



E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2017; 6(5): 2690-2695
Received: 20-07-2017
Accepted: 21-08-2017

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Studies on period of defoliation and storage condition of scion sticks for soft wood grafting in tamarind (*Tamarindus indica* L.)

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Abstract

The field experiment entitled Studies on various techniques of soft wood grafting in tamarind (*Tamarindus indica* L.) was conducted during the summer season of year 2012 at fruit research station, Aurangabad. The experiment laid out in split plot design with three defoliation treatment viz., D₀: defoliation on the day of grafting, D₁:4 days prior defoliation and D₂:8 days prior defoliation as a main plot, three storage condition of scion sticks viz., P₀: open condition or without use of polythene bag, P₁: use of 2 x 11" polythene bag and P₂: use of 6 x 9" polythene bag as a sub plot. Grafting was done in month of April 2012 from the result of experiment. It can be concluded that among different days tested, 8 days prior defoliation recorded highest growth and survival than 4 days prior defoliation and on the day of grafting respectively from different storage condition for scion sticks P₂ shows significantly superior in growth character than P₁ and P₀, while survival percentage found maximum P₀ than P₁ and P₂.

Keywords: Soft wood grafting, Storage medium, Defoliation and Tamarind

Introduction

Tamarind (*Tamarindus indica* L.) is economically important dry land fruit crop grown in India mainly for its sour pulp. Seed of tamarind has many industrial uses viz. starch, dye, oil, gum etc. The concentrate of tamarind is also being exported from India. The pulp is much used in the Indian medicine as a, refrigerant, carminative and laxative and is also commonly prescribed in febrile diseases. It is also used as dyeing, tanning and for polishing and cleaning meltware.

Tamarind is highly cross pollinated crop hence in order to perpetuate desirable characters vegetative propagation is a must. Several methods of grafting with detached scion have been tested for the propagation of Tamarind by the Purushotham and Rao (1990) [11] found more success with softwood grafting.

The grafting operation carried out in nursery has very less success when these grafts are transplanted in the field. While large number of grafts also gets damaged due to poor transport facilities and improper transplanting material. Therefore softwood grafting in situ is recommended to avoid mortality of grafts during transportation and less success of grafting in nursery.

The grafting operations carried out in the nursery beds and in situ are less success due to the high atmospheric temperature, low humidity and other climatic factors. Shading nets give the cooling ability and provide better humidity to success the grafts.

Studies on suitable defoliation period and storage of scion sticks with view of utilizing them for grafting at prevailing temperature and humidity is of practical economic utility to the nurserymen and the cultivars. However, grafting period of tamarind is in March-April i.e. in summer.

Material and methods

The present investigation was carried out to studies on various techniques for softwood grafting in tamarind (*Tamarindus indica* L.). The experimental laid out in split plot design there were 27 treatment combinations each treatment was replicated three times. Total area of each plot structure was 0.3600m² (60 x 60 cm).

Treatment detail**A. Main plot**

D : Defoliation period

D₀ : On the day of grafting

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- D₁ : 4 days prior to grafting
 D₂ : 8 days prior to grafting

B. Sub plot

- P : Storage of scion stick
 P₀ : Open condition
 P₁ : Using of 2 x 11'' polythene bag (100 gauge) for covering of scion sticks.
 P₂ : Using of 6 x 9'' polythene bags (100 gauge) for covering of scion sticks.

Grafting material

Under this set of experiment pre defoliated scion shoots (4 days prior, 8 days prior and 0 days or on the day of grafting) were taken. These shoots were of 6 to 8 months old and 8-10 cm length collected on from the plant. 540 bud sticks from each condition i.e. 4 days prior defoliation, 8 days prior defoliation and on the day or zero days of defoliation was excised from scion tree and grafting operation were carried out. Immediately after grafting 100 gauge transparent polythene bag of 2 x 11'' and 6 x 9'' size inverted on the scion stick's to cover it and tied at base of root stocks with the help of rubber according to treatment wise time of grafting operation 60 scion shoots mostly uniform in all respects were taken and used for the preparation of softwood grafts. There were 20 scion shoots replicated three times under each treatment combination the polythene caps over grafts were removed after sprouting of grafts.

