



Better Turf for Better Golf

# TURF MANAGEMENT

from the USGA Green Section

## THE NEMATODE OUTLOOK IN TURF

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**A**LTHOUGH nematodes have been described in written records since biblical times, plant nematology was not recognized until 1855 when Berkeley (1) associated root galls on cucumbers with nematodes. From then until 1940, work in plant nematology dealt largely with the root-knot organisms. However, since 1940 there has been greater recognition of other kinds of plant parasitic nematodes.

In 1951, Tarjan and Ferguson (9) reported nematodes with the "yellow tuft" disease of bentgrass in Virginia. Damage by stubbyroot nematode (*Trichodorus spp.*) was found in Florida by Kelsheimer and Overman (5) on St. Augustinegrass in 1951 and on improved bermudagrass in 1952. Sting nematode (*Belonalaimus gracilis*) was discovered in heavy infestation in the bermudagrass turf nurseries at the University of Florida in 1953.

Within the past two or three years, increasingly more attention has been given to nematodes as parasites on turfgrasses. Surveys conducted in Rhode Island by Troll and Tarjan (10) and in Florida by Christie, et al. (2) indicate that several species of nematodes may be causing serious damage on both northern and southern turfgrasses as either primary or secondary plant invaders. Following their survey in

Rhode Island, Troll and Tarjan stated pointedly that "the old idea about nematodes not causing significant damage in colder climates is fallacious." As such work continues and is expanded to other areas, undoubtedly new parasitic species will be revealed and the nature of presently recognized forms better understood.

### *Description and Symptomology*

Nematodes, called "eelworms" by the British, are members of the animal kingdom, very small to microscopic in size. They are found in almost all soil environments as part of the natural biologic complex. A heavy population may number thousands in a handful of soil. However, many of these myriads of nematodes are not parasitic to plants. In fact, some are useful in the breakdown of organic matter, while some are predatory on other nematodes and on insect life.

Parasitic forms of nematodes feed on plant rootlets. Some forms (called ectoparasites) attack the small feeder roots and root hairs externally while other forms (endoparasites) move inside the roots to feed. Infested roots become stubbed-off, restricted, and appear brown and necrotic. In extreme infestations, root hairs and feeder roots may be destroyed and the en-



**Research Assistant Robert A. Lagasse, of the University of Florida Nematology Laboratory, is collecting nematodes in Baermann funnels for later identification and counting.**

tire root system may be reduced in depth to less than two inches. In addition to direct damage, lesions formed by the feeding nematode may become ports of entry for root rot organisms and other fungi. Under such circumstances the secondary organisms may cause more damage than the nematodes.

Several visual symptoms are associated with nematode damage to turfgrasses. The infestation will usually begin in a localized area and spread outward from this center. In the early stages of damage the turf will begin to show loss of vigor. Gradually the turf will become thin and exhibit a "melting out" or dieback condition. More intensive management will be required to maintain growth. As damage progresses a spreading chlorotic condition will develop and the grass will no longer respond to treatment. Finally, the turf will show

serious wilt, numerous symptoms of mal-condition and a severe state of decline in both above and below ground parts. The increasing inefficiency of the root system to supply the water and nutrient requirements of the turf is largely responsible for the diseased and declining condition of the above ground parts of the grass.

#### *Positive Identification*

While the above ground appearance of the turf can be used as one of the signs of nematode injury, this criterion alone should not be relied upon for diagnosis. Numerous other factors may cause similar vegetative symptoms. Mineral element supply, general nutritional status, improper water relations, poor soil aeration, disease, and complexes of these and other factors may be primary causes of turf decline.

Since nematodes are receiving increased

popular emphasis, there will be an increasing tendency in many cases to blame nematodes for turf damage caused by some of the above mentioned aspects of poor management. In such cases considerable money and effort will be spent in applying materials for nematode control, only to result in lack of response and disappointment. Therefore, it is essential that strong emphasis be placed on proper diagnosis of nematode damage before control measures are taken. It will probably be a long time (if ever) before we have enough specific information on symptoms to reliably use vegetative characteristics alone for identification of nematode injury.

Since nematodes are soil inhabiting pests, it is necessary to go underground to find them. Even then, the mere presence of nematodes does not prove cause of turf decline. As already mentioned, the soil may contain many species of nematodes not parasitic to plants. Furthermore, nematodes that cause damage to other plants may not injure turf grasses. An example is the well known root-knot nematode group (*Meloidogyne spp.*). This group has long been recognized as a pest of many cultivated plants, yet has not been considered a problem on turf.

It follows, then, that diagnosis of nematode damage requires positive identification of recognized parasites by a trained worker. Adapted laboratory procedures and equipment are necessary. Identification service is performed by a number of state and federal laboratories. Some commercial concerns are establishing such laboratories and providing trained technologists to offer both research and extension identification service.

