
The use of pneumatic shears in conjunction with the pruning sled concept resulted in maximum cane cutter productivity, but the overall productivity with the three-man crew was less than that demonstrated for the two-man crew using only pneumatic shears. The tests demonstrated that, in terms of overall crew productivity the use of pneumatic shears was definitely advantageous. However, purchase of a pneumatic pruning machine cannot be justified if used only for cane severing.

MECHANICAL HARVESTING

RAISIN GRAPES

. . . an evaluation for severing

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THOMPSON SEEDLESS GRAPES can be mechanically harvested for the winery by vibratory machines which dislodge the fruit primarily as single berries. The berries are generally detached from the rachis, which not only remains on the vine but also retains the pedicels (berry capstems). The separation of the capstem from the berry produces an open wound in the berry from which some juice is lost, but this is of minor importance if the fruit is intended for the winery. However, if the objective is to produce sun-dried raisins, some of the juice lost from the berries will be distributed over the berry surface during the conveying and spreading of the fruit onto the continuous paper trays. This destroys the surface bloom and results in a shiny, sticky raisin which has a reddish, rather than the dark bluish color normally associated with hand harvested sun-dried raisins.

Many tests since 1972 have demonstrated that juice loss can be minimized and that a typical raisin color can be obtained if the fruiting canes are severed 4 to 6 days prior to mechanical harvesting. Severing the fruiting canes stops the flow of water from the vine to the fruit. This causes the leaves to become dry and brittle within several hours and the stems and fruit to wilt during the interim 4 to 6 day period between cane cutting and harvesting. More importantly, the loss of the water supply causes the capstems of the individual grape berries to dry and become brittle. When the mechanical harvester detaches the fruit from the vine, these brittle cap-

stems break. Consequently, most of the berries (70% or more) retain their capstems and thus exhibit no open wound. For those berries not retaining capstems, it has been found that most are sealed at the breakage point. Although cane severance does not result in complete absence of damage to the harvested berries, the raisins may equal or surpass the quality of hand harvested fruit.

Cane severing

Present trellising and vine training systems do not lend themselves to automatic, completely mechanical, severing of the fruiting canes. Cane severing must be done by hand with pruning shears. This task represents a new labor input to the raisin harvesting operation. However, the reduction in actual harvest labor afforded by mechanical harvesting more than justifies this additional labor input.

Cane severance is a relatively simple concept, but is not particularly easy to accomplish. The fruiting canes are generally hidden from view by the vine foliage which must be separated by the pruner in order to locate the proper cutting point. The task can be facilitated by proper trellising. After pruning, the canes that will bear the fruit, usually five or six in number and averaging 14 or 15 nodes each, are wrapped horizontally around a single wire. This wire supports the bulk of the crop and is stapled to the side of the stake about 42 inches above the vineyard floor.

The vertical supporting stakes are 6 ft long and are driven into the ground

about 16 to 18 inches. The use of a 24-inch crossarm at the top of the stake supporting two parallel foliage wires at its extremities and located 12 to 16 inches above the single cane wire will hold much of the vine foliage away from the vine head. Some mechanical trimming of the extremities of this foliage prior to cane cutting tends to make the vine head region more accessible to view by the cane cutter. It is also highly desirable to develop a well defined and compact vine head at a uniform height approximately 6 inches below the cane wire.

At pruning time, the canes are collected together and brought up to the cane wire as a compact bundle. Prior to harvest, the canes are cut at a point between the cane wire and the vine head. If the correct procedure for cane tying and vine training has been diligently followed, the location of each bundle of canes with respect to the vine head becomes standardized, and the cutting points for each of the canes in the bundle will all lie in close proximity to each other.

Such a training system requires little decision making by the cane cutter. The time and effort required to locate the canes for cutting is reduced, and the task is greatly simplified. On the other hand, if the canes are brought up to the cane wire in a random fashion from vine heads which are not compact or which are not close to the cane wire, the cane cutter must not only locate the fruiting canes but must also determine where to make the cut. In this case, making the

of methods fruiting canes

cut close the cane wire can result in a considerable quantity of the fruit being retained on the unsevered portion of the cane below the cut. As a result, this fruit will be detached by the mechanical harvester as single damaged berries without capstems, a condition which tends to defeat the purpose of cane cutting, namely, to promote a detachment of the fruit as undamaged single berries.

