TABLE 4. Comparison between method of separation and stage of maturity on pH of shelled southern peas.

Method of Separation	Stage of Maturity			Separation Mean
	Immature	Green-Shell	Overmature	
		Fall, 1964		
Visual	6.41	6.50	6.50	6.47 a 1/
Brine-Sieve	6.90	6.95	6.92	6.92 b
Maturity Mean	6.66	6.72	6.71	
		Spring, 1965		
Visual	6.64 ab 1/	5.48 a	7.32 b	6.48
Brine-Sieve	6.55 ab	6.78 ab	6.63 ab	6.63
Maturity Mean	6.60 ab	6.09 a	6.98 b	

1/ Comparable means with the same letter are not significantly different.

BLOSSOM-END CLEARING OF GRAPEFRUIT[1]

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ABSTRACT

Blossom-end clearing of grapefruit is a symptom of bruising which is common on fully mature seedless grapefruit with a thin peel that have been subjected to rough handling. However, some crops of grapefruit grown near coastal areas may develop this symptom due to the normal handling practices necessary in the picking and packing operations. Evidence of internal bruising was found in all grapefruit where blossom-end clearing was present. Most grapefruit that had been dropped experimentally or by pickers were bruised internally. Blossom-end clearing is usually visible within 24 hours after picking or dropping of susceptible fruit. Increased decay losses, mostly due to mold, were associated with bruising and blossom-end clearing.

No microorganisms were isolated from the affected area, indicating that blossom-end clearing is caused by mechanical injury.

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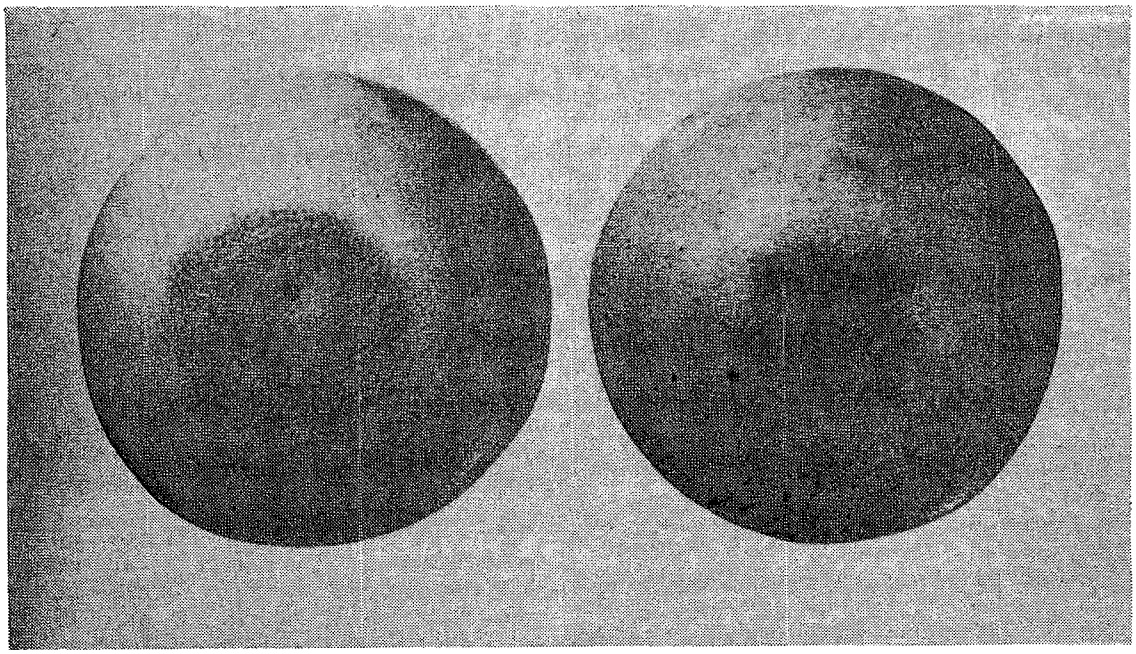

Fig. 1.—Blossom-end clearing of 'Marsh Seedless' grapefruit.

