Single Step Mechanical Thatch Removal

A GREEN SECTION SUPPORTED RESEARCH PROJECT

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Thatch build-up is a problem commonly encountered in lawns and golf courses. Usually there are two approaches for a solution to the thatch build-up problem: prevention and cure. Prevention of thatch build-up in the first place frequently can be accomplished by proper cultural practices. However, when providing a uniform playing surface in golf courses, preventive methods are seldom entirely successful. A second (cure) method where thatch already has accumulated is to mechanically loosen and remove the thatch.

Several machines are available for loosening thatch, but none satisfactorily picks up the loosened thatch under all conditions. These machines range in size from small push units to large tractor-mounted units and use blades mounted vertically on a rotating horizontal shaft to pull and cut the thatch. Depending upon the severity of thatch build-up, blades may be spaced from less than one inch to more than three inches apart. The thatch usually is loosened and left on the surface, thus requiring separate operations of raking, vacuuming and/or blowing to a side to remove the thatch. If it is left on the surface, it is unsightly and can work back into the turf and create the same build-up problem.

A research project at the University of Georgia, Georgia Station, funded in part by the USGA Green Section, is partially directed toward developing a principle of dethatching which loosens and picks up the loosened thatch in the same operation.

DESIGN CONSIDERATIONS

A dethatcher design that would achieve thatch removal and collection in a single operation would be superior to currently used methods in many respects:

1. It would not allow the loosened thatch to work back into the turf.
2. One operation would achieve both dethatching and picking, thereby reducing the labor, energy and cost of operation.
3. It would remove abrasive soil particles pulled with the thatch, thereby prolonging the life of mower blades.
4. It would achieve more efficient thatch collection.

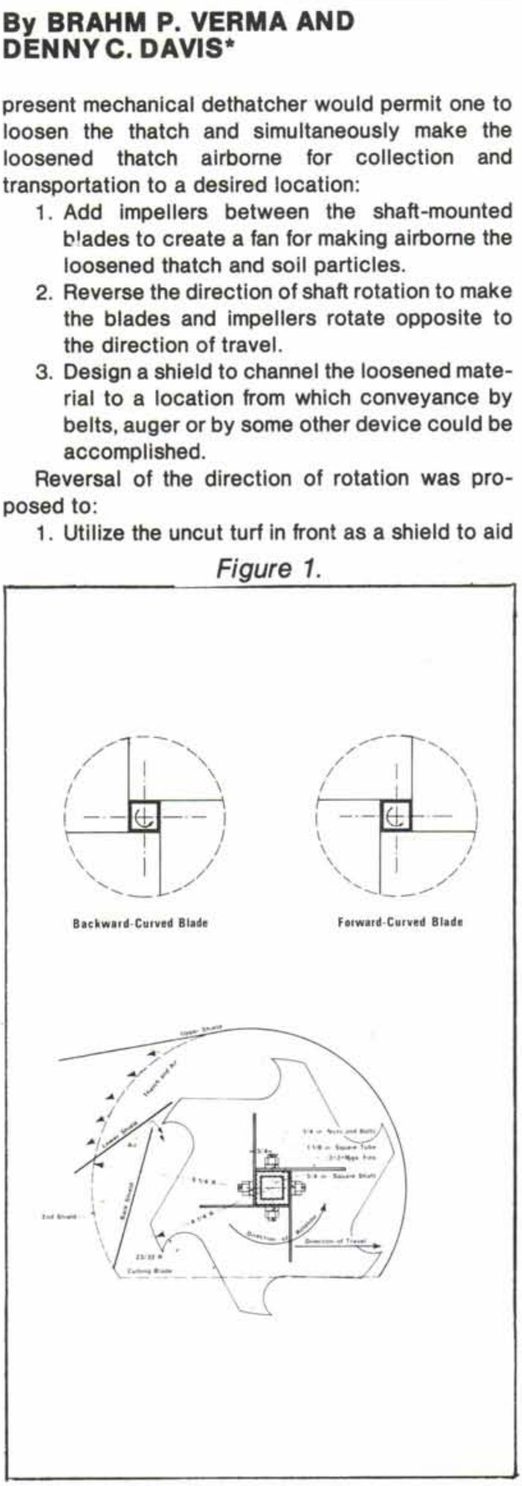
While studying mechanical dethatching it was envisioned that the following three alterations in the present mechanical dethatcher would permit one to loosen the thatch and simultaneously make the loosened thatch airborne for collection and transportation to a desired location:

1. Add impellers between the shaft-mounted blades to create a fan for making airborne the loosened thatch and soil particles.
2. Reverse the direction of shaft rotation to make the blades and impellers rotate opposite to the direction of travel.
3. Design a shield to channel the loosened material to a location from which conveyance by belts, auger or by some other device could be accomplished.

