Potential Water-Conservation through Turfgrass Selection and Irrigation Scheduling

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JUSTIFICATION

Increasing demand for a limited water supply in northern New Mexico will eventually lead to the implementation of water conservation plans that insure a permanent adequate supply in the future. Urban irrigation of turfgrass in private lawns, parks and golf-courses, sports-fields and businesses accounts for a large percentage of total domestic water-use in the region and represents one area where implementation of water conservation techniques (ie. irrigation scheduling and selection of low water-use turfs) could result in substantial water savings. Presently, information pertaining to the performance and water-use rates of various turfgrasses in northern New Mexico is lacking. The absence of this information makes it difficult to identify drought tolerant varieties suitable for the region and to schedule irrigations on turfgrass to maximize water-use efficiencies.

To schedule irrigations efficiently, accurate estimates of a plants water-use requirements (evapotranspiration or ET) must be known. Historically, crop ET estimates for irrigation scheduling purposes have been accomplished through development of crop-coefficients (relationships between measured ET and a reference ET [PET or ET_o] based on measured climate data). While an on-line, lawn watering guide has been developed for the cities of Las Cruces, Albuquerque and Farmington, the crop-coefficients used for the northern sites are based on ET data from bermudagrass grown at southern desert sites where temperatures are much warmer. In northern New Mexico, some bermudagrass tends to winterkill and Kentucky bluegrass, a cool-season, high water-using grass, is the turf of choice. If efficient turf irrigation scheduling is to be accomplished in northern New Mexico, appropriate crop coefficients must be developed for bluegrass and a variety of alternative, more water-efficient turf cultivars.

OBJECTIVES

The purpose of this project is to evaluate and demonstrate growth and water-use characteristics and irrigation scheduling needs of various turfgrasses. It will result in the formulation of crop-coefficients that will be used to develop irrigation scheduling programs for turfgrasses in New Mexico.

MATERIALS AND METHODS

Two separate sprinkler-line source designs (Fig. 1) were used to provide irrigation treatments to seven cultivars of warm-season and cool-season turf grasses in 1998 and 1999. Each plot consisted of a single sprinkler line that provided a continuous, decreasing gradient of water application to each grass on each side of the line as distance from the line increased. Irrigation treatments (subplots) were situated parallel to the line and water application depths were measured after each irrigation using catch-cans placed in subplots located at 7.5 foot intervals away from the line. Neutron probe access tubes were installed to a depth of five feet in four grasses in both plots at locations an equal distance from the line as the catch cans (Fig. 1). Soil moisture measurements were taken at these localities in depth increments of 6 inches (0-18 inch depth) and 12-inches (18 to 54 inch depth) about every 10 days during the active growing season using a neutron probe. Turf ET per period was calculated using the water balance equation:

$$ET = I + P \pm \Delta SW - D$$

Where…

I = depth of irrigation (in)
P = depth of rainfall (in)
ΔSW = change in soil water, 0-54 in (in)
D = estimated drainage below 54 in (in)

Heat units, expressed as growing degree-days (GDD), were used as an indicator of grass phenological development during the growing seasons.

GDD were calculated using the following equations:

Cool Season Grass:
$GDD = (Tmax + Tmin)/2 - 40^o$ (base)
(Tmax cutoff = 105 ^{o}F, Tmin cutoff = 40^{o}F)

Warm Season Grass:
$GDD = (Tmax + Tmin)/2 - 60^o$ (base)
(Tmax cutoff = None, Tmin cutoff = 60^{o}F)

Where…

Tmax = daily maximum temperature (^{o}F)
Tmin = daily minimum temperature (^{o}F)

Notes on cutoff temperatures:

Temperatures above Tmax cutoff are set to Tmax cutoff
Temperatures below Tmin cutoff are set to Tmin cutoff

Precipitation and other meteorological observations were recorded with an automated weather station (Campbell Scientific, Inc.) located a few hundred feet east of the plots.

Planting dates, seeding rates, fertilization and pesticide management techniques for plot maintenance during this study are summarized in Appendix A (Tables 1-5).

Irrigations were scheduled at a frequency required to maintain acceptable turf quality at subplots located 15 feet away from the line-source. Using weekly soil moisture measurements, an attempt was made to maintain soil moisture at a level near field capacity (1.5 in/ft) in the top 18 inches of the soil profile while minimizing deep drainage at these same subplots. Tables 6 and 7 in Appendix B list the dates and measured amounts of irrigation and precipitation applied to all subplots.

All plots were mowed weekly throughout the active growing seasons using a riding mower equipped with a rotary mowing deck and two mulching blades. With the exception of the Lovington blue grama and the grama/buffalograss mix, all grasses were cut to a uniform height of 2.5 to 3.0 inches at all irrigation levels. In mid-June of 1999, it was surmised that mowing had an adverse effect on the grama grass. Consequently, mowing height was adjusted to 3.5 to 4.0 inches in the grama and grama/buffalograss subplots.

The grass plots were evaluated by independent judges and/or principle investigators on several occasions during the growing seasons. Turf acceptance at each irrigation level was based on general turf appearance and quality. Factors such as color (greeness), density, uniformity, incidence of disease, and blade texture were considered in the evaluations. Numerous photographs were taken within all varieties at low, medium and high irrigation levels throughout the growing seasons.

