Budwood as a Source of Verticillium Wilt in Greenhouse Roses

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VERTICILLIUM WILT, a serious disease resulting from infection by a soil-borne fungus, is important in California on many crops including potatoes, strawberries, cotton, cherries, apricots, chrysanthemums, and roses. Although it is a more important disease in greenhouse roses grown for cut flowers, it does not cause much trouble in roses grown for the home garden. This phenomenon has been difficult to understand because they are both propagated by budding into young, rooted cuttings of rootstocks grown under the same cultural conditions, and in the same soil types, and frequently in the same fields. Another point of confusion is that greenhouse roses are commonly grown on Manetti rootstock, which is resistant to *Verticillium* fungus, whereas garden roses are grown on Odorata, Dr. Huey (also called Shafter), Burr Multiflora or Ragged Robin, all of which are more susceptible than is Manetti.

To determine why greenhouse roses are more frequently diseased, an experiment was set up to discover souces of *Verticillium* in rose plants. The experiments were conducted at the University of California Deciduous Fruit Station, San Jose, on land known to be infested with the fungus. Rose propagation and culture methods used were similar to those of commercial growers—cuttings of the rootstock varieties were struck in December, budded with buds from commercial varieties the following June, lopped (tops of rootstock varieties broken over but not removed from plant to force the bud to develop) in July, and pruned to the budded variety in August.

The experiment consisted of budding five of the most commonly used rootstocks—Manetti, Dr. Huey, Burr Multiflora, Odorata, and Ragged Robin—with two of the common greenhouse varieties, Red Delight and Red Garnet. Plants were inoculated by (1) use of a contaminated knife during the budding process (touching the knife to a spore-producing culture of the fungus); (2) contaminating the water with spores of the *Verticillium* fungus at the time of the first flood irrigation, six to seven days after budding; (3) painting the lopping wound with spores of the fungus; (4) using buds from naturally infected bud sticks; and (5) no treatment other than growing the rootstocks in infested soil, which was common to all. Each of the five treatments consisted of 20 plants of each commercial rose variety on each of the five rootstocks.

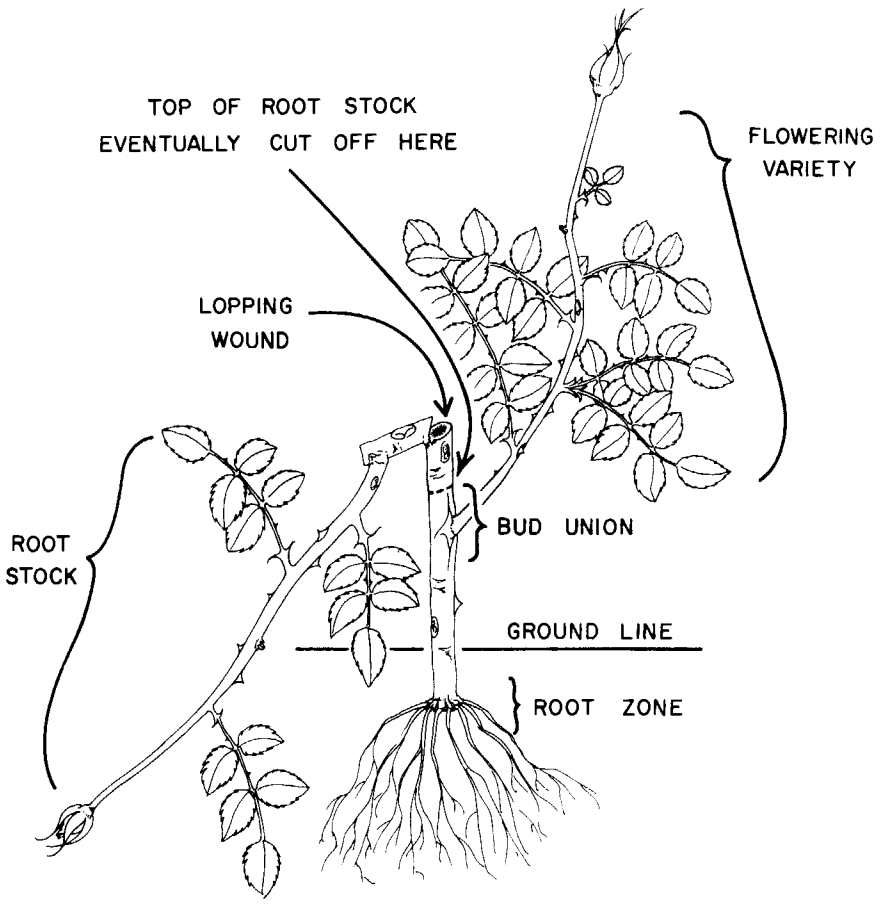
Infection was determined by cutting pieces from the experimental plants and placing them on culture media in the laboratory. Cultures were made from the root zones, bud unions, and tops of the flowering varieties of all plants after the first growing season (see sketch). In addition, the tops of the plants inoculated in the lopping wound were cultured at the time the rootstock top was cut back to the budded variety.

