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PROPAGATION OF ALMOND THROUGH BUDDING UNDER TEMPERATE CONDITIONS OF NORTH WESTERN HIMALAYA

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ABSTRACT

An experiment was carried out in Fruit Plant Nursery of Division Fruit Science, SKUAST-K, Shalimar, Kashmir during 2014 to standardize budding method, time of budding for almond (*Prunus dulcis*) and to determine the suitable portion of scion for maximum success. T-budding with 51.2% success proved significantly superior over chip budding (42.3%). Of the four budding timings tested, the highest budding success of 52.1% was achieved when budding was done in 2nd week of June. Overall, highest success of 49.4% was achieved when middle scion portion was used for budding than the lower scion portion which gave overall success of 44.1%. Of the varieties evaluated cultivar 'Non-Pareil' with budding success of 49.8% showed significant superiority over cv. 'Shalimar with budding success of 43.7%. Highest bud take (65.65%), shoot length (25.9 cm) and shoot diameter (4.16 mm) were observed in T-budding performed in the 2nd week of June. T-budding resulted in better success as compared to chip during June, July and August however chip budding performed significantly better in the month of September in both the cultivars.

Key words: Almond, budding, scions, varieties

INTRODUCTION

Almond (*Prunus dulcis* Mill.) is an important temperate nut fruit which belongs to the family Rosaceae and sub family Prunoideae. The cultivated almond species apparently originated in Central Asia (Iran) as a result of hybridization among the native species followed by local seedling selection by native people (Kester, 1982). In India it was first introduced in Kashmir in 16th century by Persian settlers but in spite of its great potential in the region, the crop could not develop on commercial scale as much as apple. Almond is found mostly in North Western Himalayan region particularly in Jammu and Kashmir, Himachal Pradesh and Uttarakhand covering an area of 23,200 ha with production of 16,300 tonnes. In Jammu & Kashmir the area under almond is 7132 ha with the production of 7060 tonnes (Anonymous, 2016). Almond is the healthiest and most nutritious nut and considered a well balanced cholesterol free food. Almond may be propagated by seed, grafting and budding on seedling of almond, peach or plum and by micro-propagation. The most commonly used rootstocks for almond in Kashmir valley are the seedling raised from sweet or bitter almond.

Most of the existing orchards in Jammu & Kashmir are of seedling origin and attain giant size which render orchard management a difficult task and does not produce superior quality almonds.

The vegetative propagated plants start bearing only after 3-4 years. The almond is propagated by T-budding on seedling rootstocks by fall, spring or June budding (Hartman *et al*., 1990; Riel and Sutter, 1996). Late summer and early fall is the most important time for budding in propagation of fruit tree nursery stocks. T-budding is a common practice for almond in Turkey usually done in July and August (Dokuzoguz and Gulcan, 1979). However, in present study efforts were made to find out the appropriate time for budding under Kashmir conditions. For this, the time of budding was started from June to September. Also, two portions of scion (lower and middle) were used.

Almond being heterozygous due to self incompatibility is propagated by seed so uniform planting material is not obtained. Therefore, budding is considered as one of the important vegetative propagation method for improving the quality of planting material and reducing the juvenile phase. This helps in producing true to type plants and thus good quality fruits can be obtained. In view of above, the present study was aimed to standardize budding method and time of budding in almond and to determine the suitable portion of scion for maximum success under temperate agro-climatic conditions of Kashmir.

