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EVALUATION OF PROPAGATION TECHNIQUES OF GUAVA (*Psidium guajava* L.)

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ABSTRACT

Expansion of guava cultivation in Sri Lanka is mainly affected by non-availability of quality planting materials in sufficient quantities. Guava is commonly propagated by patch budding method. This method is not very successful due to certain drawbacks such as long holding periods in nursery, low success rate and slow recovery period after budding. Therefore, alternative propagation techniques were evaluated at the Horticultural Farm, Bandaragama and Fruit Crop Research and Development Centre, Horana during November 2003-May 2005. Results indicated that stool (mound) layering with use of an auxin (3000 ppm 1 Naphthyl acetic acid, Secto) was found to be successful in producing well rooted planting materials within 3-4 weeks with a high success rate of 96%. In contrast to this method air layers took 6-7 weeks with a success rate of 60%. Attempts were also made on chip budding method on young root-stocks of 6-8 and 9-12 months old using deleafed bud chips resulted in success rates of 73% and 56% respectively. Unlike patch budding, this technique can be practised easily as it does not require the peeling ability of budding materials. Patch budding performed on 6-8 months old stock plants required 21 days for the bud recovery with a success rate of 73 %, whereas for much older plants it was 45 days with 76 % success. Similarly, wedge grafting and inarching were also shown to be successful on 9-12 months old root-stocks kept for 21 days with 69 % and 83 % success rates; on 13-15 old stock plants it was 23% and 96% and kept for 45 days after grafting respectively. Top working was successful for guava with 67% bud take and set fruits by 6-8 months after budding. This technique helps replacing of undesirable trees with recommended varieties. Thus, to increase the efficiency of multiplication rate of guava, stooling can be successesfully adopted. Also in bud grafting, deleafed chip and patch methods and for shoot grafting, wedging could be adopted.

KEYWORDS: Chip-bud grafting, Inarh, Stooling, Wedge-shoot grafting.

INTRODUCTION

Guava known as an excellent source of Vitamin C is one of the popular fruit among Sri Lankans. In the past, crop was confined to backyards of almost all homesteads. With the release of four high yielding varieties of high quality in 2001 along with dissemination of technical knowledge, a gradual transformation of its cultivation from home levels to small-scale commercial plantings has taken place. This increased the demand for quality planting material. In addition, the concept of enhancing the productivity of fruit crops in small farms of Sri Lanka was initiated under Small Farm Development Programme by the Ministry of Agriculture. Among several crops assigned under this programme in order to increase planting material production and distribution among farmers, guava is also included.

Guava can be propagated through patch or modified forkert methods of budding, (Gorakh-Singh and Pandey, 1998; Aulakh, 1998), air layering (Bhagat *et al.*, 1999), cleft grafting, stem cuttings (Ramiraz, 1999) and stooling (Pandey, 1996; Saroj and Pathak, 1995). In Sri Lanka guava is generally propagated by patch method of bud grafting, which has certain drawbacks. To root-stocks plants to come into growth dimensions required for grafting, a nursery stage of 12-14 months is usually taken.

Furthermore, the ability to peel off the bark of both stock plant and scion shoot is one of the important prerequisites for bud grafting. Also, budded plants take another 5-6 months period for shoot formation prior to field establishment. In some instances, even though patch bud is taken, a subsequent shoot recovery from bud growth either delays, retards or does not occur. Due to such reasons, success rate of the conventional method of propagation becomes considerably low, about 30-50%. Consequently planting material production reduces drastically. As such, it is important to overcome the existing shortcomings in patch bud grafting, and to develop efficient alternative propagation techniques of bud and shoot grafting and rooting of cuttings.

Thus, with the objective of developing efficient propagation techniques of stooling, wedge grafting inarching and top working a series of experiments was carried out at the Horticultural Farm, Bandaragama and the FCRDC, Horana during 2003-2005 period.

MATERIALS AND METHODS

Experiment I. Propagation of guava through stooling

The experiment consisted of propagation techniques of stooling, along with air layering (marcotting) as the control. It was arranged in a RCBD having 30 plants per treatment using variety Horana Red with 3 replications at the FCRDC, Horana.