Sowing of Seeds

Uniform sized and healthy seeds of tamarind were sown in 15 x 22.5 cm size 100 gauge thick and 1 kg capacity bags were selected and filled with black soil and well decomposed FYM and seed sown in polythene bag. Sowing was carried out in last week of August. The germinated seedlings were protected from insects pests and disease by spraying insecticide and fungicide as and when required.

The selection of scion sticks was done by considering healthiness, proper maturity and size of about same thickness as that of rootstock was selected for grafting. The length of scion was about 8-10 cm. These bud stick were defoliated on the mother tree 8 days prior, 4 days prior and on the days of grafting or zero days prior to grafting.

The softwood grafting was done on newly emerged tamarind shoots as per the method suggested by Amin (1978) [2] that is at the time of grafting lower end of scion was mended on 3 cm as wedge by chopping of the bark and wood from the two opposite sites taking care to remain some bark on the remaining two sides. The wedge of the stock secured finally with 1.5 cm wide and 45 cm long 200 gauge white transparent polythene strip to avoid water entry as well as damage on the graft part which could affect the graft union and subsequently graft success.

After care

After grafting operation the graft were placed in different storage condition according to treatment and water every day the sprouting of new shoot on the root stock was removed with the help of knife. Two spraying of fungicide and insecticide were also carried out at 30 days interval after grafting i.e. to avoid fungal disease and insects which may affected final success.

In this experiment 5 grafts per replication and 15 grafts under

each treatment combination were selected for different growth observation. Mean value of different growth observation are reported the details of observation such as days required to First sprout, Sprouting percentage, Survival percentage, Diameter of scion stick (cm), root stock, Stem girth above and below the joint (cm), number of bud sprouted, number of leaves per graft, length of leaf (cm), number of vegetative flushes/graft, height of graft (cm), number of branches/graft and Spread of graft NS x EW (cm²).

Result and Discussion

Effect of defoliation treatment

Days required to first sprouting from the grafting was found to differ significant amongst defoliation (Table 1). Defoliation 8 days prior to grafting (D₂) recorded significantly less number of days (12.09) to sprouting while defoliation on the day of grafting recorded more number of days to sprout (13.68) this might be due to accumulation of food material in the scion stick. The similar result reported by Patil (1980) [9].

Data presented in Table 1 indicate that defoliation 8 days prior to grafting (D₂) recorded highest spouting percentage on 30 DAG (83.15 %) and on 60 DAG (43.06) respectively than other treatment. It might be a due to the activation of bud having sufficient food material. Similar finding have been reported by Pampanna and Sulikeri (2001) [8].

The observation on the data reported of effect of defoliation period of scion regarding the final survival percentage (Table 1) indicated that in soft wood grafting the treatment 8 days defoliation before grafting operation recorded significantly highest survival percentage (36.09 %) as compare to D₁ and D₀ treatment. It might be definitely there is benefit of earlier defoliation of bud having sufficient accumulated food material. Similar finding have been reported by Kadam *et al.* (1996) [5].

Eight day prior defoliation period was recorded highest length of leaf in tamarind graft (5.66 cm) than rest of the treatment. On the day of grafting defoliation (D₀) show lowest length It might be due to a storage of food material and moisture in defoliated scion stick. This finding similar to result noticed by Jha and Brahmachari (2002) [6].

Diameter of scion sticks and root stock differ with other in different strain (Table 2). D₂ (defoliation 8 days prior) recorded maximum diameter of scion stick (0.58 cm) and diameter of root stock (0.60 cm) than other treatment. This might be due to a more moisture and nutrient availability in scion stick. This findings one presented in agreement with the finding observed by Jha and Brahmachari (2002) [4].

Height of grafts significantly influenced by different defoliation treatment. The finding are in contradiction with the result reported by Mankar *et al.* (1999) [6]. The defoliation 8 days prior to grafting (D₂) shows maximum height of graft than other defoliation treatment. This might be due to the storage of humidity and food material in the scion stick which reflects on growth stages.

