The Pharma Innovation Journal 2021; SP-10(12): 782-787

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2021; SP-10(12): 782-787

www.thepharmajournal.com
Received: 13-10-2021
Accepted: 15-11-2021

KD Mithapara
Department of Horticulture, College of Agriculture, Junagadh Agricultural University, Junagadh, Gujarat, India

KM Karetha
Department of Horticulture, College of Agriculture, Junagadh Agricultural University, Junagadh, Gujarat, India

Corresponding Author
KD Mithapara
Department of Horticulture, College of Agriculture, Junagadh Agricultural University, Junagadh, Gujarat, India

Influence of season and environmental conditions on growth parameters of softwood grafts of sapota cv. Kalipatti

KD Mithapara and KM Karetha

Abstract
An investigation was carried out at Hi-Tech Horticulture Park, Department of Horticulture, JAU, Junagadh during the year 2019-20. The treatments comprised of three level of season (S) *viz*., S_1 = February-March (Summer), S_2 = June-July (Kharif), S_3 = September-October (Winter) and three level of environmental conditions (C) *viz*., C_1 = Open field, C_2 = Net house, C_3 = Polyhouse. The experiment was laid out in Completely Randomized Design (CRD) with Factorial concept comprising nine treatment combinations with three replications. The result indicated among season February-March recorded highest scion length (8.04 cm) and (9.19 cm) at 90 and 120 DAG, respectively. September-October recorded maximum number of nodes per graft (8.50, 11.26, 12.29 and 14.43), highest graft girth (0.72 cm, 0.74 cm, 0.78 cm and 0.81 cm), highest rootstock length (19.19 cm, 19.58 cm, 20.09 cm and 20.55 cm) at 30, 60, 90 and 120 DAG, respectively and highest graft height (25.02 cm) and (26.08 cm) at 30 and 60 DAG, respectively. While maximum number of leaves per graft (8.57) and (11.43) at 30 and 60 DAG, respectively was noted in September-October whereas, (14.77) and (16.43) at 90 and 120 DAG, respectively was noted in February-March. The result indicated different environmental conditions polyhouse recorded maximum number of nodes per graft (5.87, 9.69, 11.03 and 13.58) and maximum number of leaves per graft (6.72, 12.59, 14.99 and 18.11) at 30, 60, 90 and 120 DAG, respectively whereas, highest graft girth (0.60 cm) and (0.65 cm) at 30 and 60 DAG, respectively and highest scion length (8.84 cm) at 120 DAG. The result indicated among interaction effect September-October + Open field recorded highest graft height (27.04 cm, 27.89 cm and 28.38 cm) at 30, 60 and 90 DAG, respectively and highest rootstock length (21.01 cm) and (21.26 cm) at 30 and 60 DAG, respectively. Maximum number of nodes per graft (8.80) at 30 DAG and was noted in September-October + Net house whereas, (13.13, 14.73, 18.33) at 60, 90 and 120 DAG, respectively was noted in June-July + Polyhouse. Maximum number of leaves per graft (8.90) at 30 DAG was noted in September-October + Net house while (14.00) at 60 DAG was noted in June-July + Polyhouse whereas, (16.30) and (19.90) at 90 and 120 DAG, respectively was noted in February-March + Polyhouse.

Keywords: sapota, softwood grafting, season, environmental conditions

Introduction
Sapota is botanically known as *Manilkara achras* (Mill.) Fosberg an evergreen tropical tree fruit belonging to the family Sapotaceae. Since, inarching have been commercially adapted method of vegetative propagation of sapota in the country for longer time, but this method has some disadvantages like it is expensive, time-consuming, cumbersome and laborious because rootstock seedlings have to be carried to the mother plant for grafting and also fails to produce erect plants with uniform canopy.

An alternative method to inarching; softwood grafting is becoming very popular and is commercially standardized in many fruit crops like mango (Amin, 1974), sapota (Pampanna and Sulikeri, 2000), guava (Singh *et al*., 2007), jamun (Mulla *et al*., 2011), custard apple (Ghosh *et al*., 2004), cashew (Swamy *et al*., 1990), jackfruit (Selvi, 2005), aonla (Panchbhai *et al*., 2006) [1, 15, 21, 14, 10, 24, 20, 16] etc. Advantages of this method includes; involves simple skill, convenient in handling, economically viable, cost effective, easier to adopt, rapid and can give considerable percentage of success. Normally, grafts raised by this method produce erect and stout plants of uniform canopy, which is one of the most important prerequisites for successful modern orchard like high density planting system. Also important feature of this method are; it allows higher rate of multiplication of plants and resultant plants will be vigorous. Besides these, it is very much effective in dry, hot weather or in areas of low precipitation especially in arid regions.

