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The standardization of method and time of propagation in guava (*Psidium guajava*)

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ABSTRACT

The present investigation on the standardization of method and time of propagation in guava (*Psidium guajava* L.) was experimented during four different months, viz. June, July, August and September with four different methods, i.e. cuttings, air layering, patch budding and wedge grafting during the year 2012-13. It was observed that among all propagation methods, patch budding performed during 15 to 21 August showed highest per cent success (92.07%) recorded after 90 days of propagation. After 180 days of guava propagation, maximum number of new shoots per plant (8.97), number of leaves/plant (22.39), scion thickness (1.34 cm) were recorded in wedge grafting performed during 15 to 21 September while, air layering during 15 to 21 August took minimum days to sprout (11.75) with maximum increase in plant height (61.89 cm).

Key words: Guava, Patch budding, Propagation, Wedge grafting

Guava (*Psidium guajava* L.) belongs to family Myrtaceae is considered to be one of the exquisite, nutritionally valuable and remunerative crop. Besides its high nutritional value, it bears heavy crop every year and gives good economic returns. This has prompted several farmers to take up guava orcharding on a commercial scale (Singh *et al*. 2007). In recent years, guava is getting popularity in the international trade due to its nutritional value and processed products (Singh 2005). In view of the high return and potential for processing there is tremendous scope for bringing substantial additional area under this crop in India. Guava can be propagated by different techniques, viz. patch budding (Kumar *et al.* 2007), wedge grafting (Gurjar *et al*. 2012), cuttings (Rahman *et al*. 2003) and air layering (Rambai and Reddy 2010). While, choosing a particular technique for propagation of guava, the time and method of operation should be taken into consideration as the success of each method vary from region to region due to variation in agro climatic conditions. Any particular method which may be successful at one place may not prove useful at other. Similarly, a particular method successfully adopted will vary from place to place due to environmental factors such as temperature, relative humidity etc. Therefore, the present study was conducted to standardize the method and time of propagation in guava under sub-tropical conditions.

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MATERIALS AND METHODS

The present experiment was carried out at the experimental farm of Division of Fruit Science, Faculty of Agriculture, SKUAST –J, Udheywalla, Jammu, Jammu and Kashmir state of India during 2012-13 to find out best method and time of propagation in guava. The site of experiment is situated in the sub-tropical zone at latitude of 32.40°N and longitude of 74.54°E. The altitude of the place is 300 meters from mean sea level. Meteorological data during the period of investigation is presented showed that annual precipitation is about 1200 mm. The mean annual maximum and minimum temperature was 29.60°C and 16.70°C, respectively. The winter months experience mild to severe cold and temperature ranges from 6.5°C to 21.7°C. December is the coldest month and minimum temperature goes low as 4.0°C, however, the maximum, minimum temperature and evaporation rate rises from March onwards. Four methods of vegetative propagation namely cuttings, air layering, patch budding and wedge grafting were tried for present study and four months, viz. 15 to 21 of June, July, August, September were selected for propagation. All the propagation methods were performed as described by Shanker (1999).

The biometrical observations were recorded on five randomly selected plants of each replication to assess the vegetative characters, i.e. per cent cutting/layering/bud/graft take success, number of days to sprout, percentage sprouting, plant height, number of new shoots/plant, number of new leaves/plant, stem thickness of cutting/

layered plants (cm), stem thickness of budded/grafted plants, average leaf area and for other observations, i.e. average leaf fresh weight (g), average leaf dry weight (mg) and chlorophyll percentage plants were brought to the laboratory for recording the data.

The data on the per cent cuttings/layers/buds/graft take success and per cent sprouting were recorded after 90 days of planting the cuttings/layering/budding/grafting by taking the ratio multiplied by 100. The data on average leaf area was calculated with the help of non-destructive type of laser leaf area, average fresh weight of leaves was measured from the weighing balance, average dry weight of was measured after drying in oven for 25 min at 73°C from the weighing balance and chlorophyll percentage was calculated after 90 days of propagation. The data regarding the number of days taken to sprouting were calculated by observing the plants on alternate days from the day of planting cuttings/layering/budding/grafting and their mean was used to calculate the days taken for first sprout. Plant height was measured from the ground level to tip of the axis with the help of measuring scale, stem thickness was taken by measuring radial diameter of stem, number of new shoots per plant and new leaves of fully developed plants were recorded at 30, 60, 90, 120, 150 and 180 days after propagating the plants through cuttings/layering/budding/grafting. The experiment was laid out in factorial randomized block design and was replicated thrice. The data were then analyzed as per method suggested by Panse and Sukhtame (2000).

