THESIS

EFFECTS OF TOPDRESSING ESTABLISHED KENTUCKY BLUEGRASS WITH COMPOSTED MANURE

Submitted by

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WE HEREBY RECOMMEND THAT THE THESIS PREPARED UNDER OUR SUPERVISION BY GRANT A. JOHNSON ENTITLED EFFECTS OF TOPDRESSING ESTABLISHED KENTUCKY BLUEGRASS WITH COMPOSTED MANURE BE ACCEPTED AS FULFILLING IN PART REQUIREMNETS FOR THE DEGREE OF MASTER OF SCIENCE.

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ABSTRACT OF THESIS

EFFECTS OF TOPDRESSING ESTABLISHED KENTUCKY BLUEGRASS WITH COMPOSTED MANURE

Concerns about water quality issues surrounding nutrient loading into surface and ground water from agricultural manure applications have contributed to the increasing interest in composting manure and topdressing it on turfgrass to alleviate manure pollution. Little information is available regarding the effects of composted dairy manure topdressings on established turfgrass. The objectives of this research were to evaluate the effects that topdressing composted manure has on: (i) turfgrass growth and quality, (ii) soil physical and chemical properties, (iii) turfgrass quality and soil moisture content during periods of dry down, and (iv) nutrient runoff and leaching during simulated rainfall event. Compost was topdressed onto three cultivars ('Nuglade', 'Livingston', and 'Kenblue') of established Kentucky bluegrass (*Poa pratensis* L.) at rates of 0, 33, 66, and 99 m^3 ha^{-1}, twice in 2003 and once in 2004. A synthetic fertilizer (Urea 46-0-0) was added to help balance inorganic N rates among treatments.

Compost treatments had 6-10% higher quality than the control during the growing seasons, produced 18-56% higher clipping yields in late summer months, and helped retain turfgrass color longer into the fall and allowed for faster spring green up. Compost treatment 99 m^3 ha^{-1} reduced surface soil (0-3 cm) bulk density by 5.3% and increased water retention by an average of 14.2% over all tensions tested. Compost treatments increased soil P, K, Fe and Mn in the 0-10cm depth. During 10-day dry down periods, compost treatment increased soil moisture in the 15-30 cm soil depth during the first 2-3 days, which in turn, increased soil moisture in the 0-15 cm depth towards the end of dry down and led to 1.2-3.3 °C lower canopy temperatures compared to the control. Runoff collected revealed no differences in NO3-N or total phosphorus concentrations among treatments, and mean NO_3-N concentrations (6.5 mg L^{-1}) were below the EPA standards, while mean TP concentrations (1.1 mg L^{-1}) slightly exceeded EPA standards. No differences in leaching potential occurred among treatments.

From these results it is recommended that manure compost be topdressed to Kentucky bluegrass at an optimal rate 66 m^3 ha^{-1}, which provided good quality throughout most of the year.

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CHAPTER 1

EFFECTS OF COMPOST TOPDRESSING ON TURFGRASS GROWTH, QUALITY, AND ROOTING CHARACTERISTICS

ABSTRACT

Recent interest in utilizing compost on turfgrass has been prompted due to concerns over the increased use of synthetic fertilizers on the environment and the generation of the increased amounts of animal waste. The objectives of this research were to evaluate the effects that topdressing composted manure has on: (i) turfgrass quality, (ii) turfgrass growth rates, and (iii) root mass and distribution. Compost treatments of 0, 33, 66, and 99 m^3 ha^{-1} were topdressed onto three cultivars ('Nuglade', 'Livingston', and 'Kenblue') of Kentucky bluegrass (*Poa pratensis* L.) in May and September 2003 and May 2004. A synthetic fertilizer (Urea 46-0-0) was applied to balance inorganic nitrogen rates among treatments. Topdressing compost at 66 and 99 m^3 ha^{-1} increased the overall quality by 10% of all three turfgrass cultivars for at least 12 weeks during the growing season, and allowed the turfgrass to retain color in the fall and early winter and green up faster in the spring. During the late summer months, the 66 and 99 m^3 ha^{-1} compost treated plots had 48 and 56% higher clipping yield than the control, respectively. No differences in rooting mass among treatments were detected in the 0-50 cm depth. These results suggest that compost can improve turf quality and growth via its action as a slow release fertilizer.

INTRODUCTION

Until the 1930's, composted organic amendments served as one of the principal sources of fertilizer used on golf courses (Piper and Oakley, 1921; Welton, 1930; Garling and Boehm, 2001). However, the use of compost and manure on turfgrasses declined sharply with the creation of synthetic, urea-based fertilizers that offered more consistent and predictable nutrient-release characteristics (Garling et al., 2000). Recently there has been renewed interest in utilizing compost on turf because of concerns over the increased use of synthetic fertilizers on the environment and the generation of the increased amounts of animal waste and bio-solids, especially in urban/rural interfaces.

Composting cattle manure has been shown to have a number of agronomic benefits, including a reduction in material mass and water content, pathogen suppression, decreased weed seed viability and the production of a stabilized organic material that is easier to spread (Eghball and Gilley, 1999; Eghball and Lessing, 2000; Parkinson et al., 2004). Composting manure is a useful method of producing a stabilized product that can be stored or spread with little odor or fly breeding potential (Sweeten, 1988).

Most confined animal feeding operation (CAFO) managers are aware of composting, but tend to perceive it as too expensive, too labor intensive, or logistically impossible (DeLuca and DeLuca, 1997). Until recently there has been little focus on composting as a means of manure management. During the composting process, the C and N present in the manure is converted into more stable organic and humified forms. This allows compost to maintain greater nutrient content and lower pollution potential during storage and after application (Brinton, 1985; Hervas et al., 1989; Herbert et al., 1991; Magdoff, 1992; DeLuca and DeLuca, 1997). Decomposition that occurs during composting also reduces total material mass and volume of the original compost mixture due to CO_2 and water loss (DeLuca and DeLuca, 1997). The lower moisture content of composted manure makes it easier to handle and to transport.

Although the N content of compost is generally lower than that of raw manure, more of the N in composted manure exists in stable organic forms, thus N losses during storage and during and after field application of compost are minimized (Paul and Beauchamp, 1993; DeLuca and DeLuca, 1997). The process of manure composting can yield very different products based on the way the manure was treated.

A study conducted by Garling et al. (2000) focused on the use of biosolid compost as a topdressing material on low cut turf. They found that topdressing compost at a rate of 32 m^3 ha^{-1} significantly increased foliar nitrogen by about 50 % when compared to the control. In addition, compost treatments also enhanced turfgrass color for 6-8 weeks after each application. Angle et al. (1981) showed that the quality of the turf increased with both time and the compost amendment rate during sod establishment. The increase in quality rating was attributed to increased amounts of nutrients from the compost.

In a different study, Garling and Boehm (2001) examined 1) the effects of biosolid compost and inorganic fertilizer application on turfgrass color and growth, 2) the duration and magnitude of biosolid compost topdressing on foliar N concentrations, and 3) the interaction of compost and fertilizer applications on foliar N concentrations. Nitrogen was applied as inorganic fertilizer at rates of 96, 192, and 384 kg N ha^{-1}. Compost topdressings were applied and brushed in during May and September at a rate of 32 m^3 ha^{-1} for three growing seasons. The results showed that compost topdressing significantly increased turfgrass color, growth, and foliar N concentrations. Color enhancement lasted for up to 8 weeks. In addition, inorganic applications of fertilizer also significantly enhanced turfgrass color and foliar N content. Clipping yields were significantly increased with both compost and fertilizer treatments. This study showed that compost could compete with inorganic fertilizers in the ability to enhance turfgrass color and growth.

In this study, we hypothesize that: 1) topdressing composted manure will meet the fertility needs of turfgrass to produce acceptable aesthetic quality, 2) as compost rates increase, growth rates will increase (measured by dry mass), and 3) higher compost rates will lead to more root mass, due to high levels of P that compost provides.

The objectives of this study were to evaluate the effects that topdressing composted manure onto established Kentucky bluegrass has on: (i) turfgrass quality, (ii) turfgrass growth rates, (iii) clipping water content, and (iv) root mass and distribution.

METHODS AND MATERIALS

This experiment was set up at the Colorado State University Horticulture Research Farm, located in Fort Collins, CO. The study site has a Nunn clay loam (fine, smectitic, mesic Aridic Argiustolls). The climate is semi-arid with an average annual precipitation of 365 mm. There were 36 turf plots arranged in a randomized complete block design, each measuring 1.2 by 1.8 m. Each block was made up of twelve plots, including three cultivars ('Livingston', 'Kenblue', and 'Nuglade') of Kentucky bluegrass (*Poa pratensis, L.*) and each replicated 3 times in which four compost treatments would be applied. Plots were initially established using a seeding rate of 74 kg ha^{-1} in the fall of 1998. Between 1999 and 2002, fertilization at 148 kg N ha^{-1} was applied annually. Weeds located directly in the plots were picked out by hand, while Round-Up® (glyphosate) was applied at the labeled rate four times per growing season to control weeds outside of the plots and maintain 0.3 m spacing between plots.

Before any compost treatments were applied, soil samples were taken in late April 2003 using a truck-mounted Giddings Hydraulic Soil Probe (#15-SCS Model GSRPS, Giddings Machine Company Inc., Windsor, CO) at depths of 0-10, 10-20, 20-30, 30-40, and 40-50 cm below the turf surface to establish baseline soil information. The plots were then core aerated using a Toro Greens Aerator (model 09120) with tine spacing 6.4 cm W x 5.7 cm L. Three plots in the 'Kenblue' cultivar were not aerated in order to determine the effect of aeration on turfgrass drought response. Following core aeration, four compost treatments (0, 33, 66, and 99 m^3 ha^{-1}) were randomly assigned to 'Nuglade' and 'Livingston' plots. For 'Kenblue', treatments included two controls, one aerated and one non-aerated, and two compost treatments of 66 and 99 m^3 ha^{-1}. All cultivar x compost treatments were replicated three times. The density of the compost was 958.7 kg m^{-3}.

From the beginning of May through the end of September 2003 and 2004, irrigation was applied twice weekly, delivering 4.1 cm of water per week. Electrical conductivity (EC) and sodium adsorption ratio (SAR) of the irrigation water were 2.8 dS m^{-1} and 1.8, respectively. Other chemical properties are shown in Table 1.1. Approximately 50 kg NO_3-N ha^{-1} was added to the turf from the irrigation water annually. Irrigation ceased three times for tens days to allow for turf dry down evaluation (Please see chapter 3).

When topdressing compost onto the turfgrass, a known volume of compost was spread onto the turf surface as evenly as possible, then swept into the grass and aeration holes with a broom. The compost used was produced from organic dairy cattle manure, obtained from Colorado Compost in Windsor, Colorado. The analysis of the compost is presented in Table 1.2. These treatments were applied in May 2003 and 2004, and also in September 2003.

To make all treatments balanced in inorganic nitrogen (IN), the compost was analyzed for both nitrate nitrogen and ammonium nitrogen (NO_3-N + NH_4-N) contents in the Soil, Water, and Plant Testing Laboratory at Colorado State University (Table 1.2). This analysis showed that treatments 33, 66, 99 m^3 ha^{-1} received 18, 36, and 54 kg inorganic N ha^{-1} yr^{-1}, respectively. However, this does not take into account the slow break down and release of N from organic sources in the compost. Urea (46-0-0) was applied at rates of 61, 38, and 19 kg N ha^{-1} yr^{-1} to treatments 0, 33 and 66 m^3 ha^{-1} respectively, to help balance inorganic N rates. Table 1.3 represents all sources of N applied during the experiment and shows total inorganic nitrogen (TIN) applied. The total P applied from compost was 172, 344, and 516 kg ha^{-1} yr^{-1} and the total K applied from compost was 911, 1822, and 2734 kg ha^{-1} yr^{-1} for treatments 33, 66, 99 m^3 ha^{-1}, respectively. The control plots did not receive any supplemental P or K during the duration of the experiment.

Plots were mowed once a week during the growing season at 6.4 cm height. Clippings were collected four times per growing season to determine growth and clipping water content. The rest of the time the clippings were allowed to recycle into the turf. To collect the clippings, a mesh bag was placed over the debris exhaust of the mower, and secured with a bungee cord. Each plot was mowed separately and collection area was 0.22 m^2. Following the collection, clippings were weighed within 30 min. to obtain their fresh weight, placed into an oven at 70 °C for 48 h, and then weighed to determine dry weight. The following formula was used to calculate clipping water content (CWC).

$$CWC= [(F_w-D_w)/F_w]*100\%,$$

where F_w is clipping fresh weight, and D_w is dry weight.

Visual turf quality was rated monthly throughout the experiment based on color, density, and uniformity using a scale of 1 (brown, dead turf) to 9 (optimum color, dense, and uniform turf), with a rating of 6.0 or higher indicating acceptable quality. Roots were sampled in early September of 2003 and 2004 using a truck mounted Giddings Hydraulic Soil Probe (#15-SCS Model GSRPS, Giddings Machine Company Inc., Windsor, CO), at depths of 0-12.5, 12.5-25, 25-37.5, and 37.5-50 cm using a 5.5 cm diameter probe. Samples were placed in zip-lock plastic bags and placed in a cooler. A hydro-pneumatic elutriation system was used to wash and separate the roots from the soil.

After all the roots were collected, tiny pebbles and rhizomes were hand removed with tweezers. The roots were then placed in an oven at 70 °C for 48 h, and root dry mass was determined by weighing.

Statistical Analysis

Turf quality, clipping yield, and root mass were subjected to analysis of variance using SAS Proc GLM (SAS Institute, 2002) to test effects of compost treatments within individual dates. Means were separated using a protected LSD at $P \leq 0.05$. Data on CWC were combined because no significant interaction between date and treatment existed.

RESULTS AND DISCUSSION

Turf Quality

Turf quality of 'Nuglade' Kentucky bluegrass over two growing seasons is shown in Figure 1.1. After the initial compost and fertilizer applications were applied in May 2003, there was no difference among treatments in June. However, treatment effects became significant from July through December 2003. The compost treatments at 66 and 99 m^3 ha^{-1} had better quality than the control during July and August. The second compost application was made in mid-September. The compost treatments were able to retain color longer into the fall and early winter months. In January through March 2004, no difference among treatments was observed. In April and May 2004, 'Nuglade' Kentucky bluegrass with compost treatments greened up earlier and had better quality, compared to the control. After the third compost and second fertilizer applications were made, there were no differences among treatments in June 2004. As seen during the first growing season, the compost treatments at 66 and 99 m^3 ha^{-1} had better quality than the control during July and August. During September through November 2004 the two highest compost treatments 66 and 99 m^3 ha^{-1} were able to maintain better quality than the 33 m^3 ha^{-1} treatment and the control.

Similar results and seasonal trends occurred with the 'Livingston' cultivar (Fig. 1.2). At the beginning of the experiment there was no difference in quality among treatments. Starting in July and continuing through November 2003, the compost treatments 66 and 99 m^3 ha^{-1} had better quality compared to the control. There was no difference among treatments from December 2003 through March 2004. In the spring months of April and May 2004, compost treatments 66 and 99 m^3 ha^{-1} started greening up earlier and had better quality than the control. After the 2004 spring application of compost and fertilizer, no differences were detected in June or July. In August and September 2004, the compost treatments 66 and 99 m^3 ha^{-1} regained a higher quality than the control. Even though there was no compost application in the fall of 2004, the treatments 66 and 99 m^3 ha^{-1} were able to maintain better color than the 33 m^3 ha^{-1} treatment and the control into November.

For 'Kenblue', treatments included two controls, one aerated and one non-aerated, and two compost treatments at 66 and 99 m^3 ha^{-1}. Throughout the study period (2003-2004), we did not find significant difference in turf quality between the aerated and non-aerated controls. Compost application increased turf quality of 'Kenblue' Kentucky bluegrass on most evaluation dates, following the same trend as the other two grasses (Fig. 1.3). In July 2003 the two treatments 66 and 99 m^3 ha^{-1} had better quality than the non-aerated control, and in August 2003 the compost treated plots had better quality than both of the controls. After the fall compost application was made, the treatments 66 and 99 m^3 ha^{-1} maintained a better color into December 2003. No differences were present from January to March 2004. As seen before, the compost treated plots greened up earlier in April and May 2004. After the third compost and second fertilizer applications were made in June 2004, no differences existed for the rest of the month. However, in July and August 2004 the compost treatments had better quality than both of the controls. They were also able to maintain a better quality into November 2004.

Clipping Yield and Water Content

Clippings were collected four times during each of the 2003 and 2004 growing seasons as a means of quantifying growth. For 'Nuglade' and 'Livingston' Kentucky bluegrass, there was no difference in the clipping yield for either clipping collected in June 2003 (Fig. 1.4 and 1.5). However, in July 2003 the 66 and 99 m^3 ha^{-1} compost treated plots had 47% and 48% higher clipping yield compared to the control, respectively. In early August 2003, the 66 and 99 m^3 ha^{-1} compost treated plots yielded 30% and 46% more growth than the 33 m^3 ha^{-1} treatment, and had 53% and 71% higher clipping yield than the control, respectively. The same pattern was observed in 2004, with no significant difference in clipping yield during the first two samplings. In late July, compost treatments of 66 and 99 m^3 ha^{-1} increased clipping yield by 45% and 53% compared to the control, respectively. In August, the 66 and 99 m^3 ha^{-1} treatment yielded 33-48% more clippings than the 33 m^3 ha^{-1} treatment and 48-65% more than the control.

The same trend held true for the 'Kenblue' cultivar, having no differences during the first two collections of 2003 or 2004 (Fig. 1.6). In July 2003, the clipping yield of 66 and 99 m^3 ha^{-1} treatments were 30% and 31% higher than the aerated control, and were 44% and 45% higher than the non-aerated control, respectively. In August 2003, compost treatments 66 and 99 m^3 ha^{-1} increased yield by 26% and 32% compared to the aerated control and 33 % and 40 % compared to the non-aerated control. During July 2004, the 66 and 99 m^3 ha^{-1} treatments increased yield by 63% and 69% compared to the aerated control and were 55% and 60% higher than the non-aerated control, respectively.

Clipping collection in August 2004 showed that compost treatments 66 and 99 m^3 ha^{-1} increased yield by 63% and 56% over the aerated control and 65% and 58% over the non-aerated control, respectively. On all sampling dates, aeration had no significant affect on the amount of clipping yield.

Unlike clipping yield, compost treatments had no effect on CWC in any of the cultivars (Fig. 1.7), regardless of growth rates. Clipping water content ranged from 58 to 63 %, which was lower than expected. One reason for this could be because clippings were collected with a rotary mower that might also pick up any dead or dying tissue in the canopy, which would reduce the CWC. Another reason the CWC was lower than expected could be due to the fact that clippings were placed into paper bags and ~30 min passed before they could be weighed. The paper bags probably absorbed some of the moisture escaping from the cut leaves.

The reason that the compost treatments had higher quality and increased growth throughout most of the experiment is thought to be due to a fertility effect. Nitrogen is the key element due to its influence on color, growth rate, and density (McCarty, 2001). A study conducted in Nebraska by Eghball and Power (1999) estimated that the fraction of organic N mineralized in a cornfield in the year of application was about 18%. If this estimate were applicable to our current study, then about 71, 142, and 213 kg ha^{-1} N were released from organic N of compost in 2003, and 35, 70, and 106 kg ha^{-1} N released in 2004 from the 33, 66, 99 m^3 ha^{-1} treatments, respectively. It is believed that compost treatments provided additional long-lasting N through the organic form of N that mineralized over time. Bilgili and Acikgoz (2005) showed that turf color and quality were associated with N fertility treatments, and that increasing N significantly enhanced the color and ratings of several turf mixtures. In addition, it has been shown that N applications in fall increased winter and early-spring coloration as compared to an unfertilized control (Oral and Acikgoz, 2001; Bilgili and Acikgoz, 2005), which is in agreement with the findings of this study.

Besides nitrogen, other essential elements, especially phosphorus (P) and potassium (K) present in the compost might have also played a role in overall quality. Phosphorus and K were not applied in control with a synthetic fertilizer, but substantial amounts were present in the compost (Table 1.2). Since phosphorus and potassium availability from manure compost is high (ranging from 52%-100%) (Eghball et al., 2002), we expect substantial amounts of P and K in the compost became plant-available after application. This assumption is supported by soil K and P tests conducted at the end of the study (details are reported in Chapter 2). At the termination of the study, surface (0-10 cm depth) soil P increased from 1.4 mg kg^{-1} (very low) to 4.3 mg kg^{-1} (medium level) and K increased from 340 mg kg^{-1} to 840 mg kg^{-1} with 66 and 99 m^3 ha^{-1} compost treatments.

The compost provided P and K to the turf, which could have improved the overall quality, compared to the control. Phosphorus is the second most essential element for plant growth and it is involved in the transfer of energy as the organic compound, adenosine triphosphate (ATP), during metabolic processes. Potassium is directly involved in maintaining the water status of plants, turgor pressure of cells, and the opening and closing of stomata. In addition, a fall application of compost allowed the turf to hold its color longer in the winter and also green up faster in the spring. However, due to the high P and K content in composted manure, repeated application over time may result in increased soil salinity, and continued P accumulation in the soil may possibly increase P runoff.

These findings coincide with the results of the study conducted by Garling and Boehm (2001), which evaluated the effects of composted biosolids and inorganic fertilizer application on turfgrass color and growth. Their results showed that compost topdressings significantly increased turfgrass color and growth. Color enhancement lasted for up to 8 weeks for plots receiving just composted biosolids and up to 5 weeks for plots receiving the blended composts. In either case, the higher application rates led to increased turf color and foliar N. Angle et al. (1981) also showed that both turf quality and growth of a Kentucky bluegrass and red fescue mixture increased with time and increased compost application rate. The increase in quality rating was attributed to the amounts of nutrients that the compost provided to the turf.

Roots

No significant differences in root mass existed among any of the treatments at any of the sampled depths in the fall of 2003 or 2004 (Fig. 1.8 and 1.9). There was also no difference between years. However, it was very apparent that the majority of the roots were distributed in the 0-12.5 cm depth. As expected, root mass dropped drastically in deeper depths. Turfgrasses have fibrous root systems with most of the roots being in the upper 10 cm of the soil (Qian et al., 1997). The fine texture and fibrous nature of turfgrass root systems make it difficult, tedious, and time consuming to measure root depth, extent, and distribution (Erusha et al., 2002).

Conclusions

Topdressing compost at rates of 66 and 99 m^3 ha^{-1} significantly increased the overall quality of all three turfgrass cultivars for at least 12 weeks during the growing season. Composted manure applications allowed Kentucky bluegrass to retain color in the fall and early winter and green up faster in the spring. Additionally, compost treated plots produced higher clipping yields, compared to the control. These results suggest that compost may act as a slow release fertilizer, providing nutrients throughout the growing season. However, compost treatments did not increase root mass as originally hypothesized.

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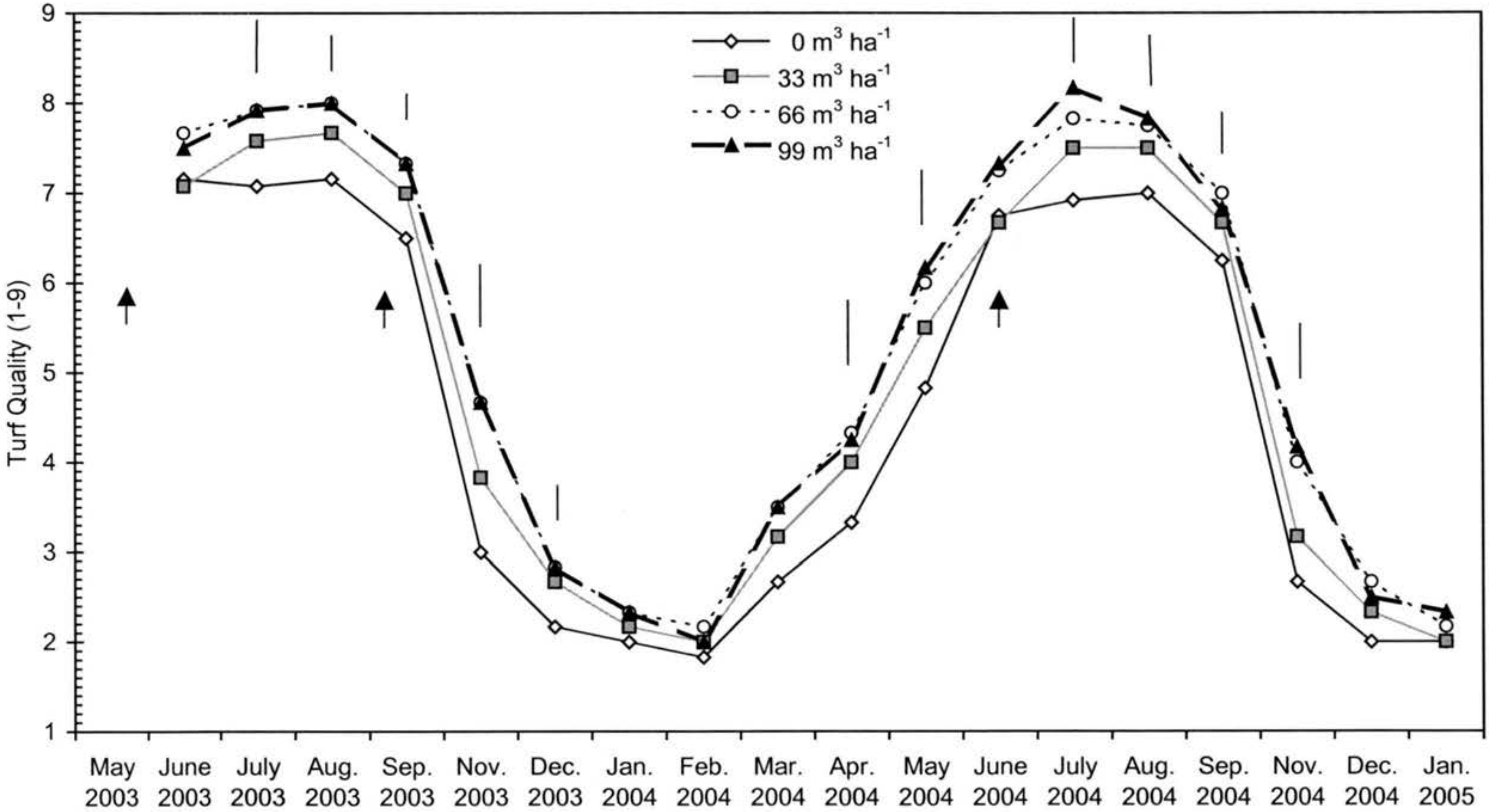

Figure 1.1 Turf quality of 'Nuglade' Kentucky bluegrass from May 2003 to January 2005. Ratings are means of three replicates. Bars indicate least significant difference (LSD) for individual dates where differences among compost treatments were significant at $P \leq 0.05$. Arrows indicate compost applications.

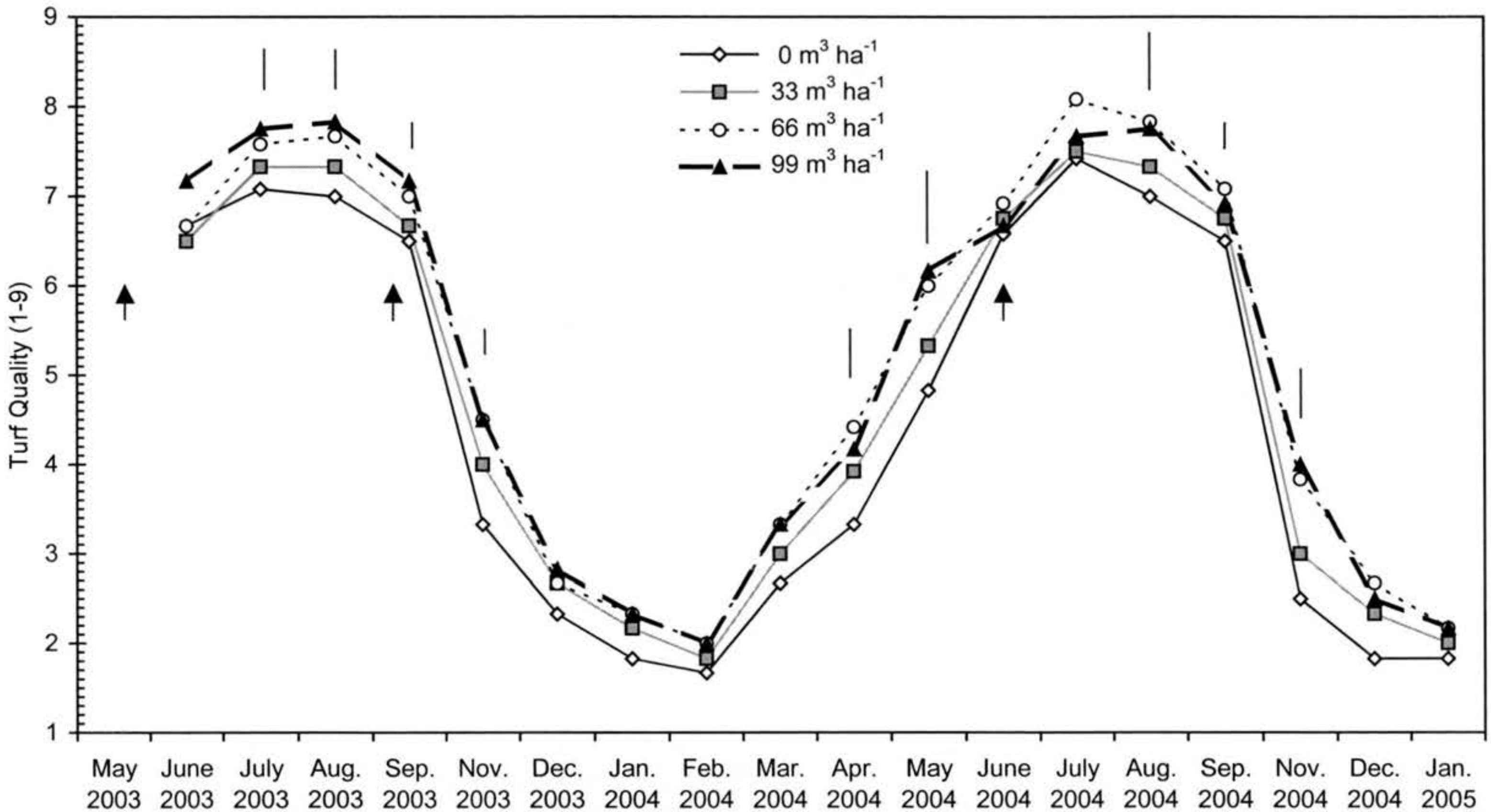

Figure 1.2 Turf quality of 'Livingston' Kentucky bluegrass from May 2003 to January 2005. Ratings are means of three replicates. Bars indicate least significant difference (LSD) for individual dates where differences among compost treatments were significant at $P \leq 0.05$. Arrows indicate compost applications.

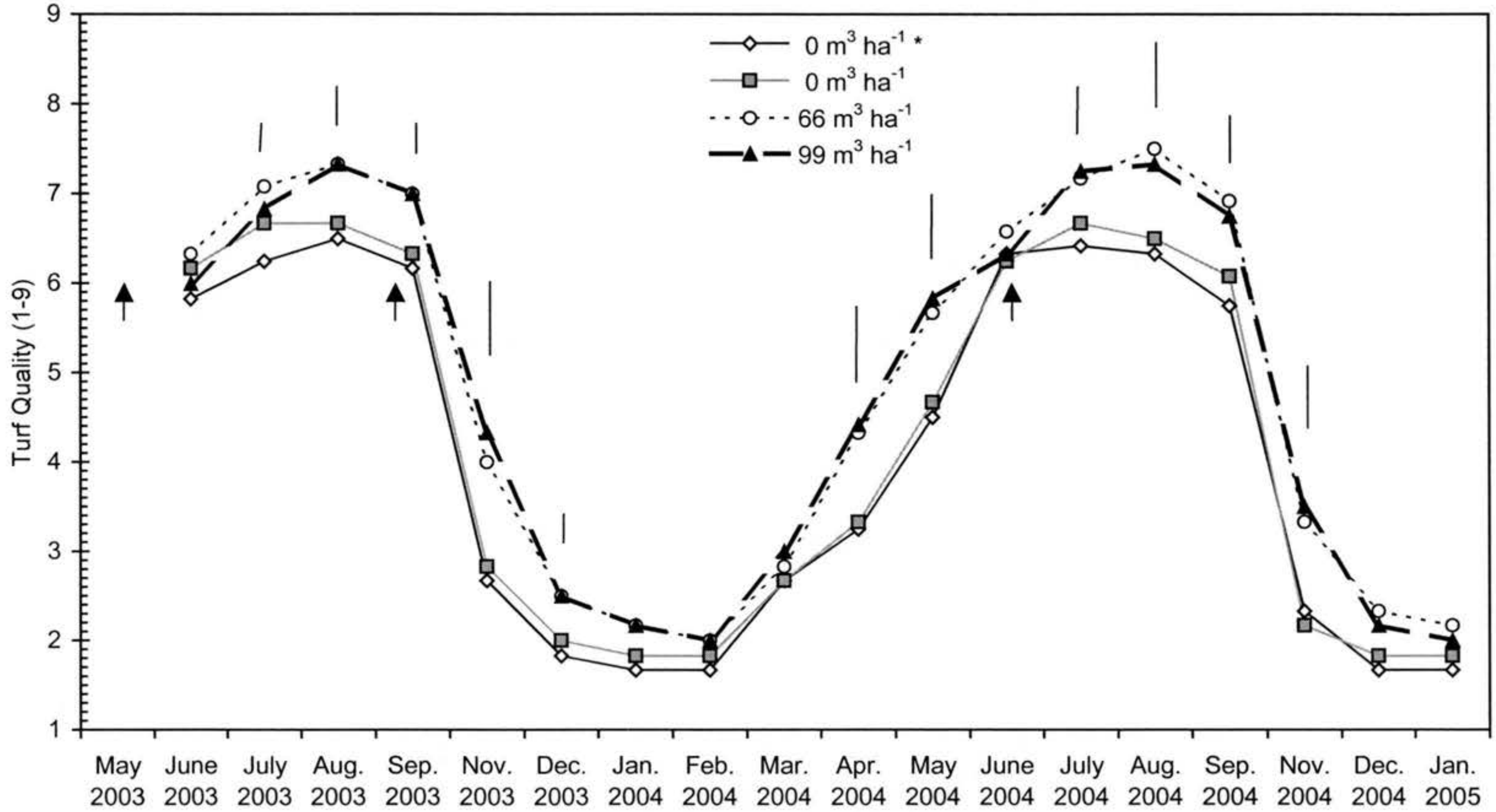

Figure 1.3 Turf quality of 'Kenblue' Kentucky bluegrass from May 2003 to January 2005. Ratings are means of three replicates. Bars indicate least significant difference (LSD) for individual dates where differences among compost treatments were significant at $P \leq 0.05$. Arrows indicate compost application. *Represents treatment that was not aerated over the course of the experiment, whereas all other treatments were aerated twice per growing season.

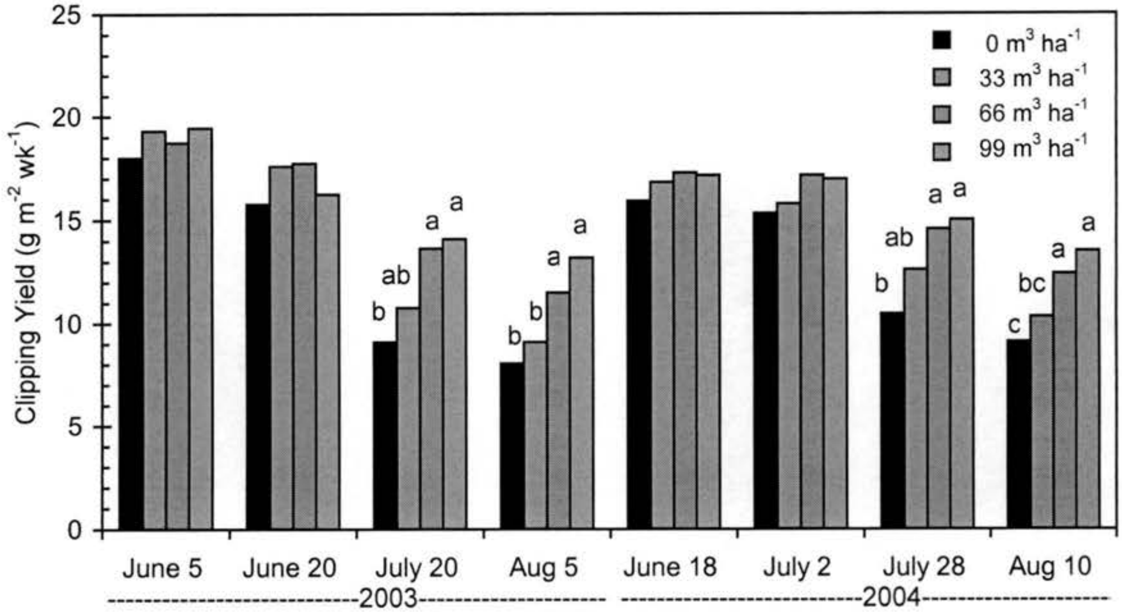

Figure 1.4 Clipping yield (g m^{-2} wk^{-1}) of 'Nuglade' Kentucky bluegrass during growing seasons 2003 and 2004. Each bar represents the mean of three replicates. Bars labeled with different letters were significantly different at $P \leq 0.05$.

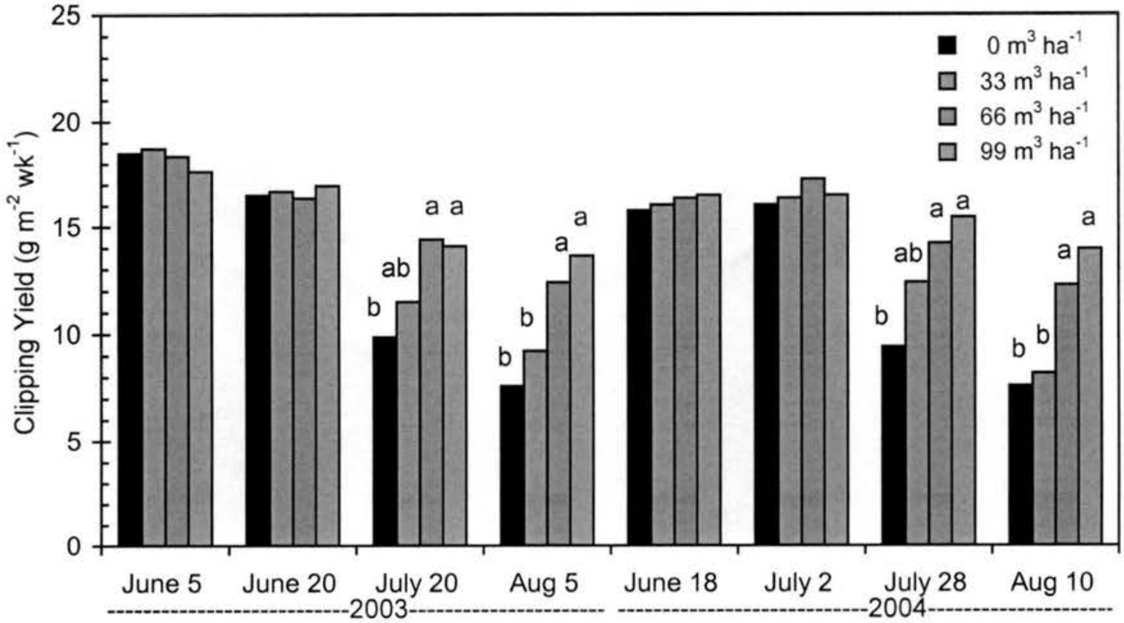

Figure 1.5 Clipping yield (g m^{-2} wk^{-1}) of 'Livingston' Kentucky bluegrass during growing seasons 2003 and 2004. Each bar represents the mean of three replicates. Bars labeled with different letters were significantly different at $P \leq 0.05$.

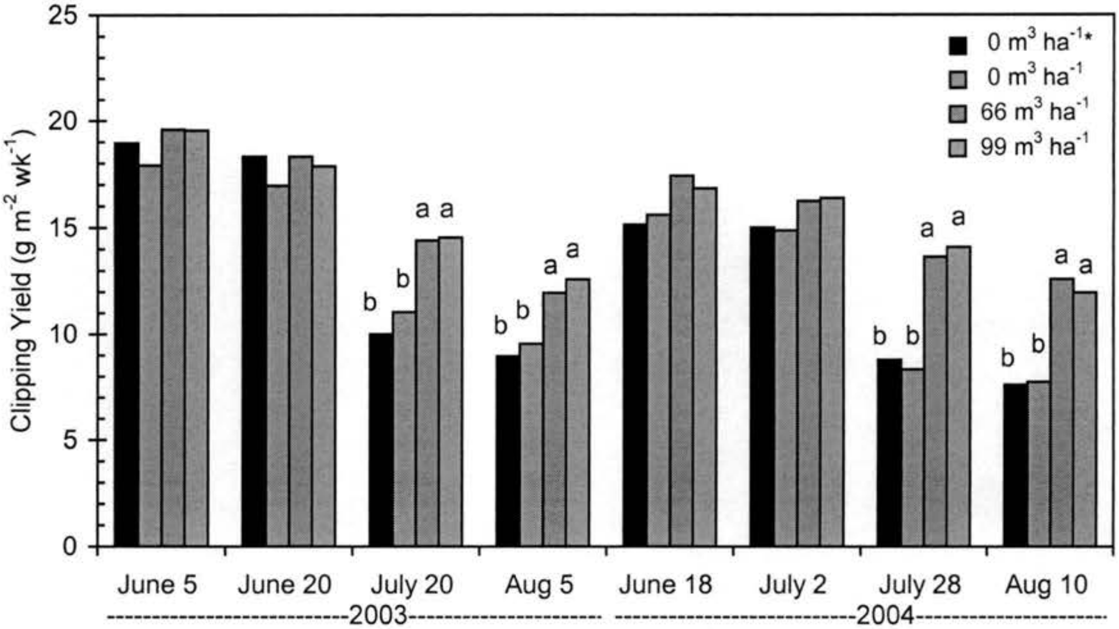

Figure 1.6 Clipping yield (g m^{-2} wk^{-1}) of 'Kenblue' Kentucky bluegrass during growing seasons 2003 and 2004. Each bar represents the mean of three replicates. Bars labeled with different letters were significantly different at $P \leq 0.05$. *Represents treatment that was not aerated over the course of the experiment, whereas all other treatments were aerated twice per growing season.

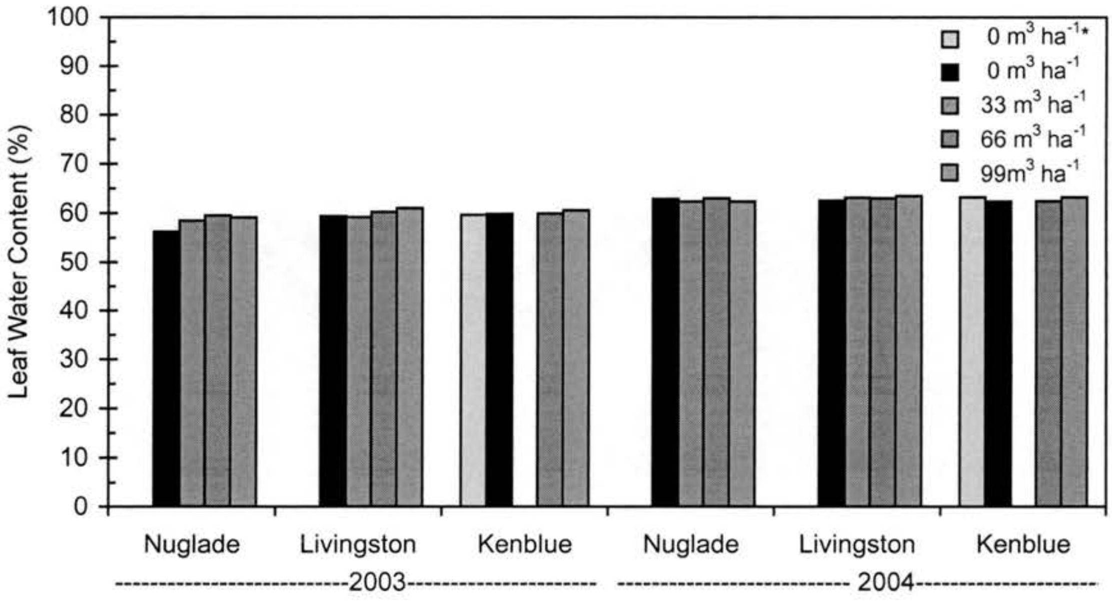

Figure 1.7 Leaf water content (%) of 'Nuglade', 'Kenblue', and 'Livingston' Kentucky bluegrass during growing seasons 2003 and 2004. Each point is mean of four collections each replicated three times. *Represents treatment that was not aerated over the course of the experiment, whereas all other treatments were aerated twice per growing season.

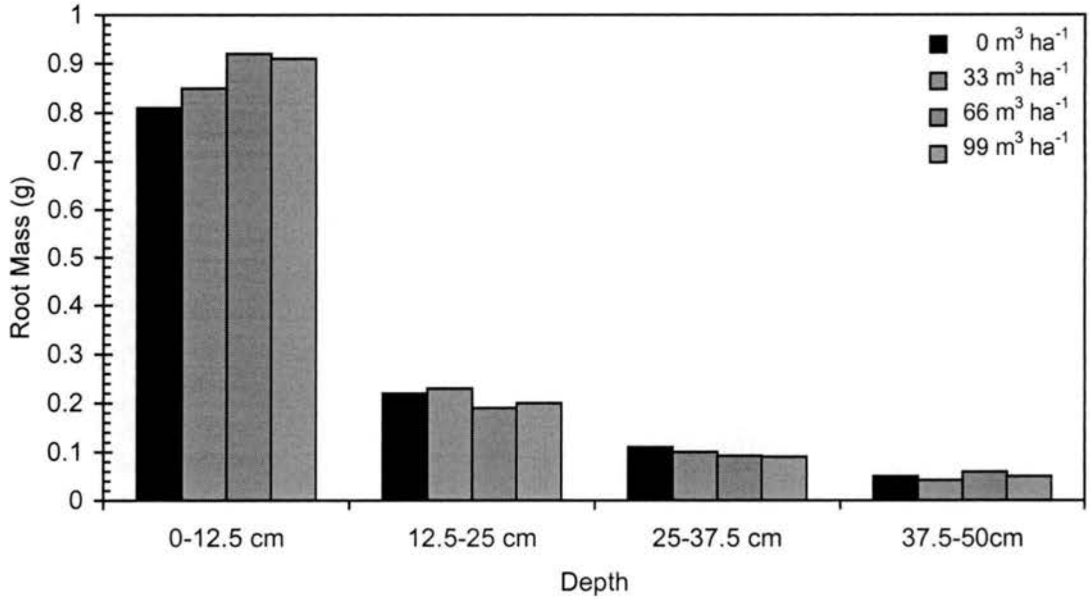

Figure 1.8 Root mass (g) sampled at four depths beneath the soil of 'Nuglade' Kentucky bluegrass in fall of 2003. Bars represent means of four compost treatments, replicated three times.

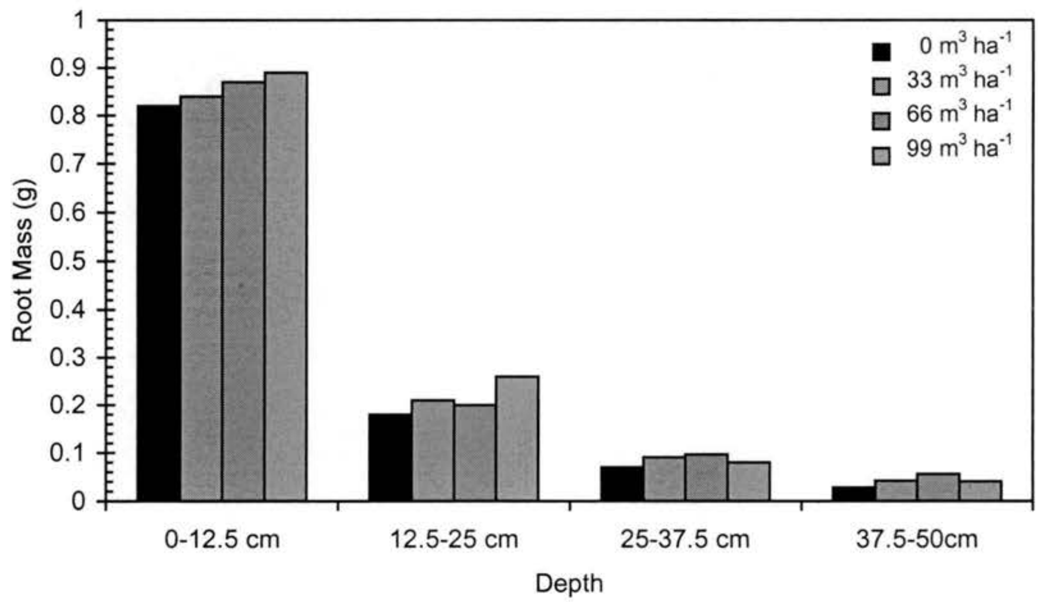

Figure 1.9 Root mass (g) sampled at four depths beneath the soil of 'Nuglade' Kentucky bluegrass in fall of 2004. Bars represent means of four compost treatments, replicated three times.

Table 1.1. Water analysis report of irrigation water used at the CSU Horticulture Farm.

pH	EC	Ca	Mg	Na	K	B	CO_3	HCO_3	SO_4	Cl	NO_3
	-dS m^{-1}-	----------	----------	----------	----------	----------	mg L^{-1}	----------	----------	----------	----------
7.5	2.8	381.7	160.5	169.3	5.5	0.0	<.01	430.9	1565	76.9	31.9

Table 1.2. Analysis of composted manure applied via topdressing to 'Nuglade', 'Livingston', and 'Kenblue' Kentucky bluegrass.

	Dry Weight Basis						
Sample	pH	EC	NH_4-N	NO_3-N	Total N	P	K
		-dS m^{-1}-	mg kg^{-1}		%		
1	9.2	31.6	241	9.9	0.60	0.26	1.41
2	9.2	30.6	385	12.8	0.68	0.28	1.48
3	9.3	36.2	191	11.9	0.67	0.27	1.42

Table 1.3 Nitrogen (N) sources applied to Kentucky bluegrass during 2003 and 2004 growing seasons.

2003

Compost Treatment	NO_3-N from water	Urea fertilizer	Compost: NO_3-N + NH_4-N	Compost: Organic-N	Total Inorganic-N (TIN)
-m^3 ha^{-1}-	kg ha^{-1}				
0	50	61.6	0	0	111.6^x
33	50	38.8	18	396	106.8
66	50	19.4	36	792	105.4
99	50	0.0	54	1188	104.0

2004

Compost Treatment	NO_3-N from water	Urea fertilizer	Compost: NO_3-N + NH_4-N	Compost: Organic-N	Total Inorganic-N (TIN)
-m^3 ha^{-1}-	kg ha^{-1}				
0	50	61.6	0	0	111.6^x
33	50	38.8	9	207	97.8
66	50	19.4	18	414	87.4
99	50	0.0	27	621	77.0

^{x} Totals were derived by combining all sources of inorganic N.

CHAPTER 2

SOIL PHYSICAL AND CHEMICAL PROPERTIES AS AFFECTED BY COMPOST TOPDRESSING

ABSTRACT

Compost has been shown to improve soil physical and chemical properties when incorporated into the soil; however, little information is available about effects that topdressing compost onto turfgrass has on soil properties. The objectives of the study were to evaluate the effects that topdressing Kentucky bluegrass with composted manure has on: (i) soil chemical properties, (ii) soil saturated hydraulic conductivity, (iii) soil water retention, and (iv) bulk density. Well-established plots of Kentucky bluegrass (*Poa pratensis* L.) were topdressed with composted at 0, 33, 66, and 99 m^3 ha^{-1}, three times in two years. Compost application of 99 m^3 ha^{-1} reduced surface soil (0-3 cm) bulk density by 5.3% and increased water retention by an average of 14.2% over all tensions tested. There were no significant differences in saturated hydraulic conductivity among treatments. Compost increased P,K, Fe, and Mn concentrations in the 0-10 cm depth. In addition, compost applications also raised the soil electrical conductivity in the 0-10 cm depth by 18-32%. Our data indicate composted manure contributed to improved soil physical properties and soil P, K, Fe, and Mn nutrient status, thereby enhancing turf quality and growth. Composted manure could be used to supplement or replace synthetic fertilizer for managed turf.

INTRODUCTION

Soil physical properties are considered one of the main attributes of soil quality (Kutilek, 2004), and research has shown that addition of organic waste materials can greatly improve a soil's physical properties and fertility levels (Epstein, 1975; Hornick et al., 1979; Hornick, 1980). Some of the beneficial effects organic materials have on soil physical properties included increased water-holding capacity, soil aggregation, soil aeration and permeability, and decreased soil crusting and bulk density (USDA, 1957; USDA 1978). Regular additions of organic materials such as animal manures and crop residues maintain the tilth, fertility and productivity of agricultural soils (Hornick and Parr, 1987). Another important soil parameter is saturated hydraulic conductivity, which measures the ability of a soil to transmit water (Wu et al., 1999). Compost and manure have been shown to increase saturated hydraulic conductivity when incorporated into the soil (Celik et al., 2004).

In addition to impacting soil physical properties, organic materials also affect the chemical properties of the soil as well. Animal manure has long been used as a source of plant nutrients and organic matter to improve fertility conditions of agricultural lands (Dao and Cavigelli, 2003). Schlegel (1992) showed that soil P, K and organic matter (OM) increased linearly with increased rates of manure compost, and concluded that amending manure compost is effective for maintaining or increasing soil nutrient levels, especially P, without excessive accumulation of NO_3-N. Likewise, Cuevas et al., (2000) explained that available P and K, concentration of NO_3-N, and EC increased significantly after a composted municipal solid waste application. Aggelides and Londra (2000) found that amending compost into the soil directly affected soil properties, increasing both OM and cation exchange capacity (CEC). Another study conducted by Egashira et al. (2003) showed that OM and N contents of soils treated with compost and cow dung were significantly higher than the control, and compost increased the CEC of the soil as well.

Little information is available in the literature about effects that topdressing compost onto established turfgrass has on soil properties. It is hypothesized that topdressing composted manure onto established turfgrass will improve soil physical properties by increasing saturated hydraulic conductivity and soil water retention, and by decreasing bulk density. It is also hypothesized that the compost will increase the amount of NO_3-N, P, K, and OM in the soil, while also increasing EC.

The objectives of this study were to evaluate the effects that topdressing composted manure onto established Kentucky bluegrass has on: (i) soil chemical properties, (ii) soil saturated hydraulic conductivity, (iii) soil water retention, and (iv) bulk density.