Introduction and Literature Review

Fully mature, seedless or nearly seedless grapefruit with a thin peel have frequently been observed to develop a water-soaked or translucent area at the blossom end (Figure 1). This condition is usually not observed until late winter or spring. As the fruit becomes more mature, this characteristic symptom occurs mere frequently. Seeded varieties are rarely affected.

Various names have been given to this symptom including "blossom-end clearing," "stylar-end clearing," "water bottom," "wet wick," and "waterlog." Blossom-end clearing has been chosen as the preferred name because it more nearly describes this symptom in commonly used terms.

A survey of packinghouses in the Indian River district, ridge areas, and on the west coast of Florida, shows that blossom-end clearing is familiar to most grapefruit packers, but is not usually a problem except on seedless grapefruit in coastal areas. Seedless grapefruit grown between U.S. Highway 1 and the Indian River usually have thin peels and are very subject to blossom-end clearing. Older, weak trees produce fruit more susceptible to blossom-end clearing than young or vigorous trees. The consensus of opinion is that blossom-end clearing is caused by rough handling and dropping of grapefruit at picking time. Blossom-end clearing rarely if ever occurs on the tree, but is observed in the packinghouse during grading, packing, and at the market.

Vines *et al.* (1) found that dropping 'Valencia' oranges 48 inches nearly doubled the respiration rate. Unpublished data by the same workers show that dropping grapefruit increases the respiration rate and decay.

A market report dated May 4, 1966, made by the Florida Citrus Commission field merhandising manager for the Boston, Massachusetts area states, "... many complaints were heard about poor holding quality of grapefruit. A breakdown referred to as translucent skin is quite prevalent and many complaints are being voiced as to crushed and bruised fruit." The research department of the FMC Corporation has prepared a mimeographed designed Technical Bulletin No. 145, dated April 23, 1945, entitled, "Stylar-end Clearing or Wet Wick of Grapefruit." This mimeograph states that this symptom usually occurs during the latter part of the citrus season when fruit is very mature. In some crops, up to 90% of the fruit have been affected.

The objective of this investigation was to study the cause of blossom-end clearing and its relationship to bruising and decay loss.

Experimental Methods

Unwashed, seedless and seeded grapefruit from different growing areas of the state were dropped 6 or 8 feet to firm turf or a concrete floor, unless otherwise noted, to study the resulting injury. Other samples were taken at different stages in the harvesting and packing operation and handled without dropping. Comparable lots were picked and dropped in the grove for comparison. Samples were usually placed in field boxes or 4/5-bushel mesh bags for transporting to the Citrus Experiment Station.

All samples were washed within 24 hours after dropping, then dried, waxed with non-fungicidal Flavorseal and placed in telescope-type, ventilated cartons and stored at 70° F. The first examination for blossom-end clearing was usually made within 24 hours after packing. All experiments were examined again at 1, 2, and in some instances 3 weeks from the picking date for additional blossom-end clearing and decay. Check samples handled by standard field and packinghouse practices were included in all experiments.

Tissues from grapefruit with blossom-end clearing symptoms were plated on Difco potato dextrose agar to determine if a casual microorganism was present.

Results and Discussion

Three experiments were completed in the spring of 1964 using 3 different varieties of grapefruit to study injury caused by dropping and the resulting blossom-end clearing. The fruit used in these experiments were 'Duncan' grapefruit with a thick peel grown at the Citrus Experiment Station, late-bloom 'Marsh Seedless' grapefruit with a very thick peel grown in the Indian River district, and 'Ruby Red' grapefruit with a thin peel grown at the Indian River Field Laboratory. In each experiment, the fruit was oriented to drop with the blossom-end down. The impact surface was either a concrete floor to stimulate grapefruit hitting a limb when falling, or firm turf to duplicate conditions of grapefruit falling in the grove during picking. Many of the fruit turned when falling, in most instances landing on their sides.

