

Soil Study Boschenmeer Golf Estate



Purpose of the study

To monitor the effect of a new product Oxyturf™ at different application rates on the soils of the greens at a golf course. The soil chemical properties and nematode populations were measured over a trial period of 7 weeks. The results are discussed in this report.

The product

Makro Organics for whom this study was done, supplied the following information regarding their product and its mode of action:

Oxyturf™ was developed to increase aerobic conditions in soil profiles by microbial stimulation of the natural breakdowns of excessive organic material. This increased process of breakdown, in which the microbes produce oxygen cause conditions which are more favourable for plant/turf growth.

Oxyturf has twofold mode of action:

- It inoculates the soil with positive, balanced aerobic bacteria and micro-digestive organisms which performs their natural aerobic digestive processes in the soil. Some of the bacteria release enzymes that catalyse production of oxygen through the breakdown of various organic compounds in the soil which contain oxygen (similar to naturally forming peroxide).
- It releases high concentrations of dissolved oxygen within the irrigation water used to apply the product, thus increasing aerobic activity within the soil profile.

Study area

The 3 putting greens next to the Boschenmeer Clubhouse were used for this experiment. Boschenmeer is situated in Paarl in the Western Cape.

Methodology

- Before any treatments were applied, composite soil samples were taken from each green 12/04.
- The samples were taken randomly using a soil sampling spade which extracted a soil core to a depth of 150mm. The complete cores were used for the samples.

- The samples were vertically split in half, with the one half of the sample going to Bemlab for chemical analyses, and the other half going to Nemconsult for nematode analyses.
- After the soil samples were taken, the OxyTurf were applied at different application rates. These applications were done using the spray cart, after which it was then washed into the soil profile using hoses.
- Green-1 was divided in 2. One half served as the control, while the other half received an application of 5ml/m² OxyTurf (Standard treatment).
Green-2 received 20ml/m² OxyTurf.
Green-3 received 2.5ml/m² OxyTurf.
The treatments were applied on 12/04, 29/04 and 24/05.
- The second set of samples were taken on 05/06. The same procedure was used as in the first sampling, and the same analyses were requested from Bemlab and Nemconsult.
- All the results from the laboratories are attached.

Other actions and occurrences

As the Golf course is an "operational" course, the normal management practices continued. This is not ideal for a scientific experiment, as these actions could all to a greater or lesser degree influence the action of the applied treatment. An abnormal amount of rain fell during the trial period, making the interpretation of data even more troublesome. It would therefore be very difficult to ascribe any result or the absence thereof solely to the applied treatments.

- Hollow tining
Hollow tining can be a severe action, as it removes soil from the profile and replaces it with inert sand. This action can affect the chemical, physical as well as the biological status of the soil. As it was applied to all of the study area, we can only assume that the effect would be the same on all of the treatments. This is somewhat of a simplistic assumption as it does not take the concentration effect of the different treatments into consideration.

The hollow tining was done to a depth of 75-100mm and a total of 44 tonne of sand was applied over an area of 1.2ha. This equals 3.7kg/m². The soil sampling was done to a depth of 150mm. The 150mm of soil depth equals 200kg/m² (density = 1.3g/cm³). The physical "dilution" of the soil profile with new material can therefore be estimated to be 1.9%, which is not too severe. However it also had an influence on aspects such as aeration, water infiltration, permeability, etc.

- Fertilization

The greens were fertilized during May with the nutrients in the table below. These applications were made to all the areas and can therefore be assumed to have the same effect on all.

Element	N	P	K	S	Mg	Mn
Application kg/ha	28	0.05	11.72	5.18	1.16	1.26

- Rainfall
Over and above the normal volume of water applied through irrigation (if any were required!), 328mm of rain were recorded during the period of the experiment. Of this 41% (136mm) were recorded in the four days before the last sampling. On a golf green which is a sandy medium designed to drain quickly, such a large volume of water would have a leaching effect on the applied treatments and soil nutrients.

Results and Discussion

Soil chemical analyses were done to determine the nutrient status of the soils. It is important to know what the pH and concentrations of cations in the soils were, and if it were influenced by the treatments.

From the attached soil analyses the following comparisons of certain parameters.

