Can We Cure Nematode Infected Plants?

C. E. Williamson, Department of Plant Pathology
Cornell Ornamentals Research Laboratory
Farmingdale, Long Island

The damage caused by parasitic nematodes is due primarily to the feeding on plant tissues. To feed, live, and reproduce, nematodes may enter, may be partially embedded, or may be outside the plant. The living habits may be the key to whether or not we can cure the infected plants by chemical therapy. Logically, the nematode that is outside the root should be easier to reach and kill than one that is entirely embedded in the root tissue. This should hold true both for established plants and for bare root planting stock.

The origination of plants, either from seed or some type of planting stock, is even more important than cultural practices in preventing a nematode problem. In steamed soil, annual crops, especially those grown from seed, rarely are damaged severely. Perennial crops grown from some type of planting stock are more likely to develop nematode troubles, because microscopic nematodes travel as unnoticed contaminants with bulbs, tubers, roots, and plants as well as in soil accompanying plants. Any prudent grower discards obviously poor planting stock. However, planting stock with unobserved nematode infections may be used which will nullify the benefits of any pre-planting treatment. For this reason effective post-planting and eradicatory pre-planting treatments for nematode infected plants must be developed. This article summarizes our work on treatments both of established and bare root plants and indicates certain areas that need further investigation.

One objective of our research is to develop methods for eliminating or reducing the population of nematodes on established plants. To do this we tested many chemicals for nematocidal ability and phytotoxicity. Of these tested only three, Nemagon, Fumazone and V-C 13, are effective nematocides and reasonably safe. Nemagon and Fumazone are identical chemically. Since Nemagon was available first, most of our work was with this material. Nemagon is a highly effective nematocide as indicated by excellent control at quite low rates of application, but is phytotoxic at higher rates. V-C 13 is slightly less effective but is a much safer material. The results of one test with these chemicals applied as drenches at planting time is sufficient to show nematocidal efficacy. In this test rooted, nematode-free cuttings and root knot infested soil were used. The results are summarized in table 1.

Both chemicals proved effective and safe for application at planting time. Other experiments demonstrated

Nematodes

(*continued from page 1*)

Table 1: Relative nematocidal efficacy of Nemagon and V-C 13 at two dosage levels.

Chemical	Rate of application in gallons active/acre	Percent control
Nemagon	0.5	25.5
Nemagon	1.0	90.4
V-C 13	4.0	62.2
V-C 13	8.0	94.1
Check	....	0.0

that (1) quickness of kill was directly related to dosage applied, (2) maximum kill was reached in approximately three weeks, and (3) both chemicals were effective as a pre-planting treatment with control comparable to that obtained with such standard pre-planting fumigants as D-D mixture and ethylene dibromide.

The efficacy of post-planting application of Nemagon and V-C 13 was demonstrated in another experiment. A naturally infested greenhouse soil from a commercial rose range, and small, nematode-free, own-rooted rose plants, variety Better Times, were used. One week after the plants were set in the infested soil, Nemagon or V-C 13 was applied in sufficient water to just saturate the soil. A steamed soil and an untreated soil series were included for comparison. After 11 months the fresh weight of tops and roots were obtained, the nematodes extracted from the soil and roots, and the number of each kind of nematode counted. The results are presented in table 2. Values in the table are average per plant.

Table 2: Effect of different treatments on plant growth and nematode control.

Treatment	Top weight (grams)	Root weight (grams)	Parasitic nematodes
Steam	34.6	58.8	1.25*
Nemagon	37.0	44.8	2.5
V-C 13	27.1	39.9	523.3
Untreated	13.3	32.0	2080.0

* Probably carried in splashing water.

These results, representative of other experiments, demonstrated that both Nemagon and V-C 13 can effectively reduce nematode populations on established plants. Visible differences in plant height and general growth indicated that both Nemagon and V-C 13 were somewhat phytotoxic. The differences in root weights also indicate phytotoxicity, but no significant differences appeared in fresh weight of tops. The plants in the untreated, nematode infested soil were stunted, chlorotic, and produced mostly blind wood.

Yield data have been obtained in one test with roses. In a commercial greenhouse one bench, known to be infested with nematodes by previous indexing of soil, was selected. In June 1958 the plants were cut back, and the flower cut then recorded for August, September, and October. In March 1959 the bench was treated with Nemagon at the rate of 1 gallon active per acre. The plants were again cut back in June and the flower cut recorded for the same three month period. Total flowers cut in the three month period in 1958 was 10,061, the total flowers cut for same three months after treatment was 11,167. The increase in number of flowers cut does not reflect the increase in quality that was obvious by the difference in growth of the plants following treatment. A comparable untreated bench in the same house did not show a similar increase for the same three month period in the second year.

Similar plant growth responses have occurred in other demonstration trials in commercial ranges where nematodes were causing reduced plant growth. However, flower production records were not kept. Additional data are much needed on change in production following treatment.

