ORIGINAL ARTICLES.

STOCK-SCION INFLUENCE IN CITRUS

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IN most countries where citrus is grown on an orchard scale the commercial method of propagation is by budding the desired scion variety on a compatible stock which can be easily raised from seed. The seedling stocks are grown in nursery beds and budded almost exclusively by the inverted T method of budding.

Budgrafts propagated vegetatively by this method on genetically uniform stocks will nearly always come true to type and bear earlier than seedling trees of comparable age. They tend to be uniform in growth and are easy to train in the orchard. They will produce fruit of uniform quality, and if they are the progeny of buds selected from inherently high yielding trees they will tend to give uniformly high yields. Their comparatively low spreading habit of growth facilitates spraying, pruning, thinning and other cultural operations in the orchard.

Seedling trees on the other hand tend to grow tall and erect and with few exceptions cannot be depended upon to breed true to type owing to possible cross pollination with other citrus varieties. Plants raised on their own roots as layers and gootees are often planted in village gardens, but the method of raising them is slow and cumbersome.

In the case of a budgraft the scion has the further advantage of being on a root stock which is probably more resistant than the scion itself on its own roots to pests and diseases and to unfavourable soil and weather conditions brought about by drought, frost, excessive rainfall &c. In a compatible stock-scion combination the stock will tend to influence the growth of the scion, its yield and fruit quality, while the scion will tend to have a similar reciprocal effect on the root system of the stock (Hodgson *et al.* 1937).

With most deciduous fruit trees a stock-scion combination which is a failure in one place is generally so in most other places regardless of environmental influence, indicating thereby that the failure is mainly due to physiological and structural differences between the stock and scion. But in the case of citrus the problem of stock-scion incompatibility is more complicated, since a stock-scion combination which does well in one place may be a complete failure in another owing to differences in environment. A striking example of this is the behaviour of the sour orange which makes a good stock for sweet orange on a commercial scale in California, Florida and Palestine but is a failure as a stock for sweet orange in South Africa, Java, and Peshawar, although when left unbudded it makes vigorous growth and crops well [Webber (1926), Toxopeus (1936), Brown (1920)]. The position is well described by Professor V. A. Blackman (1937) in a statement that

" the success of a graft like that of a marriage may depend not only on the inherent qualities of the two individuals but also on the conditions, favourable or unfavourable, to which they are exposed during their partnership ".

There are in Ceylon wide regional variations in soil and climate which make it necessary to carry out stock-scion trials with local and imported varieties in order to develop a suitable stock-scion combination for each region. Prior to the war citrus grafts were imported in large numbers mainly from Australia and South Africa and planted in various parts of the Island, but it soon became evident from the performance of these trees that many of the stock-scion combinations were not suited to local conditions. It was felt that some of these varieties were likely to do well if they were budded on local acclimatized stocks.

The experiments which form the subject of this paper were laid down under different soil and climatic conditions in the wet zone at Peradeniya in November, 1936, in the semi-dry zone at Nalanda in February, 1938, and under irrigation in the dry zone at Hingurakgoda in November, 1941, with a view to test the suitability of different stock-scion combinations in regard to their (*a*) general habit of growth and vigour, (*b*) yield and quality of fruit, (*c*) resistance to pests and diseases.

In the grapefruit stock-scion experiment at Peradeniya where the average annual rainfall is 93·5 inches there are four different stocks—Rough lemon (C. *jambhiri*. Lush), Sour orange (C. *Aurantium* L), Pummelo (C. *Maxima* Merr.) and sweet orange hybrid (C. *sinensis Hybr.*) budded with four different grapefruit varieties—Walters, Marsh seedless, Triumph and Foster. The soil here is a light loam of low fertility. A preliminary report on this trial has already been published (Richards 1938).

In the grapefruit trial at Hingurakgoda Farm where the average annual rainfall is 78 inches there are two stocks—Rough lemon and sour orange—budded with four varieties, Walters, Marsh seedless, Cecily seedless and Triumph. The experimental area is in a low lying section of the orchard which is subject to water logging during a continuous spell of wet weather. The soil is a medium loam about 3 ft. in depth, overlying partially weathered igneous rock.

Sour orange and rough lemon are used as stocks for three imported orange varieties—Mediterranean sweet, Valencia late and Navalencia, and two local varieties, Vavuniya and Katugastota orange, in the trial at Nalanda experiment, and for Valencia late, Vavuniya, Bibile and Indian sweet orange at Hingurakgoda.

