Rootzone Amendments to Improve Soil Moisture Relations Under Newly-Laid Sod

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Introduction

Turf as newly-laid sod is at its most vulnerable in terms of the need to maintain moisture around the roots until deeper roots extend through the turf underlay medium. Newly laid sod also draws attention as a visible water user. At the community level, there is an increasing need to use water more efficiently as water shortages are encountered more frequently across Australia and in most developed and developing nations around the world.

The growth of urban populations, coupled with growing lifestyle expectations and periods of lower than average rainfall, is putting greater pressure on existing water supplies to the point where arbitrary water restrictions are being imposed for long periods by local authorities. In Australia, for example, the period allowed for watering of new lawns varies from zero weeks (previously six weeks under level two restrictions) in Melbourne to just two weeks in Brisbane (under both level two and three restrictions), decisions made without any independent research validation.

In recent years, a number of products have been developed aiming to improve soil water-holding capacity. Some of these are currently being marketed to enhance the establishment of newly-laid sod, but with little or no independent research to support manufacturers/distributors claims. These products include various water-holding crystals (cross-linked polyacrylamide gels, with or without added nutrients), starch- and organic-based materials, and more recently water-absorbent foam.

There is some anecdotal evidence locally that shallow placement of products helps establish turf more rapidly and with less water. Depending on the product, manufacturers' recommendations vary from mixing them through the underlay soil to enhance long-term root development to placing the product just below the laid sod where the immediate need for moisture is greatest.

Objectives

The aim of this project was:

1. To document the development of the root system of newly-laid sod through to establishment for three warm-season turfgrasses, as a basis for developing realistic guidelines for the establishment of new lawns; and

2. To investigate if the early need for regular watering can be reduced and the rate of establishment enhanced by placing water-holding amendments (incorporated into or broadcast on the underlay soil) below the sod before laying.

Materials and Methods

Experiments 1 and 2

Two short-term experiments each covering the establishment period (approximately eight weeks) for newly-laid sod were completed. In each case, the design was a 2 x12 x3 split-split-plot design with four overall replications arranged in completely randomised blocks.

- **Main plot:** Two watering regimes (watering daily or every second day with 4 mm of water to give 28 mm and 14 mm per week respectively).

- **First split:** Twelve soil amendment treatments (unamended control and eleven soil amendment treatments applied at different soil depths [Experiment 1] or different rates [Experiment 2]).

- **Second split:** Sod of three warm-season grasses; green couch (*Cynodon dactylon*) and buffalo grass (*Stenotaphrum secundatum*)—both fast rooting species, and zoysia (*Zoysia japonica*)—a slow-rooting species.

Eight independently programmable irrigated plots were installed to accommodate the eight main plots (two watering treatment x four replications). Within each main plot, Weed Mat® or black plastic was laid over the native soil and then 7.2 x 7.2m experimental area surrounded by 10cm thick sleepers. Split-plots (3.6 x 1.2m) of each soil amendment treatment were prepared within each blocked-off main plot. Sod of the three grasses was laid on 1.2 x 1.2m split-split-plots within each of the soil amendment treatments. After laying, each area was then watered to field capacity as per normal turf laying practice, and the two watering regimes then imposed. The turf was laid on 2nd March 2007 for Experiment 1 and on the 29th May 2007 for Experiment 2.

For Experiment 1, the soil amendment treatments were either applied to the surface of the sandy loam used or incorporated to a depth of approximately 50mm. USGA grade sand was used as the bedding material for Experiment 2 due to the good water holding capacity of the sandy loam used in Experiment 1. The soil amendments were again incorporated to a depth of 50mm for Experiment 2. As roots were found growing through the weed mat and accessing water stored in the native soil profile beneath each of the plots, the black woven polypropylene Weed Mat used in Experiment 1 was replaced by damp course black plastic sheeting for Experiment 2.

Irrigation in Experiment 2 was reduced to impose greater stress on the turf in an effort to elicit comparisons between the individual treatments. However, rainfall trends negated any imposed drought stresses.

Plate 1: Sampling *(left)* and washing roots *(right)* is time-consuming, but was the best way to document progressive root development under the establishing sod in the 276 different treatment combinations investigated.

Experiment 3

Root dry weight (g) (1-100mm, 100-200mm and total) for all treatments evaluated is presented in Table 1. There were no significant interactions between any of the main effects: time after laying (3, 6, 9 and 12 weeks), watering regimes (14 and 28 mm weekly) and soil amendment treatments. Consequently the data presented is pooled i.e. watering regime data pooled for the soil amendment treatments.