Four methods

Four methods of severing the fruiting canes were studied during September 1971 at the Earl Rocca ranch in the Biola district. The vine training system described above was developed by this grower with mechanical harvesting specifically in mind. The tests were conducted in a 16-acre block of 10-year-old Thompson Seedless vines. Each test utilized a 2-man crew of cane cutters, and the productivity of this crew was determined for each of the methods. The methods were as follows:

A. Two man crew using standard pruning shears, both crew members working on the same row and "leap frogging" along the row.

B. Two man crew using pruning shears, one crew member per row.

C. Two man crew using pneumatic pruning shears, one crew member per row.

D. Two man crew using pneumatic pruning shears, one crew member per row, with each working from a seated position on an individual sled.

Time for completion of a test was the time required for the crew to sever the canes on two full rows of vines, each row being 184 vines long in the 7 x 12 ft



Experimental unit for towing cane cutting sleds and providing power for pneumatic shears in vineyard tests for mechanical harvesting of raisin grapes.

planting. After each test, the number of canes which were not severed was counted for each 10th vine, and the number of times that the cane wire was accidentally cut was determined for each row. The average number of fruiting canes for each vine (the pruning level) was taken to be five. (This was the average number of cuts required to sever all of the canes on a vine). Average productivity of the cane cutters, average percent of canes not cut, average number of wire cuts per row, and number of rows, are shown in table 1, for each of the four methods studied.

Productivity

It should be pointed out that the productivities listed in the table are ideal maximums and do not take into account rest periods or turn-around time at the end of the rows. Thus, the labor requirements per acre under actual conditions would be higher than those demonstrated. However, the relative ranking of the

methods can be expected to remain the same.

Method A vs. method B was essentially a comparison of crew organization. In this comparison the crew expressed a positive preference for method A. This preference appeared to be a psychological one, since the time to complete a row was much less than for method B. However, the tests demonstrated that, in terms of crew productivity, method B was superior to method A by about 18%.

Method B vs. method C was a comparison of cane cutting tools. Standard pruning shears require the use of both hands, while pneumatic shears require only one hand for making a cut. Consequently, the worker with a pneumatic shear can use the other hand to manipulate vine foliage. In addition, the mobile power source for the pruning shear serves to set a constant pace for the worker. As a consequence of these factors, crew productivity for method C was nearly 50% higher than for method B.

METHODS, PRODUCTIVITY, AND EFFICIENCY IN RAISIN GRAPE CANE SEVERING TRIALS FOR MECHANICAL HARVESTING

Method	Ave. cane cutter productivity		Ave. crew productivity	Crew size	% canes missed	Ave. No. wire cuts/row	No. of tests	No. of vines
	Man-hrs/Acre	Acres/Man-hr	Acres/Man-hr					
A	5.8	.17	.17	2	3.3	0	8	1472
B	4.9	.20	.20	2	1.4	.67	6	1104
C	3.3	.30	.30	2	4.2	.33	12	2208
D	2.7	.37	.25	3	2.3	1.0	10	1840

Methods A, B, and C each require bending, stooping or possible kneeling. These movements are not only fatiguing but might also be considered as non-productive efforts since they are only ancillary to the process of cane severing. Method D was tested to determine if, by reduction of these ancillary efforts, the overall task of cane cutting could be made easier without sacrificing productivity. The raisin grape spreading machine (normally used in conjunction with the mechanical harvester) was modified to serve as a power unit, as shown in the photo. Solenoid-operated hydraulic valves were used to control the rotation of hydraulic motors, each of which was coupled to a cable take-up drum.

Sleds

A flat bottomed sled with a pedestal-mounted seat was attached by means of a cable to each drum. A crew member rode facing the vine from a seated position on each sled, and each man was provided an electrical switch which permitted him to independently energize the drive motor to which the cable take-up drum was coupled. The power unit moved along between the rows at a constant speed of 22 ft per minute (.25 mph). Sled motion was initiated when the worker activated his electrical switch. When the sled was drawn to the proper position adjacent to the vine trunk, the switch was opened, the sled stopped and it remained stationary while the canes were found and cut.