Stem girth above the joint and below the joint influenced significantly by various defoliation period at all growth stages except on 60 days after grafting. Defoliation 8 days prior show highest stem girth above (1.78 cm) and below (1.87 cm) joint respectively than other treatments. It might be due to humidity and nutrient storage. This findings are presented in agreement with finding observed by Adjei and Mante (2007) [11].

Table 1: Number of average days required to First sprout, Sprouting percentage, Survival percentage, Length of Leaf (cm), number of vegetative flushes/graft influenced by various treatment

Treatment	Days required to sprouting	Days after grafting		Survival (%)	Length of Leaf (cm)			number of vegetative flushes/graft			
		30 DAG	60 DAG		30	60	90	30	60	90	
Defoliation (D)											
D ₀ - One the day of grafting	13.68	77.37 (52.80)	41.76 (24.85)	32.67 (19.09)	2.10	3.18	4.97	2.41	3.36	4.58	
D ₁ - Four days prior	13.48	79.26 (52.62)	42.84 (25.04)	33.93 (19.85)	2.13	3.24	5.28	2.52	3.59	4.68	
D ₂ - Eight days prior	12.09	83.15 (54.81)	43.06 (25.62)	36.09 (21.17)	2.19	3.39	5.66	2.68	3.64	4.81	
SE ±	0.012	0.44	0.04	0.27	0.009	0.009	0.005	0.008	0.008	0.007	
CD at 5%	0.46	1.74	0.17	1.06	0.030	0.035	0.019	0.03	0.03	0.02	
Storage of scion stick (P)											
P ₀ - Open condition	13.79	76.21 (49.94)	49.86 (31.04)	36.71 (21.57)	2.08	3.20	5.21	2.52	3.47	4.62	
P ₁ - Use 2x11" polythene bag	12.64	80.33 (53.63)	39.28 (23.81)	31.77 (18.54)	2.14	3.28	5.26	2.55	3.51	4.64	
P ₂ - Use 6x9" polythene bag	12.82	83.41 (56.68)	40.58 (24.08)	34.20 (20.01)	2.20	3.33	5.43	2.57	3.60	4.74	
SE ±	0.020	0.20	0.38	0.20	0.010	0.006	0.009	0.01	0.006	0.02	
CD at 5%	0.62	0.62	1.16	0.63	0.030	0.020	0.028	0.03	0.02	0.06	
Interaction (D x P)											
SE ±	0.35	0.35	1.65	0.35	0.016	0.012	0.016	0.02	0.01	0.03	
CD at 5%	NS	1.08	NS	NS	NS	NS	NS	0.06	0.03	0.09	
General Mean	13.08	80.04 (53.36)	43.01 (25.35)	34.23	2.14	3.27	5.30	2.55	3.53	4.69	

Table 2: Diameter of scion stick (cm), root stock and height of graft (cm) influenced by various treatment

