

# Evaluation of Citrus Rootstocks and Their Reaction to Important Diseases

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Citrus Dieback Disease Scheme, Shrirampur

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## Abstract

The evaluation of 137 cultivars from 27 citrus and related species, for resistance to important pathogens involved in citrus decline revealed the suitability of 6 cultivars from *Citrus jamberi*, 3 each from *C. limonia* and *C. reshni* and one from *C. amblycarpa* group for employment as rootstock for sweet orange. The role of tristeza, greening and phytophthora in disease syndrome was emphasized. The studies did reveal some sources of resistance.

Rootstocks exert wide, varied and profound influence on the vigour, productivity and longevity of scion material grafted on them. The later effect may be due to the influence, the rootstock exerts on resistance to or tolerance to bacterial and fungal diseases, viruses, nematodes, salts and adverse soil conditions. In view of the dieback syndrome which envelopes array of parasitic and non-parasitic agents, the selection of rootstock for sweet orange has assumed considerable importance. Involvement of tristeza, psorosis, exocortis, fovoid, xyloporosis, woody-gall, greening and phytophthora diseases viz., gummosis and foot-rot in sweet orange decline has been brought out earlier by Mali and Choudhari (1976). The authors further stated that the malady is a complex enveloping more than one factors. Under the conditions prevalent in Maharashtra, the rootstocks which would offer protection from the said diseases would be a welcome proposition. The germplasm collection available at research station of Citrus Dieback Disease Scheme Shrirampur was, therefore, screened for resistance to various factors.

## Materials and Methods

The experimental material consisting of 137 cultivars from 27 citrus and related species was screened for plant growth, vigour, occurrence of viruses, mycoplasma and fungal diseases. The various diseases were diagnosed under field conditions on the basis of symptomatology reported by Knorr (1966) for tristeza; Klotz (1961) for psorosis and exocortis; Childs (1959) for xyloporosis and Knorr (1968) for fovoid. The cultivars which did not display apparent symptoms of any major disorders under field conditions were indexed for tristeza, psorosis, exocortis and greening following the procedure and techniques described by Childs (1968). The promising rootstocks were tested for resistance to phytophthora by root inoculation following

the methods of Uppal and Kamat (1936), for salts following the procedure advocated by Bernstein (1965). The nematode population build up was studied employing standard procedures. The studies were carried out at this station in between 1974 and 1978.

## Results and Discussions

The continued and periodical observations for apparent symptoms of pathogenic diseases revealed existence of the viruses of tristeza, psorosis, exocortis, xyloporosis, woody-gall, fovoid and greening (MLO) and fungal diseases viz., foot-rot and gummosis. Though psorosis was observed to be present in a number of cultivars, its manifestation was confined only to leaf symptoms. The presence of leaf symptoms alone did not, however, muster any correlation with dieback. This disorder even according to Knorr (1970) is not a serious problem to warrant alarm. Exocortis is considered to be a disease of Rangpur lime, trifoliate orange, some citranges and citrons. Rangpur lime out of the lot is recommended as rootstock for sweet orange. Six cultivars of *C. limonia* were tested for exocortis. L-2 and L-19 strains were positive while other four cultivars were negative to this disorder. Even in cultivars positive to exocortis, only stunting aspect was evident. Other ill-effects viz., bark shredding and twig dieback were not seen. The incidence of xyloporosis was confined to sweet lime and tengelo. Formation of woody-gall was seen only on cultivars of *C. medica* and *C. limon*. Since these cultivars are not likely to be used as stocks for sweet orange, both these diseases under the prevalent conditions do not appear important. The occurrence of fovoid was common in all the cultivars. The ill-effects of this disease as earlier reported by Nauriyal *et al.* (1968) were not pronounced. The disease though un-important individually has the potential to accelerate the ill-effects of tristeza, greening and phytophthora. Marked deterioration in tree health

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was observed associated with tristeza. The ill-effects were further aggravated by its combination with either greening or foot-rot, the incidence of which was very common. These four diseases, therefore, appear rather important in citrus tree decline.