### **Sampling for Nematode Analysis**

Proper collection and preservation of samples is of paramount importance in the identification of nematodes. These very small animals seem to develop in population centers. Although individual nematodes probably do not migrate far, populations may develop rapidly under favor-

able conditions. Unless the suspicious area is thoroughly and uniformly sampled, the analysis may not give a true picture of the species involved and of the actual degree of infestation.

Several samples should be collected from the fringe immediately around the area of heaviest damage and also from relatively healthy areas. Each group of samples should be mixed into a composite sample representing each of the respective turf areas. At least a pint of soil should be submitted for each laboratory determination. Comparison of such contrasting areas often reveals important facts useful in diagnosis. Dead areas of grass should not be sampled for nematode analysis. Nematodes feed largely on live root tissue and once this food supply is dead or exhausted, the population will die off or migrate to the fringe areas in search of fresh food. For this reason, the largest nematode population will often be found in the fringe areas adjacent to dead or badly declining patches of turf.

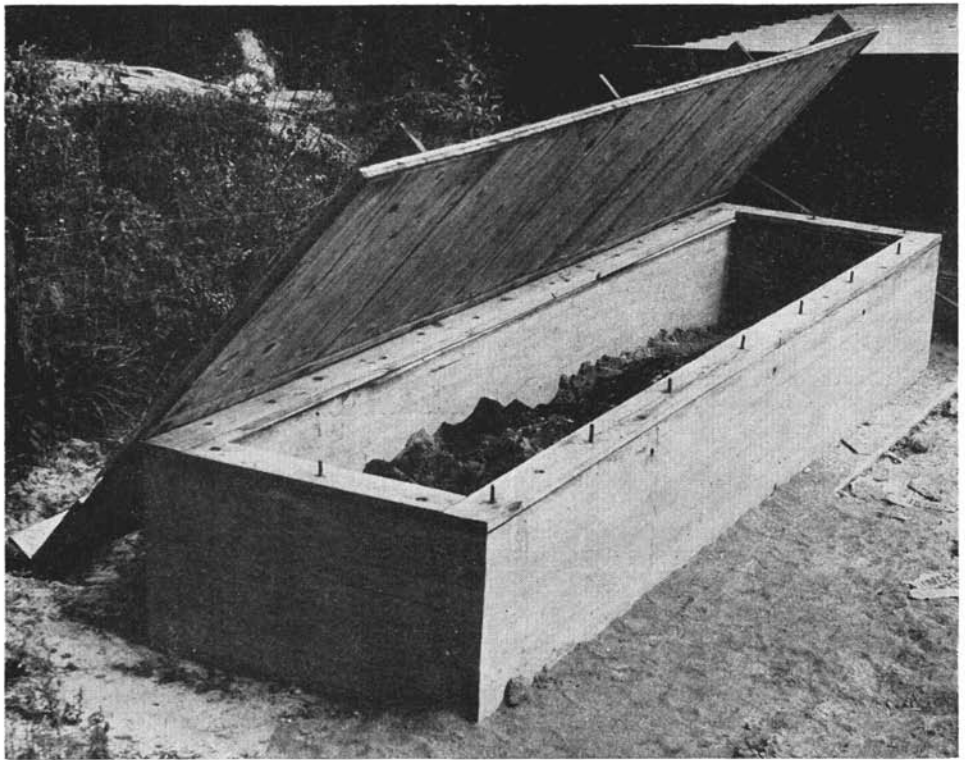
It is extremely important that samples for nematode investigation arrive at the laboratory in a moist condition. Dry soil and dead or desiccated grass samples are not suitable for laboratory identification procedures. Samples should be collected when the soil is moist (but not saturated) and packaged in protective containers which will prevent loss of moisture by evaporation. Plastic bags are excellent for this purpose.

### **Nematode Control**

Control of nematodes in turf may be divided into three phases: 1) in the plantbed, 2) topdressing sanitation and 3) in established turf.

### **Plantbed Sterilization**

Much work has been done on plantbed sterilization, or fumigation, for the control of nematodes. Several effective chemicals have been developed and are in widespread use as plantbed sterilants. Some of these materials are D.D., E.D.B., chloropicrin and methyl bromide. Steam has been



**This is a soil sterilization bin used to treat topsoil material at the University of Florida Turf Research Nurseries. The bin is made of reinforced concrete with counterbalanced, air tight lid. Methyl bromide is introduced through five entry ports around the sides.**

used very effectively for such intensive operations as nursery or greenhouse beds. Newer materials being evaluated include allyl alcohol, Craig's Experimental Material 974 and Stauffer's Vapam. Comparative properties of these various materials have been discussed (6).

