Indian J. Hort. 69(1), March 2012: 20-26

Budding performance of Nagpur mandarin on different rootstocks under Hadoti region of Rajasthan

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ABSTRACT

A study was undertaken on growth performance of Nagpur mandarin scion on different rootstocks. Maximum budding success (68.31%), maximum length of scion (17.97 cm), maximum plant height (34.584 cm), maximum leaf area (19.958 cm^2), relative water content in leaves (51.744%) and chlorophyll content (0.194 mg/g) were observed in scion budded on rough lemon rootstock. The maximum (37.268 mm) girth of rootstock, length (20.218 cm) of longest primary root, length (7.648 cm) of longest secondary root and number of secondary roots (29.540) were recorded on Rangpur lime rootstock. Rough lemon rootstock showed vigorous effect on Nagpur mandarin as compared to Rangpur lime, sour orange and Carrizo citrange rootstocks.

Key words: Growth performance, Nagpur mandarin, rootstocks, scion.

INTRODUCTION

Orange seedling trees are highly sensitive to *Phytophthora* foot rot, and since 1842, the transition toward adopting budded plants in citriculture began in different environmental conditions (Spiegal Roy and Goldschmidt, 10).

To get rid of these problems, citrus types especially mandarin are budded onto different rootstocks, which not only offers adaptability to plants to different type of stress environment but also determine the canopy and overall stature of plant. To make fruit cultivation profitable, it is important to study the growth parameters of scion over a particular rootstock. Many attributes of scion including shape, size and production etc. reflects heavily on rootstock (Castle, 1). The effects of rootstock on vigour and tree size has been highlighted by Wutscher (12). In present study, it was intended to observe the budding and growth performances of scion as well as rootstocks deployed for raising plants using scion of Nagpur mandarin, which is very important and dominating fruit type in cultivation in Hadoti region of Rajasthan. In the region, mandarin orange covers 8,062 ha area and the production is 100 thousand tonnes (2008-09) (Singh *et al*., 8). Hence, an experiment was undertaken.

MATERIALS AND METHODS

The present investigation was carried out in the nursery at the Instructional Farm, Department of Fruit Science, College of Horticulture and Forestry (MPUAT), Jhalarapatan, Jhalawar during the year 2008-09. It falls under Zone-V (Humid south-eastern plain) of Rajasthan at the edge of Malwa plateau known popularly as Hadoti region, which lies at 23°4' to 24°52' latitude and 75°29' to 76°56' E longitude. The average rainfall in this region is 954.7 mm. The maximum temperature observed during the summer is 43-48°C and the minimum 1-2.6°C during winter. The seeds of four different rootstocks, namely; rough lemon (*Citrus jambhiri* Lush), Rangpur lime (*C. limonia* Osbeck), sour orange (*C. aurantium* Linn.) and Carrizo (*C. sinensis* (C) Osbeck × *C. trifoliata* L.) were sown during October, 2007 under open bed nursery conditions. When these plants attained 12 months age, they were shield budded during October 2008 using about four-month-old, round and plump scion bud of Nagpur mandarin from among the growth appeared during the month of July. Consisting of for treatments (rootstocks), 10 plants/treatment and 5 replications, thus having 200 plants as experimental material for the study. The data pertaining to budding performance and growth attributes of scion and rootstocks were recorded. The bud take percentage was calculated by counting numbers of sprouted scion over a particular rootstock. Budding success (%) was counted on the basis of continued survival of sprouted scion after one month of budding. Days required for first sprouting and also for 50 per cent sprouting were recorded by watching the scion regularly in the nursery. The length (cm) of scion shoot and the height of plants from the level of soil surface to the highest tip were measured with the help of a metre scale. Leaf area was measured with the help of a leaf area meter.

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The number of leaves was counted from the leaves emerging from a newly sprouted scion shoot. The perimeter of the leaves was measured with the help of leaf area meter. Water potential was recorded using water potential system (Wescor, USA). The RWC (relative water content) of the leaves was measured using the formula: RWC = (FW-DW/ TW-DW) 100, where FW = Fresh weight which was measured with the help of electronic balance, DW = Dry weight which was measured by drying turgid weighed leaves in oven at 60^0C for 24 h and TW = Turgid weight of leaves, which was measured with the help of a electronic balance by dipping leaves selected for fresh weight in distilled water for 24 h. The chlorophyll content of leaves was measured using supernatant extract of leaves with the help of spectrophotometer. The girth of rootstock was measured at the broader point using Vernier callipers and the length of primary and secondary root was measured with a metre scale. The experiment was laid out in randomized block design. The significance of various treatment effects was judged with the help of "F" value at 5% level of significance.