METHODS AND MATERIALS

To examine the effects that topdressing compost has on soil chemical properties, soil samples were collected in late April 2003 for baseline data, and again in September 2004 to evaluate treatment effects. Four soil samples were taken from each plot of 'Nuglade' at depths 0-10, 10- 20, 20-30, 30-40, 40-50 cm using a truck-mounted Giddings Hydraulic Soil Probe (#15-SCS Model GSRPS, Giddings Machine Company Inc., Windsor, CO). Samples from each plot were then composited and analyzed for pH, EC, OM, and various macro- and micronutrients, at the Colorado State University Soil, Water, and Plant Testing Laboratory.

Soil pH and EC were analyzed using a saturated paste extract based on the methods of Miller and Kotuby-Amacher (1995). Soil organic matter was determined based on the methods of Self and Rodriguez (1997) by reacting soil organic matter with potassium dichromate ($K_2Cr_2O_7^{2}$) and sulfuric acid. To determine plant available P and other nutrients, soil samples were extracted using ammonium bicarbonate-DTPA (diethylenetriaminepentaacetic acid) (AB-DTPA extractant) based on the methods of Self and Rodriguez (1997). An AB-DTPA solution was made with 1M NH_4HCO_3 – 0.005 M DTPA at pH 7.6. Ten grams of air-dried soil was mixed with 20 ml AB-DTPA extracting solution and placed on a mechanical shaker for 15 minutes. After filtering, the extracts were measured for extractable P at 882 nm on a Spec 20 at an acidity of 0.18 M H_2SO_4 by reacting a sample aliquot with ammonium molybdate using ascorbic acid as a reductant in the presence of antimony. The AB-DTPA extracted Ca, Mg, K, Zn, Fe, Mn, and Cu were measured by ICP. Nitrate-N content was determined using flow-injection Cd reduction analysis.

A single ring infiltrometer was used to measure field-saturated hydraulic conductivity (K_{fs}) based on the methods of Reynolds et al. (2002) on the 'Nuglade' plots. Prior to data collection, plots were irrigated with ~2 cm of water, in order to speed up the saturation process. An 8.5 cm diameter metal ring was inserted 6.5 cm into the soil. Two ponding depths of 5 and 10 cm were used to measure the "quasi-steady flow rate", which is the rate at which discharge becomes effectively constant. Each ponding depth was allowed at least 30 minutes to reach a steady flow rate, and in some cases it took longer to reach equilibrium. After steady state was reached, water flow rate was taken every minute for the next ten minutes. This was repeated twice per plot.

The formula used to calculate field-saturated hydraulic conductivity was

$$K_{fs} = (G/r)*(\Delta Q/\Delta H)$$

where K_{fs} represents saturated hydraulic conductivity; $G = 0.316\ (d/r) + 0.184$ where d represents ring depth in the soil and r is the radius of the ring; ΔQ represents the change in quasi-steady state in $cm^3\ s^{-1}$; and ΔH is the difference of two pond depths in cm.

Modified methods of Dane and Hopmans (2002) were used to measure soil water retention. Four undisturbed soil cores, measuring ~3 cm in height and 5.4 cm inside diameter, were collected directly beneath the thatch layer in the 'Nuglade' plots and carefully transferred into PVC rings and wrapped in aluminum foil. Cores were collected with a manually operated drop hammer sampler. Pressure plate apparatuses were used to determine the volumetric water content (VWC) of the soil samples at pressures of 10, 30, 200, 500, and 1500 KPa (Soil Moisture Equipment Corp., P.O. Box

30025, Santa Barbara, CA 93105). Prior to each pressure setting, soil samples were allowed to hydrate on a porous ceramic plate for 12 hours in a wetting solution of 0.005 *M* $CaSO_4$. Samples were hydrated by slowly adding solution until the water level was nearly at the top of the plastic ring. This allowed wetting to take place from the bottom up, thereby removing any air pockets in the soil.

When samples were saturated, they were placed into the pressure chamber and set to a specific pressure. Samples remained in the chamber for varying lengths of time depending on pressure. Samples at 10 and 33 kPa were in the chamber for ~54 hours; samples at 200 and 500 kPa were in the chamber for ~72 hours; and samples at 15 kPa were in the chamber for ~120 hours. When samples were removed from the chamber, they were transferred from the porous plate to aluminum weighing pans with a metal spatula, and immediately weighed. Then samples were re-moistened, and placed back in the chamber at the next higher pressure. After samples were subjected to each pressure setting, they were oven dried at 105°C for 48 hours. After the oven dry weight was determined, water was added to samples to make saturated pastes and oven dried again, to determine the saturated water content (SWC).

Volumetric water content (θ) of the soils was calculated using the formula;

$$\theta = (M_{ws} - M_{ods}) / p_w V_s$$

where M_{ws} is the mass of the moist soil, M_{ods} is the mass of the oven-dry soil, p_w is the density of water, and V_s is the volume of the soil. Available water content (AWC) was calculated by subtracting the VWC at permanent wilting point (1500 KPa), from the VWC at field capacity (10 KPa). Bulk density (BD) was also determined using the same soil cores using the formula;

$BD = (M_{ods} / V_s)$

where M_{ods} is the mass of the oven-dry soil, and V_s is the volume of the soil.

Statistical Analysis:

Prior to the initiation of compost treatment, plots were sampled for soil chemical property analysis to establish the baselines. Means and standard errors of individual properties at 0-10, 10-20, 20-30, 30-40, and 40-50 cm depths were calculated using SAS Proc Means.

Data on soil hydraulic conductivity, water retention, bulk density, and individual soil chemical properties at 0-10, 10-20, 20-30, 30-40, and 40-50 cm measured in the fall of 2004 were subjected to analysis of variance using SAS Proc GLM (SAS Institute, 2002) to test effects of compost treatments on the soil properties. Means were separated using a protected LSD at $P \leq 0.05$.

RESULTS AND DISCUSSION

Soil Physical Properties

At the culmination of this study, there was no significant difference in K_{fs} among any of the treatment levels (Table 2.1). Although the differences were not significant, the compost treatments 33, 66, and 99 m^3 ha^{-1} had 7.6%, 11.8% and 11.8% higher K_{fs} values, compared to the control, respectively. The K_{fs} values were relatively high for a clayey soil when compared to other studies (Carsel and Parrish, 1988; Aggelides and Londra, 2000; and Miller et al., 2002), and experimental error is believed to be the reason. Likely, data were taken before the soil was actually at saturation, which could have taken up to 1 hr or more. Realizing this, plots were watered prior to data collection; however, it appeared that it still needed more time. Another source of error could have been that the ring was inserted too shallowly into the soil (~6.5 cm), and water spread vertically and horizontally from the bottom of the ring.

Other studies have seen significant results when incorporating compost into the soil. Celik et al. (2004) examined the effects that compost, manure, and fertilizer had on soil physical properties, and found that compost and manure amendment at 25 t ha^{-1} significantly increased K_s. In fact, at a depth of 0-15 cm, compost increased K_s by 65 %, compared to the control. They believed the reason for this may have been related to soil porosity, in particular macroporosity, since soils with high macroporosity generally have higher K_s. In addition, Aggelides and Londra (2000) showed that K_s was increased 32.5, 53.0, and 95.2 % in loamy soil and 55.3, 97.4, and 168.5 % in clay soil for the rates 75, 150, and 300 m^3 ha^{-1} of compost, respectively. The increase in soil porosity and hydraulic conductivity is also supported by Mathers and Stewart (1980). Although there was not a significant difference in K_{fs} in our experiment, we believe that if compost treatments continued for a longer period of time, that the hydraulic conductivity of the higher compost application rates would continue to increase. Also if more time had been allowed to reach true saturation, there would have been lower error and the treatment differences might become significant.

The bulk density of the soil steadily decreased as the compost topdressing rate increased (Table 2.1). The highest compost treatment 99 m^3 ha^{-1} had a 5.6 % lower bulk density, compared to the control. This is concurrent with the findings of Celik et al. (2004), who showed that a significantly lower bulk density was found in compost (1.17 g cm^{-3}) and manure (1.24 g cm^{-3}) treated plots at a depth of 0-15 cm compared to the control (1.46 g cm^{-3}). Similarly, it was shown that compost significantly reduced the bulk density of clay and loamy soils by as much as 16.7 % and 19.7 %, respectively (Aggelides and Londra, 2000). Organic amendments decrease soil bulk density due to the "dilution effect" of the added organic matter with the denser mineral fraction (Gupta et al., 1977; Garnier et al., 2004). OM has influences soil aggregation, which can lead to greater pore space, allowing more oxygen and water to enter the soil.

Figure 2.1 represents the soil water retention 0-3 cm beneath 'Nuglade' Kentucky bluegrass at saturation and 5 different levels of suction. There is a significant difference at every point on the curve, and at every point the amount of water held increased as compost application rates increased. Starting at saturation point, the compost treatments 66 and 99 m^3 ha^{-1} held 3.3% and 3.9% more water than the 33 m^3 ha^{-1} treatment, and held

7.2% and 7.9% more water compared to the control, respectively. At 10 kPa, which we are considering field capacity, the 99 m^3 ha^{-1} treatment held 5.4%, 13.8%, and 15.6% more water compared to treatments 66, 33 and 0 m^3 ha^{-1}, respectively. Also, the 66 m^3 ha^{-1} treatment held 8% and 9.7% more water than the 33 m^3 ha^{-1} and control treatments. At the 33 kPa suction, the 99 m^3 ha^{-1} treatment again held a significantly higher amount of water than all other treatments, holding 4.7%, 13.3% and 15.8% more water than the 66, 33, and 0 m^3 ha^{-1} treatments, respectively. The 99 m^3 ha^{-1} treatment also held 7%, 14.1%, and 16.8% more water than treatments 66, 33 m^3 ha^{-1} and control, at the 200 kPa suction, while the 66 m^3 ha^{-1} treatment held 6.5% and 9.1% more water than the 33 m^3 ha^{-1} and control treatments at this suction, respectively.

Starting at 500 kPa, there was no significant difference between the 66 m^3 ha^{-1} and 99 m^3 ha^{-1} treatments, and they held 10.2% and 13.4% more water than the 33 m^3 ha^{-1} treatment, and retained 13.1% and 16.4% more water compared to the control. At the final suction of 1500 kPa (permanent wilting point), the 66 m^3 ha^{-1} and 99 m^3 ha^{-1} treatments held 9.5% and 14.8% more water than the 33 m^3 ha^{-1} treatment, and had 13.6% and 19.1% more water than the control, respectively. In concurrence with these results, Aggelides and Londra (2000) demonstrated that compost increased the water retention capacity of both clay and loamy soils, and retention capacity was increased as compost rates increased. Celik et al. (2004) determined that compost treated soil had significantly higher water holding capacity compared to manure, fertilizer and control treatments. In addition, cattle manure was also shown to increase soil water retention (Miller et al., 2002; and Nyamangara et al., 2001).

There was no significant difference in the amount of available water content (AWC) among any of the treatment levels (Table 2.1). The AWC ranged from 9.8-10.4%, which is relatively low for a clay soil. Typically, clay soils have AWC's in the mid to high teen range. The reason that the AWC is lower than expected in this study could be due to experimental error with the pressure plate system. Perhaps field capacity was underestimated by allowing samples to sit in the chamber too long, and/or permanent wilting point was over estimated because it wasn't given enough time in the chamber.

Soil Chemical Properties

Soil samples were collected at the beginning and end of the study to evaluate changes in soil chemical properties. Baseline soil samples were analyzed to measure soil properties before any treatments were applied (Table 2.2). In September of 2004, soil samples were taken again following two growing seasons and three compost applications. Table 2.3 represents the chemical properties of the soil at the culmination of the experiment.

There was no significant difference in pH among treatments at any of the soil depths. The electrical conductivity (EC) of the soil showed some differences in the shallowest depth of 0-10 cm. The compost treatments 66 and 99 $m^3\ ha^{-1}$ had 31.8% and 18.2% higher EC values compared to the control, respectively. The reason for this was due to the fact that the compost had an EC of 30 or more $dS\ m^{-1}$ (Table 2.3). However, the EC of the irrigation water also contributed to all treatments having an EC $> 4\ dS\ m^{-1}$. Cuevas et al. (2000) reported similar increases in soil EC due to compost application. Surprisingly, there was no difference in OM levels in the 0-10 cm depth. However, in the

10-20 cm depth, the compost treatments 66 and 99 m^3 ha^{-1} had 14.8% higher OM levels, when compared to the control. The compost contained high amounts of OM, which probably moved down through the soil from frequent irrigation.

Both macro- and micronutrients were measured to classify the fertility of the soil (Table 2.3). There was no difference in NO_3-N among treatments in any of the soil depths. The concentrations of NO_3-N steadily increased, as soil depth increased. The reason for this may be due to the turf root system utilizing more of the N in the top two depths, since the large majority of the roots were shown to be in the upper 25 cm (see Chapter 1). Another possibility could be the fact that NO_3-N is very soil mobile and probably leached down through the profile. In contrast, P is very soil immobile, and it accumulated in the top depth. In fact, all of the compost treatments had higher soil P in the 0-10 cm depth, compared to the control. The same thing was also true for K as well. Soil K content of 66 and 99 m^3 ha^{-1} compost treatments were 32.4% and 48.7% higher than the 33 m^3 ha^{-1} compost treatment, and 132% and 160% higher than the control, respectively. In addition, the 33 m^3 ha^{-1} was 75% higher in K than the control. The simple fact that the compost was rich in P and K was the reason for these differences, and as compost rates increased, so did the soil concentrations of each element (Table 2.4). These results are supported by other studies (Schlegel, 1992; Cuevas et al., 2000).

Micronutrients such as zinc (Zn), iron (Fe), manganese (Mn), and copper (Cu) were also measured in the soil (Table 2.3). There was no difference in Zn concentrations except for at the final depth of 40-50 cm. Since only the 66 m^3 ha^{-1} treatment was higher than the control only at this one depth, it is believed that random soil variability and laboratory error contributed to this difference. However, compost treatments did play a role in Fe concentration the 0-10 cm depth. The two compost treatments 66 and 99 m^3 ha^{-1} had 7.6% and 8.3% higher concentrations of Fe than the 33 m^3 ha^{-1} treatment and were 15.2% and 15.9 % higher than the control, respectively. Also the 33 m^3 ha^{-1} compost treatment was 7.1% higher than the control. There was also a difference in Mn concentrations in the 0-10 cm depth as well. The compost treatments 66 and 99 m^3 ha^{-1} were 36% and 34% higher than the control, respectively. The additional Fe provided by the compost could be quite beneficial to the turfgrass, especially in helping to prevent iron chlorosis in high pH soils. There were no significant differences in Cu concentrations at any soil depth.

Conclusions

Topdressing compost onto established turfgrass had significant effects on soil physical and chemical properties. Higher application rates of compost increased soil moisture retention and reduced bulk density. Although there were no significant differences in saturated hydraulic conductivity from topdressing, other studies have shown that compost increases K_s when incorporated into the soil (Aggelides and Londra, 2000; and Celik et al., 2004).

As hypothesized, compost increased AB-DTPA-extracted P, K, Fe, and Mn concentrations in the 0-10 cm depth. These are essential elements to turfgrass and can be used by the plant beneficially. In addition, compost applications also raised the EC of the soil in the surface depth, as expected. However, the high EC of the irrigation water resulted in all treatments having an EC > 4 dS m^{-1}, and if potable water was used this effect might be reduced. Even though the EC was high, there was no noticeable impact to the turfgrass. There were no differences in the amounts of NO_3-N in the soil as originally hypothesized. Also surprising was that OM content was only significantly increased in the 10-20 cm depth. Other studies have shown that incorporating compost into the soil increases the OM content (Schlegel, 1992; Aggelides and Londra, 2000; Egashira et al., 2003).

This report is one of the few studies that determine the benefits of topdressing composted manure onto existing turfgrass. Our data indicate composted manure contributed to improved soil physical properties and improved soil N, P, K, Fe, and Mn nutrient status, thereby enhancing turf quality and growth. Composted manure could be used to supplement or replace synthetic fertilizer for managed turf.

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Table 2.1. Physical properties of soil beneath 'Nuglade' Kentucky bluegrass, subjected to four different compost topdressing treatments. Bulk density and available water content were measured using cores collected directly below the thatch layer (0-3 cm).

Compost Treatment	Saturated Hydraulic Conductitvity	Bulk Density	Available Water Content
$-m^3\ ha^{-1}-$	$-cm\ h^{-1}-$	$-g\ cm^{-3}-$	-%-
0	14.4	1.14 a	9.9
33	15.5	1.13 ab	9.8
66	16.1	1.10 ab	9.9
99	16.1	1.08 b	10.4

* Letters indicate significant differences among treatments at P < 0.05.

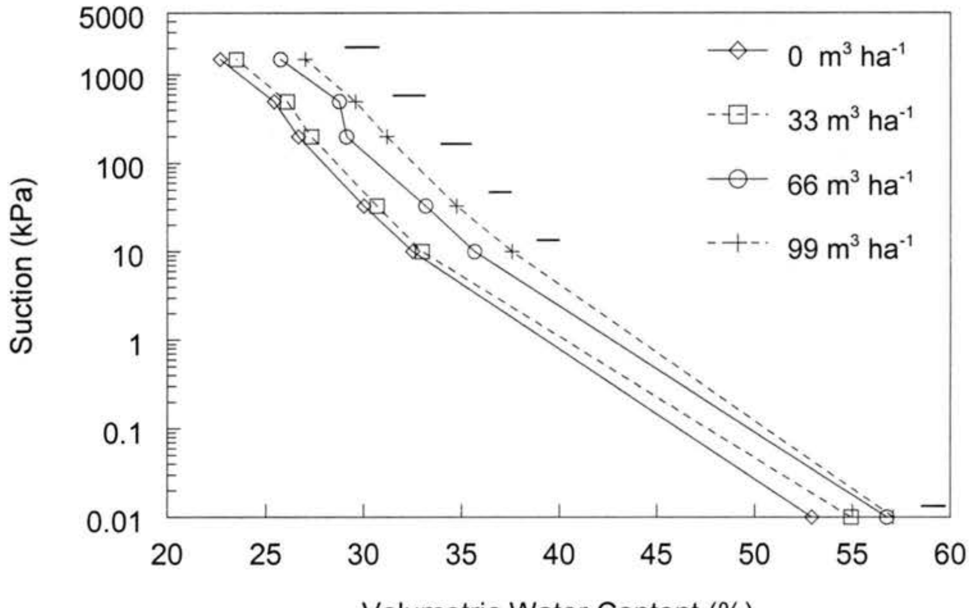

Figure 2.1 Soil moisture retention curve of cores collected beneath 'Nulgade' Kentucky bluegrass, subjected to four compost treatments. Each point is the mean of four cores per plot, replicated three times. Bars indicate least significant difference ($P < 0.05$) among treatments.

Table 2.2. Baseline soil analysis of five depths below 'Nuglade' Kentucky bluegrass. Means derived from 12 plots. Samples collected before compost treatments were applied.

Depth	pH	EC	OM	AB-DTPA extract NO_3-N	AB-DTPA extract P	AB-DTPA extract K
-cm-		---dS m^{-1}---	-----%----	mg L^{-1}	mg L^{-1}	mg L^{-1}
0-10	7.65 (0.04)*	3.88 (0.08)	5.30 (0.14)	5.24 (0.55)	1.54 (0.16)	319.50 (7.77)
10-20	7.75 (0.02)	4.51 (0.13)	4.51 (0.19)	3.73 (0.56)	0.88 (0.12)	297.25 (9.18)
20-30	7.74 (0.02)	4.69 (0.10)	4.42 (0.24)	2.88 (0.35)	0.60 (0.15)	321.42 (11.28)
30-40	7.75 (0.03)	4.74 (0.09)	4.13 (0.23)	2.40 (0.20)	0.31 (0.09)	316.08 (10.67)
40-50	7.78 (0.02)	4.80 (0.13)	3.87 (0.03)	4.36 (0.25)	0.22 (0.04)	319.92 (10.85)

Depth	AB-DTPA extract Zn	AB-DTPA extract Fe	AB-DTPA extract Mn	AB-DTPA extract Cu
-cm-	mg L^{-1}	mg L^{-1}	mg L^{-1}	mg L^{-1}
0-10	2.44 (0.51)	17.38 (1.02)	3.42 (0.17)	2.58 (0.24)
10-20	1.93 (0.66)	14.93 (1.00)	2.31 (0.07)	2.88 (0.30)
20-30	0.99 (0.08)	12.29 (1.09)	2.84 (0.20)	3.18 (0.44)
30-40	0.39 (0.06)	9.40 (0.36)	3.57 (0.13)	2.82 (0.23)
40-50	0.51 (0.16)	9.54 (0.55)	3.89 (0.11)	2.74 (0.29)

*Numbers in parenthesis indicate standard error.

Table 2.3 Soil analysis of chemical properties at the culmination of two growing seasons on 'Nuglade' Kentucky bluegrass. Means derived from three replications and tested at significance level of $P \leq 0.05$.

Depth	Compost Amount	pH	EC	OM	AB-DTPA extract		
					NO_3-N	P	K
-cm-	--m^3 ha^{-1}--		--dS m^{-1}--	--%--	------------------mg L^{-1}------------------		
0-10	0	7.43	4.17 c*	3.27	2.43	1.43 b	341 c
	33	7.40	4.43 bc	4.27	2.20	3.70 a	597 b
	66	7.53	5.50 a	4.07	2.23	4.17 a	791 a
	99	7.50	4.93 ab	3.93	2.03	4.45 a	888 a
10-20	0	7.57	4.73	1.83 b	2.77	0.70	379
	33	7.63	5.37	2.00 ab	2.57	1.10	415
	66	7.60	5.03	2.10 a	2.13	0.80	468
	99	7.67	5.20	2.10 a	2.60	1.20	528
20-30	0	7.67	5.20	1.67	3.53	0.43	361
	33	7.63	5.53	1.73	3.30	0.40	354
	66	7.63	5.77	1.67	2.73	0.60	379
	99	7.70	5.40	1.70	3.20	0.70	343
30-40	0	7.67	5.23	1.53	3.90	0.40	356
	33	7.70	5.47	1.43	3.47	0.37	326
	66	7.67	5.47	1.40	2.83	0.90	363
	99	7.73	5.27	1.40	3.53	0.70	315
40-50	0	7.73	5.23	1.23	4.80	0.60	293
	33	7.70	5.50	1.20	3.87	0.67	298
	66	7.63	5.50	1.10	3.37	0.60	319
	99	7.70	5.70	1.13	4.37	0.60	308

*Means with a common letter are not significantly different ($P \leq 0.05$) by least significant difference.

Table 2.3 continued.

Depth	Compost Amount	AB-DTPA extract			
		Zn	Fe	Mn	Cu
-cm-	--m^3 ha^{-1}--	---------------------------mg L^{-1}------------------------			
0-10	0	2.74	14.96 c	3.07 b	4.05
	33	2.23	16.02 b	3.56 ab	3.60
	66	3.43	17.24 a	4.19 a	3.38
	99	2.56	17.35 a	4.12 a	3.55
10-20	0	1.43	11.09	2.32	4.67
	33	2.72	12.10	2.45	4.21
	66	2.02	14.26	2.55	3.63
	99	1.38	13.22	2.67	4.77
20-30	0	0.57	8.61	2.01	4.61
	33	0.62	8.96	2.32	3.61
	66	0.76	9.62	2.11	3.92
	99	0.61	8.55	1.99	4.10
30-40	0	0.31	7.09	1.72	4.18
	33	0.31	7.07	1.81	3.53
	66	0.36	7.42	1.77	4.37
	99	0.33	7.07	1.50	3.83
40-50	0	0.21 b	5.97	1.40	3.20
	33	0.28 ab	6.34	1.45	3.20
	66	0.50 a	6.74	1.55	3.81
	99	0.30 ab	6.15	1.41	3.37

* Means with a common letter are not significantly different ($P \leq 0.05$) by least significant difference.

Table 2.4 Analysis of composted manure applied via topdressing to 'Nuglade', 'Livingston', and 'Kenblue' Kentucky bluegrass.

	------------	------------	------------	Dry Weight Basis	------------	------------	------------
Sample	pH	EC	NH_4-N	NO_3-N	Total N	P	K
		-dS m^{-1}-	--------mg kg^{-1}---------		--------------------%-------------------		
1	9.2	31.6	241	9.9	0.60	0.26	1.41
2	9.2	30.6	385	12.8	0.68	0.28	1.48
3	9.3	36.2	191	11.9	0.67	0.27	1.42

CHAPTER 3

COMPOST EFFECTS ON TURF QUALITY AND SOIL WATER CONTENT DURING DRY DOWN

ABSTRACT

Identifying management practices to reduce turfgrass irrigation requirements is vital to urban water conservation. Little information is available concerning the effects of compost topdressing on turfgrass drought response. The objective of this study was to evaluate the effects of topdressing Kentucky bluegrass (*Poa pratensis* L.) with composted manure on soil water content (SWC), turfgrass canopy temperatures, and turf quality during periods of drought. In May and September 2003 and May 2004 compost treatments (0, 33, 66, and 99 m^3 ha^{-1}) were applied to established 'Nuglade', 'Livingston', and 'Kenblue' Kentucky bluegrass in the field. Three 10-d dry down periods were imposed during the summers. During dry down periods, compost treatment increased SWC in the 15-30 cm soil depth during the first 2-3 days, which in turn, increased soil moisture in the 0-15 cm depth towards the end of dry down, suggesting compost topdressing allowed more water to penetrate to the 15-30 cm depth after irrigation. Higher SWC in the compost treatments led to 1.2-3.3 °C lower canopy temperatures than the control toward the end of dry down periods. While turf quality in the control of Nuglade and Livingston declined to an unacceptable level 8 d of dry down, plots with 66 and 99 m^3 ha^{-1} compost treatments maintained acceptable turf quality during the entire dry down periods. Compost treatments of 66 and 99 m^3 ha^{-1} maintained acceptable turf quality of Kenblue 2 d longer than the aerated control.

INTRODUCTION

Along the Front Range of Colorado, about 36,000 ha/year of farmland and prairie is converted to residential, commercial, and industrial land (Long, 1996). Accompanying this growth and development there has been a rapid increase in the area of turfgrass, such as home lawns, commercial landscapes, parks, recreational facilities, and other greenbelts. In most areas of the semi-arid and arid United States, turfgrass receives frequent and routine irrigation to maintain desirable turf quality throughout the growing season. An increased emphasis on turfgrass water conservation is one consequence of increasing urbanization in the semi-arid western USA (Ervin and Koski, 1998).

Irrigation demand for turfgrass maintenance is one of the many competing uses for water in urban settings. In metropolitan areas of arid and semi-arid regions, landscape irrigation accounts for approximately 50-60% of total urban water consumption during the growing season (Aurasteh, 1983; Winje and Flack, 1986). During the months of June, July, and August, urban landscape water use in Denver accounts for 60-66% of the total domestic water use (Denver Water, 1999). Due to the rising population and water use in urban areas in recent years, transfer of water from agricultural to urban use has been employed extensively along the Front Range of Colorado to satisfy the urban water demand (Smith et al., 1996). To reduce water use in urban areas, it is necessary to combine various means in such a way as to attain the maximum conservation at the lowest cost with the least inconvenience to the water consumer.

In Colorado, research has been done to address urban turfgrass water use, especially after the drought of the late 1970s, and the more recent drought of 2000-2003. Comparison of the irrigation requirements of buffalograss, tall fescue, and Kentucky bluegrass has demonstrated the superior drought resistance of buffalograss. Regular applications of irrigation water, at a level 20-30% of that required by Kentucky bluegrass, can provide an adequate buffalograss lawn (Ervin, 1995). Native grasses, such as buffalograss and blue grama need less water than the conventional Kentucky bluegrass. However, the poorer turf density and quality, weed invasion, and the loss of color during the winter have been the major deterrents to the wide public acceptance of these native warm-season grasses as turf.

The reason for the frequent irrigation requirements and low water use efficiency of turf in many development areas may be the result of poor soil physical and chemical conditions. Composted materials and humic substances have long been used by the turfgrass industry as soil conditioners and organic fertilizers (Piper and Oakley, 1917, 1921; Connellan, 1921; Garling and Boehm, 2000). The effects of topdressing composted manure onto established turfgrass on both fertilization requirements and soil properties are now areas of interest to both soil scientists and turf managers. In typical agricultural settings, organic materials have beneficial effects on soil physical properties, such as increased water-holding capacity, soil aggregation, soil aeration and permeability, and decreased soil crusting and bulk density (USDA, 1957; USDA 1978; Hornick and Parr, 1987). These improvements to soil physical properties could increase the proportion of water that is available to plants, which could reduce irrigation requirements. However, little information is available about how compost application via topdressing could meet turfgrass fertility requirements or improve water infiltration and retention in established turfgrass systems.

In this study, we hypothesize that topdressing composted manure onto established turfgrass will increase the soil water content. This in turn could increase the amount of readily available water for plant uptake, which would increase turfgrass drought tolerance and reduce Kentucky bluegrass irrigation requirements. We also hypothesize that the compost will provide better fertility to the grass, thereby increasing the overall turf quality while reducing fertilizer requirements.

The objectives of this study were to evaluate the effects that topdressing composted manure onto established Kentucky bluegrass has on: (i) turfgrass quality; (ii) soil moisture content; and (iii) turf canopy temperatures during dry down (i.e., a prolonged period without precipitation and irrigation).

METHODS AND MATERIALS

Detailed information on experimental design, turfgrass establishment, cultural conditions, and compost treatments were presented in Chapter 1.

In order to evaluate the effects of compost treatments on turfgrass drought response, three dry down periods were imposed over two growing seasons. Dry down one took place from June 30th to July 9th, 2003; dry down two lasted from July 22nd to July 31st, 2003; and dry down three was conducted from July 6th through July 15th, 2004. Prior to each drought cycle, plots were irrigated with ~ 2.5 cm of water the night before. During each dry down, irrigation was cut off, and no rainfall occurred. Plots were not mowed during the dry down periods.

Volumetric soil water content (SWC) at 0-15 cm, turf quality, and canopy temperatures were measured concurrently eight times during the 10-d dry down periods. Volumetric SWC was measured by means of time domain reflectometry (TDR) equipped with 15 cm probes (Trase, Model: 6050X1, Soil Moisture Equipment Corp., Santa Barbara, CA) for all plots. In addition, SWC at 0-30 cm soil profile was also measured with TDR using 30 cm long probes in 'Nuglade' Kentucky bluegrass plots only. Soil water content at 15-30 cm depths was calculated by the following:

$$SWC_{15\text{-}30} = (30 \times SWC_{0\text{-}30} - 15 \times SWC_{0\text{-}15})/(30\text{-}15)$$

Where $SWC_{15\text{-}30}$, $SWC_{0\text{-}30}$, and $SWC_{0\text{-}15}$ are soil water content at 15-30 cm, 0-30 cm, and 0-15 cm depths, respectively.

A visual rating system was used to measure the turf quality of each plot. This system uses a combination of turf color, uniformity, density, and texture to assign a rating between 1 and 9. A rating of 1 indicated thin, brown, and dead turf and 9 indicated optimum color, dense, and uniform turf, with a rating of 6 or higher indicating acceptable quality. An effort was made to be consistent with the way plots were rated each time. Canopy temperature was measured with an infrared thermometer (Omega, Model OS534, Omega Engineering, Inc., Stamford, CT). The thermometer was held at a 45° angle at ~0.66 m above the canopy surface.

Statistical Analysis

Data on SWC, canopy temperature, and turf quality were subjected to Proc GLM analysis of variance (SAS Institute, 2002) to test effects of compost treatment and dry down cycle for each grass on individual dates. For SWC and canopy temperature, there were significant interactions of compost treatment x dry down cycle, therefore data were presented for each dry down cycle. No significant interaction of compost treatment x dry down cycle existed for turf quality, therefore turf quality data were combined from all three dry down cycles. Treatment differences on individual dates for each grass were separated by least significant difference at the 0.05 level of probability.

RESULTS AND DISCUSSION

Soil Water Content

During the first dry down period, different compost treatments did not significantly influence SWC in the 0-15 cm depth in 'Nuglade' Kentucky bluegrass plots (Fig. 3.1A). Toward the end of the second dry down period, SWC at 0-15 cm depth of 'Nuglade' plots topdressed with compost was significantly higher than the control (Fig. 3.1B). On day 8, compost treatments of 66 and 99 m^3 ha^{-1} had 3-4% higher SWC compared to the control. On days 9 and 10, all compost treatments had 2-3% higher SWC than the control. The third dry down produced similar results to the second dry down in the 0-15 cm soil depth. On day 9, plots topdressed with compost at 99 m^3 ha^{-1} had 4% higher SWC than the control (Figure 3.1C). On the 10^{th} day of dry down, compost treatments of 66 and 99 m^3 ha^{-1} had 5% greater SWC compared to the control.

No significant differences were detected in the 15-30 cm depth during the first dry down for 'Nuglade' (Fig. 3.2A). Conversely, during the second dry down in the 15-30 cm depth treatments 33 and 99 m^3 ha^{-1} increased SWC by 2 % on day 1 and 4 % on day 2, compared to the control (Fig. 3.2B). During the third dry down all compost treatments increased SWC in the 15-30 cm depth by 3-4 % during the first 3 days after the dry down period began (Fig. 3.2C). Gardner (1979) discussed how vertical mulching (i.e. vertical channels in the soil surface layer filled with organic matter) creates large pores, accelerating water penetration into deeper soil depths. In this case, aeration took place just prior to compost application, which allowed the compost to enter the aeration holes and resulted in vertical mulching. This may, in part, explain the higher SWC at 15-30 cm observed in compost treatments after irrigation.

The 'Livingston' cultivar followed a similar trend to 'Nuglade' showing the two highest compost treatments increased the SWC by 2-5 % at 0-15 cm below soil surface on the last 3-4 days of every dry down period (Fig. 3.3).

As indicated in the Methods and Materials in Chapter I, treatments for 'Kenblue' Kentucky bluegrass plots included 2 controls (with and without aeration) and 2 compost treatments, and SWC was measured for 0-15 cm depth only. The compost treatments had higher soil moisture content, starting 4 or 7 days after the dry down period began (Fig. 3.4), when compared to treatments that received no compost. There was no difference between the aerated and non-aerated controls during the first two dry downs. However, during the third dry down, the aerated control had 1-3 % higher SWC than the non-aerated control, starting on day 4 and continuing until the end of dry down (Fig. 3.4C).

Organic materials have beneficial effects on soil physical properties, such as increased water-holding capacity, soil aggregation, soil aeration and permeability, and decreased soil crusting and bulk density (USDA, 1957; USDA 1978; Hornick and Parr, 1987). As soil conditioners, organic waste materials add soil organic matter essential for increased aggregation and workability, increased water content which is important in sandy or droughty soils, and decreased bulk density which is important in heavy clay soils (Hornick, 1982). Although we detected increased water retention in the 0-3 cm depth (see Chapter 2 for details), we did not find significant difference in SWC in the 0-15 cm depth at the beginning of each dry down for any grass. However, the 15-30 cm soil depth held significantly more water at the beginning of the second and third dry down periods, suggesting that compost allowed more water to penetrate to the 15-30 cm depth after irrigation. This might have contributed to the higher SWC in the 0-15 cm depth towards the end of the dry down periods through capillary action and/or hydraulic lift that brought some of the moisture up to the surface soil depth.

Canopy Temperature

Canopy temperatures were measured on each plot eight times during the 10-d period for all three dry downs. On days 9 and 10 into the first dry down, compost treatments at 66 and 99 m^3 ha^{-1} reduced 'Nuglade' canopy temperatures by 1.2-1.5 °C compared to the control (Table 3.1). There was not a significant difference between the 33 m^3 ha^{-1} treatment and any of the other treatments. During the second and third dry down the same trend took place, with significance starting on day 8.

For 'Livingston' during the first dry down, the compost treatments at 66 and 99 m^3 ha^{-1} lowered the canopy temperature by 1.2-1.9 °C on day 9 and 10 (Table 3.2). Compost treatment at 33 m^3 ha^{-1} did not result in significant reduction in canopy temperature. During the second dry down, there were no differences among treatments until the 10^{th} day. During the third dry down, the 99 m^3 ha^{-1} compost treatment had a significantly lower canopy temperature on days 8, 9, and 10 when compared to the control. On the 10^{th} day, compost treatments at 66 m^3 ha^{-1} also reduced canopy temperatures by 1.2 °C.

During the first dry down period, the 66 and 99 m^3 ha^{-1} compost treatments reduced 'Kenblue' canopy temperature on days 9 and 10 by 1.5 –2.4°C when compared to both of the controls (Table 3.3). During the second dry down, the 66 and 99 m^3 ha^{-1}

compost treatments reduced canopy temperatures on days 8 through 10. During the third dry down, the 66 and 99 m^3 ha^{-1} compost treatments lowered canopy temperature by 2.9-3.5°C 7 to 10 days without irrigation. There were no significant differences in canopy temperatures between aerated and non-aerated controls during any of the dry down periods. The lack of aeration effect was consistent during the all three dry down cycles.

Canopy temperature can be used to characterize the water stress level of plants. As plants become water stressed, stomata close, transpiration is reduced, and canopy temperature increases. Reduced canopy temperature certainly is beneficial during periods of high temperature stress because of evaporative cooling effects and maintenance of carbon assimilation (Kramer, 1978; Bonos and Murphy, 1999). Since the higher compost application rates were shown to have more water in the soil profile, this may have allowed evaporative cooling to continue longer, thereby lowering canopy temperatures.

Turf Quality

Turf quality ratings were assessed eight times during each 10-d dry down period. Average turf quality ratings were combined for all three dry down periods for each cultivar. At day 1 of dry down, all compost treatments exhibited better turf quality, compared to the control for 'Nuglade' (Fig. 3.5). The highest compost treatment (99 m^3 ha^{-1}) had 4.3 % higher quality than the 33 m^3 ha^{-1} compost treatment. As the dry down continued, turf quality steadily declined for all treatments. On day 10, 66 and 99 m^3 ha^{-1} treatments had 13% and 12% better quality than the 33 m^3 ha^{-1} treatment, and 21.9% and 20.9% better quality than the control, respectively. There was no significant difference between 33 m^3 ha^{-1} compost treatment and the control. All of the compost treatments stayed at or above a rating of 6, indicating acceptable quality. However, the control fell below a turf quality rating of six on day 8.

For 'Livingston', the two highest compost treatments of 66 and 99 m^3 ha^{-1} had 6% and 8.3% higher quality than the control on day 1 (Fig. 3.6). Turf quality of 99 m^3 ha^{-1} treatment was also 6% higher than the 33 m^3 ha^{-1} treatment. A similar trend took place from day 2 to day 9, where turf quality declined over time. On day 10, the two highest compost treatments of 66 and 99 m^3 ha^{-1} were 9.3% higher in turf quality than the 33 m^3 ha^{-1} treatment and 14.7% higher than the control. There was no significant difference between the 33 m^3 ha^{-1} treatment and the control. The control fell below a quality rating of 6 during the final two days of dry down, and the 33 m^3 ha^{-1} treatment dropped below 6 on the final day. The two highest compost treatments maintained acceptable quality over the duration of the dry down.

At the start of dry down (day 1) for 'Kenblue', the compost treatments 66 and 99 m^3 ha^{-1} had 6.6% and 5.6% higher turf quality than the aerated control, and 12.2% and 11.1% higher turf quality than the non-aerated control, respectively (Fig. 3.7). The aerated control had a 5.1% higher quality compared to the non-aerated control. Towards the end of dry down, the two controls were significantly different not only from the compost treatments, but also from each other. On day 10, compost treatments of 66 and 99 m^3 ha^{-1} were 22.9% and 25.3% higher in turf quality than the aerated control, and 35.9% and 38.6% higher than the non-aerated control, respectively. In addition, the aerated control had a 10.5% higher quality rating than the non-aerated control. Although each treatment eventually dropped below a quality of 6, the quality of the two controls fell much faster. The non-aerated control dropped to below 6 on day 4, and the aerated control became unacceptable on day 7. Turf quality of plots topdressed with 66 and 99 m^3 ha^{-1} maintained acceptable turf quality until 9 days after dry down began. Keeley (1996) showed that Kenblue had poor quality under drought conditions, mainly because of its shallow root system. This helps to explain why Kenblue had much lower quality during dry down compared to Nuglade and Livingston in this experiment.

Improved fertility is believed to be the main cause for the differences in turf quality ratings at the initiation of dry down. As discussed in Chapter 1, compost treatment provided additional slow released N and K and P. Greater differences among treatments toward the end of dry down (compared with at the beginning of the dry down) likely resulted from the higher SWC in the 0-15 cm depth towards the end of the dry down. Furthermore the high availability of K, P and other micronutrient with compost treatments may have also partially contributed to the improved drought stress resistance with compost treatments. The proper balance of P and K in relation to N is considered vital in achieving maximum stress tolerance of turfgrasses (Beard, 1993).

Conclusions

The dry down periods revealed many interesting differences. Compost allowed more water to penetrate to the 15-30 cm depth, which increased SWC after irrigation was applied. This is believed, in part, to contribute to the higher SWC in the 0-15 cm depth towards the end of the dry down periods. Higher SWC was associated with lower canopy temperatures toward the end of dry down periods. With more available water in the soil, the grasses were able to keep their canopies cooler due to continued evapotranspiration.

As compost treatment levels increased, turfgrass quality also increased. Although inorganic N levels were balanced at the start of each growing season, there was still a fertility effect that took place. The organic N in the compost mineralized at least partially, making more N available and acting as a slow release fertilizer. Compost also added other essential elements such as P, K, and other micronutrients that might be important in maximizing drought tolerance of turfgrass.

Based on this research, we recommend topdressing composted manure to turfgrass at an optimum rate of 66 m^3 ha^{-1}. This treatment allowed the grass to maintain a high level of quality during dry down, while also increasing soil water content and reducing canopy temperature. Although the highest rate at 99 m^3 ha^{-1} also had similar characteristics, there is no reason to apply more when the same results can be achieved with a lower application rate.

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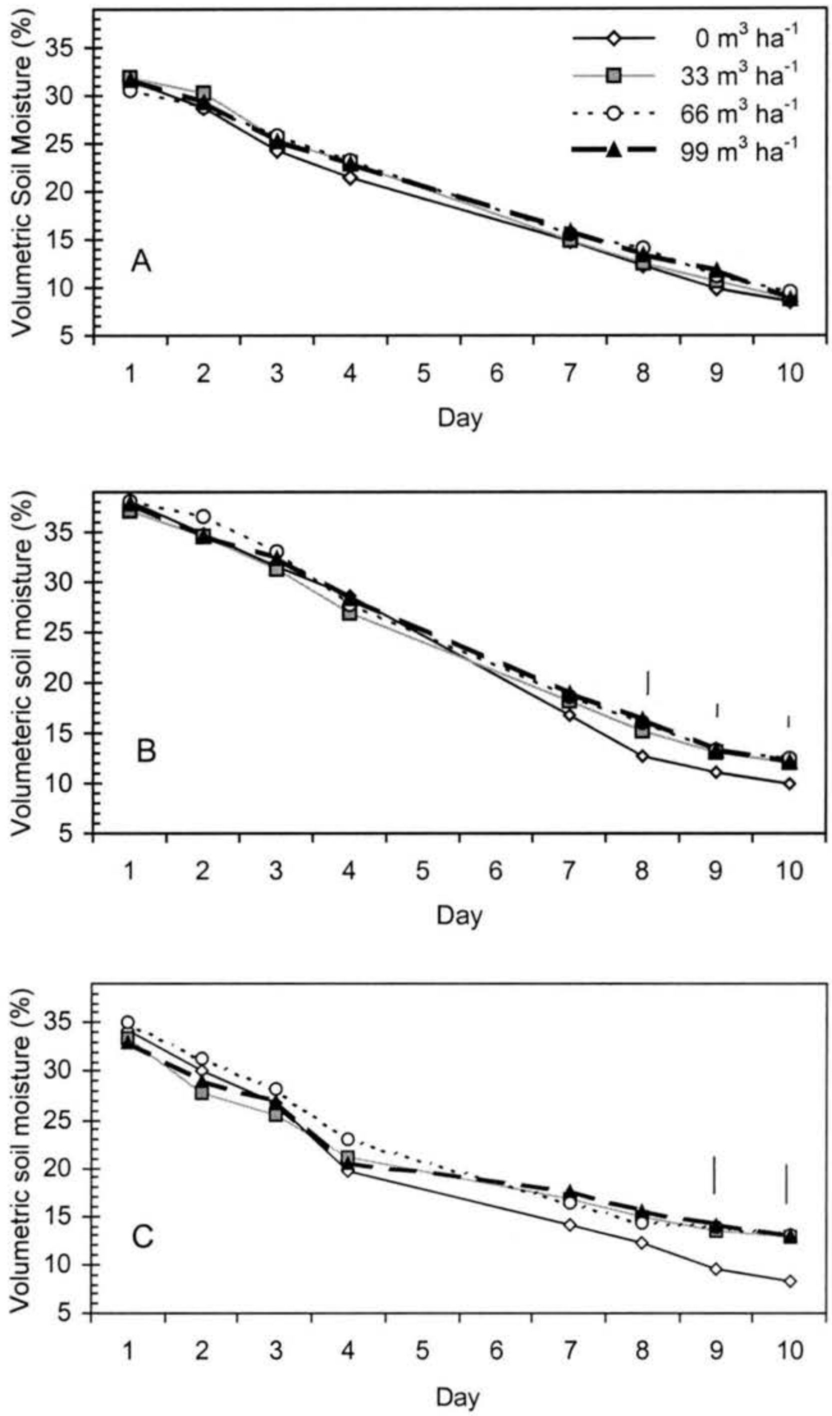

Figure 3.1 Volumetric soil water content in the 0-15 cm soil depth during dry-down, for 'Nuglade' Kentucky bluegrass subjected to four different compost treatments. A. dry down period one; B. dry down period two; C. dry down period three. Each point is the mean of three replications. Bars indicate least significant difference (LSD) for individual dates where differences among compost treatments were significant at $P \leq 0.05$.

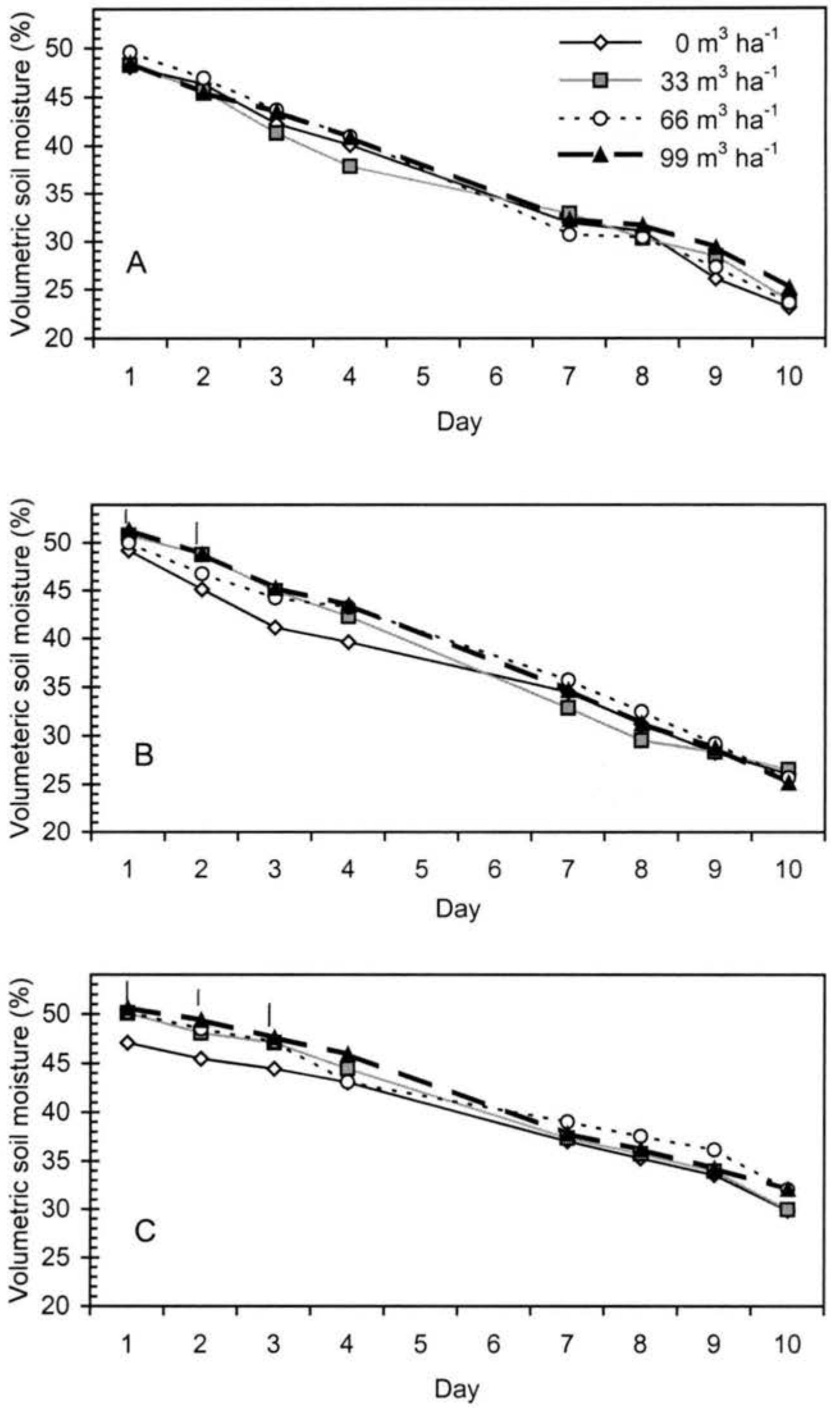

Figure 3.2 Volumetric soil water content in the 15-30 cm soil depth during dry-down, for 'Nuglade' Kentucky bluegrass subjected to four different compost treatments. A. dry down period one; B. dry down period two; C. dry down period three. Each point is the mean of three replications. Bars indicate least significant difference (LSD) for individual dates where differences among compost treatments were significant at $P \leq 0.05$.

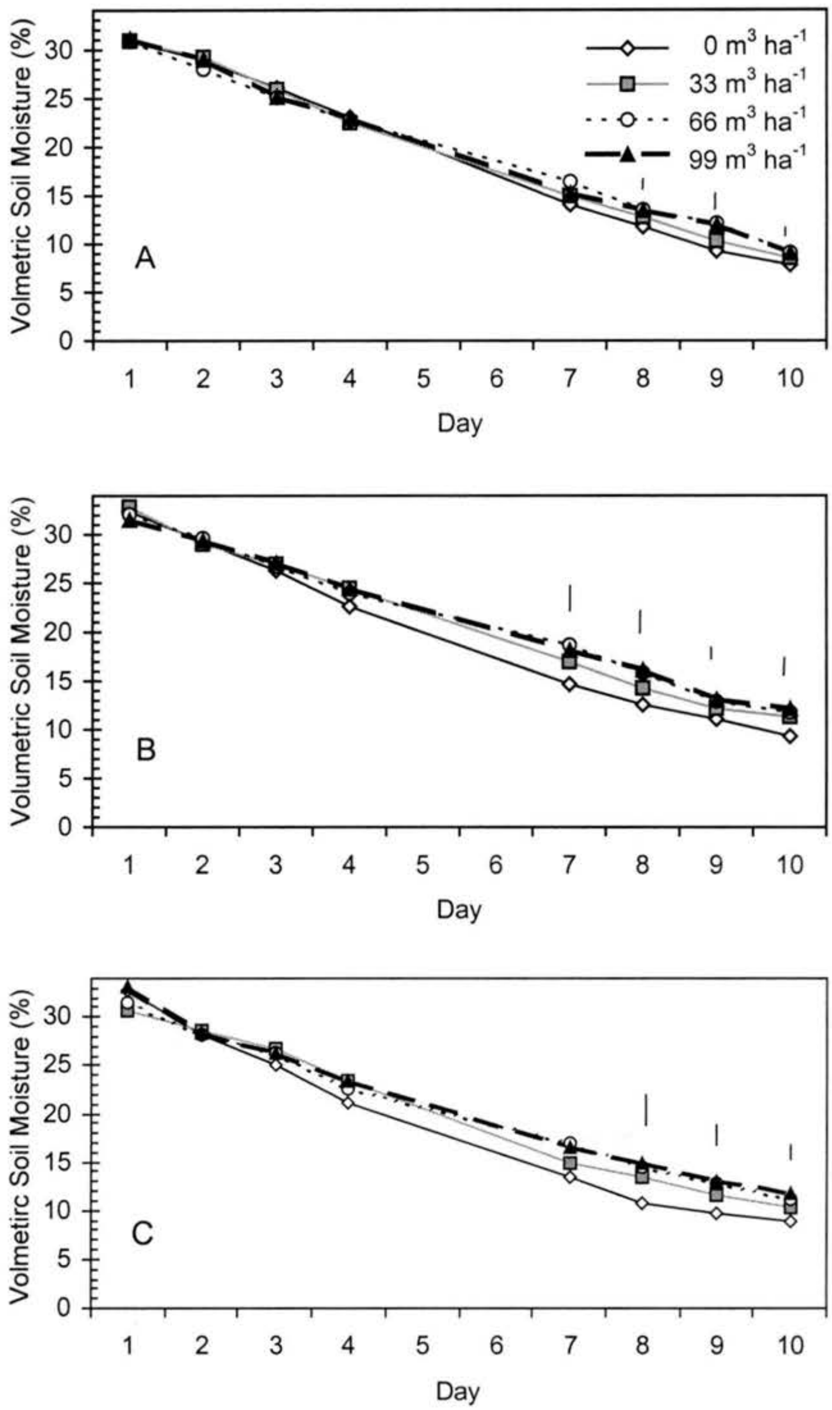

Figure 3.3 Volumetric soil water content in the 0-15 cm soil depth during dry-down, for 'Livingston' Kentucky bluegrass subjected to four different compost treatments. A. dry down period one; B. dry down period two; C. dry down period three. Each point is the mean of three replications. Bars indicate least significant difference (LSD) for individual dates where differences among compost treatments were significant at $P \leq 0.05$.

