GOLF GREEN SOIL MICROBIOLOGY AND BIOLOGICAL STIMULANTS - Trials 2015/16

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INTRODUCTION

During 2014/2015, observation trials were undertaken at Sorrento GC comparing the effects of their "biostimulant brew" versus a commercial product. The purpose was to observe any differences and to evaluate the practicalities of implementing such a program. During this period various observations were made on root and plant health and samples were taken for nematode diagnosis and soil microbial activity.

The outcomes of these observation trials were summarised as follows;

- There was excellent root health.
- Turf health and density was exceptional.
- Recovery from renovations was very good.
- High quality putting surfaces were produced.
- There were low nematode numbers. The Sorrento GC has had a history of high nematode numbers with considerable turf thinning and root damage as a result.
- Low disease incidence.
- There was an active and diverse microbial population that included Actinomycetes, Bacillus, and Trichoderma, all of which are beneficial to turfgrass health.
- There were no obvious differences between the treatments.

The microbiologist that did the testing made several observations regarding the microbial population and in particular noted that increasing rates or frequency matters little if the host is not "right". In particular the high pH of the greens tended to favour bacteria and actinomycetes over the beneficial fungi. While there were beneficial microbes present were the numbers useful? He suggested that in order to gauge what the microbial numbers meant that a control plot should be established to determine a baseline microbial population and observe how this relates to turf health and density.

TRIAL SETUP

As a result of these observation trials a more formal trial was established on the bentgrass nursery at Sorrento GC. The nursery is on a sand base and seeded with PennA1 creeping bentgrass that was seven months old. Being a relatively new profile it was expected that the microbiological community would be relatively low and provide the best opportunity to observe a response. The sand is alkaline with a pH of 8.9 – 9.2, low salinity and high in calcium. The trial consisted of 3 treatments;

- Untreated Control (UTC)
- Sorrento Brew (SGC)
- Commercial Liquid Compost (LC)

The plot size was nine square metres with three replicates of each treatment. The treatments were applied monthly commencing in September 2015 and finishing in May 2016.

The plots were assessed monthly for;

- Turf quality, density and health.
- Root depth and health.
- Thatch depth.

The data was statistically analysed and the Least Significant Difference ($P<0.05$) calculated.

On three occasions composite samples from each treatment were taken to determine the microbiological composition including nematodes. Samples were also analysed for changes in soil chemistry. The micro-organisms were determined by SWEP laboratories and the nematode counts were done by the AGCSA.

COMPOSITION OF BIOLOGICAL STIMULANTS

The Sorrento GC brew consists of Seaweed extracts, Liquid Fish + Kelp + "Microbes" Mix, Molasses and Trichoflow (*Trichoderma* sp.) while the commercial liquid compost included both Kelp and Liquid Fish. Samples of both products were sent to SWEP laboratories and tested for their microbiological composition (table 1).

Table 1: Analysis of the biological stimulants

Parameter	Liquid Compost	Sorrento GC Brew
Total Nitrogen (%w/w)	ND	ND
Total Phosphorus (%w/w)	0.0120	0.0009
Total Potassium (%w/w)	0.0574	0.0264
Total Manganese (ppm)	2.92	0.264
Total Zinc (ppm)	3.44	10.3
Total Organic Carbon (%w/w)	0.5460	0.02230
Total Plate Count (cfu*/ml)	160,000	57,000,000
Bacillus (cfu/ml)	8,000	7,000
Fungal Count (cfu/ml)	62,000	200,000
pH	4.1	5.2

cfu*= colony forming units
ND = nil detected

The two biological stimulants have a very different composition with both having some nutrients in small concentrations with the main difference being the microbial counts. The Sorrento GC brew had considerably higher numbers of total microbes and fungi. It should be noted that the Sorrento GC brew is "seeded" with *Trichoderma* sp. whereas the liquid compost is presumed to consist only of the naturally occurring microbes. The microbiologists comments indicated that the acid pH of both materials would affect the balance of organisms and those organisms that were present may not be particularly beneficial from a soil health perspective.