Treatment	Days after grafting						Days after grafting						Days after grafting						
	15	30	45	60	75	90	15	30	45	60	75	90	15	30	45	60	75	90	
Defoliation (D)																			
D ₀ - One the day of grafting	0.42	0.43	0.45	1.48	1.52	1.55	0.43	0.44	0.46	0.49	0.53	0.56	25.87	27.12	29.41	32.64	35.81	40.27	
D ₁ - Four days prior	0.42	0.43	0.45	1.48	0.52	0.56	0.44	0.44	0.46	0.50	0.54	0.58	24.97	26.05	28.96	33.28	37.15	42.06	
D ₂ - Eight days prior	0.43	0.44	1.46	1.49	0.54	0.58	0.44	0.45	0.48	0.51	0.56	0.60	25.09	26.65	29.96	33.36	37.77	43.21	
SE ±	0.002	0.001	0.001	0.002	0.002	0.001	0.003	0.001	0.001	0.003	0.002	0.001	0.09	0.08	0.02	0.08	0.14	0.12	
CD at 5%	0.009	0.003	0.003	NS	0.006	0.003	0.01	0.003	0.003	NS	0.006	0.005	0.35	0.34	0.10	0.32	0.58	0.48	
Storage of scion stick (P)																			
P ₀ - Open condition	0.43	0.44	0.46	0.48	0.53	0.55	0.44	0.45	0.47	0.49	0.53	0.56	25.52	26.81	29.39	32.79	36.84	40.91	
P ₁ - Use 2x11" polythene bag	0.42	0.43	0.46	0.49	0.52	0.56	0.44	0.45	0.47	0.50	0.53	0.59	25.38	26.71	29.77	33.39	37.59	42.60	
P ₂ - Use 6x9" polythene bag	0.43	0.44	0.45	0.48	0.52	0.57	0.43	0.44	0.46	0.50	0.54	0.59	25.02	26.20	29.23	33.01	37.28	43.04	
SE ±	0.002	0.002	0.002	0.003	0.002	0.002	0.002	0.002	0.003	0.004	0.002	0.003	0.12	0.07	0.14	0.10	0.12	0.17	
CD at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	0.35	0.21	NS	0.32	0.37	0.54	
Interaction (D x P)																			
SE ±	0.002	0.002	0.002	0.005	0.005	0.08	0.002	0.002	0.003	0.006	0.006	0.009	0.20	0.67	0.48	0.67	0.69	1.39	
CD at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	
General Mean	0.43	0.45	0.47	0.50	0.54	0.58	0.43	0.45	0.47	0.50	0.54	0.58	25.31	26.57	29.46	33.06	37.24	42.18	

Table 3: Stem girth above, below the joint (cm) and number of bud sprouted influenced by various treatment

Treatment	Days after grafting						Days after grafting						Days after grafting					
	15	30	45	60	75	90	15	30	45	60	75	90	15	30	45	60	75	90
Defoliation (D)																		
D ₀ - One the day of grafting	1.33	1.35	1.42	1.51	1.63	1.73	1.33	1.37	1.41	1.47	1.68	1.79	2.08	2.38	2.75	3.16	3.64	4.41
D ₁ - Four days prior	1.32	1.36	1.41	1.52	1.63	1.73	1.32	1.35	1.39	1.46	1.69	1.83	2.14	2.44	2.86	3.48	3.95	4.83
D ₂ - Eight days prior	1.35	1.40	1.43	1.53	1.65	1.78	1.35	1.38	1.43	1.50	1.72	1.87	2.20	2.51	3.00	3.57	4.15	5.12
SE ±	0.004	0.003	0.003	0.01	0.005	0.006	0.003	0.002	0.003	0.008	0.005	0.004	0.004	0.006	0.006	0.002	0.008	0.008
CD at 5%	0.01	0.009	0.012	NS	0.02	0.02	0.01	0.009	0.012	NS	0.025	0.017	0.014	0.03	0.02	0.07	0.03	0.03
Storage of scion stick (P)																		
P ₀ - Open condition	1.35	1.40	1.46	1.54	1.62	1.73	1.38	1.42	1.49	1.59	1.69	1.82	2.10	2.38	2.79	3.30	3.80	4.61
P ₁ - Use 2x11" polythene bag	1.34	1.37	1.45	1.53	1.63	1.73	1.32	1.41	1.48	1.58	1.69	1.82	2.15	2.44	2.89	3.38	3.90	4.80
P ₂ - Use 6x9" polythene bag	1.35	1.40	1.47	1.53	1.65	1.75	1.35	1.40	1.47	1.58	1.70	1.83	2.19	2.51	2.93	3.49	4.02	4.95
SE ±	0.006	0.007	0.01	0.01	0.006	0.01	0.005	0.005	0.008	0.01	0.006	0.008	0.01	0.01	0.02	0.01	0.02	0.01
CD at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	0.04	0.03	0.06	0.04	0.06	0.04
Interaction (D x P)																		
SE ±	0.008	0.01	0.01	0.02	0.02	0.04	0.009	0.009	0.01	0.02	0.02	0.03	0.02	0.02	0.03	0.02	0.025	0.046
CD at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
General Mean	1.35	1.39	1.45	1.54	1.64	1.75	1.37	1.41	1.48	1.59	1.70	1.82	2.14	2.48	3.00	3.49	3.91	4.79