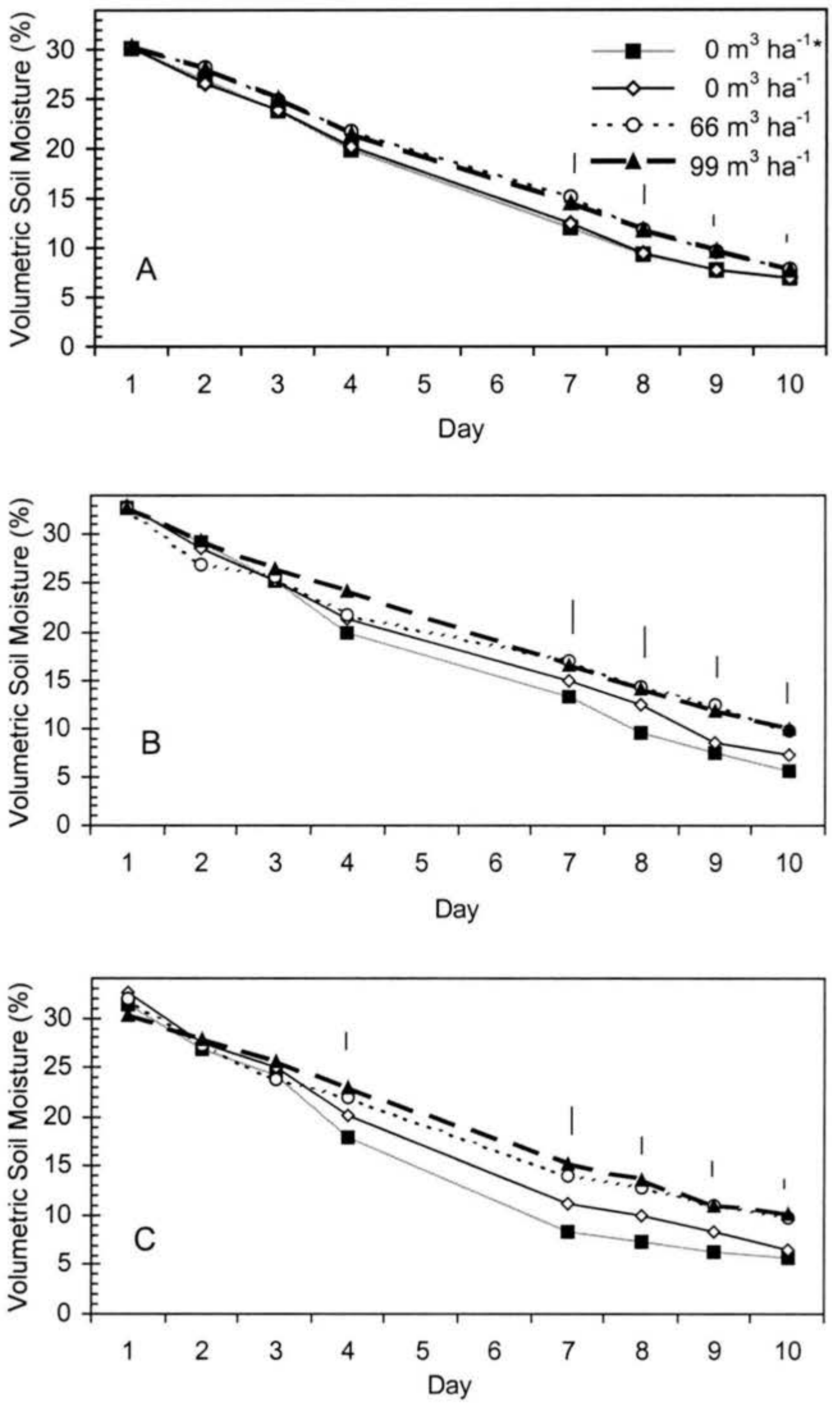

Figure 3.4 Volumetric soil water content in the 0-15 cm soil depth during dry-down, for 'Kenblue' Kentucky bluegrass subjected to four different compost treatments. A. dry down period one; B. dry down period two; C. dry down period three. Each point is the mean of three replications. Bars indicate least significant difference (LSD) for individual dates where differences among compost treatments were significant at $P \leq 0.05$. *Represents treatment that was not aerated over the course of the experiment, whereas all other treatments were aerated twice per growing season.

Table 3.1 Influences of compost treatment on canopy temperatures (°C) of 'Nuglade' Kentucky bluegrass during the course of three dry down periods.

Compost Treatment	Canopy temperature (°C) on days of dry down							
--m^3 ha^{-1}--	1	2	3	4	7	8	9	10
				Dry Down 1				
0	31.2†	35.3	37.9	37.7	37.9	35.4	45.0 a‡	35.0 a
33	30.2	35.3	37.2	37.2	37.0	34.6	44.3 ab	34.3 ab
66	30.0	34.8	36.5	37.4	36.9	34.3	43.8 b	33.8 b
99	29.6	34.6	36.1	37.6	37.2	34.6	43.5 b	33.7 b
				Dry Down 2				
0	26.4	33.1	37.8	35.7	32.9	33.5 a	35.0 a	37.8 a
33	25.4	33.1	37.8	35.6	32.8	33.0 a	34.6 a	37.4 a
66	25.2	32.9	37.4	35.0	32.5	32.4 b	33.5 b	35.7 b
99	25.0	32.8	38.1	35.4	32.0	32.2 b	33.3 b	36.1 b
				Dry Down 3				
0	25.7	35.6	37.4	38.3	41.9	42.9 a	35.4 a	39.2 a
33	25.6	35.9	37.6	37.9	41.3	41.9 ab	35.0 ab	38.3 ab
66	25.0	34.8	36.7	36.9	41.1	41.3 b	33.9 b	37.6 b
99	25.6	35.0	36.7	37.0	40.9	41.7 b	33.9 b	37.8 b

† Each temperature is mean of three replicates.
‡ On individual days within each dry down cycle, numbers labeled with different letters are significantly different at $P \leq 0.05$.

Table 3.2 Influences of compost treatment on canopy temperatures (°C) of 'Livingston' Kentucky bluegrass during the course of three dry down periods.

Compost Treatment	Canopy temperature (°C) on day of dry down						
--m^3 ha^{-1}--	1	2	3	4	7	8	9	10
			Dry Down 1					
0	30.2 †	35.4	37.4	38.8	35.7	35.9	45.1 a‡	35.2 a
33	30.2	35.2	37.0	38.5	35.6	35.6	44.8 ab	34.1 ab
66	29.3	34.6	37.0	37.8	35.0	34.8	43.7 b	33.3 b
99	30.0	35.2	36.9	38.1	35.4	35.0	43.9 b	33.3 b
			Dry Down 2					
0	26.2	34.6	37.7	35.7	32.9	34.1	35.4	37.6 a
33	25.0	33.5	37.7	35.4	32.9	33.9	34.8	37.0 ab
66	26.1	33.3	37.9	35.2	32.7	33.3	34.3	36.3 b
99	25.4	33.3	37.4	35.6	31.7	33.1	34.8	36.2 b
			Dry Down 3					
0	26.7	35.7	37.4	38.3	41.9	43.1 a	35.4 a	39.1 a
33	26.3	35.2	36.5	37.1	41.5	41.9 ab	34.3 ab	38.3 ab
66	25.9	35.6	36.9	38.3	41.4	42.0 ab	34.1 ab	37.9 b
99	25.2	35.0	36.7	38.2	40.9	41.6 b	33.5 b	37.8 b

† Each temperature is mean of three replicates.
‡ On individual days within each dry down cycle, numbers labeled with different letters are significantly different at $P \leq 0.05$.

Table 3.3 Influences of compost treatment on canopy temperatures (°C) of 'Kenblue' Kentucky bluegrass during the course of three dry down periods.

Compost Treatment	Canopy temperature (°C) on day of dry down							
--m^3 ha^{-1}--	1	2	3	4	7	8	9	10
				Dry Down 1				
0 *	30.3†	35.5	37.2	38.1	36.3	36.1	44.8 a‡	35.3 a
0	30.2	35.4	36.9	37.9	35.6	35.7	44.8 a	35.2 a
66	29.8	34.6	36.3	37.0	34.8	35.2	43.7 b	33.3 b
99	29.5	34.4	36.5	36.7	35.4	35.4	43.3 b	32.9 b
				Dry Down 2				
0 *	26.8	34.6	39.2	36.4	33.9	34.4 a	35.7 a	38.3 a
0	27.0	34.6	39.1	36.1	33.7	34.4 a	35.6 a	38.0 a
66	26.1	33.3	38.5	35.6	32.9	32.7 b	34.3 b	36.4 b
99	25.9	33.3	38.5	35.9	32.8	32.4 b	34.4 b	36.1 b
				Dry Down 3				
0 *	27.7	36.5	37.5	39.6	42.8 a	47.0 a	40.4 a	43.5 a
0	27.7	36.3	37.4	39.6	42.8 a	45.8 a	40.0 a	42.2 a
66	27.0	35.9	36.9	38.3	41.2 b	43.7 b	37.0 b	38.9 b
99	26.7	35.6	36.5	38.0	40.7 b	43.5 b	36.9 b	39.3 b

* Represents treatment that was not aerated over the course of the experiment, whereas all other treatments were aerated twice per growing season.

† Each temperature is mean of three replicates.

‡ On individual days within each dry down cycle, numbers labeled with different letters are significantly different at $P \leq 0.05$.

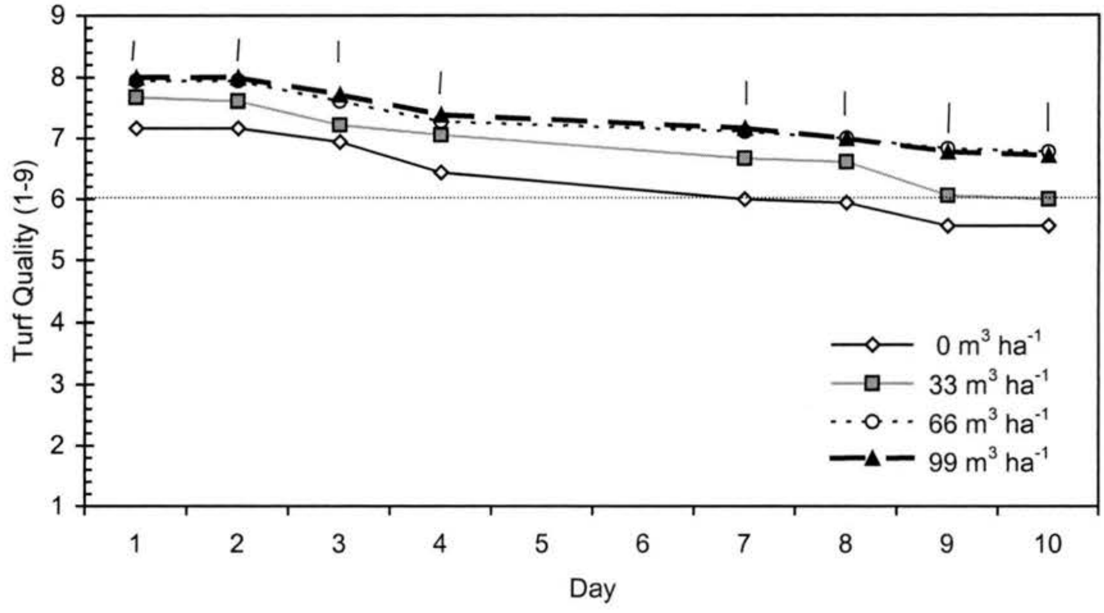

Figure 3.5 Turf quality decline of 'Nuglade' Kentucky bluegrass during dry down. Ratings are means of three replicates over three dry down periods. Bars indicate least significant difference (LSD) for individual dates where differences among compost treatments were significant at $P \leq 0.05$.

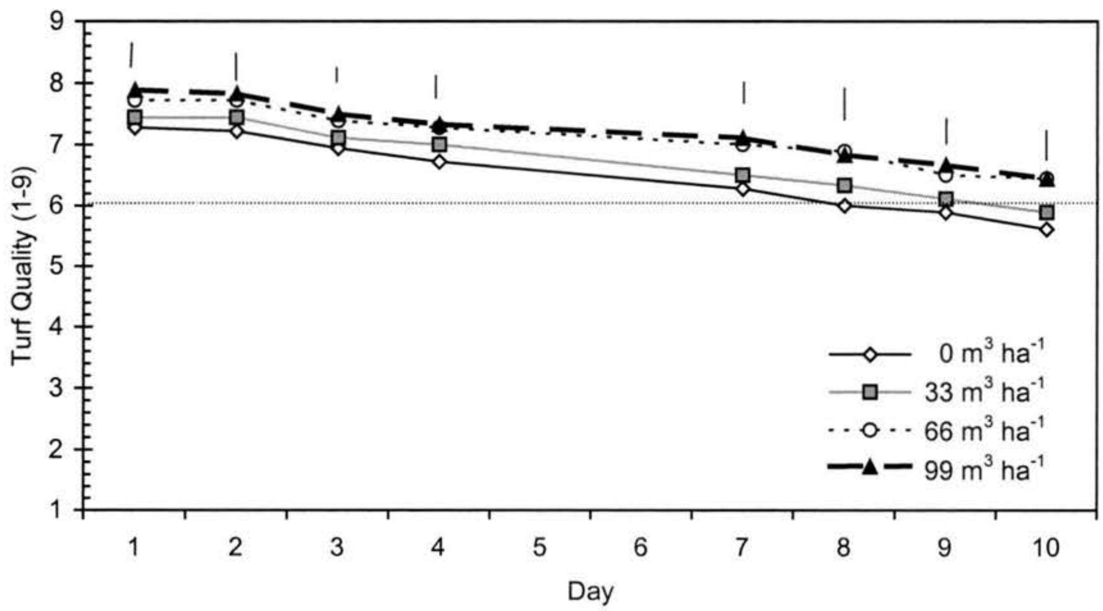

Figure 3.6 Turf quality decline of 'Livingston' Kentucky bluegrass during dry down. Ratings are means of three replicates over three dry down periods Bars indicate least significant difference (LSD) for individual dates where differences among compost treatments were significant at $P \leq 0.05$.

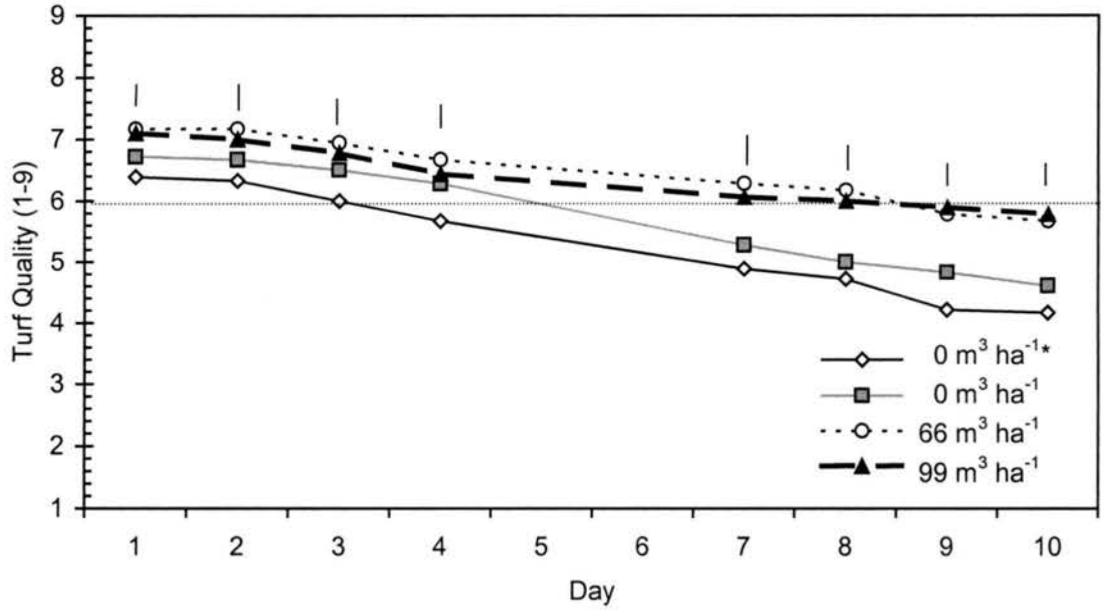

Figure 3.7 Turf quality decline of 'Kenblue' Kentucky bluegrass during dry down Ratings are means of three replicates over three dry down periods. Bars indicate least significant difference (LSD) for individual dates where differences among compost treatments were significant at $P \leq 0.05$. *Represents treatment that was not aerated over the course of the experiment, whereas all other treatments were aerated twice per growing season.

CHAPTER 4

NITROGEN AND PHOSPHORUS RUNOFF AND LEACHING POTENTIAL

ABSTRACT

Manure applied to agricultural fields is causing environmental concerns about nutrient runoff and leaching into surface and ground water. Many studies have shown that turfgrass is an excellent system for minimizing nutrient runoff and leaching. To test nutrient runoff and leaching potential after topdressing composted manure onto Kentucky bluegrass (*Poa pratensis* L.) at rates of 0, 33, 66, and 99 m^3 ha^{-1}, a rainfall simulation study was conducted and soil was sampled in 10 cm increments to the 50 cm depth. Runoff from the turf plots was collected for 60 min and analyzed for total nitrogen (TN), total inorganic nitrogen (TIN), nitrate nitrogen (NO_3-N), ammonium nitrogen (NH_4-N), total phosphorus (TP), total dissolved P (TDP), and Ortho-phosphates (OP). No differences in NO_3-N existed among treatments, and mean concentrations (~6.5 mg L^{-1}) were below EPA standards. Compost increased mean NH_4-N concentrations by 31% compared to the control. There were no differences in TP, TDP, or OP among treatments, with mean TP concentrations (~1.1 mg L^{-1}) slightly above EPA standards. The majority of the TP was contributed by sediment. There were no differences in NO_3-N or P among treatments below the root zone (30-50 cm). From this study, it is believed that topdressing compost onto established turfgrass poses minimal environmental threat from NO_3-N runoff or leaching.

INTRODUCTION

In Colorado, nutrient runoff and leaching has become a major problem along the South Platte River Basin. About 300,000 t of nitrogen and 40,000 t of phosphorus enter the South Platte River Basin annually from wastewater-treatments plants, precipitation, fertilizer, and manure (USGS, 1995). Of these sources, fertilizer and manure are predominately applied to agricultural land and turfgrass areas as a means to enhance plant growth. Therefore, when it rains or when irrigation water is applied to fields, some of the nutrients are carried with the water, and nutrient-enriched water may find its way into streams (USGS, 1995).

In addition to runoff, nitrate leaching can also be a problem because of its high soil mobility. The USDA-ARS has reported that nitrate is leaching into the South Platte's shallow alluvial aquifer from fertilizer and manure applications (Schuff, 1992). Nitrate nitrogen (NO_3) is a concern in drinking water because excessive concentrations can cause methemoglobinemia (blue baby syndrome), which restricts oxygen transport in the blood stream of infants (Hem, 1989). The U.S. Environmental Protection Agency (USEPA) has established a maximum contaminant level (MCL) for nitrate-nitrogen in drinking water of 10 mg L^{-1} (USGS, 1995).

Many studies have shown that turfgrass (similar to a grass buffer strip) is an excellent system for minimizing nutrient runoff and leaching. The dense growth habit and thatch-forming capabilities of turfgrass create a tortuous pathway slowing runoff velocities, reducing sediment loss, and increasing infiltration (Linde et al., 1995, 1998; Easton and Petrovic, 2004). In Maryland, it was found that runoff losses of sediment and all nutrients from turf were extremely low when compared with agronomic row crops (Gross et al., 1990 and 1991). Linde and Watschke (1997) reported that nitrogen and phosphorus runoff concentrations from turf areas, under normal soil moisture conditions, were below the EPA drinking water standard. Morton et al. (1988) investigated N runoff from Kentucky bluegrass turf in Rhode Island and reported that concentrations of inorganic N for all the treatments ranged from 1.1 to 4.2 mg L^{-1}.

Starr and DeRoo (1981) observed low NO_3-N leaching (0.3-10 mg L^{-1}) beneath a Kentucky bluegrass/red fescue lawn over a three year period, and noted that water samples from wells upstream, 25 and 50 m away averaged 0.9 and 2.7 mg L^{-1} NO_3-N, respectively. Mancino and Troll (1990) investigated NO_3 leaching from a creeping bentgrass turf under conditions favoring heavy leaching losses and found that NO_3 leaching averaged less than 0.5% of the applied N at a rate of 9.8 kg N ha^{-1} wk^{-1}. Miltner et al. (1996) studied the fate of urea applied to a Kentucky bluegrass turf using ^{15}N labeled $(NH_4)_2SO_4$ and found that nitrate concentrations in leachate were generally below 1 mg NO_3-N L^{-1}, collected in the drainage water of lysimeters. Morton et al. (1988) and Starr and DeRoo (1981) concluded that under management practices common to home lawns, the risk of groundwater contamination from fertilizer N is extremely low.

In rivers, lakes, and reservoirs, excessive nutrient levels can accelerate the growth of algae and other aquatic plants, causing problems such as clogged pipelines, fish kills, and restricted recreation. To avoid these problems, the USEPA recommends that total phosphorus should be less than 0.1 mg L^{-1} in rivers, and less than 0.05 mg L^{-1} where rivers enter lakes and reservoirs (USGS, 1995). The most common measurements of phosphorus are orthophosphates (PO_4 - P) and total phosphorus (TP) (Stednick, 2000). A good portion of the TP is not available for plant uptake. Most of the phosphorus that gets into water sources is by runoff or erosion because, unlike nitrogen, it is strongly sorbed and has limited leaching potential.

The turfgrass canopy reduces erosion by dissipating sediment detachment (Krenitsky et al., 1998), and reducing subsequent transport of sorbed ions such as phosphate (Easton and Petrovic, 2004). Gaudreau et al. (2002) examined P concentrations in runoff from newly established bermudagrass broadcasted with composted dairy manure (50 and 100 kg P ha^{-1}) and inorganic fertilizer (25 and 50 kg P ha^{-1}) on an 8.5 % slope. They showed that runoff losses of dissolved P from eight rain events were 44 % less for composted manure than fertilizer treatment at equal P rates. The authors concluded that compost nutrients were less soluble and transportable, however, dissolved P concentrations of runoff from compost treatments were well above 2 mg L^{-1}, which raises some environmental concerns.

In this study, it is hypothesized that topdressing composted manure onto established turfgrass will not cause nutrient problems in the environment, specifically, that N and P in runoff will be below the EPA drinking water standards, and N and P leaching potential will be minimized.

The objectives of the study were to evaluate the effects that topdressing composted manure onto 'Nuglade' Kentucky bluegrass has on: (i) total runoff and sediment losses during rainfall; (ii) nitrogen and phosphorus concentrations in runoff during rainfall; and (iii) nitrate (NO_3-N) and P leaching potential into the 0-50 cm soil depths.

METHODS AND MATERIALS

A rainfall simulation was conducted from May 27 through June 4, 2004 on 'Nuglade' Kentucky bluegrass. The purpose of the simulation was to collect runoff from the turf plots that received composted manure topdressing treatments and to analyze it for total nitrogen (TN), nitrate nitrogen (NO_3-N), ammonium nitrogen (NH_4-N), total phosphorus (TP), total dissolved P (TDP), and Ortho-phosphates (OP). Plots had a slight 1-2 % to the South West slope. To collect the runoff, a custom-made steel frame measuring 1.27 m wide, 2.03 m long, and 0.15 m in height, was driven ~10-13 cm deep into the turf plot. At the front of the frame, there was a trough designed to slope downward horizontally so runoff could be collected. To install the trough, a spade shovel was used to remove soil approximately 7.62 cm from where the edge of the plot met the soil on the West side of the plots. Then the trough was driven into the undisturbed soil directly in front of the plot, snuggly against the edge of the turf. The top of the trough was set approximately at the soil surface (Picture 4.1).

The rainfall simulator was constructed of aluminum piping, based on the design of Miller (1987). A hanging TeeJet™ ½ HH-SS50WSQ nozzle was used, which was approximately 3.048 m above the turf canopy. The simulator used a pressure regulator set at 69 kPa, which delivered a rainfall intensity of ~ 6.7 cm hr^{-1}. One rainfall simulation was conducted on each of the 12 'Nuglade' plots for 90 minutes each. Runoff was collected for 2 ½ minutes, in every five-minute interval during the first half hour. After that, runoff was collected in 2 ½ minute intervals for the remaining hour. Samples collected during time intervals ending at 2.5, 7.5, 12.5, 17.5, 22.5, 27.5, 32.5, 37.5, 42.5, 47.5, 52.5, 57.5, 62.5, 67.5, 72.5, 77.5, 82.5, and 87.5 minutes were used to measure runoff flow rate and sediment mass. The samples collected at time intervals ending at 35, 40, 45, 50, 60, 65, 70, 75, 80, 85, and 90 minutes were used to measure nutrient content. Two 50 mL sub-samples were taken from these samples. One was filtered (.45μm pore diameter), and the second was left unfiltered and acidified to pH 2 with HCl. In a few cases, insufficient amounts of runoff were collected at certain time intervals, which allowed analysis for filtered samples only (see statistical analysis). Flow rate was calculated by dividing the runoff volumes by time taken to collect each sample. Erosion rate was calculated by dividing the sediment mass (g) by time.

Nutrient leaching was determined by comparing baseline soil data (collected April 26, 2003) to samples taken at the culmination of the experiment (collected September 29, 2004). Four soil samples were taken from each plot of 'Nuglade' at depths 0-10, 10- 20, 20-30, 30-40, and 40-50 cm using a Giddings Hydraulic Soil Probe (#15-SCS Model GSRPS, Giddings Machine Company Inc., Windsor, CO) which would be assumed to extend past the majority of the root zone (see Chapter 1). Samples from each plot were combined and allowed to air dry, then ground to pass through a 2-mm sieve for nitrate and P analysis.

Laboratory Analysis

To determine sediment mass, samples were weighed, 8 drops of concentrated HCl were added, and then left to settle overnight. The following day, the clear water was poured off the sample, and the remainder of the sample was placed in an oven at 105°C for ~24 hours. After the water had evaporated, samples were weighed again to determine the sediment mass in the sample. The difference between the dry weight and bottle weight was used to obtain sediment mass (g). An additional filtering process was required because the water used in the rainfall event was fairly saline (EC 2.8 dS m^{-1}), and it left behind white flakes in the sediment sample. Sediment was filtered by adding 500 mL de-ionized water and shaken, which allowed the salts to dissolve. The liquid was poured into a glass micro-fiber filter, and was attached to a vacuum. Sediment was filtered through Whatman GF/C filter paper. Care was taken to squirt all of the sediment into the beaker using a squirt bottle. The vacuum sucked out the water and salts, and only the sediment was left. The samples were placed in the oven at 105 °C for 24 hr, and weighed after drying, and the true sediment mass was obtained.

Filtered samples

Testing of filtered (.45μm) runoff samples was conducted at the Colorado State University Soil, Water, and Plant Testing Laboratory within 24 hrs of collection. Filtered (.45μm) samples were tested for Ortho-P using the ascorbic acid colorimetric method of Murphy and Riley (1962), and Total Dissolved Phosphorus (TDP) using the inductively coupled plasma (ICP). No digestion took place prior to the analysis. Testing for ammonium nitrate (NH_4-N) and nitrate nitrogen (NO_3-N) was done using the methods for chemical analysis of water and wastes described by USEPA (1983).

Unfiltered Samples

Total P was analyzed by shaking unfiltered, acidified runoff samples prior to pouring 25 mL sub samples into digestion tubes. Then 2 mL $HClO_4$ and 5 mL HNO_3 were added to the digestion tubes and predigested at 100 °C for approximately 24 hours. Samples were removed when two mL of liquid volume remained. Any residue on the side of the tubes was scraped into the liquid. Samples were digested on a heating block for 2 hours at 200 °C and then were removed and cooled for 24 hours. The samples were brought to a final volume of 25 mL with deionized water and left to settle for 24 hours. A 10 mL sub-sample was poured off the top of each digestion tube into an ICP auto analyzer cuvet. The ICP ran a total phosphorus program and measured the sample concentrations against the introduced standards.

Kjeldahl N (including organic N and inorganic NH_4-N) was analyzed by shaking unfiltered, acidified runoff samples prior to pouring 25 mL sub samples into digestion tubes. A 2.5 mL aliquot of sulfuric acid and 1g of catalyst ($CuSO_4/K_2SO_4$) were added to the digestion tubes and predigested at 100 °C for approximately 24 hours. Samples were removed when two mL of liquid volume remained. Any residue on the side of the tubes was scraped into the liquid. Samples were digested on a heating block for 5 hours at 350 °C and then were removed and cooled for 24 hours. The samples were brought to a final volume of 25 mL with deionized water and left to settle for 24 hours. A 10 mL sub-sample was poured off the top of each digestion tube into a Flow Injector (OI Analytical Inc., College Station, TX) auto analyzer cuvet. Flow Injector ran nitrogen.

Total nitrogen (TN) was calculated by adding the unfiltered Kjeldahl N to the NO_3-N from the filtered samples. Sediment N (SN) was calculated using the formula:

$$SN = TN - [TIN*R_v / (R_m + S_m)]$$

where TN is total nitrogen; TIN represents total inorganic nitrogen; R_m represents runoff mass; and S_m equals sediment mass.

Sediment P (SP) was calculated using the formula:

$$SP = TP - [TDP*R_v / (R_m + S_m)]$$

where TP is total phosphorus; TDP is total dissolved phosphorus; R_m represents runoff mass; and S_m equals sediment mass.

Soil Analysis

Soil samples were analyzed for extractable nitrate nitrogen (NO_3-N) and phosphorus (P), by using an AB-DTPA test at the Colorado State University Soil, Water, and Plant Testing Laboratory (see Chapter 2).

Statistical Analysis

Data (by individual time and combined means) from filtered and unfiltered samples, flow rate, and erosion rate in runoff were subjected to analysis of variance using SAS Proc GLM (SAS Institute, 2002) to test effects of compost treatments on TN, TP, TIN, NH_4, NO_3, TDP, and Ortho-P. Missing data occurred 2 times in the filtered samples and 11 times in the unfiltered samples due insufficient runoff volumes. Data collected on the first test plot (33 m^3 ha^{-1}, replicate 3) were not included in the analysis of runoff volume or sediment due to large experimental error during runoff collection.

RESULTS AND DISCUSSION

Figure 4.1 represents runoff flow rate (mL min^{-1}) during rainfall simulation collected at five-minute intervals. There are no significant differences among treatments in the amount of runoff collected by time. Runoff volumes increased with time, and never seemed to level off. Perhaps more time was needed to reach a steady state. The erosion rate (g min^{-1}) also increased with time, and like runoff, no significant differences among treatments occurred throughout the entire runoff period (Fig. 4.2). Therefore, compost application had no effect on runoff or erosion rates from the plots. However, experimental error occurred due to additional sediment entering the collection bottles at the point where the trough met the soil. This contributed to higher amounts of sediment collected.

There were no differences in TN present in the runoff (with sediment included) by time (Fig. 4.3). In fact, the concentration stayed fairly consistent over time. In contrast, TP present in runoff fluctuated over the course of the rainfall event (Fig. 4.4), however, there were no statistical differences among any of the treatments by time. Figures 4.5 and 4.6 represent the amount of N and P present in the sediment, respectively, and no significant differences among any of the treatments were detected by time. Table 4.1 represents the mean N and P collected in both runoff and sediment, in which no statistical differences were detected among any of the treatment levels. The TP is higher than the EPA standard and most of it is contributed from the sediment. However, the increased amount of sediment due to experimental error probably overestimates these values.

In the filtered runoff, no significant differences in dissolved Total Inorganic Nitrogen (TIN) existed among treatments at any particular sampling time (Figure 4.7). There were no significant differences in the amount of ammonium nitrogrn (NH_4-N) or nitrate nitrogen (NO_3-N) in the filtered runoff by time (Fig. 4.8 & 4.9). However, the concentration of NO_3-N does not take into account the amounts present in the irrigation water used (see Chapter 1). When data were combined over time, compost treatments had a significantly higher amount of dissolved TIN than the control (Table 4.2). In addition, the total amount of ammonium (NH_4-N) was significantly lower for the control when compared to any of the treatments that received compost. The reason for this is probably because of the slow breakdown and release of organic N to inorganic N. Although these differences were detected, all of the concentrations of dissolved N were still below the EPA's 10 mg L^{-1} recommendation for NO_3-N.

There were no significant differences detected in Total Dissolved Phosphorus (TDP) by time (Figure 4.10) or in the overall means (Table 4.2). Likewise, Figure 4.11 and Table 4.2 show that there were no statistical differences in ortho-phosphate concentration in the filtered runoff by time or in the means, respectively. There were no implications that topdressing composted manure led to any P hazards in the runoff. The total dissolved phosphorus concentrations (Table 4.2) met the USEPA suggested concentration of less than 0.10 mg/L for rivers and less than 0.05 mg/L for rivers that enter lakes and reservoirs (USGS, 1995).

Nitrate nitrogen (NO_3-N) leaching in the soil profile is represented by Table 4.3, in which no significant differences among treatments existed by depth. Although not statistically significant, NO_3-N concentrations increased with depth for all treatments.

The reason for this is probably because nitrate is very water-soluble and can leach down through the clay/ clay loam soil profile very readily. Although it was not measured, another reason may have been that the roots absorbed more nitrogen in the shallower depths, since the large majority of the roots were in the top 25 cm of the soil (see Chapter 1), and no significant differences were detected beyond the root zone. Nitrogen sources applied over the duration of the experiment are represented in Table 4.4.

Unlike nitrate, phosphorus is strongly sorbed. Treatments that received compost were significantly higher in soil phosphorus compared to the control in the surface depth, because of the amounts of P that the compost added (Table 4.4). There were no significant differences among treatments from 10-50 cm deep, and the concentrations dropped dramatically. According to Self (2000), a very commonly used test at Colorado State University's Soil, Water, and Plant Testing Lab is called an ammonium bicarbonate-DTPA test. This test has four categories that are as follows: low (0-3 mg kg^{-1} P); medium (4-7 mg kg^{-1} P); high (8-11 mg kg^{-1} P); and very high (greater than 11 mg kg^{-1} P). In the fiscal year of July 1, 1998 to June 30, 1999, the Lab analyzed many surface soil samples sent in by farmers. Of the samples tested, 29.4% fell in the low category, 26.4% fell in the medium category, 14.1% within the high category, and a shocking 30.1% were in the very high category. Therefore, 44.2% of these soils tested in the high or very high categories. In this study, compost treatments resulted in medium (4-7 mg kg^{-1} P) concentrations and the control was in the low (0-3 mg kg^{-1} P) range in the surface depth. This indicates the turfgrass plots in this experiment had lower amounts of residual P, compared to many agricultural soils.

Conclusions

Based on these results on a uniform 1-2% slope, topdressed compost onto turf caused little environmental concern about NO_3-N runoff or leaching from two years of application, due to the fact that water concentrations were below the EPA standards and no difference in soil concentrations existed among treatments by depth. In fact, the only significant N impact was that compost contributed to higher NH_4-N concentrations in runoff compared to the control. Although there is some concern about TP concentrations in runoff, there were no differences between compost treatments and the control. If sediment losses could be minimized, the environmental risks would be reduced. There was no concern about P leaching into ground water, and in fact, the P addition could be quite beneficial to the turfgrass as it is available to the plant to take up over time.

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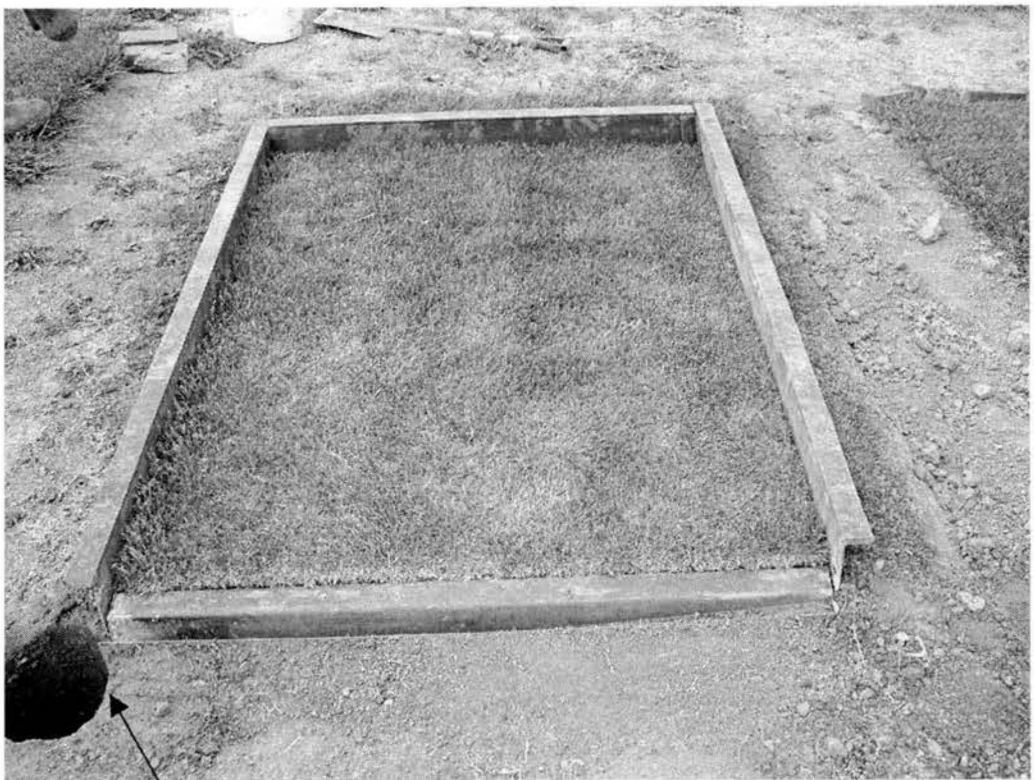
Picture 4.1 Metal frame completely installed and ready for collecting runoff from rainfall simulation, May 2004.



Hole where bottles were placed to collect runoff flowing out of the trough.

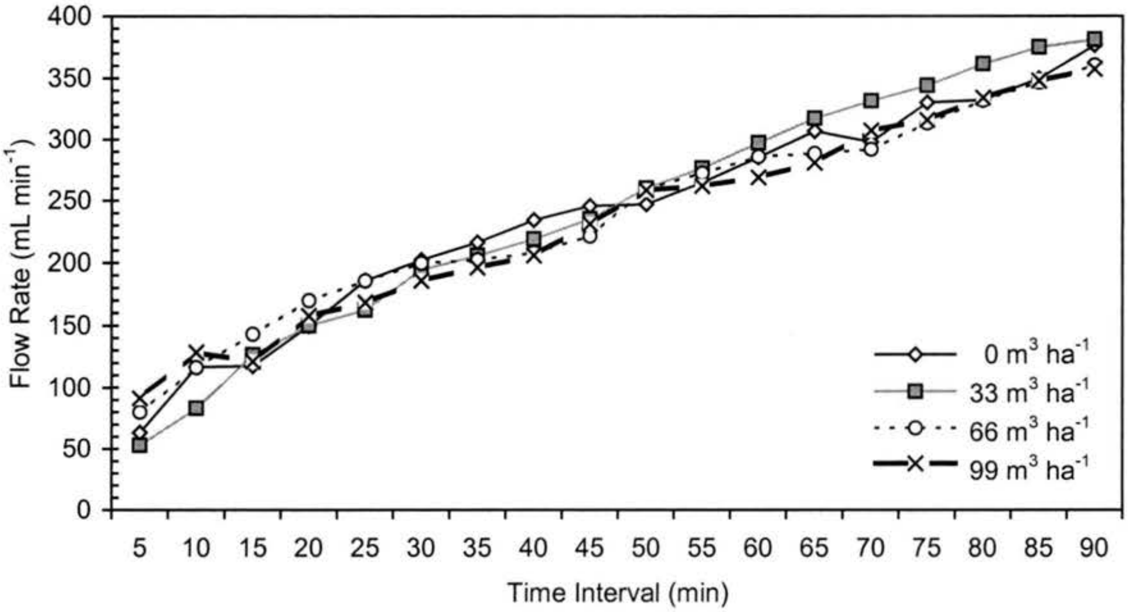


Figure 4.1 Flow of runoff as a function of , from 'Nuglade' Kentucky bluegrass plots subjected to four different compost treatments.

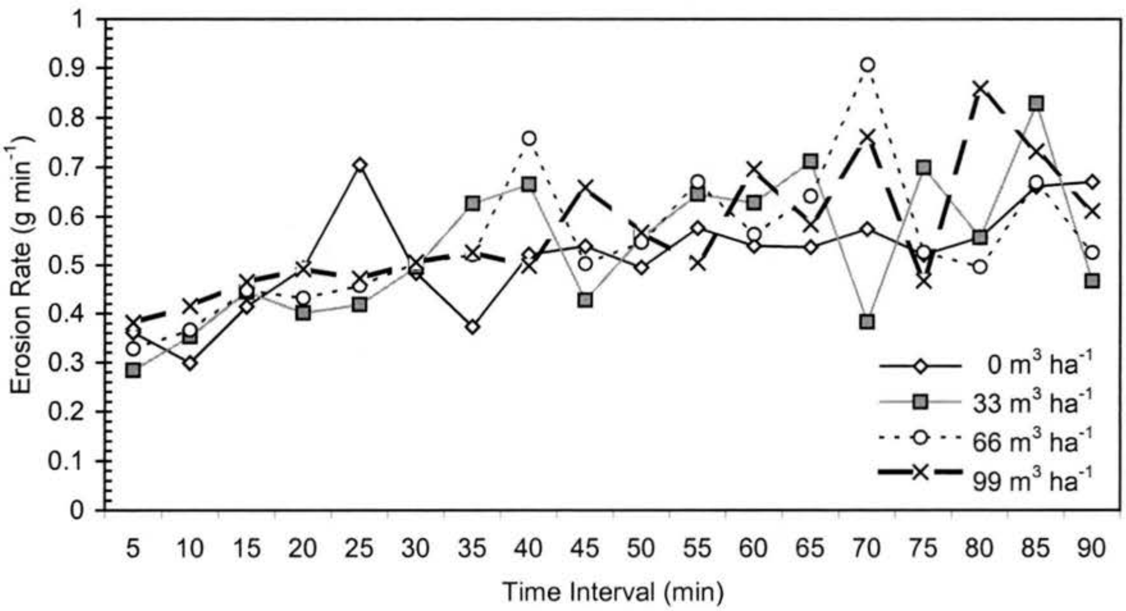


Figure 4.2 Erosion rate of runoff as a function of , from 'Nuglade' Kentucky bluegrass plots subjected to four different compost treatments.

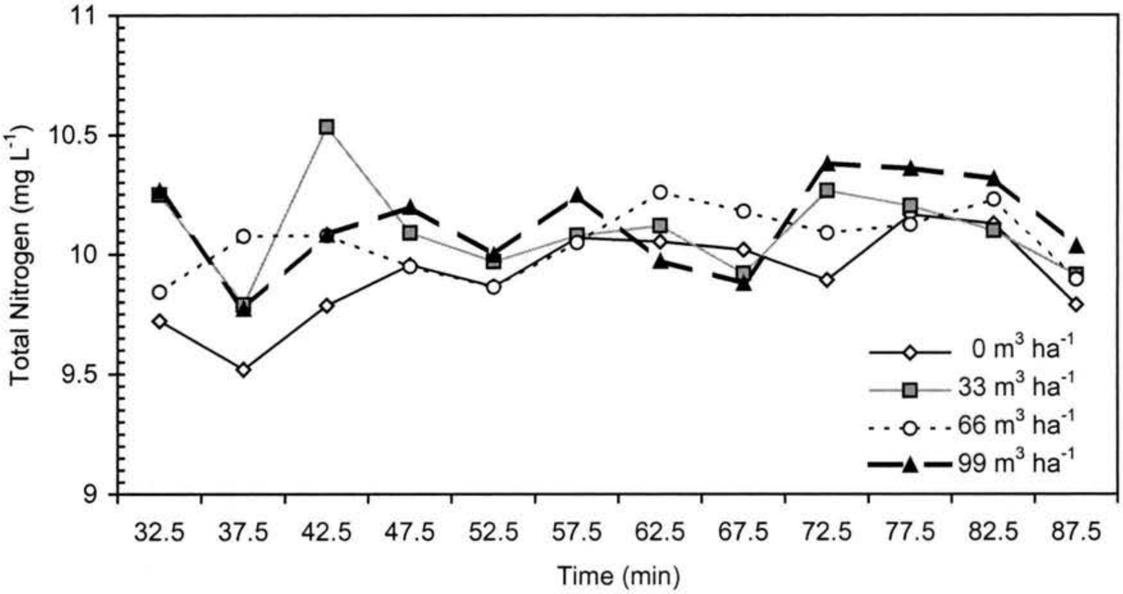


Figure 4.3 Total nitrogen in runoff as a function of time, from 'Nuglade' Kentucky bluegrass plots subjected to four different compost treatments.

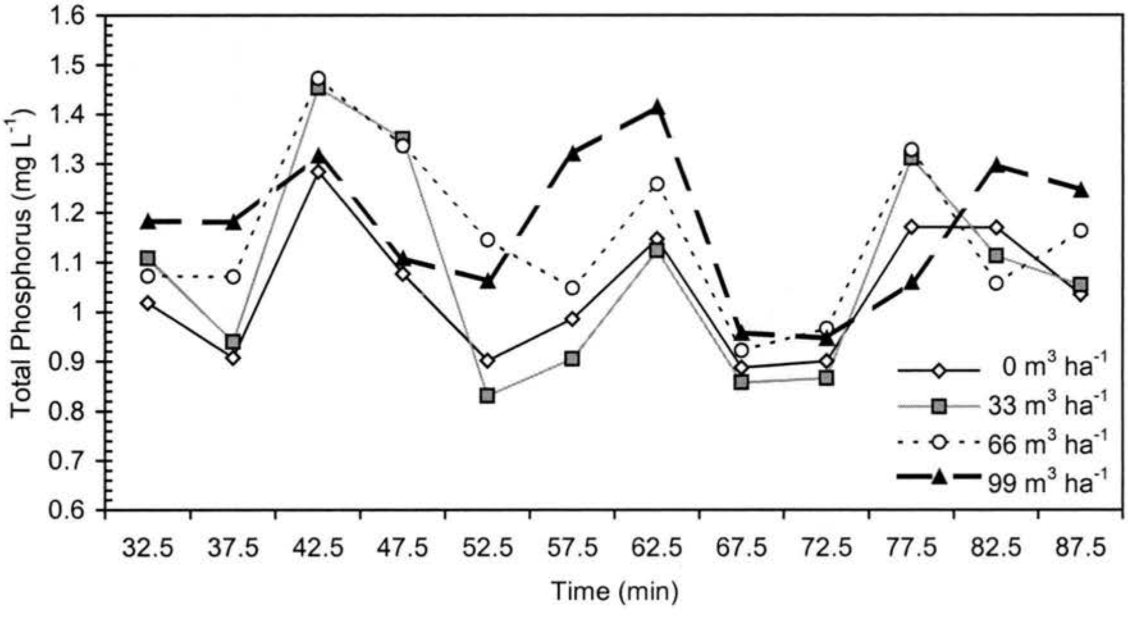


Figure 4.4 Total phosphorus in runoff as a function of time, from 'Nuglade' Kentucky bluegrass plots subjected to four different compost treatments.

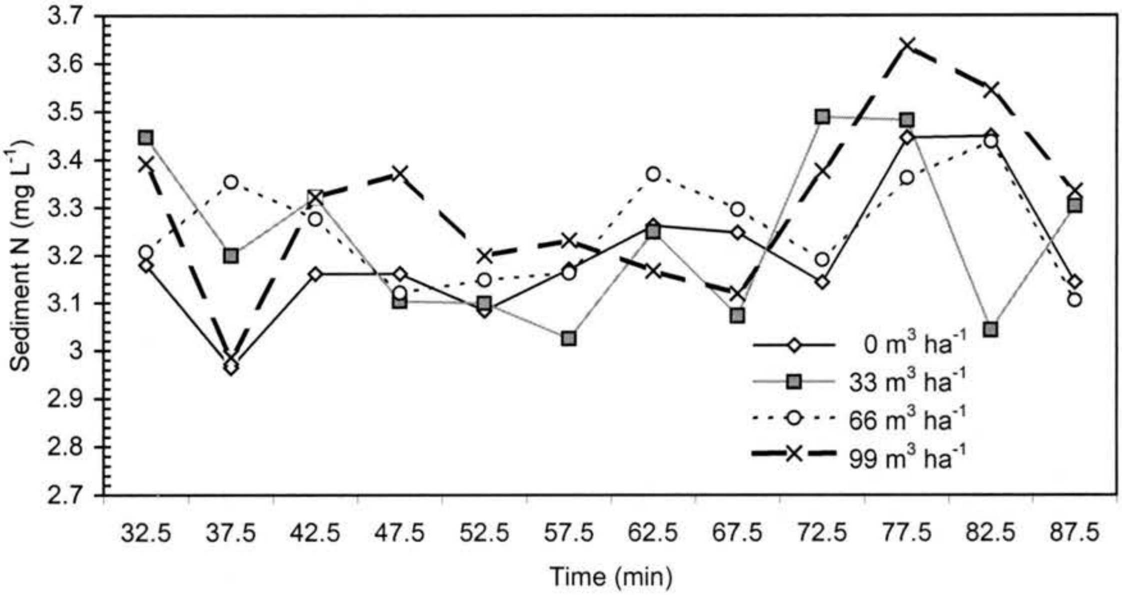


Figure 4.5 Sediment nitrogen in runoff as a function of time, from 'Nuglade' Kentucky bluegrass plots subjected to four different compost treatments.

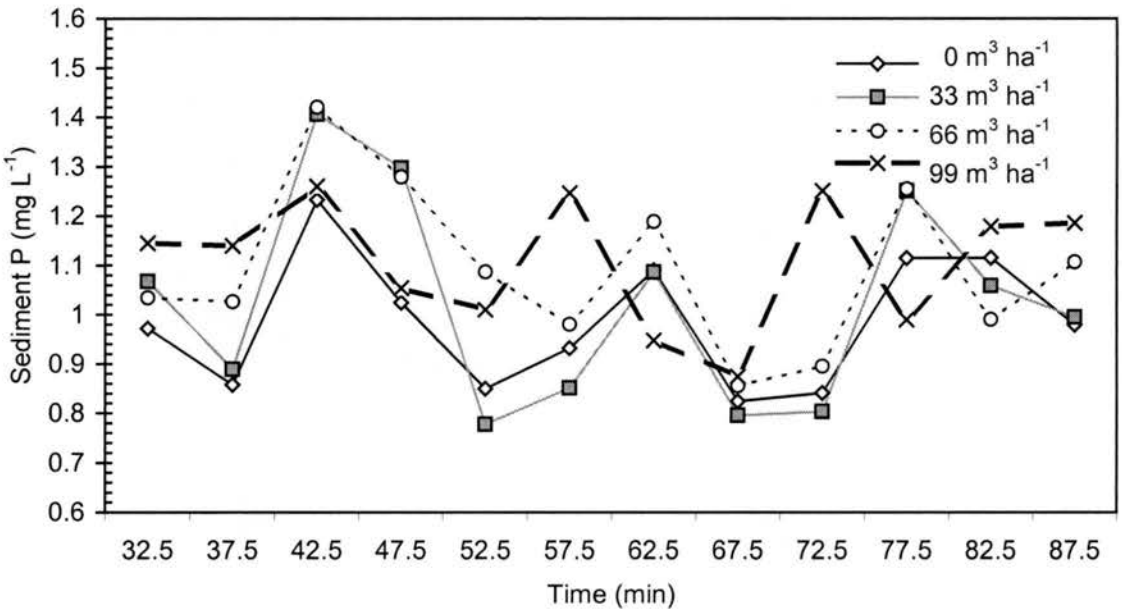


Figure 4.6 Sediment phosphorus in runoff as a function of time, from 'Nuglade' Kentucky bluegrass plots subjected to four different compost treatments.

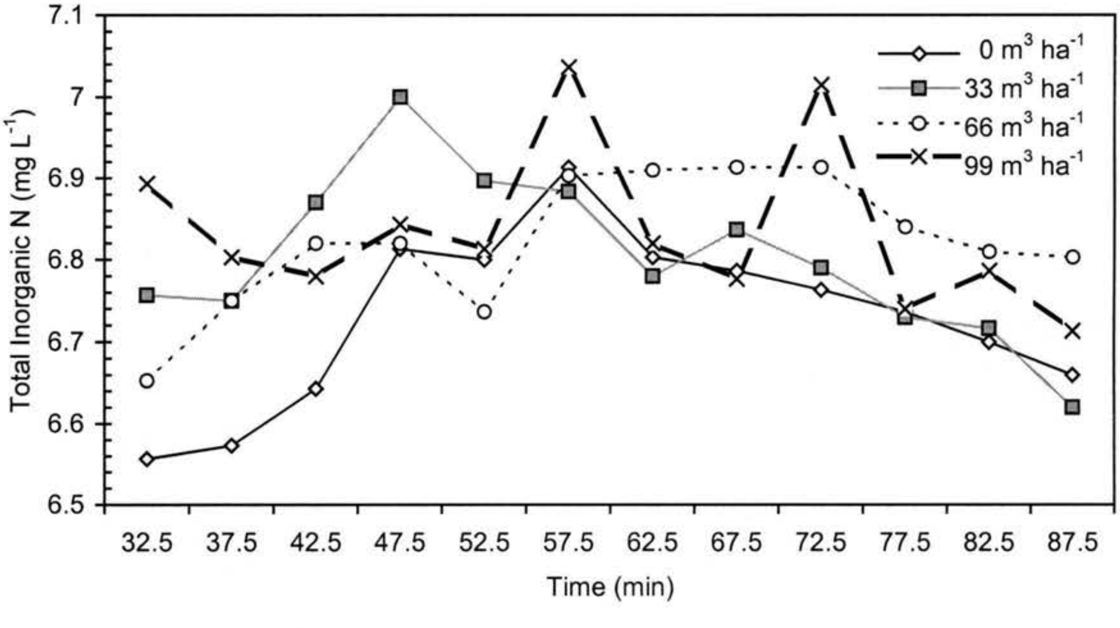


Figure 4.7 Total dissolved inorganic nitrogen (NH_4+NO_3) in runoff as a function of time, from 'Nuglade' Kentucky bluegrass plots subjected to four different compost treatments.

