Journal of Crop and Weed 7(1): 89-93 (2011)

Effect of time and species on bud union and survivability in citrus under Allahabad condition

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Received: 15.03.2011, Revised: 30.05.2011, Accepted: 04.06.2011

ABSTRACT

India is the second largest producer of fruits after China. Among the various vegetative methods used to propagate the citrus, budding is by far the most common method practiced universally in citriculture. The experiment was laid out in 3x4 factor factorial RBD with T-budding method on four varieties i.e. lime, lemon, Kinnow and grapefruit with 12 treatments in three different times of budding i.e. first week of November, second week of November and third week of November. Maximum success of budding (81.67%) was recorded with lemon budded during first week of November. Minimum days of bud sprouting(13.30) ,maximum sprout length (8.87cm), sprout girth (9.09mm), number of leaves (16.97), number of branches (2.22) was also found with lemon budded during the first week of November. However, highest net return of Rs.105132 and Benefit: Cost ratio of 8.07 per 1000 budded plants with grapefruit budded during first week of November.

Key words: Grapefruit, kinnow, lemon, lime

Fruits are nature's gift to mankind and are undoubtedly man's oldest food. India is the second largest producer of fruits after China, Citrus is the third most important fruit crop after mango and banana with an area of 967 thousand hectare and a production of 9475 thousand million tones (Anon, 2010.) Citrus (Citrus spp) is a large to medium, thorny evergreen fruit tree belonging to the family Rutaceae. In India citrus is commercially propagated by T-budding, research work carried out in recent years have clearly indicated that this technique gives 65-70% success for its large scale multiplication. Among the various vegetative methods used to propagate the citrus, budding is by far the most common method practiced universally in citriculture. In budding incompatibility is a major problem. In Uttar Pradesh most widely used rootstock is rough lemon followed by karnakhatta for most of the scions. Compatibility problem and early die-back within 10 years were observed when sweet orange and certain grapefruit cultivars were budded on root stock karnakhatta. When blood red was budded over cleopatra, mosambi over rough lemon, grapefruit and lime over karnakhatta showed smooth bud union with high yield with good quality fruits after 30 years (Harish *et al.*, 2000). Keeping in view the above fact the present investigation was conducted to find out the suitable time and species for successful budding.

MATERIALS AND METHODS

The present experiment was conducted during November 2007-February 2008, in the Department of Horticulture, Sam Higginbottom Institute of Agriculture, Technology and Sciences, Allahabad. The experiment was laid out in 3×4 factor factorial RBD with T-budding method on four varieties i.e. lime, lemon, kinnow and grapefruit with 12 treatments and each replicated thrice.The treatments were allocated randomly in each replication.

Treatment details are given as under

T_1S_1	1st week of November + lime
T_1S_2	1st week of November + lemon
T_1S_3	1st week of November + kinnow
T_1S_4	1st week of November + grapefruit
T_2S_1	2nd week of November + lime
T_2S_2	2nd week of November + lemon
T_2S_3	2nd week of November + kinnow
T_2S_4	2nd week of November + grapefruit
T_3S_1	Last week of November + lime
T_3S_2	Last week of November + lemon
T_3S_3	Last week of November + kinnow
T_3S_4	Last week of November +grapefruit

The rootstock used was Karna khatta (*Citrus karna)* budded in three different times first week of November, Second week of November, Last week of November. The rootstock plants age varied from 10-12 months the type of budding T-budding was done on the first, second and last week of November, 2006. About 10-12 months old seedlings of pencil size thickness, 25-30cm in height were selected. After removing all the leaves, sprouts and thorns on the stem of the stock upon just above the point of operation site, first a vertical cut of about 2, 5-3cm long is made in the bark of the stock, at a height of about 20cm from the ground level, and then another cut is made horizontally below the vertical cut making it an inverted T cut.

