18 Month Trial at Dundee and Perth Polo Club, Perthshire Racecourse, Scone Palace

To Monitor Variations in the Quality of Sports Turf Pitches Resulting from the Application of Various Topdressings

January 2006

Trial to Monitor Variations in the Quality of Sports Turf Pitches Resulting from the Application of Various Topdressings

Executive Summary

The trial, performed by Remade Scotland and supported by Dundee City Council, aimed to quantify the effects of applying various topdressings, on quality of sports turf pitches and asses the financial implications of such practices for the sports turf industry.

Traditional ground maintenance and renovation practices employ topdressing; the application of a thin layer of sand, soil, organic materials or a mixture of these components, often in conjunction with aeration and reseeding. Turf displays several benefits from topdressing such as improved oxygen and moisture movement in the root zone, reduced soil compaction and reduced disease incidence. The use of compost to improve soil and plant health is well documented, however little has been done to quantify the efficacy and determine the financial implications of this practice.

To evaluate the benefits of green waste derived compost for sports turf pitches, a range of topdressings, ranging from compost to conventional fertiliser were applied to individual plots over a large trial area at Perthshire Racecourse. The effects on quality indicators such as turf colour, moisture retention, root growth, re-growth of damaged areas and soil disease incidence were then monitored.

Compost, when compared to traditional fertiliser applications and a control situation was shown to have a greater:

- **Sustained sward length growth rate**
- **Improvement in turf colour**
- **Improvement of moisture retention**
- **Increase in biomass of the turf**
- **Improvement in regeneration of damaged turf**
- **Suppression of Red Thread and *Fusarium* fungal diseases**

The trial showed a slight financial penalty in opting for green compost compared with traditional fertiliser application. However, due to the falling costs of compost derived from garden waste, a significant saving has been demonstrated at present prices.

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1 Introduction

Compost is known to possess a wide range of biological, chemical and physical properties that can benefit both soil and plant health. Although these benefits have been documented on numerous occasions, very little information quantifying their efficacy and financial implications is available.

On 12th July 2004 Remade Scotland commenced an 18 month trial to monitor turf improvement from the application of compost on Pitch number 2 of Dundee and Perth Polo Club, Perthshire Racecourse in the grounds of Scone Palace. The aim of the trial was to generate sufficient information to provide an indicative quantification of the benefits of using compost as part of turf management practices.

Topdressing of turf is used by sports turf managers as a routine maintenance and renovation practice in order to improve turf and soil quality. Topdressing is often completed along with aeration and reseeding, and entails the application of a thin, uniform layer of sand, soil, organic materials, or various mixtures of these materials.

Topdressings are applied at a variety of application rates, ranging from 1 to 12mm depth. Application rates are dependant upon the intended use of the turf, mowing height and the specific purpose for the topdressing.

The benefits of topdressing include:

- Levelling of the playing surface
- Reduced soil compaction
- Improved moisture penetration and infiltration
- Improved oxygen and moisture movement in the root zone
- Proper distribution of fertiliser nutrients and pesticides
- Reduced disease incidence

Compost has been shown to have a stabilising effect on the moisture content of soils. When wet, it creates a mulch – the porous organic content within the compost swells and retains the moisture in a sponge-like effect, therefore making the ground less waterlogged. *(USCC, 2005)* It is the same sponge-like effect which allows compost to deliver moisture to the soil in dry periods. *Friend (2004)* showed that compost provided drought resistance and lower irrigation costs. He also showed that compost has the ability to provide long-term moisture dispersion deep within the soil structure, thereby reducing the necessity to irrigate as often. *Erhardt (2005)* found that compost had a more beneficial effect on nitrogen supplementation to the soil when compared to standard fertiliser applications. This was due to the slow release of nitrogen over the growing period which resulted in an increased yield within the compost-treated plots over a 10-year period by 7% compared to the fertilised plots. Research has indicated that topdressing with some composts biologically suppresses specific lawn diseases such as Red thread and Snow mould *(Boulter, 2002)*. Red thread occurs in spring and autumn during humid periods when the air temperatures are between 16°C and 24°C (60°F and

75°F). It is caused by a fungus that produces pink to red threads among the grass, which can be seen on close examination. The disease is especially severe on slow-growing nitrogen-deficient turf. The grass may become bleached in the affected area but is rarely killed. Snow mould ***(Fusarium sp.)*** is caused by a fungus that turns the grass yellow in patches, which may coalesce to form larger areas. In damp weather a white fungal growth may be visible. The disease is worst in late autumn and winter, especially if the grass has been covered with snow.

Different applications of topdressings were applied to *Dundee and Perth Polo Club, Perthshire Racecourse* to assess the effects of applying compost compared to conventional turf management practices. The trial was performed on a polo pitch, however it was anticipated that the findings would be transferable and of relevance to other turf and sports-pitch industries.