The greatest number of infected plants from these cultures (43%) resulted from using a contaminated knife. Inoculating the plants at the lopping wound transmitted almost as much infection (approximately 36% of the plants). About 12% of the plants became diseased when

SUSCEPTIBILITY TO VERTICILLIUM WILT OF ROSE ROOTSTOCK VARIETIES, BASED UPON NUMBER OF INFECTIONS IN ROOT ZONE AND BUD UNION

Rootstock	Percentage of infected plants	
	Root zone	Bud union
Manetti	0	4.0
Dr. Huey	1.9	8.4
Burr Multiflora	6.7	7.8
Odorata	17.1	24.4
Ragged Robin	35.5	44.6

Isolations of the Verticillium fungus (following inoculations) were made from areas of the root zone, bud union, lopping wound, and flowering variety as shown in sketch.



infected buds were used for inoculation. No infections could be attributed to inoculating the plants by adding spores to the flood irrigation water nor could any infection be attributed to growing the plants in soil known to be infested with the *Verticillium* fungus.

Diseased budwood

Although the possibility of the fungus gaining entrance through the pruning wound or the lopping wound was demonstrated, no infection was observed in any of the other plants in the experiment—indicating that, under field practices, the fungus does not infect plants in these ways. Although infested soil is frequently blamed as a source of infection, plants grown for one year in such soil did not become infected in these experiments. Thus, the results of the experiment indicate that the main means of infection is through the use of diseased budwood.

This conclusion also helps explain why the disease is more serious in greenhouse roses than in field-grown roses. Although both are propagated the same way, greenhouse rose varieties do not change as much as those used by home gardeners. By being in use longer, there is more chance for *Verticillium* to build up in a variety. Also, since greenhouse roses are forced the whole time they are grown for flower production, the tissues are growing continuously and tend to be more succulent—causing the plants to be more susceptible and the fungus to be more active throughout the life of a greenhouse planting. Since budwood for propagation of greenhouse varieties is taken from greenhouses producing cut flowers (while budwood for home varieties is taken from outdoor plantings), there is more chance that infected canes will be used as a source of budwood in the greenhouse. The experiments also showed considerable differences as to the susceptibility of the five rootstock varieties. The percentages of infected plants are given in the table.

Although Manetti is extremely resistant to *Verticillium*, budding an infected bud into a Manetti rootstock can result in an infected plant. In view of these findings, control should be sought by the use of *Verticillium*-free budwood in the propagation of greenhouse roses.

