"Dew Is Not Dew"

by TOM MASCARO

Dew is not dew. It is exudated liquid found along the edges of the grass blades.

THE beautiful crystal-clear droplets that you see on a turfgrass leaf in the early morning is not "Dew". They are droplets of exudated liquid being pumped out of the grass plant. Exudate is pumped out of the grass blades through its hydathodes. The hydathodes are located along the edges of the leaves.

Exudate is easy to see with the aid of a simple magnifying glass. You will see the precise location of each exudated droplet along the edges of both sides of the leaf, and a large droplet at the tip of the leaf, if it has been cut off. This liquid is crystal clear. It looks like a fine piece of jewelry.

Each droplet hides potency in its beauty. This liquid is not harmless water of codensation that we call dew. Dew is moisture from the air that condences on a cold surface. Dew and exudate are completely different in composition. Dew is water of condensation and exudate is plant sap which is pumped out of the plant through the hydathodes. Dew can sometimes be found as a whiteish coating on the leaf surface. Exudate is found primarily along the edges of the leaf.

Dew is inert, because it is pure water of condensation. Exudate, on the other hand, contains all of the elements that are present in the plant sap, such as nitrogen, phosphorous, potash, calcium, magnesium and trace elements. With these salts, we can also find sugars, such as glutamine.

"Dew Is Not Dew". When the grass is covered with millions of droplets in the early morning hours, what we have been calling "Dew" is actually exudated liquid.

The presence of salts of the elements contained in the plant sap can be demonstrated in a number of ways. With a clean glass or paper cup you can scoop up the exudate and poor it into a clean container. A clean sponge will also do.

Exudate accumulates during the night and early morning hours.

Dew is water of condensation, and forms on cold surfaces.

The concentration of solids contained in the exudate will depend upon the fertility of the soil, and how much is available to the plant.

Pour some exudate into a clean petri dish or saucer. Allow the water to evaporate. You may have to fill the dish a number of times, each time allowing the water to evaporate. When all of the water is gone, crystals of the salts present in the exudate will form, and can be observed closely with a low power magnifying glass.

If you pour a small amount of exudate on a piece of window glass, the salts will etch marks on the surface. Fill a glass with exudate from a well fertilized green and pour it on one spot of grass, and you will get a severe chemical burn.

Try pouring a small amount of exudate in the palm of your hand and allow it to dry. Feel how sticky it is.

Surprisingly, very little research has been done on the subject of exudate liquids. Dr. Randy McCoy while at Oklahoma State University, wrote his thesis on how an extract from thatch could kill seedlings.

He gathered clean thatch from a well fertilized green and placed it in a clean glass container. He then filled the container with hot water. After allowing this to seep for a while, he poured off the water, which resembled a strong tea. Using this extract from thatch, he found that he could kill any plant seedlings by simply watering them with it.

Other experiments have shown that you can kill not only seedlings, but any young plant. This extract will also burn leaves and stems of mature plants as well.

Pour some pure exudate in a petri dish or small clean saucer. In order to gather pure, uncontaminated exudate, use a glass tube or clean soda straw. Touch the end of the tube to the exudated droplet and it will be drawn into the tube by capillary action. After gathering a number of droplets in this manner, blow the liquid into your clean container. Cover the container and store in a warm place. Observe the fungi that germinate and grow in the pure exudate. Since fungi have no chlorophyl, they can only grow in a medium that has an abundant supply of ready made food. Exudated liquid is a perfect food for any fungal spores. These simple basic experiments demonstrate how exudate and turfgrass management practices can have a profound affect upon the health and growth of the turf.

When we take a glass of exudate, and pour it in one spot, we find that we can burn the turf. Great care must be exercised in the selection of fertilizer, especially its nitrogen content, and its rate of availability. Nitrogen that is quickly available will move into the plant cells and can be found in the exudate. This is the reason that quickly available nitrogen fertilizers must be applied with care. As we know, when it is applied it must be quickly watered in or it will burn the grass leaves and stems. When a lot of nitrogen is contained in the plant cells, it will move through the leaves and out of the plant as exudate. This falls on the lower leaves and stems, causing the same kind of chemical burn.