The same two stocks are used for Nagpur Santra, Beauty of Glen Retreat, and Emperor Mandarins in the stock-scion trial at Nalanda where the annual rainfall is 83 inches. The soil here is a medium loam of variable depth overlying magnesium lime stone or dolomite from which it is derived. It contains in sections a high proportion of iron nodules.

THE ROOTSTOCKS

Rough Lemon (C. *jambhiri* Lush.). The Rough lemon grows well on light sandy soils under conditions of low rainfall, and is used for that purpose on a commercial scale in parts of Australia, Florida, India and S. Africa where according to Marloth (1938) it is the only stock used. In Ceylon this varietv

is found in home gardens in the Jaffna Peninsula where it is known in Tamil as *Narathai*, but it occurs only rarely in other districts where its origin can often be traced to imported grafts in which the scion had failed.

The ordinary tubercled lime or *Kudaluthehi* (C. *hystrix*) and *Nataran* a variety of citron (C. *medica*), both of which are slow growing and unsuitable as stocks, are often mistaken for rough lemon because of the rough appearance of the fruit, but their foliage is strikingly different from that of the rough lemon.

The rough lemon seedling has a deeply penetrating taproot and fibrous laterals which are well adapted to forage in the fertile top soil. It can stand drought conditions better than most other stocks. It is inherently a vigorous grower, and is invigorating in its effect on the scion especially in the early years. Fruits produced on this stock during the first few years are generally coarse and not up to standard in quality.

The variety is more resistant to cellar rot or gummosis than most other stocks with the exception of sour orange which is highly resistant. It is very susceptible to citrus scab and to a lesser extent to citrus canker.

Sour Orange (C. *Aurantium* L.). The sour orange was until recently used almost exclusively as a stock for citrus in California. It is a popular stock for use on wet and heavy soils in Florida, Texas, Arizona, Palestine and the Southern states of Australia, since it is highly resistant to foot rot. According to Hume (1930) about 75 per cent. of the world's commercial output of citrus fruit is from trees grown on this stock.

Many strains of sour orange are known to exist of which Bitter Seville is the strain commonly used in California. Baker (1938) has reported the existence in Trinidad of certain poor strains of sour orange which, though resistant to foot rot, are susceptible to other forms of root disease. The Ceylon sour orange or *Ambuldodan* grows well in village gardens in the wet zone and produces a fruit which is valued for its medicinal properties.

The sour orange seedling is not so vigorous in growth as the rough lemon and is reputed to be semi-dwarfing in its effect on the scion. It has a strong root system with a tap root which when severed in transplanting produces several deeply penetrating roots from near the cut end.

Sweet Orange Hybrid (C. *Sinensis* hybr.). The sweet orange is more susceptible to gummosis and other root diseases than sour orange and for that reason it has not been used extensively as a root stock. With improved irrigation and cultural practices the danger of loss through gum diseases has diminished and the stock has in recent years come into favour in California and Australia since trees worked on it grow more vigorously than those on sour orange and give better yield of fruit of really good quality from the start. The root system is well provided with strong fibrous roots though it is somewhat shallow compared to that of the sour orange.

The variety used in this experiment is a hybrid type which was selected for its vigour and prolific bearing habit. These hybrid types go under different local names such as *Haldodan, Sideran* &c., and are probably produced as a result of cross pollination with other citrus varieties, such as pummelo and sour orange. The fruits are coarse and larger than the common sweet orange. They are sub-acid in flavour.

In the early stages the seedlings have numerous prominent spines and are not unlike sweet orange seedlings in appearance, but their influence on the scion is probably different from that of the true sweet orange.

Pummelo (C. *Maxima* Merr.). The pummelo or *jambola* is a large tree which grows well in home gardens in the wet zone. Several types are known to occur, some having round fruits, others pear shaped. Some are pink fleshed, while others have flesh of ordinary lemon colour. Being a monoembryonic variety the seedlings show considerable variability. They are highly susceptible to attack by scale insects and citrus canker in the nursery stage. The variety is not used as a stock on a commercial scale anywhere in the world.

DESIGN OF THE EXPERIMENTS

The Randomized split plot design has been used in all the experiments, and in each subplot there are three plants. Wishart and Sanders (1936) have shown that with the split plot lay-out all the comparisons cannot be made with the same degree of precision. In the experiment at Peradeniya, a greater degree of precision was required for the scion treatments whose effects might be smaller than for the general comparison of the stocks in which greater differences were anticipated, and accordingly the scion treatments were allotted at random to the subplots and the stock treatments to the plots. There are five blocks in the experiment with four plots in each block for the four stocks, and four subplots in each plot for the four scion varieties. The total number of plants in the experiment is 240, which is exclusive of 80 plants in the border row all round the experimental area.