Table 4: Number of leaves per graft, Number of branches/graft and Spread of graft NS x EW (cm²) influenced by various treatments

Treatment	Days after grafting						Days after grafting						Days after grafting					
	15	30	45	60	75	90	15	30	45	60	75	90	15	30	45	60	75	90
Defoliation (D)																		
D ₀ - One the day of grafting	5.13	7.78	10.82	14.68	19.78	25.05	1.89	1.98	2.13	2.37	2.57	2.75	2.97	5.90	12.28	18.43	27.51	38.64
D ₁ - Four days prior	5.45	8.59	11.79	16.87	25.49	34.72	1.96	2.05	2.22	2.57	2.81	3.21	3.03	6.07	13.65	20.07	30.46	41.86
D ₂ - Eight days prior	6.19	9.84	14.72	22.20	31.29	42.61	2.01	2.14	2.35	2.66	3.00	3.36	3.40	6.74	16.22	24.08	35.20	49.14
SE ±	0.071	0.06	0.19	0.19	0.18	0.20	0.05	0.01	0.03	0.04	0.03	0.04	0.03	0.03	0.07	0.08	0.16	0.20
CD at 5%	NS	NS	0.74	0.74	0.71	0.80	NS	0.05	0.13	0.17	0.11	0.17	0.13	0.13	0.28	0.32	0.65	0.82
Storage of scion stick (P)																		
P ₀ - Open condition	5.13	7.74	11.34	15.71	22.23	30.80	1.95	1.99	2.15	2.45	2.65	2.93	2.99	6.0	12.80	18.70	28.06	39.63
P ₁ - Use 2x11" polythene bag	5.62	8.95	12.23	18.28	25.27	33.25	1.95	2.06	2.25	2.53	2.80	3.06	3.19	6.36	14.22	21.14	31.71	43.84
P ₂ - Use 6x9" polythene bag	6.01	9.52	13.82	19.74	29.05	38.24	2.00	2.12	2.32	2.61	2.94	3.22	3.23	6.35	15.13	22.74	33.40	46.18
SE ±	0.07	0.09	0.18	0.19	0.19	0.20	0.04	0.04	0.02	0.05	0.05	0.04	0.02	0.02	0.10	0.10	0.18	0.21
CD at 5%	NS	0.30	0.58	0.58	0.61	0.63	NS	NS	0.07	NS	0.14	0.12	0.07	0.07	0.31	0.36	0.57	0.67
Interaction (D x P)																		
SE ±	0.12	0.17	0.32	0.33	0.34	0.35	0.08	0.07	0.04	0.09	0.08	0.06	0.25	0.25	0.17	0.18	0.32	0.37
CD at 5%	NS	NS	1.00	1.00	1.06	1.09	NS	NS	NS	NS	NS	NS	NS	NS	0.53	0.58	0.98	1.16
General Mean	5.59	8.74	14.78	22.20	25.52	34.13	1.96	2.06	2.24	2.53	2.80	3.07	3.14	6.24	14.05	20.86	31.06	43.21

Number of bud sprouted (Table 3) influenced significantly by various defoliation treatment. Defoliation 8 days prior to grafting (D_2) show highest number of bud sprouted (5.12) than other defoliation period this is due to the activation of bud having sufficient accumulated food material in scion stick. Similar finding was noticed by Patil (1980) [9].

Studying the data on the observation of growth in respect of number of leaves revealed that (Table 4) there was significant increase in leaves number by the treatment of 8 days defoliation period (42.61). It might be due to high number of bud sprouting and high number of branches per graft this finding similar to result noticed by Jha and Brahmchan (2002) [4].

Number of branches and number of vegetative flushes significantly influenced by various defoliation period. 8 days prior defoliation recorded highest number of branches (3.36) and vegetative flushes (4.81) than other treatment this might be due to accumulation of food material in scion sticks. Similar finding were noticed by Adei and Mante (2007) [1].

