FINAL REPORT :

CURRENT CONTROL OF PESTS, WEEDS AND DISEASES AND PESTICIDE USE ON SCOTTISH GOLF COURSES

For

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SUMMARY
Microdochium (fusarium) patch and anthracnose were the most common and severe diseases; earthworms and leatherjackets the most common and severe pests and clover, daisy and moss the most common and severe weeds on Scottish golf courses in 2005. Microdochium patch was reported as more severe on grass swards dominant in *Poa annua* compared to *Agrostis/Festuca*. The main cultural control methods used for disease management were thatch management, removal of dew and improving airflow. Clipping removal and acidifying turf were the main cultural methods used for pest control. Hand removal was the main cultural method used for weed control on greens. Plant protection products (PPPs) were used to control pests, weeds and diseases. However, with the exception of chlorpyrifos, excessive use was not reported. In almost all cases storage, use and disposal of PPPs was in accordance with current legislation. Course Managers were aware of, and employed, best practice guidelines from most of the various initiatives set up. However, the Voluntary Initiative and the Amenity Forum were not well known and need to be more widely advertised in Scotland.

INTRODUCTION
Many new initiatives and regulations have been established to reduce the use of pesticides on golf courses in Scotland. Where pesticide use is necessary, these initiatives and regulations serve to ensure safe use of all Plant Protection Products (PPPs). The current levels of awareness of these initiatives and regulations are unknown in Scotland. Further to this, there is no information regarding the decision making process to determine whether a PPP is required, which product to use, its application, storage and disposal.

Therefore, a questionnaire survey was established to determine which pests, weeds and diseases are most common on Scottish golf courses and how they are controlled, both in terms of cultural control and PPP use. The decision-making processes in determining which products to use, when they are applied, storage and disposal were all investigated. The golf sectors awareness of the new initiatives was also determined.

OBJECTIVES
The objectives of this work were to determine the spread and severity of the pests, weeds and pathogens on Scottish golf courses in 2005. The methods used to control these pests, weeds and diseases were also investigated.

MATERIALS AND METHODS
A steering group comprising of SGEG, SEPA, SGU, The R&A, BIGGA and STRI was established to develop the questionnaire (Appendix 1). This questionnaire was sent to all Scottish golf courses in November 2005. In March 2006 a selection of golf courses were visited to 'ground-truth' the replies received. A response rate of 27% was obtained (109 completed questionnaires received). However, the quality of the answers in the returned questionnaires differed. This affected the ability to analyse these data. To alleviate this, some assumptions were employed. For example, if a cross was entered into the 'severe' box for microdochium patch rather than the number of greens suffering from the disease, it was assumed that all greens suffered equally (i.e. for an 18 hole golf course, 18 greens suffered severe microdochium patch

during 2005). In some cases, where insufficient data was supplied, the course was eliminated from that part of the analysis.

RESULTS AND DISCUSSION

Results are presented either descriptively or, where the relationships between two variables were investigated, analysis was by the chi-square test. Contingency tables were prepared relating the incidence of disease to factors such as predominant grass type and nutrient input. Chi-square analysis was performed to determine whether the actual responses differed from the expected response determined from the category totals [Genstat, 2002]. In order to satisfy the assumptions of chi-square, where the fitted value cannot be below 5, some categories had to be combined. This mostly affected the 'very severe' and 'severe' categories of disease severity as there were usually too few replies with very severe problems. In some cases more than 20% of expected responses were less than 5 and chi-square analysis could not be performed [Siegel and Castellan, 1988].

Golf course type

The most common golf course type was parkland with 49% of replies (Table 1). Links courses made up 30% of replies. Heathland, moorland, hillside and coastal courses comprised the remaining 21% of questionnaire replies.

TABLE 1
Golf course type reported by Scottish golf courses in 2005

Course type	%
Parkland	49
Links	30
Heathland	6
Moorland	8
Hillside	6
Coastal	1

Number of holes

The number of holes ranged from nine to 45 (Table 2). Three quarters of replies came from 18 hole golf courses.

TABLE 2
Number of holes reported by Scottish golf courses in 2005

No. of holes	%
9	10
18	75
> 18	15

Grass species composition

The most common sward type on greens was *Agrostis*/*Poa annua* with 40% of replies (Table 3). *Agrostis*/*Festuca* was the next most common, followed by *Poa annua/Agrostis.*

TABLE 3
Predominant grass types reported by Scottish golf courses in 2005

Sward type	Greens
	%
Agrostis/Poa annua	40
Agrostis/Festuca	30
Poa annua/Agrostis	15
Agrostis	5
Festuca	5
Poa annua	4
Lolium perenne	-
Unanswered	1

Soil type

On greens, the rootzone was predominantly sand (27%; Table 4). The next most common soil type was loam (25%) followed by clay loam (22%). On tees, loam was the most common soil type. On fairways sand or clay loam was the most common soil type.

TABLE 4
Rootzone types reported by Scottish golf courses in 2005

Soil type	Greens	Tees	Fairways
	%	%	%
Sand	27	23	30
Loam	25	32	22
Clay loam	22	21	30
USGA specification	11	7	0
Peat	5	4	5
Silt	1	1	1
Other	9	8	8
Unanswered	0	4	4

Fertiliser input

Almost half of all respondents applied less than 80 kg/ha of nitrogen to greens (Table 5). Only 14% applied more than 120 kg/ha of nitrogen to greens. On tees, over 90% of respondents applied less than 120 kg/ha nitrogen.

Phosphorus was not applied to greens or tees during 2005 by 41% and 37% of respondents, respectively (Table 5). Most phosphorus applications that did occur was in the 1-20 kg/ha range with few respondents applying more than 20 kg/ha.

On greens, 51% of respondents applied less than 80 kg/ha of potassium. A further 36% applied between 80 and 160 kg/ha, with 7% of greens receiving more than 160 kg/ha. On tees, 87% of respondents applied less than 120 kg/ha of potassium.

TABLE 5
Nitrogen, phosphorus and potassium applied to Scottish golf courses in 2005

Nutrient	Application rate	Greens	Tees
	Kg/ha	%	%
Nitrogen	0-80	48	58
	80-120	33	33
	120-160	9	2
	>160	5	1
	Unanswered	5	6
Phosphorus	0	41	37
	<20	41	47
	20-40	9	7
	>40	3	2
	Unanswered	6	7
Potassium	0-80	51	60
	80-120	24	27
	120-160	12	3
	>160	7	3
	Unanswered	6	7

The latest application of fertiliser was most commonly made during October for greens and August for tees (Table 6).

TABLE 6
Latest application of fertiliser reported by Scottish golf courses in 2005

Application time	Greens	Tees
	%	%
March	0	0
April	1	0
May	1	2
June	1	1
July	12	18
August	21	27
September	27	18
October	29	20
November	4	3
December	4	0
Unanswered	0	11

The nitrogen, phosphorus and potassium input on golf greens were analysed to test relationships between fertilizer inputs and grass species composition. Sufficient data were only available for certain combinations of categories of grass species composition. For the fertiliser input data, categories had to be combined to try to obtain sufficient data in each category to perform the chi-square test. However, even with combined datasets greater than 20% of fitted values were less than 5 and so chi-square analysis could not be performed. Therefore, on this dataset, we cannot test whether nitrogen, phosphorus or potassium input has affected the grass species composition on Scottish golf courses.

Disease incidence and severity on golf greens

All golf clubs suffered from some disease (Table 7). The disease occurrence was rated where disease one was the most problematic disease on the greens and disease two was the second most problematic. Microdochium patch was the most common disease followed by anthracnose. Other diseases included red thread, take-all patch and fairy rings. The remaining diseases (leaf spot, yellow tuft, dollar spot, and dry patch) were not widely observed on Scottish golf greens in 2005.

TABLE 7
The two most common diseases reported by Scottish golf courses in 2005

Disease	Disease 1	Disease 2
	%	%
Microdochium patch	84	8
Anthracnose	4	29
Red thread	2	20
Take all patch	4	9
Fairy rings	4	16
Leaf spot	0	1
Yellow tuft	0	1
Dollar spot	0	2
Thatch fungi	0	2
Dry patch	1	0
Unanswered	1	12

Microdochium (fusarium) patch

Microdochium patch (still often called fusarium patch) is caused by *Microdochium nivale*. It is usually associated with the autumnal months in Scotland when the weather conditions are mild and wet, although it can occur all year round if the weather conditions are conducive to its development. It can be a devastating disease on golf greens as the patches may be many inches in diameter and adversely affect the playing surface as well as the aesthetic value of the green. As microdochium patch commonly occurs at times of year when grass growth is slow, scars may remain for prolonged periods even after the pathogen has been controlled, which can affect play for many months.

The severity of microdochium patch was determined on each green (Table 8). If respondents did not complete severity for the total number of golf greens present on the course, it was assumed that the disease was absent from the remaining number of greens. For example, if a response from an 18 hole golf course indicated three greens with severe, two greens with moderate and 10 greens with slight microdochium patch, it was assumed that the remaining three greens did not suffer any disease and so were placed in the absent category. Microdochium patch was the most commonly observed disease on golf greens and the only disease considered very severe or severe on a small number of greens. In most cases, microdochium patch was considered to be moderate or slight in severity.

Disease severity in relation to the predominant grass species was also determined. Microdochium patch was reported at a moderate level on *Poa annua* and on *Poa annua/Agrostis* more often than would be expected by chi-square analysis (Table 9). There was also less moderate microdochium patch reported on *Agrostis/Festuca* than would be expected. This was unsurprising and agreed with previous questionnaire surveys conducted in the UK (Mann & Newell, 2005; Windows, 2005). This would be expected as *Poa annua* is generally accepted as being more susceptible to microdochium patch than *Agrostis* or *Festuca* (Smiley *et al.*, 2005).