A slow release nitrogen fertilizer, either organic or inorganic, releases slowly and the exudate will have only small amounts of this nutrient at any one time. The danger of chemical burn at the time of application and in the exudate is greatly diminished.

Now, lets look at thatch and the experiments that Dr. Randy McCoy made. We must assume that the thatch, acting like a sponge, soaked up the high nitrogen exudates. Minimal surface watering allowed the salt concentration to build up to a point where the thatch literally changed into a potentially dangerous material. A torential rain storm and high temperatures could release enough salts to cause a severe chemical burn. Another assumption would be that disease fungi would immediately begin to flourish in dying and dead grass's and therefore should be considered the secondary cause of the grass's demise. Obviously we need a great deal of research in this area of turfgrass culture.

What about Dr. Robert Endo's research, where he demonstrated that fungal spores that germinated in water grew very slowly, while spores that germinated in droplets of exudate grew very rapidly. This research certainly demonstrated many things. Especially important to the golf course superintendent, it demonstrated why early morning syringing is important, because it dilutes the accumulated exudate by washing it off of the leaves and back into the soil.

Exudate can kill grass when salt concentration is high.

Close up of leaves and stems burned by exudate.

Extracts from thatch can kill seedlings. (Dr. Randy McCoy)

Fungal spores germinate and grow rapidly from exudate droplets. (Note growth of mycellium from exudated droplet, lower centre of picture Dr. Endo.)

We look at Dr. Mike Brittons research and his graphic illustrations of how fungal spores germinate slowly in water, while spores germinated in water with sugar added grew more rapidly. When he added glutamine to a solution, spores germinated quickly and the mycellium from these spores grew many times faster. He found that glutamine is one of the ingredients in exudated liquid.

The presence of glutamine is known to every golfer, because his hands get sticky when he plays while the so called "Dew" is on the turf. The presence of glutamine also accounts for the fact that clippings accumulate on the mowers. Syringing the turf when exudate is present in the early morning will quickly wash this material back into the soil. Clean water dries more rapidly than exudate, therefore less clippings adhere to the mowers. It is interesting to note that over forty years ago, Dr. Fred Grau, after making a survey of member clubs, found that greenkeepers (as they were called then) that practiced early morning watering had far less disease than those that didn't. Today we know that it was not the time of watering, but that the washing off of the exudate minimised the incidence of disease. Golf course superintendents have always been a very important part of turfgrass research. In practicing their science and art, they found many ways to combat problems that seemed to have no answers.

To mention a few, Carl Bretzlaf, Golf Course Superintendent of Meridian Hills, Indianapolis, and past president of the GCSAA many years ago, had a reputation of having little or no disease problems on his golf greens. His secret was that he had a home made rig that consisted of two iron wheels, and five layers of burlap bags that was pushed over the greens—to dry them off! O.J. Noer, agronomist for the city of Milwaukee, always preached that "mold nevers grows on dry bread" and on that basis Carl dried his greens. His men would then syringe the grass with water and then mow. What he was doing was physically removing the exudate, washing what remained on the grass back into the soil and then mowing.

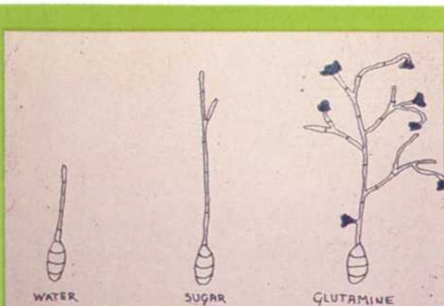
At Merion Golf Club, Ardmore, Pennsylvania, superintendent Joseph Valentine, in addition to syringing the greens, would, during periods of stress apply a little hydrated lime when the grass was dry and then wash it in. He always felt that the pH in the thatch layer was important in relation to disease incidence. He also believed in frequent light topdressing to control thatch and disease. Years later, Dr. Ralph Engle's research at Rutgers, New Jersey revealed that there was a correlation between pH and each disease organism that effects turfgrasses. Here again we see the need for basic research to explore the pH of thatch and exudate.