In the grapefruit trial at Hingurakgoda there are six blocks with four plots in each block and two subplots in each plot. Since a greater degree of precision was required in the comparison of the stock treatments each of the two stocks was allotted at random to the subplots in each plot and the scion treatments were randomized over the plots. There is a total of 144 plants exclusive of the border row plants.

Similarly in the orange stock-scion trial at Hingurakgoda there are six blocks with four plots in each block for the four scion varieties and three subplots in each plot for the three root stocks—rough lemon, sour orange and sweet orange. Owing to incidence of canker in the nursery plants on sweet orange stock could not be got ready in time for planting and the records are not complete for publication in this paper.

In the orange trial at Nalanda there are four blocks with five plots in each block for the five scion variety treatments, and two subplots in each plot for the two stock treatments, the total number of plants in the experiment being 120 in addition to those in the border rows.

Five replications are provided in the mandarin trial at Nalanda. The scion varieties are randomized over the plots, and the stocks are allotted to the subplots in each plot, the total number of plants being 120.

PLANTING MATERIAL

The seeds for the experiment were collected from known parent trees and planted in seed beds. In the grapefruit trial at Peradeniya the seedling stocks were transplanted into the experimental area and budded *in situ* after they were well established. In the other trials budgrafts raised in the nursery were used. In selecting the planting materials all variant types and bench rooted plants were rigidly culled out. Budwood was taken from a selected parent tree of each variety.

RECORDS OF GROWTH

Measurements of height and diameter were recorded yearly. The measurements of diameter of the stock and scion were taken with a pair of Vernier calipers at fixed points 6 cms. below and above the bud union.

GRAPEFRUIT TRIAL AT PERADENIYA

The analysis of variance of stock and scion diameter recorded in June 1940, 3 years after budding, is given in Appendix I. Rough lemon stock is significantly bigger in diameter than each of the other three stocks. Its invigorating effect on the scion as indicated by scion diameter is also statistically significant, the mean values for both stock and scion diameters being as follows :—

	Stock Diam. in cms.	Scion Diam. in cms.
Rough lemon	5·66 ..	5·11
Sour orange	3·18 ..	3·26
Pummelo	2·65 ..	2·18
Hybrid orange	2·59 ..	2·41

The differences in stock diameter between the other stocks are not significant, but plants on sour orange are significantly bigger in scion diameter than those on pummelo and hybrid orange, the differences between the latter being not significant. Scion overgrowth was noticeable on many plants especially of Triumph and Foster variety budded on sour orange and this is reflected in the higher mean value of 3·26 cm. for scion diameter compared to 3·18 cm. for stock diameter. In the other stock-scion combinations the mean value for scion diameter is less than that for stock diameter.

Both Walters and Marsh seedless varieties are significantly bigger in diameter than either Triumph or Foster. Their reciprocal effect on the stock as measured by the stock diameter is also significantly greater than that of Triumph or Foster, the mean values being as follows :—

	Stock Diam. in cms.	Scion Diam. in cms.
Walters	4·72 ..	4·33
Marsh seedless	4·42 ..	4·00
Triumph	2·60 ..	2·55
Foster	2·35 ..	2·10

Walters is not significantly superior to Marsh seedless, nor is Triumph superior to Foster in the effect on stock diameter, but in scion diameter the difference between Triumph and Foster is just significant. The interaction is significant in the analysis of both stock and scion diameters.

GRAPEFRUIT TRIAL AT HINGURAKGODA

The analysis of variance of stocks and scion diameters recorded in May, 1944, is given in Appendix II. Rough lemon is significantly bigger than sour orange in diameter and is also significantly more invigorating in its effect on scion. The mean values are as follows :—

	Stock Diam. in cms.	Scion Diam in cms.
Rough lemon	6·10 ..	5·28
Sour orange	4·56 ..	4·23

The interaction is significant, but not the scion treatments.

ORANGE TRIAL AT NALANDA

The analysis of variance of stock-scion diameter recorded in December 1942, is given in Appendix III.

