SUST Journal of Agricultural and Veterinary Sciences (SJAVS)
Vol. 17 No.(2)
ISSN: 1858 6775

December 2016

SUST
Journal of Agricultural and Veterinary Sciences
Journal homepage:
http:// journals.sustech.edu

Improving Vegetative Propagation of Mango

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Article History: Received: 09/06/2016
Accepted: 15/10/2016

Abstract

An experiment was conducted during three consecutive years (2010, 2011 and 2012) at the nursery of the Faculty of Agricultural science, University of Dongola, Northern State, Sudan, to study the effects of season of the year, selected pre-graft cultural treatments on scion graft take and subsequent scion shoot growth and development of mango (*Mangifera indica* L.) Three pre-cultural practices were used; namely, defoliation, decapitation and a combination of defoliation and decapitation of the source branches of scion shoots. All scion shoots were collected from a single "Abu Samaka" tree during the winter and summer seasons of each year from defoliated, decapitated, and defoliated and decapitated branches two weeks prior to grafting. Ten-to twelve- months old "Kitchiner" seedlings were used as rootstock. Grafted seedlings were kept under lath house conditions. Scions grafted during winter gave significantly higher percentage of successful graft than their summer grafted ones irrespective of the cultural treatment. Also all cultural treatments gave significantly high scion graft success relative to the control in both seasons with no significant difference between them. However, the highest percent graft success, the greatest number of scion shoots, the longest shoots, and the largest number of leaves were obtained with defoliation compared with the control or the cultural treatments tested. Both season and cultural practices tested had little or no effect on scion number, elongation and leaf number responses.

Keywords: Cleft grafting, mango, propagation, Scion, rootstock

Introduction

Mango (*Mangifera indica* L.) a popular fruit throughout the tropics and subtropics, is one of the more important species in the genus *Mangifera*. Mango a major tropical fruits in international trade and is one of the most cherished fruits, not only in flavour and taste, but also for its nutritional value. It is a good source of vitamin A and C and rich in carbohydrates, potassium, and phosphorus (Nakasone and Paull, 1998). Though fruits are known for their suitability at all stages of fruit development for processing, a greater proportion of the crop is marketed fresh.

Mango cultivation in Sudan is currently receiving more recognition as an important fruit plant at both public and private sectors. It is grown almost in every state in Sudan where suitable soils and sufficient good quality water sustain

optimum growth. The areas under mango increased tremendously during the last years. Mango fruits ranks first in Sudan horticultural exports (AOAD, 2006) and there is high potential of export to Gulf States and European markets. Despites its popularity, only very scanty information on the husbandry of the crop in Sudan is available.

The perennial evergreen mango grows in flushes that are synchronous under Sudan conditions. The main flushes arise in February and September. Although a large number of world known cultivars of mango were introduced from various countries most of mango trees in Sudan were of seedling origin. Various techniques for the propagation of mango exist including rooting of cuttings (Basu *et al*., 1972); layering (Nunez-Elisea *et al*., 1992); budding (Chaudhri, 1985); tissue culture (Shahin *et al*., 2003) and grafting (Nayak and Sen, 2000), however, none is suitable for rapid multiplication of large numbers of mango nursery trees in a short time.

In Sudan, it is standard practice to propagate superior scion cultivars on open pollinated seedlings with approach grafting method (Sidahmed, 1992) but not always with satisfactory results. Routine production of large numbers has not yet been described. The major factors limiting the efficiency and cost-effectiveness of this method for mango propagation has been the few grafts that could be performed per mother tree because of the limited number of shoots available at convenient height and the low percentage of successful graft "take". The time of the year most suitable for grafting, the physiological age of the source of scion and of the rootstock, the length, type and size of scion are governed more by practical experience and tradition rather than by scientific studies. In view of these difficulties it has been suggested by Yousif *et al*., (2005) that it might be possible and desirable to apply other grafting methods for the successful clonal propagation of selected mango cultivars.

A part from brief references (Sidahmed, 1992; Yousif *et al*., 2005) development of techniques for propagation of commercially known mango cultivars are still rare and routine production of large numbers has not yet been described. Uniform and vigorous and normally appearing growth and development of grafted scion shoots in mango propagation is essential for sufficient production of high quality mango nursery trees. Cost of grafted nursery trees of desired mango cultivars is the largest single factor contributing to total production costs of mango.

