Fall 2006

VOLUMES 8.1 and 8.2

COOPERATIVE EXTENSION
UNIVERSITY OF CALIFORNIA

CO-HORT

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Development of BMPs for Fertilizing Tall Fescue

by
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The problem addressed by this project is potential nitrate (NO_3^--N) contamination of groundwater caused by fertilization of the approximate 679,426 acres of residential yards in California. On a statewide basis, residential yards are the largest component of urban landscapes and lawns are the largest component of residential yards. Thus, a project involving the development of best management practices (BMPs) for fertilizing lawns to optimize plant performance and nitrogen (N) uptake while reducing the potential for NO_3^--N leaching focuses on a potential urban source of NO_3^--N contamination of groundwater. Since the project involves research sites in southern and northern California and will be on tall fescue, the most widely used lawngrass in California, the impact of this project will be on a statewide basis.

Petrovic prepared a review paper entitled “The fate of nitrogenous fertilizers applied to turfgrass.” He summarized 11 papers on NO_3^--N leaching from fertilizers applied to turfgrass. He concluded that leaching of fertilizer N applied to turfgrass has been shown to be highly influenced by: soil texture; N source, rate, and timing; and irrigation and rainfall. If a significantly higher than normal rate of a soluble N source is applied to a sandy turfgrass site that is highly irrigated, significant NO_3^--N leaching could occur. However, limiting irrigation to only replace moisture used by the plant, using slow-release N sources, and using less sandy soils will significantly reduce or eliminate NO_3^--N leaching from turfgrass sites. Other research has shown that there is a negligible chance of NO_3^--N leaching from turfgrass. However, these findings are normally conditional as follows: water soluble fertilizers are not applied in excess; sandy soils are not heavily irrigated; turfgrass is well maintained using standard agronomic practices including judicious use of fertilizers and irrigation; the turfgrass is not immature and the soil is not disturbed such as during establishment; and root absorption is not low because of dormancy, stress, or because of unhealthy turfgrass. In reality, home-lawn owners may cause NO_3^--N contamination of groundwater because they do not meet all the conditions that are required to not cause NO_3^--N contamination of groundwater.

This project will add to our current understanding of NO_3^--N leaching from turfgrass because we have not been able to find much work with tall fescue. Therefore, the information will be new, especially determining the best way to fertilize tall fescue grown in California for optimal plant performance and N uptake while reducing the potential for NO_3^--N contamination of groundwater.

OBJECTIVES

The objectives of the research project are to 1) evaluate the annual N rate and source on tall fescue to determine which treatments optimize plant performance and N uptake while reducing the potential for NO_3^--N leaching 2) quantify the effect of N fertilizer rate and source on: visual turfgrass quality and color; clipping yield, concentration of N in clipping tissue, and N uptake; concentration of NO_3^--N and NH_4^+-N in leachate at a depth below the rootzone; and concentration of NO_3^--N and NH_4^+-N in soil 3) develop BMPs for lawns under representative irrigation practices to optimize plant performance and N uptake while reducing the potential for NO_3^--N leaching and 4) conduct outreach activities, including oral presentations and trade journal publications, emphasizing the importance of the BMPs and how to carry out these practices for N fertilization of lawns.

DESCRIPTION

The project is being conducted at two sites with different climates and turfgrass maturity, but which are being maintained similarly. One site is a newly established tall fescue plot (sodded late Sept. 2002) in northern California at UC Davis and the other is a mature tall fescue plot (seeded Apr. 1996) in southern California at UC Riverside. Both sites were established to tall fescue, since it is the most widely used lawngrass in California, especially for urban landscapes. The plots at both sites are being irrigated at 110% CIMIS ET_o (California Irrigation Management and Irrigation System), with the amount of irrigation determined weekly based on the previous 7-day cumulative CIMIS ET_o (rainfall may cause the cancellation of irrigation events). There are three irrigation events per week, which are cycled to prevent runoff. The experimental design at both sites is a randomized complete block (RCB) with N treatments arranged in a 4×3 factorial (four N sources and three rates) (Table 1). A no-nitrogen check treatment is also included to allow for additional statistical comparisons. Therefore, there are 13 treatments which include 12 fertilizer treatments and a check treatment. Nitrogen treatments are being applied from 15 Oct. 2002 to 15 Aug. 2004 at UC Riverside and from 15 May 2003 to 15 Oct. 2005 at UC Davis.

During the 24-month field phase of this study, several measurements are being collected, including visual ratings, NO_3^--N and NH_4^+-N concentrations of soil water below the rootzone, and others (Table 2). Measurements are being taken from Oct. 2002 to Oct. 2004 at UC Riverside and from Dec. 2003 to Nov. 2005 at UC Davis.

Table 1. Protocol for 13 treatments for the tall fescue BMP fertilization study.

Date of application	N source[z] (N-P_2O_5-K_2O)	Rate (lb N/1000 ft^2) a	b	c
1 Mar.	No nitrogen check	0.0	0.0	0.0
	A. Ammonium nitrate 34-0-0	1.0	1.5	2.0
	B. Polyon 43-0-0	1.0	1.5	2.0
	C. Milorganite 6-2-0	1.0	1.5	2.0
	D. Nutralene 40-0-0	1.0	1.5	2.0
15 May	No nitrogen check	0.0	0.0	0.0
	A. Ammonium nitrate 34-0-0	1.0	1.5	2.0
	B. Polyon 42-0-0	1.0	1.5	2.0
	C. Milorganite 6-2-0	1.0	1.5	2.0
	D. Nutralene 40-0-0	1.0	1.5	2.0
15 Aug.	No nitrogen check	0.0	0.0	0.0
	A. Ammonium nitrate 34-0-0	1.0	1.5	2.0
	B. Polyon 42-0-0	1.0	1.5	2.0
	C. Milorganite 6-2-0	1.0	1.5	2.0
	D. Nutralene 40-0-0	1.0	1.5	2.0
15 Oct.	No nitrogen check	0.0	0.0	0.0
	A. Ammonium nitrate 34-0-0	1.0	1.5	2.0
	B. Polyon 43-0-0	1.0	1.5	2.0
	C. Milorganite 6-2-0	1.0	1.5	2.0
	D. Nutralene 40-0-0	1.0	1.5	2.0
Total	No nitrogen check	0.0	0.0	0.0
	A. Ammonium nitrate 34-0-0	4.0	6.0	8.0
	B. Polyon 43-0-0 and 42-0-0	4.0	6.0	8.0
	C. Milorganite 6-2-0	4.0	6.0	8.0
	D. Nutralene 40-0-0	4.0	6.0	8.0

