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Growth and Development of Wilt Resistant Grafts as Influenced by Variety, Methods of Grafting and Scion Type in Guava (*Psidium guajava* L.)

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Abstract:
To overcome wilting problem in guava by producing wilt resistant plants through grafting procedure using Polypiara seedlings as resistant rootstocks, an experiment was conducted at the Germplasm Centre, Fruit Tree Improvement Project (FTIP), Department of Horticulture, Bangladesh Agricultural University, Mymensingh. The experiment consisted of three varieties (Kazipiara, Swarupkathi and L49), three grafting methods (Cleft, Veneer and Contact) and two types of scion (Hardwood and Softwood).Variety influenced the sprouting and growth of the scion in very few cases but in most cases the effect was insignificant. But the grafting methods and scion type influenced significantly the sprouting and growth of the scion independently and sometimes combindly. Early bud sprouting was noticed in Kazipiara and also in Veneer methods of grafting and Hardwood scion. The highest scion height increase and leaf number were observed in grafting done through Contact method. Hardwood scion contributed better scion growth than Softwood scion.

Keywords:
Grafting Methods, Growth and Development of Grafts, Guava Variety, Hardwood Scion, Softwood Scion, Polypiara, Sprouting, Wilt Resistant Rootstock

1. Introduction

Guava (*Psidium guajava* L.) has attained a respectable place and popularity amongst the dietary list of common people in Bangladesh owing to its availability for a longer period during the year and also for its good taste, nourishing value and comparatively low price than other fruits. It is a very rich source of vitamin C (260 mg/100g of edible fruit) and also pectin which has industrial use for jelly preparation as mentioned in [2]. In Bangladesh a good number of varieties namely Kazipiara, Swarupkathi, Mukundapuri, Syedi, Allahabad etc. are cultivated successfully, among which Kazipiara alone contributes the lion share of total guava production. In guava cultivation, wilting is a serious problem and more or less all the guava varieties suffer

from the disease causing great problem to guava cultivation [16]. Among the guava varieties, Kazipiara has got very much susceptibility to wilting disease for which there is no effective control measure. Only the inherent potentiality of selected cultivars to resistance against wilting disease can help to overcome the problem to some extent especially, grafting with red varieties could reduce the incidence to some extent [3]. This can be ensured through the production of grafted plants using the resistant cultivars as rootstocks as discussed in [17]. Grafting with red varieties could also help getting wilt resistant guava plants [3].

Polypiara, a red variety of guava, now growing successfully in various parts of the country, is known as wilt resistant. So, vegetative propagation of guava by grafting, using Polypiara as rootstock could help in getting wilt resistant plants, but to develop a rapid and efficient method of grafting is a pre requisite for it [18]. Success in grafting and subsequent growth and development of successful grafts are dependent on a number of factors including variety, methods of grafting, scion and rootstock material and environmental conditions as discussed in [4, 5, 6, 8, 9, 13, 14, 15, 20 and 21] where most of the works done on mango grafting. Regarding grafting in guava as influenced by different factors, scientific findings are very limited. Therefore, the present investigation was undertaken with a view to finding out the best method of grafting and best scion material for getting quality guava grafts by ensuring earliest sprouting and good growth using Polypiara as rootstock to fight against wilting problem.

2. Materials and Methods

The experiment was conducted at the Germplasm Centre, Department of Horticulture (DH), Bangladesh Agricultural University (BAU), Mymensingh. Three varieties of guava viz. Kazipiara, Swarupkathi and L49, three methods of grafting namely Cleft, Veneer and Contact and two types of scion material eg. Hardwood and Softwood were applied in the present study.

2.1. Design and Layout of the Experiment

The experiment was carried out to find out an effective method of vegetative propagation of guava through grafting procedure using Polypiara rootstock as influenced by variety, methods and scion type. The three factorial experiments were laid out in Randomized Complete Block Design (RCBD) with three replications. The experiment was consisted of different levels of each factor.

Treatments

Factor A: Variety-3	Factor B: Methods of grafting-3	Factor C: Scion Type-2
i) Kazipiara (V_1) ii) Swarupkathi (V_2) iii) L49 (V_3)	iii) Cleft method (G_1) iv) Veneer Method (G_2) iii) Contact method (G_3)	i) Hardwood scion (H) ii) Softwood scion (S)

2.2. Rootstock Collection and Their Establishment

The healthy disease free Polypiara seedlings of one year age with good growing condition were used as wilt resistant rootstock. The rootstocks were planted earlier to grafting time. A total no. of 300 seedlings of disease free, healthy with good growth in poly bags were collected and brought to the experimental site. The seedlings were then kept for some days under shady place and were transferred to the experimental

plot. Proper care and management of the seedlings were taken to maintain their good health.

