Storing Horseradish Stecklings

overwinter storage of propagation stock for new commercial crop proves to be severe problem for farmers in Tulelake area

Burton J. Hoyle

Overwinter storage of horseradish stecklings—slender roots usually 8″ to 14″ long and not over ½″ in diameter—from harvest until spring planting often results in heavy losses.

Farmers at Tulelake first planted horseradish on a large scale in the spring of 1955. Among the numerous problems is the one of how best to carry forward from year to year the stecklings used for propagation. The stecklings tend to decay rapidly, usually from the smaller end. If packed tightly in a container, they will heat and spoil. Exposure to sunlight or slight air movement will cause severe shriveling and will destroy their value within a few days.

The first shipment of roots arrived at Tulelake from the St. Louis area in early December, 1954. Sound, disease-free stecklings were chosen and tied in bundles of 50 to 100 roots each. Old irrigation ditches were used for pits, and the bundles were piled in layers of five to six bundles deep and then covered by various means. About 30,000 roots were stored in each pit during December 1954 and through March 1955. In April, the pits were opened and the stecklings planted.

During storage, the rainfall totaled 2.10″, with the result that all the pits were fairly dry when opened. The coldest week of storage was that of January 3 when the average minimum was 3.7°F and the average maximum was 29.7°F. The coldest night was January 7 when −5°F was recorded. For the whole storage period the average minimum temperature was 18.9°F and the average maximum was 41.5°F.

Description of Five Pits Used to Overwinter Horseradish Stecklings.

Pit No.	Soil type	Depth of pit	Soil on top	Shape of pit cover
1	Sandy	20″	4″	Flat
2	Black organic..	20″	6″	Concave
3	Intermediate (sand-organic mixture)	20″	8″	Concave
4	Black organic..	18″	4″	Concave
5	Sandy	26″	12″	Flat

Notes:

1. Pits 1, 2 and 5 had soil sifted through the bundles as the pits were filled.
2. Pit 3 had paper over the roots and then soil over the paper.
3. In Pit 4 the roots were covered first with barley straw and then soil.
4. Pit 5 was covered with straw, then paper, then soil.

When the pits were opened, four bundles from each pit were examined. The general condition of the stecklings was excellent. The length of sprouts in all pits was about 1″ and invariably they were in the top layer only. Pits No. 3 and No. 5, as shown in the table in column 1, which were more deeply covered, showed less total sprouting. In pits No. 1, No. 2 and No. 5, where soil was sifted among the roots, there was less surface mold. Where straw lay against the roots, a thin layer of mold developed. No decay was apparent as a result of the mold.

The decay was called slight when not over 2″ of the steckling was affected. When not more than half of the steckling was rotted, the decay was termed severe. There was no slight or severe decay in any of the four bundles of roots taken from pit No. 1. Pit No. 2 had an average of 0.8% slight and 0% severe decay; pit No. 3 had 2.3% slight and 0.4% severe.

Cold Storage Tests

In mid-December 1954, a second truckload of horseradish roots arrived in Tulelake from Los Angeles where they had been shipped from Japan. They were large for stecklings, being ½″ to ¾″ in diameter and up to 16″ long. They had heated considerably in transit and a blue mold on them was advanced. Good material was selected and placed in cold storage because the ground was frozen and it was impossible to pit the stecklings. Containers used to hold the roots in storage were mostly cardboard cartons—20″ × 14″ × 14″—holding an average of 500 stecklings and weighing 35 pounds. After the filled cartons were closed, a small air hole remained in the center of the top. The cartons were piled seven high with a slight air space between them. Two cartons were lined with polyethylene liners and one with a waterproof paper.

The cold storage was held constantly at 38°F and 85% relative humidity. The rest of the storage room was full of potatoes. On March 23 it was noted that considerable heating was taking place in the cartons, so they were removed to an open-shed storage until planting. The roots in four of the cartons were evaluated, as shown in the table in column 2. Some roots listed as having no decay did have small spots of blue mold.