2 Methodology

2.1 Trial Area Plot Layout

The trial area was divided into thirty-six square plots of dimensions 20m x 20m. Each plot received one of the following treatments:

[C] Control - no application
[T1] Topdressing with 1.6 mm of compost, with one additional application of 1.6mm compost (3.2mm total equivalent to 25% of standard N application)
[T2] Standard fertiliser application (110 kg N ha)
[T3] Topdressing with 4.8 mm of compost (equivalent to 33% of standard N application)
[T4] Topdressing of 3.2mm compost and 3.2mm root zone sand (50:50) (equivalent to approximately 25% of standard fertiliser application)
[T5] Standard fertiliser application (110 kg N ha) plus Fe supplement
[T6] Topdressing with 6 mm of compost (equivalent 50% of standard N application)

The plots were treated in the pattern shown in *Figure 1* below. Although not randomised, each treatment was replicated three times for greater experimental accuracy and eighteen control plots bordered each of the treated plots.

C	T2	C	T4	C	T6
T1	C	T3	C	T5	C
C	T2	C	T4	C	T6
T1	C	T3	C	T5	C
C	T2	C	T4	C	T6
T1	C	T3	C	T5	C

***Figure 1*: Trial Area Plot Layout.**

Plots receiving topdressings [T2] – [T6] were treated with one application at the start of the trial in July 2004 before any sampling and analysis commenced. Plots treated with topdressing [T1] received one initial application on July 2004 and an additional application in March 2005.

2.2 Application of Topdressings

The trial area was demarcated into 36 plots of $400m^2$ each in a grid formation of 6 plots by 6 plots. To ensure that there was minimal contamination between treated plots, non-treated plots were interspersed in the grid pattern. The topdressings were applied to the trial area on 21st July 2004. *Photograph 1* shows the application of the Discovery Compost supplied by Dundee City Council, made from composted domestic green waste. A JCB scoop placed the correct amount of compost onto each sample site. Following topdressing application the trial area was smoothed with a chain drag mat as shown in *Photographs 2 and 3*. All plots were aerated at 6-week intervals.

***Photograph 1*: Application of Discovery Compost**

***Photographs 2 and 3*: Aeration of Trial Area using a Chain Drag Mat**

2.3 Sampling and Analysis

Observational, in-situ and laboratory-based analysis was performed throughout the trial to monitor turf quality indicators such as; grass colour and colour changes; grass growth; variations in biomass; moisture, organic and ash content.

During the trial period, Remade staff made monthly visits to the trial area to perform sampling and analysis techniques on plots receiving each type of topdressing. The groundsman of the Dundee and Perth Polo Club, Henry Maitland performed measurements to monitor grass sward growth.

2.3.1 Observational and In-Situ Analysis

- ***Grass Colour Determination***

The RHS (Royal Horticultural Society) Colour Charts, the standard reference for plant colour identification, was used as a tool to assist the determination of grass colour throughout the trial. The RHS charts have been specially developed to match nature's own colours. The colours were arranged in easy-to-use fans and each colour patch had a central porthole which was laid over the turf to assist a colour match. The colour ranges identified as most useful in this exercise were numbers 144, 143 and 141. The shades of green present in these colour ranges are displayed in *Figure 2* below.

***Figure 2*: Royal Horticultural Society Colour Charts 141, 143 & 144**

This observational technique was performed in-situ. During each sampling visit, three estimations of grass colour were made per plot. Since it was impossible to quantify the amount of "greenness" the grass had and, therefore, to calculate a mean colour, the mode (most frequent) colour observed for the plots with the same topdressing was identified.

Although the evaluation of the results was subjective, it was considered possible to interpretate the results and to draw some significant conclusions concerning grass colour, as affected by different topdressings.

Unfortunately, due to vagaries in the computerised colour palette, the representation of these colours is as shown in *Figure 3.*

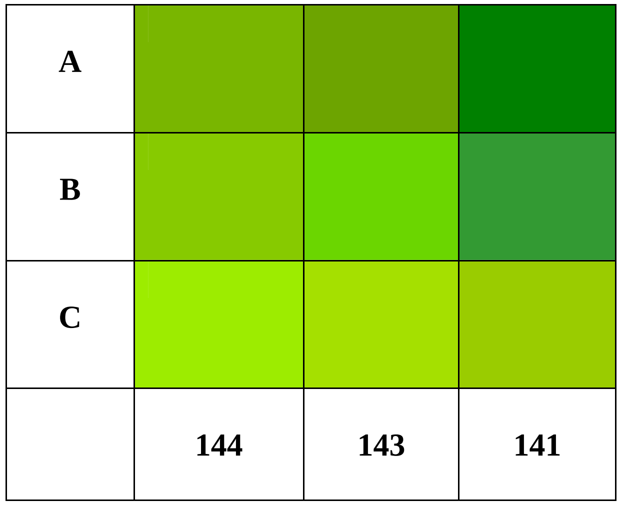


Figure 3: **Computerised colour representation of RHS colour charts 144, 143 & 141**

- ***Grass Growth***

Performed in-situ, grass sward growth was measured at 3-day intervals over a 4-week period, following application of the different treatments. The cutting height of the grass was set at 25mm. Before cutting, a rising plate meter consisting of a light vinyl card with a slot cut in the centre was used to measure the grass length.