The periodical observations exhibited presence of more than two viral, one mycoplasma and one fungal disorder in 83 cultivars. Sixteen cultivars from trifoliolate and citrange group though were devoid of any

pathogen complex were poor in growth and displayed dieback. Further studies in this regard could attribute this non-vigorous growth to adverse soil conditions viz., high pH. Wood-apple and Atlantia were also free from major diseases. These stocks have however been observed non-compatible with sweet orange. The data in respect of these 101 cultivars considered unsuitable and discarded from further studies are presented in Table 1.

Table 1. Reaction of citrus cultivars to various pathogens.

Rootstocks under observations	Reaction to various diseases					
	Tris-teza	Psor-osis	Exoc-ortis	Fov-oid	Phytop-hthora	Gree-ning
1	2	3	4	5	6	7
<i>Citrus reticulata</i> :						
Coorg santra	+	—	—	+	—	M
Orlando tangelo	+	+	—	+	—	H
Coorg orange	+	—	—	—	S	M
Laddu Coorg	+	+	—	+	S	H
Emperor mandarin	+	+	—	—	S	H
Kodaikithulli	+	+	—	—	—	H
Dancy tangerine	+	—	—	+	S	M
Kara mandarin	+	+	—	—	S	L
King of Sayam	+	+	—	—	S	H
Scarlet mandarin	+	+	—	+	—	L
Rangatra Coorg	—	+	—	+	S	L
Citrus China	+	+	—	+	S	H
Kinnow mandarin	+	—	—	+	T	H
Apple by sour orange	+	+	—	—	S	M
Japanese str. of orange	+	+	—	+	S	M
<i>Citrus sinensis</i> :						
Sweet orange Simmons	—	+	—	—	—	H
Common Malta	+	—	—	—	S	H
Pineapple orange	+	—	—	+	—	H
Satgudi	—	+	—	+	S	L
Mosambi	+	—	—	—	S	H
R 4 mosambi like	+	+	—	+	—	H
Med. sweet orange	+	—	—	—	T	H
Blood red malta	+	—	—	—	S	H
Orange tenrif	+	+	—	—	S	H
White sylette orange	—	—	—	+	S	M
Hamlin A. P.	+	+	—	—	—	H
Dessert orange	+	+	—	—	S	H
Tangelo Malta	+	+	—	+	—	L
Smooth sour orange	+	—	—	+	S	M
Paramatta orange	+	+	—	—	T	H
Ruby Malta	+	+	—	—	T	H
Homosassan orange	+	+	—	—	T	H
Mitchel Malta	+	—	—	+	S	H
<i>Citrus reshni</i> :						
Billikichilli	+	—	—	—	T	M
Cleopatra Australia	+	—	—	—	—	M
Cleopatra Coorg	+	+	—	—	—	M
Tangerine Cleopatra	+	+	—	+	—	L

Table I (Contd.)

