a widely used soil fumigant, has posed significant challenges for farmers, particularly in managing soil-borne diseases that affect crops such as tomatoes, melons, and cucumbers.

**Table No. 1: Benefits of Grafting in Vegetables**

Benefit	Explanation
<b>Disease Resistance</b>	Grafting enables the use of disease-resistant rootstocks to protect against soil-borne diseases like Fusarium wilt, Verticillium wilt, bacterial wilt, and nematodes. Reduces need for chemical treatments.
<b>Enhanced Vigor and Growth</b>	The superior root system of grafted plants improves nutrient and water uptake, leading to better growth, drought tolerance, and resilience in suboptimal conditions.
<b>Increased Yield and Fruit Quality</b>	Grafted plants produce higher yields and better-quality fruits, with enhanced fruit size, uniformity, flavor, color, and shelf life.
<b>Pest and Virus Resistance</b>	Rootstocks can provide resistance to pests like the carmine spider mite and various viruses, reducing the spread of diseases and minimizing chemical interventions.
<b>Adaptation to Different Soil Conditions</b>	Grafting allows vegetable cultivation in diverse soils, including saline and nutrient-deficient soils, by using rootstocks with higher tolerance to harsh conditions.
<b>Environmental Sustainability</b>	Grafting reduces the reliance on chemical treatments, enhances soil health, improves plant resilience, and optimizes the use of water and fertilizers for sustainable farming.

Grafting has emerged as a sustainable and effective solution to these challenges. By joining the scion, or top portion of a plant, to a rootstock with desirable traits, grafting allows for the transfer of beneficial characteristics from one plant to another, resulting in several key benefits: (Table 1).

### Techniques and advances in vegetable grafting

Vegetable grafting is a horticultural technique in which the tissue of one plant (scion) is joined to the root system of another plant (rootstock). This practice has evolved significantly, with advancements that improve efficiency, outcomes, and scalability in modern agricultural systems. Here are the techniques commonly used in vegetable grafting, along with some advanced trends:

#### 1. Grafting Techniques

Several grafting techniques are used in vegetable production, each with its own advantages and applications:

- **Splice or Tube Grafting:** This is one of the most widely used methods for tomato and eggplant grafting. The scion and rootstock are cut at an angle (usually around 45 degrees) and then joined together, secured with a small clip or grafting tube. The union is held in a controlled environment to heal.
- **Cleft Grafting:** This method is commonly used in grafting cucurbits, such as

watermelon and cucumber. A slit is made in the rootstock, and the tapered scion is inserted into the slit. The graft is secured with a clip until it heals.

- **Approach Grafting:** In this technique, the scion and rootstock are grown side by side. A section of the stem from each plant is removed, and the exposed surfaces are joined together. Once the graft union is established, the original root of the scion is cut off.
- **Hole Insertion Grafting:** In this method, the rootstock stem is pierced, and the scion is inserted into the hole. It is used for young seedlings and helps achieve a high success rate in healing.
- **Whip Grafting:** This technique involves making a diagonal cut in both the scion and rootstock, joining them, and wrapping the union securely. It is less common in vegetables but used for woody plant species.

#### 2. Advanced Trends in Vegetable Grafting

The field of vegetable grafting is rapidly advancing, with new trends and techniques emerging to address challenges in crop production:

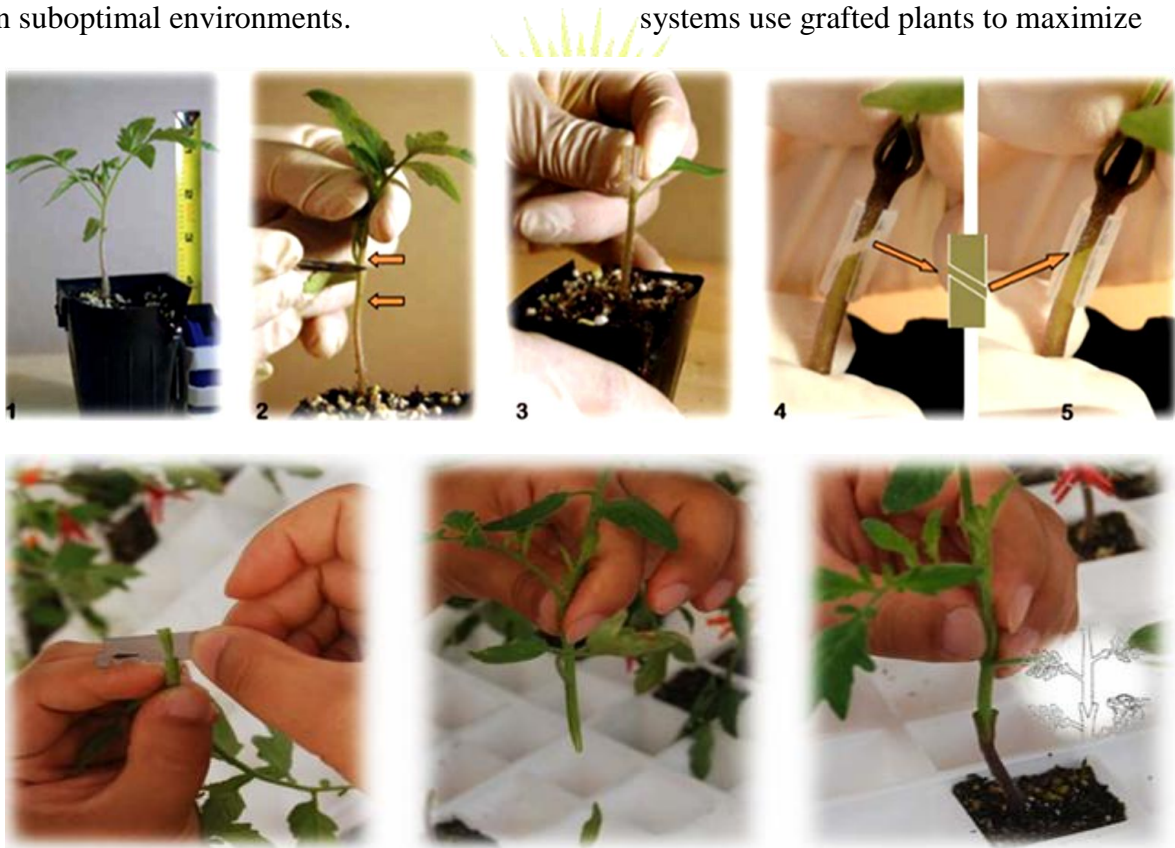
- **Automated Grafting Machines:** Labor costs and time are significant barriers to large-scale grafting. Automated grafting machines have been developed to enhance productivity, allowing for the grafting of