RESULTS AND DISCUSSION

Different time and methods of propagation had significant influence on per cent sprouting in guava. Data presented (Table 1) indicates that among different time and methods of propagation highest (67.74%) per cent success was recorded in patch budding. Per cent success was recorded highest (71.48%) during 15-21 August.

Interaction of time and methods of propagation also had a significant effect on per cent sprouting of guava. After 90 days from propagation, highest per cent success (92.07%) was recorded in patch budding during 15-21 August which was at par with wedge grafting (86.57%) performed during 15th-21st of September. Superiority of patch budding over other methods with respect to per cent success might be due to the larger bark and cambium tissues in patch which come in contact easily between stock and scion after budding operation. Highest success in patch budding is in accordance with the findings of Kumar *et al*. (2007). The findings showing success in wedge grafting are also in agreement with Gurjar *et al.* (2012) where they observed that wedge grafting success ranged from 80-90% when grafting operation was performed during September to March. The minimum or below average percentage of successful bud-take was recorded in the budding performed during 15-21 June, the low bud-take percentage during this period might be due to immature bud wood and low sap flow.

Table 1 Influence of time, method of propagation and their interaction effect on per cent success

Method of propagation	Time of propagation				
	June 15th-21st	July 15th-21st	Aug 15th-21st	Sep 15th-21st	Mean
Cutting	35.81 (34.30)	51.87 (61.80)	54.21 (65.80)	50.31 (59.23)	48.05 (55.28)
Air layering	34.15 (31.69)	49.74 (58.17)	44.42 (49.02)	40.00 (41.34)	42.08 (45.06)
Patch budding	34.35 (31.88)	50.43 (59.17)	73.70 (92.07)	69.37 (87.61)	56.96 (67.74)
Wedge grafting	32.28 (28.74)	49.83 (58.36)	63.03 (79.04)	68.47 (86.57)	53.40 (63.19)
Mean	34.15 (31.65)	50.46 (59.44)	58.84 (71.48)	50.46 (68.69)	

Factors	*SE m (±)*	*CD (P=0.05)*
Method of propagation	0.99	2.87
Time of propagation	0.99	2.87
Method × Time	1.98	5.73

Figures in parenthesis indicate observed values and others are transformed values.

Analysis of the data presented (Table 2) indicated that among different time and methods of propagation, minimum (14.65) taken to sprouting were recorded in air layering. The effect of time of propagation was also significant with respect to taken to sprouting of guava, the minimum days taken to sprout (17.76) was observed during 15-21 August.

Number of days taken to sprouting of guava was also influenced by the interaction of time and methods of propagation in guava where minimum (11.75) number of days to sprout was observed in air layering during 15-21 August.

Plant height was influenced by different time and methods of propagation (Table 3) showed non-significant differences after 30 days of propagation. Among different

Table 2 Influence of time, method of propagation and their interaction effect on number of days taken to sprouting of guava.

Method of propagation	Time of propagation				
	June 15th-21st	July 15th-21st	Aug 15th-21st	Sep 15th-21st	Mean
Cutting	19.74	21.71	16.90	18.70	19.26
Air layering	18.70	15.38	11.75	12.76	14.65
Patch budding	28.00	25.00	23.68	24.35	25.26
Wedge grafting	27.69	23.68	18.72	22.34	23.11
Mean	23.53	21.44	17.76	19.54	

Factors	*SE m (±)*	*CD (P=0.05)*
Method of propagation	0.47	1.37
Time of propagation	0.47	1.37
Method × Time	0.95	2.75

Figures in parenthesis indicate observed values and others are transformed values.