Condition of Horseradish Stecklings after Storage for 3 months at 38°F and 85% R.H in Various Types of Containers.

Condition of roots	Plain cardboard box	Paper lined crate	Polyethylene lined box
	%	%	%
No decay	68.8	67.4	74.2
Slight decay ...	20.6	22.8	19.7
Severe decay ..	7.9	4.9	6.1
Totally decayed	1.4	4.9	0.0
Dried up	1.3	0.0	0.0

Other Storage Tests

In mid-January, 1955, another load of stecklings from the St. Louis area arrived in Tulelake. From this lot, material for the tests outlined in the table in this column was selected. These stecklings were 6″ to 8″ long and ¼″ to ½″ in diameter. There were four replications of 50 roots each per treatment. They were put in storage on January 24 and removed on March 28.

Earlier observations had shown that when stecklings were in storage, the decay almost always started at exposed places, such as along the crack in the side of an orange crate. Also, it had been observed that the roots had a considerable tolerance for freezing.

Several methods of wrapping were tried. The polyethylene bags had their necks twisted, bent over, and secured in place with a rubber band. The waterproof paper and aluminum foil were rolled around the roots and the ends

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Quality of Horseradish Stecklings Stored under a Variety of Conditions

Wrapping materials	Storage conditions °F	R.H.	Ave. % decay: Slight	Severe	Complete	General appearance
1. Waterproof paper	38	85	7.0	1.6	0.6	Fair
2. None	"	"	10.0	2.6	2.0	Very poor
3. Aluminum foil	"	"	10.6	1.0	0.0	Good
4. Kraft paper	"	"	11.6	2.6	0.6	Poor
5. Polyethylene bag	"	"	4.6	0.0	0.0	Good
6. Waterproof paper	0	00	0.0	0.0	0.0	Fair
7. None	"	"	0.0	0.0	0.0	Fair
8. None	78	"	0.0	0.0	0.0	Dry, brittle

FIG

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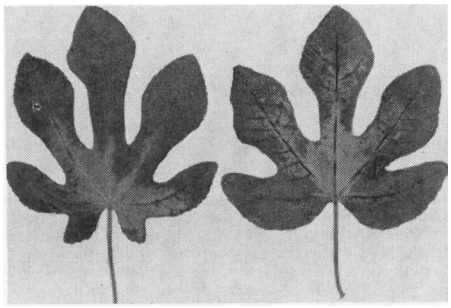
green, with small scattered white flecks. The eye is medium and the scales are chaffy. The meat is white or sometimes tinged with violet. The pulp is solid, light strawberry, with a distinctive fig flavor. The quality is very good.

In 1954, figs at Riverside continued to ripen over a long season, some still maturing on Christmas day. The extremely hot weather in August 1955 caused the



Typical 5- and 7-lobed leaves of Conadria from vigorous branches.

ripening figs to become flabby in texture and made them unfit for shipment to the fresh-fruit market.

At Fresno and Chowchilla, Conadria produced dried figs of excellent quality and remarkably free from defects.

Sugar analyses of a large number of samples of dried figs in 1951 showed the total sugar content of Verdone to be 55.88%, Calimyrna—Sari Lop—56.00%, Franciscana 57.02%, and Kadota—Dottato—57.69%. A representative sample of Conadria tested in 1954 showed 63.3% total sugar.

Development of Conadria

Actual fig breeding has been carried on at Riverside since 1928. A total of 16,650 seedlings, involving 273 combinations, have been grown and tested. Many varieties of edible figs have been used as female parents, including the commercial varieties of Dottato in 33 combinations, Franciscana in 13, Sari Lop in 16, and Verdone in 31.

