# Organic Facts and Fallacies

*The mystical world of growing turf organically and managing pests with biological controls contains a lot of facts with a large dose of fiction thrown in for good measure. How is a golf course superintendent supposed to sort out the facts from the fallacies?*

**by DR. NOEL JACKSON**

*Since the 1920s, we have known that organic matter helps produce a healthier soil with higher biological activity.*

I WAS RAISED on a small family farm in the north of England and from an early age was exposed to the organic aspects of this farm environment. Memories linger of the seemingly constant attention that dairy cows required to fuel them at one end and remove the milk and very large quantities of excreta from the other. I was never keen on this endless twice-daily routine of milking and soon figured there must be better things in life then shoveling cow manure. A common Yorkshire expression, "Where there is muck, there is money," did not ring true to me, so I chose to study agricultural botany and aspired to a college degree with the prospect of being a kid-gloved advisor or, at the very least, a gentleman farmer.

I obtained the degree, but I did not realize the rest of my goal. Instead, muck (this time in the form of sheep manure) claimed my attention. For two growing seasons, I ministered to sheep, pastured in neatly fenced enclosures. Half of the animals wore harnesses and appropriate containers to collect their excretory products. The latter were measured, sampled, and analyzed. Changes in soil and plant chemistry and botanical composition were determined from manured and nonmanured plots. So, during two long growing seasons, I developed a respect and even a *feel* for organic manures.

Trained as a pasture grass agronomist, I found the management of fine turf to be a totally alien concept. Maximizing yield from the grass sward was no longer the objective. Instead, one was required to coax agriculturally inferior, low-fertility grasses, bents and fescues, into producing immaculate playing surfaces under the most demanding of playing conditions. Multitudes of mostly unappreciative golfers then gathered in all weathers to beat the hell out of the turf and, after a bad round, registered their complaints.

Prior to World War II, quality putting green turf of desirable species was achieved in the U.K. by fertilizing frugally, manipulating soil pH, watering sparingly, adopting sound mowing practices, alleviating compaction, addressing thatch accumulation, topdressing routinely, and applying pesticides very infrequently. By 1958, however, a burgeoning number of agrichemicals (fertilizers and pesticides) were finding their way into turf management practices. However, the proven pre-war concepts were still being promulgated at Sports Turf Research Institute (STRI) when my indoctrination into the mysteries of turf management commenced. Natural organics played a large part in the scheme of things, and I was introduced to a world of dried, blood, hoof and horn meal, fish meal, guano, and their ilk.

Ammonium sulfate, super phosphate, and potassium sulfate constituted the major inorganic fertilizers, with few complete formulations available for fine turf use in the U.K. Combinations of these inorganic and organic materials were advocated by the STRI advisory officers, with the formulas and the rates being customized for particular uses. Ammonium sulfate was a pivotal part of the program for maintaining soil acidity and promoting good, competitive growth of the desired bentgrass, which we knew then as *Agrostis tenuis*. Iron sulfate was a common and widely used supplement to this regimen. Omitting the ammonium sulfate and substituting other organic nitrogen sources or going with all-natural organic fertilizers was a demonstrably sure way to wind up with turf full of *Poa annua* weeds, earthworms, and disease.

An assortment of other organic material — animal, plant, and marine in origin — was available for turf use. Benefits such as enhanced growth, improved soil physical condition, better water-holding capacity, provision of minor elements, etc., were sometimes claimed. The notion of muck and magic was already alive and well! In many cases these organic materials were subject to composting procedures on the golf course and the well-matured, screened product was then bulked with suitable sand for use as a topdressing. Liberal use of such topdressing has always been a major consideration in the art of greenkeeping.

By the time I came to Rhode Island in 1965, I had developed an abiding interest in turf pathology. What impressed me immediately was the size of the industry overall, the big budgets, the high turf quality expectations, the intensity of the management practices, and the wealth of turf products that were available commercially. American superintendents, no longer greenkeepers, seemingly faced formidable problems in the way of fungal disease, insects, nematodes, crabgrass, heat stress, winterkill, and so on. There were far and away more challenges than their British counterparts ever experienced. On what appeared to me to be ever-accelerating managerial treadmills, they needed every assistance, and commerce was responding with zeal to address all these contingencies.

Synthetic organic fertilizers were coming into vogue during the late 1960s, but one animal waste product, Milorganite, was well established. Aware of this fertilizer before arriving in the United States, I never cease to wonder at the amazing promotional job that the Milwaukee Sewage Commission has done in promoting a product of such indelicate origin. Like other researchers at the time, we were able to demonstrate a reduced incidence of dollar spot, over and above any direct nitrogen effects, when this material was used. We speculated that biological activity was affording the protection.

