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I. TITLE: Irrigation and Nitrogen Fertility Strategies for Home Lawns in the San Joaquin Valley

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INTRODUCTION

Lawn care has a significant impact on the state and on local environments. In 1999 it was conservatively estimated that California has 1.2 million acres of lawn, and commercial activities involving turfgrass alone comprise about a $7.7 billion industry (Templeton, UCB).

Turfgrass water conservation efforts are required statewide due to increasing populations in California and increasing legislation that regulate lawn and landscape water use. For example, the revisions to the Memorandum of Understanding regarding urban water conservation in CA (AB325-Best Management Practices 5 or BMP 5) has set the maximum allowable irrigation water applied annually up to 100% of historical evapotranspiration (ETo) per square foot of landscape area. The goal of the fully implemented BMP 5 is to reduce per capita water use by 15% and keep the rate of per person use of 190 gallons of water per day despite projected increase in inland growth.

Inland landscapes, which are very often planted to cool-season turfgrasses, have a physiological water need greater than 100% of ETo in the late spring and summer months unless the distribution uniformities (DU) are between 85 and 96%. It is estimated that the statewide average is about 60% DU (UCR, 1996).

In research trials conducted at UC Riverside, it has been difficult to implement the recommended Best Management Practices (BMP 5) on open turf areas and still maintain good turf quality without also implementing setting aside (banking) water during cooler months for use in warmer months. Also, issues related to nitrogen fertility and nitrogen impact on turf quality are not well defined when working within a fairly narrow range of allowable water use.

Current belief among researchers is that when water is limiting, slow release fertilizers may be a preferred source of nitrogen to minimize stress and aid in shoot growth, turf repair and recovery. Composted green waste is another form of slow release fertilizer that enhances bermudagrass turf quality. However, its effect on cool season turfgrass performance in the San Joaquin Valley is unknown (LeStrange, Geisel 1996-99).

Goals and Objectives: The goal of this experiment is to determine how best to irrigate and fertilize lawns to maintain good quality, given a fixed quantity of water. Conservation of resources and reduction of environmental pollution are key objectives. The questions we want to answer are 1) Should one follow monthly ETo rates OR conserve water in cooler months (banking water) so that additional water could be applied in warmer months? and 2) Does the source of nitrogen fertilizer affect turfgrass performance under modified irrigation regimes?

The specific objectives of this field study are:

1) To evaluate the effects of water banking strategies on tall fescue turfgrass
2) To evaluate the effects of nitrogen fertility regimes
3) To compare the effects of topdressing compost (from municipal green waste) with conventional and slow release nitrogen fertilizers, and
4) To develop BMPs for nitrogen fertility in conjunction with water conservation that supports quality turfgrass in the San Joaquin Valley climate.

Our final goal is to develop a recommendation for a fertility and irrigation regime that supports a reasonably high quality cool season turf in central valley climates utilizing a maximum of 53 inches (100% ETo for San Joaquin Valley) of water a year.

MATERIALS AND METHODS:

A field study was installed in Fresno, CA in September 2000 at the Center for Irrigation Technology on the campus of CSU Fresno. The 0.5 acre tall fescue turf site was designed to meet the stringent requirements of this experiment and included a comprehensive irrigation system that allowed twelve separately metered, automated irrigation regimes.

The field experiment was a split-plot design with three irrigation treatments assigned to the 30 ft. x 60 ft. main blocks and arranged in four randomized complete blocks. Irrigation treatments were based on historical ETo, which for the central San Joaquin Valley is 53 inches of water per year (Table 1). Treatment A applied 100% ETo to the turf on a monthly basis. Treatment B banked 25% ETo in cooler months (Jan–May, Sept–Dec) and applied 125% ETo in hotter months (May 15-Aug). Treatment C banked 50% ETo between Sept 16 through April, applied 100% ETo in May and June, and applied 150% ETo in July – Sept 15. All three irrigation treatments applied approximately 53 inches of water per year.

The sub-plots consisted of four nitrogen treatments (each totaling 6 lbs N/1000 square feet per year) and an untreated check (Table 2). Ammonium sulfate (21-0-0) was applied 4 times per year, PolyOn (42-0-0 slow release) was applied once a year in late winter, and ¼ inch of compost was topdressed twice a year and followed by either ammonium sulfate applications or a single application of PolyOn.

