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Vegetable Grafting

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Abstract

Grafted vegetable seedlings are an exceptional horticultural technique that has been used for a very long time. In the late twentieth century, this approach was introduced into Europe and other countries, along with improved grafting procedures appropriate for commercial production and productivity of grafted vegetable seedlings. Vegetable grafting is the process of removing the vegetable plant's stem at the seedling stage and connecting it to the rootstock of another vegetable plant seedling, such as wild brinjal or pumpkin. Once the attachment is made, the grafted seedling is grown in controlled climatic conditions, after which it can be planted in the field. Grafting onto certain rootstocks often gives resistance to biotic and abiotic stress, crop growth, yield, and quality, diseases transmitted by the soil, and nematodes. Grafting is an effective technology for use in combination with more sustainable crop production practices, including reduced rates and overall use of soil fumigants in many other countries. If these experts are to be believed, vegetable grafting would result in plants that are more resistant to bacterial wilt, improving their lifetime and productivity while lowering losses for vegetable growers and increasing revenue.

Introduction

Grafting is an art of joining together two plant parts (a rootstock and a scion) by means of tissue regeneration, in which the resulting combination of plant parts achieves physical reunion and grow as a single plant (Janick, 1986). Grafting fruit trees has been done for thousands of years, however in Olericulture, vegetable grafting is a comparatively modern method that is centuries old. Commercial vegetable grafting with resistant root stocks is one of the most effective tools for sustained vegetable production. Vegetable grafting decreases reliance on agrochemicals for organic production. Vegetable grafting can also increase vigour, precocity, yield and quality, survival rate, minimise infection by soil-borne pathogens, and resistance to abiotic stresses by selecting a suitable rootstock. In world, vegetable grafting is getting popularity in case of cucurbits, tomato, eggplant and pepper using vigorous and disease -resistant rootstocks to ensure adequate yields where biotic and abiotic stresses limits the productivity (Lee and Oda, 2003; Chang et al., 2008; Buller et al., 2013)

Qualities of graft scion and rootstock:

To ensure success in grafted vegetable production, proper rootstock and scion cultivars must be selected based on characteristics such as genetic purity, survival, productivity, fruitfulness, and matching customer expectations. A deeper root system (drought tolerance), good nutrient uptake potential, disease resistance, nematode tolerance, compatibility with the scion cultivar, and wider adaptability in all environmental conditions are all factors considered when choosing rootstock cultivars.

Objectives of vegetable grafting

The primary goals of vegetable grafting are to eradicate soil-borne pests and diseases that afflict crops, as well as to address salt and soil acidity issues. Other grafting aims include increasing output and increasing the grafted plant's tolerance to various temperatures.

VEGETABLES	OBJECTIVES
Cucumber	Tolerance to fusarium wilt, *phytopthora melonis*, cold hardiness, favourable sex ratio, bloomless fruits.
Eggplant	Tolerance to bacterial wilt, verticillium wilt, fusarium wilt, low temperature, nematodes, induced vigour and enhanced yield.
Tomato	Tolerance to corky root, better colour and greater lycopene content, tolerance to nematode.
Melon	Tolerance to fusarium wilt, physiological disorders, phytopthora

	diseases, cold hardiness, enhanced growth.
Watermelon	Tolerance to fusarium wilt, physiological disorders, cold hardiness and drought tolerance.

Methods of vegetable grafting

The crop, the farmer's experience, personal preference, the quantity of grafts necessary, the purpose of the graft, manpower availability, and the availability of machinery and infrastructural facilities have an impact on the grafting method used.

Tongue / approach grafting

This grafting involved the use of equal-sized rootstock and scion material. Therefore, to attain uniform size, scion seeds are sown 5-7 days earlier than rootstock seeds. This method is labor-intensive and requires a greater amount of room, but seedling survival rates are good, making it the most popular among farmers and small nursery. This method is not suitable for rootstocks with hollow hypocotyls. It is a more time process that requires more room, but it has a greater success rate than alternative methods. Both the scion and the stock are of the same size. Scion seeds are seeded one week before rootstock raising to ensure that scion size remains constant. Both the scion and the stock have a tongue-like incision, and the graft union is done with the help of a plastic clip at the graft union point.

Hole insertion/ Top insertion grafting

This procedure is used to develop grafted watermelon transplant because watermelon seedlings are smaller than bottle gourd or squash rootstocks. This has been the most popular approach for cucurbits. Small hypocotyls on the scion and rootstock are ideal for this operation. Watermelon seedlings are smaller than rootstock (bottle gourd or squash), hence hole insertion grafting is advised for grafted watermelon transplant development. For this method rootstock should be selected 7-8 days (Bottle gourd) and 3-4 days (Squash) old. Rootstock seeds are sown 5–10 days before scion seeds are sown, and grafting is done 20–25 days after scion seeds are sown in the case of tomato and aubergine. Both rootstock and scion seedlings should be homogenous, sturdy, and vigorous when grafted.

