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Compost Top Dressing Demonstration Trial at the K Club, Straffan, Co. Kildare, Ireland

Date of Report: October 2011

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EXECUTIVE SUMMARY

Preliminary trials were carried out from July to November 2008 to investigate the use of high quality composted materials in the maintenance of golf fairways. The trials were undertaken at the K Club Golf Course, County Kildare, Ireland.

Even though the compost trials performed at the K-Club during this project were short in duration (3 months), several pointers can be taken from it:

- Compost application did not increase the incidence of weed infestation;
- There was no effect on soil pH from the compost applied;
- Compost addition increased the organic matter content of the soil;
- Compost application provided a significant quick release of nitrogen to turf, providing a quick 'green-up' effect (within 14 days) without excessive growth. Hence, in a golf fairway application, compost could be used to provide a simple means of greening up turf quickly and evenly. However, by the end of the trial it was obvious by observation of the turf colour that additional nitrogen fertiliser was required;
- The application of both types (garden and garden/food material compost) of composted materials provided nutrients to the trial plots, compared to plots with no compost added;
- There was some evidence of reduced incidence of disease on the plots treated with compost materials late in trial (between days 56 to 70), compared to plots without.
- There was no significant increase in worm castings from compost application;
- The application of compost did provide a boost to growth and visual appearance of the turf, even at the lowest application rate used. The 12mm layer of compost applied to the turf surface was too thick and caused noticeable darkening. It would therefore be advisable to apply, 9mm at most, to the fairway turf.
- It is recommended that a 9mm layer of compost be applied to the surface because there was less weed cover on both the clay and sandy sites compared to the other compost treatment and control.

GUIDELINES

Based on the results of these trials the following guidelines are given for the use of compost on turf:

- Compost particle size: <10mm grade although <5mm is preferable
- Apply 40 tonnes per ha per dressing
- Apply in early March to September

1. BACKGROUND

In the early part of the 20th century, the use of compost manufactured from grass clippings, animal manure and other material was common practice on golf courses. With a move in the golf sector towards free draining, sandy top dressings, the use of compost declined (Cook & Baker, 1998[1]). Also the cost of producing compost on site became a factor and it declined in the 1950/60's.

In the 1990's, environmentally friendly maintenance of golf courses began to emerge. Therefore the use of compost gained a renewed interest. However, there is still much scepticism with golf greenkeepers about the use of compost and its effect on root zones. The concern is about the pH of compost, because the pH is more alkaline than peat. The alkaline pH is suspected to be incompatible with acidic soils on golf courses. Usually alkaline materials, such as lime, will cause fungal disease of the turf along with surface casting by earthworms. However, at the same time, there have been indications that the enhanced microbial activity produced by compost application may actually inhibit turf fungal disease.

The beneficial nature of compost as a turf top dressing for sports pitches, golf courses, amenity and domestic grassland has proved to be a valuable and long-term market for compost products. Its use is popular throughout the United States and it is commonly used in the golfing and sports pitch management sectors for this purpose. In more recent years, the UK market for compost used as a top dressing has grown substantially, due in part to the increased production of high quality composted materials. This has included its use in the UK golfing sector. To date, no research has been conducted in Ireland regarding the use of compost as a turf top dressing, and interest from the golfing sector in Ireland for this use has grown.

In October 2005 the results of a UK research trial[2], (funded by WRAP) was published by WRAP and the Sports Turf Research Institute. This demonstrated the successful use of compost as a top dressing on golf courses.

The aim of this project was to demonstrate that composted material could successfully be used as a top dressing in Ireland, using similar methods to those used by the Sports Turf Research Institute in its research.

The K-Club was identified as the trial location. This golf club has an active environmental policy and displayed an interest in identifying new methods to sustainably maintain their golf course turf. The K-Club operates two courses; one is the Smurfit Course which is a links style course, and the Palmer Course which is a more conventional woodland course. The Smurfit course possesses a sandy soil, while the Palmer course has a more fine-textured (clay, silt) soil. The K-Club is a unique golf course in that each year it core aerates (16mm hollow plugs) and top dresses its fairways with sand as a means of improving soil quality and improving playability. The overall goal of this practice is to improve fairway drainage, and to allow play after rain storms. However, this practice also makes parts of the fairways susceptible to drought and inconsistent colour.