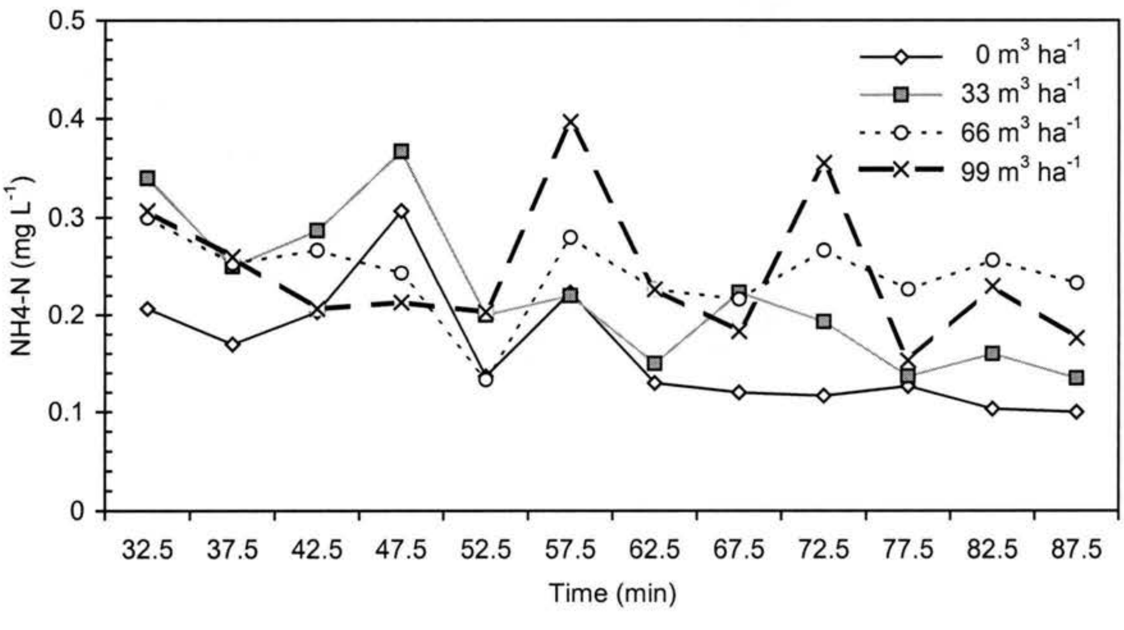


Figure 4.8 Dissolved ammonium nitrogen (NH_4-N) in runoff as a function of time, from 'Nuglade' Kentucky bluegrass plots subjected to four different compost treatments.

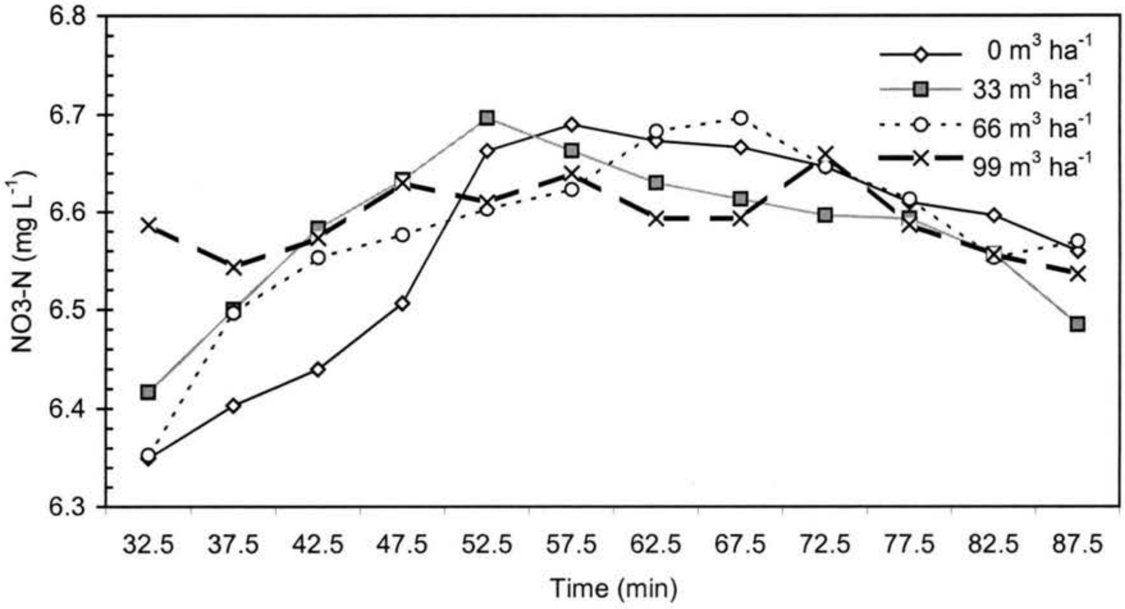


Figure 4.9 Dissolved nitrate nitrogen (NO_3-N) in runoff as a function of time, from 'Nuglade' Kentucky bluegrass plots subjected to four different compost treatments.

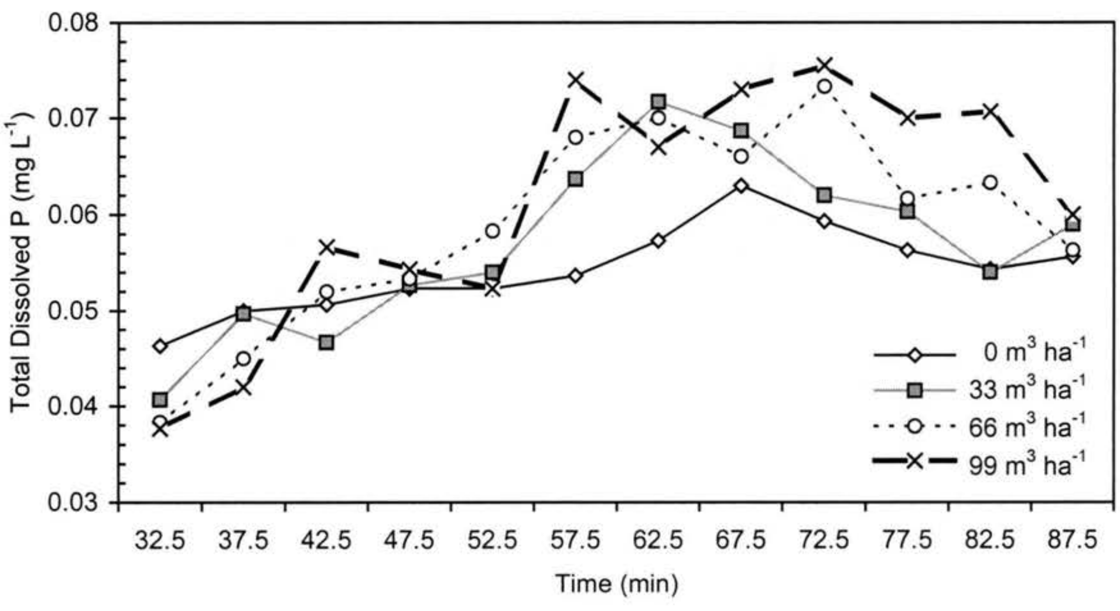


Figure 4.10 Total dissolved phosphorus in runoff as a function of time, from 'Nuglade' Kentucky bluegrass plots subjected to four different compost treatments.

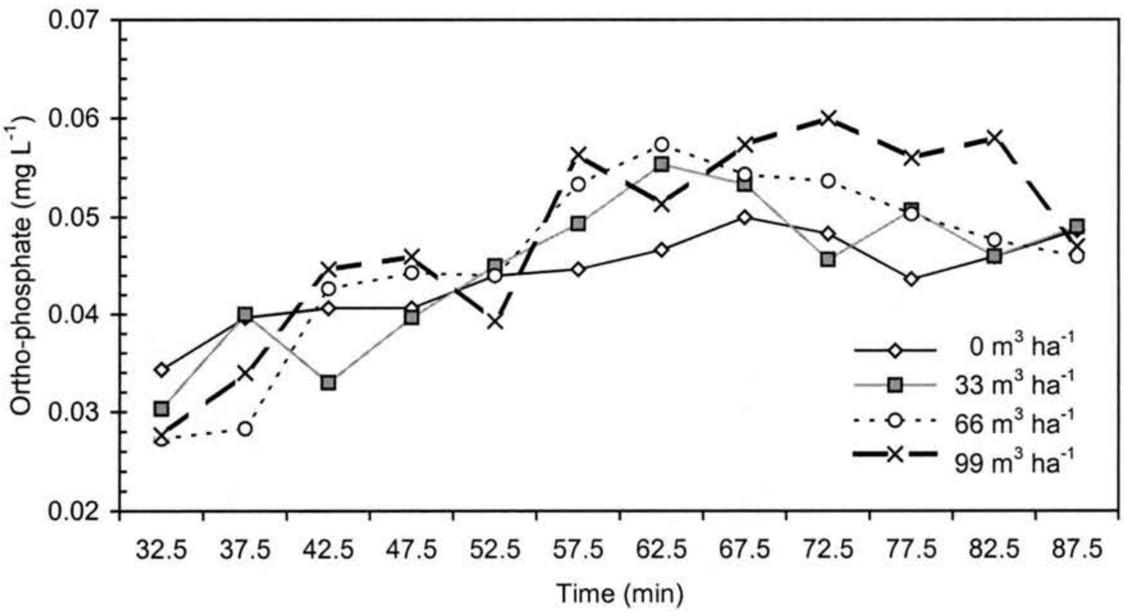


Figure 4.11 Ortho-phosphate in runoff as a function of time, from 'Nuglade' Kentucky bluegrass plots subjected to four different compost treatments.

Table 4.1 Mean nitrogen and phosphorus in runoff and sediment collected during simulated rainfall event for 'Nuglade' Kentucky bluegrass. No significant treatment effects were detected using LSD ($P \leq 0.05$).

Compost	Total N	Total P	Sediment N	Sediment P
$-m^3\ ha^{-1}-$	----------------------------	---mg L^{-1}---	----------------------------	----------------------------
0 m^3/ha	9.92 *	1.04	3.19	0.99
33 m^3/ha	10.10	1.08	3.25	1.03
66 m^3/ha	10.06	1.14	3.24	1.08
99 m^3/ha	10.12	1.16	3.29	1.10

* Individual data represent means of three plots each of which were sampled 18 times, during 2.5 minute intervals over a 90 minute duration.

Table 4.2 Mean total inorganic nitrogen (TIN), NH_4-N, NO_3-N, total dissolved phosphorus (TDP), and Ortho-P in runoff collected during simulated rainfall event for 'Nuglade' Kentucky bluegrass.

Treatment	TIN	NH_4-N	NO_3-N	TDP	Ortho-P
$-m^3\ ha^{-1}-$	----------------------------	----------------------------	---mg L^{-1}---	----------------------------	----------------------------
0 m^3/ha	6.72 b*[x]	0.162 b	6.56 a	0.054 a	0.044 a
33 m^3/ha	6.80 a	0.224 a	6.58 a	0.057 a	0.045 a
66 m^3/ha	6.82 a	0.242 a	6.58 a	0.059 a	0.046 a
99 m^3/ha	6.83 a	0.239 a	6.59 a	0.061 a	0.048 a

* Means with different letters indicate significant difference using LSD ($P \leq 0.05$).
[x] Means of three plots each of which were sampled 18 times, during 2.5 minute intervals over a 90 minute duration.

Table 4.3 Nitrate nitrogen and phosphorus content in the soil at the culmination of two growing seasons on 'Nuglade' Kentucky bluegrass. Means derived from three replications.

Depth	Compost Amount	----AB-DTPA extract----	
		NO_3-N	P
-cm-	--m^3 ha^{-1}--	------------mg L^{-1}----------	
	0	2.43 a*	1.43 b
0-10	33	2.20 a	3.70 a
	66	2.23 a	4.17 a
	99	2.03 a	4.45 a
	0	2.77 a	0.70 a
10-20	33	2.57 a	1.10 a
	66	2.13 a	0.80 a
	99	2.60 a	1.20 a
	0	3.53 a	0.43 a
20-30	33	3.30 a	0.40 a
	66	2.73 a	0.60 a
	99	3.20 a	0.70 a
	0	3.90 a	0.40 a
30-40	33	3.47 a	0.37 a
	66	2.83 a	0.90 a
	99	3.53 a	0.70 a
	0	4.80 a	0.60 a
40-50	33	3.87 a	0.67 a
	66	3.37 a	0.60 a
	99	4.37 a	0.60 a

*Means with a common letter are not significantly different using LSD at ($P \leq 0.05$).

Table 4.4. Nitrogen (N) and phosphorus (P) sources applied to Kentucky bluegrass during 2003 and 2004 growing seasons. All inorganic N sources combined to get total inorganic nitrogen (TIN) applied. Differences in 2004 are due to one compost application, compared to two applications in 2003.

2003

			Compost			
Compost Treatment	NO_3-N from irrigation	Urea fertilizer	NO_3-N + NH_4-N	Organic-N	P	TIN
-m^3 ha^{-1}-	kg ha^{-1}					
0	50	61.6	0	0	0	111.6
33	50	38.8	18	396	172	106.8
66	50	19.4	36	792	344	105.4
99	50	0.0	54	1188	516	104.0

2004

			Compost			
Compost Treatment	NO_3-N from irrigation	Urea fertilizer	NO_3-N + NH_4-N	Organic-N	P	TIN
-m^3 ha^{-1}-	kg ha^{-1}					
0	50	61.6	0	0	0	111.6
33	50	38.8	9	207	86	97.8
66	50	19.4	18	414	172	87.4
99	50	0.0	27	621	258	77.0

APPENDIX A.

Turf Quality Ratings

ID #	Grass	Trt.	Rep.	Date	Rating
1	Nuglade	2	1	2-Jun-03	7
2	Kenblue	1	1	2-Jun-03	5
3	Nuglade	1	2	2-Jun-03	7.5
4	Livingston	3	2	2-Jun-03	6
5	Kenblue	5	2	2-Jun-03	5.5
6	Nuglade	3	3	2-Jun-03	7
7	Nuglade	4	3	2-Jun-03	8
8	Livingston	1	3	2-Jun-03	7
9	Livingston	3	3	2-Jun-03	7
10	Kenblue	5	3	2-Jun-03	5.5
11	Nuglade	2	3	2-Jun-03	6.5
12	Kenblue	4	3	2-Jun-03	6
13	Livingston	2	2	2-Jun-03	7
14	Nuglade	3	2	2-Jun-03	7
15	Nuglade	4	2	2-Jun-03	7
16	Nuglade	4	1	2-Jun-03	7
17	Livingston	3	1	2-Jun-03	6
18	Nuglade	1	1	2-Jun-03	7.5
19	Livingston	2	1	2-Jun-03	7
20	Livingston	1	1	2-Jun-03	6
21	Kenblue	4	1	2-Jun-03	6
22	Kenblue	3	2	2-Jun-03	5
23	Livingston	4	2	2-Jun-03	6
24	Livingston	1	2	2-Jun-03	6
25	Livingston	4	3	2-Jun-03	7
26	Nuglade	1	3	2-Jun-03	7
27	Kenblue	1	3	2-Jun-03	7
28	Livingston	2	3	2-Jun-03	5
29	Kenblue	3	3	2-Jun-03	7
30	Kenblue	4	2	2-Jun-03	6
31	Nuglade	2	2	2-Jun-03	6.5
32	Kenblue	1	2	2-Jun-03	7
33	Livingston	4	1	2-Jun-03	7
34	Nuglade	3	1	2-Jun-03	8
35	Kenblue	3	1	2-Jun-03	7
36	Kenblue	5	1	2-Jun-03	7
1	Nuglade	2	1	16-Jun-03	8
2	Kenblue	1	1	16-Jun-03	6
3	Nuglade	1	2	16-Jun-03	7.5
4	Livingston	3	2	16-Jun-03	7
5	Kenblue	5	2	16-Jun-03	6
6	Nuglade	3	3	16-Jun-03	8
7	Nuglade	4	3	16-Jun-03	8
8	Livingston	1	3	16-Jun-03	7
9	Livingston	3	3	16-Jun-03	7
10	Kenblue	5	3	16-Jun-03	6

11	Nuglade	2	3	16-Jun-03	7.5
12	Kenblue	4	3	16-Jun-03	6
13	Livingston	2	2	16-Jun-03	7
14	Nuglade	3	2	16-Jun-03	8
15	Nuglade	4	2	16-Jun-03	8
16	Nuglade	4	1	16-Jun-03	7
17	Livingston	3	1	16-Jun-03	7
18	Nuglade	1	1	16-Jun-03	7.5
19	Livingston	2	1	16-Jun-03	7
20	Livingston	1	1	16-Jun-03	7
21	Kenblue	4	1	16-Jun-03	6
22	Kenblue	3	2	16-Jun-03	6
23	Livingston	4	2	16-Jun-03	8
24	Livingston	1	2	16-Jun-03	7
25	Livingston	4	3	16-Jun-03	7
26	Nuglade	1	3	16-Jun-03	6
27	Kenblue	1	3	16-Jun-03	7
28	Livingston	2	3	16-Jun-03	6
29	Kenblue	3	3	16-Jun-03	6
30	Kenblue	4	2	16-Jun-03	6
31	Nuglade	2	2	16-Jun-03	7
32	Kenblue	1	2	16-Jun-03	5
33	Livingston	4	1	16-Jun-03	8
34	Nuglade	3	1	16-Jun-03	8
35	Kenblue	3	1	16-Jun-03	7
36	Kenblue	5	1	16-Jun-03	5
1	Nuglade	2	1	1-Jul-03	8
2	Kenblue	1	1	1-Jul-03	7
3	Nuglade	1	2	1-Jul-03	7
4	Livingston	3	2	1-Jul-03	8
5	Kenblue	5	2	1-Jul-03	6
6	Nuglade	3	3	1-Jul-03	8
7	Nuglade	4	3	1-Jul-03	8
8	Livingston	1	3	1-Jul-03	7
9	Livingston	3	3	1-Jul-03	7
10	Kenblue	5	3	1-Jul-03	6
11	Nuglade	2	3	1-Jul-03	7.5
12	Kenblue	4	3	1-Jul-03	6
13	Livingston	2	2	1-Jul-03	7
14	Nuglade	3	2	1-Jul-03	8
15	Nuglade	4	2	1-Jul-03	8
16	Nuglade	4	1	1-Jul-03	7.5
17	Livingston	3	1	1-Jul-03	7
18	Nuglade	1	1	1-Jul-03	7
19	Livingston	2	1	1-Jul-03	7
20	Livingston	1	1	1-Jul-03	7
21	Kenblue	4	1	1-Jul-03	7
22	Kenblue	3	2	1-Jul-03	7
23	Livingston	4	2	1-Jul-03	7.5
24	Livingston	1	2	1-Jul-03	7

25	Livingston	4	3	1-Jul-03	7.5
26	Nuglade	1	3	1-Jul-03	7
27	Kenblue	1	3	1-Jul-03	6.5
28	Livingston	2	3	1-Jul-03	7.5
29	Kenblue	3	3	1-Jul-03	7
30	Kenblue	4	2	1-Jul-03	7
31	Nuglade	2	2	1-Jul-03	7
32	Kenblue	1	2	1-Jul-03	6
33	Livingston	4	1	1-Jul-03	8
34	Nuglade	3	1	1-Jul-03	7.5
35	Kenblue	3	1	1-Jul-03	7
36	Kenblue	5	1	1-Jul-03	6
1	Nuglade	2	1	22-Jul-03	8
2	Kenblue	1	1	22-Jul-03	7
3	Nuglade	1	2	22-Jul-03	7.5
4	Livingston	3	2	22-Jul-03	8
5	Kenblue	5	2	22-Jul-03	6.5
6	Nuglade	3	3	22-Jul-03	8
7	Nuglade	4	3	22-Jul-03	8
8	Livingston	1	3	22-Jul-03	7
9	Livingston	3	3	22-Jul-03	7.5
10	Kenblue	5	3	22-Jul-03	6.5
11	Nuglade	2	3	22-Jul-03	7.5
12	Kenblue	4	3	22-Jul-03	7
13	Livingston	2	2	22-Jul-03	7.5
14	Nuglade	3	2	22-Jul-03	8
15	Nuglade	4	2	22-Jul-03	8.5
16	Nuglade	4	1	22-Jul-03	7.5
17	Livingston	3	1	22-Jul-03	8
18	Nuglade	1	1	22-Jul-03	7
19	Livingston	2	1	22-Jul-03	7.5
20	Livingston	1	1	22-Jul-03	7
21	Kenblue	4	1	22-Jul-03	7
22	Kenblue	3	2	22-Jul-03	7
23	Livingston	4	2	22-Jul-03	8
24	Livingston	1	2	22-Jul-03	7.5
25	Livingston	4	3	22-Jul-03	7.5
26	Nuglade	1	3	22-Jul-03	7
27	Kenblue	1	3	22-Jul-03	6.5
28	Livingston	2	3	22-Jul-03	7.5
29	Kenblue	3	3	22-Jul-03	7
30	Kenblue	4	2	22-Jul-03	7
31	Nuglade	2	2	22-Jul-03	7.5
32	Kenblue	1	2	22-Jul-03	7
33	Livingston	4	1	22-Jul-03	8
34	Nuglade	3	1	22-Jul-03	8
35	Kenblue	3	1	22-Jul-03	7.5
36	Kenblue	5	1	22-Jul-03	6.5
1	Nuglade	2	1	12-Aug-03	7.5
2	Kenblue	1	1	12-Aug-03	6.5

3	Nuglade	1	2	12-Aug-03	7
4	Livingston	3	2	12-Aug-03	7.5
5	Kenblue	5	2	12-Aug-03	6.5
6	Nuglade	3	3	12-Aug-03	8
7	Nuglade	4	3	12-Aug-03	8
8	Livingston	1	3	12-Aug-03	7
9	Livingston	3	3	12-Aug-03	7.5
10	Kenblue	5	3	12-Aug-03	6.5
11	Nuglade	2	3	12-Aug-03	7.5
12	Kenblue	4	3	12-Aug-03	7.5
13	Livingston	2	2	12-Aug-03	7.5
14	Nuglade	3	2	12-Aug-03	8
15	Nuglade	4	2	12-Aug-03	8
16	Nuglade	4	1	12-Aug-03	8
17	Livingston	3	1	12-Aug-03	8
18	Nuglade	1	1	12-Aug-03	7.5
19	Livingston	2	1	12-Aug-03	7.5
20	Livingston	1	1	12-Aug-03	7
21	Kenblue	4	1	12-Aug-03	7
22	Kenblue	3	2	12-Aug-03	7.5
23	Livingston	4	2	12-Aug-03	8
24	Livingston	1	2	12-Aug-03	7
25	Livingston	4	3	12-Aug-03	8
26	Nuglade	1	3	12-Aug-03	7
27	Kenblue	1	3	12-Aug-03	6.5
28	Livingston	2	3	12-Aug-03	7
29	Kenblue	3	3	12-Aug-03	7
30	Kenblue	4	2	12-Aug-03	7.5
31	Nuglade	2	2	12-Aug-03	8
32	Kenblue	1	2	12-Aug-03	7
33	Livingston	4	1	12-Aug-03	7.5
34	Nuglade	3	1	12-Aug-03	8
35	Kenblue	3	1	12-Aug-03	7.5
36	Kenblue	5	1	12-Aug-03	6.5
1	Nuglade	2	1	3-Sep-03	7
2	Kenblue	1	1	3-Sep-03	6
3	Nuglade	1	2	3-Sep-03	6.5
4	Livingston	3	2	3-Sep-03	7
5	Kenblue	5	2	3-Sep-03	6.5
6	Nuglade	3	3	3-Sep-03	7
7	Nuglade	4	3	3-Sep-03	7
8	Livingston	1	3	3-Sep-03	6.5
9	Livingston	3	3	3-Sep-03	7
10	Kenblue	5	3	3-Sep-03	6
11	Nuglade	2	3	3-Sep-03	7
12	Kenblue	4	3	3-Sep-03	7
13	Livingston	2	2	3-Sep-03	7
14	Nuglade	3	2	3-Sep-03	7.5
15	Nuglade	4	2	3-Sep-03	7.5
16	Nuglade	4	1	3-Sep-03	7.5

17	Livingston	3	1	3-Sep-03	7
18	Nuglade	1	1	3-Sep-03	6.5
19	Livingston	2	1	3-Sep-03	6.5
20	Livingston	1	1	3-Sep-03	6.5
21	Kenblue	4	1	3-Sep-03	7
22	Kenblue	3	2	3-Sep-03	7
23	Livingston	4	2	3-Sep-03	7.5
24	Livingston	1	2	3-Sep-03	6.5
25	Livingston	4	3	3-Sep-03	7
26	Nuglade	1	3	3-Sep-03	6.5
27	Kenblue	1	3	3-Sep-03	6.5
28	Livingston	2	3	3-Sep-03	6.5
29	Kenblue	3	3	3-Sep-03	7
30	Kenblue	4	2	3-Sep-03	7
31	Nuglade	2	2	3-Sep-03	7
32	Kenblue	1	2	3-Sep-03	6.5
33	Livingston	4	1	3-Sep-03	7
34	Nuglade	3	1	3-Sep-03	7.5
35	Kenblue	3	1	3-Sep-03	7
36	Kenblue	5	1	3-Sep-03	6
1	Nuglade	2	1	3-Nov-03	4.5
2	Kenblue	1	1	3-Nov-03	3.5
3	Nuglade	1	2	3-Nov-03	3.5
4	Livingston	3	2	3-Nov-03	4
5	Kenblue	5	2	3-Nov-03	2.5
6	Nuglade	3	3	3-Nov-03	5
7	Nuglade	4	3	3-Nov-03	5
8	Livingston	1	3	3-Nov-03	3
9	Livingston	3	3	3-Nov-03	4
10	Kenblue	5	3	3-Nov-03	3
11	Nuglade	2	3	3-Nov-03	3.5
12	Kenblue	4	3	3-Nov-03	4
13	Livingston	2	2	3-Nov-03	4
14	Nuglade	3	2	3-Nov-03	4.5
15	Nuglade	4	2	3-Nov-03	4.5
16	Nuglade	4	1	3-Nov-03	4.5
17	Livingston	3	1	3-Nov-03	5
18	Nuglade	1	1	3-Nov-03	3.5
19	Livingston	2	1	3-Nov-03	4.5
20	Livingston	1	1	3-Nov-03	4
21	Kenblue	4	1	3-Nov-03	4.5
22	Kenblue	3	2	3-Nov-03	4
23	Livingston	4	2	3-Nov-03	4.5
24	Livingston	1	2	3-Nov-03	3
25	Livingston	4	3	3-Nov-03	4
26	Nuglade	1	3	3-Nov-03	2
27	Kenblue	1	3	3-Nov-03	2
28	Livingston	2	3	3-Nov-03	3.5
29	Kenblue	3	3	3-Nov-03	4.5
30	Kenblue	4	2	3-Nov-03	4.5

31	Nuglade	2	2	3-Nov-03	3
32	Kenblue	1	2	3-Nov-03	3
33	Livingston	4	1	3-Nov-03	5
34	Nuglade	3	1	3-Nov-03	4.5
35	Kenblue	3	1	3-Nov-03	3.5
36	Kenblue	5	1	3-Nov-03	2.5
1	Nuglade	2	1	11-Dec-03	3
2	Kenblue	1	1	11-Dec-03	2
3	Nuglade	1	2	11-Dec-03	2.5
4	Livingston	3	2	11-Dec-03	3
5	Kenblue	5	2	11-Dec-03	2
6	Nuglade	3	3	11-Dec-03	2.5
7	Nuglade	4	3	11-Dec-03	2.5
8	Livingston	1	3	11-Dec-03	2.5
9	Livingston	3	3	11-Dec-03	2.5
10	Kenblue	5	3	11-Dec-03	2
11	Nuglade	2	3	11-Dec-03	2.5
12	Kenblue	4	3	11-Dec-03	2.5
13	Livingston	2	2	11-Dec-03	2.5
14	Nuglade	3	2	11-Dec-03	3
15	Nuglade	4	2	11-Dec-03	3
16	Nuglade	4	1	11-Dec-03	3
17	Livingston	3	1	11-Dec-03	2.5
18	Nuglade	1	1	11-Dec-03	2.5
19	Livingston	2	1	11-Dec-03	3
20	Livingston	1	1	11-Dec-03	2
21	Kenblue	4	1	11-Dec-03	2.5
22	Kenblue	3	2	11-Dec-03	2.5
23	Livingston	4	2	11-Dec-03	3
24	Livingston	1	2	11-Dec-03	2.5
25	Livingston	4	3	11-Dec-03	2.5
26	Nuglade	1	3	11-Dec-03	1.5
27	Kenblue	1	3	11-Dec-03	2
28	Livingston	2	3	11-Dec-03	2.5
29	Kenblue	3	3	11-Dec-03	2.5
30	Kenblue	4	2	11-Dec-03	2.5
31	Nuglade	2	2	11-Dec-03	2.5
32	Kenblue	1	2	11-Dec-03	2
33	Livingston	4	1	11-Dec-03	3
34	Nuglade	3	1	11-Dec-03	3
35	Kenblue	3	1	11-Dec-03	2.5
36	Kenblue	5	1	11-Dec-03	1.5
1	Nuglade	2	1	9-Jan-04	2.5
2	Kenblue	1	1	9-Jan-04	2
3	Nuglade	1	2	9-Jan-04	2.5
4	Livingston	3	2	9-Jan-04	2.5
5	Kenblue	5	2	9-Jan-04	2
6	Nuglade	3	3	9-Jan-04	2
7	Nuglade	4	3	9-Jan-04	2
8	Livingston	1	3	9-Jan-04	2

9	Livingston	3	3	9-Jan-04	2
10	Kenblue	5	3	9-Jan-04	1.5
11	Nuglade	2	3	9-Jan-04	2
12	Kenblue	4	3	9-Jan-04	2
13	Livingston	2	2	9-Jan-04	2
14	Nuglade	3	2	9-Jan-04	2.5
15	Nuglade	4	2	9-Jan-04	2.5
16	Nuglade	4	1	9-Jan-04	2.5
17	Livingston	3	1	9-Jan-04	2
18	Nuglade	1	1	9-Jan-04	2
19	Livingston	2	1	9-Jan-04	2.5
20	Livingston	1	1	9-Jan-04	2
21	Kenblue	4	1	9-Jan-04	2.5
22	Kenblue	3	2	9-Jan-04	2
23	Livingston	4	2	9-Jan-04	2.5
24	Livingston	1	2	9-Jan-04	1.5
25	Livingston	4	3	9-Jan-04	2
26	Nuglade	1	3	9-Jan-04	1.5
27	Kenblue	1	3	9-Jan-04	1.5
28	Livingston	2	3	9-Jan-04	2.5
29	Kenblue	3	3	9-Jan-04	2.5
30	Kenblue	4	2	9-Jan-04	2
31	Nuglade	2	2	9-Jan-04	2
32	Kenblue	1	2	9-Jan-04	2
33	Livingston	4	1	9-Jan-04	2.5
34	Nuglade	3	1	9-Jan-04	2.5
35	Kenblue	3	1	9-Jan-04	2
36	Kenblue	5	1	9-Jan-04	1.5
1	Nuglade	2	1	20-Feb-04	2
2	Kenblue	1	1	20-Feb-04	2
3	Nuglade	1	2	20-Feb-04	2
4	Livingston	3	2	20-Feb-04	2
5	Kenblue	5	2	20-Feb-04	2
6	Nuglade	3	3	20-Feb-04	2
7	Nuglade	4	3	20-Feb-04	2
8	Livingston	1	3	20-Feb-04	2
9	Livingston	3	3	20-Feb-04	2
10	Kenblue	5	3	20-Feb-04	1.5
11	Nuglade	2	3	20-Feb-04	2
12	Kenblue	4	3	20-Feb-04	2
13	Livingston	2	2	20-Feb-04	2
14	Nuglade	3	2	20-Feb-04	2
15	Nuglade	4	2	20-Feb-04	2
16	Nuglade	4	1	20-Feb-04	2
17	Livingston	3	1	20-Feb-04	2
18	Nuglade	1	1	20-Feb-04	2
19	Livingston	2	1	20-Feb-04	2
20	Livingston	1	1	20-Feb-04	1.5
21	Kenblue	4	1	20-Feb-04	2
22	Kenblue	3	2	20-Feb-04	2

23	Livingston	4	2	20-Feb-04	2
24	Livingston	1	2	20-Feb-04	1.5
25	Livingston	4	3	20-Feb-04	2
26	Nuglade	1	3	20-Feb-04	1.5
27	Kenblue	1	3	20-Feb-04	1.5
28	Livingston	2	3	20-Feb-04	1.5
29	Kenblue	3	3	20-Feb-04	2
30	Kenblue	4	2	20-Feb-04	2
31	Nuglade	2	2	20-Feb-04	2
32	Kenblue	1	2	20-Feb-04	2
33	Livingston	4	1	20-Feb-04	2
34	Nuglade	3	1	20-Feb-04	2.5
35	Kenblue	3	1	20-Feb-04	2
36	Kenblue	5	1	20-Feb-04	1.5
1	Nuglade	2	1	26-Mar-04	4
2	Kenblue	1	1	26-Mar-04	3
3	Nuglade	1	2	26-Mar-04	3
4	Livingston	3	2	26-Mar-04	3
5	Kenblue	5	2	26-Mar-04	2.5
6	Nuglade	3	3	26-Mar-04	3.5
7	Nuglade	4	3	26-Mar-04	4
8	Livingston	1	3	26-Mar-04	2.5
9	Livingston	3	3	26-Mar-04	3.5
10	Kenblue	5	3	26-Mar-04	3
11	Nuglade	2	3	26-Mar-04	2.5
12	Kenblue	4	3	26-Mar-04	3
13	Livingston	2	2	26-Mar-04	3
14	Nuglade	3	2	26-Mar-04	3.5
15	Nuglade	4	2	26-Mar-04	3.5
16	Nuglade	4	1	26-Mar-04	3
17	Livingston	3	1	26-Mar-04	3.5
18	Nuglade	1	1	26-Mar-04	3
19	Livingston	2	1	26-Mar-04	3
20	Livingston	1	1	26-Mar-04	2.5
21	Kenblue	4	1	26-Mar-04	3
22	Kenblue	3	2	26-Mar-04	2.5
23	Livingston	4	2	26-Mar-04	3
24	Livingston	1	2	26-Mar-04	3
25	Livingston	4	3	26-Mar-04	3
26	Nuglade	1	3	26-Mar-04	2
27	Kenblue	1	3	26-Mar-04	2.5
28	Livingston	2	3	26-Mar-04	3
29	Kenblue	3	3	26-Mar-04	3
30	Kenblue	4	2	26-Mar-04	3
31	Nuglade	2	2	26-Mar-04	3
32	Kenblue	1	2	26-Mar-04	2.5
33	Livingston	4	1	26-Mar-04	4
34	Nuglade	3	1	26-Mar-04	3.5
35	Kenblue	3	1	26-Mar-04	3
36	Kenblue	5	1	26-Mar-04	2.5

1	Nuglade	2	1	5-Apr-04	4
2	Kenblue	1	1	5-Apr-04	3
3	Nuglade	1	2	5-Apr-04	3
4	Livingston	3	2	5-Apr-04	4
5	Kenblue	5	2	5-Apr-04	4
6	Nuglade	3	3	5-Apr-04	4
7	Nuglade	4	3	5-Apr-04	4.5
8	Livingston	1	3	5-Apr-04	3
9	Livingston	3	3	5-Apr-04	4
10	Kenblue	5	3	5-Apr-04	2.5
11	Nuglade	2	3	5-Apr-04	3.5
12	Kenblue	4	3	5-Apr-04	3.5
13	Livingston	2	2	5-Apr-04	3
14	Nuglade	3	2	5-Apr-04	4
15	Nuglade	4	2	5-Apr-04	4
16	Nuglade	4	1	5-Apr-04	4
17	Livingston	3	1	5-Apr-04	3.5
18	Nuglade	1	1	5-Apr-04	3
19	Livingston	2	1	5-Apr-04	3
20	Livingston	1	1	5-Apr-04	3
21	Kenblue	4	1	5-Apr-04	4.5
22	Kenblue	3	2	5-Apr-04	4
23	Livingston	4	2	5-Apr-04	4
24	Livingston	1	2	5-Apr-04	3
25	Livingston	4	3	5-Apr-04	3.5
26	Nuglade	1	3	5-Apr-04	3
27	Kenblue	1	3	5-Apr-04	3
28	Livingston	2	3	5-Apr-04	3.5
29	Kenblue	3	3	5-Apr-04	4.5
30	Kenblue	4	2	5-Apr-04	4.5
31	Nuglade	2	2	5-Apr-04	3.5
32	Kenblue	1	2	5-Apr-04	3
33	Livingston	4	1	5-Apr-04	4.5
34	Nuglade	3	1	5-Apr-04	3.5
35	Kenblue	3	1	5-Apr-04	3.5
36	Kenblue	5	1	5-Apr-04	2.5
1	Nuglade	2	1	27-Apr-04	5.5
2	Kenblue	1	1	27-Apr-04	4
3	Nuglade	1	2	27-Apr-04	4
4	Livingston	3	2	27-Apr-04	5
5	Kenblue	5	2	27-Apr-04	4
6	Nuglade	3	3	27-Apr-04	5
7	Nuglade	4	3	27-Apr-04	4.5
8	Livingston	1	3	27-Apr-04	4
9	Livingston	3	3	27-Apr-04	5
10	Kenblue	5	3	27-Apr-04	3
11	Nuglade	2	3	27-Apr-04	3.5
12	Kenblue	4	3	27-Apr-04	4
13	Livingston	2	2	27-Apr-04	4.5
14	Nuglade	3	2	27-Apr-04	4.5

15Nuglade	4	2	27-Apr-04	4.5
16Nuglade	4	1	27-Apr-04	4
17Livingston	3	1	27-Apr-04	5
18Nuglade	1	1	27-Apr-04	4
19Livingston	2	1	27-Apr-04	5
20Livingston	1	1	27-Apr-04	3.5
21Kenblue	4	1	27-Apr-04	5
22Kenblue	3	2	27-Apr-04	4.5
23Livingston	4	2	27-Apr-04	4
24Livingston	1	2	27-Apr-04	3.5
25Livingston	4	3	27-Apr-04	4
26Nuglade	1	3	27-Apr-04	3
27Kenblue	1	3	27-Apr-04	3.5
28Livingston	2	3	27-Apr-04	4.5
29Kenblue	3	3	27-Apr-04	5
30Kenblue	4	2	27-Apr-04	5
31Nuglade	2	2	27-Apr-04	4
32Kenblue	1	2	27-Apr-04	3.5
33Livingston	4	1	27-Apr-04	5
34Nuglade	3	1	27-Apr-04	5
35Kenblue	3	1	27-Apr-04	4.5
36Kenblue	5	1	27-Apr-04	3.5
1Nuglade	2	1	6-May-04	5
2Kenblue	1	1	6-May-04	4.5
3Nuglade	1	2	6-May-04	4.5
4Livingston	3	2	6-May-04	5.5
5Kenblue	5	2	6-May-04	4
6Nuglade	3	3	6-May-04	6
7Nuglade	4	3	6-May-04	5.5
8Livingston	1	3	6-May-04	5
9Livingston	3	3	6-May-04	6
10Kenblue	5	3	6-May-04	3.5
11Nuglade	2	3	6-May-04	5
12Kenblue	4	3	6-May-04	4.5
13Livingston	2	2	6-May-04	4.5
14Nuglade	3	2	6-May-04	6.5
15Nuglade	4	2	6-May-04	6
16Nuglade	4	1	6-May-04	5.5
17Livingston	3	1	6-May-04	6
18Nuglade	1	1	6-May-04	5
19Livingston	2	1	6-May-04	5.5
20Livingston	1	1	6-May-04	5
21Kenblue	4	1	6-May-04	4.5
22Kenblue	3	2	6-May-04	4
23Livingston	4	2	6-May-04	6
24Livingston	1	2	6-May-04	4
25Livingston	4	3	6-May-04	6.5
26Nuglade	1	3	6-May-04	4
27Kenblue	1	3	6-May-04	3.5
28Livingston	2	3	6-May-04	5

29	Kenblue	3	3	6-May-04	5
30	Kenblue	4	2	6-May-04	5.5
31	Nuglade	2	2	6-May-04	5.5
32	Kenblue	1	2	6-May-04	4
33	Livingston	4	1	6-May-04	6.5
34	Nuglade	3	1	6-May-04	6.5
35	Kenblue	3	1	6-May-04	6
36	Kenblue	5	1	6-May-04	4
1	Nuglade	2	1	4-Jun-04	7
2	Kenblue	1	1	4-Jun-04	6
3	Nuglade	1	2	4-Jun-04	7
4	Livingston	3	2	4-Jun-04	7.5
5	Kenblue	5	2	4-Jun-04	5.5
6	Nuglade	3	3	4-Jun-04	7.5
7	Nuglade	4	3	4-Jun-04	7.5
8	Livingston	1	3	4-Jun-04	6.5
9	Livingston	3	3	4-Jun-04	7
10	Kenblue	5	3	4-Jun-04	5
11	Nuglade	2	3	4-Jun-04	7
12	Kenblue	4	3	4-Jun-04	6.5
13	Livingston	2	2	4-Jun-04	7
14	Nuglade	3	2	4-Jun-04	7
15	Nuglade	4	2	4-Jun-04	7.5
16	Nuglade	4	1	4-Jun-04	5.5
17	Livingston	3	1	4-Jun-04	7
18	Nuglade	1	1	4-Jun-04	6.5
19	Livingston	2	1	4-Jun-04	7
20	Livingston	1	1	4-Jun-04	5.5
21	Kenblue	4	1	4-Jun-04	6.5
22	Kenblue	3	2	4-Jun-04	6
23	Livingston	4	2	4-Jun-04	7
24	Livingston	1	2	4-Jun-04	5
25	Livingston	4	3	4-Jun-04	6.5
26	Nuglade	1	3	4-Jun-04	6.5
27	Kenblue	1	3	4-Jun-04	5.5
28	Livingston	2	3	4-Jun-04	6.5
29	Kenblue	3	3	4-Jun-04	5.5
30	Kenblue	4	2	4-Jun-04	6.5
31	Nuglade	2	2	4-Jun-04	7.5
32	Kenblue	1	2	4-Jun-04	6
33	Livingston	4	1	4-Jun-04	7.5
34	Nuglade	3	1	4-Jun-04	7.5
35	Kenblue	3	1	4-Jun-04	6.5
36	Kenblue	5	1	4-Jun-04	5.5
1	Nuglade	2	1	18-Jun-04	7.5
2	Kenblue	1	1	18-Jun-04	6
3	Nuglade	1	2	18-Jun-04	7
4	Livingston	3	2	18-Jun-04	8
5	Kenblue	5	2	18-Jun-04	6
6	Nuglade	3	3	18-Jun-04	8

7Nuglade	4	3	18-Jun-04	8
8Livingston	1	3	18-Jun-04	7
9Livingston	3	3	18-Jun-04	7
10Kenblue	5	3	18-Jun-04	5.5
11Nuglade	2	3	18-Jun-04	7
12Kenblue	4	3	18-Jun-04	7
13Livingston	2	2	18-Jun-04	7.5
14Nuglade	3	2	18-Jun-04	7.5
15Nuglade	4	2	18-Jun-04	8
16Nuglade	4	1	18-Jun-04	6
17Livingston	3	1	18-Jun-04	7.5
18Nuglade	1	1	18-Jun-04	7
19Livingston	2	1	18-Jun-04	7.5
20Livingston	1	1	18-Jun-04	6
21Kenblue	4	1	18-Jun-04	7
22Kenblue	3	2	18-Jun-04	6.5
23Livingston	4	2	18-Jun-04	7
24Livingston	1	2	18-Jun-04	6
25Livingston	4	3	18-Jun-04	7
26Nuglade	1	3	18-Jun-04	7.5
27Kenblue	1	3	18-Jun-04	6
28Livingston	2	3	18-Jun-04	6.5
29Kenblue	3	3	18-Jun-04	6
30Kenblue	4	2	18-Jun-04	7.5
31Nuglade	2	2	18-Jun-04	7.5
32Kenblue	1	2	18-Jun-04	6.5
33Livingston	4	1	18-Jun-04	8
34Nuglade	3	1	18-Jun-04	8
35Kenblue	3	1	18-Jun-04	7
36Kenblue	5	1	18-Jun-04	6.5
1Nuglade	2	1	6-Jul-04	7.5
2Kenblue	1	1	6-Jul-04	6
3Nuglade	1	2	6-Jul-04	7.5
4Livingston	3	2	6-Jul-04	8
5Kenblue	5	2	6-Jul-04	6
6Nuglade	3	3	6-Jul-04	8
7Nuglade	4	3	6-Jul-04	8
8Livingston	1	3	6-Jul-04	7.5
9Livingston	3	3	6-Jul-04	7.5
10Kenblue	5	3	6-Jul-04	6.5
11Nuglade	2	3	6-Jul-04	7.5
12Kenblue	4	3	6-Jul-04	7
13Livingston	2	2	6-Jul-04	8
14Nuglade	3	2	6-Jul-04	8
15Nuglade	4	2	6-Jul-04	8.5
16Nuglade	4	1	6-Jul-04	8.5
17Livingston	3	1	6-Jul-04	8.5
18Nuglade	1	1	6-Jul-04	7
19Livingston	2	1	6-Jul-04	7.5
20Livingston	1	1	6-Jul-04	7

21	Kenblue	4	1	6-Jul-04	7.5
22	Kenblue	3	2	6-Jul-04	7
23	Livingston	4	2	6-Jul-04	7.5
24	Livingston	1	2	6-Jul-04	7
25	Livingston	4	3	6-Jul-04	7
26	Nuglade	1	3	6-Jul-04	6.5
27	Kenblue	1	3	6-Jul-04	6.5
28	Livingston	2	3	6-Jul-04	7
29	Kenblue	3	3	6-Jul-04	7
30	Kenblue	4	2	6-Jul-04	7
31	Nuglade	2	2	6-Jul-04	8
32	Kenblue	1	2	6-Jul-04	6.5
33	Livingston	4	1	6-Jul-04	8
34	Nuglade	3	1	6-Jul-04	8
35	Kenblue	3	1	6-Jul-04	7.5
36	Kenblue	5	1	6-Jul-04	6.5
1	Nuglade	2	1	30-Jul-04	7.5
2	Kenblue	1	1	30-Jul-04	6.5
3	Nuglade	1	2	30-Jul-04	7
4	Livingston	3	2	30-Jul-04	8.5
5	Kenblue	5	2	30-Jul-04	7
6	Nuglade	3	3	30-Jul-04	7.5
7	Nuglade	4	3	30-Jul-04	8
8	Livingston	1	3	30-Jul-04	8
9	Livingston	3	3	30-Jul-04	7.5
10	Kenblue	5	3	30-Jul-04	6
11	Nuglade	2	3	30-Jul-04	6.5
12	Kenblue	4	3	30-Jul-04	7
13	Livingston	2	2	30-Jul-04	8
14	Nuglade	3	2	30-Jul-04	7.5
15	Nuglade	4	2	30-Jul-04	7.5
16	Nuglade	4	1	30-Jul-04	8.5
17	Livingston	3	1	30-Jul-04	8.5
18	Nuglade	1	1	30-Jul-04	7
19	Livingston	2	1	30-Jul-04	7.5
20	Livingston	1	1	30-Jul-04	7.5
21	Kenblue	4	1	30-Jul-04	7.5
22	Kenblue	3	2	30-Jul-04	7
23	Livingston	4	2	30-Jul-04	8
24	Livingston	1	2	30-Jul-04	7.5
25	Livingston	4	3	30-Jul-04	7.5
26	Nuglade	1	3	30-Jul-04	6.5
27	Kenblue	1	3	30-Jul-04	7.5
28	Livingston	2	3	30-Jul-04	7
29	Kenblue	3	3	30-Jul-04	7.5
30	Kenblue	4	2	30-Jul-04	7.5
31	Nuglade	2	2	30-Jul-04	8
32	Kenblue	1	2	30-Jul-04	7
33	Livingston	4	1	30-Jul-04	8
34	Nuglade	3	1	30-Jul-04	8

35	Kenblue	3	1	30-Jul-04	7
36	Kenblue	5	1	30-Jul-04	6.5
1	Nuglade	2	1	6-Aug-04	7
2	Kenblue	1	1	6-Aug-04	6
3	Nuglade	1	2	6-Aug-04	7
4	Livingston	3	2	6-Aug-04	8
5	Kenblue	5	2	6-Aug-04	7
6	Nuglade	3	3	6-Aug-04	7.5
7	Nuglade	4	3	6-Aug-04	7.5
8	Livingston	1	3	6-Aug-04	7
9	Livingston	3	3	6-Aug-04	7.5
10	Kenblue	5	3	6-Aug-04	6
11	Nuglade	2	3	6-Aug-04	7.5
12	Kenblue	4	3	6-Aug-04	7.5
13	Livingston	2	2	6-Aug-04	7
14	Nuglade	3	2	6-Aug-04	8
15	Nuglade	4	2	6-Aug-04	8
16	Nuglade	4	1	6-Aug-04	8
17	Livingston	3	1	6-Aug-04	8
18	Nuglade	1	1	6-Aug-04	7
19	Livingston	2	1	6-Aug-04	7.5
20	Livingston	1	1	6-Aug-04	6.5
21	Kenblue	4	1	6-Aug-04	7.5
22	Kenblue	3	2	6-Aug-04	7.5
23	Livingston	4	2	6-Aug-04	8
24	Livingston	1	2	6-Aug-04	7.5
25	Livingston	4	3	6-Aug-04	8
26	Nuglade	1	3	6-Aug-04	7
27	Kenblue	1	3	6-Aug-04	6.5
28	Livingston	2	3	6-Aug-04	7.5
29	Kenblue	3	3	6-Aug-04	7.5
30	Kenblue	4	2	6-Aug-04	7
31	Nuglade	2	2	6-Aug-04	8
32	Kenblue	1	2	6-Aug-04	7
33	Livingston	4	1	6-Aug-04	7.5
34	Nuglade	3	1	6-Aug-04	8
35	Kenblue	3	1	6-Aug-04	7.5
36	Kenblue	5	1	6-Aug-04	6
1	Nuglade	2	1	20-Aug-04	7
2	Kenblue	1	1	20-Aug-04	6
3	Nuglade	1	2	20-Aug-04	7
4	Livingston	3	2	20-Aug-04	8
5	Kenblue	5	2	20-Aug-04	7
6	Nuglade	3	3	20-Aug-04	7.5
7	Nuglade	4	3	20-Aug-04	7.5
8	Livingston	1	3	20-Aug-04	7
9	Livingston	3	3	20-Aug-04	7.5
10	Kenblue	5	3	20-Aug-04	6
11	Nuglade	2	3	20-Aug-04	7.5
12	Kenblue	4	3	20-Aug-04	7.5

13	Livingston	2	2 20-Aug-04	7
14	Nuglade	3	2 20-Aug-04	7.5
15	Nuglade	4	2 20-Aug-04	8
16	Nuglade	4	1 20-Aug-04	8
17	Livingston	3	1 20-Aug-04	8
18	Nuglade	1	1 20-Aug-04	7
19	Livingston	2	1 20-Aug-04	7.5
20	Livingston	1	1 20-Aug-04	6.5
21	Kenblue	4	1 20-Aug-04	7.5
22	Kenblue	3	2 20-Aug-04	7.5
23	Livingston	4	2 20-Aug-04	8
24	Livingston	1	2 20-Aug-04	7.5
25	Livingston	4	3 20-Aug-04	7.5
26	Nuglade	1	3 20-Aug-04	7
27	Kenblue	1	3 20-Aug-04	6.5
28	Livingston	2	3 20-Aug-04	7.5
29	Kenblue	3	3 20-Aug-04	7.5
30	Kenblue	4	2 20-Aug-04	7
31	Nuglade	2	2 20-Aug-04	8
32	Kenblue	1	2 20-Aug-04	7
33	Livingston	4	1 20-Aug-04	7.5
34	Nuglade	3	1 20-Aug-04	8
35	Kenblue	3	1 20-Aug-04	7.5
36	Kenblue	5	1 20-Aug-04	6
1	Nuglade	2	1 10-Sep-04	6.5
2	Kenblue	1	1 10-Sep-04	6
3	Nuglade	1	2 10-Sep-04	6.5
4	Livingston	3	2 10-Sep-04	7.5
5	Kenblue	5	2 10-Sep-04	6
6	Nuglade	3	3 10-Sep-04	7
7	Nuglade	4	3 10-Sep-04	7
8	Livingston	1	3 10-Sep-04	6.5
9	Livingston	3	3 10-Sep-04	7
10	Kenblue	5	3 10-Sep-04	5.5
11	Nuglade	2	3 10-Sep-04	7
12	Kenblue	4	3 10-Sep-04	7
13	Livingston	2	2 10-Sep-04	7
14	Nuglade	3	2 10-Sep-04	7
15	Nuglade	4	2 10-Sep-04	7
16	Nuglade	4	1 10-Sep-04	7
17	Livingston	3	1 10-Sep-04	7.5
18	Nuglade	1	1 10-Sep-04	6.5
19	Livingston	2	1 10-Sep-04	7
20	Livingston	1	1 10-Sep-04	7
21	Kenblue	4	1 10-Sep-04	7
22	Kenblue	3	2 10-Sep-04	7
23	Livingston	4	2 10-Sep-04	7.5
24	Livingston	1	2 10-Sep-04	6.5
25	Livingston	4	3 10-Sep-04	7
26	Nuglade	1	3 10-Sep-04	6.5

27	Kenblue	1	3	10-Sep-04	6.5
28	Livingston	2	3	10-Sep-04	7
29	Kenblue	3	3	10-Sep-04	7
30	Kenblue	4	2	10-Sep-04	7
31	Nuglade	2	2	10-Sep-04	7
32	Kenblue	1	2	10-Sep-04	6.5
33	Livingston	4	1	10-Sep-04	7
34	Nuglade	3	1	10-Sep-04	7.5
35	Kenblue	3	1	10-Sep-04	7
36	Kenblue	5	1	10-Sep-04	6
1	Nuglade	2	1	24-Sep-04	6
2	Kenblue	1	1	24-Sep-04	5.5
3	Nuglade	1	2	24-Sep-04	6
4	Livingston	3	2	24-Sep-04	7
5	Kenblue	5	2	24-Sep-04	6
6	Nuglade	3	3	24-Sep-04	6.5
7	Nuglade	4	3	24-Sep-04	6.5
8	Livingston	1	3	24-Sep-04	6
9	Livingston	3	3	24-Sep-04	6.5
10	Kenblue	5	3	24-Sep-04	5
11	Nuglade	2	3	24-Sep-04	6.5
12	Kenblue	4	3	24-Sep-04	6.5
13	Livingston	2	2	24-Sep-04	6.5
14	Nuglade	3	2	24-Sep-04	7
15	Nuglade	4	2	24-Sep-04	6.5
16	Nuglade	4	1	24-Sep-04	7
17	Livingston	3	1	24-Sep-04	7
18	Nuglade	1	1	24-Sep-04	6
19	Livingston	2	1	24-Sep-04	6.5
20	Livingston	1	1	24-Sep-04	6.5
21	Kenblue	4	1	24-Sep-04	6.5
22	Kenblue	3	2	24-Sep-04	7
23	Livingston	4	2	24-Sep-04	7
24	Livingston	1	2	24-Sep-04	6.5
25	Livingston	4	3	24-Sep-04	6.5
26	Nuglade	1	3	24-Sep-04	6
27	Kenblue	1	3	24-Sep-04	6
28	Livingston	2	3	24-Sep-04	6.5
29	Kenblue	3	3	24-Sep-04	7
30	Kenblue	4	2	24-Sep-04	6.5
31	Nuglade	2	2	24-Sep-04	7
32	Kenblue	1	2	24-Sep-04	6
33	Livingston	4	1	24-Sep-04	6.5
34	Nuglade	3	1	24-Sep-04	7
35	Kenblue	3	1	24-Sep-04	6.5
36	Kenblue	5	1	24-Sep-04	6
1	Nuglade	2	1	2-Nov-04	3.5
2	Kenblue	1	1	2-Nov-04	2.5
3	Nuglade	1	2	2-Nov-04	2.5
4	Livingston	3	2	2-Nov-04	5