RESULTS OF TRIALS
A large amount of data was collected during the trial including observations of turf health, root depth, soil microbial counts and soil chemistry data. A portion of the data is presented below to illustrate some of the key findings.

Turf parameters
Across all the turf parameters evaluated and at each assessment date, there was no significant difference between treatments for turf quality, turf density, root depth, root health or thatch depth. Some of the data is presented in tables 2 and 3 and figures 1 and 2.

Table 2: Average turf quality, density, colour and health 23/3/16

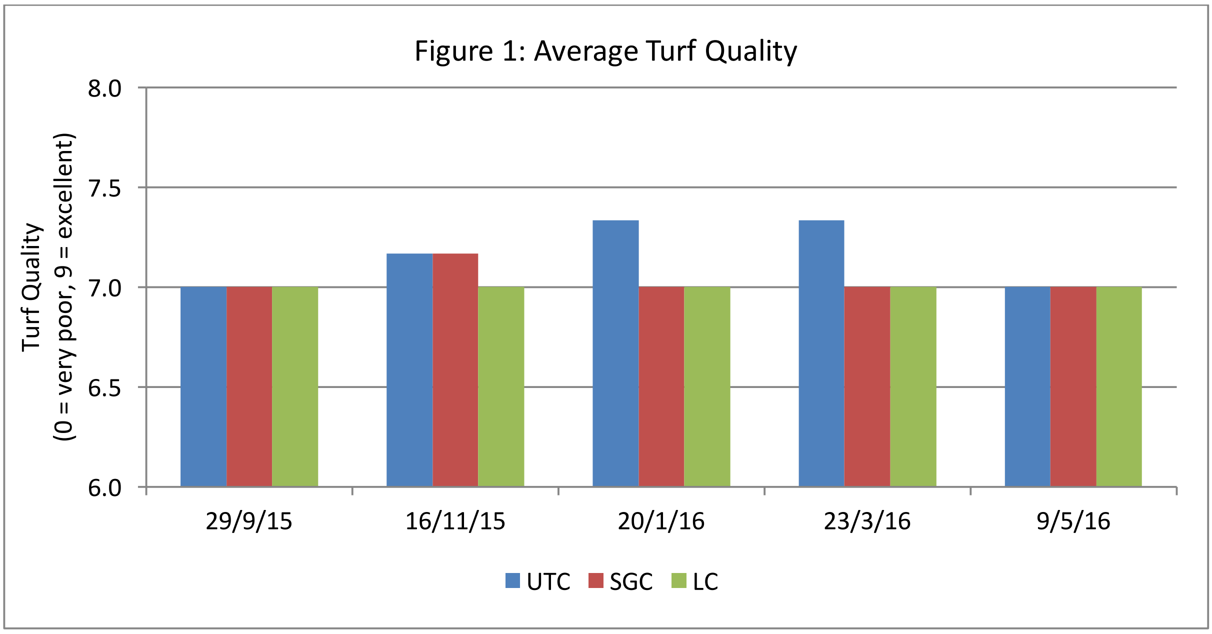
Treatment	Turfgrass quality*	Turfgrass density	Turfgrass colour	Turfgrass health
UTC	7.3	7.0	6.0	8.0
SGC	7.0	7.0	6.0	8.0
LC	7.0	7.0	6.0	8.0
LSD (P<0.05)	**NS**	**NS**	**NS**	**NS**

