

# Evaluation of Phosphorus Rate and Mixing Depth on the Growth and Establishment of *Poa pratensis* L. in Sand-based Systems

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## Introduction

Phosphorus is highly immobile in most soils and is often a limiting factor for establishment (Ben-Gal and Dudley, 2003). Mixing phosphorus through the sand profile is thought to increase P availability and improve establishment during the first year of growth. Phosphorous application to lawns in Minneapolis, MN has been regulated. Phosphorus movement in sand based systems has not been well documented and the potential of phosphate movement into drainage systems is not understood. This study was conducted to evaluate 0, 146 and 293 kg P•ha<sup>-1</sup> at placement depths of 0, 7.6, 15.2, and 22.9 cm in a sand-based system.

## Materials and Methods

This study was conducted for 12-weeks in a greenhouse at Iowa State University in Ames, Iowa. The first study was conducted from November 2002 to January 2003 and the second conducted from March 2003 to June 2003.

Local mason sand that met the United States Golf Association (USGA) specification was used as the growing medium (USGA Green Section Staff, 1993). The sand was packed into a 7.62 cm diameter polyvinyl chloride (PVC) pipe lined with a clear plastic tube. Total energy of 3.03 J•cm<sup>-2</sup> was used for compaction of the root zone. The PVC pipe was capped at the bottom and the plastic tube tied off at the base with fine holes punched to facilitate drainage. The root zone depth was 30.5 cm and the holding tube was 38.1 cm long. The columns were sodded with mature sod of 'Unique' *Poa pratensis* L. Greenhouse day/night temperature was 22.2/19.4 °C. The average light level during the 16 hr photoperiod in the greenhouse was 833.8 microEinsteins • m<sup>-2</sup> • sec<sup>-1</sup>.

Pellett and Roberts (1963) nutrient solution designed for cool-season grasses, minus P, was used to provide proper levels of other essential elements in the root zone. Triple super phosphate (Ca(H<sub>2</sub>PO<sub>4</sub>)<sub>2</sub>) was used as the P source. Phosphorus was evaluated at 0, 146 and 293 kg P•ha<sup>-1</sup> and at four mixing depths (0, 7.6, 15.2, and 22.9 cm). Phosphorus was applied on November 4, 2002, and March 17, 2003. Grass clippings were taken from each tube at approximately two-week intervals. The clippings were oven-dried at a temperature of 67 °C for 24 h and weighed. At the end of the study, root dry weight was determined by washing and oven-drying root samples at 67 °C for 24 h (Steyn, 1959). Organic matter weight for roots was also measured at the end of the study. Oven-dried roots were ashed at 490 °C for 8 h in a muffle furnace (Jones and Case, 1990) and then weighed to determine organic matter. Total clipping P concentration was determined by using a modified Vanadomolybdophosphoric Acid Method (Kuo, 1990). This procedure was conducted by using a spectrophotometer (Spectronic 20+) following dry ashing at 490 °C in 1N aqua-regia. All leachate solution was collected from a cup under the PVC pipe for final nutrient analysis. Total P leaching concentration was analyzed by using a modified Vanadomolybdophosphoric Acid Method (Kuo, 1990) and a spectrophotometer (Spectronic 20+) was used to conduct this procedure.

The experimental design was a randomized complete block design with a split-plot arrangement. The treatments were whole columns with a factorial arrangement of P rate and mixing depth as subplots, replicated four times. The data were analyzed using the t-test procedures and mean separation was performed by the Standard Error of Difference (SED) method of the Statistical Analysis System (SAS, 1987). PROC MIXED was used for multiple factor analyses of variance.

## Results and Discussion

No difference was found in clipping dry weight, root dry weight, and root organic matter (Table 1).

No differences were found in P leached from the columns (Table 1). This varies from the observations of Larry (1999), who found that P leaching increased from 1 to approximately 14 mg•L<sup>-1</sup> with increasing P rate from 0 to 253 kg•ha<sup>-1</sup> in a sand-based system. This may also have been due to the very high irrigation level of 8.75 cm per week in the Larry study. Bacon and Davey (1982) and Kargbo et al. (1991) found that P mobility and availability is affected by relatively high moisture and high irrigation frequency which may lead to higher P loss than low moisture and frequency irrigation, especially in sand-based systems.

Grass treated with 293 kg P•ha<sup>-1</sup> produced 2-30% more P in the tissue than treatments of 146 kg P•ha<sup>-1</sup>, with the exception of the application placed at the 15.2 cm mixing depth (Table 2). Surface applications of 146 and 293 kg P•ha<sup>-1</sup> produced 8-10% and 16-20% more P in tissue than subsurface applications, respectively. However, no difference was found between applications applied to the surface and the 7.6 cm mixing depth. Phosphorus sufficiency level in mature leaves range from 2000-5000ppm (Mills and Johns, 1991). The treatments in this study produced sufficient P tissue levels ranging from 2277 ppm for 146 kg•ha<sup>-1</sup> at the 15.2 cm mixing depth to 2963 ppm for surface applied P at a rate of 293 kg•ha<sup>-1</sup>. The untreated control resulted in tissue levels of 1758 ppm P, which is below the sufficiency level for mature leaves.

Under the conditions of this study, there was no advantage to incorporating P in a sand-based media for Kentucky bluegrass sod establishment. Surface applied P increased the tissue levels of P, but had no effect on growth parameters.

**Table 1.** Summary of analysis of variance from the 2002 and 2003 greenhouse study about evaluation of phosphorous rate and mixing depth on the growth and establishment of *Poa pratensis* L. in sand-based systems.

Source	df	Total clipping dry weight	Root dry weight	Root organic matter	Total leached P	Total P in clippings
Year	1	NS	*	*	**	NS
Treatment	8	NS	NS	NS	NS	**
Rate	1	NS	NS	NS	NS	**
Depth	3	NS	NS	NS	NS	**
Rate * Depth	3	NS	NS	NS	NS	NS
Year * Treatment	8	NS	NS	NS	NS	NS

\*, \*\* Significant at the  $\alpha = 0.05$  and  $0.01$  probability level, respectively. NS = not significant

**Table 2.** Mean clipping phosphorous (P) ( $\text{mg}\cdot\text{kg}^{-2}$ ) of 'Unique' *Poa pratensis* L. with factors P rate and mixing depths averaged over replications.

Rate ( $\text{kg}\cdot\text{ha}^{-1}$ )	Mixing depth (cm)				SED <sup>z</sup>
	0	7.6	15.2	22.9	
Control	1758	—	—	—	103 <sup>y</sup>
146	2498	2502	2277	2308	130 <sup>x</sup>
293	2963	2871	2475	2556	

<sup>z</sup> SED : Standard error of difference.

<sup>y</sup> Value means standard error of difference for comparison between control and the other treatment.

<sup>x</sup> Value means standard error of difference for comparison among all treatments except control.

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