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Standardization of grafting methods under different seasons of grafting in guava (*Psidium gujava* L.)

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Abstract
Experiments were conducted in the College Orchard, TNAU, Coimbatore to standardize suitable grafting method and grafting season in guava for mass multiplication. The research was conducted using three methods of grafting *viz*., approach grafting (G1), wedge grafting (G2) and side grafting (G3) at three different seasons of grafting *viz*., Oct-Nov, 2018 (S1), Feb- March, 2019 (S2) and June- July, 2019 (S3) with three replications. Observations were made on different grafting parameters and on the biochemical aspects of grafting. Among the different methods of grafting, Wedge grafting done in the month of June-July, 2019 gave highest graft survival percentage (61.65) of the grafted plants. Likewise wedge grafting performed during the month of Oct-Nov, 2018 resulted in early bud sprouting, highest graft success percentage and increased number of sprouts.

Keywords: Guava, grafting methods, grafting season, graft success percentage, chlorophyll, phenols

Introduction
Guava (*Psidium guajava* L.) is an important fruit crop of India and is the fifth most important fruit in area and production after banana, mango, papaya and citrus. The family Myrtaceae contains more than 80 genera and 3000 species, distributed in the tropics and subtropics, especially in the America, Asia and Australia. Guava has gained considerable prominence on account of its high nutritive value, availability at moderate prices, pleasant aroma, good flavour, rich vitamin-C, pectin, Ca& P and more remunerative even without much care. Considered as "poor man's apple", the guava truly happens to be the fruit for masses in terms of its continuous availability in the market and easy accessibility to the poors (Jayachandran *et al*., 2005) [3].

In the recent past, management techniques like high density planting and meadow orcharding are gaining popularity among the farmers, which requires huge quantity of planting material. Hence, the demand for quality planting material is increasing tremendously day by day. Non-availability of quality of planting material has adversely affected the guava production and productivity levels.

Although large number of nurseries has been established, there is an acute shortage for quality planting material. The scenario is changing from traditional propagation to scientific production of guava with incorporation of science and technology in nursery management and trade. Guava is propagated both sexually and asexually, majority of nursery man utilize asexual method of propagation for multiplication of economic plants and rootstock. Asexual propagation avoids genetic segregation, maintain fruits quality and have maximum potential for tree improvement in lesser time (Singh *et al*., 2004) [9]. As this crop has gained importance due to its medicinal and nutritive value, the orchardists are demanding vegetatively propagated planting materials in order to optimize production of quality of fruits, early bearing and dwarf tree type with high yield potential. Guava plants propagated through layering techniques are still not viable due to varying rate of success, absence of tap root system, cumbersome process and long duration to achieve successful planting material. In Tamil Nadu, guava is being cultivated in large scale in Ayakudi village of Dindigul district. Recently guava is threatened by root-knot nematode (*Meloidogyne enterolobii*) leading to nearly 60-70% loss of economical yield (Sourabh *et al*., 2016) [11]. Moreover, nematode infestation leads to nematode wilt complex which is much more devastating. Guava propagated by layering has adventitious roots leading to easy susceptibility of the plants by root-knot nematode/wilt infestation. So, rootstock of seedling origin has higher significance because of the strong tap root system that offers resistance to nematode and drought condition. Grafted plants are highly resistant and aids for multiplication of guava plants rapidly throughout the year in varied climatic

conditions. Hence, it is inevitable to standardize the multiplication methods through grafting with high success, which should be cost effective as well. In the light of the foregoing, studies on propagation through grafting in guava (*Psidium guajava*L.) were taken up.

Materials and Methods

Pre-raised guava seedlings of uniform age (8 to 10 months) and size (pencil thickness) were purchased from private nursery and used as rootstock for grafting purpose. The pre-cured scion (Lucknow 49) free from pest and diseases were selected from College Orchard and used for grafting purpose. The scion was prepared by defoliation of past season leaves 7 to 10 days prior to the grafting operation to activate the dormant buds. The scion shoots were collected from mother tree during early morning hours (7 to 9 am) on the day of grafting. Immediately after separation of scion from mother tree, they were wrapped in moist cloth and carried with polythene cover to the site of grafting. The scion sticks were immersed in water for 30min in order to remove the latex which interferes with the graft union.

