The Pharma Innovation Journal 2022; 11(7): 1627-1631

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; 11(7): 1627-1631

www.thepharmajournal.com
Received: 14-04-2022
Accepted: 30-06-2022

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Studies on softwood grafting of tamarind (*Tamarindus indica* L.) under different growing conditions

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Abstract
An experiment entitled "Studies on softwood grafting of Tamarind (*Tamarindus indica* L.) under different growing conditions" was conducted at Pt. Kishori Lal Shukla College of Horticulture & Research Station Rajnandgaon, Chhattisgarh. The experiment was laid out in Split plot Design, with 3 replications, there were two factors which comprised different date of grafting *viz*. 10 February 2021, 20 February 2021, 01 March 2021, 10 March 2021, 20 March 2021, 30 March 2021, 10 April 2021 and three growing condition *viz*. Mist chamber (C_1), Shade net house (C_2) and open condition (C_3). The result revealed that among different treatment combination, D_4C_1 (10 March, 2021+ mist chamber) had the significant effect on tamarind grafts and recorded minimum number of days taken to first sprouting (8.20 Days), maximum number of sprout (4.47), number of leaves (73.07), plant height (88.01 cm), number of branches (4.59), length of sprout (60.68 cm) and graft Survival percent (80.00%). Whereas, more number of days taken to first sprouting (9.27days), minimum number of sprout (2.00), number of leaves (38.27), plant height (49.13cm), number of branches (1,87), length of sprout (34.17cm) and graft survival percent (40%) were observed under treatment combination D_1C_3 (10 February, 2021 + Open field condition).

Keywords: Tamarind, softwood grafting, date of grafting, growing condition

Introduction
Tamarind tree named as “Indian date”. The word tamarind is derived from Arabic word i.e. “Tamar - E - Hind” literally meaning” “Date of India”. Tamarind is leguminous tree belong to the family fabaceae and is an indigenous to tropical Africa. The genus *Tamarindus* is monotypic, meaning that it contains only this species. It was introduced eon ago to India. Indians adopted it so well that it became (almost) indigenous to our country. It is a large evergreen tree with an exceptionally beautiful spreading crown and is cultivated throughout the whole of India, except in the Himalayas and western dry regions. The tamarind has long been naturalized in Indonesia, Malaysia, Sri Lanka, Philippines, the Caribbean and the Pacific Islands. Thailand has the largest plantations of the ASEAN nations, followed by Indonesia, Myanmar and the Philippines. It is cultivated all over India, especially in Maharashtra, Chhattisgarh, Karnataka, Telangana, Andhra Pradesh and Tamil Nadu. Presently the total area and production of tamarind in India is approximately 44,321 hectares and 15,9243 metric tons respectively. In India the state Karnataka ranks first in terms of tamarind production with 40026 MT (Anonymous, 2020) [1]. It is widely cultivated in tropical and subtropical regions for its edible fruit, the sweet and sour pulp of which is extensively used in foods, beverages, and traditional medicines.

The seedling tree begins to bear fruits at the age of 8-12 years and sometimes continue to be productive even after 100 years of age. A full-grown tamarind tree is reported to yield about 180–225 kg of fruits per season. In India, the average production of tamarind pods per tree is 175 kg and of processed pulp is 70 kg/tree. Periyakulam 1 (PKM1), an improved cultivar in Tamil Nadu, yields about 263 kg/tree.

Tamarind tree produces brown pod- like fruits that contain a fleshy, juicy, acidic pulp. It is mature when the flesh is coloured brown or reddish brown. The tamarinds of Asia have longer pods (containing 6 to 12 seeds), whereas African and West Indian varieties have shorter pods (containing one to six seeds). The fruit is best described as sweet and sour in taste, high in tartaric acid, sugar, B vitamins and calcium. Several reports of antioxidant activity in tamarind indicate that fruits contain biologically important mineral elements and have high antioxidant capacity associated with high phenolic content that can be considered beneficial to human health.

