MICHIGAN TURFGRASS REPORT

FALL

1963

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Michigan Agricultural Experiment Station
Michigan State University
East Lansing

TURFGRASS REPORT

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TURFGRASS RESEARCH PROGRESS AT MICHIGAN STATE UNIVERSITY

Dr. Kenyon T. Payne
Chairman, Department of Crop Science

Significant strides forward are being made in turfgrass research at Michigan State University.

The following report will provide an indication of the areas under study and a perspective of the approach being taken in each sub-project.

In addition to the projects outlined in the first Report, two major efforts have been initiated during the 1963 season. The first is an intensive highway roadside study which was established in late summer on interstate highway I-96 at the south end of the M.S.U. campus. The Michigan State Highway Department is supporting this work. The second is designed to answer turf problems of the drouthy, sandy soils of Northern Michigan and has been established at Traverse City.

In addition to the field plot research under way, important basic research projects concerning the effects of the environment on the biochemical and physiological processes in carbohydrate and amino acid metabolism are under way in the laboratory. A chemical laboratory is being remodeled to provide modern facilities for this work.

The extent of research in progress would not be possible without two fundamental ingredients: (1) Excellent scientists to intelligently select important problems, and, with skilled technicians, design and develop programs for the efficient and effective collection and evaluation of data, and (2) The financial support being supplied by the Michigan Turfgrass Foundation. In 1963 there are 108 contributors to the Foundation. A number of commercial firms have generously supplied equipment and materials. This expression of confidence is sincerely appreciated. Continued support of the Foundation will help assure a sustained effort in turfgrass research in Michigan

1963 IN REVIEW

Dr. James B. Beard
Department of Crop Science

The temperature data for the first nine months of 1963 at four locations in the state are shown in Table 1. The winter months of January and February were much colder than normal while the spring period had slightly warmer temperatures than normal. With the exception of late June and early July the temperatures for May through September were considerably below the average. The last week of June and the first week of July was the only period at East Lansing in which soil temperatures at the 3 inch depth exceeded 80° F. August was exceptionally cool.

Table 2 shows the precipitation data for the first nine months of 1963 at four locations in Michigan. Three of the four locations had considerable reductions in rainfall with Detroit having the largest deficits. Two extended droughty periods occurred. As a result, those turf areas without an adequate irrigation system were not able to maintain proper growth and color. These droughty periods also brought out the importance of an adequate water source for turf irrigation.

Snow mold in southern Michigan was not a severe problem in 1963 but did produce severe injury in the northern part of the state, particularly where proper fungicide practices had not been utilized.

Spring growth and coloration of the turfgrasses was extremely slow. Two late frosts occurred on May 1 and 23 producing damage to tender vegetation. The May 23 frost resulted in considerable yellowing and discoloration of the bluegrasses, ryegrasses and tall fescues.

A serious leafspot (Helminthosporium sp.) attack on Kentucky bluegrass occurred the third week in May at East Lansing. In general, the incidence of disease in the bentgrasses was minimal in 1963 primarily due to the reduced rainfall, relative humidity, and extended drought periods.

It is fortunate that the low rainfall of August was accompanied by considerably cooler temperature otherwise the detrimental effects to turf would have been much greater.

Table I. 1963 Temperature Data in °F. at Four Locations in Michigan
(Source - U.S. Weather Bureau)

Location		MONTH Jan.	Feb.	March	April	May	June	July	Aug.	Sept.
Detroit	1963 Ave. Air Temperatures	15.7	17.9	37.0	47.8	55.5	68.0	73.0	68.5	60.9
	Departure from normal	-10.9	-9.5	+1.7	+0.1	-3.6	-1.6	-1.2	-4.1	-3.9
	Maximum	37	44	78	81	88	93	96	93	88
Lansing	1963 Ave. Air Temperature	13.1	15.7	34.9	47.0	54.8	68.2	70.7	65.6	60.1
	Departure from normal	-11.2	-8.5	+2.5	+1.3	-2.3	+0.8	-1.0	-4.6	-1.9
	Maximum	40	43	78	81	84	92	94	83	86
	1963 Ave. Soil Temperatures at 3 inches	31.7	29.6	36.4	54.3	63.1	---	78.6	73.2	66.8
Grand Rapids	1963 Ave. Air Temperature	15.9	16.9	35.4	47.6	55.4	69.1	72.1	67.2	61.2
	Departure from normal	-8.5	-7.6	+3.0	+1.9	-1.6	+1.7	+0.2	-3.3	-1.0
	Maximum	39	45	80	79	82	96	96	87	84
Traverse City	1963 Ave. Air Temperature	12.5	10.3	26.8	43.5	50.0	64.7	69.1	64.5	57.2
	Departure from Normal	-10.5	-11.9	-2.2	+1.4	-3.0	+0.5	-0.8	-4.2	-3.3
	Maximum	40	37	70	81	81	96	96	89	85

