treated with 10 lbs per acre of BAY 68138 and Dasanit.

The emulsifiable concentrates were diluted with water and applied through a hose with an aspirator for mixing. Each plot was treated with approximately 2 inches of water emulsion. The plots were sampled five weeks after treatment and the nematodes were extracted under mist.

Greenhouse test

In a greenhouse test, roses infested with *M. hapla* growing in 1-gallon containers were treated with DBCP. The treatment consisted of drenching the soil with the equivalent of 1 acre-inch of water (0.62 gallon per sq ft) containing 100 ppm (w) DBCP (37.1 ml 50 per cent E.C. per 100 gallons) at weekly intervals. The plants were not watered between treatments. Samples were taken weekly to evaluate the effect of the treatment on the nematode population and to study the behavior of the DBCP. The nematodes were extracted under mist and DBCP was recovered from the soil and analyzed.

The next test was conducted in the commercial planting in 3 × 4 ft plots. In this test the E.C. formulation of DBCP was mixed with water in a container and poured on the plots. Soil samples were taken at weekly intervals to check numbers of nematodes and DBCP content. The treatment and check were replicated three times.

In the final test, entire beds of two varieties were treated. The E.C.-DBCP was mixed in a galvanized container and pumped to the beds. The emulsion was distributed over the beds manually by moving a hose slowly down the length of the 49-ft bed. All beds were sampled weekly for nematodes and DBCP for five weeks and thereafter less frequently. Collection of production data was initiated seven weeks after application of the first treatment.

Results

The first experiment with BAY 68138, Dasanit, and DBCP (table 1) shows that none of the materials reduced the nematode populations after five weeks. The pot test (table 2) shows an abrupt decrease in the numbers of *M. hapla* recovered between the fourth and fifth weeks. The DBCP data show a steady increase in concentration of this chemical in the soil until the fifth week, at which time the concentration begins to decrease. Table 3 gives the results of the small plot triple treatment with DBCP. The nematode density in all plots was low. The treated plots had the same nematode density-time trend as those in the pot test. The DBCP recovered from these plots shows the same concentration-time pattern observed in the pot test.

Table 4 gives the results of the final experiment with the large planting beds. The pattern of nematode population reduction and the quantity of DBCP recovered from the soil is the same as in the two preceding tests. The decrease in the number of nematodes recovered from the treated plots occurs between the 29th and 36th day (in weeks 4 and 5) after the start of the experiment.

The collection of production data began seven weeks after the first application of the treatment. By this time a reduction in the nematode populations could be measured. The cumulative total number of blooms produced per bed was higher in the treated than in the untreated beds. At the end of the 26th week after the first treatment there was an average of 61 more blooms per bed in the treated Pink Sensation plots and 87 more blooms in the Golden Wave plots than in the untreated plots.

These experiments show that when the proper application technique is used, DBCP effectively reduces nematode populations around the roots of living plants. Past studies have shown that effective control of *M. javanica* with DBCP requires a 21-day exposure to a concentration between 20 and 25 ppm. DBCP can disappear from the soil by vaporization and leaching. Applications of DBCP should be repeated over a relatively short time interval to help maintain a lethal concentration for the required period of time. This study indicates that the same conditions that control *M. javanica* also control *M. hapla* and *X. americanum*.

These experiments show that the reduction in the population of these nematodes in the soil resulted in increased flower production. With a continuous harvesting of roses, yields show a cyclical pattern. It will be necessary to have yield records for an extended period of time to evaluate the efficacy of treatment and to determine the rate of increase in nematode populations.

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Control of

with

Verticillium wilt caused by Verticillium albo-atrum and sclerotinia white rot caused by Sclerotinia sclerotiorum are two diseases of commercial chrysanthemums in San Diego County. Previously, the only control of verticillium wilt was soil treatment with chloropicrin or steam prior to planting. In young plants sclerotinia can be prevented by these same soil treatments but tests reported here also show control possibilities by pre-plant application of fungicides on the soil surface. Sclerotinia control may be variable in a maturing cut-flower crop under moist greenhouse conditions where the fungus attacks high on the stems.

THREE EXPERIMENTS were conducted in commercial greenhouses to test new systemic fungicides and organic amendments for control of verticillium wilt. The third experiment coincidentally yielded results on sclerotinia control.

Experiment 1

Benlate 50W—formerly DuPont 1991—[methyl 1-(butylcarbamoyl)-2-benzimidazole-carbamate] was applied at rates of 1 lb and ½ lb per 1000 square ft of chrysanthemum bed. The fungicide in suspension was drenched over established four-week-old plants, White Iceberg variety, with a garden sprinkler can on October 11, 1967. Two gallons of solution were used per 80 sq ft treatment (180 plants). Each treatment was replicated three times.