2. TRIAL DESIGN AND INSTALLATION

Two types of compost were used, Compost derived from garden material which was produced by Enrich in Kilcock, Co. Kildare and compost derived from food waste/garden material which was produced by Natural World Products (NWP) in Armagh, Northern Ireland. The NWP compost was produced to meet the Northern Ireland BSI PAS100:2005 compost specification. Both composts were tested and passed the Cré (Ireland based quality standard) research compost quality standard for heavy metals, pathogens, impurities, organic matter and stability. Each compost was less than 5mm in particle size.

Two plots were established on the driving range tee area. One trial was established on an area of sandy textured soil, the other on a more clay textured soil. Both areas had in the past been top dressed with sand. The two trial plot areas were designed using a randomised block design, with each individual plot being 1.5m x 1.5m in size. There were three replicates of each plot treatment.

[1] Cook, A. & Baker, S.W. Effects of organic amendments on selected physical and chemical properties of rootzones for golf greens. J. Turgrass Sci 74, 2-11.
[2] Lawson and Brundage (2005) Demonstration Trials of the Utilisation of Composted Materials in the Maintenance of Sports and Amenity Turfgrass. WRAP

Before topdressing, all the plots were uniformly core aerated to a depth of approximately 90mm and the cores were removed. Sand was then applied to the plots (amounts in Table 1), prior to the addition of compost at different rates.

The compost was applied on the surface (top dressed) at three application rates to provide a layer of 6mm, 9mm and 12mm across the plot area. Once the compost was applied, the top dressings were aggressively swept into the aeration holes. These treatments were compared to a control of top dressing grade sand. On the control plots, aeration core holes were backfilled with sand only. The nutrient data of the composts can be found in Table 3. The garden material compost was applied in clay based soil plots, while the food/garden material compost was applied to sandy plots. Both composts were granular in nature and easy to use for the topdressing application. Analysis of both products indicated that they both possessed chemical characteristics appropriate for this application (Table 3) as based on the WRAP topdressing specifications (from Compost Specifications for the Landscape Industry). The garden material compost contained a higher concentration of total nitrogen than the food/garden material compost.

The plots were set up on July 15, 2008. It should be noted that during plot installation, difficulties were encountered in attaining accurate application rates on individual plots, while maintaining a level plot surface (getting the aeration holes filled to the level of the soil surface). This was expected, since the core holes were known to be at a consistent size, while the application rates would be varied. To adjust for this, specific rates of sand were backfilled in the core holes before compost application. This would not be an issue in a 'real world' scenario, since additional topdressing (or compost) would be applied to level the soil surface or the holes would just be allowed to fill in through natural soil movement.

Table 1: Topdressing Applications

CLAY SITE: COMPOST DERIVED FROM GARDEN MATERIAL			
12mm 11kg compost 12.4 kg sand	**6mm** 5.5 kg compost 14.2 kg sand	**Sand** 15 kg	**9mm** 8.25 kg compost 13 kg sand
9mm 8.25 kg compost 13 kg sand	**Sand** 15 kg	**6mm** 5.5 kg compost 14.2 kg sand	**12mm** 11kg compost 12.4 kg sand
6mm 5.5 kg compost 14.2 kg sand	**9mm** 8.25 kg compost 13 kg sand	**12mm** 11kg compost 12.4 kg sand	**Sand** 15 kg

SANDY SITE: COMPOST DERIVED FROM FOOD WASTE/GARDEN MATERIAL			
12mm 12 kg compost No sand	**6mm** 6 kg compost No sand	**Sand** 10 kg sand	**9mm** 9 kg compost No sand
9mm 9 kg compost No sand	**Sand** 10 kg sand	**6mm** 6 kg compost No sand	**12mm** 12 kg compost No sand
6mm 6 kg compost No sand	**9mm** 9 kg compost No sand	**12mm** 12 kg compost No sand	**Sand** 10 kg sand

Table 2: Application Rate Equivalencies

Rate	Garden material compost applied on Clay Site	Food waste/ garden material compost applied on Sandy Site
6mm	24 t/ha	27 t/ha
9mm	37 t/ha	40 t/ha
12mm	49 t/ha	53 t/ha
Sand	67 t/ha	44 t/ha