The amount of fertiliser applied, timing of application and type of fertiliser used is also associated with the severity of many diseases. To investigate this, the relationship between the nitrogen input and the severity of microdochium patch was determined. Microdochium patch is more commonly associated with high inputs of nitrogen (Smiley *et al.*, 2005). The survey data showed that where less than 80 kg/ha of nitrogen was applied less microdochium patch was observed (Table 10). More microdochium patch in the severe category was reported where 80-120 kg/ha of nitrogen was applied. Therefore, these results supported the suggestion that the severity of microdochium patch increased where the nitrogen inputs were higher.

Similar results were obtained by analysing the relationship between the diseases and potassium and phosphorus. For example, where zero phosphorus was applied less microdochium patch was reported but more was reported where more than 20 kg/ha of phosphorus was applied (data not shown). Similarly, where less than 80 kg/ha of potassium was applied less microdochium patch was reported but more was reported where more than 80 kg/ha was applied (data not shown). However, as it is unusual that either phosphorus or potassium would be applied alone, it is more likely that increased disease incidences were associated with nitrogen inputs rather than potassium or phosphorus and so these data have not been presented.

TABLE 8
Disease severity on golf greens reported by Scottish golf courses in 2005 (number of greens reported in each category of severity as a percentage of the total number of greens)

Disease	Very severe	Severe	Moderate	Slight	Absent	Total no. of greens
Microdochium patch	0.5	3.5	23	45	28	2070
Anthracnose	0	2	7	22	69	2070
Red thread	0	1	4	26	69	2070
Take all patch	0	1	1	7	91	2070
Fairy rings	0	2	4	20	74	2070
Leaf spot	0	0	0	2	98	2070
Yellow tuft	0	0	0	4	96	2070
Dollar spot	0	0	1	0	99	2070
Dry patch	0	0	<0.5	2	98	2070

TABLE 9
Relationship between Microdochium patch severity and dominant grass type on golf greens (χ^2 at 8 d.f = 166.4, P <0.001)

Grass type	≥Moderate		Slight		Absent		Total no. of greens
	Freq	%	Freq	%	Freq	%	
Poa annua	43	53	25	31	13	16	81
Poa annua/Agrostis	135	47	136	47	17	6	288
Agrostis	18	16	53	45	46	39	117
Agrostis/Poa annua	242	28	408	47	214	25	864
Agrostis/Festuca	115	19	293	48	204	33	612

TABLE 10
Relationship between microdochium patch severity and nitrogen input on golf greens (χ^2 at 6 d.f = 42.6, P <0.001)

Nitrogen input (Kg ha^{-1})	Severe		Moderate		Slight		Absent		Total no. of greens
	Freq	%	Freq	%	Freq	%	Freq	%	
<80	31	3	211	23	364	39	321	35	927
80-120	41	6	149	21	342	49	169	24	702
>120	4	1	65	21	156	50	90	28	315

Anthracnose basal rot

Anthracnose is caused by *Colletotrichum graminicola*. This pathogen can cause two types of disease depending on the prevailing weather conditions. In hot weather conditions, especially if the soil is dry and the turf surface moist, foliar blight can occur (Smiley *et al*., 2005). Under cool, wet conditions basal stem rot may develop. This can affect the playability of turf as surface smoothness is affected, which will affect ball roll. As these symptoms are more common during late autumn and winter, the turf may not recover until the following spring leaving poor playing conditions for many months.

Approximately 30% of golf greens suffered from anthracnose, mostly with slight severity (Table 8). Anthracnose basal rot is more commonly found on *Poa annua* in the UK. The relationship between the severity of anthracnose on the predominant grass species was investigated. However, the data was not normally distributed and so could not be analysed by chi-square. Therefore, the data was analysed to look at the occurrence of anthracnose. Anthracnose was reported by 67% and 56% of respondents with predominantly *Poa annua* and *Poa annua/Agrostis* greens, respectively, much higher than those with *Agrostis* or *Agrostis/Festuca* greens, as would be expected (Table 11).

TABLE 11
The relationship between occurrence of disease and grass species composition on Scottish golf greens in 2005

Grass species	Anthracnose		Take-all patch		Fairy Rings		Total no. of greens
	Freq	%	Freq	%	Freq	%	
Poa annua	54	67	0	0	36	44	81
Poa annua/Agrostis	161	56	8	3	27	9	288
Agrostis	4	3	21	18	19	16	117
Agrostis/Poa annua	280	32	77	9	223	26	864
Agrostis/Festuca	106	17	81	13	182	30	612
Festuca	30	33	0	0	42	47	90
X^2	238.6		37.2		*		
d.f.	5		3				
P.	<0.001		<0.001				

*Data not normally distributed, therefore analysis not possible

Anthracnose is associated with low fertility as well as other stress factors such as compaction, drought and excessively low cutting heights. Therefore, the relationship between anthracnose and nitrogen application was investigated. Where more than 120 kg/ha nitrogen was applied, moderate and slight anthracnose were reported less frequently (Table 12). This supports the suggestion that higher inputs of nitrogen helped to reduce the severity of this disease.

TABLE 12
Relationship between anthracnose severity and nitrogen input on golf greens (χ^2 at 4 d.f = 39.8, P <0.001).

Nitrogen input (Kg ha^{-1})	>/=Moderate		Slight		Absent		Total no. of greens
	Freq	%	Freq	%	Freq	%	
<80	49	5	192	21	686	74	927
80-120	57	8	170	24	475	68	702
>120	5	2	44	14	266	84	315

Red Thread

Red thread is a blemish disease caused by *Laetisaria fuciformis.* Although it may detract from the aesthetic value of the golf putting green, it is generally insignificant in terms of affecting the playing surface. Red thread affected 31% of golf greens, mostly with slight severity. Red thread is also associated with low fertility and can commonly affect *Agrostis* and *Festuca*. Where less than 80 kg/ha of nitrogen was applied 32% of respondents observed red thread in the slight category and 61% of respondents indicated that red thread was absent (Table 13). Where 120 kg/ha of nitrogen or more was applied 19% of respondents observed red thread in the slight category and 76% indicated that red thread was absent. Therefore, applying more nitrogen reduced the number of respondents that observed red thread. However, in swards dominant in *Festuca*, applying extra nitrogen to control red thread needs to be balanced with keeping the *Festuca* component, which survives better at lower fertility.

TABLE 13

Relationship between red thread severity and nitrogen input on golf greens (χ^2 at 3 d.f = 57.6, P <0.001).

Nitrogen input (Kg ha^{-1})	Severe		Moderate		Slight		Absent		Total no. of greens
	Freq	%	Freq	%	Freq	%	Freq	%	
<80	9	1	58	6	295	32	565	61	927
≥120	18	2	33	3	196	19	770	76	1017

Take-all patch

Take-all patch is caused by *Gaeumannomyces graminis*. It is mostly a disease of *Agrostis* putting greens, especially during the establishment period. Take-all patches can measure over one metre in diameter and affect both the aesthetic value and the playing quality of the putting greens. Take all patch was reported on 9% of golf greens, mostly with slight severity. The occurrence of take-all patch on the predominant grass species was investigated. A higher incidence of take-all patch was reported for *Agrostis* and *Agrostis/Festuca* golf greens than on *Poa annua* greens (Table 11).

There were insufficient data reported on take-all patch to determine the effect of nitrogen application on severity. However, it was possible to determine the effect of fertiliser application on occurrence of take-all patch. The type of fertiliser is important for take-all patch as acidic fertilisers help to keep the surface and rootzone pH slightly more acidic than *Gaeumannomyces graminis* prefers. These data indicated that more take-all patch was reported where 80-120 kg/ha of nitrogen was applied (Table 14). Reasons for this are unclear without further investigation that cannot be completed on the current dataset.

Fairy rings

Many types of basidiomycetes cause fairy rings. The basidiomycetes grow on any organic matter, such as thatch, found in the rootzone. Three types of fairy ring may occur. Type one rings are the most damaging to the playing surface as they create dead zones of grass with luxuriant growth on both sides of the dead area. Type two produce rings of excessive growth due to the extra release of nitrogen by the fungi and type three only produce fruiting bodies (toadstools or mushrooms). Fairy rings were observed on 26% of golf greens. However, there were insufficient data reported to determine whether the predominant grass species had any effect on the severity or occurrence as the data were not normally distributed.

Fairy rings were reported by 36% of respondents where less than 80 kg/ha of nitrogen was applied compared to 16% and 18%, where 80-120 kg/ha and more than 120 kg/ha of nitrogen were applied, respectively. This indicated that fairy rings were more common where fertility was lower, as would be expected.

TABLE 14

The relationship between occurrence of take-all patch or fairy rings and nitrogen input on Scottish golf greens in 2005

Nitrogen input (Kg/ha)	Take-all patch		Fairy Rings		Total no. of greens
	Freq	%	Freq	%	
<80	58	6	334	36	927
80 – 120	100	14	112	16	702
>120	27	9	57	18	315
X^2	29.3		97.1		
d.f.	2		2		
P.	<0.001		<0.001		

Control of diseases

Cultural control was determined for each disease. On the questionnaire these were listed under disease one and disease two. However, for reporting, these have been combined together to determine what cultural controls were used for each disease regardless of whether it was listed as disease one or disease two.

Microdochium patch

The most effective cultural measures to manage microdochium patch include reducing leaf wetness by encouraging the penetration of morning sunlight and airflow over the turf surface, removing dew and aerating to keep thatch layers to a minimum. Optimum but never excessive fertiliser should be applied to keep the grass healthy but without excessive 'soft' growth, which can be easily infected by ***M. nivale***. If irrigation is required it should be applied as close to dawn as possible and switched early to remove dew to prevent the surface remaining wet for long periods of time.

Respondents indicated that dew removal, reducing fertility, improving the penetration of light and airflow, thatch management and decreasing irrigation were the most common methods used to manage microdochium patch as would be expected (Table 15). However, for example, only 22% of respondents indicated that they were removing dew regularly to help manage microdochium patch. It is possible that further respondents were removing dew regularly but not associating this practice with disease management. Therefore, it may be worthwhile ensuring that all benefits of this management practice are well known. Similar comments could be applied to other management practices.

