

A Study on Stionic Interaction of Kinnow

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ABSTRACT

The performance of Kinnow mandarin (*Citrus reticulata* Blanco.) was studied on nine different rootstocks i.e. Citrumelo 1452, Citrumelo 4475, Yuma citrange, Volkamariana, Rough lemon, Mithi, Carizo citrange, Troyer citrange and Brazillian sour orange. Rootstock had significant effect on tree vigour, leaf age and susceptibility to leaf miner infestation. Vigour like tree spread and its annual increment were significantly affected while plant height and stem girth as well as their increment were not affected significantly by the rootstocks. Leaf drop pattern of summer, spring and autumn flushes was highly significant for rootstocks effects and the seasons. Over all maximum leaf drop occurred on Mithi with respect to the respective flushes, more leaf drop of spring and autumn flush occurred on Carizo citrange and Troyer citrange. Trees on Volkamariana were found most attacked by leaf miner.

Key Words: *Citrus reticulata*; Kinnow; Rootstock; Vigour; Leaf age; Leaf miner

INTRODUCTION

Tree vigour, leaf age, resistance to insect pest and adaptability to various climates and soils are some of the important criteria for selecting a rootstock. Long leaf life is important for the maintenance of canopy, productivity and vigour of the tree. Leaf miner (*Phyllocnistris citrella*) is a serious insect to which exception of any citrus cultivar seems rare. However, the intensity, pattern and time of above variables have been reported with wide variation. For example, leaf drop in citrus cvs. after the last week of blossoming (Shavit, 1956), greatest leaves drop during flowering period (Erickson & Brannaman, 1960), life of citrus leaves from few days to two years or more (Whiteside *et al.*, 1988); difference in girth of stock (Singh *et al.*, 1980), vigour (Malik, 1984; Jalkop *et al.*, 1986; Wutscher, 1992), height (Saleem, 1994), resistance (Sindhu & Batra, 1978), susceptibility (Batra *et al.*, 1992) and influence of environmental factors (Cai, 1999) on different rootstocks.

This study was meant to test various rootstocks under a set of environmental conditions with reference to the parameters as mentioned above.

MATERIALS AND METHODS

Twelve years old kinnow trees, grafted on nine different rootstocks growing under similar soil and cultural conditions were selected for the study. The rootstocks were Citrumelo 1452, Citrumelo 4475, Yuma citrange, Volkamariana, Mithi, Carizo citrange, Troyer citrange, Brazillian sour orange and Rough lemon. The experiment was laid out according to Randomized Complete Block Design in three replications. The experimental trees were fertilized with recommended doses of N (1050 g) and P₂O₅ (420 g) in the form of DAP and Urea per tree. To determine the vigour of trees, stem girth, height and canopy spread of trees were measured. Girth measurements were taken at a

fixed height of 4'' above and below the graft union for scion and rootstock girth, respectively, with the help of measuring tape, to observe compatibility. To ensure that observations taken were at the same place, a black paint circle was made above (4'') and below (4'') the graft union on each tree. During the second year, girth was measured to observe the increment in the diameter. Height of the trees was measured by a telescopic pole, from the soil level to the highest top of the tree for two consecutive years. To determine the spread of trees, from East to West and North to South at right angle with the help of a measuring tape in cross section up to the maximum out-growth in each direction was recorded and average of both observations was termed as trees spread. Ten flushes each of summer, autumn and spring were tagged at four sides of each tree at shoulder height to observe leaf age. Data on the total number of leaves per flush were collected at emergence and subsequently after every two months, and thus a balance sheet was prepared regarding the number of dropped and intact leaves. To observe the effect of rootstock on the vulnerability of scion to leaf miner, ten spring flushes were tagged in one meter square area of canopy, on each side of tree and thus the number of infested leaves were counted from time to time.

