

## AGRICULTURE

# The Farmer's Fiery Serpents

**Nematodes afflict man and animals, but it is because of the huge toll in crops destroyed by these tiny animals that scientists are working on new control methods.**

By **BENITA TALL**

➤ **NEMATODES ARE** everywhere. So small that most are invisible to the naked eye, these animals are found in deserts, polar seas, on mountain tops and in the waters of hot springs.

They are parasites of man, fish, birds, animals, insects and plant life. In man, nematodes causing disease include hookworm, pinworm and the *Trichinella* worm that causes trichinosis. While there are 32 known species of nematodes that attack man and many more that infest domestic animals, causing serious losses among cattle and sheep for example, there are more than 1,000 different species of nematodes that attack plants.

The damage these microscopic worms inflict on American farms amounts to \$500,000,000 a year. They destroy more than one-tenth of the crops American farmers grow each year.

## Nematology: A New Science

Today there is a new agricultural science, nematology. Just a few years ago, however, scientists believed there was only one plant disease caused by one nematode, "the nematode." Now there are many nematodes known to parasitize every kind of plant, from citrus trees to rose bushes, alfalfa, strawberries and potatoes.

The nematodes that live on—and in—plants come uniquely equipped to dine off their hosts. At the front end of their body is a mouth with a hollow, needle-like spear or stylet. Behind this stylet is a muscular esophagus together with digestive glands. A nematode eats by inserting its stylet into a plant cell, in most cases a root cell, and sucking out the plant juices. Some nematodes first inject digestive gland fluid into the cell which "softens up" the plant.

In addition to taking away vital plant fluids, nematodes also damage the plant by mechanical injury. Some pierce through the cell wall in their travels through the plant root rather than moving between cells.

Signs that nematodes have been at work invading and feeding on plant tissues include stunted growth, wilting, leaf discoloration, stunted roots and galls or swellings.

It is partly because none of these symptoms is specific for nematode damage that scientists have overlooked the pests as the causes of so much extensive injury to agricultural crops. Sudden death or reduction in crop yield is not typical of nematode infestations. In most cases the blame has been put on drought, lack of fertilizer or "worn out" soil. The second reason nematodes have

only recently received the attention they deserve is a complex one, having to do with evolution, man's farming practices and the nematode's physiology.

Nematodes are primitive animals both in anatomy and in the sense of having been on earth for millions of years. Some scientists believe nematodes that burrow into the muscle tissue of the legs may be the "fiery plague" mentioned in the Bible. They were part of the scene when man began farming.

When a farmer's lands were worn out, or, as was more likely the case, the nematode population became so high that his crop yield was severely reduced, he moved on to untouched soil. On land given over to one-crop farming the problem of nematode infestation was, of course, most serious.

Here the pest is given whole acres of the plant it requires as a "host" and the number of nematodes per acre can build up to several billions. In one way this has been

beneficial. Intensive, one-crop farming has helped uncover the nematode menace. With new land scarce and a growing human population to feed, researchers looked for something besides bacteria or insects, drought or tired land that was destroying crops.

## Hundreds of "Worms"

What the researchers began to discover, beginning in the 1940's, was that there are literally hundreds of different kinds of nematodes eating away at the farmers' crops. The variety is a challenge to control methods.

Some of these extremely small, soil-borne pests are adapted to living on only one particular plant, others will infest a number of different plants. (Some nematodes attacking animals may grow several feet long, so even small size is not an infallible characteristic.)

Most nematodes are worm-shaped, but some change shape becoming nearly round or kidney-shaped at some stage in their life cycle.

Nematodes have complete reproductive systems with both males and females known to occur. Yet many species have been de-



**NEMATODE DAMAGE.**—A farmer shows what can happen when crops are grown in nematode-infested soils. Nematodes have gotten at the carrots at the left. The other bunch was grown in soil treated with soil fumigants, such as those developed by Shell Chemical Corporation, one way of controlling nematode damage. The insert, upper left, taken by U. S. Department of Agriculture, shows a dagger nematode, *Xiphinema diversicaudatum*, penetrating a root.

scribed that seem to lack males and asexual methods of reproduction are used by the females. Some females lay as many as 15,000 eggs.

Associated with the nematodes' reproductive processes is a further characteristic that makes some kinds particularly hard to control. This is the resistance of nematode eggs to unfavorable conditions, such as dryness. Some species have been known to lie dormant in the soil for 17 years until conditions were again suitable for growth.

While the usual method of attack is underground, nematodes also feed on plant leaves, stems and flowers. They "swim" along in the thin surface film of water found on the plant parts and on soil until their destination—the plant cell—is reached.

### Chemicals for Cures

Chemical compounds are currently being successfully used as nematocides. Applied as soil fumigants, their use has increased farmers' yields in some cases by as much as 25%. Although many control methods seem adapted only to small-scale tests or to expensive cash crops, these chemicals can provide the general farmer with a control method.

Attempts at controlling nematode damage have ranged from electrocution to steaming or flooding the soil, rotating crops, using trapcrops, hatching agents and trying to breed nematode-resistant crops. None of these methods has been successful as a generally acceptable control technique. Some, such as steaming, are suitable for greenhouse use where the affected area is small. Other methods, such as using hatching agents to get the nematode out of its protective cyst, are still in the research stage.

### Breeding for Resistance

Some varieties of nematode-resistant alfalfa are being grown commercially, but most known resistant plants are not commercially acceptable. Active breeding programs in developing resistant potatoes, soybeans, cotton and tobacco, among other crops, are now going on in all parts of the world.

Crop rotation has been used, knowingly or not, as a control method for years. When yields of one crop became unprofitably low, the farmer switched to another crop. In cases where the nematode population in the soil had its food supply removed, crop rotation was successful. However, usually there is more than one species of nematode in the soil. The second crop may simply provide the right environment for its growth.

Soil fumigation is probably the most practical control for nematode damage now available to the farmer. It may be used in combination with other methods, such as rotation. Nematocides such as ethylene dibromide, and D-D and Nemagon soil fumigants have been successfully used in field tests and actual farming.

With more nematodes being discovered each year, efforts at finding controls become increasingly necessary. Crops such as the nation's billion-dollar potato crop and the \$200,000,000 tomato crop continue to be threatened as long as the fiery serpents are around.

Science News Letter, March 1, 1958

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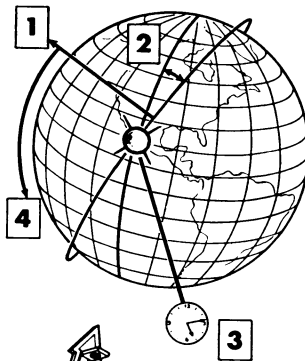
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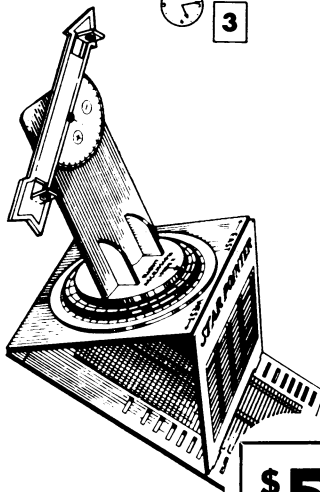
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