Table 2. 1963 Precipitation Data in Inches at Four Locations in Michigan
(Source - U.S. Weather Bureau)

Location		Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	9-month average
Detroit	1963 Totals	0.82	0.58	2.28	2.63	3.30	2.01	2.12	1.37	1.44	16.55
	Departure From Normal	-1.12	-1.37	-0.12	-0.42	-0.18	-1.27	-0.56	-1.47	-0.85	-7.36
Lansing	1963 Totals	1.02	0.39	2.12	1.95	1.97	6.09	3.48	2.84	1.69	21.55
	Departure From Normal	-0.94	-1.56	-0.28	-0.92	-1.76	+2.75	+0.90	-0.21	-0.91	-2.93
Grand Rapids	1963 Totals	2.26	0.46	3.45	3.84	2.74	2.71	3.41	3.31	2.97	25.15
	Departure From Normal	+0.35	-1.29	+1.17	+0.90	-0.72	-0.60	+0.68	+0.61	-0.01	+1.09
Traverse City	1963 Totals	1.04	0.43	2.26	0.96	3.14	1.22	2.78	1.92	2.26	16.01
	Departure From Normal	-0.78	-.097	+0.65	-1.30	+0.25	-1.60	-0.01	-0.96	-1.22	-5.94

SOIL TESTING - THE FIRST STEP IN EFFICIENT TURFGRASS PRODUCTION

Dr. John C. Shickluna
Department of Soil Science

Soil testing is widely accepted as a diagnostic tool for both the identification and prevention of plant nutrient deficiencies.

A deficiency of one or more of the nutrients essential for growth may be due to a genetic peculiarity of the plant; or the result of an inherently low supply in the soil; or perhaps the result of an unbalanced fertility condition arising from the indiscreet application of fertilizer that may promote the uptake of excessive amounts of some elements and too little of others that are equally important for plant growth.

The safest way to ensure an adequate supply and the correct balance of the various nutrient elements is to have the soil tested. Too, the importance of tissue tests should not be overlooked as a supplemental diagnostic tool in determining how to maintain optimum plant performance in a particular environment.

The General Nutrient Status of Lawn Soils

A soil test summary has recently been completed for the lawn soils submitted to the Michigan State University Soil Testing Laboratory (Tables 1 and 2).

Phosphorus and potassium soil test values are apparently related to soil texture and past management. The coarse textured soils (sands and loamy sands) had the greatest percentage testing high in phosphorus. The percentage of the samples in the various textural classes testing high in this element appeared in the following decreasing order of magnitude: sands, loamy sands, sandy loams, clay loams and loams (Table 1). Conversely, the clay loams and loam soils had the largest percentage testing high in potassium and the sands the least (Table 2).

The importance of soil texture cannot be overemphasized in the interpretation of soil test results and in the selection of fertilizer ratios that are best adapted to the soil.

The analysis of soils which have supported turf for several years may differ markedly from a soil on which a lawn has recently been established.

Indiscreet application of fertilizer frequently gives rise to unbalanced fertility conditions. For example, the application of fertilizers high in phosphorus over extended periods of time may give rise to high residual levels of soil phosphorus which may have an inhibitory effect on the availability and uptake of iron. Too, the application of low amounts of potassium under such a fertilization program may not be sufficient to support the type of growth

Table 1. Summary of Phosphorus Tests by Soil Texture, 1962.

Soil Texture	Pounds of phosphorus per acre						
	0-10	11-15	15-20	21-25	26-30	31-35	36+
	Percent in categories shown above						
Clay loams and loams	13.5	8.3	8.8	4.8	5.4	3.6	55.6
Sandy loams	13.3	9.5	6.8	5.7	0.9	5.7	58.1
Loamy sands	3.3	4.4	2.2	2.2	5.5	5.5	76.9
Sands	0.0	0.0	5.0	0.0	0.0	10.0	85.0

Table 2. Summary of Potassium Tests by Soil Texture, 1962.