[z] Ammonium nitrate is a fast-release, water soluble N source; Polyon is a slow-release, polymer-coated N source; Milorganite is a slow-release, natural organic N source; and Nutralene is a slow-release, water insoluble, methylene ureas N source.

Note: Potassium sulfate (0-0-50) and treble superphosphate (0-45-0) will be applied to all plots at an annual rate of 4.0 lb K_2O/1000 ft^2 and 3.0 lb P_2O_5/1000 ft^2.

RESULTS AND DISCUSSION

UC Riverside

This report briefly covers three important measurements that are being taken during this study: visual turfgrass quality ratings, concentration of NO_3^--N in leachate, and concentration of NO_3^--N and NH_4^+-N in soil.

Visual turfgrass quality ratings

Visual turfgrass quality ratings measure appear-

Table 2. Protocol for measurements collected during the tall fescue BMP fertilization study.

Measurement	Frequency	Method and other comments
1. Visual turfgrass quality	Once every 2 weeks	1 to 9 scale, with 1 = worst quality, 5 = minimally acceptable quality, and 9 = best quality for tall fescue
2. Visual turfgrass color	Same time as turfgrass quality	1 to 9 scale, with 1 = worst color (brown), 5 = minimally acceptable color, and 9 = best color (dark green) for tall fescue
3. Clipping yield, TKN, and N uptake	Four growth periods, with each period spanning four consecutive weekly clipping yields. All periods start one month following each of the four N-fertility treatment application dates (Table 1). Generally, periods are: 1 Apr. to 30 Apr.; 15 June to 15 July; 15 Sept. to 15 Oct.; and 15 Nov. to 15 Dec.	Weekly clipping yield, representing 7-day growth, is collected from 9.2 ft^2 (26% of the total surface area) from each plot with the same mower used for routine mowing, except a specially constructed collection box is attached to the mower. Weekly clipping yields are dried at 60 to 67 ºC in a forced-air oven for 48 hours and immediately weighed. Yield reported as $g \cdot m^{-2}$. The four weekly yields within each growth period are pooled by the 52 plots and ground. TKN analysis is conducted at the DANR laboratory located at UC Davis. With appropriate calculations, N uptake during four 4-week growth periods is determined.
4. NO_3^--N and NH_4^+-N concentration of soil water below rootzone	Once every 2 weeks	One suction plate lysimeter was installed in each plot so the distal tip of the lysimeter cup is at a depth of 2.5 ft below the soil-thatch layer (approximately 0.6 inch deep). The lysimeters were installed at a 45º angle so the lysimeter cup is below undisturbed soil. They were constructed using high-flow ceramic cups (round bottom neck top cups, 1.9-inch diameter, Soil Moisture Equipment Corp. catalog number 653X01-B01M3) and 2-inch diameter PVC pipe. A vacuum of approximately –40 KPa is applied to the lysimeters 24 h before the leachate sampling day. Samples are acidified to pH 2.4-2.8, frozen, and stored until shipped via next-day air to the DANR Laboratory, then stored at 4 ºC until analyzed for NO_3^--N and NH_4^+-N by flow injection analyzer method. Analysis occurs within 28 days of leachate collection.
5. Soil water content	Once every 7 days	Volumetric soil water content is determined from the 0- to 48-inch soil depth zone at the same time each Wednesday using four time domain reflectometry (TDR) sensors (MoisturePoint MP-917 TDR unit with Type 2 probe) installed in four null plots within the research plot. The most recent irrigation event is on Tuesday mornings.
6. NO_3^--N and NH_4^+-N concentration in soil	Beginning of study (20 Dec. 2002) and at 12 months (1 Oct. 2003) and 24 months (1 Oct. 2004) after initial fertilizer treatments	Two soil cores are taken from each plot and separated into two soil depth zones for the initial sampling: 0 to 12 inches and 12 to 30 inches. For the second and third sampling, cores are separated into three soil depth zones: 0 to 12 inches, 12 to 24 inches, and 24 to 36 inches. A grid is used to ensure that no part of the plot is sampled more than once for the duration of the study. Cores from each plot are pooled by depth; 6 g soil from each plot and depth zone is immediately placed in 40 ml of 2 M KCl to begin the extraction process. Standard procedures are followed to determine NO_3^--N and NH_4^+-N concentration on a dry soil basis.
7. Weather data	Continuous	Data obtained from a CIMIS station located at the UCR Turfgrass Research Project. Soil-temperature data loggers also are installed on the research plot.
8. Statistical procedures (to date)		Most measured variables are statistically analyzed according to a RCB design with 12 treatments arranged in a 4×3 factorial. When the no-nitrogen check treatment is included, a RCB design is used to analyze all 13 treatments. Overall analyses involved a repeated measures design, with measurement date as the repeated measures factor.