2.3. Collection and Preparation of Scions

Scions of appropriate conditions according to the need of the experiment were collected from the selected scion mother plants. Well developed, cylindrical, matured disease free and straight shoots of actively growing condition were selected as scions of Hardwood type and was marked as 'H' and terminal healthy greenish twigs having actively growing shoot buds were selected as Softwood type scions and was marked as 'S.' Scions measuring 12-15 cm in length and having nearly the same thickness as stock plants were detached from the mother plant with the help of a sharp secateurs on the day for using in the Cleft and Veneer grafting. All the leaf blades of scion shoots were trimmed off leaving their petioles intact with dormant bud. Then they were immediately transferred to polybags to minimize desiccation.

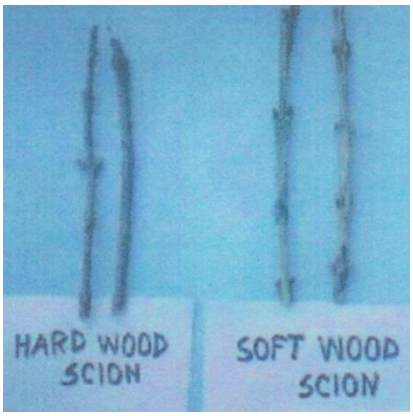

Figure 1. *Photograph showing two types of scion collected for grafting operation.*

2.4. Procedures of grafting

2.4.1. Cleft Grafting

The basal end of the scion was cut on both the sides opposite to each other into a gentle slope wedge of about 5 cm long. The stock plant was cut off 10-12 cm above the ground level and a vertical split or cleft was made by a sharp budding knife in the center of the stock having a depth of approximately 5 cm. The prepared scion was inserted in to the cleft by opening the split slightly. Then the both were brought into close contact and secured firmly with polythene stripe and was covered with a polythene bag.

2.4.2. Veneer Grafting

In the method of veneer grafting the stock was prepared with a slanting shallow downward and inward cut of about 4-5 cm in length from 9-12 cm above the ground level in one side of a smooth area of the rootstock. At the base of this cut, a second short inward and downward oblique cut intersecting the first cut was done so as to remove a piece of wood and bark and making a notch at the base. At the proximal end a similar slanting cut on one side of the scion in position so that the vascular cambium layers could be matched as closely as possible. The cut portion of the scion was inserted under the opened bark of the stock so that the cut surface attached just below the bark of the stock. The scion and the stock were then wrapped together with a polythene sheet starting from bottom to the upward direction and fastened securely at

the upper part beyond the junction. The grafted part was then tide with ropes on the top and bottom ends of the joints.

2.4.3. Contact Grafting

The rootstock with polybag was lifted and taken nearer to the previously selected scion wood of the permanent scion wood mother plant. The rootstock was then tide with the adjacent branch in such a way that the rootstock seedling and scion laid side by side in a parallel way. The seedlings were placed in such a way that the polybag was in vertical position or in the upward position to facilitate watering. At the point where the union was to occur, a slice of bark and wood of 5-6 cm length was made on both the stock and scion. The two cut surfaces were then brought together for close contact between the vascular cambium layers. The stock and scion were tide firmly and was wrapped by polythene stripes in such a way that no water could enter the grafting part as well as no moisture could go outside due to exposure in the sunlight.

For the above operations different tools and other accessories were used e.g. grafting knife, secateurs, nylon strip, polythene paper, bamboo and different shading materials. The Randomized Complete Block Design with three replication consisted 270 grafts as a combination of 3 (No. of varieties) x 3 (No. of methods) x 2 (No. of scion type) x 3 (Replication) x 5 (for each replication) = 270.

2.5. After Care

The grafts were maintained in good condition by watering, shading, removal of off-shoots, removal of the polybags & sheets etc. as and when necessary. Proper shades were provided with the help of bamboo chatai (mat) until the grafts were in good growing condition. Sometimes the shades were removed for the exposure of the grafts to the sunlight. In case of Contact grafting, care was taken so that the rootstocks were not suffered from water stress and that is why watering was done twice daily.

Polythene bags were opened after every two days to remove the accumulated moisture inside them in case of Cleft grafts. While in the Veneer grafts the polythene wrappers were united to release the accumulated water inside it and then tide again. When the graft were found to produce new flashes or begins sprouting at the terminal end, the polybage and polythene wrappers were removed from the grafts. On the other hand, the above operations were not practiced in case of Contact grafting.

In Veneer grafting top one third of each rootstock plant was cut back after one and half months from the time of operations and two weeks later another one third portion of rootstock plant were cut off and finally after one week the remainder of the rootstock plant was removed by a slanting cut close to the sprout to avoid a shock for the rootstock due to sudden removal of the top. In contact grafting, about two and half months after grafting operation the top portion of the rootstock above the union and the scion below the union were cut in two installments at an interval of one week to avoid shock. Then the leaves of the grafts were clipped off into half to reduce transpiration loss that might cause sudden death of the grafts [11, 12]. In all cases, the off shoots were removed from time to time because it affects the graft union as well as growth of the grafts. The treated grafts were also kept under shade for some days. Then the grafts were transferred to the bed providing conditions better for growth and development.