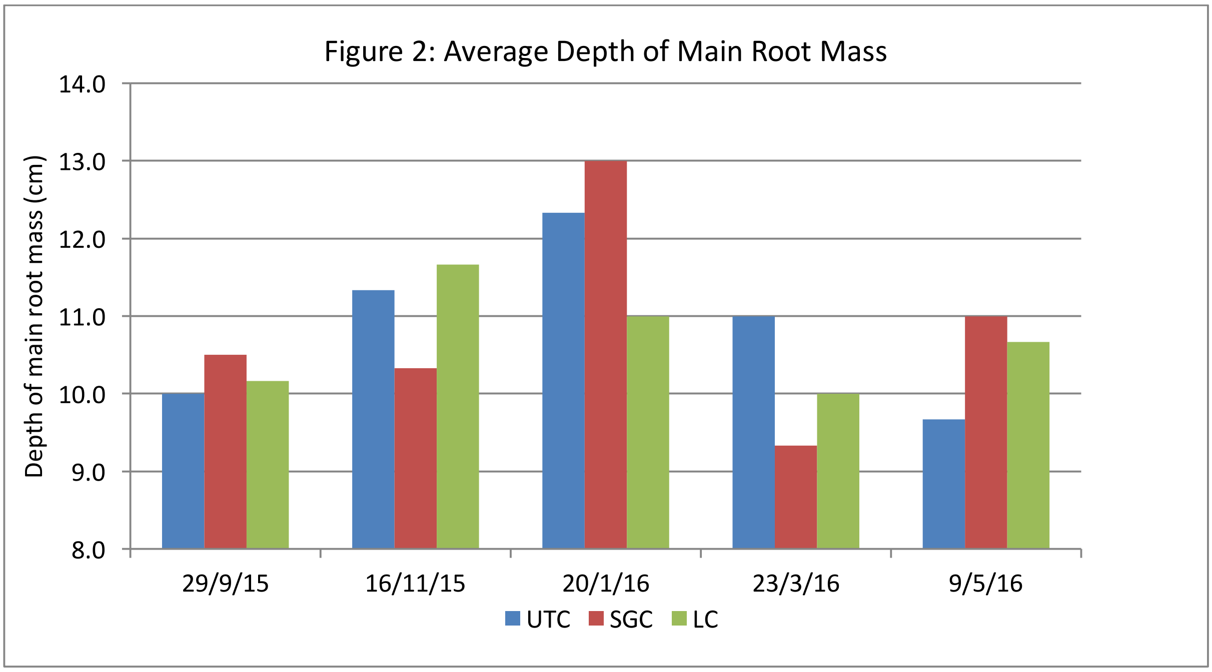
*0 = very poor, 9 = excellent

Table 3: Average root depth, root mass and thatch depth 23/3/16

Treatment	Main root mass (cm)	Max. Root depth (cm)	Thatch depth (cm)	Root health*	Root density
UTC	11.0	11.7	1.5	8.0	8.0
SGC	9.3	11.0	1.3	7.3	8.0
LC	10.0	10.0	1.3	8.0	8.0
LSD (P<0.05)	**NS**	**NS**	**NS**	**NS**	**NS**

*0 = very poor root health, 9 = excellent root health





Soil microbiology

Soil micro-organism counts were undertaken before the treatments were applied and then again in mid-summer 2015/16 and late autumn 2016. SWEP laboratories measure the proportion of active micro-organisms which is those organisms that will immediately grow under ideal conditions (generally about 7-10% of total soil biomass) and presumably to be the most responsive to organic supplements.

In assessing the microbiological population, the key species that were present included; Lactic acid bacteria, Fungi, Cellulose utilisers, Yeasts, Actinomycetes, and Photosynthetic bacteria (table 4). These micro-organisms represent what are considered to be the “most beneficial” for soil and plant health. The microbial numbers fluctuated with the seasons and peaked when the soil temperatures were at their highest (figure 3). In January 2016 the UTC had the greatest total active microbial population with the SGC treatment having the highest numbers of photosynthetic bacteria and actinomycetes. In May 2016 the overall numbers of microbes were dramatically lower than January 2016 with the liquid compost having the highest total active microbial population, fungi, cellulose utilisers and lactic acid bacteria.

With the nematodes there were very low numbers of parasitic nematodes at each sampling and high numbers of the total free-living nematodes (beneficial types). The biological treatments did not appear to have a significant effect on nematode numbers compared to the control (table 5).

