Thomas, packinghouse foreman, who participated in these studies.

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PACK-OUT AS AFFECTING PROFITS OF CITRUS PACKINGHOUSES WITH PARTICULAR REFERENCE TO FRUIT COLOR[1]

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Two previous papers (5, 6) dealing with problems relating to pack-out in citrus packinghouses showed that net profits for any given crop of tangerines or grapefruit tend to vary directly with percent pack-out. With oranges, the nature of this relationship depends on relative prices prevailing for fresh and cannery use (5).

A progress report on a continuing study of factors tending to lower pack-outs (6) indicated that blemishes due to insects (scale and rust mite principally) appeared to be decreasing, probably due to improved methods of control. Fungus blemishes (principally melanose) showed no apparent decrease over the period studied.

Two major causes of grade-lowering blemishes, windscar and green color, were related to weather. This report is concerned with the latter factor only.

It is a subject of common observation that fruit color varies greatly from year to year. Various cultural practices are also known to affect fruit color (8), but such differences are often minor compared with climatic effects. Stearns and Young (10) have shown that initial degreening of oranges is related to minimum temperatures in the grove, and Caprio (2, 3) has shown that re-greening is statistically related to climatic factors.

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The importance of this fruit-color factor tends to be generally ignored for several reasons. "Bad color years" (such as 1956-1957) occur only occasionally. The color regulations (13, 14, 15, 16) which stipulate minimum color levels are extremely difficult to enforce since terms such as "fifty percent color break," "well colored," or "fairly well colored" are both subjective and relative and hence relatively poorly colored fruit tends to move into fresh fruit channels regardless of grade specifications (15, 16). When cannery prices are high, orange "eliminations" return a cash profit. Lastly, there is far too much confidence in ethylene degreening and, for oranges, color-adding.

Despite various attempts to adapt visual comparison colorimeters (1, 7, 8), color evaluation has heretofore remained subjective, depending upon visual matching of colors. The Florida Citrus Commission now conducts a detailed study of the physiology of fruit color. One benefit of this research has been the adaptation of the Hunter Color and Color Difference Meter to the measurement of ex-

Table 1. Grade lowering defects as percentages for oranges and grapefruit by varieties during the 1958-59 season.

Blemish		Grapefruit				Oranges		
		Marsh	Duncan	Ruby Red	Pink	Hamlin	Pineapple	Valencia
No. of Samples		88	47	5	45	4	51	123
Green color		8	6	7	19	14	9	20
Windscar		33	37	29	31	21	44	45
Rust mite		8	8	12	7	10	10	10
Melanose		25	30	26	14	31	14	4
Scale		7	4	10	8	17	9	5
Plugged		1	2	4	3	4	7	3
Off-size[a]		2	1	1	1	0	b	3
Mechanical injury		1	2	1	1	2	1	b
Texture		b	b	0	b	0	2	1
Off-shape		5	3	3	5	b	b	4
Creasing		0	0	0	0	0	2	b
Microspeck		4	1	2	4	0	b	b
Peel injury		1	1	0	2	0	b	b
Miscellany		4	5	5	5	1	1	3
Stem-end russet		1	0	0	0	0	0	0
Percent Pack-out	Range	40-79	32-77	50-79	49-71	c	51-76	41-89
	Average	66	58	80	70	c	68	72

[a] This figure would be considerably higher but for the common use of pre-sizers.

[b] Less than one percent.

[c] No pack-out data obtained for Hamlins.

ternal color of citrus fruit. This instrument has already proved useful for determining the internal color of grapefruit (11, 12), oranges (9), and external color of apples (4).

Methods

Random sampling of eliminations in Florida packinghouses has been carried on since 1956-57 (6). Samples of "eliminations" were taken from the conveyor carrying rejects from the grade table to the cannery bins. The normal procedure in this study has been to take 100 fruit at random and then classify these according to the blemishes that put them out of grade.

In 1958-59 some random sampling of various packinghouses was used. However, most of all sampling was in one large cooperative which handled fruit from a variety of sources and cooperated in supplying actual pack-out figures. In this regard it should be noted that, since samples from commercial houses were used in this study, oranges and grapefruit were degreened and oranges color-added whenever the management considered such treatments to be necessary. Such figures are probably reasonably typical for the ridge district of central Florida.