Methods

The guava plants were subjected different grafting methods under different season of grafting for mass multiplication. The treatment details are given below;

Factor A: Grafting methods

G_1 - Approach grafting
G_2 - Wedge grafting
G_3 - Side grafting

Factor B: Season of grafting

S_1 - Oct- Nov, 2018
S_2 - Feb- March – 2019
S_3 - June-July, 2019
Replication: Three
Design: Factorial Completely Randomized Design (FCRD)

Grafting techniques

Preparation of rootstock and scion

Healthy, disease free, uniform sized and vigorous rootstocks were selected and the aerial portion was decapitated with sharp knife. Care was taken while selecting the scion material to match with the girth of the rootstock.

Approach grafting

The method consists of uniting the selected shoot (scion) of a desired parent tree (mother plant) with the potted seedling (rootstock) by approach grafting. For this purpose, about 8-10 months old guava seedlings purchased from private nursery were used. About one year- old scion tree (var. Lucknow 49) of about 60 cm length and nearly of the same thickness as that of the stock is chosen for grafting. A thin slice of bark and wood, about 5 cm in length, 7.5 mm width and 2 mm deep, is removed by means of a sharp grafting knife from the stem of the stock as well as from the scion branch. The cuts thus made should be absolutely flat, clean, boat shaped, even and smooth. The cut surfaces of both, i.e., stock and scion are made to coincide facing each other so that there remains no hollow space between the two. Polythene /alkathene strips of about 1.5 cm in width are tied around the union and observed for graft success.

Wedge grafting

The rootstocks of 8-10 months old were selected, beheaded and split vertically in the form of cleft to a length of 4 to 5cm downward with a sharp knife. The cleft looked like a fork or letter ‘V’. Scion was prepared by giving a cut in to gently sloping wedge of about 5 cm to the morphological base of the scion, by removing the bark and little wood from opposite side of scion. Care was taken to retain some bark on the remaining two sides of the scion. The wedge shaped scion thus prepared was inserted into ‘V’ shaped slit of the stock.

Side grafting

The softwood stock, slanting cut of 2.5 cm was made at base on angle of 20^o to 25^o with a sharp knife. Similarly, scion was prepared by giving a slating cut of 2.5 cm to match with the rootstock. After insertion of wedge shaped scion into cleft of stock plant, precautions were taken to ensure that the scion and the stock come in close contact with each other. The joint (union) was tied firmly with 1.5 cm wide and 40 cm long stretchable transparent polythene strip of 200 gauge thickness. A little more portion above and below the joint was also wrapped with polythene strips. Then the scion was covered with small polythene sleeves to avoid desiccation of the scion by creating humidity near and above the graft union. In order to achieve maximum graft success the grafted plants were watered daily except those in mist chamber. In nursery, drenching of 0.1% per cent Bordeaux mixture was given at monthly interval to protect from root rot diseases. Prophylactic spray of monocrotophos at the rate 1.5 ml/litre spray was given to control sucking pest and leaf eating caterpillar. Sprouts arising from below the graft union were removed periodically. The polythene strip was removed from the graft joint at 90 days after grafting in order to avoid girdling at the grafting joint.

