Chapter 3

THE EFFECT OF SEEDING RATE AND FERTILIZER SOURCE AND RATE ON TURFGRASS ESTABLISHMENT ON PLASTIC

ABSTRACT

For experiment one, seeding study, the germination and establishment of four turfgrass species (*Poa pratensis*, *Poa supina*, *Lolium perenne*, and *Festuca arundinacea*) within a refined wood fiber mat (Ecomat®) were evaluated using three different seeding rates over plastic sheeting. The three seeding rates were 1, 2, and 4 times the recommended seeding rates for each turfgrass species, respectively. Results determined that four times the recommended seeding rate significantly increased turfgrass cover from the recommended seeding rate, and that *Lolium perenne* had the greatest turfgrass cover. *Festuca arundinacea*, had significantly greater turfgrass density than both *Poa* species.

For experiment two, fertility study, the germination and establishment of *Poa pratensis* in Ecomat® was evaluated using different fertilizer sources and rates. Two nitrogen sources (Milorganite® and ammonium nitrate) were studied using three application rates (1.25, 2.5, and 5.0 g N m^{-2} every two weeks). The Milorganite® at the middle and high rate had significantly higher turfgrass density than all other treatments. The experimental design for both the seeding and fertility studies severely decimated the results of both experiments. Final results are inconclusive because optimal water requirements were unattainable for proper seed germination.

INTRODUCTION

Manufactured in New Westminster, British Columbia, by Canadian Forest Products Ltd., Ecomat® is used extensively as an erosion control mat for use along roadsides. Ecomat® is a recycled wood fiber mat and can be used as the growth medium on plastic sheeting for turfgrass establishment. Sod production on plastic is a unique practice and demonstrates many advantages versus traditional sod production. Root shearing during sod harvesting is eliminated when grown on plastic which allows the sod to establish faster than conventional sod. The sod is light-weight due to the absence of soil, potentially allowing for cheaper shipping costs and larger sod pieces. The sod pieces are held together by the binding of the roots, thus enabling the production of turfgrasses with bunch type growth habits. Since the Ecomat® is a soil less growing media, the recommended seeding rates and fertilizer rates and type will differ from conventional turfgrass establishment in soil. Currently, sod production on plastic utilizes wood chips, compost, and sand as the growth media for turfgrass establishment. Although sod production on soil less growing media has been practiced for a number of years, little published research exists to recommend specific establishment practices. In 1997, two separate experiments were conducted to satisfy the following objectives: 1) Determine the optimum seeding rate for turfgrass establishment on a soil less media (Ecomat®) over plastic, and 2) Determine the optimum fertilizer type (organic vs. mineral) and application rate for turfgrass establishment on a soil less media (Ecomat®) over plastic.

<u>Experiment one</u>: Seeding study

Too much seed slows turfgrass maturity (Madison, 1966). Because of excessive seedling competition, seedlings cannot develop until some factor, usually disease, decimates the population so surviving individuals have space to grow (Crocker and

Barton, 1957; Wells and Robinson, 1954). Conversely, too little seed results in a sparse stand, and while the grass slowly fills in, the area is open to weed invasion (Madison, 1966). Therefore, knowing the proper seeding rate prior to seeding affirms the possibility of achieving a more mature turfgrass stand.

Recommendations for seeding rates are based on an assumed number of seeds per unit (generally seeds/ pound or gram) (Christians, *et al.,* 1979). Estimates of the number of seeds per gram for *Poa pratensis* in current use range from 4,800 to 4,960 seeds per gram, and this differs from the estimates required for *Festuca arundinacea* (approximately 500 seeds per gram (Beard 1973; Musser and Perkins, 1969). *Poa supina* has a similar seed size to *Poa pratensis*, and *Lolium perenne* has a similar seed size to *Festuca arundinacea*, and their respective seeding rates are approximately the same.

For this experiment, four turfgrass species (*Poa pratensis*, *Poa supina*, *Lolium perenne*, and *Festuca arundinacea*) were seeded into Ecomat® over polyethylene sheeting using three different seeding rates (one, two, and four times the recommended seeding rates). Because the Ecomat® is a soil-less growing medium, the vital seed to soil contact does not exist for turfgrass establishment. Therefore, the optimal seeding rates on Ecomat® for each species need to be investigated.

