Mechanical Fruit Tree Shaking

effect of frequency and stroke on fruit removal and power requirements analyzed in study of reciprocating type shaker

P. A. Adrian and R. B. Fridley

Boom type shakers—used for the mechanical removal of fruit from trees—may cause less strain on the roots and consequently less damage than the cable type shakers according to observations made in an extensive analysis of the basic engineering principles involved in tree shaking.

The primary objectives of a study initiated in 1957 were to determine the effect of the frequency and the stroke of the reciprocating type shaker on fruit removal; the amount of tree damage; and, the forces and power required for shaking prune trees.

A 20′ front mounted boom shaker used in the study made it possible to obtain any frequency between 400 and 1,000 cycles per minute. Strokes of ½″, 1″, and 1½″ were used.

The force and power requirement tests were carried out with the use of strain gages and an oscilloscope. The signals from the strain gages were fed into the oscilloscope which recorded the force pattern during the shaking. Permanent records of the results as seen on the oscilloscope screen were kept by use of an oscilloscope camera.

The desired data are the maximum forces, peak horsepower and average horsepower required. The graph in the first column gives an indication of typical values of average horsepower. Curves plotted for the maximum horsepower and maximum forces are similar. There is no reversal in the curvature in any of the variables as frequency is increased, indicating that the natural frequency of the system is either much lower or much higher than the operating frequencies. By shaking the limb by hand and counting the vibrations it was found that the natural frequency for primary prune tree limbs is in the order of 100 cpm—cycles per minute. Unfortunately this frequency is not practical for fruit removal. If it were possible to get good fruit removal at the natural frequency of a limb the force and power requirements would be less.

The removal tests were conducted by shaking all the primary limbs on a tree with a given stroke at approximately the same frequency. The data recorded included the percent of fruit removed, the average weight and maturity of the prunes, and the average force required to pull individual prunes from the tree.

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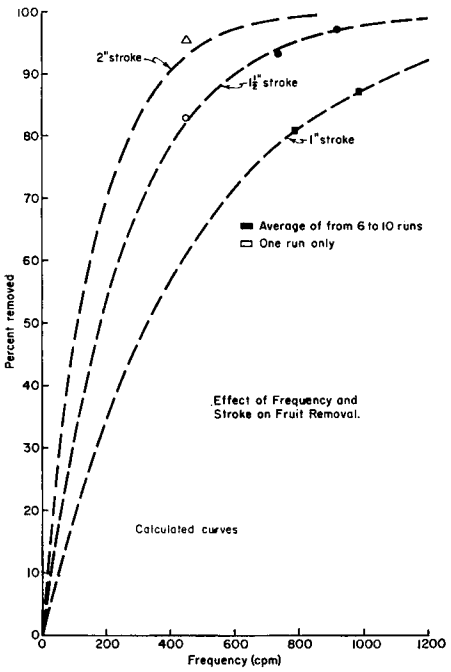
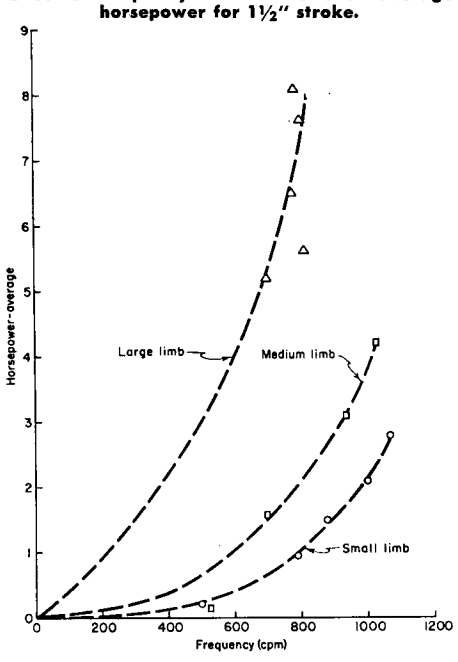
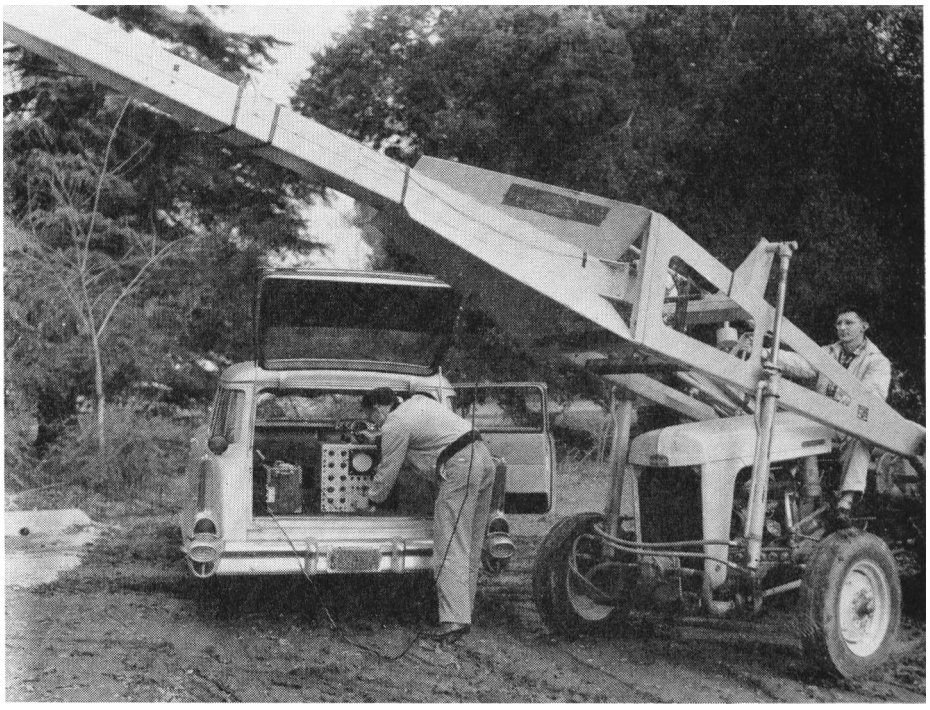
Effect of frequency and stroke on fruit removal.