RESULTS AND DISCUSSION

Vigour of Kinnow plants was determined by measuring stem girth, canopy spread and height of trees, grafted on different rootstocks. Girth of rootstock was also observed to note stionic interaction. Data (Table I) on rootstock girth during 1999 indicated being maximum (67.73 cm) and minimum (42.35 cm) in Volkamariana and Brazillian sour orange, respectively. Data on girth of the year 2000 indicated the same pattern of being maximum of Volkamariana (71.12 cm) and minimum (43.46 cm) of Brazillian sour orange. Maximum and minimum annual increment (Table I) of rootstock was also found on Volkamariana and Brazillian sour orange i.e. 3.81 cm and 1.13 cm, respectively. Difference in stock girths during

Table I. Effect of rootstocks on vegetative performance of Kinnow mandarin

Rootstocks	Rootstocks girth (cm)			Scion girth (cm)			Plant Height (m)			Plant spread (m)		
	1999	2000	MI (cm)	1999	2000	MI (cm)	1999	2000	MI (m)	1999	2000	MI (m)
Citrumelo 1452	55.21	58.42abc	3.18	46.99	48.91	1.96	2.95	3.25	0.31	4.39 d	4.67 c	0.23 bc
Citrumelo 4475	55.88	58.84abc	2.96	51.90	53.76	1.86	2.83	3.17	0.35	4.36 d	4.62 c	0.30 bc
Yuma citrange	60.96	66.89a	3.81	47.62	49.53	1.90	3.180	3.40	0.315	4.58 d	4.77 c	0.33 bc
Volkamariana	67.73	71.12a	3.38	61.38	63.42	1.95	3.58	3.89	0.307	7.67 a	8.63 a	0.96 a
Rough lemon	55.03	58.00abc	2.96	46.90	48.26	1.35	3.23	3.66	0.25	6.04 bc	6.41 b	0.29 bc
Mithi	60.64	63.33ab	1.35	57.10	59.46	2.36	3.02	3.42	0.64	7.12 ab	7.09 b	0.13 c
Carizo citrange	49.35	50.33bc	1.18	38.06	41.78	2.71	2.120	2.48	0.41	5.42 cd	6.003 bc	0.580 b
Troyer citrange	58.54	60.79ab	2.25	50.62	52.32	1.69	3.08	3.36	0.93	6.18 bc	6.76 b	0.581 b
Brazilian sour orange	42.35 _{NS}	43.46c	1.13 _{NS}	54.34 _{NS}	55.66 _{NS}	1.32 _{NS}	2.83 _{NS}	3.01 _{NS}	0.18 _{NS}	4.54d _{**}	4.92c _{**}	0.38 bc _{**}

NS= Non significant; MI= Mean increment; * Significant; ** Highly significant

Table II. Effect of rootstocks on leaf drop of summer flush

Rootstocks	Tagged leaves/ Rep.	Sep-Oct	Nov-Dec	Jan-Feb	Mar-April	May-June	July-Aug	Leaf drop (Mean)/ 2 month	Total leaf drop
Citrumelo 1452	78.83	3.58	7.08	42.08	11.25	4.83	3.83	12.11b	72.65
Citrumelo 4475	89.33	3.50	12.58	28.00	10.16	4.58	4.42	10.54b	63.24
Yuma citrange	86.75	4.00	8.08	40.87	12.00	5.37	3.85	12.36b	74.17
Volkamariana	79.58	2.42	3.50	22.42	17.25	11.50	6.33	10.57b	63.42
Rough lemon	75.0	1.83	0.58	16.58	20.42	17.00	11.25	11.27b	67.66
Mithi	78.3	2.75	0.750	20.50	37.00	13.33	3.00	19.76a	77.33
Carizo citrange	97.00	9.16	11.25	44.00	21.16	11.25	3.00	16.64a	97.00
Troyer citrange	79.83	3.00	7.50	39.92	11.33	6.58	2.83	11.86b	71.16
Brazilian sour orange	74.5	2.25	5.92	33.66	6.42	4.00	1.08	8.88b _{**}	53.33
Total Mean	72.36	6.361cd	32.0a	20.92b	8.11c	4.400d	0.915e _{**}		

**Highly significant

2000 was significant while annual increment as well as girth during 1999 was non-significant. Results regarding scion girth (Table I) indicated a non-significant effect due to rootstocks. However, maximum scion girth was found on Volkamariana and minimum on Carizo citrange for both the years. Trees on Carizo citrange showed maximum (2.7 cm) increment, while minimum (1.32 cm) on Brazilian sour orange rootstocks. Rootstock and scion girth reflect a stionic interaction between rootstock and the scions.

