Citrus Rootstock Experiments in Surinam

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CITRUS has been grown in Surinam for local use since the middle of the seventeenth century. In 1907, oranges were shipped to Holland for the first time. After that, the Agricultural Experiment Station (founded in 1903) promoted citrus culture. Nurseries were established, budwood was imported from Trinidad and the United States, fruit was exported, and a search was made for superior local varieties. Of six mother trees selected in 1922, Kwata 202 was the best.

Surinam is a fully tropical country with a humid climate, although it has recently experienced a succession of dry years. Because of the normally heavy rainfall and the heavy clay soils in the coastal area where most of the citrus has been grown, sour orange (*Citrus aurantium* L.) has been the preferred rootstock. Surinam cherished the hope that tristeza had not visited its shores, but in 1963 tristeza was discovered. Exocortis had been discovered in 1962, and psorosis was found in 1964. It is clear by now that all or most of the virus diseases of citrus are present in this country. Moreover, the efficient vector of tristeza, *Toxoptera citricida* Kirk., also occurs.

EARLY ROOTSTOCK EXPERIMENTS.—In 1923, rootstock trials for citrus were started. For that purpose, 50,000 seeds of sour orange, 25,000 of alamoen [*C. grandis* (L.) Osb.], and 5,000 of other varieties were sown in the nursery. That same year, a stock-scion experiment was started with 10 different selections of sweet orange [*C. sinensis* (L.) Osb.] budded on 3 rootstocks: sour orange, alamoen, and West Indian lime [*C. aurantifolia* (Christm.) Swing.]. For comparison, a seedling tree of each stock and scion was added. Unfortunately, the experiment was neglected and very few trees were still standing when the author started his work at the Experiment Station in 1949.

In 1924, another experiment was started, consisting of 3 sweet orange and 3 mandarin selections on 11 stocks. This experiment fared slightly better, and for 1 orange (Kwata 71) it was possible to reconstruct the experiment entirely. The rootstocks used were 3 oranges, sweet, sour, and bittersweet (*C. aurantium* L.); 3 pomelos [*C. grandis* (L.) Osb.], alamoen, grapefruit, and shaddock; 3 mandarins (*C. reticulata* Blanco), curaçao, King, and Surino; lemon [*C. limon* (L.) Burm. f.]; and citron

(*C. medica* L.). Each combination was replicated twice, but in the second replication, the last 2 rows were missing. The site was a high sandy ridge sloping towards a creek with 3 soil types at right angles to the rows. The trees had been planted in an 8 meter hexagonal system, 12 to 16 trees per row, or about 180 trees per hectare.

Twenty years of neglect had left the trees in a very bad condition. Zinc and magnesium deficiencies were severe. A dense forest of palms and other trees had grown up around the citrus trees, which harbored countless nests of ants, termites, wasps, et cetera. After clearing, pruning, and fertilizing, an experiment was started at right angles to the rows, in which zinc was either withheld, given in the fertilizer (100 grams of zinc sulphate per tree), or provided as a spray.

In 1950, the trees in this experiment produced between 19 and 148 fruits per tree, but in 1951 production increased to averages of 96 for grapefruit and 678 for King. The quick recovery of the trees suggests, as a former boss of mine liked to say: "it is easier to till them than to kill them." In 1952, the zinc experiment was discontinued. All trees had reacted immediately to the spray, whereas their reaction to the fertilizer application was much slower. The mandarin stocks seemed better able to use zinc from the soil than did the other stocks, and trees on mandarin stocks showed little zinc deficiency.

ROOTSTOCK EVALUATION.—Citron and grapefruit rootstocks were distinctly inferior. Most of the trees on citron had died, probably of footrot (*Phytophthora* sp.), whereas those on grapefruit were uniform, but unproductive. The trees on shaddock rootstock varied widely. One or 2 trees were very large and rather good producers; the others were very small or intermediate. In view of the monoembryonic nature of shaddock seeds, this is not surprising. All rootstocks of the pomelo group showed a distinct overgrowth at the budding point.

Two mandarin rootstocks, Surino and King, were far superior to the others. Trees on these rootstocks were big, vigorous, and produced more than the others, year after year. Of the remaining rootstocks, sour orange was the best, closely followed by bittersweet, lemon, curaçao mandarin, and sweet orange. The experiment was ended in 1956 and most of the trees were pulled.

THE VIRUS SITUATION.—It is not likely that virus diseases were present in this experiment because Kwata 71 was selected from a seedling mother tree in 1922. The experiment was started in 1924 before citrus viruses were known. In those days, no one considered that using different buds on one rootstock might be risky. The author can only say that he

never looked for virus symptoms and observed none in this experiment. In 1966, one of the few remaining trees of Kwata 71 was indexed for virus, so far without results.

