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GRAFTING TECHNIQUES IN VEGETABLES CROPS : A REVIEW

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Abstract

The grafting of vegetables is a technology whose main objective is to increase the yield under stresses conditions such as high temperatures, salinity, drought, diseases, etc. Commercial grafting of vegetables has started for several decades and the area under vegetable grafting is gradually increasing. Vegetable grafting has the potential to expand the area under vegetable cultivation under unstable agro-environmental systems and has the possibility of increasing production per unit of land available. The grafting of vegetables is one of the alternative tools in the development of resistance of varieties for stress conditions with ability of improvement the qualitative and quantitative in vegetables crops.

Key words : Vegetable grafting, Quality seedling, Rootstock, Cucurbitaceae, Scion, Solanaceae.

Introduction

Grafting is a technique that is used to improve production in vegetables crops. The development consists of the use of a vigorous plant to replace the root system of a cultivar of economic interest, but which is susceptible to one or more environmental effects. The new root system is called the rootstock and the top part of interest or cultivar is the scion. The first record of vegetable grafting was recorded in Japan in the late 1920s when Watermelon (*Citrullus lanatus* L.) plants were grafted onto *Lagenaria siceraria*, *L. fusarium* wilt to prevent it (Kawaide, 1985). Since then, grafting has spread throughout the world. Approximately 92 percent and 95 percent of the area grown with watermelon use grafted seedlings in Japan and Korea (Lee *et al*., 2010). Besides preventing biotic stress from root-knot nematodes (Louws *et al*., 2010; Yin *et al*., 2015) and soil - borne fungi (Crinó *et al*., 2007), grafting can be an important practice for dealing with many abiotic stresses, such as drought (Albacete *et al*., 2015; Schwarz *et al*., 2010), cold (Li *et al*., 2015). Grafting is used to improve the efficiency of production and resources of vegetable crops, mainly in protected crops. In part, the adoption of grafting depends on the establishment of appropriate grafting methods and the vigorous development of rootstock through breeding (King *et al*., 2010). Despite the benefits but not all vegetable species can be grafted because genetic compatibility, growth conditions, physiological and biochemical factors influence grafting success (Goldschmidt, 2014). 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 (Buller *et al*., 2013).

Cucurbitaceae

Several species of cucurbit are grafted, in particular watermelon, melon and cucumber. There are many commercial applications of cucurbit grafting and numerous methods for joining scion and rootstock, most of which are done at young seedling stages (Mohamed *et al*., 2014). The possibility of high - performance automation methods with operator assistance or complete robotic control can reduce grafted seedlings ‘costs’ (Comba *et al*., 2016).

Solanaceae

Eggplant, tomato and sweet pepper species appear to be especially prone to grafting, which is probably related to their regenerative ability. Although, almost all greenhouse tomatoes are grafted and eggplants are also widely grafted, sweet pepper grafting is less commonly used by producers. In fact, sweet pepper is compatible with other solanaceous species. The development of rootstocks with resistance to a wide variety of diseases, good root strength, high compatibility and the adoption of appropriate grafting methods are therefore the main constraints for increasing the yield of solanaceous crops by grafting.

Improvement the qualitative and quantitative characters by grafting

Grafting is an effective way of improving the quality of fruit under optimum conditions of growth and salinity. The quality of the fruit shooting depends, at least in part, on the root system (Flores *et al*., 2010). Grafted plants had higher marketable yields, fruit quality, in soilless tomato cultivation (Gebologlu *et al*., 2011). Eggplant grafting onto *S. torvum* has increased the size of the fruit without affecting quality or yield. Grafting and the type of rootstock used can affect sugar, flavor, colour, carotene content and texture (Davis et al., 2008). A study reported that the solutes associated with fruit quality are moved through the xylem in the scion, while quality characteristics, e.g. The rootstock is influenced by fruit shape, skin colour, skin or rind smoothness, flesh texture and colour and the concentration of soluble solids (Nicoletto *et al*., 2012). In contrast, grafting eggplants on Solanum torvum and Solanum sisymbrifolium adversely affected the content of vitamin C, strength and some sensory attributes, but the overall impression was not affected (Arvanitoyannis *et al*., 2005).

Grafting methods

The method of grafting depends on the crop, the experience of the farmers, the choice of person, the number of grafts required, the purpose of grafting, the access to work and the availability of machinery and infrastructure (Lee *et al*., 2010). Those methods as the following :

1. **Splicing grafting :** one cotyledon spliced grafting. This method is most widely used and preferred by producers and commercial grated transplant companies. It can be carried out by hand or machines in most vegetables. This method is popular for vegetable cucurbits and solanaceous crops.
2. **Pin grafting** : is similar to splice grafting. Instead of placing grafting clips, especially designed pins are used to hold the grafted position.
3. **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. This method requires an optimum temperature of 21-36 Euros until transplantation takes place. This method is very popular in China, as it leads to a strong union and vascular connection with the language grafting approach (Oda, 1999).
4. **Apical grafting :** In this case, scion plants are cut with 1 - 3 true leaves and the lower stem is cut to a slanting angle to form a tapered wedge and the clip is placed to make contact between scion and rootstock after splitting (Johnson *et al*., 2011). This method is most commonly used in sunflower crops.
5. **Tongue grafting :** Rootstock and scion material of the same size used for grafting. Therefore, seeds are sown 5 - 7 days before rootstock seeds to achieve a uniform size. This method is labor intensive and requires more space, but the survival rate of seedling is high, which is why farmers and small nurseries use it most widely. This method is not suitable for hollow hypocotyl rootstocks.

Prospects of grafting in the future

Advances have been made to expand the use of the technology, such as the development of more efficient grafting robots capable of carrying out a large number of operations in a short time, reducing the price of grafted seedlings (Comba *et al*., 2016). The development of rootstocks that provide a robust root system, resistance to soil - borne pathogens, the ability to induce increased absorption of water and nutrients and the maintenance of plant health that would 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 and protocols for grafting and micro-grafting (Turnbull *et al*., 2002). The reciprocal influence of scion and rootstock and the long - distance transport of molecules throughout the plant can therefore be investigated.

Conclusion

Given the 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. Grafting is an environmentally friendly technology that supports the production of organic vegetables. Grafting technique have many problem to solve such as popularization of grafting facilities, equipment and robots to increase grafting efficiency and reduce labor costs. Storage technology for grafted transplants requires researchers to consider the development of databases, software and crop models related to grafted vegetables to assist nursery managers and farming communities in the selection of suitable scion and rootstock cultivars.

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