Fig. 1 Enclosed greenhouse and mist systems changed thatch microfloral balances but not thatch depth.

Concerning Biological Control of Thatch in Turf*

by JAY SANFORD KOTHS

Abstract. *Changing the thatch microenvironment with a polyethylene canopy, intermittent mist, energy sources for microbes, introduction of selected microbes, and topdressing with several materials enriched composts were tested during 3 years of investigation. While all treatments produced marked changes in microbial balances, topdressings were the most effective in altering the thatch decomposition rate, and tended to effect a natural balance between thatch formation and microbial degradation.*

INTRODUCTION

Thatch in turf normally disappears due to microbial degradation. Thatch formation balances degradation, but sometimes degradation lags behind, and the thatch layer increases in depth to a point that it is undesirable or even detrimental.

*This research was supported in part by the USGA Green Section, the Connecticut Research Commission, and the Storrs Agricultural Experiment Station.

A soil microbiologist in the Plant Science Department, University of Connecticut, Dr. Koths is conducting research in ammonium ion toxicities in soils, heavy metal effects on the soil microflora, biological control of soilborne plant pathogens and also has Extension responsibilities in commercial greenhouse operation.

To accelerate degradation, the biological activity of the thatch microflora must be sped up so that the thatch layer depth will be acceptable. This suggests alteration of the microbial population or the microenvironment.

External influences can alter microbial balances and change biological activity. Previous researchers have investigated many facets of thatch degradation including introduction of microbial foods, enzymes, mechanical removal and topdressings. During the last three years some of these premises, and others, were tried. These are described briefly as follows:

1. The greenhouse effect.

Grasses can flourish in empty, closed greenhouses during the summer when temperatures sometimes exceed 140°F. To determine whether this would accelerate thatch degradation, a 12'x 18'x7' high greenhouse (Fig. 1) was covered with polyethylene and placed over turf for periods of seven days. Six experiments were conducted on separate sites. Even with adequate soil moisture and/or constant moisture from an intermittent low pressure mist in the greenhouse, the turf showed signs of stress. Therefore, this approach was abandoned. No acceleration of thatch degradation was found.

Fig. 2. Light actuated mist equipment with injection of fertilizers and humic acid. Portions of the plastic mist barriers were temporarily removed.

2. Water stress.

If it is true, as postulated, that water is the usual limiting factor in thatch degradation, the application of mist (Fig. 1) so that the area is uniformly constantly moist should be beneficial.

A Solatrol (a light-operated interval switch) controlled mist application in proportion to solar radiation so that just enough water was applied to maintain moisture from the leaves down through the thatch layer. With impinging nozzles spaced 2'x2', a 12-second mist period every six minutes during bright sunlight was found to be optimum. Since misting was in proportion to solar radiation, the frequency gradually decreased until misting ceased at nightfall.

In instances where dead leaf blades from mist treatments were examined, decay was advanced in seven days, and the tissue was at times swarming with protozoa and nematodes. This was not found in non-misted areas when similar leaves were wetted for an hour or two, then examined. Although this decay was observed on softer tissue, no decrease in thatch was attributed to seven day treatments in eight experiments when measurements were made for two months (in one experiment, 13 months) following treatment.

3. Fertilizer injection in mist.

Frequent watering and sprinkling of golf greens leaches soluble fertilizer elements from the thatch layer. Although carbonaceous compounds are plentiful in the thatch layer, available nitrogen may be insufficient for microbial growth. This may limit thatch degradation. In eight experiments, the mist contained a fertilizer solution proportioned through a 1:128 injector to provide 100 ppm N, 50 ppm P_2O_5 and 100 ppm K_2O. (Fig. 2) This resulted in a rate of 1.1 to 2.3 lbs. N/1,000 sq. ft. depending upon the calls for mist.

This introduction of fertilizer elicited more luxuriant growth than that occurring under the accompanying non-treated areas. This growth might be expected to increase the thatch layer. This did not occur and it is postulated that degradation was increased in proportion to thatch formation, resulting in no net change.