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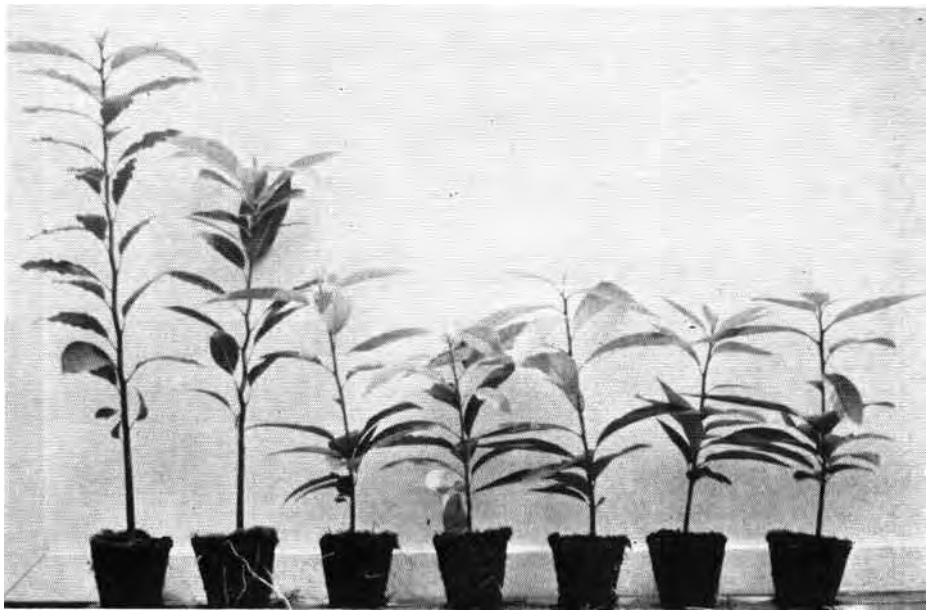

Duke avocado seedlings 5½ months after seed was soaked in gibberellin. Left to right: 10,000 ppm, 1,000 ppm, 100 ppm, 10 ppm, 1 ppm, 0—water only, and no soaking. (Note crooked internode areas of two plants at left.)

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Soaking Duke variety avocado seeds in high concentrations of gibberellic acid for 24 hours prior to planting increased the rate of germination, seedling height, and stem diameter.

THE DUKE AVOCADO has been known in California since the early 1920's, when many trees were planted because it has considerable cold-hardiness and wind resistance. The fruit is green, medium-sized, and early maturing. However, propagation has not been continued (except for an occasional tree) because the fruit is mediocre in quality and has a tendency to develop

EFFECTS OF GIBBERELLIN TREATMENTS ON AVOCADO SEEDLING EMERGENCE AND HEIGHT

TABLE 1.

	SEEDLING EMERGENCE COUNTS*						
Treatments	A	B	C	D	E	F	G
Date evaluated (1966)							
Jan. 1	1	1	2	0	1	8	5
Jan. 28	8	6	7	2	9	10	15
Feb. 4	12	11	16	5	12	12	18
Feb. 11	14	13	18	13	17	13	19
Feb. 18	17	15	20	15	18	15	19
Mar. 22	20	19	20	19	20	20	20
May 18	20	20	20	20	20	20	20

* Total of 20 seeds in each treatment, planted Dec. 21, 1965.

TABLE 2.

	AVERAGE HEIGHT OF SEEDLINGS IN CENTIMETERS*						
Treatments	A	B	C	D	E	F	G
Date measured (1966)							
Jan. 1	0.7	2.0	0.7	0.0	2.2	2.8	2.7
Jan. 28	1.7	2.5	2.3	3.0	1.4	4.8	3.6
Feb. 4	3.6	4.2	3.1	3.2	3.6	8.1	7.4
Feb. 11	5.4	6.1	4.7	2.6	4.7	11.6	10.8
Feb. 18	5.8	6.8	5.2	4.4	6.4	13.8	16.3
Mar. 22†	9.1	9.4	8.4	8.0	10.5	23.4	31.1
May 18	28.8	29.5	28.7	26.6	32.5	44.2	54.4

(See table 1 for number of plants used for these averages)
* 1 cm = .3937 inch.
† Seedling height of plants in treatments F & G on March 22 & May 18 were significantly higher (1% level).