5	Kenblue	5	2	2-Nov-04	2
6	Nuglade	3	3	2-Nov-04	5
7	Nuglade	4	3	2-Nov-04	5
8	Livingston	1	3	2-Nov-04	3
9	Livingston	3	3	2-Nov-04	3.5
10	Kenblue	5	3	2-Nov-04	2.5
11	Nuglade	2	3	2-Nov-04	3.5
12	Kenblue	4	3	2-Nov-04	3.5
13	Livingston	2	2	2-Nov-04	3.5
14	Nuglade	3	2	2-Nov-04	4
15	Nuglade	4	2	2-Nov-04	4
16	Nuglade	4	1	2-Nov-04	4.5
17	Livingston	3	1	2-Nov-04	4
18	Nuglade	1	1	2-Nov-04	2.5
19	Livingston	2	1	2-Nov-04	3.5
20	Livingston	1	1	2-Nov-04	2.5
21	Kenblue	4	1	2-Nov-04	3.5
22	Kenblue	3	2	2-Nov-04	4
23	Livingston	4	2	2-Nov-04	4.5
24	Livingston	1	2	2-Nov-04	3
25	Livingston	4	3	2-Nov-04	4.5
26	Nuglade	1	3	2-Nov-04	3
27	Kenblue	1	3	2-Nov-04	2
28	Livingston	2	3	2-Nov-04	4
29	Kenblue	3	3	2-Nov-04	3
30	Kenblue	4	2	2-Nov-04	3.5
31	Nuglade	2	2	2-Nov-04	4
32	Kenblue	1	2	2-Nov-04	2
33	Livingston	4	1	2-Nov-04	4.5
34	Nuglade	3	1	2-Nov-04	3.5
35	Kenblue	3	1	2-Nov-04	3
36	Kenblue	5	1	2-Nov-04	2.5
1	Nuglade	2	1	15-Dec-04	2.5
2	Kenblue	1	1	15-Dec-04	2
3	Nuglade	1	2	15-Dec-04	2.5
4	Livingston	3	2	15-Dec-04	2.5
5	Kenblue	5	2	15-Dec-04	1.5
6	Nuglade	3	3	15-Dec-04	2.5
7	Nuglade	4	3	15-Dec-04	2.5
8	Livingston	1	3	15-Dec-04	2
9	Livingston	3	3	15-Dec-04	2.5
10	Kenblue	5	3	15-Dec-04	2
11	Nuglade	2	3	15-Dec-04	2.5
12	Kenblue	4	3	15-Dec-04	2.5
13	Livingston	2	2	15-Dec-04	2
14	Nuglade	3	2	15-Dec-04	2.5
15	Nuglade	4	2	15-Dec-04	2.5
16	Nuglade	4	1	15-Dec-04	2.5
17	Livingston	3	1	15-Dec-04	3
18	Nuglade	1	1	15-Dec-04	2

19	Livingston	2	1	15-Dec-04	3
20	Livingston	1	1	15-Dec-04	2
21	Kenblue	4	1	15-Dec-04	2
22	Kenblue	3	2	15-Dec-04	2
23	Livingston	4	2	15-Dec-04	3
24	Livingston	1	2	15-Dec-04	1.5
25	Livingston	4	3	15-Dec-04	3
26	Nuglade	1	3	15-Dec-04	1.5
27	Kenblue	1	3	15-Dec-04	2
28	Livingston	2	3	15-Dec-04	2
29	Kenblue	3	3	15-Dec-04	2
30	Kenblue	4	2	15-Dec-04	2
31	Nuglade	2	2	15-Dec-04	2
32	Kenblue	1	2	15-Dec-04	1.5
33	Livingston	4	1	15-Dec-04	1.5
34	Nuglade	3	1	15-Dec-04	3
35	Kenblue	3	1	15-Dec-04	3
36	Kenblue	5	1	15-Dec-04	1.5
1	Nuglade	2	1	10-Jan-05	2
2	Kenblue	1	1	10-Jan-05	2
3	Nuglade	1	2	10-Jan-05	2
4	Livingston	3	2	10-Jan-05	2.5
5	Kenblue	5	2	10-Jan-05	2
6	Nuglade	3	3	10-Jan-05	2
7	Nuglade	4	3	10-Jan-05	2.5
8	Livingston	1	3	10-Jan-05	2
9	Livingston	3	3	10-Jan-05	2
10	Kenblue	5	3	10-Jan-05	1.5
11	Nuglade	2	3	10-Jan-05	2
12	Kenblue	4	3	10-Jan-05	2
13	Livingston	2	2	10-Jan-05	2
14	Nuglade	3	2	10-Jan-05	2.5
15	Nuglade	4	2	10-Jan-05	2.5
16	Nuglade	4	1	10-Jan-05	2
17	Livingston	3	1	10-Jan-05	2
18	Nuglade	1	1	10-Jan-05	2
19	Livingston	2	1	10-Jan-05	2
20	Livingston	1	1	10-Jan-05	2
21	Kenblue	4	1	10-Jan-05	2
22	Kenblue	3	2	10-Jan-05	2
23	Livingston	4	2	10-Jan-05	2.5
24	Livingston	1	2	10-Jan-05	1.5
25	Livingston	4	3	10-Jan-05	2
26	Nuglade	1	3	10-Jan-05	2
27	Kenblue	1	3	10-Jan-05	1.5
28	Livingston	2	3	10-Jan-05	2
29	Kenblue	3	3	10-Jan-05	2.5
30	Kenblue	4	2	10-Jan-05	2
31	Nuglade	2	2	10-Jan-05	2
32	Kenblue	1	2	10-Jan-05	2

33Livingston	4	1	10-Jan-05	2
34Nuglade	3	1	10-Jan-05	2
35Kenblue	3	1	10-Jan-05	2
36Kenblue	5	1	10-Jan-05	1.5

Clippings 03'

Date	Plot ID	Grass	Trt	Rep	Wet Wt.	Dry Wt.	LWC
Aug5	2	Kenblue	1	1	4.7	2	57.45
Aug5	27	Kenblue	1	3	5.3	2.1	60.38
Aug5	32	Kenblue	1	2	5.2	2.2	57.69
Aug5	22	Kenblue	3	2	6.1	2.6	57.38
Aug5	29	Kenblue	3	3	6.9	2.8	59.42
Aug5	35	Kenblue	3	1	7	2.5	64.29
Aug5	12	Kenblue	4	3	7.6	3.1	59.21
Aug5	21	Kenblue	4	1	9	2.8	68.89
Aug5	30	Kenblue	4	2	6.3	2.4	61.90
Aug5	5	Kenblue	5	2	5.5	2.2	60.00
Aug5	10	Kenblue	5	3	4.8	1.9	60.42
Aug5	36	Kenblue	5	1	4.4	1.8	59.09
July20	2	Kenblue	1	1	4.2	2.1	50.00
July20	27	Kenblue	1	3	6.5	2.5	61.54
July20	32	Kenblue	1	2	7.7	2.7	64.94
July20	22	Kenblue	3	2	6.8	3.3	51.47
July20	29	Kenblue	3	3	8.1	3	62.96
July20	35	Kenblue	3	1	7.7	3.2	58.44
July20	12	Kenblue	4	3	9	3.6	60.00
July20	21	Kenblue	4	1	7.8	2.6	66.67
July20	30	Kenblue	4	2	7	3.4	51.43
July20	5	Kenblue	5	2	7.8	2.4	69.23
July20	10	Kenblue	5	3	5.1	2.5	50.98
July20	36	Kenblue	5	1	3.9	1.7	56.41
June20	2	Kenblue	1	1	9.6	3.9	59.38
June20	27	Kenblue	1	3	10.7	3.6	66.36
June20	32	Kenblue	1	2	9.5	3.7	61.05
June20	22	Kenblue	3	2	12.5	4.6	63.20
June20	29	Kenblue	3	3	10.3	3.5	66.02
June20	35	Kenblue	3	1	10.7	4	62.62
June20	12	Kenblue	4	3	11.3	4.2	62.83
June20	21	Kenblue	4	1	10.7	3.7	65.42
June20	30	Kenblue	4	2	9.7	3.9	59.79
June20	5	Kenblue	5	2	11.1	3.9	64.86
June20	10	Kenblue	5	3	8.6	3.3	61.63
June20	36	Kenblue	5	1	13.5	4.9	63.70
June5	2	Kenblue	1	1	9.4	3.69	60.74
June5	27	Kenblue	1	3	9.5	4.1	56.84
June5	32	Kenblue	1	2	11.6	4.44	61.72
June5	22	Kenblue	3	2	9	4	55.56
June5	29	Kenblue	3	3	12.1	5.12	57.69
June5	35	Kenblue	3	1	9.5	3.8	60.00

June5	12	Kenblue	4	3	8.3	3.6	56.63
June5	21	Kenblue	4	1	12.7	5.2	59.06
June5	30	Kenblue	4	2	9.1	4.1	54.95
June5	5	Kenblue	5	2	6.6	2.8	57.58
June5	10	Kenblue	5	3	12	4.94	58.83
June5	36	Kenblue	5	1	10.2	4.76	53.33
Aug5	8	Livingston	1	3	4.5	1.7	62.22
Aug5	20	Livingston	1	1	4.5	1.9	57.78
Aug5	24	Livingston	1	2	3.6	1.4	61.11
Aug5	13	Livingston	2	2	4.4	1.9	56.82
Aug5	19	Livingston	2	1	5.7	2.4	57.89
Aug5	28	Livingston	2	3	4.8	1.8	62.50
Aug5	4	Livingston	3	2	6.8	2.8	58.82
Aug5	9	Livingston	3	3	6.3	2.5	60.32
Aug5	17	Livingston	3	1	6.9	2.9	57.97
Aug5	23	Livingston	4	2	8.5	2.7	68.24
Aug5	25	Livingston	4	3	8.6	3.2	62.79
Aug5	33	Livingston	4	1	7.5	3.1	58.67
July20	8	Livingston	1	3	6	2.3	61.67
July20	20	Livingston	1	1	5.2	2.3	55.77
July20	24	Livingston	1	2	4.2	1.9	54.76
July20	13	Livingston	2	2	6.5	2.9	55.38
July20	19	Livingston	2	1	3.6	1.6	55.56
July20	28	Livingston	2	3	7.8	3.1	60.26
July20	4	Livingston	3	2	7.8	3.2	58.97
July20	9	Livingston	3	3	7.3	3.3	54.79
July20	17	Livingston	3	1	8.4	3	64.29
July20	23	Livingston	4	2	6.6	3.3	50.00
July20	25	Livingston	4	3	6.9	2.9	57.97
July20	33	Livingston	4	1	8.6	3.1	63.95
June20	8	Livingston	1	3	8.6	3.1	63.95
June20	20	Livingston	1	1	10.5	4.1	60.95
June20	24	Livingston	1	2	10	3.7	63.00
June20	13	Livingston	2	2	9.8	3.6	63.27
June20	19	Livingston	2	1	11.5	4.4	61.74
June20	28	Livingston	2	3	8.4	3	64.29
June20	4	Livingston	3	2	7.9	3.1	60.76
June20	9	Livingston	3	3	10.2	3.8	62.75
June20	17	Livingston	3	1	10.8	3.9	63.89
June20	23	Livingston	4	2	10.6	4	62.26
June20	25	Livingston	4	3	9.3	3.1	66.67
June20	33	Livingston	4	1	11.2	4.1	63.39
June5	8	Livingston	1	3	10.5	3.95	62.38
June5	20	Livingston	1	1	9.4	4.2	55.32
June5	24	Livingston	1	2	8.7	4.05	53.45
June5	13	Livingston	2	2	11.2	4.44	60.36
June5	19	Livingston	2	1	6.9	3.2	53.62
June5	28	Livingston	2	3	11.5	4.73	58.87
June5	4	Livingston	3	2	9.7	3.84	60.41
June5	9	Livingston	3	3	8.8	3.55	59.66

June5	17Livingston	3	1	12	4.74	60.50
June5	23Livingston	4	2	11.3	4.39	61.15
June5	25Livingston	4	3	9.2	3.79	58.80
June5	33Livingston	4	1	8.4	3.45	58.93
Aug5	3Nuglade	1	2	4.3	1.9	55.81
Aug5	18Nuglade	1	1	3.7	1.7	54.05
Aug5	26Nuglade	1	3	3.9	1.7	56.41
Aug5	1Nuglade	2	1	4.2	1.9	54.76
Aug5	11Nuglade	2	3	4.4	1.8	59.09
Aug5	31Nuglade	2	2	6	2.3	61.67
Aug5	6Nuglade	3	3	6.6	2.2	66.67
Aug5	14Nuglade	3	2	5.5	2.5	54.55
Aug5	34Nuglade	3	1	6.8	2.9	57.35
Aug5	7Nuglade	4	3	6.9	2.8	59.42
Aug5	15Nuglade	4	2	7.8	3.1	60.26
Aug5	16Nuglade	4	1	7	2.8	60.00
July20	3Nuglade	1	2	3.5	1.3	62.86
July20	18Nuglade	1	1	5	2.5	50.00
July20	26Nuglade	1	3	3.3	2.2	33.33
July20	1Nuglade	2	1	6	2.5	58.33
July20	11Nuglade	2	3	6.6	2.8	57.58
July20	31Nuglade	2	2	3.9	1.8	53.85
July20	6Nuglade	3	3	7.3	3.4	53.42
July20	14Nuglade	3	2	7.5	3.1	58.67
July20	34Nuglade	3	1	5.6	2.5	55.36
July20	7Nuglade	4	3	6.9	3.2	53.62
July20	15Nuglade	4	2	7.1	3.4	52.11
July20	16Nuglade	4	1	6.5	2.7	58.46
June20	3Nuglade	1	2	9.1	3.3	63.74
June20	18Nuglade	1	1	9.5	3.6	62.11
June20	26Nuglade	1	3	9.1	3.5	61.54
June20	1Nuglade	2	1	7.7	3.4	55.84
June20	11Nuglade	2	3	13.5	4.9	63.70
June20	31Nuglade	2	2	8.8	3.3	62.50
June20	6Nuglade	3	3	17.2	6	65.12
June20	14Nuglade	3	2	7.3	2.5	65.75
June20	34Nuglade	3	1	8.2	3.2	60.98
June20	7Nuglade	4	3	9.9	3.6	63.64
June20	15Nuglade	4	2	11.5	4.1	64.35
June20	16Nuglade	4	1	8	3	62.50
June5	3Nuglade	1	2	8.7	3.98	54.25
June5	18Nuglade	1	1	10.4	4.1	60.58
June5	26Nuglade	1	3	9.5	3.79	60.11
June5	1Nuglade	2	1	8.4	3.64	56.67
June5	11Nuglade	2	3	10.2	4.27	58.14
June5	31Nuglade	2	2	11.8	4.83	59.07
June5	6Nuglade	3	3	11	4.36	60.36
June5	14Nuglade	3	2	10	4.2	58.00
June5	34Nuglade	3	1	9	3.8	57.78
June5	7Nuglade	4	3	11.2	4.95	55.80

June5	15	Nuglade	4	2	9.7	4.09	57.84
June5	16	Nuglade	4	1	9.9	3.81	61.52

Clippings 04'

Date	Plot ID	Grass	Trt	Rep	Wet Wt.	Dry Wt.	LWC
Aug10	2	Kenblue	1	1	4.8	1.7	64.58
Aug10	27	Kenblue	1	3	5.3	2	62.26
Aug10	32	Kenblue	1	2	3.8	1.4	63.16
Aug10	22	Kenblue	3	2	9.5	3.4	64.21
Aug10	29	Kenblue	3	3	7.4	2.8	62.16
Aug10	35	Kenblue	3	1	5.6	2.1	62.50
Aug10	12	Kenblue	4	3	6.1	2.4	60.66
Aug10	21	Kenblue	4	1	7.8	2.8	64.10
Aug10	30	Kenblue	4	2	7.3	2.7	63.01
Aug10	5	Kenblue	5	2	5	1.6	68.00
Aug10	10	Kenblue	5	3	3.7	1.4	62.16
Aug10	36	Kenblue	5	1	5.2	2	61.54
July2	2	Kenblue	1	1	7.5	3.1	58.67
July2	27	Kenblue	1	3	10.4	3.7	64.42
July2	32	Kenblue	1	2	8.6	3	65.12
July2	22	Kenblue	3	2	10.4	3.8	63.46
July2	29	Kenblue	3	3	10.1	3.8	62.38
July2	35	Kenblue	3	1	8	3.1	61.25
July2	12	Kenblue	4	3	9.6	3.5	63.54
July2	21	Kenblue	4	1	10.1	3.8	62.38
July2	30	Kenblue	4	2	9.4	3.5	62.77
July2	5	Kenblue	5	2	9.9	3.7	62.63
July2	10	Kenblue	5	3	9.5	3.5	63.16
July2	36	Kenblue	5	1	7	2.7	61.43
July28	2	Kenblue	1	1	5.2	1.8	65.38
July28	27	Kenblue	1	3	5.8	2.1	63.79
July28	32	Kenblue	1	2	4.4	1.6	63.64
July28	22	Kenblue	3	2	8.8	3	65.91
July28	29	Kenblue	3	3	8.8	2.8	68.18
July28	35	Kenblue	3	1	9	3.2	64.44
July28	12	Kenblue	4	3	8.3	2.9	65.06
July28	21	Kenblue	4	1	8.9	3	66.29
July28	30	Kenblue	4	2	10.7	3.4	68.22
July28	5	Kenblue	5	2	6.3	2	68.25
July28	10	Kenblue	5	3	3.6	1.3	63.89
July28	36	Kenblue	5	1	7.5	2.5	66.67
June18	2	Kenblue	1	1	9.5	3.7	61.05
June18	27	Kenblue	1	3	7	3.1	55.71
June18	32	Kenblue	1	2	8.8	3.5	60.23
June18	22	Kenblue	3	2	9.6	3.8	60.42
June18	29	Kenblue	3	3	8.9	3.7	58.43
June18	35	Kenblue	3	1	9	4	55.56
June18	12	Kenblue	4	3	10	4	60.00
June18	21	Kenblue	4	1	9.9	3.7	62.63
June18	30	Kenblue	4	2	8.5	3.4	60.00

June18	5Kenblue	5	2	6.9	2.6	62.32
June18	10Kenblue	5	3	9.5	3.9	58.95
June18	36Kenblue	5	1	8.7	3.5	59.77
Aug10	8Livingston	1	3	5.3	1.9	64.15
Aug10	20Livingston	1	1	4.4	1.8	59.09
Aug10	24Livingston	1	2	3.7	1.3	64.86
Aug10	13Livingston	2	2	5	1.8	64.00
Aug10	19Livingston	2	1	4.5	1.9	57.78
Aug10	28Livingston	2	3	4.4	1.7	61.36
Aug10	4Livingston	3	2	6.2	2.4	61.29
Aug10	9Livingston	3	3	8.6	3	65.12
Aug10	17Livingston	3	1	7.2	2.7	62.50
Aug10	23Livingston	4	2	7.7	2.8	63.64
Aug10	25Livingston	4	3	8.3	2.9	65.06
Aug10	33Livingston	4	1	9.3	3.5	62.37
July2	8Livingston	1	3	12.3	4.6	62.60
July2	20Livingston	1	1	8.8	3.3	62.50
July2	24Livingston	1	2	7.3	2.7	63.01
July2	13Livingston	2	2	9	3.1	65.56
July2	19Livingston	2	1	11	3.9	64.55
July2	28Livingston	2	3	11.4	3.8	66.67
July2	4Livingston	3	2	10	4	60.00
July2	9Livingston	3	3	10.7	3.5	67.29
July2	17Livingston	3	1	11.4	3.9	65.79
July2	23Livingston	4	2	9.2	3.1	66.30
July2	25Livingston	4	3	11.6	4.1	64.66
July2	33Livingston	4	1	11.3	3.7	67.26
July28	8Livingston	1	3	6.8	2.3	66.18
July28	20Livingston	1	1	4.6	2	56.52
July28	24Livingston	1	2	6.1	1.9	68.85
July28	13Livingston	2	2	8.4	2.9	65.48
July28	19Livingston	2	1	6.3	2.5	60.32
July28	28Livingston	2	3	8.2	2.8	65.85
July28	4Livingston	3	2	10.8	3.8	64.81
July28	9Livingston	3	3	9	3.1	65.56
July28	17Livingston	3	1	6.7	2.5	62.69
July28	23Livingston	4	2	11.3	3.9	65.49
July28	25Livingston	4	3	8.8	3.1	64.77
July28	33Livingston	4	1	9	3.2	64.44
June18	8Livingston	1	3	8.6	3.3	61.63
June18	20Livingston	1	1	7.8	3.1	60.26
June18	24Livingston	1	2	10.3	4	61.17
June18	13Livingston	2	2	8.8	3.4	61.36
June18	19Livingston	2	1	8.9	3.3	62.92
June18	28Livingston	2	3	10.2	3.9	61.76
June18	4Livingston	3	2	11	4.1	62.73
June18	9Livingston	3	3	8.7	3.4	60.92
June18	17Livingston	3	1	7.9	3.3	58.23
June18	23Livingston	4	2	9.3	3.7	60.22
June18	25Livingston	4	3	7.6	3.3	56.58

June18	33Livingston	4	1	10	3.9	61.00
Aug10	3Nuglade	1	2	5.7	2.1	63.16
Aug10	18Nuglade	1	1	5.6	1.9	66.07
Aug10	26Nuglade	1	3	5.7	2	64.91
Aug10	1Nuglade	2	1	5.5	1.9	65.45
Aug10	11Nuglade	2	3	6.3	2.1	66.67
Aug10	31Nuglade	2	2	7.9	2.8	64.56
Aug10	6Nuglade	3	3	8.5	2.7	68.24
Aug10	14Nuglade	3	2	8.3	3	63.86
Aug10	34Nuglade	3	1	6.9	2.5	63.77
Aug10	7Nuglade	4	3	10	3.2	68.00
Aug10	15Nuglade	4	2	8.3	2.8	66.27
Aug10	16Nuglade	4	1	8.7	2.9	66.67
July2	3Nuglade	1	2	7.9	3	62.03
July2	18Nuglade	1	1	9.1	3.5	61.54
July2	26Nuglade	1	3	10	3.6	64.00
July2	1Nuglade	2	1	10.2	3.7	63.73
July2	11Nuglade	2	3	8.9	3.3	62.92
July2	31Nuglade	2	2	9.2	3.4	63.04
July2	6Nuglade	3	3	11	4	63.64
July2	14Nuglade	3	2	10.1	3.6	64.36
July2	34Nuglade	3	1	9.4	3.7	60.64
July2	7Nuglade	4	3	10	3.5	65.00
July2	15Nuglade	4	2	10.1	3.8	62.38
July2	16Nuglade	4	1	10.6	3.9	63.21
July28	3Nuglade	1	2	7.2	2.4	66.67
July28	18Nuglade	1	1	5.3	2	62.26
July28	26Nuglade	1	3	7.5	2.5	66.67
July28	1Nuglade	2	1	5.8	2.5	56.90
July28	11Nuglade	2	3	8.5	3	64.71
July28	31Nuglade	2	2	8.4	2.8	66.67
July28	6Nuglade	3	3	7.1	2.8	60.56
July28	14Nuglade	3	2	9.9	3.7	62.63
July28	34Nuglade	3	1	8.9	3.1	65.17
July28	7Nuglade	4	3	9.8	3.4	65.31
July28	15Nuglade	4	2	8.2	3	63.41
July28	16Nuglade	4	1	9	3.5	61.11
June18	3Nuglade	1	2	8.6	3.6	58.14
June18	18Nuglade	1	1	7.2	3.2	55.56
June18	26Nuglade	1	3	10.1	3.7	63.37
June18	1Nuglade	2	1	8.1	3.2	60.49
June18	11Nuglade	2	3	8.4	3.8	54.76
June18	31Nuglade	2	2	9.9	4.1	58.59
June18	6Nuglade	3	3	9.1	3.6	60.44
June18	14Nuglade	3	2	8.4	3.3	60.71
June18	34Nuglade	3	1	11.9	4.5	62.18
June18	7Nuglade	4	3	8.6	3.5	59.30
June18	15Nuglade	4	2	9.7	3.8	60.82
June18	16Nuglade	4	1	7.5	4	46.67

Root data

Plot #	Treat	Rep.#	Year	Depth	Mass
1	2	1	1	a	0.9094
1	2	1	1	b	0.2474
1	2	1	1	c	0.0958
1	2	1	1	d	0.0292
2	1	2	1	a	0.8092
2	1	2	1	b	0.2979
2	1	2	1	c	0.0452
2	1	2	1	d	0.0378
3	3	3	1	a	0.9388
3	3	3	1	b	0.1684
3	3	3	1	c	0.099
3	3	3	1	d	0.0288
4	4	3	1	a	0.9569
4	4	3	1	b	0.0904
4	4	3	1	c	0.0506
4	4	3	1	d	0.0367
5	2	3	1	a	0.8129
5	2	3	1	b	0.236
5	2	3	1	c	0.1585
5	2	3	1	d	0.0799
6	3	2	1	a	1.033
6	3	2	1	b	0.1901
6	3	2	1	c	0.0655
6	3	2	1	d	0.0497
7	4	2	1	a	0.9491
7	4	2	1	b	0.305
7	4	2	1	c	0.159
7	4	2	1	d	0.0621
8	4	1	1	a	0.8172
8	4	1	1	b	0.1972
8	4	1	1	c	0.0661
8	4	1	1	d	0.0507
9	1	1	1	a	0.8231
9	1	1	1	b	0.2246
9	1	1	1	c	0.1846
9	1	1	1	d	0.0662
10	1	3	1	a	0.7815
10	1	3	1	b	0.1213
10	1	3	1	c	0.1089
10	1	3	1	d	0.0472
11	2	2	1	a	0.8337
11	2	2	1	b	0.238
11	2	2	1	c	0.0507
11	2	2	1	d	0.0166
12	3	1	1	a	0.7806
12	3	1	1	b	0.2103
12	3	1	1	c	0.1045
12	3	1	1	d	0.0972

1	2	1	2	a	0.7929
1	2	1	2	b	0.2081
1	2	1	2	c	0.1246
1	2	1	2	d	0.0641
2	1	2	2	a	0.7515
2	1	2	2	b	0.1535
2	1	2	2	c	0.0994
2	1	2	2	d	0.0292
3	3	3	2	a	0.8396
3	3	3	2	b	0.2155
3	3	3	2	c	0.0944
3	3	3	2	d	0.0698
4	4	3	2	a	1.0068
4	4	3	2	b	0.2082
4	4	3	2	c	0.1162
4	4	3	2	d	0.0655
5	2	3	2	a	0.8641
5	2	3	2	b	0.1135
5	2	3	2	c	0.0753
5	2	3	2	d	0.0329
6	3	2	2	a	0.9789
6	3	2	2	b	0.1887
6	3	2	2	c	0.0937
6	3	2	2	d	0.0395
7	4	2	2	a	0.8267
7	4	2	2	b	0.3614
7	4	2	2	c	0.0298
7	4	2	2	d	0.026
8	4	1	2	a	0.8379
8	4	1	2	b	0.1974
8	4	1	2	c	0.0953
8	4	1	2	d	0.0313
9	1	1	2	a	0.8411
9	1	1	2	b	0.1937
9	1	1	2	c	0.0578
9	1	1	2	d	0.0298
10	1	3	2	a	0.8641
10	1	3	2	b	0.1862
10	1	3	2	c	0.0521
10	1	3	2	d	0.0255
11	2	2	2	a	0.8595
11	2	2	2	b	0.2944
11	2	2	2	c	0.0743
11	2	2	2	d	0.0295
12	3	1	2	a	0.7863
12	3	1	2	b	0.1843
12	3	1	2	c	0.1033
12	3	1	2	d	0.0576

APPENDIX B.

Hydraulic conductivity

Plot	Trt	Rep	Ks cm/hr
1	2	1	12.05948
1	2	1	13.91479
2	1	2	13.31134
2	1	2	11.8323
3	3	3	17.37869
3	3	3	12.57182
4	4	3	18.55305
4	4	3	17.00893
5	2	3	14.37861
5	2	3	21.8158
6	3	2	22.72748
6	3	2	13.31134
7	4	2	14.42062
7	4	2	15.16013
8	4	1	13.6811
8	4	1	17.62539
9	1	1	14.05086
9	1	1	15.52989
10	1	3	16.23392
10	1	3	15.30626
11	2	2	15.89965
11	2	2	14.84244
12	3	1	14.79038
12	3	1	15.77009

Soil moisture retention

Plot	Trt	Rep	Pressure	VWC	VWC Sat.
1	2	1	0.1	0.33	0.55
1	2	1	0.3	0.30	0.55
1	2	1	2	0.26	0.55
1	2	1	5	0.26	0.55
1	2	1	15	0.24	0.55
1	2	1	0.1	0.33	0.56
1	2	1	0.3	0.32	0.56
1	2	1	2	0.30	0.56
1	2	1	5	0.26	0.56
1	2	1	15	0.24	0.56
1	2	1	0.1	0.33	0.53
1	2	1	0.3	0.30	0.53
1	2	1	2	0.27	0.53
1	2	1	5	0.27	0.53
1	2	1	15	0.23	0.53
1	2	1	0.1	0.35	0.61
1	2	1	0.3	0.33	0.61

1	2	1	2	0.31	0.61
1	2	1	5	0.30	0.61
1	2	1	15	0.28	0.61
2	1	2	0.1	0.34	0.59
2	1	2	0.3	0.31	0.59
2	1	2	2	0.29	0.59
2	1	2	5	0.29	0.59
2	1	2	15	0.25	0.59
2	1	2	0.1	0.32	0.57
2	1	2	0.3	0.29	0.57
2	1	2	2	0.27	0.57
2	1	2	5	0.26	0.57
2	1	2	15	0.23	0.57
2	1	2	0.1	0.32	0.58
2	1	2	0.3	0.30	0.58
2	1	2	2	0.27	0.58
2	1	2	5	0.26	0.58
2	1	2	15	0.23	0.58
2	1	2	0.1	0.32	0.53
2	1	2	0.3	0.30	0.53
2	1	2	2	0.27	0.53
2	1	2	5	0.27	0.53
2	1	2	15	0.24	0.53
3	3	3	0.1	0.36	0.56
3	3	3	0.3	0.33	0.56
3	3	3	2	0.31	0.56
3	3	3	5	0.30	0.56
3	3	3	15	0.25	0.56
3	3	3	0.1	0.36	0.50
3	3	3	0.3	0.34	0.50
3	3	3	2	0.31	0.50
3	3	3	5	0.32	0.50
3	3	3	15	0.28	0.50
3	3	3	0.1	0.37	0.56
3	3	3	0.3	0.35	0.56
3	3	3	2	0.30	0.56
3	3	3	5	0.30	0.56
3	3	3	15	0.27	0.56
3	3	3	0.1	0.34	0.58
3	3	3	0.3	0.32	0.58
3	3	3	2	0.28	0.58
3	3	3	5	0.27	0.58
3	3	3	15	0.24	0.58
4	4	3	0.1	0.38	0.59
4	4	3	0.3	0.36	0.59
4	4	3	2	0.32	0.59
4	4	3	5	0.32	0.59

4	4	3	15	0.30	0.59
4	4	3	0.1	0.38	0.55
4	4	3	0.3	0.35	0.55
4	4	3	2	0.33	0.55
4	4	3	5	0.32	0.55
4	4	3	15	0.30	0.55
4	4	3	0.1	0.37	0.57
4	4	3	0.3	0.35	0.57
4	4	3	2	0.32	0.57
4	4	3	5	0.31	0.57
4	4	3	15	0.29	0.57
4	4	3	0.1	0.41	0.61
4	4	3	0.3	0.38	0.61
4	4	3	2	0.34	0.61
4	4	3	5	0.33	0.61
4	4	3	15	0.31	0.61
5	2	3	0.1	0.34	0.56
5	2	3	0.3	0.31	0.56
5	2	3	2	0.27	0.56
5	2	3	5	0.27	0.56
5	2	3	15	0.25	0.56
5	2	3	0.1	0.34	0.54
5	2	3	0.3	0.32	0.54
5	2	3	2	0.28	0.54
5	2	3	5	0.26	0.54
5	2	3	15	0.24	0.54
5	2	3	0.1	0.34	0.58
5	2	3	0.3	0.32	0.58
5	2	3	2	0.28	0.58
5	2	3	5	0.28	0.58
5	2	3	15	0.25	0.58
5	2	3	0.1	0.30	0.49
5	2	3	0.3	0.28	0.49
5	2	3	2	0.24	0.49
5	2	3	5	0.23	0.49
5	2	3	15	0.20	0.49
6	3	2	0.1	0.35	0.57
6	3	2	0.3	0.32	0.57
6	3	2	2	0.28	0.57
6	3	2	5	0.28	0.57
6	3	2	15	0.25	0.57
6	3	2	0.1	0.36	0.60
6	3	2	0.3	0.33	0.60
6	3	2	2	0.29	0.60
6	3	2	5	0.28	0.60
6	3	2	15	0.26	0.60
6	3	2	0.1	0.37	0.57

6	3	2	0.3	0.34	0.57
6	3	2	2	0.31	0.57
6	3	2	5	0.30	0.57
6	3	2	15	0.28	0.57
6	3	2	0.1	0.36	0.59
6	3	2	0.3	0.33	0.59
6	3	2	2	0.28	0.59
6	3	2	5	0.28	0.59
6	3	2	15	0.25	0.59
7	4	2	0.1	0.35	0.59
7	4	2	0.3	0.33	0.59
7	4	2	2	0.29	0.59
7	4	2	5	0.29	0.59
7	4	2	15	0.26	0.59
7	4	2	0.1	0.37	0.59
7	4	2	0.3	0.34	0.59
7	4	2	2	0.31	0.59
7	4	2	5	0.31	0.59
7	4	2	15	0.28	0.59
7	4	2	0.1	0.37	0.63
7	4	2	0.3	0.34	0.63
7	4	2	2	0.31	0.63
7	4	2	5	0.30	0.63
7	4	2	15	0.26	0.63
7	4	2	0.1	0.35	0.57
7	4	2	0.3	0.31	0.57
7	4	2	2	0.26	0.57
7	4	2	5	0.26	0.57
7	4	2	15	0.23	0.57
8	4	1	0.1	0.37	0.59
8	4	1	0.3	0.35	0.59
8	4	1	2	0.32	0.59
8	4	1	5	0.29	0.59
8	4	1	15	0.27	0.59
8	4	1	0.1	0.40	0.47
8	4	1	0.3	0.37	0.47
8	4	1	2	0.33	0.47
8	4	1	5	0.28	0.47
8	4	1	15	0.25	0.47
8	4	1	0.1	0.38	0.50
8	4	1	0.3	0.34	0.50
8	4	1	2	0.30	0.50
8	4	1	5	0.26	0.50
8	4	1	15	0.24	0.50
8	4	1	0.1	0.38	0.59
8	4	1	0.3	0.35	0.59
8	4	1	2	0.31	0.59

8	4	1	5	0.28	0.59
8	4	1	15	0.25	0.59
9	1	1	0.1	0.32	0.43
9	1	1	0.3	0.28	0.43
9	1	1	2	0.24	0.43
9	1	1	5	0.20	0.43
9	1	1	15	0.18	0.43
9	1	1	0.1	0.34	0.52
9	1	1	0.3	0.31	0.52
9	1	1	2	0.27	0.52
9	1	1	5	0.25	0.52
9	1	1	15	0.23	0.52
9	1	1	0.1	0.33	0.53
9	1	1	0.3	0.30	0.53
9	1	1	2	0.27	0.53
9	1	1	5	0.24	0.53
9	1	1	15	0.21	0.53
9	1	1	0.1	0.36	0.54
9	1	1	0.3	0.34	0.54
9	1	1	2	0.29	0.54
9	1	1	5	0.27	0.54
9	1	1	15	0.25	0.54
10	1	3	0.1	0.32	0.51
10	1	3	0.3	0.30	0.51
10	1	3	2	0.26	0.51
10	1	3	5	0.25	0.51
10	1	3	15	0.23	0.51
10	1	3	0.1	0.31	0.50
10	1	3	0.3	0.30	0.50
10	1	3	2	0.27	0.50
10	1	3	5	0.26	0.50
10	1	3	15	0.24	0.50
10	1	3	0.1	0.31	0.51
10	1	3	0.3	0.29	0.51
10	1	3	2	0.26	0.51
10	1	3	5	0.26	0.51
10	1	3	15	0.23	0.51
10	1	3	0.1	0.31	0.54
10	1	3	0.3	0.28	0.54
10	1	3	2	0.24	0.54
10	1	3	5	0.24	0.54
10	1	3	15	0.20	0.54
11	2	2	0.1	0.32	0.54
11	2	2	0.3	0.30	0.54
11	2	2	2	0.26	0.54
11	2	2	5	0.24	0.54
11	2	2	15	0.21	0.54

11	2	2	0.1	0.33	0.55
11	2	2	0.3	0.31	0.55
11	2	2	2	0.28	0.55
11	2	2	5	0.26	0.55
11	2	2	15	0.23	0.55
11	2	2	0.1	0.34	0.57
11	2	2	0.3	0.31	0.57
11	2	2	2	0.28	0.57
11	2	2	5	0.27	0.57
11	2	2	15	0.24	0.57
11	2	2	0.1	0.31	0.51
11	2	2	0.3	0.28	0.51
11	2	2	2	0.25	0.51
11	2	2	5	0.23	0.51
11	2	2	15	0.21	0.51
12	3	1	0.1	0.36	0.58
12	3	1	0.3	0.33	0.58
12	3	1	2	0.28	0.58
12	3	1	5	0.28	0.58
12	3	1	15	0.25	0.58
12	3	1	0.1	0.37	0.57
12	3	1	0.3	0.35	0.57
12	3	1	2	0.30	0.57
12	3	1	5	0.29	0.57
12	3	1	15	0.26	0.57
12	3	1	0.1	0.34	0.57
12	3	1	0.3	0.32	0.57
12	3	1	2	0.28	0.57
12	3	1	5	0.28	0.57
12	3	1	15	0.25	0.57
12	3	1	0.1	0.34	0.56
12	3	1	0.3	0.32	0.56
12	3	1	2	0.28	0.56
12	3	1	5	0.27	0.56
12	3	1	15	0.25	0.56

Bulk Density

Plot	Trt	Rep	BD
1	2	1	1.29
1	2	1	1.06
1	2	1	1.01
1	2	1	1.12
2	1	2	1.26
2	1	2	1.15

2	1	2	1.16
2	1	2	1.22
3	3	3	1.19
3	3	3	1.07
3	3	3	1.17
3	3	3	1.22
4	4	3	1.26
4	4	3	0.94
4	4	3	1.26
4	4	3	1.05
5	2	3	1.22
5	2	3	1.16
5	2	3	1.23
5	2	3	1.04
6	3	2	1.11
6	3	2	1.18
6	3	2	1.05
6	3	2	1.10
7	4	2	1.14
7	4	2	1.08
7	4	2	1.17
7	4	2	1.05
8	4	1	1.07
8	4	1	0.90
8	4	1	0.98
8	4	1	1.03
9	1	1	1.05
9	1	1	1.14
9	1	1	1.15
9	1	1	1.13
10	1	3	1.06
10	1	3	1.08
10	1	3	1.14
10	1	3	1.19
11	2	2	1.11
11	2	2	1.17
11	2	2	1.12
11	2	2	1.14
12	3	1	1.06
12	3	1	0.99
12	3	1	1.13
12	3	1	1.02

Soil Analysis

Year	Plot	Rep	Depth	Trt	pH	E.C.	O.M.	NO3-N	P	K	Zn	Fe	Mn	Cu
1	1	1	1	2	7.4	3.8	5.6	2.1	1.5	286	1.60	19.40	3.33	1.81
1	1	1	2	2	7.6	4	4.1	5.2	1.3	234	1.00	17.40	2.07	1.93
1	1	1	3	2	7.6	4.4	4.7	1.4	0.3	347	0.81	11.70	2.95	2.24
1	1	1	4	2	7.5	4.6	4.4	1.5	0.2	370	0.38	9.12	3.59	2.10
1	1	1	5	2	7.7	4.3	4.5	5.3	0.1	374	0.79	9.73	4.02	2.03
1	2	2	1	1	7.6	3.9	5.6	5.3	2.2	300	1.75	23.40	2.93	3.49
1	2	2	2	1	7.8	4.4	4.9	3	1	310	1.63	18.90	2.07	2.47
1	2	2	3	1	7.7	4.5	4.8	3.1	0.5	352	0.71	13.60	2.74	2.52
1	2	2	4	1	7.7	4.4	4.7	2.6	0.2	356	0.86	10.60	3.49	2.50
1	2	2	5	1	7.7	4.5	4.3	3.6	0.2	349	2.05	13.80	4.48	2.20
1	3	3	1	3	7.6	3.7	5.9	8.5	2.5	305	2.68	21.20	4.23	2.57
1	3	3	2	3	7.7	4.1	5.4	3.9	1.8	261	1.43	19.60	2.37	2.91
1	3	3	3	3	7.8	4.6	5.5	2.2	0.6	295	0.86	14.20	2.10	2.63
1	3	3	4	3	7.8	4.8	3.1	2.2	0.2	273	0.41	9.30	2.82	2.88
1	3	3	5	3	7.8	4.7	2.6	4.3	0.6	281	0.25	9.31	3.69	3.61
1	4	3	1	4	7.6	3.8	4.4	2.3	1.4	286	1.78	19.30	3.19	3.72
1	4	3	2	4	7.7	4.1	3.6	1.7	0.6	317	1.53	14.10	2.22	2.96
1	4	3	3	4	7.7	4.5	3.3	1.9	0.5	302	1.57	9.66	2.86	2.39
1	4	3	4	4	7.8	4.5	3.2	1.4	0.1	285	0.28	7.70	3.32	4.05
1	4	3	5	4	7.8	4.5	2.5	3.8	0.2	360	0.95	8.13	3.76	3.26
1	5	3	1	2	7.8	3.9	4.6	6.8	0.8	316	1.66	13.50	3.16	4.43
1	5	3	2	2	7.8	4.9	3.5	9.1	0.6	294	1.36	10.20	2.32	4.85
1	5	3	3	2	7.8	4.8	3.5	5.5	0.6	281	0.74	9.69	2.66	2.62
1	5	3	4	2	7.8	5.2	3	2.9	0.2	269	0.27	8.42	3.38	3.20
1	5	3	5	2	7.9	5.8	2.8	4.3	0.2	248	0.30	7.25	3.65	2.36
1	6	2	1	3	7.7	3.8	5	6.3	1.2	314	1.35	20.20	2.41	1.98
1	6	2	2	3	7.8	4.6	4.7	4.4	1	251	1.13	19.50	1.97	2.53
1	6	2	3	3	7.8	4.6	5.2	4.1	0.1	324	0.72	10.60	2.28	3.35
1	6	2	4	3	7.8	4.6	4.8	3.2	0.1	318	0.22	9.15	3.34	2.42
1	6	2	5	3	7.8	4.6	4.9	2.7	0.1	324	0.20	9.15	3.42	3.25
1	7	2	1	4	7.6	3.3	5.6	3.9	1.4	341	1.70	17.30	2.70	2.20
1	7	2	2	4	7.8	3.9	4.7	2.6	0.8	317	1.03	16.60	2.12	2.33
1	7	2	3	4	7.8	4.4	4.5	4.1	2	417	1.26	21.60	4.81	7.46
1	7	2	4	4	7.8	4.3	4.9	1.5	0.1	384	0.23	11.10	4.17	2.37
1	7	2	5	4	7.8	4.3	4.6	4.5	0.2	350	0.17	12.10	3.60	1.78
1	8	1	1	4	7.7	3.8	5.7	6.8	1.5	342	1.90	17.60	3.60	2.25
1	8	1	2	4	7.8	4.6	4.7	3	0.5	324	1.14	15.70	2.52	2.11
1	8	1	3	4	7.7	4.9	4	2.1	1	270	0.96	16.90	2.40	1.93
1	8	1	4	4	7.7	5	4.5	2.5	1.2	305	0.52	10.70	2.96	2.62
1	8	1	5	4	7.8	5.4	4.5	6	0.1	328	0.19	9.85	4.54	2.49
1	9	1	1	1	7.5	4	5.6	6.1	1.6	306	2.46	15.60	3.51	2.19
1	9	1	2	1	7.7	4.4	4.8	2.2	0.5	299	1.18	12.40	2.30	2.22
1	9	1	3	1	7.6	4.3	4.6	2.8	0.2	338	0.91	11.30	2.82	2.21
1	9	1	4	1	7.7	4.4	4.3	3	0.4	327	0.37	11.10	4.18	2.15
1	9	1	5	1	7.7	5	4.3	5.1	0.3	342	0.22	10.30	4.17	2.13

1	10	3	1	1	7.8	4.1	4.7	6.1	2.4	315	3.21	15.90	4.30	2.37
1	10	3	2	1	7.7	5.3	3.7	3.9	0.6	304	1.38	11.00	2.52	5.15
1	10	3	3	1	7.8	5.5	3	2.7	0.8	314	1.17	9.03	2.68	4.46
1	10	3	4	1	7.8	5.1	3.1	2.6	0.2	298	0.71	7.64	3.68	4.73
1	10	3	5	1	7.8	4.8	2.7	4.8	0.1	297	0.26	7.19	4.14	5.34
1	11	2	1	2	7.8	4.4	5.6	3.9	1	375	7.74	14.10	4.15	2.26
1	11	2	2	2	7.8	5.2	5.5	2.9	1.4	333	9.19	12.60	2.56	3.06
1	11	2	3	2	7.8	5	5.4	1.6	0.4	313	1.33	10.10	2.93	3.27
1	11	2	4	2	7.9	5.2	5.2	1.9	0.5	302	0.28	8.40	4.11	2.65
1	11	2	5	2	7.8	5.1	4.5	4.1	0.4	289	0.52	8.67	3.52	2.51
1	12	1	1	3	7.7	4.1	5.3	4.8	1	348	1.41	11.10	3.58	1.71
1	12	1	2	3	7.8	4.6	4.5	2.8	0.5	323	1.13	11.20	2.72	2.07
1	12	1	3	3	7.8	4.8	4.5	3	0.2	304	0.88	9.05	2.79	3.05
1	12	1	4	3	7.8	4.8	4.3	3.5	0.3	306	0.19	9.58	3.78	2.16
1	12	1	5	3	7.8	4.6	4.2	3.9	0.1	297	0.16	9.00	3.65	1.94
2	1	1	1	2	7.3	4.0	4.9	2.7	3.1	585	1.97	16.30	2.78	4.04
2	1	1	2	2	7.5	4.5	2	1.5	1.5	423	1.37	14.20	1.93	6.46
2	1	1	3	2	7.5	4.7	1.8	1.2	0.3	392	0.07	9.48	2.25	3.86
2	1	1	4	2	7.6	4.4	1.4	1.1	0.2	355	0.28	7.68	1.62	4.28
2	1	1	5	2	7.6	4.2	1.3	3.2	0.2	334	0.29	7.44	1.55	4.68
2	2	2	1	1	7.4	4.2	3.5	1.9	1.5	349	2.08	15.27	2.96	4.66
2	2	2	2	1	7.5	4.6	1.7	2.5	0.6	394	1.29	13.43	2.19	5.80
2	2	2	3	1	7.6	5.0	1.5	1.6	0.3	346	0.44	8.40	1.74	4.53
2	2	2	4	1	7.7	4.8	1.4	1.6	0.6	348	0.21	6.85	1.42	3.24
2	2	2	5	1	7.7	5.0	1.2	4.4	0.3	287	0.24	5.68	1.19	2.91
2	3	3	1	3	7.5	5.3	5.3	2.1	4.1	726	5.93	17.29	4.15	3.76
2	3	3	2	3	7.5	4.6	2.5	2.1	0.3	615	3.98	18.82	3.69	4.57
2	3	3	3	3	7.6	5.9	1.7	2.8	.	379	0.96	11.05	2.33	3.53
2	3	3	4	3	7.7	5.5	1.4	1.6	2.1	327	0.32	7.43	1.76	2.89
2	3	3	5	3	7.7	5.9	1	2.9	0.6	314	0.37	5.56	1.67	2.85
2	4	3	1	4	7.5	4.9	4.1	2.5	4.3	845	2.60	18.24	4.30	2.58
2	4	3	2	4	7.6	4.7	2.3	2.7	0.6	656	1.53	14.92	3.04	3.21
2	4	3	3	4	7.7	5.0	1.8	2.2	0.9	344	0.54	8.78	2.09	3.70
2	4	3	4	4	7.8	4.6	1.4	2.2	1.5	340	0.32	7.89	1.65	3.22
2	4	3	5	4	7.7	5.2	1.1	1.9	0.6	289	0.40	5.41	1.32	2.23
2	5	3	1	2	7.4	4.7	3.9	2.2	2.8	640	2.09	15.65	3.74	3.11
2	5	3	2	2	7.7	6.0	2.1	4.4	0.9	390	1.28	10.84	2.27	2.63
2	5	3	3	2	7.7	6.1	1.7	6.3	0.3	344	0.61	8.71	2.27	3.83
2	5	3	4	2	7.7	6.4	1.4	6.9	0.3	297	0.30	6.69	1.97	2.86
2	5	3	5	2	7.7	6.1	1.2	6.6	0.9	280	0.27	5.93	1.47	2.40
2	6	2	1	3	7.5	5.3	3.7	2.5	4.8	791	2.39	17.66	3.97	2.15
2	6	2	2	3	7.6	4.7	1.9	1.6	1.2	407	1.00	11.50	1.87	2.16
2	6	2	3	3	7.6	5.3	1.6	2.5	0.6	364	0.57	8.99	1.97	2.64
2	6	2	4	3	7.5	5.3	1.4	3.4	0.3	383	0.37	7.47	1.85	4.45
2	6	2	5	3	7.5	4.8	1.1	3.3	0.6	346	0.80	7.51	1.68	3.99
2	7	2	1	4	7.5	5.0	4.3	1.9	.	889	3.27	17.20	3.79	5.26
2	7	2	2	4	7.7	5.4	2	3	2.1	517	1.25	13.42	2.22	4.63

2	7	2	3	4	7.7	6.0	1.6	3.3	0.6	343	0.64	8.69	1.84	3.50
2	7	2	4	4	7.7	5.5	1.4	2.6	0.3	322	0.38	7.09	1.44	3.97
2	7	2	5	4	7.7	5.7	1.1	2.3	0.6	306	0.36	6.09	1.30	3.88
2	8	1	1	4	7.5	4.9	3.4	1.7	4.6	930	1.80	16.63	4.26	2.82
2	8	1	2	4	7.7	5.5	2	2.1	0.9	410	1.37	11.31	2.76	6.48
2	8	1	3	4	7.7	5.2	1.7	4.1	0.6	343	0.65	8.17	2.03	5.09
2	8	1	4	4	7.7	5.7	1.4	5.8	0.3	284	0.28	6.24	1.42	4.31
2	8	1	5	4	7.7	6.2	1.2	8.9	0.6	329	0.33	6.96	1.62	4.01
2	9	1	1	1	7.4	3.7	3.1	3.1	1.6	312	1.33	14.61	3.28	4.40
2	9	1	2	1	7.5	3.8	1.8	2.7	0.6	366	1.06	10.34	2.25	5.11
2	9	1	3	1	7.6	4.3	1.8	2.0	0.5	344	0.67	9.25	1.87	5.83
2	9	1	4	1	7.6	4.2	1.5	2.3	0.3	320	0.43	7.51	1.82	5.95
2	9	1	5	1	7.7	4.4	1.2	2.4	0.6	280	0.22	6.18	1.34	3.53
2	10	3	1	1	7.5	4.6	3.2	2.3	1.2	362	4.80	14.99	2.97	3.08
2	10	3	2	1	7.7	5.8	2	3.1	0.9	378	1.95	9.51	2.53	3.11
2	10	3	3	1	7.8	6.3	1.7	7.0	0.5	392	0.61	8.17	2.42	3.47
2	10	3	4	1	7.7	6.7	1.7	7.8	0.3	401	0.28	6.91	1.93	3.36
2	10	3	5	1	7.8	6.3	1.3	7.6	0.9	311	0.17	6.06	1.66	3.16
2	11	2	1	2	7.5	4.6	4	1.7	5.2	565	2.82	16.12	4.17	3.66
2	11	2	2	2	7.7	5.6	1.9	1.8	0.9	433	5.51	11.25	3.14	3.53
2	11	2	3	2	7.7	5.8	1.7	2.4	0.6	327	1.17	8.68	2.45	3.13
2	11	2	4	2	7.8	5.6	1.5	2.4	0.6	326	0.34	6.85	1.83	3.45
2	11	2	5	2	7.8	6.2	1.1	1.8	0.9	279	0.28	5.66	1.34	2.51
2	12	1	1	3	7.6	5.9	3.2	2.1	3.6	856	1.96	16.78	4.45	4.24
2	12	1	2	3	7.7	5.8	1.9	2.7	0.9	383	1.08	12.48	2.09	4.17
2	12	1	3	3	7.7	6.1	1.7	2.9	0.6	394	0.75	8.83	2.02	5.59
2	12	1	4	3	7.8	5.6	1.4	3.5	0.3	378	0.40	7.36	1.71	5.61
2	12	1	5	3	7.7	5.8	1.2	3.9	0.6	297	0.34	7.14	1.31	4.61

APPENDIX C.