1. pH

Parameter	Sampling date	Treatment			
		Control	1	2	3
Soil pH	12/04	5.3	5.3	5.2	6.2
	05/06	5.2	5.7	5.5	5.9
Comments		The pH remained quite constant, but tends to be slightly higher in the treated samples. This despite the lower Ca values as will be seen later.			

2. Phosphate (P)

Parameter	Sampling date	Treatment			
		Control	1	2	3
Phosphate ppm P	12/04	8	8	9	12
	05/06	6	6	6	11
Comments		There is an overall uniform decrease in the P values. Can probably be ascribed to the hollow tining and rainfall.			

3. Potassium (K)

Parameter	Sampling date	Treatment			
		Control	1	2	3
Potassium ppm K	12/04	67	67	117	54
	05/06	23	20	18	23
Comments		K showed a drastic decrease in value. Taking into consideration the high rainfall and the nature of the soil medium, this is probably not a surprise. However it can be a reason for concern as will be discussed in the conclusion.			

4. Calcium (Ca)

Parameter	Sampling date	Treatment			
		Control	1	2	3
Calcium ppm Ca	12/04	512	512	573	670
	05/06	312	432	362	787
Comments		Ca decreased in all treatments except no 3, where it increased. This is difficult to explain as no Ca-nutrition was supplied and we do not have an analysis of the sand used for hollow tining. Even so all the areas received the same hollow tining treatment.			

5. Carbon (C)

Parameter	Sampling date	Treatment			
		Control	1	2	3
Carbon % C	12/04	0.76	0.76	0.81	0.79
	05/06	0.71	0.64	0.58	0.48
Comments		There is a definite trend of lower C-values in the treated profiles than in the control. This was to be expected as the mode of action of the OxyTurf is the breakdown of Carbon compounds in the soil through the process of microbial decomposition.			

6. Trace elements Cu, Zn, Mn, B

The trace elements showed a decrease similar to that of the above mentioned Macro elements. The exception is Copper (Cu), which showed higher values in the second set of

samples. The reason for this is unclear as no Cu containing fungicides or pesticides were used.

The nematode analyses were done for two reasons:

- To be used as an indicator of the effect of the treatments on soil microbial life. Soil microbiology is very complex and difficult to measure.
- To determine if the treatments have an impact on nematodes, as the control of pathogenic nematodes is a constant problem on golf greens.

7. Saprophytic Nematodes (Vrylewend)

Parameter	Sampling date	Treatment			
		Control	1	2	3
Saprophytic Nematodes	12/04	960	960	540	2090
	05/06	600	410	390	170
Comments		There is a definite trend of lower numbers of the saprophytic nematodes in the treated profiles. However, as these nematodes do not cause any harm to plants a healthy soil, as a rule of thumb, should contain >500. It seems that the dosage and the frequency of the OxyTurf treatment may be very important.			

8. Spiral Nematodes (Spiraal)

Parameter	Sampling date	Treatment			
		Control	1	2	3
Spiral Nematodes	12/04	530	530	30	490
	05/06	1930	30	180	1080
Comments		Treatment 1 seems very successful in reducing the numbers of these parasitic nematodes, especially when the numbers seemed to have increased in all the other treatments. This increase may also be a function of the reduced numbers of saprophytic nematodes in the profile, creating an opportunity for the more aggressive parasitic species. It once again seems that the dosage and the frequency of the OxyTurf treatment may be very important.			

Conclusions

The treated greens showed as marked improvement in comparison to the control in the rate of recovery after the hollow tining. This improved rate of recovery holds the advantage that the course can return to normal playing conditions much quicker than before. This has obvious advantages for the Club as well as the players.

1. Soil Chemistry

From the analyses it is clear that the reaction was not due to improved soil nutrient status. The nutritional status of the soils was actually poorer at the end of the trial than in the beginning. The biggest reason for the lower concentrations is the combined effect of the hollow tining and the high rainfall. The nutrients were simply leached from the profile into the drainage water.

It is worth noting that, working on averages, K decreased from 79ppm to 21ppm during the period of the trial. Over the 150mm of soil depth this equates to 157kg K for the 1.2ha of green area. If the K applied as fertilizer is also taken into account, 171kg K was lost. This is not only a financial loss, but the K ended up in the drainage water and will eventually find its way to rivers and wetlands. As climate change confronts us with more erratic weather patterns we shall face increasingly difficult management challenges. Even with small things such as the management of our fertilizer.