Anthracnose

Anthracnose is best managed culturally as it indicates that the turf is not healthy. Ultimately, as anthracnose is most common on ***P. annua***, preventing its ingress into golf putting greens will stop the disease occurring. Therefore, management practices, such as attention to fertilisation and irrigation, to encourage ***Agrostis/Festuca*** at the expense of ***P. annua***, form part of the control measures. Removing any stress (or stresses) will help prevent anthracnose occurring. This may be alleviating compaction through aeration or moving walkways on and off greens. Drought conditions (especially a moist surface and dry soil) should be avoided by irrigating infrequently but to wet the whole rootzone rather than frequent light irrigation. Ensuring the grass is not mown below the optimum cutting height will also reduce the impact of anthracnose. As anthracnose is associated with low fertility, increasing the fertility will help to reduce the disease, especially on ***P. annua*** dominant swards.

Respondents indicated that dew removal, increasing fertility, improving airflow, and thatch management were the most common methods of managing anthracnose (Table 15). However, less than 20% of respondents indicated that they carried out one of these cultural methods of control. Raising the cutting height and increasing fertility (carefully to avoid excessive fertility and encourage the more damaging microdochium patch) was used by only 5% and 9% of respondents, respectively. On predominantly ***P. annua*** swards these two practices alone will reduce the symptoms of anthracnose basal rot.

Red thread

Laetisaria fuciformis also needs a moist turf surface to infect the grass. Therefore, removing dew will help to prevent infection occurring. Respondents (22%) indicated that this was the most common method used to manage red thread (Table 15). Improving the airflow over the turf surface will also help to reduce the length of time that the turf surface remains wet and was used

by 10% of respondents. As red thread is commonly associated with low fertility, 11% of respondents increased fertility.

Take-all patch

Gaeumannomyces graminis proliferates in alkaline soil conditions and survives saprophytically in the thatch layer. Therefore, the addition of acidic materials, such as acidifying fertilisers or iron sulphate will help to reduce the alkaline conditions in the upper rootzone, reducing the infection potential. Keeping the thatch layer to a minimum will also help to reduce the amount of inoculum present in the rootzone. Respondents (19%) indicated that this was the most common cultural method used to prevent take-all patch (Table 15). As take-all is most severe on *Agrostis*, oversowing affected areas with *Festuca* will reduce the impact of the disease as the patches will infill with *Festuca*. This practice may also reduce the amount of *P. annua* that ingresses the sward. Respondents (16%) indicated that this was the second most common practice to reduce take-all patch.

Fairy rings

Control of fairy rings can be difficult. The basidiomycete fungi do not directly affect the grass plants but they adversely affect the rootzone, making it hydrophobic and the grass suffers from localised drought. The rootzone beneath fairy rings can often be very difficult to rewet. The best methods to prevent fairy rings are keeping the thatch layer to a minimum as this is the food source for the basidiomycetes and using a regular programme of wetting agents and targeted irrigation to ensure the rootzone does not become hydrophobic. Respondents indicated that thatch management and using wetting agents were the most common methods of managing fairy rings (Table 15).

TABLE 15

Cultural control (respondents who indicated they used each control as a percentage of the total number of responses for each disease) of the main diseases on Scottish golf courses in 2005

Cultural control	Disease				
	Microdochium patch (%)	Anthracnose (%)	Red thread (%)	Take-all patch (%)	Fairy ring (%)
Dew removal	22	11	22	19	16
Increase fertility	1	9	11	2	1
Decrease fertility	8	5	5	2	1
Light and often fertiliser	6	6	10	4	2
Overseeding	6	9	1.5	16	8
Improve airflow	10	14	10	14	14
Improve light	9	7	5	0	4
Thatch management	18	16	14	19	24
Raise cutting height	3	5	1.5	4	8
Use of wetting agent	7	6	17	12	15
Increase irrigation	1	5	1.5	0	2
Decrease irrigation	9	7	1.5	8	5
Total no. of responses	421	172	63	51	80

The use of PPPs was also investigated for each disease. Again, on the questionnaire, these were listed for disease one and two but have been combined to give the total use for each disease. Plant protection products were predominantly used to control microdochium patch (Table 16). Where other products were indicated these were the less common fungicidal products such as Inzacur, Ringer and Nuturf Carbendazim, wetting agents, microbial products such as Floratine and iron products.

As microdochium patch was the most common and severe disease, most fungicides were used in its control. Chipco Green was the most commonly used fungicide, followed by Heritage and Rimidin. Most respondents monitored for diseases at all times and applied fungicide on one or two occasions. Only two respondents applied fungicide four or more times. Although most respondents indicated that they were happy with the performance of the fungicidal products they used, there were some who indicated that the performance was poor. These included 20% of those using pyraclostrobin (Insignia), 25% of those using carbendazim (Mascot systemic), 20% of those using myclobutanil (Masalon), 33% of those using trifloxystrobin (Scorpio) and 25% of those using thiophanate-methyl (Snare). All of these products are best applied before symptom expression due to their mode of action. When applied correctly, their performance is generally found to be very good. However, if the symptoms of disease are already present, these products may not be as effective as applying chlorothalonil (Daconil Turf) or iprodione (Chipco Green), especially in cases where the disease has been observed and conditions are conducive to rapid spreading.

In some cases an application of fungicide may not have been the best method of control. For example, red thread is commonly managed by an application of 8.0.0 (N.P.K) and often does not need a fungicide application. Chipco Green, Scorpio, Turfclear and other fungicides were used by 4%, 19%, 4% and 30%, respectively, primarily to control red thread. It is possible that a low dose of nitrogen would have produced the same result.

TABLE 16

Plant protection products used (respondents who indicated the number of greens treated with each product as a percentage of the total number of greens treated by each product) to control the main diseases on Scottish golf courses in 2005.

Plant protection product	Disease					Total No. of greens treated
	Microdochium patch (%)	Anthracnose (%)	Red thread (%)	Take-all patch (%)	Fairy ring (%)	
Daconil Turf	67	33	0	0	0	386
Chipco Green	93	3	4	0	0	1660
Fusonil Turf	60	40	0	0	0	92
Heritage	79	7	0	11	3	691
Insignia	58	28	0	14	0	65
Mascot Systemic	62	19	0	0	19	95
Masalon	100	0	0	0	0	200
Mildothane Turf	58	36	0	0	0	287
Rimidin	100	0	0	0	0	407
Scorpio	81	0	19	0	0	95
Snare	100	0	0	0	0	65
Turfclear	96	0	4	0	0	268
Other	34	9	30	6	21	463

The number of applications of each fungicide ranged from one to five (Table 17). In most cases one application of a fungicide was used (125), with 58 respondents indicating that they used the same product twice, seven used the same product three times and two respondents used Chipco Green five times. Most respondents indicated that the results obtained from the use of fungicides were good.

To prevent resistance occurring in any pathogen the Fungicide Resistance Action Group (FRAG) advise that individual active ingredients (or active ingredients from the same chemical group) should not be continually used in succession. For example, azoxystrobin (Heritage), pyraclostrobin (Insignia) and trifloxystrobin (Scorpio) all belong to the Strobilurins. The advice

from FRAG is not to apply any more than two successive applications of a strobilurin as the potential for resistance to occur is considered high. All fungicidal applications should be rotated from different chemical groups, prophylactic treatments should be avoided, full use should be made of multisite fungicides (as there is much less chance of resistance developing to multisite fungicides). Further to this, disease resistant varieties (where appropriate) should be used. The survey data indicated that most respondents rotated fungicide application from different groups. There were only two cases where a better rotation of chemical groups would be advised. In both cases Chipco Green was applied five times to control microdochium patch. Although this number of applications is not illegal, there may be an increased risk that resistance to iprodione may occur within the *Microdochium nivale* population. Resistance to iprodione has been shown in *M. nivale* populations in America (Chastagner & Vassey, 1982). One of these respondents indicated that the control provided by iprodione was good, the other indicated it was poor. It is possible that the second respondent is experiencing a reduction in the efficacy of iprodione (although more investigation would be required to prove this as inaccurate application may also produce the same effect).

TABLE 17

Number of applications of plant protection products used to control the main diseases on Scottish golf courses in 2005 and the respondents (% of the total number of applications) who considered the control provided as good or poor.

Plant protection product	Number of applications				Good (%)	Poor (%)	Unknown (%)
	1	2	3	≥ 4			
Daconil Turf	9	7	1	0	58	8	34
Chipco Green	26	28	3	2	52	4	44
Fusonil Turf	4	1	0	0	83	0	17
Heritage	26	9	0	0	75	7	18
Insignia	5	0	0	0	80	20	0
Mascot Systemic	7	1	0	0	63	25	12
Masalon	10	0	0	0	70	20	10
Mildothane Turf	14	1	0	0	81	13	6
Rimidin	10	4	2	0	63	4	33
Scorpio	6	0	0	0	67	33	0
Snare	2	1	0	0	50	25	25
Turfclear	6	6	1	0	57	0	43

Pest severity on greens, tees and fairways

Earthworms and leatherjackets were the most common pests on greens, tees and fairways (Tables 18-20). Earthworms were reported on 56% of greens, 71% of tees and 73% of fairways. Earthworms were reported on a very small number of tees in the very severe category. Calculated as a percentage this was much less than 0.5%. Therefore, when this occurred, these results were presented as <0.5% to show a trace number of greens, tees or fairways affected but not included in the total 100%. Earthworms produce casts, which produce uneven playing surfaces, bring weed seeds to the surface (such as *P. annua*) and provide an ideal seedbed for their germination.