Table 3: Compost Analyses

	COMPOST FROM GARDEN MATERIAL		COMPOST FROM FOOD WASTE/GARDEN MATERIAL	
Total Nutrients	**As received mg/l**	**as dry matter mg/kg**	**As received mg/l**	**as dry matter mg/kg**
Nitrogen As N	4789	17950	3566	9850
Calcium as Ca	17477	65501	Not determined	Not determined
Copper as Cu	15.8	59.3	23.9	66
Zinc as Zn	52	195	74.5	206
Heavy Metal	**As received mg/l**	**as dry matter mg/kg**	**As received mg/l**	**as dry matter mg/kg**
Zinc	52	195	74.5	206
Copper	15.8	59.3	23.9	66
Lead	15.2	57	23.8	65.7
Mercury	<0.05	0.13	<0.05	<0.05
Cadmium	0.26	0.98	0.14	0.38
Chromium	6.65	24.9	12.3	33.9
Nickel	6.01	22.5	13.2	36.5
Other Characteristics	**As received**	**as dry matter**	**As received**	**as dry matter**
pH	8.9		8.4	
Organic matter (%) (w/w)	14	52.3	13.2	36.4
Moisture (%) (w/w)	41.10		48	
C:N Ratio	16.8		21.4	
Electrical Conductivity (µS/cm)	723		1710	
Organic Carbon %		30.4		21.2
Dry Matter %	58.9		52	
Impurities				
% of total sample >2 mm particle size	0.00		0.03	
Pathogens				
E. coli units	<10		<20	
Salmonella units	0		0	
Stability				
OUR mgO2/kgdm/h	4.59		3.97	

Core aerated plot

Template placed on plot

Application of compost

Plots showing the compost and sand treatments

3. MAINTENANCE

All the plots were mowed weekly at the same time as the adjoining driving range turf. Irrigation was from natural precipitation. No fertilisation was applied until after the trial was completed and the final soil and turf samples were collected.

4. MONITORING AND ASSESSMENTS

The monitoring methods used for the assessments listed in Table 4 were based on standard operation procedures (SOP) operated by the Sports Turf Research Institute. Assessments were carried out every two weeks. The assessments were started on July 29th 2008 and were carried out on days 14, 28, 42, 58, 70, 84, 98 and 112 of the trial.

Samples of turf and soil samples were obtained from the plots prior to the start of the trial. Soil samples were subsequently obtained at the end of the study on 4th November and turf samples on 26th November 2008.

Table 4: Turf Parameters Monitored

Turf Colour	Assessment of depth of green colouration on a scale of 1 to 10; 1 indicating white; 10 indicating dark green.	SOP No. 1B0803
Ground cover by grass	Assessment by point quadrat	SOP No. 1B1199
Turf disease cover	The proportion of turf surface affected by fungal disease assessed visually	SOP No. 1B2204
Turf weed cover	Weed numbers counted within an experimental plot	SOP No. 1B2303

Turf samples were analysed for nutrient content, while the soil samples were analysed for nutrient and organic matter content, and pH. An accredited laboratory using standard testing methodologies was used in all cases. Tables 5 and 6 contain results of these analyses.

4.1 Statistical Analysis

The results for weed cover, turf colour, disease cover and plant tissue were statistically analysed using the Agriculture Research Manager (ARM) software. Analysis of variance at 0.05 confidence level was conducted.

5. RESULTS

5.1 Plot Soil

Both compost products had similar nutritional characteristics. As illustrated in Table 5, generally, the greater the compost application rate, the greater the amount of macronutrients (phosphorus and potassium) found in the soil. In the sandy soil, the nitrate level remained constant and in all of the compost treatments on the clay soil this decreased to a constant reading of 5ppm. The organic matter of the soils increased with the addition of compost.

The nutrient content of the soil in the sand topdressed plots (controls) increased. This was caused by nutrient drift (movement of nutrients along with moisture). Prior to the trial the soil was fertilised by the K-Club green keepers. The clay soil contained a higher nutrient content. This is likely because it possesses a higher organic matter content and cation exchange capacity (CEC)[3] (clay- 19.7 CEC meq/100g, sandy soil – 4.1 CEC meq/100g) than the sandy soil. The pH of the soil was not affected by the addition of compost.