4. Energy sources for microbes.

The introduction of foods for microbes in solution through low pressure mist (Fig. 2) for a period of a week changes the ecological balances in thatch. If glucose or sucrose is added, the rapid multipliers proliferate. If humic acid is supplied, microbes adept at utilizing it multiply. When casein is applied as dried milk, the population of ammonifiers increased to 3 million per gram from a normal of 1.1 million, then rapidly decreased to less than the normal population but returned to a balanced condition in about three weeks. None of these changes however, were associated with accelerated thatch breakdown.

5. Introduction of thatch-degrading microbes.

When isolations of microbes are made from thatch (6,000 plates were poured during these experiments), some of them will grow on sterile thatch plugs and degrade them. Several were selected, grown in microbial media and reintroduced to the turf. One of these, a form of *Actinomyces albus,* was successfully established by insistent introduction in mist over 7-day periods in 4 experiments. (Fig. 3) While this demonstrates that the procedure may be successful, the increase in thatch degradation was not significant. Efforts were therefore directed toward increasing the activity of the resident microflora rather than attempting to change the population through isolate introduction.

6. Topdressings and compost.

The speed of biological disintegration of thatch is determined by the activity of the

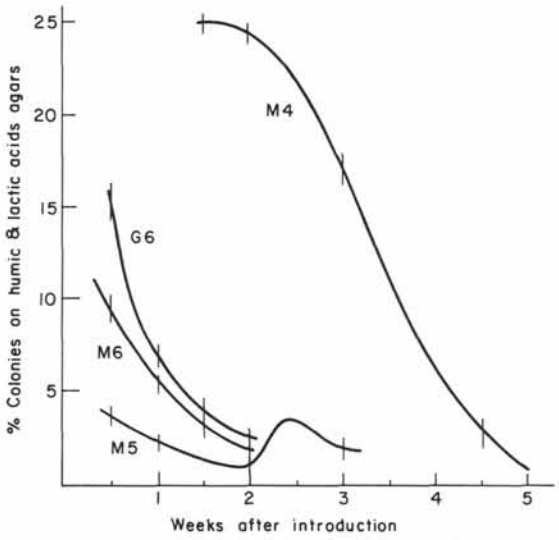

Fig. 3. Re-isolation of an introduced thatch-degrading micro-organism from three mist and one greenhouse experiment where they comprise less than .9 per cent in the controls.

microflora/microfuana complex. The small proportion of the living flora that is active can be increased by topdressing with soil. This provides sites for microbes on otherwise relatively clean thatch strands and retains enough water to sustain biological activity over more extended periods.

DISCUSSION AND RESULTS

The simplest way to alter the microenvironment and enable microbes to remain active in degrading thatch is introduction of soil to the thatch layer. In other words, topdress with a compost or soil mix that will provide conditions favorable for the normal thatch microflora and also result in proper structural support when the organic matter from the thatch is mineralized.

For example, the addition of clay might improve the physical properties for microbial activity within the thatch layer, but would also result in the worst possible physical properties as soon as the thatch begins to disappear. A topdressing mix should provide an ideal matrix after the thatch disappears. Mixing this clay with sand, calcined clay (arcillite) or other coarse aggregate along with some organic matter such as sphagnum peat is often practiced. The benefit from sphagnum peat moss in this situation is open to challenge.

Sphagnum peat is frequently used as a topdressing additive. It improves the appearance of the mix. Furthermore, if prepared in advance, the microbes in the mix may increase in sphagnum peat degradation activity. But stimulation of the thatch degradation activity of the resident thatch microflora by the addition of this topdressing is questionable. There are sufficient carbonaceous materials in the thatch layer. If sphagnum peat accelerates thatch decomposition, it is probably through physical changes in the thatch layer, rather than the introduction of available food or thatch degrading organisms.

A composted topdressing should be of greater value than a mineral soil. For example, a compost prepared from thatch would contain more thatch decomposing organisms, since those capable of utilizing thatch as food would be favored. Applying a 2 mm topdressing (1 cubic yard per 4,000 square feet, a light application) to a 20 mm thatch layer indicates (if the same microbial counts are present) an introduction of 10 per cent enriched microflora. Normally, introducing organisms to a soil situation where an existing population is established is not successful. In thatch, the introduced microbes from enriched compost should find their new home satisfactory and become established even in face of the resident population. Results in this study, presented in Fig. 4, show that topdressings reduced damage caused by lack of water in this greens nursery.