Table 3 Influence of time, method of propagation and their interaction effect on plant height of guava.

Method of propagation	Time of propagation														
	June 15th-21st	July 15th-21st	Aug 15th-21st	Sep 15th-21st	Mean	June 15th-21st	July 15th-21st	Aug 15th-21st	Sep 15th-21st	Mean	June 15th-21st	July 15th-21st	Aug 15th-21st	Sep 15th-21st	Mean
	After 30 days					*After 60 days*					*After 90 days*				
Cutting	14.38	15.67	18.43	17.17	16.88	15.63	17.43	20.33	19.43	18.20	16.50	19.50	23.27	21.43	20.12
Air layering	46.93	44.40	51.23	51.00	48.14	46.47	48.17	53.60	48.53	49.19	47.93	50.67	54.80	50.03	50.86
Patch budding	15.00	15.33	14.47	16.68	15.42	15.53	17.97	20.97	20.97	18.86	17.27	21.10	26.07	24.10	22.13
Wedge grafting	16.34	16.68	18.73	17.69	17.37	16.90	18.86	23.54	23.53	21.02	18.27	23.37	28.33	26.57	24.13
Mean	23.16	23.25	26.25	25.63		23.64	25.60	29.61	28.12		24.99	28.61	33.12	30.61	
Factors	*SEm (±)*		*CD (P=0.05)*			*SEm (±)*		*CD (P=0.05)*			*SE m (±)*		*CD (P=0.05)*		
Method of propagation			NS			0.16		0.48			0.24		0.71		
Time of propagation			NS			0.16		0.48			0.24		0.71		
Method × Time			NS			0.33		0.96			0.50		1.42		
	After 120 days					*After 150 days*					*After 180 days*				
Cutting	18.47	20.40	23.16	21.50	20.88	19.00	21.27	24.08	22.07	21.60	22.37	25.70	28.69	27.39	26.04
Air layering	50.90	52.30	57.83	52.10	53.28	51.90	54.23	60.00	54.97	52.27	52.70	55.10	61.89	58.47	56.79
Patch budding	19.25	21.87	27.40	26.40	23.73	21.32	24.90	31.07	29.87	26.79	23.52	30.86	33.52	30.76	29.66
Wedge grafting	21.71	23.73	28.90	28.90	25.48	23.72	27.27	32.77	29.57	28.33	26.91	30.01	35.40	32.35	31.17
Mean	27.58	29.57	33.63	32.31		28.98	31.92	36.98	34.12		31.40	35.17	39.87	37.24	
Factors	*SEm (±)*		*CD (P=0.05)*			*SEm (±)*		*CD (P=0.05)*			*SE m (±)*		*CD (P=0.05)*		
Method of propagation	0.32		0.93			0.22		0.62			0.34		0.97		
Time of propagation	0.32		0.93			0.22		0.62			0.34		0.97		
Method× Time	0.64		1.86			0.43		1.25			0.67		1.94		

methods of propagation maximum (49.19 cm, 50.86 cm, 53.28 cm, 52.27 cm, 56.79 cm) plant height was recorded in air layering after 60, 90, 120, 150 and 180 days respectively. Among different time of propagation maximum (29.61 cm, 33.12 cm, 33.63 cm, 36.98 cm and 39.87 cm) plant height was recorded at 60, 90, 120, 150 and 180 days respectively during 15th to 21st of August.

It is evident from the data (Table 3) that interaction of time and methods of propagation had non-significant effect with respect to plant height at 30 days of propagation. The maximum plant height after 60, 90, 120, 150 and 180 days of propagation was found maximum (53.60 cm, 54.80 cm, 57.83 cm, 60.00 cm and 61.89 cm respectively) in air layering during 15 to 21 August. Early sprouting and maximum increase in plant height of air layered plants as compared to plants propagated with other methods might be due to the reason that in air layering there is no callus formation and bud union as in wedge grafting and patch budding. These results are in accordance with Rymbai and Reddy (2010) in air layering of guava, where they demonstrated that root characters had progressively improved from 15 June to 15 August, suggesting that the rooting was affected due to environmental conditions, steady increase in relative humidity from June to August with temperature approaching down from high temperature of summer to moderate temperature of rainy and autumn season made the conditions congenial for growth and development of plant in month of August.

