STOCK SCION REACTION OF CITRUS TO QUICK DECLINE DISEASE IN CEYLON

1. The Present Status of Stock Scion Experiments at Bibile

By

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INTRODUCTION

QUICK Decline or Tristeza of citrus is a devastating virus disease in most citrus growing countries. Inoculation tests have amply demonstrated that tolerance to the virus varies considerably with the type of rootstock on w ich the sweet orange (*Citrus sinensis Osb.*) is budded. The disease s known to be fatal if the rootstock is that of the sour orange type (*Citrus aurantium L.*). As early as 1928 Toxopeus (7) recognised the disease in Java as having assumed epidemic proportions in most citrus varieties grown on sour orange rootstock. It practically destroyed most commercial orchards established on sour orange rootstock both in Argentina and Brazil. In the state of São Paulo, Brazil, this disease killed more than 7,000,000 trees representing nearly 75 per cent of the plantation (4). In Argentina the number of trees affected was equally high (8). Since 1939 the loss of nearly 400,000 trees on sour orange stock has been attributed to this disease in California (2). In Ceylon the disease was first recognised in 1957 (3) and subsequently demonstrated (5) to be due to the Quick Decline virus. It is prevalent in most parts of the country and is easily detected in the Lower Uva valley which is the main citrus growing area. The disease is known to cause the bud union collapse, stem pitting, vein banding, chlorosis and sudden wilt of apparently healthy trees after an abnormally heavy crop. The reaction of the budded plant to quick decline results from an interaction of the scion and the rootstock whereas that of a seedling depends on its inherent tolerance or susceptibility. In areas where the disease is prevalent the only practical method of control is by the use of appropriate quick decline tolerant stock scion combination or by planting tolerant citrus seedling varieties.

The causative virus is transmitted predominantly by the Tropical Citrus Aphid (*Toxoptera citricidus* Kirkaldy) and to a lesser degree by *Aphis gossypii* Glover. Both these insect vectors are fairly widespread in most citrus growing parts of the Island. Once an area becomes infected by the disease it is highly impractical to eradicate it because of the wide distribution of *T. citricidus* and its high efficiency in transmitting the virus from diseased to healthy plants.

In the present paper investigations on the stock scion reaction to tristeza disease are discussed. The results presented herein, however, are not final as the experiments are 3 to 5 years duration. The present status of these experiments in regard to the stock scion reaction to disease, compatibility, growth and performance are dealt with.

EXPERIMENTAL PROCEDURE

It is possible to introduce seed of citrus varieties and rootstocks from foreign countries without the danger of introducing the virus (1). Seed of rootstock varieties found promising in the classical rootstock experiments at the Baldwin Park, California, was obtained through the courtesy of Prof. Bitters (personal communication). Varieties of citrus introduced from Brazil and those collected locally were also included in this study.

ROOTSTOCK VARIETIES

Nurseries of rootstocks were established at the Citrus Research Station, Bibile. The following rootstock varieties were incorporated in these investigations :—

Sweet Orange.—

Valencia Late, Caipira, Koethan, Bessie Sweet, Limoneria 5B, Bidwells Bar, Liyangolla (local), Bibile Sweet Orange (local) and Omanthai (local).

Sour Orange.—

Ambul Dodan (sour orange local)

Lemon.—

Florida Rough Lemon, Limoneira 8A 36-2, Rough Lemon (local) and Limao Cravo.

Lime.—

West Indian Lime and Philippine Red Lime.

Mandarin.—

Mandarin (local) Cleopatra, Dancy, Ponkan and Willow Leaf Mandarin.

Trifoliate Orange.—

Webber Fawcett, Rubidoux and Trifoliate (local).

Trifoliate Hybrids.—

Citrumello trifoliate

Miscellaneous.—

Nasnaran and Heennaran.

Stocks listed above and not mentioned in Table 3 have been incorporated into stock scion trial 4 based on similar lines. No attempt has been made to give details of observations as this trial is 2 years old.