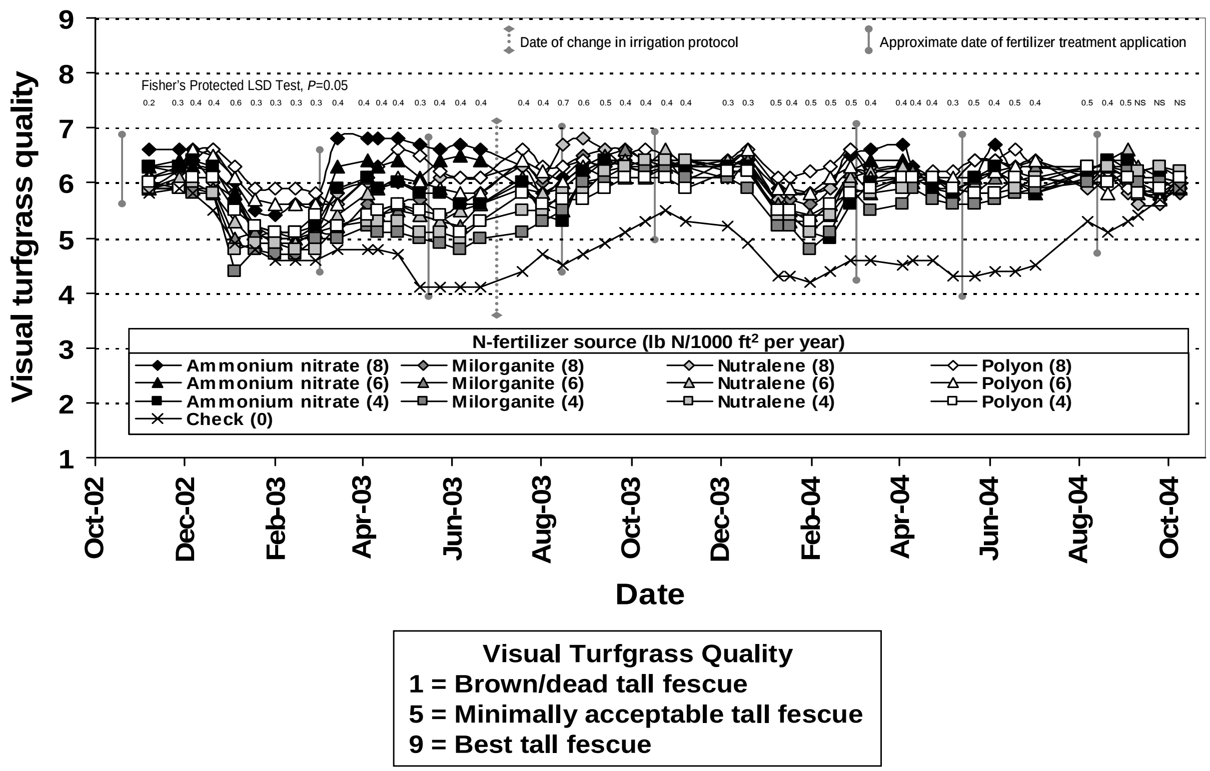
ance based on several characteristics that normally include color, texture (leaf width and length), uniformity, and density. It should be noted that each characteristic also can be rated by visual means.

This report covers data and analyses of visual turfgrass quality for 48 rating dates, taken from 6 Nov. 2002 to 8 Oct. 2004 (Fig. 1).

In terms of overall analyses of 13 treatments, all fertilizer treatments were within range of an acceptable tall fescue lawn. This assumes that most people are satisfied with a tall fescue lawn when visual turfgrass quality is within the range of 5.5 to 6.5 (1 to 9 scale, with 1 = worst, 5 = minimally acceptable, and 9 = best tall fescue). Overall visual turfgrass quality ranged from 5.5 for Milorganite at an annual N rate of 4.0 lb/1000 ft^2 to 6.2 for ammonium nitrate and Polyon at an annual N rate of 8.0 lb/1000 ft^2; the check treatment was 4.8.

In terms of overall analyses of 12 fertilizer treatments, arranged in a 4×3 factorial design, ammonium nitrate and Polyon produced overall visual turfgrass quality of 6.0 while Milorganite and Nutralene produced 5.8 and 5.9, respectively. Also, annual N rates of 8, 6, and 4 lb/1000 ft^2 produced overall visual turfgrass quality of 6.1, 5.9, and 5.7,

Figure 1. The effect of 13 treatments on visual turfgrass quality of tall fescue from 6 Nov. 2002 to 8 Oct. 2004.



respectively.

In terms of 48 rating dates, all fertilizer treatments resulted in a visual turfgrass quality rating ≥ 5.5 on 50% or more rating dates. Fertilizer treatments that resulted in a visual turfgrass quality rating ≥ 6.0 on 50% or more rating dates included all fertilizer sources at the annual N rate of 8.0 lb/1000 ft^2; all fertilizer sources at the annual N rate of 6.0

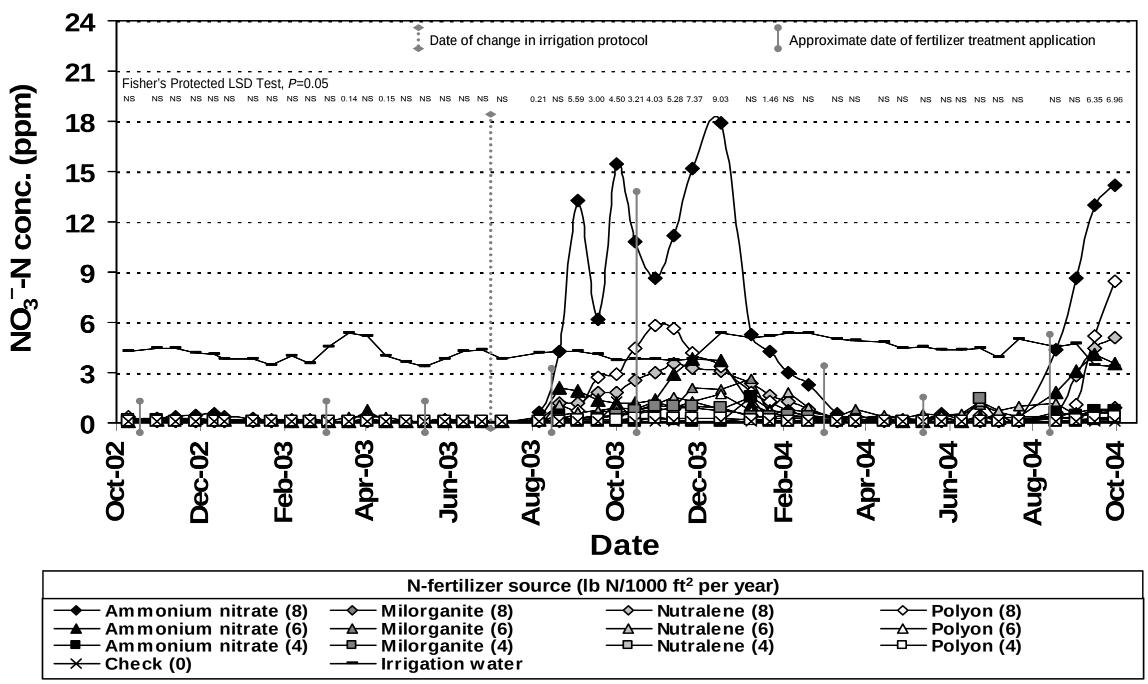
lb/1000 ft^2, except for Nutralene; and only one fertilizer source (ammonium nitrate) at the annual N rate of 4.0 lb/1000 ft^2.