1	2	3	4	5	6	7
<i>Citrus limonia</i> :						
L-19 Rangpur lime	+	-	+	+	T	M
Nematange Assam	+	-	-	+	T	M
Rangpur lime Australia	+	-	+	+	T	H
<i>Citrus jamberi</i> :						
Jamberi local	+	-	-	+	S	L
Limao Russodo Brazil	+	-	-	+	T	M
Jamberi Saoner	+	-	-	-	T	H
Smooth lemon Assam	-	+	-	+	S	M
Moognimbe	+	+	-	-	T	M
Rough lemon Assam	+	-	-	-	T	H
R. lemon Australia	+	-	-	+	T	H
R. lemon S. Africa	-	+	-	+	T	M
Limao cravo Brazil	+	+	-	-	T	H
R. lemon Tharsa	+	-	-	+	-	L
R. lemon Coorg	+	+	-	-	-	M
Jamberi Kodur	+	+	-	-	-	M
Jamberi Bombay	+	+	-	+	T	M
Saville orange	+	+	+	-	S	H
Sohymdong	+	+	-	-	-	L
Citrus limao socilno	+	+	-	+	-	H
<i>Citrus aurantium</i> :						
Karunjamir	+	+	-	+	T	H
Herale	+	+	-	-	T	H
<i>Citrus medica</i> :						
Bengal citron	+	-	+	+	S	H
Magiphal sweet	+	+	+	+	T	H
C. kerna ( Karnakatta )	+	+	-	+	S	L
<i>Citrus aurantifolia</i> :						
Phillipnes red lime	+	-	-	+	T	M
St. Bardon red limo	+	-	+	+	T	L
Western key lime	+	+	-	+	S	L
Key lime	+	-	+	+	S	L
Mexican key lime	+	+	-	+	S	L
Kaghzi lime	+	-	-	+	S	M
Coorg lime	+	-	-	-	S	H
<i>Citrus limon</i> :						
L-15 Braz. lemon	-	+	-	+	S	L
Rajmundri lemon	+	+	+	-	T	H
Lemon Galgal	+	+	-	+	S	H
Pat lemon	+	-	+	+	T	H
Malta lemon	+	-	+	+	T	H
L-8 seedless lemon	-	+	-	+	T	H
Lemon long	+	-	+	-	T	H
L 12 Euroca lemon	+	-	+	-	S	L
Citrus lemon	+	-	-	+	S	L
<i>Citrus grandis</i> :						
Pummelo red sour	+	-	-	+	S	M
Pummelo red Sweet	+	+	-	+	T	H
Pink pumraelo	+	-	-	-	S	H

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Table 1 (Contd.)

1	2	3	4	5	6	7
Watson pummelo	+	+	-	+	T	H
Turanj	+	-	-	-	T	H
Rababtanga	+	-	-	+	-	M
<i>Citrus paradisi</i> :						
Grape fruit Marsh	+	+	-	-	S	H
Grape fruit Duncan	+	-	-	+	S	H
Grape fruit	+	-	-	+	S	H
<i>Citrus mederaspatana</i> :						
Belladikithulli	-	+	-	+	S	L
Wadapuli mutant	+	+	-	-	S	L
Kichilli	+	+	-	+	S	H
<i>Citrus pennivesiculata</i> :						
Badvapuli	+	+	-	+	S	L
Gajnimma	+	-	-	+	S	M
Citrus maduransis	+	+	-	-	T	H
Citrus limettiodes	+	+	-	-	S	L
Citrus nobilis	+	-	-	-	S	H
C. semiperflorence	+	+	-	-	S	H
C. latipes	+	+	-	+	S	H
C. assamensis	+	-	-	+	S	H
C. monophylla	+	-	-	-	S	L
Atlantia monophylla	-	-	-	-	T	L
Fernia limpra	-	-	-	-	T	L
<i>Trifoliate &amp; hybrids</i> :						
Rubidox	-	+	+	-	-	L
Trifoliata trifosta	+	-	-	-	-	L
Savage citrange	+	-	-	-	-	L
Troyer citrange	-	-	+	-	-	L
Troyer citrange Punjab	-	-	+	-	-	L
Carrizo Punjab	+	-	+	-	-	L
Troy. citrange Australia	-	-	-	-	S	H
Troy. citrange Morrocco	-	-	+	-	-	M
Citrange Rusk Morrocco	+	-	-	-	-	M
Citrange Morton Morrocco	-	-	-	-	-	H
Troy. citrange Brazil	+	-	-	-	-	M
Citrange A. P.	-	-	-	-	T	M
Tangelo	-	+	-	+	T	H
Tangerine	+	+	-	-	T	M
Tangerine Pan	+	-	-	-	-	L
<i>Other Citrus species</i> :						
Severonia	+	+	-	-	-	L
Gabbuchini	+	+	-	+	T	H
Westim Brazil	+	+	+	-	T	H
Quinshin	+	+	-	-	S	H
Kamquat	+	+	-	-	S	H

+ = Presence, - = absence, S = susceptible, T = Tolerant L = low, M = moderate, H = High.

