Article: RT605

Biotica Research Today
Vol 3:5 399/401
2021

How to cite this article?
Singh, 2021. Vegetable Grafting: A Tool for Improving Quality and Yield of Crop. Biotica Research Today 3(5): 399-401.

Vegetable Grafting: A Tool for Improving Quality and Yield of Crop

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Keywords
Abiotic and biotic stress, Rootstock, Scion, Vegetable grafting

Abstract

Grafting technique has emerged as alternative tool to enhance crop yield by increasing resistance against abiotic and biotic stress in plants. The interaction between rootstock and scion can improve the quantitative and qualitative characteristics of fruits. It is an easy and efficient method of crop production. The various methods can be utilized in several vegetable and other horticultural crops. Vegetable grafting is common in cucurbits, tomato, eggplant, chilli, *etc*. With reduced application of artificial source of nutrients, it is an eco-friendly technique that supports organic cultivation of vegetables. This article explains the significance and basic requirements of grafting techniques.

Introduction

Grafting is a process of combining plants of different or same species together whereby top of one plant, called scion is attached to root system of another plant, called rootstock *via* a graft union. The major objective of grafting is to reduce the limitations of either scion or rootstock. For example, different soil-borne diseases (*Fusarium*, *Verticillium*, *Ralstonia*) or pests such as nematodes, damage the root systems of many susceptible crops. Development of resistance in such pest-susceptible crops *via* crossing with resistant source or closely related species is an efficient method but it takes many numbers of years and successful outcome is still not guaranteed. Grafting is easier and an effective method of producing healthy plants. The first grafted vegetable plant was produced in the late 1920's in Japan and Korea where they grafted watermelon onto gourd rootstock to improve the quality and yield of watermelon. At present time, more than 95% of watermelon and oriental melon produced in Japan, Korea and Taiwan are grafted on squash and gourd rootstock before transplanting.

Basic Requirements before Vegetable Grafting

Selection of scion is based on purity, viability, quality of fruits, yield and market demand. Similarly, the selection of rootstock is based on purity, viability, compatibility with scion, resistance/ tolerance to diseases and its adaptability to soil and environmental conditions. Care should be taken that selected scion and rootstock have the same diameter to overcome graft incompatibility for a successful union. Equipment used like grafting blade and pins should be contamination free. It should be done at the 2-3 leaf stage and such seedlings have to be kept for 7-10 days for acclimatization as hardening treatment.

Article History
Received in 27th May 2021
Received in revised form 28th May 2021
Accepted in final form 29th May 2021

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Grafting Methods Used in Vegetables

The grafting technique has established as a better alternative for rapid development of resistance. This approach can access pest resistance simply by using pest resistant material as a rootstock. Scion is taken from a cultivar of high quality, high yield potential but it may be disease/ pest sensitive, hence, is then grafted onto resistant rootstock. It provides a way to effectively arrest the strengths of both scion (high quality, high yield) and rootstock (pest tolerant) in a single plant. The most popularly used method of grafting in vegetable crops are splice or tube grafting, tongue grafting and cleft method. Selection of the method depends on the crop, farmers experience, personal choice, number of grafts required, purpose of grafting, access to labour, strengths and limitations of methods, availability of machinery and infrastructure facilities (Lee *et al*., 2010). Different techniques are appropriate for different vegetable crops. Selection of compatible rootstock and scion material and their utilization at the correct developmental stage is of utmost importance for the success of any grafting operation. In cucurbits, it should be done before the four-leaf stage of plant. After this, plants should be kept in a mist chamber for about a week to allow healing of graft union.

Table 1: Grafting methods for different rootstocks of vegetable crops

Scion plant	Rootstock	Method
Eggplant	*S. torvum*	Tongue grafting
	S. sissymbrifolium	Cleft method
	S. khassianum	Tongue, Cleft method
Tomato	*L. pimpinelifolium*	Cleft method
	S. nigrum	Tongue, Cleft method
Cucumber	*C. moschata*	Hole insertion, Tongue grafting
	Cucurbita maxima	Hole insertion
Water melon	*Benincasa hispida*	Hole insertion, Cleft method
	C. moschata	Hole insertion, Cleft method
	C. moschata x C. maxima	Hole insertion
Bitter gourd	*C. moschata*	Hole insertion, Tongue grafting

Post-Graft Healing Environment

A proper care of grafted plants and transplant is recommended at the first 2-3 days as it is crucial time for relatively higher water loss from scion which may result in severe damage of wilting and eventually failure of the process. So, to avoid such damage, humidity level should be maintained at 95% by practicing moisture conservation methods such as mulching with black plastic sheets (5-7 days). Mulching helps in increasing humidity, reducing light intensity and weed growth. Healing of grafts is reported best under plastic tunnels which have been accounted for 95% success rate on a commercial scale (Dong *et al*., 2015). Such plantlets should not be exposed to direct sunlight during the process of their healing.

Advantages of Grafting Vegetables

Vegetable grafting has proved to be effective in improving tolerance against higher or stress conditions of temperature, flood and salt. Under low temperature, grafts have a higher potential to initiate flowering, fruiting, more content of linolenic acid, proline, vitamin-C and water-soluble sugars. In tomato, it is done for tolerance against nematode and corky root, for better colour with greater lycopene content, while, in eggplant it is done for inducing resistance against bacterial wilt, verticillium wilt, fusarium wilt, low temperature, nematodes, enhancing yield and plant vigour. Grafted tomato also has a higher degree of resistance against thermal stress. Brinjal grafted on the heat-tolerant rootstock of brinjal variety has given a promising rise in yield up to 10%. The objectives of using rootstock in watermelon, bitter gourd and cucumber are to develop tolerance against *Fusarium* wilt, *Phytophthora melonis*, cold hardiness, drought and occurrence of favourable sex ratio. The inter-generic grafting in cucurbits has provided flood tolerance. For example, grafting of bitter gourd (*Momordia charanthia*) onto sponge gourd (*Luffa cylindria*) has produced flood-tolerant plants. It also aids in improving the quality of vegetables. Color, flavor, texture, pH, sugar, carotenoid and ascorbic acid content in tomato can be affected by the type of rootstock used. The technique can also be adopted for generating an alternative for pesticides and can increase farmers' interest in growing organic or pesticide-free crops. Selection of appropriate rootstocks, may lead to reduction in the consumption of fertilizer, water and other inputs in the crops. It also improves vigour of crop, resulting in earlier and higher yields of superior quality.

Conclusion

The process of vegetable grafting to develop healthy seedlings has diverse applications worldwide. It has the potential to reduce problems faced in vegetable production in Indian climatic conditions and can play important role in the enhancement of farmer's income by improving disease and pest resistance; thus, crop yield. The application of this technique aids in reducing cost of expensive fertilizers and pesticides which makes it an 'ecofriendly technology'. The scientists should emphasis on the automated

grafting technique to reduce the labour dependency of nursery management.

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