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Nucellar Lines in the State of São Paulo, Brazil

THE USE OF NUCELLAR embryony is believed to be the most reliable means of freeing citrus clones from viruses (2, 4). The production of nucellar clones from 40 citrus varieties was begun at the Limeira Citrus Experiment Station in 1938. The true value of these nucellar clones was not, however, fully appreciated until after the devastating losses caused by tristeza and the subsequent losses to unselected budwood sources on specific rootstocks when these sources frequently carried a virus such as that of exocortis. The need for clones free from all bud-transmitted citrus viruses was then fully realized and attention was given to trees that had been propagated in 1940 from the nucellar lines.

Nucellar Clones of Baianinha Orange

The production of trees that were propagated from 85 nucellar seedlings of a single old-line Baianinha Navel orange and that were budded on Caipira sweet orange rootstock showed great variation during the first 9 years (1954-62). Total production ranged from 770 to 6,990 fruit per tree. Four trees produced less than 1,000 fruit in the first 9 crops, 6 trees produced 1,001 to 2,000 fruit, 22 trees produced 2,001 to 3,000, 22 trees produced 3,001 to 4,000, 18 trees produced 4,001 to 5,000, 9 trees produced 5,001 to 6,000, and 4 trees produced 6,001 to 7,000. It is significant that the trees with the largest crops during the first 4 years of production were also the trees that produced the largest crops during the entire 9 seasons.

Some of the nucellar Baianinha orange lines were selected in 1958 according to whether they ranked low, medium, or high in production

and were budded onto Rangpur lime rootstock. Two lines were taken to represent the trees of each group (IA-13 and IA-79 for high, IA-59 and IA-49 for medium, and IA-34 and IA-75 for low production). Two other outstanding nucellar lines of Baianinha orange (IA-80 and Batan), not included in the group of 85 budded on Caipira sweet orange rootstocks, were also included in this study. The trees were propagated on October 1, 1958, and planted in the field on January 1, 1960, in randomized blocks. The total numbers of fruit from 10 trees produced in 1962-63 were as follows: IA-13, 2,399; IA-79, 2,360; IA-59, 2,681; IA-48, 2,319; IA-34, 1,587; IA-75, 3,246; IA-89, 2,970; and Batan, 2,738. The differences in production were not significant, except for clone IA-34. All trees of this clone made slower growth and produced less fruit. The fruit of clone IA-79 turned color a little earlier than those of other clones. No other differences in fruit quality were found in these two first crops.

Nucellar Clones of Other Varieties

Studies of nucellar lines of many different varieties confirmed in general the reports from California (1, 3) that trees of nucellar lines are very vigorous, develop thorns in the first years, and take about two years longer to come into production than trees of old-line clones. The fruit of the first crops of nucellar lines have a smaller number of viable seeds (Table 1), more rag, and thicker peel than those of old-line clones. In Navel orange, the navel is often very small and closed.

TABLE 1. AVERAGE NUMBER OF VIABLE SEEDS PER FRUIT FROM NUCELLAR AND OLD-LINE BARÃO SWEET ORANGE TREES ON 10 DIFFERENT ROOTSTOCKS

Rootstocks	Number of seeds per fruit	
	Old line	Nucellar
Florida rough lemon	10.0	4.9
Limeira rough lemon	7.7	4.3
Caipira orange	7.3	5.7
Pera orange	7.5	4.7
Navel orange	8.9	6.9
Rusk citrange	10.8	9.5
Morton citrange	8.9	9.0
Uvalde citrange	7.7	4.0
Savage citrange	5.9	7.0
Cunningham citrange	6.8	5.8
Average	8.1	6.1

Since 1955 the production of nucellar clones has been undertaken to include all citrus varieties represented in the collection at the Limeira Citrus Experiment Station. Buds from young seedlings of more than 200 different citrus varieties were budded onto Rangpur lime rootstock in October, 1957. Three trees of each scion-rootstock combination were transplanted to the field in November, 1958. Fruit production in 1962-63 has shown that there exist great differences in precocity of bearing of different citrus groups. Varieties of mandarin-lime averaged 864 fruit per tree, sweet lime 464 fruit, tangelo 212 fruit, acid lime 202 fruit, lemon 198 fruit, sour orange 169 fruit, grapefruit 56 fruit, citron 29 fruit, tangerine 27 fruit, sweet orange 24 fruit, and tangor 3 fruit. It is evident that the varieties of sweet orange were in general late in coming into production. However, there were some exceptional varieties that came into production earlier. These were Pera, Sanguinea, and Sanguinea Piracicaba. The precocity of the Pera orange is related to its intolerance to tristeza virus. The trees are, in fact, strongly pitted. This is also true of varieties of acid lime, grapefruit, and citron.

Nucellar Lines in Commercial Groves

Nucellar budwood has become extremely important to the citrus industry of Brazil. The distribution of nucellar budwood from the Limeira Citrus Experiment Station started in 1955 and amounted to more than 40,000 buds in that year. From that time through the spring of 1962, more than one million buds have been distributed. Many growers are taking buds from their original nursery, which was started with material from the Limeira Station, to increase their supply of nucellar budwood. The buds distributed included representatives of the following varieties: Baianinha Navel, Barão, Valencia, and Pera orange, Dancy, Cravo, and Ponkan tangerine, and Willow-leaf mandarin.

Data on fruit production in commercial groves, from thousands of trees, showed yields of 4-5 field boxes (90 pounds each) per tree at 5 years of age (Table 2). This production is two to three times the production from old-line clones of the same variety. Some nucellar Hamlin orange trees, 5½ years old, in commercial groves, heavily fertilized, produced, as observed in May, 1963, as much as 10 field boxes, the equivalent of about 2,500 fruit per tree.

In addition to supplying nucellar budwood to Brazilian growers, the Limeira Experiment Station has been furnishing it to several countries

TABLE 2. AVERAGE TREE PRODUCTION OF NUCELLAR CLONES IN EXTENSIVE PRIVATE COMMERCIAL GROVES. ALL TREES BUDDED ON RANGPUR LIME ROOTSTOCK. DATA FROM 1963 CROP

Farm Name	Variety	Age of trees	Production per tree 90 pound boxes
Bailão	Baianinha Navel orange	5 years and 3 months	5½
	Hamlin orange	5 years and 3 months	5
Cassiano	Baianinha Navel orange	4 years and 9 months	4½
	Hamlin orange	4 years and 3 months	3½
Guerreiro	Baianinha Navel orange	5 years and 3 months	4½
Andes	Hamlin orange	5 years	5

where tristeza virus is endemic and where specific requests have come from responsible governmental organizations.

Discussion and Conclusions

The data here presented emphasize the horticultural value of nucellar lines. Description of the advanced stage reached in Brazil in the work of producing, selecting, and distributing to growers the nucellar clones of commercial varieties should be of value to other countries that are not so advanced in this respect.

Based on the results of the experiments reported, the authors suggest that at least 10 or more nucellar seedlings of each commercial variety be produced. Buds from these seedlings should be budded on the commonly used rootstocks and the budded trees planted under comparable conditions. Production and fruit quality should be studied, for selecting the superior lines. It seems that 4 or 5 crops are sufficient for selecting the most productive clones. Those starting to produce large crops in the first years will very probably continue to be the most productive clones.

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