For stooling, underneath shoots (45-60 cm in length) of the mother plants were ringed (0.5-1.0 cm in width) and applied with a rooting hormone containing 3000 ppm NAA (Secto). Then shoots were earthed up using a 15-20 x15-20 cm sized layer of wet coir dust placed around the mother plant. A similar set of shoots was stooled without addition of hormone. Shoots were watered when required. For air layering, shoots of 45-60 cm long were ring barked (0.5-1 cm in width). The ringed portion was wrapped tightly with 300 gauge opaque polythene placing wet coir dust with and without adding the rooting hormone used for stooling.

Ten of each stooled and air-layered shoots were detached from mother trees at 3, 6 and 9 weeks after the treatment and the percentage success was recorded. Then those were established in pots containing a mixture of coir dust, top soil, well-rotted cow dung and sand (1:1:1:1) and were kept in a non-mist propagator for 2 weeks and another week for hardening. The percentage survival was also recorded 3 weeks after each establishment.

Experiment II. Effect of deleafing on success of chip and patch bud grafting techniques

The experiment was carried out in a RCBD with 5 replications having 10 uniformly grown seedlings per treatment at the Horticultural Farm, Bandaragama. Two sets of guava seedlings (var. Pubudu) of 6-8 months old (diameter of 0.5-0.7 cm) for chip budding and 9-12 months old (diameter of 0.8-1.0 cm) for patch bud grafting were used as root-stocks, each consisting of 50 plants. Fifteen days prior to bud grafting, scion sticks of mother plants (var. Pubudu) were deleafed leaving ½ of the leaf stalk and 2 apical leaves intact. Seedlings to be used for patch budding were sprayed with 1 % urea solution at 15 days before grafting for easy separation of stem bark away from wood when budding. Two methods of bud grafting, patch and chip were done. For chip budding, greenish brown colour (partially matured) stem chips (2-2.5 cm in length) each having well-grown bud with chip of wood attached and for patch budding, brown colour (well-matured) easily separable bark patches (1cm x 2cm) each with a well-grown bud were used. Number of bud-take was recorded at 2 months after bud grafting.

Experiment III. Effect of age on root-stock on the success of four techniques of propagation

The experiment was carried out in a RCBD with 3 replications at FCRDC, Horana. Guava (var. Pubudu) seedlings of 6-8 months old (stem diameter of 0.6-0.75 cm) and 9-12 months old (stem diameter 0.8-1.8 cm) and 13-15 months old (stem diameter 1.2-1.8 cm) having 20 uniformly grown plants per treatment were used as root-stocks.

When seedlings of each category were suitable for bud and shoot grafting, techniques of chip, patch, wedge and inarch (in-situ grafting) were done. For chip budding, green colour well grown bud with a piece of wood attached was taken. Two weeks before chip and patch bud grafting, scion shoots were deleafed. One percent urea solution was given as a foliar spray for stock plants at 2 weeks prior to patch budding to facilitate peeling off bark from wood. The scion wood used for chip (2-2.5 cm in length), patch (1 cm x 2 cm) budding and shoot (wedge) grafting (15-20 cm in length) was uniform and extracted from well maintained mother plants of variety Pubudu. Before inarching, stock plants were uprooted and repotted in sealed pots using

wet coir dust. These were inarched on to 45-60 cm long shoots of well-maintained 3 mother plants. Wedge-grafted plants covered with 100 gauge transparent sealed polythene bags served as single propagators. Ten each of inarched plants were severed from mother plants at 21 days and 45 days after inarching. Then those were repotted in 25 x 30 cm pots and kept in non-mist propagator for 2 weeks. The percentage success was recorded.

Removal of polythene strip on 10 plants of each chip and bud graft and uncovering of wedge grafts were done at 21 and 45 days after bud/shoot grafting. The success of graft take was observed at 2 months after grafting.

Experiment IV. A study on possibility of top working of guava

Ten years old trees with low yielding, poor quality fruits established in FCRDC, Horana were headed back. Out of 10-15 new shoots formed, leaving 5-7 well-grown uniform shoots the rest were cut off. When they were in 0.8-1.0 cm girth, patch budded using deleafed (2 weeks before patch budding) shoots of variety Pubudu. Thirty days after patch budding, bud union was uncovered and percentage bud success was recorded at 2 months after top working. The number of fruits formed on new shoots was also observed.

All data were analyzed by using the SAS package.