RESULTS AND DISCUSSION

With regard to budding performance (Table 1), maximum bud take percentage (78.93%) was recorded on sour orange and minimum (27.89%) on Carrizo. However, maximum budding success (68.31%) was observed on rough lemon rootstock. It may be accounted to rapid complete union of xylem and cambium tissue (Hartmann *et al*., 4) of the scion and rootstock favouring survival of the sprouts. The maximum days required for first sprouting was 46.20 days in case of Carrizo rootstock. Earlier, Ganpathy *et al*. (3) reported higher bud take of Coorg mandarin on Rangpur lime. Joolka (5) found the maximum bud take (90 per cent) of Kinnow on rough lemon (*Citrus jambhiri* Lush) under Palampur conditions.

The length of growing scion shoot (Table 2), was maximum (17.97 cm) in case of budding on rough lemon and minimum (3.59 cm) on Carrizo. Dubey and Singh (2) reported that the Darjeeling mandarin and Sikkim mandarin had maximum scion length when budded over the rough lemon rootstock. The higher length of scion shoot over rough lemon may be due to quick and strong formation of union between the rootstock and the bud (Skene *et al*., 9) and subsequently might be due to greater utilization of nutrient by sprouted shoot

Regarding plant height (Table 3), on rough lemon rootstock, the plant had significantly maximum height (34.58 cm) by the end of observation period (May). It was followed by sour orange (31.66 cm) and Rangpur lime (29.76 cm) during the same period. However, on Carrizo rootstock the plant had minimum height (9.76

Table 1. Effect of different rootstocks on budding performance in Nagpur mandarin.

Rootstock	Bud take (%)	Budding success (%)	Days required for first sprouting	Days required for 50% sprouting
Rough lemon	73.62 (90.0)*	68.31 (86.0)*	21.0	54.4
Rangpur lime	69.04 (84.0)	59.44 (74.0)	18.7	54.4
Sour orange	78.93 (94.0)	66.68 (84.0)	25.8	59.6
Carrizo	27.89 (22.0)	27.89 (22.0)	46.2	177.0
CD at 5%	14.13	8.41	1.45	4.38

*Figures in parentheses indicate angular transformed value

Table 2. Effect of different rootstocks on length of scion shoot (cm) during post budding period in Nagpur Mandarin

Rootstock	Period				
	January	February	March	April	May
Rough lemon	8.03	12.06	14.53	16.92	17.97
Rangpur lime	8.04	9.45	13.10	13.70	14.32
Sour orange	8.03	9.38	13.80	14.37	15.36
Carrizo	0.00	0.00	0.00	3.18	3.59
CD at 5%					
Rootstock (R)	0.41				
Period (P)	0.45				
R × P	0.91				

Table 3. Effect of different rootstocks on number of leaves on scion and plant height (cm) during different months in Nagpur mandarin.

Rootstock	January		February		March		April		May	
	Plant height (cm)	leaves on scion	Plant height (cm)	leaves on scion	Plant height (cm)	leaves on scion	Plant height (cm)	leaves on scion	Plant height (cm)	leaves on scion
Rough lemon	22.68	6.46	27.13	9.64	32.26	17.03	33.52	17.56	34.58	17.84
Rangpur lime	17.60	10.00	20.01	12.45	27.23	24.40	29.02	24.45	29.76	24.46
Sour orange	19.80	8.46	22.94	9.62	30.25	14.83	31.50	15.04	31.66	15.64
Carrizo	0.00	0.00	0.00	0.00	0.00	0.00	8.91	6.45	9.76	6.84
CD at 5%										
Rootstock (R)	1.030	0.675								
Period (P)	1.151	0.755								
R × P	2.303	1.510								

cm) by the May. The perusal of data clearly shows that both the factors of rootstock and period and their interaction had significant effect on height of Nagpur mandarin. The maximum plant height on rough lemon may be due to its vigorous nature in comparison to the other rootstocks facilitating greater absorption of nutrients and water from soil. The vigorous attributes of rough lemon (*C. jambhiri*) has also been reported by Singh *et al.* (7).