The tall fescue was maintained according to UC cultural guidelines. Mowing height was 3”in summer and 2” during the remainder of the year with aeration in fall and spring. A live, ten foot tall wind break of elephant grass was grown on the north and east border of the turf site to minimize wind influence on sprinkler distribution. Several can tests were performed throughout the three year study to ensure that the distribution uniformity was maintained at 85% or higher. Data collection consisted of monthly quality ratings and bimonthly clipping yields from spring to fall. Additionally seasonal nutritional status, soil moisture, and surface water applications were monitored.

Table 1: Irrigation Treatments – with Reference ETo

Treatment		ETo in/month (CSUF CIMIS station)						Reference ETo total	% ETo	Treatment Inches applied
A	Jan - Mar	0.96	1.78	3.22				5.96	100	5.96
	Apr - June	5.05	6.83	7.80				19.68	100	19.68
	July - Sept	8.32	7.36	5.29				20.97	100	20.97
	Oct - Dec	3.55	1.63	0.95				6.13	100	6.13
							Total	**52.74**		**52.74**
Treatment B	Jan - May 15	0.96	1.78	3.22	5.05	3.12		14.13	75	10.60
	May 16 - Aug	3.71	7.8	8.32	7.36			27.19	125	33.99
	Sept - Dec	5.29	3.55	1.63	0.95			11.42	75	8.56
							Total	**52.74**		**53.15**
Treatment C	Jan - Apr	0.96	1.78	3.22	5.05			11.01	50	5.51
	May - June	6.83	7.8					14.63	100	14.63
	July - Sept 15	8.32	7.36	2.93				18.61	150	27.91
	Sept 16 - Dec	2.36	3.55	1.63	0.95			8.49	50	4.24
							Total	**52.74**		**52.29**