Spread of graft influenced by various defoliation days while highest spread recorded when defoliation was done on 8 days prior to grafting (49.14 cm^2) than other treatment. It might be due to a highest height of graft and number of braches similar finding reported by Patil (1980) [9].

Effect of storage of scion stick

The effect of storage of scion sticks on the time taken for sprouting of bud sticks was found significant. In present finding significantly less number of days (12.64) were taken for sprouting under the treatment where the scion sticks were stored in 2×11 " polythene bag (P_2) while delayed sprouting noticed when bud stick stored in open condition (P_0). It might be due to the fact of polythene bag increase inside humidity and kept moderate temperature. Similar finding reported by Jacomino *et al.* (1999) [3].

Data presented in Table 1 indicated that on 30 DAG sprouting percentage was found maximum in storage of scion stick by using 6×9 " polythene bag (83.41 %) followed P_1 (80.33 %) and P_2 (76.21 %) respectively. It might be due to favorable humidity and temperature inside polythene bag at initial stage. On 60 DAG maximum sprouting percentage recorded when scion stored in open condition without any polythene bag use (49.86 %). Because of improper graft union the vascular connection between scion and root stock polythene bag recorded less sprouting percentage than control treatment.

Maximum survival percentage (36.76) found on 90 DAG when scion stick stored in open condition followed by P_2 (34.20) and P_1 (31.77) respectively this might be a due to improper graft union.

Diameter of scion stick, diameter of root stock, Girth of stem above the joint and bellow the joint not differ significantly due to various storage condition for scion sticks after grafting maximum diameter of scion sticks (0.56 cm), root stock (59) stem girth above the joint (1.75) and bellow the joint (1.83) was found maximum when it stored in 6×9 " polythene bag. It could be because proper humidity and temperature resulted in avoiding the loss of moisture through scion.

The different polythene bag used for storage of scion sticks after grafting had significant influence in increasing height of the graft while scion sticks stored in 6×9 " polythene bag recorded maximum height of graft (43.04 cm) on 90 DAG whereas, comparatively poor growth was noticed in open condition (40.91 cm). It may be because of the deterioration of and dehydration of scion sticks during storage avoided. Similar finding reported by Nimbalkar *et al.* (2011) [7].

Different polythene caps used for storing scion sticks influenced significant effect on number of bud spouted. Maximum number of bud sprouted (4.95) was noticed. When bud stick stored in 6×9 " polythene bag (P_2) followed by P_1 (2×11 " polythene bag) and P_0 (open condition). It could be because of proper humidity and temperature resulted in avoiding the loss of moisture through scion during the storage period.

Data presented in Table 4 and Table 1 indicated number of leaves per plant and length of leaves significantly influenced by use of polythene bags for storage of scion stick. Maximum number of leaves (38.24) and length leaf (5.43 cm) was recorded when scion stick stored in 6×9 " sized polythene bag than rest of the treatment. Production of more leaves and length of leaves may because storage of moisture at initial stage of grafting. Similar finding were noticed by Ram Chandra and Jadhav (2012) [2].

Number of vegetative flushes influenced significantly by various storage conditions of scion sticks. Maximum number of branches (3.22) and vegetative flushes (4.74) were recorded when scion stick stored by using 6×9 " polythene bag (P) followed by P_1 and P_0 at 90 DAG. It might be due to storage of humidity in scion stick at initial stage. Similar finding was recorded by Paunovic *et al.* (2012) [10].

Spread of graft influenced significantly by storage of scion stick. Maximum spread of graft found (46.18) when scion stick stored in 6×9 " polythene bag (P_2) than rest of treatment. It might be due to moderate moisture condition. Similar finding reported by Nimbalkar *et al.* (2011) [7].

Interaction

Interaction effect between defoliation days (D) and storage of scion sticks (P) among each other was not found significant in following growth characters i.e days required to first sprout, spouting percentage 60 DAG, survival percentage, length of leaf, diameter of scion and root stocks, height of grafts, girth of sticks stem above and below the joint, number of buds and number of branches.