Where turf is being established in areas found to be infested with parasitic nematodes, soil sterilization is a basic requirement. On more valuable areas such as greens, tees and high quality lawns, it would be wise to select a sterilant also effective against weeds and weed seeds. The upper 10-12 inches of putting green topsoil could be sterilized in bins before it is placed on the green. It is more practical, however, to sterilize the topsoil in place on the green after grading, leveling, and mixing have been completed. It should be

pointed out that on golf greens the effective depth of sterilization should exceed the depth of the cup cutter. Otherwise, the green will become re-infested in the routine process of changing the cup.

### **Topdressing Sanitation**

A nematode-free green may be infested by the use of contaminated topdressing materials. It is poor management to risk infestation of nematodes on newly planted, sterilized greens or tees. This is entirely a matter of topdressing sanitation. Sterilization bins for handling topsoil and topdressing materials (similar to the one illustrated) can be constructed easily and inexpensively. Methyl bromide has proven to be one of the most effective and practical materials for this type of sterilization.

Gas-type sterilants are more suitable and effective than drench type materials for

compost sterilization. Drenches must be applied in high gallonage to uniformly wet the loose soil and avoid channeling effects. Large volumes of water cause drainage problems around the compost bin, leach away valuable nutrients, and leave the top-dressing in a wet and unusable state.

Where sterilization bins are not available, compost material may be spread upon the ground in long, shallow piles, covered with sheets of plastic and quickly sterilized with methyl bromide. This relatively cheap but very important process insures nematode, weed, disease and insect free top-dressing material for producing high quality greens.

### **In Established Turf**

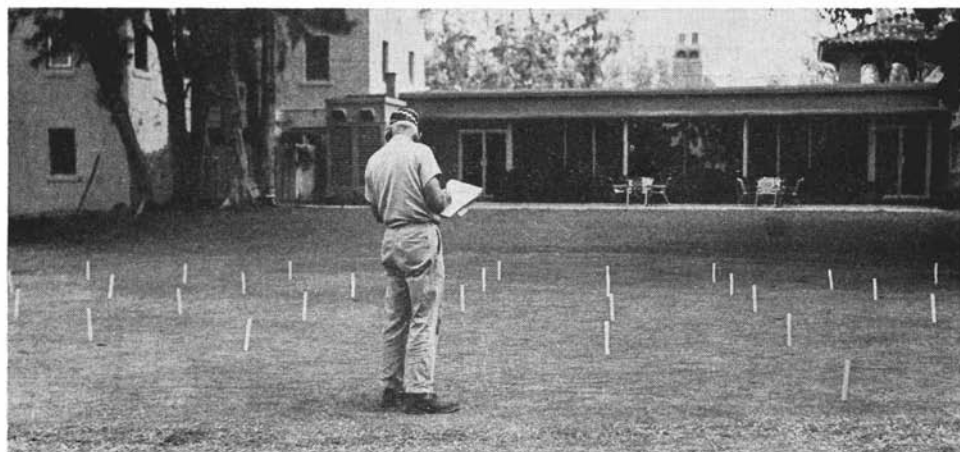
While pre-planting sterilization is effective in controlling nematodes in the planted, reinfestation may occur in time as the population from below the sterilized zone migrates back into the root zone. Periodic examination and analyses will be needed to check on this situation.

Until recently there was no way to control nematodes in established turf. The materials used to sterilize plantbeds could not be used on established turf because they were highly toxic to the turf as well as to the nematodes. As the nematode

population increased, the turf gradually declined to the point where complete renovation and plantbed sterilization were again necessary. It was fortunate that while recent surveys and preliminary research were discovering the serious nature and distribution of nematode damage on turf, industry had anticipated this problem. At almost the same time, Goodrich, Shell and Virginia-Carolina Chemical Companies introduced chemicals which showed promise for nematode control in established turf. Both industry and the turf research centers immediately began testing these materials. To further investigate nematode problems in turf and to initiate control studies, research grants were placed at the Florida Agricultural Experiment Station by each of the three above mentioned companies. The U. S. Golf Association Green Section added a sizeable amount of money to augment the scope of these studies. Some preliminary results have been published (7). The work is being continued and expanded during the current year.