Leatherjackets were reported on 55% of greens, 44% of tees and 44% of fairways. Leatherjackets feed on roots, organic matter beneath the surface and grass leaves. They can leave depressed marks due to their feeding activity at the surface. Birds will peck at the turf to find leatherjackets increasing the damage to the playing surface. In mild winters, leatherjackets may feed all winter at a time when grass growth is slow or may have ceased. In such circumstances, turf may not recover until spring.

Chafer grubs, bibionid flies, frit fly, moles and rabbits were not widespread in 2005 and were infrequently reported. These survey data on pest occurrence also agreed with a previous questionnaire for the UK (Mann and Newell, 2005).

Control of pests

The most common and severe pests were earthworms and leatherjackets. Boxing off clippings and acidifying turf is recommended to reduce the casting by earthworms (Baker *at al*., 2000). Over half of Course Managers employed both of these methods on greens, as well as applying sand top dressing, which can also deter earthworms (Backman *et al*., 2001). As earthworms feed on organic matter, keeping thatch to a minimum will help to reduce the earthworm population. Managing thatch was used by almost half of all Course Managers to manage earthworms on greens, tees and fairways. Most chemical control of earthworms will not begin until casting starts to appear during warm moist weather and waiting until casting occurs would be expected. Carbendazim and thiophanate-methyl were used to reduce earthworm casting on greens, tees and fairways by 40, 35 and 23 respondents, respectively.

Similar cultural management techniques were employed for leatherjackets. In most cases chlorpyrifos was applied once. However, a few respondents exceeded the maximum permitted number of applications of two per year. For leatherjackets, symptoms may not be detected until spring, when most of the over-winter feeding damage has been done and the larvae are large. Treating in spring can be less effective and the preceding damage cannot be undone. This may lead to over application of insecticidal products to control leatherjackets. Exceeding the maximum permitted number of treatments of chlorpyrifos is illegal and expensive. In most cases a single application of the product at the correct time will give good results. Monitoring for any possible leatherjacket infestation in late autumn and early winter when the larvae are small but before symptoms of feeding are observed and applying chlorpyrifos at this stage, if required, will help to prevent the over-winter feeding damage and excessive use of chlorpyrifos.

TABLE 18

Pest occurrence on golf greens reported by Scottish golf courses in 2005 (number of greens reported in each category of severity as a percentage of the total number of greens).

Pest	Very severe	Severe	Moderate	Slight	Absent	Total no. of greens
Earthworms	0	4	13	39	44	2070
Leatherjackets	2	6	10	37	45	2070
Chafers	0	0	0	4	96	2070
Bibionid flies	0	0.5	0	<0.5	99.5	2070
Frit fly	0	0	0	0	100	2070
Other (moles)	0	0	0	1	99	2070

TABLE 19

Pest occurrence on golf tees reported by Scottish golf courses in 2005 (number of tees reported in each category of severity as a percentage of the total number of tees).

Pest	Very severe	Severe	Moderate	Slight	Absent	Total no. of tees
Earthworms	<0.5	8	29	34	29	2070
Leatherjackets	1	3	12	28	56	2070
Chafers	0	0	0	2	98	2070
Bibionid flies	0	0.5	0	0	99.5	2070
Frit fly	0	0	0.5	0	99.5	2070

TABLE 20

Pest occurrence on golf fairways reported by Scottish golf courses in 2005 (number of fairways reported in each category of severity as a percentage of the total number of fairways).

Pest	Very severe	Severe	Moderate	Slight	Absent	Total no. of fairways
Earthworms	2	9	28	34	27	2070
Leatherjackets	2	6	14	22	56	2070
Chafers	0	0	1	4	95	2070
Bibionid flies	0	0	1	0	99	2070
Frit fly	0	0	0	0	100	2070
Other (moles)	1	0	0	0	99	2070
Other (rabbits)	0	0	0.5	0	99.5	2070

Plant protection products were used to control earthworms and leatherjackets. In most cases chlorpyrifos was used to control leatherjackets on greens, tees and fairways, with a small proportion used for frit fly control on tees (Tables 21-23). Chlorpyrifos was used to control chafer grubs and bibionid flies on greens by 1.5% of respondents. However, although this use is at the Course Managers own risk, it is not recommended, as there is no evidence of chlorpyrifos being effective against these two pests. Carbendazim and thiophanate-methyl were almost exclusively used to suppress earthworm casting on greens, tees and fairways. Use of carbendazim against leatherjackets on tees would not be expected to have any effect.

Many respondents used cultural methods of control to help manage earthworms and leatherjackets. Most respondents boxed off clippings, acidified turf and used sand top dressings to manage earthworms on greens tees and fairways.

TABLE 21

Control measures used on golf greens (respondents who indicated they used each control as a percentage of the total number of responses for each pest) for the main pests reported by Scottish golf courses in 2005

Control measure	Pest					Total responses
	Earthworms	Leatherjackets	Chafers	Bibionids	Frit fly	
Chlorpyrifos	1.5	95.5	1.5	1.5	0	63
Carbendazim	100	0	0	0	0	38
Thiophanate-methyl	100	0	0	0	0	2
Box off clippings	54	38	7	1	0	56
Acidify turf	78	22	0	0	0	27
Sand top dressing	69	31	0	0	0	54
Thatch management	47	43	7	1.5	1.5	60
Physical kill	33	67	0	0	0	3
Other (switching)	100	0	0	0	0	3

TABLE 22

Control measures used on golf tees (respondents who indicated they used each control as a percentage of the total number of responses for each pest) for the main pests reported by Scottish golf courses in 2005

Control measure	Pest					Total responses
	Earthworms	Leatherjackets	Chafers	Bibionids	Frit fly	
Chlorpyrifos	0	96	0	4	0	23
Carbendazim	97	3	0	0	0	31
Thiophanate-methyl	100	0	0	0	0	4
Box off clippings	70	28	2	0	0	40
Acidify turf	78	22	0	0	0	27
Sand top dressing	73	27	0	0	0	52
Thatch management	67	31	2	0	0	36
Physical kill	100	0	0	0	0	1
Other (switching)	100	0	0	0	0	2

TABLE 23

Control measures used on golf fairways (respondents who indicated they used each control as a percentage of the total number of responses for each pest) for the main pests reported by Scottish golf courses in 2005

Control measure	Pest					Total responses
	Earthworms	Leatherjackets	Chafers	Bibionids	Frit fly	
Chlorpyrifos	0	100	0	0	0	19
Carbendazim	95	5	0	0	0	19
Thiophanate-methyl	100	0	0	0	0	4
Box off clippings	70	30	0	0	0	10
Acidify turf	100	0	0	0	0	8
Sand top dressing	86	14	0	0	0	14
Thatch management	67	33	0	0	0	15
Physical kill	0	0	0	0	0	2
Other (switching)	100	0	0	0	0	1
Other (iron)	100	0	0	0	0	2
Other (vertidrain)	100	0	0	0	0	1

Chlorpyrifos was applied between one and four times to golf greens (Table 24). Most respondents applied chlorpyrifos once. Of those using chlorpyrifos 90% considered the control they received to be good. The maximum number of chlorpyrifos treatments permitted in one year is two. Three respondents had exceeded this permitted number of applications. It is important to note that not exceeding the maximum number of treatments is a statutory requirement. Carbendazim was applied once by 27 respondents, twice by seven respondents and three or four times by one respondent to golf greens. Again the majority of users (76%) indicated that the performance they obtained was good. Those respondents that indicated that they boxed off clippings did so at most if not every cut. However, only 34% indicated that this control measure was good. Of those respondents who top-dressed their golf greens with sand 17 carried this out more than 4 four times and 52% indicated that this was a good control measure.

TABLE 24

Number of applications of control measures used to control the main pests on Scottish golf greens in 2005 and the respondents (% of the total number of applications) who considered the control provided as good or poor.

Control measure	Number of applications				Good (%)	Poor (%)	Unknown (%)
	1	2	3	≥ 4			
Chlorpyrifos	42	13	2	1	90	2	8
Carbendazim	27	7	1	1	76	19	5
Thiophanate-methyl	0	2	0	0	50	0	50
Box off clippings	0	0	0	13	34	4	62
Acidify turf	1	1	5	3	44	4	52
Sand top dressing	0	3	2	17	52	6	42
Thatch management	1	2	0	13	38	3	59
Physical kill	0	0	0	0	33	0	67
Other (switching)	0	0	0	2	67	0	33

Sixteen respondents applied chlorpyrifos once to tees (Table 25). Most chlorpyrifos users indicated that the results achieved were good. However, one respondent exceeded the maximum permitted number of applications of chlorpyrifos to tees. Carbendazim was applied to tees once by 21 respondents and twice by seven respondents, with 80% of respondents indicated that the results were good. Sand top dressing was not applied as many times to tees as to greens, with 11 respondents indicating two applications and only three indicating more than four applications on tees.

TABLE 25

Number of applications of control measures used to control the main pests on Scottish golf tees in 2005 and the respondents (% of the total number of applications) who considered the control provided as good or poor.

Control measure	Number of applications				Good (%)	Poor (%)	Unknown (%)
	1	2	3	≥ 4			
Chlorpyrifos	16	3	1	0	87	4	9
Carbendazim	21	7	0	0	80	10	10
Thiophanate-methyl	2	1	0	0	75	0	25
Box off clippings	0	0	0	11	40	5	55
Acidify turf	3	5	1	1	41	11	48
Sand top dressing	4	11	3	3	43	13	44
Thatch management	4	1	3	2	36	8	56
Physical kill	1	0	0	0	100	0	0
Other (switching)	0	0	0	1	50	0	50

On fairways fewer PPPs were used compared to greens and tees. Chlorpyrifos was applied by 16 respondents and 78% of these indicated that the results were good (Table 26). However, again one respondent applied more than the maximum permitted number of chlorpyrifos treatments. Carbendazim was applied to fairways by 17 respondents, with 95% indicating that the results were good. Only a few respondents applied sand top dressing or acidified the turf.