Data on days requiring for sprouting and growth parameters as indicated by the increment of scion height and leaf number were recorded at 15 days interval after scions started sprouting.

3. Results and Discussion

Data on different parameters were analyzed statistically and the results have been presented in different figures and tables. The results of each parameter have been adequately discussed and possible interpretations wherever necessary have been elaborated as below:

3.1. Bud Breaking or Sprouting of the Grafts

Bud sprouting was started after getting successful union of the scion shoot with the rootstocks. The number of days for initiation of buds in the grafts as influenced by variety, methods of grafting and scion type is presented in Table 1. Varieties showed significant effect ($p>0.05$) on the bud breaking in guava grafts (Table 1 and Table 4). Minimum time (23.90 days) for bud breaking was required in Kazipiara while in Swarupkathi maximum time (26.12 days) was required to bud sprouting, which was statistically similar to that (25.67 days) of L49. The less time requirement to bud break in guava grafts of Kazipiara was due to the inherent potentiality of the plants of the variety of Kazipiara having faster and vigorous growth.

Table 1. *Main effects of variety, methods of grafting and scion type on the days to bud breaking in guava grafts.*

Treatment	Variety			Methods of grafting		Scion type	
	V_1	V_2	V_3	G_1	G_2	H	S
Days to bud break	23.90	26.12	25.67	26.84	23.61	23.34	27.12
LSD (0.05)	1.541			1.258		1.258	
LSD (0.01)	NS			1.689		1.689	

V_1: Kazipiara, V_2: Swarupkathi, V_3: L49, G_1: Cleft method, G_2: Veneer method, H: Hardwood scion, S: Softwood scion

The methods of grafting also influenced the bud sprouting significantly (Table 4). Veneer method ensured earlier bud break (23.61 days) over cleft method (26.84 days) whereas, it was not detectable in contact method before severing from the mother plant (reason for absent G_3 under methods of grafting in Table 1). This results tally with the findings of Dhar [4], who observed earliest bud sprouting in side grafting followed by Veneer and Splice method, while Cleft method took the maximum time for bud sprouting in jackfruit. The earlier bud break as well as the graft union in veneer method due to keeping the rootstock as a functional plant (it is cut off after having successful grafts union) helped in auxin synthesis and translocation to the union portion that helped formation of the cambium and vascular bundle as observed by Hartman et al. [5].

The influence of scion type on bud sprouting showed conspicuous variation and the faster bud break was observed in Hardwood scion (23.34 days) while, Softwood scion took longer time (27.12 days) for bud sprouting (Table 1 and Table 4). Physiologically mature Hardwood scion having more reserved food materials than Softwood scion attributed to faster callus formation and union of the scion leading to earlier bud break as supported by Hartman et al. [5], Kulwal and Tayde [10] and Patil et. al. [19]. It should be mentioned here that, in case of contact grafting, the scion

shoots are not separated before the completion of graft union. So, it is not possible to find out whether the grafts unite successfully or not before the separation of the scion shoots from the mother plant. For that reason, the parameter bud break was observed and analysed only in the grafts done through veneer and cleft grafting methods.

The interaction of variety and methods of grafting, variety and scion type, methods of grafting and scion as well as all the three factors did not show significant variation in the time requirement for bud sprouting (Table 2, Table 3 & Table 4). However, combindly Kazipiara ensured faster bud break (20.34 days) when hardwood scion was grafted following veneer method and Swarupkathi required the longest time (31.96 days) in case of softwood scion when done through cleft method. It was also found that the time requirement for sprouting was not uniform throughout the experiment.

Table 2. *Interaction effect of methods of grafting and scion type on the bud breaking in guava grafts.*

Methods of grafting	Scion type	
	H	S
G_1	24.78	28.91
G_2	21.90	25.33
LSD (0.05)	NS	
LSD (0.01)	--	

G_1: Cleft method, G_2: Veneer method, H: Hardwood scion, S: Softwood scion

Table 3. *Combined effect of variety, methods of grafting and scion type on bud sprouting in guava grafts.*

Treatment	Days to bud breaking			
	G_1		G_2	
	H	S	H	S
V_1	22.47	27.22	20.34	25.58
V_2	24.97	31.96	22.49	25.02
V_3	26.89	27.54	22.85	25.40
LSD (0.05)	3.081			
LSD (0.01)	4.137			

V_1: Kazipiara, V_2: Swarupkathi, V_3: L49, G_1: Cleft method, G_2: Veneer method, H: Hardwood scion, S: Softwood scion

Table 4. *Analysis of variance of the data of bud break as influenced by variety, methods of grafting and scion type in guava.*

Sources of variance (sv)	**Degree of freedom (df)**	**Mean sum of squire**
Replication	2	2.104^{NS}
Treatment	11	18.045**
Variety (A)	2	16.355*
Methods of grafting (B)	1	93.864**
Interaction (AxB)	2	6.021^{NS}
Scion type (C)	1	128.785**
Interaction (AxC)	2	10.779^{NS}
Interaction (BxC)	1	1.078^{NS}
Interaction (AxBxC)	2	8.365^{NS}
Error	22	3.448^{NS}