2.3.2 Laboratory-based Analysis

Simple laboratory-based analysis techniques were employed to gain information regarding variations in bulk density, leaf/root biomass, moisture content, organic matter and ash content. The methodology used is detailed in APPENDIX 1 – METHODOLOGY, following the report.

3 Results

3.1 Grass Colour Changes

Variations in grass colour occurred over the trial period within individual plots and also between plots that received different treatments. Monthly grass colour observations made over the course of the trial have been shown in *Figure 3* below as modal (most frequent) grass colour.

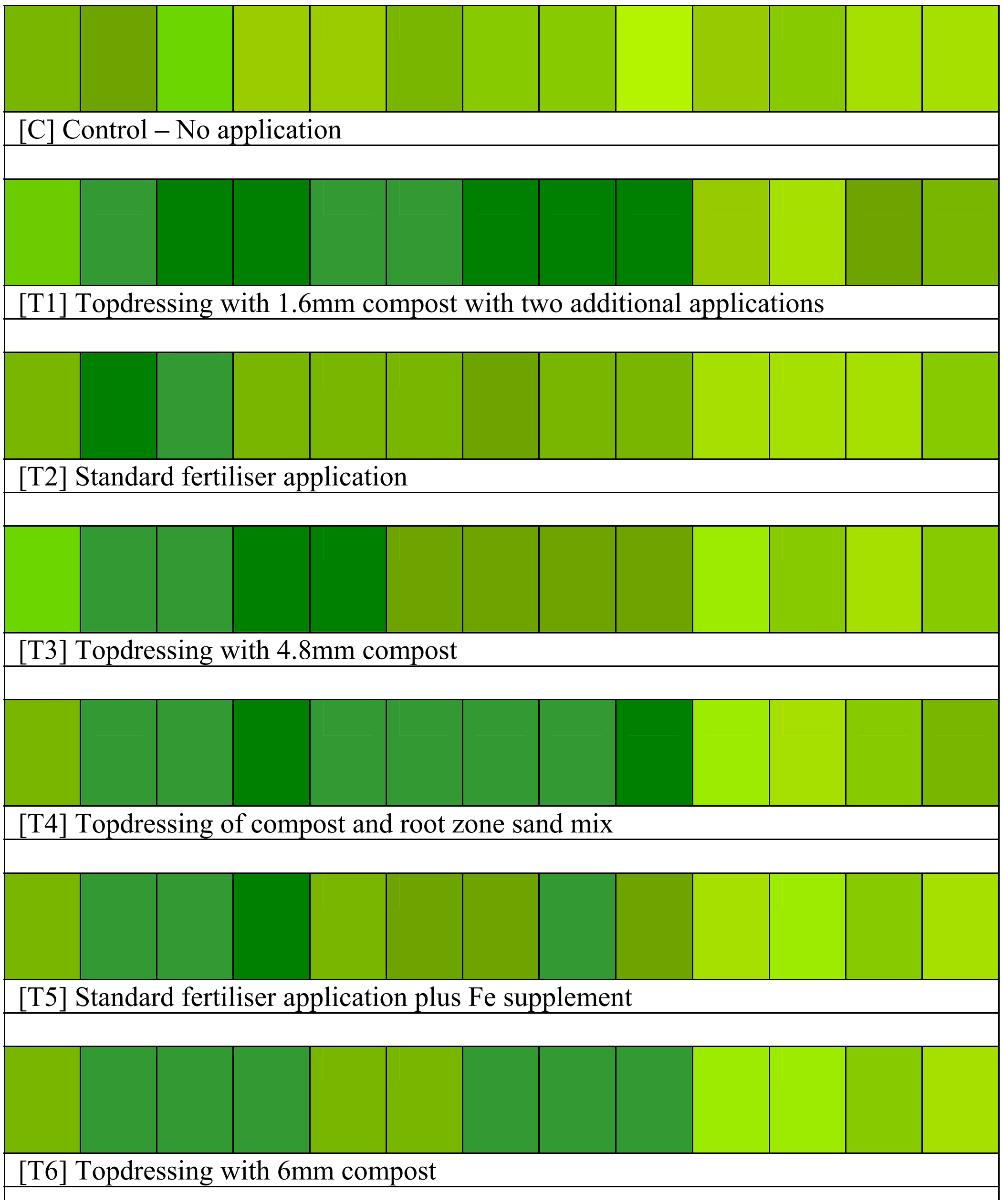


***Figure 4*: Timescale Changes for Modal Grass Colour**

The greatest variation in grass colour over the course of the trial was observed between the control plots [C], which showed a general yellowing of the grass and the plots that were treated with 1.6mm of compost with one additional application [T1], which showed a deepening of colour towards the blue-green end of the spectrum lasting for eight months.

The grass in plots treated with fertiliser-containing topdressings [T2] and [T5] showed an initial flush of growth with an immediate deepening of colour, however, this tended to be fairly short-lived. The topdressing containing the iron supplement [T5] appeared to extend the period of deeper colour in these plots.

