


Dr. Stephen Baker and Daniel Binns of the STRI, give an insight into the results of the questionnaire which was completed by greenkeepers last year on the earthworm problem



Opening

a can of worms

The cost to UK
golf courses per
year due to
earthworms...

£2m

Moderate to
serious earthworm
cast problems
on fairways...

49%

Moderate to
serious earthworm
cast problems
on tees...

42%



When the use of chlordane was revoked in December 1992, we anticipated that the problems of earthworm casting on golf courses would increase substantially because of the withdrawal of this effective (but environmentally unacceptable) form of chemical control. Fortunately, R&A also recognised that extensive casting would have substantial effects on the quality of golf courses (a problem that had bedevilled greenkeepers in the first part of this century) and were prepared to fund an extensive programme of research at the STRI to examine alternative strategies for earthworm control. This is the first of a number of articles that we plan to publish in *Greenkeeper International* this year detailing some of the main findings so far from this work. This month we intend to examine the severity of earthworm casting and to consider some of the factors associated with high rates of casting activity.

How bad is the problem of casting?

Problems associated with casting are easy to list; surface smearing, unevenness, water retention, slipperiness and weed invasion. It is perhaps more difficult to get information of the severity of the problem, so this was the subject of a questionnaire survey sent to golf clubs in April 1997 to coincide with the end of the main period of casting activity. In total, 297 clubs (nearly always the Head Greenkeeper or Course Manager) kindly completed a very detailed questionnaire.

The first main message from the results was indeed that there was a major problem with casting on UK golf courses and, more importantly, the problem was increasing. The situation was worst on tees and fairways. Of the questionnaire returns 49% indicated moderate to severe problems on fairways and for tees the corresponding figure was 42%. Casting was lower on greens and only 9% of clubs indicated moderate to severe problems on the putting surface.

In the period shortly before the use of chlordane was banned, many courses were treated with this persistent organochlorine compound and this undoubtedly had residual effects. This was coupled with the fact that both 1995 and 1996 were abnormally dry years which probably affected earthworm populations

and certainly reduced the amount of casting activity. However by April 1997 when the questionnaire was sent out, nearly two-thirds of respondents suggested that rates of casting had increased compared with the period before December 1992 when chlordane was available and 22% of responses suggested that casting was a much greater problem. The autumn and winter of 1997/98 were very wet and, judging from visits to courses during this period to monitor earthworm activity, we suspect that had the questionnaire been sent out a year later the number of courses reporting severe problems would have been substantially higher.

In 1996 the average expenditure by a golf club on pesticides for earthworm control was estimated to be £525 and 14% of clubs were spending more than £1000 per year

prisingly, the relationship between casting activity and acidity was not statistically significant.

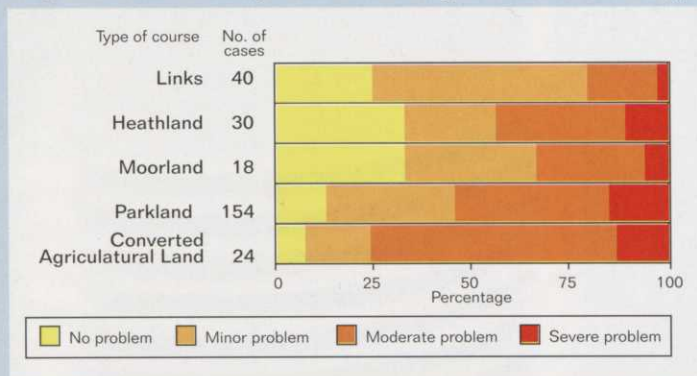
On many courses casting activity was greater on certain holes and the main reasons for this, listed in order of the number of responses in the questionnaire data, were higher moisture contents (poor drainage), heavier soils, imported topsoil or turf, higher pH/lime application and low-lying areas.

These relationships were examined in much more detail in the second phase of the work which consisted of visits to 32 golf clubs to carry out detailed measurement of soil factors that might be related to earthworm activity.