RESULTS AND DISCUSSION

Re-establishment

Cool-season grasses: The cool-season grasses broke dormancy in early to mid-March but did not begin actively growing until after the initial irrigation on April 13 and April 16, 1998 and 1999, respectively. By April 30, all cool season grasses were green except the Seville perennial ryegrass, which did not turn a uniform green until about May 7. The Shenandoah tall fescue and Park bluegrass had a greater rate of growth and provided a fuller green color earlier than the other grasses, especially at the low levels of irrigation. Due to sporadic stand establishment away from the SLS, the cool-season grasses were irrigated uniformly prior to the initial gradient irrigation on June 2, 1998 and May 17, 1999.

Warm-season grasses: With the exception of NM Sahara Bermuda, the warm-season grasses broke dormancy and began greening up at the end of April in both years. The buffalograsses greened up faster at the plots located farthest from the line source than at those plots that received full irrigation in the previous growing season. In 1999, the Sahara bermuda appeared to be winter killed at all irrigation levels, and did not become fully re-established from the rhizomes until the end of June. All of the other warm season grasses were uniformly green across all irrigation levels by mid-May. Stand density however, was slightly reduced at the two lowest irrigation levels in the grama and buffalo grasses.

Response to Irrigation

By over-irrigating some subplots and under-irrigating others with the line source design, we were able to accurately identify the water needs of each grass. That is, the farthest location away from the line-source where turf quality remained acceptable. In some cases, this subplot occurred at a location equidistant from the line as the soil moisture and catch can measurements. In other cases, the acceptable level was located in-between catch-cans and ET was interpolated. Total seasonal ET required to produce acceptable appearance and quality averaged 24.5 inches in the warm-season grasses and 35.0 inches in the cool-season grasses over both years (Fig 2).

Within the warm-season grasses, the NM Sahara Bermuda, and the Bison and Texoka buffalograsses had the lowest seasonal water requirements (about 24 in.). However, the low water use of the Sahara Bermuda was due to a shorter active growing season (mid-June to mid September) than the other grasses. The Guymon Bermuda, Tatanka buffalograss and the gramagrass used between 25 and 28 inches of water to produce acceptable quality. However, the grama was judged to be unacceptable for turf purposes at any irrigation level.

Averaged over both years, the Adelphi and Park bluegrasses used less water (about 35 inches) to exhibit acceptable turf quality than all other cool-season grasses (Fig 2). However, due to consistent disease or fertilizer stress symptoms at all irrigation levels, we would not recommend Park bluegrass for the Farmington area. The tall fescue and three other bluegrasses; Goldrush, Ascot and Coventry, required about an inch more water than the Adelphi bluegrass. The Seville perennial ryegrass required more water (about 38 inches) than all of the grasses to produce an acceptable quality turf.

Consumptive-use – 1999:

Seasonal consumptive-use patterns at minimum acceptable irrigation level varied between turf species and between years within a species (Figures 3, 4 and 5). The cool-season grasses greened up sooner and exhibited a faster rate of growth in the spring than the warm-season varieties. Consequently, daily water-use rates in the cool season grasses increased rapidly after green-up to an average peak value of 0.22 in/day, which occurred in June and early July (Figs. 3 and 5). Conversely, daily ET rates of the warm season grasses increased more slowly in spring and early summer and the average peak daily ET (0.19 in/day) was not reached until late July (Figs. 4 5). The only exception to this was the blue grama. It had a faster growth rate than the other warm-season grasses and exhibited a seasonal consumptive-use pattern more similar to the cool-season grasses except that the peak daily ET was only 0.20 inches.

For easy comparison, Figure 5 shows the consumptive-use patterns for the grasses that exhibited the lowest and highest water requirements to produce acceptable quality in the cool and warm season turf plots. The Seville perennial ryegrass had greater daily, water-use requirements, and a greater peak water-use (0.23 in/day) than all other grasses (Fig. 5). Of the cool season grasses, the Adelphi bluegrass had the lowest daily water requirements throughout the season (peak ET = 0.21 in/day). The Bison buffalograss had the lowest peak daily water requirement (0.17 in) of all grasses in this study (Fig. 5). The NM Sahara bermuda exhibited a higher rate of daily ET than the Guymon bermuda (0.21 in vs. 0.19 in) during mid-summer when both were actively growing (Fig. 4).

However, since NM Sahara did not green up until June, its seasonal water requirement was less than that of Guymon.

Crop Coefficients

The information provided above and in Figs. 3-5 can be of value when used for irrigation scheduling in the Farmington area during a typical season. However, because climatic variability affects plant water-use on both a daily and seasonal basis, turf water use patterns will differ between seasons and locations. To compensate for this variability, measured ET was indexed to a reference ET (ET_o) that was computed using air temperature, relative humidity, solar radiation and wind data measured at the site (Fig. 6). To further compensate for the effects of temperature on the initiation and duration of the active growing (green period), and on plant growth and development during the season, the ratio of ET to ET_o or crop coefficient (K_c), was plotted against a heat unit time scale, expressed as cumulative growing degree-days (GDD) for both the cool season (Fig. 7) and warm season (Fig. 8) grasses at those subplots farthest away from the line-source that exhibited acceptable quality. The parameters of these crop-coefficients are shown in Appendix C.

