Relations of Micro-organisms to Control of Thatch*

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The problem of thatch control is one that is seldom encountered in agricultural soils. In agriculture, attempts are made to retain soil organic matter and to increase it if possible, because its disappearance is much too rapid under cultivated crops. In agriculture, therefore, one resorts to addition of organic materials to soils. Substances such as animal manures, green manures, and cover crops are used, or there is crop rotation involving growth of grasses which are particularly effective for adding organic matter and improving soil structure.

The development of thatch is similar in some respects to the use of organic mulches, in that the organic matter accumulates on the soil surface. The problem appears to be primarily, that of accumulation of organic matter in which bent grass is the principal offender but in which Bermuda grass may also be concerned. Troublesome thatch is seldom formed by other grasses. This suggests that in the effects brought about by bent grass there is something unique that is responsible for its resistance to decomposition. The fact that bent grass grows rapidly and makes extensive top growth probably is part of the explanation for thatch formation with this grass. The persistence of the organic matter results in the formation of an undesirable surface cushion, which fails to absorb water, resulting in dry spots and uneven growth of turf. Furthermore, there are frequently serious disease problems on thatched areas.

FACTORS AFFECTING DECOMPOSITION OF ORGANIC MATTER

Chemical Composition of Plant

Microorganisms, like other living things, are continuously searching for food for growth. Different microorganisms can use different organic materials for food. Some use sugars, whereas others use amino acids, cellulose, or other compounds. A great variety of substance is contained in plants, and as a consequence many different microorganisms are involved in the breakdown of residues of bent grass or of those of other plants.

Data on the composition of the rye plant, included in Table 1, indicate two things: 1. plants are complex in composition; 2. plants vary in composition with age. The young plant has a high content of water-soluble materials, which consist principally of sugars, amino acids, and other simple readily decomposable substances, and also has a high protein content. In contrast, these constituents are relatively scarce in the mature plant. The content of structural materials — hemicelluloses, cellulose, and lignins — is lower in the young plant than in the mature plant, 45% and 79% respectively. This affects the decomposability of the plant. In general, the water-soluble materials and proteins decompose rapidly, the hemicelluloses more slowly, the cellulose still more slowly, and the lignins the most slowly of all. There is thus a decrease in the readily decomposable substances and an increase in the more resistant ones as the plant grows older. Lignin not only resists decomposition but becomes asociated with the other structural materials, the hemicelluloses and

TABLE 1
Composition of young and mature rye plants

	Per cent of dry material in stems and leaves	
	Young plants 10"-14" high	Mature plants
Fats and waxes	3	1
Water-soluble materials	29	14
Hemicelluloses	17	23
Cellulose	18	36
Lignin	10	20
Protein	15	2
Ash	8	4

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cellulose, "incrusting" them and thus causing them to resist decomposition. Therefore, the residues of young plants decompose more readily than do those of mature plants of the same type. Among the outstanding differences in composition of different kinds of plants is the high nitrogen content of young plants compared to mature plants, the high cellulose content of woody tissues and straw, and the high lignin content of tree products. These are reflected in the rates at which they decompose and in the amounts of residual organic matter that accumulate.

Fertilizer Material and Decomposition

In order to grow, microorganisms require not only organic materials as sources of energy but also various nutrient elements such as nitrogen, phosphorus, potassium, and sulfur. In case these elements are not available in the organic matter undergoing decomposition, they must be provided by the soil in which the decomposition takes place. Nitrogen is required in much greater quantities than any of the other nutrient elements, followed by phosphorus, potassium, and sulfur. For decomposition of one ton of fresh plant material with 20 per cent dry weight, about 9 pounds of nitrogen would be required. Part of this would be supplied by the organic matter itself, but if half of that needed was thus available, there would still be required an amount of nitrogen equivalent to that supplied by 90 pounds of a 5-10-5 fertilizer. This is the reason that fertilizer materials are added to substances being composted. It is also possible that nitrogen and some other elements are deficient in the grass risidues and that addition of fertilizer salts would accelerate decomposition.

