

# Grafting of Vegetable Crops

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## ABSTRACT

*Grafting of vegetable seedlings is a unique horticultural technology practiced for many years in East Asia to overcome issues associated with intensive cultivation using limited arable land. Grafting is a simple method of propagation in which desired rootstocks are obtained to induce vigor, precocity, enhanced yield and quality, to increase nutrient and mineral uptake to the Shoot, better survival under biotic and abiotic stress conditions, such as cold, salinity, drought, and heavy metal toxicity, due to the resistance found in the rootstock. Grafting method can be used for new goal such as multiplication in difficult propagation vegetable crops such as multiplication seedless watermelon. Several vegetable varieties, including nightshades and cucurbits, are commonly grafted commercially. The technology of grafting is potential in promoting the cultivation of vegetables in customized and fragile agricultural-ecosystem.*

## INTRODUCTION

India is the world's second largest producer of vegetable crops after China. Vegetables are considered as an important component in the diversification of horticulture to provide food and nutritional security for the growing population. With increasing population, there is need to boost the production of vegetable crops.

The grafting is one of the tools for sustainable vegetable production by using resistant rootstock. It reduces dependence on agrochemicals for the organic production. Grafting has been utilized in horticulture ever since the first millennium. Grafting or graftage is a horticultural technique whereby tissues of plants are joined so as to continue their growth together. Grafting can be defined as the natural

or deliberate fusion of plant parts so that vascular continuity is established between them and the resulting composite organism functions as a single plant. The practice involves selecting a rootstock, a plant variety that offers disease resistance and vigorous growth qualities, to be the in-ground portion of the plant. Then grafting it to a scion with desirable fruit characteristics to be the above-ground part. The survival rate of grafted plants depends on compatibility between scion and rootstock, quality and age of seedlings, quality of the joined section, and post-grafting management *i.e.*, acclimatization of grafted seedlings.

### Benefits from growing grafted vegetables

**1. Resistance/tolerance to biotic stress (soil borne diseases):-** Fusarium wilt: cucumber, melon, watermelon, tomato, Fusarium crown and root rot: tomato, cucumber, watermelon, Verticillium wilt: tomato, eggplant, watermelon, Phytophthora blight: pepper, Bacterial wilt: tomato, eggplant, Root-knot nematodes: tomato, eggplant, pepper.

**2. Tolerance to environmental stresses (abiotic stress) :-** A) Grafting is useful to initiate flowering and fruit set at low temperature. B) Grafted plants have more content of Linolenic acid, which helps in the survival of plants under low temperature. C) Concentration of proline, vitamin-C and water soluble sugars were higher in grafted seedling than in ungrafted seedling. Grafted plants can survive at 10°C also. D) Use grafted tomato may give certain degree of resistance against thermal stress. Eggplants grafted onto a heat-tolerant rootstock of eggplant seemed to be promising and resulted in a prolonged growth stage and yield increase up to 10%. E) Inter-generic grafting imparts flood tolerance in cucurbits. Grafting improved flooding tolerance of bitter melon (*Momordia charanthia* L. cv. New Known You) when grafted onto sponge gourd (*Luffa cylindria* Roem cv. Cylinder).

**3. Enhanced nutrient and water uptake.** 4) Improved plant growth. 5) Yield increase. 6) Rootstock effect on fruit quality. Grafting increases number of marketable fruits and decrease number of malformed fruits in tomato. (Pandey and Rai, 2003), Flavor, pH, sugar, color, carotenoid content, and texture can be affected by grafting and the type of rootstock used. (Davis *et al.*, 2008). An increase in ascorbic acid content in tomato was found with grafting. (Zhu *et al.*, 2006). Grafted fruit had a better colour and highest lycopene content in tomato.

**4. Complementary to breeding programs -** graft hybrid, rapid development of new genetic sources, takes full advantage of germplasm

### Basic pre-requisites for vegetable grafting

**1. Selecting the right rootstock/scion:** Select the desirable rootstock and scion having the same stem size (diameter). Grafting should be done at 2-3 true leaf stage. **2. Graft compatibility:** Compatible rootstock and scion minimizes the Mortality rate even in later stage of growth. **3. Grafting aids:** Commonly used aids to perform grafting *i.e.*, Grafting clips, Tubes, Pins, and Grafting Blade. **4. Screening house:** Used for growing seedlings prior to grafting. It should be constructed with 60-mesh nylon net. **5. Healing of grafts:** Healing is most critical to provide favourable conditions to promote callus formation of grafted seedlings. In healing chamber, temperature should be 28-29 °C with 95% relative humidity for 5-7 days in partially shaded place (darkness for 1-2 days) to promotes callus formation at union. It helps in formation of better graft union by reducing transpiration, maintains high humidity, maintains optimum temperature and reduces light intensity. **6. Acclimatization of the grafted plants:** After the callus has formed and the wounded surfaces are healed, plants may be put under a mist system, greenhouse or placed under a clear plastic cover for acclimatization to prevent leaf burning and wilting.

## Methods of grafting

Different grafting techniques were adopted for different scions and rootstocks; they depend on grafting objectives, farmers' experience.