SELECTION OF SCION VARIETIES

Considerable evidence hitherto presented reveal that the decline of Bibile Sweet Orange seedling type and Bibile Seedless Sweet Orange, a bud sport of the former may be partly caused by Tristeza (3, 5). Reports of virus decline of seedling sweet orange types appear to be uncommon. Costa (personal communication), however, reports of an indigenous sweet orange type Pera showing signs of decline which could be attributed to Tristeza in Brazil. It was, therefore, considered necessary that sweet orange varieties known to exhibit some field tolerance should be selected as scions. Valencia Late, a true sweet orange reputed to show tolerance to virus infection and the local selection Liyangolla, probably a sinensis hybrid, combining both good fruit quality and high degree of virus tolerance, were selected as the two sweet orange scion varieties for this investigation (3).

METHODS

A series of rootstock trials were set down at the Citrus Research Station, Bibile, where the treatments were exposed to natural infection by Tristeza. These trials, except trials 2 and 4 which included 6 and 9 rootstocks respectively, comprised of seven rootstocks and two scion varieties, replicated thrice and randomised in the usual manner. The scions were budgrafted in the nursery and planted as replants in the experimental area where the vector activity has been observed to be moderately high. Every alternate plant in each treatment was inoculated with budwood from Tristeza infected trees by

the tissue grafting technique. Inoculations were made in all cases a few inches above the graft union. " Bud take " was poor in the first attempt with about 40 per cent success; tissue grafting was repeated three weeks later with better results. At the time of inoculation the growth and performance in all combinations except on sour orange and West Indian Lime rootstocks was generally satisfactory. Symptom expression was assessed qualitatively at half year intervals, symptoms taken into consideration being stunting, chlorosis, vein clearing and banding, stem pitting and depletion of starch in the root system. Growth statistics were also taken regularly.

RESULTS OF EXPERIMENTS

Both qualitative observations and growth statistics are collectively summarised in Tables 1, 2 and 3. The following is the present condition of the interaction of the rootstock and scion varieties in relation to tristeza disease:—

Lemon, *Citrus limon* (Linn) Burm

Rough Lemon (local).—This rootstock has performed satisfactorily with both scion varieties. (Plate I) A slight discolouration of the leaves was observed at the peak of the dry season. The starch content of roots of 3/4 inch diameter and above was extremely good when tested an year after inoculation. Height records reveal a definite increase of Liyangolla over the variety Valencia Late. Data on the performance of Florida Rough Lemon, Limoneira 8A 36-2 and Limao Cravo is not presently available.

Sweet Orange, *Citrus sinensis* (Linn) Osbeck

1. *Liyangolla.*—The performance of Liyanagolla too was superior to that of Valencia Late from the point of view of symptom expression. Growth does not appear to be retarded by virus inoculation. The starch status in roots is normal. Plants on Liyangolla rootstocks appear to spread better than on rough lemon.

2. *Caipira.*—Excellent growth, with mild symptoms in the case of few grafts, was recorded on Caipira rootstock. This stock has supported better Liyangolla tops than other rootstocks used in this experiment with the exception of Rough Lemon (local).

3. *Valencia Late.*—There is no appreciable difference to Liyangolla and Caipira rootstocks. The symptoms, however, persisted for a longer period in combinations having Valencia rootstock.

PLATE I

Plate I.—Budgraft of Liyangolla Sweet Orange on local Rough Lemon rootstock inoculated with tristeza. Note excellent growth and profuse spreading.

PLATE II

Plate II.—Severe stunting of Liyangolla Sweet Orange top on *Poncirus trifoliata* rootstock. Budgraft inoculated with tristeza.

4. *Omanthai.*—This variety has been found to show field tolerance to virus infection (5). As a rootstock it has supported average sized crowns. The virus inoculation has not suppressed growth in both scion varieties. The starch status in roots is normal.

5. *Bibile.*—This, as a rootstock, is the least tolerant of the sweet orange varieties under investigation. Small leaf formation and thin foliage was observed in the case of both tops.

Mandarin, *Citrus reticulata* Blanco

Mandarin (Local).—The inoculated grafts showed suppression of growth. Some of these combinations have shown persistent symptoms. The mandarins have been listed as uncertain in trials conducted in California (2).

Trifoliate Orange, *Poncirus trifoliata* (Linn) Raf.

Growth of both scion varieties on this rootstock has been unsatisfactory. (Plate II). Plants are, however, free of symptoms of tristeza infection. The trifoliate orange as a stock appears to be of little value under climatic conditions prevailing in Lower Uva.