Rough lemon is again significantly superior to sour orange in stock diameter and in its effect on the diameter of the scion, the mean values being as follows :—

	Stock Diam. in cms.	Scion Diam. in cms.
Rough lemon	8·50 ..	5·90
Sour orange	3·27 ..	2·55

In scion diameter only Mediterranean sweet orange is significantly superior to all the varieties except Navalencia, but in its effect on stock diameter it is significantly superior only to Vavuniya and Valencia late orange, the mean values are as follows :—

	Stock Diam. in cms.	Scion Diam. in cms.
Mediterranean Sweet orange	6·99 ..	5·29
Navalancia	6·13 ..	4·39
Katugastota Orange	6·09 ..	4·08
Valencia Late	5·58 ..	3·77
Vavuniya Orange	4·64 ..	3·60

There are no significant differences in scion diameter between the other varieties, but in regard to the effect on stock growth both Katugastota orange and Navalencia give significantly higher values than Vavuniya orange. The difference in scion diameter between Vavuniya and Valencia late is not significant.

MANDARIN TRIAL AT NALANDA

The analysis of variance of stock and scion diameters recorded in December 1942, is given in Appendix IV.

Rough lemon is significantly superior to sour orange at the 1 per cent. point in the mean values for stock and scion diameter which are as follows :—

	Stock Diam. in cms.	Scion Diam. in cms.
Rough lemon	8·28 ..	5·63
Sour orange	5·64 ..	3·98

The interaction is also significant, but not the scion variety treatments.

DISCUSSION

Though grown under different conditions of soil and climate all the citrus varieties have made healthy growth on rough lemon which is shown to be not only vigorous in itself but invigorating in its effect on the scion. No symptoms of chlorosis or die-back were observed on young plants budded on this stock, and nearly all of them have now come into bearing.

Lal Singh and Sham Singh (1942, 1944) report that rough lemon has given the best results as a stock for Blood Red Orange in the citrus root stocks trials in the Punjab. In the earlier trials they found that it induced vigorous vegetative growth in young trees of Malta orange, Santra mandarin and grapefruit budded on it.

Similar observations on the vigour of budgrafts of sweet orange and acid lime on rough lemon stock in the root stock trials at Kodur, S. India, are recorded by Naik (1941). Nandi and Bhattacharya (1943) have found rough lemon to be an invigorating stock for local mandarin in Assam.

The sour orange appears to have a variable effect on the citrus varieties budded on it. There is considerable variability even among the budgrafts of the same variety, some being healthy, others are stunted and chlorotic. Most of the Triumph and Foster grapefruit plants were stunted on it and displayed marked scion overgrowth above the budunion. The initial growth of Marsh seedless and Walters was satisfactory, but subsequently gradual decline set in and many of them died back.

The growth of the imported sweet orange varieties was equally poor on sour orange, and many of them were stunted and chlorotic. The two local varieties, especially vavuniya orange, made good initial growth without developing symptoms of chlorosis and die-back, but their rate of growth showed a tendency to slow down after the second year.

The Nagpur Santra mandarin made steady growth on sour orange stock in the early years, but the growth of the two imported Australian varieties was not satisfactory. It remains to be seen whether the Nagpur Santra mandarin plants will continue to grow well on this stock.

The failure of sour orange as a stock for sweet orange has been reported from Java by Toxopeus (1936) who considers that the cause of the failure may not lie in the stock itself, but in some toxic reaction of the scion upon the stock. He found that the scion variety grew normally for 2 to 3 months but eventually declined and withered within 8 to 12 months. No reason is known for the striking failure of sour orange as a stock for sweet orange in S. Africa.

Lal Singh and Sham Singh (1944) report the failure of Blood Red orange through delayed incompatibility with *Kharna Khatta* which is presumably a variety of sour orange. But they find that the local Malta and Santra mandarin grow well on it. This is contrary to the behaviour of the local mandarin in Assam which, according to Nandi and Bhattacharya (1943), is incompatible with Seville or true sour orange. Both Hume (1930) and Swingle (1909) report that Satsuma mandarin is a failure on sour orange in America.

In recent years there has been a marked decline in vigour of lemon trees budded on sour orange in California, and a condition known as " Quick Decline " resulting in the death of Naval and Valencia orange trees on this stock has also been reported by Fawcett (1945).

The sweet orange hybrid has not made a good stock for grapefruit varieties. Many plants of Triumph and Foster, which appear to be inherently weak scions, were stunted and chlorotic on this stock. The other varieties developed symptoms of delayed incompatibility. It is proposed to carry out trials with the common sweet orange as stock.