<u>Experiment two</u>: Fertility study

Various recommendations on rates, ratios, and placement of fertilizer for turfgrass establishment have been made (Davis, *et al*., 1964; Harper, *et al*., 1962; Skogley, 1962). In particular, the recommendations vary in the amounts of phosphorous recommended relative to nitrogen and potassium (King and Skogley, 1969). In addition, the amount of nitrogen suggested varies (King and Skogley, 1969). Establishing turfgrass in a relatively inert material such as the Ecomat®, nutrient availability and holding capacity is limited, and increased fertilizer application rates may be warranted.

To combat the detrimental effects of compaction on soil physical properties for heavily trafficked turfgrass areas, sandier growing media are being used (Waddington, *et al.*, 1990). Zimmerman (1969) reported that increasing sand in the rootzone mix decreased cation exchange capacity and available nutrient levels. This same effect also exists when Ecomat® is used as the growing media. Using organic sources of nitrogen is one way to aid in compensating for the low nutrients in the growth media without changing the physical properties in growing media such as sandy soils and Ecomat®. Effects of an organic fertilizer (Milorganite®) rate resulted in increased concentrations of phosphorous, potassium, calcium, sulfur, manganese, iron, copper, and zinc for turfgrass establishment in a sand growing medium (Waddington, *et al.*, 1990).

For this experiment, different sources of nitrogen (Milorganite® and ammonium nitrate) were investigated at different rates (1.25, 2.5, and 5 g N m^{-2}) for *Poa pratensis* establishment in Ecomat® over polyethylene sheeting. In addition, one rate of urea (2.5 g N m^{-2}) and two rates of phosphorous and potassium (2.5 and 5.0 g P or K m^{-2}) were investigated as orthogonal contrasts to the 2.5 g N m^{-2} ammonium nitrate fertilizer treatment.

MATERIALS AND METHODS

Experiment one: Seeding rate

Four cool season turfgrasses were established from seed in Ecomat® over impermeable polyethylene sheeting (6 mil thickness) at the Hancock Turfgrass Research Center, Michigan State University, during summer 1997. The experiment was a 2 factor randomized complete block design (RCBD) with 3 replications. Factor one was the four turf species, which included: *Poa pratensis* L. (Kentucky bluegrass), *P. supina* Schrad. (supina bluegrass), *Lolium perenne* L. (perennial ryegrass), and *Festuca arundinacea* Schreb . (tall fescue). Factor two was the three seeding rates for each turf species (Table 12). The initial seeding rate was the typical recommended seeding rate for conventional turfgrass establishment on soil (Turgeon, 1991). There was a total of 36- 1.22 m by 1.83 m plots which were seeded on 7 June 1997. Seed was applied using a hand shaker, and each plot was individually seeded. Straw was mulched over the seeded plots. Prior to seeding all plots were fertilized with 5 g N m^{-2} using Lebanon Country Club (13-25-12) Starter Fertilizer. Every two weeks an additional 2.5 g N m^{-2} was applied using the 13-25-12 fertilizer for a total of seven fertilizer applications. Water was applied, as needed using an automatic irrigation system. Mowing began four weeks after seeding, and was done twice per week using a reel mower at a 32 mm mowing height. Turf density was visually estimated to determine percent turfgrass cover for establishment.

Table 12. Seeding rates (g m^{-2}) for turfgrass establishment on four turf species, East Lansing, MI. 1997.

