Evaluation of different grafting methods to citrus cultivars

Zahoor Hussain1,2, Faheem Khadija3, Abdul Aziz3, Muhammad Nawaz Khan3, Muhammad Raza Salik3 & Raheel Anwar3

SUMMARY

Citrus is one of the most important fruit crops of the world and are propagated by sexual and asexual methods. Citrus rootstocks are produced by seed (zygotic seedling) while scion cultivars are propagated by asexual methods such as budding, cutting, layering and grafting. In Punjab-Pakistan, mostly T-budding and T-grafting as well as side grafting are used to propagate new plants with low success rate. In the current study, we investigated the effects of different methods of grafting such as ‘side grafting’, ‘wedge (or cleft) grafting’ and ‘tongue grafting’ to propagate mandarin cv. Kinnow and sweet orange \([Citrus sinensis (L.) Osbeck]\) cvs. Succri and Jaffa on rough lemon \((C. jambhiri Lush.)\) rootstock. The experiment was designed as a split-plot in a randomized complete block designed, with three replications, where a single plant was considered as an experimental unit. Thirty plants were grafted in each method of grafting. The results showed that wedge and side grafting had the highest graft take with Kinnow mandarin (90.00% and 86.67%, respectively); tongue grafting had the highest graft take with the Jaffa sweet orange (76.67%); and, the side grafting alone had the highest graft take with the Succri sweet orange. The shoot length was significantly higher in mandarins cv. Kinnow (16.00 cm) followed by sweet orange cv. Succri (11.67 cm) as compared to Jaffa (11.00 cm). In general, the results showed that side grafting was the most effective method of propagation for all evaluated cultivars in the province of Punjab-Pakistan.

Index terms: Kinnow mandarin, Succri sweet orange, Jaffa sweet orange, side graft, wedge graft, tongue graft.

Avaliação de diferentes métodos de enxertia para cultivares de citros

RESUMO

Os citros constituem de um grupo de frutíferas das mais importantes do mundo e estes são propagados por métodos sexuais e assexuais. Os porta-enxertos de citros são produzidos por sementes (plantulas zigóticas ou nuclares), enquanto as cultivares de copa são propagadas por métodos assexuados, como a bobulhia, estaquia, encostia e enxertia. Em Punjab, Paquistão, são utilizadas principalmente as técnicas de bobulhia em “T” invertido, garfagem em “T” e a garfagem lateral para propagar novas plantas, porém com baixas taxas de sucesso. Nesta pesquisa, forma investigados os efeitos de diferentes métodos: ‘garfagem lateral’, garfagem em ‘fenda cheia’ e a garfagem em ‘ingles complicado’, para a propagação de tangerina Kinnow e das laranjas-doce \([Citrus sinensis (L.) Osbeck]\) cvs. Succri e Jaffa, em porta-enxertos de limão rugoso \((C. jambhiri\)

1 University College of Agriculture, University of Sargodha, Sargodha, Pakistan
2 Citrus Research Institute, Sargodha, Pakistan
3 Institute of Horticultural Sciences, University of Agriculture, Faisalabad, Pakistan

Corresponding author: Zahoor Hussain, University College of Agriculture, University of Sargodha, Sargodha, Pakistan. zahoorhussain@uos.edu.pk and zachoundi@yahoo.com
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in the take, dwarfism in trees depending on rootstock types (Simons, 1987), resistance against insects and pests, salinity tolerance (Colla et al., 2010) as well as enhancing the fruit production (Mitani et al., 2008; Mng’omba, 2007). Therefore, many tropical and subtropical as well as temperate fruits such as mango, avocado, citrus, peach, pear, and plums are commonly propagated by grafting as compare to stem cuttings and marcots which may not be successful as a result of difficulties in root development.

There are many factors that influence on grafting, such as skilled grafter, air temperature, relative humidity, moisture and plant water status, growth stage of scion and rootstock, method and time of grafting, compatible size of grafts of both scions and their respective rootstocks (Hartmann et al., 2007; Mng’omba et al., 2010; Pina & Errea, 2005) and age of the mother plants (Salauddin, 2003). Rootstock with 10-mm stem diameter has been considered ideal for grafting of citrus (Hartmann et al., 1997).

