

Effect of Traditional and Hybrid Rootstocks on Leaf Mineral Composition and Reproductive Characteristics of Kinnow Mandarin (*Citrus reticulata* Blanco)

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ABSTRACT

Leaf analysis and reproductive behaviour of kinnow mandarin grafted on nine different rootstocks was studied. Leaf nutrient status of NPK in spring and autumn season differed significantly among the trees due to rootstocks. Maximum N i.e. 2.23% was recorded on Volkamariana and minimum i.e. 1.14% on Citrumelo 4475. Maximum P (0.14%) on Yuma citrange and minimum (0.086%) on Troyer citrange was found. As regard K, it ranged from 1.11 to 0.77% on Citrumelo 1452 and Brazillian sour orange rootstock, respectively. Difference in blooming intensity was found highly significant being maximum blooming on Yuma citrange and fruit set percentage (79.62%) on Troyer citrange. June drop as well as July-September drop effects were also significantly different due to rootstocks. Maximum June-drop i.e. 29.43% was observed on Citrumelo 4475 while higher July-September drop was observed on Mithi i.e. 10.06%. The highest number of fruits per tree was recorded on Volkamariana (589.3 fruits) and lowest (204 fruits) on Carizo citrange rootstock.

Key Words: *Citrus reticulata*; Rootstock; Fruit set; Nutrients; Yield

INTRODUCTION

Citrus rootstocks differ in their degree of compatibility and adaptability to a scion under a set of climate and soil conditions. A number of studies have been conducted to find out suitable rootstocks for various commercial cultivar of citrus throughout the world (Ahmad, 1962; Ismail *et al.*, 1965; Compbell, 1973; Wutscher *et al.*, 1975; Wutscher & Shull, 1976; Ranjit *et al.*, 1978; Gowda *et al.*, 1982; Path *et al.*, 1989; Howei & Lloyd, 1989; Esmail *et al.*, 1991; Compbell 1991; Cedeno-Maldanodo *et al.*, 1994; Shahid *et al.*, 1999).

The performance of different rootstock was found variable under different climatic and edaphic conditions. Hence, in view of several drawbacks in the presently used rootstock, it is deemed desirable to study performance of various rootstocks under local conditions to find out a compatible rootstock for kinnow, the most popular cultivar of the region. Therefore, the present studies were conducted as a part of an on going citrus rootstocks research project.

MATERIALS AND METHODS

Nine rootstocks i.e. Citrumelo 1452, Citrumelo 4475, Yuma citrange, Volkamariana, Rough lemon, Mithe, Carizo citrange, Troyer citrange and Brazillian sour orange were used for kinnow mandarin, the scion cultivar. Twelve years old trees already under trial were selected and evaluated during the year 1999-2000 for mineral composition and reproductive characteristics. The experiment was laid out according to Randomized Complete Block Design in three replications. The recommended fertilizer application program was carried out for all the experimental plants. Leaf sample were taken after the onset of autumn and just

prior to spring season, to determine their comparative nutrition status.

Leaves were crushed to fine powder and stored in plastic bottles for further analysis as described by Chapman and Parker (1961). Reproductive characteristics of kinnow on different rootstocks were determined by tagging 40 spring flushes of the same size on each tree, on four sides before blooming. The bloom in March and then the fruit set on marked flushes was counted on April 5, 2000 and determined by using the following formula:

$$\frac{\text{Total fruit set}}{\text{Total bloom}} \times 100$$

Fruit drop were observed during May, June and July-September. Fruit drop percentage was calculated by the following formula:

$$\frac{\text{Total number of fruit dropped}}{\text{Total fruit set}} \times 100$$

Yield per tree was recorded by counting the total number of fruits per tree at ripe stage and the average was reported.

RESULTS AND DISCUSSION

Leaf nutrient status. Data on nitrogen percentage of leaves indicated highly significant differences among the trees grafted on various rootstocks and was also significantly different for autumn and spring season flushes. The range of nitrogen content during spring season was generally, higher than autumn season leaves in almost every treatment. A

comparison of the mean values (Table I) revealed that Volkamariana, Rough lemon and Carizo citrange contained highest range of N i.e. 2-2.2%. While Citrumelo 4475 has the lowest level of nitrogen contents. Data indicated that phosphorus level in spring season leaves was significantly higher over autumn in every treatment. The observations (Table I) revealed that trees on Yuma citrange, Citrumelo 1452 and Rough lemon contained significantly higher (0.14%) phosphorus percentage than the others. Lowest phosphorus (0.08%) was observed in case where Troyer citrange was a rootstock. Observation recorded on potassium content (Table I) indicated non-significant differences between spring and autumn season flushes, while significant for different rootstocks. K contents of the trees grown on Citrumelo 1452 were significantly higher (1.11%) than all other rootstocks, followed by Carizo citrange, Rough lemon and Troyer citrange, which were significantly similar to each other. The lowest status of K was observed in leaves on Brazillian sour orange i.e. 0.77%. Observations indicated that rootstocks played significant part in translocation of NPK but none of them was so suitable, which could have higher status of all nutrients. Level of N could be easily correlated with the vigour of growth. Previous result of experiments related to rootstock of Wutscher *et al.* (1975), Wutscher and Shull (1976), Path *et al.* (1989) and Ranjit *et al.* (1978) showed almost similar effects that rootstock contributed towards nutrient status of the scion cultivars.

Reproductive behaviour. Information procured on the number of flowers, fruit set and yield depicted highly

significant differences for rootstock effect (Table II). Results indicated significant superiority of Yuma citrange over the other rootstocks, except Citrumelo 4475 and Brazillian sour orange regarding blooming intensity. Number of flowers on tagged flushes ranged between 7.25 to 21.83 on Carizo citrange and Yuma citrange, respectively. It can be inferred that difference of total number of flowers could be an interaction between stock and the scion variety. The results were close to the findings of Ahmad (1962), and Howie and Lloyd (1989).