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Meteorological data during the period of investigation

Weekly intervals	Temperature (°C)		Relative humility (%)		Rainfall(mm)
	Max.	Min.	Max.	Min.	
NOVEMBER					
1st week	33.0	18.0	84	58	0.0
2nd week	32.6	17.0	87	51	0.0
3rd week	31.6	12.0	90	34	0.0
4th week	29.6	10.4	90	34	0.0
Remaining days	28.6	11.5	96	36	0.0
DECEMBER					
1st week	28.0	9.0	92	30	0.1
2nd week	26.0	9.4	100	35	1.5
3rd week	24.4	4.0	97	33	0.0
4th week	25.2	3.8	95	27	0.0
Remaining days	24.0	6.7	95	29	0.0
JANUARY					
1st week	24.0	6.0	92	28	0.0
2nd week	29.8	7.8	95	26	0.0
3rd week	28.4	9.5	88	30	0.0
4th week	21.8	4.6	98	34	0.3
Remaining days	21.4	5.3	93	30	0.0
FEBRUARY					
1st week	26.8	3.8	93	21	2.3
2nd week	23.0	5.4	92	30	8.6
3rd week	29.4	5.2	84	24	0.0
Remaining days	31.0	10.2	89	24	0.0

Source: Agro-meteorology observatory unit, College of Forestry SHIATS-Allahabad

Then the flaps are carefully lifted without injuring the tissue below, by the blunt end of budding knife .Then a bud shield of 2.5cm without a slice of wood is carefully inserted beneath the flaps with the bud facing upwards and then wrapped tightly with polythene sheets both at the upper and lower ends, leaving the buds uncovered. When the uptake of bud is assured half of the top of the rootstock above the bud union is removed. When the sprouted buds have made about 4-5cm growth the remaining portion of the rootstock is removed leaving 2-3cm from the bud union. All the shoots emerging below or above the bud union are removed from time to time. Observations were recorded at 10 days interval starting from 40th day after budding to70th days after budding. Data on various parameters were recorded analyzed statistically and presented in table.

RESULTS AND DISCUSSION

The data pertaining to budding success, number of days taken for bud sprouting sprout length, sprout girth; number of leaves per plant, number of branches per plant, leaf length, and leaf width of different species and time of budding in citrus are presented in table 1.

Success of budding

It is clear from table 1 the success of budding differed significantly due to different species and time of budding. Highest success of budding was observed in the first week of November (81.67%) which was followed by second week of November (78.33%) and minimum success of budding was recorded in the last week of November (76.67%). Lemon (95.56%) species was found significantly superior than lime (82.22%) grapefruit (80.0%) and kinnow (57.78%) gave minimum success of budding.

The interaction between time and species was also significant with lemon (100%) species budded in the first week of November. Lemon budded in second (93.33%) week were statistically at par with lemon budded in the last week of November (93.33%) followed by lime (86.67%) budded in the first week of November. Lime budded in the second (80%) week of November were also statistically at par with lime budded in the last (80%) week of November. Grapefruit budded in the first week(60%) of November were also at par with grapefruit budded in second(60%) and last week(60%) of November and kinnow budded in the first week (60%),second week(60%) of November. Minimum success was recorded in the last week (53.33%) of November in kinnow.

The better result might be due to availability of better scion stock and active sap flow in tissue in lemon and lime species as compared to other species of citrus. The reason for minimum success in the last

week of November might de due to low temperature and humidity. The results are in conformation with the work of Bhullar *et al.* (1980) in citrus species, Pandey *et al.* (1980) in aonla species, Valsalakumari *et al.*(1985)in cashew and Dimri (1999) in lemon.

Days taken to bud sprouting

The data pertaining to the number of days taken for bud sprouting of inserted citrus buds (Table 1) reveals that minimum number of days taken for bud sprouting was recorded in the first week of November (18.90) and maximum days was taken in the last week of November (24.09) for bud sprouting. The effect of species on days taken for bud sprouting was also found significant and observed minimum in lemon (14.0) followed by lime (15.83), and maximum days were taken in kinnow (31.87).

The effect of time and species on the number of days taken for bud sprouting was recorded minimum in lemon (13.30) budded in the first week of November followed by lemon budded in second (13.73) week of November. Grapefruit budded in the last week (30.64) of November and Kinnow budded in the first week (30.64), second week (30.64) was statistically at par whereas maximum success was recorded in the last week (34.33) of November in kinnow. Good sap flow in Lemon compared to other cultivars might be the factors that favoured early callusing and perforation at the bud union. Similar findings have been reported in other crops (Patel *et al.*, 2003; Anuja *et al.*, 2004; Palanda *et al.*, 2004 and Patel *et al.*, 2005).