TABLE 26

Number of applications of control measures used to control the main pests on Scottish golf fairways in 2005 and the respondents (% of the total number of applications) who considered the control provided as good or poor.

Control measure	Number of applications				Good (%)	Poor (%)	Unknown (%)
	1	2	3	≥ 4			
Chlorpyrifos	12	3	1	0	78	11	11
Carbendazim	14	3	0	0	95	0	5
Thiophanate-methyl	2	1	0	0	75	0	25
Box off clippings	0	0	0	1	30	10	60
Acidify turf	2	1	1	1	24	38	38
Sand top dressing	4	1	1	0	43	21	36
Thatch management	1	2	1	0	27	13	60
Physical kill	0	0	0	0	0	0	0
Other (iron)	1	0	0	0	100	0	0
Other (vertidrain)	1	0	0	0	100	0	0

Weed occurrence

On greens most weeds occurred with a slight severity. Moss was the most common weed (Table 27). Daisy occurrence on greens was reported by 37.5% of respondents mostly at slight severity. Only 0.5% of respondents indicated that daisy, clover and moss were very severe on greens. Toadrush, yarrow, cats ear and parsley piert were not widespread on golf greens.

The most common weeds were clover, daisy and moss. On greens, many Course Managers removed weeds by hand and reported good results. Selective herbicides and mossicides were used on greens, tees and fairways to control weeds. In most cases only one herbicide application was required to achieve good control.

TABLE 27
Weed occurrence on golf greens reported by Scottish golf courses in 2005 (number of greens reported in each category of severity as a percentage of the total number of greens).

Weed	Very severe	Severe	Moderate	Slight	Absent	Total no. of greens
Chickweed	0	<0.5	1	5	94	2070
Clover	0.5	0	2	16.5	81	2070
Daisy	0.5	1	4	32	62.5	2070
Moss	0.5	1	7.5	41	50	2070
Pearlwort	0	<0.5	2	10	88	2070
Toadrush	0	0	0	5	95	2070
Yarrow	0	0	<0.5	4	96	2070
Other (Parsley piert)	0	0	0	1	99	2070
Other (cats ear)	0	0	0	1	99	2070

On tees, no weeds were considered to be very severe (Table 28). Daisy and moss were reported as severe by 2% and 1% of respondents, respectively. Daisy was the most common weed, reported by 65% of respondents. Clover and moss were also widespread, reported by 50% and 40% of respondents, respectively. Self heal, toadrush and cats ear were not widespread on tees.

TABLE 28
Weed occurrence on golf tees reported by Scottish golf courses in 2005 (number of tees reported in each category of severity as a percentage of the total number of tees).

Weed	Very severe	Severe	Moderate	Slight	Absent	Total no. of tees
Buttercup	0	0	1	10	89	2070
Chickweed	0	0	2	8	90	2070
Clover	0	0	8	42	50	2070
Daisy	0	2	9	54	35	2070
Dandelion	0	0	1	21	78	2070
Moss	0	1	4	35	60	2070
Pearlwort	0	0	3	5	92	2070
Plantain	0	0	1	20	79	2070
Self heal	0	0	0	3	97	2070
Speedwell	0	0	1	5	94	2070
Toadrush	0	0	<0.5	1	99	2070
Yarrow	0	0	1	9	90	2070
Other (cats ear)	0	0	0	1	99	2070

There was a more varied selection of weeds reported on fairways. Buttercup, clover, daisy, dandelion, moss and plantain were widespread. Daisy and plantain was reported as very severe on fairways by 2% and 1% of respondents, respectively (Table 29). There were also more weeds reported with a moderate severity, such as clover, daisy and moss reported by 16%, 24% and 14% of respondents, respectively. Most respondents indicated that weed severity on fairways was in the slight category. Some weeds, such as self heal, ragwort and red sorrel were not widespread.

TABLE 29

Weed occurrence reported by golf fairways on Scottish golf courses in 2005 (number of fairways reported in each category of severity as a percentage of the total number of fairways).

Weed	Very severe	Severe	Moderate	Slight	Absent	Total no. of fairways
Buttercup	0	0	4	29	67	2070
Chickweed	0	0	2	13	85	2070
Clover	<0.5	1	16	43	40	2070
Daisy	2	2	24	49	23	2070
Dandelion	0	<0.5	6	32	62	2070
Moss	0	4	14	32	50	2070
Pearlwort	0	0	1	11	88	2070
Plantain	1	0	4	31	64	2070
Self heal	0	0	0	3	97	2070
Speedwell	0	0	2	9	89	2070
Toadrush	0	0	<0.5	5.5	94.5	2070
Yarrow	0	0	2	18	80	2070
Other (ragwort)	0	0	0	1	99	2070
Other (red sorrel)	0	0	0	1	99	2070

On greens, removal of weeds by hand was common and results from this method were considered good by 92% of the respondents using this method (Table 30). Eighteen respondents who indicated problems with broadleaved weeds used selective herbicides including Bastion T, Dicotox, Greenor, Mascot, Re-act and Spearhead. Most respondents described the results from selective herbicides as good. Mossicide was also commonly used to manage moss and 88% of respondents indicated good results. Other much less common methods of managing weeds included water management, altering the fertility, applying lawn sand, scarifying, verticutting and aeration.

TABLE 30

Number of applications of control measures used to control the main weeds on Scottish golf greens in 2005 and the respondents (% of the total number of applications) who considered the control provided as good or poor.

Control measure	Number of applications				Good (%)	Poor (%)	Unknown (%)
	1	2	3	≥ 4			
Hand removal	9	12	5	4	92	2	6
Water management	0	0	1	2	40	10	50
Increase fertility	0	0	1	0	50	0	50
Decrease fertility	0	0	0	2	75	0	25
Herbicide	12	3	1	1	95	0	5
Mossicide	13	4	3	2	88	12	0
Other (iron)	0	4	1	2	100	0	0
Other (lawn sand)	3	0	0	0	50	17	33
Other (scarify)	2	1	0	0	67	0	33
Other (verticut)	0	0	0	2	50	0	50
Other (Aeration)	0	0	0	1	100	0	0

On tees, herbicidal control of broadleaved weeds was the most commonly used management option by 64 respondents. Selective herbicides were applied to tees once by 45% of respondents, twice by 11% of respondents and three times by 1% of respondents (Table 31). Of those who applied herbicide to tees 95% described the results as good. The herbicides used included Bastion T, Greenor, Headland Relay, Intrepid, Relay Turf, Spearhead, and Supertox 30. Mossicide was applied to manage moss on tees by 14 respondents. The number of applications ranged from 1 to 3 and the results were described as good by 92% of respondents. Some

respondents removed weeds on tees by hand and described the results as good. Other management methods were much less commonly used and included water management, altering fertility, applying iron, scarifying and verticutting.

TABLE 31

Number of applications of control measures used to control the main weeds on Scottish golf tees in 2005 and the respondents (% of the total number of applications) who considered the control provided as good or poor.

Control measure	Number of applications				Good (%)	Poor (%)	Unknown (%)
	1	2	3	≥ 4			
Hand removal	2	0	1	3	82	0	18
Water management	0	2	0	0	43	14	43
Increase fertility	2	0	1	0	75	0	25
Decrease fertility	0	0	0	1	100	0	0
Herbicide	45	11	1	0	95	0	5
Mossicide	7	4	3	0	92	8	0
Other (iron)	1	2	0	0	100	0	0
Other (scarify)	1	1	0	0	100	0	0
Other (verticut)	0	2	0	0	100	0	0

On fairways, the most common method of managing weeds was by applying selective herbicide. Herbicide to control broadleaved weeds was applied by 91 respondents, of these, 95% described the results as good. The herbicides used included Bastion T, Greenor, Headland Relay, Holster, Re-act, Spearhead and Supertox 30. All other methods of managing weeds were not commonly used on fairways but included hand removal, applying iron, scarifying and employing a contractor to treat the weeds.

TABLE 32

Number of applications of control measures used to control the main weeds on Scottish golf fairways in 2005 and the respondents (% of the total number of applications) who considered the control provided as good or poor.

Control measure	Number of applications				Good (%)	Poor (%)	Unknown (%)
	1	2	3	≥ 4			
Hand removal	1	1	0	0	50	50	0
Herbicide	72	16	0	0	95	4	1
Mossicide	3	1	0	0	50	50	0
Other (iron)	2	1	1	0	100	0	0
Other (scarify)	1	2	0	0	100	0	0
Other (contractor)	1	0	0	0	100	0	0

Decisions concerning pesticide use

In most cases respondents monitored for pests, weeds and diseases at all times. This was especially true for diseases, where only 15% of respondents monitored disease activity only at certain times of the year or when symptoms occurred (Table 33). For pests and weeds, more respondents monitored at certain times of the year. This would be as expected as diseases can occur at any time of the year if the environmental conditions are conducive to the pathogen. However, most pest and weeds are seasonal and so tend to occur at certain times of the year.

TABLE 33

Monitoring of pest, weeds and diseases on Scottish golf courses in 2005 (Number of respondents as a percentage of the total response)

Monitoring time	Disease (%)	Pest (%)	Weeds (%)	Total no. of replies
At all times	85	62	65	108
At certain times of the year	9	30	26	109
When symptoms occur	6	8	9	109

When applying fungicides, 39% of respondents indicated that they considered application after the occurrence of initial symptoms when the weather was conducive to the pathogen (Table 34).

A further 23% waited until symptoms were observed and the disease was likely to spread. A lower proportion (12% and 9%) considered applying fungicide when weather conditions were conducive and when 'indicator' areas showed symptoms. The 'other' consideration times given were applying as a last resort and that fungicides were never applied.

For insecticides 14% of respondents would consider applying when the weather conditions were conducive to the pest (Table 34). A further 13% considered application when their indicator areas showed symptoms. Most waited until they saw the initial symptoms and the weather was conducive to the pest or the spread of the pest seemed likely.

