J. Indian Soc. Coastal agric. Res. 31(1): 72-77 (2013)

Studies on Softwood Grafting in Carambola (*Averrhoa carambola* L.)

G.R. SONAWANE*, R. G. KHANDEKAR, G.N. KORAKE,
SANA MUKADAM and P.M. HALDANKAR

Department of Horticulture, College of Agriculture
Dr. BalasahebSawantKonkanKrishiVidyapeeth
Dapoli - 415 712, Maharashtra

Received: 30.06.2013 Accepted: 30.08.2013

Softwood grafting in carambola (*Averrhoa carambola* L.) was attempted with scion sticks of three different ages (4, 5, 6 months) and varying lengths (5, 7.5, 10 cm), and their combinations. The experiment consisted of nine treatment combinations, which were replicated thrice and laid out in factorial randomized block design. Five months-old scion sticks recorded maximum sprouting (98.50%) and survival (92.42%). With respect to the combined effects of age and length, 5 - 6 months-old scion sticks of 7.5 – 10 cm recorded maximum sprouting (100%) and survival (95.47%), besides minimum number of days required for initiation (14.66 days) and completion (18.33 days) of sprouting and growth of the grafts.

(***Key words:*** *Carambola, Softwood grafting, Scion stick)*

Carambola/Kamrakh or Star fruit (*Averrhoa carambola* L.) is a curious, attractive fruit of the Oxalidaceae family. No systematic plantations of this crop have been found as it is one of the neglected, underutilized, unexploited fruit crop. In Dahanu Tahesil of Thane district, Maharashtra some farmers have started cultivation of carambola on trial basis. The two distinct classes of carambola are viz. sour and sweet (Chadha, 2001). Sour type is smaller in size, very sour, richly flavored with more oxalic acid and the other sweet type is larger in size, mild flavored, rather bland, with less oxalic acid. Since existing plantations of carambola are of seedling types they need further improvement. Carambola is often propagated through seeds. The seeds have low viability and hence, should be sown fresh. After cleaning and drying the seeds, they should be sown on raised beds and regularly watered. As seedling type is heterozygous, the seedlings are unlikely to produce fruits which closely resemble to mother tree. It is known for producing variable progeny which fruit in about four years of planting. Grafted plants on the other hand, commence fruiting after about 10 months of planting (Singh, 1963). The different techniques of grafting in common use are wedge, splice, side, veneer and approach grafts. The softwood grafting method however, has not been practiced yet, also it can be practiced year around with availability of suitable scion stick and rootstock for grafting. Since the softwood grafting is a simple method of propagation, an attempt was made to standardize the softwood grafting in carambola by studying the effect of age and length of scion stick on percentage success and survival of softwood grafts.

MATERIALS AND METHODS

The experiment was laid out in factorial randomized block design with 9 treatment combinations and three replications comprising three levels of age of scion stick and three levels of length of scion stick. The treatments are age of scion sticks i.e. 4 months (M_1), 5 Months (M_2), 6 months (M_3) and length of scion sticks i.e. 5 cm (L_1), 7.5 cm (L_2), and 10 cm (L_3) were used for experimentation. The details of treatment combinations are as follows: 4 month + 5 cm (M_1L_1), 4 month + 7.5 cm (M_1L_2), 4 month + 10 cm (M_1L_3), 5 month + 5 cm (M_2L_1), 5 month + 7.5 cm (M_2L_2), 5 month+10 cm (M_2L_3), 6 month + 5 cm (M_3L_1), 6 month + 7.5 cm (M_3L_2) and 6 month +10 cm (M_3L_3).

Healthy carambola seedlings of six months age in polythene bags were selected for grafting. The scion sticks were selected at three maturity stages according to treatment requirement. The scion sticks were selected at sprouting stage and tagged with labels to identify their maturity. The selected scion sticks were cut for grafting of requisite size at four, five and six months age after sprouting. The carambola scion sticks selected from female