NS= Not significant
**= Significant at 5% level*
***= Significant at 1% level*

3.2. Scion Height and Leaf Number

Increase in scion height and leaf number is the indication of successful graft and its subsequent growth and development. The scion height and leaf number measured at 15 days interval showed significant variation due to the effects of variable factors employed in the experiment at different dates after grafting (DAG) operation. Variety showed significant variation in respect of scion height and leaf number (Fig. 2 & Fig.3) and Kazipiara appeared to be the best for these two attributes of plant growth. After 150 DAG the scion reached to the height of 33.03 cm producing 32.48 nos. of leaves followed by L49 (32.20 cm and 31.28 nos.) whereas, Swarupkathi gave the lowest scion height and leaf numbers (31.70 cm and 31.35 nos., respectively).

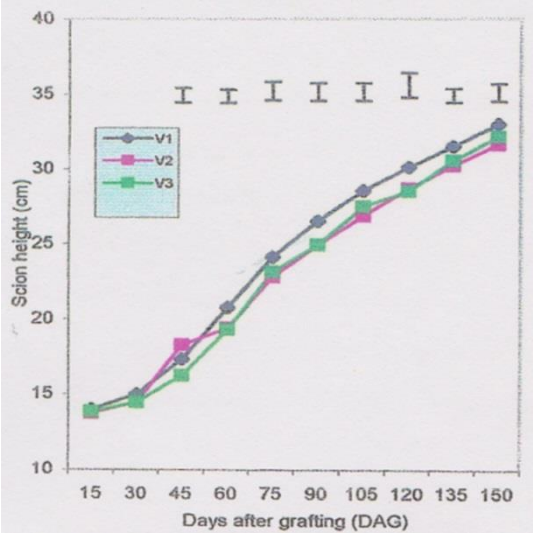

***Figure 2**. Graph showing effect of variety on the scion height of guava grafts (vertical bars represent LSD at 0.05 level of significance.*

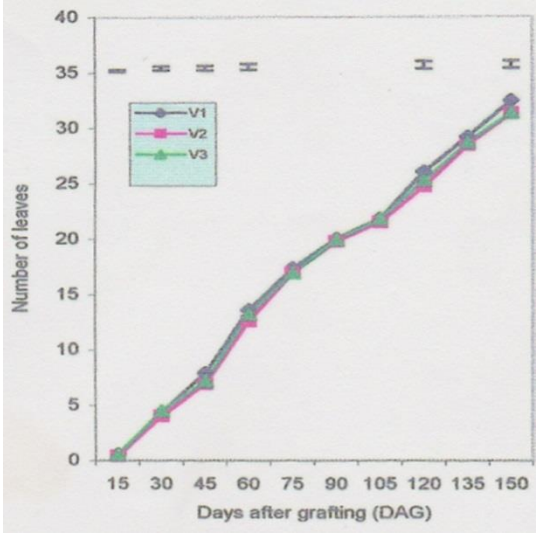

***Figure 3**. Graph showing effect of variety on the number of leaves of guava grafts (vertical bars represent LSD at 0.05 level of significance).*

The effect of grafting method was very prominent regarding scion height and leaf number (Fig.4, Fig.5 & Fig.6). A linear trend of increase in scion height and leaf number was observed in the grafts done through Contact method but in case of Veneer and Cleft grafts there was no increase in scion height and leaf number. Contact grafting contributed to the highest scion height (36.70 cm) and leaf number (35.93) after 150 days of grafting followed by Veneer and Cleft methods of grafting. A long time attachment with the mother plant ensured the continuous growth of the scion in Contact grafting to increase more in height and leaf number than Veneer and Cleft grafts. The superiority of veneer grafts over cleft grafts was due to the better graft union and early bud break leading to proper nutrient supply to the growing shoot which is also supported by the findings of Dhar [4] in Jackfruit and Bhandary and Mukhargy [1] in guava. They obtained higher plant growth of Veneer grafts than that of Cleft grafts.

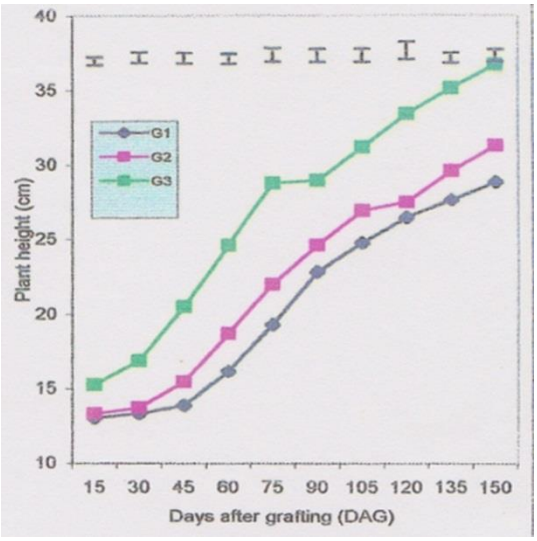

***Figure 4**. Graph showing effect of methods of grafting on the scion/plant height of guava grafts (vertical bars represent LSD at 0.05 level of significance.*

