

# 1999 RUTGERS Turfgrass Proceedings



THE NEW JERSEY TURFGRASS ASSOCIATION

In Cooperation With

RUTGERS COOPERATIVE EXTENSION  
NEW JERSEY AGRICULTURAL EXPERIMENT STATION  
RUTGERS, THE STATE UNIVERSITY OF NEW JERSEY  
NEW BRUNSWICK

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# **1999 RUTGERS TURFGRASS PROCEEDINGS**

**of the**

**New Jersey Turfgrass Expo  
December 7-9, 1999  
Trump Taj Mahal  
Atlantic City, New Jersey**

**Volume 31  
Published July, 2000**

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The Rutgers Turfgrass Proceedings is published yearly by the Rutgers Center for Turfgrass Science, Rutgers Cooperative Extension, and the New Jersey Agricultural Experiment Station, Cook College, Rutgers University in cooperation with the New Jersey Turfgrass Association. The purpose of this document is to provide a forum for the dissemination of information and the exchange of ideas and knowledge. The proceedings provide turfgrass managers, research scientists, extension specialists, and industry personnel with opportunities to communicate with co-workers. Through this forum, these professionals also reach a more general audience, which includes the public. Articles appearing in these proceedings are divided into two sections.

The first section includes lecture notes of papers presented at the 1999 New Jersey Turfgrass Expo. Publication of the New Jersey Turfgrass Expo Notes provides a readily available

source of information covering a wide range of topics. The Expo Notes include technical and popular presentations of importance to the turfgrass industry.

The second section includes research papers containing original research findings and reviews covering selected subjects in turfgrass science. The primary objective of this section is to facilitate the timely dissemination of original turfgrass research for use by the turfgrass industry.

Special thanks are given to those who have submitted papers for this proceedings, to the New Jersey Turfgrass Association for financial assistance, and to those individuals who have provided support to the Rutgers Turf Research Program at Cook College - Rutgers, The State University of New Jersey.

Dr. Ann B. Gould, Editor  
Dr. Bruce B. Clarke, Coordinator

# IMPACT OF MINERAL SILICON PRODUCTS ON POWDERY MILDEW IN GREENHOUSE GROWN TURF

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Fertilization with silicon provides effective control of powdery mildew on cucumber (Cherif et al., 1994), muskmelon, and zucchini (Menzies et al., 1992). Rice yields in silicon-poor soils increased, with a concomitant decrease in the severity of fungal diseases, when silicon was added to the soil in field trials (Winslow, 1997). Powdery mildew is evolving as an economic problem in turf. This study was performed in the greenhouse during the winter to determine the influence of silicon nutrition on disease suppression of powdery mildew in Kentucky bluegrass.

Kentucky bluegrass was grown on non-mineral potting mix and on a mineral soil. Most mineral soils contain high, though largely unavailable, levels of silicon (approximately 28%). Non-mineral potting mixes typically are not rich in silicon, so differences may occur that are dependent on growing media. Silicon was added as liquid solution of potassium silicate, called Protekt<sup>2</sup>, and in a solid form as Reclime<sup>2</sup>, a finely pulverized stainless steel slag containing magnesium and calcium silicates and oxides.

## MATERIALS AND METHODS

Two potted turf experiments were conducted in the greenhouse at the Rutgers Plant Science Research Station near Adelphia, NJ. In both experiments, strips of previously established Kentucky bluegrass (cv. Midnight) were gathered from field plots as circular sod plugs. All soil remnants were washed from the roots, and the

sod plugs were transplanted into 6 inch plastic pots filled with 1200 g of soil or potting mix.

The experiments differed by choice of potting medium and by treatment. The medium used in Experiment 1 was a non-mineral potting mix comprised of 0.5 bushel peat moss and 0.5 bushel vermiculite. A Quakertown silt loam soil of pH 5.8, obtained from a farm in Hunterdon County, New Jersey, was used in Experiment 2. Treatments are listed in Tables 1 and 2 and are described below.

Liquid treatments were applied immediately after transplanting; solid treatments were mixed with the medium immediately prior to transplanting. Care was taken to avoid contact of the silicon materials with the blades of the turf. All pots also received liquid fertilizer, Miracle Gro Lawn Food (36-6-6), at transplanting. This fertilizer did not contain monopotassium phosphate (MKP), which has been found to inhibit powdery mildew when applied to foliage (Heckman, 1998). The potting media were kept moist.