Results and Discussion

Days taken for bud sprouting

The number of days taken for bud sprouting from grafting was significantly influenced by different grafting methods and different season of grafting and their interaction (Table 1). Among the different grafting methods, less number of days taken for bud sprouting (20.67 days) was noticed in wedge grafting (G_2) followed by approach grafting (G_1) (21.89 days). Grafting done during the month of Oct- Nov, 2018 (S_1) took minimum (20.67 days) for bud sprouting followed by grafting during June-July, 2019 (S_3) (22.44 days) and February- March (S_2) (22.56 days) which were on par with each other. It was perhaps due to the fact that improved interlocking of parenchymatous cells by both stock and scion along with establishment of intimate contact of cambial region of both stock and scion under favourable environmental conditions like relatively higher temperature and relative humidity during the month of Oct- Nov promoted better and early sprouting. These results are in consonance with the earlier findings (Singh and Pandey, 1998) [8] and Joshi *et al*., (2014) [4] in guava. The earlier formation of cambial tissue between stock and scion increased the percentage of graft sprouting and development of new flushes on the sprout (Taiz and Zeiger, 2012) [13]. Further, optimum temperature and water availability increased the rate of photosynthesis leading to the production of more food material that facilitate improved growth and development of graft sprout. This result is in close conformity with the result as obtained (Sivudu *et al*., 2014) [10] in mango and Syamal *et al*. (2013) [12] in Bael.

Table 1: Effect of different grafting methods and season of grafting on days taken for bud sprouting

Method of grafting	Season of Grafting			Mean
	S_1 (Oct- Nov 2018)	S_2 (Feb- March 2019)	S_3 (June-July 2019)	
G_1 - Approach grafting	20.67	22.33	22.67	21.89
G_2 - Wedge grafting	19.00	22.00	21.00	20.67
G_3 - Side grafting	22.33	23.33	23.67	23.11
Mean	20.67	22.56	22.44	
	SEd		CD (0.05%)	
G	1.52		0.29	
S	0.17		0.35	
G x S	0.35		0.70	

Graft success percentage

Significant differences were observed for graft success percentage with regard to method of grafting and season of grafting. The maximum graft success (77.39%) was noted in wedge grafting (G_2) and minimum graft success (61.07%) was noted in side grafting (G_3).Among the different seasons of grafting, maximum graft success (73.75%) was observed in plants grafted during Oct- Nov, 2018 (S_1) and minimum graft success (66.35%) was found during grafting during Feb-March, 2019 (S_2) which was on par with June- July, 2019 (S_3) (Table 2). Interaction between different grafting methods and season of grafting revealed highest graft success (82.65%) in G_2S_1 (Wedge grafting done during Oct-Nov, 2018), whereas, lowest graft success (59.36%) was noted in G_3S_2 (side grafting done during Feb- March, 2019). Relative humidity and temperature plays a significant role for graft success percentage in a particular season. After grafting, stored auxins in scion gets accumulated on graft union due to basipetal movement leading to early cambial tissue development and quick graft healing to make strong and successful graft union. This helps to uptake water and nutrient from soil, synthesis of more amount of photosynthates, increase the transport of water and nutrient leading to faster growth of grafts. Similar finding was reported by Pathak and Saroj (1988) [7], Munthaj (2014) [6] in guava and Adjei *et al*., (2005) [1] in avocado.

Table 2: Effect of different grafting methods and season of grafting on graft success percentage

Method of grafting	Season of Grafting			Mean
	S_1 (Oct- Nov 2018)	S_2 (Feb- March 2019)	S_3 (June-July 2019)	
G_1 - Approach grafting	74.50	68.45	65.50	69.48
G_2 - Wedge grafting	82.65	71.25	78.26	77.39
G_3 - Side grafting	64.10	59.36	59.74	61.07
Mean	73.75	66.35	67.83	
	S Ed		CD (0.05%)	
G	0.33		0.67	
S	0.41		0.82	
G x S	0.81		1.64	

Graft survival percentage

Graft survival percentage revealed significant difference for different grafting methods and season of grafting and their interaction effect (Table 3).The highest (67.84%) graft survival was found in wedge grafting (G_2) followed by approach grafting (G_1) (60.48%). Lowest (50.29%) graft survival was noted in side grafting (G_3). It could be attributed to many factors including maximum degree of wound surface exposed to scion and rootstock in wedge grafting which would have facilitated easy graft union. Wedge grafting usually provides strong unity by tension in the form of wedge, like a lances piercing into the rootstock which helps in high cell activity and better graft union as compared to other grafting methods. Among the different season of grafting, higher (61.65%) graft survival was recorded during June-July, 2019 (S_3), whereas, lowest (56.01%) graft survival was found in plants grafted during Feb- March, 2019 (S_2). The quick and strong union formation, better compatibility of the scion-stock combination, better nutrient uptake and ample growing period under open field conditions during June-July might have positively influenced the successful graft survival percentage. The wedge grafting performed during June- July with favourable micro-climatic conditions along with congineal environment within the plant tissues, especially the cambium, would have been the probale reason for comparatively improved graft survival percentage. These results are in agreement with the findings of Anushma *et al*., (2014) [2] in jamun; Kalabandi *et al*., (2014) [5] in sapota.