The promising tamarind genotype IGTAM-14 identified in Bastar region of Chhattisgarh have been found better for many micro and macro nutrients as well as for other physico-chemical properties (Shukla and Singh, 2020) [10].

Tamarind trees are generally raised from seeds; seedling trees usually show high level of heterogeneity with a long juvenile phase. The method of vegetative propagation came into practice largely out of the desire to perpetuate elite seedling clone and the practice of raising trees from seed has been discontinued. Among the vegetative methods of propagation, soft wood grafting and air layering are most commonly practiced for mass production of identified elite clones. Softwood grafting is gaining popularity among nurserymen and growers; the procedure involved is simple, economical and less cumbersome. Main advantage of using this method results in fairly high rate of graft success and survival. As a solution to these problems, softwood grafting gives an excellent response by higher graft success and survival percentage of quality grafts with the least possibility of mortality which helps in better and uniform orchard establishment (Ram and Pathak, 2006) [9]. Therefore present investigation was under taken to find out the suitable time of grafting along with the best growing condition for production of tamarind grafts.

Material and Method

The experiment was conducted at the Horticulture Research Farm, Pt. K. L. Shukla College of Horticulture and Research Station Rajnandgaon (C.G.) during the year 2020-21. It is located in central plane of Chhattisgarh at latitude of 21.10° North and longitude of 81.03° East and an altitude of 330.70 meters above the mean sea level. An average annual rainfall of 1200 mm is generally appeared and mostly concentrated during the period from June to September. In general weekly maximum temperature goes upto 45°C during the summer season and minimum temperature fails upto 5°C during the winter season and maximum and minimum relative humidity varied from 91.1% to 52.1%.

The scions for promising genotype IGTAM-14 were taken for propagation of tamarind grafts. For this purpose 3-4 months old shoots of previous season free from pests and disease was defoliated 9 days before grafting. On the day of grafting defoliated scion were cut and detached from mother parent by using of sharp secateurs. The rootstock was decapited at 15 to 20 cm above soil level and about 3 cm deep cut was made at the top of the rootstock to create "V" shaped notch in the wood which depends on the stock width. The lower portion of scion was cut to make a "V" shaped wedge. Insertion of the pre prepared scion into the rootstock cut is done carefully to match the cambiums on the thick side of the scion in such a way that the cambium layer of scion is in touch with the cambium layer of the stock. Later the grafts were arranged and placed under three growing conditions *Viz*. mist-chamber, shade net house and open field condition.

Results and Discussion

Number of days taken to first sprouting

The least Number of days taken to first sprouting (9.48 days) was observed, when grafting was performed on 10 March (D_4), followed by 20 March (D_5). However, the longest time taken for first sprouting (16.80 days) was recorded in grafting performed on 10 February (D_1). In growing condition mist chamber (C_1) was recorded the minimum number of days for first sprouting (9.40 days), followed by shade net house (C_2). While the more number of days required for first sprouting (14.93 days) was recorded in open condition (C_3).

Among various treatment combination the minimum number of days (8.20 days) taken for sprouting was observed when grafting was performed on 10 March under mist chamber (D_4C_1), which was at par with 01 March under mist chamber (D_3C_1) 9.27 days, 20 March under mist chamber (D_5C_1) 9.07 days. However, the maximum number of days taken for first sprouting (21.53 days) was observed when grafting was performed on 10 February under open condition (D_1C_3). Among the different treatment combination, 10 March under mist chamber (D_4C_1) noted a lower number of days for first sprouting. The possible reason might be the presence of favourable climatic conditions, which are responsible for early contact of vascular tissue and the formation of cambium layer, resulting in early sprouting. Similar findings were obtained by Raghavendra *et al.* (2011) [8] in wood apple and Chander *et al*. (2016) [2] in jamun.

Number of sprout per grafts

The maximum number of sprouts per graft (4.31) was observed when grafting was performed on 10 March (D_4), followed by 01 March (D_3). However, the minimum number of sprouts (2.53) was noted in grafting performed on 10 February (D_1). In various conditions mist chamber (C_1) recorded a significantly maximum number of sprout (3.67) followed by shade net house (C_2). Whereas, minimum number of sprouts per graft (2.86) was recorded in open conditions (C_3).