thousands of plants per hour. These machines can perform cuts, clip placement, and transfer grafted plants into healing chambers, improving grafting efficiency.

- **Grafting for Abiotic Stress Tolerance:** Modern grafting techniques aim to increase tolerance to abiotic stresses such as salinity, drought, and extreme temperatures. Rootstocks that can withstand harsh conditions are being developed to extend the growing season, enhance plant survival, and improve yields in suboptimal environments.

disease resistances. These rootstocks are engineered to combat various pathogens simultaneously, offering broad-spectrum protection. The use of resistant rootstocks has become an essential tool in integrated pest management strategies, especially in organic farming.

- **Grafting under Controlled Environments:** Incorporating grafting in high-tech agricultural systems, like hydroponics and vertical farming, has become increasingly popular. These systems use grafted plants to maximize



**Fig1: Process of grafting in vegetable grafting**

- **Disease-Resistant Rootstocks:** Advanced breeding programs are continuously developing rootstocks with multiple space and resources, improve growth efficiency, and reduce the incidence of soil-borne diseases.

➤ **Use of Growth Enhancers and Hormonal Treatments:** Application of growth regulators, hormones, and natural enhancers at the graft union can improve healing rates and graft success. This trend is gaining traction as a way to optimize the physiology of the grafted plants for better integration.

### Crops Suitable for Grafting in Vegetables

Grafting is particularly effective in several types of vegetable crops, each with unique benefits and considerations:

#### 1. Tomatoes

Tomato grafting is widely practiced, especially in greenhouses and high tunnels where soil-borne diseases like Fusarium wilt and root-knot nematodes are prevalent. Grafted tomatoes exhibit improved resistance to these diseases, enhanced growth, and increased fruit yield. The practice is common in North America, with over 40 million grafted tomato seedlings used annually. Selecting the appropriate rootstock is crucial for achieving the desired benefits in tomato grafting. Rootstocks like Maxifort, Beaufort, and Multifort are popular choices due to their disease resistance and vigor.

#### 2. Melons and Cucumbers

Grafting is commonly used in melons and cucumbers to combat soil-borne pathogens such as Fusarium wilt and to improve the plants' resilience to environmental stresses. In

these crops, rootstocks derived from Lagenaria species or interspecific hybrid squash (*Cucurbita maxima* × *Cucurbita moschata*) are frequently used. These rootstocks offer robust disease resistance, tolerance to salinity, and improved nutrient uptake.

#### 3. Eggplants (Brinjal)

Eggplant grafting is practiced to enhance resistance to bacterial wilt and root-knot nematodes, which can significantly reduce crop yield. Grafting onto *Solanum torvum* or *Solanum sisymbriifolium* rootstocks helps protect the plants from these issues, allowing for healthier growth and increased production.

#### 4. Peppers

Grafting in peppers is used primarily to manage soil-borne diseases and to increase tolerance to suboptimal soil conditions. Rootstocks derived from *Capsicum* species with strong disease resistance can improve the survival and productivity of pepper plants in regions with high disease pressure.

#### 5. Watermelons

Watermelon grafting gained popularity in Japan in the early 20th century to combat Fusarium wilt. The practice has since spread globally, with interspecific hybrid squash rootstocks commonly used to confer disease resistance and improve growth. Grafting also allows for earlier planting in cooler regions, extending the growing season.

## 6. Squash and Pumpkins

Grafting squash and pumpkins can help protect against soil-borne diseases and improve plant vigor. The technique is often employed in organic farming systems where chemical soil treatments are not an option. Rootstocks with high resistance to common pathogens are selected to enhance crop resilience.

### Conclusion

Grafting is a time-tested horticultural technique that continues to play a vital role in modern agriculture. Its historical roots date back thousands of years, with significant contributions from various cultures that have refined and passed down the practice. Today, grafting is essential for sustainable vegetable production, particularly in the face of challenges such as soil-borne diseases, pest infestations, and climate variability. The benefits of grafting extend beyond disease resistance, encompassing improved plant vigor, increased yield, enhanced fruit quality, and environmental sustainability. As the global agricultural landscape evolves, grafting remains a valuable tool for meeting the demands of intensive farming while minimizing the impact on natural resources. With the ongoing advancements in grafting techniques and rootstock development, the potential for even greater benefits in vegetable cultivation is on the horizon. As farmers and

researchers continue to explore innovative applications of grafting, this ancient practice will undoubtedly remain a cornerstone of sustainable agriculture, ensuring food security and quality for future generations. Incorporating grafting into vegetable production not only addresses the challenges posed by soil-borne diseases and pests but also offers a pathway to more resilient and adaptable farming systems. By leveraging the strengths of both traditional knowledge and modern research, grafting can help create a more sustainable and productive agricultural

future.