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Investigate the impact of time and growing conditions on the success and growth of soft wood grafting in guava (*Psidium guajava* L.)

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Abstract
The present investigation was conducted in the Department of Fruit Science, College of Horticulture, Banda University of Agriculture & Technology Banda, (Uttar Pradesh) during 2021-22. Study was undertaken to highlight the effect of different time and growing conditions on success and growth rate of softwood grafting in guava (*Psidium guajava* L.) cv. Lalit under the climatic condition of Bundelkhand region of Uttar Pradesh. The experiment was laid out in Factorial Randomized Block Deign with 18 treatments and three replications. Under open field condition, maximum leaf area (cm^2) at 30 days (25.11), leaf area (cm^2) at 60 days (56.27), average number of leaf at 30 days (5.46), average number of leaf at 60 days (9.30), shoot diameter 5 cm above graft union (cm) at 30 days (0.40), shoot diameter 5 cm above graft union (cm) at 60 days (0.65), shoot diameter 5 cm below graft union (cm) at 30 days (0.44), shoot diameter 5 cm below graft union (cm) at 60 days (0.67), root length (cm) 30 days (12.21), root length (cm) 60 days (19.10), fresh weight of graft shoots (g) at 60 days (19.68), dry weight of graft shoots at 60 days (6.96), fresh weight of graft root at 60 days (13.55), dry weight of graft roots at 60 days (5.21) was recorded as compared to other condition *i.e.* shade house and poly house. Therefore, on the basic of result, open field condition from 15th February found best for highest success growth rate of soft wood grafting in guava.

Keywords: softwood grafting, laid

Introduction
Guava (*Psidium guajava* L.) is a tropical fruit that can withstand well in subtropical climates. Popularly it is known as “apple of the tropics” and “poor man's apple.” It is one of India's most common and important fruits, currently ranks fourth in area and production after mango, citrus, banana, and apple. Guava is commercially cultivated in Mexico, Peru, India, South Asian countries, the Hawaiian Islands and Cuba (Kumar *et al.* 2011) [8]. In India, the best quality guava is produced in Utter Pradesh and the district Prayagraj has a reputation of growing the best quality guava in Utter Pradesh. Its plants are quite hardy, prolific bearer and considered to be nutritionally valuable and referred as highly remunerative crop (Kumar *et al.* 2020) [7].

Vegetatively propagated guava yields a crop that is true to type and has a short juvenile phase. Several guava propagation methods, including sexual seed (Zamir *et al.* 2003) [15] and asexual methods such as softwood grafting, layering, cutting, and budding, have been practiced (Singh, 1985, Chandra *et al.* 2004, Mortan, 1987) [13, 5, 10]. Softwood grafting is a quick method of guava propagation. Softwood grafting, which has been practiced successfully in fruit crops such as mango, tamarind, custard apple, cashew, and jack fruit, can also be used in guava. Success of propagation method like softwood grafting depends on several factors such as, time of grafting and compatibility of scion variety. The time of grafting play the major role on which the final survival of grafts depends. Softwood grafting in guava provides an excellent response by increasing graft success and survival percentage of quality grafts with the least possibility of mortality, resulting in better and more uniform orchard establishment (Ram and Pathak, 2006) [11].

Materials and Methods
The present experiment was carried out in Fruit Nursery, Department of Fruit Science, College of Horticulture, Banda University of Agriculture and Technology, Banda during 2021-22.