Daily reference ET (or potential ET [PET]) is computed for numerous sites within New Mexico where the necessary weather data is collected and linked to New Mexico Climate Center. These reference ET values, along with complete daily weather records, can be found on the internet through the New Mexico Climate Center (NMSU) at the following URL:

http://weather.nmsu.edu/.

Additionally, actual real-time ET estimates can be obtained for the grasses that were included in this study by accessing the ET calculator at…

http://weather.nmsu.edu/nmcrops/grasses/index.htm.

These estimates are based on the crop-coefficients formulated at Farmington but can be used to assist in scheduling irrigations at various sites within New Mexico.

In times of drought when available water for irrigation is restricted, it is important to know what the effects of deficit irrigation (ie. irrigation amounts less than that required for optimum growth and quality) will be on turf. The figures in Appendix C show the consumptive-use curves of each turf grass at low, middle and high irrigation levels as they compare to the lowest ET required to provide acceptable quality. These graphs and the coefficients describing the curves, along with photographs of the turf subplots at each irrigation level, are also shown on the web site. These exhibits allow the turf manager to compare turf varieties and the effects of various irrigation scheduling strategies on the quality of turf. In times of drought or irrigation shortages, the manager could choose to use the low irrigation curve to maintain the crop while preventing permanent wilting.

The crop-coefficients presented in this report are designed to serve as a guide only. While they are valuable in establishing a baseline for irrigation scheduling, they are not designed to replace actual field observations. Irrigation management strategies must always consider variables such as proper system design and maintenance, system efficiencies, microclimatic influences, soil characteristics and other factors. There is no substitute for the wise use of a soil probe to monitor soil moisture on a regular basis.

Other observations (refer to web-site photos)

Cool season grasses

In both 1998 and 1999, the cool season grasses were generally judged to be more acceptable than the warm season grasses at high irrigation levels due to their darker green color and longer green season. However, in mid-summer, 1999, fungal diseases caused some yellowing of the bluegrasses at the mid-irrigation levels and their appearance was less attractive.

Within the cool season grasses, the rating given to individual varieties and irrigation levels varied considerably with day of season. Early in the season (end of May), all grasses except the Park bluegrass (which had a yellow-green color) had excellent dark green color and stand density at high irrigation levels. At lower irrigation levels, stand density was reduced in all varieties but was more pronounced in the tall fescue, ryegrass, and Ascot bluegrass than the others. Fairy rings (mushrooms) were noted at the high irrigation levels in all bluegrasses except Goldrush in 1999. By late July, due to a fungus infection, the bluegrasses began turning yellowish, especially at the mid-irrigation levels. The tall fescue and ryegrass were not visually affected. By mid August, a few weeks after fungicide was applied, the Coventry bluegrass appeared to overcome the fungal infection as it was greener than the other bluegrasses. By the end of August, all of the bluegrasses except Park were beginning to turn a darker green color . However, only Coventry bluegrass, Seville perennial ryegrass and Shenandoah tall fescue were dark green. Even though the Coventry bluegrass and Seville perennial ryegrass were rated as having the best dark color of all grasses, grubs attacked the perennial ryegrass at the high irrigation level creating clumps of dead grass. By mid to late September, the cool season grasses were green across most irrigation levels due to heavy rains in August. However, stand density at lower levels was still unacceptable

Warm season grasses

Ratings of warm season grasses varied somewhat with day of season but were more stable throughout the season than the cool season ratings. After green-up in early May, all of the grasses, except the NM Sahara (which remained dormant) appeared to be equally green across all irrigation levels and water stress did not affect stand density as much as it did in the cool season grasses. By the end of May, the buffalograsses remained green and had acceptable quality across all irrigation levels. The Lovington blue grama and Guymon bermuda did not appear to be as drought tolerant as the buffalograsses since the quality decreased slightly with distance from the line-source. This trend continued through June except that the Sahara Bermuda finally began to become re-established. By early July, drought stress became evident in plots beyond three catchment cans away from the SLS in all grasses. The buffalograsses and NM Sahara bermuda (which was now a rich, dark green color near the SLS), appeared to be more drought tolerant than the blue grama based on soil probe penetration depth. Based on color, the bermudas (which provided a dark green color equivalent to the cool season grasses), were given the highest rating among the warm season grasses. The blue grama and grama/buffalo mix, were rated the lowest and were considered unacceptable for turf purposes due to yellowing and ragged appearance after mowing. Mower tire marks, although noticeable in the fungus infected plots of the cool season grasses, were very evident in the grama and Bison and Texoka buffalograss plots at mid-irrigation levels. We would therefore recommend that these grasses not be cut or driven over when drought stressed. In early August, after 1.5 inches of rain between July 30 and August 9, all of the warm season grasses greened up across the entire irrigation gradient. In contrast to the cool season grasses, stand density was not noticeably affected by previous periods of drought stress and so these grasses had acceptable ratings at all irrigation levels. Later (mid-September), all grasses began turning brown at plots receiving the lowest amount of irrigation. However, the bermudas appeared to stay greener at slightly lower levels of irrigation than the buffalograsses. By the end of September, all of the warm season grasses began entering dormancy and by October 1, the NM Sahara bermuda was completely dormant. Because of the short green period, we would not recommend NM Sahara bermuda at the Farmington location. However, due to its aggressiveness and dark green color, it may be quite acceptable in the southern parts of New Mexico.