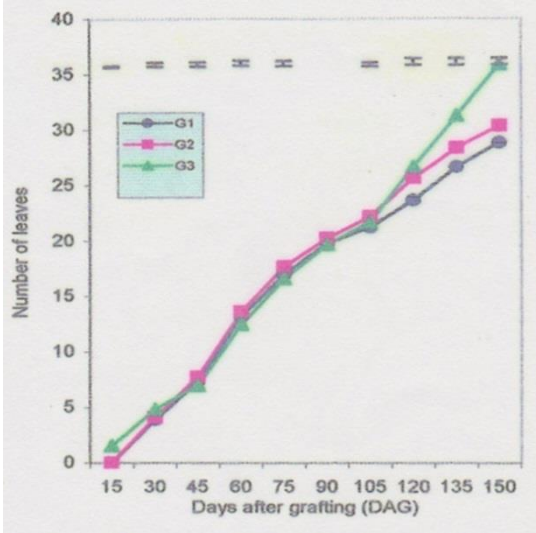

***Figure 5**. Graph showing effect of method of grafting on the number of leaves of guava grafts (vertical bars represent LSD at 0.05 level of significance).*

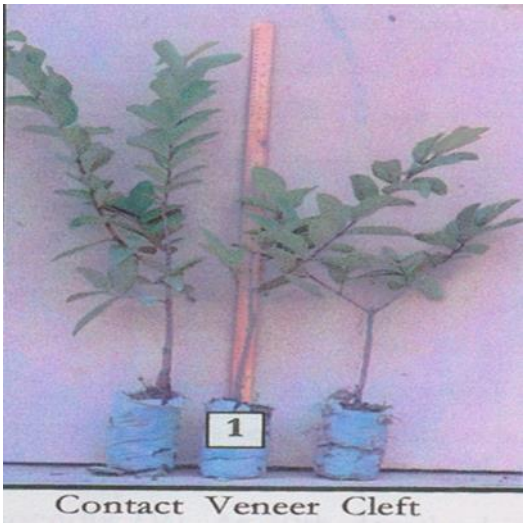

***Figure 5**. Photograph showing the effects of methods of grafting on the growth and development of guava grafts.*

Scion type greatly influenced the increase in scion height and leaf numbers (Fig.7, Fig.8 & Fig.9). Initially the increase in scion height and leaf numbers of Softwood scion were very slow but after getting recovery with the advancement of time the increments noticed rapidly. The mean scion height and leaf number after 150 DAG were 34.02 cm & 33.83 nos. and 30.59 cm & 29.61 nos. for Hardwood scion and Softwood scion, respectively. The inherent potentiality of physiologically matured best scion material of the Hardwood scion gave earlier bud break and faster growth of grafts over the Softwood scion leading to incremental scion height and leaf numbers. The same explanation had been given in HRDP [7].

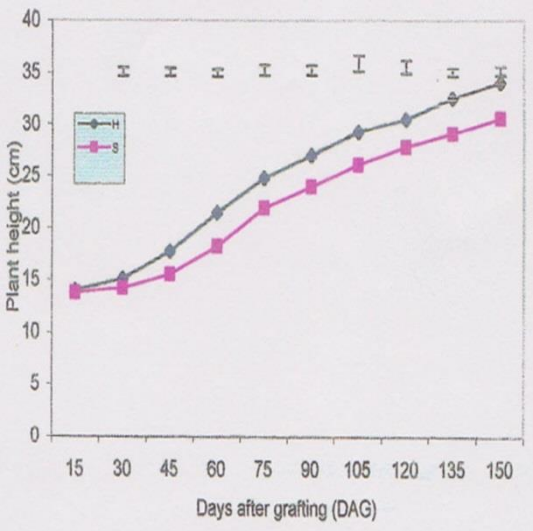

Figure 7. *Graph showing effect of scion type on the scion height of guava grafts (vertical bars represent LSD at 0.05 level of significance).*

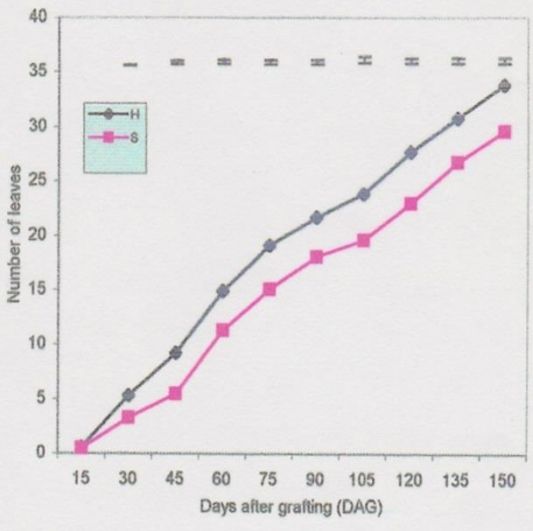

Figure 8. *Graph showing effect of scion type on the number of leaves of guava grafts (vertical bars represent LSD at 0.05 level of significance).*