Fruit crop guava (*Psidium guajava* L.) cv. Lalit was selected for conducting the experiment with different time and growing conditions on success and growth rate of softwood grafting. The different time and growing conditions on success and growth were applied 15th September, 15th October, 15th November, 15th December, 15th January, and 15th February. The experiment was conducted under shade house, poly house and open field conditions. The climate of Bundelkhand region is chiefly by semi-arid/tropical that has dry & warm summer, pleasant monsoon and mildly cold winter. The average annual rainfall of 800–910 mm in this region was recorded out of which more than 80 percent is received from third week of June to first week of September and very little is received during October and up to February month. May is the hottest month and December is the coolest month in this region. The maximum temperature of this region may reach as high as 46-49˚C during summer and minimum may fall to 5-7˚C during winter. The relative humidity is high from June to October. The treatment combinations *i.e.* T_1C_1-15th September in open field, T_2C_1=15th October in open field, T_3C_1=15th November in open field, T_4C_1=15th December in open field, T_5C_1=15th January in open field, T_6C_1=15th February in open field, T_1C_2= 15th September in Shade net house, T_2C_2=15th October in Shade net house, T_3C_2=15th November in Shade net house, T_4C_2=15th December in Shade net house, T_5C_2=15th January in Shade net house, T_6C_2=15th February in Shade net house, T_1C_3= 15th September in Poly house, T_2C_3=15th October in Poly house, T_3C_3=15th November in Poly house, T_4C_3=15th December in Poly house, T_5C_3=15th January in Poly house and T_6C_3=15th February in Poly house were tested in Random Block Design in a Factorial with three replication.

Results and Discussion

Leaf area and number of leaves (30 days and 60 days)

It is clear from the experiment that different time and growing conditions had a significant effect (Table-1) on higher leaf area (cm^2) at 30 and 60 days (25.11 cm^2) and (56.27 cm^2), respectively, was observed with C_1 (open field) whereas the minimum leaf area (cm^2) at 30 and 60 days (20.06 cm^2) and (39.34 cm^2) with C_2 (shade net house) was recorded. For the leaf area (cm^2) at 30 and 60 days it was observed significant higher T_6 (27.34 cm^2) and (70.98 cm^2) where the minimum leaf area (cm^2) at 30 and 60 days with T_4 (17.20 cm^2) and (41.59 cm^2), respectively, interaction effect on leaf area (cm^2) at 30 and 60 days was significant higher with T_6C_1 (31.55 cm^2) and (70.98 cm^2) and minimum with T_4C_3 (16.33 cm^2) and (28.35 cm^2). Significant maximum number of leaves at 30 and 60 days (5.46) and (9.30) was observed with C_1 (open field) where the minimum (3.68) and (7.86) with C_3 (poly house) was recorded. For the number of leaf at 30 and 60 days it was observed significant maximum with T_6 (5.14) and (9.07) where the minimum with T_4 (4.03) and (7.84),whereas interaction effect on number of leaves at 30 and 60 days recorded maximum with T_6C_1 (6.10) and (9.86) and minimum with T_4 C_3 (3.20) and (7.33).Temperature plays an important role in photosynthetic activity of the leaves and optimum temperature increases the rate of photosynthesis and leads to the formation of more food materials that facilitate and improve the growth and development of the graft sprout. Raghavendra *et al*. (2009) in wood apple. Kukshal *et al*. (2017) [9] revealed that the wedge grafting in guava had significant effect.

Shoot diameter (30 days and 60 days)

It is clear from the data presented in the Table -1 that significant effect was observed on higher shoot diameter 5 cm above graft union at 30 and 60 days (0.40) and (0.65) with C_1 (open field) where the minimum (0.30) and (0.57) with C_3 (poly house). Significant higher shoot diameter 5 cm above graft union at 30 and 60 days was observed with T_6 (0.47) and (0.68) where the minimum in T_4 (0.31) and (0.56). Interaction effect shoot diameter 5 cm above graft union at 30 and 60 days noted higher with T_6C_1 (0.52) and (0.71) where the minimum with T_4 C_3 (0.30) and (0.51). Maximum Shoot diameter 5 cm above graft at 30 and 60 days (0.44) and (0.67) was observed with C_1 (open field) where the minimum (0.36) and (0.57) with C_3 (poly house) was noticed. For the significant maximum Shoot diameter 5 cm above graft below 30 and 60 days T6 (0.49) and (0.71) where the minimum T_4 (0.33) and (0.54) and interaction effect on shoot diameter 5 cm above graft union after 30 and 60 days recorded with maximum T_6 C_1 (0.54) and (0.74) where the minimum with T_4C_3 (0.31) and (0.47). The high relative humidity and slightly inclined temperature operable in poly house condition might have desirable effect to increase in scion diameter under poly house followed by shade house and open field conditions. Similar finding have also been reported by Kumar *et al.* (2020) [7]. Scion diameters get enhanced due to higher accumulation of carbohydrate in scion. Islam *et al.* (2004) also observed same trend with epicotyls grafting in jackfruit.