We need research to update the research of Dr. J. K. Wilson, Cornell University, New York, that he performed in 1923. (Sixty-four years ago). Dr. Wilson was walking across campus early one morning and noticed that there was more "Dew" on some areas of the lawns than others. He suspected that it was due to soil moisture. However, when analyzed the moisture content of the soils, he found, surprisingly, it was the same in the light "dew areas" and the "heavy dew" areas.

These results piqued his curiosity, so he decided to investigate. His research disclosed that the droplets that he found on the grass blades were not "dew" at all. It was liquid pumped out of the leaves.

This liquid, first found and reported in Egypt in 1893 was referred to as guttated water. Guttated water and exudated water are one and the same, and can be found reported either way in the literature.

Dr. Wilson also made another interesting discovery. He found that all grasses do not exudate at the same rate. He classified each of the turfgrasses in the following order: the Bentgrasses, Bermudagrasses, and Poa Annua were prolific pumpers of exudated fluid. The Bluegrasses were medium pumpers (except Poa Annua). We can also include St. Augustinegrasses as medium pumpers. The Fescuegrasses, Zoysiagrasses and the ryegrasses were the low pumpers.



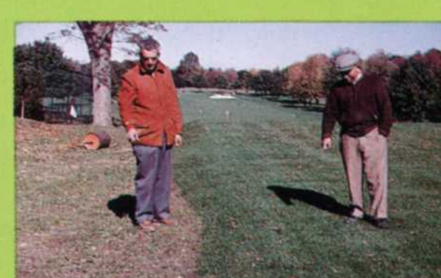
Germination of fungus spores in various solutions. Note differences in the development of mycellium and appressorium in the same time frame. (Dr. Britton)


Early morning syringing has proven to be a sound practice. If exudated liquid is diluted, its effects are minimised. (Dr. Fred Grau)


Different species of turfgrasses exudate at different rates.


Bentgrasses and Poa Annua are prolific pumpers of exudate. (J.K. Wilson)


Bermudagrasses also exudate at a high rate. (J.K. Wilson)


The bluegrasses, excluding Poa Annua, are medium pumpers of exudate. (J.K. Wilson)

Many greens have been lost for no apparent reason.

The fescue grasses, ryegrasses and zoysiagrasses were classified as low pumpers of exudate. (J.K. Wilson)

Grass dies overnight. During periods of stress, temperatures rise to dangerous levels. Reason for loss of 18 greens — unknown.

Soil must be open and porous, so that exudate can be washed down into the soil.

We have all seen these differences in the amount of exudate, when we look at an area of mixed grasses in the early morning. Can we not draw the conclusion from Dr. Wilsons work that there must be a correlation between grass species, exudate and diseases on turfgrass areas? More exudate means more problems. It is obvious that more diseases occur on Bentgrasses, Bermudagrasses, and Poa Annua. The Bluegrasses, excluding Poa Annua, have less diseases than the foregoing species. Zoysiagrasses, Fescuegrasses and Ryegrasses have little or no problems with diseases.

After sixty-five years, it seems that we have a great deal of research to catch up on. Golf course superintendents cannot do this research alone.

When we lose grass for some unknown reason, we need to find the answers. When 18 greens are lost overnight, we need to take a hard look at our management practices and an even harder look at research. We need research that gives us answers to problems and not just cures.

Lets briefly review what we have discussed. First, lets look closely at exudated water. It is a natural function of the plant to force this liquid out when it imbibes too much water. This, in a few words is a very simplistic answer to a complicated function that needs answers.

As the exudate forms and falls to the lower leaves and stems, new droplets are formed. No one knows how much exudate forms under conditions of high or low humidity, or at what temperature. No one knows when the chemical concentration is critical. On windy nights, when exudate evaporates, do the residual salts remain to cause problems later? How much sugar and glutamines are formed? Does the nitrogen in the exudate become nitrate, and upon exposure to the air become nitrite? This is only a short list of questions that need answers.

In the meantime, what do we do about dew and exudate? The answer for the present is to modify management practices to recognize that exudate plays an important role, especially during periods of stress.

Until money is found from sources other than industry for needed research, we might want to look at turfgrass management in a different way. A popular cliche' is "when you look at a doughnut, don't look at the hole, look at the whole doughnut".