2. Soil Carbon

The treatments however did seem to have a pronounced effect on the Carbon content of the soil. All three treatments showed %C-values much lower than that of the control and from the values of the samples taken at the beginning of the trial. As the stated mode of action for Oxyturf is "the breakdown of excessive organic material", it seems that that was achieved.

This is also the reason for the better recovery rate of the treated areas when compared to the control. The microbes broke down the organic material/compounds in the soil profile releasing CO_2 , and opening up the pore space in the soil. The pores/cavities between the mineral soil particles can either be filled with water or air. In a compacted soil (such as the greens) the porosity is reduced and most of the pores are saturated with water. Breaking up the organic matter that "clogs" the pores, thus frees up space, improving infiltration and permeability and allows more air (O_2) to penetrate the soil.

Only plants with chlorophyll, can photosynthesize and produce O_2 into the environment. All respiration and decomposition processes produce CO_2 . When the microbes break down the organic compounds in the soil, CO_2 is emitted and the nitrogen is built into their protoplasm. When the process of decomposition is complete, the microbial activity drops. Many of the microbes die which in turn serve as a source of energy for surviving microbes and as a source of N for the plants.

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To summarize: The positive growth response was caused by the reduction in organic compounds, which in this compacted, over irrigated/rained soil system opened up pore space allowing better drainage and thus the influx of more air (O₂) into the system. This improved aerobic conditions aided by the N supplied by the recycling microbial population stimulated the growth of the turf.

It must be noted that the same result is unlikely to be obtained in soils with a very low %C. The effect of the treatments on the reduction of the %C in the soil profile must definitely be kept in mind when using the product, as it has the ability to break down all organic compounds in the soil. Soil without organic material cannot sustainably support healthy plants.

3. Nematodes

OxyTurf did have a marked effect on the nematode populations of the soils. Controlling the nematode population would definitely have a positive effect on the rate of recovery and the quality of the turf after the greens have been hollow tined. It seems that when applied at the recommended concentration (Treatment 1), it decreased the number of parasitic nematodes, without destroying the saprophytic population. This is a positive result in so far that nematode control has been obtained through the use of a biological product. This result was obtained under the difficult conditions that prevailed during the trial. However, the other treatments gave results similar to the control, indicating a narrow band of efficiency in application rates. More work would need to be done in this regard to quantify the extent to which OxyTurf can be used as a nematocide.

Declaration of Independence

Benjamin Diedericks, who undertook the soil assessment and prepared this document on behalf of Resalt, holds an Honors degree in B.Sc Agric (Soil Science) from the University of Stellenbosch. He has more than 20 years of advisory experience in practical agriculture. He is an independent consultant and neither he nor Resalt has any vested or financial interests in the production or marketing of the OxyTurf product.

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Boord	Lab. No.	Diepte (cm)	Grond	pH (KCl)	Weerst. (Ohm)	H ⁺ (cmol/kg)	Klip (Vol %)	P Bray II mg/kg	K	Uitruilbare katione (cmol(+)/kg)				Cu	Zn	Mn	B	Fe mg/kg	C %
										Na	K	Ca	Mg						
Boschenmeer 1	12990		Sand	5.3	1260	0.25	2	8	67	0.05	0.17	1.31	0.18	0.33	6.5	22.0	0.12	87.93	0.76
Boschenmeer 2	12991		Sand	5.2	1640	0.20	2	9	117	0.06	0.30	1.47	0.24	0.21	5.8	14.7	0.13	63.08	0.81
Boschenmeer 3	12992		Sand	6.2	1070		2	12	54	0.07	0.14	1.72	0.14	0.29	5.5	17.1	0.13	56.05	0.79
Metodes [#]				3108	3106	3109		3117		3113	3113	3113	3113	3115	3115	3115	3114		3107

Indien pH > 7.0 is word die Olsen metode(3118) vir die bepaling van P gebruik.

[#]Verwys na BemLab werkinstruksies

Monster toestand: Monsters ontvang in goeie toestand.

Verklaring: Die gerapporteerde resultate is slegs van toepassing op die monster(s) ontvang. Enige advies wat by hierdie verslag ingesluit is, is op die aanname gebaseer dat die monster(s) verteenwoordigend is van die bulk waaruit dit geneem is.