Sprout length

The table 1 revealed that the maximum length (5.35cm) of sprouts was obtained in the first week of November, whereas minimum length of sprout (4.14cm) was recorded in the last week of November. Lemon showed maximum sprout length (7.37cm) followed by lime (5.12cm), grapefruit (3.63cm) and minimum in kinnow (2.59cm). Lemon budded (8.87cm) in the first week of November showed maximum sprout length followed by lemon budded in second (6.84cm) week of November and minimum sprout length was recorded in the last week (2.31cm) of November in kinnow. Maximum sprout length in lemon may be due to its vigorous growth character and minimum sprout length in kinnow might be due to dwarfing character of the variety. The present findings are in agreement with the findings of Aulakh (1998), Patel *et al.* (2003), Palanda *et al.* (2004), Gagan *et al.* (2005) and Patel *et al.* (2005).

Sprout girth

Sprout girth of different cultivars were found to differ significantly (Table 1). The maximum sprout girth was noticed in first week of November (6.29mm) followed by second week (5.69mm) and minimum in the last week of November (5.03mm). Lemon showed maximum sprout girth (8.04mm) followed by lime(6.01mm) ,grapefruit (4.91mm) and minimum sprout girth in kinnow (3.72mm).

The interaction between time and species was recorded maximum sprout girth in lemon (9.09mm) budded in the first week of November followed by lemon budded in second (8.24mm) week of November whereas minimum sprout girth was recorded in the last week (3.33mm) of November in kinnow. The maximum sprout girth obtained in the first week of November might be due to the congenial temperature and humidity for the early growth and minimum sprout girth in the third week of November might be because of the start of winter season. i.e. low temperature and humidity. Similar results have been reported by Patel *et al.* (2005).

Number of leaves plant^{-1}

The data presented in table 1 indicate that lemon produced the maximum number of leaves (14.08) plant^{-1} followed by lime (8.84) and minimum number of leaves in kinnow (5.04). The effect of time on the number of leaves per plant was recorded maximum in the first week of November (10.07), followed by second week (8.16) of November and minimum in the last week of November (7.70).

Lemon (16.97) budded in the first week of November gave maximum number of leaves per plant followed by lemon budded in second (13.19) week of November, whereas minimum number of leaves was recorded in the last week (4.73) of November in kinnow. The maximum number of leaves per plant might be due to maximum sprout length in lemon and minimum sprout length in kinnow. Patel *et al.* (2003), Anuja *et al.* (2005), Gagan *et al.* (2005) and Patel *et al.* (2005) reported similar results.

Number of branches per plant

The result obtained in Table 1showed that among the different species budded, lemon (2.22) produced better response followed by lime (1.22), and minimum in kinnow (1.04) in increasing the number of branches per plant. However the maximum number of branches was recorded in the first week of November (1.43), followed by second (1.26) week of November and minimum number of branches in the third week of November (1.22).

Lemon (2.22) budded in the first week of November showed maximum number of branches. Lemon budded in second (1.66) week of November was statistically at par with lemon budded in last week of November (1.66). Lime (1.33) budded in the first week of November were statistically at par with lime budded in the second (1.22).Lime budded in the last (1.11) week of November, and grapefruit budded in the first (1.11), second week (1.11) and last week of November. And minimum success was recorded in the last week (1.00) of November in kinnow. Anuja *et al.* (2004) reported highest number of branches in aonla.