Root length (30 days and 60 days)

It is clear from the experiment (Table-2) that different time and growing conditions had a significant effect on root length at 30 days and 60 days after grafting. The higher value (12.21 mm) and (19.10 mm) was recorded with C_1 (open field) whereas, the lower reaches value (10.06 mm) and (15.48 mm) with C_3 (poly house) treatment. Significant higher value for root length at 30 days and 60 days after grafting noted with T_6 (13.31) and (20.92) whereas the minimum with T_4 (9.53) and (14.07). Interaction effect shown significant effect and had higher value for root length at 30 days and 60 days after grafting in treatment T_6 (14.43) and (22.93) whereas lower value with T_4 treatment (9.00) and (12.66). For growing conditions, the highest root length was recorded in poly house followed by shade house. However, lowest root length observed under open field conditions as investigated by Deshmukh *et al.* (2017) of rootstocks rough lemon.

Fresh weight and dry weight (graft shoot 60 days)

Significant maximum value for fresh weight and dry weight of graft shoot 60 days after grafting (19.86) and (6.96) was observed with C_1 (open field) whereas lower reaches value (17.99) and (5.98) C_3 (poly house) was observed. Significant maximum value for fresh weight and dry weight of graft shoot 60 days after grafting noted with treatment T_6 (20.93) and (7.61) where minimum value with T_4 (16.20) and (5.03). In

Interaction effect, maximum value for fresh weight and dry weight of graft shoot 60 days after grafting with T_6C_1 (22.03) and (8.13) whereas, minimum value recorded with T_4C_3 (15.70) and (4.66). The maximum fresh weights of shoot were obtained when higher number of leaf present on shoot and is also due to higher rate of photosynthesis as it is favorable for higher accumulation of food Baghel *et al.* (2016) noted in guava.

Fresh weight and dry weight (graft root 60 days)

Significant effect higher value fresh weight and dry weight of graft root 60 days after grafting (13.55) and (5.21) in C_1 (open field) whereas the minimum value (12.20) and (3.97) with C_3 (poly house) was recorded. For the significant higher value fresh weight and dry weight of graft root 60 days after grafting T_6 (14.41) and (5.62) whereas minimum value with T_4 (10.75) and (3.73). Under Interaction effect, higher value for Fresh weight and dry weight of graft root 60 days after grafting recorded with T_6C_1 (15.10) and (6.10) and minimum value noted with T_4C_3 (10.33) and (3.20). It might be due to the prevalence of favorable atmospheric conditions like temperature and humidity that is favorable for the vegetative growth Visen *et al*. (2010) [14] investigated in guava

Conclusion

On the basic of result obtained during the present investigation, different time and growing conditions on success and growth rate of softwood grafting exhibited significantly of guava. Therefore, on the basis of results, it can be concluded and recommended that, for guava propagation, soft wood grafting in guava under agro-climatic conditions of Banda should be carried during mid of February under poly house conditions to achieve maximum grafting success and seedling growth.