### *Much Research Needed*

Results to date from the Florida investigations have brought out some useful facts and emphasized some problems concerning nematode control in established turf. The need for more information on the basic



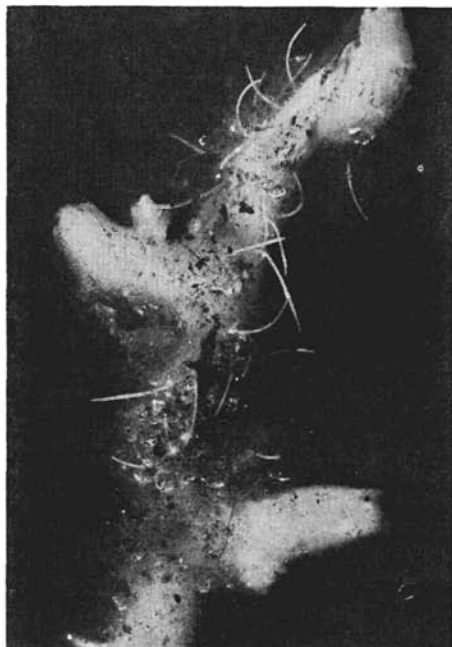
**Colonel Frank Ward, of the Bradenton Country Club, Bradenton, Fla., is shown recording turf conditions on a practice green following treatment for nematode control. The green was heavily infested with lance, ring and sting nematodes.**

biology and cultural relationships of the various parasitic nematodes has become evident. Information is needed on the influence of temperature, soil moisture and other environmental factors on the fluctuation of nematode populations. It is obvious also that detailed study on nematode control must be carried out with each chemical for each species of nematodes. For example, all three of the original materials tested (Nemagon, Nemakril and VC-13) brought about turf improvement on a heavily infested St. Augustine turf. However, application of these materials did not result in a clear-cut reduction in nematode population. Three species of parasitic nematodes were involved in the study and each species responded differently to treatment. Furthermore, there was considerable variation among species as to seasonal activity in both treated and untreated areas.

Although turf improvement resulted from treatment, it cannot be explained on the basis of reduction in nematode population. While turf improvement is the ultimate goal of control efforts, population behavior must be explained before treatment results can be understood and recommendations reliably made. At present little is known about the adaptation, life cycles, mobility, host preference and resistance, and ecology of these newly discovered turf parasites. We are not really sure what constitutes a threatening population level. It is quite possible that differential behavior among species of nematodes might account for some of the differences in nematode behavior following treatment. To answer this and other important problems, we will have to look to expanded research.

#### **Suggested Approach to Nematode Control**

As the nematode problem becomes more widespread and recognized throughout the country, need for control will also rise. It is obvious that golf superintendents and other workers in turf must face the problem and make the most practical attempt at control. In this light, and until ex-



*Photo courtesy by Dr. J. R. Christie*

**This is a close-up showing a root heavily infested with lance nematode, an internal parasite.**

panded research will permit official recommendations, the following steps are suggestions for approaching the nematode problem:

1. Maintain the turf under a good nutritional status with proper regard for pH and major and minor element balance.
2. Be thoroughly familiar with insect problems of the area—their symptomology and control.
3. Know the principal disease of the area—the environmental relationship and appearance of all stages of infestation.
4. Maintain proper soil moisture-aeration relationships. Avoid compaction, water logging and mat formation.
5. Make periodic inspection of the root system. If appearance suggests nematode damage and the above factors are not involved, have nematode tests conducted by a qualified nematology laboratory.

Follow good sampling procedure and sample all suspicious greens, tees and similar turf areas.

6. If nematodes are found which are known parasites on turf grasses, set up a spot test on a small section of infested area, applying available materials at company recommendation.
7. Base extensive control efforts on results of spot tests. Be sure to allow sufficient time for materials to react before making evaluations.
8. Following treatment, practice careful sanitation with topdressing materials and equipment to avoid re-contamination of treated areas.
9. On newly constructed greens, tees, and fine turf areas *strongly consider* use of general plantbed sterilant before planting.
10. Keep in contact with USGA Green Section Directors, Turf Research Centers and commercial representatives for latest information on nematode problems and control recommendations.

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## MOWING AND THE THATCH PROBLEM

FOR many years frequent topdressings of bent greens was considered necessary. In the past ten years topdressing has been used only when it was desired to smooth up the putting surface or change the soil structure. This change in maintenance practices has caused a new problem. An accumulation of stems and leaves, called thatch or mat, has built up on the surface of the greens, interfering with the circulation of air and water. As most of the fungi damaging to fine turfgrasses attack the grass above the soil line, we have an excellent breeding place in the thatch.

Overwatering, poor air circulation, high humidity and temperatures spell ruin for a heavily thatched green. Raking, brushing, aerifing and vertical cutting devices help control this thatch accumulation, but do not answer the problem completely. How does the design of our putting green mowers fit into the thatch picture?

Could the design of our present putting green mowers be one of the causes of thatch? We set the cutting height with a gauge or from a level surface. We do this very carefully and then go out to mow greens. All our careful adjusting goes for naught. With the cutting mechanism mounted between the guide points, (the front roller or caster and the rear roller)

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