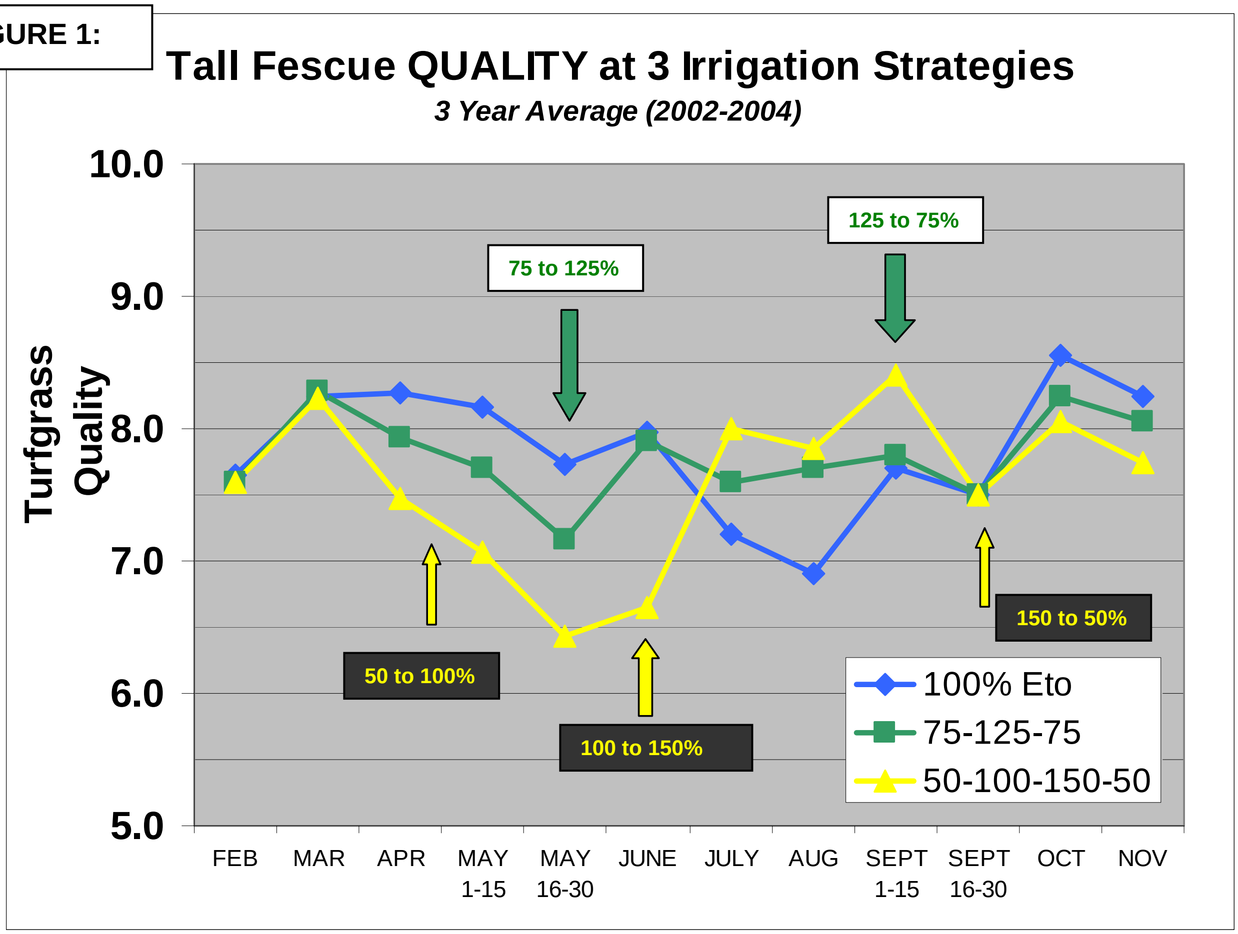
Table 2: Nitrogen Treatments and Application Schedule	**Feb 15**	**Apr 15**	**Sept 15**	**Nov 15**
1. untreated check				
2. ammonium sulfate, 1.5 lbs N/1000 – 4 apps/yr	AS	AS	AS	AS
3. PolyOn slow release, 6 lbs/N/year in one application	Poly			
4. ammonium sulfate + compost (apply ¼”compost (2 lbs N) – Feb and Nov apply ammonium sulfate (1 lbN) – Apr and Sept)	Comp	AS	AS	Comp
5. poly + compost (apply ¼” compost (2 lb N) – Feb and Nov apply PolyOn (2 lb N) – Apr)	Comp	Poly	--	Comp

RESULTS AND DISCUSSION:

Turfgrass Quality (Figure 1): Irrigation at 100% ETo (Treatment A) for the entire year resulted in good turf quality most of the year except in the height of summer when quality ratings significantly declined. In spring and fall turfgrass quality ratings ranged from 7.5 to 8.6. By August turf quality had declined to 6.8, which is still acceptable. This decline may reflect the less than perfect distribution uniformity of the sprinkler system. There is virtually no margin for error when exceedingly high temperatures predominate for extended periods of time. Besides high temperatures, prevailing winds, and decreases in water pressure due to high water demand overall would also have a negative influence on individual irrigation distribution patterns. At 100% ETo with virtually no water to spare for error, the turf shows symptoms of water stress.

Irrigating at 75% ETo (Treatment B) February through May and late September through November (and thereby banking water for summer use) and at 125% ETo in summer months resulted in uniformly high quality turf throughout the year and was the preferred irrigation strategy. Quality ratings were 7.5 and above throughout the year. The timing of the transition from 75% to 125% ETo in the late spring (May) is critical. That change should occur prior to the onset of high temperatures which may fluctuate from year to year, e.g. some years have early versus late springs and/or summers.