Soil Texture	Pounds of potassium per acre					
	0-50	51-100	101-150	151-180	181-250	251+
	Percentage in categories shown above					
Clay loams and Loams	1.5	13.3	14.4	6.9	34.1	29.8
Sandy loams	13.5	14.4	22.2	6.7	19.2	24.0
Loamy sands	5.5	28.8	27.9	12.2	16.7	8.9
Sands	19.9	40.0	30.1	5.0	0.0	5.0

desired, particularly on coarse textured soils (sands and loamy sands). These soils have a low potassium supplying power and are subject to leaching, especially under irrigation.

Soils that have been irrigated for a long time with water high in calcium and magnesium gradually become alkaline in reaction. It has been suggested, therefore, that lawn soils should not be limed unless they are very strongly acid (pH 5.0 or below).

Soil Tests Available at the University Laboratory

The following tests are made on all soil samples at a charge of $1.50 per sample: pH, lime requirement, available phosphorus, potassium, calcium, magnesium, cation exchange capacity and soil texture.

A mechanical analysis of the soil (determination of the percent sand, silt, and clay) may be obtained at a cost of $3.00 per sample.

How to Take Accurate Soil Samples

We must not overlook the fact that soil tests are no better than the samples tested. It is imperative, therefore, that a sample for testing should be as representative as possible for the area.

From each predetermined area, prepare a composite sample by taking not less than 20 samplings consisting of vertical columns or cores of soil 1/2 of an inch in diameter and 2 inches deep.

It has been found that 20 well-taken samplings or soil cores per composite sample from a given area result in laboratory tests which can be duplicated much more frequently than where only 5 or 10 samplings comprise the composite sample.

As the individual samplings are taken, place them in a clean pail until 20 or more are collected from the area involved and mix thoroughly.

Packaging and Sending the Sample

After the sample is thoroughly mixed, place a pint of the soil in the container for transferring to the laboratory. Special sample containers may be obtained from the Soil Science Department of Michigan State University or from the office of your County Agricultural Agent. There is a charge of $1.50 for the cost of the container which automatically pays for the cost of analyses.

1963 CROP SCIENCE TURFGRASS RESEARCH REPORT

Dr. James B. Beard
Department of Crop Science

The turfgrass variety and management studies initiated in the summer of 1962 are continuing as part of a five year study. The following is a progress report of the results to-date. The final evaluation and conclusions cannot be made for three more years.

BLUEGRASSES

Table 1. 1963 Bluegrass Variety Evaluations. Planted July 26, 1962, East Lansing.

Entry	Variety	Quality Rating (1-best, 9-poorest) Ave. of 5 ratings.	Helminthosporium Lesion Rating 6/5/63 (1-none, 9-severe)	Density 10/5/63 (Shoots per 12.5 sq. in)	Spring Greenup 4/2/63 (1-best, 9-poorest)
1	K 5(47)	2.0	2.7	182	5.0
2	Prato	2.2	6.3	219	5.3
3	Merion	2.2	1.3	175	5.0
4	Newport	2.3	4.0	151	4.3
5	C-1	2.4	4.3	167	3.7
6	Park	3.5	6.3	149	5.0
7	Delta	4.0	7.7	140	4.0
8	Common	4.7	7.7	109	3.3

The Penn State selection K 5(47) has been outstanding. Although a few Helminthosporium lesions were noted the footrot and thinning stage did not develop. K 5(47) is far superior to Merion in rate of establishment.

Prato, a selection from the D. J. van der Have Co. of the Netherlands, has a leaf width similar to common Kentucky but has twice the density. (Table 1). The Helminthosporium susceptability is somewhat uncertain at this time. Numerous lesions were observed on Prato but no significant leaf thinning occurred in 1963. Prato shows good establishment vigor.

Newport and C-1 are still performing similarly. All data to date indicate that C-1 is not significantly different from Newport.

Newport has ranked similar to Merion during the initial two years. The next two years will be critical for Newport because data from Rutgers and several other states show a severe deterioration and thinning in the third year and subsequent years.

Although Park and Delta were as severely thinned by Helminthosporium as common Kentucky bluegrass their rate of recovery from thinning was superior as indicated by the fall density counts.