A continuing challenge for mango growers interested in replanting or in establishing new mango groves has been the inaccessibility of planting material of desired cultivars. There is a need for the rapid build-up of techniques so that grafted nursery trees may be available in sufficient quantities for commercial production. Reliable and rapid scion graft take and scion shoot elongation are desirable for the production of mango nursery trees.

Experience has shown that success of scion shoots graft and subsequent growth can be obtained only during spring (February-March) and often fail to take or are slow to start growth at any other time. This would appear to be a reflection of the natural growth cycle where maximum growth occurs during spring. Physical or chemical Induction of growth of scion shoots before excision and grafting may enhance scion shoot

take and subsequent scion shoot growth and development. The defoliation of scion wood prior to grafting of mango scion shoots is standard practice among mango growers in the Northern State of Sudan to facilitate handling at grafting. Substantial evidence for the beneficial effects of removal of leaves from the scion source prior excision and grafting in mango has been demonstrated (Shrivastava *et al.,* 1989; Yousif *et al.,* (2005).

The objective of this study was to develop a simple, repeatable and cost-effective procedure that would allow the production of nursery mango trees ready for field planting on year-round basis.

Materials and Methods

Experiments were conducted during winter (December-March) and summer (April-July) seasons of the years 2010, 2011 and 2012 using scion shoots obtained from an un-pruned 10-years-old "Abu Samaka" tree growing in the open fields of the Nursery of the Department of Horticulture, Faculty of Agricultural Science, Dongola University, Alseliem (Latitude 16° 20′ N; Longitude 25° 32′ E) Sudan. The tree was selected on the basis of its vigorous growth habit and uniformity of fruiting. Stock seedlings 9-months-old and 60 cm in height germinated in a lath house from open pollinated "Kitchener" cultivar seeds, were used as rootstock. The seedlings were grown in silt soil in 15 cm diameter black plastic bags (one seedling per bag), watered with tap water as required and no fertilizer was applied. The grafting process and incubation of grafted seedlings were carried out under lath house conditions. Grafted seedlings were watered on an alternate day basis, using tap water, and rootstock suckers were removed as soon as they appeared. Shoots that were used as source of scion graft with uniform thickness were selected for experimentation. The treatments consisted of three pre- graft cultural practices; viz, shoots were left intact (control), shoots were defoliated (physical removal of leaves), shoots were decapitated (physical removal of the terminal portion) and shoots were defoliated and decapitated; a total of four treatments. Thirty shoots were used for each treatment, two weeks prior to scion excision and grafting.

Ten-to12-month-old "Kitchener" stock seedlings were selected on the basis of uniformity in size and growth habit grown in a lath house were used as rootstock. The cleft grafting technique was used throughout this study. Scion shoots, 10 to 15 cm long, 10 to 15 mm thick with three axillary buds, were obtained from the appropriate treated shoots on the same day of grafting and kept in wetted newspaper with moist saw dust. The graft was wrapped by a stretchable plastic budding tape; each grafted scion being slanted outward slightly at the top so as to obtain maximum contact of its vascular cambium with that of the rootstock. Each grafted scion was covered by sliding a narrow ice cream plastic bag to maintain high moisture around the graft union, being removed soon after scion take and initiation of leaves.

A completely randomized block design was used with each treatment replicated 3 times in each season, 10 grafts per replication. In each treatment 30 grafts were employed (10 cuttings x three replications). Experiments were terminated after 6 weeks from planting. Parameters measured and recorded were scion-take percentage, number and length of scions and number of leaves per successful graft.

Data were taken at weekly intervals. The mean values were recorded only after the termination of the experiment. All observations were based on 30 scion graft per treatment. The percentages refer to the proportion of the graft that took. Data were recorded at the end of each experiment and were analyzed by analysis of variance procedure on Excel computer programme. Duncan's multiple range test was used to separate treatments means.

Results and Discussion

Scion graft success was the principal morphogenic pattern in this study. All pre-cultural treatments increased scion shoot take. The effects of time of propagation and selected pre-graft cultural practices on success of grafting of mango scions are shown in Table 1.

