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Propagation studies in guava

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Abstract
The present investigation was undertaken during 2020-2021 with objectives to standardize suitable method of propagation for rapid multiplication in guava and to study the growth of plants multiplied by different methods of propagation. There were six treatments viz., tongue layering in earthen pot, tongue layering in polybag, air layering, saddle grafting, wedge grafting and modified wedge grafting with four repetitions. The minimum number of days taken for sprouting(11.50 days), maximum graft take percentage (91.25%), maximum sprouting percentage (86.75%), maximum height of layer/graft (49.18 cm) and maximum number of leaves per shoot(9.50)were recorded in tongue layering in polybag. Maximum number of shoots per layer/graft (5.69) was recorded in saddle grafting and maximum number of leaves per layer/graft (46.68) was recorded under tongue layering in polybag. The maximum (3.09 cm) girth of layer/graft was recorded in air layering. The highest success percentage (82.75%) and highest survival percentage (95.40%) were recorded under tongue layering in polybag.

Keywords: guava, tongue layering in earthen pot, tongue layering in polybag, air layering, saddle grafting, wedge grafting, modified wedge grafting

Introduction
Guava (*Psidium guajava* L.) is native of tropical America and belongs to Myrtaceae family (Hayes, 1960) [6]. It was introduced in India in early seventeenth century (Singh, 1969) [18]. It is popularly known as poor man's apple. Guava is tropical fruit crop also cultivated in subtropical climate. Guava fruit is rich in vitamin C (260 mg/100 g fruit), having 9.73% TSS (Phandis, 1970) [15]. Guava is highly demanded fruit for table purpose and processing industries particularly for jam and jelly. Due to high economic returns it is one of the popular fruit crop of Indian farmers. High density plantation and meadow orchard technique of guava cultivation increases the production and productivity of guava in last decade.

In Maharashtra several farmers adopted meadow orchard guava cultivation on a commercial scale. In recent years, guava is getting popularity in the international trade due to its nutritional content and processed products. However, the greatest handicap in guava plantation is shortage of planting material and indiscriminate multiplication of plants from unreliable sources by nursery men. Proper care is not exercised in the selection of scion materials from really outstanding and disease free mother plants. The result is that the large number of low quality guava plants are distributed and planted in the field every year. These trees became a permanent liability to the growers as no amount of fertilization and care can change their genetic qualities. Non-availability of quality planting material and consequent substitution of poor quality seedlings had adversely affected the guava production and productivity. The initial planting material is the basic requirement on which the final crop depends both in quality and quantity.

In guava different grafting techniques were followed for vegetative propagation. Tongue layering, stooling, mound layering, air layering, wedge grafting and saddle grafting methods are generally followed by the nursery owners (Chadha, 2003) [2]. However, the survival percentage in stooling and mound layering is very low hence not recommended for commercial purpose (Majumdar and Mukherjee, 1968) [10]. In air layers success depends upon the time of operation, climatic conditions and chemical treatments (Sharma *et al.*, 1975) [16]. Hence, it is inevitable to standardize suitable method of propagation for rapid multiplication in guava and to study the growth of plant multiplied by different methods of propagation.

Materials and Methods
The experiment was conducted at Horticulture Nursery, Department of Horticulture, Mahatma Phule Krishi Vidyapeeth, Rahuri, Dist. Ahmednagar during the year 2020-2021.

The experiment was laid out in Completely Randomized Design (CRD) with four replications and six treatments. The data were analyzed using Analysis of Variance (ANOVA) given by Fischer (1950) [4]. The results are expressed as mean values and standard deviation (SD) as per method given by Panse and Sukhatme (1985) [14]. The number of plants propagated per treatment per replication were 100.Healthy and vigorous trees of about 10 years old from mother orchard of guava were selected as mother tree for the experiment. Healthy and vigorous seedlings of guava having 8-10 month old with stem of pencil thickness were used for grafting. The scion of pencil thickness (0.5 to 1.0 cm) with three to four healthy buds and 15 cm length were selected for grafting. Selected scions were defoliated on the mother plants, about one week prior to detachment. At the same time apical growing portion of selected shoots were also beheaded, which helped in forcing the dormant buds to swell. This helps for becoming scion ready for grafting.