	Turfgrass species			
Seeding rate	*P. pratensis*	*P. supina*	*L. perenne*	*F. arundinacea*
1x	7.3	7.3	39.1	39.1
2x	14.7	14.7	78.2	78.2
3x	29.3	29.3	156.4	156.4

Experiment two: Fertility type and rates

On 10 June 1997, 45 0.91 m by 1.22 m Ecomat™ plots were laid on plastic, with 0.5 m *Poa pratensis* sod strips between each plot to act as a buffer. The study consisted of six main treatments consisting of two fertilizer types (two forms of nitrogen (N)), and three fertility rates with five replications (Table 13). The two types of fertilizers used were a organic fertilizer (Milorganite™ 6-2-0), and a mineral fertilizer (ammonium nitrate 34-0-0). The three fertility rates compared were 1.25, 2.5, and 5 g N m^{-2}. An additional three treatments were included for orthogonal contrasts with the 1.25 g N m^{-2} ammonium nitrate treatment (Table 13). The additional treatments included high potassium, high phosphorous, and using urea as the mineral form of nitrogen. The urea (46-0-0), phosphorous (0-46-0), and potassium (0-0-50) were applied at 1.25 g N m^{-2} every two weeks. High nitrogen and phosphorous treatments were applied prior to seeding as a bed source of nutrients. Four post fertilizer treatment applications were made every two weeks after seeding. Table 2 shows the arrangement of the fertilizer treatments. On 11 June 1997 all plots were seeded with *Poa pratensis* var. 'Touchdown' at 7.3 g m^{-2}, and then mulched with straw. Water was applied, as needed using an automatic irrigation system. Mowing began four weeks after seeding, and was done twice per week using a reel mower at a 32 mm mowing height. Turfgrass cover was estimated visually on a percent scale.

Table 13. Fertilizer treatment types and rates for *Poa pratensis* establishment within Ecomat® over plastic, East Lansing, MI. 1997.

Treatment†	Bed N	Post‡ N	Bed P	Post P	Bed K	Post K
1	10 (O)	1.25	10	1.25	0	1.25
2	10 (O)	2.5	10	1.25	0	1.25
3	10 (O)	5.0	10	1.25	0	1.25
4	10 (M)	1.25	10	1.25	0	1.25
5	10 (M)	2.5	10	1.25	0	1.25
6	10 (M)	5.0	10	1.25	0	1.25
7	10 (M)	2.5	10	2.5	0	1.25
8	10 (M)	2.5	10	1.25	0	2.5
9	10 (U)	2.5	10	1.25	0	1.25

† Treatment rates are all in g m^{-2}.

‡ Post treatments began two weeks after seeding and were applied every two weeks. O=organic form of nitrogen (Milorganite™), M=mineral form of nitrogen (ammonium nitrate), and U=mineral form of nitrogen (urea).

RESULTS

Experiment one: Seeding study

Significant differences in turfgrass cover among the four turf species studied occurred (Table 14). *Lolium perenne* had significantly greater cover than any of the other turf species investigated on all five sampling dates (Table 14). *Festuca arundinacea* had significantly greater turfgrass cover than both *Poa pratensis* and *Poa supina*. The greater turfgrass cover of the *Lolium perenne* and *Festuca arundinacea* were expected on the early data collection dates because, of their superior germination rate than the two *Poa* sp. These results were anticipated, because *Lolium perenne* and *Festuca arundinacea* are faster germinating turves. However, even after two months, the two *Poa* sp. had significantly less cover than the *Lolium perenne* and *Festuca arundinacea*. Overall, only the *Lolium perenne* had what would be considered acceptable turfgrass cover two months after seeding (76.3%).

Significant differences in turfgrass cover among the three seeding rates occurred on all sampling dates except the 2 July rating date (Table 14). Differences between the 1x rate and the 4x rate were significant for all turfgrass cover sampling dates. When seeding at the recommended seeding rate, turfgrass cover was relatively poor even after two months.

Table 14. Seeding study – Effect of three seeding rates on turfgrass cover† for four turfgrass species utilizing Ecomat® on plastic, East Lansing, MI. 1997.