The data presented in Table 3 further indicate as regard to maximum number of leaves on scion by May on Rangpur lime (24.46) followed by those budded on rough lemon (17.840), sour orange (15.64) and Carrizo (6.84) rootstocks. The same trend was observed on these rootstocks irrespective of the period. The data on perimeter of leaves (cm^2) on different rootstocks are presented in Table 4. Data reveals that perimeter of leaves increased with advancement of periods of observation period from February to May. The maximum perimeter of leaves (15.06 cm^2) by May was observed in scion budded on rough lemon rootstock followed by those budded on Rangpur lime (13.91 cm^2), sour orange (12.92 cm^2) and the minimum (10.29 cm^2) was recorded on Carrizo rootstock. The interaction of rootstock and period had significant effect on perimeter of leaves. An increase in leaf area with advancement of observation period during February to May was noted. At the end of observation during May, the maximum leaf area (15.95 cm^2) of scion was observed on rough lemon, which was significantly higher over other treatments. The minimum leaf area (8.52 cm^2) was recorded on Carrizo rootstock by the end of period (May). There was a significant difference in water potential of leaves of scion shoots (Table 5) budded over different rootstocks except the scion budded on rough lemon. The interaction of rootstock and period was also significant. It appears that the data did not show any definite patterns of change during different period of observations. By May, the minimum water potential of leaves (-0.500 Mpa) was observed on Carrizo, which was significantly lower over all other rootstocks. The maximum water potential (-0.140 Mpa) of leaves of scion shoot was recorded on rough lemon rootstock. RWC of leaves of scion shoots (Table 6) expressed decreasing trend during different successive periods of observations except in leaves of scion shoot budded over sour orange during February to March, whereas, there was an increase in it over preceding period of observation. Further, during May, the maximum RWC of leaves (51.74%) was observed in scion budded on rough lemon, and minimum (44.23%) on sour orange rootstock. The chlorophyll content of leaves at different rootstocks did not show any definite trend of change during different period of observations (Table 7). However, there was a reduction in its content over different rootstocks during February till March. During May, the maximum chlorophyll content (0.194 mg/g) in the leaves of scion shoot was noted over Rough lemon rootstock and minimum (0.054 mg/g) over Rangpur lime rootstock during May. The interaction effect of rootstock and period was found significant in effecting chlorophyll content in leaves. Such type of findings may be due to better potency of rough lemon to absorb and translocate nutrients besides its better photosynthetic ability. More photo-oxidation of the Chlorophyll pigment on Rangpur lime may be ascribed to minimum chlorophyll content of this pigment in the shoot grown on this rootstock. The oxidative degradation of chlorophyll has been highlighted by (Thimann, 11). The maximum RWC in leaves on rough lemon might be due to inherent character of this species, as it is a vigorous (Singh

Table 4. Effect of different rootstocks on leaf perimeter (cm^2) and leaf area (cm^2) during different period in Nagpur mandarin.

Rootstock	15 February		1 March		15 March		1 April		15 April		1 May	
	Leaf perimeter	Leaf area	Leaf perimeter	Leaf area	Leaf perimeter	Leaf area	Leaf perimeter	Leaf area	Leaf perimeter	Leaf area	Leaf perimeter	Leaf area
Rough lemon	12.37	13.12	12.84	14.29	13.45	15.04	14.04	15.72	14.26	15.9014	15.06	15.958
Rangpur lime	11.78	7.75	11.87	8.47	13.03	8.86	13.06	9.03	13.74	9.472	13.91	9.510
Sour orange	10.34	8.79	11.16	9.25	11.72	9.85	12.35	9.85	12.82	10.454	12.92	10.440
Carrizo	0.00	0.00	0.00	0.00	0.00	0.00	9.05	7.75	9.72	8.442	10.29	8.52
CD at 5%												
Rootstock (R)	0.246	0.244										
Period (P)	0.275	0.273										
R × P	0.550	0.547										

Table 5. Effect of different rootstocks on water potential of leaves (-Mpa) during different period in Nagpur mandarin.

Rootstock	Period					
	15 February	1 March	15 March	1 April	15 April	1 May
Rough lemon	0.52	0.22	0.50	0.26	0.18	0.14
Rangpur lime	0.48	0.42	0.64	0.36	0.34	0.46
Sour orange	0.48	0.04	0.30	0.20	0.32	0.24
Carrizo	0.00	0.00	0.00	0.52	0.44	0.50
CD at 5%						
Rootstock (R)		0.060				
Period (P)		0.068				
R × P		0.136				

Table 6. Effect of different rootstocks on RWC of leaves (%) during different period in Nagpur mandarin.

