

Soil microbial enhancement

The theory developed from these experiments was that the inoculum which was not normally found in the rhizosphere could not compete with native bacteria.

The idea of a dynamic microbial equilibrium that is established in the root zone of the plant led to the belief that any introduced microorganism will not be able to establish itself in the soil.

Two important breakthroughs in recent years have brought the use of biological agents for plant management into practical use. The discovery of mutant strains of bacteria that lived off root exudates and altered the indigenous microbial populations of the root zone, to allow their colonization throughout the season, and techniques to measure their establishment. Selective breeding for host specific strains that process known plant pathogens or biodegrade organic matter has brought us the products being marketed today.

The area most likely to be successfully colonized by beneficial microbes is a newly constructed USGA style green. This is basically a sterilized soil medium where the inoculum can be more easily established. Along with the microbes, it is important to supply a food source until the root system becomes sufficient to support their growth. The supplier of the microbes should be able to recommend an available substrate.

If the supplier can't provide this information, you should reconsider using the inoculum he is selling. Some bacteria are inoculated onto fertilizer carriers that supply an adequate food source for a short time.

Another important consideration is that the inoculum must be delivered to the rhizosphere, as bacteria are not all mobile and must have moisture present to survive and move to the desired location. The incorporation of bacteria and a food source into the soil before planting may provide the best opportunity for establishing healthy colonies where they can do the most good.

Practical Application II Banyan Golf Club

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At Banyan Golf Club we have been working on biological control agents for many years. We started with the white amur fish in our lakes to reduce the undesirable aquatic vegetation. We have not had to conduct mechanical removal or herbicide applications for 15 years and our lakes remain weed free.

We have introduced the red eye fly and the *steinernema scapterisci* nematode for mole cricket control. The results are inconclusive at this point.

A strict IPM program has reduced our pesticide usage by 40%. We spray for curative control only.

We are currently in the process of setting up a program to control diseases and parasitic nematodes with microorganisms.

The future of biological and organic control of pests is exciting, and Banyan Golf Club plans to stay on the cutting edge.

The application of products through irrigation systems is an efficient method for moving the microbes into the soil, however may not be cost efficient due to application in non target areas. If the entire course is to be treated, this is probably the best way available to move the bacteria into thatch or the root zone.

Core cultivation before inoculation should greatly improve their ability to reach the intended destination. It is important to know the part of the plant the microbes are designed to work, as applying them incorrectly or without a sufficient food source will ensure their failure to establish and compete.

Once the colonies become established, there are products available to be applied in granular form or through fertigation that will aid in their survival and efficient growth.

There are additional factors that directly affect the life processes of the microbes and their ability to perform the task they were applied for. Extended wet periods or very compacted soils can rob the bacteria of oxygen necessary to remain in an anaerobic state and some re-inoculation may be necessary after the poor conditions are alleviated. There is conflicting data on the effects of chemical pesticide on non target microorganisms, so the manufacturer of the bacteria should be consulted as to when re-inoculation can safely take place. These factors indicate that the most efficient way of en-

couraging the establishment of beneficial microbes would be a system that provides a constant source of inoculum, with the proper food source, through a well-designed irrigation system.

The ability to do this is available today, but the cost is high and the results are difficult to quantify and cannot be expected to give rewards for two or more years. There are also products that can be applied with spray equipment on specific areas like greens or trouble spots and watered in.

At Emerald Dunes, we feel that we are receiving benefits from our management program that justifies its continuance. The use of chemical pesticides and amount of fertilizer applied has decreased gradually over the past three years. There has not been a significant cost reduction in the fertilizer budget since the nutrient sources used are more expensive per pound, however less frequent applications provide for some labor saving and less disruption of play.

The course seems to recover more quickly from poor weather conditions and stand up better to heavy traffic. Overall, we feel the quality of the turf above and below the ground has continued to improve with no corresponding budget increase since our biological enhancement programs were begun. Our knowledge of the symbiotic relationship of the plant, soil and microbial populations is

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