MATERIALS AND METHODS

The study was conducted at Fruit Plant Nursery, Division of Fruit Science, SKUAST-K, Shalimar, Kashmir during the year 2014. The experiment was carried out under open field conditions with two budding methods *viz.*, T- budding and chip budding performed at monthly interval from 2nd week of June. The seedlings of uniform growth, size and age (1 year old) raised from bitter almonds were used as rootstocks. The bud wood was collected from healthy, strong and disease-free trees of 'Shalimar' and 'Non-Pareil' cultivars of almond. The bud wood was collected one day prior to the date of budding; after detaching the bud sticks were defoliated, leaving a small portion of petiole to facilitate the removal of bud from stick and its insertion in rootstock. The current year's growth about 30 cm long of pencil thickness was used. During budding operation bud sticks were kept in a pot with lower end submerged in water to avoid desiccation. The bud sticks used as scion were divided into three portions *viz.*, upper, middle and lower. The middle and lower portions of bud stick were used for budding and upper portion discarded. The experimental design was split plot design. The data on bud take, bud sprouting, budding success, days taken for leafing out (with respect to reference date which was fixed as 1st March), number of leaves, shoot length and shoot diameter were recorded. The observation on bud take was taken one month after budding. However, shoot length, shoot diameter and budding success was recorded on 15th June, 2015. Statistical analysis was done using CPCS-1 software in split plot design and as per the procedure given by Gomez and Gomez (1986).

RESULTS AND DISCUSSION

Bud take success

Budding performed in June resulted in highest mean bud take of 66.2% (Table 1). The higher bud take in case of budding performed in June appears due to conducive temperature and free flow of sap in root stock and scion which is important for proper growth of both stock and scion. Proper temperature and humidity could also facilitate the union between stock and scion (Maryam *et al.*, 2015). Ahmad *et al.* (2012) reported maximum bud take success (85%) in plants budded in June and least bud take success (80%) in plants budded in July. The methods of budding indicate a significant influence on bud take. T-budding exhibited higher mean bud take (65.6%).

Table 1: Effect of cultivars, budding method, timing and scion portion on bud take (%) one month after budding

Scion portion used (C)	Timing of budding (D)	Almond cultivar (A)						Mean		Overall Mean	Mean of timing
		Non-Pareil			Shalimar						
		Method of budding (B)									
		T-budding	Chip-budding	Mean	T-budding	Chip-budding	Mean	M1	M2		
Lower	June	90.00	66.66	78.33	83.33	60.00	71.66	86.66	63.33	74.99	
		(9.52)	(8.22)	(8.87)	(9.17)	(7.79)	(8.48)	(9.34)	(8.00)	(8.67)	66.24
	July	70.00	53.33	61.66	66.66	46.66	56.66	65.33	49.99	59.16	(8.15)
		(8.41)	(7.36)	(7.88)	(8.22)	(6.89)	(7.55)	(8.31)	(7.12)	(7.71)	
	August	63.33	56.66	59.99	53.33	50.00	51.66	58.33	53.33	55.82	
		(8.01)	(7.58)	(7.79)	(7.36)	(7.11)	(7.23)	(7.68)	(7.34)	(7.51)	64.99
	September	46.66	60.00	53.33	43.33	60.00	51.66	44.99	60.00	52.49	(8.08)
		(6.89)	(7.79)	(7.34)	(6.64)	(7.79)	(7.21)	(6.76)	(7.79)	(7.27)	
Mean		67.49	59.16	63.32	61.66	54.16	57.91	63.82	56.66	60.61	
		(8.20)	(7.73)	(7.97)	(7.84)	(7.39)	(7.61)	(8.02)	(7.56)	(7.80)	
Middle	June	66.66	53.33	59.99	60.00	50.00	55.00	63.33	51.66	57.49	
		(8.22)	(7.36)	(7.79)	(7.79)	(7.11)	(7.45)	(8.00)	(7.23)	(7.62)	62.49
	July	83.33	63.33	73.33	76.66	60.00	68.33	79.99	61.66	70.83	(7.94)
		(9.17)	(8.01)	(8.59)	(8.80)	(7.79)	(8.29)	(8.98)	(7.90)	(8.44)	
	August	76.66	66.66	71.66	70.00	63.33	66.66	73.33	64.99	69.16	
		(8.80)	(8.22)	(8.51)	(8.41)	(8.01)	(8.21)	(8.60)	(8.11)	(8.36)	57.07
	September	56.66	70.00	63.33	53.33	66.66	59.99	54.99	68.33	61.66	(7.58)
		(7.58)	(8.41)	(7.99)	(7.36)	(8.22)	(7.79)	(7.47)	(8.31)	(7.89)	
Mean		70.82	63.33	67.07	64.99	59.99	62.49	67.49	61.66	64.78	
		(8.44)	(8.00)	(8.22)	(8.09)	(7.78)	(7.93)	(8.26)	(7.93)	(8.08)	
Overall Mean		69.15	61.24	65.19	63.32	57.07	60.20	65.65	59.16	62.69	
		(8.32)	(7.86)	(8.10)	(7.96)	(7.58)	(7.78)	(8.15)	(7.73)	(7.94)	
Main effect and interaction effect				A	B	C	D	A x B x C x D			
$CD_{0.05}$				0.10	0.10	0.10	0.13	ns			