Dry Down VWC

Date	Plot ID	Grass	Trt	Rep	0-15cm	15-30cm
30-Jun-03	2	Kenblue	1	1	30.4	
30-Jun-03	5	Kenblue	5	2	31.2	
30-Jun-03	10	Kenblue	5	3	28.9	
30-Jun-03	12	Kenblue	4	3	27.2	
30-Jun-03	21	Kenblue	4	1	29.8	
30-Jun-03	22	Kenblue	3	2	29.4	
30-Jun-03	27	Kenblue	1	3	28.8	
30-Jun-03	29	Kenblue	3	3	30.3	
30-Jun-03	30	Kenblue	4	2	31.1	
30-Jun-03	32	Kenblue	1	2	31.3	
30-Jun-03	35	Kenblue	3	1	30.8	
30-Jun-03	36	Kenblue	5	1	30.2	
1-Jul-03	2	Kenblue	1	1	27.1	
1-Jul-03	5	Kenblue	5	2	27.9	
1-Jul-03	10	Kenblue	5	3	27.3	
1-Jul-03	12	Kenblue	4	3	26.2	
1-Jul-03	21	Kenblue	4	1	27.8	
1-Jul-03	22	Kenblue	3	2	27.1	
1-Jul-03	27	Kenblue	1	3	26.5	
1-Jul-03	29	Kenblue	3	3	28.6	
1-Jul-03	30	Kenblue	4	2	30.2	
1-Jul-03	32	Kenblue	1	2	26.1	
1-Jul-03	35	Kenblue	3	1	28.8	
1-Jul-03	36	Kenblue	5	1	25.5	
2-Jul-03	2	Kenblue	1	1	22.1	
2-Jul-03	5	Kenblue	5	2	23	
2-Jul-03	10	Kenblue	5	3	23.3	
2-Jul-03	12	Kenblue	4	3	24.4	
2-Jul-03	21	Kenblue	4	1	24.3	
2-Jul-03	22	Kenblue	3	2	24.5	
2-Jul-03	27	Kenblue	1	3	21.1	
2-Jul-03	29	Kenblue	3	3	25.2	
2-Jul-03	30	Kenblue	4	2	26.5	
2-Jul-03	32	Kenblue	1	2	22	
2-Jul-03	35	Kenblue	3	1	24.9	
2-Jul-03	36	Kenblue	5	1	21.1	
3-Jul-03	2	Kenblue	1	1	12.5	
3-Jul-03	5	Kenblue	5	2	16.5	
3-Jul-03	10	Kenblue	5	3	21.8	
3-Jul-03	12	Kenblue	4	3	20.8	
3-Jul-03	21	Kenblue	4	1	21.6	
3-Jul-03	22	Kenblue	3	2	20.6	

3-Jul-03	27 Kenblue	1	3	18.4
3-Jul-03	29 Kenblue	3	3	21.5
3-Jul-03	30 Kenblue	4	2	22
3-Jul-03	32 Kenblue	1	2	16.5
3-Jul-03	35 Kenblue	3	1	23
3-Jul-03	36 Kenblue	5	1	17.2
6-Jul-03	2 Kenblue	1	1	11.5
6-Jul-03	5 Kenblue	5	2	13.8
6-Jul-03	10 Kenblue	5	3	10.3
6-Jul-03	12 Kenblue	4	3	13.7
6-Jul-03	21 Kenblue	4	1	13.4
6-Jul-03	22 Kenblue	3	2	15.1
6-Jul-03	27 Kenblue	1	3	11.2
6-Jul-03	29 Kenblue	3	3	15.4
6-Jul-03	30 Kenblue	4	2	16.7
6-Jul-03	32 Kenblue	1	2	12.4
6-Jul-03	35 Kenblue	3	1	14.9
6-Jul-03	36 Kenblue	5	1	12.1
7-Jul-03	2 Kenblue	1	1	10
7-Jul-03	5 Kenblue	5	2	9.7
7-Jul-03	10 Kenblue	5	3	9.7
7-Jul-03	12 Kenblue	4	3	12.1
7-Jul-03	21 Kenblue	4	1	10.1
7-Jul-03	22 Kenblue	3	2	11
7-Jul-03	27 Kenblue	1	3	9.5
7-Jul-03	29 Kenblue	3	3	12
7-Jul-03	30 Kenblue	4	2	13.4
7-Jul-03	32 Kenblue	1	2	10
7-Jul-03	35 Kenblue	3	1	12.5
7-Jul-03	36 Kenblue	5	1	8.7
8-Jul-03	2 Kenblue	1	1	7.5
8-Jul-03	5 Kenblue	5	2	8.6
8-Jul-03	10 Kenblue	5	3	7.4
8-Jul-03	12 Kenblue	4	3	10.6
8-Jul-03	21 Kenblue	4	1	8.9
8-Jul-03	22 Kenblue	3	2	9.2
8-Jul-03	27 Kenblue	1	3	7.9
8-Jul-03	29 Kenblue	3	3	10.2
8-Jul-03	30 Kenblue	4	2	9.9
8-Jul-03	32 Kenblue	1	2	8
8-Jul-03	35 Kenblue	3	1	9.6
8-Jul-03	36 Kenblue	5	1	7.3
9-Jul-03	2 Kenblue	1	1	6.9
9-Jul-03	5 Kenblue	5	2	7.7
9-Jul-03	10 Kenblue	5	3	6.3
9-Jul-03	12 Kenblue	4	3	7.7
9-Jul-03	21 Kenblue	4	1	7.8

9-Jul-03	22 Kenblue	3	2	7.8
9-Jul-03	27 Kenblue	1	3	7.5
9-Jul-03	29 Kenblue	3	3	8
9-Jul-03	30 Kenblue	4	2	7.9
9-Jul-03	32 Kenblue	1	2	7.3
9-Jul-03	35 Kenblue	3	1	7.8
9-Jul-03	36 Kenblue	5	1	6.9
30-Jun-03	4 Livingston	3	2	30
30-Jun-03	8 Livingston	1	3	30.3
30-Jun-03	9 Livingston	3	3	29.9
30-Jun-03	13 Livingston	2	2	30.3
30-Jun-03	17 Livingston	3	1	30.8
30-Jun-03	19 Livingston	2	1	31.7
30-Jun-03	20 Livingston	1	1	32
30-Jun-03	23 Livingston	4	2	30.5
30-Jun-03	24 Livingston	1	2	33
30-Jun-03	25 Livingston	4	3	30.1
30-Jun-03	28 Livingston	2	3	29.9
30-Jun-03	33 Livingston	4	1	32.7
1-Jul-03	4 Livingston	3	2	29.6
1-Jul-03	8 Livingston	1	3	27.4
1-Jul-03	9 Livingston	3	3	27.5
1-Jul-03	13 Livingston	2	2	28.4
1-Jul-03	17 Livingston	3	1	28.8
1-Jul-03	19 Livingston	2	1	30.2
1-Jul-03	20 Livingston	1	1	28.6
1-Jul-03	23 Livingston	4	2	28.3
1-Jul-03	24 Livingston	1	2	30.5
1-Jul-03	25 Livingston	4	3	27.3
1-Jul-03	28 Livingston	2	3	27.3
1-Jul-03	33 Livingston	4	1	30
2-Jul-03	4 Livingston	3	2	26.7
2-Jul-03	8 Livingston	1	3	25
2-Jul-03	9 Livingston	3	3	24.6
2-Jul-03	13 Livingston	2	2	26.1
2-Jul-03	17 Livingston	3	1	24.9
2-Jul-03	19 Livingston	2	1	27.4
2-Jul-03	20 Livingston	1	1	25.3
2-Jul-03	23 Livingston	4	2	25.8
2-Jul-03	24 Livingston	1	2	27.7
2-Jul-03	25 Livingston	4	3	24
2-Jul-03	28 Livingston	2	3	24.3
2-Jul-03	33 Livingston	4	1	25.7
3-Jul-03	4 Livingston	3	2	25.4
3-Jul-03	8 Livingston	1	3	13.5
3-Jul-03	9 Livingston	3	3	22.3
3-Jul-03	13 Livingston	2	2	20.8

3-Jul-03	17 Livingston	3	1	21.8
3-Jul-03	19 Livingston	2	1	24.9
3-Jul-03	20 Livingston	1	1	15.2
3-Jul-03	23 Livingston	4	2	24.9
3-Jul-03	24 Livingston	1	2	26.8
3-Jul-03	25 Livingston	4	3	20.6
3-Jul-03	28 Livingston	2	3	19.9
3-Jul-03	33 Livingston	4	1	23.5
6-Jul-03	4 Livingston	3	2	21.6
6-Jul-03	8 Livingston	1	3	11.9
6-Jul-03	9 Livingston	3	3	15.7
6-Jul-03	13 Livingston	2	2	15.5
6-Jul-03	17 Livingston	3	1	16.5
6-Jul-03	19 Livingston	2	1	17
6-Jul-03	20 Livingston	1	1	13.8
6-Jul-03	23 Livingston	4	2	14.9
6-Jul-03	24 Livingston	1	2	16.5
6-Jul-03	25 Livingston	4	3	14.3
6-Jul-03	28 Livingston	2	3	12.4
6-Jul-03	33 Livingston	4	1	16.6
7-Jul-03	4 Livingston	3	2	15.7
7-Jul-03	8 Livingston	1	3	10.4
7-Jul-03	9 Livingston	3	3	12.5
7-Jul-03	13 Livingston	2	2	13
7-Jul-03	17 Livingston	3	1	15.4
7-Jul-03	19 Livingston	2	1	13.2
7-Jul-03	20 Livingston	1	1	10.8
7-Jul-03	23 Livingston	4	2	14.1
7-Jul-03	24 Livingston	1	2	12.4
7-Jul-03	25 Livingston	4	3	11.8
7-Jul-03	28 Livingston	2	3	10.1
7-Jul-03	33 Livingston	4	1	14.5
8-Jul-03	4 Livingston	3	2	14.1
8-Jul-03	8 Livingston	1	3	8.8
8-Jul-03	9 Livingston	3	3	10.3
8-Jul-03	13 Livingston	2	2	12.5
8-Jul-03	17 Livingston	3	1	13
8-Jul-03	19 Livingston	2	1	9.5
8-Jul-03	20 Livingston	1	1	9.5
8-Jul-03	23 Livingston	4	2	10.1
8-Jul-03	24 Livingston	1	2	9.5
8-Jul-03	25 Livingston	4	3	10.6
8-Jul-03	28 Livingston	2	3	8.8
8-Jul-03	33 Livingston	4	1	12.2
9-Jul-03	4 Livingston	3	2	14.5
9-Jul-03	8 Livingston	1	3	7.2
9-Jul-03	9 Livingston	3	3	8.2

9-Jul-03	13 Livingston	2	2	8.8	
9-Jul-03	17 Livingston	3	1	11.1	
9-Jul-03	19 Livingston	2	1	8.9	
9-Jul-03	20 Livingston	1	1	8.1	
9-Jul-03	23 Livingston	4	2	8.5	
9-Jul-03	24 Livingston	1	2	8.9	
9-Jul-03	25 Livingston	4	3	7.6	
9-Jul-03	28 Livingston	2	3	7.9	
9-Jul-03	33 Livingston	4	1	8.7	
30-Jun-03	1 Nuglade	2	1	33.6	48.2
30-Jun-03	3 Nuglade	1	2	33.2	47.4
30-Jun-03	6 Nuglade	3	3	31.9	49.7
30-Jun-03	7 Nuglade	4	3	30.4	49.8
30-Jun-03	11 Nuglade	2	3	29.7	47.9
30-Jun-03	14 Nuglade	3	2	30.3	49.1
30-Jun-03	15 Nuglade	4	2	32	48.8
30-Jun-03	16 Nuglade	4	1	32.6	47
30-Jun-03	18 Nuglade	1	1	32.5	48.3
30-Jun-03	26 Nuglade	1	3	29.1	48.7
30-Jun-03	31 Nuglade	2	2	32.4	48.8
30-Jun-03	34 Nuglade	3	1	29.5	50.1
1-Jul-03	1 Nuglade	2	1	33.1	44.7
1-Jul-03	3 Nuglade	1	2	29.9	46.7
1-Jul-03	6 Nuglade	3	3	30.3	47.3
1-Jul-03	7 Nuglade	4	3	28.1	45.7
1-Jul-03	11 Nuglade	2	3	27.8	44.2
1-Jul-03	14 Nuglade	3	2	28.6	46.2
1-Jul-03	15 Nuglade	4	2	28.8	46.8
1-Jul-03	16 Nuglade	4	1	31.1	43.9
1-Jul-03	18 Nuglade	1	1	29.7	46.5
1-Jul-03	26 Nuglade	1	3	26.5	45.9
1-Jul-03	31 Nuglade	2	2	29.9	48.1
1-Jul-03	34 Nuglade	3	1	27.6	47.4
2-Jul-03	1 Nuglade	2	1	28.4	38
2-Jul-03	3 Nuglade	1	2	25.7	44.3
2-Jul-03	6 Nuglade	3	3	26.3	42.7
2-Jul-03	7 Nuglade	4	3	25.5	44.5
2-Jul-03	11 Nuglade	2	3	23	40.6
2-Jul-03	14 Nuglade	3	2	25.7	44.7
2-Jul-03	15 Nuglade	4	2	23.2	43.6
2-Jul-03	16 Nuglade	4	1	27	42.4
2-Jul-03	18 Nuglade	1	1	25	40.6
2-Jul-03	26 Nuglade	1	3	22.1	41.9
2-Jul-03	31 Nuglade	2	2	25	45.4
2-Jul-03	34 Nuglade	3	1	25.4	43.6
3-Jul-03	1 Nuglade	2	1	27	36
3-Jul-03	3 Nuglade	1	2	22.3	42.1

3-Jul-03	6 Nuglade	3	3	24.1	39.3
3-Jul-03	7 Nuglade	4	3	22.2	42.4
3-Jul-03	11 Nuglade	2	3	20.9	36.1
3-Jul-03	14 Nuglade	3	2	22.7	42.9
3-Jul-03	15 Nuglade	4	2	21.9	41.5
3-Jul-03	16 Nuglade	4	1	24.6	38.8
3-Jul-03	18 Nuglade	1	1	22.1	36.9
3-Jul-03	26 Nuglade	1	3	19.9	41.3
3-Jul-03	31 Nuglade	2	2	21.1	41.5
3-Jul-03	34 Nuglade	3	1	22.9	40.7
6-Jul-03	1 Nuglade	2	1	17.5	30.7
6-Jul-03	3 Nuglade	1	2	14.6	32
6-Jul-03	6 Nuglade	3	3	16.7	31.1
6-Jul-03	7 Nuglade	4	3	15.5	36.5
6-Jul-03	11 Nuglade	2	3	12.4	34.2
6-Jul-03	14 Nuglade	3	2	15	32
6-Jul-03	15 Nuglade	4	2	15.1	33.7
6-Jul-03	16 Nuglade	4	1	17.1	26.7
6-Jul-03	18 Nuglade	1	1	14.4	31.8
6-Jul-03	26 Nuglade	1	3	15.5	32.1
6-Jul-03	31 Nuglade	2	2	14.8	33.8
6-Jul-03	34 Nuglade	3	1	15.1	29.1
7-Jul-03	1 Nuglade	2	1	14	32
7-Jul-03	3 Nuglade	1	2	12.2	31.6
7-Jul-03	6 Nuglade	3	3	16.1	29.5
7-Jul-03	7 Nuglade	4	3	12.9	33.7
7-Jul-03	11 Nuglade	2	3	10.9	29.7
7-Jul-03	14 Nuglade	3	2	12.9	31.7
7-Jul-03	15 Nuglade	4	2	14	32.6
7-Jul-03	16 Nuglade	4	1	13.4	28.8
7-Jul-03	18 Nuglade	1	1	12.3	31.5
7-Jul-03	26 Nuglade	1	3	12.4	30.2
7-Jul-03	31 Nuglade	2	2	12.7	29.3
7-Jul-03	34 Nuglade	3	1	13.3	30.1
8-Jul-03	1 Nuglade	2	1	13.3	24.9
8-Jul-03	3 Nuglade	1	2	9.8	24
8-Jul-03	6 Nuglade	3	3	12.5	26.1
8-Jul-03	7 Nuglade	4	3	11.9	31.1
8-Jul-03	11 Nuglade	2	3	10	27.2
8-Jul-03	14 Nuglade	3	2	12.3	27.1
8-Jul-03	15 Nuglade	4	2	11.6	30.4
8-Jul-03	16 Nuglade	4	1	11.9	26.7
8-Jul-03	18 Nuglade	1	1	9.8	28.6
8-Jul-03	26 Nuglade	1	3	10.1	25.7
8-Jul-03	31 Nuglade	2	2	8.7	33.3
8-Jul-03	34 Nuglade	3	1	8.9	28.7
9-Jul-03	1 Nuglade	2	1	8.5	24.3

9-Jul-03	3 Nuglade	1	2	8.4	19.2
9-Jul-03	6 Nuglade	3	3	10.7	22.9
9-Jul-03	7 Nuglade	4	3	9.2	24.4
9-Jul-03	11 Nuglade	2	3	9.4	22.6
9-Jul-03	14 Nuglade	3	2	9.9	24.5
9-Jul-03	15 Nuglade	4	2	8.3	26.3
9-Jul-03	16 Nuglade	4	1	9	24.8
9-Jul-03	18 Nuglade	1	1	8.2	26.4
9-Jul-03	26 Nuglade	1	3	9.1	23.9
9-Jul-03	31 Nuglade	2	2	8.7	24.7
9-Jul-03	34 Nuglade	3	1	8.1	23.5
22-Jul-03	2 Kenblue	1	1	37.2	
22-Jul-03	5 Kenblue	5	2	32.1	
22-Jul-03	10 Kenblue	5	3	36.4	
22-Jul-03	12 Kenblue	4	3	32.5	
22-Jul-03	21 Kenblue	4	1	31.9	
22-Jul-03	22 Kenblue	3	2	33.8	
22-Jul-03	27 Kenblue	1	3	30.1	
22-Jul-03	29 Kenblue	3	3	34.1	
22-Jul-03	30 Kenblue	4	2	34.1	
22-Jul-03	32 Kenblue	1	2	31.6	
22-Jul-03	35 Kenblue	3	1	30.1	
22-Jul-03	36 Kenblue	5	1	29.6	
23-Jul-03	2 Kenblue	1	1	32.3	
23-Jul-03	5 Kenblue	5	2	28.3	
23-Jul-03	10 Kenblue	5	3	32.1	
23-Jul-03	12 Kenblue	4	3	30.1	
23-Jul-03	21 Kenblue	4	1	27.9	
23-Jul-03	22 Kenblue	3	2	26.6	
23-Jul-03	27 Kenblue	1	3	25.3	
23-Jul-03	29 Kenblue	3	3	26.6	
23-Jul-03	30 Kenblue	4	2	30.2	
23-Jul-03	32 Kenblue	1	2	28.5	
23-Jul-03	35 Kenblue	3	1	27.8	
23-Jul-03	36 Kenblue	5	1	27.1	
24-Jul-03	2 Kenblue	1	1	28.2	
24-Jul-03	5 Kenblue	5	2	24.3	
24-Jul-03	10 Kenblue	5	3	25.7	
24-Jul-03	12 Kenblue	4	3	27.8	
24-Jul-03	21 Kenblue	4	1	24.8	
24-Jul-03	22 Kenblue	3	2	25.8	
24-Jul-03	27 Kenblue	1	3	22.8	
24-Jul-03	29 Kenblue	3	3	26.1	
24-Jul-03	30 Kenblue	4	2	26.7	
24-Jul-03	32 Kenblue	1	2	25	
24-Jul-03	35 Kenblue	3	1	25.5	
24-Jul-03	36 Kenblue	5	1	25.9	

25-Jul-03	2 Kenblue	1	1	24.1
25-Jul-03	5 Kenblue	5	2	19.7
25-Jul-03	10 Kenblue	5	3	22.6
25-Jul-03	12 Kenblue	4	3	25.6
25-Jul-03	21 Kenblue	4	1	20.4
25-Jul-03	22 Kenblue	3	2	21.2
25-Jul-03	27 Kenblue	1	3	18.6
25-Jul-03	29 Kenblue	3	3	21.9
25-Jul-03	30 Kenblue	4	2	26.5
25-Jul-03	32 Kenblue	1	2	21.5
25-Jul-03	35 Kenblue	3	1	22.3
25-Jul-03	36 Kenblue	5	1	17.6
28-Jul-03	2 Kenblue	1	1	16.3
28-Jul-03	5 Kenblue	5	2	12.6
28-Jul-03	10 Kenblue	5	3	14.1
28-Jul-03	12 Kenblue	4	3	16.6
28-Jul-03	21 Kenblue	4	1	15.5
28-Jul-03	22 Kenblue	3	2	16.4
28-Jul-03	27 Kenblue	1	3	11.3
28-Jul-03	29 Kenblue	3	3	16.6
28-Jul-03	30 Kenblue	4	2	17.8
28-Jul-03	32 Kenblue	1	2	17.2
28-Jul-03	35 Kenblue	3	1	18.2
28-Jul-03	36 Kenblue	5	1	12.8
29-Jul-03	2 Kenblue	1	1	13.9
29-Jul-03	5 Kenblue	5	2	9.2
29-Jul-03	10 Kenblue	5	3	10.2
29-Jul-03	12 Kenblue	4	3	14.8
29-Jul-03	21 Kenblue	4	1	13.7
29-Jul-03	22 Kenblue	3	2	12.9
29-Jul-03	27 Kenblue	1	3	9.4
29-Jul-03	29 Kenblue	3	3	15.4
29-Jul-03	30 Kenblue	4	2	14.1
29-Jul-03	32 Kenblue	1	2	14.2
29-Jul-03	35 Kenblue	3	1	14.8
29-Jul-03	36 Kenblue	5	1	9.5
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30-Jul-03	5 Kenblue	5	2	6.9
30-Jul-03	10 Kenblue	5	3	8.8
30-Jul-03	12 Kenblue	4	3	11.8
30-Jul-03	21 Kenblue	4	1	11
30-Jul-03	22 Kenblue	3	2	11.3
30-Jul-03	27 Kenblue	1	3	7.1
30-Jul-03	29 Kenblue	3	3	13.8
30-Jul-03	30 Kenblue	4	2	12.9
30-Jul-03	32 Kenblue	1	2	8.8
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31-Jul-03	5 Kenblue	5	2	5.6
31-Jul-03	10 Kenblue	5	3	5.1
31-Jul-03	12 Kenblue	4	3	10.1
31-Jul-03	21 Kenblue	4	1	9.6
31-Jul-03	22 Kenblue	3	2	7.4
31-Jul-03	27 Kenblue	1	3	6
31-Jul-03	29 Kenblue	3	3	10.5
31-Jul-03	30 Kenblue	4	2	9.9
31-Jul-03	32 Kenblue	1	2	7.1
31-Jul-03	35 Kenblue	3	1	11.3
31-Jul-03	36 Kenblue	5	1	5.9
22-Jul-03	4 Livingston	3	2	33.8
22-Jul-03	8 Livingston	1	3	34.3
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22-Jul-03	13 Livingston	2	2	32.5
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22-Jul-03	19 Livingston	2	1	33.1
22-Jul-03	20 Livingston	1	1	31.5
22-Jul-03	23 Livingston	4	2	31.6
22-Jul-03	24 Livingston	1	2	31.3
22-Jul-03	25 Livingston	4	3	31
22-Jul-03	28 Livingston	2	3	32.9
22-Jul-03	33 Livingston	4	1	32
23-Jul-03	4 Livingston	3	2	31.3
23-Jul-03	8 Livingston	1	3	30.1
23-Jul-03	9 Livingston	3	3	27.7
23-Jul-03	13 Livingston	2	2	30
23-Jul-03	17 Livingston	3	1	29.9
23-Jul-03	19 Livingston	2	1	28.7
23-Jul-03	20 Livingston	1	1	28.7
23-Jul-03	23 Livingston	4	2	29
23-Jul-03	24 Livingston	1	2	29
23-Jul-03	25 Livingston	4	3	29.7
23-Jul-03	28 Livingston	2	3	28.3
23-Jul-03	33 Livingston	4	1	29.5
24-Jul-03	4 Livingston	3	2	28
24-Jul-03	8 Livingston	1	3	26.8
24-Jul-03	9 Livingston	3	3	24.5
24-Jul-03	13 Livingston	2	2	27.5
24-Jul-03	17 Livingston	3	1	27.7
24-Jul-03	19 Livingston	2	1	26.7
24-Jul-03	20 Livingston	1	1	26.9
24-Jul-03	23 Livingston	4	2	27.2
24-Jul-03	24 Livingston	1	2	25.2
24-Jul-03	25 Livingston	4	3	26.9

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24-Jul-03	33 Livingston	4	1	27.2
25-Jul-03	4 Livingston	3	2	25.3
25-Jul-03	8 Livingston	1	3	23.3
25-Jul-03	9 Livingston	3	3	22.3
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25-Jul-03	20 Livingston	1	1	22.8
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25-Jul-03	24 Livingston	1	2	21.8
25-Jul-03	25 Livingston	4	3	24.4
25-Jul-03	28 Livingston	2	3	23.4
25-Jul-03	33 Livingston	4	1	23.7
28-Jul-03	4 Livingston	3	2	21.4
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28-Jul-03	13 Livingston	2	2	18.9
28-Jul-03	17 Livingston	3	1	18.1
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28-Jul-03	20 Livingston	1	1	15.4
28-Jul-03	23 Livingston	4	2	17.8
28-Jul-03	24 Livingston	1	2	14.1
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28-Jul-03	33 Livingston	4	1	18.01
29-Jul-03	4 Livingston	3	2	18.5
29-Jul-03	8 Livingston	1	3	12.3
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29-Jul-03	13 Livingston	2	2	15.2
29-Jul-03	17 Livingston	3	1	14.7
29-Jul-03	19 Livingston	2	1	15.3
29-Jul-03	20 Livingston	1	1	13.1
29-Jul-03	23 Livingston	4	2	16.7
29-Jul-03	24 Livingston	1	2	12.4
29-Jul-03	25 Livingston	4	3	16.1
29-Jul-03	28 Livingston	2	3	12.3
29-Jul-03	33 Livingston	4	1	15.7
30-Jul-03	4 Livingston	3	2	14.5
30-Jul-03	8 Livingston	1	3	11
30-Jul-03	9 Livingston	3	3	11.9
30-Jul-03	13 Livingston	2	2	12.4
30-Jul-03	17 Livingston	3	1	12.4
30-Jul-03	19 Livingston	2	1	12.2
30-Jul-03	20 Livingston	1	1	10.8
30-Jul-03	23 Livingston	4	2	13.2
30-Jul-03	24 Livingston	1	2	11.5

30-Jul-03	25 Livingston	4	3	12.9	
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30-Jul-03	33 Livingston	4	1	13.3	
31-Jul-03	4 Livingston	3	2	13.3	
31-Jul-03	8 Livingston	1	3	10.4	
31-Jul-03	9 Livingston	3	3	10.6	
31-Jul-03	13 Livingston	2	2	11.9	
31-Jul-03	17 Livingston	3	1	11.5	
31-Jul-03	19 Livingston	2	1	11.2	
31-Jul-03	20 Livingston	1	1	9.5	
31-Jul-03	23 Livingston	4	2	12.3	
31-Jul-03	24 Livingston	1	2	8.2	
31-Jul-03	25 Livingston	4	3	12.2	
31-Jul-03	28 Livingston	2	3	10.9	
31-Jul-03	33 Livingston	4	1	12.1	
22-Jul-03	1 Nuglade	2	1	39.1	50.9
22-Jul-03	3 Nuglade	1	2	36.1	48.9
22-Jul-03	6 Nuglade	3	3	38.5	50.7
22-Jul-03	7 Nuglade	4	3	38.4	52.2
22-Jul-03	11 Nuglade	2	3	36.2	51.2
22-Jul-03	14 Nuglade	3	2	36.6	49.8
22-Jul-03	15 Nuglade	4	2	36.1	51.7
22-Jul-03	16 Nuglade	4	1	39.1	50.3
22-Jul-03	18 Nuglade	1	1	39.4	50
22-Jul-03	26 Nuglade	1	3	38.7	48.7
22-Jul-03	31 Nuglade	2	2	36	50.4
22-Jul-03	34 Nuglade	3	1	39.1	49.5
23-Jul-03	1 Nuglade	2	1	37.9	49.1
23-Jul-03	3 Nuglade	1	2	34.3	45.9
23-Jul-03	6 Nuglade	3	3	37.7	46.3
23-Jul-03	7 Nuglade	4	3	33.5	47.5
23-Jul-03	11 Nuglade	2	3	32.5	49.1
23-Jul-03	14 Nuglade	3	2	35.4	47.2
23-Jul-03	15 Nuglade	4	2	32.7	49.9
23-Jul-03	16 Nuglade	4	1	37.5	49.1
23-Jul-03	18 Nuglade	1	1	33.3	46.9
23-Jul-03	26 Nuglade	1	3	37	42.6
23-Jul-03	31 Nuglade	2	2	33.3	48.1
23-Jul-03	34 Nuglade	3	1	36.6	46.8
24-Jul-03	1 Nuglade	2	1	33.5	43.9
24-Jul-03	3 Nuglade	1	2	31.3	41.9
24-Jul-03	6 Nuglade	3	3	33.2	42.4
24-Jul-03	7 Nuglade	4	3	30.6	47
24-Jul-03	11 Nuglade	2	3	30.2	46.2
24-Jul-03	14 Nuglade	3	2	33.8	44.4
24-Jul-03	15 Nuglade	4	2	31.1	46.7
24-Jul-03	16 Nuglade	4	1	35.5	42.1

24-Jul-03	18 Nuglade	1	1	30.2	44.8
24-Jul-03	26 Nuglade	1	3	33.1	36.7
24-Jul-03	31 Nuglade	2	2	30.2	44.8
24-Jul-03	34 Nuglade	3	1	32.1	45.9
25-Jul-03	1 Nuglade	2	1	29.8	42.6
25-Jul-03	3 Nuglade	1	2	29.9	38.5
25-Jul-03	6 Nuglade	3	3	26.8	41.6
25-Jul-03	7 Nuglade	4	3	28.2	46.8
25-Jul-03	11 Nuglade	2	3	25.5	42.9
25-Jul-03	14 Nuglade	3	2	28.7	43.7
25-Jul-03	15 Nuglade	4	2	27.3	43.7
25-Jul-03	16 Nuglade	4	1	29.7	39.9
25-Jul-03	18 Nuglade	1	1	26.1	45.1
25-Jul-03	26 Nuglade	1	3	29.9	35.3
25-Jul-03	31 Nuglade	2	2	25.5	41.3
25-Jul-03	34 Nuglade	3	1	27.8	44.4
28-Jul-03	1 Nuglade	2	1	23.6	32.6
28-Jul-03	3 Nuglade	1	2	15.5	35.5
28-Jul-03	6 Nuglade	3	3	20.9	32.7
28-Jul-03	7 Nuglade	4	3	18.1	36.5
28-Jul-03	11 Nuglade	2	3	14.2	33.2
28-Jul-03	14 Nuglade	3	2	17.2	38.8
28-Jul-03	15 Nuglade	4	2	16.5	36.1
28-Jul-03	16 Nuglade	4	1	22.3	31.5
28-Jul-03	18 Nuglade	1	1	17.1	36.7
28-Jul-03	26 Nuglade	1	3	17.7	31.3
28-Jul-03	31 Nuglade	2	2	16.8	32.8
28-Jul-03	34 Nuglade	3	1	17.8	35.6
29-Jul-03	1 Nuglade	2	1	16.8	30.8
29-Jul-03	3 Nuglade	1	2	12.2	31.8
29-Jul-03	6 Nuglade	3	3	16.7	29.5
29-Jul-03	7 Nuglade	4	3	15.8	34.2
29-Jul-03	11 Nuglade	2	3	13.8	28.6
29-Jul-03	14 Nuglade	3	2	15.8	36.2
29-Jul-03	15 Nuglade	4	2	14.3	33.9
29-Jul-03	16 Nuglade	4	1	19	25.8
29-Jul-03	18 Nuglade	1	1	13.7	32.1
29-Jul-03	26 Nuglade	1	3	12.2	29.8
29-Jul-03	31 Nuglade	2	2	15	29.2
29-Jul-03	34 Nuglade	3	1	15.6	31.8
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30-Jul-03	3 Nuglade	1	2	10.6	28
30-Jul-03	6 Nuglade	3	3	13.3	27.3
30-Jul-03	7 Nuglade	4	3	12.3	29.5
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30-Jul-03	15 Nuglade	4	2	12.9	31.1

30-Jul-03	16 Nuglade	4	1	14.9	25.7
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30-Jul-03	26 Nuglade	1	3	10.1	26.9
30-Jul-03	31 Nuglade	2	2	12.8	28.6
30-Jul-03	34 Nuglade	3	1	13.5	29.7
31-Jul-03	1 Nuglade	2	1	11.9	27.3
31-Jul-03	3 Nuglade	1	2	9.9	25.5
31-Jul-03	6 Nuglade	3	3	12.8	24.6
31-Jul-03	7 Nuglade	4	3	11.2	24.8
31-Jul-03	11 Nuglade	2	3	12.1	26.5
31-Jul-03	14 Nuglade	3	2	12.8	25.8
31-Jul-03	15 Nuglade	4	2	12.2	26.6
31-Jul-03	16 Nuglade	4	1	13.2	24.2
31-Jul-03	18 Nuglade	1	1	10.1	27.9
31-Jul-03	26 Nuglade	1	3	9.9	24.9
31-Jul-03	31 Nuglade	2	2	12.2	25.8
31-Jul-03	34 Nuglade	3	1	11.9	26.7
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6-Jul-04	5 Kenblue	5	2	31.2	
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6-Jul-04	12 Kenblue	4	3	31.2	
6-Jul-04	21 Kenblue	4	1	29.7	
6-Jul-04	22 Kenblue	3	2	29.9	
6-Jul-04	27 Kenblue	1	3	30.1	
6-Jul-04	29 Kenblue	3	3	34.1	
6-Jul-04	30 Kenblue	4	2	30.2	
6-Jul-04	32 Kenblue	1	2	32.6	
6-Jul-04	35 Kenblue	3	1	32	
6-Jul-04	36 Kenblue	5	1	31.1	
7-Jul-04	2 Kenblue	1	1	28.8	
7-Jul-04	5 Kenblue	5	2	28.8	
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7-Jul-04	12 Kenblue	4	3	28.5	
7-Jul-04	21 Kenblue	4	1	27.9	
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7-Jul-04	27 Kenblue	1	3	27.6	
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7-Jul-04	30 Kenblue	4	2	27.2	
7-Jul-04	32 Kenblue	1	2	26.3	
7-Jul-04	35 Kenblue	3	1	27.8	
7-Jul-04	36 Kenblue	5	1	22.8	
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8-Jul-04	5 Kenblue	5	2	26.4	
8-Jul-04	10 Kenblue	5	3	25.7	
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8-Jul-04	21 Kenblue	4	1	25.8	
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8-Jul-04	30 Kenblue	4	2	24.6
8-Jul-04	32 Kenblue	1	2	24.4
8-Jul-04	35 Kenblue	3	1	25.5
8-Jul-04	36 Kenblue	5	1	20.4
9-Jul-04	2 Kenblue	1	1	21.6
9-Jul-04	5 Kenblue	5	2	17.9
9-Jul-04	10 Kenblue	5	3	18.3
9-Jul-04	12 Kenblue	4	3	23.8
9-Jul-04	21 Kenblue	4	1	24.5
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9-Jul-04	29 Kenblue	3	3	22.5
9-Jul-04	30 Kenblue	4	2	20.9
9-Jul-04	32 Kenblue	1	2	18.7
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9-Jul-04	36 Kenblue	5	1	17.6
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12-Jul-04	30 Kenblue	4	2	14.5
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13-Jul-04	10 Kenblue	5	3	7.2
13-Jul-04	12 Kenblue	4	3	13.5
13-Jul-04	21 Kenblue	4	1	15
13-Jul-04	22 Kenblue	3	2	11.5
13-Jul-04	27 Kenblue	1	3	10.1
13-Jul-04	29 Kenblue	3	3	12.4
13-Jul-04	30 Kenblue	4	2	12.3
13-Jul-04	32 Kenblue	1	2	10.1
13-Jul-04	35 Kenblue	3	1	14.4
13-Jul-04	36 Kenblue	5	1	7.7
14-Jul-04	2 Kenblue	1	1	8.6
14-Jul-04	5 Kenblue	5	2	6
14-Jul-04	10 Kenblue	5	3	6.2
14-Jul-04	12 Kenblue	4	3	11.3
14-Jul-04	21 Kenblue	4	1	11.3

14-Jul-04	22 Kenblue	3	2	9.9
14-Jul-04	27 Kenblue	1	3	8.1
14-Jul-04	29 Kenblue	3	3	11
14-Jul-04	30 Kenblue	4	2	10.6
14-Jul-04	32 Kenblue	1	2	8.4
14-Jul-04	35 Kenblue	3	1	12.3
14-Jul-04	36 Kenblue	5	1	6.8
15-Jul-04	2 Kenblue	1	1	6.8
15-Jul-04	5 Kenblue	5	2	5.6
15-Jul-04	10 Kenblue	5	3	5.4
15-Jul-04	12 Kenblue	4	3	10.1
15-Jul-04	21 Kenblue	4	1	10.7
15-Jul-04	22 Kenblue	3	2	9
15-Jul-04	27 Kenblue	1	3	6.6
15-Jul-04	29 Kenblue	3	3	9.7
15-Jul-04	30 Kenblue	4	2	9.9
15-Jul-04	32 Kenblue	1	2	6.4
15-Jul-04	35 Kenblue	3	1	10.5
15-Jul-04	36 Kenblue	5	1	5.9
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6-Jul-04	8 Livingston	1	3	35.3
6-Jul-04	9 Livingston	3	3	28.6
6-Jul-04	13 Livingston	2	2	30.1
6-Jul-04	17 Livingston	3	1	31.5
6-Jul-04	19 Livingston	2	1	31
6-Jul-04	20 Livingston	1	1	32.4
6-Jul-04	23 Livingston	4	2	32.4
6-Jul-04	24 Livingston	1	2	30.8
6-Jul-04	25 Livingston	4	3	32.4
6-Jul-04	28 Livingston	2	3	30.8
6-Jul-04	33 Livingston	4	1	34.5
7-Jul-04	4 Livingston	3	2	31.3
7-Jul-04	8 Livingston	1	3	29
7-Jul-04	9 Livingston	3	3	23.5
7-Jul-04	13 Livingston	2	2	28.5
7-Jul-04	17 Livingston	3	1	29.9
7-Jul-04	19 Livingston	2	1	28.7
7-Jul-04	20 Livingston	1	1	28.9
7-Jul-04	23 Livingston	4	2	30
7-Jul-04	24 Livingston	1	2	26.7
7-Jul-04	25 Livingston	4	3	25.8
7-Jul-04	28 Livingston	2	3	28.5
7-Jul-04	33 Livingston	4	1	29.3
8-Jul-04	4 Livingston	3	2	29
8-Jul-04	8 Livingston	1	3	25.3
8-Jul-04	9 Livingston	3	3	22.1
8-Jul-04	13 Livingston	2	2	26.4

8-Jul-04	17 Livingston	3	1	27.7
8-Jul-04	19 Livingston	2	1	26.8
8-Jul-04	20 Livingston	1	1	24.7
8-Jul-04	23 Livingston	4	2	28.4
8-Jul-04	24 Livingston	1	2	25.5
8-Jul-04	25 Livingston	4	3	23.6
8-Jul-04	28 Livingston	2	3	26.9
8-Jul-04	33 Livingston	4	1	27.2
9-Jul-04	4 Livingston	3	2	26.7
9-Jul-04	8 Livingston	1	3	21.1
9-Jul-04	9 Livingston	3	3	17.6
9-Jul-04	13 Livingston	2	2	22.6
9-Jul-04	17 Livingston	3	1	23.2
9-Jul-04	19 Livingston	2	1	24.9
9-Jul-04	20 Livingston	1	1	21.6
9-Jul-04	23 Livingston	4	2	23.1
9-Jul-04	24 Livingston	1	2	20.9
9-Jul-04	25 Livingston	4	3	21.5
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9-Jul-04	33 Livingston	4	1	25.7
12-Jul-04	4 Livingston	3	2	22.4
12-Jul-04	8 Livingston	1	3	13.6
12-Jul-04	9 Livingston	3	3	11.3
12-Jul-04	13 Livingston	2	2	14.1
12-Jul-04	17 Livingston	3	1	17.3
12-Jul-04	19 Livingston	2	1	16.6
12-Jul-04	20 Livingston	1	1	13.8
12-Jul-04	23 Livingston	4	2	17.5
12-Jul-04	24 Livingston	1	2	13.3
12-Jul-04	25 Livingston	4	3	14.6
12-Jul-04	28 Livingston	2	3	14.2
12-Jul-04	33 Livingston	4	1	17.5
13-Jul-04	4 Livingston	3	2	18.5
13-Jul-04	8 Livingston	1	3	10.1
13-Jul-04	9 Livingston	3	3	10.3
13-Jul-04	13 Livingston	2	2	13.4
13-Jul-04	17 Livingston	3	1	15
13-Jul-04	19 Livingston	2	1	14.7
13-Jul-04	20 Livingston	1	1	11.2
13-Jul-04	23 Livingston	4	2	15.7
13-Jul-04	24 Livingston	1	2	10.9
13-Jul-04	25 Livingston	4	3	12.3
13-Jul-04	28 Livingston	2	3	12.2
13-Jul-04	33 Livingston	4	1	16.7
14-Jul-04	4 Livingston	3	2	15.5
14-Jul-04	8 Livingston	1	3	9
14-Jul-04	9 Livingston	3	3	9.8

14-Jul-04	13 Livingston	2	2	11.2	
14-Jul-04	17 Livingston	3	1	13.3	
14-Jul-04	19 Livingston	2	1	12.3	
14-Jul-04	20 Livingston	1	1	10.5	
14-Jul-04	23 Livingston	4	2	14.2	
14-Jul-04	24 Livingston	1	2	9.9	
14-Jul-04	25 Livingston	4	3	11.5	
14-Jul-04	28 Livingston	2	3	11.5	
14-Jul-04	33 Livingston	4	1	13.5	
15-Jul-04	4 Livingston	3	2	12.6	
15-Jul-04	8 Livingston	1	3	8.2	
15-Jul-04	9 Livingston	3	3	9.2	
15-Jul-04	13 Livingston	2	2	10	
15-Jul-04	17 Livingston	3	1	11.9	
15-Jul-04	19 Livingston	2	1	10.9	
15-Jul-04	20 Livingston	1	1	9.8	
15-Jul-04	23 Livingston	4	2	12.7	
15-Jul-04	24 Livingston	1	2	8.5	
15-Jul-04	25 Livingston	4	3	10.2	
15-Jul-04	28 Livingston	2	3	9.9	
15-Jul-04	33 Livingston	4	1	12.7	
6-Jul-04	1 Nuglade	2	1	34.2	50.2
6-Jul-04	3 Nuglade	1	2	37.5	46.9
6-Jul-04	6 Nuglade	3	3	37.3	51.1
6-Jul-04	7 Nuglade	4	3	36.8	49.2
6-Jul-04	11 Nuglade	2	3	32	50
6-Jul-04	14 Nuglade	3	2	33.7	49.5
6-Jul-04	15 Nuglade	4	2	30.9	51.3
6-Jul-04	16 Nuglade	4	1	31.2	51.4
6-Jul-04	18 Nuglade	1	1	34.2	46.2
6-Jul-04	26 Nuglade	1	3	31.2	48.2
6-Jul-04	31 Nuglade	2	2	34.1	50.1
6-Jul-04	34 Nuglade	3	1	34.4	50
7-Jul-04	1 Nuglade	2	1	30.4	47.6
7-Jul-04	3 Nuglade	1	2	33.3	45.7
7-Jul-04	6 Nuglade	3	3	34.5	48.9
7-Jul-04	7 Nuglade	4	3	31.4	48.6
7-Jul-04	11 Nuglade	2	3	24.8	48.8
7-Jul-04	14 Nuglade	3	2	28.3	47.7
7-Jul-04	15 Nuglade	4	2	28.7	48.7
7-Jul-04	16 Nuglade	4	1	26.9	50.9
7-Jul-04	18 Nuglade	1	1	29.1	45.1
7-Jul-04	26 Nuglade	1	3	28.1	45.7
7-Jul-04	31 Nuglade	2	2	28.1	47.9
7-Jul-04	34 Nuglade	3	1	31.2	49
8-Jul-04	1 Nuglade	2	1	27.1	46.7
8-Jul-04	3 Nuglade	1	2	30.1	46.3

8-Jul-04	6 Nuglade	3	3	29.8	46.4
8-Jul-04	7 Nuglade	4	3	29.2	47
8-Jul-04	11 Nuglade	2	3	22.9	48.1
8-Jul-04	14 Nuglade	3	2	25.8	46.8
8-Jul-04	15 Nuglade	4	2	26.5	47.3
8-Jul-04	16 Nuglade	4	1	25	48.6
8-Jul-04	18 Nuglade	1	1	26.1	43.3
8-Jul-04	26 Nuglade	1	3	24.4	43.8
8-Jul-04	31 Nuglade	2	2	26.5	46.5
8-Jul-04	34 Nuglade	3	1	28.8	48.4
9-Jul-04	1 Nuglade	2	1	25	45.2
9-Jul-04	3 Nuglade	1	2	22.6	43.8
9-Jul-04	6 Nuglade	3	3	24.1	44.3
9-Jul-04	7 Nuglade	4	3	22.6	44.6
9-Jul-04	11 Nuglade	2	3	12.3	47.7
9-Jul-04	14 Nuglade	3	2	22.7	45.9
9-Jul-04	15 Nuglade	4	2	23.6	45.4
9-Jul-04	16 Nuglade	4	1	15.6	47.8
9-Jul-04	18 Nuglade	1	1	19.8	42.2
9-Jul-04	26 Nuglade	1	3	16.8	40.2
9-Jul-04	31 Nuglade	2	2	26.1	40.5
9-Jul-04	34 Nuglade	3	1	22.1	44.1
12-Jul-04	1 Nuglade	2	1	19.7	38.7
12-Jul-04	3 Nuglade	1	2	15.4	37.6
12-Jul-04	6 Nuglade	3	3	16.5	38.1
12-Jul-04	7 Nuglade	4	3	21.9	36.3
12-Jul-04	11 Nuglade	2	3	10.8	39.4
12-Jul-04	14 Nuglade	3	2	15.8	40.8
12-Jul-04	15 Nuglade	4	2	16.8	37.6
12-Jul-04	16 Nuglade	4	1	14.2	39.6
12-Jul-04	18 Nuglade	1	1	15.9	35.7
12-Jul-04	26 Nuglade	1	3	11.2	37.8
12-Jul-04	31 Nuglade	2	2	20	34
12-Jul-04	34 Nuglade	3	1	16.6	38.2
13-Jul-04	1 Nuglade	2	1	17.9	36.7
13-Jul-04	3 Nuglade	1	2	14.9	35.3
13-Jul-04	6 Nuglade	3	3	14.3	34.5
13-Jul-04	7 Nuglade	4	3	18	34.4
13-Jul-04	11 Nuglade	2	3	10	37.2
13-Jul-04	14 Nuglade	3	2	13.8	39.2
13-Jul-04	15 Nuglade	4	2	15.5	36.5
13-Jul-04	16 Nuglade	4	1	13.3	37.7
13-Jul-04	18 Nuglade	1	1	11.1	34.1
13-Jul-04	26 Nuglade	1	3	10.5	36.5
13-Jul-04	31 Nuglade	2	2	16.9	33.3
13-Jul-04	34 Nuglade	3	1	15	39
14-Jul-04	1 Nuglade	2	1	15.8	34.6

14-Jul-04	3	Nuglade	1	2	9.2	33.4
14-Jul-04	6	Nuglade	3	3	13.7	34.7
14-Jul-04	7	Nuglade	4	3	14.2	32.8
14-Jul-04	11	Nuglade	2	3	8.9	36.1
14-Jul-04	14	Nuglade	3	2	13.5	37.1
14-Jul-04	15	Nuglade	4	2	14.7	35.3
14-Jul-04	16	Nuglade	4	1	13.5	34.7
14-Jul-04	18	Nuglade	1	1	9.5	32.9
14-Jul-04	26	Nuglade	1	3	10.2	34.4
14-Jul-04	31	Nuglade	2	2	16	31.2
14-Jul-04	34	Nuglade	3	1	14.5	36.7
15-Jul-04	1	Nuglade	2	1	15.4	29.6
15-Jul-04	3	Nuglade	1	2	8.6	31.4
15-Jul-04	6	Nuglade	3	3	13.1	31.3
15-Jul-04	7	Nuglade	4	3	14	31.8
15-Jul-04	11	Nuglade	2	3	8	30
15-Jul-04	14	Nuglade	3	2	12.9	34.1
15-Jul-04	15	Nuglade	4	2	12.8	33.4
15-Jul-04	16	Nuglade	4	1	12.7	31.1
15-Jul-04	18	Nuglade	1	1	7.9	30.7
15-Jul-04	26	Nuglade	1	3	8.5	27.5
15-Jul-04	31	Nuglade	2	2	15.5	30.3
15-Jul-04	34	Nuglade	3	1	13.4	30.8

Dry Down Canopy Temp's

Period	Date	Plot ID #	Grass	Treatment	Rep	Temp.C
1	June30	1	Nuglade	2	1	30.00
1	July1	1	Nuglade	2	1	34.44
1	July2	1	Nuglade	2	1	37.22
1	July3	1	Nuglade	2	1	36.11
1	July6	1	Nuglade	2	1	36.11
1	July7	1	Nuglade	2	1	33.89
1	July8	1	Nuglade	2	1	43.33
1	July9	1	Nuglade	2	1	33.89
1	June30	2	Kenblue	1	1	31.11
1	July1	2	Kenblue	1	1	34.44
1	July2	2	Kenblue	1	1	37.22
1	July3	2	Kenblue	1	1	38.89
1	July6	2	Kenblue	1	1	36.11
1	July7	2	Kenblue	1	1	36.11
1	July8	2	Kenblue	1	1	45.56
1	July9	2	Kenblue	1	1	35.56
1	June30	3	Nuglade	1	2	28.89
1	July1	3	Nuglade	1	2	33.89
1	July2	3	Nuglade	1	2	36.67
1	July3	3	Nuglade	1	2	38.33
1	July6	3	Nuglade	1	2	35.56

1July7	3Nuglade	1	2	36.11
1July8	3Nuglade	1	2	45.56
1July9	3Nuglade	1	2	35.00
1June30	4Livingston	3	2	28.89
1July1	4Livingston	3	2	33.89
1July2	4Livingston	3	2	36.67
1July3	4Livingston	3	2	37.78
1July6	4Livingston	3	2	35.56
1July7	4Livingston	3	2	35.56
1July8	4Livingston	3	2	43.33
1July9	4Livingston	3	2	32.78
1June30	5Kenblue	5	2	30.56
1July1	5Kenblue	5	2	35.56
1July2	5Kenblue	5	2	37.22
1July3	5Kenblue	5	2	38.89
1July6	5Kenblue	5	2	36.67
1July7	5Kenblue	5	2	36.67
1July8	5Kenblue	5	2	43.89
1July9	5Kenblue	5	2	35.56
1June30	6Nuglade	3	3	30.00
1July1	6Nuglade	3	3	33.89
1July2	6Nuglade	3	3	35.56
1July3	6Nuglade	3	3	37.22
1July6	6Nuglade	3	3	36.67
1July7	6Nuglade	3	3	34.44
1July8	6Nuglade	3	3	44.44
1July9	6Nuglade	3	3	33.33
1June30	7Nuglade	4	3	30.00
1July1	7Nuglade	4	3	33.89
1July2	7Nuglade	4	3	35.00
1July3	7Nuglade	4	3	37.78
1July6	7Nuglade	4	3	37.78
1July7	7Nuglade	4	3	34.44
1July8	7Nuglade	4	3	43.33
1July9	7Nuglade	4	3	33.89
1June30	8Livingston	1	3	31.11
1July1	8Livingston	1	3	35.56
1July2	8Livingston	1	3	36.67
1July3	8Livingston	1	3	38.33
1July6	8Livingston	1	3	35.56
1July7	8Livingston	1	3	36.67
1July8	8Livingston	1	3	46.11
1July9	8Livingston	1	3	35.00
1June30	9Livingston	3	3	29.44
1July1	9Livingston	3	3	34.44
1July2	9Livingston	3	3	37.22
1July3	9Livingston	3	3	38.33
1July6	9Livingston	3	3	34.44
1July7	9Livingston	3	3	35.00
1July8	9Livingston	3	3	43.89

1 July9	9 Livingston	3	3	33.33
1 June30	10 Kenblue	5	3	30.56
1 July1	10 Kenblue	5	3	34.44
1 July2	10 Kenblue	5	3	36.11
1 July3	10 Kenblue	5	3	37.78
1 July6	10 Kenblue	5	3	35.56
1 July7	10 Kenblue	5	3	35.56
1 July8	10 Kenblue	5	3	45.00
1 July9	10 Kenblue	5	3	35.56
1 June30	11 Nuglade	2	3	29.44
1 July1	11 Nuglade	2	3	36.11
1 July2	11 Nuglade	2	3	36.67
1 July3	11 Nuglade	2	3	37.22
1 July6	11 Nuglade	2	3	37.22
1 July7	11 Nuglade	2	3	35.56
1 July8	11 Nuglade	2	3	44.44
1 July9	11 Nuglade	2	3	34.44
1 June30	12 Kenblue	4	3	27.78
1 July1	12 Kenblue	4	3	35.00
1 July2	12 Kenblue	4	3	36.67
1 July3	12 Kenblue	4	3	36.67
1 July6	12 Kenblue	4	3	36.11
1 July7	12 Kenblue	4	3	35.00
1 July8	12 Kenblue	4	3	43.89
1 July9	12 Kenblue	4	3	33.33
1 June30	13 Livingston	2	2	28.33
1 July1	13 Livingston	2	2	35.56
1 July2	13 Livingston	2	2	36.67
1 July3	13 Livingston	2	2	38.89
1 July6	13 Livingston	2	2	36.67
1 July7	13 Livingston	2	2	35.56
1 July8	13 Livingston	2	2	44.44
1 July9	13 Livingston	2	2	35.00
1 June30	14 Nuglade	3	2	29.44
1 July1	14 Nuglade	3	2	35.56
1 July2	14 Nuglade	3	2	37.22
1 July3	14 Nuglade	3	2	37.78
1 July6	14 Nuglade	3	2	37.22
1 July7	14 Nuglade	3	2	33.89
1 July8	14 Nuglade	3	2	43.89
1 July9	14 Nuglade	3	2	33.89
1 June30	15 Nuglade	4	2	29.44
1 July1	15 Nuglade	4	2	33.89
1 July2	15 Nuglade	4	2	36.67
1 July3	15 Nuglade	4	2	37.78
1 July6	15 Nuglade	4	2	37.22
1 July7	15 Nuglade	4	2	35.00
1 July8	15 Nuglade	4	2	43.33
1 July9	15 Nuglade	4	2	33.89
1 June30	16 Nuglade	4	1	30.56