Sprouting percentage on 30 DAG significantly influenced by $D \times P$. Interaction D_2P_2 showed maximum sprouting percentage (84.97%). It might be due to storage of food material and humidity.

Number of leaves influenced significantly by various interaction between various factors $D \times P$ interaction on 45, 60, 75 and 90 DAG show significant effect while D_2P_2 combination recorded maximum number of leaves.

Number of vegetative flushes significantly influenced by $D \times P$ interaction. D_2P_2 combination significantly superior.

Spread of graft in NS \times EW direction influenced significantly by interaction between various factors. $D \times P$ interaction significantly influenced on 45, 60 75 and 90 DAG. D_2P_2 combination recorded maximum spread of graft. It might be a due to storage of food material and favorable environment factors.

Summary and conclusion

Number of days required to first sprouting which is less in treatment D_2 (12.09) compared to other. In storage condition P_1 is significantly (12.64) superior over condition.

Sprouting percentage observed on 30 and 60 DAG. On 30 days D_2 (83.15%) and P_2 (83.41%) shows maximum Sprouting percentage while on 60 days D_2 (43.06%) and P_0 (49.86%) show maximum sprouting percentage. Interaction between $D \times P$ on 30 days show significant result and among all combination D_2P_2 show maximum sprouting percentage.

Survival percentage recorded on 90 days after grafting which significantly influenced by various factor. Defoliation 8 days prior to grafting (36.09%) and storage of scion stick in open condition (36.71%) shows highest survival percentage than other treatments.

Length of leaf was found to be maximum when defoliation done 8 days prior to grafting (D₂) and stored scion sticks by using 6 x 9" polythene bag graft than other treatment at all stages of growth of graft.

Number of vegetative flushes influenced significantly by various treatment. Defoliation 8 days prior (D₂) and storage of scion sticks by using 6 x 9" polythene bag shows highest number of vegetative flushes than other treatment. Interaction between D x P show significant effect while D₂P₂ shows highest number of vegetative flushes than other combination.

The storage of scion sticks did not influence on the diameter of scion sticks while the defoliation eight days prior (D₂) observed superior in diameter of scion sticks. The diameter of root stock recorded maximum when defoliation done 8 days prior to grafting (D₂). Storage of scion sticks did not influence diameter of root stock. The graft height increased continuously. Defoliation 8 days prior to grafting and scion stick storage in 6 x 9" polythene bag observed significantly superior.

The stem girth above the joint and below the joint was not influenced significantly by storage of scion sticks. Number of bud sprouted recorded at 15, 30, 45, 60 and 90 DAG. Different defoliation period and storage of scion sticks on influenced significantly on number of bud sprouted. D₂ (5-12) and P₂ (4.95) significantly higher number of bud sprouted than other treatment.

The maximum number of functional leaves were maximum in D₂ treatment (42.63) and P₂ treatment (38.24) respectively over other treatment. Interaction between D x P significant on 60, 75 and 90 DAG. In D x P interaction D₂P₂ combination shows highest number of leaves per graft.

Defoliation days and storage of scion sticks influence number of branches per graft. Defoliation 8 days prior (D₂) and storage of scion stick by using 6 x 9" Polythene bag (P₂) shows maximum number of branches than other treatment.

The highest spread of graft observed when defoliation was done 8 days prior to grafting (D₂) and storage of scion stick by using 6 x 9" polythene bag than other treatment. Interaction between D x P show significant result on 60, 75 and 90 DAG. In D x P interaction D₂P₂ combination show maximum spread of graft than other combination.

Conclusion

The findings of present investigation are concluded as below:

1. Among the defoliation treatment, 8 days prior to grafting shows maximum growth, sprouting percentage and survival percentage than 4 days prior to grafting and on the day of grafting defoliation.
2. The storage of scion by using polythene bag of size 6 x 9" shows highest growth than other but the open condition shows highest survival percentage hence adopt storage of scion stick without using polythene bag.

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