On pummelo all the grapefruit varieties except Walters developed symptoms of both chlorosis and mottled leaf in the early stages and were stunted in growth. Walters, which appears to be a vigorous scion variety, grew well at the start, but symptoms of delayed incompatibility began to appear after about two years and most of the plants turned chlorotic and died back. Yellowing of foliage followed by die-back has also been noticed

on Valencia late and Meditterranean sweet orange plants budded on this stock.

It was observed by Lee (1921) in the Philippines that most of the commercial varieties of citrus budded on pummelo were attacked by mottled leaf, but trees upon mandarin orange and calamondin stocks made healthy growth. Lal Singh and Sham Singh (1942) have also reported the appearance of mottled leaf on grapefruit trees budded on pummelo stock. Chlorotic symptoms have also been observed on local mandarin plants budded on pummelo in Assam by Nandi and Bhattacharya (1943).

It is clear from the available evidence that pummelo is least suited for use as a stock for citrus. It makes vigorous and healthy growth when left unbudded, and the failure of the scion is probably due to its inability to obtain its requirements of nutrients through the pummelo stock. Apparently when a vigorous scion is grown on it under favourable conditions the appearance of symptoms of incompatibility is delayed.

Whatever the reason may be for the failure of certain stock-scion combinations, it is evident from these trials that rough lemon is an invigorating stock which is compatible with all varieties of grapefruit, sweet orange and mandarin under study, and that it should be used for this purpose in commercial production until more is known of the performance of sour orange and the common sweet orange as root stocks for citrus under local conditions.

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APPENDIX I.

Grapefruit Trial—Peradeniya

(i) Analysis of Variance of Stock Diameters

	DF.	SS	Variance	F	1% Point.
Blocks ..	4 ..	80·37 ..	20·09 ..	2·53	
Stock treatments ..	3 ..	1133·01 ..	377·67 ..	47·57 ..	5·95
Error (*a*) ..	12 ..	95·24 ..	7·94		
Scion Treatments	3 ..	806·78 ..	268·93 ..	24·29 ..	4·22
Interaction ..	9 ..	697·91 ..	116·32	10·50 ..	2·15
Error (*b*) ..	48 ..	531·50 ..	11·07 ..		
	79	3344·81			

(ii) Analysis of Variance of Scion Diameters

Blocks ..	4 ..	62·81 ..	15·70 ..	2·50	
Stock Treatments	3 ..	956·66 ..	318·89 ..	50·86 ..	5·95
Error (*a*) ..	12 ..	75·29 ..	6·27		
Scion Treatments ..	3 ..	630·95 ..	210·32 ..	89·88 ..	4·22
Interaction ..	9 ..	541·72 ..	60·19 ..	25·72 ..	2·15
Error (*b*) ..	48 ..	112·17 ..	2·34		
	79	2379·60			

	Rough lemon in cms.	Sour orange in cms.	Pummelo in cms.	Sweet orange hybrid in cms.	Significant differences in cms.
Mean values per subplot for stock effect on diameter of scion ..	15·33 ..	9·77 ..	6·53 ..	7·24 ..	2·42
Mean stock diameter per subplot ..	16·97 ..	9·55 ..	7·96 ..	7·78 ..	2·72

	Walters in cms.	Marsh seedless in cms.	Triumph in cms.	Foster in cms.	Significant difference in cms.
Mean scion diameter per subplot	12·98 ..	12·00 ..	7·65 ..	6·30 ..	1·30
Mean values per subplot for scion effect on stock diameter ..	14·17 ..	13·25 ..	7·80 ..	7·04 ..	2·82

APPENDIX II.

Grapefruit Trial—Hingurakgoda

Analysis of Variance of Stock Diameters

	DF	SS	Variance	F	1% Point.
Blocks ..	5 ..	73·72 ..	14·74		
Scion treatments ..	3 ..	68·01 ..	22·67 ..	2·54 ..	5·42
Error (*a*) ..	15 ..	133·67			
Stock treatments ..	1 ..	212·52 ..	8·91 ..	54·63 ..	8·02
Interaction ..	3 ..	103·56 ..	34·52 ..	8·87 ..	4·87
Error (*b*) ..	21 ..	81·85			
	48 ..	697·33			

Analysis of Variance of Scion Diameters

	DF	SS	Variance	F	1% Point
Blocks	5	40·51	8·10	1·03	
Scion treatments	3	39·91	13·30	1·69	5·42
Error (*b*)	15	118·01	7·87		
Stock treatments	1	117·50	117·50	35·93	8·02
Interaction	3	70·28	23·43	7·17	4·87
Error (*b*)	21	68·65	3·27		
	48	454·86			

	Rough lemon in cms.	Sour orange in cms.	Significant difference in cms.
Mean values per subplot for stock effect on scion diameter	15·83	12·70	1·45
Mean stock diameter per subplot	18·30	13·68	1·61

APPENDIX III.