Treatment with compost as in plots [T1], [T4] and [T6] extended the length of time of colour change, however this was variable. The most remarkable effects were observed in the plots that received two applications of 1.6mm compost [T1] over the timescale of this trial.

Subjectively, there was a significant difference in the colour of grass observed in plots that had been treated with compost or fertiliser and plots that received no application i.e. control plots, with a clear checkerboard pattern emerging as in *Photograph 4*.

In the last few months of the trial there was similar yellowing of the grass in all areas, suggesting that the trial area was becoming nutrient deficient, regardless of the treatment.

***Photograph 4*: Checkerboard Pattern of Trial Area**

Although the modal values for grass colour had to be used for this part of the trial and the results are subjectively qualitative, rather than quantitative, it can be concluded that topdressing does have an effect on the colour of grass, thereby suggesting a positive effect on the quality of growth of turf. This effect is shown to be fairly short-lived in the case of standard fertiliser applications in comparison with compost applications. However the addition of supplements, such as iron, sand and an increase in the frequency of applications have all shown an extension in the timescales of these effects.

3.2 Grass Growth

The grass growth rate over 3-day intervals (millimetres) has been plotted and displayed in *Figure 4* to show the variation in growing rates between grass in the controlled plots [C], fertilised plots [T2] and the plots treated with 4.8mm of compost [T3]. The first reading was taken on the 21st July 2004, just prior to the application of compost.

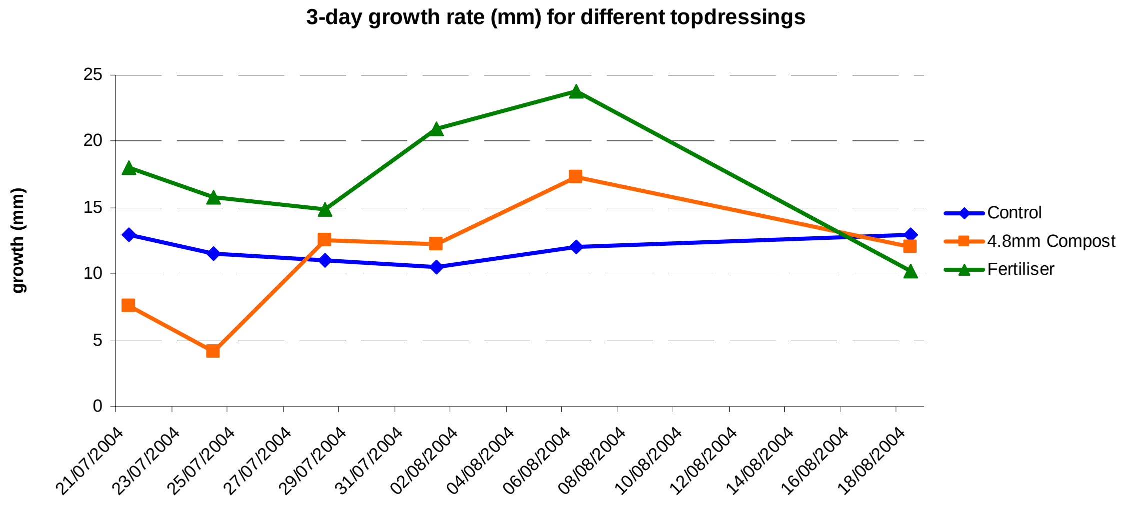


Figure 5: **Three-day Grass Growth Rate**

The results of the grass growth measurements for the 4-week testing period indicate a flourish of growth in plots treated with 4.8mm compost. The 4.8mm compost topdressing improved turf growth, but in a more gradual way. From a turf manager's point of view, the colour enhancement and growth pattern characteristic of the compost improved turf is preferable to an excessive flush of growth that would require additional mowing. A reduction in mowing frequency could provide turf managers with a significant cost saving over the longer term.

3.3 Grass Regeneration

Area composted, showing rapid skid damage regeneration in 2 days *compared with* ***No skid damage regeneration in non composted area***

The application of compost also had the benefit of stimulating more rapid regeneration and repair in areas which suffered skid damage from the horses' hooves and impacts resulting from polo matches. The above images are representative of the differences observed between areas treated with and without compost.

3.4 Laboratory Analysis

Bulk density and leaf/root biomass were determined for samples collected from plots receiving different treatments:

Sample 1 - [C] control (no application)
Sample 2 - [T6] 6mm compost
Sample 3 - [T4] 3.2mm compost and 3.2mm sand
Sample 4 - [T2] fertiliser.

The results are tabulated in APPENDIX 2 – LABORATORY RESULTS following the report. The results for biomass, moisture content and organic matter content were have been graphed and are discussed in the following sections.

Also, the incidence of fungal infection was measured 9 months after the application of the various treatments.

3.4.1 Variations in Biomass

Biomass showed significant seasonal variation dependent on the available light source and rate of growth as shown in *Figure 5*, with the most significant increase in biomass occurring in the late summer and a gradual decline over the winter months.