Reversal of the direction of rotation was proposed to:

1. Utilize the uncut turf in front as a shield to aid

Figure 1.



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in lifting the loosened material and making it airborne.

2. Prevent the material from floating into the previously cut slot (as happens with the forward-rotating blades).
3. Improve the cutting and loosening of thatch by utilizing pull forces and eliminating the initial compression that occurs with forward-rotating blades.

CONSTRUCTION OF AN EXPERIMENTAL UNIT

To incorporate the design considerations into a unit for testing, a 12 inch wide hand-push experimental dethatching unit was constructed. The blade assembly shown in Figure 1 included four 8½ inch diameter, commercially-available dethatching blades with six cutting points mounted three inches apart on a ¾ inch square shaft. Spacers between the blades were made from 1⅛ inch square tubing on which two ¼ inch bolts were brazed on each face. The bolts provided the means for fastening impellers between the cutting blades. The assembly was mounted in bearings on a suitable frame structure and was driven by a V-belt connection to a five horsepower gasoline engine. Four rubber wheels for moving the dethatcher were fastened to the frame in a manner which permitted adjustment for the depth of cut. Twelve straight impellers for each of two impeller sizes tested (3 x 3 inch and 3 x 3½ inch) were cut and drilled to match the bolts brazed to the spacers.

The shield assembly included two partial-circle end shields, a curved upper shield, a lower shield, and a back shield as seen in Figure 1. The upper shield forms the base of a discharge channel between the blade and the upper shield. The channel depth gradually increases and forms a discharge chute with the lower shield. One end of the lower shield barely clears the blade (⅛ inch clearance) to insure complete discharge. The back shield forms a ½ inch slot opening for air to enter at the low pressure area below the lower shield.

Figure 2 shows the blade, impeller and shield assembly viewed from the bottom.

EXPERIMENTAL DESIGN

An experiment was designed to test the performance of the dethatching unit for a selected range of design and operating conditions. The selected range of operational and design conditions were as follows:

(1) 2 positions of impellers (P): P_b=backward-curved and
P_f=forward-curved blades

(2) 2 lengths of impellers (L): L_1 = 3 in. (impeller clears the turf)
and L_2 = 3.5 in. (impeller touches the top of turf)

(3) 3 rotation speeds (RPM): 1100, 1800, and 2500.

(4) 2 ground speeds (S): S_1 = 0.75, and S_2 = 1.25 mph.

The two positions of impellers shown in Figure 1 represent the backward-curved and forward-curved blades in centrifugal fan theory. The two lengths of impellers were selected so that the shorter impellers cleared the surface of the grass and the longer impellers penetrated approximately a quarter inch into the grass. The tests were conducted in a uniform Tifgreen turf plot.

To determine the performance of the dethatching unit, a measure of both the thatch collected in the catch tray and the thatch left on the grass was required. Three different measurements for quantifying the grass and thatch were selected. They were (1) fresh weight, (2) fresh volume, and (3) dry weight. Weight measurements were accomplished by standard methods, but volume measurements required the development of a procedure by which the samples could be brought to a constant density condition. A simple correlation analysis yielded a high degree of correlation among the three measurements; therefore, fresh weight was used to quantify the performance of the unit.