TABLE 34

Time that respondents would consider applying a fungicide or insecticide to control diseases or pests on Scottish golf courses in 2005 (Number of respondents as a percentage of the total response for each plant protection product)

Consideration time	Fungicide (%)	Insecticide (%)
Conducive weather conditions	12	14
Initial symptoms regardless of weather	5	8
When 'indicator' areas show symptoms	9	13
Initial occurrence of symptoms and conducive weather	39	26
Symptoms are observed and spread appears likely	23	23
Other	12	16
Total no. of responses	109	109

The most important aspects considered when choosing a plant protection product were longevity of control, resistance management and mode of action. This is not surprising as considering these three aspects (along with the development stage of the problem) could make the difference between managing the problem with one application rather than requiring two. Familiarity with the product and the forecasted weather conditions were of medium importance. Advertising was not considered important. Other factors that were suggested were cost, effectiveness of the product and supplier recommendations.

TABLE 35

Aspects of plant protection products considered important when choosing a product (average reported by respondents from a 1-9 scale where 1 is most important)

Aspect under consideration	Importance
Longevity of control	2.4
History of active ingredient use for resistance management	2.7
Mode of action	2.8
Development stage of the problem	4.0
Familiarity with the product	4.1
Forecasted weather conditions	4.3
Availability	6.2
Advertising	7.9
Contractor chooses product	8.0
Other	4.3

For diseases, 52% of respondents treated all susceptible areas and 40% treated only the affected areas (Table 36). For pests, 50% treated only affected areas and 37% treated all susceptible areas. More respondents (67%) only treated the areas affected by weeds. This would be the expected breakdown where more Course Managers would treat susceptible areas for disease, especially in conducive weather, to prevent its spread over the golf course. However, with weeds, the spread would not occur with the same speed as for certain diseases and it is more economical to treat only affected areas.

TABLE 36
Areas treated with plant protection products on Scottish golf courses in 2005 (Number of respondents as a percentage of the total response)

Areas treated	Disease (%)	Pest (%)	Weeds (%)	Total no. of replies
Affected areas only	40	50	67	109
All susceptible areas	52	39	22	109
Other	8	11	11	109

Plant protection products were applied to Scottish golf courses mostly by Greenstaff (69%). Only 1% of respondents indicated that PPPs were applied solely by contractors and 30% were applied by both Greenstaff and contractors. Most Course Managers choose which products would be applied (Table 37). Decisions were made solely by contractors for only 18% of herbicides. There were some cases, again mostly with herbicides, where the decision was jointly made between the Course Manager and the contractor.

TABLE 37
Choice of plant protection products on Scottish golf courses in 2005 (Number of respondents as a percentage of the total response)

Decision maker	Fungicide (%)	Insecticide (%)	Herbicide (%)
Greenkeeper/Course Manager	90	85	50
Contractor	0	0	18
Both	10	15	32
Total No. of replies	21	20	34

The most important reasons for choosing a contractor were health and safety, contractor expertise and staff time (Table 38). COSHH regulations, availability of machinery and cost were of medium importance.

TABLE 38
Reasons for using a contractor (average reported by respondents from a 1-9 scale where 1 is most important)

Reason	Importance
Health and safety	2.5
Contractor expertise	2.7
Staff time	2.9
COSHH regulations	3.4
Availability of machinery	3.6
Cost	4.5

Pesticide stores were audited every 6 months, 12 months or 18 months in 47%, 51% and 2% of cases, respectively. Most PPPs were measured out in a wash bay area (74%) prior to application. Other areas used to measure PPPs were on the course (13%), specialist area with closed loop wash down facility (4%), area flowing into a reed bed (2%), portable bund (1%), in the greenkeeping compound (3%), on a roadway (2%) and measured by the contractor (1%).

Tank washings were used to treat the practice area by 50% of respondents. The last green, tee or fairway requiring treatment was used to dispose of washings by 24% of respondents and the turf nursery by 10%. Other areas used to dispose of tank washings included waste ground (5%), kept to reuse (2%), rough or semi-rough (7%) and sent to a waste disposal contractor (1%).

Most golf courses had an area to wash down machinery (80%) following pesticide application. In 92% of cases this was a wash bay area. Much less common wash down areas included a

specialist area with closed loop facility (6%), an area that flows to a reed bed (1%) and the rough (1%).

Before disposal empty containers were kept in the pesticide store by 62% and in the greenkeeper sheds by 24% of respondents. Removal by the contractor accounted for 1% of respondent's empty containers and the further 13% were kept in a locked area of the collection bin.

Empty pesticide containers were sent to registered disposal agencies by 88% and returned to the manufacturing company by 8% of respondents. Other methods of disposal included the contractor disposing of containers (1%), taken to a local authority waste site (2%) and buried (1%).

The number of staff with the National Proficiency Test Council certificate PA01 ranged from 0 to 10, PA02 from 0 to 10 and PA06 from 0 to 9 (Table 39).

Table 39
Number of staff with National Proficiency Test Council certificates on Scottish golf courses in 2005

Certificate	0	1	2	3	4	5	6	>7	Unanswered
PA 01 – Foundation	2	16	15	20	24	11	9	8	4
PA02 – Ground Crop Sprayer	2	24	22	16	17	3	4	3	18
PA06 – Hand Held Applicators	2	19	20	23	20	9	5	5	6
Other (Chainsaw)	0	1	0	0	0	0	0	0	108

Of the 27 respondents who indicated that someone applied pesticide on their golf course but did not hold a NPTC certificate, 70% were exempt due to the Grandfather clause and 22% were training under supervision (8% did not complete either reason).

The National Sprayer Testing Scheme (NSTS) was familiar to 60% of respondents. However, only 9% had all spraying equipment tested, 18% had their tractor mounted sprayers tested, 6% had knapsack sprayers tested and 1% had pedestrian sprayers tested. Of those that used a contractor, 47% determined whether the spraying machinery used by the contractor had been certified by NSTS.

Most Course Managers (85%) had heard of Local Environmental Risk Assessments for Pesticides (LERAPS). LERAPS were applied by 88% of respondents when spraying pesticides.

Respondents were aware of The R&A Best Practice Guidelines, the Scottish Golf Environment Group Publications and Award Scheme and Integrated Pest Management (Table 40). Most respondents also followed The R&A Best Practice Guidelines (Table 41).

To use PPPs optimally, Course Mangers must go through a decision making process to determine the best product for each situation. This decision can be influenced by many factors. Respondents indicated that longevity of control; history of active ingredient use for resistance management and the mode of action of the active ingredient were the most important factors. Most Course Managers decided which product to use even when contractors carried out the application. Most pesticide application was carried out in-house by competent and certificated greenstaff. Most Course Managers knew about the National Sprayer Testing Scheme but less than 20% had spraying equipment tested. Storage, measuring and disposal of pesticides, washings and containers were carried out according to the Code of Practice for Using Plant Protection Products. However, one respondent indicated that they still buried empty pesticide containers, a practice no longer permitted.

Course Managers were aware of many of the initiatives. However, the two that were least known were the Voluntary Initiative and the Amenity Forum. Widespread advertisement of these schemes would be appropriate in Scotland.

TABLE 40
Respondents who indicated they were aware of initiatives

Initiative	No. of respondents
Voluntary Initiative	15
Amenity Forum	11
R&A Best Practice Guidelines	90
Turfgrass Protection Management Plan	30
Integrated Pest Management	52
Scottish Golf Environment Group Publications and Award Scheme	57
None of the above	9

TABLE 41
Respondents who indicated they followed the initiatives

Initiative	No. of respondents
R&A Best Practice Guidelines	65
Turfgrass Protection Management Plan	17
Integrated Pest Management	33

Most respondents spent between £100 and £200 on fertilisers per hole (Table 42). Some respondents spent less than £100 (14%) and some spent more than £400 (11%). Over half of respondents spent less than £100 on fungicides, with only 13% spending more than £200. Herbicides cost 71% of respondents less than £100 per hole, with only 4% spending more than £200. Insecticides cost 87% of respondents less than £100, with only 1% spending more than £200.

TABLE 42
Amount spent on fertilisers, plant protection products and microbial products per hole by Scottish golf courses in 2005 (respondents in each category as a percentage of the total response).

Management tool	<£100	£100-200	£200-400	>£400	Total response
Fertilisers	14	41	34	11	109
Fungicides	55	32	12	1	109
Herbicides	71	25	4	0	109
Insecticides	87	12	1	0	109
Microbial/biostimulants	78	17	4	1	109

The relationship between the amounts spent on fertilisers and on fungicides was determined as it is often suggested that the more fertiliser applied, the more fungicide is required to control the resulting disease outbreaks. These data showed that where less than £200 was spent on fertilisers, they also spent less on fungicides (73% spent less than £100 and only 1% spent more than £200; Table 43). Where respondents spent more than £200 on fertiliser, it was more common to also spend more on fungicide (33% spent less than £100 but 26% spent more than £200 per hole). Therefore, these data do show an association between a higher spend on fertiliser and fungicide.

TABLE 43
Relationship between the amount spent of fertiliser per hole and the amount spent on fungicide per hole on Scottish golf courses in 2005 (χ^2 at 2 d.f = 23.2, P <0.001).

Amount spent on fertiliser	Amount spent on fungicide						
	<£100		£100-£200		>£200		Total
	Freq	%	Freq	%	Freq	%	Freq
<£200	44	73	15	25	1	2	60
>£200	16	33	20	41	13	26	49

Course Managers spent more on fertilisers, compared to PPPs. However, a link between nitrogen input and disease incidence was found as well as a link between fertiliser spend and fungicide spend. It is possible that this is associated with a higher incidence of disease. However, it is also possible that different standards are applied on high and low maintenance courses, with low levels of disease more likely to be treated on the higher maintenance course.