Different grafting methods are used to propagate different fruit species, such as tongue, wedge and veneer in walnut (Muzaffar & Kumar, 2011), cleft grafting in citrus (Hartmann et al., 1997; Coronel & Dotto, 2001; Ledesma & Campbell, 2001), soft wood grafting in Khasi mandarin (Patel et al., 2010) and epicotyls grafting in mango (Baghel et al., 2002; Hema et al., 2002).

In the current study, we investigated the effects of different methods of grafting such as side, wedge and tongue to propagate different species of citrus such as mandarins (Citrus reticulata Blanco) cv. Kinnow and sweet orange [C. sinensis (L.) Osbeck] cvs. Succri and Jaffa.

MATERIALS AND METHODS

The current study was conducted at the experimental area of Department of Horticulture, University College of Agriculture, University of Sargodha, in 2015. The experiment
was conducted in open field during autumn (September, 2015) and at a temperature of 25±5 °C. One-year old seedlings of Rough lemon (C. jambheri Lush) were selected on the basis of size, vigor and other morphological character’s in order to keep the variation at minimal level. Similarly, scion wood of three different cultivars of citrus such as mandarin’s cv. Kinnow and sweet oranges (cv's. Succri and Jaffa) were selected to be grafted on the Rough lemon rootstock. The side, wedge and tongue methods of grafting were used. In vegetative propagation, however, no genetic change takes place since no genetic union with recombination of genes occurs.

Propagation through wedge grafting is preferred for deciduous and top working older tree of inferior varieties (Malik, 1994). Similarly, whip and tongue grafting are commonly used for bench grafting fruit trees. Tongue or whip graft works best when the stock and scion are of similar diameter, preferably between 1/4 and 1/2 inch. The scion wood was prepared by clipping off the leaves leaving petiole stubs 0.5 cm long intact. Graft wood, 10 cm in length, 9 to 12 months old, rounded with white streaks, was detached from the scion trees and grafted on 12-month-old seedling stocks at 20 cm from the ground level. Polythene sheet was wrapped over the graft and both ends were tied with polythene sheet (to conserve the moisture) covering the scion/stock union. The binding material and the top of the graft were removed when enough sprouting from the graft was observed. De-sprouting of the stock below the graft union was continued since the time of grafting. All the agronomic and cultural practices such as spraying pesticides and fertilizer as well as weeding were kept constant and carried out regularly with all treatments.

Grafts take percentages were recorded by using the method of Chalise et al. (2013). The sprouted scions were recorded in successful graft take. However, in some cases, the late sprouting was also observed and, finally, sprouting percentage was considered as the graft success percentage in relation to the total number of grafts.

Death of sprouted grafts was observed during the study and the survival percentage was calculated by using the method of Chalise et al. (2013) in relation to the total number of sprouted grafts. Similarly, the shoot length and number of shoots were recorded according the method of Salik et al. (2015). The experiment was designed as a split-plot in a randomized complete block designed, with three replications, where a single plant was considered as an experimental unit.

The standard procedure was used for data collection such as graft success percentage, mortality percentage, shoot length (cm) and number of shoots after 5 months since the treatment application.

**RESULTS AND DISCUSSION**

The data recorded on survival percentage of grafts showed that the wedge and side grafting had the highest graft take with Kinnow mandarin (90.00% and 86.67%, respectively); tongue grafting had the highest graft take with the Jaffa sweet orange (76.67%); and, the side grafting alone had the highest graft take with the Succri sweet orange (Tables 1 and 2). It may have argued that success in grafting, subsequent growth of scion shoot and development of the successful graft depend on a number of factors including time of grafting, fruit type variety, method of grafting, selection and preparation of stock and scion.