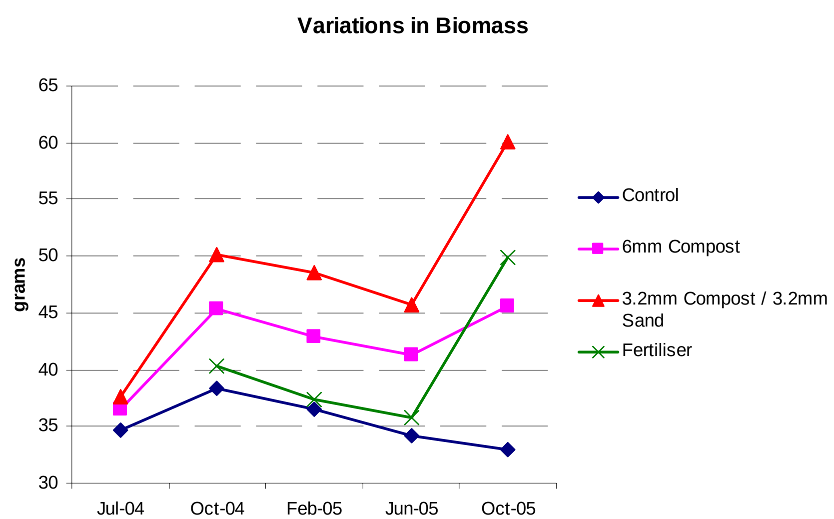


***Figure 6*: Variations in Biomass**

Trendlines derived for the controlled plots and the plots receiving different topdressings are shown in *Figure 6*. The line gradients in the graph are indicative of the leaf and root growth rates experienced. A more positive gradient indicates a faster leaf and root growth rate. The most positive gradient (fastest growth rate) was observed in the plots receiving a combination of 'compost and sand' (m = 4.061), followed by 'fertiliser' (m = 2.721) and 'compost' (m = 1.418). A decrease in biomass over this period was observed for the control, denoted by a negative gradient (m = -0.763), suggesting that the turf in controlled plots had used the available nutrients and were struggling to maintain any growth.

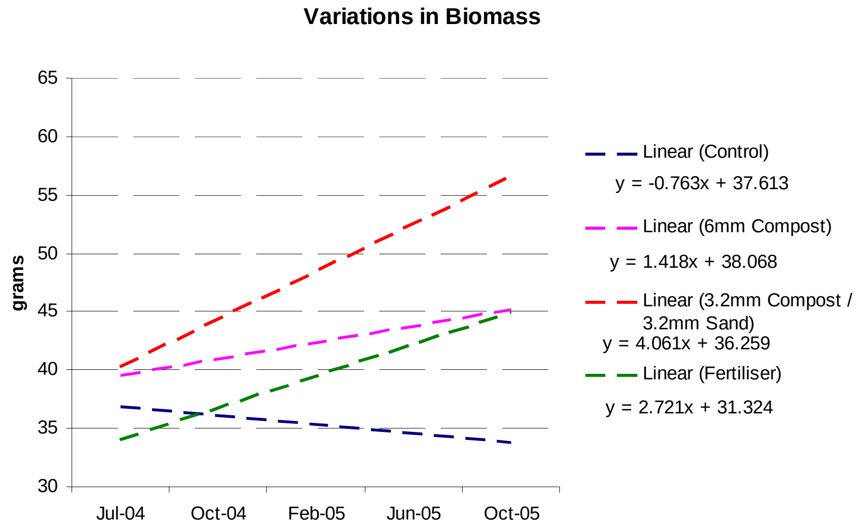


***Figure 7*: Trend lines of Variations in Biomass**

3.4.2 Variations in Moisture Content

During the 18 month trial period there was particularly low rainfall and consequently a significant drying out of the soil samples at some stages, as shown by the moisture content results displayed in *Figure 7* below.

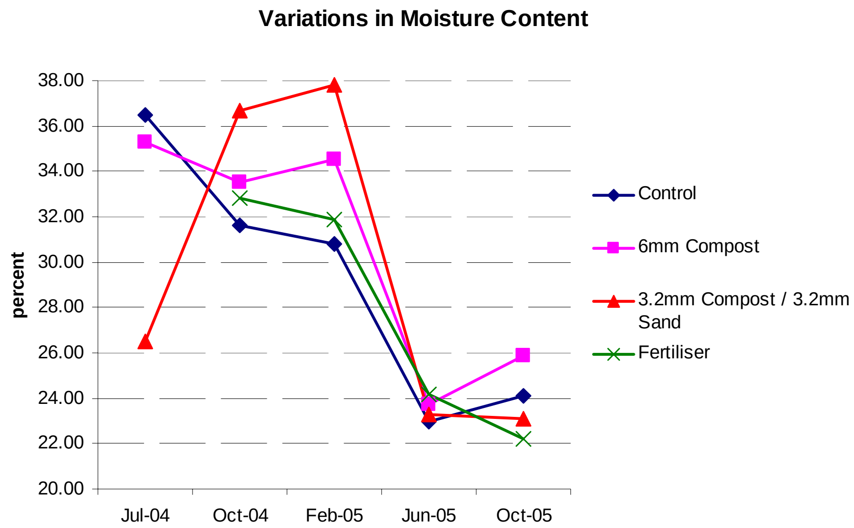


***Figure 8*: Variations in Moisture Content**

Trendlines for these variations were derived and are shown in *Figure 8*. The negative gradients stated in the legend are indicative of the average rate of drying experienced by soil samples from differently treated plots for this time period. The plots that were treated with 'compost' (m = -2.852) and 'compost and sand' (m = -2.018) have a more positive gradient than the 'control' (m = -3.342) and 'fertilised' plots (m = -3.95). This suggests that the plots treated with compost-containing topdressings sustained less drying. It can therefore be deduced that compost application to turf can significantly increase the moisture-retaining capacity of the underlying soil.

