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Vegetable Grafting Technique

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INTRODUCTION

Grafting is the union of two identical formulation plants that grow as one. The rootstock is chosen for its vigour and disease resistance, while the scion is chosen for its fruit quality and taste. Grafting increases the efficiency of nutrient uptake and utilization in a variety of plant species, including fruits, vegetables, and ornamentals. Grafting uses selected rootstocks from the same species or close relatives. Rootstocks absorb more water and ions than self-rooted plants and carry them to the aboveground scion. Vegetable grafting has been safely adapted for the production of organic and environmentally friendly produce while minimizing the uptake of undesirable agrochemical residues.

The number and size of commercial vegetable seedling producers has grown significantly, reflecting farmers' preference for grafted seedlings of higher quality and performance. Aside from the well-known benefits of disease tolerance and high crop yields, grafting technology is also highly effective in mitigating crop losses caused by adverse environmental conditions such as low soil temperature and high soil salts, particularly in protected cultivations where successive cropping or continuous farming is routinely practised. Grafted seedlings are popular in hydroponic farming systems, where noxious diseases can spread quickly once infected. The quality of grafted transplants is critical for maximizing high-quality crop yield. With the increased use of improved soil mix or substrate, farmer preferences for better seedlings, efficient management of nursery systems, lower prices of grafted seedlings, and an efficient nationwide delivery and/or transportation system, the use of grafted vegetables has increased. Improved grafting methods that reduce labour costs for grafting and subsequent handling of plug-grown grafted transplants will contribute even more to the increased use of grafted vegetables around the world.

OBJECTIVES OF GRAFTING

The main objective of vegetable grafting is to eliminate soil borne pests that infect vegetables and problems of salinity and soil acidity. Other objectives of grafting are to increase productivity, to increase the grafted plant tolerance to different temperature. East Asia is the largest market for vegetable grafting because of high concentration of cucurbits and other grafted vegetables.

Vegetables	Objectives
Cucumber	Tolerance to fusarium wilt, *Phytophthora melonis*, cold hardiness, better sex ratio, and bloomless fruits
Egg plant	Tolerance to bacterial wilt, verticillium wilt, fusarium wilt, cold, nematodes, induced vigour, and increased yield
Tomato	Tolerance to corky root, improved colour and lycopene content, and nematode tolerance
Melon	Tolerance to fusarium wilt, physiological disturbances, Phytophthora diseases, cold hardiness, and increased growth
Watermelon	Fusarium wilt tolerance, physiological disorders, cold hardiness, and drought tolerance
Bittergourd	Fusarium wilt tolerance

Potential advantages from grafted vegetables

- Better nutrient and water uptake
- Better nutrient and water uptake Improved plant growth
- Grafting increases yield by improving water uptake, nutrient uptake, and manipulating harvest period
- Improvement in fruit quality

- **Tolerance to biotic stress**:
  - Fusarium wilt: Cucumber, Melon, Watermelon, Tomato
  - Fusarium crown and root rot: Tomato, Cucumber, Watermelon
  - Monosporascus wilt: Melon, Watermelon
  - Verticillium wilt: Tomato, Eggplant, Watermelon
  - Phytophthora blight: Pepper
  - Bacterial wilt: Tomato, Eggplant
  - Root-knot nematodes: Tomato, Eggplant, Pepper

- **Tolerance to abiotic stress:**
  - Low temperature tolerance:
  - High temperature tolerance
  - High salt tolerance
  - Drought tolerance

DISADVANTAGES OF GRAFTING

- Expensive labor if done manually, or for an automaton if done automatically, as well as rootstock costs.
- Grafting Incompatibility
- Fruit quality may suffer as a result of the rootstock/scion variety combination.

