REFERENCES TO THE LITERATURE

1. Bitters, W. P., N. W. Dukeshire, and J. A. Brusca. 1953. Stem pitting and quick decline symptoms as related to rootstock combination. California Citrog. **38:** 154, 170-171.

2. Cohen, M. 1956. Injury and loss of citrus trees due to tristeza disease in an Orange County grove. Florida State Hort. Soc. Proc. **69:** 19-24.

3. Costa, A. S., T. J. Grant, and S. Moreira. 1950. Relatives of tristeza. A possible relation between tristeza and the stem-pitting disease of grapefruit in Africa. Citrus Leaves **30** (2): 12-13, 35, 38.

4. Costa, A. S., T. J. Grant, and S. Moreira. 1954. Behavior of various citrus rootstock-scion combinations following inoculation with mild and severe strains of tristeza virus. Florida State Hort. Soc. Proc. **67:** 26-30.

5. DuCharme, E. P., and L. C. Knorr. 1954. Vascular pits and pegs associated with diseases in citrus. U. S. Dept. Agr. Pl. Dis. Reptr. **38:** 127-142.

6. Grant, T. J., and A. S. Costa. 1951. A mild strain of the tristeza virus of citrus. Phytopathology **41:** 114-122.

7. Grant, T. J., and H. Schneider. 1953. Initial evidence of the presence of tristeza, or quick decline, of citrus in Florida. Phytopathology **43:** 51-52.

8. Hughes, W. A., and C. A. Lister. 1949. Lime disease in the Gold Coast. Nature **164:** 880.

9. Hughes, W. A., and C. A. Lister. 1953. Lime dieback in the Gold Coast, a virus disease of the lime, **Citrus aurantifolia** (Christmann) Swingle. Jour. Hort. Sci. **28:** 131-140.

10. Knorr, L. C. 1956. Suscepts, indicators, and filters of tristeza virus, and some differences between tristeza in Argentina and in Florida. Phytopathology **46:** 557-560.

11. Knorr, L. C., E. P. DuCharme, and A. Banfi. 1951. The occurrence and effects of "stem pitting" in Argentine grapefruit groves. Citrus Mag. **14** (2): 32-36.

12. McClean, A. P. D. 1950. Possible identity of three citrus diseases. Nature **165:** 767-768.

13. McClean, A. P. D. 1950. Virus infections of citrus in South Africa. III. Stem-pitting disease of grapefruit. Farming in So. Africa **25:** 289-296.

14. McClean, A. P. D., and J. E. van der Plank. 1955. The role of seedling yellows and stem pitting in tristeza of citrus. Phytopathology **45:** 222-224.

15. McClean, A. P. D. 1956. Tristeza and stem-pitting diseases of citrus in South Africa. FAO Pl. Prot. Bul. **4:** 88-94.

16. Oberholzer, P. C. J., I. Mathews, and S. F. Stiemie. 1949. The decline of grapefruit trees in South Africa. A preliminary report on so-called "stem pitting." Union So. Africa Dept. Agr. Sci. Bul. 297. 18p.

17. Oberholzer, P. C. J. 1953. Degeneration of our citrus clones. Farming in So. Africa **28:** 173-174.

18. Olson, E. O. 1956. Mild and severe strains of tristeza virus in Texas citrus. Phytopathology **46:** 336-341.

19. Oxenham, B. L., and O. W. Sturgess. 1953. Citrus virus diseases in Queensland. Queensland Dept. Agr. and Stocks. Pamphlet 154. 8p.

20. Steyaert, R. L., and R. Vanlaere. 1952. La "Cannelure" ou "Stem-Pitting" du Pamplemoussier au Congo Belge. Bul. Agr. du Congo Belge **43:** 447-454.

SEASONAL CHANGES IN THE JUICE CONTENT OF PINK AND RED GRAPEFRUIT DURING 1955-'56[1]

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Pink and red grapefruit in the early season does not always meet the minimum juice requirements as established by the Florida State maturity laws (3, 4). Because of the low juice content, harvest of these two varieties is often delayed, especially since the adoption of higher juice standards; these being raised approximately 10 percent during August 1 to October 15, and approximately 5 percent during October 16 to November 15. For the remainder of the season, the lower juice requirements defined by the Citrus Code of 1949 remain in effect. The relatively high juice required in the early season delays harvest of much of the pink and red grapefruit until the period of low juice standards of November 16 to July 31 during each season.

Several factors influence juiciness of citrus fruit. Generally, juice content varies markedly with and during seasons; it is relatively low in the immature fruit and high in the fully ripened fruit late in the season. High rainfall and irrigation tend to raise juice volume, such factors accounting for variations from year to year. Still other factors are: location, variety, rootstock, age of trees, time of bloom, shape of fruit, and certain cultural deficiencies. Oil (7) or arsenic (1, 2) sprays have not been found to affect significantly the amount of juice in the fruit.

