RESEARCH UPDATE

The search for the PERFECT green

by P M Canaway of the STRI

THE game of golf has its origins on the coastal links of Scotland. The original links greens consisted of fine bent and fescue species established on naturally occurring freely drained coastal sand. The game gradually spread inland and golf course architects made use of the indigenous soils available. Some of these were suitable and in some ways similar to the links soils, being of low productivity and to which bents and fescues were well adapted. Others were developed on heavy pasture-type soils more suited to beef production that the production of a golf course.

In this country the most important factor limiting the use of courses is the inability of most naturally occurring soils to transmit water away from the surface at a sufficient rate. This, combined with the effects of play on soil structure, notably soil compaction, means that many greens are unfit for play due to waterlogging during periods of heavy or prolonged rainfall.

In 1981 my former colleague, Caroline Ward, carried out a questionnaire survey of drainage on golf courses and found that 70% of courses were closed due to waterlogging at some time during the year of the survey. Greens were more prone to waterlogging than tees or fairways and over 80% of courses had at least one green with drainage problems of some kind.

The need to keep courses open all year round, partly due to public demand and the general interest in the game, and partly due to commercial pressures, has led increasingly to the view that a waterlogged green is unacceptable on the modern golf course. This in turn has provided greater impetus for the use of sand-based rootzones for golf green construction. By 'sand based' is meant a rootzone having a high preponderance of sand, either sand only, or sand mixed with soil and/or organic matter. Whichever variant is used the objective is to provide a free-draining surface and good playing conditions, regardless of rainfall.

Problems of fertiliser nutrition and sand-based rootzones

Because sand-based rootzones are so free draining, it means that soluble fertilisers, especially nitrogen and potassium, are readily leached through the rootzone by rainfall or excess irrigation water. This, together with the inherent low nutrient status of sands, means that fertiliser nutrition can be a problem. Also, the pH (acidity/alkalinity) of sand greens can be a cause of concern since sands have little buffering capacity. The use of acid-reacting fertilisers such as ammonium sulphate can cause pH to fall rapidly to low levels. Consequently, light but frequent liming has been suggested to counteract this tendency. However the use of slightly alkaline top dressing materials is more likely to be desirable in view of some of the deleterious consequences of lime application to bent/fescue turf. These include disease, particularly take-all patch, and invasion by annual meadow-grass. There has been little previous work done in the UK on the effects of fertilisers on sand-based greens prior to 1985 and since this represented an area where the STRI was being more frequently asked for advice, there was a potential gap in scientific knowledge which needed to be filled.

R & A support for fertiliser research on sand-based greens

In 1985 the R & A generously provided support for a project to study the effects of the three major plant nutrients (nitrogen - N, potassium - K and phosphorus - P) and lime on bent/fescue turf grown on a sand-based golf green construction. Much of the initial expense was on construction of the trial area, which was completed during the summer of 1985. Operations were similar to those in construction of a new golf green, with the eventual rootzone consisting of a very clean, lime-free, quarried sand to which 10% by volume of peat was added to aid moisture retention. There was considerable debate during the planning stages as to whether we should use a sand-only or a sand-soil type of construction. Indeed, this is a controversial issue which has rumbled on in the USA for many years. However, in research, in the early stages of any investigation it is always sensible to look at the extreme situations first - in this case sand-only - where problems of nutrient leaching and inherent lack of nutrients are at their most severe because of the free movement of water through the rootzone. The area was prepared and seeded in August 1985 with an 80:20 mixture of 'Frida' Chewings fescue and 'Highland' browntop bent.

In 1986 the experimental fertiliser treatments started, and these included three rates of N, P and K, with and without lime, in all possible combinations of nutrients. The total number of trial plots is 108 , which requires considerable time and effort to collect the scientific data, and in summer 1986 Tim Colclough was appointed to take over the day to day running of the R & A trial.

Playing quality

Much of the research on greens in the past has used agronomic or ecological methods of assessment which, satisfactory as far as they go, do not take into account the needs of the player except indirectly. Tim Colclough has been collecting data not only on ground cover and grass species composition, but also on aspects of the green which affect the player - this we term 'playing quality'. Aspects of playing quality include green 'speed', ball bounce, hardness and 'holding power'.

Green speed has been measured for many years by a device called a Stimpmeter after its inventor, Stimpson. This consists of an inclined ramp with a notch at one end which holds the ball. The ramp is laid on the ground and the end with the ball is gradually raised until a critical angle is reached and the ball rolls down the ramp. The distance rolled by the ball after it leaves the ramp is a measure of green'speed' and the USGA has published green speeds for different classes of play.