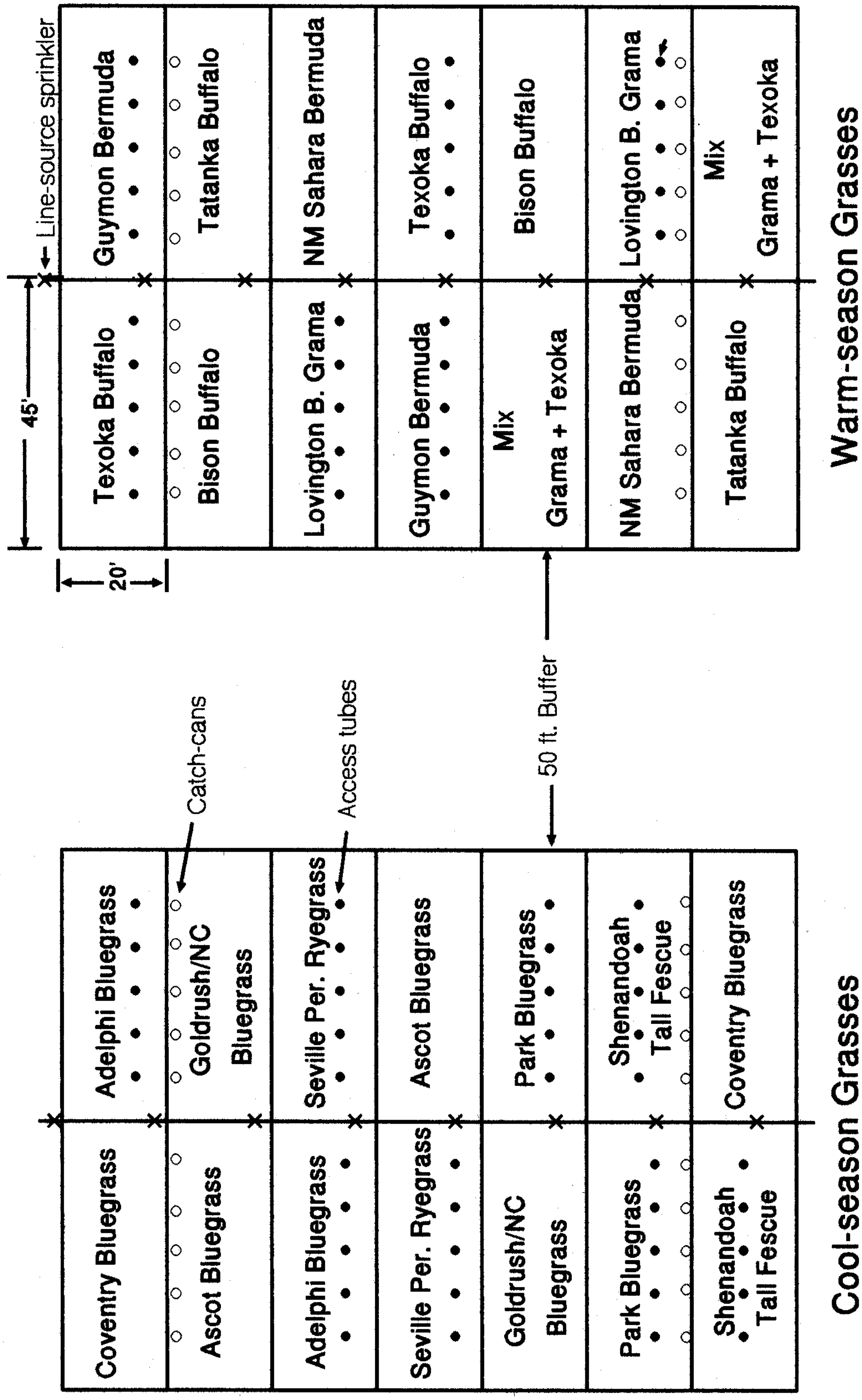


Fig. 1. Diagram of the sprinkler line-source plots used to evaluate turfgrass water requirements at Farmington, NM, 1998 and 1999.