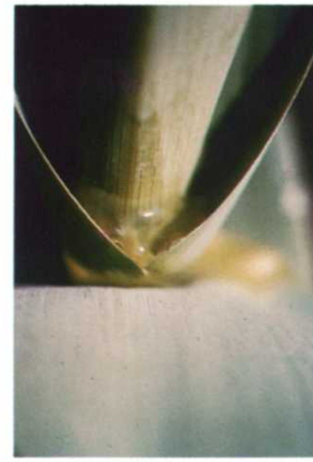
Starting with the management of the soil, we concentrate on the need to relieve compaction so that air, and nutrients can move into the root zone. What about exudated liquid. An open pourous soil allows the exudate to be diluted and washed down into the soil to be recycled. Aerification, therefore is essential to minimize or eliminate high concentration of salts at the soil surface.

Next, lets look at the grass species. If the grass that we are using, exudates at a high rate, then we must manage it differently than a grass that exudates at a low rate.

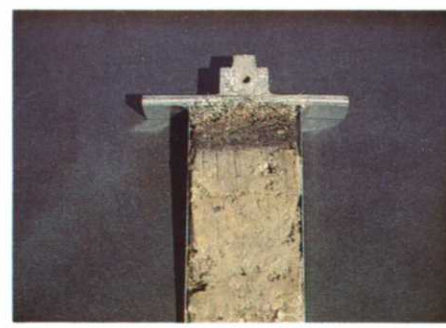
What about our irrigation practices? Dilution at the right time is one of the keys to control exudate. Irrigation can be done anytime, but careful syringing in the morning to dilute and wash off the exudate, and get it down into the soil is vital. If the exudate is washed down into the thatch or soil surface without dilution, problems may occur.

Now, lets turn to fertilization. We have heard the expression, "nitrogen is nitrogen, no matter what the source". This may be true but if one is growing grass on a golf green, or any intensive use

Exudated water is a beautiful natural function of the grass plant. Poets have called it magic rain. Others will call it dew. The turfgrass manager recognizes nature's recycling process, and uses it to produce better turf.



When syringing, apply enough water to wash exudate out of pockets where leaf joins stem. Poling or preventing dew formation should not be substituted for a two minute irrigation syringin cycle.



Heavy thatch layers can become sponges that absord and hold exudated liquid.

Acknowledgements:

Dr. Randy McCoy, Oklahoma State University
Dr. Robert Endo, University of S. California
Dr. Mike Britton, University of Illinois
Dr. J.K. Wilson, Cornell University
Dr. Fred V. Grau, USGA Green section
Dr. O.J. Noer, City of Milwaukee
Dr. George N. Hoffer, Purdue University

All photographs by Author

area, more emphasis should be placed on how quickly the nitrogen moves into the plant and out with the exudate, than the source of nitrogen.

Fast release nitrogens must be applied frequently and in light amounts. This will minimize the concentration of this element in the plant tissue and exudate. Slow release nitrogen sources are safer, and result in lower concentrations in the tissue and exudate. Care must be exercised with some slow release materials, in that a portion of the nitrogen is quickly water soluble when first applied.

What do we know about the salt index of nutrients for turfgrasses? We know that more research is needed in this area. Muriate of potash, for instance has a salt index of 116, while sulphate of potash has a salt index of 46, which do we use and when? We know that the higher the salts in a soil, the higher the need for water. On intensive use areas, are we watering too much because of our selection of nutrients that have a high salt index? We also know that exudated water will contain salts in relation to their availability to the plant cells.

What about pH levels in the exudated liquid? Is it affected by acidifying fertilizers? If they are, can these differences in pH be found in the soil and the plant cells? If they are, then can we predict which pathogen will affect the grass plant.?

Lastly, we look at management practices. We have learned that early morning syringing is a sound practice. Almost everything we do in turfgrass management comes into play when we think in terms of biological culture. These, of course, include aerification, verticutting, height and frequency of cut, controlled nutrient applications, soil profile temperatures, pH at all levels of the soil horizon, topdressing, irrigation practices, etc.

We know that we can rely on some proven research, some theory, and lots of green thumb hands on experience to keep grass alive during periods of stress.

We also desperately need more meaningful research to seperate dew from exudate. As we get the answers, turfgrass management will become more biological and cultural than curative. ■