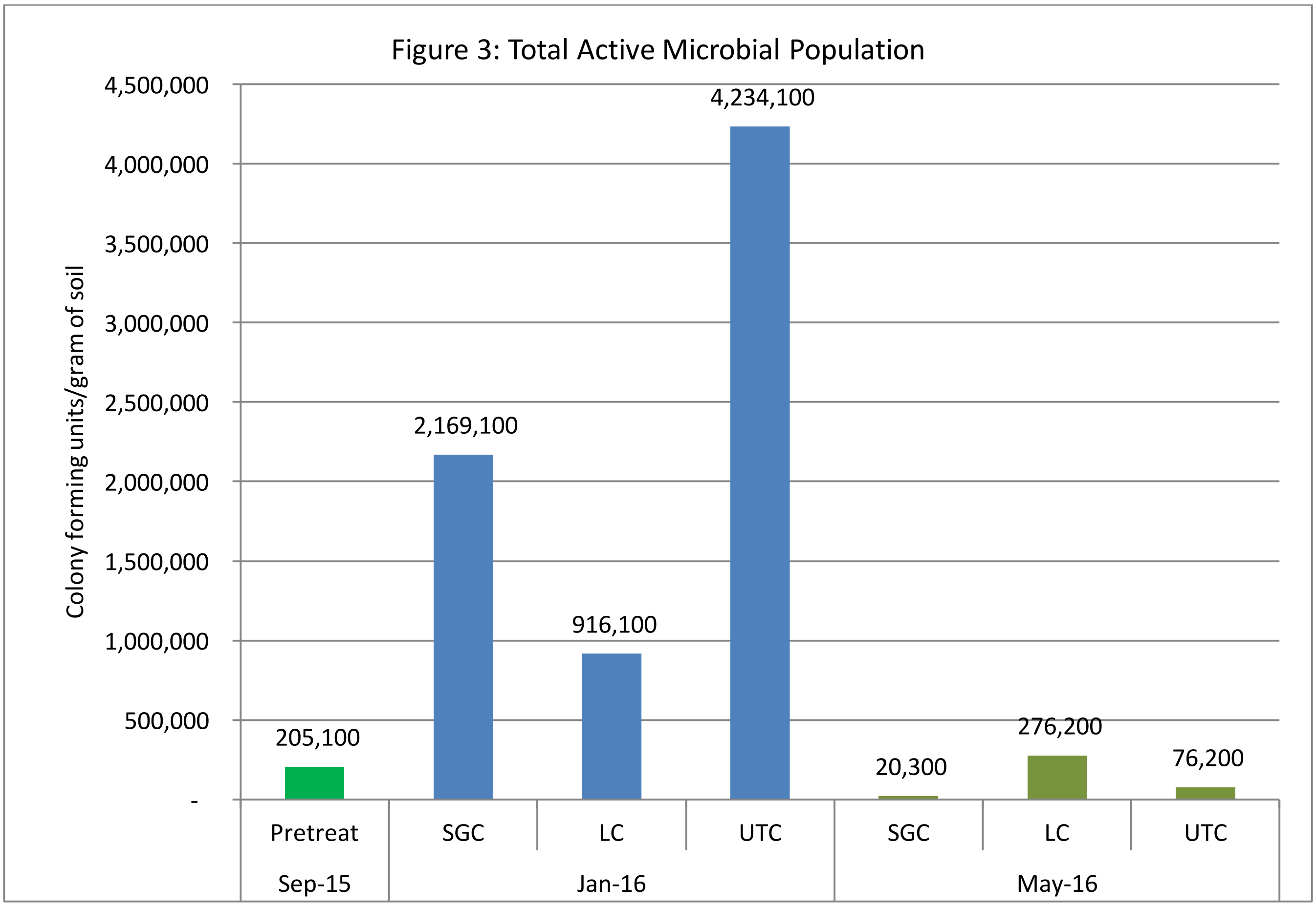


Table 4: Soil microbial numbers

	Sep-15	Jan-16			May-16		
Micro-organism	**Pre-treatment**	**SGC**	**LC**	**UTC**	**SGC**	**LC**	**UTC**
Active lactic acid bacteria (cfu/g soil)	30,000	2,050,000	900,000	4,100,000	1,000	120,000	1,000
Active Fungi (cfu/g soil)	100,000	9,000	3,000	90,000	18,000	25,000	18,000
Cellulose utilisers (cfu/g soil)	20,000	40,000	11,000	40,000	100	130,000	56,000
Total active fungi (cfu/g soil)	120,000	49,000	14,000	130,000	18,100	155,000	74,000
Active yeasts (cfu/g soil)	25,000	10,000	1,000	3,000	100	100	100
Active actinomycetes (cfu/g soil)	30,000	60,000	1,000	1,000	1,000	1,000	1,000
Active photosynthetic bacteria (cfu/g soil)	100	100	100	100	100	100	100
Total Active Population (TAP): (cfu/g soil)	205,100	2,169,100	916,100	4,234,100	20,300	276,200	76,200