Five treatments were arranged in a complete randomized block design with four replications. The plants were rated five times for incidence of powdery mildew on a scale of 0 to 9, where 0 = no disease to 9 = total coverage of growth by the fungus. Disease was rated at weeks 5 and 7 post-transplant. The turf was clipped to the height of 1 inch during week 9, and then new growth was rated at week 10. The rating of new growth, preceded by clipping, also occurred at

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<sup>2</sup> The use of trade names do not imply endorsement by the New Jersey Agricultural Experiment Station of the product named, or criticisms of similar ones not mentioned.

weeks 13 and 14. At the end of the experiments, pH was measured using a (1:1) soil:water suspension.

Analysis of variance was performed using SAS Statistical Software, with means separated using the *t*-test for least significant difference (LSD) ( $\alpha = 0.05$ ).

#### *Experiment 1: Non-Mineral Potting Mix*

The treatments added to the potting mix are described in Table 1. For treatments 1 to 4, Limecrest, a calcitic liming material with calcium carbonate equivalent (CCE) = 90%, was mixed prior to planting at a rate of 200 g/bushel potting mix. Treatment 5 was the only treatment in this study designed to measure the ability of the calcium silicate material Reclime<sup>3</sup> to act as both a liming material and to suppress powdery mildew. Reclime was mixed at the rate of 200 g/bushel (3.3 g/pot), which is equivalent to Limecrest since both have a CCE = 90%.

Treatments 1 to 4 received a commercial soluble potassium silicate solution called Protekt, which contains 3.8% dipotassium oxide (K<sub>2</sub>O) and 7.8% silicon dioxide (SiO<sub>2</sub>). The label rate of Protekt, 52 ppm SiO<sub>2</sub> (2.5 ml Protekt/gal), was applied in treatment 2. Since a solution of 100 ppm SiO<sub>2</sub> (equivalent to 1000 ppm foliar spray) was found to control powdery mildew in hydroponically grown vegetables (Menzies et al., 1992), twice the label rate (104 ppm) was applied in treatment 3. Four times the recommended rate (208 ppm) was applied in treatment 4. For each treatment, 10 ml of dilute Protekt solution was added to the potting media to result in an application of 0.65, 1.3, and 2.6 mg SiO<sub>2</sub> to treatments 2, 3, and 4, respectively.

#### *Experiment 2: Mineral Soil.*

The treatments added to mineral soil are listed in Table 2. Limecrest (treatments 1 and

2), Reclime (treatments 3 and 5), or both (treatment 4) was incorporated into the soil at a rate of 5600 lb/acre (3.3 g/pot). In addition, 20 ml of 102 ppm Protekt solution (equivalent to 1.3 mg SiO<sub>2</sub>) was added to treatments 2 and 5.

## RESULTS AND DISCUSSION

#### *Experiment 1: Potting Mix.*

Plants were rated for powdery mildew at weeks 5 and 7 post-transplant (Table 1). At week 7, treatment 2, which contained the lowest rate of Protekt, suppressed powdery mildew compared to the control (treatment 1). At week 9, the grass was clipped to a 1 inch height, and by week 10, all treatments significantly suppressed disease development in the new growth. Applications of Reclime (treatment 5) and the highest rate of liquid silicate (treatment 4), however, equally suppressed powdery mildew development to the greatest extent.

Plants were clipped again and rated at week 13. Whereas all treatments suppressed disease development compared to the control, only the Reclime (treatment 5) and intermediate Protekt (treatment 3) treatments were significant. Following re-clipping and regrowth, the Reclime treatment at week 14 significantly suppressed disease; disease development in the other treatments, although less than the control, was not significantly different.

The pH of the treated potting mix was measured at the end of the study and ranged from 5.7 to 6.2. The pH decreased with an increase in Protekt concentration, but was increased by the addition of Reclime. The Limecrest control and the Reclime treatments were expected to have similar effects on pH, since they both have a CCE of 90%, but this was not found. The results indicate that pH was not raised excessively by the treatments, and, therefore, higher application rates of silicate material are feasible.

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<sup>3</sup> The exact amount of silicon, as silicates, in this product is unknown.

### *Experiment 2: Mineral Soil.*

As with the potting mix experiment, the turf was rated for incidence of powdery mildew at weeks 5 and 7 post-transplant and then was clipped and rated three more times. Although disease suppression occurred intermittently in all treatments, no significant differences were noted in the first three ratings (weeks 5, 7, 10) (Table 2). At week 13, the combined Reclime and Protekt treatment (treatment 5) significantly suppressed powdery mildew compared to both the control (treatment 1) and to the Limecrest plus Protekt treatment (treatment 2). At week 14, disease suppression had occurred in all treatments; however, there were no statistically significant differences from the control.

Soil pH, measured at the end of the experiment, ranged from 5.8 to 6.1. There were no significant differences in pH among treatments.