Also this method becomes important when planting materials from mother plants Are limited as many grafts prepared from a single tree.

Only 4-5 months are suitable for propagation period of sapota in Gujarat lasts from February-July, mostly carried out on the onset of monsoon which limits the availability of planting material for that particular season. Therefore, using net and poly house for production of off-seasonal planting material. A controlled environmental condition showing congenial for faster healing and callus formation results in better success and survival of grafts (Chander, 2016a) [4]. The controlled environment conditions including mist chamber, shade net, low tunnel and green house, where one can increase the rate of success percent by providing favorable conditions (Vishnuvardhan, 2002) [25]. In India, construction of temporarily low cost polyhouse is become popular for raising nursery of fruit plant in off-season.

A lot of research work has been done on propagation of sapota at various places regarding with seasonal variation and influence of climatic conditions on growth of grafts. But information regarding to the impact of season and environmental conditions on growth of grafts of sapota under Saurashtra region of Gujarat conditions is still unknown. Keeping in view of above facts, an attempt was made to find out the suitable season as well as propagation environment for their response to growth of grafts in comparison with open conditions to obtain commercial production of grafts throughout the year.

Material & Methods

The present investigation was carried out at Hi-Tech Horticulture Park, Department of Horticulture, JAU, Junagadh during the year 2019-20. The treatments comprised of three level of season (S) *viz*., S_1 = February-March (Summer), S_2 = June-July (Kharif), S_3 = September-October (Winter) and three level of environmental conditions (C) *viz*., C_1 = Open field, C_2 = Net house, C_3 = Polyhouse. The experiment was laid out in Completely Randomized Design (CRD) with Factorial concept comprising nine treatment combinations with three replications. Junagadh is situated in South Saurashtra Agro-climatic region of Gujarat state. Geographically, this place is situated at 21.5º N latitude and 70.5º E longitude with an altitude of 60 meters above the mean sea level and 80 kilometers away from Arabian Sea Coast on western side at the foothill of the mount Girnar.

The grafting operation was done on 1.5 years old khirni rootstock seedlings. Non-flowered terminal or lateral shoots of current season's growth with pencil thickness, greenish brown coloured mature and healthy scions were collected from Kalipatti variety of sapota trees at Hiravadi Farm, Department of Soil and Water Conservation Engineering, College of Agricultural Engineering and Technology, JAU, Junagadh. Defoliation of scion on mother tree was done at 15 days prior to grafting. The petiole stubs dried up and dropped off when touched leaving a healed scar of defoliated scion sticks at this stage indicated that scion was ready for grafting. Unsprouted scion sticks with well-developed buds were detached from the selected mother tree in the morning on the day of grafting.

Method of softwood grafting

On the rootstock two pairs or 3-4 bottom leaves were retained and the other leaves were removed using a sharp grafting knife. The selected rootstock was headed back about 15 cm above the polybag where soft wood portion was available on the rootstock and the terminal shoot was removed with the help of secateur. A deep vertical straight cut of 4 cm was made on the center of the beheaded rootstock with the help of sharp grafting knife. A matching thickness of rootstock, scion was reduced to a convenient length for grafting and cutting off the excess portion at the bottom with the help of secateur to exposes fresh tissue. Slant cut was made in both sides of lower part of scion stick to make a V-wedge shaped smooth cut of same length (4 cm) and to retain some bark on the remaining two sides with thin tip of wedge using a sharp grafting knife. V-wedge shaped scion stick inserted into the splitted rootstock. The graft joint was secured properly with 2 cm wide and 30 cm long white polythene strip of 200 gauge thickness in order to provide proper contact of cambium cells and avoid the desiccation of the graft union.

The observations were recorded growth parameters *viz*., Number of nodes per graft (No.), Number of leaves per graft (No.), Graft height (cm), Graft girth (cm), Scion length (cm) and Rootstock length (cm), all parameters were recorded at 30, 60, 90 and 120 DAG. Various characters under study were statistically analysed by using analysis of variance technique for Completely Randomized Design (CRD) with Factorial concept as described by Panse and Sukhatme (1985) [17].

Results & Discussion

Number of nodes per graft (No.)