Conclusion

The pests, weeds and diseases that caused problems on Scottish golf courses were as would be expected. Earthworms and leatherjackets were the most common pests and also the pests that affect the playability of the turf surface. Similarly the two most common diseases, microdochium patch and anthracnose are also the two diseases that affect the playing surface and the aesthetic value of golf putting greens. Both of these diseases were more commonly associated with golf greens dominant in *P. annua*. Microdochium patch was also associated with higher applications of nitrogen fertiliser. More fungicide was required where more fertiliser was applied and this may indicate a link between fertiliser input, the predominance of *P. annua* in the sward, the occurrence of microdochium patch and the requirement of fungicide. However, more research would be required to prove this link.

In general, Course Managers applied Plant Protection Products in accordance with the current legislation, with only three cases of excessive use. Advice from various groups was also implemented to follow good practice, such as that from the Fungicide Resistance Action Group on rotation of chemical groups to avoid resistance developing in the pathogen populations. Similarly, storage, use and disposal of PPPs was also in accordance with current legislation in almost all cases.

Overall, there was a good awareness of regulations and initiatives. However, these should continually be emphasised, especially when any changes occur to ensure current legislation and best practice are adhered to. Most Scottish Course Managers showed that they considered all aspects of pest, weed and disease control and implemented a program to manage current problems efficiently and safely.

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Signed : Ruth Mann **(Study Director)**

Date :11 July 2006

Please ensure that your Sales/Marketing Department is aware that this research has been carried out under contract and that the consent of the STRI must be obtained where information contained in the report is to be used in advertising or promotional literature.

QUALITY STATEMENT

We confirm that this report is a true representation of the original data collected and that the Standard Operating Procedures referred to in the S.T.R.I. Manual of Standard Operating Procedures, and those relevant to data collection, data preparation, archiving of data and preparation of reports have been implemented in full.

Prepared by : Ruth Mann 13.07.06

(Signature and date)

Checked by : Andy Newell 13.07.06

(Signature and date)

Final version checked
and reviewed by : Andy Newell 13.07.06

(Signature and date)

APPENDIX 1

Questionnaire sent to golf courses in Scotland in 2005

SCOTTISH Golf Environment GROUP

CURRENT CONTROL OF PESTS, WEEDS AND DISEASES AND PESTICIDE USE ON SCOTTISH GOLF COURSES

The aim of this project is to determine the methods used to control pests, weeds and diseases on Scottish golf courses during the last 12 months and to establish that golf is a responsible user of pesticides.

Please answer the following questions on your golf course for the previous 12 months.

PLEASE NOTE THAT ALL INDIVIDUAL QUESTIONNAIRES WILL BE TREATED AS STRICTLY CONFIDENTIAL AND ALL PUBLISHED INFORMATION WILL BE ANONYMOUS.

SCOTTISH GOLF UNION

SEPA SCOTTISH ENVIRONMENT PROTECTION AGENCY

R&A

STRI

SCOTTISH EXECUTIVE

BIGGA

PESTS, WEEDS AND DISEASES QUESTIONNAIRE 2005

SECTION A – General information about your golf course

Club name ……..… Post code…….. Date…….……. No. of holes…….

How would you describe your golf course? (Please circle ONE).

Links	Parkland	Heathland	Moorland	Hillside	Coastal

What is the predominant turf type on the greens, tees and fairways? (Please circle ONE – i.e. the most common. AMG = annual meadow-grass; Bent/AMG = more than 50% bentgrass; AMG/bent = more than 50% AMG).

GREENS	Bent	Fescue	Bent/fescue	AMG	Bent/AMG	AMG/bent	
TEES	Bent	Fescue	Bent/fescue	AMG	Bent/AMG	AMG/bent	Ryegrass
FAIRWAYS	Bent	Fescue	Bent/fescue	AMG	Bent/AMG	AMG/bent	Ryegrass

What is the predominant rootzone (or soil) type on the greens, tees and fairways? (Please circle ONE – i.e. the most common. Please specify the soil type if 'other').

GREENS	USGA specification	Sand	Clay loam	Loam	Silt	Peat soil	
TEES	USGA specification	Sand	Clay loam	Loam	Silt	Peat soil	Other
FAIRWAYS	USGA specification	Sand	Clay loam	Loam	Silt	Peat soil	Other

What was your **TOTAL FERTILISER** input on the greens, tees and fairways during the last season? (Please circle ONE per nutrient in kg/ha where 1 oz/yd^2 = 339 kg/ha and 1 g/m^2 = 10 kg/ha).

	Nitrogen (N) kg/ha	**Phosphorus (P_2O_5) kg/ha**	**Potassium (K_2O) kg/ha**
GREENS	0 - 80 80 - 120 120 – 160 >160	0 <20 20 - 40 >40	0 - 80 80 - 120 120 – 160 >160
TEES	0 - 80 80 - 120 120 – 160 >160	0 <20 20 - 40 >40	0 - 80 80 - 120 120 – 160 >160
FAIRWAYS	0 <80 80 - 120 120 – 160 >160	0 <20 20 - 40 >40	0 <80 80 - 120 120 – 160 >160

When did (or will) you apply your last fertiliser for the 2005 growing season? (Please circle ONE).

GREENS	July	August	September	October	November	December
TEES	July	August	September	October	November	December
FAIRWAYS	July	August	September	October	November	December

SECTION B – Please answer the following section on the DISEASES observed on your golf course and the methods used to control them in the last 12 months

What diseases have been observed in the last 12 months? (Please indicate the **TOTAL NUMBER** of **GREENS**, including surrounds, affected for each disease in each severity category). Key – slight = <25% of green affected; moderate 25-50% of green affected; severe 50-75% of green affected and very severe = 75-100% of green affected.

	Very severe	**Severe**	**Moderate**	**Slight**	**Absent**
Fusarium patch					
Anthracnose					
Red thread					
Take-all patch					
Fairy rings					
Leaf spots					
Yellow tuft					
Other (please specify)					

Please indicate the **TWO** diseases that you consider to have been the most problematic on your **GREENS** (including surrounds) and please **CIRCLE** what (if any) **CULTURAL CONTROL** measures were taken to manage these diseases in the last 12 months?

Disease 1:			
Dew removal	Increase fertility	Decrease fertility	Light and often fertiliser
Overseeding	Improve airflow	Improve light	Thatch management
Raise cutting height	Use of wetting agents	Increase irrigation	Decrease irrigation
Other (please specify)			
Disease 2:			
Dew removal	Increase fertility	Decrease fertility	Light and often fertiliser
Overseeding	Improve airflow	Improve light	Thatch management
Raise cutting height	Use of wetting agents	Increase irrigation	Decrease irrigation
Other (please specify)			

For these **TWO** diseases, please indicate what (if any) **CHEMICAL CONTROL** measures were taken to manage these diseases in the last 12 months. Please indicate the number of treatments applied and the level of control achieved in your opinion.

Disease 1:			Level of control	
	No. of greens treated	No. of treatments applied	Good	Poor
Daconil Turf				
Chipco Green				
Fusonil Turf				
Heritage				
Insignia				
Mascot Systemic				
Masalon				
Mildothane Turf				
Rimidin				
Scorpio				
Snare				
Super Mosstox				
Turfclear				
Other (specify)				

CONTINUED OVERLEAF

Disease 2:			Level of control	
	No. of greens treated	No. of treatments applied	Good	Poor
Daconil Turf				
Chipco Green				
Fusonil Turf				
Heritage				
Insignia				
Mascot Systemic				
Masalon				
Mildothane Turf				
Rimidin				
Scorpio				
Snare				
Super Mosstox				
Turfclear				
Other (specify)				

Did you apply fungicide to control any other disease on your **GREENS** (including surrounds) in the last 12 months? **YES/NO**

If yes, please specify the disease, product used, number of greens treated and number of treatments.

Disease	Product	No. of greens treated	No. of treatments applied

Did you apply fungicide to control any disease on your **TEES** in the last 12 months? **YES/NO**

If yes, please specify the disease, product used, number of tees treated and number of treatments.

Disease	Product	No. of tees treated	No. of treatments applied

Did you apply fungicide to control any disease on your **FAIRWAYS** in the last 12 months? **YES/NO**

If yes, please specify the disease, product used, number of fairways treated and number of treatments.

Disease	Product	No. of fairways treated	No. of treatments applied

SECTION C - Please answer the following section on the PESTS observed on your golf course and the methods used to control them in the last 12 months

What pests have been observed on the **GREENS** (including surrounds) in the last 12 months? (Please indicate the NUMBER of GREENS, including surrounds, affected for each disease in each severity category). Key – slight = <25% of green affected; moderate 25-50% of green affected; severe 50-75% of green affected and very severe = 75-100% of green affected.

	Very severe	**Severe**	**Moderate**	**Slight**	**Absent**
Earthworms (EW)					
Leatherjackets (LJ)					
Chafer grubs (CG)					
Fever Fly (FeF)					
Frit fly (FrF)					
Other (specify)					

What pests have been observed on the **TEES** in the last 12 months? (Please indicate the NUMBER of TEES affected for each disease in each severity category). Key – slight = <25% of tee affected; moderate 25-50% of tee affected; severe 50-75% of tee affected and very severe = 75-100% of tee affected.

	Very severe	**Severe**	**Moderate**	**Slight**	**Absent**
Earthworms (EW)					
Leatherjackets (LJ)					
Chafer grubs (CG)					
Fever Fly (FeF)					
Frit fly (FrF)					
Other (specify)					

What pests have been observed on the **FAIRWAYS** in the last 12 months? (Please indicate the NUMBER of FAIRWAYS affected for each disease in each severity category). Key – slight = <25% of fairway affected; moderate 25-50% of fairway affected; severe 50-75% of fairway affected and very severe = 75-100% of fairway affected.