All stocks particularly citranges and citrumelos were thicker in diameter than the scion while Brazilian sour orange was thinner than the scion although union was perfect for commercial fruit production. The observations indicated that scion and stock growth affected each other but not significantly. Data (Table I) pertaining to tree height and its increment also proved non-significant. Trees on Volkamariana were tallest while all other rootstocks were moderate and similar in height. The result (Table I) of canopy spread indicated highly significant differences for rootstocks. Trees on Volkamariana developed significantly larger spread of kinnow over all other rootstocks. As indicated by Multiple Range Test, Mithi, Troyer citrange and Rough lemon were of significantly larger spread as compared to Carizo citrange. Trees on Yuma citrange, Brazilian sour orange, Citrumelo 1452 and Citrumelo 4475 had smaller canopy volume than others. Volkamariana also

promoted significantly larger annual increment in canopy spread over other rootstocks i.e. 0.96 m spread during a year while Mithi had minimum increment of 0.13 m. Kinnow tends to develop a compact canopy and this character appeared on all type of rootstocks. Similar results were reported by Hutchison *et al.* (1982), Malik (1984), Wutschcher (1994) and Saleem (1994).

Leaf drop pattern. Citrus cultivars have been observed to drop leaves in various patterns and times under the effect of climate and rootstocks. Flushes of different times were observed to know the age of leaves on these flushes. Observations on summer flush on different rootstocks with respect to the age of leaves could be divided into two groups (Table II). The number of leaves dropped by each group was significant to each other. Mithi and Carizo citrange were in one group which dropped 19.76 leaves per two months where total of 77.33 leaves dropped, out of 78.3 per replication on 10 flushes and 16.64 leaves per two months where 97 leaves dropped out of 98 leaves on ten flushes per replication, respectively.

In second group all the other rootstocks were included. Minimum (8.88) leaf drop occurred per two months in trees on Brazilian sour orange, and 53.3 during the year where leaves per replication were 74.5 (Table II). The overall results indicated that maximum leaf drop (32 leaves per rootstock) of summer flush occurred during

November-December while minimum during July-August. Our observation shows that more common factor contributing to the drop of leaves was sudden drop in temperature i.e. below 13°C.

Average number of leaves per summer flush was significantly affected by rootstock. Carizo citrange had maximum (10.00) leaves per flush while Brazillian sour orange had minimum (5.33) leaves. Our results showed that trees on Carizo citrange had more number of leaves per flush and more leaf drop also occurred on the same rootstock. Trees on Brazillian sour orange had minimum number of leaves per flush and least leaf drop occurred on the same rootstock.

Spring flush. The leaf drop in these flushes started immediately after tagging in March and continued up to the month of September. The study could not be continued beyond September, and thus data during winter which caused heavy leaf drop in other flushes could not be observed.

Table III indicates a significant effect of rootstocks and months on leaf drop of Kinnow scion. Maximum leaf drop occurred on Carizo citrange i.e. 15.83 leaves per two months and 47.48 leaves dropped out of 75.0 per 10 flushes during the period of study. Brazillian sour orange had reduced leaf drop and thus out of 51.58 leaves per 10 flushes, only nine dropped being e.g. 3 leaves per two months.

citrance dropped all of its tagged leaves, which were 45.25 on 10 flushes of each replications, an average of 15.4 leaves per two months (Table IV).