Among season significantly maximum number of nodes per graft (8.50, 11.26, 12.29 and 14.43) at 30, 60, 90 and 120 DAG, respectively was noted in S_3 (September-October). Minimum number of nodes per graft (1.94, 3.89, 5.33 and 6.47) at 30, 60, 90 and 120 DAG, respectively was noted in S_1 (February-March). Higher number of nodes might be due to higher carbohydrate content stored for flowering. Such grafts then produced more number of nodes and leaves. Minimum number of nodes might be due to inadequate flow of cell sap.

Among environmental conditions significantly maximum number of nodes per graft (5.87, 9.69, 11.03 and 13.58) at 30, 60, 90 and 120 DAG, respectively was noted in C_3 (Polyhouse) which was at par with C_2 (Net house) at 30 DAG. Minimum number of nodes per graft (4.96, 6.64, 7.60 and 8.92) at 30, 60, 90 and 120 DAG, respectively was noted in C_1 (Open field). Maximum number of nodes per graft influenced by the warmer environment inside the polyhouse than other conditions. The similar kind of findings was recorded by Sivudu (2013) in mango.

Among interaction effect significantly maximum number of nodes per graft (8.80) at 30 DAG was noted in S_3C_2 (September-October + Net house) which was at par with S_3C_1 (September-October + Open field) and S_3C_3 (September-October + Polyhouse). Whereas, (13.13, 14.73, 18.33) at 60, 90 and 120 DAG, respectively was noted in S_2C_3 (June-July + Polyhouse) which was at par with S_3C_2 (September-October + Net house) and S_3C_3 (September-October + Polyhouse) at 60 and 90 DAG, at par with S_3C_3 (September-October + Polyhouse) at 120 DAG. Minimum number of nodes per graft (1.53, 3.20 and 5.77) at 30, 60 and 120 DAG, respectively was noted in S_1C_2 (February-March + Net house) whereas, (4.67) at 90 DAG was noted in S_1C_3 (February-March + Polyhouse). This might be due to combined effect of photosynthetic accumulation in grafts which in turns increased the number of nodes with congenial conditions.

Table 1: Influence of season and environmental conditions on no. of nodes/grafts (No.) and no. of leaves/grafts (No.) of sapota cv. Kalipatti

Treatments		Number of nodes per graft (No.)				Number of leaves per graft (No.)			
		30 DAG	60 DAG	90 DAG	120 DAG	30 DAG	60 DAG	90 DAG	120 DAG
A. Season									
S_1 (February-March)		1.94	3.89	5.33	6.47	3.70	10.97	14.77	16.43
S_2 (June-July)		5.70	8.58	10.06	12.06	6.20	9.16	10.43	12.44
S_3 (September-October)		8.50	11.26	12.29	14.43	8.57	11.43	13.57	16.22
S.Em.±		0.216	0.329	0.451	0.496	0.263	0.266	0.398	0.448
C.D. at 5%		0.64	0.98	1.34	1.47	0.78	0.79	1.18	1.33
B. Environmental Conditions									
C_1 (Open field)		4.96	6.64	7.60	8.92	5.70	8.91	11.24	12.97
C_2 (Net house)		5.32	7.39	9.04	10.46	6.04	10.06	12.53	14.02
C_3 (Polyhouse)		5.87	9.69	11.03	13.58	6.72	12.59	14.99	18.11
S.Em.±		0.216	0.329	0.451	0.496	0.263	0.266	0.398	0.448
C.D. at 5%		0.64	0.98	1.34	1.47	0.78	0.79	1.18	1.33
Interaction (S x C)									
T_1	S_1C_1	2.13	4.83	6.17	7.43	3.70	11.27	13.20	13.97
T_2	S_1C_2	1.53	3.20	5.17	5.77	3.17	10.50	14.80	15.43
T_3	S_1C_3	2.17	3.63	4.67	6.20	4.23	11.13	16.30	19.90
T_4	S_2C_1	4.03	5.50	6.47	7.67	4.70	5.87	6.93	8.23
T_5	S_2C_2	5.63	7.10	8.97	10.17	6.07	7.60	9.80	11.20
T_6	S_2C_3	7.43	13.13	14.73	18.33	7.83	14.00	14.57	17.90
T_7	S_3C_1	8.70	9.60	10.17	11.67	8.70	9.60	13.60	16.70
T_8	S_3C_2	8.80	11.87	13.00	15.43	8.90	12.07	13.00	15.43
T_9	S_3C_3	8.00	12.30	13.70	16.20	8.10	12.63	14.10	16.53
S.Em.±		0.374	0.569	0.781	0.858	0.455	0.461	0.690	0.776
C.D. at 5%		1.11	1.69	2.32	2.55	1.35	1.37	2.05	2.31
C.V. %		12.03	12.47	14.67	13.53	12.81	7.59	9.24	8.94