Splitting frequently occurred when grapefruit with a thin peel fell on its side. Very few of the grapefruit with a thick peel were noted to split, regardless of the point of impact. 'Duncan' grapefruit did not develop blossom-end clearing but some splitting was observed. Fruit which landed on the blossom-end or stem-end did not split. No cases of a water-soaked area comparable to blossom-end clearing were observed on the stem-end. All of the fruit that were dropped showed internal bruising with the exception of the late-bloom Indian River grown 'Marsh Seedless' grapefruit. The results of the experiment with 'Ruby Red' grapefruit are given in Table 1. Dropping caused splitting, blossom-end clearing, and internal bruising as well as a marked increase in decay.

Experimental work during the latter part of the 1964-1965 season (Table 2) added evidence that dropping of grapefruit increases decay even when blossom-end clearing does not develop. 'Marsh Seedless' grapefruit from the Citrus Experiment Station picked March 8, 1965, and dropped to firm turf did not develop blossom-end clearing, but decay increased. Grapefruit from the Indian River Field Laboratory dropped from a height of 8 feet onto firm turf developed more decay and blossom-end clearing than fruit dropped 6 feet on the same surface.

In another experiment, large size 'Duncan' grapefruit from the Indian River Field Laboratory, picked on March 24, 1965, were dropped onto firm turf from a height of 8 feet. This treatment resulted in 13% blossom-end clearing but no increase in decay.

'Marsh Seedless' grapefruit from the Indian River Field Laboratory picked March 24, 1966, were used to compare decay and blossom-end clearing of carefully picked fruit with that dropped under the tree at picking time or dropped on firm turf at the Citrus Experiment Station the day after picking (Table 3). The fruit dropped at picking time fell under the tree where there were sufficient leaves and grass to break the fruit's fall. Dropping caused blossom-end clearing and increased decay.

'Red Marsh Seedless' grapefruit grown near Winter Beach in the Indian River district, were sampled on April 8, 1966, during commercial picking and packing to study the development of blossom-end clearing. This grove was chosen because it had a history of blossom-end clearing.

Table 1. Blossom-end clearing and decay of dropped 'Ruby Red' grapefruit. Picked at the Indian River Field Laboratory on May 11, 1964.

	Split fruit after dropping - %	Blossom-end clearing* - %	Total decay 2 weeks after picking*
1. Check	--	0	5.6
2. Dropped 6 ft onto hard turf	4.2	15.3	31.6
3. Dropped 8 ft onto hard turf	28.6	37.5	57.7
4. Dropped 8 ft onto a concrete floor	31.9	40.0	62.3

*Percentages calculated on the number of apparently sound fruit placed in each carton.

Table 2. Blossom-end clearing and decay caused by dropping 'Marsh Seedless' grapefruit.

Fruit source	Treatment*	Blossom-end clearing - %	Total decay weeks from picking -% 1	2
1. Citrus Experiment Station picked 3-8-65	Check	0	0	4.9
	Dropped 6 ft	0	2.6	7.9
2. Indian River Field Laboratory picked 3-24-65	Check	2.3	3.4	4.5
	Dropped 6 ft	14.9	8.0	14.9
	Dropped 8 ft	36.9	22.6	33.3
3. Indian River Field Laboratory picked 5-25-65	Check	0	1.3	14.7
	Dropped 6 ft	5.6	4.2	23.6
	Dropped 8 ft	9.7	9.7	29.2

*Grapefruit dropped on firm turf.

Table 3. Blossom-end clearing and decay caused by dropping Indian River grown 'Marsh Seedless' grapefruit.*

No.	Treatment	Blossom-end clearing - %	% total decay 1 wk	2 wks	3 wks
1.	Check--picked carefully	0	1.7	5.2	15.5
2.	Dropped approximately 8 ft from tree at picking time	4.3	8.4	14.8	21.2
3.	Dropped 8 ft onto firm turf at the Citrus Experiment Station	33.8	31.6	42.6	52.1

*Picked March 24, 1966.