Figures in parenthesis are square root transformed value

The highest bud take success was obtained in T-budding as compared to chip budding. This may be due to larger cambial contact in T-budding. These results are in accordance with Dwivedi *et al.* (2000) who in apricot reported better bud take success in T-budding and significantly low rate of success in patch method. These results are in conformity with Rayga *et al.* (2009) in case of almond. Bud take was significantly influenced by scion portion. Maximum bud take (64.8%) occurred when middle portion of scion was used. This may be due to the fact that the rate of cell division is more in juvenile buds as compared to the buds of older scion portion. On overall mean basis, almond cv. 'Non-Pareil' showed significantly better bud take of 65.2% whereas cv. 'Shalimar' showed 60.2% bud take which might be the varietal character.

Budding success

Method and time of budding, varieties and scion portion significantly influenced budding success in almond plants (Table 2). Among the methods, higher budding success was observed in 'T' budding (51.2%) as compared to chip budding (42.3%). This may be due to the maximum bud take in case of T-budding. Better success with T-budding may also be attributed to greater contact area between matrix of stock and scion as compared to chip budding method. Among the different timings of budding, the highest budding success was achieved in plants budded in June with 52.1% success and minimum budding success in plants budded in September (40.8%) which may be attributed to more bud take in June. The results are in close conformity with Kasmi *et al.* (2013) and Maryam *et al.* (2015) who reported 80% budding success in June budding in walnut and cherry. Success in 'T' budding depends on bark slipping, at that period the vascular cambium is actively dividing thereby

Table 2: Effect of cultivars, budding method, timing and scion portion on budding success (%)

Scion portion used (C)	Timing of budding (D)	Almond cultivar (A)						Mean of budding methods		Overall Mean	Mean of timing
		Non-Pareil			Shalimar						
		Method of budding (B)						B1	B2		
		T-budding	Chip-budding	Mean	T-budding	Chip-budding	Mean				
Lower	June	73.33	46.66	59.99	66.66	43.33	54.99	69.99	44.99	57.49	
		(58.98)	(43.05)	(51.01)	(54.76)	(41.13)	(47.94)	(56.87)	(42.09)	(49.47)	52.08
	July	53.33	36.66	44.99	50.00	30.00	40.00	51.66	33.33	42.49	(46.25)
		(46.90)	(37.20)	(42.05)	(44.98)	(32.98)	(38.98)	(45.94)	(35.09)	(40.51)	
	August	46.66	40.00	43.33	43.33	33.33	38.33	44.99	36.66	40.83	
		(43.05)	(39.13)	(41.09)	(41.13)	(35.20)	(38.16)	(42.09)	(37.16)	(39.62)	47.91
	September	33.33	46.66	39.99	23.33	40.00	31.66	28.33	43.33	35.82	(43.73)
		(35.20)	(43.05)	(39.12)	(28.76)	(39.13)	(33.94)	(31.98)	(41.09)	(36.53)	
	Mean	51.66	42.49	47.05	45.83	36.66	41.24	48.74	39.57	44.15	
		(46.03)	(40.60)	(43.31)	(42.40)	(37.11)	(39.75)	(44.21)	(38.85)	(41.54)	
Middle	June	60.00	40.00	50.00	53.33	33.33	43.33	56.66	36.66	46.66	
		(50.83)	(39.13)	(44.98)	(46.90)	(35.20)	(41.05)	(48.86)	(37.16)	(43.01)	46.25
	July	66.66	46.66	56.66	60.00	40.00	50.00	63.33	43.33	53.33	(42.79)
		(54.76)	(43.05)	(48.90)	(50.83)	(39.13)	(44.98)	(52.79)	(41.09)	(46.94)	
	August	60.00	50.00	55.00	53.33	43.33	48.33	56.66	46.66	51.66	
		(50.83)	(44.98)	(47.90)	(46.90)	(41.13)	(44.01)	(48.86)	(43.05)	(45.95)	40.83
	September	40.00	56.66	48.33	36.66	50.00	43.33	38.33	53.33	45.83	(39.53)
		(39.13)	(48.82)	(43.97)	(37.20)	(44.98)	(41.09)	(38.16)	(46.90)	(42.53)	
	Mean	56.66	48.33	52.49	50.83	41.66	46.24	53.74	44.99	49.37	
		(48.88)	(43.99)	(46.43)	(45.45)	(40.11)	(42.78)	(47.16)	(42.05)	(44.61)	
Overall Mean		54.16	45.41	49.77	48.33	43.64	43.74	51.24	42.28	46.76	
		(47.45)	(42.29)	(44.88)	(43.92)	(38.60)	(41.26)	(45.70)	(40.46)	(41.84)	
$CD_{0.05}$		A = 0.94;		B = 0.94;		C = 0.94;		D = 1.12;		A x B x C x D = ns	

