EFFECT OF MECHANICAL HARVESTING ON SUITABILITY OF ORANGES AND GRAPEFRUIT FOR PACKINGHOUSE AND CANNERY USE[1]

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ABSTRACT

'Hamlin,' 'Pineapple,' and 'Valencia' oranges and 'Marsh' grapefruit from mechanical harvesting trials have been evaluated for 4 seasons. Keeping quality of 'Hamlin,' 'Valencia,' and 'Marsh' harvested with current mechanical equipment is within the limits normally experienced with cannery fruit, losses consistently being no more than in hand-picked 'Pineapple' oranges. Except for this variety, there was little difference in damage between mechanical shaker and air-shaker harvesting, the latter being harder on 'Pineapples.' Most external damage occurred before the fruit left the tree and took the form of cuts and punctures which were seldom more numerous than the 'plugs" in hand-picked fruit. However, a high percentage of adhering stems affords an unsolved problem. Least damage was with the spindle harvester using a bank of rubber augers. A good yield of intact sections was obtained in a single experiment with 'Duncan' grapefruit. No relationship was discernible between internal quality and keeping-quality. If granted FDA approval, new fungicidal sprays may control decay well enough to permit field storing fruit in "windrows" for several days, but sunburn remains an unsolved problem.

INTRODUCTION

For the past 4 seasons, the engineering studies on mechanical harvesting of citrus fruits have been paralleled by post-harvest studies checking physical damage to, and keeping-quality of fruit from the mechanical harvesting plots, including the hand-picked controls. This work has been reported only in a series of contract reports to the U. S. Department of Agriculture (10) and in a very much condensed form in the Annual Reports of the Florida Agricultural Experiment Station (5). No attempt is made here to give a complete account, particularly as the equipment was being developed and improved throughout this 4-year period. Thus, the data offered here represent the "current state of the art," together with a certain amount of admittedly subjective judgement as to practicability for commercial use.

MATERIALS AND METHODS

Grove Techniques

Mechanical harvesting equipment has been described elsewhere (3,4). The use of abscission sprays to facilitate mechanical harvesting and, indirectly, reduce fruit damage, has recently been reviewed by Wilson and Coppock (11).

Field Plot Studies: Fruit for evaluation has been available from field plots of 4 varieties: 'Hamlin,' 'Pineapple,' and 'Valencia' oranges and 'Marsh' grapefruit. Experimental design involved 4 tree plots replicated 8 times and picked 4 times per season for each variety. Thus, a given tree was subjected to a given harvesting method (shaker-catchframe, air-blast, or hand-picked control) for 4 successive seasons. For 3 of these seasons, 1 field box (approximately 90 lbs. of fruit) was obtained for evaluation of fruit damage and keeping-quality from each plot at each picking. Results of these systematic samplings are presented in terms of averages for each variety, each year. More elaborate analysis of data was not considered suitable due to the constant revisions in the harvesting equipment and procedures, and the season-to-season variability due to weather conditions.

Equipment Changes and Modifications: At the start of these experiments, the shaker-catchframe system was fairly well developed and modifications were comparatively minor involving, principally, the manner in which the fruit was collected for transfer from the catchframe

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to the highway truck (3). Considerable experimenting was done with the air-shaker method, checking out such variables as fan speeds, forward speed of the equipment, and rate of oscillation of the air blast. Eventually, this line of study was taken over by a commercial company (FMC Corporation). Thus, comparisions between the 2 major mechanical harvesting methods are made for individual years and the multi-year comparisons involve hand harvesting and the shaker-catchframe method only.

Spindle Harvesting: Development of the spindle harvester equipped with banks of rubber augers has been carried on intermittently, principally, with the thought that this might provide a mechanical method for picking fruit for the fresh fruit market (4). Thus, evaluations of fruit from this equipment have been quite limited.

Picking Aid for Specialty Fruits: A "Selma" picking aid was imported from California by Minute Maid Corporation and used on the harvesting of 'Dancy' tangerines for the fresh fruit market. This consisted of a self-propelled vehicle with a hydraulically controlled picking stand in which the picker stood, controlling his position in the tree. A series of conveyors lowered the fruit to a box-filling position.