Table 2: Influence of season and environmental conditions on graft height (cm) and rootstock length (cm) of sapota cv. Kalipatti

Treatments		Graft height (cm)				Rootstock length (cm)			
		30 DAG	60 DAG	90 DAG	120 DAG	30 DAG	60 DAG	90 DAG	120 DAG
A. Season									
S_1 (February-March)		21.91	23.39	25.24	27.12	15.89	16.41	17.21	17.95
S_2 (June-July)		22.93	23.91	24.89	25.98	17.02	17.44	17.91	18.39
S_3 (September-October)		25.02	26.08	27.07	28.15	19.19	19.58	20.09	20.55
S.Em.±		0.576	0.606	0.694	0.767	0.592	0.621	0.667	0.682
C.D. at 5%		1.71	1.80	NS	NS	1.76	1.84	1.98	2.03
B. Environmental Conditions									
C_1 (Open field)		23.63	24.74	25.81	26.84	17.81	18.20	18.74	19.17
C_2 (Net house)		23.32	24.48	25.80	27.03	17.59	18.08	18.69	19.18
C_3 (Polyhouse)		22.92	24.16	25.59	27.37	16.70	17.15	17.77	18.53
S.Em.±		0.576	0.606	0.694	0.767	0.592	0.621	0.667	0.682
C.D. at 5%		NS	NS	NS	NS	NS	NS	NS	NS
Interaction (S x C)									
T_1	S_1C_1	23.00	24.58	26.41	28.06	16.95	17.47	18.39	18.98
T_2	S_1C_2	22.58	23.93	25.75	27.16	16.62	17.15	17.85	18.37
T_3	S_1C_3	20.16	21.64	23.57	26.13	14.09	14.60	15.39	16.49
T_4	S_2C_1	20.84	21.74	22.65	23.58	15.48	15.87	16.33	16.78
T_5	S_2C_2	22.62	23.51	24.40	25.31	16.97	17.37	17.81	18.16
T_6	S_2C_3	25.31	26.49	27.62	29.06	18.61	19.08	19.59	20.23
T_7	S_3C_1	27.04	27.89	28.38	28.89	21.01	21.26	21.51	21.75
T_8	S_3C_2	24.76	26.00	27.26	28.63	19.16	19.72	20.42	21.02
T_9	S_3C_3	23.28	24.35	25.58	26.93	17.41	17.76	18.33	18.87
S.Em.±		0.997	1.050	1.202	1.329	1.025	1.075	1.155	1.181
C.D. at 5%		2.96	3.12	3.57	NS	3.05	3.19	NS	NS
C.V. %		7.42	7.43	8.09	8.50	10.23	10.46	10.88	10.79

Table 3: Influence of season and environmental conditions on graft girth (cm) and scion length (cm) of sapota cv. Kalipatti

Treatments	Graft girth (cm)				Scion length (cm)			
	30 DAG	60 DAG	90 DAG	120 DAG	30 DAG	60 DAG	90 DAG	120 DAG
A. Season								
S_1 (February-March)	0.44	0.53	0.59	0.68	6.02	6.97	8.04	9.19
S_2 (June-July)	0.58	0.65	0.69	0.73	5.95	6.47	6.99	7.60
S_3 (September-October)	0.72	0.74	0.78	0.81	5.94	6.50	6.98	7.60
S.Em.±	0.015	0.01	0.011	0.014	0.202	0.216	0.225	0.280
C.D. at 5%	0.04	0.03	0.03	0.04	NS	NS	0.67	0.83
B. Environmental Conditions								
C_1 (Open field)	0.55	0.62	0.68	0.73	5.92	6.52	7.07	7.70
C_2 (Net house)	0.59	0.64	0.69	0.74	5.78	6.42	7.12	7.85
C_3 (Polyhouse)	0.60	0.65	0.69	0.75	6.22	7.01	7.82	8.84
S.Em.±	0.015	0.01	0.011	0.014	0.202	0.216	0.225	0.28
C.D. at 5%	0.04	0.03	NS	NS	NS	NS	NS	0.83
Interaction (S x C)								
S.Em.±	0.025	0.017	0.019	0.025	0.350	0.375	0.389	0.485
C.D. at 5%	NS	NS	NS	NS	NS	NS	NS	NS
C.V. %	7.59	4.63	4.84	5.86	10.15	9.77	9.18	10.34