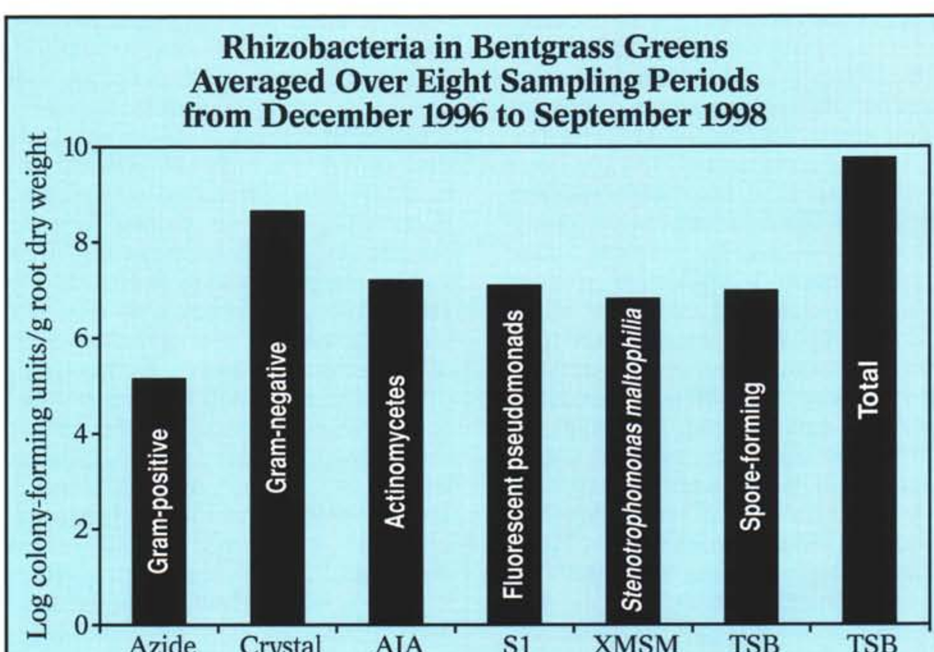
The concept of disease suppression in turf by organic amendments had surfaced, but further investigation and practical application was still down the road. At that time, pesticides were plentiful, relatively inexpensive, and generally very effective. The heavy reliance on chemical controls began to be challenged in the late '60s and '70s as environmental contamination and public safety issues were raised. Withdrawal of materials from the market and the development of resistance by some pests and pathogens to commercial pesticides prompted a reassessment of control strategies, and shifted attention to biological measures as safer and potentially effective alternatives.

The teeming populations of microorganisms that inhabit the turfgrass and soil, many as yet unidentified, invariably include pathogenic species that at times are able to incite disease. Disease incidence largely is determined by environmental conditions that can pose stresses that predispose a suceptible host to infection and, at the same time, promote the aggressiveness of the pathogen. Thus, when the pathogen is favored at the expense of the host, disease will likely occur. The microbial population, however, also includes numerous representatives that may improve plant health. Species of fungi, bacteria, and actinomycetes can protect plants from invasion by infectious agents in various ways. They can increase the availability of nutrients and water, and they can generate stimulants to plant growth. Degradation of organic matter, naturally occurring or introduced, fuels these and other interdependent systems in the turf, soil, and thatch. However, the dynamics of the forces involved are very complex and still very poorly understood. The postulated mechanisms whereby beneficial microbes affect disease control include the following:

- Competition for pathogen habitats and survival sites.
- Predation or parasitism of the pathogens.
- Antagonistic and pathogenic impacts on the pathogens.

The old doggerel "Big bugs have little bugs upon their backs to bite 'em, and little bugs have smaller bugs and so on ad infinitum" seems especially appropriate. So it is a real war down there! The rival troops are battling back and forth trying to gain ascendancy. If the pathogens win, then disease may ensue. Usually, an equilibrium is struck and an armed truce established. However, in some soils it was observed that pathogens always seemed at a disadvantage and seldom infected the host. These were termed "suppressive soils." Their existence has been known for years, especially in soils devoted to cereal growing. Constituents of the soil microbial population suppressive to common take-all, a severe disease of cereals, have now been identified, and they include fungi in the genus *Phialophora* and *pseudomonad* bacteria. Hopes were raised that related take-all patch disease of bentgrass might be controlled by these antagonists. Though laboratory and greenhouse trials using suppressive soil against these diseases were successful, similar trials for take-all patch in actual turf situations generally have failed. In practice, what we do to manage take-all patch is use sulfate of ammonia to reduce pH. In some part this encourages the bacteria that in turn then suppress the take-all pathogens.