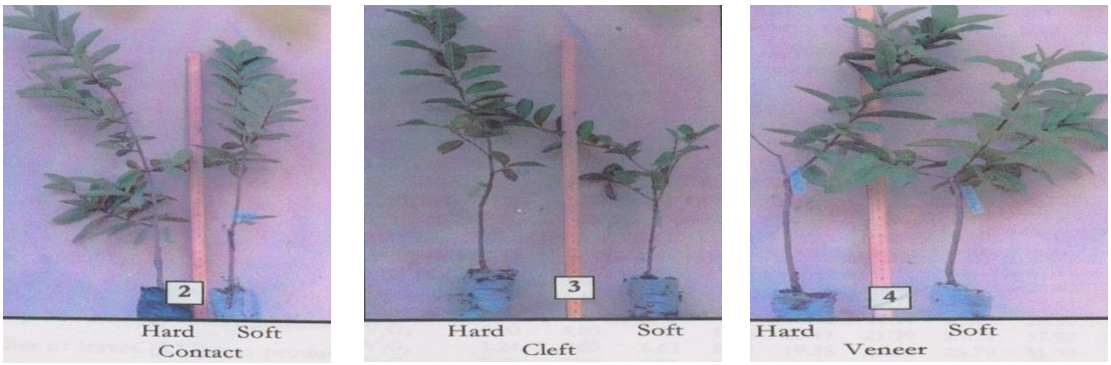

Figure 9. *Photograph showing the effects of methods of grafting and scion type on the growth and development guava grafts.*

Scion height and leaf number did not show significant variation due to the interaction effect of variety, methods of grafting and scion type (Table 9 & Table 10) indicating that in most cases the variation of these two attributes of graft growth was found to be different either by variety, or by method or by scion type. But grafting method and scion type sometimes interacted significantly in this regards (Table 5, Table 6, Table 7, Table 8, Table 9 & Table 10). Combindly, the highest scion height (38.30 cm) and leaf number (39.02 nos.) were found in grafts of Kazipiara when Hardwood scion was grafted following Contact method after 150 DAG whereas, the lowest scion height (25.21 cm) and leaf number (26.09 nos.) were obtained in Swarupkathi when Softwood scions were grafted through Cleft method.

Table 5. *Combined effect of Variety and methods of grafting on the number of leaves developed in guava grafts.*

Treatment combinations	Number of leaves developed per graft at									
	15 DAG	30 DAG	45 DAG	60 DAG	75 DAG	90 DAG	105 DAG	120 DAG	135 DAG	150 DAG
V_1G_1	0.00	4.15	7.92	13.77	17.25	19.95	21.17	24.23	27.18	29.48
V_1G_2	0.00	3.91	8.31	13.99	18.13	20.32	22.55	26.35	28.83	31.17
V_1G_3	1.75	5.12	7.23	13.06	16.73	19.81	21.78	27.61	31.61	36.78
V_2G_1	0.00	3.90	6.72	12.53	16.73	19.71	21.11	23.15	26.39	28.71
V_2G_2	0.00	4.00	7.43	13.00	17.58	20.11	21.79	25.21	37.92	29.73
V_2G_3	1.24	3.60	6.62	12.20	16.57	19.55	21.63	25.79	31.08	35.52
V_3G_1	0.00	3.87	7.31	13.35	16.94	19.71	21.41	23.54	26.43	28.39
V_3G_2	0.00	4.25	7.58	13.93	17.39	20.33	22.30	25.45	28.41	30.26
V_3G_3	1.68	2.85	6.67	12.24	16.58	19.72	21.71	26.74	31.22	35.48
LSD (0.05)	NS	0.6512	NS	NS	NS	NS	NS	NS	NS	NS
LSD (0.01)	--	0.8742	--	--	--	--	--	--	--	--

V_1: Kazipiara, V_2: Swarupkathi, V_3: L49, G_1: Cleft method, G_2 : Veneer method, G_3: Contact method, H: Hardwood scion, S: Softwood scion

Table 6. *Combined effects of methods of grafting and scion type on the scion height in guava grafts.*

Treatment combinations	Scion height at									
	15 DAG	30 DAG	45 DAG	60 DAG	75 DAG	90 DAG	105 DAG	120 DAG	135 DAG	150 DAG
G_1H	13.17	13.70	14.70	18.34	21.66	25.30	27.19	28.71	30.44	31.53
G_1S	12.93	12.95	13.11	14.06	16.99	20.38	22.43	24.27	24.92	26.25
G_2H	13.37	14.11	16.90	20.52	23.20	25.70	27.90	28.11	30.61	32.72
G_2S	13.26	13.35	14.05	16.91	20.86	23.59	26.02	26.94	28.63	29.95
G_3H	15.50	17.50	21.65	25.50	29.60	30.04	32.64	34.71	36.56	37.81
G_3S	15.03	16.30	19.43	23.74	27.99	27.92	29.79	32.19	33.70	35.58
LSD (0.05)	NS	NS	NS	NS	1.433	1.376	1.382	NS	NS	1.324
LSD (0.01)	--	--	--	--	1.924	1.847	1.856	--	--	1.777