Data regarding fruit set percentage (Table II) revealed highly significant differences among rootstocks. Trees on Carizo citrange, Troyer citrange and Brazillian sour orange were significantly superior over others, while Yuma citrange was at the bottom. However, the fruit set percentage ranged from 34.31 to 79.62%. Information recorded on fruit set percentage indicated that various rootstocks could produce and translocate hormones in different quantity, which could be helpful in increasing the fruit set. However, the initial fruit set could affect the final harvest of the trees. Present results corroborate the finding of Esmeil *et al.* (1991) and Shahid *et al.* (1999) who found that rootstocks affect the fruit set.

The observation on fruit drop in April and May revealed non significant differences for different rootstocks. However, maximum drop (39.93%) during April was observed on Mithi while minimum (21.72%) on Brazillian sour orange. Maximum drop in May was recorded in Yuma citrange i.e. 32.59% and minimum 20.63% on Volkamariana rootstock (Table II).

Table I. Effect of rootstocks on nutrient status and yield of Kinnow

Rootstocks	N (%)		Mean	P(%)		Mean	K (%)		Mean	Yield (No of Fruit / Tree)
	Spring	Autumn		Spring	Autumn		Spring	Autumn		
Citrumelo 1452	1.59	1.19	1.39cd	0.17	0.11	0.14a	0.88	1.34	1.11a	391.0abc
Citrumelo 4475	1.27	1.01	1.14d	0.16	0.09	0.12ab	0.84	1.3	1.07ab	250.3bc
Yuma Citrange	1.97	1.82	1.79abc	0.16	0.12	0.14a	0.85	1.08	0.97abc	392.0abc
Volkamariana	2.49	1.97	2.23a	0.13	0.09	0.12ab	1.16	0.72	0.94abc	589.3a
Rough Lemon	2.35	2.003	2.22a	0.15	0.13	0.14a	1.13	0.93	1.03ab	360.3bc
Mithi	1.99	1.76	1.88abc	0.101	0.10	0.10ab	0.91	0.95	0.88bc	489.0ab
Carizo Citrange	2.22	1.88	2.05ab	0.13	0.11	0.12ab	1.19	0.88	1.04ab	204.0c
Troyer Citrange	1.76	1.59	1.67bc	0.09	0.08	0.08b	0.99	0.99	0.99ab	227.50c
Brazillian SourOrange	1.94	1.5	1.72abc**	0.13	0.10	0.12ab**	0.66	0.88	0.77c**	386.3abc*
Mean	1.93	1.65*		0.135a	0.102*		0.99	0.99N.S.		

Table II. Effect of rootstocks on fruit set and fruit drop of Kinnow from April to September

Rootstocks	Blooming Intensity	Fruit Set (%)	Fruit Drop (%age)			
			April	May	June	July-Sep.
Citrumelo 1452	13.25cd	39.55cd	33.26	25.97	28.02ab	5.63bc
Citrumelo 4475	15.92abc	47.15c	27.42	25.45	29.43a	7.71ab
Yuma Citrange	21.83a	34.31d	33.91	32.59	11.77bcd	3.03bc
Volkamariana	14.25bc	59.51b	27.04	20.63	3.89d	1.95bc
Rough Lemon	13.00cd	61.51b	34.22	31.26	3.17d	0.03c
Mithi	15.50bc	60.51b	39.93	28.63	24.80abcd	10.06a
Carizo Citrange	7.25d	74.07a	37.42	26.05	4.79d	0.43c
Troyer Citrange	7.66d	79.62a	22.99	32.44	9.92cd	3.41bc
Brazillian Sour Orange	2.00ab**	69.28b**	21.72N.S.	34.64N.S.	8.55cd**	1.36c*

* = Significant; ** = Highly Significant; N.S. = Non significant

Data on June drop indicated that Citrumelo 4475 dropped significantly higher number of fruits over all other rootstock i.e. 29.43% and minimum drop occurred on Carizo citrange, Volkamariana and Rough lemon which were similar in their pattern of fruit drop (Table II). Data on total fruit drop percentage from July to September (Table II) indicated that Citrumelo 4475, Citrumelo 1452 and Mithi dropped significantly more number of fruits over the others. However, minimum and maximum fruit drop ranged between almost nil to 10.6% on Rough lemon and Mithi rootstock, respectively. These studies indicate that April and May drop were as if not affected by rootstock. Observations during June and July-September indicated that drop percentage was affected by rootstocks significantly. The cause of heavy June drop could be attributed to higher initial fruit set and inability of trees to hold them because of competition for food. It may also be related to competition of water because these were the hottest and dry days of the year. Mostly the September drop appeared not only nutritional or physiological but also biological and pathological because fruit fly as well as citrus wither tip (*Colletotrichum gloeosporioides*) generally attack on trees during these days. Data on yield per tree (Table I) indicated to be significantly different for rootstocks. Volkamariana had significantly highest yield (589.33 fruit tree⁻¹) while lowest (204.00 fruits tree⁻¹) were observed on Carizo citrange. The results regarding the effect of rootstock on fruit drop and yield were supported by the earlier results of Campbell (1973), Campbell (1991), Esmail (1991) and Cedeno-Maldonado *et al.* (1994).

CONCLUSION

It is concluded that rootstocks significantly influence the leaf mineral composition and reproductive characteristics of Kinnow Mandarin. The Volkamariana can be used as substitute of Rough Lemon after further studies at different agroclimatic conditions due to its influence on Kinnow scion to keep the leaf mineral contents and yield higher with lower fruit drop than other rootstocks.

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