LATER EXPERIMENTS.—In 1953, a new series of rootstock experiments was started and 3 stocks were used: sour orange, Rangpur lime (*C. reticulata* var. *austera* hyb.), and Cleopatra mandarin. Buds were to be taken from 1 apparently healthy Kwata 202 tree, but the lack of sufficient budwood forced us to use 2 or 3 trees. The trees were planted about 10 per row in 5 replications, at 7 meters square, at 3 locations on different soil types as follows: Dirkshoop, young coastal plain sandy soil; Slootwijk, young coastal plain clay soil; and Lelydorp, old coastal plain sandy soil. A similar rootstock experiment with grapefruit buds was added at Dirkshoop.

The choice of locations proved unfortunate for several reasons. At Dirkshoop the trees were planted on old citrus land, where big, but un-

TABLE 1. NUMBER OF FRUITS PER TREE OF KWATA 202 ORANGE 11 YEARS OLD ON 3 ROOTSTOCKS AT 3 LOCATIONS

Location and soil type	Rootstocks		
	Sour orange	Rangpur lime	Cleopatra mandarin
DH,[a] sandy, young coastal	196	42	68
SLW, clay, young coastal	546	183	261
LDP, sandy, old coastal	86	70	125

a. DH = Dirkshoop; SLW = Slootwijk; LDP = Lelydorp.

productive West Indian lime trees on sour stock had been pulled 3 years previously. Growth was disappointingly slow here. Slootwijk, a private plantation, was too far from the Station for regular check-ups and the trees were neglected for several years. At Lelydorp, the subsoil was subsequently found to be rich in bauxite. This means that at 15 years of age the trees will be replaced by a mine. This doubtless explains the very high aluminum content in the leaves (600-1000 ppm) of these trees.

The trees on sour orange grew better than the others at all three locations. Those on Rangpur lime remained small and some, but not all, developed bark symptoms after several years. It proved fortunate that different bud sources had been used. Trees on Cleopatra were fairly good at two locations. Production of the Kwata 202 trees at 11 years of age is shown in Table 1.

Production was normal in only one instance, trees on sour orange stock at Slootwijk. In three instances it was low, and in five it was very low. In spite of the meager results, these experiments were of consider-

able importance. Kraaijenga (2) showed in 1962 that the bark symptoms and small size of trees on Rangpur lime were caused by exocortis virus. Some of the Kwata trees and most Marsh trees were not infected, however. In 1963, Childs (1) found leaf symptoms of tristeza on seedling West Indian lime trees, and in 1964, Kraaijenga (3) transmitted the virus experimentally to West Indian lime test plants in the greenhouse. Subsequently, xyloporosis was discovered, and the possibility of stubborn disease exists. These discoveries completely changed the picture. Freedom from exocortis virus was not enough. Budwood free of all viruses not transmitted by insects was required.

To begin with, a large number of seedling trees was studied. The promising ones were indexed, and seeds were sown for the production of new lines. In 1965, budwood from Florida was imported under quarantine.

RECENT EXPERIMENTS.—In 1964, a new series of rootstock experiments was set out using buds of new lines or of seedlings on a large number of stocks. In order to avoid former mistakes, new land was chosen at three locations, Dirkshoop, sand; LaPoule, clay; and Brokobaka, laterite. Later, another location, Baboenhol—a loamy sandy river terrace of the interior —was added.

The rootstocks used were as follows: sour orange, Caipira sweet orange, Dominica wild grapefruit, Rough lemon, Milam Rough lemon, Cleopatra, Surino, King, and Sunki mandarins, sweet lime, Rangpur lime, Troyer citrange, and *Poncirus trifoliata*. At all four locations, the rootstocks were planted in the field before virus-free budwood was available. Some new varieties have been received since, but are not yet incorporated in the experiments.

Some rootstocks were budded with locally selected sweet orange seedling (No. 1 Allidjan) or with grapefruit seedling (Hooghart). When the Florida imports are released from quarantine, they will be budded on these trees.

Conclusions

These experiments are of great importance to citrus production in Surinam. Two of the locations are in the interior of the country where citrus has not been grown commercially heretofore. This may greatly enlarge the possibilities for citrus growing in Surinam. It is hoped that past mistakes, such as indiscriminate importation of plants, insufficient knowledge of research carried on elsewhere, and lack of continuity in experimental work will be avoided in the future.

Literature Cited

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