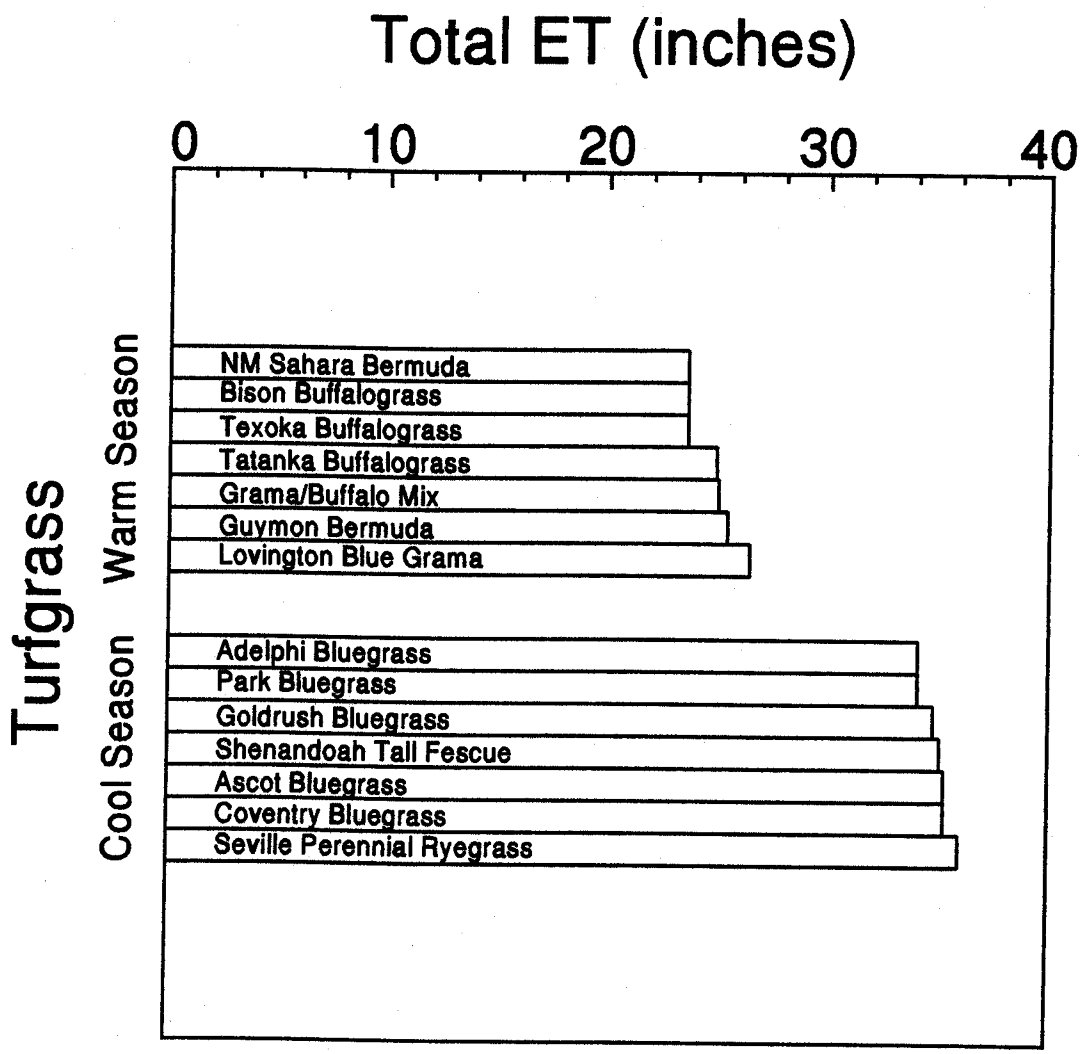


Fig. 2. Total measured evapotranspiration (ET) at turf plots exhibiting acceptable quality. Average of 1998 and 1999, Farmington, NM.

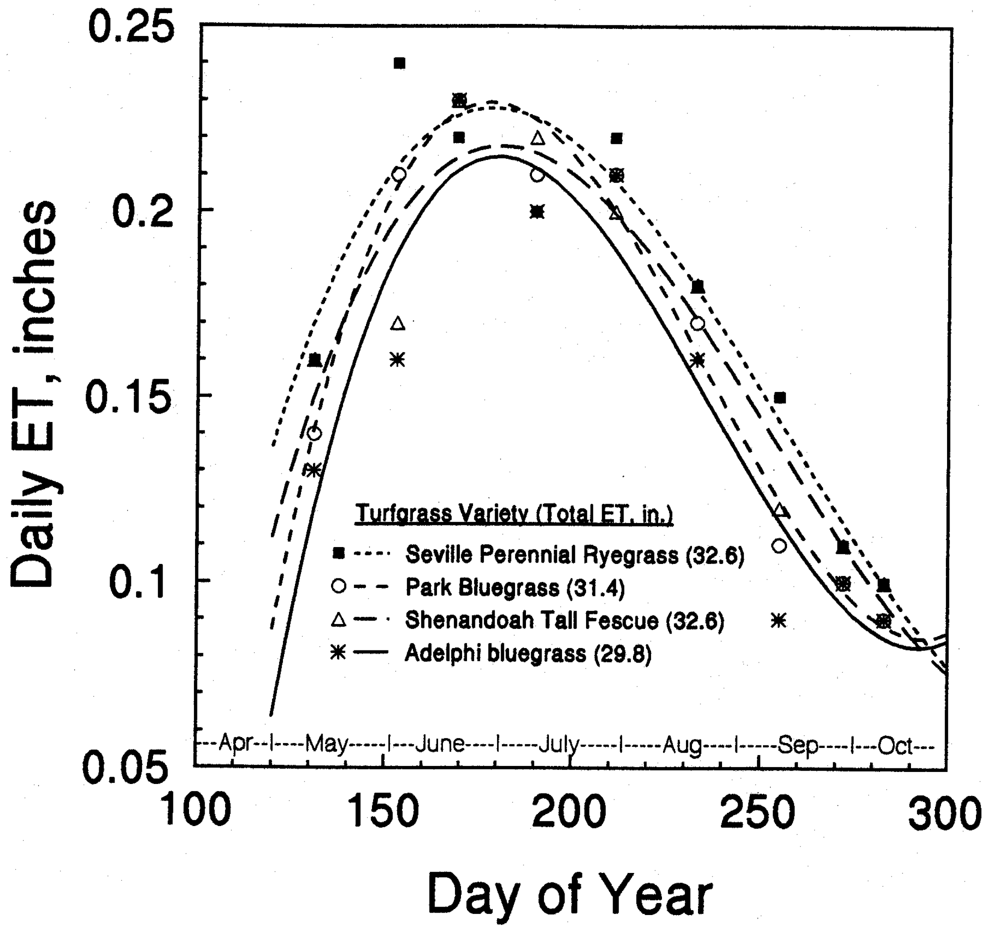


Fig. 3. Average daily water-use (ET) of four cool-season turfgrasses at the lowest irrigation level where acceptable turf quality was observed in 1999 at Farmington, NM.