Color readings were obtained by two methods, both using the Hunter meter with an ivory standard with Rd + 60.7, a − 2.0, b + 22.7. In the first, two readings were taken on the side of each fruit midway between the stem and stylar ends. One of these readings was for the greenest side, the other for the best colored side. In the second method a single reading was taken at random on each fruit. When comparing eliminations and "in grade" fruit, the latter were taken from the packing bins.

The expression of profit as related to pack-out uses a synthetic figure computed from: (a) average growing and packing costs as used before (5); (b) prices, F. O. B. and cannery, for the day on which the samples were taken (17); and (c) actual pack-outs for the same day.

Results and Discussion

Table 1 shows the proportions of various blemishes found in packinghouse eliminations for 1958-59, presented as averages but broken down into principal varieties.

Table 2 shows the extent to which poor fruit color contributed to packinghouse eliminations from 1956-57 to 1958-59. The figures confirm the common observation that there are "good color years" and "poor color years". No instrumental analysis of such "good" or "bad" color was available until the Hunter Meter method (already in use for oranges in another study) was used on packinghouse samples in the spring of 1959.

Figure 1 shows color measurements, as Hunter "a" values, obtained from "eliminations" and packable oranges. To reduce the number of values to manageable proportions only the range and the average "a" values are presented for each sampling date. A fairly clear-cut pattern is discernible. At any given date, "a" readings for the poorest colored fruit being packed tend to be higher than for oranges eliminated for poor color. Values for "natural-color" fruit tend to group below those for "color added". The single set of values for the "best colored fruit being packed" are very much higher and approach those for California fruit purchased in Chicago and mailed to Lake Alfred. Nevertheless they overlap with the "a" values of Valencias eliminated for poor color in February. Thus it would appear that the Hunter "a" values are a real index of fruit color for oranges.

Table 2

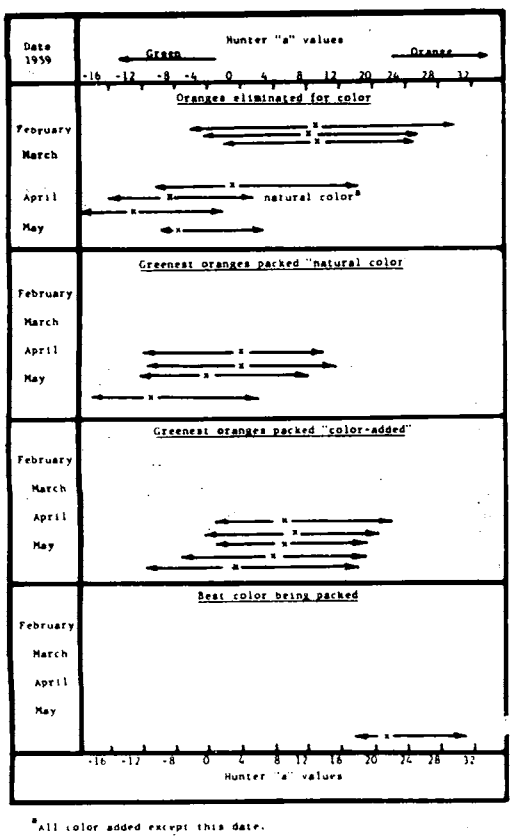
Proportion of packinghouse eliminations graded out for substandard color. Averages from 1956-57 to 1958-59 as percent.

Type of citrus	1956-57	1957-58		1958-59
		Pre-freeze	Post-freeze	
Oranges	43	16	18	10
Grapefruit	46	12	13	16
Tangerines	--[a]	67	14	--[a]

a. Too few figures obtained to present a reliable average.

In view of this, it becomes of interest to note how, as the "regreening" season develops, there is a sharp downward trend in "a" values, not only for "eliminations", but also for the "in-grade" fruit being packed. For both psychological and mechanical reasons there is a very real tendency for graders unconsciously

to set their standards higher for good crops than for poor crops. This example demonstrates how prevalent this can be even for a single grade lowering factor such as fruit color. Both direct and indirect economic consequences can be expected to result from this, in that thus raising pack-out usually tends to cause a net increase in immediate



*All color added except this date.

Figure 1. Color of Valencia oranges, 1959, shown as ranges and averages of Hunter "a" values for various samples from a commercial packinghouse.

profit. It can be conjectured that the long term results of this often unintentional lowering of grade standards will have an adverse effect on the market.