Common Kentucky ranks highest in both spring and fall color. The first heavy frost in the fall of 1963 produced considerable temporary yellowing and discoloration of Park, Delta, and Prato.

First year data from the northern bluegrass variety tests at Traverse City (91% sand) planted May 15, 1963, show Park and Delta to be outstanding on the sandy site.

Seventeen other bluegrass varieties are currently under evaluation.

RED FESCUES

Table 2. 1963 Red Fescue Variety Evaluations

Entry	Variety	East Lansing Planted 6/11/62 Ave. of 4 ratings	Traverse City Planted 5/15/63 Ave. of 4 ratings	Density 10/15/63 (shoots per 12.5 sq. inches)	Spring Greenup 4/16/63 (1-best, 9-poorest)
1	S-59	2.1	-----	247	3.7
2	Golfrood	2.7	-----	349	5.7
3	MSU-47-Fr	2.9	4.8	231	4.7
4	Rainer	3.7	3.9	145	3.3
5	Pennlawn	3.7	3.7	140	4.3
6	Common Creeping	4.1	5.3	127	3.3
7	Illahee	4.2	3.4	168	4.3
8	Common Chewings	4.6	2.6	119	3.7

At East Lansing the four creeping red fescues (Rainer, Pennlawn, Common Creeping and Illahee) have performed quite similar during the initial two years (Table 2). Common chewings has been slightly inferior to the creeping red fescues especially in density. However, at Traverse City on 91% sand common chewings red fescue has been the outstanding perennial grass during the initial establishment year.

S-59, Golfrood, and MSU 47-Fr were superior to the commercially available red fescue varieties in overall seasonal quality and density. MSU-47-Fr is similar to Pennlawn in the initial establishment year but developes an outstanding turf in the second year. It has an excellent dark green color and has a minimum susceptability to leafspot. An improved polycross from MSU-47-Fr was sent to Oregon in the fall of 1963 for seed increased. Twelve other red fescue selections are also being evaluated.

BENTGRASSES

Table 3. 1963 Bentgrass Variety Evaluation for Use as Putting Green Turf. Dormant Planting in Late Fall of 1961 in East Lansing.

Entry	Variety	Quality Rating (1-best, 9-poorest) Ave. of 4 ratings	Density 10/12/63 (leaves per 2 sq. in.)	Yellow Tuffs (1-least, 9-most)	Thatching (Puffing) (1-least, 9-poorest)	Spring Greenup 4/2/63 (1-best 9-poorest)
1	Cohansey (C-7)	1.6	206	1.0	1.3	2.2
2	Congressional (C-19)	1.9	204	1.0	1.0	3.8
3	Toronto (C-15)	2.2	237	2.0	2.7	2.2
4	Washington (C-50)	5.2	149	3.0	1.0	6.5
5	Penncross	2.5	165	6.3	1.3	2.5
6	Seaside	3.4	187	2.7	1.3	3.4
7	Astoria	5.4	183	3.7	1.0	6.0

Cohansey, Congressional, and Toronto rank as the best vegetative bentgrasses through the initial two years (Table 3). If not managed properly Toronto will have a tendency to thatch and become puffy. Penncross ranks as the outstanding seeded bentgrass.

Evansville, a new release from Purdue, proved highly susceptable to snow mold. Nimisilla, a private selection from Ohio, was severely thinned by an unidentified soil pathogen in June, 1963, and was not in acceptable playing condition. Prior to the incidence of disease Nimisilla had ranked with Cohansey and Toronto. Fifteen other bentgrass varieties are under evaluation.

PERENNIAL RYEGRASSES

Norlea, a dark green selection from Canada, has out-performed common perennial ryegrass both in seasonal quality, density and winter survival. Common perennial exhibited 97% winterkill while Norlea had only 30% winterkill. Norlea retains the difficult mowing characteristics of common perennial ryegrass and is susceptable to rust.

A number of MSU selections have been outstanding in turf quality, winter survival, and rust resistance. Several of these have now been combined in a polycross. Even in these improved selections the difficult mowing characteristics are retained.

TALL FESCUE

Kentucky 31 and Alta have performed similarly in 1962-63. Twenty percent winterkill occurred in Kentucky 31 and 25% in Alta.