Table 1: Effects of season, defoliation and topping on scion graft take, scion shoot elongation and number of newly formed scion shoots and leaves of cleft grafted mango scion shoots; six weeks from grafting

Season	Treatment	Graft- take (%)	Shoot no.	Shoot length(cm)	Leaf no.	Treatment means
	Defoliation	90 [a]	2.00 [a]	4.70 [a]	7.80 [a]	26.13 [a]
	Topping	75 [a]	1.50 [a]	4.60 [a]	6.30 [a]	21.90 [a]
Winter	Defoliation +Topping	85 [a]	1.48 [a]	4.58 [a]	6.60 [a]	24.42 [a]
	Control	65 [b]	1.40 [a]	3.30 [a]	5.40 [a]	18.78 [b]
	Mean	78.75	1.60	4.21	6.53	
	Defoliation	75 [a]	1.36 [a]	4.60 [a]	7.60 [a]	22.14 [a]
	Topping	68 [a]	1.33 [a]	3.56 [a]	6.10 [a]	19.75 [a]
Summer	Defoliation + Topping	70 [b]	1.33 [a]	4.20 [a]	6 45 [a]	20.50 [a]
	Control	55 [b]	1.20 [a]	2.60 [a]	5.20 [a]	16.00 [b]
	Mean	67.00	1.30	3.74	6.33	

Means in a column followed by the same letter within each column are not significantly different at P=0.05, according to Duncan Multiple Range Test

Data of the two seasons indicated significant differences between the three cultural practices tested and the control on scion take. Scion graft percentage, number and length of scion shoot and leaf number were substantially affected by the cultural practices tested. The superiority of defoliation compared to the other two cultural practices tested was noted in all parameters measured. The non-treated scion had significantly less percentages of successful graft than treated scions during both seasons. The highest percentage of successful graft during winter was obtained with defoliation (90%) followed by defoliation plus decapitation (85%), decapitation (75%) and non- treated (65%). The data of the summer season followed the same trend where significantly less percentage of successful grafts was obtained with non-treated scions, (55%) relative to treated scions. Not only was percentage scion graft take greatest with winter grafts in comparison with summer graft, but number and length of scion shoots and number of leaves were likewise better and greater. There were no differences among cultural practices tested on season of grafting on shoot number and length or leaf number. All cultural treatments significantly increased scion shoot take over the control, but no significant difference between treatments was perceived. Regardless of

propagation date higher scion graft success, greater number of shoots, longest shoots and larger number of leaves were obtained with defoliation compared with the other treatments tested (Figure 1). The beneficial effects of defoliation were also reflected in the high values obtained in the other growth parameters measured.

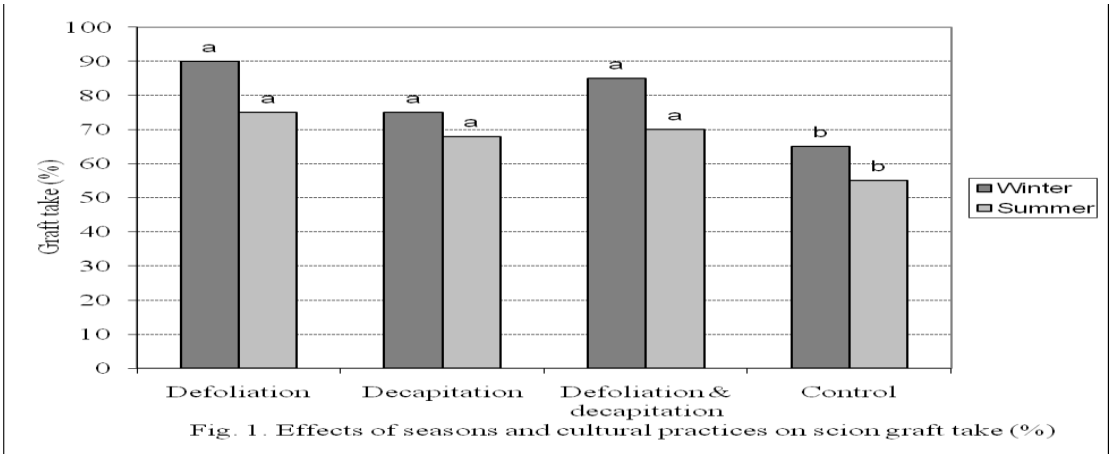

Figure 1: Effects of seasons and cultural practices on scion graft take (%)