Data presented (Table 4) on per cent sprouting was also influenced by different time and methods of propagation, maximum (86.17%) per cent sprouting was recorded in patch budding. The effect of time of propagation was also significant with respect to per cent sprouting, the maximum (86.97%) sprouting was observed during 15-21

Table 4 Influence of time, method of propagation and their interaction effect per cent sprouting of guava

Method of propagation	Time of propagation				
	June 15th-21st	July 15th-21st	Aug 15th-21st	Sep 15th-21st	Mean
Cutting	43.06 (46.68)	45.69 (51.23)	65.25 (82.50)	62.76 (79.08)	54.19 (64.87)
Air layering	41.59 (44.00)	52.41 (62.71)	63.76 (80.00)	55.45 (67.70)	53.28 (63.60)
Patch budding	57.46 (71.11)	64.79 (81.90)	82.02 (98.00)	75.56 (93.68)	69.96 (86.17)
Wedge grafting	57.44 (71.07)	64.52 (81.53)	69.20 (87.37)	73.44 (91.90)	66.15 (82.97)
Mean	49.86 (58.21)	56.85 (69.39)	70.05 (86.97)	66.80 (83.90)	
Factors		*SEm (±)*		*CD (P=0.05)*	
Method of propagation		1.12		3.23	
Time of propagation		1.12		3.23	
Method × Time		2.23		6.45	

Figures in parenthesis indicate observed values and others are transformed values.

August. Interaction effect of time and methods of propagation on percentage sprouting in guava recorded maximum sprouting (98.00%) in patch budding during 15-21 of August which was at par with (93.68%) patch budding during 15-21 September and in wedge grafting (91.90%) during 15-21 September after 90 days of propagation. The results related to maximum sprouting in patch budded plants are in line with the findings of Negi *et al*. (2010) where they reported that patch budding gave the highest mean bud sprouting in anola among other methods of propagation. The possible cause for supremacy of patch budding might be that it is easy to remove the bark in the form of rectangular patch. Kumar *et al*. (2005) also reported that maximum bud sprout in ber (*Zizyphus mauritiana*) was observed during beginning of August and mid-August as compared to the budding done during the month of September and October. Good results of sprouting in wedge grafting are in consonance with that of Visen *et al*. (2010) where they reported that highest sprouting was observed by use of poly cap irrespective of scion cultivars and month of grafting due to creation of high humidity around graft-scions which reduced the desiccation of active tissue of scion bud as compared with open conditions. Seasons of propagation play an important role in per cent sprouting. Maximum sprouting was observed during 15-21 August and during 15-21 September when temperature was 32°C to 33°C and high relative humidity, which might be due to early callus formation and proliferation at bud union. The lower success during June is also due non-availability of healthy bud wood because of fruit available on the trees.

Number of shoots was influenced by different method and time of propagation as presented (Table 5) showed non-significant differences after 30 days of propagation. Among different methods of propagation maximum (3.30, 3.80, 4.50, 5.11 and 7.23) number of shoots was observed at 60, 90, 120, 150 and 180 days respectively in wedge grafting. Among different time of propagation maximum (3.34, 3.88, 4.57, 4.98 and 6.54) number of shoots were observed at 60, 90, 120, 150 and 180 days respectively during 15 to 21 August.

As shown (Table 5) interaction of time and method of propagation had non-significant effect with respect to number of shoots at 30 days of propagation. Data obtained on effect of time and methods of propagation on number of shoots per plant revealed that number of shoots in guava propagated plants at different intervals of time were found maximum (3.69. 4.07, 4.98, 5.08 and 8.97) in wedge grafting during 15 to 21 August at 60, 90, 120, 150 and 180 days respectively.