Of the many combinations, the most promising seedlings producing edible figs were obtained from the Dottato and the Verdone crosses, especially from the latter. One such cross—Number 143—made in 1944, involved Verdone and a seedling male fig or caprifig, Number 72–80. Both parents are parthenocarpic—the fruits reach maturity without the stimulus of flower pollination or deposition of eggs by fig insects—in development of fruit. The resulting progeny totaled 72 seedlings; 38 produced edible fruit and 26 of these were parthenocarpic in fruit developmeut. Three of the seedlings were regarded as worthy of distribution and trial in other areas. One especially, Number 143–5, has proven to be of sufficient promise—fruits were first produced in 1947—to warrant the distinction of having a variety name given to it. The selected name—Conadria—is a combination of the names Adriatic and Condit.

Conadria seems to be a very promising new variety of fig for the production of both fresh and dried fruit. It is especially promising for dried fruit in the San Joaquin Valley.

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HORSERADISH

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twisted. Actually, slight air movement could pass through these two types of bundles.

Roots held in the office at 78°F did not produce any growth when subsequently planted. Those held at 0°F appeared in fairly good condition after thawing. However, only 4% produced any growth. Unwrapped stecklings and those in porous Kraft paper held in cold storage were poor. A striking advantage in favor of the tightly sealed polyethylene bags was apparent because the stecklings had the least decay and were firmer than any of the other lots.

Other Observations

One grower's pit was located under the eves of a building where it collected much more water than those in the open. The roots were wet when the pit was opened and were more turgid and in better condition than the roots in any of the other pits.

Stecklings were actually frozen in some of the shallower covered pits but thawed when the ground warmed up with no apparent damage to the roots.

Stecklings which were much shriveled on arrival were buried in a wet sawdust pit and emerged in excellent turgid shape.

Stecklings did not keep satisfactorily in the common nonrefrigerated earth-covered potato cellars of the area.

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STRAWBERRY

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ing white, and clothed with root hairs in contrast to irregularly shaped, amber-colored rootlets devoid of root hairs in the check areas. The acre fumigated with chloropicrin yielded in 1954 an estimated 19,590 pounds—9.8 tons—of fruit. The average yield per acre for the check areas was under four tons. Thus, during the first year, Verticillium wilt control and increased growth which attended the fumigation with chloropicrin gave a net increase of nearly six tons of berries to the acre.

Verticillium Wilt Control in Lassen Strawberry by Chloropicrin Fumigation of Land Previously Repeatedly Planted to Tomatoes.*

Dosage per sq. ft.	Description of treatment after fumigation	% losses from Verticillium wilt over 2 years.**
2.0 ml.	½-in. water seal.....	12.7
2.0 ml.	½-in. water seal.....	12.0
2.0 ml.	Rolled, rototilled and rolled in 24 hours...	15.3
2.0 ml.	Rolled, rototilled and rolled in 24 hours...	18.0
3.0 ml.***	Rolled, no water seal.	10.7
3.0 ml.	Rolled, no water seal.	9.3
3.0 ml.	Rolled, rototilled and rolled in 24 hours...	8.7
3.0 ml.	Rolled, rototilled and rolled in 24 hours...	12.7
Check	No fumigation	51.0
Check	No fumigation	55.0

* Experiments conducted at the U. C. Deciduous Fruit Field Station at San Jose.

** Plants showing symptoms were dug from the plots to facilitate recording.

*** The actual dosage ranged from 2.5 to 2.8 ml. per square foot.

During the second growing year—1955—the acre fumigated with chloropicrin showed exceptional vigor, and the check areas began to decline. The decline is thought to be due to the presence of root-invading fungi not related to Verticillium wilt. The yield from the fumigated acre was estimated at 33,400 pounds—16.7 tons—in contrast to an average of approximately 7.6 tons per acre for the check areas. The increase per acre attributable to the disease control and increased growth attending chloropicrin fumigation was 9.1 tons. The fumigated acre manifested exceptional vigor to the end of the second year and gave every indication of a good third year.

Since the beginning of this experiment late in 1953, considerable progress has been made in machine application of chloropicrin. Machine application may ultimately take the place of hand guns without loss in precision performance.

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