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EVALUATION OF TRASH REMOVAL DEVICES FOR MECHANICALLY HARVESTED ORANGES

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Abstract. **In 1973, a trash eliminator belt assembly was tested on the USDA's rake-pickup machine. Results from these tests led to the design and construction of an experimental portable cleaner. Cleaning trials were conducted with different belt speeds, angles of incline, directions of discharge, and feed rates to determine the optimum cleaner position and speed for a given set of trash conditions. The best overall separation occurred when the trash belt was set at 80 fpm at a 12° incline, and the discharge belt traveling in the same direction as the trash belt.**

In the 1971-72 season, Florida produced over 6.5 million tons of oranges and it is estimated that by the 1979-80 season this figure will have increased to 9.0 million tons, or 200 million boxes (1, 2). Removal of trash and unwholesome fruit is creating considerable concern to the processing plants because of the increase in mechanical harvesting, and common practice of hand pickers dropping the fruit on the ground before placing it into field containers. Trash includes leaves, sticks, cans, and bottles. Unwholesome fruit consists of split, decayed, soft, or rotten fruit. Handling problems at the processing plant can be minimized by removing trash and unwholesome fruit, either on the fruit pickup unit or at a roadside station before the fruit is transferred into trailers. The objective of this study was to design and test different arrangements and devices that could be used in the grove for removing trash and unwholesome fruit before loading the trailers.

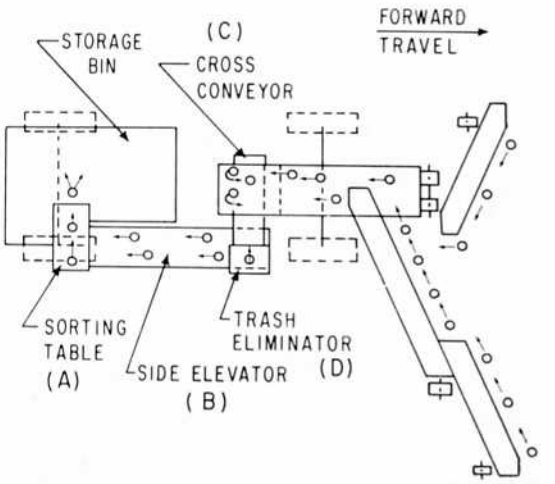
Materials and Methods

Rake-Pickup Test

Harvesting trials were conducted in March, 1973, using the USDA rake-pickup (3), which was equipped with a trash eliminator and sorting table as shown in Fig. 1. Four samples of approximately 1000 lb. each of mechanically harvested oranges were raked and picked up. The trash eliminator assembly was mounted at the end of the cross conveyor and ran in the same direction as the cross conveyor. The trash eliminator belt was 12 x 20 inches (length x width) and was inclined at an angle of 30°. Belt speed was 110 fpm. Trash was discharged at the end of the conveyor while the fruit rolled down the incline into the side elevator. After the trash was removed, two hand graders removed unwholesome fruit from the sorting table conveyor. This conveyor was 36 x 24 inches and operated at a belt speed of 130 fpm.

Field Tests

Based on the results with the rake-pickup, a system for removing trash and unwholesome fruit was designed in December, 1973, that would be



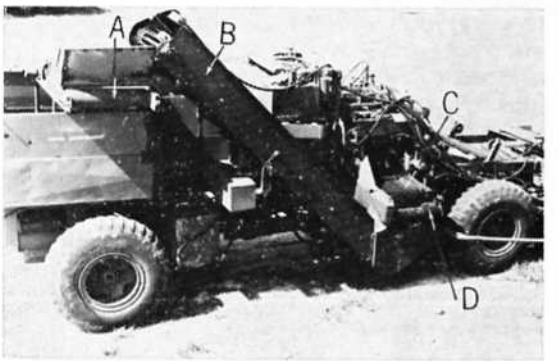


Fig. 1. Self-propelled USDA rake-pickup. (A) Storting table, (B) side elevator, (C) cross conveyor, (D) trash eliminator.