1 July1	16 Nuglade	4	1	36.11
1 July2	16 Nuglade	4	1	36.67
1 July3	16 Nuglade	4	1	37.22
1 July6	16 Nuglade	4	1	36.67
1 July7	16 Nuglade	4	1	34.44
1 July8	16 Nuglade	4	1	43.89
1 July9	16 Nuglade	4	1	33.33
1 June30	17 Livingston	3	1	29.44
1 July1	17 Livingston	3	1	35.56
1 July2	17 Livingston	3	1	37.22
1 July3	17 Livingston	3	1	37.22
1 July6	17 Livingston	3	1	35.00
1 July7	17 Livingston	3	1	33.89
1 July8	17 Livingston	3	1	43.89
1 July9	17 Livingston	3	1	33.89
1 June30	18 Nuglade	1	1	32.78
1 July1	18 Nuglade	1	1	35.56
1 July2	18 Nuglade	1	1	38.33
1 July3	18 Nuglade	1	1	37.78
1 July6	18 Nuglade	1	1	39.44
1 July7	18 Nuglade	1	1	34.44
1 July8	18 Nuglade	1	1	44.44
1 July9	18 Nuglade	1	1	34.44
1 June30	19 Livingston	2	1	31.67
1 July1	19 Livingston	2	1	34.44
1 July2	19 Livingston	2	1	36.67
1 July3	19 Livingston	2	1	38.89
1 July6	19 Livingston	2	1	35.56
1 July7	19 Livingston	2	1	36.11
1 July8	19 Livingston	2	1	45.00
1 July9	19 Livingston	2	1	33.33
1 June30	20 Livingston	1	1	29.44
1 July1	20 Livingston	1	1	35.56
1 July2	20 Livingston	1	1	37.22
1 July3	20 Livingston	1	1	39.44
1 July6	20 Livingston	1	1	36.11
1 July7	20 Livingston	1	1	35.56
1 July8	20 Livingston	1	1	45.00
1 July9	20 Livingston	1	1	35.56
1 June30	21 Kenblue	4	1	30.00
1 July1	21 Kenblue	4	1	34.44
1 July2	21 Kenblue	4	1	35.56
1 July3	21 Kenblue	4	1	36.11
1 July6	21 Kenblue	4	1	35.56
1 July7	21 Kenblue	4	1	35.56
1 July8	21 Kenblue	4	1	43.33
1 July9	21 Kenblue	4	1	32.78
1 June30	22 Kenblue	3	2	30.00
1 July1	22 Kenblue	3	2	34.44
1 July2	22 Kenblue	3	2	35.56

1 July3	22 Kenblue	3	2	36.67
1 July6	22 Kenblue	3	2	35.00
1 July7	22 Kenblue	3	2	34.44
1 July8	22 Kenblue	3	2	43.89
1 July9	22 Kenblue	3	2	32.78
1 June30	23 Livingston	4	2	30.00
1 July1	23 Livingston	4	2	35.56
1 July2	23 Livingston	4	2	36.67
1 July3	23 Livingston	4	2	37.22
1 July6	23 Livingston	4	2	35.56
1 July7	23 Livingston	4	2	35.56
1 July8	23 Livingston	4	2	44.44
1 July9	23 Livingston	4	2	33.33
1 June30	24 Livingston	1	2	30.00
1 July1	24 Livingston	1	2	35.00
1 July2	24 Livingston	1	2	38.33
1 July3	24 Livingston	1	2	38.89
1 July6	24 Livingston	1	2	35.56
1 July7	24 Livingston	1	2	35.56
1 July8	24 Livingston	1	2	44.44
1 July9	24 Livingston	1	2	35.00
1 June30	25 Livingston	4	3	30.56
1 July1	25 Livingston	4	3	35.56
1 July2	25 Livingston	4	3	36.67
1 July3	25 Livingston	4	3	38.89
1 July6	25 Livingston	4	3	34.44
1 July7	25 Livingston	4	3	35.00
1 July8	25 Livingston	4	3	43.33
1 July9	25 Livingston	4	3	33.89
1 June30	26 Nuglade	1	3	32.22
1 July1	26 Nuglade	1	3	36.67
1 July2	26 Nuglade	1	3	38.89
1 July3	26 Nuglade	1	3	37.22
1 July6	26 Nuglade	1	3	38.89
1 July7	26 Nuglade	1	3	35.56
1 July8	26 Nuglade	1	3	45.00
1 July9	26 Nuglade	1	3	35.56
1 June30	27 Kenblue	1	3	30.00
1 July1	27 Kenblue	1	3	37.22
1 July2	27 Kenblue	1	3	37.22
1 July3	27 Kenblue	1	3	38.33
1 July6	27 Kenblue	1	3	35.00
1 July7	27 Kenblue	1	3	35.00
1 July8	27 Kenblue	1	3	44.44
1 July9	27 Kenblue	1	3	35.00
1 June30	28 Livingston	2	3	30.56
1 July1	28 Livingston	2	3	35.56
1 July2	28 Livingston	2	3	37.78
1 July3	28 Livingston	2	3	37.78
1 July6	28 Livingston	2	3	34.44

1	July7	28	Livingston	2	3	35.00
1	July8	28	Livingston	2	3	45.00
1	July9	28	Livingston	2	3	33.89
1	June30	29	Kenblue	3	3	30.00
1	July1	29	Kenblue	3	3	34.44
1	July2	29	Kenblue	3	3	36.11
1	July3	29	Kenblue	3	3	37.22
1	July6	29	Kenblue	3	3	35.56
1	July7	29	Kenblue	3	3	35.56
1	July8	29	Kenblue	3	3	43.33
1	July9	29	Kenblue	3	3	32.78
1	June30	30	Kenblue	4	2	30.56
1	July1	30	Kenblue	4	2	33.89
1	July2	30	Kenblue	4	2	37.22
1	July3	30	Kenblue	4	2	37.22
1	July6	30	Kenblue	4	2	34.44
1	July7	30	Kenblue	4	2	35.56
1	July8	30	Kenblue	4	2	42.78
1	July9	30	Kenblue	4	2	32.78
1	June30	31	Nuglade	2	2	31.11
1	July1	31	Nuglade	2	2	35.56
1	July2	31	Nuglade	2	2	37.78
1	July3	31	Nuglade	2	2	38.33
1	July6	31	Nuglade	2	2	37.78
1	July7	31	Nuglade	2	2	34.44
1	July8	31	Nuglade	2	2	45.00
1	July9	31	Nuglade	2	2	34.44
1	June30	32	Kenblue	1	2	29.44
1	July1	32	Kenblue	1	2	34.44
1	July2	32	Kenblue	1	2	36.11
1	July3	32	Kenblue	1	2	36.67
1	July6	32	Kenblue	1	2	35.56
1	July7	32	Kenblue	1	2	36.11
1	July8	32	Kenblue	1	2	44.44
1	July9	32	Kenblue	1	2	35.00
1	June30	33	Livingston	4	1	29.44
1	July1	33	Livingston	4	1	34.44
1	July2	33	Livingston	4	1	37.22
1	July3	33	Livingston	4	1	38.33
1	July6	33	Livingston	4	1	36.11
1	July7	33	Livingston	4	1	34.44
1	July8	33	Livingston	4	1	43.89
1	July9	33	Livingston	4	1	32.78
1	June30	34	Nuglade	3	1	29.44
1	July1	34	Nuglade	3	1	35.00
1	July2	34	Nuglade	3	1	36.67
1	July3	34	Nuglade	3	1	37.22
1	July6	34	Nuglade	3	1	36.67
1	July7	34	Nuglade	3	1	34.44
1	July8	34	Nuglade	3	1	43.33

1 July9	34 Nuglade	3	1	34.44
1 June30	35 Kenblue	3	1	29.44
1 July1	35 Kenblue	3	1	35.00
1 July2	35 Kenblue	3	1	37.22
1 July3	35 Kenblue	3	1	37.22
1 July6	35 Kenblue	3	1	33.89
1 July7	35 Kenblue	3	1	35.56
1 July8	35 Kenblue	3	1	43.89
1 July9	35 Kenblue	3	1	34.44
1 June30	36 Kenblue	5	1	30.00
1 July1	36 Kenblue	5	1	36.67
1 July2	36 Kenblue	5	1	38.33
1 July3	36 Kenblue	5	1	37.78
1 July6	36 Kenblue	5	1	36.67
1 July7	36 Kenblue	5	1	36.11
1 July8	36 Kenblue	5	1	45.56
1 July9	36 Kenblue	5	1	35.00
2 July22	1 Nuglade	2	1	24.44
2 July23	1 Nuglade	2	1	33.33
2 July24	1 Nuglade	2	1	37.78
2 July25	1 Nuglade	2	1	35.56
2 July28	1 Nuglade	2	1	33.33
2 July29	1 Nuglade	2	1	32.78
2 July30	1 Nuglade	2	1	34.44
2 July31	1 Nuglade	2	1	37.22
2 July22	2 Kenblue	1	1	27.22
2 July23	2 Kenblue	1	1	35.00
2 July24	2 Kenblue	1	1	39.44
2 July25	2 Kenblue	1	1	36.67
2 July28	2 Kenblue	1	1	33.89
2 July29	2 Kenblue	1	1	35.00
2 July30	2 Kenblue	1	1	36.11
2 July31	2 Kenblue	1	1	38.33
2 July22	3 Nuglade	1	2	26.67
2 July23	3 Nuglade	1	2	32.78
2 July24	3 Nuglade	1	2	37.78
2 July25	3 Nuglade	1	2	36.11
2 July28	3 Nuglade	1	2	33.33
2 July29	3 Nuglade	1	2	33.89
2 July30	3 Nuglade	1	2	35.56
2 July31	3 Nuglade	1	2	38.33
2 July22	4 Livingston	3	2	25.56
2 July23	4 Livingston	3	2	33.33
2 July24	4 Livingston	3	2	37.78
2 July25	4 Livingston	3	2	34.44
2 July28	4 Livingston	3	2	29.44
2 July29	4 Livingston	3	2	32.78
2 July30	4 Livingston	3	2	33.33
2 July31	4 Livingston	3	2	35.56
2 July22	5 Kenblue	5	2	26.67

2July23	5Kenblue	5	2	34.44
2July24	5Kenblue	5	2	39.44
2July25	5Kenblue	5	2	37.22
2July28	5Kenblue	5	2	34.44
2July29	5Kenblue	5	2	33.89
2July30	5Kenblue	5	2	36.11
2July31	5Kenblue	5	2	38.89
2July22	6Nuglade	3	3	24.44
2July23	6Nuglade	3	3	32.78
2July24	6Nuglade	3	3	38.33
2July25	6Nuglade	3	3	35.56
2July28	6Nuglade	3	3	33.33
2July29	6Nuglade	3	3	31.67
2July30	6Nuglade	3	3	33.33
2July31	6Nuglade	3	3	36.11
2July22	7Nuglade	4	3	24.44
2July23	7Nuglade	4	3	32.78
2July24	7Nuglade	4	3	38.33
2July25	7Nuglade	4	3	35.56
2July28	7Nuglade	4	3	32.22
2July29	7Nuglade	4	3	32.22
2July30	7Nuglade	4	3	33.33
2July31	7Nuglade	4	3	36.67
2July22	8Livingston	1	3	26.67
2July23	8Livingston	1	3	33.89
2July24	8Livingston	1	3	38.33
2July25	8Livingston	1	3	35.00
2July28	8Livingston	1	3	32.78
2July29	8Livingston	1	3	34.44
2July30	8Livingston	1	3	35.56
2July31	8Livingston	1	3	37.22
2July22	9Livingston	3	3	26.11
2July23	9Livingston	3	3	33.89
2July24	9Livingston	3	3	38.89
2July25	9Livingston	3	3	35.56
2July28	9Livingston	3	3	34.44
2July29	9Livingston	3	3	33.33
2July30	9Livingston	3	3	34.44
2July31	9Livingston	3	3	36.67
2July22	10Kenblue	5	3	26.11
2July23	10Kenblue	5	3	35.56
2July24	10Kenblue	5	3	39.44
2July25	10Kenblue	5	3	36.11
2July28	10Kenblue	5	3	33.33
2July29	10Kenblue	5	3	34.44
2July30	10Kenblue	5	3	35.00
2July31	10Kenblue	5	3	37.78
2July22	11Nuglade	2	3	26.67
2July23	11Nuglade	2	3	32.78
2July24	11Nuglade	2	3	38.33

2July25	11Nuglade	2	3	36.11
2July28	11Nuglade	2	3	32.78
2July29	11Nuglade	2	3	32.78
2July30	11Nuglade	2	3	35.00
2July31	11Nuglade	2	3	37.78
2July22	12Kenblue	4	3	25.00
2July23	12Kenblue	4	3	33.89
2July24	12Kenblue	4	3	38.89
2July25	12Kenblue	4	3	36.11
2July28	12Kenblue	4	3	31.67
2July29	12Kenblue	4	3	32.22
2July30	12Kenblue	4	3	33.89
2July31	12Kenblue	4	3	36.11
2July22	13Livingston	2	2	24.44
2July23	13Livingston	2	2	33.33
2July24	13Livingston	2	2	37.78
2July25	13Livingston	2	2	34.44
2July28	13Livingston	2	2	32.22
2July29	13Livingston	2	2	33.89
2July30	13Livingston	2	2	35.00
2July31	13Livingston	2	2	36.67
2July22	14Nuglade	3	2	25.56
2July23	14Nuglade	3	2	32.78
2July24	14Nuglade	3	2	36.67
2July25	14Nuglade	3	2	34.44
2July28	14Nuglade	3	2	32.22
2July29	14Nuglade	3	2	32.78
2July30	14Nuglade	3	2	33.89
2July31	14Nuglade	3	2	35.56
2July22	15Nuglade	4	2	25.00
2July23	15Nuglade	4	2	32.22
2July24	15Nuglade	4	2	38.33
2July25	15Nuglade	4	2	35.56
2July28	15Nuglade	4	2	31.11
2July29	15Nuglade	4	2	31.67
2July30	15Nuglade	4	2	33.33
2July31	15Nuglade	4	2	36.11
2July22	16Nuglade	4	1	25.56
2July23	16Nuglade	4	1	33.33
2July24	16Nuglade	4	1	37.78
2July25	16Nuglade	4	1	35.00
2July28	16Nuglade	4	1	32.78
2July29	16Nuglade	4	1	32.78
2July30	16Nuglade	4	1	33.33
2July31	16Nuglade	4	1	35.56
2July22	17Livingston	3	1	26.67
2July23	17Livingston	3	1	32.78
2July24	17Livingston	3	1	37.22
2July25	17Livingston	3	1	35.56
2July28	17Livingston	3	1	34.44

2July29	17Livingston	3	1	33.89
2July30	17Livingston	3	1	35.00
2July31	17Livingston	3	1	36.67
2July22	18Nuglade	1	1	26.11
2July23	18Nuglade	1	1	33.33
2July24	18Nuglade	1	1	37.22
2July25	18Nuglade	1	1	36.11
2July28	18Nuglade	1	1	32.78
2July29	18Nuglade	1	1	33.33
2July30	18Nuglade	1	1	34.44
2July31	18Nuglade	1	1	37.22
2July22	19Livingston	2	1	25.00
2July23	19Livingston	2	1	32.78
2July24	19Livingston	2	1	36.11
2July25	19Livingston	2	1	35.56
2July28	19Livingston	2	1	32.78
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2July30	19Livingston	2	1	33.89
2July31	19Livingston	2	1	37.22
2July22	20Livingston	1	1	26.11
2July23	20Livingston	1	1	34.44
2July24	20Livingston	1	1	37.22
2July25	20Livingston	1	1	36.11
2July28	20Livingston	1	1	32.78
2July29	20Livingston	1	1	33.89
2July30	20Livingston	1	1	35.56
2July31	20Livingston	1	1	37.78
2July22	21Kenblue	4	1	26.67
2July23	21Kenblue	4	1	33.33
2July24	21Kenblue	4	1	37.78
2July25	21Kenblue	4	1	35.56
2July28	21Kenblue	4	1	33.89
2July29	21Kenblue	4	1	32.22
2July30	21Kenblue	4	1	34.44
2July31	21Kenblue	4	1	36.67
2July22	22Kenblue	3	2	26.67
2July23	22Kenblue	3	2	32.78
2July24	22Kenblue	3	2	38.33
2July25	22Kenblue	3	2	35.56
2July28	22Kenblue	3	2	32.22
2July29	22Kenblue	3	2	32.22
2July30	22Kenblue	3	2	35.00
2July31	22Kenblue	3	2	36.67
2July22	23Livingston	4	2	26.67
2July23	23Livingston	4	2	33.33
2July24	23Livingston	4	2	36.67
2July25	23Livingston	4	2	36.11
2July28	23Livingston	4	2	33.33
2July29	23Livingston	4	2	33.33
2July30	23Livingston	4	2	35.56

2July31	23Livingston	4	2	36.11
2July22	24Livingston	1	2	26.11
2July23	24Livingston	1	2	35.56
2July24	24Livingston	1	2	37.78
2July25	24Livingston	1	2	36.11
2July28	24Livingston	1	2	33.33
2July29	24Livingston	1	2	33.89
2July30	24Livingston	1	2	35.00
2July31	24Livingston	1	2	37.78
2July22	25Livingston	4	3	25.00
2July23	25Livingston	4	3	32.78
2July24	25Livingston	4	3	37.22
2July25	25Livingston	4	3	35.00
2July28	25Livingston	4	3	32.78
2July29	25Livingston	4	3	33.33
2July30	25Livingston	4	3	35.00
2July31	25Livingston	4	3	37.22
2July22	26Nuglade	1	3	26.67
2July23	26Nuglade	1	3	33.33
2July24	26Nuglade	1	3	38.33
2July25	26Nuglade	1	3	35.00
2July28	26Nuglade	1	3	32.78
2July29	26Nuglade	1	3	33.33
2July30	26Nuglade	1	3	35.00
2July31	26Nuglade	1	3	37.78
2July22	27Kenblue	1	3	26.67
2July23	27Kenblue	1	3	35.00
2July24	27Kenblue	1	3	38.89
2July25	27Kenblue	1	3	36.11
2July28	27Kenblue	1	3	33.89
2July29	27Kenblue	1	3	33.89
2July30	27Kenblue	1	3	36.11
2July31	27Kenblue	1	3	38.33
2July22	28Livingston	2	3	25.56
2July23	28Livingston	2	3	34.44
2July24	28Livingston	2	3	39.44
2July25	28Livingston	2	3	36.11
2July28	28Livingston	2	3	33.89
2July29	28Livingston	2	3	33.33
2July30	28Livingston	2	3	35.56
2July31	28Livingston	2	3	37.22
2July22	29Kenblue	3	3	26.11
2July23	29Kenblue	3	3	32.78
2July24	29Kenblue	3	3	38.89
2July25	29Kenblue	3	3	36.11
2July28	29Kenblue	3	3	32.78
2July29	29Kenblue	3	3	33.33
2July30	29Kenblue	3	3	33.33
2July31	29Kenblue	3	3	36.11
2July22	30Kenblue	4	2	26.11

2July23	30Kenblue	4	2	32.78
2July24	30Kenblue	4	2	38.89
2July25	30Kenblue	4	2	36.11
2July28	30Kenblue	4	2	32.78
2July29	30Kenblue	4	2	32.78
2July30	30Kenblue	4	2	35.00
2July31	30Kenblue	4	2	35.56
2July22	31Nuglade	2	2	25.00
2July23	31Nuglade	2	2	33.33
2July24	31Nuglade	2	2	37.22
2July25	31Nuglade	2	2	35.00
2July28	31Nuglade	2	2	32.22
2July29	31Nuglade	2	2	33.33
2July30	31Nuglade	2	2	34.44
2July31	31Nuglade	2	2	37.22
2July22	32Kenblue	1	2	27.22
2July23	32Kenblue	1	2	33.89
2July24	32Kenblue	1	2	38.89
2July25	32Kenblue	1	2	35.56
2July28	32Kenblue	1	2	33.33
2July29	32Kenblue	1	2	34.44
2July30	32Kenblue	1	2	35.00
2July31	32Kenblue	1	2	37.22
2July22	33Livingston	4	1	24.44
2July23	33Livingston	4	1	33.89
2July24	33Livingston	4	1	38.33
2July25	33Livingston	4	1	35.56
2July28	33Livingston	4	1	28.89
2July29	33Livingston	4	1	32.78
2July30	33Livingston	4	1	33.89
2July31	33Livingston	4	1	35.56
2July22	34Nuglade	3	1	25.56
2July23	34Nuglade	3	1	33.33
2July24	34Nuglade	3	1	37.22
2July25	34Nuglade	3	1	35.00
2July28	34Nuglade	3	1	32.22
2July29	34Nuglade	3	1	32.78
2July30	34Nuglade	3	1	33.33
2July31	34Nuglade	3	1	35.56
2July22	35Kenblue	3	1	25.56
2July23	35Kenblue	3	1	34.44
2July24	35Kenblue	3	1	38.33
2July25	35Kenblue	3	1	35.00
2July28	35Kenblue	3	1	33.89
2July29	35Kenblue	3	1	32.78
2July30	35Kenblue	3	1	34.44
2July31	35Kenblue	3	1	36.67
2July22	36Kenblue	5	1	27.78
2July23	36Kenblue	5	1	33.89
2July24	36Kenblue	5	1	38.89

2July25	36Kenblue	5	1	36.11
2July28	36Kenblue	5	1	33.89
2July29	36Kenblue	5	1	35.00
2July30	36Kenblue	5	1	36.11
2July31	36Kenblue	5	1	38.33
3July6	1Nuglade	2	1	25.56
3July7	1Nuglade	2	1	37.22
3July8	1Nuglade	2	1	37.22
3July9	1Nuglade	2	1	36.67
3July12	1Nuglade	2	1	40.56
3July13	1Nuglade	2	1	42.22
3July14	1Nuglade	2	1	34.44
3July15	1Nuglade	2	1	38.33
3July6	2Kenblue	1	1	28.33
3July7	2Kenblue	1	1	36.11
3July8	2Kenblue	1	1	37.22
3July9	2Kenblue	1	1	39.44
3July12	2Kenblue	1	1	42.78
3July13	2Kenblue	1	1	45.00
3July14	2Kenblue	1	1	39.44
3July15	2Kenblue	1	1	41.67
3July6	3Nuglade	1	2	25.56
3July7	3Nuglade	1	2	35.56
3July8	3Nuglade	1	2	37.22
3July9	3Nuglade	1	2	38.89
3July12	3Nuglade	1	2	42.22
3July13	3Nuglade	1	2	43.33
3July14	3Nuglade	1	2	35.00
3July15	3Nuglade	1	2	38.89
3July6	4Livingston	3	2	25.56
3July7	4Livingston	3	2	35.00
3July8	4Livingston	3	2	36.11
3July9	4Livingston	3	2	37.78
3July12	4Livingston	3	2	42.22
3July13	4Livingston	3	2	42.22
3July14	4Livingston	3	2	34.44
3July15	4Livingston	3	2	37.78
3July6	5Kenblue	5	2	27.22
3July7	5Kenblue	5	2	37.22
3July8	5Kenblue	5	2	37.78
3July9	5Kenblue	5	2	40.00
3July12	5Kenblue	5	2	43.33
3July13	5Kenblue	5	2	46.11
3July14	5Kenblue	5	2	38.89
3July15	5Kenblue	5	2	44.44
3July6	6Nuglade	3	3	24.44
3July7	6Nuglade	3	3	34.44
3July8	6Nuglade	3	3	36.11
3July9	6Nuglade	3	3	36.11
3July12	6Nuglade	3	3	41.11

3July13	6Nuglade	3	3	41.67
3July14	6Nuglade	3	3	33.33
3July15	6Nuglade	3	3	37.22
3July6	7Nuglade	4	3	25.00
3July7	7Nuglade	4	3	35.56
3July8	7Nuglade	4	3	36.11
3July9	7Nuglade	4	3	35.00
3July12	7Nuglade	4	3	40.56
3July13	7Nuglade	4	3	41.11
3July14	7Nuglade	4	3	33.89
3July15	7Nuglade	4	3	38.33
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3July7	8Livingston	1	3	36.11
3July8	8Livingston	1	3	37.22
3July9	8Livingston	1	3	38.33
3July12	8Livingston	1	3	41.67
3July13	8Livingston	1	3	43.33
3July14	8Livingston	1	3	35.56
3July15	8Livingston	1	3	38.89
3July6	9Livingston	3	3	26.11
3July7	9Livingston	3	3	36.11
3July8	9Livingston	3	3	36.67
3July9	9Livingston	3	3	38.89
3July12	9Livingston	3	3	41.11
3July13	9Livingston	3	3	41.11
3July14	9Livingston	3	3	34.44
3July15	9Livingston	3	3	37.78
3July6	10Kenblue	5	3	28.89
3July7	10Kenblue	5	3	36.11
3July8	10Kenblue	5	3	37.78
3July9	10Kenblue	5	3	39.44
3July12	10Kenblue	5	3	41.67
3July13	10Kenblue	5	3	47.22
3July14	10Kenblue	5	3	40.56
3July15	10Kenblue	5	3	42.78
3July6	11Nuglade	2	3	26.11
3July7	11Nuglade	2	3	35.56
3July8	11Nuglade	2	3	38.33
3July9	11Nuglade	2	3	39.44
3July12	11Nuglade	2	3	42.22
3July13	11Nuglade	2	3	41.67
3July14	11Nuglade	2	3	35.00
3July15	11Nuglade	2	3	37.78
3July6	12Kenblue	4	3	26.11
3July7	12Kenblue	4	3	35.00
3July8	12Kenblue	4	3	35.56
3July9	12Kenblue	4	3	37.22
3July12	12Kenblue	4	3	40.56
3July13	12Kenblue	4	3	43.33
3July14	12Kenblue	4	3	37.22

3July15	12Kenblue	4	3	37.78
3July6	13Livingston	2	2	26.11
3July7	13Livingston	2	2	35.56
3July8	13Livingston	2	2	36.11
3July9	13Livingston	2	2	36.11
3July12	13Livingston	2	2	41.11
3July13	13Livingston	2	2	42.78
3July14	13Livingston	2	2	33.33
3July15	13Livingston	2	2	38.33
3July6	14Nuglade	3	2	25.00
3July7	14Nuglade	3	2	35.00
3July8	14Nuglade	3	2	37.22
3July9	14Nuglade	3	2	36.67
3July12	14Nuglade	3	2	41.67
3July13	14Nuglade	3	2	41.11
3July14	14Nuglade	3	2	34.44
3July15	14Nuglade	3	2	37.22
3July6	15Nuglade	4	2	26.11
3July7	15Nuglade	4	2	35.00
3July8	15Nuglade	4	2	37.22
3July9	15Nuglade	4	2	38.33
3July12	15Nuglade	4	2	41.11
3July13	15Nuglade	4	2	41.11
3July14	15Nuglade	4	2	33.33
3July15	15Nuglade	4	2	37.22
3July6	16Nuglade	4	1	23.89
3July7	16Nuglade	4	1	34.44
3July8	16Nuglade	4	1	36.67
3July9	16Nuglade	4	1	37.78
3July12	16Nuglade	4	1	41.11
3July13	16Nuglade	4	1	42.78
3July14	16Nuglade	4	1	34.44
3July15	16Nuglade	4	1	37.78
3July6	17Livingston	3	1	26.11
3July7	17Livingston	3	1	35.56
3July8	17Livingston	3	1	37.78
3July9	17Livingston	3	1	38.33
3July12	17Livingston	3	1	41.11
3July13	17Livingston	3	1	42.78
3July14	17Livingston	3	1	33.33
3July15	17Livingston	3	1	38.33
3July6	18Nuglade	1	1	25.56
3July7	18Nuglade	1	1	35.00
3July8	18Nuglade	1	1	37.22
3July9	18Nuglade	1	1	38.33
3July12	18Nuglade	1	1	41.11
3July13	18Nuglade	1	1	42.78
3July14	18Nuglade	1	1	35.56
3July15	18Nuglade	1	1	39.44
3July6	19Livingston	2	1	26.11

3July7	19Livingston	2	1	35.00
3July8	19Livingston	2	1	36.11
3July9	19Livingston	2	1	38.33
3July12	19Livingston	2	1	40.56
3July13	19Livingston	2	1	41.11
3July14	19Livingston	2	1	35.00
3July15	19Livingston	2	1	37.78
3July6	20Livingston	1	1	25.56
3July7	20Livingston	1	1	35.56
3July8	20Livingston	1	1	37.78
3July9	20Livingston	1	1	39.44
3July12	20Livingston	1	1	41.11
3July13	20Livingston	1	1	42.78
3July14	20Livingston	1	1	34.44
3July15	20Livingston	1	1	39.44
3July6	21Kenblue	4	1	26.67
3July7	21Kenblue	4	1	35.56
3July8	21Kenblue	4	1	36.11
3July9	21Kenblue	4	1	38.33
3July12	21Kenblue	4	1	40.56
3July13	21Kenblue	4	1	43.89
3July14	21Kenblue	4	1	36.11
3July15	21Kenblue	4	1	41.67
3July6	22Kenblue	3	2	26.67
3July7	22Kenblue	3	2	36.11
3July8	22Kenblue	3	2	37.22
3July9	22Kenblue	3	2	37.78
3July12	22Kenblue	3	2	41.67
3July13	22Kenblue	3	2	43.89
3July14	22Kenblue	3	2	37.78
3July15	22Kenblue	3	2	38.89
3July6	23Livingston	4	2	25.56
3July7	23Livingston	4	2	35.00
3July8	23Livingston	4	2	35.56
3July9	23Livingston	4	2	37.78
3July12	23Livingston	4	2	40.00
3July13	23Livingston	4	2	42.78
3July14	23Livingston	4	2	32.78
3July15	23Livingston	4	2	37.22
3July6	24Livingston	1	2	26.11
3July7	24Livingston	1	2	35.56
3July8	24Livingston	1	2	37.22
3July9	24Livingston	1	2	37.22
3July12	24Livingston	1	2	42.78
3July13	24Livingston	1	2	43.33
3July14	24Livingston	1	2	36.11
3July15	24Livingston	1	2	38.89
3July6	25Livingston	4	3	25.00
3July7	25Livingston	4	3	34.44
3July8	25Livingston	4	3	36.67

3July9	25Livingston	4	3	38.89
3July12	25Livingston	4	3	41.11
3July13	25Livingston	4	3	40.56
3July14	25Livingston	4	3	34.44
3July15	25Livingston	4	3	37.78
3July6	26Nuglade	1	3	26.11
3July7	26Nuglade	1	3	36.11
3July8	26Nuglade	1	3	37.78
3July9	26Nuglade	1	3	37.78
3July12	26Nuglade	1	3	42.22
3July13	26Nuglade	1	3	42.78
3July14	26Nuglade	1	3	35.56
3July15	26Nuglade	1	3	39.44
3July6	27Kenblue	1	3	27.22
3July7	27Kenblue	1	3	36.11
3July8	27Kenblue	1	3	37.22
3July9	27Kenblue	1	3	38.89
3July12	27Kenblue	1	3	43.33
3July13	27Kenblue	1	3	47.22
3July14	27Kenblue	1	3	40.56
3July15	27Kenblue	1	3	42.22
3July6	28Livingston	2	3	26.67
3July7	28Livingston	2	3	35.00
3July8	28Livingston	2	3	37.22
3July9	28Livingston	2	3	36.67
3July12	28Livingston	2	3	42.78
3July13	28Livingston	2	3	41.67
3July14	28Livingston	2	3	34.44
3July15	28Livingston	2	3	38.89
3July6	29Kenblue	3	3	27.78
3July7	29Kenblue	3	3	36.67
3July8	29Kenblue	3	3	37.22
3July9	29Kenblue	3	3	36.67
3July12	29Kenblue	3	3	41.11
3July13	29Kenblue	3	3	43.89
3July14	29Kenblue	3	3	36.11
3July15	29Kenblue	3	3	39.44
3July6	30Kenblue	4	2	27.22
3July7	30Kenblue	4	2	36.11
3July8	30Kenblue	4	2	37.78
3July9	30Kenblue	4	2	38.33
3July12	30Kenblue	4	2	41.11
3July13	30Kenblue	4	2	43.33
3July14	30Kenblue	4	2	37.22
3July15	30Kenblue	4	2	38.33
3July6	31Nuglade	2	2	25.00
3July7	31Nuglade	2	2	35.00
3July8	31Nuglade	2	2	37.22
3July9	31Nuglade	2	2	37.78
3July12	31Nuglade	2	2	41.11

3July13	31Nuglade	2	2	41.67
3July14	31Nuglade	2	2	35.56
3July15	31Nuglade	2	2	38.89
3July6	32Kenblue	1	2	27.78
3July7	32Kenblue	1	2	36.67
3July8	32Kenblue	1	2	37.78
3July9	32Kenblue	1	2	40.56
3July12	32Kenblue	1	2	42.78
3July13	32Kenblue	1	2	45.00
3July14	32Kenblue	1	2	40.00
3July15	32Kenblue	1	2	42.78
3July6	33Livingston	4	1	25.00
3July7	33Livingston	4	1	35.56
3July8	33Livingston	4	1	37.78
3July9	33Livingston	4	1	37.78
3July12	33Livingston	4	1	41.67
3July13	33Livingston	4	1	41.67
3July14	33Livingston	4	1	33.33
3July15	33Livingston	4	1	38.33
3July6	34Nuglade	3	1	24.44
3July7	34Nuglade	3	1	35.00
3July8	34Nuglade	3	1	36.67
3July9	34Nuglade	3	1	37.78
3July12	34Nuglade	3	1	40.56
3July13	34Nuglade	3	1	41.11
3July14	34Nuglade	3	1	33.89
3July15	34Nuglade	3	1	38.33
3July6	35Kenblue	3	1	26.67
3July7	35Kenblue	3	1	35.00
3July8	35Kenblue	3	1	36.11
3July9	35Kenblue	3	1	40.56
3July12	35Kenblue	3	1	41.11
3July13	35Kenblue	3	1	43.33
3July14	35Kenblue	3	1	37.22
3July15	35Kenblue	3	1	38.33
3July6	36Kenblue	5	1	27.22
3July7	36Kenblue	5	1	36.11
3July8	36Kenblue	5	1	37.22
3July9	36Kenblue	5	1	39.44
3July12	36Kenblue	5	1	43.33
3July13	36Kenblue	5	1	47.78
3July14	36Kenblue	5	1	41.67
3July15	36Kenblue	5	1	43.33

Dry Down Quality

Period	Date	Plot ID	Grass	Trt	Rep	Rating
1	30-Jun-03	1	Nuglade	2	1	8
1	1-Jul-03	1	Nuglade	2	1	8
1	2-Jul-03	1	Nuglade	2	1	7
1	3-Jul-03	1	Nuglade	2	1	7
1	6-Jul-03	1	Nuglade	2	1	7
1	7-Jul-03	1	Nuglade	2	1	6.5
1	8-Jul-03	1	Nuglade	2	1	6
1	9-Jul-03	1	Nuglade	2	1	6
1	30-Jun-03	2	Kenblue	1	1	7
1	1-Jul-03	2	Kenblue	1	1	7
1	2-Jul-03	2	Kenblue	1	1	6.5
1	3-Jul-03	2	Kenblue	1	1	6.5
1	6-Jul-03	2	Kenblue	1	1	5
1	7-Jul-03	2	Kenblue	1	1	5
1	8-Jul-03	2	Kenblue	1	1	4.5
1	9-Jul-03	2	Kenblue	1	1	4
1	30-Jun-03	3	Nuglade	1	2	7
1	1-Jul-03	3	Nuglade	1	2	7
1	2-Jul-03	3	Nuglade	1	2	7
1	3-Jul-03	3	Nuglade	1	2	6.5
1	6-Jul-03	3	Nuglade	1	2	6
1	7-Jul-03	3	Nuglade	1	2	6
1	8-Jul-03	3	Nuglade	1	2	5.5
1	9-Jul-03	3	Nuglade	1	2	5.5
1	30-Jun-03	4	Livingston	3	2	8
1	1-Jul-03	4	Livingston	3	2	8
1	2-Jul-03	4	Livingston	3	2	8
1	3-Jul-03	4	Livingston	3	2	7.5
1	6-Jul-03	4	Livingston	3	2	7
1	7-Jul-03	4	Livingston	3	2	7
1	8-Jul-03	4	Livingston	3	2	6.5
1	9-Jul-03	4	Livingston	3	2	6.5
1	30-Jun-03	5	Kenblue	5	2	6
1	1-Jul-03	5	Kenblue	5	2	6
1	2-Jul-03	5	Kenblue	5	2	5.5
1	3-Jul-03	5	Kenblue	5	2	5.5
1	6-Jul-03	5	Kenblue	5	2	4.5
1	7-Jul-03	5	Kenblue	5	2	4.5
1	8-Jul-03	5	Kenblue	5	2	4
1	9-Jul-03	5	Kenblue	5	2	4
1	30-Jun-03	6	Nuglade	3	3	8
1	1-Jul-03	6	Nuglade	3	3	8
1	2-Jul-03	6	Nuglade	3	3	8
1	3-Jul-03	6	Nuglade	3	3	7.5

1	6-Jul-03	6 Nuglade	3	3	7
1	7-Jul-03	6 Nuglade	3	3	6.5
1	8-Jul-03	6 Nuglade	3	3	6.5
1	9-Jul-03	6 Nuglade	3	3	6.5
1	30-Jun-03	7 Nuglade	4	3	8
1	1-Jul-03	7 Nuglade	4	3	8
1	2-Jul-03	7 Nuglade	4	3	7.5
1	3-Jul-03	7 Nuglade	4	3	7.5
1	6-Jul-03	7 Nuglade	4	3	7
1	7-Jul-03	7 Nuglade	4	3	7
1	8-Jul-03	7 Nuglade	4	3	6.5
1	9-Jul-03	7 Nuglade	4	3	6.5
1	30-Jun-03	8 Livingston	1	3	7
1	1-Jul-03	8 Livingston	1	3	7
1	2-Jul-03	8 Livingston	1	3	6.5
1	3-Jul-03	8 Livingston	1	3	6.5
1	6-Jul-03	8 Livingston	1	3	6.5
1	7-Jul-03	8 Livingston	1	3	6
1	8-Jul-03	8 Livingston	1	3	6
1	9-Jul-03	8 Livingston	1	3	5.5
1	30-Jun-03	9 Livingston	3	3	7
1	1-Jul-03	9 Livingston	3	3	7
1	2-Jul-03	9 Livingston	3	3	7
1	3-Jul-03	9 Livingston	3	3	7
1	6-Jul-03	9 Livingston	3	3	6.5
1	7-Jul-03	9 Livingston	3	3	6.5
1	8-Jul-03	9 Livingston	3	3	6
1	9-Jul-03	9 Livingston	3	3	5.5
1	30-Jun-03	10 Kenblue	5	3	6
1	1-Jul-03	10 Kenblue	5	3	6
1	2-Jul-03	10 Kenblue	5	3	5.5
1	3-Jul-03	10 Kenblue	5	3	5.5
1	6-Jul-03	10 Kenblue	5	3	4.5
1	7-Jul-03	10 Kenblue	5	3	4.5
1	8-Jul-03	10 Kenblue	5	3	4
1	9-Jul-03	10 Kenblue	5	3	4
1	30-Jun-03	11 Nuglade	2	3	7.5
1	1-Jul-03	11 Nuglade	2	3	7.5
1	2-Jul-03	11 Nuglade	2	3	7
1	3-Jul-03	11 Nuglade	2	3	7
1	6-Jul-03	11 Nuglade	2	3	7
1	7-Jul-03	11 Nuglade	2	3	6.5
1	8-Jul-03	11 Nuglade	2	3	6
1	9-Jul-03	11 Nuglade	2	3	5.5
1	30-Jun-03	12 Kenblue	4	3	6.5
1	1-Jul-03	12 Kenblue	4	3	6
1	2-Jul-03	12 Kenblue	4	3	6

1	3-Jul-03	12 Kenblue	4	3	5.5
1	6-Jul-03	12 Kenblue	4	3	5.5
1	7-Jul-03	12 Kenblue	4	3	5.5
1	8-Jul-03	12 Kenblue	4	3	5.5
1	9-Jul-03	12 Kenblue	4	3	5.5
1	30-Jun-03	13 Livingston	2	2	7
1	1-Jul-03	13 Livingston	2	2	7
1	2-Jul-03	13 Livingston	2	2	6.5
1	3-Jul-03	13 Livingston	2	2	6.5
1	6-Jul-03	13 Livingston	2	2	6.5
1	7-Jul-03	13 Livingston	2	2	6
1	8-Jul-03	13 Livingston	2	2	6
1	9-Jul-03	13 Livingston	2	2	6
1	30-Jun-03	14 Nuglade	3	2	8
1	1-Jul-03	14 Nuglade	3	2	8
1	2-Jul-03	14 Nuglade	3	2	7.5
1	3-Jul-03	14 Nuglade	3	2	7
1	6-Jul-03	14 Nuglade	3	2	7
1	7-Jul-03	14 Nuglade	3	2	7
1	8-Jul-03	14 Nuglade	3	2	6.5
1	9-Jul-03	14 Nuglade	3	2	6.5
1	30-Jun-03	15 Nuglade	4	2	8
1	1-Jul-03	15 Nuglade	4	2	8
1	2-Jul-03	15 Nuglade	4	2	8
1	3-Jul-03	15 Nuglade	4	2	7.5
1	6-Jul-03	15 Nuglade	4	2	7
1	7-Jul-03	15 Nuglade	4	2	6.5
1	8-Jul-03	15 Nuglade	4	2	6.5
1	9-Jul-03	15 Nuglade	4	2	6.5
1	30-Jun-03	16 Nuglade	4	1	7.5
1	1-Jul-03	16 Nuglade	4	1	7.5
1	2-Jul-03	16 Nuglade	4	1	7.5
1	3-Jul-03	16 Nuglade	4	1	7.5
1	6-Jul-03	16 Nuglade	4	1	7.5
1	7-Jul-03	16 Nuglade	4	1	6.5
1	8-Jul-03	16 Nuglade	4	1	7
1	9-Jul-03	16 Nuglade	4	1	6.5
1	30-Jun-03	17 Livingston	3	1	7
1	1-Jul-03	17 Livingston	3	1	7
1	2-Jul-03	17 Livingston	3	1	6.5
1	3-Jul-03	17 Livingston	3	1	6.5
1	6-Jul-03	17 Livingston	3	1	6
1	7-Jul-03	17 Livingston	3	1	6
1	8-Jul-03	17 Livingston	3	1	6
1	9-Jul-03	17 Livingston	3	1	6
1	30-Jun-03	18 Nuglade	1	1	7
1	1-Jul-03	18 Nuglade	1	1	7

1	2-Jul-03	18 Nuglade	1	1	7
1	3-Jul-03	18 Nuglade	1	1	5.5
1	6-Jul-03	18 Nuglade	1	1	5
1	7-Jul-03	18 Nuglade	1	1	5
1	8-Jul-03	18 Nuglade	1	1	4.5
1	9-Jul-03	18 Nuglade	1	1	4.5
1	30-Jun-03	19 Livingston	2	1	7
1	1-Jul-03	19 Livingston	2	1	7
1	2-Jul-03	19 Livingston	2	1	6.5
1	3-Jul-03	19 Livingston	2	1	6.5
1	6-Jul-03	19 Livingston	2	1	6.5
1	7-Jul-03	19 Livingston	2	1	6.5
1	8-Jul-03	19 Livingston	2	1	6.5
1	9-Jul-03	19 Livingston	2	1	5.5
1	30-Jun-03	20 Livingston	1	1	7
1	1-Jul-03	20 Livingston	1	1	7
1	2-Jul-03	20 Livingston	1	1	6.5
1	3-Jul-03	20 Livingston	1	1	6
1	6-Jul-03	20 Livingston	1	1	6
1	7-Jul-03	20 Livingston	1	1	5.5
1	8-Jul-03	20 Livingston	1	1	5.5
1	9-Jul-03	20 Livingston	1	1	5
1	30-Jun-03	21 Kenblue	4	1	7
1	1-Jul-03	21 Kenblue	4	1	7
1	2-Jul-03	21 Kenblue	4	1	7
1	3-Jul-03	21 Kenblue	4	1	6.5
1	6-Jul-03	21 Kenblue	4	1	6
1	7-Jul-03	21 Kenblue	4	1	6
1	8-Jul-03	21 Kenblue	4	1	6
1	9-Jul-03	21 Kenblue	4	1	6
1	30-Jun-03	22 Kenblue	3	2	7
1	1-Jul-03	22 Kenblue	3	2	7
1	2-Jul-03	22 Kenblue	3	2	7
1	3-Jul-03	22 Kenblue	3	2	7
1	6-Jul-03	22 Kenblue	3	2	6.5
1	7-Jul-03	22 Kenblue	3	2	6.5
1	8-Jul-03	22 Kenblue	3	2	6
1	9-Jul-03	22 Kenblue	3	2	6
1	30-Jun-03	23 Livingston	4	2	8
1	1-Jul-03	23 Livingston	4	2	7.5
1	2-Jul-03	23 Livingston	4	2	7.5
1	3-Jul-03	23 Livingston	4	2	7
1	6-Jul-03	23 Livingston	4	2	7
1	7-Jul-03	23 Livingston	4	2	6.5
1	8-Jul-03	23 Livingston	4	2	6.5
1	9-Jul-03	23 Livingston	4	2	6.5
1	30-Jun-03	24 Livingston	1	2	7.5

1	1-Jul-03	24 Livingston	1	2	7
1	2-Jul-03	24 Livingston	1	2	6.5
1	3-Jul-03	24 Livingston	1	2	6.5
1	6-Jul-03	24 Livingston	1	2	6
1	7-Jul-03	24 Livingston	1	2	6
1	8-Jul-03	24 Livingston	1	2	6
1	9-Jul-03	24 Livingston	1	2	5.5
1	30-Jun-03	25 Livingston	4	3	7.5
1	1-Jul-03	25 Livingston	4	3	7.5
1	2-Jul-03	25 Livingston	4	3	7
1	3-Jul-03	25 Livingston	4	3	7
1	6-Jul-03	25 Livingston	4	3	7
1	7-Jul-03	25 Livingston	4	3	6.5
1	8-Jul-03	25 Livingston	4	3	6.5
1	9-Jul-03	25 Livingston	4	3	6
1	30-Jun-03	26 Nuglade	1	3	7
1	1-Jul-03	26 Nuglade	1	3	7
1	2-Jul-03	26 Nuglade	1	3	6
1	3-Jul-03	26 Nuglade	1	3	6
1	6-Jul-03	26 Nuglade	1	3	5
1	7-Jul-03	26 Nuglade	1	3	5
1	8-Jul-03	26 Nuglade	1	3	5
1	9-Jul-03	26 Nuglade	1	3	5
1	30-Jun-03	27 Kenblue	1	3	6.5
1	1-Jul-03	27 Kenblue	1	3	6.5
1	2-Jul-03	27 Kenblue	1	3	6.5
1	3-Jul-03	27 Kenblue	1	3	6
1	6-Jul-03	27 Kenblue	1	3	5
1	7-Jul-03	27 Kenblue	1	3	4.5
1	8-Jul-03	27 Kenblue	1	3	4.5
1	9-Jul-03	27 Kenblue	1	3	4
1	30-Jun-03	28 Livingston	2	3	7.5
1	1-Jul-03	28 Livingston	2	3	7.5
1	2-Jul-03	28 Livingston	2	3	7
1	3-Jul-03	28 Livingston	2	3	7
1	6-Jul-03	28 Livingston	2	3	6.5
1	7-Jul-03	28 Livingston	2	3	6.5
1	8-Jul-03	28 Livingston	2	3	6
1	9-Jul-03	28 Livingston	2	3	6
1	30-Jun-03	29 Kenblue	3	3	7
1	1-Jul-03	29 Kenblue	3	3	7
1	2-Jul-03	29 Kenblue	3	3	7
1	3-Jul-03	29 Kenblue	3	3	6.5
1	6-Jul-03	29 Kenblue	3	3	6.5
1	7-Jul-03	29 Kenblue	3	3	6.5
1	8-Jul-03	29 Kenblue	3	3	6
1	9-Jul-03	29 Kenblue	3	3	6

1	30-Jun-03	30	Kenblue	4	2	7.5
1	1-Jul-03	30	Kenblue	4	2	7
1	2-Jul-03	30	Kenblue	4	2	7
1	3-Jul-03	30	Kenblue	4	2	7
1	6-Jul-03	30	Kenblue	4	2	7
1	7-Jul-03	30	Kenblue	4	2	7
1	8-Jul-03	30	Kenblue	4	2	6.5
1	9-Jul-03	30	Kenblue	4	2	6.5
1	30-Jun-03	31	Nuglade	2	2	7.5
1	1-Jul-03	31	Nuglade	2	2	7
1	2-Jul-03	31	Nuglade	2	2	7
1	3-Jul-03	31	Nuglade	2	2	7
1	6-Jul-03	31	Nuglade	2	2	6.5
1	7-Jul-03	31	Nuglade	2	2	6.5
1	8-Jul-03	31	Nuglade	2	2	5.5
1	9-Jul-03	31	Nuglade	2	2	5.5
1	30-Jun-03	32	Kenblue	1	2	6.5
1	1-Jul-03	32	Kenblue	1	2	6
1	2-Jul-03	32	Kenblue	1	2	6
1	3-Jul-03	32	Kenblue	1	2	6
1	6-Jul-03	32	Kenblue	1	2	5
1	7-Jul-03	32	Kenblue	1	2	5
1	8-Jul-03	32	Kenblue	1	2	4.5
1	9-Jul-03	32	Kenblue	1	2	4.5
1	30-Jun-03	33	Livingston	4	1	8
1	1-Jul-03	33	Livingston	4	1	8
1	2-Jul-03	33	Livingston	4	1	7.5
1	3-Jul-03	33	Livingston	4	1	7.5
1	6-Jul-03	33	Livingston	4	1	7
1	7-Jul-03	33	Livingston	4	1	7
1	8-Jul-03	33	Livingston	4	1	6.5
1	9-Jul-03	33	Livingston	4	1	6
1	30-Jun-03	34	Nuglade	3	1	7.5
1	1-Jul-03	34	Nuglade	3	1	7.5
1	2-Jul-03	34	Nuglade	3	1	7.5
1	3-Jul-03	34	Nuglade	3	1	7.5
1	6-Jul-03	34	Nuglade	3	1	7.5
1	7-Jul-03	34	Nuglade	3	1	7
1	8-Jul-03	34	Nuglade	3	1	7
1	9-Jul-03	34	Nuglade	3	1	7
1	30-Jun-03	35	Kenblue	3	1	7
1	1-Jul-03	35	Kenblue	3	1	7
1	2-Jul-03	35	Kenblue	3	1	7
1	3-Jul-03	35	Kenblue	3	1	6.5
1	6-Jul-03	35	Kenblue	3	1	6
1	7-Jul-03	35	Kenblue	3	1	6
1	8-Jul-03	35	Kenblue	3	1	5

1	9-Jul-03	35 Kenblue	3	1	5
1	30-Jun-03	36 Kenblue	5	1	6
1	1-Jul-03	36 Kenblue	5	1	6
1	2-Jul-03	36 Kenblue	5	1	5.5
1	3-Jul-03	36 Kenblue	5	1	5.5
1	6-Jul-03	36 Kenblue	5	1	4.5
1	7-Jul-03	36 Kenblue	5	1	4.5
1	8-Jul-03	36 Kenblue	5	1	4
1	9-Jul-03	36 Kenblue	5	1	4
2	22-Jul-03	1 Nuglade	2	1	8
2	23-Jul-03	1 Nuglade	2	1	8
2	24-Jul-03	1 Nuglade	2	1	7.5
2	25-Jul-03	1 Nuglade	2	1	7.5
2	28-Jul-03	1 Nuglade	2	1	7
2	29-Jul-03	1 Nuglade	2	1	7
2	30-Jul-03	1 Nuglade	2	1	6.5
2	31-Jul-03	1 Nuglade	2	1	6.5
2	22-Jul-03	2 Kenblue	1	1	7
2	23-Jul-03	2 Kenblue	1	1	7
2	24-Jul-03	2 Kenblue	1	1	7
2	25-Jul-03	2 Kenblue	1	1	6.5
2	28-Jul-03	2 Kenblue	1	1	6
2	29-Jul-03	2 Kenblue	1	1	5
2	30-Jul-03	2 Kenblue	1	1	5
2	31-Jul-03	2 Kenblue	1	1	5
2	22-Jul-03	3 Nuglade	1	2	7.5
2	23-Jul-03	3 Nuglade	1	2	7.5
2	24-Jul-03	3 Nuglade	1	2	7
2	25-Jul-03	3 Nuglade	1	2	6.5
2	28-Jul-03	3 Nuglade	1	2	6.5
2	29-Jul-03	3 Nuglade	1	2	6.5
2	30-Jul-03	3 Nuglade	1	2	6.5
2	31-Jul-03	3 Nuglade	1	2	6.5
2	22-Jul-03	4 Livingston	3	2	8
2	23-Jul-03	4 Livingston	3	2	8
2	24-Jul-03	4 Livingston	3	2	7.5
2	25-Jul-03	4 Livingston	3	2	7.5
2	28-Jul-03	4 Livingston	3	2	7.5
2	29-Jul-03	4 Livingston	3	2	7.5
2	30-Jul-03	4 Livingston	3	2	7
2	31-Jul-03	4 Livingston	3	2	7
2	22-Jul-03	5 Kenblue	5	2	6.5
2	23-Jul-03	5 Kenblue	5	2	6.5
2	24-Jul-03	5 Kenblue	5	2	6
2	25-Jul-03	5 Kenblue	5	2	5.5
2	28-Jul-03	5 Kenblue	5	2	5.5
2	29-Jul-03	5 Kenblue	5	2	5

2	30-Jul-03	5 Kenblue	5	2	4.5
2	31-Jul-03	5 Kenblue	5	2	4
2	22-Jul-03	6 Nuglade	3	3	8
2	23-Jul-03	6 Nuglade	3	3	8
2	24-Jul-03	6 Nuglade	3	3	7.5
2	25-Jul-03	6 Nuglade	3	3	7
2	28-Jul-03	6 Nuglade	3	3	7
2	29-Jul-03	6 Nuglade	3	3	7
2	30-Jul-03	6 Nuglade	3	3	7
2	31-Jul-03	6 Nuglade	3	3	6.5
2	22-Jul-03	7 Nuglade	4	3	8
2	23-Jul-03	7 Nuglade	4	3	8
2	24-Jul-03	7 Nuglade	4	3	7.5
2	25-Jul-03	7 Nuglade	4	3	7
2	28-Jul-03	7 Nuglade	4	3	7
2	29-Jul-03	7 Nuglade	4	3	7
2	30-Jul-03	7 Nuglade	4	3	6.5
2	31-Jul-03	7 Nuglade	4	3	6.5
2	22-Jul-03	8 Livingston	1	3	7
2	23-Jul-03	8 Livingston	1	3	7
2	24-Jul-03	8 Livingston	1	3	7
2	25-Jul-03	8 Livingston	1	3	6.5
2	28-Jul-03	8 Livingston	1	3	6.5
2	29-Jul-03	8 Livingston	1	3	6
2	30-Jul-03	8 Livingston	1	3	6
2	31-Jul-03	8 Livingston	1	3	5.5
2	22-Jul-03	9 Livingston	3	3	7.5
2	23-Jul-03	9 Livingston	3	3	7.5
2	24-Jul-03	9 Livingston	3	3	7.5
2	25-Jul-03	9 Livingston	3	3	7
2	28-Jul-03	9 Livingston	3	3	7
2	29-Jul-03	9 Livingston	3	3	6.5
2	30-Jul-03	9 Livingston	3	3	6.5
2	31-Jul-03	9 Livingston	3	3	6.5
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2	23-Jul-03	10 Kenblue	5	3	6.5
2	24-Jul-03	10 Kenblue	5	3	6.5
2	25-Jul-03	10 Kenblue	5	3	5
2	28-Jul-03	10 Kenblue	5	3	4.5
2	29-Jul-03	10 Kenblue	5	3	4
2	30-Jul-03	10 Kenblue	5	3	3.5
2	31-Jul-03	10 Kenblue	5	3	3.5
2	22-Jul-03	11 Nuglade	2	3	7.5
2	23-Jul-03	11 Nuglade	2	3	7.5
2	24-Jul-03	11 Nuglade	2	3	7
2	25-Jul-03	11 Nuglade	2	3	6.5
2	28-Jul-03	11 Nuglade	2	3	6