In the meantime, the open center directional hydraulic control valve allowed the cable to unwind from the drum as the power unit continued its advance along the row. A cable length of 11 ft permitted a maximum stationary time for the sled of 30 seconds, the additional time being needed under occasional adverse cane cutting conditions due to dense foliage or improper cane position. Normally, the worker spent about 16 seconds in a stationary position, and drum speed was designed so that sled movement from vine to vine could be achieved in three seconds. On the average, total cycle time was 19 seconds per vine.

Method B can be adopted without any capital investment. Method C requires the use of a pneumatic pruning machine. These are commercially available and can easily accommodate the necessary crew size for cane cutting. However, the labor savings which can be realized with method C are not sufficient to justify the capital investment in a pneumatic pruner

when cane cutting is the only use made of the machine. Growers who already own these machines or who may be contemplating purchase for vine pruning in the winter can use them to serve a dual purpose, thereby reducing their labor costs.

Individual cane cutter

A higher productivity of the individual cane cutter was demonstrated with method D than with any other method tested. The cane wire was within easy reach and at about shoulder height for the worker in his seated position, and all bending and kneeling motions were eliminated. However, this method required an additional crew member to serve as operator for the towing unit. Thus, the overall productivity of this three man crew was .25 acres per man hour, which was lower than for the two man crew using method C. In order to make method D comparable with method C, the productivity of each cane cutter on the sleds would have to be .45 acres per man hour, an increase of 21 percent. The design of the equipment could be improved to further the productivity of the workers. However, even if such a high level of productivity was attained, the crew size required would still be the same as for method C. Therefore, overall crew productivity and size required with the sled concept would, at best, be no different than for method C. Consequently, the additional capital investment required to adopt the sled concept cannot be justified.

Canes-not-cut were less than 5%, and acceptable from the standpoint of harvesting for each of the four methods studied. The average number of wire cuts per row was also quite low, especially considering that the shears were activated more than 900 times per row. However, any cutting of the trellis wire is undesirable since the severed wire sags to the ground and the fruit can not be detached by the harvester. In some cases, this may result in the complete loss of the fruit on two full adjacent spans. In addition, the cost of trellis maintenance is increased. The use of a high tensile strength cane wire may provide a practical solution to this problem, since this wire offers high resistance to cutting.

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NURSERY SPA

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Increasing the spacing of container-grown trees increased trunk caliper and taper, but growth in height was less than those spaced can-to-can. At the closest spacings, the lower foliage was sparse, giving the trees a leggy appearance. Adequate spacing (about twice the can-to-can area) gave benefits of increased trunk caliper and taper, and fuller foliage with a minimum sacrifice in height.

SPACING AND ARRANGEMENT of containers in nursery production commonly uses the least area consistent with ease of providing adequate care. Plants in gallon cans usually are placed can-to-can in beds of several hundred containers. Larger containers usually are closely spaced in 2- or 4-can rows with narrow aisles between.

Tree height and caliper growth of nursery-grown trees largely determines their monetary value and how well they will be able to stand upright in the landscape. Earlier observations of the lack of response to pruning treatments of close-spaced, container-grown trees raised the question of the influence of spacing on trunk development of young trees.

This study was carried out at Oki Nursery in Sacramento and at the Saratoga Horticultural Foundation. Seedlings of *Betula verrucosa* Ehrh., European white birch; *Dodonaea viscosa* 'Purpurea' Jacq., purple leaved dodonaea; *Eucalyptus sideroxylon* A. Cunn., eucalyptus or mulga ironbark; and *Liquidambar styraciflua* L., Liquidambar or sweetgum, planted in gallon cans were placed during late June and early July, 1967 in blocks having spacings of 7, 10, and 14 inches on center. These spacings gave surface areas per plant of about 50, 100, and 200 square inches (300, 600, 1200 cm²), or area relationships of about 1 (can-to-can spacing), 2, and 4. The growing media were modifications of "U.C. Type" mixes containing sand, organic matter, etc. Six plants were replicated three times at each spacing with each replicate surrounded by guard plants at the appropriate spacing.