Table 5[4] – Analysis of Soils Data

CLAY SITE: GARDEN MATERIAL COMPOST					
	Before the trial started	At the End of the Trial			
		6mm	9mm	12mm	sand/control
Organic N (ppm)	21	42	30	35	31
Nitrate (ppm)	12	5	5	5	5
Phosphorus (ppm)	9.9	32.4	38.6	43.9	27.1
Potassium (ppm)	158.3	230.4	227.5	268.9	204.5
pH	7.5	7.6	7.7	7.6	7.6
Organic matter	8.2	8.5	8.8	9.5	7.5

SANDY SITE: FOOD/GARDEN MATERIAL COMPOST					
	Before the trial started	At the End of the Trial			
		6mm	9mm	12mm	sand/control
Organic N (ppm)	12	39	32	35	38
Nitrate (ppm)	3	3	4	3	5
Phosphorus (ppm)	16.8	48.7	40.6	47.9	33.3
Potassium (ppm)	104.7	185.5	160	199.2	138.7
pH	7.7	7.9	8	7.9	7.8
Organic matter	2.6	3.6	3.3	3.4	2.7

5.2 Turf Analysis

Phosphorus and potassium increased with increased compost applications rates. Some nutrients (potassium and magnesium) increased in the turf analyses from clay soil. Phosphorus and magnesium increased in the turf from the sandy soil. Again, like the soil analyses, nutrient content of the control plot turf was also found to be higher than those taken before compost application. Potassium showed no obvious trends. Magnesium levels increased in all treatments, including the sand control. Sodium levels in the sandy soils showed, as with potassium, a marked and unexpected decline in the compost and sandy soil control treatments. Manganese increased in all treatments, including the sandy soil control, as did iron and aluminium. There may have been significant concentrations of some nutrients (e.g. manganese) in the sandy soil. In several cases, the target level[5] (agricultural herbage) for nutrient content was met and sustained over a three month period with the addition of compost.

[3] Cation Exchange Capacity is a value given on a soil analysis report to indicate its capacity to hold cation nutrients

[4] A bulk soil or herbage sample was taken for each treatment within the trial (6mm, 9mm, 12mm and control), i.e., a sample of soil was taken from the four 6 mm treatments within a trial and mixed together to form one sample and this was sent for analyses, likewise for herbage sampling. Therefore the values presented are not the mean value of 4 replicates, they represent one bulk sample.

[5] Teagasc 2008 recommendations: "Major & Micro Nutrient Advice for Productive Agricultural Crops" 3rd Edition

Although the target level was also met with nitrogen, by the end of the trial it was obvious by observation of the turf colour that additional nitrogen fertiliser was required.

Table 6[6] – Analysis of Turf Data

CLAY SITE: GARDEN MATERIAL COMPOST						
	Before the trial started	At the End of the Trial				
		6mm	9mm	12mm	sand/control	Target Level
Nitrogen (%)	2.4	4	4.3	3.8	4.5	3.5
Calcium (ppm)	4500	10150	8250	9950	9550	6000
Phosphorus (ppm)	3700	5500	6345	5800	6150	4000
Potassium (ppm)	25741	25249	26799	27044	27782	30000
Magnesium (ppm)	1030	2103	2090	27405	2102	3000
Sodium (ppm)	159	385	316	465	316	3000
Sulphur (ppm)	2800	4550	5450	4500	5400	2500
Zinc (ppm)	22	31	28	31	33	50
Manganese (ppm)	38	152	104	149	159	100
Iron (ppm)	310	2398	1274	2485	2540	150
Aluminium (ppm)	180	1538	540	1765	1510	100

SANDY SITE: GARDEN/FOOD MATERIAL COMPOST						
	Before the trial started	At the End of the Trial				
		6mm	9mm	12mm	sand/control	Target Level
Nitrogen (%)	2.3	4	3	4.1	3.4	3.5
Calcium (ppm)	4540	11350	15100	13750	18650	6000
Phosphorus (ppm)	4050	5790	5000	6150	5000	4000
Potassium (ppm)	32392	20213	16720	21233	16893	30000
Magnesium (ppm)	1010	2385	2515	3005	2380	3000
Sodium (ppm)	1037	608	557	770	556	3000
Sulphur (ppm)	2650	4950	4250	5300	4550	2500
Zinc (ppm)	20	38	42	41	36	50
Manganese (ppm)	31	238	301	254	268	100
Iron (ppm)	245	4325	6950	4805	5850	150
Aluminium (ppm)	155	1890	3284	2410	2607	100

5.3 Turf Parameter Results

5.3.1 Turf Quality

Overall, the turf quality was visually superior to the clay treatments, as opposed to the sandy treatments, suggesting less plant stress (e.g. nutrient, moisture) on the grass grown in the clay soil. A significant difference in turf quality between the compost and sand treatments on the sandy site were observed, but there was no significant difference on the clay site. This suggests that the sandy soil did not support increased plant growth and was more prone to stress when compared to the clay soil and consequently the difference in turf quality between treatments was more evident.