The Florida Citrus Commission has been conducting a four-year survey of red and pink grapefruit to obtain a better understanding of the internal quality and maturity chacacteristics of these varieties. When the survey was begun in the fall of 1953, the soluble solids content in much of the fruit did not meet standards; however, since the juice re-

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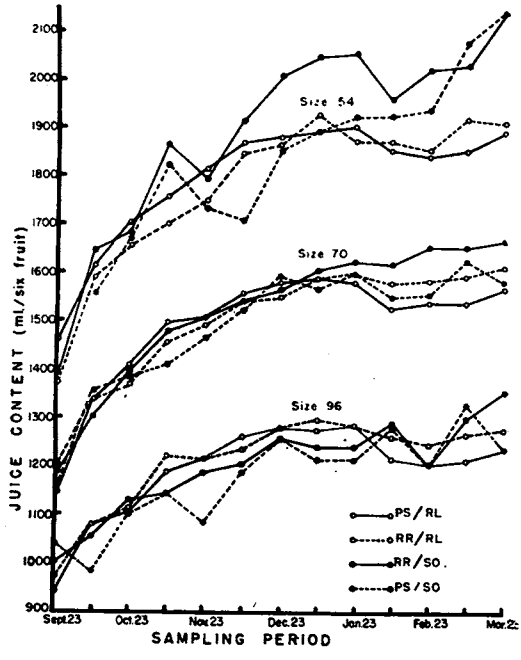

Fig. 1. Seasonal changes in the average juice content of pink (P.S.) and red (R.R.) grapefruit of three sizes (96, 70, 54) grown on sour orange (S.O.) and rough lemon (R.L.) rootstocks during 1955-56.

quirements were raised in 1955, juice content became the limiting factor in maturity. Therefore, a study of juiciness was included during the 1955-56 season.

A preliminary report is here presented for the purpose of ascertaining the juice content of pink and red grapefruit of three sizes grown throughout the State during the 1955-56 season. Special emphasis was placed on its relationship to legal juice requirements. In addition to seasonal changes in juice content, the variations among samples during each sampling period as well as the daily increases in the juice are included.

Experimental

For this survey, 137 groves were selected throughout the citrus area of Florida, including the Ridge section, and the East and West coasts. Of the total number, 68 groves were Ruby red and 41 pink seedless on rough lemon, and 20 groves were red and 8 pink on sour orange rootstock. Fruit sampling was similar to that used commercially; that is, each sample consisted of six fruit of one size picked from different trees. Three sizes (96, 70, and 54) were collected from tagged trees at intervals of 14-16 days during the 1955-56 season, extending from September to March. Juice was expressed at the rate of 40 fruit per minute using a Food Machinery In-Line extractor (5) with a flush setting, ½ inch orifice tube, strainer tube of 3/32 inch openings, and a cup of six inches in diameter. The juice was then passed through a Chisholm-Ryder finisher of the tapered screw type equipped with 0.033 inch perforated screen, weighed and expressed as milliliters in each sample of six fruit. In compiling the data the average juice volume for each period of 14-16 days was used.

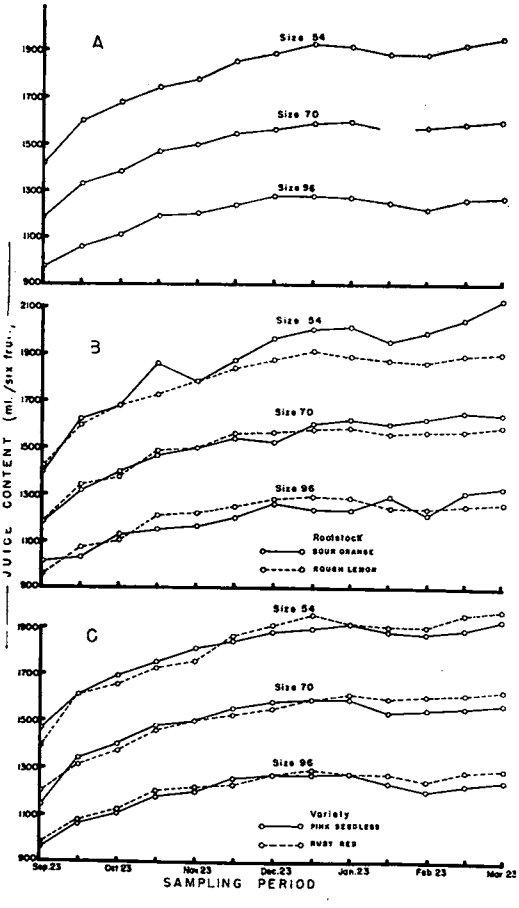

Fig. 2. Seasonal changes in the average juice content of two varieties of fruit of three sizes grown on two rootstocks during 1955-56.