Cleft grafting

Apical or wedge grafting is a substitute term for it. The bottom stem of the scion plant is cut at a slant angle to form a tapered wedge, and a clip is used to create contact between the scion and the rootstock after inserting it into the split. Solanaceous crops are the most often employed crops in this technique.

Pin grafting

Is like splice grafting. Instead of placing grafting clips, specially designed pins are used to hold the grafted position.

Tube grafting

The most typical method for growing seedlings in plug trays is as follows. It is a more convenient and time-saving method of vegetable grafting than conventional grafting. Smaller seedlings can be accommodated in a healing room or an acclimation chamber. In rootstock, a 450 incision below the cotyledon produces results. A comparable cut is available in scion as well. The rootstock and scion relate to a tube, and the tray is placed in a healing chamber for up to 7 days.

Healing and Acclimatization

Acclimatization is critical for the healing and survival of grafted plants. Acclimatisation is the process of mending the wounded surface and hardening it for life in the outdoors or greenhouse. Maintaining correct moisture levels before and after grafting is crucial for producing consistent grafted seedlings. After grafting, keeping the grafted plants in the dark for seven days at 28-30°C and more than 95% relative humidity improves survival rates. The relative humidity is gradually reduced, while the light intensity increases. To maintain high humidity throughout healing and acclimatisation, the tunnel's air temperature must be kept constant. Grafted plants are often healed and acclimated in a plastic tunnel lined with materials that offer shade and regulate interior humidity. After healing maintain the light level to 3000-5000 Lux. Before grafting the scion and rootstock should be exposed to sunshine for two to three days and water should be withheld from plant to avoid spindly growth. All these improves the survival rate of grafted plants.

Recent innovations of vegetable grafting

There have been numerous new innovations produced to accomplish grafting in vegetables recently, and a few of them are detailed below:

Double grafted and single grafted tomato:

Tomatoes are plants that have been grafted from vegetables. Cleft grafting was employed to attach tomato scions to potato rootstocks. More than 500 cherry tomatoes with a TSS of 100° Brix were gathered above ground. Indigo Rose, Brandywine, and Sun Sugar are individual tomato grafts. Log House pioneered the use of Big Beef or Geronimo rootstock to cultivate double-grafted tomato plants with red and yellow pear tomato scions in the United States in 2010.

Micrografting:

To remove viruses from infected plants, in vitro grafting using extremely tiny or micro explants (1/1000th mm3) from meristematic tissues is utilised. Micro grafting has been utilised in herbaceous plants to study the physiology of grafting as well as the chemical foundation of cell-cell interactions. Although expensive, this method enables the fast multiplication of virus-free plants.

Grafting Robots:

A fully automated model created in the Netherlands can graft 1,000 tomato or aubergine seedlings each hour and has other capabilities such as automatically picking matching rootstock and scion seedlings, which is an important procedure for increasing success rates. According to Kobayashi (Kobayashi et al.), the first commercial model of a grafting robot (GR800 series; Iseki & Co. Ltd., Matsuyama, Japan) became available for cucurbits in 1993, followed by numerous semi- and fully automated grafting robots. The publications also mentioned grafting robots produced in other nations.

Prospects of grafting in the future

Advances in technology have led to the creation of more efficient grafting robots capable of performing several operations in a short period of time, lowering the cost of grafted seedlings. The production of rootstocks that give a strong root system, resistance to soil-borne diseases, the capacity to induce enhanced water and nutrient absorption, and plant health management, all of which contribute to productivity. Grafting is an important research tool in plant science, in addition to its current use in horticultural, physiological, biochemical, and molecular research, by combining plant models such as Arabidopsis thaliana, Pea (Pisum sativum L.), and dwarf tomatoes, cv. Micro-Tom, with grafting and micro-grafting protocols (Turnbull et al. 2002). The reciprocal impact of scion and rootstock, as well as long-distance molecular transport throughout the plant, may therefore be examined.

Conclusion

Given the vast range of uses for vegetable grafting across the world, this technology has the potential to alleviate vegetable industry challenges and increase farmer incomes by enhancing crop yields and lowering the cost of purchasing huge quantities of fertilisers and pest control chemicals. Grafting is an ecologically beneficial method that helps to produce organic veggies. Grafting techniques face several challenges, including the widespread adoption of grafting facilities, equipment, and robots to improve grafting efficiency and lower labour costs. Researchers must investigate developing databases, software, and crop models linked to grafted vegetables to aid nursery managers and agricultural communities in selecting appropriate scion and rootstock cultivars.