Trees grafted on Mithi dropped least number of leaves like 9.66 leaves out of 32.5 leaves on flushes of each replication within six months. Maximum leaf drop of autumn flush occurred during March-April. Data on average number of autumn flush indicated that Carizo citrange and Troyer citrange had maximum number of leaves/flush i.e. 9.00 leaves per flush. Tree on Citrumelo 4475 and Yuma citrange produced least number of leaves. The studies indicated that peak of leaf drop of different flushes occurred at different times. Similar results have also been reported by Shavit (1956), Malik (1984), Whiteside *et al.* (1988).

Leaf miner. The data pertaining to leaf miner infestation were found significantly affected by rootstocks. Trees grafted on Volkamariana were more frequently attacked by the insect while minimum attack was noticed on trees grafted on Yuma citrange. However, the data (Table V) ranged between 1.05 to 7.31% while all other rootstocks were ranked between these two extremes. These studies indicate that the leaf miner infestation may also be due to a particular rootstock. The most vigorous rootstock like Volkamariana rootstock were found more attacked as compared to others. Our observations completely support earlier findings of Sandhu and Batra (1978), Batra *et al.*

Table III. Effect of rootstocks on leaf drop pattern of spring flush

Rootstocks	Tagged leaves/Rep.	April-May	June-July	Aug-Sept.	Leaf drop (Mean)/ 2 month	Total leaf drop
Citrumelo 1452	52.50	1.667	4.470	3.250	3.129d	9.39
Citrumelo 4475	62.00	0.5000	1.583	8.750	3.661d	10.84
Yuma citrange	58.72	1.083	3.583	15.17	6.611c	19.83
Volkamariana	56.00	0.6667	4.333	11.42	5.472cd	16.41
Rough lemon	46.30	0.000	1.167	12.92	4.694cd	14.08
Mithi	44.50	1.000	2.000	8.500	3.833d	11.50
Carizo citrange	75.00	1.317	9.167	37.00	15.83a	47.48
Troyer citrange	63.30	2.00	8.250	18.25	9.500b	28.50
Brazillian sour orange	51.58	1.00	1.750	6.250	3.000d **	9.00
Mean	55.76	1.03c	4.034b	13.50a **		

**Highly significant

Table IV. Effect of rootstocks on leaf drop of autumn flush

Rootstocks	Tagged leaves/ Rep.	March-April	May-June	July-Aug	Leaf drop (Mean)/ 2 month	Total leaf drop
Citrumelo 1452	42.60	11.00	19.50	10.58	13.69ab	41.08
Citrumelo 4475	35.00	15.37	9.06	5.50	9.97b	29.93
Yuma citrange	30.75	13.16	12.83	3.75	9.92b	29.74
Volkamariana	31.75	16.00	11.16	3.92	10.36b	31.08
Rough lemon	31.33	13.75	8.50	7.00	9.75b	29.25
Mithi	32.5	13.50	8.50	7.00	9.66b	29.0
Carizo citrange	39.16	20.00	13.50	6.00	13.16ab	39.16
Troyer citrange	45.25	33.58	9.42	2.42	15.14a	45.25
Brazillian sour orange	39.58	29.25	7.50	2.83	13.19ab	39.58
Mean	35.30	18.411a	11.11b	5.44c **		

**Highly significant

Autumn flush. Leaf drop was affected significantly by rootstocks and months. The trees growing on Troyer

(1992) and Cai (1999) that rootstock affect the susceptibility of scion to leaf miner infestation.

Table V. Percentage of leaf miner infected leaves of Kinnow grafted on different rootstocks

Rootstocks	Leaf miner infected leaves
Citrumelo 1452	2.393 cd
Citrumelo 4475	3.754 bc
Yuma citrange	1.050 d
Volkamariana	7.308 a
Rough lemon	2.885 cd
Mithi	2.451 cd
Carizo citrange	1.333 d
Toryer citrange	6.651 ab
Brazilian sour orange	2.434 cd**

**Highly significant

CONCLUSION

An overall performance of Volkamariana rootstock was better in terms of mineral uptake and vigour as compared to other rootstocks. Therefore, this can be used as a rootstock for Kinnow mandarin.

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