Rootstock	Period					
	15 February	1 March	15 March	1 April	15 April	1 May
Rough lemon	87.65	71.88	70.98	70.90	68.43	61.88
	69.445	57.984	57.334	57.359	55.816	
Rangpur lime	77.01	76.71	61.81	62.76	59.30	53.28
	61.359	60.928	51.874	51.964	50.365	46.886
Sour orange	73.09	81.91	68.11	66.76	61.70	48.67
	58.767	64.842	55.621	54.799	51.770	44.238
Carrizo	0.00	0.00	0.00	-	62.18	59.20
	0.000	0.000	0.000		52.052	
CD at 5%						
Rootstock (R)		0.790				
Period (P)		0.884				
R × P		1.768				

et al., 7; Rajput *et al*., 6) both in term of water and nutrient absorption as compared to sour orange, Carrizo and Rangpur lime rootstocks which are lazy rootstocks during early growth as compared to rough lemon.

A perusal of data indicates that rootstock girth (Table 8) increased on every successive periods of observations. Significantly maximum girth of rootstock (37.26 mm) by May was observed in Rangpur lime and minimum on Carrizo (19.12 mm) after 8 months of budding. The effect of rootstock, period and their interaction was found significant in influencing girth of rootstock. The length of primary and secondary roots increased with advancement of growing period. The maximum length of primary root (20.21 cm) was observed in Rangpur lime and minimum (14.39 cm) in Carrizo. The same trend regarding length of secondary roots was recorded over these rootstocks. The data on number of secondary root (cm) as observed in different rootstocks at 0 day of budding and after 8 months of growth after budding are presented in Table 8. The evaluation of data reveals that number of secondary roots increased with successive advancement of growing period. After 8 months of growth after budding, the maximum number of secondary roots was there in Rangpur lime (29.54 cm), whereas, the minimum (26.31 cm) was recorded in Carrizo after 8 months of growth after budding. The effect was significant irrespective of the rootstock, periods and their interaction.

ACKNOWLEDGEMENTS

The authors are grateful to the Deptt. of Horticulture, Government of Rajasthan, Pant Krishi Bhawan, Jaipur for providing support and the college administration for the research facilities.

Table 7. Effect of different rootstocks on chlorophyll content (mg/g) during different period in Nagpur mandarin.

Rootstock	15 February			1 March			15 March			1 April			15 April			1 May		
	Chl a	Chl b	Total	Chl a	Chl b	Total	Chl a	Chl b	Total	Chl a	Chl b	Total	Chl a	Chl b	Total	Chl a	Chl b	Total
Rough lemon	0.19	0.08	0.27	0.12	0.06	0.18	0.02	0.01	0.04	0.12	0.03	0.15	0.11	0.03	0.14	0.14	0.05	0.19
Rangpur lime	0.41	0.15	0.56	0.21	0.10	0.32	0.02	0.07	0.10	0.30	0.06	0.37	0.11	0.05	0.16	0.03	0.02	0.05
Sour orange	0.20	0.27	0.47	0.12	0.00	0.15	0.00	0.00	0.08	0.13	0.0	0.17	0.12	0.03	0.15	0.07	0.02	0.10
Carrizo	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.03	0.13	0.19	0.05	0.24	0.08	0.06	0.15

CD at 5% 5%	Chl a	Chl b	Total
Rootstock (R)	0.041	0.048	0.076
Period (P)	0.046	0.053	0.084
R × P	0.092	0.107	0.169

Table 8. Girth and length of longest primary and secondary roots during different period in Nagpur mandarin.

Rootstock	0 day			After 8 months		
	Girth (mm)	Length of longest primary root (cm)	Length longest secondary root (cm)	Girth (mm)	Length of longest primary root (cm)	Length longest secondary root (cm)
Rough lemon	5.21	8.43	2.44	31.80	18.45	5.55
Rangpur lime	4.73	7.56	2.45	37.26	20.21	7.64
Sour orange	4.62	9.16	3.26	34.07	19.39	6.59
Carrizo	3.50	9.32	2.35	19.12	14.39	3.31
CD at 5%						
Rootstock (R)	7.456	0.146	0.153			
Period (P)	8.336	0.056	0.171			
R x P	16.672	0.112	0.342			

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Received: February, 2011; Revised: September, 2011; Accepted: December, 2011