NATIONAL SURVEY OF

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Survey work in action with the concentric rings being used for infiltration measurements

Most of the research work that is carried out on golf course construction and agronomy is based on replicated experimental plots, for example on the trials grounds at the Sports Turf Research Institute. This gives the necessary controlled conditions so that the effects of different treatments, e.g. grass type, fertiliser rate or pesticide application can be studied in conditions where all other aspects of construction and maintenance are held constant. For instance, in a construction trial the rootzones may vary but all plots on the trial area will be sown with the same seeds mixture, receive the same amount of fertiliser, top dressing and aeration and all plots will be subjected to artificial wear at the same times.

This careful scientific approach is essential if we are to understand in detail the response of turfgrasses to different forms of management and to make meaningful comparisons between different products so that the best possible advice can be passed on to golf clubs. However there is also a need to monitor what is actually happening on golf courses as this allows a wider range of environmental conditions to be considered, it can provide some additional information on interactions between different management procedures and it also gives information of long term development of golf greens by selecting greens that have been established for many years.

GOLF GREENS

Monitoring of the performance of a large number of golf greens also gives an indication of any commonly occurring problems that should be addressed by additional research work.

In 1993 the Royal and Ancient Golf Club of St Andrews agreed to finance a national survey of golf greens. Many of the objectives of the monitoring work are listed above but there was a particular need to identify performance requirements for golf greens, especially for playing quality. The need to examine performance requirements has been brought about in part by work by the European Committee for Standardisation (CEN) which is developing standards for sports surfaces, including golf greens. However from a research point of view it is also essential to develop a range of measurement techniques to characterise the performance of a golf green and to identify ranges of values that provide an acceptable compromise between the needs of the golfer and the needs of the greenkeeper. This gives objective methods for assessing all future trials on golf green management.

The measurements of playing quality and development of performance standards will be discussed in a later issue of Greenkeeper International, but in this article I wish to consider some of the findings particularly with respect to soils, grasses and management.

THE SURVEY

Over a seventeen month period between June 1993 and Octoher 1994 my colleagues Tim Lodge, Phil Hind, Jonathan Hunt, Daniel Binns and I visited 74 golf clubs around the country. To minimise travel costs there was an inevitable concentration on northern and central England but the overall geographical coverage was from south-west England to the north of Scotland (Figure 1). We tried to select different types of course roughly in proportion to their numbers in the country as a whole. As a result 55% of the courses visited were classified as parkland, 14% as meadowland, 11% as golf links with smaller numbers of moorland, upland, heathland and seaside courses. At each course testing took place on two greens selected by the greenkeeping staff as being one of their best and one of their poorest greens. This gave a total of 148 greens with a variety of construction types and ranging in age from six months to over 120 years.

Our measurements were varied including soil physical and chemical properties, grass cover, species composition, thatch depth and playing characteristics (green speed, hardness and the stopping distance of balls fired at the turf simulating five iron and nine iron shots. At each course the greenkeeper kindly filled in a detailed maintenance questionnaire and questionnaires were also filled in by players so we could get an impression of the performance of each green.

The main results and principal findings are given below.

Fig. 1: Location of courses in study

SOIL: PHYSICAL PROPERTIES

We did not specifically choose courses where the greens had modern sand dominated rootzones (although some were included in the study), so the greens were developed on a number of soil types. For the lower 100-180mm depth, 47% of the greens had a sand or loamy sand textured soil, 35% were on sandy loam soil and 18% on heavy sandy clay loam or clay loam soils. Rootzone amendment and

NATIONAL SURVEY OF GOLF GREENS

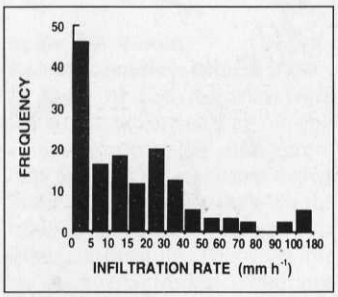

Fig. 2: Number of greens with water infiltration values within specific ranges

top dressing with sandy materials meant that the surface layer (10-90mm) was generally lighter, with 65% of greens having a sand or loamy sand texture and only 6% occurring in the sandy clay loam and clay loam categories. Inevitably the highest sand contents were found on the links and heathland courses, along with newer courses where sand dominated rootzones had been used.

Drainage rates were measured by ponding water in two concentric rings and measuring the rate at which water entered the green's surface. The range of infiltration rate values for all the greens summarised in Figure 2 and some important points are evident. The highest value of 171mm/hr was recorded on a long established heathland course and in general the questionnaire completed by greenkeepers indicated that drainage problems were minimal on those greens with 285% sand in the rootzone but increased as the texture became heavier.

Infiltration rates also decreased with the age of the green and averaged a very respectable 22mm/hr for greens up to five years old but fell to an average of 10mm/hr on greens greater than ten years old. This is likely to be a function of increased compaction and greater blockage of the pore space by organic matter, but changes in construction practices over time could also be important as many of the newer greens have been built with specially prepared rootzone mixes.

