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Vegetable Grafting: Technical Aspects and Dissemination

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INTRODUCTION

Vegetable grafting is extensively used today in agricultural production to control soil-borne pathogens, abiotic and biotic stresses and to improve phenotypic characteristics of the scion. Commercial vegetable grafting is currently practiced in tomato, watermelon, melon, eggplant, cucumber, and pepper. It is also regarded as a rapid alternative to the relatively slow approach of breeding for increased environmental-stress tolerance of fruit vegetables. Vegetable grafting is a horticultural technique in which two distinct plants are joined to form a composite plant. The lower portion (rootstock) provides the root system, while the upper portion (scion) contributes the shoot system. This practice enhances disease resistance, abiotic stress tolerance, yield potential, and environmental adaptability. Rootstocks are selected for vigor and resistance, whereas scions are chosen for superior yield and quality traits.

Grafting was introduced from East Asia to Europe during the 20th century, but it has become more popular during the past 30 years. Grafted plants are commonly used today in the commercial production of tomato (*Solanum lycopersicum*), watermelon (*Citrullus lanatus*), melon (*Cucumis melo*), eggplant (*Solanum melongena*), cucumber (*Cucumis sativus*), pepper (*Capsicum annuum*), and many more. It is still unknown how plant grafting was discovered but it is likely that it originated from the occurrence of grafting in nature when two different plants come randomly in contact and unite their limbs or roots without human intervention.

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Advantages of Vegetable Grafting

- **Enhanced Disease Resistance**: Grafted plants exhibit tolerance to soil-borne pathogens due to resistant rootstocks.
- **Abiotic Stress Tolerance**: Improves resilience against drought, salinity, and extreme temperatures.
- **Yield Augmentation**: Extended plant longevity results in higher productivity compared to non-grafted plants.
- **Adaptability in Diseased Soils**: Enables successful cultivation in pathogen-infested soils and repetitive cropping systems.

Grafting Techniques

Scion and Rootstock plants ready for grafting purpose

- Rootstock seeds are sown earlier than scion seeds to synchronize stem diameters.
- Seedlings are raised in nursery trays under controlled conditions

Sowing of seeds in portrays

Plants ready for rootstock use

Plants readv for Scion use

Methods of Grafting

- **Slant grafting (most common):** In this type of vegetable grafting the stems of the rootstock and scion are cut at the same angle (approximately 35-60 degrees). The slanted cut surface of the scion is then joined to the slanted cut surface of the rootstock, and the two are secured together with a grafting clip.
- **Cleft (V-shape) Grafting**: In this type of grafting, a 1.5 cm long vertical incision is made in the centre of the rootstock stem, and the scion is cut diagonally on both sides to form a "V" shape, also 1.5 cm long. The prepared scion is then inserted into the incision in the rootstock, and the joint is secured with a grafting clip. This grafting technique has the highest success rate in Solanaceae vegetables.
- **Pinhole Grafting Method:** This is a simple grafting technique in which a small hole (pinhole) is made in the middle of the stem of the rootstock plant, when it is in the two-leaf stage, using a thin needle, pin, or pointed rod. The lower part of the scion is then cut diagonally and carefully inserted into this hole so that the vascular tissues of both parts can connect, resulting in a strong, grafted plant. This method is especially used in cucurbitaceous vegetables such as pumpkins and gourds.

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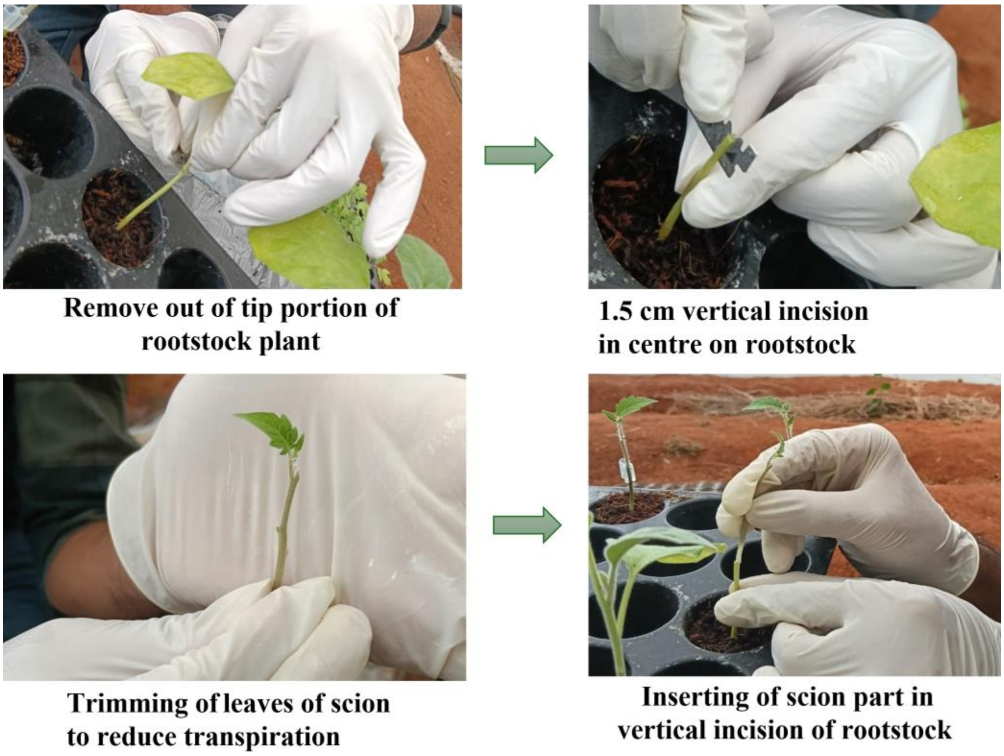
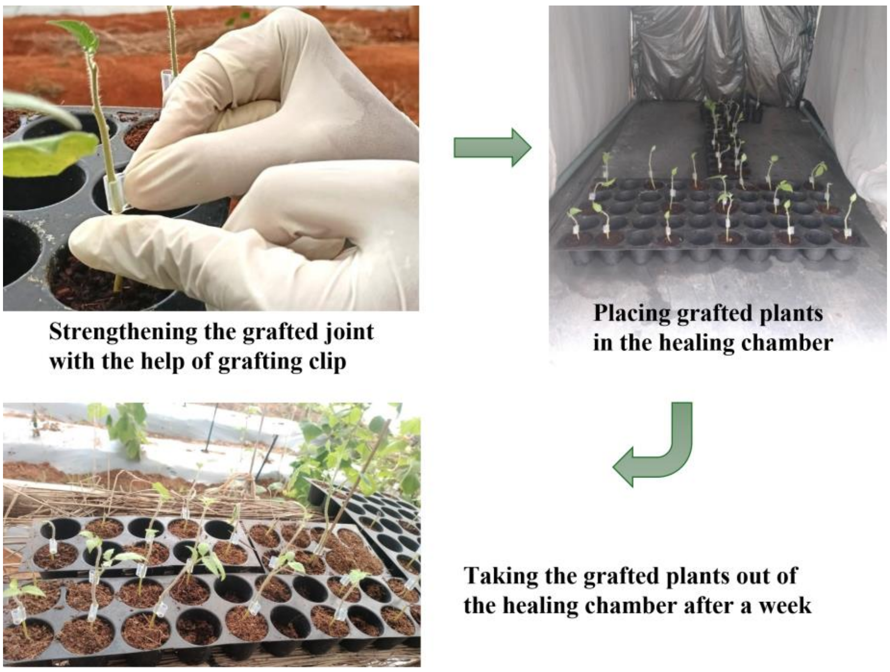