Concentration of NO_3^--N in leachate

Data for NO_3^--N concentrations in leachate on 48 sample dates from 9 Oct. 2002 to 29 Sept. 2004 are shown in Fig. 2.

These data were affected by a change in irrigation protocol on 2 July 2003. From 16 Oct. 2002 to 1 July 2003, the protocol was (100% ET_{crop}/DU) minus rainfall, based on the previous 7-day cumulative CIMIS ET_o. The goal of this protocol was to irrigate according to plant water use needs and not to over-irrigate nor under-irrigate. However, we gradually realized that in making up rainfall, we may have caused some dry soil conditions, especially in the 0- to 6-inch soil depth zone. However, visual drought symptoms were not apparent on all dates, when visual turfgrass quality and color ratings were taken. To alleviate this situation of trying to micromanage a plot that was maintained on the "edge" in terms of plant water use and soil water depletion, we decided to fall back on our historical knowledge of maintaining tall fescue during the summer in Riverside; that is 110% CIMIS ET_o, based on the previous 7-day cumulative CIMIS ET_o. Thus, we initiated the new irrigation protocol on 2 July 2003 and continued it until the end of the field study which was 12 Oct. 2004.

Figure 2. The effect of 13 treatments on NO_3^--N concentration in leachate from 9 Oct. 2002 to 29 Sept. 2004.



During minimalist irrigation from 16 Oct. 2002 to 1 July 2003, NO_3^--N concentrations in leachate were low (< 1 ppm) and differences among treatments were basically not significant. It should be noted that the average NO_3^--N concentration of irrigation water was 4.3 ppm.

During well-watered irrigation from 2 July 2003 to 29 Sept. 2004, NO_3^--N concentration in leachate was higher than the previous period. However, concentrations are probably not problematic except for one fertilizer treatment: ammonium nitrate at an annual N rate of 8.0 lb/1000 ft^2 (four applications at a N rate of 2.0 lb/1000 ft^2). On several sample dates during the months of September through December, NO_3^--N concentration in leachate exceeded 10 ppm. Data also showed significant N source and N rate effects on concentration of NO_3^--N in leachate. Basically, ammonium nitrate and the annual N rate of 8.0 lb/1000 ft^2 resulted in the highest concentrations of NO_3^--N in leachate.

These data concerning nitrate leaching, from a well-established tall fescue, will help support BMPs for fertilizing tall fescue lawns to optimize plant performance and nitrogen uptake while reducing the potential for nitrate leaching. Listed below are several observations.

1. Minimalist irrigation reduces the potential for nitrate leaching. However, sufficient irrigation is needed to promote healthy turfgrass.
2. An annual N rate of 4 to 6 lb/1000 ft^2 produces an acceptable to good quality tall fescue lawn. Higher rates are normally not necessary and may increase the risk of nitrate leaching.
3. Slow-release N sources (Nutralene, Milorganite, and Polyon) cause less nitrate leaching than a fast-release N source (ammonium nitrate).
4. The amount of nitrate leaching from a fast-release N source can be drastically reduced if N rates of individual applications do not exceed 1.0 to 1.5 lb/1000 ft^2.

Concentration of NO_3^--N and NH_4^+-N in soil

During the beginning of the study (20 Dec. 2002), NO_3^--N concentrations were low (< 1 ppm), fairly uniform across the plots, and slightly higher in the 12- to 30-inch soil depth zone than the 0- to 12-inch soil depth zone. Also, NH_4^+-N concentrations were low (< 1 ppm) and slightly higher in the 0- to 12-inch soil depth zone than the 12- to 30-inch soil depth zone.

During 1 year following fertilizer treatment applications (9 Oct. 2003), NO_3^--N concentrations were low (< 2 ppm) and significantly affected by the 13 treatments but not the three soil depth zones (0 to 12 inches,12 to 24 inches, and 24 to 36 inches). Also, NH_4^+-N concentrations were low (normally < 2 ppm) and not significantly affected by the 13 treatments but significantly affected by the three soil depth zones; NH_4^+-N soil concentrations were highest at the 0- to 12-inch soil depth zone.

During 2 years following fertilizer treatment applications (6 Oct. 2004), NO_3^--N concentrations were low (< 2 ppm) and significantly affected by the 13 treatments and the three soil depth zones. Also, NH_4^+-N concentrations were low (< 2 ppm) and not significantly affected by the 13 treatments but significantly affected by the three soil depth zones; NH_4^+-N soil concentrations were highest at the 0- to 12-inch soil depth zone.