Hardness is measured with an instrument called a Clegg Impact Soil Tester which consists of a 0.5 kg cylindrical hammer containing an accelerometer. The hammer is dropped on the green from a standard height and its deceleration recorded.The greater the deceleration, the harder the green. The figures are given out on a liquid crystal screen display which is connected by a cable to the hammer.

Ball bounce is measured by the release of golf balls from a 5m high ball bounce apparatus and recording the impacts with a video camera. The apparatus has a graduated scale fixed to the stand so that the height of rebound can be easily determined from the video films.

Study of 'holding power' of greens is more complicated since it requires that balls are fired at the greens with realistic speed and spin, and the resulting behavior of the ball studied. Fortunately, another project financed by the R & A is concerned with ball impacts on greens. Steve Haake, who

works at the STRI but is registered for a PhD at Aston University, has developed equipment for simulating and recording the impacts of balls on greens. The ball is fired out of a specially developed ball-firing machine at about 35 miles per hour with 4500 revs. per minute of backspin (all golf shots correctly hit have backspin) at an angle of 45 degrees. If the speed seems slow compared to the speed off the club head, remember the ball slows considerabley throughout its flight due to aerodynamic drag. In the holding power test the distance between initial impact and the next bounce is measured after the ball is fired out as described.

Findings to date

To date, the effects on grass cover and species composition have been solely due to N, with no effects of P, K or lime. N increased cover and the content of bent, whilst fescue content decreased with N. Both lime and N reduced green speed,

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Ball bounce is tested during an R & A trial

RESEARCH UPDATE

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although this should be seen in context in that the low N plots were pretty bare and grass cover would not have been acceptable to members or greenkeepers.

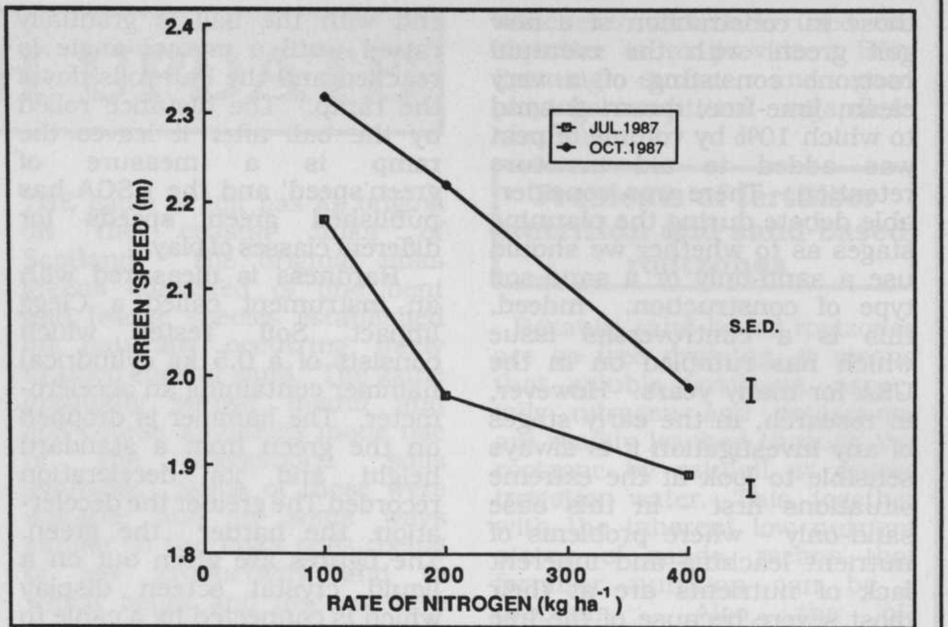
Ball bounce increased with N, producing a more 'springy' turf. There were also significant effects of K, lime and an interaction between lime and N. 'Holding power' or rather bounce length after impact also increased with N - this may be related to ball bounce, but what was more surprising was that there was a significant interaction of N and P. At high N, bounce length decreased with increasing P whereas at low N, bounce length decreased with increasing P.

The conclusions so far show that: (1) at least 20 g/m2 of pure N is required for healthy growth on sand. (2) Increasing N favours bent at the expense of fescue. (3) Playing quality tests have demonstrated effects of nutrients not detectable by botanical analysis. The ball bounce and 'holding power' tests are a world 'first' in golf green research and their sensitivity and relevance to play make the results even more interesting.

