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Asmita Jalal

Department of Horticulture,
College of Agriculture, Govind
Ballabh Pant University of
Agriculture and Technology,
Pantnagar, Uttarakhand, India

Shailesh Tripathi

Department of Horticulture,
College of Agriculture, Govind
Ballabh Pant University of
Agriculture and Technology,
Pantnagar, Uttarakhand, India

Anjana Kholiya

Department of Horticulture,
College of Agriculture, Govind
Ballabh Pant University of
Agriculture and Technology,
Pantnagar, Uttarakhand, India

Ajit Kumar

Department of Horticulture,
College of Agriculture, Govind
Ballabh Pant University of
Agriculture and Technology,
Pantnagar, Uttarakhand, India

Karishma Kohli

Department of Horticulture,
College of Agriculture, Govind
Ballabh Pant University of
Agriculture and Technology,
Pantnagar, Uttarakhand, India

Correspondence**Asmita Jalal**

Department of Horticulture,
College of Agriculture, Govind
Ballabh Pant University of
Agriculture and Technology,
Pantnagar, Uttarakhand, India

Response of growing environment in propagation of different cultivars of Aonla (*Emblca officinalis Gaertn*)

Asmita Jalal, Shailesh Tripathi, Anjana Kholiya, Ajit Kumar and Karishma Kohli

Abstract

The experiment was laid out in split-split plot design with three replications. The experiment consisted of (i) two cultivars *viz.*, NA-7 and Francis (ii) two seasons i.e. spring and rainy season and (iii) two propagation methods *viz.*, cleft grafting and tongue grafting under two environmental conditions *viz.*, polyhouse and open field conditions. Minimum time (11.61 days) taken for bud sprout, 100% graft take, maximum (0.88 cm) rootstock diameter was obtained under polyhouse condition. The maximum (37.00) number of leaves, maximum scion diameter (0.75) and highest graft survival (80.00%) was recorded in open field condition. Cultivar NA-7 was noticed more adoptable than Francis and rainy season grafts proved better over spring season grafts.

Keywords: Aonla, propagation, environment, season

Introduction

Plants and their bioactive compounds formed the foundation of traditional medicine system as well as of modern pharmaceutical world. Aonla is a member of Euphorbiaceae family and a popular Ayurvedic herb, in the Indian pharmacopoeia considered to be one of the strongest *rasayana*, especially for the bones, liver, blood and heart. The ascorbic acid and other constituents are well retained in dried aonla fruits (Roy, 1996) [16].

Success and survivability of grafts depends upon various factors *viz.*, source of scion, grafting/budding season, method, age of rootstock and climatic factors (Hartmann *et al.*, 1997) [6]. Among these factors, variety and time of grafting are important factors for high success and survivability of grafts (Bhuva *et al.*, 1990; Kulkarni, 1990) [3, 10]. Temperature, also affects the growth of grafts because it is associated with the cellular activity and callus formation. The optimum temperature condition at the time of grafting leads to early healing of graft junction. In general, the optimum temperature range for cellular activity varies from 12° to 35°C. Provision of shade during and after grafting, was found to have beneficial effect on success of grafting. Light is essential for triggering photosynthetic activity and thereby better nourishment of grafts. The rate of photosynthetic activity varies with the level of shade (Swamy, 1993) [21].

As demand for planting material of this medicinal plant is increasing every year, it is important to produce grafts throughout the year by creating optimum environmental conditions. The protected environment conditions includes polyhouse, mist chamber, shade net and green houses, where one can increase the rate of success percent by providing favourable conditions (Vishnuvardhan, 2002) [22]. Hence, there is a need to standardize growing environment for its commercial propagation. Therefore, the present investigation has been chosen to identify and standardize the best growing environment and season for propagation of aonla in *tarai* region.

Materials and methods

The present investigation was carried out at Medicinal Plants Research and Development Centre, Govind Ballabh Pant University of Agriculture and Technology, Pantnagar, during the year 2016-17. Pantnagar is situated in foot hills of Himalayas and falls in the humid subtropical climate. Maximum and minimum temperature of this region ranges from 30-43 °C and 5-10 °C, respectively. The soils at Pantnagar come under order mollisols. The optimum sized aonla seedlings were used as a rootstock for grafting. For raising of rootstock, healthy, uniform sized and bold seeds were collected from Horticulture Research Centre, Patharchatta, Pantnagar.