The concept that topical amendments, both organic and inorganic, can affect the composition and activity of the microbial biomass has spawned a




*Recent surveys of bentgrass putting greens conducted by scientists at Clemson University indicate that there are large numbers and a variety of microorganisms present.*

wealth of commercial products and claims of great benefits. Many are hard to prove. One example where the promise has not met the expectations involves topical amendments for nematode control in turf. Soil-inhabiting parasitic nematodes are a common problem on warm-season grasses and an increasing one in the cool Northeast. Nematodes are particularly increasing in our area. Chitin, a constituent of shrimp shells, has been shown over the years to encourage populations of microbial microorganisms that degrade it. Thus, the theory goes that if you have sufficiently high populations of these chitin-degrading bacteria, the organisms then will attack the nematodes and fungi in which chitin also is present. This hopefully results in the death of the pathogen or nematode. Commercial exploitation of this process proceeded, but repeated field trials in our northeast region have failed to show any positive results. An assortment of other products, mostly of plant origin, including sesame meal, neem, molasses, etc., all purported to control nematodes, also have failed. Our reliance on Nemacur, the single registered nematicide, continues, but how long this threatened material will continue to be available remains to be seen.

Composts, on the other hand, are an expanding disease control success story. During the 1970s, growers of containerized plants noticed that few fungal disease outbreaks occurred when composted hardwood bark was included in the potting mix. The disease-suppressive properties of this and other composts, including those prepared from municipal sewage, were confirmed at Ohio State and elsewhere. Dr. Harry Hoitink and his cohorts at Ohio State University have conducted a sustained and productive program over the years, and their pioneer research has given enormous impetus to the utilization of composted organic waste. It was no small achievement to establish suitable composting procedures that eliminate harmful pathogens, both plant and human, and determine the critical parameters that promote natural recolonization by desirable antagonists. The technology has now advanced to where specific suppressive organisms can be introduced successfully into the composting process for their optimum development and subsequent potency. One member of the Ohio team, Dr. Eric Nelson, now of Cornell University, deserves much of the credit for extending this technology into the field. Another cohort, Dr. Mike Boehm, also now at Ohio State University, is also involved in this area. Both were graduate students of Dr. Harry Hoitink.

Extensive trials at Cornell and elsewhere have confirmed the value of good quality compost from organic waste as a useful source of plant nutrients, and have regularly demonstrated their suppressive activity against a range of turfgrass diseases when used topically or incorporated into the rootzone. The introduction of beneficial microbial populations by suitable composts has obvious application in high sand greens. The latter initially are very low in overall microbial activity and are particularly vulnerable to root diseases like take-all patch and *Pythium* — induced root rot during the first few years of establishment. Inclusion of compost as an organic component in the rootzone mix and subsequently topdressing with the same material should introduce and support beneficial microflora. However, the quality of the compost in terms of physical and chemical properties needs careful attention. There is great variation in the quality of the available products. Analysis for organic matter content, ash content, moisture content, pH, nutrients, metals, and soluble salts should be a standard procedure. Inadequate screening to remove particles of the bulking agent in some compost renders these products unacceptable for fine turf use. This applies particularly to the yard waste materials that are put in many composts. Similarly, repeated use of compost from substrate that contains a high ash residue will lead to an accumulation of fine particles that eventually may impede percolation. However, replacing all or part of the peat, which is particularly low in microorganisms, with compost has the advantage of boosting a wealth of microorganisms early in the establishment period. Will the inclusion of some suitable topsoil do the same? Probably, but the microbial population would include potential pathogens. The soil would also include microbial inoculum which might confer some disease and stress protective properties. Is that a worthwhile tradeoff? It is very debatable. Currently, the compost would have my vote provided it is a proven, quality product because the practical value of mycorrhizal in turf situations to my mind is still unproven.

The economics of putting green rootzone mixes also must be considered. Canadian peat at the moment is inexpensive. In fact, it is a lot cheaper than most appropriate composts. Regardless, with this increasing current attention to compost, it is interesting to speculate how the greenkeepers of old would view these modern developments. They would probably say something to the effect that we have reinvented the wheel. Maybe they didn't know much about the microbiology of their composts, but they knew that topdressing was part muck and part magic — and it worked.