UC Davis

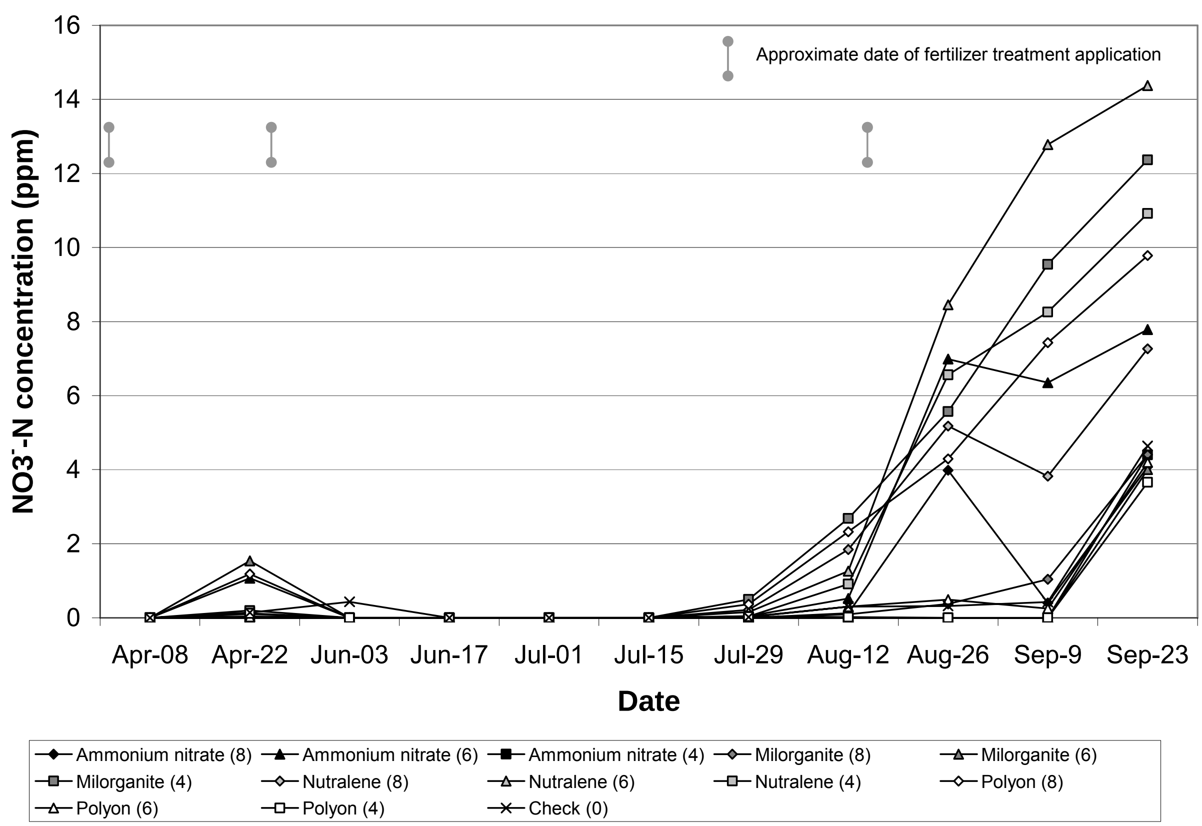
This report briefly describes the results we obtained during 2005. As in 2004 and even with prophylactic fungicide applications, *Rhizoctonia* brown patch infested much of the experimental turfgrass plot area during the early- and mid-summer months. This along with an uneven fertilizer treatment application in May 2005 prevented worthwhile color and quality evaluations. Therefore, our focus was on the regular and routine collection of soil water leachate samples for the analysis of NO_3^--N.

Concentration of NO_3^--N in leachate

Data from NO_3^--N concentrations in leachate on 11 sample dates from 8 Apr. to 23 Sept. 2005 are shown in Figure 3.

During this time period, the plots were irrigated using 110% CIMIS ET_o values obtained from a local weather station. Weekly application rates were based on the previous 7-day cumulative CIMIS ET_o values. NO_3^--N concentrations stayed low (under 2 ppm) from April to early August. A slight rise in April in response to the March fertilization was noted. In early August and in advance of the 16 Aug. fertilizer applications, leachate NO_3^--N concentrations began to increase. By mid-to-late September, several treatments had leachate NO_3^--N concentrations near or above 10 ppm. These included: Nutralene (annual N rate of 4.0, 6.0, and 8.0 lb/1000 ft^2, Milorganite (annual N rate of 4.0 lb/1000 ft^2), Polyon (annual N rate of 8.0 lb/1000 ft^2) and ammonium nitrate (annual N rate of 6.0 lb/1000 ft^2). Unlike the results at UC Riverside, the highest rate of ammonium nitrate (annual N rate of 8.0 lb/1000 ft^2) did not result in high concentrations of NO_3^--N in the leachate. The NO_3^--N concentration of the irrigation water was always below 1 ppm, except for the 23 Sept. analysis when it was 3.2 ppm.

Figure 3. The effect of 13 treatments on NO_3^--N concentrations in leachate at UC Davis from 8 Apr. to 23 Sept. 2005.



The high NO_3^--N in the leachate from the slow-release fertilizers (Nutralene and Polyon) is of concern. This result was not seen at UC Riverside and will be followed closely at UC Davis until the end of the project (late 2005).

Thanks are given to the California Department of Food and Agriculture, Fertilizer Research and Education Program (CDFA FREP) for funding this project. Thanks are also given to other researchers involved in this study who include Amber Bruno, Alberto Chavez, Melody Meyer, and John Jacobsen. This paper was adapted from a paper published in the Proceedings of the 13th Annual, CDFA FREP Conference, Nov. 30, 2005, Salinas, California, p. 8-13.

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For more information about turfgrasses in California, please see http://ucrturf.ucr.edu.