Basis Versadiging

Boord No.	Lab. No.	Na %	K %	Ca %	Mg %	T-Waarde cmol/kg
Boschenmeer 1	12990	2.34	8.73	67.11	9.04	1.96
Boschenmeer 2	12991	2.48	13.13	64.85	10.72	2.27
Boschenmeer 3	12992	3.38	6.63	83.15	6.84	2.07

DATA ON BOOR 10/03/2010

Boord	Lab. No.	Diepte (cm)	Grond	pH (KCl)	Weerst. (Ohm)	H ⁺ (cmol/kg)	Klip (Vol %)	P Bray II mg/kg	K	Uitruilbare katione (cmol(+)/kg)				Cu	Zn	Mn	B	Fe mg/kg	C %
										Na	K	Ca	Mg						
1A- Treated	20756		Sand	5.7	4740	0.25	2	6	20	0.01	0.05	1.11	0.13	1.05	4.5	18.6	0.15	55.75	0.64
1B- Control	20757		Sand	5.2	5830	0.30	2	6	23	0.01	0.06	0.80	0.13	1.00	3.7	17.9	0.11	86.98	0.71
2	20758		Sand	5.5	8030	0.25	2	6	18	0.01	0.05	0.93	0.13	0.97	3.5	13.1	0.12	54.40	0.58
3	20759		Sand	5.9	4490	0.15	2	11	23	0.01	0.06	2.02	0.13	1.11	3.9	21.9	0.12	54.02	0.48
Metodes [#]				3108	3106	3109		3117		3113	3113	3113	3113	3115	3115	3115	3114		3107

Indien pH > 7.0 is word die Olsen metode(3118) vir die bepaling van P gebruik.

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Basis Versadiging

Boord No.	Lab. No.	Na %	K %	Ca %	Mg %	T-Waarde cmol/kg
1A- Treated	20756	0.58	3.34	71.58	8.34	1.55
1B- Control	20757	0.55	4.56	61.80	9.77	1.29
2	20758	0.75	3.31	68.21	9.41	1.36
3	20759	0.29	2.53	85.41	5.43	2.37

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Hierdie ontleding was gedoen deur Nemconsult en is nie deel van Bemlab se akkreditasie skedule nie

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7 Mei 2013

Lab Nr	Bemlab lab nr	Blok	Kultivar	Nematodes per 250 cc grond en 10g wortels								
				Vrylewend	Knopwortel	Ring	Dolk	Letsel	Stompwortel	Spiraal	Skede	
U1002	12846	1	Gras									
Nematodes per 250 cc grond				960	0	0	0	0	0	0	530	0
Nematodes per 10 g wortels (Geen wortels)				-	-	-	-	-	-	-	-	-
Totale aantal nematodes				960	0	0	0	0	0	0	530 (hoog)	0
<i>Kommentaar:</i> Ek stel voor dat u die toediening van 'n behandeling oorweeg. Ander grond organismes ook waargeneem.												
U1003	12847	2	Gras									
Nematodes per 250 cc grond				540	0	0	0	0	0	20	30	120
Nematodes per 10 g wortels (Geen wortels)				-	-	-	-	-	-	-	-	-
Totale aantal nematodes				540	0	0	0	0	0	20 (laag)	30 (laag)	120 (matig)

Kommentaar: Ek voorsien nie die nodigheid vir die toediening van 'n behandeling nie. Ek stel slegs voor dat die aalwurm getalle streng gemonitor word. **Ander grond organismes ook waargeneem.**

U1004	12848	3	Gras								
Nematodes per 250 cc grond				2090	0	0	30	40	0	490	0
Nematodes per 10 g wortels (Geen wortels)				-	-	-	-	-	-	-	-
Totale aantal nematodes				2090	0	0	30 (laag)	40 (laag)	0	490 (matig)	0
<i>Kommentaar:</i> Indien die groeikrag nie optimaal is nie, stel ek voor dat u die toediening van 'n behandeling oorweeg. Ander grond organismes ook waargeneem.											

Belangrik: Die volgende nematisiede is tans op wingerd geregistreer: furfural (Crop Guard), fenamiphos (Nemacur) en cadusaphos (Rugby). Die behandelings moet geskied net voor die wortelgroeipieke in die lente en herfs. Die optimum tyd van toediening is binne 30 dae na oes opgevolg deur die periode net voor en na bot. Daar kan dwarsdeur die jaar behandel word maar bogenoemde tye gee die beste resultate. Dit is belangrik dat die periodes tussen die behandelings tot 6 maande beperk word. Die jaar-op-jaar behandelings is nie suksesvol nie.