Table 1: Effect of grafting time, growing conditions and their interaction on leaf area, number of leaf, shoot diameter 5 cm above graft union, shoot diameter 5 cm above graft below

Treatments	Leaf area 30 days	Leaf area 60 days	Number of leaf at 30 days	Number of leaf at 60 days	Shoot diameter 5 cm above graft union 30 days	Shoot diameter 5 cm above graft union 60 days	Shoot diameter 5 cm above graft below 30 days	Shoot diameter 5 cm above graft below 60 days
T_1	23.58	59.85	4.67	8.73	0.36	0.64	0.40	0.63
T_2	20.50	57.90	4.43	8.51	0.33	0.58	0.38	0.62
T_3	18.54	46.14	4.31	8.11	0.32	0.58	0.35	0.58
T_4	17.20	41.59	4.03	7.84	0.31	0.56	0.33	0.54
T_5	24.71	61.69	4.87	8.81	0.42	0.65	0.44	0.67
T_6	27.34	70.98	5.14	9.07	0.47	0.68	0.49	0.71
SEm±	0.03	0.05	0.02	0.03	0.004	0.005	0.003	0.006
CD at 5%	0.09	0.15	0.07	0.10	0.012	0.014	0.01	0.01
C_1	25.11	56.27	5.46	9.30	0.40	0.65	0.44	0.67
C_2	20.76	46.78	4.58	8.37	0.36	0.62	0.39	0.63
C_3	20.06	39.34	3.68	7.86	0.33	0.57	0.36	0.57
SEm±	0.04	0.07	0.03	0.05	0.006	0.007	0.005	0.009
CD at 5%	0.13	0.22	0.10	0.15	0.017	0.019	0.01	0.02
T_1C_1	27.23	59.85	5.53	9.50	0.41	0.70	0.47	0.70
T_2C_1	23.39	57.90	5.40	9.33	0.34	0.60	0.43	0.70
T_3C_1	20.38	46.14	5.23	8.96	0.33	0.63	0.37	0.63
T_4C_1	18.79	41.59	4.80	8.43	0.33	0.60	0.35	0.60
T_5C_1	29.33	61.69	5.73	9.73	0.49	0.70	0.51	0.69
T_6C_1	31.55	70.98	6.10	9.86	0.52	0.71	0.54	0.74
T_1C_2	21.99	48.05	4.60	8.56	0.34	0.63	0.38	0.61
T_2C_2	18.93	43.59	4.50	8.26	0.33	0.58	0.36	0.60
T_3C_2	17.31	40.07	4.40	8.03	0.31	0.60	0.34	0.59
T_4C_2	16.50	34.47	4.10	7.73	0.31	0.56	0.33	0.56
T_5C_2	23.31	52.81	4.83	8.70	0.42	0.63	0.43	0.69
T_6C_2	26.53	61.16	5.06	9.06	0.48	0.70	0.50	0.73
T_1C_3	21.51	41.14	3.90	8.23	0.33	0.59	0.37	0.58
T_2C_3	19.17	33.64	3.40	7.93	0.32	0.56	0.35	0.56
T_3C_3	17.94	35.85	3.30	7.36	0.31	0.53	0.33	0.54
T_4C_3	16.33	28.35	3.20	7.33	0.30	0.51	0.31	0.47
T_5C_3	21.50	44.48	4.06	8.00	0.36	0.62	0.40	0.63
T_6C_3	23.95	52.60	4.26	8.30	0.41	0.64	0.43	0.66
SEm±	0.08	0.13	5.14	0.09	0.01	0.012	0.008	0.015
CD at 5%	0.23	0.38	0.06	0.26	0.03	0.033	0.02	0.04

Where: C_1=Open field, C_2= Shade net house, C_3=Poly house, T_1= 15th September, T_2=15thOctober, T_3=15thNovember, T_4= 15th December, T_5=15th January, T_6=15th February, T_1C_1= 15th September in open field, T_2C_1=15th October in open field, T_3C_1=15th November in open field, T_4C_1=15th December in open field, T_5C_1=15th January in open field, T_6C_1=15th February in open field, T_1C_2=15th September in Shade net house, T_2C_2=15th October in Shade net house, T_3C_2=15th November in Shade net house, T_4C_2=15th December in Shade net house, T_5C_2=15th January in Shade net house, T_6C_2=15th February in Shade net house, T_1C_3= 15th September in Poly house, T_2C_3=15th October in Poly house, T_3C_3=15th November in Poly house, T_4C_3=15th December in Poly house, T_5C_3=15th January in Poly house and T_6C_3=15th February in Poly house.