Grapefruit, *Citrus paradisi* Macf.

On this rootstock both scion varieties have shown appreciable growth. Stem pitting and vein banding are notable symptoms of Tristeza present. The combination has shown premature fruiting.

Lime, *Citrus aurantifolia* (Christm.) Swing

Acid limes in general are not tolerant to Tristeza and usually suffer severe injury. On West Indian lime both inoculated and uninoculated plants with Valencia top show severe decline symptoms. With the Liyangolla top, however, the inoculated plants exhibit the typical 'staghorn' appearance whereas the uninoculated show slight suppression of growth accompanied by mild vein clearing symptoms. (Plate III).

MISCELLANEOUS

Heennaran, *Citrus crenatifolia var. lycopersiciformis*

It has shown promise as a rootstock exhibiting tolerance to tristeza infection. A characteristic feature of this variety is the perfect merger of the stock and scion at the bud union. Of the two scion varieties under evaluation Liyangolla shows superior performance on this stock.

PLATE III

Plate III.—Budgraft of Liyangolla Sweet Orange on West Indian Lime rootstock inoculated with tristeza. Note characteristic "staghorn" appearance and severe decline symptoms.

PLATE IV

Plate IV.—Premature fruiting and severe decline symptoms of Liyangolla Sweet Orange top on Sour Orange rootstock. Budgraft inoculated with tristeza.

Nasnaran, *Citrus japonica var. lakkanovensis*

Although height records reveal satisfactory growth, Nasnaran as a rootstock is the most inferior of the local citrus species under investigation. Plants exhibit chlorosis and vein banding symptoms. The starch content of roots is unsatisfactory.

Sour or Seville Orange, *Citrus aurantium* **Linn**

Sour Orange when used as a stock for grapefruit and sweet orange was found to hasten the decline of these tops (6). The presence of the virus was not known at this time but the symptoms described confirm its presence even as far back as 1945. Most of the trees with Valencia scion showed symptoms in 6-8 months after planting. As given in Tables 1, 2 and 3 all Valencia tops succumbed immediately on inoculation. However, Liyangolla tops survived with very poor growth and profuse flowering and fruiting. (Plate IV). Tests revealed the complete absence of stored carbohydrates in the root system.

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TABLE 1

Reaction of Valencia Late and Liyangolla Sweet Orange budded on different rootstocks six months after inoculation with tristeza. Number of budgrafts showing the type of reaction

ROOTSTOCK	*Valencia Late Scion*						*Liyangolla Scion*					
	Inoculated			*Uninoculated*			*Inoculated*			*Uninoculated*		
	Symptoms Present	*Symptoms Uncertain*	*Symptoms Absent*	*Symptoms Present*	*Symptoms Uncertain*	*Symptoms Absent*	*Symptoms Present*	*Symptoms Uncertain*	*Symptoms Absent*	*Symptoms Present*	*Symptoms Uncertain*	*Symptoms Absent*
Rough Lemon	—	4	2	—	—	6	2	3	1	—	—	6
Valencia	3	1	2	—	—	6	1	1	4	1	—	5
Heennaran	3	1	2	—	—	6	1	1	4	1	—	5
Liyangolla (local)	3	1	2	—	—	6	1	5	—	—	—	6
Omanthai (local)	1	5	—	—	—	5	2	4	—	—	—	6
Caipira	2	1	3	—	—	6	4	2	—	—	1	5
Bibile Sweet (local)	3	2	—	—	—	7	3	2	1	—	—	6
Trifoliate orange	—	3	—	—	—	4	1	3	—	—	1	5
Mandarin (local)	1	2	1	1	—	3	5	1	—	—	—	6
Nasnaran	1	1	1	—	—	4	4	2	—	—	—	6
Grape Fruit (Triumph)	2	3	1	—	—	6	2	1	3	—	—	6
West Indian Lime	1	2	—	4	—	1	3	2	—	—	2	5
Sour Orange*	all dead			all dead			6	—	—	—	—	6

* Profuse flowering and fruiting observed.