Among various treatment combinations the maximum number of sprouts per graft (4.47) was observed when grafting was performed on 10 March under mist chamber (D_4C_1), which was at par with 10 March under shade net house (D_4C_2) and 10 March inside open condition (D_4C_3). However, the minimum number of sprouts per graft (2.00) was observed when grafting was performed on (D_1C_3). The production of maximum number of sprouts could be due to the ideal temperature and relative humidity which is favorable to plant activity, which increased carbohydrate accumulation, resulting in a higher number of sprouts. The results is supported by the studies of Swetha (2012) [11] in Jackfruit.

Number of leaves per graft

The maximum number of leaves (44.71 and 69.81) was recorded when grafting was performed on 10 March (D_4), followed by 20 March (D_5) at 60 days after grafting and at 90 DAG 01 March (D_3) respectively. However, the minimum number of leaves (32.12 and 46.64) was observed at 60 and 90 DAG respectively, when grafting was performed on 10 April (D_7). Among different growing conditions, maximum number of leaves (43.53 and 65.64 leaves) were observed in graft under mist chamber (C_1) followed by shade net (C_2) at 60 and 90 DAG, respectively. The minimum number of leaves (33.76 and 51.76 leaves) was recorded in open condition (C_3) at 60 and 90 DAG, respectively.

The interaction effect of different date of grafting and growing conditions resulted in a significantly maximum number of leaves (48.99) when grafting was performed on 10 March under mist chamber (D_4C_1), followed by 20 March under mist chamber (D_5C_1) at 60 days after grafting. At 90 DAG, maximum number of leaves (73.07) was noted when grafting was performed on 10 March under mist chamber

(D_4C_1) followed by 10 March under shade net house (D_4C_2). However, the minimum number of leaves (28.03 and 38.27) was observed when grafting was performed on 10 April under open condition (D_7C_3) at 60 and 90 DAG, respectively. Increasing in number of leaves might be due to favorable conditions prevailing under mist chamber and shade net stimulating rapid callusing and early contact of cambial layers, which enables the graft to heal quickly and make a strong union ultimately leading to faster growth of grafts by producing more leaves. These findings are in conformity with Praveenakumar *et al.* (2019) [7] in tamarind and Naik and Kumar (2018) [5] in jack fruit.

Plant height

The maximum plant height (57.02 cm) was noted when grafting was done on 10 March (D_4), followed by 20 March (D_5) at 60 days after grafting. At 90 days after grafting the maximum plant height (76.28 cm) was recorded when grafting was performed on 10 March (D_4) which was at par with 01 March (D_3). Whereas the minimum plant height (45.43 cm and 58.81 cm) was observed on 10 April (D_7) at 60 DAG and 90 DAG, respectively. Among different growing conditions, maximum plant height (53.74 cm and 79.47 cm) was recorded in graft under mist chamber (C_1) followed by shade net (C_2) at 60 and 90 DAG, respectively. Although, the minimum plant height (45.43 cm and 60.61 cm) was recorded in open condition (C_3) at 60 and 90 DAG, respectively.

In case of interaction (DxC) the maximum plant height (62.07 cm and 88.01 cm) was observed when grafting was performed on 10 March under mist chamber (D_4C_1), followed by 20 March under mist chamber (D_5C_1) at 60 and 90 DAG, respectively. However, the minimum plant height (39.87 cm and 49.13 cm) was observed when grafting performed on 10 April under open condition (D_7C_3) at 60 and 90 DAG, respectively. The maximum plant height might be due to presence of congenial environmental conditions under the mist chamber stimulating rapid callus formation and early contact of cambial layers, which enable the graft to heal quickly and make a strong union ultimately leading to better strength and faster growth of grafts. This result also obtained by Chander *et al.* (2016) [2] in jamun and Nanditha *et al.* (2017) [6] in guava.