	Very severe	**Severe**	**Moderate**	**Slight**	**Absent**
Earthworms (EW)					
Leatherjackets (LJ)					
Chafer grubs (CG)					
Fever Fly (FeF)					
Frit fly (FrF)					
Other (specify)					

What control measures have been used to control **PESTS** on your **GREENS** (including surrounds), **TEES** and **FAIRWAYS** in the last 12 months? Please indicate which pests the treatments was implemented to control (where EW = earthworms, LJ = leatherjackets, CG = chafer grubs, FeF = fever fly and FrF = frit fly), the number of treatments applied and the level of control achieved in your opinion.

GREENS								
	Used to control?					No. of treatments applied	Level of control	
	EW	**LJ**	**CG**	**FeF**	**FrF**		Good	Poor
Chlorpyrifos								
Carbendazim								
Thiophanate-methyl								
Box off clippings								
Nematodes								
Acidify turf								
Sand top dressing								
Thatch management								
Physical kill								
Other (specify)								

TEES								
	Used to control?					No. of treatments applied	Level of control	
	EW	**LJ**	**CG**	**FeF**	**FrF**		Good	Poor
Chlorpyrifos								
Carbendazim								
Thiophanate-methyl								
Box off clippings								
Nematodes								
Acidify turf								
Sand top dressing								
Thatch management								
Physical kill								
Other (specify)								

FAIRWAYS								
	Used to control?					No. of treatments applied	Level of control	
	EW	**LJ**	**CG**	**FeF**	**FrF**		Good	Poor
Chlorpyrifos								
Carbendazim								
Thiophanate-methyl								
Box off clippings								
Nematodes								
Acidify turf								
Sand top dressing								
Thatch management								
Physical kill								
Other (specify)								

SECTION D - Please answer the following section on the WEEDS observed on your golf course and the methods used to control them in the last 12 months

What weeds have been observed on the **GREENS** (including surrounds), **TEES** and **FAIRWAYS** in the last 12 months? (Please indicate the NUMBER of GREENS (including surrounds), TEES and FAIRWAYS affected by each weed in each severity category). Key – slight = <25% of area affected; moderate 25-50% of area affected; severe 50-75% of area affected and very severe = 75-100% of area affected.

GREENS					
	Very severe	**Severe**	**Moderate**	**Slight**	**Absent**
Chickweed					
Clover					
Daisy					
Moss					
Pearlwort					
Toadrush					
Yarrow					
Other (please specify)					

TEES					
	Very severe	**Severe**	**Moderate**	**Slight**	**Absent**
Buttercup					
Chickweed					
Clover					
Daisy					
Dandelion					
Moss					
Pearlwort					
Plantain					
Self heal					
Slender speedwell					
Toadrush					
Yarrow					
Other (please specify)					

FAIRWAYS					
	Very severe	**Severe**	**Moderate**	**Slight**	**Absent**
Buttercup					
Chickweed					
Clover					
Daisy					
Dandelion					
Moss					
Pearlwort					
Plantain					
Self heal					
Slender speedwell					
Toadrush					
Yarrow					
Other (please specify)					

What control measures have been used to control weeds on your **GREENS**, **TEES** and **FAIRWAYS** in the last 12 months? Please indicate the number of greens, tees and fairways treated, number of treatments applied and the level of control achieved in your opinion.

GREENS				
Treatment	No. of greens treated	No. of treatments applied	Level of control	
			Good	Poor
Hand removal				
Water management				
Increase fertility				
Decrease fertility				
Herbicide (specify)				
Herbicide (specify)				
Mossicide (specify)				
Other (specify)				

TEES				
Treatment	No. of tees treated	No. of treatments applied	Level of control	
			Good	Poor
Hand removal				
Water management				
Increase fertility				
Decrease fertility				
Herbicide (specify)				
Herbicide (specify)				
Mossicide (specify)				
Other (specify)				

FAIRWAYS				
Treatment	No. of fairways treated	No. of treatments applied	Level of control	
			Good	Poor
Hand removal				
Water management				
Increase fertility				
Decrease fertility				
Herbicide (specify)				
Herbicide (specify)				
Herbicide (specify)				
Mossicide (specify)				
Other (specify)				

SECTION E - Please answer the following section on HOW DECISIONS CONCERNING PESTICIDE USE WERE MADE on your golf course in the last 12 months

When do you monitor for **DISEASE** activity on your golf course? (Please circle one).

At all times	At certain times of the year	When symptoms occur
Other (specify)		

When do you monitor for **PEST** activity on your golf course? (Please circle one).

At all times	At certain times of the year	When symptoms occur
Other (specify)		

When do you monitor **WEEDS** on your golf course? (Please circle one).

At all times	At certain times of the year	When symptoms occur
Other (specify)		

When would you consider applying a fungicide or insecticide? (Please tick one for fungicide and one for insecticide).

	Fungicide	Insecticide
When weather conditions are conducive to the potential occurrence of the problem		
When symptoms of the pest or disease initially occur regardless of weather		
When 'indicator areas' show symptoms		
When symptoms initially occur and weather conditions are conducive to the spread of the problem		
When symptoms become worse and spread of the pest or disease appears likely		
Other (specify)		

Please number the following in order of importance when choosing a product (No. 1 being the most important).

	Importance
Longevity of control	
Mode of action	
History of active ingredient use in relation to resistance management	
Forecasted weather conditions	
Development stage of the problem	
Contractor chooses product	
Availability	
Advertising	
Familiarity with the product	
Other (specify)	

After choosing to use a certain product, what areas would you treat? Please indicate the areas for fungicide, insecticide and herbicide application.

	Fungicide	Insecticide	Herbicide
Affected areas only			
All susceptible areas			
Other (specify)			

SECTION F - Please answer the following section on PESTICIDE APPLICATION on your golf course in the last 12 months

Who applies pesticides to your golf course? (Please circle one).

Greenstaff/club employees	Contractor	Both greenstaff/club employees and contractor	Other (specify)

If you use contractors, do you specify the product or does the contractor decide? Please tick the box for fungicides, herbicides and insecticides.

	Fungicide	Insecticide	Herbicide
Myself			
Contractor			
Both myself and contractor			
Other (specify)			

Why do you use a contractor? Please number the following in order of importance (No. 1 most important).

Cost		COSHH regulations	
Health and safety		Availability of machinery	
Contractor expertise		Other (specify)	
Staff time			

How regularly do you audit the pesticide stock to check expiry dates? (Please circle one).

Every 6 months	24 months or more
Every 12 months	Other (specify)
Every 18 months	

Where are the products measured and the tank filled? (Please circle one).

Area that flows to a Reed bed	Wash bay area
Biobed	Other (specify)
Portable bund	
Specialist area with closed loop wash down facility	

How do you dispose of tank washings? (Please circle one).

Practice area	Last green, tee or fairway requiring spraying
Turf nursery	Other (specify)

Do you have a specialist area to wash down machinery? **YES/NO**

If yes, what does it consist of?

Area that flows to a Reed bed	Specialist area with closed loop wash down facility
Biobed	Wash bay area
Portable bund	Other (specify)

How do you dispose of empty pesticide containers?

To a registered disposal agency	Back to the manufacturing company
Other (specify)	

Where are the empty containers stored before collection/disposal? (Please circle one).

Pesticide store	In greenkeeper sheds
Other (specify)	

SECTION G - Please answer the following section on CURRENT INITIATIVES AND REGULATIONS

How many staff do you have with the following National Proficiency Test Council (NPTC) certificates?

	No. of staff
PA01 - Foundation module	
PA02 – Ground crop sprayer	
PA06 – Hand held applicators	
Other (please specify)	

Does anyone apply pesticide who does not currently hold a NPTC certificate? **YES/NO**

If yes, what qualifications do they have to allow application?

Exempt due to Grandfather clause	Training for certification under supervision
Other (specify)	

Have you heard of the National Sprayer Testing Scheme (NSTS)? **YES/NO**

If yes, do you have your pesticide application machinery tested? Please tick machinery tested.

	Tested
Tractor mounted sprayers only	
Knapsack sprayers only	
Pedestrian sprayers only	
All equipment	

If you use a contractor, do you determine whether his machinery is certified by NSTS? **YES/NO**

Have you heard of Local Environmental Risk Assessments for Pesticides (LERAPS)? **YES/NO**

If yes, do you apply LERAPS when spraying pesticides? **YES/NO**

Are you aware of any of the following? (Please tick those you know about).

Voluntary Initiative (www.voluntaryinitiative.org.uk)	
Amenity Forum (www.amenity.org.uk)	
R&A Best Practice Guidelines (www.bestcourseforgolf.org)	
Turfgrass Protection Management Plan (www.basis-reg.com)	
Integrated Pest Management	
Scottish Golf Environment Group Publications and Award Scheme (www.sgeg.org.uk)	
None of the above	

Do you follow any of the following? (Please tick those that you do follow).

R&A Best Practice Guidelines	
Turfgrass Protection Management Plan	
Integrated Pest Management	
Other (specify)	

Please could you indicate the amount you spent on the following during the last 12 months? (Please circle one for each category).

Fertiliser	<£1000	£1000-2000	£2000-5000	£5000-10,000	>£10,000
Fungicides	<£1000	£1000-2000	£2000-5000	£5000-10,000	>£10,000
Herbicides	<£1000	£1000-2000	£2000-5000	£5000-10,000	>£10,000
Insecticides	<£1000	£1000-2000	£2000-5000	£5000-10,000	>£10,000
Microbial/biostimulant products	<£1000	£1000-2000	£2000-5000	£5000-10,000	>£10,000

THANK YOU FOR TAKING THE TIME TO COMPLETE THIS QUESTIONNAIRE. PLEASE COMPLETE THE SIGNATURE REQUIREMENT BELOW AND RETURN IT IN THE ENVELOPE PROVIDED BY **DECEMBER 20th 2005** RESULTS WILL BE AVAILABLE IN LATE SPRING 2006.

Completed by:…… **Position……..**

Authorised by:…… **Position……..**

Please note that all individual questionnaires will be treated as strictly confidential and any published data will be anonymous.