Tongue layering in earthen pot

Mother trees used for tongue layering were beheaded at ground level. After well sprouting one season old, healthy, pencil size thick shoots were selected for tongue layering. Leaves of the selected shoots were removed retaining some at the top. The shoot was bent down so that some part of it touches the ground. At that portion, 15-30 cm away from the terminal end, sharp slanting inward cut of about four to six centimeter i.e. tongue like incision in inverted fashion was given. The shoot was bent down and covered the cut part with potting mixture filled in earthen pot 'Pela'. Some weight or stone over the buried part was kept to avoid the pulling upward and remains in the same position. Irrigation and weeding was followed regularly. After 75 days of layering the layers were separated from mother plant by giving two cuts just below the operated part at weekly interval and transferred in the greenhouse. Irrigation, weeding and plant protection measures were taken at regular interval.

Tongue layering in polybag

In this method, polybag was used instead of earthen pot. Similar cut was given to the selected shoot as in above method. The shoot was inserted from the base of polybag and removed from the top by making a hole at one side of polybag. Potting mixture was filled in polybag by adjusting the tongue shape cut given to the shoot exactly at the centre. Other practices followed were same as in above method.

Air layering

Healthy and vigorously growing aerial shoots having pencil-size thickness were selected for air layeringon selected mother plants. A ring of bark of about 2.5 cm wide was removed just below the eye buds and 30 cm back from the tip of the shoot with a sharp knife without injuring the underlying wood from each selected shoot. IBA (5000 ppm) was applied through lanolin paste to the wounded portion. Excessive moisture from sphagnum moss was squeezed out before placing it over the cut portion. The ringed part was covered with moist sphagnum moss of good quality and then it was firmly wrapped with polythene film securing the ends tightly with pieces of jute ropes as to make it water proof. The air layers were separated from mother plant when roots were observed through the transparent polyethylene film. The rooted layers were transferred in polybag filled with potting mixture and kept in greenhouse. Irrigation, weeding and plant protection measures were taken at regular interval.

Saddle grafting

Saddle grafting consists of uniting the selected scion shoot of a mother plant with the rootstock. Selection of mother plants and shoots was same as in tongue layering and about 8-10 months old guava seedlings were used for rootstock. The selected shoot was bent down so that some part of it touches the ground and 15-30 cm away from the terminal end, sharp slanting inward cut of about four to six centimeter i.e. tongue like incision in inverted fashion was given. The inverted wedge shape cut was given to the stock equal to the cut of scion shoot and inserted carefully in the opened tongue of scion shoot. Polythene strip of about 2.5 cm in width was tied around the union. Irrigation and weeding was followed regularly. The grafts were separated from mother plants after 75 days by giving two cuts just below the graft joint at weekly interval and transferred in the greenhouse. Irrigation, weeding and plant protection measures were taken at regular interval.

Wedge grafting

The scion of past season growth, having pencil thickness from the healthy mother plants was selected. The selected scions were defoliated one week prior to grafting. After a week i.e., 7 to 8 days scions were separated from the mother plant. The rootstock of 8-10 months old and having pencil thickness were selected for grafting. The rootstock was beheaded with sharp, clean and hygienic knife at 15 cm height from the base. The stem was split vertically in the form of cleft ('V' shape) to a length of 4 to 5 cm downward with a sharp grafting knife. Scion stick at the basal portion was cut from both sides into a tapering wedge shape approximately 4-5 cm long. The tapered end was inserted into the split stem ('V' shaped slit) of the rootstock. The graft joint was wrapped tightly with 2.5 cm wide and 30 cm long polythene strips. Immediately after grafting the scion stick was covered with polythene cap. After sprouting of the scion, polythene cap was gradually removed. The grafted plants were kept in greenhouse, watered daily and due care was taken. Shoots arising from rootstock were removed as and when observed. Irrigation, weeding and plant protection measures were taken at regular interval.

Modified wedge grafting

Selection of scion and rootstock was same as in wedge grafting, whereas modification was done for cut given to both scion and rootstock while grafting. The rootstock was beheaded with sharp, clean and hygienic knife at 15 cm height from the base. The vertical 4-5 cm deep cut was given to the rootstock and stem was split in the form of 'V' shape cleft in order to become one side ¾ and one side ¼ in thickness. One third part of thinner side of V shape cleft was cut with a sharp grafting knife. At the base of selected scion 4-5 cm slanting cut from one side and 2-3 cm slanting cut was given from another side. The scion was inserted in the rootstock in order to join both sides carefully. The graft joint was wrapped tightly with 2.5 cm wide and 30 cm long polythene strips. Other practices followed were same as in above method.