Environmental Factors

Among the environmental factors affecting decomposition are temperature, reaction (pH), aeration, and moisture.

Temperature. The higher the temperature the more rapid the decomposition. There is virtually no decomposition at the freezing temperature of water, but rapid breakdown at summer temperatures of 60° to 80°F.

Reaction. Reaction is readily controlled. There is abundant evidence that decomposition of organic matter in the acid soils of the eastern seaboard is increased by liming. It is possible that liming would serve a useful process in accelerating the breakdown of thatch.

Aeration. Well-aerated soil is the most favorable for breakdown of organic matter, whereas under conditions of deficient aeration or where oxygen is excluded, organic matter persists. The outstanding evidence of the latter is formation of peat, which develops in soils continuously covered with water. Aeration is unlikely to be a common factor in thatch formation; at least, thatch develops on the soil surface and is encountered on the surface of well-aerated soils.

Moisture. Moisture is required for decomposition, and this is one of the principal factors limiting decomposition of mulches. It may indeed be one of the most important factors in thatch formation. Moist organic matter may contain two to four times as much water as dry material. Decomposition is more rapid when the organic matter is moist; when dry, it resists decomposition. A mulch tends to decompose where it makes contact with the soil, but persists at the top where it is dry most of the time. Whereas most organic materials used as mulches persist on the soil surface, they decompose when mixed with the soil. Even clippings of bluegrass and fescues serve reasonably well as mulches, but they decompose exceedingly rapidly in the soil. This is due principally to the low moisture content of the mulch but, in addition, the mulch loses considerable of its nutrients and readily decomposable constituents through leaching by rain. When the organic matter is mixed with the soil, the microorganisms that attack it can obtain mineral nutrients from the soil to make up for deficiencies of these nutrients in the plant residue.

The decomposition of organic matter mixed with soil is a more continuous process than that of organic matter on the soil surface. There are less frequent and rapid changes in moisture content. Once the microbial population has become established on the organic matter within the soil, the organisms continue to grow and multiply at the expense of the plant materials at rates determined by the amount and kind of organic matter. On the soil surface there may be intervals when the organic matter is moist or wet such as following rains or watering or after heavy dews. When moisture is the limiting factor, these will be periods favoring microbial development, but as growth becomes established in these in-

BALTIMORE'S MOUNT PLEASANT CHARMING TEST

Baltimore's Mount Pleasant public course where the Eastern Open is held each year and where the National Public Links championship was played in 1939 is rated by many tourney stars as the nation's most beautiful municipal course.

Above illustration shows the 140 yd. 6th hole and to the right on the tee is C. A. (Gus) Hook, supt. of Baltimore parks who started to build the course in 1932, using WPA labor. Gus was a sharpshooting amateur who'd made a study of golf architecture. He began park work with the Forestry division of the Baltimore park board in 1913. That background shows in the 4500 trees planted to combine beauty and golf architecture on the course.

The Mount Pleasant course reflects excellent construction advice from members of the Mid-Atlantic Golf Course Supts.' Assn. Gus got much help from his fellow members when the job was under construction and during its maintenance. Bob Scott, veteran supt. of Baltimore CC courses, has been Gus' particular buddy and consulting genius.

Baltimore Sun's Sunday magazine section ran a big illustrated feature on the course telling of its history and features and referring to effective use Gus made of his turf colleagues' cooperation in providing Baltimore with a prize exhibit among municipal courses.

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tervals it is interrupted by desiccation during warm daytime periods. Desiccation results in destruction of most of the microorganisms, leaving relatively small numbers of survivors. When the organic matter becomes wet again there is a lag period of reestablishment of the microorganisms before decomposition again becomes active. The appearance of the cottony webs of fungi causing brown patch and other evidences of fungus attack of grass in period of high humidity and their disappearance in dry weather illustrate the effects of moisture on the cyclic development of microorganisms.

Conditions Favorable for Decomposition

The conditions favoring rapid decomposition of organic matter can be briefly summarized as follows: The organic matter should be inherently readily decomposable; there should be an abundance of nitrogen and other elements required by the microorganisms either in the organic matter or added as fertilizer salts; the reaction should be close to neutrality; there should be good aeration and high temperature, and the moisture content should be continuously high. Most of these factors can be controlled somewhat in turf.