[6] A bulk soil or herbage sample was taken for each treatment within the trial (6mm, 9mm, 12mm and control), i.e., a sample of soil was taken from the four 6 mm treatments within a trial and mixed together to form one sample and this was sent for analyses, likewise for herbage sampling. Therefore the values presented are not the mean value of 4 replicates, they represent one bulk sample.one bulk sample.

5.3.2 Turf Colour

Turf colour was evaluated from 1 to 10, 10 being the darkest in colour. As illustrated in Figures 1 and 2 (mean results reported), compost application provided a significant quick release of nitrogen to turf, providing a quick 'green-up' effect (within 14 days). Grass on all of the compost treatments produced significantly better turf colour than the control plots on day 14, 56 and 84 measurements on the clay site than the sandy soil. The turf was off colour (lighter green) by the end of trial.

Figure 1: Turf Colour at Sandy Soil Site

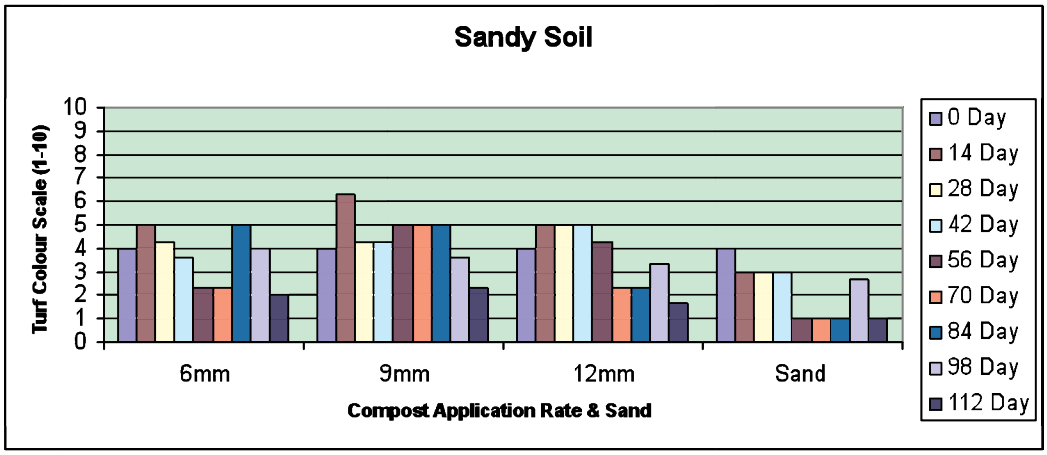
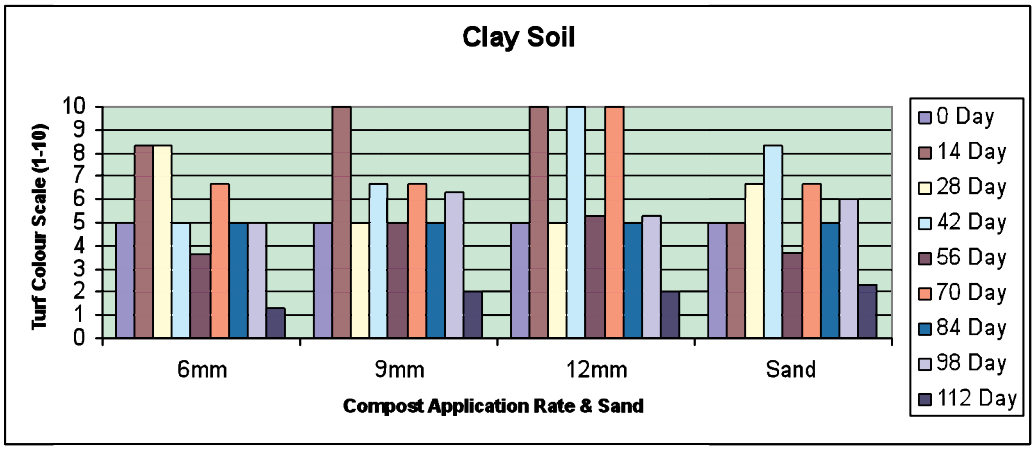


Figure 2: Turf Colour at Clay Soil Site



5.3.3 Disease Cover (Incidence)

The objective was to determine the percentage turf area affected by disease. There was significantly less disease incidence on the compost treatments on the clay site at the day 56 and 70 measurements (Figure 4). The turf disease cover was low in the sandy soil.