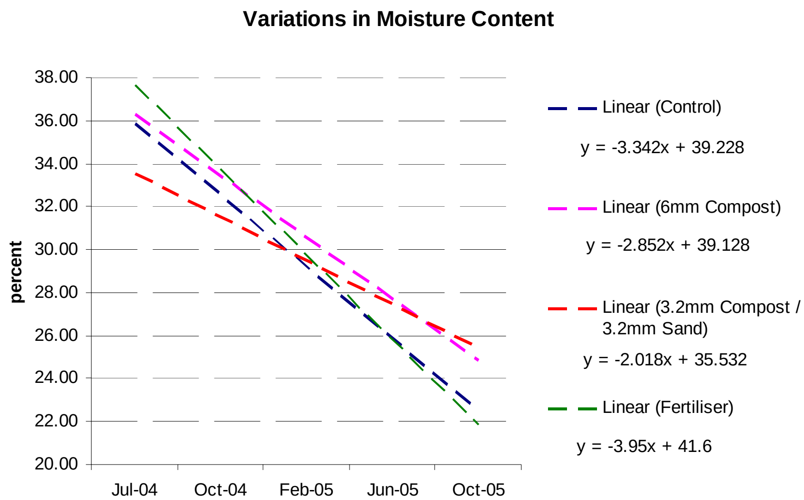
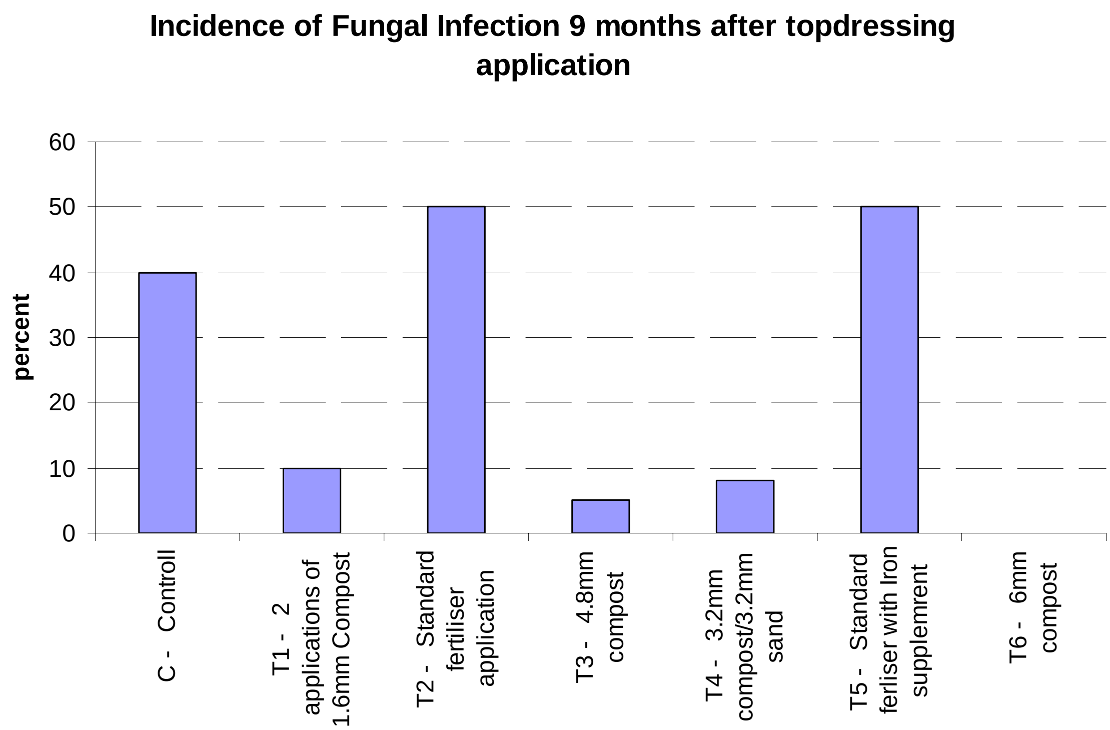


***Figure 9*: Trendlines of Variations in Moisture Content**

3.4.3 Disease Suppression

The polo pitch regularly suffers from ***Fusarium*** (snow mould) and ***Red Thread***. In previous years this had required 2 annual treatments of fungicide to suppress disease growth. However, during the first winter of the trial, no applications were made to assess the disease-deterrent actions of the various topdressings.