2	29-Jul-03	11 Nuglade	2	3	6.5
2	30-Jul-03	11 Nuglade	2	3	6
2	31-Jul-03	11 Nuglade	2	3	6
2	22-Jul-03	12 Kenblue	4	3	7
2	23-Jul-03	12 Kenblue	4	3	7
2	24-Jul-03	12 Kenblue	4	3	7
2	25-Jul-03	12 Kenblue	4	3	6.5
2	28-Jul-03	12 Kenblue	4	3	6.5
2	29-Jul-03	12 Kenblue	4	3	6.5
2	30-Jul-03	12 Kenblue	4	3	6.5
2	31-Jul-03	12 Kenblue	4	3	6
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2	23-Jul-03	13 Livingston	2	2	7.5
2	24-Jul-03	13 Livingston	2	2	7.5
2	25-Jul-03	13 Livingston	2	2	7
2	28-Jul-03	13 Livingston	2	2	6.5
2	29-Jul-03	13 Livingston	2	2	6.5
2	30-Jul-03	13 Livingston	2	2	6
2	31-Jul-03	13 Livingston	2	2	5.5
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2	23-Jul-03	14 Nuglade	3	2	8
2	24-Jul-03	14 Nuglade	3	2	7.5
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2	28-Jul-03	14 Nuglade	3	2	7
2	29-Jul-03	14 Nuglade	3	2	7
2	30-Jul-03	14 Nuglade	3	2	7
2	31-Jul-03	14 Nuglade	3	2	7
2	22-Jul-03	15 Nuglade	4	2	8.5
2	23-Jul-03	15 Nuglade	4	2	8.5
2	24-Jul-03	15 Nuglade	4	2	8
2	25-Jul-03	15 Nuglade	4	2	7.5
2	28-Jul-03	15 Nuglade	4	2	7.5
2	29-Jul-03	15 Nuglade	4	2	7.5
2	30-Jul-03	15 Nuglade	4	2	7
2	31-Jul-03	15 Nuglade	4	2	7
2	22-Jul-03	16 Nuglade	4	1	7.5
2	23-Jul-03	16 Nuglade	4	1	7.5
2	24-Jul-03	16 Nuglade	4	1	7.5
2	25-Jul-03	16 Nuglade	4	1	7
2	28-Jul-03	16 Nuglade	4	1	7
2	29-Jul-03	16 Nuglade	4	1	7
2	30-Jul-03	16 Nuglade	4	1	7
2	31-Jul-03	16 Nuglade	4	1	7
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2	23-Jul-03	17 Livingston	3	1	8
2	24-Jul-03	17 Livingston	3	1	7.5
2	25-Jul-03	17 Livingston	3	1	7.5

2	28-Jul-03	17 Livingston	3	1	7.5
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2	30-Jul-03	17 Livingston	3	1	6.5
2	31-Jul-03	17 Livingston	3	1	6.5
2	22-Jul-03	18 Nuglade	1	1	7
2	23-Jul-03	18 Nuglade	1	1	7
2	24-Jul-03	18 Nuglade	1	1	7
2	25-Jul-03	18 Nuglade	1	1	6.5
2	28-Jul-03	18 Nuglade	1	1	6.5
2	29-Jul-03	18 Nuglade	1	1	6.5
2	30-Jul-03	18 Nuglade	1	1	6.5
2	31-Jul-03	18 Nuglade	1	1	6.5
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2	23-Jul-03	19 Livingston	2	1	7.5
2	24-Jul-03	19 Livingston	2	1	7.5
2	25-Jul-03	19 Livingston	2	1	7
2	28-Jul-03	19 Livingston	2	1	6.5
2	29-Jul-03	19 Livingston	2	1	6
2	30-Jul-03	19 Livingston	2	1	6
2	31-Jul-03	19 Livingston	2	1	5.5
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2	23-Jul-03	20 Livingston	1	1	7
2	24-Jul-03	20 Livingston	1	1	7
2	25-Jul-03	20 Livingston	1	1	6.5
2	28-Jul-03	20 Livingston	1	1	6
2	29-Jul-03	20 Livingston	1	1	5.5
2	30-Jul-03	20 Livingston	1	1	5.5
2	31-Jul-03	20 Livingston	1	1	5
2	22-Jul-03	21 Kenblue	4	1	7
2	23-Jul-03	21 Kenblue	4	1	7
2	24-Jul-03	21 Kenblue	4	1	6.5
2	25-Jul-03	21 Kenblue	4	1	5.5
2	28-Jul-03	21 Kenblue	4	1	5.5
2	29-Jul-03	21 Kenblue	4	1	5.5
2	30-Jul-03	21 Kenblue	4	1	5.5
2	31-Jul-03	21 Kenblue	4	1	5
2	22-Jul-03	22 Kenblue	3	2	7
2	23-Jul-03	22 Kenblue	3	2	7
2	24-Jul-03	22 Kenblue	3	2	6.5
2	25-Jul-03	22 Kenblue	3	2	6
2	28-Jul-03	22 Kenblue	3	2	6
2	29-Jul-03	22 Kenblue	3	2	5.5
2	30-Jul-03	22 Kenblue	3	2	5.5
2	31-Jul-03	22 Kenblue	3	2	5.5
2	22-Jul-03	23 Livingston	4	2	8
2	23-Jul-03	23 Livingston	4	2	8
2	24-Jul-03	23 Livingston	4	2	8

2	25-Jul-03	23 Livingston	4	2	7.5
2	28-Jul-03	23 Livingston	4	2	7.5
2	29-Jul-03	23 Livingston	4	2	7
2	30-Jul-03	23 Livingston	4	2	7
2	31-Jul-03	23 Livingston	4	2	6.5
2	22-Jul-03	24 Livingston	1	2	7.5
2	23-Jul-03	24 Livingston	1	2	7.5
2	24-Jul-03	24 Livingston	1	2	7.5
2	25-Jul-03	24 Livingston	1	2	7
2	28-Jul-03	24 Livingston	1	2	6.5
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2	30-Jul-03	24 Livingston	1	2	6
2	31-Jul-03	24 Livingston	1	2	6
2	22-Jul-03	25 Livingston	4	3	7.5
2	23-Jul-03	25 Livingston	4	3	7.5
2	24-Jul-03	25 Livingston	4	3	7.5
2	25-Jul-03	25 Livingston	4	3	7
2	28-Jul-03	25 Livingston	4	3	7
2	29-Jul-03	25 Livingston	4	3	6.5
2	30-Jul-03	25 Livingston	4	3	6.5
2	31-Jul-03	25 Livingston	4	3	6.5
2	22-Jul-03	26 Nuglade	1	3	7
2	23-Jul-03	26 Nuglade	1	3	7
2	24-Jul-03	26 Nuglade	1	3	7
2	25-Jul-03	26 Nuglade	1	3	6.5
2	28-Jul-03	26 Nuglade	1	3	6
2	29-Jul-03	26 Nuglade	1	3	6
2	30-Jul-03	26 Nuglade	1	3	5.5
2	31-Jul-03	26 Nuglade	1	3	5.5
2	22-Jul-03	27 Kenblue	1	3	6.5
2	23-Jul-03	27 Kenblue	1	3	6.5
2	24-Jul-03	27 Kenblue	1	3	6.5
2	25-Jul-03	27 Kenblue	1	3	6.5
2	28-Jul-03	27 Kenblue	1	3	5.5
2	29-Jul-03	27 Kenblue	1	3	4.5
2	30-Jul-03	27 Kenblue	1	3	4.5
2	31-Jul-03	27 Kenblue	1	3	4
2	22-Jul-03	28 Livingston	2	3	7.5
2	23-Jul-03	28 Livingston	2	3	7.5
2	24-Jul-03	28 Livingston	2	3	7
2	25-Jul-03	28 Livingston	2	3	7
2	28-Jul-03	28 Livingston	2	3	6.5
2	29-Jul-03	28 Livingston	2	3	6
2	30-Jul-03	28 Livingston	2	3	6
2	31-Jul-03	28 Livingston	2	3	6
2	22-Jul-03	29 Kenblue	3	3	7
2	23-Jul-03	29 Kenblue	3	3	7

2	24-Jul-03	29 Kenblue	3	3	7
2	25-Jul-03	29 Kenblue	3	3	6.5
2	28-Jul-03	29 Kenblue	3	3	6.5
2	29-Jul-03	29 Kenblue	3	3	6.5
2	30-Jul-03	29 Kenblue	3	3	6.5
2	31-Jul-03	29 Kenblue	3	3	6
2	22-Jul-03	30 Kenblue	4	2	7
2	23-Jul-03	30 Kenblue	4	2	7
2	24-Jul-03	30 Kenblue	4	2	7
2	25-Jul-03	30 Kenblue	4	2	6.5
2	28-Jul-03	30 Kenblue	4	2	6.5
2	29-Jul-03	30 Kenblue	4	2	6
2	30-Jul-03	30 Kenblue	4	2	5.5
2	31-Jul-03	30 Kenblue	4	2	5.5
2	22-Jul-03	31 Nuglade	2	2	7.5
2	23-Jul-03	31 Nuglade	2	2	7.5
2	24-Jul-03	31 Nuglade	2	2	7.5
2	25-Jul-03	31 Nuglade	2	2	7
2	28-Jul-03	31 Nuglade	2	2	6.5
2	29-Jul-03	31 Nuglade	2	2	6.5
2	30-Jul-03	31 Nuglade	2	2	6
2	31-Jul-03	31 Nuglade	2	2	6
2	22-Jul-03	32 Kenblue	1	2	7
2	23-Jul-03	32 Kenblue	1	2	7
2	24-Jul-03	32 Kenblue	1	2	6.5
2	25-Jul-03	32 Kenblue	1	2	6
2	28-Jul-03	32 Kenblue	1	2	5
2	29-Jul-03	32 Kenblue	1	2	5
2	30-Jul-03	32 Kenblue	1	2	5
2	31-Jul-03	32 Kenblue	1	2	4.5
2	22-Jul-03	33 Livingston	4	1	8
2	23-Jul-03	33 Livingston	4	1	8
2	24-Jul-03	33 Livingston	4	1	7.5
2	25-Jul-03	33 Livingston	4	1	7.5
2	28-Jul-03	33 Livingston	4	1	7.5
2	29-Jul-03	33 Livingston	4	1	7
2	30-Jul-03	33 Livingston	4	1	7
2	31-Jul-03	33 Livingston	4	1	6.5
2	22-Jul-03	34 Nuglade	3	1	8
2	23-Jul-03	34 Nuglade	3	1	8
2	24-Jul-03	34 Nuglade	3	1	8
2	25-Jul-03	34 Nuglade	3	1	7.5
2	28-Jul-03	34 Nuglade	3	1	7.5
2	29-Jul-03	34 Nuglade	3	1	7.5
2	30-Jul-03	34 Nuglade	3	1	7
2	31-Jul-03	34 Nuglade	3	1	7
2	22-Jul-03	35 Kenblue	3	1	7.5

2	23-Jul-03	35 Kenblue	3	1	7.5
2	24-Jul-03	35 Kenblue	3	1	7
2	25-Jul-03	35 Kenblue	3	1	6.5
2	28-Jul-03	35 Kenblue	3	1	6.5
2	29-Jul-03	35 Kenblue	3	1	6
2	30-Jul-03	35 Kenblue	3	1	6
2	31-Jul-03	35 Kenblue	3	1	5.5
2	22-Jul-03	36 Kenblue	5	1	6.5
2	23-Jul-03	36 Kenblue	5	1	6
2	24-Jul-03	36 Kenblue	5	1	6
2	25-Jul-03	36 Kenblue	5	1	5.5
2	28-Jul-03	36 Kenblue	5	1	5
2	29-Jul-03	36 Kenblue	5	1	4.5
2	30-Jul-03	36 Kenblue	5	1	4
2	31-Jul-03	36 Kenblue	5	1	4
3	6-Jul-04	1 Nuglade	2	1	7.5
3	7-Jul-04	1 Nuglade	2	1	7.5
3	8-Jul-04	1 Nuglade	2	1	7
3	9-Jul-04	1 Nuglade	2	1	7
3	12-Jul-04	1 Nuglade	2	1	7
3	13-Jul-04	1 Nuglade	2	1	7
3	14-Jul-04	1 Nuglade	2	1	6.5
3	15-Jul-04	1 Nuglade	2	1	6.5
3	6-Jul-04	2 Kenblue	1	1	6.5
3	7-Jul-04	2 Kenblue	1	1	6.5
3	8-Jul-04	2 Kenblue	1	1	6.5
3	9-Jul-04	2 Kenblue	1	1	6
3	12-Jul-04	2 Kenblue	1	1	5
3	13-Jul-04	2 Kenblue	1	1	5
3	14-Jul-04	2 Kenblue	1	1	5
3	15-Jul-04	2 Kenblue	1	1	5
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3	8-Jul-04	3 Nuglade	1	2	7
3	9-Jul-04	3 Nuglade	1	2	7
3	12-Jul-04	3 Nuglade	1	2	6.5
3	13-Jul-04	3 Nuglade	1	2	6.5
3	14-Jul-04	3 Nuglade	1	2	6
3	15-Jul-04	3 Nuglade	1	2	6
3	6-Jul-04	4 Livingston	3	2	8
3	7-Jul-04	4 Livingston	3	2	8
3	8-Jul-04	4 Livingston	3	2	7.5
3	9-Jul-04	4 Livingston	3	2	7.5
3	12-Jul-04	4 Livingston	3	2	7.5
3	13-Jul-04	4 Livingston	3	2	7.5
3	14-Jul-04	4 Livingston	3	2	7
3	15-Jul-04	4 Livingston	3	2	7

3	6-Jul-04	5 Kenblue	5	2	7
3	7-Jul-04	5 Kenblue	5	2	7
3	8-Jul-04	5 Kenblue	5	2	6.5
3	9-Jul-04	5 Kenblue	5	2	6.5
3	12-Jul-04	5 Kenblue	5	2	5.5
3	13-Jul-04	5 Kenblue	5	2	5.5
3	14-Jul-04	5 Kenblue	5	2	5
3	15-Jul-04	5 Kenblue	5	2	5
3	6-Jul-04	6 Nuglade	3	3	8
3	7-Jul-04	6 Nuglade	3	3	8
3	8-Jul-04	6 Nuglade	3	3	7.5
3	9-Jul-04	6 Nuglade	3	3	7.5
3	12-Jul-04	6 Nuglade	3	3	7
3	13-Jul-04	6 Nuglade	3	3	7
3	14-Jul-04	6 Nuglade	3	3	7
3	15-Jul-04	6 Nuglade	3	3	7
3	6-Jul-04	7 Nuglade	4	3	8
3	7-Jul-04	7 Nuglade	4	3	8
3	8-Jul-04	7 Nuglade	4	3	7.5
3	9-Jul-04	7 Nuglade	4	3	7.5
3	12-Jul-04	7 Nuglade	4	3	7
3	13-Jul-04	7 Nuglade	4	3	7
3	14-Jul-04	7 Nuglade	4	3	6.5
3	15-Jul-04	7 Nuglade	4	3	6.5
3	6-Jul-04	8 Livingston	1	3	8
3	7-Jul-04	8 Livingston	1	3	8
3	8-Jul-04	8 Livingston	1	3	7.5
3	9-Jul-04	8 Livingston	1	3	7.5
3	12-Jul-04	8 Livingston	1	3	6.5
3	13-Jul-04	8 Livingston	1	3	6.5
3	14-Jul-04	8 Livingston	1	3	6
3	15-Jul-04	8 Livingston	1	3	6
3	6-Jul-04	9 Livingston	3	3	7.5
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3	8-Jul-04	9 Livingston	3	3	7
3	9-Jul-04	9 Livingston	3	3	7
3	12-Jul-04	9 Livingston	3	3	6.5
3	13-Jul-04	9 Livingston	3	3	6.5
3	14-Jul-04	9 Livingston	3	3	6
3	15-Jul-04	9 Livingston	3	3	6
3	6-Jul-04	10 Kenblue	5	3	6.5
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3	8-Jul-04	10 Kenblue	5	3	6.5
3	9-Jul-04	10 Kenblue	5	3	6
3	12-Jul-04	10 Kenblue	5	3	5
3	13-Jul-04	10 Kenblue	5	3	5
3	14-Jul-04	10 Kenblue	5	3	4.5

3	15-Jul-04	10 Kenblue	5	3	4.5
3	6-Jul-04	11 Nuglade	2	3	7.5
3	7-Jul-04	11 Nuglade	2	3	7.5
3	8-Jul-04	11 Nuglade	2	3	7.5
3	9-Jul-04	11 Nuglade	2	3	7
3	12-Jul-04	11 Nuglade	2	3	6
3	13-Jul-04	11 Nuglade	2	3	6
3	14-Jul-04	11 Nuglade	2	3	5.5
3	15-Jul-04	11 Nuglade	2	3	5.5
3	6-Jul-04	12 Kenblue	4	3	7
3	7-Jul-04	12 Kenblue	4	3	7
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3	8-Jul-04	13 Livingston	2	2	7.5
3	9-Jul-04	13 Livingston	2	2	7.5
3	12-Jul-04	13 Livingston	2	2	7
3	13-Jul-04	13 Livingston	2	2	7
3	14-Jul-04	13 Livingston	2	2	6.5
3	15-Jul-04	13 Livingston	2	2	6.5
3	6-Jul-04	14 Nuglade	3	2	8
3	7-Jul-04	14 Nuglade	3	2	8
3	8-Jul-04	14 Nuglade	3	2	7.5
3	9-Jul-04	14 Nuglade	3	2	7.5
3	12-Jul-04	14 Nuglade	3	2	7
3	13-Jul-04	14 Nuglade	3	2	7
3	14-Jul-04	14 Nuglade	3	2	6.5
3	15-Jul-04	14 Nuglade	3	2	6.5
3	6-Jul-04	15 Nuglade	4	2	8
3	7-Jul-04	15 Nuglade	4	2	8
3	8-Jul-04	15 Nuglade	4	2	8
3	9-Jul-04	15 Nuglade	4	2	7.5
3	12-Jul-04	15 Nuglade	4	2	7
3	13-Jul-04	15 Nuglade	4	2	7
3	14-Jul-04	15 Nuglade	4	2	7
3	15-Jul-04	15 Nuglade	4	2	7
3	6-Jul-04	16 Nuglade	4	1	8.5
3	7-Jul-04	16 Nuglade	4	1	8.5
3	8-Jul-04	16 Nuglade	4	1	8
3	9-Jul-04	16 Nuglade	4	1	7.5
3	12-Jul-04	16 Nuglade	4	1	7.5
3	13-Jul-04	16 Nuglade	4	1	7.5

3	14-Jul-04	16 Nuglade	4	1	7
3	15-Jul-04	16 Nuglade	4	1	7
3	6-Jul-04	17 Livingston	3	1	8.5
3	7-Jul-04	17 Livingston	3	1	8.5
3	8-Jul-04	17 Livingston	3	1	8
3	9-Jul-04	17 Livingston	3	1	8
3	12-Jul-04	17 Livingston	3	1	7.5
3	13-Jul-04	17 Livingston	3	1	7.5
3	14-Jul-04	17 Livingston	3	1	7
3	15-Jul-04	17 Livingston	3	1	7
3	6-Jul-04	18 Nuglade	1	1	7
3	7-Jul-04	18 Nuglade	1	1	7
3	8-Jul-04	18 Nuglade	1	1	7
3	9-Jul-04	18 Nuglade	1	1	6.5
3	12-Jul-04	18 Nuglade	1	1	6.5
3	13-Jul-04	18 Nuglade	1	1	6
3	14-Jul-04	18 Nuglade	1	1	5.5
3	15-Jul-04	18 Nuglade	1	1	5.5
3	6-Jul-04	19 Livingston	2	1	7.5
3	7-Jul-04	19 Livingston	2	1	7.5
3	8-Jul-04	19 Livingston	2	1	7.5
3	9-Jul-04	19 Livingston	2	1	7.5
3	12-Jul-04	19 Livingston	2	1	6
3	13-Jul-04	19 Livingston	2	1	6
3	14-Jul-04	19 Livingston	2	1	6
3	15-Jul-04	19 Livingston	2	1	6
3	6-Jul-04	20 Livingston	1	1	7.5
3	7-Jul-04	20 Livingston	1	1	7.5
3	8-Jul-04	20 Livingston	1	1	7
3	9-Jul-04	20 Livingston	1	1	7
3	12-Jul-04	20 Livingston	1	1	6
3	13-Jul-04	20 Livingston	1	1	6
3	14-Jul-04	20 Livingston	1	1	6
3	15-Jul-04	20 Livingston	1	1	6
3	6-Jul-04	21 Kenblue	4	1	7.5
3	7-Jul-04	21 Kenblue	4	1	7.5
3	8-Jul-04	21 Kenblue	4	1	7
3	9-Jul-04	21 Kenblue	4	1	7
3	12-Jul-04	21 Kenblue	4	1	6
3	13-Jul-04	21 Kenblue	4	1	6
3	14-Jul-04	21 Kenblue	4	1	6
3	15-Jul-04	21 Kenblue	4	1	6
3	6-Jul-04	22 Kenblue	3	2	7
3	7-Jul-04	22 Kenblue	3	2	7
3	8-Jul-04	22 Kenblue	3	2	7
3	9-Jul-04	22 Kenblue	3	2	7
3	12-Jul-04	22 Kenblue	3	2	6

3	13-Jul-04	22 Kenblue	3	2	6
3	14-Jul-04	22 Kenblue	3	2	5.5
3	15-Jul-04	22 Kenblue	3	2	5.5
3	6-Jul-04	23 Livingston	4	2	8
3	7-Jul-04	23 Livingston	4	2	8
3	8-Jul-04	23 Livingston	4	2	7.5
3	9-Jul-04	23 Livingston	4	2	7.5
3	12-Jul-04	23 Livingston	4	2	7
3	13-Jul-04	23 Livingston	4	2	7
3	14-Jul-04	23 Livingston	4	2	6.5
3	15-Jul-04	23 Livingston	4	2	6.5
3	6-Jul-04	24 Livingston	1	2	7
3	7-Jul-04	24 Livingston	1	2	7
3	8-Jul-04	24 Livingston	1	2	7
3	9-Jul-04	24 Livingston	1	2	7
3	12-Jul-04	24 Livingston	1	2	6.5
3	13-Jul-04	24 Livingston	1	2	6.5
3	14-Jul-04	24 Livingston	1	2	6
3	15-Jul-04	24 Livingston	1	2	6
3	6-Jul-04	25 Livingston	4	3	8
3	7-Jul-04	25 Livingston	4	3	8
3	8-Jul-04	25 Livingston	4	3	7.5
3	9-Jul-04	25 Livingston	4	3	7.5
3	12-Jul-04	25 Livingston	4	3	7
3	13-Jul-04	25 Livingston	4	3	7
3	14-Jul-04	25 Livingston	4	3	6.5
3	15-Jul-04	25 Livingston	4	3	6.5
3	6-Jul-04	26 Nuglade	1	3	7.5
3	7-Jul-04	26 Nuglade	1	3	7.5
3	8-Jul-04	26 Nuglade	1	3	7.5
3	9-Jul-04	26 Nuglade	1	3	7
3	12-Jul-04	26 Nuglade	1	3	6
3	13-Jul-04	26 Nuglade	1	3	6
3	14-Jul-04	26 Nuglade	1	3	5
3	15-Jul-04	26 Nuglade	1	3	5
3	6-Jul-04	27 Kenblue	1	3	6.5
3	7-Jul-04	27 Kenblue	1	3	6.5
3	8-Jul-04	27 Kenblue	1	3	6.5
3	9-Jul-04	27 Kenblue	1	3	6.5
3	12-Jul-04	27 Kenblue	1	3	5.5
3	13-Jul-04	27 Kenblue	1	3	5.5
3	14-Jul-04	27 Kenblue	1	3	5
3	15-Jul-04	27 Kenblue	1	3	5
3	6-Jul-04	28 Livingston	2	3	7.5
3	7-Jul-04	28 Livingston	2	3	7.5
3	8-Jul-04	28 Livingston	2	3	7
3	9-Jul-04	28 Livingston	2	3	7

3	12-Jul-04	28 Livingston	2	3	6.5
3	13-Jul-04	28 Livingston	2	3	6.5
3	14-Jul-04	28 Livingston	2	3	6
3	15-Jul-04	28 Livingston	2	3	6
3	6-Jul-04	29 Kenblue	3	3	7.5
3	7-Jul-04	29 Kenblue	3	3	7.5
3	8-Jul-04	29 Kenblue	3	3	7
3	9-Jul-04	29 Kenblue	3	3	7
3	12-Jul-04	29 Kenblue	3	3	6
3	13-Jul-04	29 Kenblue	3	3	6
3	14-Jul-04	29 Kenblue	3	3	5.5
3	15-Jul-04	29 Kenblue	3	3	5.5
3	6-Jul-04	30 Kenblue	4	2	7.5
3	7-Jul-04	30 Kenblue	4	2	7.5
3	8-Jul-04	30 Kenblue	4	2	7
3	9-Jul-04	30 Kenblue	4	2	7
3	12-Jul-04	30 Kenblue	4	2	6
3	13-Jul-04	30 Kenblue	4	2	6
3	14-Jul-04	30 Kenblue	4	2	6
3	15-Jul-04	30 Kenblue	4	2	6
3	6-Jul-04	31 Nuglade	2	2	8
3	7-Jul-04	31 Nuglade	2	2	8
3	8-Jul-04	31 Nuglade	2	2	7.5
3	9-Jul-04	31 Nuglade	2	2	7.5
3	12-Jul-04	31 Nuglade	2	2	7
3	13-Jul-04	31 Nuglade	2	2	7
3	14-Jul-04	31 Nuglade	2	2	6.5
3	15-Jul-04	31 Nuglade	2	2	6.5
3	6-Jul-04	32 Kenblue	1	2	7
3	7-Jul-04	32 Kenblue	1	2	7
3	8-Jul-04	32 Kenblue	1	2	6.5
3	9-Jul-04	32 Kenblue	1	2	6.5
3	12-Jul-04	32 Kenblue	1	2	5.5
3	13-Jul-04	32 Kenblue	1	2	5.5
3	14-Jul-04	32 Kenblue	1	2	5.5
3	15-Jul-04	32 Kenblue	1	2	5.5
3	6-Jul-04	33 Livingston	4	1	8
3	7-Jul-04	33 Livingston	4	1	8
3	8-Jul-04	33 Livingston	4	1	7.5
3	9-Jul-04	33 Livingston	4	1	7.5
3	12-Jul-04	33 Livingston	4	1	7
3	13-Jul-04	33 Livingston	4	1	7
3	14-Jul-04	33 Livingston	4	1	7
3	15-Jul-04	33 Livingston	4	1	7
3	6-Jul-04	34 Nuglade	3	1	8
3	7-Jul-04	34 Nuglade	3	1	8
3	8-Jul-04	34 Nuglade	3	1	7.5

3	9-Jul-04	34 Nuglade	3	1	7
3	12-Jul-04	34 Nuglade	3	1	7
3	13-Jul-04	34 Nuglade	3	1	7
3	14-Jul-04	34 Nuglade	3	1	7
3	15-Jul-04	34 Nuglade	3	1	7
3	6-Jul-04	35 Kenblue	3	1	7.5
3	7-Jul-04	35 Kenblue	3	1	7.5
3	8-Jul-04	35 Kenblue	3	1	7
3	9-Jul-04	35 Kenblue	3	1	7
3	12-Jul-04	35 Kenblue	3	1	6.5
3	13-Jul-04	35 Kenblue	3	1	6.5
3	14-Jul-04	35 Kenblue	3	1	6
3	15-Jul-04	35 Kenblue	3	1	6
3	6-Jul-04	36 Kenblue	5	1	6.5
3	7-Jul-04	36 Kenblue	5	1	6.5
3	8-Jul-04	36 Kenblue	5	1	6
3	9-Jul-04	36 Kenblue	5	1	6
3	12-Jul-04	36 Kenblue	5	1	5
3	13-Jul-04	36 Kenblue	5	1	5
3	14-Jul-04	36 Kenblue	5	1	4.5
3	15-Jul-04	36 Kenblue	5	1	4.5

APPENDIX D.

Runoff liquid & Sediment

Plot	Trt	Rep	Interval	Time (sec)	Runoff- (L)	Sediment (g)
1	2	1	5	150	0.17007	1.042
1	2	1	10	150	0.25808	1.016
1	2	1	15	150	0.38803	2.1101
1	2	1	20	150	0.47878	1.3168
1	2	1	25	150	0.5324	0.9634
1	2	1	30	150	0.64604	1.7798
1	2	1	35	150	0.67915	1.6921
1	2	1	40	150	0.69046	2.806
1	2	1	45	150	0.70543	2.0106
1	2	1	50	150	0.75822	1.6543
1	2	1	55	150	0.78009	2.6132
1	2	1	60	150	0.81876	1.6799
1	2	1	65	150	0.85911	2.02
1	2	1	70	150	0.8733	0.9276
1	2	1	75	150	0.89468	1.9379
1	2	1	80	148	0.90322	2.4676
1	2	1	85	147	0.91538	2.5552
1	2	1	90	150.	.	
2	1	2	5	150	0.20495	0.7261
2	1	2	10	150	0.30549	0.5254
2	1	2	15	150	0.25916	0.3292
2	1	2	20	150	0.41695	0.7022
2	1	2	25	150	0.52121	1.5127
2	1	2	30	150	0.55225	1.128
2	1	2	35	150	0.61279	0.4078
2	1	2	40	150	0.63618	0.8511
2	1	2	45	150	0.70556	1.2108
2	1	2	50	150	0.75364	0.4689
2	1	2	55	150	0.78602	0.8272
2	1	2	60	150	0.83811	1.3693
2	1	2	65	150	0.86962	0.5151
2	1	2	70	150	0.89149	1.1233
2	1	2	75	145	0.92483	0.6717
2	1	2	80	140	0.95275	0.6464
2	1	2	85	138	0.96827	0.9203
2	1	2	90	135	0.95777	1.0358
3	3	3	5	150	0.20564	0.4185
3	3	3	10	150	0.31352	0.7213
3	3	3	15	150	0.38272	0.9127
3	3	3	20	150	0.45769	0.8873
3	3	3	25	150	0.53058	1.0852
3	3	3	30	150	0.60543	0.763
3	3	3	35	150	0.63008	1.3432
3	3	3	40	150	0.6596	1.0554
3	3	3	45	150	0.71244	1.2992
3	3	3	50	150	0.76363	1.3706

3	3	3	55	150	0.80478	0.6598
3	3	3	60	150	0.84902	1.0429
3	3	3	65	150	0.86724	1.4028
3	3	3	70	150	0.81418	1.1837
3	3	3	75	150	0.83865	1.5192
3	3	3	80	147	0.89567	0.9146
3	3	3	85	145	0.90465	1.1333
3	3	3	90	141	0.92477	1.1162
4	4	3	5	150	0.19183	1.0897
4	4	3	10	150	0.26569	1.4626
4	4	3	15	150	0.23101	1.0938
4	4	3	20	150	0.29083	1.2739
4	4	3	25	150	0.31287	1.1802
4	4	3	30	150	0.35737	1.3463
4	4	3	35	150	0.40867	2.0563
4	4	3	40	150	0.45609	1.4372
4	4	3	45	150	0.52349	1.7991
4	4	3	50	150	0.60767	2.164
4	4	3	55	150	0.6578	2.065
4	4	3	60	150	0.68099	2.3387
4	4	3	65	150	0.72976	1.8673
4	4	3	70	150	0.78678	3.25
4	4	3	75	150	0.79961	1.0294
4	4	3	80	150	0.85459	4.223
4	4	3	85	150	0.87832	2.0508
4	4	3	90	150	0.89097	1.8935
5	2	3	5	150	.	.
5	2	3	10	150	.	.
5	2	3	15	150	.	.
5	2	3	20	150	.	.
5	2	3	25	150	.	.
5	2	3	30	150	.	.
5	2	3	35	150	.	.
5	2	3	40	150	.	.
5	2	3	45	150	.	.
5	2	3	50	150	.	.
5	2	3	55	150	.	.
5	2	3	60	150	.	.
5	2	3	65	150	.	.
5	2	3	70	150	.	.
5	2	3	75	150	.	.
5	2	3	80	150	.	.
5	2	3	85	150	.	.
5	2	3	90	150	.	.
6	3	2	5	150	0.13384	1.4209
6	3	2	10	150	0.20917	1.1906
6	3	2	15	150	0.27489	1.3564
6	3	2	20	150	0.30967	1.4648
6	3	2	25	150	0.33886	1.7701
6	3	2	30	150	0.35966	2.1109

6	3	2	35	150	0.3774	1.37
6	3	2	40	150	0.37897	2.7948
6	3	2	45	150	0.42526	1.486
6	3	2	50	150	0.43655	1.7156
6	3	2	55	150	0.44656	3.5339
6	3	2	60	150	0.46826	2.1388
6	3	2	65	150	0.42778	2.6011
6	3	2	70	150	0.40895	4.0048
6	3	2	75	150	0.48753	1.5104
6	3	2	80	150	0.5105	1.8399
6	3	2	85	150	0.58817	3.4072
6	3	2	90	150	0.59606	1.3694
7	4	3	5	150	0.19628	1.06
7	4	3	10	150	0.30546	0.62
7	4	3	15	150	0.27975	0.98
7	4	3	20	150	0.35519	0.71
7	4	3	25	150	0.37574	0.73
7	4	3	30	150	0.41033	1.27
7	4	3	35	150	0.45719	0.64
7	4	3	40	150	0.47209	0.9
7	4	3	45	150	0.54986	0.4
7	4	3	50	150	0.60341	0.63
7	4	3	55	150	0.61719	0.81
7	4	3	60	150	0.63977	1.52
7	4	3	65	150	0.65475	0.99
7	4	3	70	150	0.72413	0.69
7	4	3	75	150	0.77097	0.75
7	4	3	80	150	0.79895	0.56
7	4	3	85	150	0.85127	1.5
7	4	3	90	150	0.89217	1
8	4	1	5	150	0.29846	0.7171
8	4	1	10	150	0.39351	1.0379
8	4	1	15	150	0.3991	1.42
8	4	1	20	150	0.5381	1.7054
8	4	1	25	150	0.57443	1.6395
8	4	1	30	150	0.62737	1.1834
8	4	1	35	150	0.60576	1.257
8	4	1	40	150	0.61683	1.4029
8	4	1	45	150	0.66097	2.7446
8	4	1	50	150	0.728	1.4635
8	4	1	55	150	0.69024	0.9132
8	4	1	60	150	0.69685	1.3669
8	4	1	65	150	0.72327	1.5248
8	4	1	70	150	0.79518	1.7739
8	4	1	75	150	0.79947	1.7294
8	4	1	80	150	0.85425	1.6575
8	4	1	85	150	0.88036	1.9417
8	4	1	90	150	0.89901	1.6925
9	1	1	5	150	0.15081	1.6685
9	1	1	10	150	0.24085	1.4667

9	1	1	15	150	0.21875	1.6245
9	1	1	20	150	0.17682	2.0242
9	1	1	25	150	0.26012	2.5906
9	1	1	30	150	0.32543	1.969
9	1	1	35	150	0.32277	1.4102
9	1	1	40	150	0.34012	1.6798
9	1	1	45	150	0.36169	1.7347
9	1	1	50	150	0.35967	2.0246
9	1	1	55	150	0.36703	1.5624
9	1	1	60	150	0.45554	1.3157
9	1	1	65	150	0.54768	1.5617
9	1	1	70	150	0.46454	1.418
9	1	1	75	150	0.5824	1.9587
9	1	1	80	150	0.48019	2.6121
9	1	1	85	150	0.49584	3.5926
9	1	1	90	150	0.67536	1.6846
10	1	3	5	150	0.11948	0.3178
10	1	3	10	150	0.33029	0.2543
10	1	3	15	150	0.40429	1.1581
10	1	3	20	150	0.53149	0.9779
10	1	3	25	150	0.613	1.1855
10	1	3	30	150	0.63934	0.5359
10	1	3	35	150	0.68756	0.9802
10	1	3	40	150	0.78158	1.3844
10	1	3	45	150	0.77645	1.1017
10	1	3	50	150	0.74071	1.2219
10	1	3	55	150	0.83463	1.9357
10	1	3	60	150	0.84703	1.3652
10	1	3	65	150	0.88525	1.9526
10	1	3	70	150	0.8784	1.7674
10	1	3	75	145	0.90816	1.2799
10	1	3	80	141	0.93304	0.9229
10	1	3	85	137	0.98274	0.4472
10	1	3	90	135	0.97828	2.3109
11	2	2	5	150	0.09497	0.3769
11	2	2	10	150	0.15823	0.75
11	2	2	15	150	0.24436	0.1157
11	2	2	20	150	0.27109	0.69
11	2	2	25	150	0.28036	1.13
11	2	2	30	150	0.32602	0.7
11	2	2	35	150	0.34986	1.44
11	2	2	40	150	0.40465	0.52
11	2	2	45	150	0.47028	0.1292
11	2	2	50	150	0.54248	1.13
11	2	2	55	150	0.60363	0.616
11	2	2	60	150	0.6674	1.46
11	2	2	65	150	0.72724	1.54
11	2	2	70	150	0.78523	0.99
11	2	2	75	150	0.82671	1.56
11	2	2	80	147	0.8751	0.3178

11	2	2	85	146	0.91634	1.59
11	2	2	90	145	0.92139	1.1675
12	3	1	5	150	0.26004	0.619
12	3	1	10	150	0.35039	0.8407
12	3	1	15	150	0.41626	1.09
12	3	1	20	150	0.50793	0.89
12	3	1	25	150	0.52342	0.58
12	3	1	30	150	0.53367	0.9126
12	3	1	35	150	0.51054	1.2
12	3	1	40	150	0.52251	1.84
12	3	1	45	150	0.5225	0.99
12	3	1	50	150	0.75022	1.02
12	3	1	55	150	0.79216	0.8347
12	3	1	60	150	0.82771	1.0456
12	3	1	65	148	0.85779	0.81
12	3	1	70	140	0.9018	1.61
12	3	1	75	137	0.93498	0.92
12	3	1	80	135	0.95872	0.9718
12	3	1	85	132	0.94798	0.48
12	3	1	90	129	0.96756	1.46

Filtered Runoff

Plot	Trt	Rep	Time	Total P	Ortho P	Total IN	NH4-N	NO3-N
1	2		132:30	0.041	0.032	6.82	0.21	6.61
1	2		137:30	0.068	0.051	6.74	0.14	6.60
1	2		142:30	0.065	0.047	7.45	0.26	7.19
1	2		147:30	0.095	0.084	7.14	0.15	6.99
1	2		152:30	0.042	0.039	7.46	0.12	7.34
1	2		157:30	0.072	0.060	7.28	0.12	7.16
1	2		162:30	0.053	0.037	6.91	0.07	6.84
1	2		167:30	0.099	0.084	6.81	0.08	6.73
1	2		172:30	0.051	0.031	6.77	0.03	6.74
1	2		177:30	0.090	0.087	6.73	0.05	6.68
1	2		182:30	0.075	0.073	6.76	0.12	6.64
1	2		187:30	.	.	.	.	.
2	1		232:30	0.070	0.055	6.62	0.18	6.44
2	1		237:30	0.055	0.053	6.44	0.09	6.35
2	1		242:30	0.073	0.052	6.40	0.16	6.24
2	1		247:30	0.077	0.056	6.90	0.55	6.35
2	1		252:30	0.074	0.063	6.75	0.11	6.64
2	1		257:30	0.075	0.063	7.01	0.28	6.73
2	1		262:30	0.070	0.051	6.96	0.08	6.88
2	1		267:30	0.062	0.055	6.86	0.10	6.76
2	1		272:30	0.078	0.062	6.71	0.06	6.65

2	1	277:30	0.083	0.064	6.79	0.09	6.70
2	1	282:30	0.094	0.079	6.61	0.04	6.57
2	1	287:30	0.063	0.057	6.64	0.04	6.60
3	3	332:30	0.032	0.025	6.20	0.30	5.90
3	3	337:30	0.065	0.052	6.29	0.10	6.19
3	3	342:30	0.072	0.062	6.45	0.12	6.33
3	3	347:30	0.072	0.060	6.67	0.20	6.47
3	3	352:30	0.073	0.060	6.55	0.05	6.50
3	3	357:30	0.075	0.071	6.61	0.14	6.47
3	3	362:30	0.092	0.084	6.73	0.15	6.58
3	3	367:30	0.081	0.075	6.73	0.11	6.62
3	3	372:30	0.088	0.072	6.60	0.07	6.53
3	3	377:30	0.075	0.067	6.49	0.08	6.41
3	3	382:30	0.083	0.079	6.38	0.09	6.29
3	3	387:30	0.073	0.064	6.47	0.14	6.33
4	4	332:30	0.029	0.017	6.18	0.40	5.78
4	4	337:30	0.020	0.015	6.36	0.44	5.92
4	4	342:30	0.061	0.043	6.31	0.24	6.07
4	4	347:30	0.063	0.055	6.55	0.18	6.37
4	4	352:30	0.048	0.031	6.43	0.20	6.23
4	4	357:30	0.072	0.060	6.65	0.22	6.43
4	4	362:30	0.065	0.049	6.61	0.25	6.36
4	4	367:30	0.065	0.050	6.64	0.19	6.45
4	4	372:30	.	.	.	.	.
4	4	377:30	0.079	0.063	6.65	0.10	6.55
4	4	382:30	0.052	0.038	6.65	0.15	6.50
4	4	387:30	0.050	0.033	6.53	0.08	6.45
5	2	332:30	0.043	0.03	6.29	0.30	5.99
5	2	337:30	0.033	0.028	6.49	0.21	6.28
5	2	342:30	0.047	0.031	6.16	0.23	5.93
5	2	347:30	0.050	0.034	6.63	0.28	6.35
5	2	352:30	0.082	0.072	6.30	0.18	6.12
5	2	357:30	0.083	0.067	6.51	0.23	6.28
5	2	362:30	0.14	0.118	6.57	0.10	6.47
5	2	367:30	0.082	0.064	6.80	0.27	6.53
5	2	372:30	0.111	0.095	6.65	0.17	6.48
5	2	377:30	0.063	0.051	6.60	0.15	6.45
5	2	382:30	0.066	0.052	6.55	0.12	6.43
5	2	387:30	0.056	0.044	6.32	0.07	6.25
6	3	232:30	0.018	0.004	6.74	0.25	6.49
6	3	237:30	0.015	0.001	6.89	0.32	6.57

6	3	242:30	0.010	0.005	6.79	0.23	6.56
6	3	247:30	0.046	0.034	6.78	0.22	6.56
6	3	252:30	0.039	0.019	6.75	0.16	6.59
6	3	257:30	0.047	0.018	7.15	0.53	6.62
6	3	262:30	0.048	0.033	6.93	0.28	6.65
6	3	267:30	0.029	0.015	6.94	0.29	6.65
6	3	272:30	0.025	0.001	7.04	0.43	6.61
6	3	277:30	0.038	0.022	6.98	0.33	6.65
6	3	282:30	0.041	0.004	6.90	0.31	6.59
6	3	287:30	0.014	0.001	6.85	0.22	6.63
7	4	232:30	0.042	0.035	7.13	0.23	6.90
7	4	237:30	0.048	0.042	6.98	0.18	6.80
7	4	242:30	0.058	0.050	6.97	0.17	6.80
7	4	247:30	0.047	0.040	6.89	0.24	6.65
7	4	252:30	0.057	0.043	6.88	0.13	6.75
7	4	257:30	0.068	0.045	6.85	0.21	6.64
7	4	262:30	0.058	0.043	6.77	0.19	6.58
7	4	267:30	0.091	0.071	6.77	0.28	6.49
7	4	272:30	0.073	0.058	7.07	0.56	6.51
7	4	277:30	0.069	0.055	6.65	0.23	6.42
7	4	282:30	0.082	0.070	6.79	0.40	6.39
7	4	287:30	0.055	0.045	6.61	0.25	6.36
8	4	132:30	0.042	0.031	7.37	0.29	7.08
8	4	137:30	0.058	0.045	7.07	0.16	6.91
8	4	142:30	0.051	0.041	7.06	0.21	6.85
8	4	147:30	0.053	0.043	7.09	0.22	6.87
8	4	152:30	0.052	0.044	7.13	0.28	6.85
8	4	157:30	0.082	0.064	7.61	0.76	6.85
8	4	162:30	0.078	0.062	7.08	0.24	6.84
8	4	167:30	0.063	0.051	6.92	0.08	6.84
8	4	172:30	0.078	0.062	6.96	0.15	6.81
8	4	177:30	0.062	0.050	6.92	0.13	6.79
8	4	182:30	0.078	0.066	6.92	0.14	6.78
8	4	187:30	0.075	0.063	7.00	0.20	6.80
9	1	132:30	0.025	0.017	6.49	0.36	6.13
9	1	137:30	0.033	0.010	6.56	0.27	6.29
9	1	142:30	0.025	0.019	6.82	0.32	6.50
9	1	147:30	0.037	0.029	6.79	0.27	6.52
9	1	152:30	0.021	0.009	6.71	0.13	6.58
9	1	157:30	0.028	0.015	6.74	0.21	6.53
9	1	162:30	0.050	0.042	6.63	0.22	6.41

9	1	167:30	0.042	0.025	6.63	0.16	6.47
9	1	172:30	0.029	0.018	6.72	0.18	6.54
9	1	177:30	0.035	0.025	6.56	0.19	6.37
9	1	182:30	0.024	0.019	6.65	0.17	6.48
9	1	187:30	0.035	0.026	6.55	0.13	6.42
10	1	332:30	0.044	0.031	6.56	0.08	6.48
10	1	337:30	0.062	0.056	6.72	0.15	6.57
10	1	342:30	0.054	0.051	6.71	0.13	6.58
10	1	347:30	0.043	0.037	6.75	0.10	6.65
10	1	352:30	0.062	0.060	6.94	0.17	6.77
10	1	357:30	0.058	0.056	6.99	0.18	6.81
10	1	362:30	0.052	0.047	6.82	0.09	6.73
10	1	367:30	0.085	0.070	6.87	0.10	6.77
10	1	372:30	0.071	0.065	6.86	0.11	6.75
10	1	377:30	0.051	0.042	6.86	0.10	6.76
10	1	382:30	0.045	0.040	6.84	0.10	6.74
10	1	387:30	0.069	0.063	6.79	0.13	6.66
11	2	232:30	0.038	0.029	7.16	0.51	6.65
11	2	237:30	0.048	0.041	7.02	0.40	6.62
11	2	242:30	0.028	0.021	7.00	0.37	6.63
11	2	247:30	0.013	0.001	7.23	0.67	6.56
11	2	252:30	0.038	0.024	6.93	0.30	6.63
11	2	257:30	0.036	0.021	6.86	0.31	6.55
11	2	262:30	0.022	0.011	6.86	0.28	6.58
11	2	267:30	0.025	0.012	6.90	0.32	6.58
11	2	272:30	0.024	0.011	6.95	0.38	6.57
11	2	277:30	0.028	0.014	6.86	0.21	6.65
11	2	282:30	0.021	0.013	6.84	0.24	6.60
11	2	287:30	0.062	0.054	6.92	0.20	6.72
12	3	132:30	0.065	0.053	7.02	0.35	6.67
12	3	137:30	0.055	0.032	7.07	0.34	6.73
12	3	142:30	0.074	0.061	7.22	0.45	6.77
12	3	147:30	0.042	0.039	7.01	0.31	6.70
12	3	152:30	0.063	0.053	6.91	0.19	6.72
12	3	157:30	0.082	0.071	6.95	0.17	6.78
12	3	162:30	0.070	0.055	7.07	0.25	6.82
12	3	167:30	0.088	0.073	7.07	0.25	6.82
12	3	172:30	0.098	0.088	7.10	0.30	6.80
12	3	177:30	0.072	0.062	7.05	0.27	6.78
12	3	182:30	0.075	0.060	7.15	0.37	6.78
12	3	187:30	0.082	0.073	7.09	0.34	6.75

Unfiltered Runoff

Plot	Trt	Rep	Start time	TP mg/L	TN mg/L
	1	2	132:30	1.1085	10.25
	1	2	137:30	0.89745	9.71
	1	2	142:30	1.8445	10.92
	1	2	147:30	1.9535	10.18
	1	2	152:30	0.63675	10.76
	1	2	157:30	0.8798	10.48
	1	2	162:30	1.882	10.7
	1	2	167:30	0.84385	10.2
	1	2	172:30	0.8598	11.19
	1	2	177:30	1.718	11.97
	1	2	182:30	1.312	10.93
	1	2	187:30	.	.
	2	1	232:30	1.375	9.75
	2	1	237:30	1.346	9.38
	2	1	242:30	2.2355	9.55
	2	1	247:30	2.0495	10.07
	2	1	252:30	1.0265	10.36
	2	1	257:30	1.279	10.26
	2	1	262:30	1.2255	10.1
	2	1	267:30	1.121	10.29
	2	1	272:30	1.137	9.79
	2	1	277:30	1.3315	10.8
	2	1	282:30	1.437	10.74
	2	1	287:30	1.1485	10.6
	3	3	332:30	1.3093	11.09
	3	3	337:30	1.1506	10.75
	3	3	342:30	1.8065	10.6
	3	3	347:30	1.237	10.03
	3	3	352:30	1.1445	9.57
	3	3	357:30	1.493	9.68
	3	3	362:30	1.5305	10.09
	3	3	367:30	1.2905	10.51
	3	3	372:30	1.492	10.31
	3	3	377:30	1.5645	9.72
	3	3	382:30	1.621	10.57
	3	3	387:30	1.7115	10.23
	4	4	332:30	0.779	8.53
	4	4	337:30	0.82665	8.58
	4	4	342:30	1.02485	8.76
	4	4	347:30	1.1435	10.3
	4	4	352:30	0.3311	8.67
	4	4	357:30	0.36485	9.11
	4	4	362:30	0.21435	9.45
	4	4	367:30	0.186	9.34
	4	4	372:30	.	.
	4	4	377:30	1.3174	10.16

4	4	382:30	1.0573	10.15
4	4	387:30	1.2265	8.89
5	2	332:30	.	.
5	2	337:30	0.9821	9.87
5	2	342:30	.	.
5	2	347:30	1.278	9.85
5	2	352:30	0.95885	9.41
5	2	357:30	.	.
5	2	362:30	.	.
5	2	367:30	.	.
5	2	372:30	0.87065	10.04
5	2	377:30	1.2091	9.48
5	2	382:30	0.9755	9.29
5	2	387:30	1.02605	9.58
6	3	232:30	0.6844	8.57
6	3	237:30	0.8919	9.47
6	3	242:30	0.9626	9.4
6	3	247:30	.	.
6	3	252:30	1.0755	9.87
6	3	257:30	0.31735	10.2
6	3	262:30	0.44175	10.07
6	3	267:30	0.30955	9.84
6	3	272:30	0.3618	9.42
6	3	277:30	.	.
6	3	282:30	0.44595	8.95
6	3	287:30	0.4774	8.89
7	4	232:30	0.9232	10.38
7	4	237:30	0.8365	9.77
7	4	242:30	1.08345	10.03
7	4	247:30	1.044	9.9
7	4	252:30	1.1425	10.32
7	4	257:30	0.75695	9.54
7	4	262:30	0.8583	9.9
7	4	267:30	1.01255	9.6
7	4	272:30	0.9847	10.15
7	4	277:30	0.96715	10.16
7	4	282:30	1.1064	9.98
7	4	287:30	0.93445	9.8
8	4	132:30	1.847	11.89
8	4	137:30	1.882	10.97
8	4	142:30	1.842	11.46
8	4	147:30	1.1385	10.4
8	4	152:30	1.715	11.01
8	4	157:30	2.84	12.1
8	4	162:30	1.9715	10.57
8	4	167:30	1.646	10.7
8	4	172:30	1.6695	10.61
8	4	177:30	0.89585	10.76
8	4	182:30	1.5855	10.82
8	4	187:30	1.578	11.42

9	1	132:30	0.7838	9.63
9	1	137:30	0.4761	9.35
9	1	142:30	0.66895	9.9
9	1	147:30	0.45375	9.91
9	1	152:30	0.7474	9.41
9	1	157:30	0.86385	9.9
9	1	162:30	1.1808	9.76
9	1	167:30	0.6329	9.57
9	1	172:30	0.6684	9.66
9	1	177:30	0.99585	9.46
9	1	182:30	1.0439	9.2
9	1	187:30	0.9371	9.18
10	1	332:30	0.8969	9.79
10	1	337:30	0.9022	9.83
10	1	342:30	0.9478	9.91
10	1	347:30	0.7274	9.89
10	1	352:30	0.9332	9.83
10	1	357:30	0.81525	10.05
10	1	362:30	1.037	10.3
10	1	367:30	0.90885	10.2
10	1	372:30	0.89725	10.23
10	1	377:30	1.1874	10.24
10	1	382:30	1.0297	10.45
10	1	387:30	1.02065	9.59
11	2	232:30	.	.
11	2	237:30	.	.
11	2	242:30	1.062	10.15
11	2	247:30	0.8199	10.24
11	2	252:30	0.89865	9.74
11	2	257:30	0.9313	9.68
11	2	262:30	0.36675	9.54
11	2	267:30	0.8722	9.64
11	2	272:30	0.86825	9.57
11	2	277:30	1.00765	9.16
11	2	282:30	1.05155	10.08
11	2	287:30	1.0834	10.25
12	3	132:30	1.2245	9.87
12	3	137:30	1.172	10.01
12	3	142:30	1.6495	10.24
12	3	147:30	1.4355	9.87
12	3	152:30	1.216	10.15
12	3	157:30	1.335	10.27
12	3	162:30	1.804	10.62
12	3	167:30	1.1665	10.19
12	3	172:30	1.045	10.54
12	3	177:30	1.093	10.53
12	3	182:30	1.1055	11.17
12	3	187:30	1.3025	10.57