FIGURE 1:



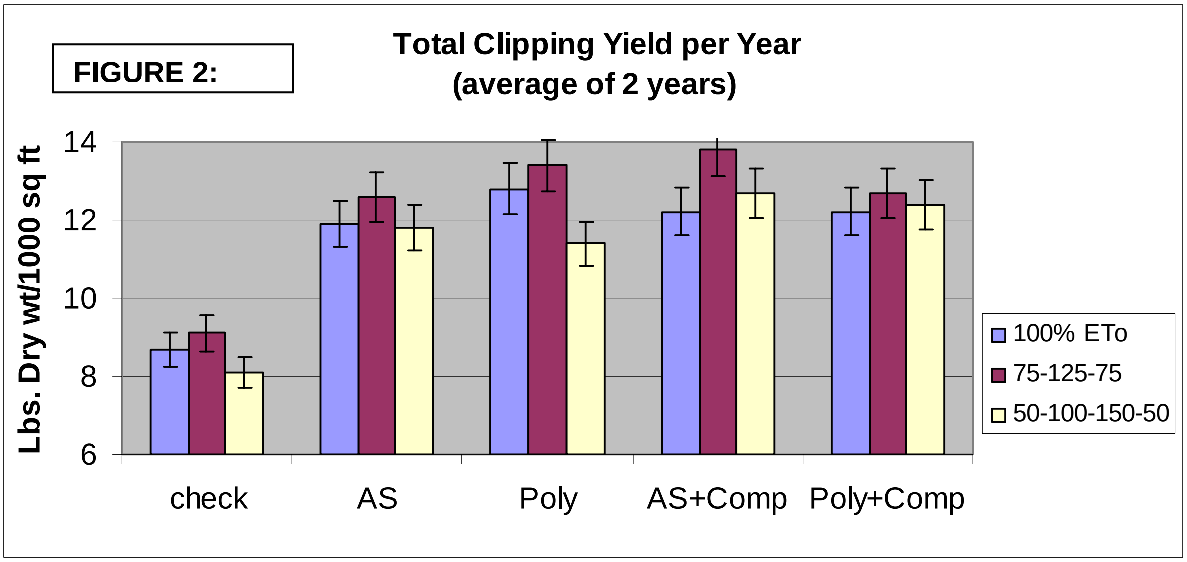
Irrigating at 50% ETo (Treatment C) during coolest months, then raising to 100% in warmer, and 150% in the hottest months resulted in the poorest and most erratic turf quality. Turfgrass quality virtually decreased each month in spring from a high of 8.4 to a low of 6.3 in mid May. Irrigating at 50% ETo in the spring and fall was determined to be insufficient for adequate growth perhaps because roots do not develop as densely as they might with more irrigation. With inadequate root development in spring the turfgrass enters the hottest season already under stress. In July when irrigation was increased to 150% ETo, quality improved significantly and was actually higher than the other two irrigation treatments. Quality went from 6.3 back up to a high of 8.5 by late August. It was, however, for such a brief period that it does not justify the use of such extreme water banking, especially since quality declines again during the fall. Results were consistent over the three year study.

Nitrogen Fertilizer Treatments: An industry standard amount of nitrogen fertilizer (6 lbs N/1000 square feet/year) was applied to all turfgrass plots (with the exception of an untreated check) and subjected to the irrigation treatments. The purpose of using different nitrogen sources was to determine if changes in irrigation practices affected by nitrogen sources would have an effect on turfgrass quality and/or clipping yield. Surprisingly very little differences in turf quality could be attributed to nitrogen source. Some quality and clipping yield differences were observed between the fertilizer sources, however these were difficult to document statistically. Observations include:

- Ammonium sulfate treatments tended to lose color faster, i.e. the dark green color faded, but for the majority of the year provided adequate turf color, uniformity, and density.
- Slow release (PolyOn) fertilizer treatments were observed to be similar to ammonium sulfate with the exception that fading of color was more gradual. The only advantage was that applications were reduced to one time per year.
- Compost treatments when mixed with either ammonium sulfate or slow release nitrogen retained the highest quality, color, uniformity, and density for the longest period of time between applications. Additionally there was no adverse visual effect from light topdressings (¼-inch) of compost on a regular basis.

Clipping Yields (Figure 2): Over a two year period average clipping yields were not found to be significantly different due to irrigation treatments. The more extreme water banking irrigation treatment (50-100-150-50) tended to produce fewer clippings and the moderate water banking irrigation treatment (75-125-75) tended to produce more clippings over all fertilizer treatments, but these were not statistically significant from the uniform irrigation treatment of 100% ETo. Therefore one would not expect lower or higher maintenance costs or more greenwaste overall from banking irrigation water.