The figures in parenthesis are arcsine transformed values

produces young, thin-walled cells on either side of cambium. These newly formed cells interlock easily resulting in better union formation (Hartmann *et al.*, 2007). Among the two scion portions, the plants budded with middle portion of scion had higher budding success of 49.4% than those budded with lower portion of scion (44.2% budding success). Among the two cultivars 'Non-Pareil' performed better than 'Shalimar' with respect to the parameters studied which shows that varietal differences or genetic constitution of plant plays prominent role in propagation success. Ullah *et al.* (2000) reported maximum budding success in almond cv. 'Tuono' and minimum in cv. 'Genco'.

Shoot length

Maximum shoot length was observed in T-budded plants (25.9 cm) and minimum in chip budded plants (23.8 cm) (Table 3). Better growth of T-budded plants may be attributed to the better graft union between cambial layers of stock and scion, early completion of bud sprouting and initiation of subsequent growth. These results are in agreement with Dwivedi *et al*. (2000) who in apricot reported better linear growth in T-budding than patch budding. Plathia (2011) also reported maximum shoot length in T-budding and inverted T-budding. Of the budding timings, the budding performed in June proved significant superior in scion length (32.4 cm) over other budding timings. It may be due to early graft union formation and early sprouting in June budded plants as well as due to the greater number of leaves produced that elevated the availability of photosynthates for growth and development of composite plants. These results are in agreement with Bhatt *et al.* (2013) who reported maximum shoot length of 50.27 cm when patch budding was done during mid June in Guava. Ahmad *et al.* (2012) reported maximum budding growth (127.9 cm) in peach plants budded on 15th June. In present study the shoot length was found more in cv. 'Non-Pareil' (26.4 cm) than in

Table 3: Effect of cultivars, budding method, timing and scion portion on shoot length (cm)

Scion portion used (C)	Timing of budding (D)	Almond cultivar (A)						Mean		Overall Mean	Mean of timing
		Non-Pareil			Shalimar						
		Method of budding(B)						M1	M2		
		T-budding	Chip-budding	Mean	T-budding	Chip-budding	Mean				
Lower	June	35.36	33.23	34.29	32.50	30.30	31.40	33.93	31.76	32.84	32.40
	July	33.20	31.43	32.31	30.30	28.46	29.38	31.75	29.94	30.84	
	August	25.76	24.53	25.40	22.80	20.23	21.51	24.28	22.38	23.45	31.14
	September	14.66	12.46	13.56	11.43	9.10	10.26	13.04	10.78	11.91	
Mean		27.24	25.41	26.39	24.25	22.02	23.13	25.75	23.71	24.76	
Middle	June	34.63	32.43	33.53	31.50	29.30	30.40	33.06	30.86	31.96	23.60
	July	34.03	32.23	33.13	30.96	28.56	29.76	32.46	30.39	31.44	
	August	26.43	23.46	24.94	23.60	21.56	22.58	25.01	22.51	23.76	12.41
	September	15.43	13.40	14.41	12.40	10.46	11.43	13.91	11.91	12.92	
Mean		27.63	25.38	26.50	24.61	22.47	23.54	26.11	23.91	25.02	
Overall Mean		27.43	25.39	26.44	24.43	22.24	23.33	25.93	23.81	24.89	
Main effect and interaction effect					A	B	C	D		A x B x C x D	
$C.D_{0.05}$					0.10	0.10	0.10	0.14		ns	