V_1: Kazipiara, V_2: Swarupkathi, V_3: L49, G_1: Cleft method, G_2 : Veneer method, G_3: Contact method, H: Hardwood scion, S: Softwood scion

Table 7. *Combined effects of methods of grafting and scion type on the number of leaves developed in guava grafts.*

Treatment combinations	Number of leaves developed per graft at									
	15 DAG	30 DAG	45 DAG	60 DAG	75 DAG	90 DAG	105 DAG	120 DAG	135 DAG	150 DAG
G_1H	0.00	5.05	9.42	15.23	19.30	21.88	23.73	26.32	28.95	30.84
G_1S	0.00	2.90	5.22	11.19	14.65	17.70	18.72	20.96	24.39	26.87
G_2H	0.00	5.04	9.73	15.77	20.01	22.54	24.94	28.47	30.49	32.30
G_2S	0.00	3.07	5.81	11.50	15.38	17.97	19.49	22.88	26.28	28.47
G_3H	1.67	4.25	8.53	13.71	17.99	20.75	22.83	28.36	32.99	38.36
G_3S	1.44	3.46	5.42	11.29	15.25	18.63	20.58	25.07	29.60	33.50
LSD (0.05)	NS	0.5317	NS	0.7258	NS	NS	0.6398	0.926	NS	NS
LSD (0.01)	--	0.7138	--	0.9744	--	--	0.859	1.244	--	--

V_1: Kazipiara, V_2: Swarupkathi, V_3: L49, G_1: Cleft, G_2 : Veneer, G_3: Contact, H: Hard, S: Soft

Table 8. *Combined effect of Variety, methods of grafting and Scion type on the scion height in guava grafts.*

Treatment combinations	Scion height at									
	15 DAG	30 DAG	45 DAG	60 DAG	75 DAG	90 DAG	105 DAG	120 DAG	135 DAG	150 DAG
V_1G_1H	13.21	13.89	15.35	19.35	22.25	26.25	28.51	29.35	31.50	32.61
V_1G_1S	13.00	13.05	13.35	14.50	17.60	21.51	23.60	25.86	26.31	27.40
V_1G_2H	13.50	14.62	17.77	21.09	23.81	26.40	28.21	29.50	31.17	33.50
V_1G_2S	13.35	13.57	14.76	18.08	21.75	24.50	27.05	27.85	29.05	30.15
V_1G_3H	15.80	18.50	22.40	27.05	31.15	32.16	34.11	35.97	37.05	38.30
V_1G_3S	15.15	16.41	20.50	24.61	28.31	28.45	30.13	32.50	34.30	36.21
V_2G_1H	13.13	13.45	14.28	17.85	20.65	24.51	25.86	28.15	29.60	30.64
V_2G_1S	12.86	12.87	12.92	13.64	16.51	20.13	21.50	23.14	23.96	25.21
V_2G_2H	13.15	13.85	16.41	20.31	22.60	25.18	27.45	28.96	30.15	32.20
V_2G_2S	13.31	13.32	13.88	16.15	20.61	23.05	25.80	26.45	28.40	29.50
V_2G_3H	15.30	17.15	21.05	25.15	29.40	29.51	31.30	33.50	36.24	37.50
V_2G_3S	14.80	16.15	19.30	23.40	27.15	27.35	29.51	32.19	33.30	35.15
V_3G_1H	13.18	13.75	14.49	17.82	22.08	25.15	27.21	28.64	30.21	31.35
V_3G_1S	12.93	12.95	13.05	14.05	16.86	19.50	22.19	23.81	24.50	26.15
V_3G_2H	13.45	13.85	16.51	20.15	23.18	25.51	28.05	25.87	30.51	32.45
V_3G_2S	13.13	13.15	13.50	16.50	23.21	23.21	25.21	26.52	28.45	30.21
V_3G_3H	15.40	16.83	21.51	24.31	28.25	28.45	32.51	34.64	36.40	37.64
V_3G_3S	15.15	16.35	18.50	23.21	28.51	27.96	29.75	31.87	33.50	35.37
LSD (0.05)	1.419	2.027	1.911	1.758	2.482	2.383	2.394	3.305	1.888	2.293
LSD (0.01)	1.905	2.722	2.566	2.360	3.333	3.200	3.214	4.438	2.534	3.078
CV (%)	6.16	8.34	6.92	5.34	6.40	5.64	5.22	6.83	3.69	4.28

V_1: Kazipiara, V_2: Swarupkathi, V_3: L49, G_1: Cleft method, G_2 : Veneer method, G_3: Contact method, H: Hardwood scion, S: Softwood scion