The incidence of disease was monitored at 9 months following the application of the treatments. It was found that in the control plots **[C]**, 40% of grass plants were infected with either one or both fungi whilst the fertilised plots suffered a 50% infection rate (in both the fertiliser alone and the fertiliser with iron supplement topdressings). In the composted areas, the 2 applications of 1.6mm compost suffered a 10% infection rate; the 3.2mm compost / 3.2mm sand had about 8% disease; 4.8mm compost suffered 5% infection; whilst the 6mm compost was completely disease free.



In this trial chemical fertilisers were shown to have a degrading effect on the resistance to disease of the turf when compared to controls.

3.4.4 Summary of Results

- The compost provided an excellent, and somewhat immediate, greening of the turf, which was superior to the chemical fertiliser treated plots. The compost is known to contain both nitrogen and iron.

- Root growth on the compost and compost/sand treated plots was also superior to plots only treated with chemical fertiliser.

- The compost also seemed to suppress specific soil borne diseases, such as Red thread and ***Fusarium***, for much of the summer growing season.

- Perhaps the greatest benefit has been the increased density of the sward on the compost treated plots. There was a noticeable difference between the density of the turf on the compost and fertiliser treated plots. This improved turf density should reduce the damage caused by the horses' hooves. When a polo pony accelerates or stops suddenly, their hooves slide over the turf. On neighbouring untreated plots, the hooves cut through the grass blades, leaving large tears in it. Where the tears have occurred on the compost treated plots, the re-growth of the turf has been accelerated. On some of the untreated plots, however, there are injured areas of the pitch that still have not completely filled in six months later.

4 Financial Implications

A costing analysis of the trial was made comparing conventional management (using fertiliser at 250kgs/Ha) with compost (using 30 tonnes/Ha). The comparison assumes that aeration costs etc. would be the same under either regime and ignores these costs.

Conventional Fertiliser Management		Green Compost Management	
Fertiliser @ 250kg/Ha	**£90.00/Ha**	Compost @ 30 tonnes/Ha	**£390.00/Ha**
Application Cost	**£12.35/Ha**	Application Cost	**£40.00/Ha**
Fungicide Cost	**£27.35/Ha**	Fungicide Cost	**Nil**
Mowing every 3 days or 61 cuts per season	**£723.00/Ha**	Mowing every 5 days or 37 cuts per season	**£444.00/Ha**
Overall cost per Ha/Yr	**£825.70/Ha**	**Overall cost per Ha/Yr**	**£874.00/Ha**

There was a minor financial penalty in opting for the compost regime. This was due to the cost of green compost at the time of the study. However, the cost of this application has fallen over the past year due to the increase in composting of green household waste in Scotland.

Assuming present prices of green compost at £10-11/tonne, the cost per Ha/Yr would be reduced to £784 - £814 (assuming the same costs for application and mowing). This would confer a saving in addition to a suppression of soil-borne fungal diseases.

5 Conclusions

The results of this trial indicate that compost is superior to fertiliser, in sward growth, colour, biomass and moisture retention of the soil, for sports turf. The turf chosen for this trial suffered significant trauma throughout the course of the study, due to frequent use by polo ponies, and appeared to regenerate faster in the composted areas. It has also been shown that the effects of compost are longer-lived than that of fertiliser, and if the frequency of application of compost is increased or sand is added to the mix, then these effects are further prolonged.

The compost used for this trial was Discovery Compost, derived from "green" garden waste in the City of Dundee. Since the advent of recycling targets, the amount of segregated green waste, collected for composting by every Council in Scotland, has significantly increased. This trial has shown that the compost derived from green waste has a higher efficacy in sports turf management than traditional topdressings. Due to its abundance, it is significantly lower in price than fertiliser products and therefore, should confer marked cost-savings for the turf management industry.

This study has shown that there are clear advantages in terms of turf health and appearance

- environmental targets could be achieved by many organisations
- green waste can be constructively diverted from landfill
- pesticide use is reduced
- less energy is spent producing artificial fertilisers

This study has shown that green-waste compost has a stabilising effect on the moisture content of soils, reducing the effects of waterlogging and drought. The study has also indicated that topdressing with compost biologically suppresses specific lawn diseases such as Red thread and Snow mould ***(Fusarium sp.)***.

Although the financial implications of using compost (compared with fertiliser) proved slightly more costly at the time of the study, this has been shown to be offset at current prices of green compost and, indeed, a financial saving by using green compost would be made.

6 References

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J. Boulter, G. Boland and J. Trevors Assessment of compost for suppression of Fusarium Patch **(*Microdochium nivale*)** and Typhula Blight **(*Typhula ishikariensis*)** snow molds of turfgrass. *Biological Control, Volume 25, Issue 2, October 2002, Pages 162-172*

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With thanks to Ron Alexander (Consultant), Henry Maitland (The Landscape Resource Centre), and the Remade Scotland Team of Paolo Cruz, Fiona McInally, Iain MacLeod, Dr Chen Liang, Dr Olivia Doyle and Colin Murchison for their help in the design, data collection, laboratory analysis and write-up of this project.