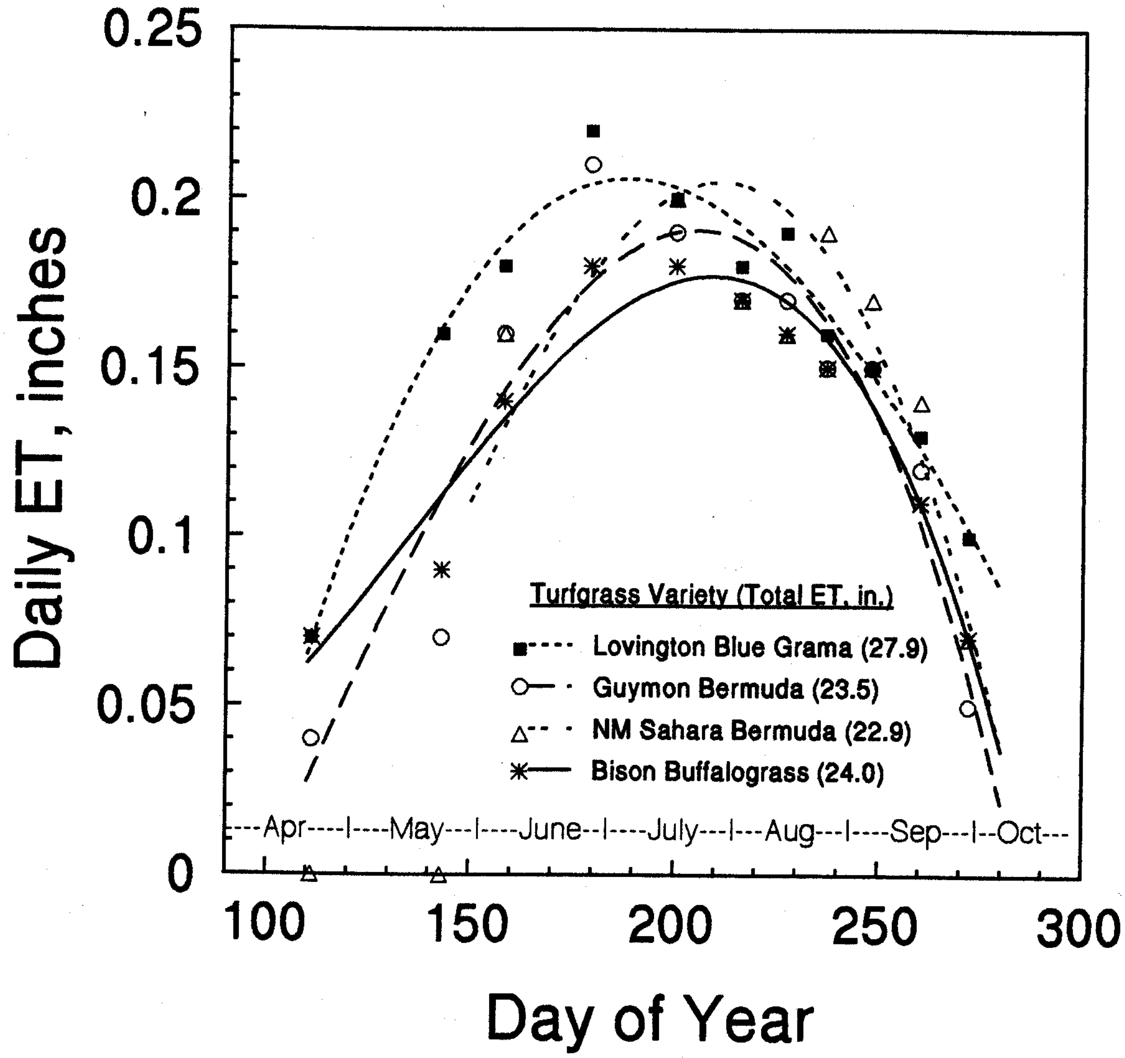


Fig. 4. Average daily water-use (ET) of four warm-season turfgrasses at the lowest irrigation level where acceptable turf quality was observed in 1999 at Farmington, NM.