Results and Discussion

In general the average juice content of pink and red grapefruit of three sizes on rough lemon and sour orange rootstocks gradually increased with the advance of the season, with some exceptions (Fig. 1). Some irregularities were apparent for size 54 fruit on sour orange rootstock. In addition the juice volumes in the fruit of the three sizes decreased slightly during January and February (Fig. 2-A).

Rootstock apparently does not influence juice content in white varieties of grapefruit (6). However in the pink and red varieties, significantly more juice is found in fruit grown on sour orange than on rough lemon rootstock during the latter part of the season (Fig. 2-B). This variation was first apparent in December for size 54 fruit, and during March for size 96. On the average for the season more juice was found in fruit on sour orange than on rough lemon rootstock.

The seasonal trends in the juice of two varieties and three sizes are shown in Fig. 2-C. The red variety contains significantly higher juice content than the pink grapefruit during the latter part of the season, January to March. However, it is similar in the two varieties during the early season from September to January. On the average for the season Ruby red fruit contains more juice than the pink variety.

The percentages of samples of size 96 grapefruit meeting the legal juice requirements through December are listed in Table 1. Very little fruit can be picked under the 1955 juice standards, since only 7.7 percent of the samples attained sufficient juice (1110 ml.) at that time. During October 1 to 15, 32.1 percent of the fruit met the strict regulations. When the requirement is lowered to 1080 ml. during October 16 to November 15, 63.2 percent of the fruit met the standard during the first part of this period, and 84.5 percent during the latter part. Although the lower standard is restrictive, the majority of the samples acquired adequate juice. After November 15 when the requirement is lowered to 1020 ml. most of the fruit had enough juice for harvest. The size of the fruit appears to have no influence on the time of attainment of the high juice standards effective through October 15 since approximately one-third of the samples of each size met the standards during the period.

Table 1. Percentage of grapefruit samples picked throughout the State attaining juice standards from September to December, 1955 (size 96)

Juice Requirements	Sampling Period						
	September	October		November		December	
	15-30	1-15	16-31	1-15	16-30	1-15	16-30
ml/6 fruit				Percent			
1110 (a) and above	7.7	32.1	46.5	76.8	85.0	81.1	96.3
1080 (b) and above	12.8	41.9	63.2	84.5	85.0	86.9	97.3
1020 (c) and above	31.7	69.5	81.3	93.6	95.0	90.8	100.0
Below 1020	68.2	30.4	18.7	6.4	5.0	9.2	-0-

(a) Minimum juice requirement for Aug. 1 - Oct. 15

(b) Minimum juice requirement for Oct. 16-Nov. 15

(c) Minimum juice requirement for Nov. 16-July 31.

Table 2. The average juice content and standard deviation for grapefruit of size 70 for 13 sampling periods during 1955-56.

Sampling Period	Juice (ml/6 fruit)	Standard Deviation
Sept. 15-30	1171	122.2
Oct. 1-15	1332	125.5
Oct. 16-31	1392	126.7
Nov. 1-15	1465	122.7
Nov. 16-31	1495	114.7
Dec. 1-15	1541	126.2
Dec. 16-31	1571	125.7
Jan. 1-15	1590	108.2
Jan. 16-31	1603	139.7
Feb. 1-15	1568	104.7
Feb. 16-29	1585	103.0
March 1-15	1604	109.7
March 16-31	1609	110.7

The average juice content and the standard deviations for size 70 fruit for 13 sampling periods are shown in Table 2. The standard deviations are generally higher during the earlier part of the season than during the latter part with some exceptions. The average juice and the standard deviation can be helpful in ascertaining the range distribution about the mean, especially if used in the early season. For example, during September, the average juice content for size 70 fruit was 1171 ml. with a standard deviation of 122.2 ml. Of the samples tested, approximately one-third fell between 1171-1293 ml., and one-sixth fell above 1293 ml. It is evident that with the juice requirement of 1380 ml., less than one-sixth of the samples met this high requirement, and therefore fruit cannot be picked because of low juice volume.

The daily average increases in juice volume for one fruit of each size during sampling periods from October through December, are shown in Table 3. Large daily increases for all three sizes occurred during the October 8 sampling period, with smaller amounts during the remaining periods. With sizes, the highest daily increase in juice was found for size 54, and the lowest for size 96. On the average the juice increased by 0.6, 0.7, and 0.9 ml for sizes 96, 70, and 54, respectively. An estimate of the time of meeting juice regulations can be made by knowing the average daily increase in the juice. Of course, these values will vary with location, seasons, and other factors but can be useful as a guide to the time of harvesting.