It was observed that number of leaves was influenced by different method and time of propagation (Table 6) showed non-significant differences after 30 days of propagation. Among different methods of propagation maximum (8.12, 13.88, 15.89, 17.51 and 19.63) number of leaves was recorded in wedge grafting at 60, 90, 120, 150 and 180 days respectively. Among different time of propagation maximum (9.04, 13.65, 16.02, 17.45 and 19.55) number of leaves was recorded during 15 to 21 August at 60, 90, 120, 150 and 180 days respectively.

Non-significant effect was observed for the interaction of time and method of propagation with respect to number of leaves per plant at 30 days of propagation as presented (Table 6). Number of leaves were found maximum (9.19, 15.00, 18.67, 19.44 and 22.39) in wedge grafting during 15 to 21 August at 60, 90, 120, 150 and 180 days respectively. The maximum number of shoots and leaves in wedge grafting might be due to presence of 3-4 buds on scionwood used for wedge grafting instead of single bud on patch used for patch budding. Visen *et al*. (2010) and Singh *et al*. (2011) also reported that number of bud sticks on scion stick 3-4 buds was all direction ideal for wedge grafting. Findings showing maximum number of shoots and leaves during 15-21 August are in line with the results of Gurjar and Singh (2012) in anola, where they observed that during rainy season well matured rootstock favoured with high atmospheric humidity along with fairly high temperature, is found congenial for rapid callus production that ensures formation of an early and strong union between stock and scion.

Perusal of data related to influence of time and method of propagation on stem thickness is shown (Table 7) showed non-significant differences after 30 days of propagation. Among different methods of propagation maximum (1.09 cm, 1.14 cm, 1.19 cm, 1.25 cm and 1.30 cm) thickness was recorded in wedge grafting after 60, 90, 120, 150 and 180 days respectively. Among different time of propagation maximum (1.09 cm, 1.13 cm, 1.19 cm, 1.25 cm and 1.30 cm) stem thickness was recorded during 15 to 21 August at 60, 90, 120, 150 and 180 days respectively. Interaction of time and method of propagation had non-

Table 5 Influence of time, method of propagation and their interaction effect on number of shoots per plant of guava

Method of propagation	Time of propagation														
	June 15th-21st	July 15th-21st	Aug 15th-21st	Sep 15th-21st	Mean	June 15th-21st	July 15th-21st	Aug 15th-21st	Sep 15th-21st	Mean	June 15th-21st	July 15th-21st	Aug 15th-21st	Sep 15th-21st	Mean
	After 30 days					*After 60 days*					*After 90 days*				
Cutting	1.01	1.48	1.81	1.25	1.39	1.98	1.97	3.04	2.01	2.25	2.95	3.82	3.97	3.89	3.66
Air layering	1.70	2.01	1.77	2.08	1.88	2.00	2.03	3.06	2.38	2.37	2.92	3.38	3.47	3.38	3.28
Patch budding	1.80	1.10	1.33	1.03	1.07	2.38	3.37	3.56	3.45	3.19	2.98	3.86	4.05	3.96	3.71
Wedge grafting	1.18	1.03	1.50	1.80	1.38	2.44	3.49	3.69	3.57	3.30	3.17	3.98	4.07	3.98	3.80
Mean	1.17	1.40	1.60	1.53		2.20	2.71	3.34	2.85		3.00	3.71	3.88	3.80	
Factors	*SEm (±)*	*CD (P=0.05)*				*SEm (±)*	*CD (P=0.05)*				*SE m (±)*	*CD (P=0.05)*			
Method of propagation		NS				0.08		0.22			0.01		0.01		
Time of propagation		NS				0.08		0.22			0.01		0.01		
Method × Time		NS				0.15		0.44			0.01		0.03		
	After 120 days					*After 150 days*					*After 180 days*				
Cutting	3.18	4.02	4.17	4.07	3.86	3.99	4.81	4.88	4.70	4.59	4.37	5.19	5.36	5.28	5.05
Air layering	3.16	3.97	4.10	4.05	3.82	3.78	4.75	4.88	4.82	4.56	4.27	5.10	4.94	5.21	4.88
Patch budding	3.28	4.76	4.97	4.87	4.47	5.39	4.93	5.07	5.00	5.10	6.28	6.71	6.88	6.76	6.66
Wedge grafting	3.38	4.78	4.98	4.88	4.50	5.40	4.94	5.08	5.01	5.11	6.30	6.81	8.97	6.85	7.23
Mean	3.25	4.38	4.57	4.47		4.64	4.86	4.98	4.88		5.30	5.95	6.54	6.02	
Factors	*SEm (±)*	*CD (P=0.05)*				*SEm (±)*	*CD (P=0.05)*				*SE m (±)*	*CD (P=0.05)*			
Method of propagation	0.01		0.01			0.04		0.11			0.04		0.12		
Time of propagation	0.01		0.01			0.04		0.11			0.04		0.12		
Method × Time	0.01		0.03			0.07		0.21			0.08		0.24		