Figure: Cleft grafting

Healing and Acclimatization

- Grafted seedlings are maintained under controlled humidity (85–95%) and stable temperature to minimize transpiration losses.
- Plants are initially kept under polyhouse/plastic cover, gradually exposed to sunlight, and finally acclimatized in open conditions.



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Transplanting

- Transplantation is performed once plants attain sufficient vigor.
- Care is taken to avoid soil contact with the graft union to prevent adventitious rooting.

Precautions

- Rootstock selection must align with local agro-climatic conditions.
- Stem diameters of rootstock and scion must be uniform.
- Grafting clips should be allowed to detach naturally to avoid mechanical injury.

Challenges

- Limited supply of grafted seedlings relative to demand.
- Requirement of specialized farmer training, often involving additional costs.
- Intensive post-grafting care increases production costs.

Effect of grafting on abiotic stresses

- Grafting used as a tool for reducing the effect of abiotic stresses. Grafted watermelon has potential to survive under abiotic stress. The watermelon grafted onto bottle gourd rootstock in heavy or loam soils, it enhances flooding tolerance. Cucurbits may be grafted onto pumpkin will provide some drought tolerance in sandy soil.

Effect of grafting on biotic stresses:

Grafting plays an important role in controlling disease by using various rootstocks. Grafting of watermelon onto other cucurbitaceous rootstocks to provide soil-borne disease resistance has been highly successful (Ali , 2012)

Effect of grafting on quantitative characters:

Grafting in solanaceous vegetable crops increase in yield as mentioned in several reportsIn tomato, grafting resulted in the formation of more number of internodes and flowers in outdoor cultivation and number and total weight of fruits in indoor cultivation (Voutsela, et al.,2012)

Dissemination and Adoption of Vegetable Grafting Technology by Farmers

The agricultural extension system plays a crucial role in ensuring the successful dissemination and effective adoption of vegetable grafting technology by farmers. Currently, this technology is proving extremely useful for farmers as a solution to challenges such as soil-borne diseases, climate change, and rising production costs. Through training programs, farm schools, and field demonstrations organized by the Department of Agriculture, Krishi Vigyan Kendras (KVKs), and agricultural universities, farmers are provided with practical knowledge of various grafting methods, selection of suitable rootstock and scion, and plant management. Frontline demonstrations compare grafted and non-grafted plants, clearly illustrating the differences in yield, disease resistance, and plant growth, thereby increasing farmers' confidence in the technology. Training is provided to local nurseries, farmer producer organizations, and self-help groups to ensure the availability of high-quality grafted planting material. Furthermore, information related to the technology is being widely disseminated through Information and Communication Technology (ICT)-based platforms such as mobile applications, WhatsApp groups, YouTube, and Kisan Call Centres. Cost-benefit analysis is used to demonstrate to farmers that despite higher initial costs, grafted plants yield higher production and economic benefits in the long run. In addition, skill-based training is being provided to women farmers and rural youth to develop employment and income generation opportunities through grafting technology.

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CONCLUSION

Grafting is a method of plant propagation, done by utilising selective rootstock and scion combinations for tolerance against soil borne diseases that directly influences the production of vegetable crops. As a result, increased net returns achieved in wide range of soil and environmental stress conditions even in off season. It is a rapid alternative means to the moderately slow breeding methodology. In recent days, grafting application leads the limit use of harmful soil disinfectants which minimizes the toxic residues in vegetables and environmental pollution. Hence, it is suggested that, by adopting modern innovations and indigenous wild relatives, we can realize commercial use of grafting to attain the low input sustainable horticulture in future.

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