Table 9. *Analysis of variance of the data of scion height at different days after grafting (DAG) as influenced by variety, methods of grafting and scion type in guava.*

Sources of variation (sv)	Degree of freedom (df)	Mean sum of squire									
		Scion height (cm)									
		15 (DAG)	30 (DAG	45 (DAG)	60 (DAG)	75 (DAG)	90 (DAG)	105 (DAG)	120 (DAG)	135 (DAG)	150 (DAG)
Replication	2	5.434	17.81	35.75	44.31	21.50	46.06	54.288	24.35	38.47	30.30
Treatment	17	3.24**	9.17**	30.63**	50.37**	59.98**	32.28**	33.71**	40.08**	44.07**	45.63**
Variety (A)	2	0.267 NS	1.72 NS	6.89*	11.83**	8.46*	15.09**	13.40**	14.14**	16.156**	8.11*
Methods of grafting (B)	2	26.35**	68.90**	216.74**	336.33**	428.32 **	179.24**	191.304**	253.48**	537.92**	286.72**
Interaction (AxB)	4	0.041 NS	0.23 NS	0.31 NS	0.49 NS	0.44 NS	0.38 NS	0.78 NS	2.200 NS	3.309 NS	0.68 NS
Scion type (C)	1	0.99 NS	10.89**	66.62**	139.46**	111.49**	125.74**	135.03**	99.254**	160.86**	158.55**
Interaction (AxC)	2	0.020 NS	0.62 NS	0.44 NS	0.48 NS	0.35 NS	0.55 NS	1.109 NS	0.529 NS	0.092 NS	0.126 NS

Interaction (BxC)	2	0.151 NS	0.29 NS	1.76 NS	7.62 **	11.50 **	11.84 **	9.661**	12.163**	30.49 **	11.899**
Interaction (AxBxC)	4	0.066 NS	0.26 NS	0.29 NS	0.566 NS	2.31 NS	2.022 NS	1.001 NS	3.162 NS	0.291 NS	0.197 NS
Error	34	0.731	1.49	1.33	1.122	2.24	2.063	2.08	3.968	1.294	1.909

DAG= Days after grafting
NS= Not significant
**= Significant at 5% level*
***= Significant at 1% level*

Table 10. *Analysis of variance of the data of number of leaves at different days after grafting (DAG) as influenced by variety, methods of grafting and scion type in guava.*

Sources of variation (sv)	Degree of freedom (df)	Mean sum of squire									
		Leaf number									
		15 (DAG)	30 (DAG	45 (DAG)	60 (DAG)	75 (DAG)	90 (DAG)	105 (DAG)	120 (DAG)	135 (DAG)	150 (DAG)
Replication	2	0.002	0.075	0.182	0.413	0.02	0.331	1.63	3.001	8.35	9.041
Treatment	17	1.782 **	3.736 **	12.458**	12.404**	14.225**	11.64 **	16.49 **	25.33 **	25.33 **	44.69 **
Variety (A)	2	0.154	2.661 **	5.656 **	4.809 **	0.990	0.256	0.567	8.28**	2.65	7.665 **
Methods of grafting (B)	2	14.55 **	0.169	2.876 **	5.981 **	5.373 **	1.616	4.352 **	44.01 **	98.72 **	248.97**
Interaction (AxB)	4	0.154 *	2.839 **	0.217	0.414	0.180	0.030	0.255	0.324	0.135	0.350
Scion type (C)	1	0.078	36.179**	188.68**	172.74**	216.92**	177.27**	242.10**	303.55**	221.80**	240.67**
Interaction (AxC)	2	0.006	1.035 **	0.255	0.806	0.055	0.374	0.136	1.405	0.35	0.325
Interaction (BxC)	2	0.078	2.446 **	1.434 *	4.57**	5.412 **	7.794 **	13.531**	7.114 **	1.600	1.397
Interaction (AxBxC)	4	0.006	0.838 *	0.448	1.035	0.133	0.118	0.013	1.026	0.412	0.243
Error	34	0.057	0.308	0.375	0.574	0.526	0.526	0.446	0.935	0.96	0.991

DAG= Days after grafting
NS= Not significant
**= Significant at 5% level*
***= Significant at 1% level*

4. Conclusions

Formulating an effective control measure against wilt disease in guava is being felt necessary as Bangladesh is facing a serious problem in the production of guava for

this disease. Vegetative propagation with grafted plants of wilt resistant rootstocks may be an effective measure in this regard. Factors for which the growth and development of the grafts considered to be greatly influenced are variety, methods of grafting and scion type as major of them with some other factors. An investigation was, therefore, carried out to evaluate the best and effective methods of grafting and scion type with their varietal responses through the scientific observation of graft union and subsequent growth and development of guava grafts. Methods of grafting and scion type significantly influenced bud sprouting and subsequent growth and development of the grafts as indicated by their continuous increase in height and production of leaves. Contact method of grafting with physiologically matured hardwood scion showed the best performance in the growth and development of grafts in guava.

Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this article.

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