MIXTURE STUDIES

Data from two year old sods show mixtures of Merion Kentucky bluegrass and red fescue or tall fescue to be superior in quality to mixtures of common Kentucky bluegrass and red fescue or tall fescue. However, no significant differences were found in density. Whenever ryegrass or redtop was included in the mixture the second year quality was considerably reduced.

Although ryegrass does provide better initial establishment, it offers no other advantage to the mixture. Therefore it is best to exclude ryegrasses and redtop from the mixture when seeding at the proper time of year and in conjunction with proper seeding practices. However, under adverse conditions such a high erosion probability, moisture stress conditions, or improper seeding time it is advantageous to include ryegrass in the seed mixture.

MERION THATCH INVESTIGATIONS

Thatch is defined as a tightly intermingled layer of living and dead stems, leaves and roots of grasses which develop between the layer of green vegetation and the soil surface. The increase in watering, higher rates of nitrogen fertilization, and development of more vigorous grass varieties have contributed to the current prominance of the thatch problem.

As the amount of thatch increases the conditions for disease activity (leafspot, Fusarium rosium, and stripe smut) are enhanced. Also thatch an inch or more in thickness tends to elevate the grass crowns above the soil thus reducing the resistance to drought.

An indication of the amount of thatch that can accumulate in one year on an irrigated Merion bluegrass turf is shown in Table 4 which summarizes the 1963. data at East Lansing.

Table 4. The Amount (expressed on a dry weight basis) of Thatch Removed From an Irrigated Merion Bluegrass Turf One Year After Planting When Maintained Under Four Different Management Systems.

Cutting Height	Pounds per acre of thatch removed	
	Clippings Removed	Clippings Returned
1"	332	1,135
2"	850	1,621

Clipping removal can greatly reduce the rate of thatch accumulation. In addition, there are a number of machines currently available which mechanically remove thatch and which could be used annually as a routine maintenance practice.

MOWING QUALITY STUDY

Evaluations were made between reel and rotary type mowers for an entire season at 1/2", 1", 1 1/2" and 2" on bluegrass. Mowers were kept sharp at all times. At all mowing heights the reel type treatment was much superior to the rotary in terms of visual turf quality. A browned appearance was noted on the rotary plots for 4 to 5 days following each mowing.

ICE COVERS AS FACTORS IN WINTER INJURY

Extensive studies conducted in 1961 and 1962 have shown that oxygen suffocation or toxic accumulation of carbon dioxide under ice sheets are of minimum importance in the winter injury of common Kentucky bluegrass, annual bluegrass, and Toronto creeping bentgrass. Also, submergence in water at 35° F. for up to 90 days produced no injury. Current studies indicate that certain combinations of freezing and thawing especially in association with high tissue moisture contents during the thawing of ice covers may be of more importance in the winter injury of turfgrasses.

Annual bluegrass is the major turf species affected by winter injury. Recent results show the injury to be characterized by severe mechanical disruption of the crown tissue with no initial injury to the shoots and leaves. The resultant death of the plant is caused by desiccation due to inadequate uptake of water by the severely injured root system.

GRASS ESTABLISHMENT AND SOIL STABILIZATION ON HIGHWAY SLOPES

Under limited moisture conditions, the only satisfactory mulch was found to be straw (2 tons per acre) and asphalt (100 gal/acre). The asphalt functioned to stabilized the straw from blowing by wind. Several mulches gave adequate soil erosion control but only straw provided the proper moisture micro-environment for seed germination and establishment. Mulches which did not retain adequate moisture for germination included jute net, soil-set, erosion net, and Troyturf. In ditch bottoms having high velocity water flow either sod or jute net will provide the best erosion control.

Sodding with muck soils should be avoided under limited moisture situations where irrigation is not possible such as on roadside banks. Replicated studies show upland (clay-loam) sods to survive better than muck sods under these droughty conditions.

EFFECTS OF EXCESSIVE NITROGEN FEEDING ON THE CARBOHYDRATE FRACTIONS OF GRASSES

Investigations by David Green as part of his masters thesis involved characterization of the soluble carbohydrates occurring in Merion and common Kentucky bluegrass, Toronto creeping bentgrass, and Pennlawn red fescue. Merion was the only species which contained significant levels of fructosan in the leaf tissue. An oligosaccharide was the dominant sugar fraction in all four species. The disaccharide, sucrose, and the two monosaccharides, glucose and fructose, were unaffected by nitrogen feeding rates as high as 12# of nitrogen per 1,000 sq. ft. in either one application or six seasonal fractions. Effects attributable to nitrogen treatments were only observed in the oligasaccharide and polysaccharide fractions of leaf tissue but conditions such as summer dormancy in common Kentucky bluegrass and Pennlawn red fescue which produced critical decreases in the mono- and disaccharide fractions resulted in corresponding increases in the polysaccharides.