*Corresponding author : E-mail: sonawaneganesh78@gmail.com

carambola trees (age 10-15 years) were cut into 5, 7.5 and 10 cm length at different maturity stages. The top portion of the fresh growth developed on the stock plant was decapitated with knife keeping about 8.0 cm fresh stem. Then a top portion of seedlings was carefully split vertically in 'V' shape up to 3 cm length. The scion of about the same thickness as that of stock having a length of 10 cm was selected. The wedge of scion was inserted into 'V' shaped slit of stock and secured firmly with 1.5 cm wide and 45 cm long, 200 guage thickness white transparent polythene strip. The softwood grafting operation was performed by the method described by (Amin, 1974) The prepared grafts were covered from top by polythene bags 36 cm x 30 cm size keeping its knot below the graft joint. The bag was retained on the graft for one month or till sprouting was observed in the graft. The observations on percentage success, survival percentage, days required for initiation of sprouting were recorded on graft. The growth observations such as length of sprouted scion shoot, number of leaflets per scion shoot were recorded at 30th day and thereafter at an interval of 15days up to a period of two months. The data were statistically analyzed by using standard method of analysis (Panse and Sukhatme, 1995).

RESULTS AND DISCUSSION

The data presented in Table 1 revealed that there was significant difference in sprouting percentage of carambola softwood grafts due to different ages of scion sticks. The mean maximum sprouting (98.50%) was recorded in M_2 (5 months-old) treatment, which was significantly superior to the rest of the treatments under study. The minimum sprouting (81.68%) was recorded in M_1 (4 months-old scion stick) treatment. The results analogous to these findings have been reported by Desai (1987) in jackfruit, Panicker (1986) in mango and Khandekar *et al.*, (2006) in nutmeg. The sprouting percentage of carambola softwood grafts was significantly affected by the length of scion sticks treatments under study. The mean maximum sprouting (96.26%) was recorded in L_2 (7.5 cm length) treatment, which was statistically on par with L_3 (10 cm length) treatment. The minimum sprouting (85.50%) was recorded in L_1 (5 cm length) treatment (Table 2). The data on interaction effect of age and length of scion stick on sprouting percentage of carambola softwood grafts (Table 3) revealed that the significantly maximum sprouting (100%) was recorded in M_2L_2 (5 month + 7.5 cm) which was on par with M_2L_3 (5 month + 10 cm) and M_3L_2 (6 month + 7.5 cm) treatments. The treatment M1L1 (4 month + 5 cm) recorded minimum sprouting (73.47%). The survival percentage of carambola softwood grafts showed significant differences as a result of interaction effect of age and length of scion stick under study.

The days required for initiation of sprouting of carambola softwood grafts was significantly affected by different treatments (age of scion stick) under study. The mean minimum number of days required for initiation of sprouting (15.66 days) was recorded in M_3 (6 months-old scion stick) treatment which was on par with M_2 (5 months-old scion stick) treatment (Table 4). The maximum number of days required for sprouting (18.77 days) was recorded in M_1 (4 months-old scion stick) treatment. These findings were in close agreement with Desai, (1987) in jackfruit and Khandekar *et al.,* (2006) in nutmeg. There was significant reduction in number of days required for initiation of sprouting due to varying length of scion stick treatments (Table 5). The mean minimum number of days required for initiation of sprouting (16.00 days) was recorded in L_3 (10 cm scion stick) treatment which was on par with L_2 (7.5 cm scion stick). However, the maximum number of days required for initiation of sprouting (18.55 days) was recorded in L_1 (5 cm scion stick) treatment.

Table 1. *Effect of age and length of scion stick on sprouting (%) and survival (%) in carambola softwood grafts*

Treatment (Age)	Sprouting (%)	Survival (%)	Treatment (Length)	Sprouting (%)	Survival (%)
M_1 (4 month)	81.68 (64.66)	75.96 (60.64)	L_1 (5 cm)	85.50 (67.62)	79.65 (63.19)
M_2 (5 month)	98.50 (82.95)	92.42 (74.02)	L_2 (7.5 cm)	96.26 (78.85)	88.50 (70.18)
M_3 (6 month)	91.17 (72.71)	86.10 (68.11)	L_3 (10 cm)	92.25 (73.85)	87.64 (69.42)
Mean	73.44	67.59	Mean	73.44	67.59
SEm +	2.39	2.33	SEm+	2.39	2.33
CD at 5%	7.19	7.00	CD at 5%	7.19	NS

The mean minimum number of days required for initiation of sprouting (14.66 days) was recorded in M_3L_3 (6 month + 10 cm scion stick) treatment, which was on par with M_2L_3 (5 month + 10 cm scion stick) and M_3L_2 (6 month + 7.5 cm scion stick) treatment (Table 5). The minimum number of days required for completion of sprouting (18.33 days) was recorded in M_3L_3 treatment.