Number of branches per graft

Significantly the maximum number of branches per graft (4.08) was exhibited, when grafting was performed on 10 March (D_4), followed by 20 March (D_5). Whereas, the minimum number of branches per graft (2.44) was recorded in grafting performed on 10 February (D_1) at 90 DAG. Among the different growing conditions, when grafting was performed under mist chamber (C_1), showed the significant maximum number of branches per graft (3.93) followed by shade net house (C_2). While, the minimum number of branches per graft (2.79) was recorded in open conditions (C_3) at 90 day after grafting. This result was accordance with Praveenakumar *et al.* (2019) [7] in tamarind.

Among various treatment combinations the maximum number of branches per graft (4.59) was observed when grafting was performed on 10 March under mist chamber (D_4C_1), which was at par with 20 March (D_5C_1) and 30 March (D_6C_1) under mist chamber at 90 DAG. However, the minimum number of branches per graft (1.87) was observed when grafting performed on 10 February under open condition (D_1C_3) at 90 day after grafting. The production of maximum number of branches per graft could be due to climatic factors such as optimum temperature and relative humidity, which encourage increased cell activity and early sprouting; leading in more leaves and branches per graft. Similar findings have also been found by Uchoi (2010) [13] in jamun and Thejashwani (2018) [12] in tamarind.

Diameter of Scion (cm)

The maximum scion diameter (0.57 cm and 0.61 cm) was noted when grafting was done on 20 March (D_5), followed by 10 March (D_4) at 60 and at 90 DAG, respectively. Whereas the minimum scion diameter (0.39 cm and 0.48 cm) was observed on 10 February (D_1) at 60 DAG and 90 DAG, respectively. Among different growing conditions, maximum scion diameter (0.55 cm and 0.60 cm) was recorded under mist chamber (C_1), followed by shade net (C_2) at 60 and 90 DAG, respectively. Whereas, the minimum scion diameter (0.43 cm and 0.48 cm) was recorded in open condition at 60 and 90 DAG, respectively.

Among various treatment combinations, the maximum scion diameter (0.61 cm and 0.66 cm) was observed when grafting was performed on 20 March under mist chamber (D_5C_1), followed by 10 March under mist chamber (D_4C_1) at 60 and at 90 DAG, respectively. However, the minimum scion diameter (0.33 cm and 0.42 cm) was observed when grafting was performed on 10 February under open condition (D_1C_3) at 60 and 90 DAG, respectively The probable reason might be due to the favorable temperature and relative humidity in the environment during this period, which contributed to the increase in scion diameter. Similar findings have been also reported by Karna *et al.* (2018) [4] in mango.

Rootstock diameter (cm)

Significantly maximum diameter of rootstock (0.59 cm and 0.63 cm) was recorded when grafting was done on 20 March (D_5), which was at par with 10 March (D_4) at 60 and 90 DAG, respectively. Whereas, the minimum diameter of rootstock (0.44 cm and 0.48 cm) was observed on 10 February (D_1) at 60 and 90 DAG, respectively. Among different growing conditions, maximum diameter of rootstock (0.60 cm and 0.64 cm) was recorded under mist chamber (C_1) followed by shade net (C_2) at 60 and 90 DAG, respectively. However the minimum diameter of rootstock (0.45 cm and 0.49 cm) was recorded in open condition (C_3) at 60 and 90 DAG, respectively.

Among various treatment combinations, the maximum rootstock diameter (0.67 cm and 0.70 cm) was observed when grafting was performed on 20 March under mist chamber (D_5C_1), followed by 10 March under mist chamber (D_4C_1) at 60 and 90 DAG, respectively. Although, the minimum rootstock diameter (0.38 cm and 0.42 cm) was observed when grafting was performed on 10 February under open condition (D_1C_3) at 60 and 90 DAG, respectively. The high relative humidity and slightly inclined temperature prevailing in mist house condition might have favoured the increase in rootstock diameter under mist house. This result were found similar with Chander *et al.* (2016) [2] and Nanditha *et al.* (2017) [6] in guava.