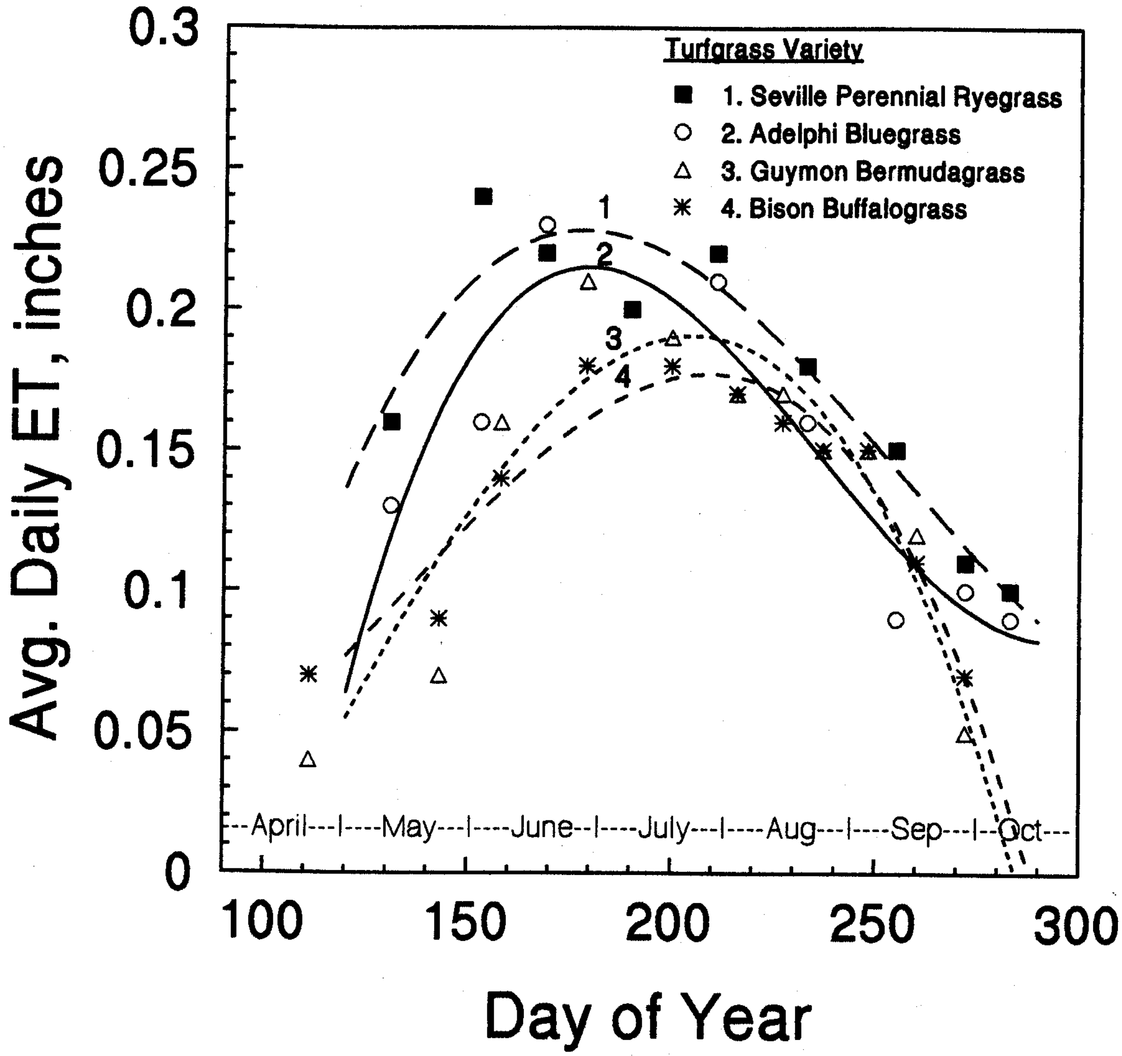


Fig. 5. Consumptive-use curves for representative cultivars of warm-season and cool-season turf grasses during 1999 at Farmington, NM.