Table 5: Nematode numbers

	Sep-15	Jan-16			May-16			
Nematode species	**Pre-treatment**	**UTC**	**LC**	**SGC**	**UTC**	**LC**	**SGC**	**Treatable threshold**
Stubby root nematode (*Paratrichodorus* sp.)	8	36	25	68	0	4	8	80
Spiral nematode (*Helicotylenchus* sp.)	28	176	240	216	96	108	224	600
Sheath nematode	4	4	36	16	28	16	22	160

(*Helicycliophora* sp.)								
Root lesion nematode (*Pratylenchus* sp.)	0	4	0	0	8	7	40	100
Root knot nematode (*Meloidogyne* sp.)	0	0	0	0	4	0	0	100
Total free-living nematodes	**600**	**1160**	**1300**	**1200**	**1044**	**1114**	**1745**	**NA**

Soil chemistry
On each sampling date the soil chemistry was analysed. The soils were consistently highly alkaline (pH 9), low in salinity, moderate organic matter, high calcium, low sodium and consistent CEC. There were no differences between the treatments.

CONCLUSION
These trials were replicated and comprehensive and indicate that there were no obvious benefits from the application of these organic supplements at this trial site. First and foremost there was no significant difference in any of the measures of plant health between the two biological treatments and the untreated control.

When looking at the effects on the soil microbiology, the numbers and composition of the microbes and nematodes continue to be variable and do not provide a clear indication as to the benefits of biological supplements. At the January 2016 assessment the untreated control had the greatest number of microbes whereas in May 2016 the liquid compost appeared to be superior. This may mean that ideally a trial of this type may need to run for many years so as to better determine the trends. The other important consideration is that while the microbial population may be manipulated and "improved", it may not be translated into improvements in plant growth and health.

The outcome of this trial is consistent with the scientific literature. That is, while some research demonstrates the positive aspects of microbes and biostimulants, for each positive result there is an indifferent result where the benefits are difficult to quantify. The Turfgrass Information File is an excellent source of this research and is recommended reading for those interested in these studies and is accessible through the member's area of the AGCSA website (www.agcsa.com.au).

So where are we at?
Turfgrass rootzone microbiology is a complex area of study and there is still a lot to be understood and the evidence in the literature supporting the benefits of using biostimulants and microbes is variable. In an article by Neher (2010) soils are described as the final biotic frontier and it is suggested that we know more about outer space and the depths of the ocean than we do about the soil biology of our own backyard. This certainly puts the soil microbiology of golf green rootzones into perspective.

So, do we give up on organic and biostimulants completely? In short, no. Biostimulants and microbes can be beneficial as part of a well-balanced maintenance program, however, every site is different and the benefits may be localised. It is also important to reinforce that they are not a substitute but an addition to normal turfgrass management practices.

If you are considering the use of biostimulants and microbes; trial them and observe the results and then decide whether it is right for your circumstances. Having a control plot just with your normal program is important for comparative purposes. Realistically you may need to run the program for 12 months or more before the benefits or otherwise are realised. It is also strongly recommended to take samples and have them analysed by SWEP to determine what the microbial population is in your situation. It is also recommended that you read the article by Zuberer (2012) to provide a good overview of soil microbes in turfgrass systems.

REFERENCES
David Zuberer (2012). Soil Microbes: Some practical perspectives for turfgrass systems. Green Section Record Vol. 50 (15) July 20, 2012

Neher, D. A. 2010. Ecology of Plant and Free-Living Nematodes in Natural and Agricultural Soil. Annual Review of Phytopathology. Vol. 48: 371-394