RESULTS AND DISCUSSION

Propagation through stooling

Stooling tested along with air (aerial) layering (as the control) indicated with addition of NAA, a success rate of 96% with numerous well-developed roots at 3 weeks after stooling (Table 1). Whereas, air layers treated with NAA emerged with only 1-2 poorly developed roots by 3 weeks. However, by 6 weeks after treatment air layers also showed 60 % success in rooting. In stooling, an ample space of 15-20 x15-20 cm of moist coir dust was provided on the soil surface to develop the initiated root system without having any constraint. Whereas in air layering, only a restricted amount of rooting medium is supplied for the root growth. Furthermore, roots developed in layers receive penetrated sunlight through polythene wrapper whereas stools are deprived of sunlight. These may be causes for delay in root emergence and subsequent root growth in air-layers, while early root emergence and densely grown root system in stools.

NAA growth hormone treated stools formed roots at 3 weeks after the treatment, while untreated stools initiated only a few roots with low number of rooted stools by 6 weeks. Similarly in air layers also NAA increased rooting ability. Both stools and air layers had a survival rate of 100% at 6 weeks after stooling and 9 weeks after layering respectively (Table 1). Therefore, rooting hormone plays an important role in emergence and development of root system.

Table 1. Effect of application of NAA on % success of rooting of stooled and air layered shoots of guava (mean of 10 shoots).

Technique of propagation	*Time period after propagation (weeks)*					
	% success			% survival		
	3	6	9	6	9	12
Air layering (NAA)	0 [b]	60 [b]	100	-	100	90
Air layering (untreated)	0 [b]	50 [c]	60	-	-	-
Stooling (NAA)	96 [a]	100 [a]	100	100	100	80
Stooling (untreated)	0 [b]	13 [d]	65	-	-	-
CV %	4.93	8.67				

Values followed by the same letter in each column are not significantly different at P=0.05.

Propagation of guava by means of stooling has been investigated with the use of growth regulators such as NAA, IBA and paclobutrazol at various concentrations to improve root formation by several researchers. Chaudharu *et al.* (1994) revealed that application of 4500 ppm IBA + 400 ppm NAA enhanced rooting percentage (100% after 60 days) and survival percentage (80% after 90 days).

In another study on response of IBA and NAA to rooting of pineapple guava (variety Nikitski) rooting and survival were the highest (72% and 76% respectively) with the application of 1000 IBA in stooling (Pandey, 1996).

Using 2500 ppm paclobutrazol in lanolin paste significantly increased rooting, survival percentage number of primary and secondary roots in stools of 2 guava varieties of guava in Rajasthan, India (Singh, 1998). The highest percentage rooting and the best root development were obtained on the stools treated with 4500 ppm IBA and grown in polythene bag containing a medium of soil, sand and cow dung mixture. Roots were visible 45-60 days after stooling (Bhagat *et al.*, 1998; Dod *et al.*, 1998).

Results of the current experiment are consistent with these findings and showed that shoots dipped in NAA produced well-developed root system in relatively a short time period of 21 days after stooling. Stooled plants were ready to field transplant after another 2 weeks in the non-mist

propagator and 1 week left in sun light for hardening. Hundred percent survival rate was shown 6 weeks after stooling (Table 1).

In contrast to stooling, air layers with added rooting hormone (NAA) took 9 weeks to detach from the mother plant with a 100% success rate (Table 1). Layers usually take another 2-2.5 months to recover for field planting (Sharma *et al.*, 1991; Tomar *et al.*, 1999). Considering the time factor in comparison to layering, stooling can easily be adopted to propagate guava to hasten the planting material production. It was reported that stooling was standardized for faster multiplication of guava. It can be successfully practised twice a year, getting 30-40 stools/plant/year. This technique has been popularized as a commercial propagation method in India and replaced tedious methods of inarching and air layering which were popular in the recent past (Anon., 1999).

Deleafing and bud graft success of chip and patch methods

Defoliation of scion shoots (leaving only 2 leaves at the apex with ½ of leaf petiole intact) fifteen days prior to bud grafting indicated a significantly higher bud take of both chip and patch methods than that of undefoliated control (Fig. 1). Remaining portion of petiole abscised making bud to swell, by the time of bud grafting. Such swollen buds form better unions and grow readily after grafting. This consequently enhanced the number of successful bud grafts at 2 months after grafting. Thus, deleafing can be adopted to increase bud success in chip and patch methods. Khattak *et al.* (2002) reported that apex excision of bud stick made better bud sprouting in Pakistan.