Table 3: Effect of different grafting methods and season of grafting on graft survival percentage

Method of grafting	Season of Grafting			Mean
	S_1 (Oct- Nov 2018)	S_2 (Feb- March 2019)	S_3 (June-July 2019)	
G_1 - Approach grafting	62.20	58.60	60.63	60.48
G_2 - Wedge grafting	70.56	60.68	72.28	67.84
G_3 - Side grafting	50.05	48.76	52.05	50.29
Mean	60.94	56.01	61.65	
	S Ed		CD (0.05%)	
G	0.47		0.95	
S	0.58		1.17	
G x S	1.16		2.33	

Number of sprouts

The number of sprouts from grafted plants was significantly influenced by different grafting methods and different seasons of grafting. Observations were made at 30, 60 and 90 days after grafting and the results are depicted in Table 4. Wedge grafted plants exhibited increasing trend in number of sprouts produced in all three stages of observation. The highest number of sprouts (2.39) was recorded in wedge grafting (G_2) followed by approach grafting (G_1) (2.21) at 60th day after grafting. Among the different grafting seasons, highest number of sprouts (2.42) was noted in grafted plants during Oct- Nov,2018 (S_1), whereas, lowest number of sprouts (2.03) was found in plants grafted during Feb- March, 2019 (S_2) at 60 DAG. The greater outbreak during October may be due to affable environment especially relative humidity (76.02%) favouring early bud break. The collection of scion during the period of rain and humid conditions had better bud swell which eventually sprouted on grafting may be attributed for highest sprouts of grafted plants during October compared to February- March. The results are line with the findings of Munthaj (2014) [6] and Sivudu *et al.* (2014) [10] in mango.

On the basis of results obtained from the present investigation, it can be concluded that the best results were obtained in the wedge grafted plants during the months of Oct-Nov resulted in early bud sprouting, highest graft success percentage (72.28) and increased number of sprouts per graft and the highest graft survival percentage (61.65) of the grafted plants was observed by grafting performed during the month of June-July.

Table 4: Effect of different grafting methods and season of grafting on number of sprouts at 30, 60 and 90 days after grafting

Method of grafting (G)	Season of grafting (S)											
	30 Days				60 Days				90 Days			
	S_1 (Oct-Nov 2018)	S_2 (Feb-March 2019)	S_3 (June-July 2019)	Mean	S_1 (Oct-Nov 2018)	S_2 (Feb-March 2019)	S_3 (June-July 2019)	Mean	S_1 (Oct-Nov 2018)	S_2 (Feb-March 2019)	S_3 (June-July 2019)	Mean
G_1 - Approach grafting	1.75	1.62	1.66	1.67	2.42	2.07	2.21	2.23	2.37	1.83	1.84	2.01
G_2 - Wedge grafting	1.84	1.64	1.76	1.75	2.62	2.17	2.38	2.39	2.44	1.97	2.22	2.21
G_3 - Side grafting	1.54	1.38	1.39	1.44	2.23	1.86	1.82	1.97	2.17	1.64	1.63	1.81
Mean	1.71	1.55	1.60		2.42	2.03	2.14		2.33	1.81	1.90	
Source	S.Ed		C.D (0.05%)		S.Ed		C.D (0.05%)		S.Ed		C.D (0.05%)	
T	0.01		0.03		0.02		0.07		0.04		0.08	
C	0.02		0.04		0.04		0.08		0.05		0.10	
T X C	0.04		0.07		0.09		0.17		0.1		0.19	

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