Rainfall intensities of over 20mm/hr for anything but a few minutes are very rare but ideally infiltration rate values should be >20mm/hr if the green is to cope with very high intensities of rain, for example during a summer thunderstorm. However a minimum drainage rate of 10mm/hr is a more realistic target for most golf greens and provided that they do not have major hollows that hold water, any surface ponding will normally be short lived. In the study 43% of greens had infiltration rates c10mm/hr and almost one third had values less than 5mm/hr. This situation is far from ideal. It must be remembered however that half of the greens were deliberately selected as being amongst the worst on the course and poor drainage would have been one of the factors influencing greenkeepers' nominations of greens to study. Indeed infiltration rates were significantly higher on those greens classifled as "good" by the greenkeeper, averaging 14mm/hr compared to 8mm/hr on greens classified as "poor".

The other noteworthy physical characteristic is the air-filled porosity. In the laboratory we measured air-filled porosity at two levels of suction: values measured at a water potential of -4kPa are probably the most useful as this gives an indication of the amount of soil air present through much of the winter period. Using measurements from all the greens in the study, the air-filled porosity of the 10-90mm depth averaged 6.6% and the corresponding figure for the 100-180mm depth was 6.9%. This is below the figure of 10% air-filled pore space which is sometimes quoted as being a desirable minimum value. Indeed 41% of greens had values <5%. Again it must be remembered that the sample of greens was not fully representative as greenkeepers deliberately selected half the greens as being poorer ones from their course, nevertheless when taken in conjunction with the infiltration figures it does suggest that many greens have far from desirable soil physical characteristics.

SOIL: CHEMICAL PROPERTIES

Greenkeepers were asked to fill in a questionnaire on maintenance and this included information of the fertiliser that they had put on in the preceding twelve months. Most greens received between 75-225 kg/ha of nitrogen, which would seem satisfactory in view of the range of soils at different sites. There were however some cases where we calculated the rate to be over 300 kg/ha which is certainly on the high side even for a sand based green. No phosphate was added on 61% of greens and on 56% of greens no more than 40 kg/ha of potassium (as K_2O) was applied. Phosphate levels

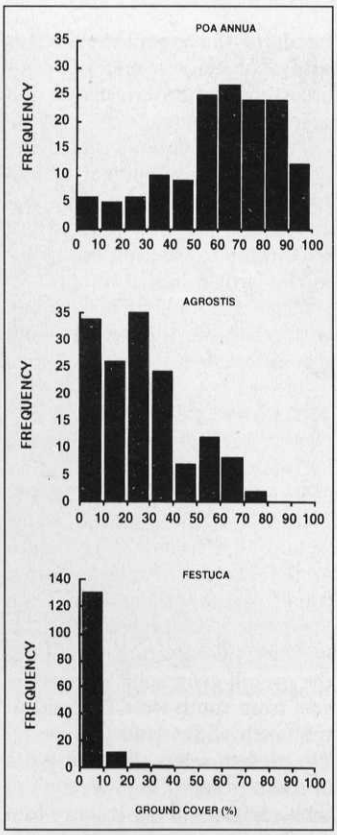

Fig. 3: Species composition of the greens examined, showing the number of greens with measured amounts of annual meadow grass (*Poa annua*), bent (*Agrostis*) and fescue (*Festuca*)

were very variable and there was no relationship between the amount of phosphate applied and measured values in the soil. This almost certainly reflects unnecessarily high levels of phosphate nutrition in the past and the lack of mobility of this element in the soil. In spite of the fact that no phosphate was applied on 61% of the greens, over half the greens had P_2O_2 levels >30 mg/l.

There was a signiflcant, albeit relatively weak, relationship between the amount of potassium applied and levels recorded in the soil. For the main rooting depth (10-90mm) almost one third of the greens had potassium levels classified as very low and for the 100-180mm depth half the greens had nutrient levels falling into this category.

Potassium is relatively mobile within the soil and normally between 60-150 kg/ha of K_2O should be added on an annual basis, depending mainly on the texture of the rootzone. In the light of the flgures that were recorded it would appear that potassium is being under applied on a fairly high percentage of greens.

GRASSES

Averaged over the 148 greens in the study, annual meadow-grass was by far the dominant grass type with three quarters of greens having an annual meadow-grass content exceeding 50% (Figure 3). Bent was the most common of the desirable grass species but fescue was recorded on less than half the greens in the study, with the highest fescue contents being found on relatively new greens less than five years old and on links courses. There were significant relationships between species composition of the greens and the soil physical properties, for example annual meadow-grass increased as the clay content and moisture retention of the green became higher. Fescues on the other hand were more common where sand content was greater and where higher levels of air-fllled pore space were recorded.

SOME CLOSING THOUGHTS

The survey has highlighted the fact that greens developed on all but the sandiest of natural soils will not have the soil physical properties generally thought necessary for ideal conditions of growth. Heavier soils are inevitably more water retentive and this tends to give poorer growing conditions which, along with a variety of other factors, will encourage annual meadow-grass invasion into the sward. It is a credit therefore to the greenkeeping staff at the courses visited that they generally managed to produce excellent putting surfaces in spite of the unfavourable soil conditions that many were having to work with.