The sprout length of carambola softwood grafts was significantly affected by the difference in age of scion sticks at 30th to 90th DAS (Table 6). At 90th DAS, maximum sprout length (3.14 cm) was recorded in M_3 (6 monthsold) treatment. However, the minimum shoot length (3.01 cm) was recorded in M_1 (4 months old scion) treatment. The observations were in close agreement with Panicker (1986) in mango and Khandekar *et al.*, (2006) in nutmeg. The sprout length of carambola softwood grafts was not significantly affected by variation in the length of scion sticks at 30th to 90th DAS except at 90th DAS (Table 7). The sprout length of carambola softwood grafts was significantly affected by different treatments of age x length of scion stick at 30th to 90th DAS. The sprout length increased steadily from 30th to 90th DAS irrespective of the treatments (Table 8). The mean maximum sprout length (3.23 cm) at 90th DAS was recorded in M_3L_3 (6 month + 10 cm scion stick) which was followed by M_3L_2 (6 month + 7.5 cm scion stick) and M_2L_2 (5 month + 7.5 cm scion stick). A minimum sprout length of 2.97 cm was recorded in M_1L_1 (4 month + 5 cm scion stick) followed by M_1L_3 (3.01 cm). The results obtained are in corroboration with Khandekar *et al.*, (2006) in nutmeg, Desai (1987) in jackfruit and Haldankar (1993) in kokum.

Table 2. *Interaction effect of age and length of scion stick on sprouting (%) and survival (%) in carambola softwood grafts*

Treatment (Age x Length)	Sprouting (%)	Survival (%)
M_1L_1	73.47 (59.00)	73.47 (59.00)
M_1L_2	86.98 (68.85)	80.68 (63.93)
M_1L_3	83.64 (66.14)	73.47 (59.00)
M_2L_1	93.30 (75.00)	84.28 (66.64)
M_2L_2	100.00 (90.00)	95.47 (77.71)
M_2L_3	98.85 (83.85)	95.47 (77.71)
M_3L_1	86.98 (68.85)	80.68 (63.93)
M_3L_2	95.47 (77.71)	86.98 (68.85)
M_3L_3	90.00 (71.57)	90.00 (71.57)
Mean	73.85	67.59
SEm +	4.15	4.04
CD at 5 %	12.45	12.13

The number of leaflets of carambola softwood grafts was significantly affected by difference in age of scion sticks at 30th to 90th DAS (Table 9). Thenumber of leaflets increased gradually from 30th to 90th DAS in all the treatments. At 90th DAS, the mean maximum number of leaflets (23.64) was noticed in M_3 (6 month) and minimum in M_1 (4 months-old scion stick). These findings are quite analogous with that of Panicker (1986) in mango and Khandekar *et al.*, (2006) in nutmeg. The number of leaflets of carambola softwood grafts was not affected significantly due to difference in length of scion stick at all the days of observation i.e. 30th to 90th DAS (Table 10). The number of leaflets increased gradually from 30th to 90th DAS in all interaction treatments. The number of leaflets differed significantly by various treatments at 30th to 90th DAS. At 90th DAS, a maximum number of leaflets (23.73) was observed in M_3L_3 (6 month + 10 cm scion stick) which was statistically on par with M_3L_2 (6 month + 7.5 cm scion stick) and M_3L_1 (6 month + 5 cm scion stick).