Figure 3: Turf Disease Cover at Sandy Soil Site

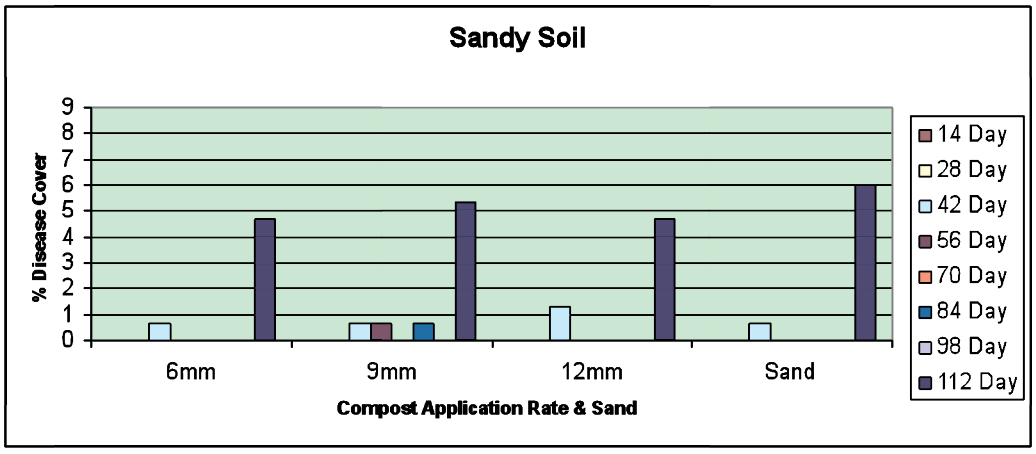
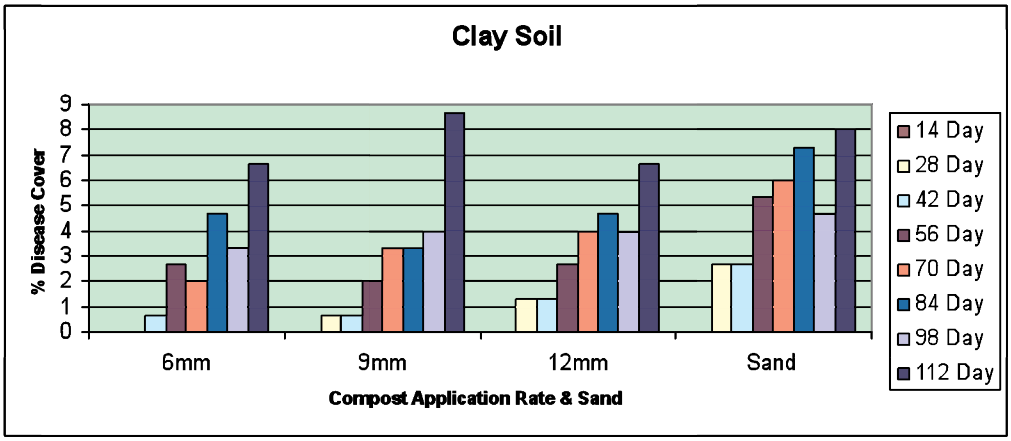


Figure 4: Turf Disease Cover at Clay Soil Site



5.3.4 Turf Weed Cover

Although it appeared that greater clover infestation had occurred on some of the control plots, no significant variation in broadleaf weed numbers or species were found in either trial.