Results and Discussion

Days taken for sprouting

Among the different layering and grafting methods, significantly minimum number of days taken for sprouting (11.50 days) was recorded under treatment T_2 (Tongue layering in polybag) which was at par with (13.00 days)

treatment T_1 (Tongue layering in earthen pot) (Control) followed by (14.63 days) treatment T_4 (Saddle grafting). Whereas, significantly maximum number of days taken for sprouting (24.33 days) was recorded under treatment T_3 (Air layering) followed by (22.53 days) treatment T_6 (Modified wedge grafting). Early sprouting was observed under tongue layering in polybag (T_2) followed by tongue layering in earthen pot (T_1) and saddle grafting (T_4). This might be due to in these treatments layers/grafts were kept up to 75 days on mother plants for rooting and acclimatization. The continuous supply of food material from mother plant helped for better rooting in tongue layering and interlocking of parenchymatous cells of stock and scion, as well as the establishment of intimate contact between the stock and scion's cambium regions in saddle grafting. This promoted better and earlier sprouting after detachment and shifting in greenhouse. These results are in consonance with the earlier findings by Singh *et al*. (2005) [17] and Joshi *et al*. (2016) [7] in guava. The present result is also in accordance with result of Gotur *et al*. (2017) [5] in guava and revealed that polyhouse condition gave better response as compared to open field condition with respect to days taken for sprouting.

Graft take percentage

Significantly maximum graft take percentage (91.25%) was recorded under treatment T_2 (Tongue layering in polybag) which was at par with (90.25%) treatment T_4 (Saddle grafting) followed by (78.75%) treatment T_6(Modified wedge grafting). Whereas, significantly minimum graft take percentage (55.00%) was recorded under treatment T_3 (Air layering) followed by (68.25%) treatment T_5 (Wedge grafting).After grafting and shifting of layers in greenhouse when buds started swelling and get ready for sprouting, immediately graft take percentage was recorded at this stage. Among different methods of propagation, tongue layering in polybag (T_2) showed maximum graft take percentage whereas, minimum was recorded under air layering (T_3). The reason behind this was same as discussed in days taken for sprouting. Present findings are duly supported by Gotur *et al*. (2017) [5] and reported that wedge grafting performed in polyhouse gave maximum graft take percentage as compared to wedge grafting performed in open field conditions. The results are alsoin accordance with the results of Muthaj (2014) [12] who recorded maximum graft take percentage (74.00%) by the grafts prepared during the month of July.

Sprouting percentage

Significantly the maximum sprouting percentage (86.75%) was recorded under treatment T_2 (Tongue layering in polybag) which was at par with (84.75%) treatment T_4 (Saddle grafting) followed by (74.25%) treatment T_6 (Modified wedge grafting). Whereas, significantly minimum sprouting percentage (52.25%) was recorded under treatment T_3 (Air layering) followed by (65.25%) treatment T_5 (Wedge grafting) which was at par with (67.25%) treatment T_1 (Tongue layering in earthen pot) (Control). Out of propagation methods, tongue layering in polybag was found to be better than any other method in respect of sprouting percentage. Significantly maximum sprouting percentage was recorded under treatment T_2 (Tongue layering in polybag),this might be due to continuous supply of food material from mother plant helped for better rooting in tongue layering in polybag. Even though it was same with tongue layering in earthen pot, sprouting percentage recorded was not at par with polybag method. The reason behind this was, in earthen pot method the wounded portion was buried in the upper layer of propagation media while it was at the centre in polybag method. In earthen pot method there was less contact of wounded part with moisture and media as compare to polybag method, hence less rooting and less sprouting percentage. The results were in close conformity to the findings of Gotur *et al*. (2017) [5]. Dixit *et al*. (2018) [3] in guava reported that highest sprouting percentage (64.13%) was recorded in shade condition as compare to open condition.

Height of layer/graft (cm)

The height of layer/graft was recorded significantly maximum (49.18 cm) under treatment T_2 (Tongue layering in polybag) which was at par with (47.55 cm)treatment T_4 (Saddle grafting), (46.40 cm)treatment T_1 (Tongue layering in earthen pot),(43.92 cm) treatment T_6 (Modified wedge grafting) and (42.06 cm) treatment T_5 (Wedge grafting) whereas, minimum height of layer/graft (35.50 cm) was recorded under treatment T_3 (Air layering).Maximum height of layer/graft recorded under tongue layering in polybag might be due to more initial height at the time of detachment from mother plant. The possible reason for this difference also might be due to favourable environmental condition and better production of assimilates for the growth. Similar finding was obtained by Dixit *et al*. (2018) [3] in guava performed wedge grafting and maximum plant height (43.36 cm) was recorded in the month of march under shade condition whereas minimum plant height (39.33 cm) was recorded in the month of July under open condition. The present findings were also in accordance with the findings of Syamal *et al*. (2012) [19] in guava and observed that polyhouse gave better response than open field conditions with respect to height of graft in wedge grafting.