The composts used in the Fig. 4 study were placed in composters (Fig. 5) after being prepared as follows:

WCC 3 parts aerifier plugs containing little soil, from the greens nursery area at the Waterbury Country Club which had a thatch layer of nearly ¾ inch; 2 parts fine sandy loam; 1 part coarse washed sand; 15 lbs. limestone per cubic yard (to give a pH of 6.4); and 5 lbs. superphosphate (0-20-0).

ECC aerifier plugs from the Ellington

Fig. 4. Influence of topdressings on percentage of bentgrass (with 2/3 inch thatch layer) surviving water stress.

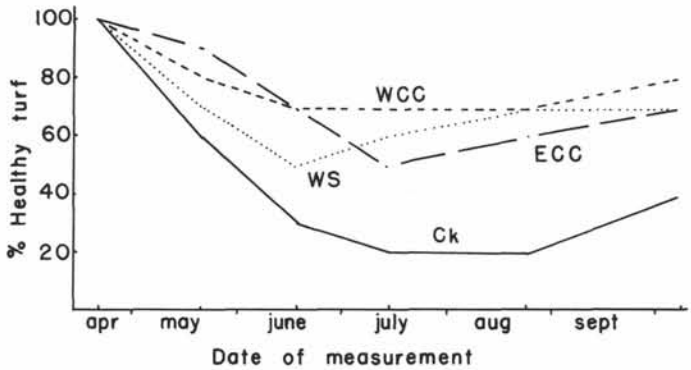

Fig. 5. Composters containing thatch plug mixtures to produce topdressings containing higher proportions of thatch degrading micro-organisms. The maximum temperature during composting was 131°F.

Country Club which were two to three years old and contained about 50 per cent sandy loam soil were shredded and placed in a composter without amendment.

WS a fine sandy loam topsoil.

The thatch layer measurements in this experiment were undoubtedly influenced by the lack of vigor and browning out of the turf. Samples were taken only in the healthiest areas. With initial topdressing on April 20 and repeated on June 17, 1971, the decrease in thatch depth in comparison to the control was as follows:

May 20	June 17	July 17	August 24	October 6
7%	1%	19%	16%	14%

This difference was highly significant. No significance was found due to the three types of topdressings. This is in accord with a 1970 experiment where a 10 per cent reduction in thatch due to topdressing was highly significant. While these reductions appear to be minimal, it should be remembered that the process of biological degradation of thatch should be slow and natural, achieving a desirable balance through years of turf management.

Compost preparation may be altered in many ways. If an amended sewerage sludge or similar organic fertilizer (Milorganite or Electra) is added to a compost containing freshly collected plugs (and/or grass clippings), striking results are produced. The temperature rise during composting is much greater than that produced by comparable amounts of nitrogen from calcium nitrate or ammonium nitrate. Even though temperature increase was minimal in some tests due to small compost volumes, the microfuana was severely affected. Nematodes disappeared. Protozoa, sometimes reduced to a single species, were usually eliminated.

The decimation of the microfuana may have no beneficial effects. Nematodes are not considered to be especially harmful to greens turf in Connecticut, but the concomitant death of undesirable weed species such as *Poa annua* is desirable. Elimination of many pathogenic fungi occurs before weed seed death during composting so it may be assumed that plant pathogen incidence is minimal.

Microfuanal degradation of thatch may be of overlooked importance. Some of these small animals are able to utilize organic particles, and some parts of thatch may be considered as possible food sources, but the microfuana almost never operates alone. They coexist with bacteria in commensalistic, if not symbiotic harmony, while feeding upon them. The study of such interactions is complex to an indescribable degree, since the removal of any species in this ecological balance changes the capabilities of the others.

SUMMARY

Although changes in the thatch microenvironment bring about quantitative changes in microbial balances, such ecological changes do not necessarily contribute to a more desirable thatch balance. A great proportion of the viable microflora is inactive. Increasing activity is important and can be obtained through topdressings. Composting such topdressings may enhance their desirability by depleting the populations of weed seeds, nematodes and some protozoa, while proportions of thatch degrading microbes are increased. The advantage of compost over soil topdressing may be of more importance than indicated in these experiments. Changing the physical characteristics of the thatch layer to provide microecological sites that promote continued activity by the resident microflora may be the most important attribute of topdressing.