Figure 5: Weed Cover at Sandy Soil Site

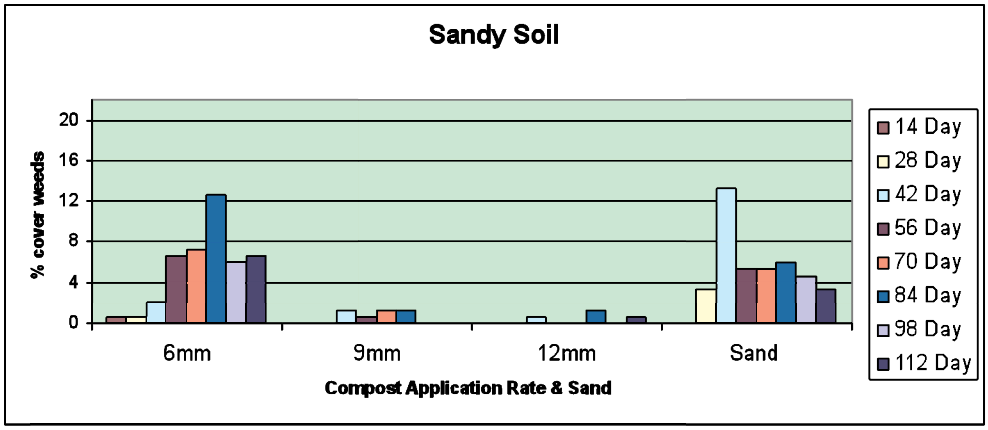
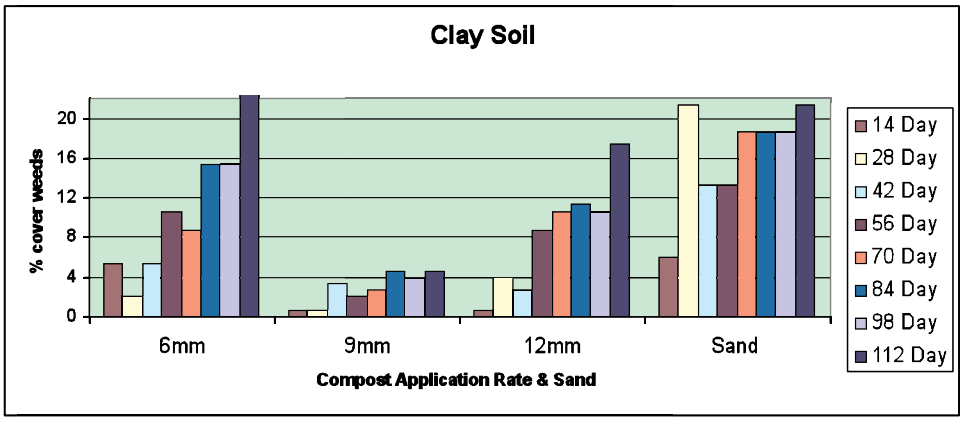


Figure 6: Weed Cover at Clay Soil Site



5.3.5 Grass Ground Cover

Ground cover is the proportion of ground cover occupied by the perpendicular projection of live grass material above it. There was no variation between the compost treatments and sand in Figures 7 and 8. On the final day of the trial, there was less ground cover in the clay soil compared to the sandy soil treatments.