	Date				
	2 July	18 July	30 July	8 Aug.	8 Sept.
Turf species (TS)	% cover				
Poa pratensis‡ (KBG)	0.2	13.7	15.1	16.7	19.2
Poa supina‡ (SBG)	1.3	12.0	17.7	19.6	23.0
Lolium perenne§ (PRG)	29.7	74.1	71.9	73.0	76.3
Festuca arundinacea§ (TF)	12.9	40.0	37.6	37.0	41.1
$LSD_{(0.05)}$	10.7	19.0	18.1	17.6	18.9
Seeding rate (SR)					
1x (times) recommend rate	5.4	23.0	23.6	24.6	27.3
2x (times) recommend rate	12.8	37.3	36.2	36.8	41.3
4x (times) recommend rate	14.9	44.6	46.9	48.3	51.3
$LSD_{(0.05)}$	ns	16.5	15.7	15.2	16.4
TS x SR					
KBG x 1x	0.0	6.0	7.7	9.7	11.0
KBG x 2x	0.7	21.7	21.7	24.3	28.3
KBG x 4x	0.0	13.3	16.0	16.0	18.3
SBG x 1x	0.0	2.7	2.3	2.7	3.0
SBG x 2x	0.0	3.3	17.3	17.7	24.3
SBG x 4x	4.0	30.0	33.3	38.3	41.7
PRG x 1x	20.0	65.0	65.0	66.7	71.7
PRG x 2x	38.3	84.0	79.0	80.0	82.3
PRG x 4x	30.7	73.3	71.7	72.3	75.0
TF x 1x	1.7	18.3	19.3	19.3	23.3
TF x 2x	12.0	40.0	26.7	25.0	30.0
TF x 4x	25.0	61.7	66.7	66.7	70.0
$LSD_{(0.05)}$	ns	ns	ns	ns	ns

ns Indicates no significance at the $p = 0.05$ probability level.

† Turfgrass cover was visually rated on a percent scale (0-100%).

‡ The recommended seeding rate for *P. pratensis* and *P. supina* is 7.3 g m^{-2}.

§ The recommended seeding rate for *L. perenne* and *F. arundinacea* is 39.1 g m^{-2}.

<u>Experiment two</u>: Fertility study

Significant differences in turfgrass cover occurred within each factor on all four sampling dates (Table 15). Significant interactions between the two factors (nitrogen fertilizer type and rate) also occurred. These results indicate that the use of an organic fertilizer (Milorganite®) significantly increased turfgrass cover during establishment compared to the mineral nitrogen source (ammonium nitrate). This supports conclusion found by Waddington, *et al.*, (1990); where, the use of an organic fertilizer increased turfgrass establishment in sandy soils that had low cation exchange capacity and nutrient availability.

Simply increasing the rate of nitrogen fertility significantly increased turfgrass cover. These results determined that 2.5 g N m^{-2} (every two weeks) using the organic fertilizer was required to increase turfgrass cover (Table 15). King and Skogley (1969) also concluded that increased nitrogen rates increased turfgrass growth or establishment rate.

Table 15. Fertility study – Effect of fertilizer type and rate on turfgrass cover† for establishing *Poa pratensis* within Ecomat® over plastic (seeded 11 June 1997), East Lansing, MI. 1997.

	Date			
	10 July	30 July	8 Aug.	8 Sept.
Fertilizer type (FT)	% cover			
Milorganite‡ (M)	11.4	29.0	31.5	35.5
Ammonium nitrate§ (AN)	3.9	14.3	12.7	14.9
LSD	*	*	*	*
Fertilizer rate (FR)				
1.25 g m^{-2} (A)	3.5	15.8	13.9	16.6
2.5 g m^{-2} (B)	9.1	21.6	23.6	26.2
5 g m^{-2} (C)	10.5	27.5	28.8	32.8
$LSD_{(0.05)}$	3.2	7.0	8.2	9.6
FT x FR				
M x A	2.6	14.8	13.6	15.6
M x B	15.2	33.0	38.0	42.0
M x C	16.6	39.2	43.0	49.0
AN x A	4.4	16.8	14.2	17.6
AN x B	3.0	10.2	9.2	10.4
AN x C	4.4	15.8	14.6	16.6
$LSD_{(0.05)}$	4.2	9.0	10.6	12.3

* Indicates significance at the 0.01 probability level.

† Turfgrass cover was visually estimated on a percent cover scale (0-100%).

‡ Milorganite® has a 6-2-0 analysis.