FACTORS CONCERNED IN THE CONTROL OF THATCH

One may be inclined to search for a simple means of eliminating thatch, such as inoculation with microorganisms able to rapidly decompose the plant risidues, or the use of chemicals that would destroy the thatch. There is no reason, however, to believe that the problem can be solved in either of these ways. It is unlikely that inoculation with microorganisms of any kind will accelerate decomposition.

Microorganisms develop in response to a particular set of conditions, and if conditions are favorable for their growth they will develop from the great diversity of microorganisms that inhabit the soil. There are chemical substances that will decompose organic matter, but these would destroy the plants and also produce unfavorable soil conditions.

Relatively little can be done to control the temperature, and there is no need to consider the factor of aeration. It is possible, however, to provide additional nutrient substances as fertilizer salts and to modify the reaction with lime. Fertilizer materials may exert their effects not only on the decomposition of organic matter but also on growth of the grass itself. Addition of fertilizer salts would increase growth of the grass and might result in an aggravated thatch condition. High rates of application of nitrogen, such as 6 to 8 pounds of nitrogen per 1000 square feet per season, are often associated with thatch accumulation. The effects of fertilizer both on thatch decomposition and on increased growth of the grass should be evaluated before this procedure is adopted for thatch control.

The problem could be solved by substituting for bent grass another grass that does not produce thatch, but it is unlikely that such a change would be made until some new grass became available. If the type of plant is fixed, it is not possible to affect the composition of the organic material appreciably.

Physical treatment of thatch provided a considerable degree of control. The turf is spiked, scratched, cut, and torn. All of these treatments solve the primary problem, that of getting water into the soil. In all cases the thatch is broken and openings are provided through which water can move to the soil beneath. Other things are also accomplished. By scratching and tearing, a considerable amount of the plant residues is lifted, cut, and then taken away, thus physically removing part of the thatch. Spiking not only breaks holes in the turf, but also brings a considerable amount of soil to the surface of the thatch. Top dressing with soil brought in from another area or added by spiking has effects similar in some respects to those produced by mixing plant residues with soil; as mentioned previously, the organic matter is kept moist through contact with the moist soil, nutrient materials are provided by the soil, and conditions are favorable for more nearly continuous microbial development than where the plant residues rest on the soil surfece. Top dressing without disturbance of the thatch would be less effective than top dressing after scratching and removal of part of the plant material, because there would be more intimate mingling of the soil and plant residues in the latter case. Furthermore, the addition of soil on top of the thatch would leave an undesirable layer of organic matter.

The persistence of residues of bent grass and thatch formation may be due principally to the repelling action on water; the surfaces shed water instead of absorbing it. Some of the treatments are based on this assumption. A direct approach that appears to have been given little or no consideration is the use of wetting agents. There are many different wetting agents, and some will doubtless be toxic. This was true of some trial tests caried out by Dr. Ralph Engel at the New Jersey Agricultural Experiment Station. Undesirable rather than desirable effects resulted from these tests. Problems will also arise regarding dosage and method of application, but the possibilities of wetting agents for control of thatch have not been thoroughly investigated.

Turf Maintenance of N. Y. Courses, $5,000,000

New York State Turf Assn. Bulletin No. 44 says:

There are about 150 eighteen-hole and 280 nine-hole golf courses in New York State. Conservative estimates indicate that a golf course has 4 acres of turf per hole, 1/9 acre of putting green turf per hole, and maintenance costs about $1,000 per hole. On this basis:

Annual turf maintenance costs of New York Golf Courses=	$5,220,000
Total turf acreage on New York Golf Courses	2,088

No accurate data are yet available as to the amount of play received by golf courses, but some indication can be drawn from the records of the New York City Park System. In 1947 the 10 city-owned courses registered 469,467 rounds of golf. Golf is not necessarily a rich man's game. This play is admittedly very heavy. Even if play were only half as heavy on the average this indicates nearly 10 million rounds in the State per year.