The time of the year at which scion shoots were collected from source-plants and grafted onto the rootstock could be the first step in obtaining maximum number of successful graft. With many plant species there is an optimal period of the year for successful vegetative propagation. The influence of time of the year on success of vegetative propagation by budding (Nauer *et al*., 1979), grafting (Nayak and Sen, 2000) and rooting of stem cuttings (Swelih and Said, 2009) has been realized. The current results show that best successful graft percentage of mango scions was obtained during winter. Percent graft success, however, declined during the summer season in general agreement with previous reports on rooting of stem cuttings of kiwifruit (Caldwell *et al*., 1988) and lime (Swelih and Said, 2009) where high rooting percentage was obtained during autumn and winter with a sharp decline during summer. The less graft success percentage recorded in the summer is attributed to the hot dry desiccating winds that predominate at the time of graft performance. The positive scion shoot growth responses during winter are related primarily to the gradual increase in relative humidity and decrease in temperature in winter. As evident from these results and earlier studies (Kulwal and Tayde, 1989; Nayak and Sen, 2000; Yousif *et al*., 2005), both temperature and relative humidity appear to be the most important factors that influence scion-take through their effects on water loss from the scion shoot and/or the planting media. Consistent with these findings were those reported by Upadhyay and Prasad, (1988) who obtained significantly higher graft success during periods of increased atmospheric humidity than the dry months of the year.

It is worth mentioning that mango nurserymen in the Northern State claimed that sliding down a plastic ice cream bag over the graft area increases graft-take, most probably through maintenance of high relative humidity

around the graft union. On the other hand, Rijan and Sinha, (1987), obtained high values of graft success by surrounding the graft area with aluminium foil probably through protection from excessive heat. More or less, similar findings were reported by Salih and Said, (2012) working with grapefruit budding and Swelih and Said, (2009) working with rooting of lime stem cuttings where high values of percent bud take, and rooting percentage, were obtained respectively under greenhouse conditions.

The significantly high value of graft success obtained in winter compared with summer is attributable to the presence of optimal levels of growth promoters in the scion and rootstock tissues. On the other hand the lesser graft success recorded during summer than winter may be attributed to the presence of sub-optimal or supra-optimal levels growth promoters during summer time in accordance with the report of Swelih and Said, (2009) on rooting of stem cuttings of lime. Variation in cambial activity of the scion shoot and the stem of the rootstock could possibly be implicated in scion graft take. Rapid development of the graft union is necessary so that the scion shoot wood may be supplied with water and nutrient from the rootstock by the time scion shoot started to sprout. Conditions during winter may have been favourable for enhancing the rate of active cell division. Actively dividing cambial cells in both rootstock and scion shoot are needed for considerable vascular cambium contact and connection, quick healing and subsequent formation of a strong graft union. Similar results were obtained and similar conclusions were reached by Ahmed, (1964) and Reddy and Melanta, (1988) where significantly higher percentages of successful grafts in spring were recorded than summer attributing that to high cambial activity of the scions and rootstocks in spring.

In response to defoliation and topping treatments tested, growth variables were more vigorous with defoliation than the other two treatments tested and the graft unions of the scion with the rootstock are usually normal indicating good congeniality. Significant differences between treatments and the control on scion shoot take were noted. The beneficial effects of defoliation reported herein corroborate preceding reports on mango scion shoots grafting (Maiti and Biswas, 1980; Nunez-Elisea *et al*., 1996; Shrivastava *et al.*, 1989; Yousif *et al.*, 2005) who obtained maximum number of successful grafts with defoliated scions. Defoliation has been used as a cultural practice to induce bud-break of insufficiently chilled deciduous fruit trees (Walser *et al*., 1981; Erez and Lav, 1985; Edwards, 1987; Diaz *et al*., 1987), to promote rooting of stem cuttings (Eltayeb and Ibrahim, 2003) and to enhance branching in intact plants (Wertheim, 1978; Popenoe and Barritt, 1988; Quellette *et al*., 1996). The results clearly revealed that defoliation resulted in the highest values in all parameters measured. This would appear to be the result of alterations in the levels of endogenous hormones and growth factors to levels that are optimal for bud-break. This contention agrees with the findings of Edwards, (1985) and Jarvis, (1986) that leave removal limits the formation and/or accumulation of bud-break inhibitors.