The grafting operation was undertaken on mid of February and mid of June 2016 on 1 year old seedlings. The scion material was collected from the identified elite types of aonla trees of cultivar NA-7 and Francis from the Horticulture Research Centre, Patharchatta, Pantnagar. The experiment was laid out in split-split plot design having 16 treatments with three replications. Among the propagation methods, cleft and tongue grafting (M₁- Cleft grafting, M₂- Tongue grafting) were adopted, which were performed at two different seasons (S₁- spring season and S₂ rainy season) in two different varieties (V₁- NA-7 and V₂- Francis). The observations were recorded on various parameters *viz.*, days taken for bud sprouting, percent graft take, number of leaves per graft, diameter of scion, diameter of rootstock, stock scion ratio and success percent of graft. After grafting operation, grafts were observed regularly for its greening till it was sprouted or dried and after that mean was computed. Numbers of leaves developed per graft were recorded, 120 days after grafting operation. Scion diameter and Rootstock diameter of randomly selected five observational plants was recorded separately in each treatment with the help of vernier calliper recorded in centimeter. In successful grafts, the stock to scion ratio was recorded 120 days after grafting operation. The grafts were under observation regularly up to 120 days after grafting operation and then final survival was recorded and after computing the mean, it was recorded as success percent of grafts. The observations on different parameter were recorded respectively in open field and polyhouse condition.

Results and Discussion

Days taken for bud sprout: Data demonstrated in Table 1 signifies that cv. NA-7 took less days (12.42 and 11.42) for bud sprout than cv. Francis (14.63 and 13.29 days) in both the growing conditions i.e. open field and polyhouse respectively. The varietal difference in bud sprouting possibly attributed with the genotypic differences. Seasonal conditions of propagation also significantly influenced the bud sprout. Spring season grafts recorded minimum days (11.63 and 10.67) for bud sprouting and statistically superior over rainy season which took maximum days (15.42 and 14.04) in both the growing conditions. It might be due to favourable environmental conditions like warm weather and higher relative humidity during rainy season which increases meristematic activity of cells. Singh *et al.* (2007) [19] also reported that relative humidity is a key factor in bud sprouting and higher humidity, leads to early bud sprouts in guava. Among the different methods of propagation, minimum days (15.58 and 14.08) taken for bud sprout were observed in cleft grafting which was statistically superior over the tongue grafting (15.83 days and 14.83) in both the growing conditions. Among the interactions (Table 2), minimum days (13.67 and 11.61) taken for bud sprout were associated with cv. NA-7 in spring season cleft grafting in both the environmental condition. The result is in corroboration with the findings of Negi *et al.* (2010) [12] in aonla. By comparing both the environmental conditions, slightly early bud initiation (11.33 days) was recorded in polyhouse condition as compared to open field condition (12.67 days).

Number of leaves: The data recorded on number of leaves per graft, 120 days after grafting in both the environmental conditions i.e. open field and polyhouse respectively, showed that the effect of varieties was non-significant but the influence of methods of propagation was noticed significant, cleft grafting was recorded statistically superior, having maximum number of leaves (33.17 and 26.17) over tongue

grafting in both open field and protected condition. The similar finding was reported by Jadia *et al.* (2015) [9] and Rani *et al.* (2015) [13] in guava. Regarding season of grafting, there was no significant effect on growth of leaves. The effect of interaction (Table 2) of variety x season x method of propagation on number of leaves was found non-significant in both the conditions. Regarding number of leaves on aonla grafts, grown under two different environmental conditions, the maximum leaves (37.00) were obtained under open condition as compared to polyhouse condition (30.33 leaves).

Graft-take percentage: The effect of variety on percent graft take and bud sprout was found non-significant. The influence of season on graft take was reported significant, the maximum percentage (71.67% and 78.33) was observed during rainy season and minimum (59.17% and 65.00) in spring season under both growing environment. Maximum percentage of graft take and bud sprout in rainy season might be due to the congenial weather conditions i.e. warm temperature and relative humidity, because they activate the cambium cells during the rainy season. Maximum percentage of graft take and bud sprout in rainy season might be due to the congenial weather conditions i.e. warm temperature and relative humidity, because they activate the cambium cells during the rainy season. Similar findings were also reported by Singh (2009) [18] in tamarind and Rani *et al.* (2015) [13] in guava. In case of method of propagation, highest percentage of graft take (75.00% and 80.00) was obtained by cleft grafting in both growing conditions. Chandra *et al.* (2011) [4] also reported similar results in pomegranate. The effect of interaction (Table 2) *viz.*, variety x season x method of propagation on graft take percentage was significant. Regarding percentage of graft take in two different environmental conditions i.e., open and polyhouse, complete graft take percentage (100%) was obtained in the polyhouse conditions.