Effect of frequency and limb size on average horsepower for 1½″ stroke.



Shaker and recording instruments used in analytical study of effect of boom type shaker on prune trees.



Use of IBA was definitely beneficial in rooting plum cuttings in each of the three instances where untreated controls were included. The photograph on page 14 shows typical root systems which developed from the cuttings of the varieties used in the 1957–58 tests.

Hudson T. Hartmann is Associate Professor of Pomology, University of California, Davis.

Carl J. Hansen is Professor of Pomology, University of California, Davis.

TREE SHAKING

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Fruit removal was found to be affected primarily by four variables: *1*, the frequency of the shake; *2*, the stroke; *3*, the force required to remove the fruit divided by the weight of the fruit—F/W—and, *4*, by the number of limber fruit bearing hangers in any given tree.

The upper graph on page 3 shows the relationship of stroke and frequency with fruit removal. At low frequencies there is a large difference in the percent removed by use of the various strokes. However, at higher frequencies the difference is small. The relationship represents the average removal that could be expected, but any particular tree or group of trees might vary from this as a result in the effect of F/W and the number of limber fruit bearing hangers.

No attempt has been made to isolate the effect of F/W or the number of limber hangers. However, F/W, which is the number of g's—unit weight—acceleration required, is of importance because fruit removal by shaking is the result of accelerating the limb away from the fruit. With regard to the limb characteristics, it was found that the percent of fruit removed was less on trees having several limber hangers than on rigid type trees with few hangers.

Tree damage tests indicate that limb breakage increases with increasing stroke. However, minimum damage occurred within a frequency range of 700–900 cpm. The damage may be greater when using a higher or lower frequency. All combinations of frequencies and strokes are possibly acceptable to growers, although the long stroke with a low frequency causes the tree tops to whip which increases limb breakage particularly on old brittle trees.

A number of years observations are needed before final judgment on possible root damage caused by shaking can be made. However, visual observations made in these studies indicate that boom shakers may cause less tree damage than cable shakers.

Further studies are planned to evaluate the effect of the position of the clamp on the limb, and the F/W on fruit removal and power required.

P. A. Adrian is Agricultural Engineer, Agricultural Research Service, USDA, and Cooperative Agent, University of California, Davis.