Table 4. Blossom-end clearing and decay of Indian River 'Red Marsh Seedless' grapefruit resulting from grove and packinghouse handling.*

No.	Treatment	Blossom-end clearing - %	Total decay Days from picking 6	14
	Picked April 8, 1966			
1.	Picked carefully into 4/5-bu mesh bags	2.9	0	8.7
2.	Taken from top of palletbox in the grove	16.7	3.3	20.0
3.	Fruit dropped by pickers under trees	16.5	18.7	35.2
4.	Picked from trees and dropped 7-1/2 ft in grove	32.3	10.1	36.4
5.	Taken from top of pallet box at packinghouse	14.4	5.6	17.8
6.	Taken from bottom of pallet box at packinghouse	22.9	3.7	23.9
	Picked April 7, 1966		Days from picking 7	15
7.	Fruit with blossom-end clearing taken from bins and cull boxes	100	29.7	70.3

*Peel thickness 0.5 cm to 0.8 cm.

Table 5. Decay resulting from dropping 'Marsh Seedless' grapefruit at picking time.*

No.	Treatment	No. of fruit	Avg total decay - % 1 wk	2 wks	3 wks
1.	Check, picked without dropping	184	0	0	1.6
2.	Dropped approximately 8 ft when picked	184	5.4	7.0	11.4

*Peel thickness 0.9 cm to 1.7 cm.

Blossom-end clearing was not observed on the tree but it did devolop in carefully picked fruit placed in 4/5-bushel mesh bags. Samples of grapefruit taken from the top of pallet boxes in the grove and from the top of another pallet box at the packinghouse had a comparable percent of blossom-end clearing and decay (Table 4). Fruit taken from the bottom of a pallet box at the packinghouse had more blossom-end clearing and decay that fruit taken from the top of the same box. Fruit dropped by the pickers had the same percent of blossom-end clearing as samples taken from the top of pallet boxes, but it had an appreciably higher decay loss. A sample made up entirely of fruit with blossom-end clearing taken from the packinghouse bins had very high decay.

These results show that mature seedless grapefruit with a thin peel, grown in the Indian River district, may develop blossom-end clearing as the result of the normal handling practices necessary in the picking and packing operation. In this study, the fruit was handled more carefully, both in the grove and packinghouse than is customary.

'Marsh' grapefruit with a thick peel from

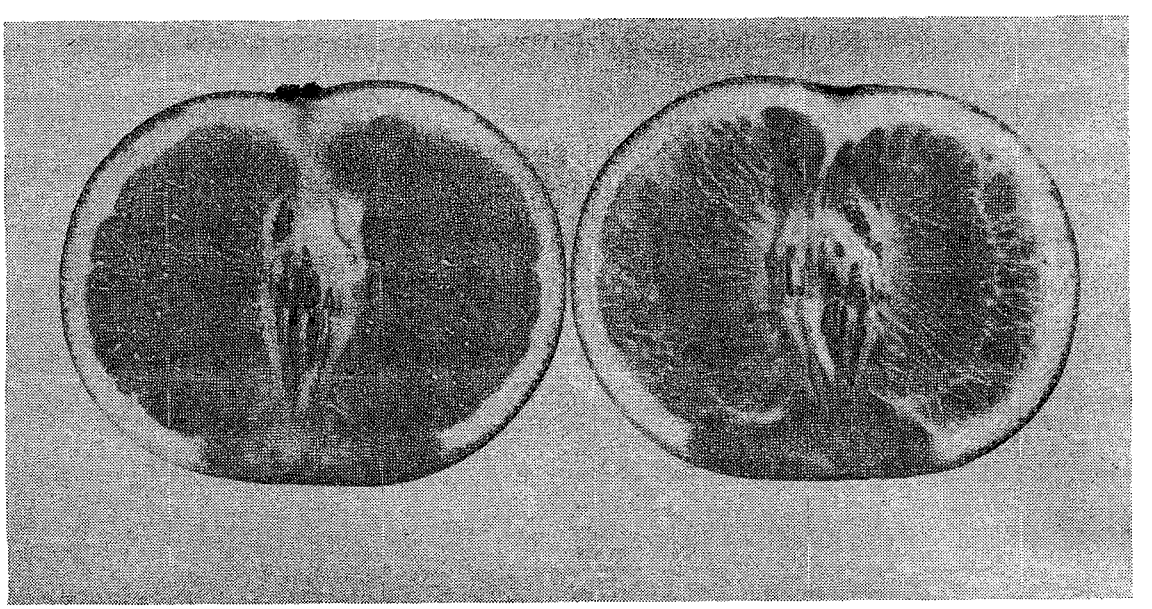

Fig. 2.—Internal view of 'Marsh Seedless' grapefruit with the blossom-end clearing.