It is clear from the data obtained in the investigation that the mature scion wood of 5 month and 6 months age is the most suitable for successful softwood grafting in carambola. Higher success

Table 3. *Effect of age of scion stick on initiation and completion of sprouting in carambola softwood grafts*

Treatment (Age)	Days required for sprouting		Treatment (Length)	Days required for sprouting	
	Initiation	Completion		Initiation	Completion
M_1 (4 month)	18.77	22.55	L_1 (5 cm)	18.55	22.22
M_2 (5 month)	17.55	21.11	L_2 (7.5 cm)	17.44	21.88
M_3 (6 month)	15.66	20.44	L_3 (10 cm)	16.00	20.00
Mean	17.33	21.37	Mean	17.33	21.37
SEm +	0.21	0.24	SEm+	0.21	0.25
CD at 5%	0.64	0.75	CD at 5%	1.64	0.75

Table 4. *Interaction effect of age and length of scion stick on initiation and completion of sprouting in carambola softwood grafts*

Treatment (Age x Length)	Days required for sprouting	
	Initiation	Completion
M_1L_1	19.66	22.66
M_1L_2	18.66	22.33
M_1L_3	18.00	22.66
M_2L_1	19.33	22.33
M_2L_2	18.00	22.00
M_2L_3	15.33	19.00
M_3L_1	16.66	21.66
M_3L_2	15.66	21.33
M_3L_3	14.66	18.33
Mean	16.00	20.00
SEm +	0.37	0.43
CD at 5 %	1.11	1.30

obtained by using mature scion stick (5 month and 6 months age) appeared due to more reserved food material in the mature scion, which provides energy for respiration, callus formation and early growth of scion. The possible explanation for non-significant effect of length of scion stick treatment on survival of graft could be attributed to uniform meristematic activity in the scion sticks throughout its length. However, minimum number of days required for initiation and completion of sprouting at maximum length (6 cm) appeared to be due to early wound healing and callus formation resulting into faster growth in maximum length i.e. 6 cm. Similar results were obtained in kokum (Haldankar,1993), mango (Panicker, 1986), jackfruit (Desai, 1987) and in nutmeg (Khandekar *et al.*, 2006). They could not get any significant differences in percentage survival of grafts among different length.

Table 5. *Effect of age of scion stick on length of sprout (cm)*

Treatment	30 DAS	45 DAS	60 DAS	75 DAS	90 DAS
M_1 (4 month)	1.11	1.65	2.15	2.50	3.01
M_2 (5 month)	1.18	1.76	2.19	2.54	3.07
M_3 (6 month)	1.14	1.79	2.22	2.59	3.14
Mean	1.14	1.73	2.19	2.54	3.07
SEm +	0.01	0.01	0.01	0.01	0.01
CD at 5%	0.05	0.03	0.04	0.04	0.03

Table 6. *Effect of length of scion stick on sprout length (cm)*

Treatment	30 DAS	45 DAS	60 DAS	75 DAS	90 DAS
L_1 (5 cm)	1.13	1.73	2.16	2.51	3.02
L_2 (7.5 cm)	1.14	1.72	2.19	2.55	3.09
L_3 (10 cm)	1.16	1.75	2.21	2.56	3.10
Mean	1.14	1.73	2.19	2.54	3.07
SEm +	0.01	0.01	0.01	0.01	0.01
CD at 5 %	NS	NS	NS	NS	NS

Table 7. *Interaction effect of age and length of scion on sprout length (cm)*

Treatment	30 DAS	45 DAS	60 DAS	75 DAS	90 DAS
M_1L_1	1.14	1.63	2.06	2.51	2.97
M_1L_2	1.33	1.68	2.16	2.50	3.04
M_1L_3	1.06	1.64	2.23	2.48	3.01
M_2L_1	1.20	1.78	2.22	2.54	3.06
M_2L_2	1.17	1.71	2.20	2.54	3.08
M_2L_3	1.18	1.80	2.16	2.54	3.07
M_3L_1	1.06	1.78	2.21	2.48	3.04
M_3L_2	1.13	1.76	2.21	2.62	3.14
M_3L_3	1.22	1.82	2.26	2.67	3.23
Mean	1.16	1.75	2.21	2.56	3.10
SEm +	0.03	0.02	0.02	0.02	0.02
CD at 5%	0.09	0.06	0.07	0.07	0.06

Table 8. *Effect of age of scion stick on number of leaflets*

Treatment	30 DAS	45 DAS	60 DAS	75 DAS	90 DAS
M_1 (4 month)	5.37	10.26	14.51	18.64	22.93
M_2 (5 month)	5.57	10.37	14.73	18.77	22.95
M_3 (6 month)	5.44	10.42	14.77	19.24	23.64
Mean	5.46	10.35	14.67	18.88	23.17
SEm +	0.06	0.04	0.06	0.09	0.08
CD at 5 %	0.18	0.12	0.18	0.27	0.26