With grapefruit no apparent relationships appeared between color as "a" values and color as a grade lowering factor. This may be due to an inadequate sampling technique, or to the "a" value not being the most appropriate one to use for grapefruit – this is being investigated further.

No correlation was found between pack-out and profit for oranges over the period for which pack-out figures were obtained, January 10 - May 16, 1959. This was a period of unusual price structure. Cannery prices (ranging from $2.78 to as high as $4.00 per box) continued to reflect the effect of reduced inventories resulting from the severe freezes of 1957-58. At the same time an especially large California crop kept a "lid" on the fresh fruit market at approximately $4.50 - $4.75. Thus, during the period covered in this study, there were very few occasions on which profit on an individual orange crop would not have been higher if it had been sent directly to the cannery.

Figure 2 indicates a strong positive relationship between profits and pack-out of grapefruit, particularly for the Duncan variety.

The necessary figures were available for 36 lots. Of these, three were packed at a loss. In one instance the house just broke even and in 32 out of 36 crops realized a profit of between 8 cents and 73 cents per field box dumped. On the average, profitable packing of grapefruit started at 45 percent pack-out.

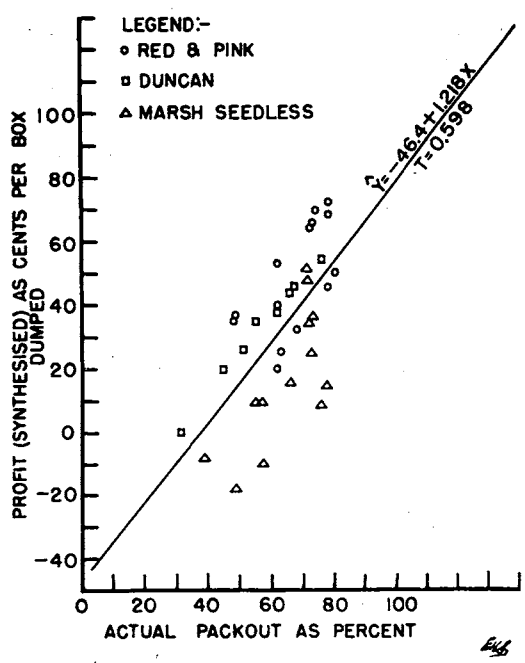


Figure 2. Relationship between actual pack-out and synthesized profits for grapefruit, January 10 to May 16, 1959.

From there on profits increased at approximately 13 cents per box dumped for every 10 percent increase in pack-out.

The average pack-out for grapefruit was 65.5 percent for which the theoretical profit per box dumped is 34 cents as against a corresponding figure of 79 cents at 100 percent pack-out, a difference of 45 cents. Green color accounted for 16 percent of grapefruit eliminated here; 16 percent of 45 cents is 7.2 cents per box dumped, as penalty for green color on these grapefruit. This figure is typical, not absolute, and would, of course, vary with day to day prices, the pack-out on each crop, etc. It is, however, quite representative, even though 1958-59 was a "good color year".

SUMMARY

The relative importance in 1958-59 of various fruit blemishes contributing to low pack-outs of fresh citrus is presented as part of a continuing study. Particular attention was paid to the role of fruit color as a grade lowering factor. The "a" scale on the Hunter Color and Color Difference Meter provided a purely objective measurement of color of oranges, corresponding to grade specifications. Such measurements showed that the judgment of commercial fruit graders with respect to color standards tended to become more lenient with the development of the regreening season. No correlation was found between the Hunter "a" scale and color of grapefruit.

No correlation between net profit and pack-out was found for oranges due to an unusual price structure. Profits on grapefruit increased approximately 13 cents per box per 10 percent increase in pack-out. Fruit graded out for green color reduced potential profits by over seven cents per box of grapefruit.

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HESPERIDIN IN ORANGE JUICE AND PEEL EXTRACTS DETERMINED BY U.V. ABSORPTION

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Examination of the ultraviolet absorption of orange juice and peel extracts has revealed a more sensitive and specific technique for evaluating the hesperidin content of citrus products. The procedure is based on the ultraviolet absorbance of glucosides at 290-300 millimicrons (2) and is an extension of similar work by the authors on the naringin content of grapefruit juices (3, 4). It was anticipated that a more discriminatory analytical procedure would be of much interest and value to the citrus industry. Even though hesperidin does not have a bitter flavor that would materially affect the flavor of a juice

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