At three weeks after planting treatments 4, 6, 8, 9 and 11 produced the greatest total root dry weight (g), significantly ($p<0.05$) greater than the untreated control (Treatment 1). After six weeks of root growth, treatments 7, 9 and 11 produced a significantly (<0.05) greater total root dry weight than the untreated control. Treatments 6, 8 and 9 after nine weeks of root growth produced a significantly ($p<0.05$) greater total root dry weight (g) than the untreated control. At the final sampling (12 weeks), several treatments produced a significantly greater total root dry weight (g) than the untreated control, namely, treatments 6, 7, 8, 9, 10, 12 and 13.

Table 1. Root dry weight (g) of *Cynodon dactylon* (cv. Conquest™) sampled at 3, 6, 9 and 12 weeks after planting sod for 13 soil amendment treatments. Roots sampled from a USGA sand profile at depths of 0-100 mm, 100-200 mm and total soil profile (0-200 mm).

	3 Weeks			6 Weeks			9 Weeks			12 Weeks		
Treatment	0-100	100-200	Total	0-100	100-200	Total	0-100	100-200	Total	0-100	100-200	Total
1	1.46	0.3758$_{f}$	1.836$_{d}$	2.628	1.348$_{cd}$	3.975$_{d}$	2.5	1.637$_{de}$	4.137$_{de}$	2.369$_{cd}$	1.386$_{e}$	3.755$_{e}$
2	2.43	0.6907$_{ef}$	3.122$_{bcd}$	2.215	1.967$_{bcd}$	4.182$_{bcd}$	2.847	1.553$_{e}$	4.4$_{cde}$	2.855$_{abcd}$	1.812$_{bcde}$	4.666$_{cde}$
3	1.58	0.8212$_{cde}$	2.401$_{cd}$	2.326	1.725$_{bcd}$	4.051$_{cd}$	2.446	1.571$_{e}$	4.016$_{e}$	2.233$_{d}$	1.662$_{cde}$	3.895$_{e}$
4	2.81	0.4812$_{ef}$	3.295$_{abc}$	2.545	1.703$_{bcd}$	4.248$_{bcd}$	2.799	1.474$_{e}$	4.272$_{de}$	2.974$_{abc}$	1.508$_{de}$	4.482$_{de}$
5	2.46	0.3815$_{ef}$	2.837$_{cd}$	3.376	1.134$_{d}$	4.51$_{bcd}$	2.92	1.525$_{e}$	4.445$_{cde}$	2.884$_{abcd}$	1.578$_{de}$	4.462$_{de}$
6	3.00	0.743$_{ef}$	2.766$_{cd}$	3.261	2.129$_{bcd}$	5.39$_{bcd}$	3.096	2.494$_{bcd}$	5.59$_{abc}$	3.016$_{abc}$	2.394$_{abcd}$	5.411$_{abcd}$
7	2.02	1.2518$_{bc}$	4.255$_{ab}$	3.018	2.712$_{b}$	5.73$_{ab}$	2.815	2.60$_{bc}$	5.415$_{bcd}$	3.314$_{ab}$	2.529$_{abc}$	5.843$_{abc}$
8	3.00	1.196b$_{cd}$	4.191$_{ab}$	2.784	2.310$_{bc}$	5.094$_{bcd}$	3.025	3.70$_{a}$	6.725$_{a}$	3.515$_{a}$	2.994$_{a}$	6.508$_{a}$
9	2.47	2.0068$_{a}$	4.474$_{a}$	3.161	3.906$_{a}$	7.067$_{a}$	2.748	3.138$_{ab}$	5.886$_{ab}$	2.735$_{bcd}$	2.602$_{abc}$	5.338$_{abcd}$
10	2.08	0.734$_{ef}$	2.818$_{cd}$	2.621	2.596$_{b}$	5.216$_{bcd}$	2.268	2.281$_{bcde}$	4.549$_{cde}$	3.317$_{ab}$	2.748$_{ab}$	6.066$_{ab}$
11	2.64	1.5383$_{b}$	4.180$_{ab}$	2.951	2.636$_{b}$	5.588$_{abc}$	2.596	2.654$_{bc}$	5.25$_{bcde}$	2.936$_{abc}$	2.084$_{abcde}$	5.021$_{bcde}$
12	2.23	0.7973$_{def}$	3.025$_{bcd}$	2.608	1.757$_{bcd}$	4.365$_{bcd}$	2.731	1.863$_{cde}$	4.595$_{bcde}$	2.613$_{cd}$	2.578$_{abc}$	5.19b$_{cd}$
13	2.01	0.457$_{ef}$	2.469$_{cd}$	2.801	2.086$_{bcd}$	4.887$_{bcd}$	2.539	2.593$_{bc}$	5.132$_{bcde}$	3.027$_{abc}$	2.749$_{ab}$	5.776$_{abc}$
lsd (p=0.05)	ns	0.4421	1.33	ns	1.053	1.569	ns	0.8851	1.296	0.6888	0.9478	1.289

NB Values with the same letter are not significantly different from each other ($p<0.05$). ns = not significant

Plate 2 - Split columns enabled access to roots for examination and assessment of root mass.