Table 2: Effect of grafting time, growing conditions and their interaction on root length, fresh and dry weight of graft shoot, fresh and dry weight of graft root

Treatments	Root length 30 days after grafting	Root length 60 days after grafting	Fresh weight of graft shoot 60 days after grafting	dry weight of graft shoot 60 days after grafting	Fresh weight of graft root 60 days after grafting	dry weight of graft root 60 days
T_1	11.05	18.08	20.01	6.83	13.50	4.82
T_2	10.63	16.01	19.27	6.61	12.62	4.17
T_3	10.14	15.43	17.17	5.43	11.62	4.00
T_4	9.53	14.07	16.20	5.03	10.75	3.73
T_5	12.40	19.53	20.40	7.16	14.14	5.24
T_6	13.31	20.92	20.93	7.61	14.41	5.62
SEm±	0.61	0.14	0.07	0.03	0.05	0.03
CD at 5%	0.17	0.40	0.21	0.09	0.14	0.11
C_1	12.21	19.10	19.86	6.96	13.55	5.21
C_2	11.26	17.44	19.13	6.38	12.77	4.61
C_3	10.06	15.48	17.99	5.98	12.20	3.97
SEm±	0.08	0.19	0.1	0.04	0.07	0.05
CD at 5%	0.25	0.57	0.30	0.12	0.20	0.15
$T_1 C_1$	12.03	19.76	21.26	7.36	14.13	5.36
$T_2 C_1$	11.43	18.30	19.96	7.13	13.40	5.03
$T_3 C_1$	10.93	17.26	17.83	6.10	12.70	4.73
$T_4 C_1$	10.43	15.46	16.63	5.36	11.30	4.33
$T_5 C_1$	14.03	20.86	21.46	7.70	14.70	5.70
$T_6 C_1$	14.43	22.93	22.03	8.13	15.10	6.10
$T_1 C_2$	11.10	18.20	20.10	6.76	13.36	4.73
$T_2 C_2$	10.73	16.70	19.33	6.63	12.63	4.16
$T_3 C_2$	10.13	15.70	17.36	5.16	11.60	4.03
$T_4 C_2$	9.16	14.10	16.26	5.06	10.63	3.66
$T_5 C_2$	12.73	19.63	20.66	7.10	14.10	5.36
$T_6 C_2$	13.70	20.33	21.10	7.60	14.30	5.53
$T_1 C_3$	10.03	16.30	18.66	6.36	13.00	4.36
$T_2 C_3$	9.73	13.03	18.53	6.06	11.83	3.33
$T_3 C_3$	9.36	13.33	16.33	5.03	10.56	3.23
$T_4 C_3$	9.00	12.66	15.70	4.66	10.33	3.20
$T_5 C_3$	10.43	18.10	19.06	6.70	13.63	4.66
$T_6 C_3$	11.80	19.50	19.66	7.10	13.83	5.03
SEm±	0.15	0.34	0.18	0.07	0.12	0.09
CD at 5%	0.43	0.98	0.52	0.22	0.35	0.27

Where: C_1=Open field, C_2= Shade net house, C_3=Poly house, T_1=15th September, T_2=15thOctober, T_3=15thNovember, T_4=15th December, T_5=15th January, T_6=15th February, T_1C_1= 15th September in open field, T_2C_1=15th October in open field, T_3C_1=15th November in open field, T_4C_1=15th December in open field, T_5C_1=15th January in open field, T_6C_1=15th February in open field, T_1C_2= 15th September in Shade net house, T_2C_2=15th October in Shade net house, T_3C_2=15th November in Shade net house, T_4C_2=15th December in Shade net house, T_5C_2=15th January in Shade net house, T_6C_2=15th February in Shade net house, T_1C_3= 15th September in Poly house, T_2C_3=15th October in Poly house, T_3C_3=15th November in Poly house, T_4C_3=15th December in Poly house, T_5C_3=15th January in Poly house and T_6C_3=15th February in Poly house.

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