### **CONCLUSION**

Powdery mildew on Kentucky bluegrass grown in the greenhouse was suppressed by the addition of silicate products to the growing medium, particularly when the medium for turf was a potting mix. Reclime, which contains calcium and magnesium silicates, suppressed the growth of powdery mildew on turf grown on a non-mineral potting mixture. The liquid product Protekt, which contains soluble potassium silicates, exhibited a similar suppression of powdery mildew.

Addition of the silicon material did not result in pronounced changes in pH. Limecrest, a calcium carbonate liming material, raised potting mix pH less than Reclime, which contains the liming material calcium silicate. The replacement of calcium carbonate liming materials with calcium silicate liming materials may be useful for the additional benefit of eliminating fungicide costs.

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Table 1. Incidence of powdery mildew of Kentucky bluegrass (cv. Midnight) grown on potting mix (experiment 1).

Treatment	-----Week-----					pH Week 14
	5 Pre-clip	7 Pre-clip	10 Post-clip	13 Post-clip	14 Post-clip	
	-----Rating <sup>1</sup> -----					
1 3.3 g Limecrest <sup>2</sup> (control)	4.3 a	4.5 a	4.5 a	6.0 a	5.0 a	5.7 c
2 3.3 g Limecrest + 0.65 mg SiO <sub>2</sub> as Protekt <sup>3</sup>	4.8 a	3.3 b	3.3 b	5.8 a	4.8 a	6.1 ab
3 3.3 g Limecrest + 1.3 mg SiO <sub>2</sub> as Protekt	4.5 a	4.5 a	2.8 bc	4.8 bc	3.8 ab	5.8 bc
4 3.3 g Limecrest + 2.6 mg SiO <sub>2</sub> as Protekt	4.3 a	4.0 ab	2.3 c	5.3 ab	4.8 a	5.6 c
5 3.3 g Reclime <sup>4</sup>	4.5 a	4.5 a	2.3 c	4.3 c	2.8 b	6.2 a
<i>Pr &gt; F</i>	0.792	0.011	0.000	0.004	0.031	0.016
LSD at 5%	NS	0.754	0.79	0.87	1.51	0.34
C.V.	14.5	12	17	11	24	3.8

<sup>1</sup>Rating: 0 = no incidence of powdery mildew to 9 = complete coverage of plants by powdery mildew. Ratings followed by the same letter are not significantly different

<sup>2</sup>Limecrest is a calcitic liming material with a CCE = 90%

<sup>3</sup>Protekt is a liquid potassium silicate material containing 7.8% SiO<sub>2</sub>

<sup>4</sup>Reclime is a stainless steel manufacturing by-product with a CCE = 90%

Table 2. Incidence of powdery mildew of Kentucky bluegrass (cv. Midnight) grown on a mineral soil (experiment 2).

Treatment	-----Week-----					pH Week 14
	5 Pre-clip	7 Pre-clip	10 Post-clip	13 Post-clip	14 Post-clip	
	-----Rating <sup>1</sup> -----					
1 3.3 g Limecrest <sup>2</sup> (control)	4.5 a <sup>3</sup>	4.3 a	2.8 a	5.8 a	4.0 a	5.9 a
2 3.3 g Limecrest + 1.3 mg SiO <sub>2</sub> as Protekt <sup>3</sup>	4.3 a	4.5 a	2.8 a	5.3 a	3.8 a	5.8 a
3 3.3 g Reclime <sup>4</sup>	4.3 a	4.0 a	2.8 a	5.0 a	3.8 a	6.0 a
4 3.3 g Limecrest + 3.3 Reclime	3.8 a	4.0 a	3.0 a	5.0 a	3.0 a	6.1 a
5 3.3 g Reclime + 1.3 mg SiO <sub>2</sub> as Protekt	4.8 a	4.0 a	2.3 a	4.0 b	3.5 a	6.0 a
<i>Pr &gt; F</i>	0.545	0.721	0.721	0.004	0.431	0.74
LSD at 5%	NS	NS	NS	0.78	NS	NS
C.V.	19.2	14.9	14.9	10.0	20.9	5.5

<sup>1</sup>Rating: 0 = no incidence of powdery mildew to 9 = complete coverage of plants by powdery mildew. Ratings followed by the same letter are not significantly different

<sup>2</sup>Limecrest is a calcitic liming material with a CCE = 90%

<sup>3</sup>Protekt is a liquid potassium silicate material containing 7.8% SiO<sub>2</sub>

<sup>4</sup>Reclime is a stainless steel manufacturing by-product with a CCE = 90%