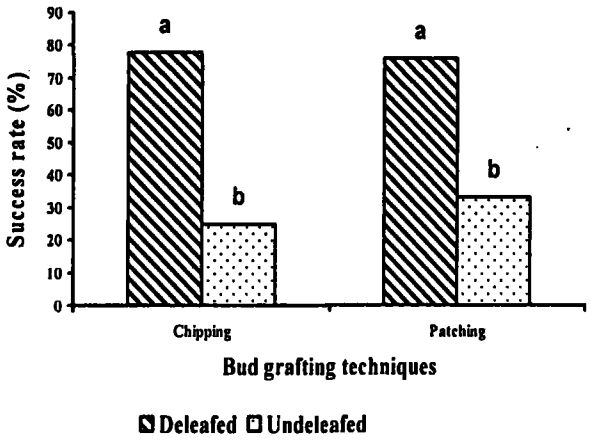


Figure 1. Effect of deleafing on success of chip and patch bud grafting techniques Bars with the same letter are not significantly different at p=0.05.

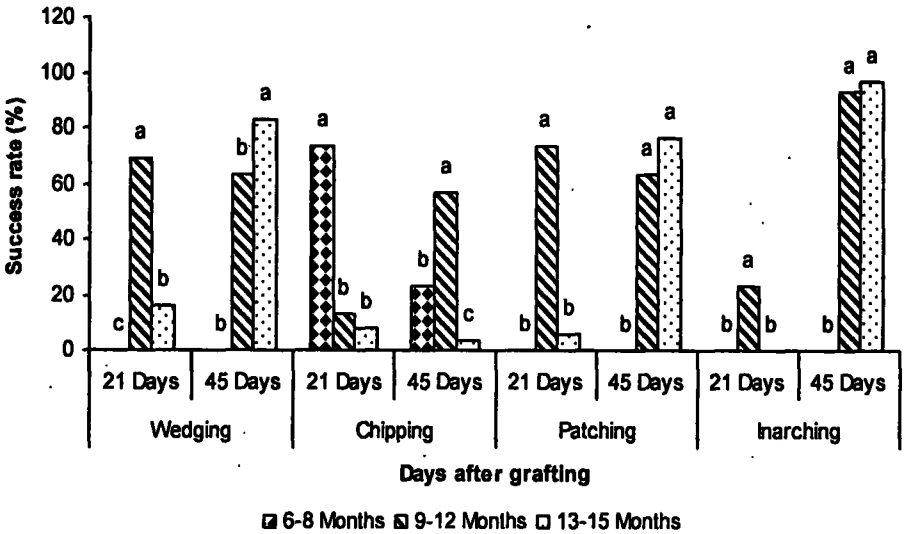
Comparing the conventional patch bud method with the chip method, no significant difference was observed in the bud success when deleafed. Khattak *et al.* (2002) also showed a bud take of 73% in chip method.

Patch budding is best done when the rind of both stock plant and scion shoot including bud is easily separable from the wood, which largely influences the graft success. In addition, good vegetative growth potential as found in well-maintained parent scion materials and young actively growing root-stocks is an important prerequisite for graft success. Apart from agronomic maintenance practices, ability of peeling off of budding materials is also partially dependent on climatic parameters where parent plants are grown. Therefore, patching cannot be performed when it is required. In comparison to patch budding, chip separation of peel from wood is not required in chip budding since a bud containing the chip is taken along with the piece of wood attached. Similarly removal of a chip portion is done on stock plant. Thus, despite the peeling, quality of budding materials for chipping can be maintained easily.

Age of root-stock and percentage success of bud shoot grafting techniques
Chip bud grafting

Chip budding on root-stocks of 3 different age groups indicated that there is a significant difference in bud takes, at 21 and 45 days after grafting (Fig. 2). Out of root-stocks of three ages tested, graft success was found to be the highest (73%) in chip budding of the youngest root -stocks (6-8 months old) and bud union can be uncovered at 21 days after grafting (Fig. 2). Thus, with the maturity of root-stock increased, the number of successful grafts decreased. Jaffe (1970) also reported that green chip budding can be readily accomplished when tissues are tender.