TABLE 2

Reaction of Valencia Late and Liyangolla Sweet Orange budded on different rootstocks one year after inoculation with tristeza. Number of budgrafts showing the type of reaction

ROOTSTOCK	*Valencia Late Scion*						*Liyangolla Scion*					
	Inoculated			*Uninoculated*			*Inoculated*			*Uninoculated*		
	Symptoms Present	*Symptoms Uncertain*	*Symptoms Absent*	*Symptoms Present*	*Symptoms Uncertain*	*Symptoms Absent*	*Symptoms Present*	*Symptoms Uncertain*	*Symptoms Absent*	*Symptoms Present*	*Symptoms Uncertain*	*Symptoms Absent*
Rough Lemon	1	—	5	1	1	4	1	—	5	—	1	4
Valencia	1	—	5	—	—	6	1	1	4	1	—	5
Heennaran	—	1	4	1	—	4	—	1	5	1	—	5
Liyangolla (local)	1	—	5	—	2	3	2	–	4	1	—	5
Omanthai (local)	3	—	3	1	—	4	2	1	3	—	1	5
Caipira	1	1	3	1	—	5	1	2	3	—	—	6
B. S. O. (local)	2	1	2	1	2	4	2	1	3	—	1	5
Trifoliate Orange	—	3	1	—	—	3	—	1	3	—	1	4
Mandrian (local)	1	3	—	1	2	1	3	1	2	3	2	1
Nasnaran	1	1	1	2	—	2	2	3	1	—	2	3
Grape Fruit (triumph)	4	1	—	2	3	1	2	3	—	4	2	1
West Indian Lime	3	—	—	3	—	—	5	—	—	4	2	—
Sour Orange *	all dead	all dead	all dead	all dead	all dead	all dead	6	—	—	4	2	—

* Profuse flowering and fruiting observed.

TABLE 3

The influence of Tristeza Infection on Growth of Liyangolla and Valencia Late Sweet Orange Varieties budded on different rootstocks

ROOTSTOCK	*Liyangolla Sweet Orange Scion*						*Valencia Late Sweet Orange Scion*					
	Inoculated			*Uninoculated*			*Inoculated*			*Uninoculated*		
	Average plant height in cm.	*Average stock girth in cm.*	*Average scion girth in cm.*	*Average plant height in cm.*	*Average stock girth in cm.*	*Average scion girth in cm.*	*Average plant height in cm.*	*Average stock girth in cm.*	*Average scion girth in cm.*	*Average plant height in cm.*	*Average stock girth in cm.*	*Average scion girth in cm.*
Experiment No. 1 planted in 1959												
Caipira	179	17	16	229	20	17	147	13	11	170	18	15
Valencia	177	15	15	159	14	13	185	15	14	175	15	13
Heennaran	172	15	14	136	13	13	123	11	10	162	17	13
Liyangolla	166	14	13	213	19	17	180	15	14	180	17	15
Grape Fruit	156	15	14	199	16	14	112	12	10	131	15	12
Nasnaran	143	14	12	148	14	13	124	13	11	130	13	17
Sour Orange	120	12	11	144	14	12	—	—	—	—	—	—
Experiment No. 2 planted in 1959												
Rough Lemon	211	22	20	274	25	22	200	15	15	222	17	15
Mandarin	183	15	13	193	19	14	90	6	6	133	11	9
Omanthai	180	17	15	194	18	15	145	16	12	148	14	12
Bibile Sweet Orange	156	15	13	100	13	10	138	15	12	152	17	13
Trifoliate	124	12	10	180	15	11	135	12	9	106	11	8
West Indian Lime	96	11	9	162	15	12	87	8	7	83	6	5
Experiment No. 3 planted in 1960												
Philippine Red Lime	159	16	13	162	16	14	132	12	10	131	12	9
Limoneira 5B	156	13	12	161	14	12	139	12	12	149	13	11
Limoneira 8A 36-2	152	15	13	167	14	12	90	6	4	110	12	10
Limavo Cravo	151	17	12	165	15	13	97	11	10	121	12	12
Citrumello trifoliate	149	12	11	163	12	12	89	7	6	110	9	8
Omanthai	135	12	11	153	13	12	156	12	10	167	14	12
Florida Rough Lemon	130	11	7	162	14	12	160	15	11	171	17	13