Winter weeds in turf and ornamentals

by

Milt McGiffen

For much of California there is a noticeable change from summer to fall. Within a few weeks, temperatures may change from highs in the 100's to pleasant 70's. Plant species are generally adapted for optimal growth in a specific temperature range. You may start to notice that nutsedge and Bermudagrass that were growing furiously now seem to be standing still. Weed control programs have to reflect the change in weed emergence and growth. The summer weed control programs that were in place for nutsedge or crabgrass would now do little good and should be discontinued until temperatures warm again in the spring. You will begin to notice many of the winter weeds begin to appear, such as: malva, groundsel, London rocket and other mustards, stinging nettle, pineapple weed, prickly lettuce, and sowthistle.

Hand weeding and mulches are always standard weed control methods to fall back on. Chemical controls vary with the turf or ornamental species.

For more control information, check the University of California IPM program website: http:www.ipm.ucdavis.edu/PMG/selectnewpest.landscape.html

Understanding Physical and Chemical Characteristics of Artificial Substrates

by
Donald Merhaut

The types of substrates used for the production of containerized ornamentals have changed over the years, with changes occurring as a result in fluctuations in product availability and product cost. Substrates such as peat are becoming more expensive, and the costs of peat-alternatives have come down in cost. New by-products from agricultural practices have been introduced which can easily replace peat. Of these materials, products such as composted rice hulls and the husks of coconuts (coir) have become cost-effective alternatives to peat when used properly. The following article discusses what chemical and physical parameters to consider so that you know how to choose substrates to customize your media blends based on your crop needs.

Containerized crops require different types of chemical and physical parameters since the root environment is much different: (1) there is a larger concentration of roots in a small space; and (2) containers are usually above ground, subjecting the roots and media to extreme fluctuations in temperature.

Substrate Types. There are many substrates available. The least expensive substrates are usually those that are derived from local sources. In California, many nursery growers may acquire products, such as pine bark and rice hulls, at fairly reasonable prices.

Inorganic substrates include native soils, sand, perlite, pumice, and vermiculite. Organic substrates include coir-fines, coir chips, peat, composted plant waste, pine bark, cedar bark, rice hulls, ground nut shells, ground treefern wood, redwood shavings, and sawdust.

If substrates are selected and handled properly, one can: 1) reduce the incidence of root pests and diseases; 2) reduce water and nutrient runoff; 3) improve plant growth; and 4) reduce production costs.

Physical Parameters:

1. Bulk Density
2. Water Holding Capacity
3. Aeration
4. Particle Size
5. Uniformity
6. Ease of mechanical mixing
7. Water rewetting ability – hydrophobic vs. hydrophilic

Chemical Parameters:

1. Cation Exchange Capacity (CEC)
2. Anion Exchange Capacity (AEC)
3. Soluble Salts (Electrical Conductivity)
4. Acidity (pH)
5. Disease resistance/sterility

Physical Parameters:

1. **Bulk density (BD)** is the weight per unit volume (i.e.: grams/2.4 L) and is directly influenced by substrate type and compaction of the media. High BD substrates include native soil and sand. Low BD products include many organic substrates such as peat, coir, and pine bark. Using some

sand as part of the media blend will increase weight of the container and reduce the likelihood of containers being blown over. However, too much of a high BD substrate, such as sand, will also increase shipping and handling costs. There is no linear correlation between BD and water-holding capacity or drainage.

2. **Water-Holding Capacity (WHC)** is the ability of the substrate to absorb water. As WHC increases, aeration decreases; therefore, while it is ideal to increase the WHC, which reduces the frequency of irrigations, the higher WHC also reduces the aeration of the media, which impairs root growth. The WHC is usually fairly uniform for individual substrates; however, differences may occur between batches based upon differences in particle sizes. For example, there are two components of coir: pith and fiber. In processing coconut husks, the fiber is separated and removed from the pith to manufacture rugs and other materials. The fiber has a lower WHC than the pith. Coir products can vary based on the percentage of pith vs. fiber; the more fiber, the lower the WHC, but the higher the aeration, and vice versa.

3. **Aeration** is the concentration of air spaces in the substrates. Roots require oxygen to carry out respiration, the physiological process of converting carbohydrates to energy. The aeration of a containerized media decreases from the top to the bottom of the container because a zone of water saturation, 'standing water', exists in containers. The more porous a mix, the smaller the zone of water saturation in a container. This saturation zone is greater for wider, shallow pots compared to deeper, narrow pots. The degree of aeration required is crop specific. Plants such as E*quisetum*, which can grow in standing water, require minimal aeration, while many California natives require excellent aeration.

4. **Particle size** is the size of the substrate particles. Usually, as particle size increases, WHC decreases and aeration increases. However, if a blend of different substrates of different particle sizes occurs, the physical properties of the resulting blended media can be quite varied, as smaller particles can sometimes fill in the gaps of the spaces between the larger particles.

5. **Uniformity**. There is usually variability within a substrate source. Piles of a material have fines settling out over time. Fines may settle to the bottom of a truck during shipping and the freezing and thawing cycles of stored peat can break apart fibers. Additional loss of uniformity occurs when substrates are poorly blended together to form a medium. Mixing substrates with a skip loader is not recommended. Fertilizer blending into the media should always be done with proper equipment.

6. **Ease of mixing** is a quality in substrates based on the physical properties of the particles. Some fibrous substrates, such as course shredded redwood bark or shredded cedar bark do not go through mechanical conveyors well. Therefore, while these products may have some favorable physical and chemical properties for root systems, their suitability for use with certain nursery equipment should be carefully considered.

7. **Water Rewetting Ability** is the characteristic of the substrate to rewet after drying out. Products such as peat are notorious for being difficult to rewet (hydrophobic). Other products such as coir are easy to rewet. Such products are considered hydrophilic – 'water loving'.

With proper consideration of these chemical and physical characteristics, one can choose a substrate, or blend of substrates to meet the needs of specific crops under their specialized cultural practices.

