Verticillium Wilt Controlled

chloropicrin achieves effective control of Verticillium wilt in strawberry plantings if properly applied as soil fumigant

Stephen Wilhelm and Edward C. Koch

Three milliliters of chloropicrin injected 6″ deep into moist soil will diffuse a cubic foot of soil volume in sufficient concentration to kill the Verticillium wilt fungus. This information—obtained from laboratory and greenhouse research—has been generally substantiated in commercial fumigation for Verticillium wilt control in chrysanthemums. It applies to soils varying from light sandy loams to moderately heavy clay loams; to soil temperatures of 45°F to 60°F; to soil moisture of a seedbed level extending to the soil surface; and to a completely pulverized soil tilth extending to at least a 9″ depth.

Experience has shown that the cloddiness of the soil and the level of soil moisture—particularly in the surface soil—are the key factors affecting disease control by fumigation. In one heavily infested soil where Verticillium wilt control in chrysanthemums was studied, 90% of healthy Verticillium-free plants were obtained in plots sprinkled two days prior to fumigation, in contrast to only 52% of healthy plants in beds not sprinkled. The dosage was three milliliters of chloropicrin to each square foot of soil surface in each instance. The sprinkling provided adequate moisture in the surface soil in the plot giving the better level of disease control.

Studies carried on at the University of California Deciduous Fruit Field Station at San Jose indicated that if the soil is moist to the surface at the time of fumigation, a light rolling will take the place of a water seal, and also that rototilling and rolling the fumigated soil 24 to 48 hours after fumigation will take the place of a water seal. Neither of these procedures is effective in soil dry two to three inches down from the surface. The Verticillium wilt fungus occurs in high concentration in surface soil, and if the soil is dry, the fungus escapes the action of the chloropicrin vapors.

Beginning in 1953, Verticillium wilt control in strawberries was studied in a 2¼-acre test plot near Soquel. From previous studies, the land was known to carry a heavy infestation of the Verticillium wilt fungus, and Verticillium wilt was responsible for the nearly complete failure of the strawberry planting during the three previous years.

A portion of a check area two years—1955—after fumigation with ethylene dibromide, showing the general up-and-down condition.

In November 1953, one acre was fumigated by the use of handguns. Three milliliters of chloropicrin was injected 6″ into each square foot, requiring approximately 480 pounds for the acre. The soil was moist up to the surface from recent rains. An area 20′ by 50′ in one corner of the acre was left untreated as a check. As additional checks, an adjacent area of 1¼ acres and a neighboring four acres were fumigated with six gallons of ethylene dibromide to the acre. Certified Shasta strawberry plants were planted in January 1954.

During the first growing year of 1954, an average of 14 plants to each 3,100—0.45%—showed Verticillium wilt in the chloropicrin fumigated acre. In no portion of the fumigated acre was the disease incidence higher. In the check areas the distribution of Verticillium wilt was spotty. Large areas failed, with as high as 82% wilt. On the average, and excluding the areas of near complete failure from wilt, 120 plants to each 1,060—11.3%—showed wilt.

Growth of the strawberry plants in the chloropicrin-fumigated area was exceptional. Feeder rootlets were long, glisten-

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Planting before fumigation. This area, showing a high evidence of Verticillium wilt in July 1953, was fumigated in November 1953, with chloropicrin, three milliliters per square foot, injected 6″ deep.

Vigorous growth of Shasta strawberries two years—1955—after fumigation with chloropicrin. Yields per acre the first year were 9.8 tons, the second, 16.7 tons, compared to four and seven tons in the checks.

FIG

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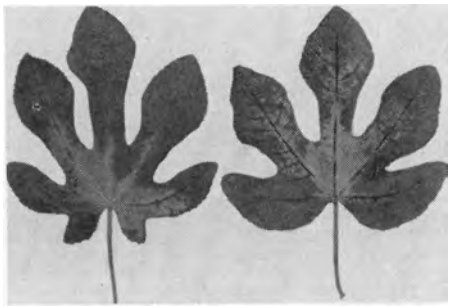
green, with small scattered white flecks. The eye is medium and the scales are chaffy. The meat is white or sometimes tinged with violet. The pulp is solid, light strawberry, with a distinctive fig flavor. The quality is very good.

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 development. 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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