Development of Prune Harvester

new pickup principle improves machine designed to harvest French prunes from ground after removal from tree by shaking

R. B. Fridley and P. A. Adrian

A basic analysis of various pickup principles applied in the construction of prune harvesters was made during the spring of 1957 to develop—if possible—a gentle method of fruit pickup which would simulate hand picking and give a positive pickup without disturbing the soil surface.

Shaking the fruit to the ground and then picking it up rather than catching it on a frame at first appears to be the wrong approach. However, observations during the 1956 season indicated that, in general, a pickup machine is more economical and requires only about 50% of the labor required by frames. Also, there was little damage to fruit that fell on a smooth ground surface. Therefore, because it is necessary that the ground be relatively smooth for mechanical pickup, little fruit damage would be expected if the machine were not too aggressive.

Field Conditions Simulated

Following the 1956 observations a test apparatus was set up whereby field conditions could be simulated in the shop. Each principle to be tested was rigidly mounted above a tray—on which was placed soil and fruit—that moved under the test unit at the desired ground speed. Movies of the fruit pickup were taken with a high speed camera for a study of the effects of the fruit being elevated from the ground surface to the conveying system.

The tests pointed out two important facts. *1*, The fingers of a reel—which rotates with the direction of travel—contact the fruit when they are traveling in a downward direction and tend to push the fruit into the ground. *2*, Radial fingers of a reel—which rotates against the direction of travel—are nearly vertical when they contact the fruit, resulting in a horizontal force that has a windrowing effect on the fruit before the pickup is accomplished.

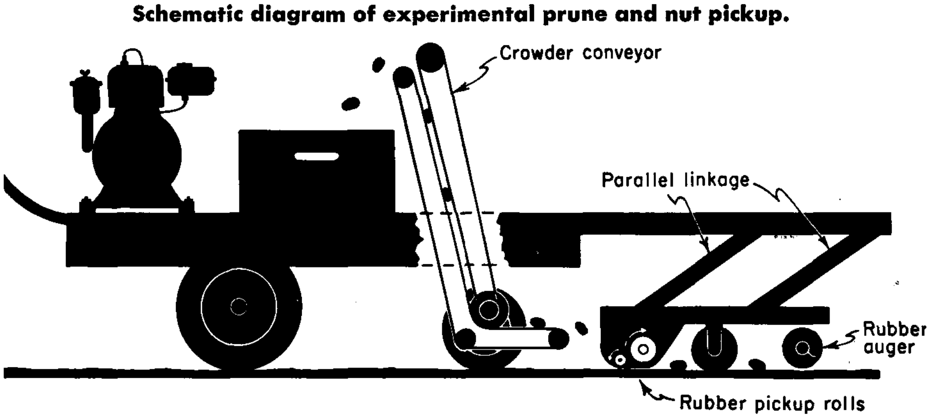
The first attempt toward eliminating the windrow effect was to design a 12″ diameter reel—with forward curved fingers—which would rotate against the direction of travel. It was intended that the curved fingers would give the fruit some upward acceleration as the head of a golf club imparts loft to a ball. The performance was satisfactory for the 60%–70% of the fruit that was at a correct position relative to the lowest point of travel of the finger in question. The remaining fruit was topped and rolled forward. A study of the path of the finger tips indicated that a smaller percentage would be topped by using a smaller reel. Tests with a 6″ diameter reel confirmed this and topping of only about 10%–15% of the fruit occurred.

Parallel Rolls

Results of the tests led to the use of the principle of two parallel rolls rotating in opposite directions. A 1″ diameter rear roll placed close to the ground—and rotating against the direction of travel—delivers an upward force on fruit that comes into contact with its forward surface. A second roll—approximately 3″ in diameter—is placed above and in front of the rear roll so the fruit is gripped between the rolls and lifted as the unit moves forward into the fruit. The pickup occurs the instant fruit enters the unit when the adjustments are such that the fruit can be touched by each roll and the ground simultaneously.

The larger front roll was made spongy to minimize fruit damage by wrapping foam rubber spirally around a shaft. Over this was bonded a harder, wear resistant rubber covering. The rear roll, which occasionally touches the soil, was covered with abrasion resistant material—with a high coefficient of friction—to minimize relative motion between the fruit and the roll. Fluted rubber water hose was satisfactory.

Schematic diagram of experimental prune and nut pickup.



Field Tests

In field tests, the unit gave encouraging results. The use of gage wheels and a parallel linkage yielded good flotation and the rubber cross augers were acceptable for clearing the fruit out of the path of the gage wheels. The only major difficulty was found in fruit falling to the ground through the space between the rubber pickup rolls and the crowder conveyor. The trajectory of the fruit—after leaving the rolls—depends upon the size of fruit, the firmness of fruit, and the speed and position of the rolls. Because of this, minimization of the space between the pickup rolls and the conveyor is of utmost importance.