§ Ammonium nitrate has a 34-0-0 analysis.

No significant differences occurred in turfgrass cover when the post phosphorous and potassium application rates were doubled (Table 16). Again, this supports findings by King and Skogley (1969) where turfgrass response to different levels of phosphorous was inconsistent.

Finally, establishment results between the two types of mineral nitrogen sources (ammonium nitrate and urea) investigated had no significant differences occur in turfgrass cover (Table 16).

Table 16. Fertility study – Effect of increasing post phosphorous and potassium rates, or using urea nitrogen on turfgrass cover† for establishing *Poa pratensis* within Ecomat® over plastic, East Lansing, MI. 1997.

	Date			
	10 July	30 July	8 Aug.	8 Sept.
Phosphorous‡ rate	% cover			
1.25 g m^{-2}	2.0	10.2	9.8	11.8
2.5 g m^{-2}	7.2	16.2	17.2	20.2
LSD	ns	ns	ns	ns
Potassium§ rate				
1.25 g m^{-2}	1.8	10.2	9.8	10.8
2.5 g m^{-2}	3.6	18.6	13.8	15.6
LSD	ns	*	ns	ns
Nitrogen form 2.5 g m^{-2}				
Ammonium nitrate	2.4	10.2	9.8	14.2
Urea	4.6	17.8	18.8	24.6
LSD	ns	ns	ns	ns

* Indicates significance at the 0.01 probability level, ns = not significance at p = 0.05 probability level.

† Turfgrass cover was visually estimated on a percent cover scale (0-100%).

‡ Additional phosphorous was applied using super phosphate 0-46-0.

§ Additional potassium was applied using sulfate of potash 0-0-50.

DISCUSSION

Environmental:

Results from the two experiments are somewhat inconclusive, because weather and more importantly water played a critical role to decimate the outcome of the two studies. Unfortunately, the configuration of the experiments made watering a near impossible task. Conflicts in watering requirements between the two studies eliminated the practical application of the automatic irrigation system. Therefore, hand watering was necessary and became the primary method for irrigating. In addition, any rainfall that occurred flooded the plots (especially the fertility study). Often the plots were under water from rainfall or the irrigation. Conversely, if the plots were not flooded they were often too dry for proper seed germination and establishment.

Experiment one: Seeding study

It was determined that the seeding at four times the recommended seeding rate significantly increased turfgrass density. However, the repeated flooding and drying out of the plots as a result of the watering problems severely limited the potentials of each species. The poor outcome of the study eliminated the application of a secondary test to determine turfgrass maturity. Because the turves did not establish to an acceptable level (density), the intended root box study was abandoned. Root box pulls were to be done to determine the amount of rooting for each turf species investigated at the three different seeding rates. It was anticipated to find that, although the four times seeding rate provided the greatest turfgrass density that the plants were too immature as a result of over crowding. In turn, reduced rooting would be evident.

Experiment two: Fertility study

It is likely that the organic nitrogen source (Milorganite®) did significantly better than the mineral nitrogen source (ammonium nitrate) as a result of the test site being poorly drained. This in turn, led to too much water accumulating as a result of rainfall or too much irrigation. On many occasions the research plots were submerged under water for long periods of time (as long as 24 hours), and denitrification of the ammonium nitrate likely occurred; therefore, greatly reducing the amount of available nitrogen required for the germinating plants. However, it is likely that the poor results of the ammonium nitrate was because of runoff as a result of the repeated flooding that occurred (Waddington *et al.*, 1994). Denitrification probably did not occur because the decomposing carbon source and the chemoheterotrophic bacteria necessary to break down the nitrate were not present in the Ecomat® (Foth and Ellis, 1988). Conversely, if there were any effects from the ammonium nitrate fertilization, it would likely have caused toxicity (burn) to the immature seedlings. In addition, the high volume of Milorganite® may have been adding to the physical properties of the Ecomat®, and in turn providing a more favorable seedbed for turfgrass establishment.

Similar to the Seeding study, the application of a root box study to determine fertilizer effects on rooting was abandoned as a result of the unacceptable turfgrass density.