Table 1: Effect of different date of grafting, growing condition and their interaction on softwood grafting of Tamarind

Treatments	Days taken to first sprouting	No. of sprouts	No. of leaves		Height of graft (cm)		No. of branches per graft	Diameter of Scion (cm)		Diameter of Rootstock (cm)		Length of sprout (cm)		Graft Survival Percent (%)
	(Days)	at 30 DAG	at 60 DAG	at 90 DAG	at 60 DAG	at 90 DAG	at 90 DAG	at 60 DAG	at 90 DAG	at 60 DAG	at 90 DAG	at 90 DAG	at 120 DAG	at 120 DAG
Date of grafting (D)														
(D1) 10 February	16.80	2.53	34.60	51.65	48.56	62.41	2.44	0.39	0.48	0.44	0.48	36.85	42.85	52.22 (46.38)
(D2) 20 February	15.19	2.85	37.55	57.47	50.44	68.08	2.71	0.44	0.50	0.48	0.53	39.39	44.63	54.44 (47.79)
(D3) 01 March	11.38	3.48	39.02	64.17	53.53	74.47	3.06	0.48	0.52	0.52	0.55	41.19	47.39	57.78 (50.00)
(D4) 10 March	9.48	4.31	44.71	69.81	56.05	76.28	4.08	0.53	0.57	0.55	0.59	43.86	49.08	65.56 (56.05)
(D5) 20 March	10.60	3.33	41.04	59.58	53.74	71.07	3.64	0.57	0.61	0.59	0.63	39.49	47.43	63.33 (53.26)
(D6) 30 March	13.11	3.23	37.13	54.45	52.45	65.99	3.58	0.50	0.55	0.54	0.58	36.79	43.35	62.22 (52.59)
(D7) 10 April	13.24	2.63	32.12	46.64	45.43	58.81	2.97	0.47	0.51	0.50	0.52	33.55	39.03	57.78 (50.00)
S.Em±	0.27	0.11	0.35	0.70	0.41	0.81	0.09	0.009	0.014	0.014	0.016	0.33	0.39	1.93 (1.60)
C.D at 5%	0.85	0.34	1.10	2.17	1.29	2.53	0.27	0.029	0.043	0.043	0.050	1.04	1.22	6.00 (4.98)
CV%	6.39	6.93	2.79	3.62	2.41	3.58	7.94	9.25	8.36	8.67	8.08	2.58	2.63	9.78 (9.42)
Condition (C)														
(C1) Mist chamber	9.40	3.67	43.53	65.64	53.74	79.47	3.93	0.55	0.60	0.60	0.64	45.48	52.67	74.29 (60.80)
(C2) Shade net	14.16	3.05	36.78	55.63	52.45	64.39	2.92	0.47	0.52	0.49	0.53	36.32	42.39	56.67 (49.03)
(C3) Open condition	14.93	2.86	33.76	51.76	45.43	60.61	2.79	0.43	0.48	0.45	0.49	34.39	39.42	46.19 (42.77)
S.Em±	0.16	0.06	0.25	0.45	0.23	0.42	0.05	0.007	0.007	0.007	0.008	0.35	0.24	1.12 (0.88)
C.D at 5%	0.46	0.18	0.72	1.31	0.67	1.23	0.15	0.020	0.022	0.022	0.023	1.03	0.70	3.25 (2.56)
CV%	5.69	7.00	2.99	3.57	2.06	2.84	7.30	6.54	5.91	6.13	5.72	4.19	2.44	8.67 (7.92)