Table 1: Effect of time species and their interaction on the bud union in citrus

Treatment	Budding success (%)	Days to sprout	Sprout length (cm)	Sprout girth (cm)	Leaves plant^{-1}	Branches plant^{-1}	Leaf length (cm)	Leaf width (cm)
Time								
T_1	81.67	18.90	5.35	6.29	10.07	1.43	3.50	1.65
T_2	72.33	20.33	4.54	5.69	8.16	1.26	2.91	1.36
T_3	76.67	24.90	4.14	5.03	7.70	1.22	2.28	1.20
LSD(0.05)	**1.03**	**0.38**	**0.14**	**0.24**	**0.28**	**0.11**	**0.16**	**0.07**
Species								
S_1	82.22	15.83	5.12	6.01	8.84	1.22	3.44	1.54
S_2	85.65	14.00	7.37	8.04	14.08	1.85	5.17	2.27
S_3	57.78	31.87	2.59	3.72	5.04	1.04	1.12	0.56
S_4	80.00	22.71	3.63	4.91	6.62	1.10	1.86	1.23
LSD(0.05)	**1.18**	**0.43**	**0.16**	**0.27**	**0.33**	**0.12**	**0.86**	**0.08**
Time Species								
T_1S_1	86.67	15.12	5.67	6.40	9.42	1.33	4.07	1.68
T_1S_2	100.00	13.30	8.87	9.07	16.97	2.22	6.51	2.92
T_1S_3	60.00	30.64	2.78	4.30	5.55	1.07	1.17	0.58
T_1S_4	80.00	16.44	4.08	5.40	8.34	1.11	2.27	1.42
T_2S_1	80.00	15.89	5.15	6.00	8.74	1.22	3.67	1.49
T_2S_2	93.33	13.73	6.84	8.24	13.19	1.66	4.38	1.98
T_2S_3	60.00	30.64	2.69	3.53	4.82	1.05	1.17	0.56
T_2S_4	80.00	21.05	3.47	5.00	5.90	1.11	2.00	1.40
T_3S_1	80.00	16.40	4.54	5.63	8.33	1.11	2.59	1.45
T_3S_2	93.33	14.98	6.38	6.80	12.07	1.66	4.20	1.92
T_3S_3	53.33	34.33	2.31	3.33	4.73	1.00	1.02	0.55
T_3S_4	80.00	30.64	3.33	4.33	5.63	1.09	1.30	0.88
LSD(0.05)	**2.05**	**0.75**	**0.28**	**0.47**	**0.57**	**0.10**	**0.31**	**0.14**

Leaf length and width

There was significant difference in leaf length and width of budded citrus species. The maximum leaf length (3.50cm) and leaf width (1.65cm) was obtained in the first week of November followed by second week (1.26cm), (1.36cm). However minimum length of leaf (2.28cm) and leaf width (1.20cm) was recorded in the last week of November.

Among the species, lemon showed maximum leaf length (5.17cm) and leaf width (2.27cm) and minimum in kinnow (1.12cm) and (0.56cm), respectively. Lemon budded (6.51cm) in the first week of November showed maximum leaf length and leaf width (2.92cm). Kinnow budded in the first week (1.17cm) was statistically at par with kinnow budded in second week (1.17cm) whereas minimum leaf length (1.30cm) and leaf width (0.55cm) was recorded in the last week of November in kinnow. The present findings are in agreement with the findings of Patel *et al* (2005) in guava.

Economics of different citrus species budded in three different times are given in table 2. The highest net return ₹105132.00 and B: C ratio 1:8.1

were recorded in grapefruit budded in the first week of November and minimum net return ₹ 50132.00 and B: C ratio 1:4.4 were recorded in lemon budded in the third week of November.

Therefore under Allahabad climatic condition Lemon gave the best result among the four species of citrus and first week of November was found suitable for budding of lime, lemon, kinnow and grapefruit. Budding of lemon on karnakhatta rootstock in the first week of November was found superior than other species and time. Economically grapefruit budded in the first week of November was found superior to other species.

Table 2: Economics of sale of ten thousand budded plants treatment wise

Sl. No.	Particulars	Cost price (₹)	Selling price (₹ plant^{-1})	Gross return (₹)	Net return (₹)	B:C
1.	Lime (1st week November)	14868.00	8.00	80000.00	65132.00	5.38
2.	Lemon (1st week November)	14868.00	8.00	80000.00	65132.00	5.38
3.	Kinnow (1st week November)	14868.00	10.00	100000.00	85132.00	6.73
4.	Grapefruit (1st week November)	14868.00	12.00	120000.00	105132.00	8.07
5.	Lime (2nd week November	14868.00	7.00	70000.00	55132.00	4.71
6.	Lemon (2nd week November)	14868.00	7.00	70000.00	55132.00	4.71
7.	Kinnow (2nd week November)	14868.00	9.00	90000.00	85132.00	6.05
8.	Grapefruit (2nd week November)	14868.00	11.00	110000.00	75132.00	7.40
9.	Lime (3rd week November)	14868.00	6.50	65000.00	50132.00	5.38
10.	Lemon (Last week November)	14868.00	6.50	65000.00	50132.00	4.37
11.	Kinnow (Last week November)	14868.00	8.00	80000.00	65132.00	4.37
12.	Grapefruit (Last week November)	14868.00	10.00	100000.00	85132.00	6.73

* *B:C= Benefit cost ratio*

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