According to Browse (1992), chip bud grafting can be carried out at any time of the year provided that well matured buds are available and as it provides a greater cambial contact between root-stocks and scion than does shield (patch) method.



Bars with same letter are not significantly different at p=0.05.

Figure 2. Effect of age of the root-stock on four techniques on the success of propagation of guava.

Patch bud grafting technique

Performance of patch bud method with the age of root-stocks indicated that, a significant increase in percentage success (73%) was observed on moderately mature root-stocks than those of either tender or well matured, at 21 days after grafting (Fig. 2). The reasons for the lowest success rate recorded on tender root-stocks may possibly be the inadequate maturity of stock and scion portions for patch budding. A higher success rate (76%) was obtained when patch budding was done on aged root-stocks (13-15 months old), kept for 45 days, for bud recovery (Fig. 2). Aulakh (1998) also found a bud success of 95% with the use of 12 months old seedlings. Investigation of relative efficiency of patch and forkert budding indicated that patch was more successful and the best time for budding was months of July and August (Gorakh-Singh and Pandey, 1998).

Wedge-shoot grafting

Shoot grafting using wedge method on 3 age types of root-stocks showed a significant difference in graft take at 21 and 45 days after grafting (Fig. 2). The success rate (69%) of graft was recorded on 9-12 months old, moderately aged stock plants at 21 and 45 days after grafting. Whereas, the lowest rate was given on the youngest (6-8 months old) stocks in both time periods (Fig. 2). This suggests that tender shoots used as scion wood for young stock plants might have been subjected to higher moisture

loss resulting in lower number of successful grafts. Wedging performed on the oldest root stocks (13-15 months old) had a higher graft success (83%) when kept for 45 days, showing mature shoots need much time to form union. Previous findings are in support of observations made in this study that there is a stock-scion interaction with the age of stock. Ramiraz *et al.* (1999) reported that guava can be successfully propagated through cleft and side veneer grafting, which have similarities with wedge grafting technique in the present experiment.

Inarching

Similar nature of graft take was observed in inarching as in the wedge method (Fig. 2). In inarching, a largely grown well-mature twig is grafted, while it is on the parental tree. It generally takes more time period for uniting the inarched union. As such, inarched shoots have shown good success rates (96% and 93%) when inarched onto well-matured (13-15 months old) and moderately aged (9-12 months) stocks at 45 days after inarching. (Fig. 2). However, the minimum success rates were shown on root-stocks on all three ages at 21 days after inarching.

Even though inarching was shown to be a laborious technique, it can be adopted when largely grown plants are required as planting materials. Consequently, it may be possible to obtain early yields on inarched plants.

Top working of guava

Results indicated that top working was successful for guava with 67% bud take. Top worked plants initiated flowers and set fruits (4-10/ plant) by 6-8 months after budding (Table 2). By utilizing the established root structure of the undesirable tree, a new tree can be developed readily and with less effort when compared to replanting a young plant. Findings of Lyannaz (1994) confirmed these results that 95% success rate was achieved on cultivar Beamount and onset of production was earlier than replanting a new plant.

Table 2. Success rate (%) of top working of guava.

Tree No.	*No. of shoots patch budded/tree*	*No. of bud take*	*No. of fruit set / plant*
1	7	5	10
2	8	5	8
3	7	4	7
4	6	5	4
Total	20	19	
% success		67%	

CONCLUSIONS

Among several propagation techniques evaluated for guava, stooling was found to be the most promising. In contrast to bud grafting technique, this approach constitutes a rapid multiplication, which saves a considerable amount of time and maintenance cost.

Guava can also be propagated by deleafed chip bud and wedge grafting on root-stocks of 6-11 and 9-15 months old respectively. Chip budding and wedge grafting can be performed as and when required.

Efficiency of patching can also be improved by deleafing scion shoots. Furthermore, results revealed that bud and shoot grafting done on relatively aged (12-15 months) root stocks needed 45 days for satisfactory graft take.

Also, inarching can be adopted effectively to develop well-grown large sized planting materials. In addition, top working can also be applied in the rehabilitation of unwanted guava trees, which provides a fast way of changing tree canopy with a desired variety without replanting.

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