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Remaining 36 cultivars on indexing for tristeza, psorosis, exocortis, greening and inoculation for phytophthora made possible elimination of another 20 cultivars. The number of cultivars thus rejected and selected from observed species are presented in Table 2.

Table 2. Number of cultivars observed and rejected on the basis of their reaction to pathogens.

Citrus species	Number of promising cultivars	Number of cultivars rejected		
		Apparent symptoms	Indexing results	Total No. rejected
<i>Citrus reticulata</i>	-	15	-	15
<i>Citrus sinensis</i>	-	18	-	18
<i>Citrus reshini</i>	3	-	4	4
<i>Citrus limonia</i>	3	-	3	3
<i>Citrus jamberi</i>	6	12	4	16
<i>Citrus aurantium</i>	-	2	-	2
<i>Citrus medica</i>	-	1	1	2
<i>C. aurantifolia</i>	-	6	1	7
<i>Citrus limon</i>	-	7	2	9
<i>Citrus grandis</i>	-	5	1	6
<i>Citrus paradisi</i>	-	3	-	3
<i>C. mederaspatana</i>	-	2	1	3
<i>C. pennivesiculata</i>	-	2	-	2
Other citrus species	3	7	3	10
Trifoliolate hybrids	1	16	-	16
Misc. citrus cultivars	-	5	-	5

The studies pinpointed unsuitability of the observed cultivars from *C. reticulata*, *C. sinensis*, *C. aurantium*, *C. medica*, *C. aurantifolia*, *C. limon*, *C. grandis*, *C. paradisi*, *C. mederaspatana*, *C. pennivesiculata* and other 13 miscellaneous species. Few cultivars from *C. limonia*, *C. reshini*, *C. jamberi* and *C. amblycarpa* groups revealed promise. The resistance to disease complex was observed to differ not only in species but in various cultivars from the same species. The data in respect of 16 cultivars observed promising from the angle of tolerance to pathogens are presented in Table 3.

Cleopatra mandarin (Morocco), Narana and Grabstan strain (*Citrus reshini*); Rangpur lime, L-2 Rangpur lime and marmalade orange (*C. limonia*); Rough lemon Chetthali; Rough lemon M. P., Rough lemon 58-III-IV, Rough lemon limonaria, Florida Rough, smooth lemon Assam (*C. jamberi*) and Nasnaran (*C. amblycarpa*) appeared to hold promise for employment as rootstock for sweet orange. Trifoliolate orange, *C. macroptera* and *C. macrophylla* appear important from the angle of breeding for resistance to tristeza and phytophthora, greening and salts respectively. The merits and demerits of each of the above stocks are discussed hereunder under appropriate headlines.

Table 3. Tolerance of few citrus cultivars to certain important factors involved in decline.

Rootstock details	Tolerance to imp. disorders					Nematode build up	Salts
	Tris-teza	Psor-osis	Exoc-ortis	Green-ing	Phytop-hthora		
<i>Citrus reshini</i> :							
Cleo. mandarin Morr.	R	R	R	L	R	300	HT
<i>C. mandarin</i> Narana	HT	R	R	L	HT	2285	HT
<i>C. mandarin</i> Grabstan	R	HT	R	L	HT	960	HT
<i>Citrus limonia</i> :							
Rangpur lime	T	HT	R	L	WS	1900	HT
Marmalade orange	R	HT	R	L	HT	4240	HT
L 2 Rangpur lime	R	HT	S	H	WS	6785	WS
<i>Citrus jamberi</i> :							
Rough lemon M.P.	HT	HT	R	L	WS	9200	HT
R. lemon Chetthali	T	HT	R	L	HT	8200	S
R. Lemon 58-III IV	T	R	R	H	HT	3260	WS
R. lemon limonaria	T	R	R	L	WS	4650	T
Florida rough	T	R	R	H	WS	9600	T
Smooth lemon Assam	T	R	R	L	WS	5700	T
<i>Citrus amblycarpa</i> :							
Nasnaran	HT	R	R	L	WS	800	T
<i>Citrus macroptera</i> :							
Satkara	T	T	R	R	S	9600	T
<i>Poncirus trifoliata</i> :							
Trifoliolate orange	R	R	S	L	R	300	S
<i>Citrus macrophylla</i>	S	T	R	L	T	@	R