Special Experiments

A number of minor experiments were carried out independently of the broad design of the field work. Although not elaborate, several of these merit reporting.

Cannery Grapefruit for Sections: The grapefruit plots for mechanical harvesting have all been of the "Marsh' variety, which is not generally used for the production of canned grapefruit sections. Hence, a lack of external damage to mechanically-harvested grapefruit was no assurance that the integrity of the sections was preserved as is necessary in the canning of sections. Late in the 1964-65 season, half of the fruit on a single 'Duncan' (seedy) grapefruit tree was picked by hand. The remaining half was shaken to the ground with a mechanical shaker and picked up in field boxes. Samples from both lots were stained by scratching with a wire brush and dipping in dilute food color. These stained fruit were then run through the Sections Plant at the Florida Citrus Canners Cooperative, Lake Wales. Spotters picked off the stained fruit just prior to the mechanical peelers, and the 2 lots were peeled separately and then sectionized into cans by the professional sectionizers.

Internal Quality: Fruit samples from every picking of the mechanical harvesting plots were checked for standard maturity factors of juice content, Brix, acid, and ratio (8).

Staining: Initially, stain tests were done by the method of Long (7), using indigotine sulfate. Later, a reversible tannic acid method, developed by Sunkist, was used (9).

"Windrowing": At the request of the Industry Harvesting Committee, we have tested the effect of accumulating fruit in "windrows" down the center of the row. For this, the usual procedure has been to have the fruit hand-picked, dropped onto canvases, and the canvases pulled to the center of the row, spilling the fruit in a ridge down the center of the row, convenient for a pick-up machine. Such "windrows," left on the ground for several days, were sampled at intervals to determine the effect on the development of decay. In individual experiments, the effect of a pre-harvest fungicidal spray (1,2) and of position in the windrow have been checked.

RESULTS

Comparison of Mechanical Harvesting Methods.

Sample Variability: Although harvested from the same plots for several successive years, sample variability afforded a major problem in evaluation of data, even within a given season. Table 1 shows minimum and maximum losses from decay in individual samples, by varieties, in 1964-65, together with averages for the season. These are contrasted with the average decay levels in control samples in the Decay Control Project. (This latter affords as good a picture of the average decay level for the season as we have been able to find.) With such extreme range in decay potential, it becomes essential to evaluate data so that the consequent recommendations will minimize the chance of weak crops from weak varieties being handled with the roughest method, thus resulting in disastrous losses.

Mechanical Shaker v. Air-Shaker: Table 2 compares decay at 1 week from picking in 1964-65 in 3 varieties of oranges and one of grapefruit, harvested by 3 methods: hand-picking, mechanical shaking, and air-shaker. Note that results from each type of mechanical picking have to be compared with a separate control

Table 1. Variability in decay at 1 week from picking at 70° F (as per cent).

Decay levels	Grapefruit Marsh Hand	Grapefruit Marsh Shaker	Orange varieties Hamlin Hand	Hamlin Shaker	Pineapple Hand	Pineapple Shaker	Valencia Hand	Valencia Shaker
Min.	0.0	0.0	1.0	11.0	15.0	16.2	0.0	0.0
Max.	15.0	35.0	27.0	42.0	46.0	90.0	5.5	10.2
Avg.	2.1	12.8	9.1	25.8	25.7	54.1	1.6	3.8
Project 1198* Avg.	0.3	-	19.0	-	2.0	-	2.3	-

*Project 1198 is the Florida Citrus Commission's Decay Control Program. The values shown here are supplied by Mr. A. A. McCornack and represent the averages from control samples picked at approximately weekly intervals throughout the crop season for each variety.

Table 2. Post-harvest decay at 70°F in various varieties as related to method of picking (as per cent).

Variety	Mechanical shaker-catchframe Hand picked	Mech. picked	% increase	Air-shaker Hand picked	Mech. picked	% increase
Marsh G.F.	2.1	12.8	609.5	4.9	11.4	232.7
Hamlin	9.1	25.8	283.5	19.0	44.9	236.3
Pineapple	25.8	54.1	209.7	24.8	56.9	229.4
Valencia	1.5	3.8	253.3	1.4	3.4	242.8
Oranges avg.	12.1	27.9	248.8	15.1	35.1	236.2