Earthworm Ecology Survey

In response to the questionnaire survey, 32 golf courses were targeted to assess the severity of casting

Fig 1: Earthworm casting on tees and fairways in relation to course type



on pesticides. When the costs of labour and spraying equipment are also included, the humble earthworm must cost UK golf courses well over £2 million per year and this figure appears to be increasing.

Environmental factors influencing earthworm casting activity

The questionnaire returns also provided useful information on soil and management factors that may influence earthworm populations and casting activity. Course type had a major influence on earthworm casting and, for example, Fig 1 shows that for fairways far more problems were reported on converted agricultural land and parkland courses than on links courses. The effects of casting was also greater on heavier soils but, perhaps sur-

activity and factors influencing earthworm populations. Due to ease of access from STRI Headquarters in Bingley, 19 of these courses were located in northern England, five in southern England and the Midlands, six in Scotland and two in Wales. By analysing soil samples for texture, pH and compaction and most importantly identifying the species of earthworms present, our aim has been to gain a greater understanding of the biology of earthworm populations. This in turn will help to target earthworm control strategies in the future.

In most cases data was collected from two fairways on each course, one an area of high casting activity and the other area selected was usually the second fairway.

Soil physical measurements

included a full particle size analysis, soil pH, organic matter content, thatch depth, bulk density (an indication of soil compaction) and moisture content. Most of these measurements were taken at more than one depth between 0-300 mm which helps us understand the variations in soil profile.

Measurements of earthworm activity included the number of earthworm casts per square metre and a measurement of the mean dry weight of soil per earthworm cast. The number of earthworms per square metre was also measured using an expellant method.

For a golf course to be included in the table shown below, there had to be a difference of 50% between fairways when counting the number of casts per square metre. This allows us to analyse data taken on different days in different conditions in a more controlled manner and more importantly it allows us to compare the differences between an area of high earthworm activity and one of "normal" activity. Data from areas treated with worm killers in the last three months were not used during analysis.

From the table on the right, we can see that a number of factors significantly affect earthworm casting rates. First of all, obvious though it may seem... the more earthworms that are found in the ground (in this case expelled to the surface), the greater the amount of

casting. Also as casting increases, so does the size of cast.

However, the results also show that casting activity is greatest in areas of high soil pH, high soil moisture content and where grass growth is, for a variety of possible reasons (e.g. moisture or fertility), more vigorous.

Relationships with organic matter content are interesting and casting is highest in areas of low organic matter content. In some respects, higher populations may be associated with more organic matter as this would give a greater food supply. However, it is likely that the higher organic matter contents and increased thatch depth in the areas with less casting activity result from lower rates of organic matter breakdown. This could be related to more acid soils, drier soils and the lack of earthworm activity which is an important first stage in the decomposition of organic material.

The results of this survey work have shown that many soil factors can affect earthworm populations and casting activity. This has many implications in the way we might manage golf courses to minimise casting activity with reduced pesticide application. This will be examined in a further article in the autumn and we also intend to provide an update on work based on chemical control methods examining the effectiveness of different materials as an alternative to chlor-dane.

	High casting fairway	Normal fairway
Number of earthworms expelled/m ²	54	24*
Mean cast weight (g)	1.1	0.7*
pH (50-130mm)	5.5	5.0*
pH (130-300mm)	5.8	5.2*
Volumetric moisture content (50-130mm) (%)	36.3	30.4*
Bulk density (g cm ³)	1.28	1.27
Organic matter content (0-50mm) (%)	17.2	28.8*
Organic matter content (0-300mm) (%)	10.4	15.0*
Thatch depth (mm)	8.6	13.3*
Vigour of grass growth (1-10 scale, 10=highest)	7.1	6.4*
Sand content (%)	54	50
Silt content (%)	27	30
Clay content (%)	19	20

* Statistically significant

Differences in soil physical properties for areas of high casting activity and more normal conditions

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