Thus, nitrogen feeding rates as high as 12# of nitrogen per 1,000 sq. ft. in either one single application or six seasonal fractions failed to deplete the carbohydrate level of leaf tissue in the four grasses studied. Much data is available showing the decrease in root production at higher nitrogen feeding rates. Since these results indicate that the leaf is capable of photosynthesizing sufficient carbohydrates it is possible that a blockage or defect is occurring in the transport of carbohydrates to the root system.

SHADE GRASS ECOLOGY STUDY

The study was initiated in 1961 to investigate the relative degree of the mechanisms of shade adaptation. It was conducted under extremely heavy natural shade (5% of incident light) with eighteen grass mixtures included. The main conclusion from this study was that disease and not light competition was the major factor influencing the heavy shade adaptation and culture of turfgrasses.

NOT FOR PUBLICATION

HIGH TEMPERATURE GROWTH INHIBITION STUDIES

Preliminary studies by masters candidate Harland Stoin have shown that high temperate growth stoppage at 95° F. can be overcome by foliar applications of the amide glutamine in both Merion Kentucky bluegrass and Toronto creeping bentgrass. This was found to be more than just a nitrogen response but was from the glutamine itself.

INVESTIGATIONS INITIATED IN 1963

1. Highway Vegetation Studies -- A three year investigation supported by a $10,500 grant from the Michigan State Highway Department. The location is a four acre area on the north side of I-96 just south of East Lansing.

2. Northern Michigan Turfgrass Investigations -- Turfgrass variety, mixture, and management studies being conducted at the Traverse City Country Club, Traverse City, Michigan. Soil on the site is 91% sand, 6% silt and 3% clay. All studies are being maintained under both irrigated and non-irrigated conditions.

3. Fairway Renovation - Improvement Study -- Located at the Cascade Country Club, Grand Rapids. Involves mechanical and chemical methods of reducing the annual bluegrass population and encouraging bentgrass sod formation when maintained under close mowing and irrigated conditions. Comparisons are being made of various methods of seed and vegetative bentgrass establishment.

4. Investigation of Factors Causing Thatch Formation -- Cooperative study with Dr. John Lockwood, Department of Botany and Plant Pathology.

EXTENSION ACTIVITIES

Over 55 golf courses were visited during 1963. Emphasis of these visitations was on observations regarding the performance of grass varieties for tees as well as the associated management systems.

The 1964 Turfgrass Field Day at East Lansing will be held in mid-September. It should be pointed out that you are welcome to visit the experimental plots at anytime you are in the area.

A field day is also planned for the Northern Turfgrass Experimental area at Traverse City the first week in September. Current plants also include a turfgrass equipment show in conjuction with the field day.

The Annual Michigan Turfgrass conference sponsored by the Department of Soil Science is scheduled for March 12 and 13, 1964.

The Michigan Turfgrass Foundation, which is a major source of research funds, has increased in membership from 38 to 109 in the past year. The Board of Directors meeting is scheduled for December 17, 1963.

EXPERIMENTAL PLANS FOR 1964

1. The variety, mixture and management studies will be continued at both East Lansing and Traverse City.

2. In August of 1964 the shade ecology study will be re-initiated under irrigated conditions.

3. The highway mulch, mixture and establishment studies will be continued.

4. Additional cooperative bentgrass fairway renovation tests will be established.

5. Continuing emphasis will be placed on winter injury causal factors, metabolic mechanisms in high temperature growth stoppage and thatch formation.

