KATE YORK delves deeper into the mysteries of dry patch, in this her concluding article on the disease

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The first of these two articles, published in last month's Greenkeeper International, outlined the typical symptoms expressed in areas affected by dry patch and detailed results obtained from a comprehensive questionnaire survey of golf courses across the UK, together with a comparison between the chemical and physical soil characteristics of affected and unaffected areas.

This article concentrates on results obtained from studies involving the possible correlation between automatic irrigation systems and the location of areas affected by dry patch on specific greens and the progress made to date in elucidating the identity of the water-repellent materials which are known to be present in soils affected by dry patch. Also included for interest is information relating to the discovery that certain fungi are capable of producing water-repellence in soil which, prior to their colonisation, showed no such tendency.

Dry patch distribution and automatic irrigation systems

It is generally recognised that to provide sufficient water to an entire golf green, without over or under irrigating any area, is almost impossible. High spots and slopes will affect the final distribution of irrigation water on the surface and the underlying soil profile, as will factors such as prevailing wind speed and direction. However, automatic irrigation systems can be set up to give as near as possible an even water coverage under 'normal' wind conditions and applying water at optimal times during the day, when required, reduce to a minimum the problems which can occur with under or over watering.

With this in mind, an investigation into the possible correlation between areas of a golf green affected by dry patch, relative heights across the green and the volume of water deposited by the installed irrigation system, was completed for one representative green on each of three courses. The three greens selected for this study varied in their expression of the symptoms of dry patch. The first green was affected in large areas which were generally restricted to the edges of the green. The second showed several almost parallel strips of affected turf along the length of the green, from the apron towards the back edge. Finally, on the third, the symptoms appeared as interwoven ribbons of affected areas across the entire surface.

Data relating to the relative height changes across the surface of each green were recorded by using an ordinary surveyors level, positioned at 1 m intervals, which were identified by small marker pins placed on the putting surface. These data were used to produce a three-dimensional representation of each surface, identifying the presence of high spots, slopes and ridges. At 2 m intervals across the green, the rate of water deposited by the irrigation system was calculated by collecting the volume of water in plastic plant pot holders, which fell at each point during a given time period. The results were used to prepare a diagram which identified the rate of irrigation water falling at each 2 m interval across the surface of each green under observation. The third assessment completed on each green identified the percentage of the surface area affected by dry patch in each 1m² as marked out on the greens' surface using pins shown in Figure 1. Using the information recorded, diagrams were completed which identified the exact location and severity of areas affected by dry patch across each green.

Because of the amount of data collected in this investigation, a complete analysis of the results is not possible in this article. However, a general review of the findings may prove useful to greenkeepers. On the first green identified, where the condition existed as large affected areas generally around the edge of the green, there did appear to be a significant correlation between where the symptoms occurred and the low water availability to these areas and associated ridges, slopes and high spots. A similar situation was observed on the second course in which the symptoms of dry patch followed the central area of the greens' surface, although a slight difference existed in that low levels of irrigation were calculated across the entire central part of the green, as no ridges or slopes existed in this situation. Finally, on the green identified as expressing ribbon-like symptoms across the surface, no significant height differences were detected on the green (ie. it was almost completely flat) and no correlation could be detected with changes in irrigation rates at each assessment interval.

In summary, therefore, it is necessary to identify the facts which have been highlighted from this study. High spots, ridges and slopes may support areas which have developed the symptoms of dry patch, but equally the condition can be expressed, albeit in a slightly different form, across the surface of a green which is devoid of any significant height variations. Symptoms of droughting are easily confused with those of dry patch because ultimately areas affected by dry patch, which are innately water-repellent, are unable to retain sufficient available water for healthy grass growth. The grass is effectively droughted, not because the water is unable to reach the roots per se, but because the soil which supports the roots is unable to hold any water which passes through it.

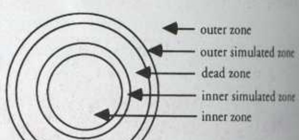
The end result is the same for droughted areas as for those with dry patch, but this study clearly shows that although automatic irrigation systems are unlikely to provide an even and adequate water supply to all areas of a green, for whatever reason, the irrigation pattern and green contours themselves do not predispose a turf surface to dry patch. It is likely, however, that if dry patch has developed, both inefficient irrigation and green contours can exacerbate the severity of the symptoms.

Can water-repellent soils be caused by fungi?