Root dry weight (g) for each of the treatments at 0-100 and 100-200mm are graphically depicted in the complete research report available from TPI. There were no significant differences ($p>0.05$) between the treatments for root dry weight (g) where the roots were collected from 0-100mm at three, six and nine weeks after planting.

At 12 weeks after planting treatments 7, 8 and 10 produced a significantly ($p<0.05$) greater root dry weight (g) than the untreated control for the 0-100mm sampling.

At a depth of 100-200mm, treatment 9 produced a significantly ($p<0.05$) greater root dry weight (g) than all other treatments when sampled three weeks after planting. Additionally at six weeks after planting, treatment 9 produced a significantly greater ($p<0.05$) root dry weight at 100-200mm than all other treatments. This accounted for more than 50 percent of the total root dry weight (g) produced at this time.

Field Observation

The field observation was unreplicated; consequently, the data is not presented. Additionally, specifics are difficult to determine. Results tended to indicate that treatments 7, 8, 9, 10, 11, 12 and 13 may have allowed all turf species to survive for longer than all other treatments.

Discussion

The studies of water-holding soil amendments reported on here were directed at the establishment of newly laid turf. Consequently, the results relate only to the short term establishment phase (up to 12 weeks) and not any potential longer-term effects on soil water storage and turf water use. This area requires additional research and the likelihood of this additional research is currently being investigated.

The use of different soil underlay products resulted in inconsistent results. This was primarily due to the different water-holding capacity of each of the soil types used. The general consensus reached as a result was that there is no benefit to turf establishment if using soil amendment products where the soil already has a good water-holding capacity. This is evident in the results from Experiment 1 where little or no benefit was obtained by using soil amendments with a soil that had good water-holding capacity. There was no evidence to indicate whether the use of soil amendments will aid the long-term water-holding capacity of a good soil base.

The rapid development of turf grass roots at depth (100-200mm) is critical to the early establishment and survival of the turfgrass, particularly when there is a climate of water rationing as a result of prolonged drought. In Experiment 3, the use of soil amendment products in a sand-based soil profile resulted in roots getting down to 200mm within three weeks of laying. This provides the turfgrass with access to a greater reservoir of soil moisture that can then aid in the establishment of the turf. This will prove to be beneficial in instances where the supply of irrigation for establishment is restricted to a period of two to three weeks, which is the case where water restrictions are imposed due to the pressures of drought.

Some amendment products like the polyacrylamide gels come in different grades (fine, medium and coarse) according to their particle size range. The results of Experiment 2 where medium sized particles were used and inadequate incorporation occurred resulted in excessive expansion of the particles following heavy rainfall. Consequently, a fine grade product is desirable along with adequate incorporation of the crystals into the soil profile as opposed to applying the product at or near the sod/ soil interface.

Plate 3 (a) Polyacrylamide gel crystals can swell to their full extent following long periods of rain. (b) Concentrated applications of these can cause surface stability problems and disrupt turf establishment.

Experiments 1 and 3 showed that turf establishment was more responsive to the products at higher application rates. The higher rates also increased the risk of surface stability problems and influenced, detrimentally, turf establishment as experienced in experiments 1 and 2. The soil provides both air and water to the turfgrass roots, and a proper balance between moisture and air in the soil must be maintained for healthy growth. The soil amendment products, when wetted up, take up air spaces in the soil profile. To what extent this has a detrimental effect on the growth and establishment of the turf is unknown. The results from this series of experiments gave no insight into how air/water balance in the soil is affected by the use of these products.

Further research is needed to document the long-term effects on soil water storage and turf growth and water use following the incorporation of water-holding soil amendment products into the soil during establishment. In particular, there is a need to establish independent moisture release curves to determine how much of the water that is held by these various products is actually made available to plants.

There are also questions as to how long these various products remain effective in the soil and how further product might then be re-incorporated in an established turf profile and at what cost – all of which only goes to emphasize the need to start with a good soil profile as the long-term base for your new lawn.