DIFFERENT METHODS OF GRAFTING

The crop, the farmer's experience, personal preference, the number of grafts required, the purpose of grafting, access to labour, and the availability of machinery and infrastructure facilities all influence the method of grafting chosen (Lee et al., 2010). Despite the development of numerous machines and grafting robots, manual grafting remains the most popular and widely used method (Lee et al., 2010)

1. Cleft grafting:

Apical or wedge grafting is another name for it. Here, scion plants with 1-3 true leaves are pruned, and the lower stem is cut at a slant angle to form a tapered wedge, and a clip is placed to make contact between the scion and the rootstock after inserting the scion into the split (Johnson et al., 2011). This technique is most commonly used in Solanaceous crops.

2. Tongue Approach/Approach Graft:

For this grafting, equal-sized rootstock and scion material were used. As a result, scion seeds are sown 5-7 days earlier than rootstock seeds to achieve uniform size. This method is more labour intensive and takes up more space, but the seedling survival rate is high, so it is most commonly used by farmers and small nurseries. This method is incompatible with rootstocks that have hollow hypocotyls.

3. Hole Insertion/Top Insertion Grafting:

Because watermelon seedlings are smaller than bottle gourd or squash rootstock, this method is preferred for grafted watermelon transplant production. This method necessitates a temperature range of 21-36 ° C prior to transplanting. This method is very popular in China because it produces a stronger union and vascular connection than tongue grafting.

4. Splice grafting/ tube grafting/ one cotyledon splice grafting:

Growers and commercial grated transplant producers prefer and use this method the most. It can be done by hand or machine in most vegetables. This method is widely used in the cultivation of Cucurbits and Solanaceous vegetable crops.

5. Pin grafting:

Splice grafting and pin grafting are similiar methods of grafting. To hold the grafted position, specially designed pins are used instead of grafting clips.

6. Automated Grafting

In 1993, the first semiautomatic cucumber grafting system was commercialized. With two operators, a simple grafting machine can produce 350–600 grafts per hour, whereas manual grafting techniques produce around 1,000 grafts per person per day. It is fully automated grafting system that can perform 750 grafts per hour with a success rate of 90-93 percent. It is applicable to both solanaceous and cucurbitaceous vegetables.

GRAFTING METHODS FOR DIFFERENT ROOTSTOCKS

SCION PLANT	ROOTSTOCK	METHOD
Eggplant	*S. torvum* *S. sissymbrifolium* *S. khassianum*	Tongue graftingCleft method Tongue and cleft
Tomato	*L. pimpinelifoliumS.nigrum*	Cleft method Tongue and cleft
Cucumber	*C.moschata Cucurbita maxima*	Hole insertion and Tongue graftingHole insertion
Water melon	*Benincasa hispidaC.moschata* *C.moschata x C. maxima*	Hole insertion and Cleft method Hole insertion and Cleft methodHole insertion
Bitter gourd	*C.MoschataC.moschataLuffa sps*	Hole insertion and Tongue graftingHole insertion and Tongue grafting

Post-Graft Healing Environment

- Proper care of newly grafted transplants is required to ensure a higher grafting success rate. Water loss from the scion during the first two days may result in wilting of the scion and, ultimately, failure of the grafting process; thus, humidity should be maintained to prevent (95 percent) water loss.
- Grafted transplants should be covered with black plastic sheeting for 5-7 days after grafting to increase humidity, reduce light intensity, and promote healing.
- As healing chambers, plastic tunnels are used. On a commercial scale, healing rooms can achieve 95% grafting success. During the healing process, keep the grafted plantlets away from direct sunlight.

Problems Faced During Vegetable Grafting

- Labour intensive technique and required specialized trained workers

- It necessitates time management for rootstock and scion seed sowing
- It necessitates graft healing in a controlled environment
- Rootstock-scion incompatibility is observed during the initial stages or after transplantation under field conditions
- Grafting can increase the risk of pathogen spread, particularly in the nursery for seed-borne pathogens. Workers performing grafting within a greenhouse and growth chamber face heat stress and discomfort, particularly during the months of April-June, September, and October.

CONCLUSION

Given the vast range of uses for vegetable grafting around the world, this technology has the potential to help India's vegetable industry overcome its challenges and increase farmers' income by increasing crop output and lowering the cost of fertilisers, pesticides, and disease control products. Grafting is an environmentally friendly method of promoting organic vegetable production.

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