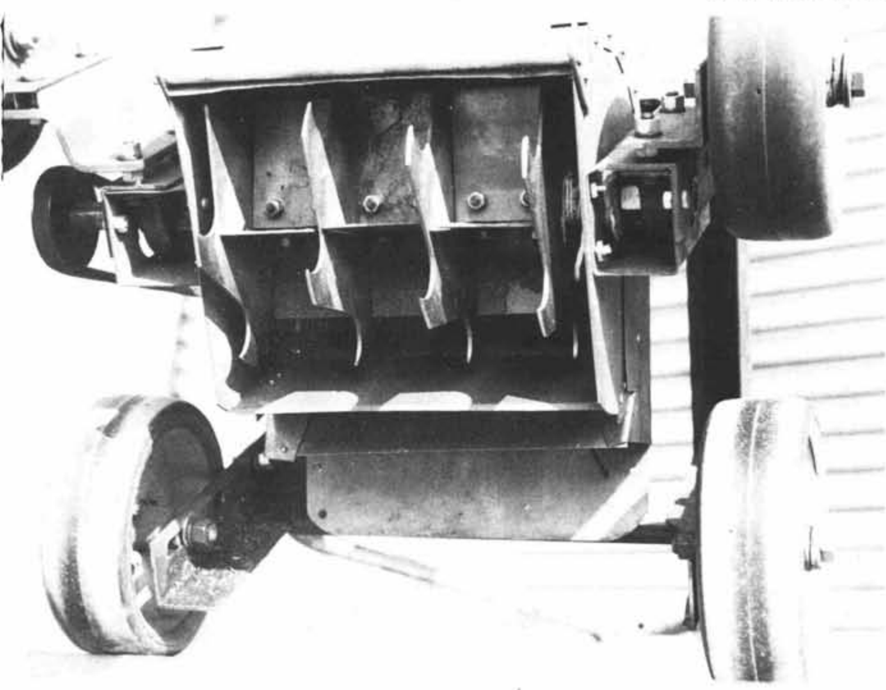


Figure 2. Cutting blade, impellers and shield assembly of the experimental dethatcher viewed from the bottom.

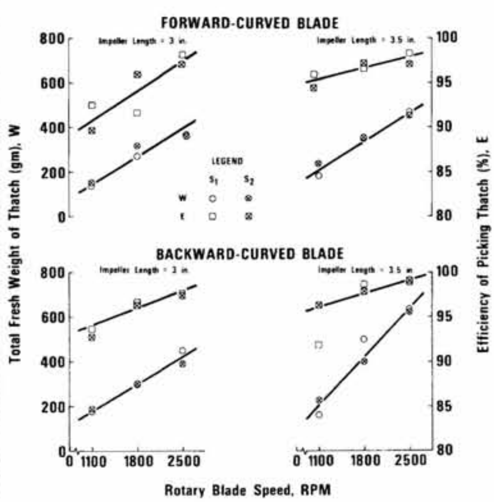
RESULTS AND DISCUSSION

To evaluate dethatching performance at various design and operating conditions, total fresh weight of loosened thatch from the turf, W, (fresh weight of thatch collected plus fresh weight of thatch left on the ground) was used in a factorial analysis of variance. The analysis shows that at 95 per cent probability level there was a significant effect due to position, length and rotational speed of the blade but no effect due to ground speed or replication. A further analysis indicated that all three levels of rpm were significantly different and that with an increase in rotational speed there was a significant increase in total fresh weight of thatch at all test conditions. (See Figure 3).

Picking performance of the dethatcher was measured by determining the ratio of the fresh weights of the thatch picked up by the machine to the total thatch loosened (efficiency of picking). At 95 per cent probability level there was a significant effect due to position, length and rotational speed of the blade but no effect due to ground speed or replication. Again all three levels of rpm were significantly different. Figure 3 shows a plot of rpm versus efficiency of picking at all test conditions.

The statistical analysis has shown the effects of rpm on both loosening thatch (W) and efficiency of picking (E). As the rotational speed was increased from 1,100 rpm to 2,500 rpm there was a nearly linear increase in W and a significant increase in E for all test conditions. This result is easily attributed to the more vigorous action of the cutting blade for loosening thatch at the higher rpm. The increase in rpm also caused greater air flow which helped to carry the loosened thatch around for deposit in the catch tray.

Figure 3.



The two positions of the impellers, forward-curved (P_f) and backward-curved (P_b) blades, have a significant effect on the efficiency of picking. The backward-curved blade condition was slightly more efficient than the forward-curved blade condition. The longer impellers were more efficient in picking up loosened thatch than were the shorter impellers. The gain in the efficiency of picking, however, resulted at the cost of severe bruising to the top of the turf. The gain in the total fresh weight of the loosened thatch is attributed to the additional grass tips cut by the longer impellers.

CONCLUSIONS

The test data and analysis show that any one of the reported test conditions would be satisfactory for the loosening and pickup of the loosened thatch. Rotational speeds of the blade and impellers in the range from 1,800 to 2,500 rpm, the backward-curved impeller position, and impeller lengths which clear the top of the turf gave best performance. Under these conditions the efficiency of picking thatch ranged between 96.5 and 98 per cent. Dethatching performance was not significantly affected by ground speeds from 0.75 to 1.25 mph.

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ACKNOWLEDGMENT

The work upon which this publication is based was supported in part by funds provided by the United States Golf Association Green Section under a grant to the University of Georgia Agricultural Experiment Stations. Authors express appreciation to Alexander M. Radko, National Research Director, and to James B. Moncrief, Southern Director USGA Green Section, for their consultations. Special thanks are due to Dr. Robert E. Burns, Agronomy Department, for his cooperation in making a uniform Tifgreen plot available for the conduct of the experimental phase of the study.