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SHORT COMMUNICATION

Grafting Time Affects scion Growth in Sweet Orange under Arid Environment

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ABSTRACT

Budding and grafting of sweet orange (*Citrus sinensis*) is usually performed in the spring or fall seasons. It is timed just before spring to ensure a good bud union or in early autumn season to avoid frost injury of tender shoots in winter season. In this study, grafting of rootstocks of sweet orange was performed during 2006-2008 at the Horticultural Research Sub-Station, Dera Ghazi Khan, Pakistan having arid environmental conditions. Experimental treatments included T1 to T8 (Grafting of rootstocks during 1st week of February, 2nd week of February, 3rd week of February, 4th week of February, 1st week of October, 2nd week of October, 3rd week of October, and 4th week of October, respectively). Parameters including first sprout (days), percent survival of the grafts, length of grafts attained, and number of side branches appeared within first three months of grafting were recorded. The first sprout occurred during 2nd week of February and took only 26 days after grafting. Rootstocks grafted during the 1st week of February had the maximum (89.3%) survival rate that was statistically significant ($P < 0.05$) and more than the number of days for the rest of treatments except T2. The maximum length of graft (i.e., 19.5 cm) was attained within 3 months of grafting, i.e. during second week of February; whereas, statistically different ($P < 0.05$) and the shortest length of graft was 14 cm that occurred during 4th week of October (T8). During 2nd week of February the scions grafting produced the maximum (~2) side branches. In general, this indicates that the grafting during first and second week of February gave better results, followed by those rootstocks which were grafted in second week of October. Therefore, these dates are recommended to schedule the grafting of sweet orange under arid environmental conditions of other parts of Pakistan with soil and environmental conditions resembling to those of Dera Ghazi Khan, Punjab-Pakistan.

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INTRODUCTION

Orange trees are widely grown in tropical, subtropical, semiarid, and arid climates for production of sweet fruit. In Punjab, orange is cultivated on the largest area among the all other fruits and is grown on 183297.5 hectares with a record production of 2097734 tonnes during the year 2012-13 (Anonymous, 2013). Success of vegetatively propagated plants, to a lot extent, depends upon a suitable time, techniques of uniting the cambium tissues of stock and scion (Khan et al., 1992). T-budding is the most common method of citrus asexual propagation and can be performed any time

during spring (February-March) and autumn seasons (August-October) when the bark slips freely and both the stock and scion plants show active growth (Chaudhary, 2000). T-budding of avocado in spring has been reported to produce 96% of bud takes. Chaudhary and Ishfaq (2004) accounted that the effect of temperature on vegetative growth was highly significant. The seedlings of sweet and sour orange make virtually no shoot elongation at a constant temperature of 13 °C. The shoot growth rate reached maximum somewhere between about 25 and 31 °C and then began to decrease again at about 33 °C onwards. However, shoot growth stopped at a constant

temperature of 37°C to 38°C. Elam (1997) concluded that budding and grafting of citrus and avocado were the best as done in the spring or fall when the bark was easily separated from the wood. He suggested that the time to be early enough so that warm weather would help ensure good bud union. In citrus, different aspects *viz* choice of assortment and wood, grafting time, irrigation before grafting, graft height, graft count and management after connecting must be considered. It was suggested that citrus should be grafted and gone on from the last ten days of February to the end of March in spring so long as the scion be kept well or grafting time be lengthened.

Budding and grafting of sweet orange is usually performed in the spring or fall when the bark is easily separated from the stem wood. It should be timed just before spring season so that coming warm weather may help to ensure a good bud union with root stock. Simultaneously, it should not be so late in autumn season to avoid frost burn of the tender shoots of scion (Wajid et al., 2007). Budding is usually done when seedling stems are 1/4 to 3/8 inch in diameter (about the diameter of pencil) budding can be done any time there is suitable stock on which the bark is slipping and when suitable bud wood is available. Usually, the bark slips from April to November, depending on location. The area to be budded should be pruned clean of thorns and twigs. The preferred budding height is 15 cm above the ground level (Williamson and Jackson, 1994.) Literature reports miscellaneous timings of sprouting after budding. Shahid (1996) noted that the initial sprouting in T-budding of citrus took place after 35 days of budding in spring seasons. Intensive literature search did not reveal the best time of grafting in sweet oranges under arid conditions and soil types of southern Punjab – Pakistan. Therefore, the present study was designed to find out the best time of grafting in sweet orange cv. *Succari* under arid environmental conditions of Dera Ghazi Khan, Punjab - Pakistan.