R. B. Fridley is Assistant Specialist in Agricultural Engineering, University of California, Davis.

CYANAMID

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the treated area introduces a new source of weed infestation.

In moist, sandy loam soils, planting was started 8–10 days after treatment, but in heavier soils a waiting period of two weeks after irrigation or rainfall was found necessary.

The observations made at the test plots were verified in commercial field treatments.

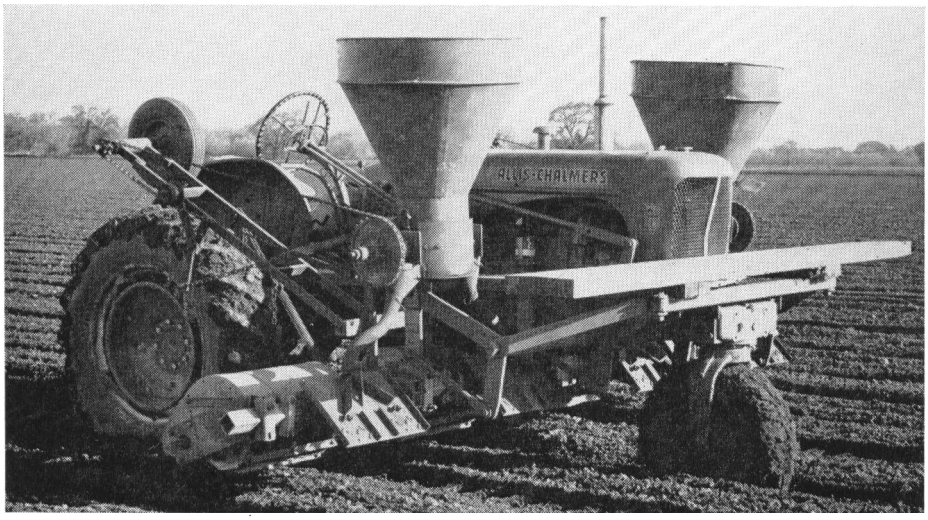
The amount of cyanamid applied varies with the distance between beds and the width of band treated. A rate of 1,500 to 2,000 pounds per acre is required but the amount actually applied depends on the treated portion of the field. If two 6″ bands of cyanamid are applied to 36″ beds only one third of the soil is treated. Therefore, between 500 and 666 pounds applied meet the required rate of 1,500 to 2,000 pounds per acre.

Because cyanamid contains 21% nitrogen, the cost of the treatment—$25–$30 per acre for material—was divided equally between nitrogen fertilizer and weed control.

Garland E. May is Farm Advisor, Stanislaus County, University of California.

William A. Harvey is Extension Weed Control Specialist, University of California, Davis.

Calcium cyanamid applicator and mulcher units mounted on same tractor used in treatment for weed control.



CDEC

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Crop injury was rated in terms of stand reduction and stunting of growth. Stand reduction at the 18-day rating was based on the unthinned stand. The rating at maturity was based on the stand left after hand thinning. Normal field thinning eliminated any evidence of stand reduction caused by CDEC.

Crop Injury from Treatment with CDEC

Variety	Stand reduction		Stunting	
	18-day	Mature	18-day	Mature
Red leaf	None	None	None	None
Salad bowl	None	None	2%–5%	None
Butter lettuce	5%	None	5%	None
Romaine	None	None	2%–5%	None
Endive	None	None	None	None

Stunting consisted of a slight curling and twisting of the leaf margins. This symptom appeared on only the first leaves and later leaves were normal. At maturity no differences between the treated and the untreated plants were observed.

Complete weed control was not obtained with CDEC at rates up to 10 pounds per acre, but the results—although from only one test in one area—warrant further trials with the herbicide as a method of selective weed control for pre-emergence treatment of lettuce.

C. D. McCarty is Extension Field Technologist, University of California, Riverside.

D. C. Purnell is Farm Advisor, San Bernardino County, University of California.

M. J. Garber is Assistant Biometrician, University of California, Riverside.

H. F. Arle, Field Crops Research Branch, USDA, Phoenix, Arizona, and W. D. Pew, Arizona Agricultural Experiment Station, reported the experiments conducted in Arizona.

The Fujiwara Brothers, ranchers in the Chino area, cooperated in the experiment with CDEC.

The above progress report is based on Agricultural Extension Service Project No. 4188.