A second aim of our research is to devise methods of eradicating nematodes on and in the roots of bare root plants. Not only would such eradicatory treatments have application to certain florist crops, such a rose, gardenia and camellia, but also to the large and important nursery industry in New York State. In early screening tests many chemicals were used as root dips on root knot infected plants, but the chemicals available were either ineffective or phytotoxic. Root dip tests were resumed about 2 years later when new materials became available. Two experiments were conducted with 5 and 7 year old, nematode-infected rose plants, variety Better Times budded on Manetti, discarded from commercial rose ranges. Prior to selecting the plants for the test, nematodes were extracted from soil and root samples to determine the kinds and numbers present. The infected plants were dug, washed, pruned and sorted into comparable lots. Bundles of plants were taken at random, dipped in the chemical solution, allowed to drain for 2 to 3 minutes, then potted in steamed soil in steamed 8" clay pots. Plants were spaced on bare wood benches to minimize accidental transfer of nematodes. When the plants were harvested after 6 months, excellent to perfect control of Pratlenchus (meadow or lesion nematode) and Criconemoides (ring nematode) was obtained with a 10 minute soak of 1% Nemagon or 0.125% 18,133EC solution or with a 30 minute soak in 0.1% Thimet solution. In a second trial with rose plants infected only with Pratylenchus, the same treatments produced similar results.

Because of the excellent control, small scale grower trials were set up to observe plant growth and varietal response under commercial conditions. One grower dipped several lots of Better Times and Golden Rapture roses, budded on Manetti, in 1% Nemagon solution for 10 minutes without any plant damage. In a second trial, Nemagon 1% for 10 minutes, 18,133EC 0.125% for 10 minutes, and Thimet 0.1% for 30 minutes were used on three varieties, White Charm, White Bouquet, and Golden Garnette, all budded on Manetti. The roots on the White Bouquet and Golden Garnette were quite dry and somewhat shriveled, while the roots on the White Charm were moist and in good condition. All plants were treated and planted on May 11. When observed on May 27, the buds on White Bouquet and Golden Garnette plants treated with Nemagon were definitely delayed and the shoots that were growing were stunted. By 6 weeks the Nemagon-

(*continued on page 5*)

Nematodes

(continued from page 3)

treated Garnette had recovered, while White Bouquet was still stunted and had fewer breaks. After 18 weeks the effects of the Nemagon treatment are still evident on White Bouquet. Possibly the condition of the roots was correlated with the injury, but further work is necessary to determine if this is a varietal difference.

The excellent control of Pratclenchus, which lives both inside and outside of roots, achieved with root dips encouraged further tests with root knot infected plants. The results of a root dipping experiment with Weigelia were completely negative, but a second experiment with privet indicated that a soak in a 0.25% solution of 18,133EC for 30 minutes gave complete control of root knot nematode. The results with privet are encouraging but in the light of all previous failures must be verified. Further work is now in progress on this phase.

DISCUSSION

Although Nemagon, Fumazone, and V-C 13 take 2 to 3 weeks to achieve maximum kill, they are effective in lowering the population of nematodes in the soil. However, these materials are somewhat phytotoxic and should not be used indiscriminantly. Nemagon (and Fumazone) are generally used at 0.5 to 4.0 gallons active per acre. This chemical is highly phytotoxic to many kinds of plants at rates much in excess of 4.0 gallons per acre. Our results indicate that 0.5 to 1.0 gallon active per acre is equal in effectiveness to higher rates. Use of these lower rates allows a greater margin of safety to plants and permits a second application at a later date. Rose plants were killed by a single application of 3.36 gallons active per acre, but tolerated 2 applications of 2.0 gallons active applied 8 months apart. V-C 13 apparently is a safer material to plants, but 16 to 24 gallons active per acre is necesssary for effective control. At these rates the cost factor becomes important even in greenhouse culture.

When nematodes are definitely limiting plant growth, the stimulation of plant growth resulting from nematode control more than offsets the decrease in growth caused by the chemical. Because of the phytotoxicity, we do not recommend applications of either chemical unless the presence of moderate numbers of parasitic nematodes can be demonstrated and correlated with plant growth.

A reduction in nematode population alone is not sufficient to obtain grower acceptance, and use, of nematocides —we also must prove that a paticular treatment will yield a profit. A ratio of 4 to 1 between selling price and cost of production is a measure commonly used by many people associated with Agriculture. In other words an application of a particular material should yield a return of four times the total cost of that treatment. For example, if chemical, labor and use of application equipment cost $40 to treat an acre, then the selling price of the products from the acre must increase by $160. In our test Nemagon applied to a bench of rose moderately infected with nematodes increased the number of flowers cut by 1006 in a three month period. The cost of chemical and labor for application amounted to approximately $3.50. If we assume a selling price of 5 cents per flower, this single application returned a handsome profit to the grower.

Dipping or soaking roots in chemical solutions appears promising for cleaning up bare roots infected with certain kinds of nematodes. The success obtained in two experiments with infected rose plants warrants small scale grower trials if an eradicant treatment of bare root planting stock seems advisable. For a trial do not treat more plants than you can afford to lose. Keep in mind the variation in plant tolerance observed on the three rose varieties all budded on Manetti understock! Control of root knot nematode with root dips may prove feasible but further work is necessary.

Progress is slow on these phases of nematode control. Although acceptable post-planting treatments have been developed, the search for safer and more effective materials continues. In the eradicant root dip work we need to determine the kinds of nematodes controlled as well as plant tolerance to the chemicals. Here, too, the screening program to find safer and more effective materials must continue. From the results so far we can surely look forward to a time when nematode infected plants can be "cured."

SUMMARY

Nemagon, Fumazone, and VC-13 are effective for treating plants in place. Because of their phytotoxicity these materials should be used only if a nematode problem is known to exist.

Root dips appear to have promise in eradicating certain kinds of nematodes from bare root planting stock.