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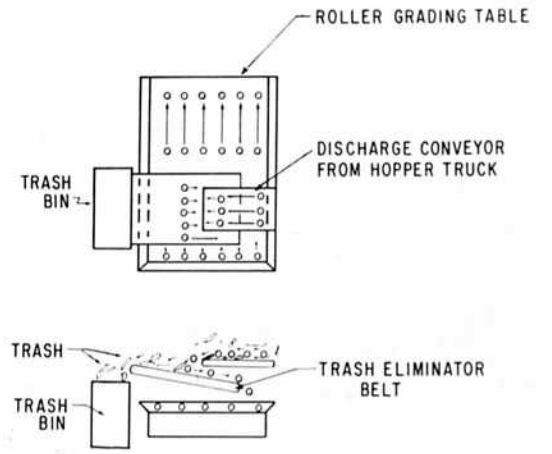
portable and could be used in the field. A self-unloading bulk box was mounted on a truck as a storage hopper to feed material to the cleaner. Two belt conveyors and a grading table were mounted on a trailer to convey and clean the harvested fruit before it was loaded in the roadside trailer, as shown in Fig. 2.

The truck was equipped with a double pump that provided all the hydraulics for the complete cleaner operation. Some trash fell through the rod draper chain (21 x 3/8 inch, with a 1-1/4 inch pitch) in the bottom of the hopper as the sample was conveyed to the cleaner.

The fruit was dumped into the bulk hopper by hi-lift grove trucks. The discharge conveyor on the cleaning trailer was installed in a manner that permitted the bulk hopper truck to unload from a position parallel to the roadside trailer. This arrangement also provided enough room for the hi-lift grove trucks to unload and return to the grove. From the discharge conveyor the fruit was dropped onto the 60 x 30 inch trash eliminator belt, which was traveling in the same direction as the discharge conveyor and inclined to separate trash and flat fruit (damaged by field machinery) from round fruit. The round fruit rolled onto a 72 x 52 inch grading table where hand graders removed some of the unwholesome fruit before it was elevated into the roadside trailer. The incline and belt speed of the trash eliminator were varied to determine their effect on separation.



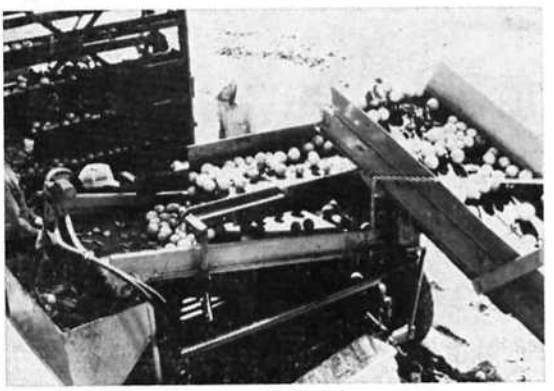


Fig. 2. Portable cleaner for separating trash and unwholesome fruit from good fruit.

The first trash removal experiment was set up in a commercial grove in January, 1974. This particular grove block consisted of 'Hamlin,' 'Queen,' and 'Pineapple' orange varieties. Little or no grove preparation was done prior to harvesting. An abscission chemical was used to loosen the fruit and both a trunk shaker and air shaker were used to remove the fruit from the tree. The fruit was windrowed, picked up, and loaded into a hi-lift grove truck which transported the fruit to the roadside loading area. There were 12 runs of approximately 370 boxes each in this field test.

The feed rate from the bulk hopper was calculated for each hopper load of fruit. The good fruit and unwholesome fruit that had not been removed by the trash eliminator belt was discharged onto the grading table from which four hand graders removed the unwholesome fruit. The material that was removed from each sample was collected and counted. The grove owner provided copies of their trip tickets and inspection certificates on each trailer load that had been run through the cleaner, and from these records the exact sample size was obtained.

Four-box Sample Test

In February, 1974, additional testing was done on a 4-box sample size. The oranges were weighed and counted to determine the number of fruit per box. Trash was mixed in with the sample to make up 10% by volume, and 10% of the fruit was physically flattened. The same equipment from the January field test was used. Each sample was placed in the bulk hopper by hand, and all the material was collected and counted after each run. Three replications for each condition were run. Angle settings of 10 , 12 , 15°, and 20° were used on the trash eliminator belt along with speeds of 52.4, 78.5, and 104. 7 fpm. Two directions of discharging the fruit sample onto the trash eliminator belt were tried: (1) The same direction as the trash eliminator belt and (2) the opposite direction. Fruit feed rates were 96 and 163 boxes/hr in this experiment. No hand grading was done in

the test, and the samples did not contain any split fruit.