Rootstock diameter: The influence of variety, season and method of propagation on rootstock diameter varied significantly. In both of the varieties, maximum rootstock diameter (0.71 cm and 0.70 cm) was recorded in cv. NA-7 while minimum in cv. Francis (0.68 cm and 0.67 cm) in both the growing conditions. The differences among the different varieties in their grafting success and further growth may be related to their efficiency for callus formation and differentiation of parenchymal cells in vascular system. Ratna (2012) [14] reported the similar outcomes in sapota. Regarding to the season of propagation, rainy season gave maximum rootstock diameter (0.74 cm and 0.72 cm) as compared to spring season (0.66 cm and 0.65 cm) in both growing conditions. The maximum rootstock diameter recorded in rainy season grafting might be due to the hasty cell elongation and cell division at that time which promotes the growth of plant as well as diameter of rootstock. Similar results were also reported by Bhadra (2012) [2] in carambola and Islam and Rahim (2010) [8] in mango. In case of method of propagation, cleft grafting gave maximum rootstock diameter (0.74 cm and 0.75cm) and was found statistically superior over tongue grafting (0.66 cm and 0.62cm) in both growing conditions. The effect of interaction (Table 2), *viz.*, variety x season x method of propagation had significant effect on diameter of rootstock. Similar result was also reported by Reshma *et al.* (2016) [15] in guava. Regarding rootstock diameter, maximum diameter (0.88 cm) was obtained under polyhouse condition as compared to open field condition (0.80 cm).

Scion diameter: The data indicated that scion diameter varied significantly by the effect of season and method of propagation. There was no significant effect of variety on scion diameter. Season of propagation influenced the scion diameter significantly and maximum scion diameter (0.70 cm and 0.67cm) was obtained during rainy season and minimum in spring season (0.64 cm and 0.63cm) under both growing conditions. The significant difference in scion diameter can also occur due to the growing stage of scion which encourages the maximum scion diameter with respect to temperature and relative humidity presented in the atmosphere. The result was similar with the results of Singh *et al.* (2012) [20] in mango. Regarding method of propagation, cleft grafting recorded maximum scion diameter (0.71 cm and 0.69cm) than tongue grafting (0.63 cm and 0.61cm) in both growing conditions which may be due to the formation of good graft union and rapid healing of cambium cells. The effect of interaction (Table 2), *viz.*, variety x season x method of propagation had no significant effect on scion diameter. Regarding scion diameter, it was recorded equivalent in both the growing environments, maximum scion diameter (0.75 cm) was observed in open field condition which was almost equal to scion diameter recorded in polyhouse condition (0.74 cm).

Stock scion ratio: The Table 1 demonstrates that the influence of variety, season and method of propagation on the ratio between rootstock and scion diameter had no significant effect. In both of the varieties, Francis (1.03 and 1.02) gave better ratio as compared to NA-7 (1.07 and 1.08) in both growing conditions. In case of season, rainy season showed maximum (1.06 and 1.07) stock scion ratio and optimum (1.04 and 1.02) in spring season under both the environmental conditions. Regarding to the propagation methods, cleft grafting gave better stock scion ratio (1.04 and 1.08) as compared to tongue grafting (1.06 and 1.01). The influence of interaction of variety x season x method of propagation had non-significant effect on stock-scion ratio. However, the stock scion ratio near to 1 was considered satisfactory for good

grafting success but in the present investigation, under two different environmental conditions, optimum ratio (1.01) was achieved under both open and polyhouse conditions.

Success percent: The data signified that the success percent of aonla grafts as influenced by variety, season and method used for propagation. Regarding varieties, NA-7 gave maximum success percent of aonla grafts (48.33% and 38.33%) and was statistically superior over Francis (34.17% and 28.33%) in both the growing conditions. The different success rates of aonla varieties may be due to presence of different level of endogenous phytochemicals and physiological stage of scions at the time of grafting. Ghosh (2008) [5] reported similar result in ber. Response of season over success of aonla grafts was found significant and highest success percent (48.33% and 40.00%) was observed in rainy season whereas, minimum (34.17% and 26.67%) in spring season under both environmental conditions. Temperature plays an important role for enhancing cell activity which is important for a good graft union (Shippy, 1930) [17]. Among the different methods used for propagation, cleft grafting gave maximum success (43.33% and 36.67%) in both growing conditions and was found statistically superior over tongue grafting. This variation in different methods could be due to improper graft union and this problem can occur either due to cellular disturbances at the graft union or lack of callus formation which results into poor cambium continuity between stock and scion. Malik *et al.* (2012) [11] also reported the similar results in khirni. Achim (2000) [1] also suggested that success percent was affected by the methods used for propagation and stimulation of callus tissues. The interaction (Table 2) *viz.*, variety x season x method of propagation had non-significant effect over success percent of aonla grafts but, the highest success (80.00% and 66.67%) was recorded in NA-7 during rainy season by cleft grafting. The highest success percent of aonla grafts was achieved under open field condition (86.67%) as compared to the polyhouse condition (73.33%).