MATERIALS AND METHODS

Study area

Experimental site of this study was Horticultural Research Sub-Station Dera Ghazi Khan which is located in a strip between the river Indus and the Koh-Suleman range of mountains separating it from the Baluchistan Province. The climate of the district is hot in summer and cold in winter. However, the climate is almost uniform throughout the district except hilly-portion which has severe winter and a mild summer seasons. Similarly, except the hilly tracks, the land of the Dera Ghazi Khan Tehsil is plain while the land of Taunsa Tehsil is traversed by 'Rod Kohis' (hill torrents) floods which run from the mountains through the plains. The prevailing wind direction is South to North.

Due to the barren mountains of Koh-Suleman and the sandy soil of the area, windstorms are very common in the summer season. Weather summary of experimental site is given in Table 1.

Experimental treatments

The methods employed for the execution of the research were as follows. Rootstocks of same age and size were selected and grafted with the scions at different eight times including T₁ (Grafting of rootstocks during 1st week of February), T₂ (Grafting of rootstocks during 2nd week of February), T₃ (Grafting of rootstocks during 3rd week of February), T₄ (Grafting of rootstocks during 4th week of February), T₅ (Grafting of rootstocks during 1st week of October), T₆ (Grafting of rootstocks during 2nd week of October), T₇ (Grafting of rootstocks during 3rd week of October) and T₈ (Grafting of rootstocks during 4th week of October). During the grafting, the 240 rootstocks of Jatti Khatti (*Citrus jambhiri* L.) and 240 grafts/scion of sweet orange (*Citrus Sinensis* L.) variety "Succari" were used. Grafting instruments *viz* budding knife, scissors, transparent plastic for wrapping and sun fiber (seba) for tying the scion and stock were used.

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 18 month old stocks seedling at a point having a T-shaped cut at a height 20 cm from the ground level. The graft was tied with sun fiber, polythene sheet wrapped over the graft and both ends were tied with sun fiber covering the scion stock union. The binding material and the top to 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 were kept constant and carried out regularly with all treatments.

The treatments were applied under the Randomized Complete Block Design with three replications. The standard procedure were used for data collection and time taken for first sprout (days), length of graft (cm), percent survival of the graft, number of side branches after 3 months since the treatment application. Two years (2006-2008) data were pooled and statistically analyzed by employing M-Stat C program and the differences among treatment means were compared by using the least significant difference (LSD) test at 5% probability level (Steel et al., 1997)

RESULTS

Climatic conditions

Table 1 presents prevailing climatic conditions of the experimental site during the study period. The Maximum temperature ranged from 15-35°C and

minimum temperature ranged from 5-25°C; the weather was suitable for sweet orange grafting. Humidity ranged between 62 and 86%. The highest rainfall (5.3 mm) was received during second week of February. No rainfall was received during fourth week of February, first week of October and third week of October.

Time taken for first sprout

The results showed that the scions grafted during fourth week of October took significantly ($P<0.05$) the maximum times (41.3 days) for first sprout (Table 2). The data regarding time taken for first sprout indicated that scions grafted during second week of February took minimum time (*i.e.*, 25.7 days) for first sprout; however, it was statistically similar with the scions grafted during first week of February (27.6 days). The scion grafted during third and fourth week of February were statistically similar with those of grafted during the first week of October.

Survival (%) of the grafts

The data recorded on survival percentage of grafts showed that the scion grafted during first week of February had the maximum survival (89.3%) of grafts, which was statistically similar with the scions grafted during second week of February (88.5%). The grafting during second week of October scored third position with 75% survival. However, it was statistically similar to the scions grafted during third, fourth week of February and first week of October (treatments T₃, T₄ and T₅, respectively). The minimum survival of the grafts (43.3%) was observed by the scions grafted during fourth week of October (Table 2).