Chemical Parameter:

1. **Cation Exchange Capacity (CEC)** is the ability of a substrate/soil particle to adsorb positively-charged elements and compounds, such as cal-

cium (Ca^{+2}), magnesium (Mg^{+2}), ammonium (NH_4^+), potassium (K^+), iron ($Fe^{+2,+3}$), Zn (Zn^{+2}), manganese (Mn^{+2}), and copper (Cu^{+2}), onto the negatively-charged outside surfaces of the substrate/soil particles. This is similar to iron filings attaching to the outside of a magnet. The CEC of some common substrates is presented in Figure 1.

2. **Anion Exchange Capacity (AEC)** is the ability of a substrate/soil particle to a**d**sorb negatively charged compounds, such as nitrate (NO_3^-), phosphates ($PO_4^{-,-2}$), and sulfates (SO_4^{-2}), onto the positively-charges outside surface of the substrate/soil particles. In general, the AEC of most substrates is 1-5% of the CEC of the substrates. This low AEC of substrates/soils is one of the primary reasons why compounds, such as nitrates and phosphates, are easily leached..

3. **Soluble Salts or Electrical Conductivity (EC)** is the amount of soluble fertilizer salts and organic salts in the media and water. It is called 'electrical conductivity' because the concentration of dissolved salts in the water is directly related to the ability of the water to transfer or conduct an electrical current. Common units for EC are decisiemens per meter (dS/m), millisiemens per centimeter (mS/cm), or millimhos per centimeter (mhos/cm). 1 dS/m = 1 mS/cm = 1 mhos/cm.

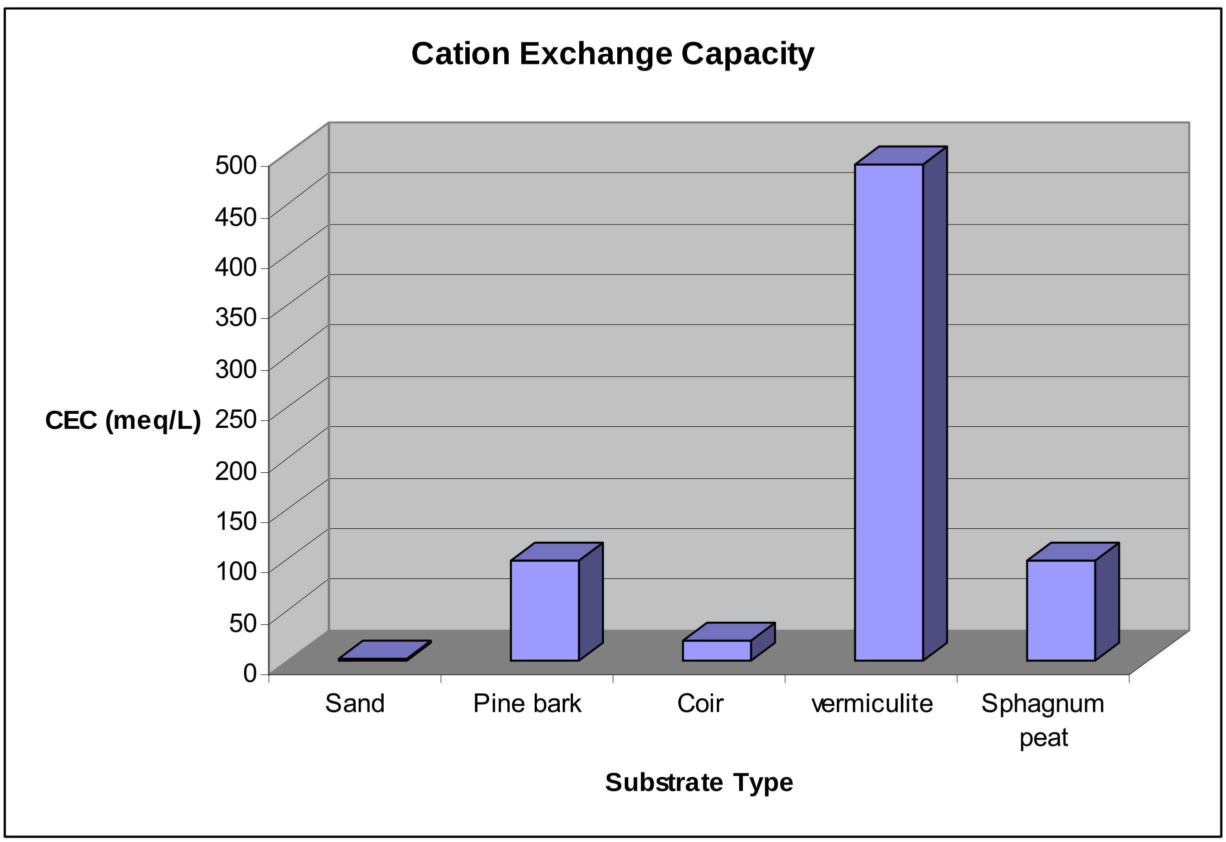

Figure 1. Cation Exchange Capacity (CEC) of different substrates.

Usually, city water supplies have EC around 0.5 dS/m. Many cut flower crops have a water EC tolerance below 2.0 dS/m while many woody ornamentals may have a tolerance of 3.0 dS/m or greater for optimum plant performance. However, there is a broad range of tolerance among crops. In addition, the seedling stage of many plant types is more sensitive to soluble salt levels than the same plant at maturity.

4. **Acidity** or solution pH is the measure of acidity (H^+) or alkalinity (OH^-) of a soil solution or of irrigation water. Chemically speaking, it is the measure of hydrogen ion (H^+) concentration in the solution. The lower the pH, the higher the concentration of H^+ ions.

5. **Disease Resistance/Sterility** of substrates is quite variable. Some products contain chemicals that are suppressive to certain root pathogens. Many substrates and field soils undergo sterilization to kill all microorganisms (both beneficial and harmful).

Proper turning of compost piles to provide aeration throughout composting process.

IMPLEMENTATION OF STATEWIDE LANDSCAPE IRRIGATION MANAGEMENT RECOMMENDATIONS

by
Dennis Pittenger

Source: Mary Ann Dickinson and Marsha Prillwitz, California Urban Water Conservation Council.