SOIL TESTING FOR THE PRESENCE OF HARMFUL NEMATODES

Dr. John A. Knierim
Department of Entomology

Many agricultural and horticultural crops are host to numerous species of plant feeding nematodes. Plants respond in various ways to a variety of stimuli which are introduced into plant tissue as these microscopic, translucent roundworms feed. Some plants react to toxic chemicals, in the digestive juices injected into plant tissues through needle-like mouthparts of feeding nematodes, by developing galled, stunted, fleshy, malformed or excessively branched and reduced root systems. Mechanical destruction of cell tissue results from migration of some species of nematodes through the root as they feed and reproduce inside the plant. Water and soil nutrients are usually not taken up from the soil in sufficient quantity and translocated through the plant efficiently enough to produce a normal vigorously growing plant when the roots are heavily infested with plant feeding nematodes. Secondary infection with viruses transmitted by nematodes are known to occur. Pathogenic fungi and bacteria enter the plant through wounds in the roots made by feeding nematodes.

A steadily increasing number of growers are becoming more aware of the potential hazard that plant feeding nematodes present in the production of crops of high quality and good yield. In addition to applying adequate fertilizers and correctly timed chemical sprays to control insects, mites, fungal and bacterial pests, many growers are controlling nematode pests with chemical nematocides and crop rotation.

The Entomology Department at Michigan State University maintains a soil and plant analysis laboratory to assist growers in determining whether species of nematodes are present in their fields which could be harmful to a growing crop or a crop to be planted, and whether they are present in sufficient numbers to warrant the cost of control. Samples of soil and plant material are collected by growers and sent to the laboratory to be assayed. Nematodes are separated from the soil by agitating the sample in a bucket partially filled with water. The muddy water with suspended nematodes, clay particles and debris is sieved through 25 and 325 mesh screens. The nematodes and debris are caught on the fine screen, and the clay particles are washed through the screen with clean tap water. Nematodes are separated from the debris caught on the fine screen by use of a modified Baerman funnel technique. The residue washed off the screen settles onto a piece of unbleached muslin cloth submerged in water in a glass funnel. The nematodes wiggle through two separated layers of the cloth and settle into vials, completely free of debris. After settling four days they are poured onto glass observation slides. The plant feeding species are identified and counted under a compound microscope.

Whenever larvae or males of cyst-forming nematodes are recovered, or when there is reason to suspect the presence of cysts, some of the soil is processed especially to recover cysts. Older cysts are usually found floating against the slides of the container at the water level. Newly formed cysts and live females do not float, and are found on the bottom of the container in which the residue on the screen is washed.

A report is sent to the grower within fifteen days after receipt of the sample listing the genera and in some cases the species of harmful nematodes recovered, and the relative severity of the infestation of each. Recommendations for control and other pertinent remarks are also included in the report. Forms with instructions for taking samples and forms to be filled in with information about the sample can be obtained from your county agent. There is no charge for this service at the present time. The following are examples of the forms used.

Instructions for collecting soil samples to be examined for the presence of plant feeding nematodes

1. Taking sample from a growing crop:
   Herbaceous plants
   Take sample from plants showing poor vigor or from plants suspected of being infested with nematodes. Include the root system and soil in intimate association with the growing feeder roots.
   Woody plants
   Dig far enough from the trunk or main stem to find the growing root tips. Follow a root out until the growing end is located. Include the feeder roots and the soil intimately associated with the young roots. Take samples from several locations around the plant.

2. Taking soil samples from bare fields:
   Take numerous vertical profile samples 10 inches deep with a soil probe, auger or garden trowel and combine into one composite sample. Take at least one composite sample from an area no larger than one-half acre.

3. Size of sample
   Mineral soil - minimum amount one quart
   Muck soil - minimum amount two quarts

4. Containers and care of sample
   Moisture
   Always put the sample in a moisture proof container such as a plastic bag, waxed cardboard milk container, etc. Never use a paper bag. Most plant feeding nematodes die and cannot be recovered if soil becomes dry.
   Heat
   Do not allow the sample to become over-heated in an automobile parked in sunshine with the windows closed. Prolonged periods at temperatures above 110° F. will kill many nematodes.

5. Labeling the sample
   Be sure to include the following information:
   1. Sample number to identify the location in the field from which it was taken
   2. Grower's name and mailing address
   3. County, township and section number of sampled field
   4. Crop - name and variety and age of the plant from which the sample was taken
   5. Symptoms of crop damage
   6. Other - any additional information such as cropping history, rotations, crop yields or failures, previous soil fumigation history, condition and source of transplants, source of irrigation water, source of topping soil, soil added at planting time or soil obtained for greenhouse beds or other specialized cultural techniques or harvesting practices may be helpful in answering some of your problems concerning plant feeding nematodes.