Length of graft

The results showed that the treatments effects on length of graft was not significant ($P>0.05$) among most of the treatments. However, the maximum and significantly greater ($P<0.05$) length of graft (19.5 cm) was attained within 3 months by the scions grafted during second week of February (T₂) while minimum length of graft (14.0 cm) was in T₈ (Table 2).

Number of side branches

The scions which was grafted during second week of February produced the maximum side branches (1.9) within 3 months (T₂) and it was statistically similar (as depicted by the similar LSD letters in Table 2) by the scions grafted during first week of February (1.7). The treatments T₃, T₄ and T₅ were showed statistically similar effects on number of side branches as depicted by the similar LSD letters in Table 2 for number of side of branches in these treatments. The minimum number of side branches (1.1) within 3 months was recorded by the scions grafted during fourth week of October (Table 2).

DISCUSSION

The current study revealed that the most optimum time of grafting for sweet orange cv. Succari is first and second week of February in spring season or second week of October in autumn under Dera Ghazi Khan's agricultural and arid environmental conditions. At these stages of graft took the minimum time for first sprout, maximum survived, attained the higher length of the

Table 1: Prevailing temperature, relative humidity and rainfall on average basis of experimental site at Dera Ghazi Khan

Week of the month	Mean maximum temperature (°C)	Mean minimum temperature (°C)	Relative humidity range (%)	Mean rainfall (mm)
1 st week of February	15.5	4.7	62-78	2.3
2 nd week of February	18.4	5.5	71-86	5.3
3 rd week of February	23.9	6.3	65-85	2.5
4 th week of February	27.5	7.2	72-82	-
1 st week of October	37.4	24.6	72-79	-
2 nd week of October	35.5	23.4	74-84	2.0
3 rd week of October	34.2	21.6	58-76	-
4 th week of October	33.8	19.7	53-84	1.0

Source of data- Weather register maintained in the office of EDO Agriculture Extension Dera Gahzi Khan

Table 2: Effect of time for sprout on graft survival (%), graft and number of side branches in sweet orange (*Citrus sinensis*) cv. Succari

Treatments	Time taken for 1 st sprout (days)	Survival (%) of the graft	Length of graft (cm)	Number of side branches
T ₁ (Grafting in 1 st week of Feb)	27.6 c	89.3a	17.7a	1.7ab
T ₂ (Grafting in 2 nd week of Feb)	25.7c	88.5a	19.5a	1.9a
T ₃ (Grafting in 3 rd week of Feb)	33.5b	71.7b	18.5a	1.6bc
T ₄ (Grafting in 4 th week of Feb)	32.7b	70.5b	17.7a	1.5bc
T ₅ (Grafting in 1 st week of Oct)	35.0b	72.4b	17.8a	1.5bc
T ₆ (Grafting in 2 nd week of Oct)	28.5c	75.0b	18.6a	1.6bc
T ₇ (Grafting in 3 rd week of Oct)	29.9bc	58.3c	17.0a	1.4a
T ₈ (Grafting in 4 th week of Oct)	41.3a	43.3d	14.0b	1.1d

Means values that share different letters in a column vary significantly at $P\leq 0.05$.

graft and had more number of side branches. High humidity range 62 to 86% favoured the success of grafting compared to the low humidity range during the experimental period. Occurring of comparatively high intensity rainfall (5.5 mm) had positive effect on the success of grafting as it increased the relative humidity in the atmosphere particularly during the second week of February that showed the best results in the reported experiments.

These results support the findings of previous studies which concluded that the temperature plays a significant role with respect to vegetative growth of walnut (Karadeniz, 2005) and citrus (Chaudhary and Ishfaq, 2004). Furthermore, the optimum grafting time is dependent on prevailing weather conditions, variety of the fruit plant, budding, grafting technique and the locality (Gandev, 2007; Elam, 1997; Khan et al., 1992; Anderson et al., 1992).

Conclusion

Based on findings of this study it can be concluded that for first sprout, survival of the grafts, length of grafts and number of side branches within the first three months of grafting can appear if the grafting is performed during first and second week of February, followed by those rootstocks grafted during second week of October. While formulating the best management practices for citrus cultivation, the scientists may consider these dates to schedule the grafting of sweet orange (*Citrus sinensis*) under arid environmental conditions of other parts of Pakistan with soil and environmental conditions resembling to those of Dera Ghazi Khan Punjab, Pakistan.

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