Orange Trial—Nalanda

Analysis of Variance of Stock Diameters

	DF	SS	Variance	F	1% Point.
Blocks	3	63 07	21·02	3·22	
Scion treatments	4	212·84	53·21	8·15	5·41
Error (*a*)	12	78·35	6·53		
Stock treatment	1	2468·04	2468·04	2468·04	8·68
Interaction	4	263·87	65·97	8·59	4·89
Error (*b*)	15	115·23	7·68		
	39	3201·40			

Analysis of Variance of Scion Diameters

	DF	SS	Variance	F	1% Point.
Blocks	3	21·94	7·31		
Scion treatments	4	129·27	32·32	6·36	5·41
Error (*a*)	12	60·96	5·08		
Stock treatments	1	1012·04	1012·04	1012·04	8·68
Interaction	4	150·23	37·56	11·05	4·89
Error (*b*)	15	51·03	3·54		
	39	1425·47			

	Rough lemon in cms.	Sour orange in cms.	Significant difference in cms.
Mean values per subplot for stock effect on scion	17·71	7·65	1·72
Mean stock diameter per subplot	25·51	9·80	2·58

	Measurements in cms.					
	Medit. Sweet Orn.	Navalencia	Katug. Orn.	Valencia Late Orn.	Vavuniya Sw. Orn.	Signif. Dif.
Mean scion diameter per subplot	15·88	13·18	12·25	11·30	10·80	3·44
Mean values per subplots for scion effect on stock diameter	20·96	18·38	18·26	16·73	13·93	3·90

APPENDIX IV.

Mandarin Trial—Nalanda

Analysis of Variance of Stock Diameters

	DF	SS	Variance	F	1% Point
Blocks	4	45·06	11·27		
Scion treatments	2	60·00	30·00	1. 9	8·65
Error (*a*)	8	123·52	15·44		
Stock treatments	1	471·24	471·24	33. 8	9·33
Interaction	2	217·15	108·58	7.79	6·93
Error (*b*)	12	167·45	13·95		
	29	1084·42			

Analysis of Variance Scion Diameter

	DF	SS	Variance	F	1% Point
Blocks	4	26·41	6·60		
Scion treatments	2	28·22	14·11	1·5	8·65
Error (*a*)	8	74·62	9·33		
Stock treatments	1	183·03	183·03	20·8	9·33
Interaction	2	124·96	62·48	7·1	6·93
Error (*b*)	12	105·12	8·80		
	29	542·86			

	Rough lemon in cms.	Sour orange in cms.
Mean values per subplot for stock effect on scion diameter	16·88	11·95
Mean stock diameter per subplot	24·85	16·92

SUMMARY

All four varieties of grapefruit (C. *paradisi* Macf.) at Peradeniya—Walters, Marsh Seedless, Triumph and Foster—made healthy growth on rough lemon (C. *jambhiri* Lush.), an invigorating stock.

On sour orange (C. *Aurantium* L) and hybrid sweet orange (C. *sinensis* hybr.) their growth was variable with a tendency for most plants to be stunted and chlorotic. Scion overgrowth was noticeable in many on sour orange, a semi-dwafing stock.

All the varieties failed on pummelo (C. *maxima* Merr.). Triumph and Foster were the first to become stunted and chlorotic while Walters the most invigorating scion was the last.

All four varieties—Walters, Cecily Seedless, Marsh Seedless and Triumph—at Hingurakgoda showed similar behaviour as at Peradeniya on rough lemon and sour orange.

The seven varieties of sweet orange—Vavuniya, Bibile, India, Valencia Late, Mediterranean Sweet and Washington Naval, at Nalanda and Hingurakgoda were compatible with rough lemon, but on sour orange the gowth of the imported varieties was variable, many being stunted and chlorotic. The local varieties, especially Vavuniya, made healthy growth although the plants were comparatively small.

All three mandarin varieties (C. *nobilis Var*, deliciosa)—Nagpur Santra, Emperor and Beauty of Glen Retreat at Nalanda were compatible with rough lemon, but on sour orange Nagpur Santra made healthy growth while Beauty of Glen Retreat and to some extent Emperor were failures.