

# Verticillium in Chrysanthemum

costly disease controlled by practice of culture-indexing and soil fumigation with chloropicrin

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**Verticillium disease** of chrysanthemum can be controlled by fumigation.

Experiments of the past two years showed that returns from fumigated land more than offset the rather high cost of treatment. At present the cost for the fumigant alone—chloropicrin—varies from 1¢ to 1½¢ per square foot of soil.

Previous to control by fumigation, losses were particularly severe in such varieties as Albatross, Indianapolis,

Waite, Pocket, White Mensa, J. W. Prince, and Paul Miller—all good shippers which make up the backbone of the northern California chrysanthemum industry.

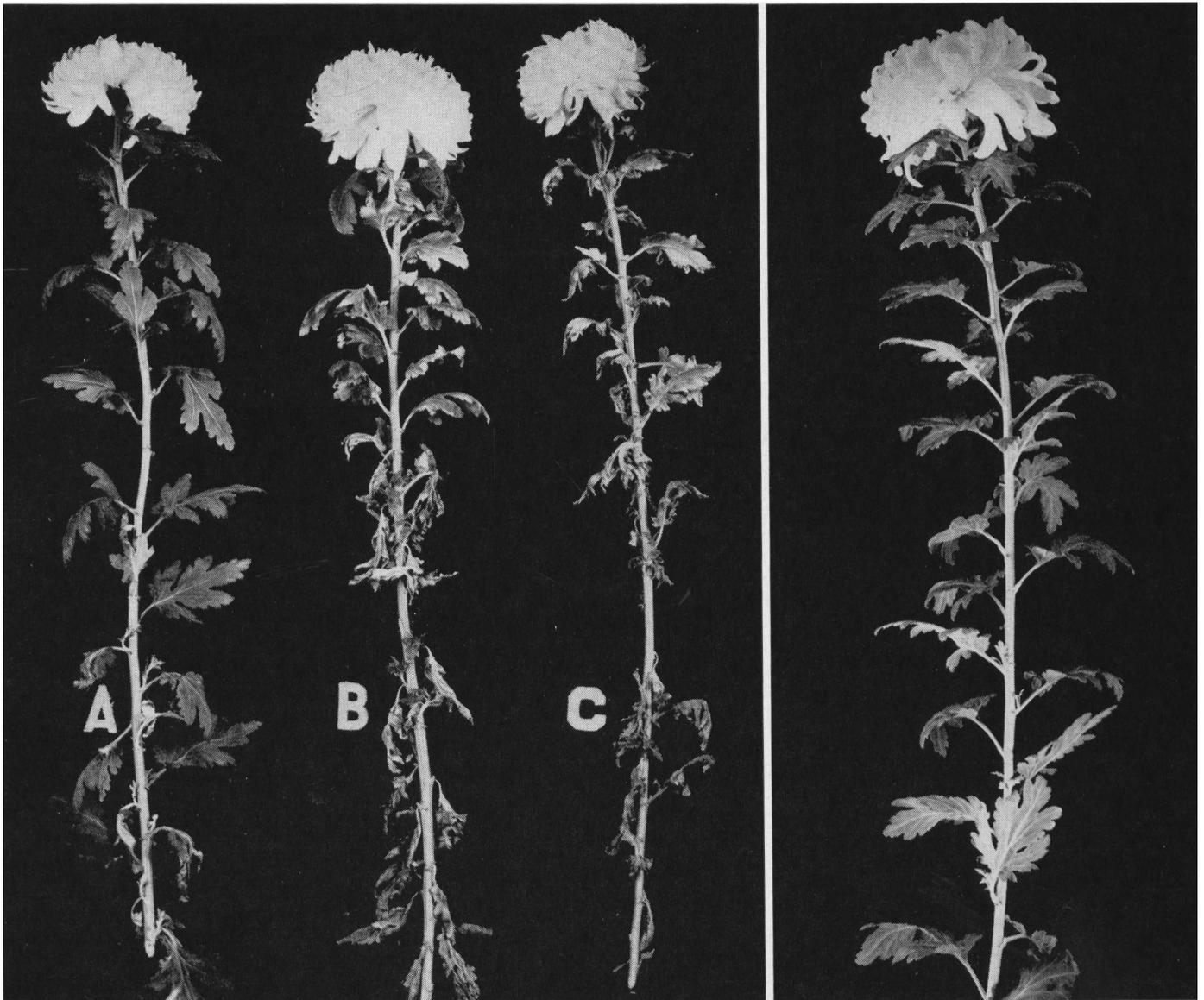
Increased land subdivision for housing in San Mateo and Santa Clara counties has forced many chrysanthemum growers to grow continually on the same parcel of land without rotation. Continuous cropping to the same susceptible

crop causes a rapid build-up of the Verticillium fungus in the soil and has intensified losses to the industry.

Chrysanthemum growers in San Mateo and Santa Clara counties have adopted a fumigation control as part of the growing routine and thus have forestalled a possible movement of the industry to other areas. Though relatively small in acreage, this intensive Bay Area industry

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**Verticillium wilt in a mild (A), moderate (B) and severe (C) form in the Albatross chrysanthemum, typical of production on old nonfumigated land. A healthy Albatross produced in fumigated soil is on the right.**



## CHRYSANTHEMUM

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try yields more than 15% of the total chrysanthemum production in the United States and has a gross annual income of over \$2,000,000.