Also thanks to the Landscape Resource Centre for their help on costing this project. (www.landscape-re-source.co.uk)

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Appendix 1

METHODOLOGY

TECHNIQUES FOR FIELD AND LABORATORY WORK FOR SOIL SAMPLES

Bulk Density: BS7755-5.6:1999 ISO11272:1998
Using excavation method 4.2

Apparatus:

- Spade with long ,straight edged, sharp blade,
- Knife , for hard or stony soil
- Plastic bags for containing samples once collected
- Permanent marker pen for writing area and sample number
- Plastic film, e.g. cling film for surfacing dug out area
- Funnel for pouring sand
- Graduated cylinder for measuring volume of sand
- Dry graded sand
- Balance, weighing to an accuracy of 0.1g
- Ventilated oven heating to a temperature of 105ºC (+/- 2ºC)
- Vacuum desiccator with self indicating desiccant.
- Sieve with 2mm apertures.
- Depth gauge

Field work:

- Level off soil surface with straight leveled blade of spade,
- Dig a hole in the leveled soil, having a representative content of a larger gravel and stones
- Put soil into the bags for laboratory analysis.
- Line hole with plastic film, and using the funnel measure out how much sand it takes to fill the hole with use of the measuring cylinder and funnel, put the funnel onto the depth gauge to measure the depth of sand in hole.

Laboratory work:

- Determine the mass in grams of the moist soil sample.(M_{pw})
- Using the sieve, separate the stones and gravel from the sample.
- Clean the gravel and stones with either a cloth or a stiff brush and weigh on the laboratory balance.(M_{xw})
- Dry the stones and gravel in the oven at 105ºC (+/- 2ºC), once dry weigh again (M_x)

- Determine the water content of the fine soil (<2.0mm diameter) by drying a representative sample of 5-10g (noting mass used of course) in the oven at 105ºC until a constant mass is reached.
- This is achieved by bringing out of the oven at set time intervals and leaving to cool in the desiccator until the previous two weights are no less that 0.01 apart. Once weighed the final time, the water content (w) is the initial weight of sample minus the new weight, the total water content is therefore calculated as a mass ratio of the total moist sample.

Calculations:

The dry bulk density is calculated using the following equations:

$$B_{\rho s} = \frac{M_x + M_{fp}}{V}$$

$$M_{fp} = M_{pw} - M_{xw} - M_w$$

$$M_{fw} = M_{pw} - M_{xw}$$

$B_{\rho s}$ = dry bulk density of the soil in g/cm³
M_x = mass of dry gravels and stones in g
M_{fp} = the mass of the dry fine soil in g
M_w= the mass of the dry fine soil in g
V = volume of the hole in cm³
M_{pw}= the mass of the excavated moist soil in g
M_w = the mass of water from the excavated fine soil
W = the water content of the excavated fine soil, in grams of water per gram of oven dried soil.
M_{xw} = mass of moist gravels and stones in g
M_{fw} = the mass of the moist fine soil in g.

Leaf / Root Biomass (about 6 samples)

Apparatus:

- Spade
- Knife
- Scissors
- Plastic bags
- Drying oven at 60ºC
- Sample trays

Field work:

- Using the spade make a square 18cm by 18cm (length of spade)
- Dig down at the edges of this square to a set depth of 10cm and cut of end of root with a pair of scissors.
- Quarter the sample and place the new smaller samples into bags and label contents and location within the sample area.

Laboratory work:

- Measure and weight the sample to nearest 0.01g
- Wash off all soil and separate into root and leaves
- Put in oven overnight at 60ºC to dry out
- Weigh the root and leaf biomass to nearest 0.001g

7 Appendix 2

LABORATORY RESULTS

	Sample 1	no application of Compost			
	Jul-04	Oct-04	Feb-05	Jun-05	Oct-05
Bulk Density	1.118	1.19	1.18	1.41	1.23
Biomass (g)	34.71	38.3	36.5	34.13	32.98
Moisture Content	36.51	31.6	30.8	23	24.1
	Sample 2	**6mm Compost**			
	Jul-04	Oct-04	Feb-05	Jun-05	Oct-05
Bulk Density	1.142	1.15	1.14	1.42	1.34
Biomass (g)	36.45	45.4	42.9	41.24	45.62
Moisture Content	35.26	33.5	34.5	23.7	25.9
	Sample 3	**3.2mm Compost and 3.2mm Sand**			
	Jul-04	Oct-04	Feb-05	Jun-05	Oct-05
Bulk Density	0.819	0.87	0.85	1.37	1.33
Biomass (g)	37.58	50.2	48.6	45.69	60.14
Moisture Content	26.49	36.7	37.8	23.3	23.1
	Sample 4	**Fertiliser**			
	Jul-04	Oct-04	Feb-05	Jun-05	Oct-05
Bulk Density		1.19	1.2	1.35	1.27
Biomass (g)		40.3	37.4	35.78	49.91
Moisture Content		32.8	31.9	24.2	22.2