### Table 1. Degrees of freedom (df) and P-values (P-value > F) of the on the primary effects and possible interactions of cultivars and grafting methods on the graft take, shoot length and number of shoots

| Source       | df | Graft take | Shoot Length | Number of shoots | P-value > F |
|--------------|----|------------|--------------|------------------|-------------|
| Cultivars    | 2  | 0.022*     | 0.556        | 0.346            |
| Methods      | 2  | 0.003**    | 0.199        | 0.999            |
| Cultivars * Methods | 4  | 0.006**   | 0.0474*      | 0.465            |

* P<0.05; ** P<0.01.

### Table 2. Effect of different grafting methods on graft take percentage of different citrus cultivars

| Grafting Methods | Cultivars          | Graft take percentage |
|------------------|--------------------|-----------------------|
|                  | Kinnow             | Succri                | Jaffa               |
| Side Grafting    | 86.67 aA           | 82.33 aA              | 74.33 abA           |
| Tongue Grafting  | 61.00 abB          | 50.00 bB              | 76.67 aA            |
| Wedge Grafting   | 90.00 aA           | 63.33 bB              | 61.00 bA            |

Means followed by the same letter within each interaction do not differ (Tukey, 5%); lowercase letters = between cultivars (row); uppercase letters = between grafting methods (column).
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The current study was supported by the findings of Poon (1999) has also observed higher success (91.75%) with veneer method in mandarin. However, Gautam et al. (2001) has been reported highest success (87.50%) when grafting was done at 31st January as compared to the grafting (85.00%) which was carried out during 16th January at Lumle, Kaski. Adhikari (2006) also observed highest graft success (79.73%) when acid lime was grafted on trifoliate orange. Salauddin (2003) also done an experiment on grafting and found that best season for grafting operation was June as compared to July and August. Similarly, the author also found that scion collected from higher age (6 years old) showed excellent results as compared to other scions of different ages. Similarly, Soft wood grafting in Khasi Mandarin (C. reticulata) were carried out by Patel et al. (2007) at Meghalaya, India under poly-house, net-house and open field conditions at 15-day intervals from 15 June to 15 October. The found early sprouting, graft success and best scion growth under poly-house conditions and C. Jambhiri, was the best rootstock for soft wood grafting in Khasi Mandarin.

It may be argued that mortality may occur due to the transpiration loss from the tender leaves due to lack of cuticle layer and higher number of stomata on the young leaves. In short term, sufficient moisture is the responsible for mortality in the young emerging plants. Similarly, higher temperature is also another factor which causes the mortality in young emerging plants. Similarly, Chalise et al. (2013) was also observed lowest (0.17%) mortality of sprouted grafts in 29th December grafting, while it was observed higher in earlier and late season grafting.

The shoot length and numbers were also recorded, and a significant interaction effect was found only in shoot length (Table 1). The highest shoot length (16.00 cm) was recorded in mandarin’s cv. Kinnow with the wedge grafting, relative to others cultivars; and, the lowest shoot length was recorded in sweet orange cv. Succri (11.67 cm) and Jaffa (11.00 cm) (Table 3).

Grafting is not a new method of propagation fruit plants and in recent decades also with vegetable. Taxonomic proximity is a general prerequisite for successful graft-take and long-term survival of the grafted, composite plant (Goldschmidt, 2014). It may be argued that auxin play an important role in the wound healing and vascular regeneration within the graft union zone. It has been previously reported that success in grafting, subsequent growth of scion shoot and development of the successful graft depend on grafting season, method, selection and preparation of scion, rootstock materials and environmental condition such as temperature (Hartmann et al., 1997).

Similarly, it has been reported previously that temperature plays a significant role with respect to vegetative growth in different horticultural plants such as citrus (Chaudhary & Ishfaq, 2004), sweet orange (Salik et al., 2015), pummelo (Paudyal, 1999), acid lime (Adhikari, 2006), watermelon (Colla et al., 2010), mango (Baghel et al., 2002; Hema et al., 2002; Kumar et al., 2000) and walnut (Karadeniz, 2005; Muzaffar & Kumar, 2011).

### CONCLUSIONS

For the conditions encountered in study, it was concluded that in general, side grafting is the most effective method of propagation in the Sargodha-province of Punjab-Pakistan for the evaluated citrus cultivars.

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