No injury could be observed to the chrysanthemums. When the flowers reached harvest stage on January 8, 1968, a distinct difference in treatments was plainly visible. The untreated plots had yellow and necrotic foliage, typical

Verticillium and Sclerotinia of Chrysanthemums Systemic Fungicides

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of verticillium wilt, half way up the lower part of the stems. Only a few yellow leaves were apparent in the ½ lb Benlate treatments, and the plants in the 1 lb rate treatments had almost entirely normal green foliage. On January 31, ten basal stem samples were taken at random from each plot and aseptic isolations were made in the laboratory. Table 1 shows these results, confirming visual observations of the treatments.

TABLE 1. PERCENT OF CHRYSANTHEMUM STEM SAMPLES, OUT OF 30, INFECTED WITH VERTICILLIUM ALBO-ATRUM

Treatment	Diseased
	%
Control	73.3
Benlate (50W) 8 oz/1000 per sq ft	40.0
Benlate (50W) 16 oz/1000 per sq ft	3.3

TABLE 2. PER CENT OF CHRYSANTHEMUM STEM SAMPLES, OUT OF 40, INFECTED WITH VERTICILLIUM ALBO-ATRUM

Treatment	Infected
	%
Pine shavings 1 lb/sq ft + 1% nitrogen	70.0
Redwood shavings 1 lb/sq ft	87.5
Peat Moss 1 lb/sq ft	87.5
Benlate 50W oz/1000 per sq ft, preplant, mixed in top inch	75.0
Benlate 50W 8 oz/1000 per sq ft, post plant drench (13 days)	35.0
TBZ 60W 6.7 oz/1000 per sq ft, preplant, mixed in top inch	75.0
TBZ 60W 13.3 oz/1000 per sq ft, post plant drench (13 days)	90.0
Benlate 50W 4 oz/100 gal + 8 oz surfactant F. post plant spray (6 days), again at 4 weeks	95.0
Benlate 50W 8 oz/100 gal + 8 oz surfactant F. post plant spray (6 days), again at 4 weeks	100.0
TBZ 60W 4 oz/100 gal, post plant spray (6 days), again at 4 weeks	97.5
TBZ 60W 8 oz/100 gal, post plant spray (6 days), again at 4 weeks	97.5
Control	97.5

TABLE 3. PER CENT OF CHRYSANTHEMUM PLANTS INFECTED WITH SCLEROTINIA, OUT OF 180 PLANTS PER PLOT.

Treatment	Infected
	%
Control	53.3
Benlate 50W 8 oz/1000 per sq ft	27.6
Benlate 50W 16 oz/1000 per sq ft	23.9

Experiment 2

In March 1968, twelve treatments on 40-square-ft plots (90 plants) were replicated four times. Three treatments included the addition of pine shavings, redwood shavings, and peat moss at the rate of 1 lb of dry material per square foot of soil. These were incorporated to a depth of 6 inches prior to planting. Benlate 50W and TBZ (Thiabendazole) 60W [2-(4-thiazolyl) benzimidazole] were applied as pre-plant soil incorporations, post-plant drenches, and post-plant sprays. Yellow Iceberg chrysanthemums were planted on March 20. Basal stem samples, 10 per plot, were taken on July 24, 1968, and aseptic isolations were made in the laboratory. These results are shown in table 2.

Experiment 3

Treatments were identical to experiment 1. The Benlate drenches were applied November 6, 1968, four weeks after plants were established. The treatments covered 80 sq ft, replicated six times. The variety used was Yellow Iceberg. In this experiment verticillium wilt was not apparent, but a severe infection of sclerotinia developed during a prolonged rainy period in January and February. The site of fungal infection was usually half-way up the stem, or about 24 inches above the soil surface, which indicates infection from airborne spores. On March 5, 1969, marked differences were apparent between the treated areas and the controls. Plants infected with sclerotinia were readily evident due to wilting or collapse. Table three shows the percentage of diseased plants out of 180 plants per plot.

Results

Results of these experiments indicate that Benlate is effective for reducing infections of both verticillium and sclerotinia in greenhouse chrysanthemums. Post-plant drenches of either 8 oz or 16 oz of the 50W formulation per 1000 sq ft of bed four weeks after plants were established were both effective. TBZ at 6.7 or 13.3 oz of the 60W formulation, similarly applied did not give satisfactory control of verticillium.

Pre-plant treatments of either Benlate or TBZ mixed into the first inch of soil or plant sprays of both materials six days and again four weeks after planting were not effective. Soil incorporations of either pine shavings, redwood shavings, or peat moss were not effective in controlling verticillium. Sclerotinia was effectively reduced with the same post-plant drench of Benlate as was used for verticillium. TBZ was not tested for sclerotinia control.

Two post-plant Benlate sprays at the rate of 8 oz of 50W formulation per 100 gallons applied at 1 gallon per 258 plants represents less than one-fifth the amount of material applied compared with a single drench of 8 oz of Benlate 50W per 1000 square ft of bed. This may account for the ineffective control of verticillium with spray treatments of Benlate as used in experiment 2.

Additional experiments are needed to test higher rates of TBZ in post plant drenches and higher rates of TBZ and Benlate applied as sprays. The fungicides used in these experiments are not registered for use on chrysanthemums. This report does not constitute a University of California recommendation.

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