Topping is a common cultural practice used by nurserymen in subtropical regions for rejuvenation and propagation purposes (Edwards, 1987). In citrus nurseries, forcing of newly budded scion

buds and subsequent shoot elongation is commonly hastened by the physical removal of the terminal portion of the rootstock (Rouse, 1988; Krajewski and Rabe, 1995). The substantial increase in growth responses with scion shoots obtained from decapitated branches would appear to be the result of a loss in apical dominance in agreement with Rubinstein and Nagao's, (1976) contention that apical buds in plants repress growth and development of lateral buds Removal of apical buds result in bud break and growth and development of lateral buds. It is to be noted that all pre-cultural practices tested had little or no effect on scion shoot number, length or number of leaves. This is likely due to competition between these responses and the newly established scion shoot for assimilates (source-sink relationship). Most food reserves and growth substances in the rootstock tissues might have been diverted for scion shoot forcing and take. Initiated scion shoots cannot compete with the newly forced scion shoot and the subsequent scion take.

It could, therefore, be concluded, that successful commercial application of this procedure for "Abu Samaka" mango cultivar clonal propagation rest on the ability to obtain high rates of scion shoot take on a year round basis as well as the need to reproduce the results at will. Application of defoliation of source branches of scion shoots prior to collection and grafting may be a useful method for increasing scion shoot take in the grafting process of mango. The procedure developed shows high potential for use in the production of grafted mango trees and may provide a foundation for development of a general vegetative propagation means for other mango cultivars. It proved to be simple, repeatable, cost-effective, fast and easier to learn and apply and would remove the constraint of seasonality for commercial mango propagation. This work mainly focused on scion graft take. Further experiments will be needed to optimize percent scion shoot take and to evaluate the ability of such grafted materials to survive under field conditions.

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تحسين التكاثر الخضري للمانجو

عبداللطيف الخير عمر[1] و عبدالغفار الحاج سعيد[2] و تاج السر إبراهيم محمد[2]

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المستخلص:

اجريت تجربه لثلاث سنوات متتاليه (2010 و2011 و2012) لدراسة تأثير الموسم و بعض المعاملات الزراعيه المختاره قبل التطعيم على نجاح الطعم و نموه و تكشفه في المانجو(*Mangifera indica* L.) .أستخدمت ثلاث معاملات زراعيه مختاره هي إزالة الاوراق، التطويش، و الجمع بين الاثنين لافرع الشجره المصدر قبل فصل الطعوم. جمعت كل الطعوم من شجرة مانجو "ابو سمكه" واحده اثناء فصلي الشتاء و الصيف لكل سنه من افرع مزالة الاوراق، مطوشه او مزالة الازراق و مطوشه قبل اسبوعين من التطعيم. أستخدمت شتلات صنف "كتشنير" بعمر 10 إلى 12 شهراً كأصل للتطعيم. اعطت الطعوم المطعومه في فصل الشتاء نسباً عاليه نجاح الطعوم مقارنةً بمثيلاتها الصيفيه بصرف النظر عن المعامله الزراعيه، و كذلك اعطت كل المعاملات الزراعيه قيماً عاليه معنوياً لنسبة نجاح الطعوم مقارنةً بمعاملة الشاهد و لم تكن هناك فروق معنويه بينها. و تم الحصول على اعلى نسبة نجاح للطعم، اكبر عدد لسيقانه و اطولها واكثر الاوراق بمعاملة إزالة الاوراق خلال فصلي الشتاء و الصيف مقارنةً بالمعاملات الاخرى المختبره. كان لموسم التطعيم والمعاملات الزراعيه تأثير قليل او لا تأثيرً على عدد وطول السيقان و عدد الاوراق.