Table 9. *Effect of length of scion on number of leaflets*

Treatment	30 DAS	45 DAS	60 DAS	75 DAS	90 DAS
L_1 (5 cm)	5.48	10.33	14.66	18.68	23.00
L_2 (7.5 cm)	5.46	10.42	14.62	18.97	23.26
L_3 (10 cm)	5.44	10.31	14.73	19.00	23.24
Mean	5.46	10.35	14.67	18.88	23.17
SEm +	0.06	0.04	0.06	0.09	0.08
CD at 5 %	NS	NS	NS	NS	NS

Table 10. *Interaction effect of age and length of scion on number of leaflets*

Treatment	30 DAS	45 DAS	60 DAS	75 DAS	90 DAS
M_1L_1	5.66	10.13	14.26	18.20	22.60
M_1L_2	5.26	10.40	14.53	18.66	22.86
M_1L_3	5.20	10.26	14.73	19.06	23.33
M_2L_1	5.40	10.26	14.86	18.86	22.93
M_2L_2	5.73	10.53	14.73	18.73	23.26
M_2L_3	5.60	10.33	14.60	18.73	22.66
M_3L_1	5.40	10.60	14.86	19.00	23.53
M_3L_2	5.40	10.33	14.60	19.53	23.66
M_3L_3	5.53	10.33	14.86	19.20	23.73
Mean	5.44	10.31	14.73	19.00	23.24
SEm +	0.10	0.07	0.10	0.16	0.15
CD at 5%	0.32	0.21	0.32	0.48	0.46

Significant effect of age and length of scion stick on sprouting and survival of grafts could be attributed to combined effect of both these factors could have resulted in favourable growth changes, which would have led to uniform meristematic activity in the scion sticks and higher success and survival of grafts in carambola. Similar results were reported by several workers in other crops. Khandekar *et al.*, (2006) in nutmeg reported significant effect on survival and sprouting of grafting in nutmeg crops due to age of scion sticks. The mean maximum sprouting and survival were recorded in 5 months-old scion stick in combination with all length of scion stick treatments appeared to be due to maximum reserved food material in the matured sticks which also can sustain injury of grafting operation that led to fast callus proliferation activity and higher success over immature scion sticks with all length in combination. The length of scion stick had proved significant effect on sprouting and survival of grafts. The minimum number of days required for initiation and completion of sprouting appeared to be due to uniform meristematic activity in the scion sticks throughout its length that resulted in faster wound healing and early sprouting of grafts.

REFERENCES

Amin, R. S. (1974). A study on the establishment of mango orchard with wedge graft on *in-situ* grown mango seedling in dry region of Gujarat. *Haryana Journal of Horticultural Science* **3**: 160-167.

Chadha, K. L. (2001). Carambola. Handbook of Horticulture, ICAR Publication, New Delhi, pp 159-160.

Desai, S. A. (1987). Studies on standardization of epicotyl and softwood grafting in Jackfruit. *M.Sc. (Ag.) Thesis*, D.B.S.K.K.V., Dapoli. Maharashtra.

Haldankar, P.M., Salvi, M. J., Joshi, G.D. and Patil, J. L. (1993). Factors influencing softwood grafting in kokum. *Indian Cocoa Arecanut and Spices Journal* **17**(1-2): 15-18.

Khandekar, R.G., Joshi, G.D., Daghoral, L. K., Manjarekar, R.G. and Haldankar, P.M. (2006). Effect of time of soft wood grafting on sprouting and growth of nutmeg grafts. *Journal of Plantation Crops* **24**(3): 226-228.

Panicker, P. (1986). Studies on softwood grafting in Mango var. Alphonso. *M.Sc. (Agri.) Thesis*, D.B.S.K.K.V., Dapoli.

Panse, V. G. and Sukhatme, P. V. (1995). *Statistical Methods for Agricultural Workers* (eds. Sukhatme P. V. and Amble, V.N.) ICAR, pp 145-146.

Singh Daljit (1963). Kamrakh: Sweet and Vitamin Rich. *Indian Horticulture* **7**(2): 8.