It has been almost one year since the Landscape Task Force, authorized in the 2004 by Assembly Bill 2717, submitted their report, *Water Smart Landscapes for California*, to the California Legislature and the Governor. Following is a summary of recent actions that have been taken thus far in 2006 to implement those recommendations.

Passage of Assembly Bill 1881

Several of the report's recommendations were implemented when Assembly Bill 1881 was passed by the Legislature and signed by the Governor on September 28, 2006. To review the full text of this legislation, please go to: http://www.cuwcc.org/ab2717_landscape_task_force.lasso.

The legislation's key provisions include:

- The California Department of Water Resources (DWR) is directed to update the State Model Water Efficient Landscape Ordinance, based on recommendations set forth in the Landscape Task Force report, by January 1, 2009;
- Local ordinances must be "at least as effective

as" the State Model Ordinance by January 1, 2010;

- Charter cities and counties, once exempt, are now subject to these regulations;
- Common interest development (property owners associations) shall not prohibit the use of low water-using plants;
- The California Energy Commission (CEC) is directed to adopt performance standards and labeling requirements for landscape irrigation controllers and moisture sensors by 2010;
- The sale or installation of irrigation controllers or moisture sensors is prohibited unless the equipment meets the requirements adopted by the CEC by 2012; and
- Directs water purveyors to require separate landscape water meters for new development with landscaped area greater than 5,000 square feet by 2008, excluding single-family homes.

Department of Water Resources Actions

The California Department of Water Resources has taken the following actions in response to the Task Force's recommendations:

- DWR released the draft 2007 Water Use Efficiency Proposal Solicitation Package (PSP) October 18, 2006 that gives priority to "urban projects that expedite or improve landscape-related BMPs recommended by the Landscape Task Force, Water Smart Landscapes for California." To review the draft PSP, please go to: http://www.owue.water.ca.gov/finance/index.cfm.
- DWR will soon initiate the process to update the State Model Water Efficient Landscape Ordinance. If you would like to be added to DWR's mailing list so that you will receive information and provide comments on proposed revisions of the Model Ordinance, please send an e-mail to DWR's Kent Frame at *kframe@water.ca.gov* or call him at (916) 651-7030.

California Urban Water Conservation Council (CUWCC) Actions

The CUWCC (Council) has acted to revise key landscape irrigation Best Management Practices that they oversee.

- *Best Management Practice 5: Large Landscape Conservation Programs and Incentives.* The Council's Landscape Subcommittee voted unanimously to reduce the landscape water budget from 100 percent of ETo to 80 percent on September 25, 2006. This proposed revision will be reviewed by a BMP Revision Public Advisory Committee (PAC), the Steering Committee and then presented to the Plenary for review and approval. For more information, please go to: http://www.cuwcc.com/committee_sub_landscape.lasso.
- *Best Management Practice 11: Conservation Pricing.* The Council has formed a PAC that has been actively involved in drafting revisions to BMP 11. As part of the BMP 11 revision process, the Council will host two outreach workshops to provide information on the proposed draft revision language and to receive input from interested stakeholders. The Council will also have several panels: a) perspectives on the proposed revisions, and b) case studies. For more information on BMP 11 draft proposed revisions, please go to: http://www.cuwcc.org/committee_sub_rates.lasso.
- *BMP 13: Water Waste Prohibition:* The Landscape Subcommittee is drafting changes to this BMP to reflect Task Force recommendations related to run-off and overspray. The proposed draft revision to BMP 13 can be found at: http://www.cuwcc.com/committee_sub_landscape.lasso.
- *Statewide Marketing Survey and Public Outreach Plan.* The U.S. Bureau of Reclamation and the California Urban Water Agencies are funding partners in the Council's effort to conduct a state-

wide marketing survey and public outreach plan to promote landscape water use efficiency. The Council has entered into a contract with California State University, San Bernardino on behalf of the Institute of Applied Research together with the Water Resources Institute to conduct a market research project that will explore and analyze customer behavior relating to landscape water use in all sectors (residential, multi-family, commercial, industrial and institutional) so that the Council, its partners and California water utilities can develop appropriate water conservation communication tools and strategies to reduce inefficient landscape water use. Information will be posted on the Council website at www.cuwcc.org as the project progresses.

Landscape Industry Actions

The California Landscape Contractors Association and the Irrigation Association are updating and expanding their education, training and certification programs in response to the Task Force recommendations. The Council is working through the Landscape Subcommittee to assist in the development of these programs and coordinate the various activities of the various stakeholder groups. More information can be found at: http://www.cuwcc.com/committee_sub_landscape.lasso.

California Energy Commission Actions

The Energy Commission anticipates initiating the process to adopt performance standards for landscape irrigation controllers and moisture sensors in the next year. Information will be posted as it becomes available at http://www.energy.ca.gov.

If you have any questions or suggestions regarding the implementation of the Landscape Task Force recommendations, please contact Marsha Prillwitz at marsha@water.ca.gov or 916.552.5885, extension 22.

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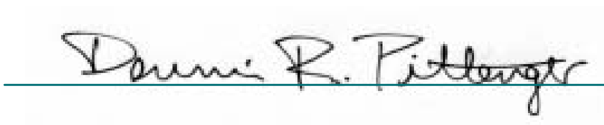

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Co-Hort is published 2 times per year (Spring, Fall) and distributed to U.C. Farm Advisors, Specialists, and Department Faculty associated with environmental horticulture. It summarizes current research and information on issues related to urban landscapes, turfgrass, and ornamental/floriculture crop production in an effort to support research and educational programs meeting the environmental horticulture industry's needs in California. This publication is written and edited by Donald J. Merhaut, and Dennis R. Pittenger, and prepared by Lynne Cochran. Please address any correspondence concerning this publication to the editors.

Co-Hort is issued in furtherance of Cooperative Extension work, Acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture, W. R. Gomes, Director of Cooperative Extension, University of California.