Table 6 Influence of time, method of propagation and their interaction effect on number of leaves per plant of guava

Method of propagation	Time of propagation														
	June 15th-21st	July 15th-21st	Aug 15th-21st	Sep 15th-21st	Mean	June 15th-21st	July 15th-21st	Aug 15th-21st	Sep 15th-21st	Mean	June 15th-21st	July 15th-21st	Aug 15th-21st	Sep 15th-21st	Mean
	After 30 days					*After 60 days*					*After 90 days*				
Cutting	1.24	2.32	3.56	2.47	2.40	6.33	7.94	9.01	8.11	7.85	10.22	11.25	12.10	12.87	11.61
Air layering	1.83	3.27	3.33	4.33	3.19	6.42	7.92	8.88	8.52	7.93	10.13	11.80	11.95	11.87	11.44
Patch budding	1.83	1.90	1.81	1.26	1.70	6.52	8.06	9.09	8.19	7.96	11.39	12.48	14.12	13.56	13.11
Wedge grafting	1.53	2.15	2.73	2.55	2.24	6.62	8.27	9.19	8.41	8.12	12.22	13.68	15.00	14.11	13.88

table contd.

Table 6 (*Concluded*)

Mean	1.61	2.41	2.86	2.65		6.47	8.06	9.04	8.31		10.99	12.30	13.65	13.10	
Factors	*SEm (±)*		*CD (P=0.05)*			*SEm (±)*		*CD (P=0.05)*			*SE m (±)*		*CD (P=0.05)*		
Method of propagation			NS			0.03		0.09			0.01		0.03		
Time of propagation			NS			0.03		0.09			0.01		0.03		
Method × Time			NS			0.06		0.18			0.02		0.07		
			After 120 days					*After 150 days*					*After 180 days*		
Cutting	11.55	11.97	15.17	12.98	12.92	13.67	15.33	18.78	16.33	16.03	16.97	16.49	19.49	16.63	16.89
Air layering	10.30	11.50	12.77	12.90	11.87	11.22	12.11	16.12	13.11	13.14	14.78	15.09	16.58	16.53	15.74
Patch budding	13.22	14.67	17.62	15.62	15.28	14.67	15.22	15.44	16.22	15.39	16.10	19.11	19.77	18.75	18.43
Wedge grafting	13.87	15.02	18.67	16.02	15.89	15.92	18.11	19.44	16.56	17.51	17.93	19.03	22.39	19.17	19.63
Mean	11.99	12.93	16.02	14.07		13.87	15.19	17.45	15.55		15.94	17.44	19.55	17.77	
Factors	*SEm (±)*		*CD (P=0.05)*			*SEm (±)*		*CD (P=0.05)*			*SE m (±)*		*CD (P=0.05)*		
Method of propagation	0.04		0.13			0.15		0.43			1.00		0.34		
Time of propagation	0.04		0.13			0.15		0.43			1.00		0.34		
Method × Time	0.09		0.26			0.29		0.85			1.99		0.69		

Table 7 Influence of time, method of propagation and their interaction effect on stem thickness of guava