**1. Cleft grafting:** This method is widely used in crops like tomato and brinjal. The seeds for the root stock are sown 5-7 days earlier than the scion. The seedlings at 4-5 leaf stage are selected for grafting and are cut at right angles; each with 2-3 leaves remaining on the stem. This technique involves cutting the rootstock horizontally, removing the top of the plant, and then making a ¼-inch vertical cut down the center of the stem. Then cut the scion tip into a matching wedge to be inserted into the rootstock incision. Hold it together with a spring clip or grafting film. This technique holds the graft together more tightly than a splice graft. The technique can also be inverted with the root stock trimmed to a wedge point and the scion v-notched to fit over the wedge. This version is called a **Saddle Graft**.

**2. Tongue approach grafting:** This method is commonly used on members of the cucurbitaceous vegetables because it ensures a higher survival rate. This method most widely used by farmers and small nurseries. Grafted seedlings have a uniform growth rate but it is not suitable for rootstocks with hollow hypocotyls. In this method, seeds of cucumber are sown 10-13 days before grafting and pumpkin seeds 7-10 days before grafting, to ensure uniformity in the diameter of the hypocotyl of the scion and rootstock. The shoot apex of the rootstock is removed so that the shoot cannot grow. The hypocotyl of the scion and rootstock are cut in such a way that they tongue in to each other and the graft is secured with a plastic clip. The hypocotyl of the scion is left to heal for 3-4 days and then crushed between the fingers or partially cut below the graft.

**3. Slant grafting:** This is also known as one cotyledon grafting. It has recently been adopted by commercial seedling nurseries. It is applicable to most vegetables. Grafting can be

done by making slant cuts on both root stock and scion by retaining only one cotyledon leaf on the rootstock. Grafted plants should be maintained in the dark at 25°C and 100% humidity for three days for successful graft union.

**4. Hole insertion grafting:** This is also called as top insertion grafting. This method is preferred for the production of grafted watermelon transplants because the watermelon seedlings are relatively small in size than bottle gourd or squash rootstock. When scion and rootstock have hollow hypocotyls, this method is preferred. In this method grafting can be performed by making hole on the top of the root stock and by inserting the scion in that hole which should be prepared in such a way to similar diameter as math with hole measurements of stock. One person can produce 1,500 or more grafts/day. To achieve a high rate of success, relative humidity should be maintained at 95%. After healing, temperature should maintain at 21-36°C up to transplanting.

**5. Tube or Japanese Grafting:** It is similar to slant grafting except that in this method root stock & scion joined are held with an elastic tube instead of clips. It is more popular in tomato, brinjal. This grafting has been developed for vegetable seedlings grown by plug culture. Cut rootstock under cotyledons in a 45° or sharper angle. Prepare the scion with matching hypocotyl width cut in the same angle at about 5- 10 mm below the cotyledons. Place one tube a half way down on top of the cut end of rootstock hypocotyl. Insert the scion into the grafting tube so that cut surface aligns perfectly with that of rootstock.

**6. Pin grafting:** It is also same as the slant grafting. In this instead of grafting clips, to hold the grafted position, specially designed pins are used. The ceramic pin is nearly about 15 mm long and 0.5 mm in diagonal width of the hexagonal cross-section: Pin grafting is basically the same as the splice grafting. Instead of placing grafting clips, especially designed pins are used to hold the grafted position. The

pins are made of natural ceramic so it can be left on the plant without any problem.

### Recent innovations of Vegetable Grafting

Now a day's many new innovations developed to perform grafting in vegetables, few are summarized below: i) Double grafted and single grafted tomato: Pomato is a plant resultant of vegetable grafting. In this tomato scions were grafted onto potato rootstocks by cleft grafting. Above the ground harvest over 500 cherry tomatoes with 100 Brix TSS. There are single tomato grafts like Indigo Rose, Brandywine and Sun Sugar. Log House is introduce the technique of producing double grafted tomato plants, red and yellow pear tomato as scions by using on Big Beef or Geronimo rootstock in U.S. and marketed in 2010. ii) Micro-grafting: In vitro grafting using very small or micro explants from meristematic tissues to eliminate the viruses from infected plants. Micro grafting has been used in herbaceous plants to evaluate the physiology of grafting and determine the chemical basis of cell to cell contacts. This method provides rapid propagation of virus free plants although, it is expensive. iii) Grafting Robots: A full automation model developed in the Netherlands can graft 1,000 tomato or eggplant seedlings per hour and has more functions such as automatically selecting matching rootstock and scion seedlings, which is a crucial process to increase the success rate. First commercial model of a grafting robot (GR800 series; Iseki & Co. Ltd., Matsuyama, Japan) became available for cucurbits in 1993 and there were various semi- and fully automated grafting robots. The reports also noted of grafting robots developed in other countries.

### 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. diverse applications of vegetable grafting worldwide, this technique can solve the problems of vegetable industry and boost farmers incomes by improving crop yields and reducing the cost of purchasing large quantities of fertilizers and pest control products. 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. Grafting technique is useful for low-input sustainable horticulture of the future following the abandonment of methyl bromide. Vegetable grafting has potential to promote cultivation of the vegetables under non-traditional conditions and fragile agro-eco-systems. Grafting application leads the limit use of harmful soil disinfectants which minimizes the toxic residues in vegetables and environmental pollution. Further, inventions in mechanized and robotic grafting is a fillip for this eco-friendly approach.

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