On well prepared land the unit picked up the fruit very well with a relatively low soil pickup. Any fruit in a slight soil depression that comes in contact with the bottom of the rear roll will be rolled forward and picked up. Fruit in a deep indentation will be missed. Clods and trash above the soil surface will be picked up with the fruit. However, if the surface is rolled prior to shaking the fruit there are very few clods above the soil surface, even on a cloddy soil. Performance checks indicate that the soil pickup was less than one pound of soil per box of fruit and the clods picked up were smaller than prune size for the most part. This is approximately four times as much as is found in hand picking but it is about one half the amount picked up by other type machines operating under the very best conditions. Since the

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Gibberellin on Orange Fruit

content of ascorbic acid, hydrogen ion and juice increased while rind color, thickness and texture coarseness decreased

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To evaluate the influence of gibberellin on citrus fruit development and quality—and other tree responses—Thompson Improved Navel Oranges were treated with potassium gibberellate during the first week of November 1957. Oranges 2.5″–2.6″ in diameter were individually dipped along with four subtending leaves in the treatment solutions. Concentrations of technical gibberellin—containing approximately 82% potassium gibberellate—used were 500, 1,000, and 2,000 ppm—parts per million. A non-ionic wetting agent was added at 0.05%. Oranges which served as controls were selected for size but were not treated. A randomized complete block design with eight replications was used. Each plot consisted of three trees with 17 test oranges on each.

Nontreated oranges of the same size as the treated fruits were collected near treatment time. The percent juice was found to be 40.9%, soluble solids 11.7% and total acid—expressed as citric—0.98%. At treatment time the oranges were just beginning to lose the green color.

Thirty oranges per plot were harvested January 31, 1958, and data collected on color, transverse and longitudinal diameters, weight, rind thickness, and percent juice. The juice was analyzed for total soluble solids, total acids, hydrogen ion concentration, and ascorbic acid.

The remainder of the treated oranges were harvested March 13. The same data and—in addition—the number of puffy oranges were recorded.

Control fruit were more orange in color than those dipped in gibberellin. Differences in color were very marked at both harvest dates. At the second harvest, small, pin-point size, depressed brown spots were numerous on the rind of treated fruit. Similar spots were present on untreated oranges, but to a low degree.

Treatment with gibberellin in this experiment increased percent juice. On January 31 untreated oranges contained 47.3% juice while those dipped in 500, 1,000, or 2,000 ppm gibberellin contained 50.4, 51.0 and 51.3% juice, respectively. Similar results were obtained for the March 13 harvest. The content of ascorbic acid in the juice was also significantly increased. Ascorbic acid content in untreated fruit was 63.8 mg—milligrams—per 100 ml—milliliters—of juice on January 13. Juice from oranges dipped in 500 ppm gibberellin contained 70.8 mg ascorbic acid per 100 ml. The value for 1,000 ppm was 71.4 mg per 100 ml and 69.8 mg per 100 ml for 2,000 ppm. Similar results were obtained for the second harvest. Hydrogen ion concentration of the juice appeared to be significantly higher January 31 in treated than in control oranges. Juice from untreated oranges contained a hydrogen ion concentration of 0.197 mg per liter. The values for 500, 1,000, and 2,000 ppm were 0.235, 0.227 and 0.232 mg per liter; no such difference was apparent on March 13.

Oranges treated with gibberellin appeared to have a rind smoother than the rind of untreated oranges. Small but significant differences in rind thickness were measured. At the first harvest only oranges dipped in 2,000 ppm appeared to have a thinner rind than the control. All gibberellin treatments appeared to cause thinner rinds by the second harvest. Untreated oranges had a rind thickness of 4.81 mm—millimeters—whereas those dipped in 500, 1,000, or 2,000 ppm gibberellin had a rind thickness of 4.52, 4.51 and 4.47 mm. Significant differences in fruit drop, puff, weight or shape of oranges, percent soluble solids in the juice, and soluble solids ratio to acid were not detected.

The effects of treating navel oranges in November—when they were almost fully developed—suggest that this compound may have additional effects on the morphology and composition of citrus and other fruits, particularly if applied through a wide range of development stages.

Influence of Gibberellin on Some Quality Factors of Navel Oranges Treated November 4, 1957. Harvested January 31 and March 13, 1958

Concentration of gibberellin ppm	Color[a]		Juice w/w %		Ascorbic acid mg/100 ml		Rind thickness mm		Hydrogen ion concentration mg/liter	
	Jan. 31	Mar. 13	Jan. 31	Mar. 13	Jan. 31	Mar. 13	Jan. 31	Mar. 13	Jan. 31	Mar. 13
0	7.3	8.5	47.3	45.5	63.8	63.6	4.62	4.81	0.197	0.141
500	4.6**	5.5**	50.4**	50.5**	70.8**	71.2**	4.49	4.52*	0.235*	0.157
1,000	4.6**	5.6**	51.0**	50.1**	71.4**	76.0**	4.45	4.51*	0.227*	0.158
2,000	4.4**	5.1**	51.3**	51.7**	69.8**	73.1**	4.37*	4.47*	0.232*	0.155
A (0.05)[b]	0.33	0.33	1.24	1.58	3.7	4.3	0.17	0.27	0.028	NS
A (0.01)	0.45	0.45	1.68	2.14	5.1	5.8	NS	NS	NS	NS

[a] An arbitrary color rating estimated visually for each fruit with an index of 5 = pale yellow and 8 = good orange.

[b] Dunnett's one-sided test was used in statistical treatment of these data.

* Significantly different from untreated oranges at the 0.05% level.

** Significantly different from untreated oranges at the 0.01% level.

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fruit is mechanically washed prior to processing, the problem of picking up extraneous matter is not an insurmountable one.

The capacity of the new type machine —22″ swath width—was approximately one box per minute depending upon the fruit density on the ground, which probably would lead to an average output of 20–30 boxes per hour, comparable to machines of other types and is an increase of five or six times the rate of hand picking.

To minimize the importance of land leveling plans are under way to design and build a tractor mounted machine—with separately floated pickup units approximately 24″ wide—attached in offset tandem.

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The above progress report is based on Research Project No. 1717.