Method of propagation	Time of propagation														
	June 15th-21st	July 15th-21st	Aug 15th-21st	Sep 15th-21st	Mean	June 15th-21st	July 15th-21st	Aug 15th-21st	Sep 15th-21st	Mean	June 15th-21st	July 15th-21st	Aug 15th-21st	Sep 15th-21st	Mean
			After 30 days					*After 60 days*					*After 90 days*		
Cutting	0.79	0.88	1.07	1.02	0.94	0.85	1.06	1.08	1.07	1.01	0.97	1.10	1.11	1.09	1.07
Air layering	0.77	0.87	0.93	0.88	0.87	0.79	0.89	1.00	0.96	0.91	0.86	1.00	1.07	1.06	1.00
Patch budding	0.66	0.65	0.79	0.68	0.70	0.88	1.09	1.14	1.12	1.05	0.99	1.11	1.17	1.14	1.10
Wedge grafting	0.76	0.80	0.91	0.82	0.82	0.90	1.13	1.16	1.15	1.09	1.02	1.18	1.19	1.16	1.14
Mean	0.75	0.80	0.93	0.85		0.85	1.05	1.09	1.08		0.96	1.10	1.13	1.11	
Factors	*SEm (±)*		*CD (P=0.05)*			*SEm (±)*		*CD (P=0.05)*			*SE m (±)*		*CD (P=0.05)*		
Method of propagation			NS			0.01		0.02			0.01		0.01		
Time of propagation			NS			0.01		0.02			0.01		0.01		
Method × Time			NS			0.01		0.05			0.01		0.03		
			After 120 days					*After 150 days*					*After 180 days*		
Cutting	1.07	1.14	1.18	1.16	1.14	1.14	1.18	1.23	1.21	1.19	1.21	1.25	1.29	1.27	1.25

table contd.

Table 7 (*Concluded*)

Air layering	1.05	1.05	1.14	1.09	1.08	1.10	1.15	1.21	1.19	1.16	1.13	1.21	1.25	1.23	1.20
Patch budding	1.09	1.15	1.21	1.20	1.16	1.16	1.18	1.26	1.25	1.21	1.21	1.29	1.33	1.31	1.28
Wedge grafting	1.11	1.18	1.24	1.22	1.19	1.17	1.25	1.31	1.28	1.25	1.23	1.30	1.34	1.32	1.30
Mean	1.08	1.13	1.19	1.17		1.14	1.19	1.25	1.23		1.20	1.26	1.30	1.28	
Factors	*SEm (±)*	*CD (P=0.05)*				*SEm (±)*	*CD (P=0.05)*				*SE m (±)*	*CD (P=0.05)*			
Method of propagation	0.01	0.02				0.01	0.01				0.01	0.01			
Time of propagation	0.01	0.02				0.01	0.01				0.01	0.01			
Method × Time	0.01	0.05				0.01	0.02				0.01	0.02			

significant effect with respect to stem thickness at 30 days of propagation (Table 7). At 60, 90, 120, 150 and 180 days stem thickness was observed maximum (1.16 cm, 1.19 cm, 1.24 cm, 1.31 cm and 1.43 cm respectively) in wedge grafting during 15 to 21 August. These results regarding maximum stem thickness in wedge grafted plants are in agreement with the findings of Somkuwar *et al*. (2009) where they reported that wedge grafting during 15 August in grape cv. Tas-A-Ganesh as scion resulted in thickest shoot.

As shown (Table 8 and 9) it was observed that average leaf area, leaf fresh weight, leaf dry weight and chlorophyll percentage were influenced by different method and time of propagation. After 90 days of propagation maximum (15.47 cm^2) leaf area was recorded in patch budding while, maximum leaf fresh weight (0.30 g) and leaf dry weight (23.85 mg) were recorded in wedge grafting, and chlorophyll per cent (0.15%) was recorded maximum in wedge grafting which was at par with chlorophyll per cent (0.15%) in patch budding. Among different time of propagation maximum leaf area (18.20 cm^2), leaf fresh weight (0.32 g), leaf dry weight (24.02 mg) and chlorophyll percentage (0.17%) was recorded during 15th to 21st of August. Significant effect

Table 8 Influence of time, method of propagation and their interaction effect on average leaf area, leaf fresh weight, leaf dry weight of guava