Number of leaves per graft (No.):

Among season significantly maximum number of leaves per graft (8.57) and (11.43) at 30 and 60 DAG, respectively was noted in S_3 (September-October) which was at par with S_1 (February-March) at 60 DAG. Whereas, (14.77) and (16.43) at 90 and 120 DAG, respectively was noted in S_1 (February-March) which was at par with S_3 (September-October) at 120 DAG. Minimum number of leaves per graft (3.70) at 30 DAG was noted in S_1 (February-March) whereas, (9.16, 10.43 and 12.44) at 60, 90 and 120 DAG, respectively were noted in S_2 (June-July). Quick and strong union formation and better nutrient uptake might have caused for more number of leaves. The similar kind of findings were recorded by Kudmulwar *et al*. (2008), Patil *et al.* (2017) and Dhutraj *et al.* (2018a) [13, 19, 7] in custard apple; Chouksey *et al.* (2016) [5] in guava; Ghojage *et al*. (2011); Gadekar *et al*. (2011) [9, 8] and Chander *et al.* (2016b) [3] in jamun; Dhutraj *et al.* (2018b) [6] in tamarind.

Among environmental conditions significantly maximum number of leaves per graft (6.72, 12.59, 14.99 and 18.11) at 30, 60, 90 and 120 DAG, respectively was noted in C_3 (Polyhouse) which was at par with C_2 (Net house) at 30 DAG. Minimum number of leaves per graft (5.70, 8.91, 11.24 and 12.97) at 30, 60, 90 and 120 DAG, respectively was noted in C_1 (Open field). This might be due to that favourable growing conditions with enhanced CO_2 assimilation in poly house as compared to other conditions, which increased the rate of photosynthesis and development of more number of leaves. The similar kind of findings were recorded by Sivudu (2014) [23] in mango; Gotur *et al.* (2017b) [11] in guava and Patel *et al.* (2007) [18] in mandarin.

Among interaction effect significantly maximum number of leaves per graft (8.90) at 30 DAG was noted in S_3C_2 (September-October + Net house) which was at par with S_2C_3 (June-July + Polyhouse), S_3C_1 (September-October + Open field) and S_3C_3 (September-October + Polyhouse). While (14.00) at 60 DAG was noted in S_2C_3 (June-July + Polyhouse) which was at par with S_3C_3 (September-October + Polyhouse). Whereas, (16.30) and (19.90) at 90 and 120 DAG, respectively was noted in S_1C_3 (February-March + Polyhouse) which was at par with S_1C_2 (February-March + Net house) and S_2C_3 (June-July + Polyhouse) at 90 DAG, at par with S_2C_3 (June-July + Polyhouse) at 120 DAG. Minimum number of leaves per graft (3.17) at 30 DAG was noted in S_1C_2 (February-March + Net house) whereas, (5.87, 6.93 and 8.23) at 60, 90 and 120 DAG, respectively was noted in S_2C_1 (June-July + Open field). This might be due to variation in temperature and relative humidity prevailing during different season and conditions.

Graft height (cm)

Among season highest graft height (25.02 cm) and (26.08 cm) at 30 and 60 DAG, respectively was noted in S_3 (September-October), while non-significant for 90 and 120 DAG. Lowest graft height (21.91 cm) and (23.39 cm) at 30 and 60 DAG, respectively was noted in S_1 (February-March). This might be due to that graft height positively correlated with number of leaves. The photosynthetic food produced by leaves was in turn utilized to continue the primary growth at a faster rate and resulted as higher graft height. The similar kind of findings were recorded by Ghojage *et al.* (2011) and Chander *et al.* (2016b) [9, 3] in jamun; Bhavya *et al.* (2018) [2] in karonda and Karna *et al.* (2018) [2] in mango.

Effect of environmental conditions was observed non-significant for graft height at 30, 60, 90 and 120 DAG.