The logical progression in biocontrol is to isolate, identify, and culture any beneficial organisms and then return them in optimum numbers to afford the required protection. Successful techniques have been developed to accomplish the first three of the requirements listed, and numerous microorganisms are now available and undergoing evaluation. While striking results can often be demonstrated in the lab or greenhouse, few have achieved practical success in the field. The major problems lie in the formulation and delivery of optimum amounts of inoculum and, secondly, sustaining that inoculum at sufficiently high populations for beneficial activity to occur. Now, two systems have gone some way in meeting these requirements. Bio-Trek 22G, based on the fungus *Trichoderma harzianum*, was first tested in 1990. Bio-Trek was EPA registered in 1996 for commercial use on turf. Applied twice in the spring and again in the fall when temperatures are in the 50s and 60s, the fungus does become established in the rhizosphere and can supplement the microbial community to reduce soil-borne disease. However, Bio-Trek does not have an effect on foliar disease. Sprayable suspensions of the spores of the fungus have been attempted experimentally to control the latter and they do work. It appears, however, that frequent applications are needed for effective foliar disease prevention (at least once a week), and some fungicides are lethal to *Tricoderma*. They must be avoided.

The second system, the BioJect, involving the bacterium *Pseudomonas aureafaciens* strain TX1, has been developed over the past few years. Very recently, it became the second turf disease bio-control agent with EPA registration. Protocols for practical use have been largely the result of research done by Dr. Joe Vargas. The lethal

*Thus far, the success of disease biological control products has been limited due to problems with the formulation, delivery, persistence, and competition from naturally occurring microorganisms. To date, only two disease biocontrol products are registered with the U.S. EPA as pesticides.*

effects of exposure to UV light and drying greatly impact these biologicals. I quote Dr. Vargas: "For biologicals to work, they need to be applied almost daily." With respect to the practical application of this BioJect technology, there are happy people and there are some who are particularly unhappy. I think this is an example where the technology has potential but still needs some refinement. It is also a good illustration of what happens when the hyping of unreasonable expectations outpaces the basic science and sound engineering of a product.

Now, I have danced around the topic and avoided any chance of lynching, but the question still arises: What about all those biological or organic products that proliferate each year? How do you separate the good, the bad, and the ugly? Those are not my words. I throw it back to the USGA and to Matt Nelson, USGA agronomist. He posed this question in a succinct and eloquent article entitled "The Microbial World" in the *Green Section Record*. His comments were mirrored closely by Drs. Gail Schumann, Monica Elliott, and Paul Vincelli in their article in *Golf Course Management* magazine entitled "Evaluating New Turf Products." So I leave you with their combined recommendations on the points to raise and the procedures to adopt.

- When you are looking at one of these products, ask the vendor what it is recommended for. Is it just for turf? If it is a general catchall or a universal cure, beware!
- Does the product have EPA registration for pest or disease control? This is your protection against liability, particularly the safety considerations.
- Who was the principal investigator who did the initial research? Was it independent or in-house?
- Where was the research conducted? Was it just in the lab or the greenhouse, or did it go out to the field?
- What was the growing medium? Was it in sand, soil, or compost?
- How were the experiments designed? Did they have good replication and were good comparative treatments included in the trial?
- Were the results statistically analyzed and were the differences statistically significant?
- Has the experiment been repeated over two or three years at different sites and with similar results?
- Have the results been published in a refereed journal? In this publishing process, a reviewer goes through the data and decides whether the material cuts the mustard.
- Watch out for slick pamphlets. They are no substitutes for the information that is provided above.
- If you want to conduct a test of the material, obtain a small sample for use on a small area. Don't go overboard and shell out big bucks. You might be buying a lemon.
- Test products at several locations, replicate the plots in your trials, and put in controls. You must have check plots to compare the treated plots against so you know what is happening. You need at least two years of field data for an accurate assessment. Rate the plots regularly for observable differences — color, disease, stress tolerance, etc.
- Conduct an independent nutrient analysis to eliminate the possible effect of fertilizer response. Some of these products give a great surge of growth, and you don't know why.
- Finally, consider the possible impact of favorable weather, better cultivation, or improved growing environment. Any change in management practice may have produced the effect rather than a response from the product. In this realm, the old adage applies — *let the buyer beware!*

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DR. NOEL JACKSON, *Professor of Turfgrass Pathology at the University of Rhode Island, has just the experience and facts needed to help address this question.*