Phosphate requirements of creeping bent (*Agrostis stolonifera*) putting-green turf

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Abstract

Research was conducted to establish critical soil phosphate (P) and tissue P levels for the maintenance of creeping bent putting greens on sand based rootzone media. Three sands ranging in P buffering capacity ($PBC_{0.3}$) (Ozanne and Shaw, 1967) from 20 to 87 ml/g and three commercially available creeping bent varieties (Lofts L-93, Penn G-2, and SR1020) were used. Mitschelich type response curves were fitted to results. Soil P sufficiency ranges (Bray 2) at 90% relative yield (RY) were between 6.4 and 13.6 mg/kg. Tissue sufficiency ranges at 90%RY were between 3.47 and 3.88 mg/kg.

Media summary

Turf maintenance practitioners often apply more phosphate fertiliser than necessary. Our research provides improved recommendations for the maintenance of bent putting greens that should result in reduced phosphate inputs.

Key words

Phosphate, turfgrass, *Agrostis stolonifera,* creeping bent

Introduction

Phosphorus, absorbed in the form of the orthophosphate ion, is an essential element for plant growth. It is also an environmental pollutant if allowed to escape into surface or subsurface water bodies. Turfgrass species requirements for P have been the subject of previous trials but the variations in rootzone media, environment, and management practices have resulted in no meaningful recommendations for many turf situations. As a result, turf maintenance practitioners generally apply heavier P fertiliser applications than may be necessary.

Jones (1980) gives tissue P levels of between 0.30 and 0.55% as adequate for turf species, although he states that these are “based on general observations and therefore, not equally applicable to all turf or every growing condition or situation”. The species covered by the statement are not specified. Jones cautions against allowing tissue P concentrations to exceed 1% due to “adverse effects”. Waddington et al. (1978) found no growth response to P applied to creeping bent that had average tissue P levels of from 5.0 to 8.4 g/kg (0.50 to 0.84%).

Waddington et al. (1978) found little growth response of bent turf despite low soil test P levels. Christians et al. (1979) found no growth response of bent grown in sand culture and supplied with levels of solution P down to 2 mg/L.

There is a need for the establishment of critical soil test P levels for the maintenance of creeping bent putting greens constructed on sand based rootzones. There is also a need to establish critical tissue P levels for the maintenance of creeping bent under putting green conditions.

Methods and Materials

A yield trial was conducted in deep pots over a period of two years between October 2002 and October 2004. The trial consisted of 180 pots set up in a complete randomised block design. Each pot was constructed using 150 mm PVC drainage pipe 400 mm deep, and closed at the bottom by a layer of shade mesh. A layer of drainage gravel 100 mm deep was placed in the bottom of each pot.

Three rootzone materials with phosphate buffering capacities ($PBC_{0.3}$) varying from 20 to 87 ml/g as measured by the method of Ozanne and Shaw (1967) were selected, and a rootzone layer of 280 mm was placed over the gravel layer. The gravel and rootzone material were selected to comply with the United States Golf Association recommendations on rootzone material particle sizes and bridging factors.

Three commercial varieties of creeping bent (*Agrostis stolonifera*) were obtained as mature turf. The turf was cut into the shape of the pot, washed free of soil and placed on the rootzone. The turf was hand-clipped weekly and the clippings were collected and dried for 24 hours in an oven at 70^0C.

Nutrients were applied fortnightly using a nutrient solution based on that of Hoagland and Arnons No.2 solution. The solution was modified to provide five levels of phosphate: 0, 110, 221, 442 or 884 g/100 m^2/year, with all other nutrients being constant.

Samples were taken from each pot at eight-week intervals by extracting 8 cores with a 15.6 mm diameter corer to a depth of 75 mm. The cores were dried, crushed, and the fibrous grass and root material was removed by hand. Testing of soils for plant-available P was carried out using the Bray No 2 method (Bray and Kurtz 1945). The holes left by the coring process were filled with the same media as originally used and the surface very lightly topdressed.

Tissue analysis was conducted by digesting the dried clipping samples using the method of Hutton and Nye (1958) and analysing for P colorimetrically (Kitson and Mellon 1944).

A Mitscherlich type yield curve was fitted to the data using the Genstat? (6th Edition, 2002) data analysis software. The fitted curves took the form of $Yield = A + BR^{(Bray\ P\ or\ TissueP)}$

Results

Several months of growth were required before the clipping yields of the low P input pots decreased. This is attributed to stored P in the plants, which had previously been well fertilised, and P provided by the decomposition of residual thatch attached to the washed turf.

Visual symptoms of P deficiency appeared as thinning of the turf, a reduction in leaf width and a darkening of the leaf colour to a deep green, and in extreme cases, taking on a red tinge. The colour change was most noticeable during the winter months, and more pronounced in L-93 bent. Figure 1 shows the P deficiency symptoms for pots of L-93 bent that had Bray-2 extractable P levels of 3 mg/kg (left) and 10 mg/kg (right).

Figure 1. Deficiency symptoms of L-93 bent (left) compared with adequately fertilised turf (right).

Figure 2 shows the yield data from August-September 2003 with the fitted yield curve. As the fitted curve is an exponential curve, the critical Bray-2 P level has been taken at 90% of relative yield (RY). Table 1 summarises the critical soil test (Bray-2) P levels at 90%RY for all of the tested soil/bentgrass variety combinations.