Summary and Conclusions

A preliminary report of the juice content of seedless pink and red grapefruit of sizes 96, 70, and 54 grown on rough lemon or sour orange rootstocks is presented. The samples were collected twice monthly from 137 groves during the 1955-56 season. In general, the juice content increased with the advance of the season, increasing approximately one-third from September to March. In the latter part of the season, the red fruit contained more juice than the pink variety. Likewise, fruit on sour orange rootstock contained more juice than that grown on rough lemon. On the average, the red grapefruit on sour orange had the most juice while the pink variety on rough lemon had the least amount.

As far as meeting the high juice standards in effect from August 1 to October 15, approximately 8 percent of the fruit in September and 32 percent in October met the strict juice regulations. At the time of the medium juice requirements from October 16 to November 15, approximately 63 and 85 percent met

Table 3. Average daily increase in juice content per fruit of grapefruit of three sizes (96, 70, and 54) during October to December 1955.

Sampling Period	Size		
	96	70	54
	ml/fruit/day		
Oct. 1-15	1.1	1.7	2.1
Oct. 16-31	0.5	0.5	0.8
Nov. 1-15	0.9	1.0	0.8
Nov. 16-30	0.1	0.3	0.4
Dec. 1-15	0.4	0.5	0.8
Dec. 16-31	0.4	0.2	0.4
Average	0.6	0.7	0.9

regulations in October and November, respectively. After November 15, most of the fruit met the low juice standards then in effect.

The variations in the juice content for each sampling period as well as the daily increases in juice volumes are presented.

LITERATURE CITED

1. Deszyck, E. J. and J. W. Sites. 1954. The effect of lead arsenate sprays on quality and maturity of Ruby red grapefruit. Proc. Fla. State Hort. Soc. 67: 38-42.

2. Deszyck, E. J. and J. W. Sites. 1955. Juice content in early Ruby red grapefruit. Proc. Fla. State Hort. Soc. 68: 47-49.

3. The Florida Citrus Code of 1949. Chapter No. 25149. State of Fla. Dept. Agr. Citrus & Vegetable Inspection Div.

4 General Laws of Florida. 1955. Minimum juice content for grapefruit. Chapter 29760, Senate Bill No. 562.

5. Gerwe, R. D. 1954. Extracting citrus juices. Proc. Fla. State Hort. Soc. 67: 173-176.

6. Harding, P. L. and D. F. Fisher. 1955. Seasonal changes in Florida grapefruit. U. S. Dept. Agr. Tech. Bul. 886.

7. Taylor, O. C., G. E. Carman, R. M. Burns, P. W. Moore, and E. M. Naeur, 1956. Effect of oil and parathion sprays on orange size and quality. Calif. Citrograph 41: 452-454.

EFFECTIVENESS OF DIFFERENT ZINC FERTILIZERS ON CITRUS

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Zinc foliage sprays have been used for more than 20 years for the correction and prevention of zinc deficiency or frenching in Florida citrus groves. Such sprays are reasonably effective in controlling frenching in most groves even though the zinc sources now used are very slowly absorbed and highly inefficient (7). Sprays have the additional disadvantage of leaving a residue on the leaves which increases the scale population. Hence there is need for an effective and inexpensive method of supplying zinc to citrus trees by application of a suitable zinc fertilizer to the soil. The studies reported here were carried out in an effort to find such a method.

Soil application of zinc, chiefly as the sulfate, has been far less dependable than foliage sprays as a method of supplying zinc to citrus. Camp (3) reported in 1934 that in some cases no visible result was obtained from soil applications of zinc sulfate, whereas in others application of from 5 to 15 pounds per tree broadcast gave good responses. Even where soil applications of zinc are effective absorption of zinc and correction of the zinc deficiency leaf pattern are relatively slow. The effectiveness of soil applications of zinc varies greatly with various soil characteristics; for example, this element is much less available at a soil pH of 6.0 or 7.0 than at more acid soil reactions.

Jones, Gall, and Barnette (6) reported that when zinc compounds are applied to the soil, they react to form three types of compounds: (a) water soluble zinc compounds, (b) combinations formed by the reaction of soluble zinc compounds and the organic and inorganic colloidal complex of the soil (replaceable zinc), and (c) combinations insoluble in water and not in combination with the colloidal complex of the soil (not replaceable). They found that when low concentrations of soluble zinc compounds react with the soil, the major portion of the zinc enters into combination with the colloidal complexes and may be replaced by a normal ammonium chloride solution. Under these conditions they found a near equivalence between the replaceable zinc of the soil and calcium removed from the colloidal complex. When high concentrations of soluble zinc compounds react with the soil, they found that the zinc is present not only in water soluble and replaceable forms but also in an insoluble form. They state that organic matter, clay, replaceable bases, carbonates and phosphates influence the fixation of zinc in the soil.

Jamison (4), however, reported little difference in the fixation of zinc in the presence and the absence of superphosphate in the soil. He states that the forces which retain zinc in these soils are far stronger than those holding zinc as phosphates or basic compounds ordinarily considered insoluble.

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