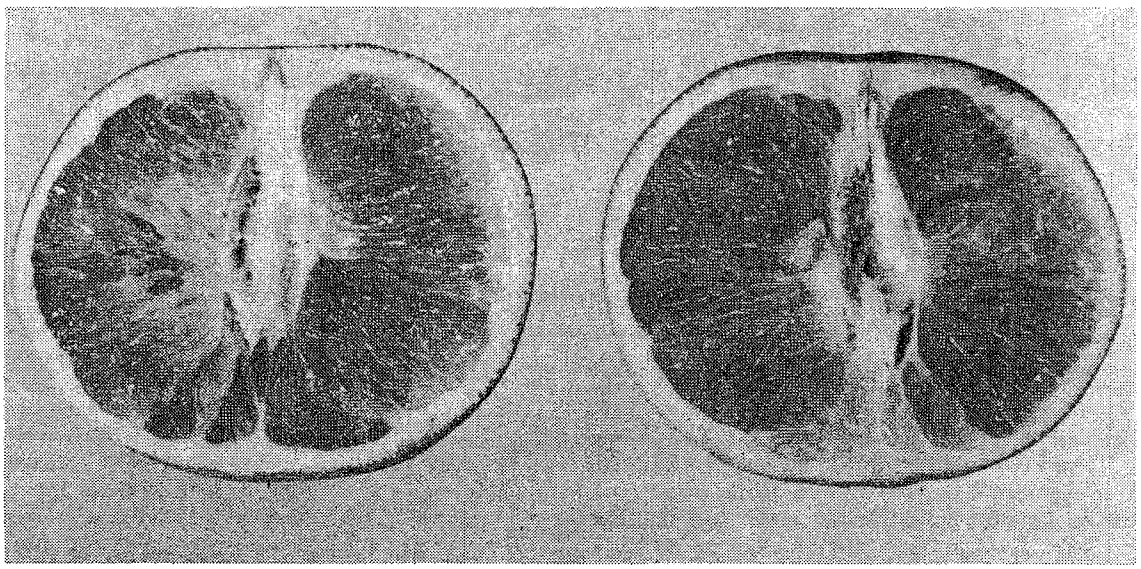

Fig. 3.—Internal bruising of 'Marsh Seedless' grapefruit that did not develop blossom-end clearing.

the Citrus Experiment Station were dropped in the grove at picking time (April 13, 1966). Check lots were picked without dropping. No blossom-end clearing developed in either lot but decay, mostly due to mold, was much higher in the dropped fruit (Table 5).

Blossom-end clearing is most frequently observed during the packing operation or at the market. When affected fruit are cut through the translucent area, internal bruising is clearly visible. Seedless grapefruit which have been dropped may have a marked increase in decay, mostly due to mold, even when the blossom-end clearing symptom is not present. Seeded varieties rarely develop blossom-end clearing even if roughly handled.

Internal bruising is characterized by a water-soaked or translucent area at the blossom end, separation of the juice sacs, or both (Figures 2 and 3). Juice sacs in the bruised areas usually have a gray cast when compared with unbruised tissue. A dark red discoloration is sometimes present in the albedo. Ruptured peel oil cells (oleocellosis) may be a symptom of internal bruising.

Three separate isolation tests failed to show that a microorganism was responsible for blossom-end clearing of grapefruit.

The results of a survey and experimental work indicated that grapefruit, especially mature, seedless varieties, should be handled with care to avoid bruising and the resulting blossom-end clearing. Grapefruit from a grove with a history of blossom-end clearing should be picked early in the season, preferably before early March.

LITERATURE CITED

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