Fertilizer treatments were not statistically different from each other either and averaged 11.7 pounds dry weight per 1000 square feet per year. Only the unfertilized check produced a significantly lower clipping yield of 8.6 pounds dry weight per 1000 square feet per year.



Soil Moisture Percentage (Table 3): Soil cores from 0 to 60" depth were only collected one time (April 2004) to evaluate water content and water movement beyond the turfgrass root zone. At the shallowest depth (0-24") irrigation treatment had an effect on water content. As expected 100% ETo had more water in the profile than 75%, and 75% ETo contained more than the 50% ETo irrigation regime. At lower depths there were no significant differences between irrigation treatments.

Table 3:	**Percent moisture at 0 to 60" soil depth**		
Irrigation Treatment	**0- 24"**	**24-36"**	**36-60"**
A	11.3	9.10	7.67
B	8.67	7.74	8.37
C	6.89	7.77	6.43
LSD .05	2.58	11.71	2.26
CV%	15.9	20.22	21.58

SUMMARY:

The results from this project revealed that when water is restricted, banking water during cooler times of the year for use in warmer times of the year proved to be a viable option to maintain turf quality. The optimum water banking strategies are those that are moderate in saving water for use later in the season, e.g. irrigation treatment B. As long as a moderate fertility program is consistently employed, the type of fertilizer used did not seem to significantly influence turf quality or turfgrass clippings.

Objective 1: To evaluate the effects of water banking strategies on tall fescue turfgrass.

Identified optimum water management strategies for tall fescue home lawns grown in the San Joaquin Valley. Demonstrated how to manage turfgrass irrigation and fertilization under restricted water budgets, which limit water use to 100% historical ETo. This three year study demonstrated that moderate water banking (Treatment B) during cooler parts of the year such that it could be applied later during warm summer months provided the most consistent, highest turf quality without significant increases in maintenance costs. Determined that there was no significant increase in clipping yields over time with water banking irrigation regimes

Objectives 2 and 3: To evaluate the effects of nitrogen fertility regimes and to compare the effects of topdressing compost (from municipal green waste) with conventional and slow release nitrogen fertilizers.

Determined that as long as sufficient nitrogen was applied regularly (in accordance with the source of nitrogen used) that fertilizer type did not affect turf quality with or without water banking. Turfgrass quality was similar within irrigation regimes regardless of whether the nitrogen fertilizer source was ammonium sulfate, slow release nitrogen fertilizer, and/or composted municipal greenwaste. Determined that there were no visual adverse effects from topdressing light amounts of composted greenwaste on tall fescue turfgrass.

Objective 4: To develop BMPs for nitrogen fertility in conjunction with water conservation that supports quality turfgrass in the San Joaquin Valley climate.

The goals of Best Management Practices (BMPs) in turfgrass are to conserve renewable resources at a sustainable level, while maintaining a reasonable level of quality. This project suggests that the BMPs for tall fescue home lawns in the San Joaquin Valley should include irrigation at 75% ETo in the spring and fall and 125% ETo in the summer, paying particular attention to the timing of the transition with actual local temperatures. This irrigation strategy actually allows a little more room for distribution non-uniformity because it provides a slight "water cushion" when compared to irrigating at only 100% ETo. With 100% ETo there is less water available to mitigate errors in water distribution during summer months.

Fertility BMPs suggested by this project are that 6 lbs nitrogen, irrespective of source, per 1000 square feet per year is adequate to provide good quality turf, which is defined as a dense, uniform stand of good green color without weeds.

Impact Statements:

1. Demonstrated how to manage home lawn irrigation and fertilization under restricted water budgets, which limit water use to 100% historical ETo. This could potentially save millions of gallons of water per year.
2. The average household can obtain a higher quality cool season lawn in the San Joaquin Valley without applying more water just by using a moderate water banking irrigation strategy.
3. Determined that nitrogen source had minimal impact upon tall fescue lawn quality as long as a consistent rate was applied.
4. Determined that composted greenwaste could be lightly topdressed on tall fescue lawns at least 2 times a year for several years with no adverse effect on turf culture and quality. The compost, when applied with conventional fertilizer, tended to enhance turf color for longer periods compared to conventional fertilizer applied alone.

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