Results and Discussion

Rake-Pickup Test

Table 1 shows the test results conducted in March, 1973, with the USDA rake-pickup. From 3 to 4.5% by volume of the load was trash, and 100% of the trash was removed by the trash eliminator belt in each of the 4 tests. Six % of the fruit picked up was considered unwholesome. Unwholesome fruit removed by the hand graders was 1.04% of the total fruit, at a pickup rate of 315 boxes/hr.

Field Tests

In January, 1974, a total of 4,447.64 boxes of oranges were run through the cleaner, and 392.14 boxes of unwholesome fruit were removed. The mean trash content was 1.38% by volume and the mean percentage of flat fruit was 3.11% by volume. All of this material was removed by the trash eliminator belt. The percentage of unwholesome fruit removed by the hand graders varied from 3.69 to 9.17%, and the mean for the total run was 5.87%. The trash eliminator belt was inclined at 12° and operated at a speed of 80 fpm. The mean feed rate was 417.41 boxes/hr. With this particular arrangement, all of the trash and flat fruit that had been damaged by field machinery, was removed by the trash eliminator belt. The 4 hand graders removed approximately 85% of the split fruit from each sample. Fruit in this particular grove block was extremely soft and thin skinned.

Four-Box Sample Test

Fig. 3 shows the results from this experiment. A higher percentage of trash and flattened fruit was removed from the sample when the discharge conveyor belt was running in the same direction of travel as the trash eliminator belt than when it was running in the opposite direction. Increasing the angle of incline on the trash eliminator

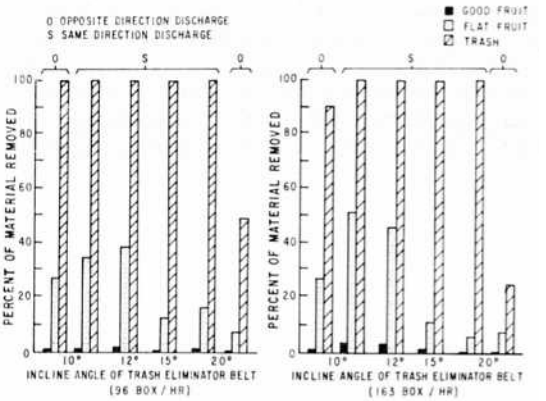


Fig. 3. Separation results from 4-box sample test when 2 feed rates, 2 direction of discharge, and various belt angles were used.

Table 1. Results of trash and unwholesome fruit removal from harvesting trials with rake-pickup, March, 1973.

		Material removed on rake-pickup					
			Unwholesome fruit removed by hand graders			Vol of trash removed by trash eliminator belt	
Test no.	Feed rate boxes/min	Material picked up lb.	Split fruit no.	Rotten fruit no.	Flat fruit no.	Cubic ft	% of total vol picked up
1	4.47	925	2	16	7	1	4
2	4.48	1250	0	21	12	1	3
3	6.09	1425	8	9	9	1.5	4
4	6.22	1175	5	12	9	1.5	4.5
Avg	5.25	--	--	--	--	1.25	--
Total	--	4775	15	58	37	--	--
% of total[z]	--	--	.14	.55	.35	--	--

[z]Calculated using 200 fruit/90 lb. field box

belt gave a low removal percentage of good fruit and also a low removal percentage of flattened fruit. With the trash belt inclined at 20° and the discharge belt running in the opposite direction from that of the trash belt, only 25% of the trash and 5% of the flattened fruit was separated out at the feed rate of 163 boxes/hr. At a feed rate of 96 boxes/hr and the same conditions as above, 47% of the trash and 8% of the flattened fruit were removed.

Conclusions

Results of these tests indicated that a belt-type trash eliminator could separate out more than 95% of the trash in the field and that a high percentage of the mechanically damaged fruit could also be removed. However, unwholesome fruit that are still round required hand grading before being loaded into the roadside trailers. The highest percentage of trash and flat fruit removal occurred with a 12° incline on the trash eliminator belt at a speed of 80 fpm when the material was entering in the same direction as the trash belt travel.

Acknowledgement

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