Among interaction effect highest graft height (27.04 cm, 27.89 cm and 28.38 cm) at 30, 60 and 90 DAG, respectively was noted in S_3C_1 (September-October + Open field) which was at par with S_2C_3 (June-July + Polyhouse) and S_3C_2 (September-October + Net house) at 30 and 60 DAG, at par with S_1C_1 (February-March + Open field), S_1C_2 (February-March + Net house), S_2C_3 (June-July + Polyhouse), S_3C_2 (September-October + Net house) and S_3C_3 (September-October + Polyhouse) at 90 DAG, while non-significant for 120 DAG. Lowest graft height (20.16 cm) and (21.64 cm) at 30 and 60 DAG, respectively was noted in S_1C_3 (February-March + Polyhouse) whereas, (22.65 cm) at 90 DAG was noted in S_2C_1 (June-July + Open field). This might be due to that September-October + Open field received fairly long periods of favourable temperature, relative humidity and soil moisture for vegetative growth.

Graft girth (cm)

Among season significantly highest graft girth (0.72 cm, 0.74 cm, 0.78 cm and 0.81 cm) at 30, 60, 90 and 120 DAG, respectively was noted in S_3 (September-October). Lowest graft girth (0.44 cm, 0.53 cm, 0.59 cm and 0.68 cm) at 30, 60, 90 and 120 DAG, respectively was noted in S_1 (February-March)**.** This might be due to that more cambium contact between the cut portion of stock and scion that contributed in early callus development leading to quicker repair of broken

cells resulting in early union development and thereby, maintained increased rate of growth in terms of girth of graft. The similar kind of findings were recorded by Ghojage *et al.* (2011) and Chander *et al.* (2016b) [9, 3] in jamun; Bhavya *et al.* (2018) [2] in karonda.

Among environmental conditions highest graft girth (0.60 cm) and (0.65 cm) at 30 and 60 DAG, respectively was noted in C_3 (Polyhouse) which was at par with C_2 (Net house) at 30 DAG, at par with C_1 (Open field) and C_2 (Net house) at 60 DAG, while non-significant for 90 and 120 DAG. Lowest graft girth (0.55 cm) at 30 DAG was noted in C_1 (Open field). This might be due to that polyhouse provide congenial conditions for more meristematic activity resulted in increased graft girth. The similar kind of findings was recorded by Gotur *et al*. (2017b) [11] in guava.

The interaction effect of season and environmental conditions was observed non-significant for graft girth at 30, 60, 90 and 120 DAG.

Scion length (cm)

Among season highest scion length (8.04 cm) and (9.19 cm) at 90 and 120 DAG, respectively was noted in S_1 (February-March), while non-significant for 30 and 60 DAG. Lowest scion length (6.98 cm) at 90 DAG was noted in S_3 (September-October) whereas, (7.60 cm) at 120 DAG was noted in S_2 (June-July) and S_3 (September-October). This might be due to that prevailing ideal temperature and relative humidity during different season congenial for plant activity which had resulted in increased scion length. The similar kind of findings were recorded by Ghosh *et al.* (2004) and Kudmulwar *et al.* (2008) [10, 13] in custard apple; Chouksey *et al.* (2016) [5] in guava; Gadekar *et al.* (2011) [8] in jamun.

Among environmental conditions conditions highest scion length (8.84 cm) at 120 DAG was noted in C_3 (Polyhouse) while non-significant for 30, 60 and 90 DAG and lowest scion length (7.70 cm) at 120 DAG was noted in C_1 (Open field).

The interaction effect of season and environmental conditions was observed non-significant for scion length at 30, 60, 90 and 120 DAG.

Rootstock length (cm)

Among season significantly highest rootstock length (19.19 cm, 19.58 cm, 20.09 cm and 20.55 cm) at 30, 60, 90 and 120 DAG, respectively was noted in S_3 (September-October). Lowest rootstock length (15.89 cm, 16.41 cm, 17.21 cm and 17.95 cm) at 30, 60, 90 and 120 DAG, respectively was noted in S_1 (February-March). This might be due to that high physiological activity and good sap flow in the rootstock along with favourable temperature and relative humidity available for a comparatively longer period.

Effect of environmental conditions was observed non-significant for rootstock length at 30, 60, 90 and 120 DAG.

Among interaction effect highest rootstock length (21.01 cm) and (21.26 cm) at 30 and 60 DAG, respectively was noted in S_3C_1 (September-October + Open field) which was at par with S_2C_3 (June-July + Polyhouse) and S_3C_2 (September-October + Net house) at 30 and 60 DAG, while non-significant for 90 and 120 DAG. Lowest rootstock length (14.09 cm) and (14.60 cm) at 30 and 60 DAG, respectively was noted in S_1C_3 (February-March + Polyhouse). This might be due to that high physiological activity and good sap flow in the rootstock along with favourable temperature and relative humidity available for a comparatively longer period.

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