Send all samples to: Dr. John Knierim, 245 Natural Science Building,
Michigan State University, East Lansing, Michigan

Form 2 Processing Number_____

Plant Nematode Sample Information

Please fill in and return with each sample Date_____

1. Sample number (to identify location of sampled area in field)_____
2. How sample was taken _____
3. Grower's name _____
4. Grower's address _____
5. County (location of field) _____
   Township (location of field) _____
   Section number (field) _____
6. Crop and variety from which sample was taken_____
7. Age of plants from which sample was taken _____
8. Symptoms or description of damage _____
9. Crop to be planted and approximate planting date _____

History of Plant Vigor

Please check appropriate spaces

	Excellent	Good	Fair	Poor	Abnormal Number Plants Died
10. Sequence of cropping history					
a. same crop continuously					
crop _____					
No. years _____					
b. rotation history					
1963 cover crop _____					
" summer " _____					
1962 cover crop _____					
" summer " _____					
1961 cover crop _____					
" summer " _____					
1960 cover crop _____					
" summer " _____					
1959 cover crop _____					
" summer " _____					

11. Additional information on cropping history, rotations, crop yields or failures, previous soil fumigation history, condition and source of transplants, source of irrigation water, source of topping soil, soil added at planting time, or soil obtained for greenhouse beds or other specialized cultural techniques or harvesting practices may be helpful in answering some of your problems concerning plant feeding nematodes.

send all samples to: Dr. John Knierim
Assistant Professor
Department of Entomology
245 Natural Science Building
Michigan State University
East Lansing, Michigan

Form 3

Dear

The items checked below refer to the sample you sent regarding a nematode problem.

_____ Your soil or plant sample was received in good condition. It will be processed and a report sent to you within the next fifteen days.

_____ Your soil or plant sample was received in poor condition.

_____ Most of the moisture has evaporated leaving the sample very dry.

_____ Although some nematodes can be recovered from soil or plant material which has become dry, most plant feeding species will not survive this treatment. The species and number of plant feeding nematodes recovered from this sample would not be representative of the harmful nematodes in the soil from which the sample was taken.

_____ Information to be gained from processing this sample does not warrant the effort or expense involved.

_____ The volume of soil in your sample is inadequate for analysis.

_____ Always include soil with samples of plant roots. Nematodes can usually be recovered from the soil when often they cannot be found in the root tissue.

_____ Please send another sample taken and protected from loss of moisture as described in "Instructions for collecting soil samples."

_____ Instructions for collecting and preserving soil and plant samples are enclosed.

_____ Special comments _____

_____

_____

Very truly yours,

John A. Knierim
Assistant Professor

Form 4

Processing Number _____

The sample of _____ was examined and the follcwing nematodes identified:

Common Name of Nematode	Scientific Name	Infestation*
Cyst	Heterodera sp.	
Dagger	Xiphinema americanum	
Foliar	Aphelencoides sp.	
Lance	Hopolaimus ccronatus	
Pin	Paratylenchus sp.	
Ring	Criconemoides sp.	
Root knot	Meloidogyne hapla	
Root lesion	Pratylenchus sp.	
Spiral	Helicotylenchus sp.	
Stem & Bulb	Ditylenchus	
Stubby root	Trichodorus sp.	
Stylet	Tylenchorhynchus sp.	

NO COMMON NAME	Scientific Name	Infestation*
	Heterodera schachtii	
	Boleodorus	
	Longidorus sp.	
	Nothotylenchus sp.	
	Psilenchus hilarulus	
	Rotylenchus sp.	
	Tetylenchus sp.	
	Tylencholaimellus sp.	
	Tylenchus costatus	
	Tylenchus sp.	

*Degree of Infestation: 5-Very Heavy; 4-Heavy; 3-Moderate; 2-Light; 1-Very Light

Other plant feeding nematodes: _____

RECOMMENDATIONS:

No soil fumigation recommended ☐

Fumigate the soil with one of the following: ☐

Nemagon or Fumazone at the rate of	_____	/ acre
DD or Vidden D " " " "	_____	/ acre
Dowfume W-85 " " " "	_____	"
Telone " " " "	_____	"
Trizone " " " "	_____	"
Biozone " " " "	_____	"
Dowfume MC-2 (methyl bromide) "	_____	"

Other fumigants: _____

REMARKS: _____

Very truly yours