Method of propagation	Time of propagation														
	Average leaf area					Leaf fresh weight					Leaf dry weight				
	June 15th-21st	July 15th-21st	Aug 15th-21st	Sep 15th-21st	Mean	June 15th-21st	July 15th-21st	Aug 15th-21st	Sep 15th-21st	Mean	June 15th-21st	July 15th-21st	Aug 15th-21st	Sep 15th-21st	Mean
	After 90 days					*After 90 days*					*After 90 days*				
Cutting	11.68	15.28	18.17	16.27	15.35	0.22	0.23	0.32	0.26	0.26	16.65	20.00	23.63	21.66	20.50
Air layering	11.18	15.42	18.18	16.58	15.34	0.20	0.21	0.30	0.26	0.24	16.00	17.17	22.32	19.90	18.85
Patch budding	11.42	15.41	18.18	16.88	15.47	0.28	0.26	0.32	0.30	0.29	19.90	21.27	24.10	23.13	22.10
Wedge grafting	11.28	15.42	18.28	16.48	15.37	0.29	0.27	0.34	0.31	0.30	21.12	23.23	25.96	25.07	23.85
Mean	11.39	15.38	18.20	16.48		0.24	0.24	0.32	0.28		18.42	20.42	24.02	22.44	
Factors	*SEm (±)*	*CD (P=0.05)*				*SEm (±)*	*CD (P=0.05)*				*SE m (±)*	*CD (P=0.05)*			
Method of propagation		0.01		0.01			0.01		0.01			0.12		0.35	
Time of propagation		0.01		0.01			0.01		0.01			0.12		0.35	
Method × Time		0.01		0.01			0.01		0.01			0.24		0.69	

Table 9 Influence of time, method of propagation and their interaction effect on chlorophyll percentage of guava

Method of propagation	Time of propagation				
	June 15th-21st	July 15th-21st	Aug 15th-21st	Sep 15th-21st	Mean
Cutting	1.67 (0.11)	1.99 (0.14)	2.28 (0.17)	2.16 (0.15)	2.02 (0.14)
Air layering	1.65 (0.10)	1.94 (0.13)	2.23 (0.16)	2.11 (0.14)	1.98 (0.13)
Patch budding	2.03 (0.15)	1.94 (0.15)	2.28 (0.17)	2.21 (0.16)	2.12 (0.15)
Wedge grafting	2.12 (0.14)	1.91 (0.15)	2.46 (0.19)	2.14 (0.15)	2.16 (0.15)
Mean	1.87 (0.12)	1.94 (0.13)	2.31 (0.17)	2.16 (0.15)	
Factors		*SEm (±)*		*CD (P=0.05)*	
Method of propagation		0.01		0.01	
Time of propagation		0.01		0.01	
Method × Time		0.01		0.02	

Figures in parenthesis indicate observed values and others are transformed values.

was recorded for the interaction of time and method of propagation on average leaf area, leaf fresh weight and leaf dry weight as shown (Table 8 and 9). Response of wedge grafting after 90 days was also found to be best in terms of average leaf area (18.28 cm^2), leaf fresh weight (0.34 g) and leaf dry weight (25.96 gm). Data related to chlorophyll percentage was also found maximum (0.17%) in wedge grafted plants. Good results obtained in case of wedge grafting are in conformation with findings of Bao *et al*. (2012) where they reported that chlorophyll content directly affected the survival rate of propagated plants. Singh *et al*. (2007) also reported that wedge grafting performed during August and September gave good success as compared to wedge grafting performed during June and July. Saroj *et al*. (2000), Tewari and Bajpai (2002) has also confirmed the same findings in aonla and reported that highest success of graft is possible in August (85%).

Based on the experimental results obtained, it may be concluded that patch budding performed during 15 to 21 August was found to be the best method for guava propagation. Due to lack of standard propagation technique farmers generally prefer to raise guava plants through seeds which does not give true to type planting material and they do not get good remuneration from their produce. Hence the standardization of patch budding method of propagation will facilitate the large scale multiplication of genuine planting material by farmers, which will increase productivity. Increase in yield and quality will help the farmers to fetch good price in market thus raising their socio-economic condition.

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