Much speculation has existed over past years regarding the possibility that fungi are capable of directly causing the build up of water-repellent materials in the soil and hence the expression of symptoms associated with dry patch. This study is believed to be the first to show conclusively that water-repellence can be conferred by the movement of certain fungi through the soil profile. Thatch fungi or superficial fairy rings, which are generally caused by members of the basidiomycete group of fungi, have often been thought of as having some role to play in dry patch development. Their usual 'ribbon-like' appearance on affected areas of turf is seen as mimicking the symptoms of dry patch. However, because of the numbers of fungi naturally present in any soil or areas of decaying organic matter (such as the thatch of turf), isolation of the specific causal organism has often proved unsuccessful. Other fungi belonging to the basidiomycete family are, however, more readily identifiable and one such example exists as the Type 1 fairy ring caused by *Marasmius oreades.* This fungus was used in recent studies to identify whether or not a fungus is capable of directly producing water-repellence within the soil through which it has passed.

As with all fairy ring fungi, *Marasmius oreades* moves through the soil profile by means of 'cotton wool' like mycelia, which grows radically outwards from its origin. For the first few years the symptoms of this fungi are indistinguishable on the turf surface, but as the ring matures the amount of mycelium present within the soil increases and eventually symptoms such as those seen in Figure 2 are expressed. As the mycelium passes through the soil it breaks down organic matter, releasing available nutrients to the grass and hence stimulating grass growth. With time the older mycelium dies and breaks down, thereby releasing further available nutrients to the grass. This process ultimately shows itself in the typical symptoms of Type 1 fairy rings which are shown diagrammatically below.

Fig. 2: Type 1 fairy ring caused by *Marasmius oreades*



Each of these zones can be clearly identified in Figure 2 and it is this typical expression which has enabled us to study the possible role of this fungus in relation to the development of water-repellence. Soil samples were taken from the inner, dead and outer zones of three *Marasmius oreades* rings at each of the two different sites; one being a golf course having a sandy loam and the second a course with a much heavier clay loam soil. The soil samples were used to obtain information regarding soil moisture content, soil organic matter content, presence of active fungal mycelium and the presence/severity of water-repellence expressed in each of the three zones.

As with the study on irrigation and green features discussed earlier, this work produced a large amount of information which can readily be summarised for the context of this article. In essence what was discovered was that in the dead zone, ie. the zone which contains the highest concentration of active fungal mycelium, levels of water-repellence were found to be severe. This was not unexpected because fungal mycelium, particularly in such high concentrations, is known to repel

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Fig. 1: Golf green affected by dry patch, showing marker pins, plant pot holders

water due to the nature of the mycelium itself. However, it was discovered that soil samples from the inner zone had relatively high levels of water-repellence compared with soil samples from the outer zone through which the fungus had not yet passed. The depth of water-repellent soil varied between the two chosen field sites. On the lighter sandy loam soil, the fungal mycelium penetrated the profile to a greater depth than on the heavier clay loam. Soil samples from the inner zone showed high levels of water-repellence corresponding to the depth of the mycelium in the active part of the ring. However, studies confirmed that there were no mycelial fragments present in the samples taken from the inner zone and in fact, from our knowledge of the growth rate of this fungus, the soil from the inner zone would have been free of active fungal mycelium on average for about five years. This result is important because we now know that fungi have the capability in some way of producing water-repellency as a direct result of their passage through the soil.

Can we identify the water-repellent compounds in dry patch soils?

The fundamental question being asked in this present study of dry patch as it exists in UK golf greens is – 'what is the identity of the material present in affected areas which causes this repellence to develop?' Two approaches have been taken to provide an answer to this question, these being the extraction of the water-repellent material(s) from the affected soil using specific organic solvents, and a more direct approach to remove the water-repellent material from the surface of affected sand particles, by heating them with a laser beam to a temperature whereby they are made volatile and can be subsequently identified using specific analytical techniques.

This research has been completed in the last few weeks and at present the information obtained from these experiments has yet to be fully analysed. We know that the materials responsible for this water-repellency are present in soils which may show no symptoms, but with time build up to levels which result in the expression of symptoms specific to dry patch. Certain chemicals have been initially identified in soils expressing dry patch, these compounds being 'waxy' materials, which may be responsible for the water-repellency. Although at this time it is not possible to identify conclusively the materials present in soils affected by dry patch, it is believed that completion of analysis still in progress will clearly show the nature of the compounds which build up in affected soils. Ultimately this will lead to the solution of this important maintenance problem.

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