Interaction (D×C)														
D1C1	10.01	2.80	34.53	49.73	53.03	73.05	3.18	0.50	0.55	0.54	0.58	40.26	46.87	70.00 (57.00)
D1C2	18.87	2.40	32.53	48.27	47.43	57.77	2.27	0.35	0.46	0.40	0.44	35.54	42.03	46.67 (42.99)
D1C3	21.53	2.00	31.00	44.71	45.23	56.40	1.87	0.33	0.42	0.38	0.42	34.73	39.67	40.00 (39.15)
D2C1	9.63	3.07	37.73	57.00	55.73	77.65	3.37	0.54	0.58	0.57	0.62	43.86	50.32	73.33 (59.21)
D2C2	16.93	2.73	36.93	55.27	49.27	61.73	2.43	0.40	0.48	0.44	0.49	38.23	43.37	46.67 (43.08)
D2C3	19.00	2.47	33.07	52.73	46.33	64.87	2.33	0.37	0.45	0.41	0.46	36.08	40.22	43.33 (41.07)
D3C1	9.27	3.73	42.27	67.41	58.18	82.58	3.99	0.56	0.61	0.61	0.65	47.22	55.19	76.67 (61.92)
D3C2	11.73	3.87	37.80	64.40	52.55	73.09	2.73	0.45	0.49	0.49	0.51	40.40	45.88	50.00 (45.00)
D3C3	13.13	2.80	34.07	60.33	49.87	67.73	2.47	0.43	0.47	0.45	0.48	35.94	41.11	46.67 (43.08)
D4C1	8.20	4.47	50.01	73.07	62.07	88.01	4.59	0.60	0.64	0.64	0.68	53.09	60.68	80.00 (68.07)
D4C2	9.93	4.33	45.00	71.00	53.42	74.47	4.07	0.53	0.57	0.53	0.55	39.81	44.45	63.33 (53.07)
D4C3	10.30	4.13	40.13	65.33	52.67	66.37	3.59	0.47	0.51	0.47	0.53	38.68	42.11	53.33 (47.01)
D5C1	9.07	3.40	41.80	61.07	58.65	83.96	4.19	0.61	0.66	0.67	0.70	49.32	56.81	76.67 (61.92)
D5C2	11.27	3.27	42.17	56.21	54.02	68.30	3.40	0.57	0.62	0.57	0.63	36.02	44.27	63.33 (52.86)
D5C3	11.47	3.33	35.20	53.33	48.53	60.95	3.33	0.52	0.55	0.54	0.56	33.13	41.23	50.00 (45.00)
D6C1	10.00	4.33	34.47	51.87	56.19	78.43	4.28	0.55	0.60	0.62	0.66	44.76	52.24	73.33 (59.71)
D6C2	15.73	2.47	41.47	50.60	52.23	60.73	2.93	0.50	0.53	0.52	0.55	33.23	40.39	66.67 (55.07)
D6C3	13.60	3.13	35.13	46.40	48.93	58.80	3.53	0.46	0.51	0.48	0.53	32.38	37.43	46.67 (42.99)
D7C1	9.59	3.00	33.20	46.07	52.75	72.62	3.90	0.53	0.56	0.56	0.59	39.86	46.59	70.00 (57.79)
D7C2	14.67	2.40	28.93	40.93	43.67	54.67	2.60	0.48	0.50	0.50	0.52	31.01	36.34	60.00 (51.14)
D7C3	15.47	2.13	28.03	38.27	39.87	49.13	2.40	0.42	0.48	0.44	0.47	29.77	34.17	43.33 (41.07)
S.Em±	0.47	0.24	1.10	0.44	0.72	1.41	0.15	0.02	0.02	0.02	0.03	0.58	0.68	3.33 (2.77)
CD at 5%	1.26	0.73	3.35	1.29	1.83	3.36	0.40	NS	NS	NS	NS	NS	1.89	8.84 (NS)