Three factors—of fundamental importance in the *Verticillium* disease cycle in chrysanthemum—bear on control: 1. The fungus colonizes the infected plant after its death and forms resting sclerotia which persist for long periods in the soil. 2. The fungus is built up in the soil with each succeeding chrysanthemum crop, whether the varieties are resistant or susceptible. 3. The fungus can be carried undetected in planting stock.

Culture indexing of mother plant stocks to detect the *Verticillium* carriers—Typhoid Marys—became a practical reality some years ago and reduced the over-all disease problem about one half.

Chloropicrin, the tear gas of World War I—an old and well-known chemical—has proved to be the most effective soil fumigant tried to date against the *Verticillium* fungus. Other chemicals are being studied and will be reported in turn.

Laboratory experiments indicated that a dosage of chloropicrin lethal to *Verticillium* was somewhere between 2cc.—cubic centimeters—and 3cc. per square foot of soil—23 to 35 gallons per acre.

Field experiments during the past two years—with the very susceptible Albatross chrysanthemum as a test plant—indicated that the minimal dosage was 3cc. per square foot, as shown in the table below.

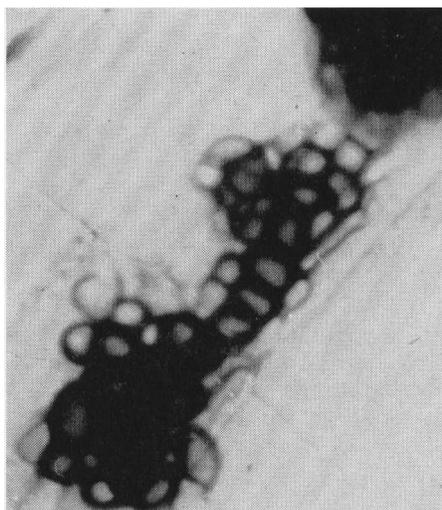
**Effects of Chloropicrin Fumigation.**

Dosage of chloropicrin per sq. foot	Potential flower production*	Visibly diseased plants**	Infected plants
	%	%	%
No treatment	18.0***	100.0	100.0
	21.0	100.0	100.0
2.0cc.	80.	28.	81.
2.5cc.	80.	22.	70.
	85.	19.	69.
	84.	25.	72.
3.0cc.	99.	1.	9.
	99.	1.	10.
Commercial treatments			
3.0cc.	99.	1.	11.
	85.	12.	48.

\* Potential flower production was estimated at 3.5 per plant or 560 per 150 sq. ft. of bed area, walk included.

\*\* Many of these plants produced one or more marketable flowers.

\*\*\* These flowers, though marketed, were cut from obviously diseased plants.



**Microsclerotium of *Verticillium* formed in infected root tissue under natural conditions. Greatly enlarged. These resting bodies in and on plant tissue are what the soil fumigant must kill.**

Every plant in each test plot was cultured—laboratory tested—for the *Verticillium* fungus, after the flowers had been cut. Always—by the end of the season—more plants were found to be infected by the fungus than had actually manifested the disease symptoms. For instance, in a fumigation plot of 160 Albatross plants in which only two showed the disease, fifteen were found to be infected when the plants were cultured. This means fifteen contaminated areas at the end of the season in a bed of approximately 150 square feet. Thus fumigation permits a good commercial harvest but does not completely eliminate the fungus. Fumigation must be done every year.

A great reduction in the amount and severity of the *Verticillium* disease, with attendant significant improvement in

plant growth, was achieved by the low dosages of 2.0cc. and 2.5cc. of chloropicrin per square foot. But an average of approximately 20% of the flowers was lost, and by the end of the season—December 1—approximately 70% to 80% of the plants were infected.

Experimental fumigation with 3cc. per square foot has given nearly complete control of the disease and has reduced the plants infected at the end of the season to usually less than 10%.

Commercial fumigation, as might be expected in the first year, has given somewhat variable results even in different portions of the same grower's field. Usually, however, satisfactory commercial control was achieved.

The method for fumigation, as recommended, is to prepare the land as for planting, working it 9" to 12" deep if possible, and to inject into the moist soil 3cc. of chloropicrin at each 12" staggered spacing. The injection depth is 6". A water seal which wets the soil surface 1/2" to 1" is then applied, and approximately two weeks are allowed for the gas to escape before planting. Satisfactory results have also been obtained by omitting water and in its place covering the soil with a plastic cover. Only culture-indexed, *Verticillium*-free plants should be planted in fumigated beds.

Nearly all the commercial fumigation was done by hand fumi-guns. Tractor-drawn power-injection machinery was used on a limited scale and shows promise of giving adequate control. Additional experimentation on this approach is desirable.

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**Diagram of a fumigation plot of approximately 150 square feet in area, showing the position and number of *Verticillium*-infected Albatross chrysanthemum plants—the black squares—at the end of the season. Forty per cent were at the periphery of the plot and only two showed symptoms of the disease. Healthy, noninfected plants are represented by the white squares.**