Number of leaves per layer/graft

Maximum number of leaves per layer/graft (46.68) was recorded underthe treatment T_2 (Tongue layering in polybag) which was at par with (42.59) treatment T_1 (Tongue layering in earthen pot) whereas minimum number of leaves per layer/graft (16.30) was recorded under treatment T_5 (Wedge grafting). Number of leaves per layer/graft depends on pre-condition shoots on mother plant, the speed and number of root formation on layer/graft and post separation environment to which the layer/graft is exposed. The above results are similar with Manga *et al*. (2017) [11] who reported the highest number of leaves (22.64) per layer were observed 90 days after separation from the mother plant, when the layers were placed in a shade house for hardening. This finding is in agreement with the result obtained by Sharma *et al*. (1975) [16] and Kakon *et al*. (2005) [8] in air layering of guava.

Success percentage

The highest success percentage (82.75%) was recorded under treatment T_2 (Tongue layering in polybag) which was at par (79.25%) with treatment T_4 (Saddle grafting). Under modified wedge grafting (T_6) the success percentage was 70.75% while it was 61.25% under wedge grafting (T_5) and 61.75% under Tongue layering in earthen pot (T_1), whereas the lowest success percentage (44.25%) was recorded under treatment T_3 (Air layering). The continuous supply of food material from mother plant helped for better rooting in tongue layering and interlocking of parenchymatous cells of stock and scion, as well as the establishment of intimate contact between the stock and scion's cambium regions in saddle grafting. This

promoted better and earlier establishment after detachment and shifting in greenhouse. In wedge grafting (T_5) and modified wedge grafting (T_6) due to more time required for union of cambium layers and uptake of nutrients towards scion, comparatively less success percentage was observed. Similar findings were reported by Padmapriya *et al.* (2020) [13] and reported that wedge grafting performed during the month of Oct-Nov, 2018 resulted the highest graft success rate in guava. The results are further supported by Muthaj (2014) [12] in guava and Adjei *et al*. (2005) [1] in avocado.

Survival percentage

The highest survival percentage (95.40%) was recorded under treatment T_2 (Tongue layering in polybag) which was at par with treatmentsT_6, (Modified wedge grafting), T_5 (Wedge grafting) and T_4 (Saddle grafting), whereas lowest survival percentage (84.62%) was recorded under treatment T_3 (Air layering). Favourable micro-climatic conditions along with congenial environment within the plant tissues, especially the cambium, would have been the probable reason for more survival percentage. Even though sprouting success percentage was more under tongue layering in polybagas compare to wedge grafting methods, the survival percentage of grafting methods was at par with them. This might be due to in layering after separation of layers the transplanting shock reduces the establishment when get independent, while in grafting once get sprouted there will be more survival percentage as compare to layering methods. Similar results were also obtained by Padmapriya *et al.* (2020) [13] and reported that, among the different methods of grafting, wedge grafting performed in the month of June-July, 2019 gave highest graft survival percentage (61.65%) of the grafted plants. This finding is in strong agreement with the result obtained by Gotur *et al*. (2017) [5] and reported that polyhouse condition gave better response as compared to open field condition with respect to survival percentage in wedge grafting of guava.

Table 1: Days taken for sprouting, graft take percentage and sprouting percentage

Treatments	Details	Days taken for sprouting	Graft take (%)	Sprouting (%)
T_1	Tongue layering in earthen pot(control)	13.00	75.25	67.25
T_2	Tongue layering in polybag	11.50	91.25	86.75
T_3	Air layering	24.33	55.00	52.25
T_4	Saddle grafting	14.63	90.25	84.75
T_5	Wedge grafting	21.08	68.25	65.25
T_6	Modified wedge grafting	22.53	78.75	74.25
	S. E. (m) ±	0.80	1.22	1.34
	C. D. at 5%	2.39	3.63	3.97

Table 2: Height of layer/graft, Number of leaves per layer/graft, success percentage and survival percentage

Treatments	Details	Height of layer/graft	Number of leaves per layer/graft	Success (%)	Survival (%)
T_1	Tongue layering in earthen pot (control)	46.40	42.59	61.75	91.79
T_2	Tongue layering in polybag	49.18	46.68	82.75	95.40
T_3	Air layering	35.50	21.28	44.25	84.62
T_4	Saddle grafting	47.55	38.55	79.25	93.56
T_5	Wedge grafting	42.06	16.30	61.25	93.91
T_6	Modified wedge grafting	43.92	16.50	70.75	95.28
	S. E. (m) ±	2.41	1.55	1.25	0.81
	C. D. at 5%	7.17	4.61	3.71	2.41

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