Note: Data in the parenthesis indicate are-sin transformed values used in statistical analysis

T1	- D1C1	: 10 February 2021 + Mist chamber	T12	- D4C3	: 10 March 2021 + Open condition
T2	- D1C2	: 10 February 2021 + Shade net house	T13	- D5C1	: 20 March 2021 + Mist chamber
T3	- D1C3	: 10 February 2021 + Open condition	T14	- D5C2	: 20 March 2021 + Shade net house
T4	- D2C1	: 20 February 2021 + Mist chamber	T15	- D5C3	: 20 March 2021 + Open condition
T5	- D2C2	: 20 February 2021 + Shade net house	T16	- D6C1	: 30 March 2021 + Mist chamber
T6	- D2C3	: 20 February 2021 + Open condition	T17	- D6C2	: 30 March 2021 + Shade net house
T7	- D3C1	: 01 March 2021 + Mist chamber	T18	- D6C3	: 30 March 2021 + Open condition
T8	- D3C2	: 01 March 2021 + Shade net house	T19	- D7C1	: 10 April 2021 + Mist chamber
T9	- D3C3	: 01 March 2021 + Open condition	T20	- D7C2	: 10 April 2021 + Shade net house
T10	- D4C1	: 10 March 2021 + Mist chamber	T21	- D7C3	: 10 April 2021 + Open condition
T11	- D4C2	: 10 March 2021 + Shade net house			

Length of sprout (cm)

The maximum length of sprout (43.86 cm and 49.08 cm) was noted when grafting was done on 10 March (D_4), followed by 01 March (D_3) at 90 days after grafting and at 120 DAG, followed by 20 March (D_5) respectively. Whereas, the minimum length of sprout (33.55 cm and 39.03 cm) was recorded on 10 April (D_7) at 90 and 120 DAG, respectively. Among different growing conditions, maximum length of sprout (45.48 cm and 52.67 cm) was observed under mist chamber (C_1) followed by shade net (C_2) at 90 and 120 DAG,

respectively. The minimum length of sprout (34.39 cm and 39.42 cm) was observed in open condition (C_3) at 90 and 120 DAG, respectively.

Among various treatment combinations the maximum length of sprout (53.09 cm and 60.68 cm) was noted when grafting was performed on 10 March under mist chamber (D_4C_1), followed by 20 March under mist chamber (D_5C_1) at 90 and 120 DAG, respectively. However, the minimum length of sprout (29.77 cm and 34.17 cm) was noted when grafting was performed on 10 April under open condition (D_7C_3) at 90 and 120 DAG, respectively. The most probable reason increase in length of shoot inside mist chamber might be due to prevailing optimum temperature and relative humidity which helped in faster growth in meristematic cells coupled with better process like photosynthesis and lower respiration. The results are supported by the studies of Dhutraj *et al.* (2018) [3] and Praveenakumar *et al.* (2019) [7] in tamarind.

Graft survival percent

The maximum graft survival percent (65.56%) was observed, when grafting was performed on 10 March (D_4), which was at par with 20 March (D_5) and 30 March (D_6). However, the minimum graft survival percent (52.22%) was recorded in grafting performed on 10 February (D_1) at 120 DAG. Different growing conditions showed a significant effect of graft survival. The maximum graft survival percent (74.29%) was noted, when grafting was performed under Mist chamber (C_1), followed by shade net house (C_2). While, the minimum graft survival percent (46.19%) was recorded in open condition (C_3).

Among various treatment combinations the highest graft survival percent (80.00%) was observed when grafting was performed on 10 March under mist chamber (D_4C_1), which was at par with 20 February under mist chamber (D_2C_1), 01 March under mist chamber (D_3C_1), 20 March under mist chamber (D_5C_1) and 30 March under mist chamber (D_6C_1). However, the minimum graft survival percent (40.00%) was observed when grafting was performed on 10 February (D_1C_3) at 120 DAG. The highest graft survival on 10 March under mist chamber condition might be due to optimum conditions (higher temperature and relative humidity) inside the mist chamber for a longer period which prevented desiccation of the scion and formation of better union of grafted scion and stocks that helped for better survival of the grafts. The mentioned result is in accordance with Raghavendra *et al.* (2011) [8] in jamun.

Conclusion

Among the different treatment combination D_4C_1 (10 March + mist chamber) was found better for most of the growth parameter *viz*. least number of days taken for first sprouting, maximum number of sprouts, number of leaves, plant height, number of branches, length of sprout per graft, graft success and survival per cent except graft diameter of scion and rootstock which was observed under treatment combination D_5C_1 (20 March, 2021 + mist chamber).

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