NB. ; Xyloporosis was absent while foveoid present in all the cases. The incidence could not be confirmed under controlled conditions.

@=Not tested; R=Resistant; HT=Highly tolerant; L=low; H=High; WS=weakly susceptible; S=Susceptible; T=Tolerant.

Cleopatra mandarin (Morocco), exhibited resistance to tristeza, psorosis, exocortis and phytophthora. Incidence of greening and nematode population build up was very low. It is also highly tolerant to salts. Cleopatra mandarin Narana and Grabstan strain though displayed slight variation in the levels of tolerance/resistance, these cultivars also appear equally good. All these 3 cultivars could be used as stocks for sweet orange. Cleopatra mandarin (Morocco) could also be used as male parent in breeding of rootstocks for resistance to tristeza, phytophthora and nematodes. In *C. limonia* group, L-2 Rangpur lime and marmalade orange displayed resistance while Rangpur lime was tolerant to tristeza. All these cultivars exhibited leaf symptoms of psorosis, but were considered highly tolerant to this malady. L-2 Rangpur was susceptible to exocortis while other two cultivars were resistant. Incidence of greening was high in L-2 Rangpur which was further observed susceptible to phytophthora. Marmalade orange appears to be distinct improvement over Rangpur lime while L-2 Rangpur has the potential as donor for tristeza resistance. The cultivars of *C. jamberi* were in between tolerant to highly tolerant to tristeza. Rough lemon 58-III-IV, smooth lemon Assam and Florida rough were resistant to psorosis while other cultivars exhibited high tolerance. Incidence of greening was high in Rough lemon 58-III-IV and Florida rough while others had it low. High tolerance to phytophthora was evident only in Rough lemon (Chethali) and 58-III-IV while other stocks were weakly susceptible. Nematode count was high under all the cultivars. Except for susceptibility to salts, Rough lemon (Chethali) and Rough lemon 58-III-IV appear promising. Nasnaran had all the desirable traits except susceptibility to phytophthora. This rootstock can be used for budding of sweet orange. Trifoliate orange is resistant to tristeza, phytophthora and nematodes. It can be used as a male

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parent since it is a failure under high pH soils. Whether this stock could be used for double grafting also needs to be explored. Satkara (*C. macroptera*) has been observed resistant to greening. *C. macrophylla* showed high tolerance to salts. Both these cultivars may be useful in breeding.

The results suggest that cultivars from *limonia*, *reshini*, *jamberi* and *amblycarpa* may only be useful for employment as rootstocks for mosambi under the existing conditions. Rootstocks observed promising from these groups need to be tried in rootstock trials. Observed sources of resistance also need to be exploited in breeding.

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## Studies on Water Availability to the Crops at Akola (Maharashtra)

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#### Abstract

Climatic water balance was calculated by using the average weekly rainfall and potential evapotranspiration (PE) at Akola so as to know the pattern of water availability to the crops on the basis of receiving rainfall at a given time and loss of ground water storage, if any, during the same time. This study demarcated that at Akola Centre, the humid and moist period of water availability starts from 24th Std. week (11-17 June) and continues upto 47th Std. week (19-25 Nov.), whereas moderate moisture stress starts from the last week of November (48 std. week) and continues upto 5th std. week with the break in 4th std. week.

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