Figure 7: Ground Cover (% live grass tissue) at Sandy Soil Site

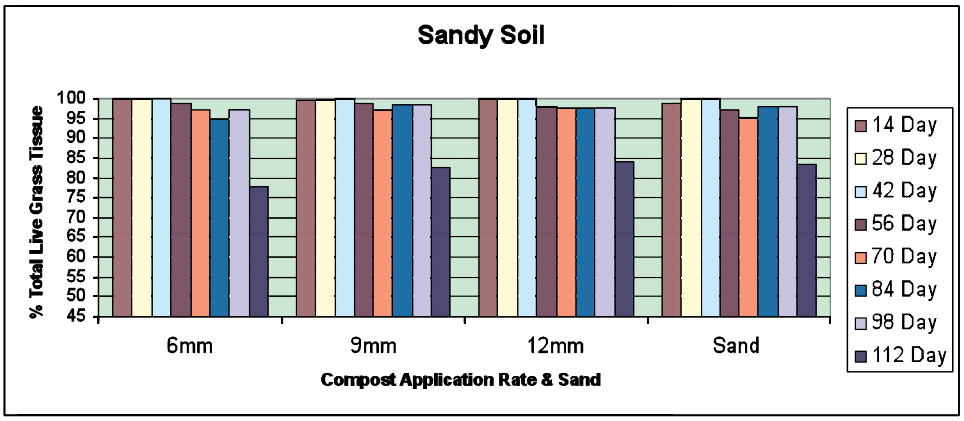
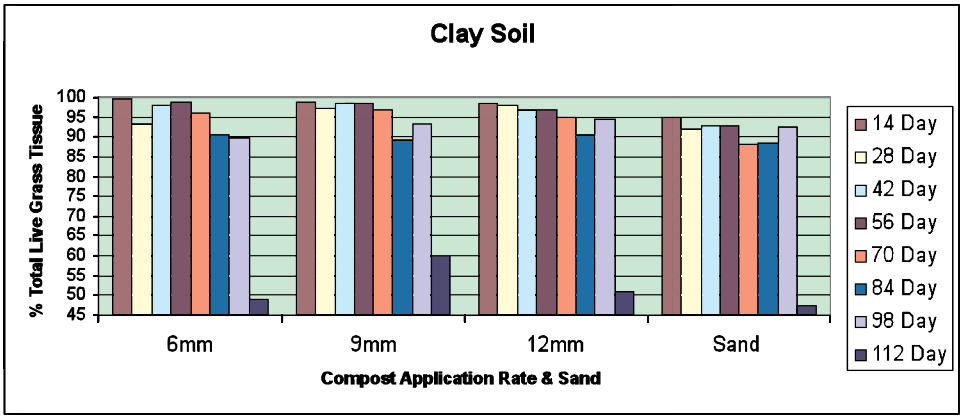


Figure 8: Ground Cover (% live grass tissue) at Clay Soil Site



5.3.6 Compost Treatment Comparisons

This section examines which of the three different compost application rates (6, 9 or 12mm) performed best.

Turf Colour:

The only difference in turf colour between the compost treatments was that the turf colour was darker with the 12mm application on clay soil on some occasions.

Turf Disease:

There was no difference in the disease cover between the treatments.

Weed Cover:

There was reduced weed cover for 9mm and 12mm compared to the 6mm and control in sandy soil.
There was reduced weed cover with the 9mm compared to the control and other compost treatment on the clay soil.

Ground Cover:

The ground cover was similar for the compost treatments and controls on the clay and sandy sites.

Recommendation:

It is recommended that a 9mm layer be applied because there was less weed cover on both the clay and sandy sites compared to the other compost treatment and control.

6. RECOMMENDATIONS

- The trials were completed during an extremely wet summer, which may have affected some of the research results. In particular, any effects of compost in aiding soil moisture retention under drought conditions could not be tested. For this reason, it is recommended to complete similar or larger trials during a more typical weather year. They should be conducted for a longer period and on a large area of a fairway.
- Investigate the ability of compost to enhance soil properties through multiple topdressing applications.
- Investigate the disease suppressive qualities of compost in different cultural scenarios (e.g. grass type, soil type, wet year, dry).
- Investigate compost blended with sand (vs. sand or soil and sand blends) for green and tee maintenance.

7. OPEN DAY OF TRIALS

Prior to completion of the trial and as part of the overall project, an open day was held on 15 October 2008 at the K-Club's Smurfit Club House, Straffan, Co. Kildare. The event was held pre-completion of the trial to pre-empt the dormancy stage of the grass. The event was well received and was reported in Greenside Magazine (December 2008), the official Magazine of the Golf Course Superintendents Association of Ireland.

Outlined below are the comments received from stakeholders at the open day:

- Larger trials over a longer period on the entire fairway are needed;
- Conduct economic analysis on reduced fertiliser, fungicide use etc;
- Produce a fact sheet to aid compost producers to sell their product to golf courses in Ireland;
- Need to conduct sand trial by adding chemical NPK to match the NPK on the compost sites;
- Add a chemical fertiliser control to the trial (applied NPK) and then apply treatments:
  1. 30% less fertiliser
  2. 40% less fertiliser
  3. 50% less fertiliser and assess grass colour;
- Determine the dry matter content of the turf. Lower dry matter would result in less mowing of grass and financial savings for the golf course;
- Plot areas were small, encroachment from outside of plot area may have affected the trial;
- Continue the current trials and assess the disease status (e.g. red thread) next spring; and
- Investigate customised compost treatments (e.g. blending animal manures with compost).

Golf Course Superintendents Examining the Plot at the Open Day

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