Biologiese beheer opsies sluit in die gebruik van bakterieë (bv. *Pasteuria penetrans*, *Bacillus* spp. & *Burkholderia* spp.) en swamme (bv. *Paecilomyces lilacinus*, *Trichoderma harzianum*, *Verticillium chlamydosporum*, *Arthrobothrys* spp. & *Myrothecium verrucaria*). Sommige chemiese en biologiese produkte kan selfs in kombinasie gebruik word vir optimale beheer.

Toevoeging van organiese materiaal is ook baie voordelig deurdat dit wortelgroeï en natuurlike vyande (voordelige grondorganismes) bevorder. Sodoende word aalwurm skade verminder en neem hul getalle oor die langtermyn af.

Ek stel voor dat u slegs 'n chemiese middel toedien indien u bome nie optimaal of tot u verwagtinge groei nie, ongeag van die mate van aalwurm infestasië. Streng monitering van die aalwurm getalle na die toediening van 'n chemiese middel is van groot belang.

Advies is onderhewig aan die voorwaarde dat die korrekte monsternemingsprosedure gevolg word.

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Aalwurmontledingsverslag

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Hierdie ontleding was gedoen deur Nemconsult en is nie deel van Bemlab se akkreditasie skedule nie

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Boschenmeer



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17 Junie

Lab Nr	Bemlab	Blok	Kultivar	Nematodes per 250 cc grond en 10g wortels
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	lab nr			Vrylewend	Knopwortel	Ring	Dolk	Letsel	Stompwortel	Spiraal	Skede
U1168	20760	1A Treated	Gras								
Nematodes per 250 cc grond				410	0	0	0	0	0	30	0
Nematodes per 10 g wortels (Geen wortels)				-	-	-	-	-	-	-	-
Totale aantal nematodes				410	0	0	0	0	0	30 (laag)	0
<i>Kommentaar:</i> Ek voorsien nie die nodigheid vir die toediening van 'n behandeling nie. Ek stel slegs voor dat die aalwurm getalle streng gemonitor word. Ander grond organismes ook waargeneem.											
U1169	20761	1B Control	Gras								
Nematodes per 250 cc grond				600	0	0	0	0	220	1930	0
Nematodes per 10 g wortels (Geen wortels)				-	-	-	-	-	-	-	-
Totale aantal nematodes				600	0	0	0	0	220	1930 (baie hoog)	0
<i>Kommentaar:</i> Ek stel voor dat u die toediening van 'n behandeling oorweeg. Meer as een opvolg behandeling sal waarskynlik nodig wees. Ander grond organismes ook waargeneem.											
U1170	20762	2	Gras								
Nematodes per 250 cc grond				390	0	0	0	0	90	180	80
Nematodes per 10 g wortels (Geen wortels)				-	-	-	-	-	-	-	-
Totale aantal nematodes				390	0	0	0	0	90 (matig)	180 (matig)	80 (laag)
<i>Kommentaar:</i> Ek voorsien nie die nodigheid vir die toediening van 'n behandeling nie. Ek stel slegs voor dat die aalwurm getalle streng gemonitor word. Ander grond organismes ook waargeneem.											
U171	20763	3	Gras								
Nematodes per 250 cc grond				170	0	0	0	0	0	1080	0
Nematodes per 10 g wortels (Geen wortels)				-	-	-	-	-	-	-	-

Totale aantal nematodes	170	0	0	0	0	0	1080 (baie hoog)	0
<i>Kommentaar:</i> Indien die groeikrag nie optimaal is nie, stel ek voor dat u die toediening van 'n behandeling oorweeg. Ander grond organismes ook waargeneem.								

Belangik:

Kontak asb. u plaaslike agent i.v.m. die toediening van 'n geskikte nematisied.

Biologiese beheer opsies sluit in die gebruik van bakterieë (bv. *Pasteuria penetrans*, *Bacillus* spp. & *Burkholderia* spp.) en swamme (bv. *Paecilomyces lilacinus*, *Trichoderma harzianum*, *Verticillium chlamyosporum*, *Arthrobothrys* spp. & *Myrothecium verrucaria*). Sommige chemiese en biologiese produkte kan selfs in kombinasie gebruik word vir optimale beheer.

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