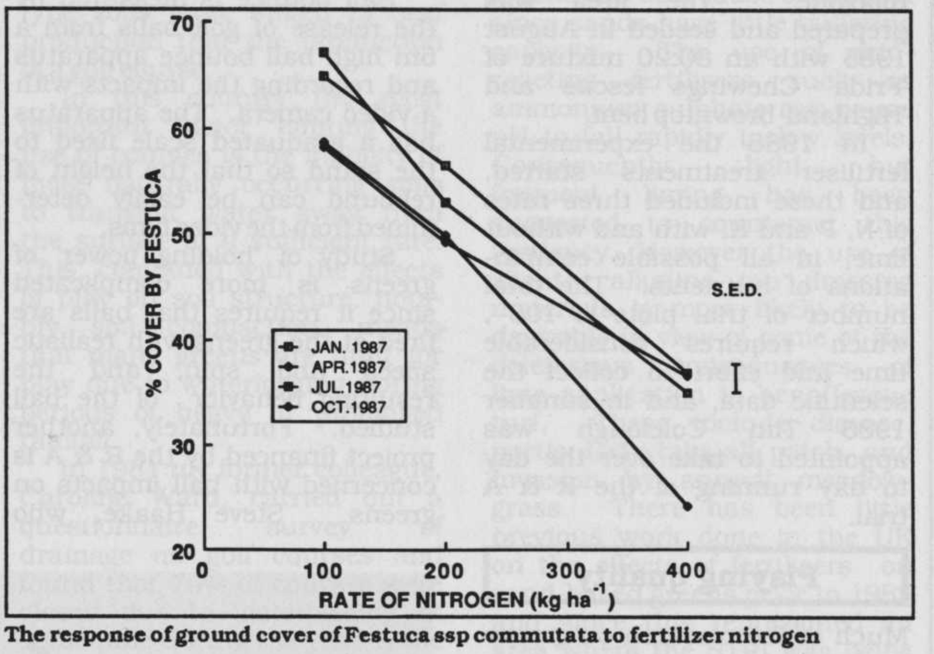
Looking ahead

The R & A has put up further funds - to the sum of £50,000 per year - and part of these monies will be used for the next stage of the programme which is to look at the interactions between rootzone construction, fertiliser nutrition and irrigation of golf green turf.

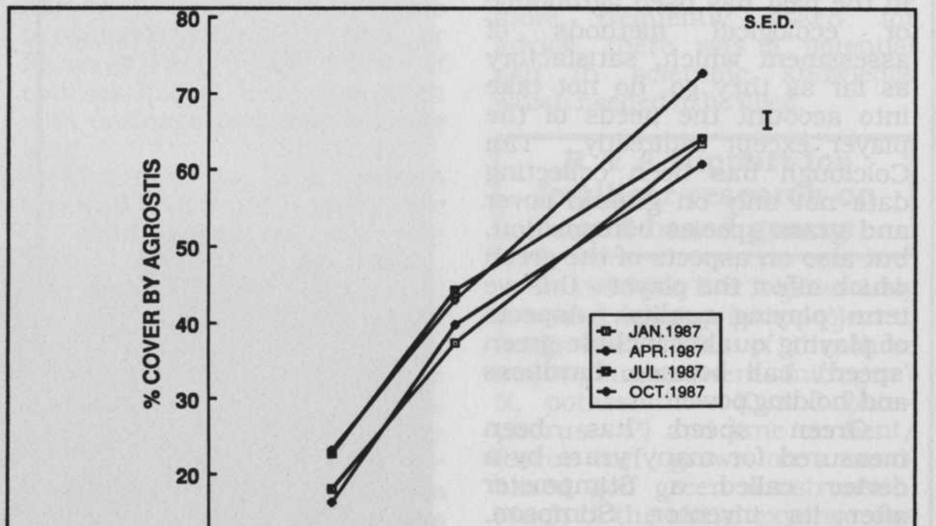
This will include sand, sand/soil, and soil greens and is probably the most complex and ambitious golf experiment ever attempted anywhere in the world. It will include three irrigation regimes and twelve nutrient combinations, as well as the three greens' construction types and will, hopefully, answer many questions about greens construction and maintenance which have been of concern to greenkeepers and agronomists alike.



The response of green 'speed' to fertilizer nitrogen



The response of ground cover of Festuca ssp commutata to fertilizer nitrogen



The response of ground cover of Agrostis castellana to fertilizer nitrogen