Table 1: Effect of variety, season and propagation techniques on different growth parameters of Aonla under open and polyhouse condition.

	open/field condition								polyhouse condition							
	Days taken to sprouting	Number of Leaves	Graft take %	Rootstock diameter (cm)	Scion diameter (cm)	Stock: scion	Success %	Days taken to sprouting	Number of leaves	Graft take %	Rootstock diameter (cm)	Scion diameter (cm)	Stock: scion	Success %		
Method of Grafting (M₁- Cleft grafting, M₂- Tongue grafting)																
M ₁	15.58	33.17	75.00	0.74	0.71	1.04	43.33	14.08	26.37	80.00	0.75	0.69	1.08	36.67		
M ₂	15.83	25.50	73.33	0.66	0.63	1.06	35.00	14.83	24.00	76.67	0.62	0.61	1.01	26.67		
SE(m)±	0.29	2.20	4.25	0.00	0.01	0.02	2.06	0.24	3.67	3.47	0.02	0.02	0.01	0.22		
CD at 5%	0.59	4.55	8.77	0.01	0.02	N.S.	2.78	0.50	7.58	7.16	0.04	0.04	0.03	0.46		
Cultivar (V₁-NA-7 and V₂-Francis)																
V ₁	12.42	27.63	69.17	0.71	0.67	1.07	48.33	11.42	23.50	74.17	0.70	0.65	1.08	38.33		
V ₂	14.63	25.29	61.67	0.68	0.66	1.03	34.17	13.29	21.00	69.17	0.67	0.65	1.02	28.33		
SE(m)±	0.17	2.14	2.50	0.00	0.02	0.04	0.11	0.14	1.84	2.50	0.01	0.01	0.02	0.22		
CD at 5%	0.72	N.S.	N.S.	0.01	N.S.	N.S.	0.47	0.62	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.		
Season of Grafting (S₁-spring season and S₂-rainy season)																
S ₁	11.63	24.71	59.17	0.66	0.64	1.04	34.17	10.67	18.92	65.00	0.65	0.63	1.02	26.67		
S ₂	15.42	28.21	71.67	0.74	0.70	1.06	48.33	14.04	25.58	78.33	0.72	0.67	1.07	40.00		
SE(m)±	0.12	1.35	1.18	0.00	0.01	0.05	0.14	0.19	1.44	2.20	0.01	0.01	0.02	0.16		
CD at 5%	0.33	N.S.	3.27	0.01	0.04	N.S.	0.40	0.52	4.00	6.12	0.02	0.02	0.04	0.43		

Table 2: Interaction effect of variety, season and propagation techniques on different growth parameters of Aonla under open condition and polyhouse condition.

Growth parameters		In open condition				In polyhouse condition				SE(m)±	CD at 5%
		M1		M2		M1		M2			
		S1	S2	S1	S2	S1	S2	S1	S2		
Days for bud sprout	V1	13.67	15.00	14.33	15.00	11.61	13.67	13.00	14.33	0.26	N.S.
	V2	16.00	17.67	16.33	17.67	15.33	15.67	15.33	16.67		
Number of leaves	V1	37.00	30.00	31.33	28.33	13.00	14.33	28.33	28.00	1.91	N.S.
	V2	35.67	30.00	30.67	11.67	15.33	16.67	30.00	9.67		
Graft take%	V1	93.33	53.33	93.33	73.33	26.33	28.67	86.67	73.33	1.67	4.63
	V2	93.33	60.00	93.33	33.33	30.33	19.33	100.00	46.67		
Rootstock diameter	V1	0.68	0.80	0.61	0.76	0.68	0.88	0.62	0.62	0.00	0.01
	V2	0.76	0.71	0.59	0.67	0.70	0.76	0.60	0.62		
Scion diameter	V1	0.67	0.75	0.60	0.69	0.65	0.71	0.61	0.62	0.02	N.S.
	V2	0.71	0.70	0.58	0.67	0.67	0.74	0.59	0.61		
Rootstock: Scion	V1	1.02	1.04	1.02	1.18	1.04	1.24	1.02	1.01	0.02	N.S.
	V2	1.08	1.01	1.03	1.01	1.02	1.02	1.02	1.01		
Success%	V1	80.00	26.67	60.00	33.33	66.67	20.00	46.67	26.67	3.73	N.S.
	V2	53.33	13.33	33.33	13.33	46.67	13.33	26.67	6.67		

Conclusion

The grafts prepared under open field condition, gave the higher success in terms of maximum final graft survival, number of leaves, stock scion ratio and scion diameter. The minimum days taken for bud sprout and maximum rootstock diameter were obtained in polyhouse condition. Among the two different sources of scion, variety NA-7 gave better performance in both the growing conditions. In interaction, the treatment combination, cultivar NA-7 with cleft grafting gave highest final survival percentage of grafts in rainy season.

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