cv. Shalimar (23.3). Akbudak *et al.* (1995) also reported maximum shoot length in cv. 'Non-Pareil' and minimum in 'Tuono'.

Shoot diameter

Method and time of budding and plant cultivar had a profound impact on shoot diameter (Table 4). 'T' budding gave maximum shoot diameter (4.16 mm) than chip method (4.00 mm). It seems that more number of leaves on T-budded plants resulted in higher accumulation of carbohydrates. The results are in accordance with Dwivedi *et al*. (2000) who reported higher radial growth in T-budding in apricot as compared to patch budding. lathia (2011) also observed maximum shoot girth in T-budded and inverted T-budded plants. Of the different timings of budding, the maximum shoot diameter was obtained in budding done in June (5.33 mm) which was at par with budding performed in July (5.22 mm) but significantly higher than August and September budding. Early sprouting and early initiation of vegetative growth seems to have resulted in more carbohydrates formation and their utilization for growth and development in earlier month buddings. Plathia (2011) also reported maximum shoot girth in all the budding methods performed in June. Non-significant differences

Table 4: Effect of cultivars, budding method, timing and scion portion on shoot diameter (mm)

Scion portion used (C)	Timing of budding (D)	Almond cultivar (A)						Mean		Overall Mean	Mean of timing
		Non-Pareil			Shalimar						
		Method of budding (B)						M1	M2		
		T-budding	Chip-budding	Mean	T-budding	Chip-budding	Mean				
Lower	June	5.66	5.50	5.58	5.46	5.30	5.38	5.56	5.40	5.48	5.33
	July	5.26	5.10	5.18	5.03	4.90	4.96	5.14	5.00	5.07	
	August	3.46	3.30	3.38	3.26	3.06	3.16	3.36	3.18	3.27	5.22
	September	2.43	2.33	2.38	2.20	2.06	2.13	2.31	2.19	2.25	
Mean		4.20	4.05	4.13	3.98	3.83	3.90	4.09	3.94	4.02	
Middle	June	5.36	5.20	5.28	5.16	5.00	5.08	5.26	5.10	5.18	3.41
	July	5.56	5.40	5.48	5.36	5.20	5.28	5.45	5.30	5.38	
	August	3.76	3.60	3.68	3.50	3.36	3.43	3.63	3.48	3.56	2.37
	September	2.63	2.56	2.59	2.46	2.30	2.38	2.54	2.43	2.48	
Mean		4.31	4.19	4.25	4.12	3.96	4.04	4.22	4.07	4.15	
Overall Mean		4.26	4.12	4.19	4.05	3.89	3.97	4.16	4.00	4.08	
Main effect and interaction effect				A		B	C	D		A x B x C x D	
$C.D_{0.05}$				0.14		0.14	ns	0.20		ns	

were observed in shoot diameter among different scion portion. However, the plants budded with middle scion portion gave 4.15 mm shoot diameter than the plants budded with lower scion portion (4.02 mm). Significant differences between two cultivars were also observed in shoot diameter with maximum shoot diameter in cv. 'Non-Pareil' (4.19 mm) than in cv. 'Shalimar' (3.97 mm).

Conclusion: T-budding performed in June with buds taken from lower scion portion was best for almond propagation under temperate conditions of North Western Himalaya. If budding is delayed, it should be performed in July and August by the same budding method but with buds taken from middle scion portion. Any unsuccessful budded plants should be chip budded in September.

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