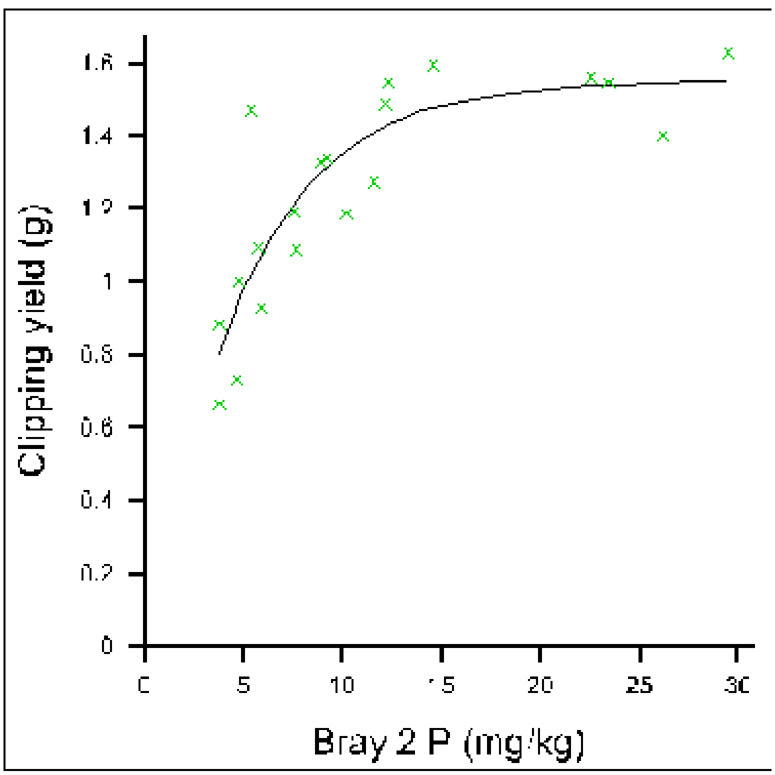

Fig. 2. August-September yield graph for L-93 bent growing in soil C.

Table 1. Critical soil test P levels from August-September 2003 clipping harvest.

Combination of variety and soil	Critical Bray-2 soil test P (mg/kg) for 90%RY
G-2 Soil A	7.31
G-2 Soil B	6.42
G-2 Soil C	9.09
L-93 Soil A	11.23
L-93 Soil B	6.83
L-93 Soil C	11.62
1020 Soil A	10.93
1020 Soil B	13.55
1020 Soil C	7.60

Figure 3 shows a sample of the data illustrating tissue P effect on the yield of G-2 bent in June-July 2003. Table 2 gives the critical tissue P levels at 90%RY for the three bent varieties in June-July 2003.

Table 2 June-July Critical tissue P levels (mg/kg) for 90%RY.

Variety	Critical level (90%RY)
Penn G-2	3734
Lofts L-93	3882
SR 1020	3469

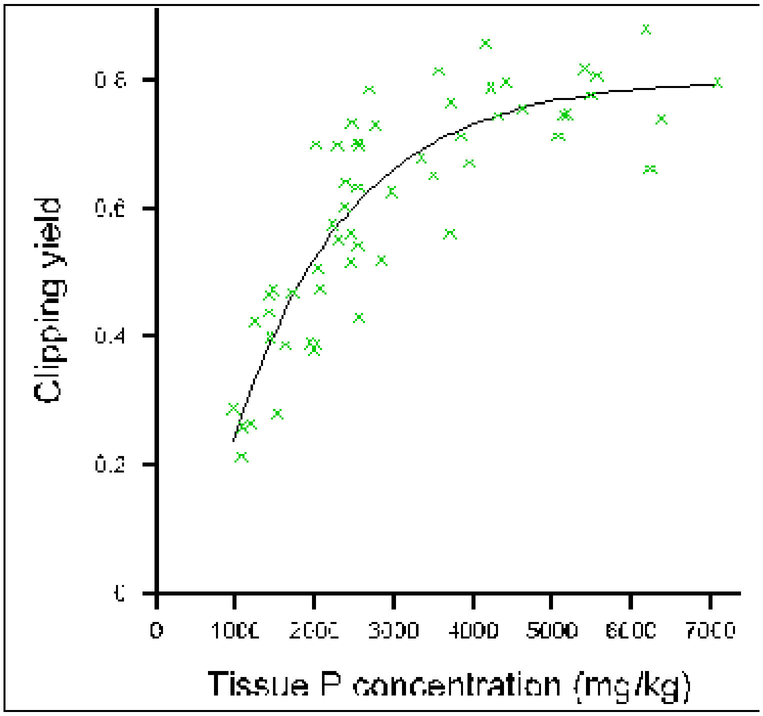

Fig. 3 June- July tissue P v clipping yield (g) of G-2 bent.

Conclusions

This trial indicates critical levels of Bray-2 extractable P of between 6 and 14 mg/kg at 90%RY. These levels are somewhat less than generally indicated in the literature.

Critical concentrations of tissue P for 90%RY ranged from 3400-3900 mg/kg. These results provide useful guidelines for diagnosing the P status of creeping bent.

Further testing to determine seasonal variation in critical levels, causes of variation between cultivars, and the influence of sampling method on soil test results is continuing. The phosphate buffering capacity of the soil-organic matter system will be undertaken at the end of the experiment as two years of production and decomposition of organic material would be likely to alter this property relative to the original soil.

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