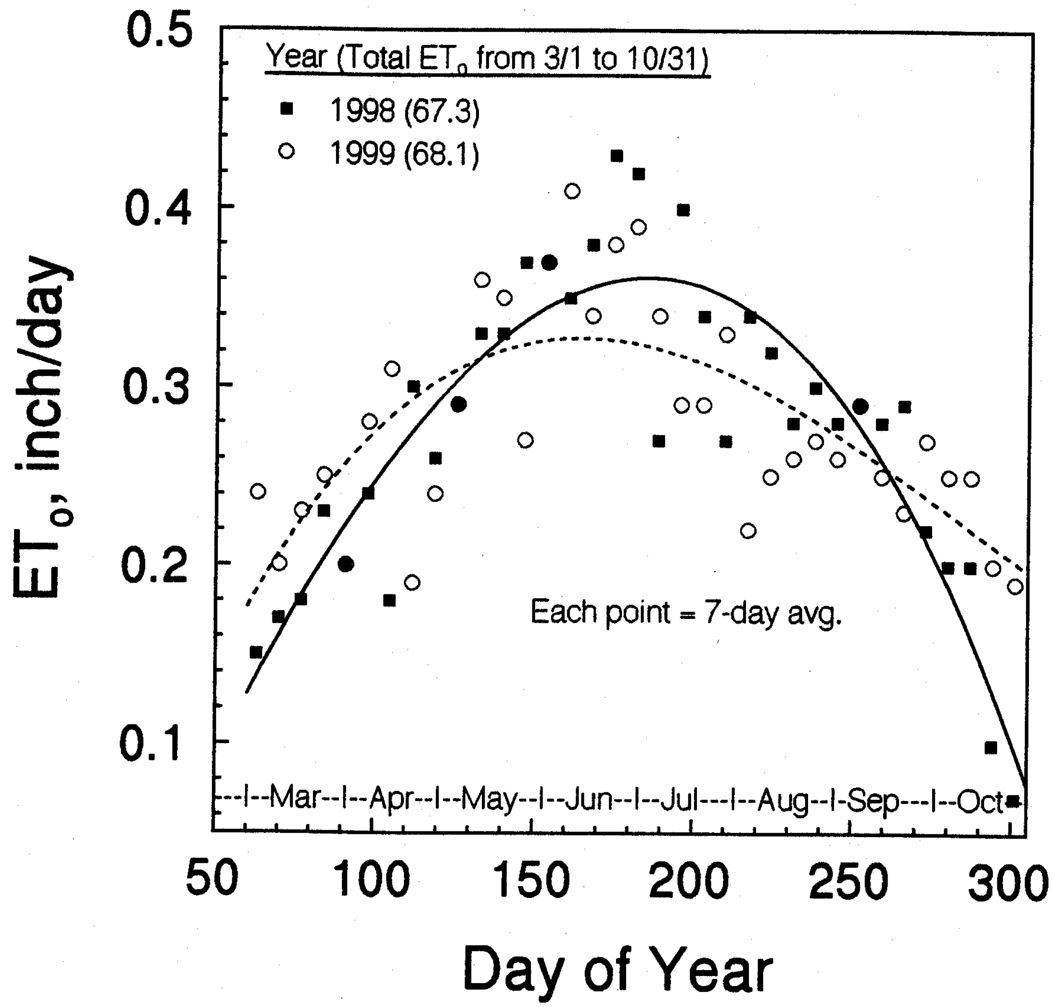


Fig. 6. Average daily reference evapotranspiration (ET_0) from March 1 to October 31, 1998 and 1999 at Farmington, NM.

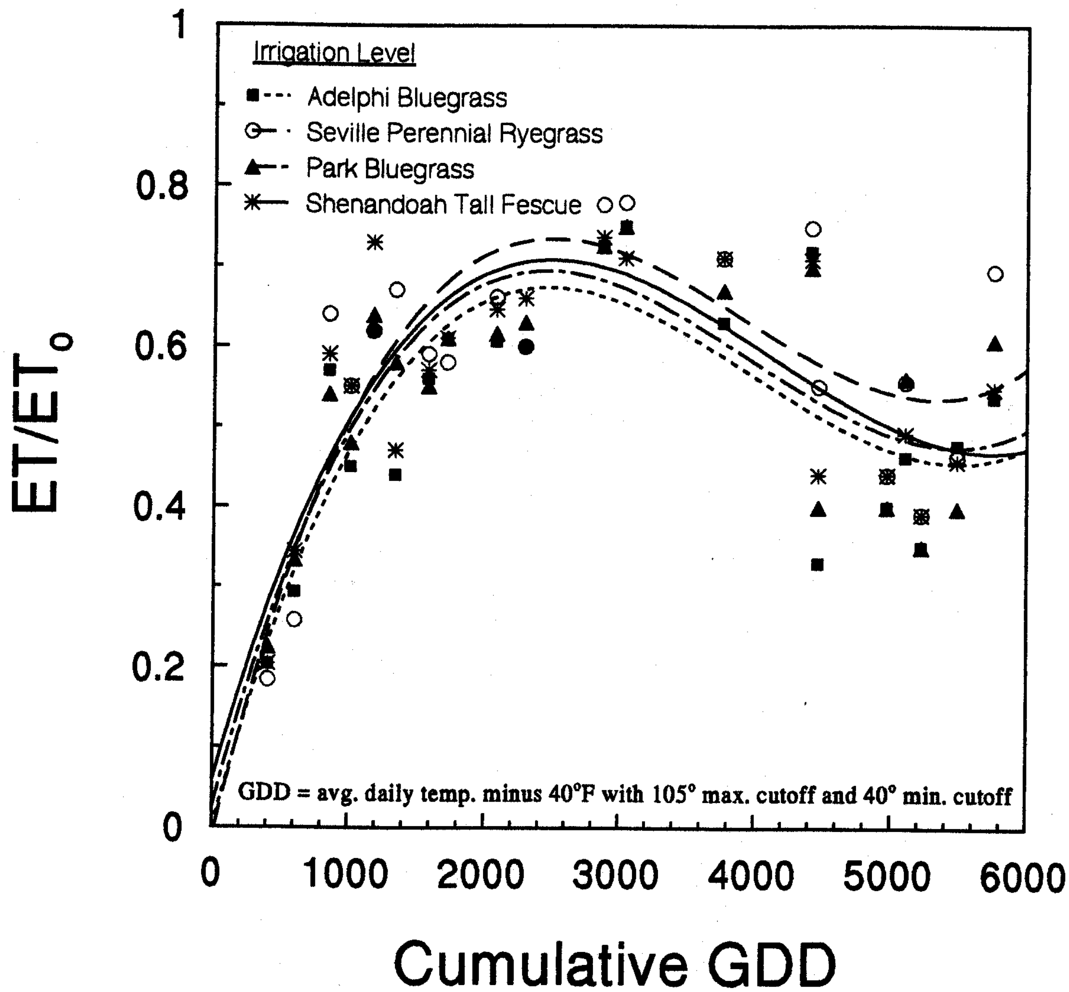


Fig. 7. Seasonal crop coefficients for four cool season turfgrasses at Farmington, NM based on data collected at subplots in a line-source that received the lowest irrigation treatment exhibiting acceptable quality turf.

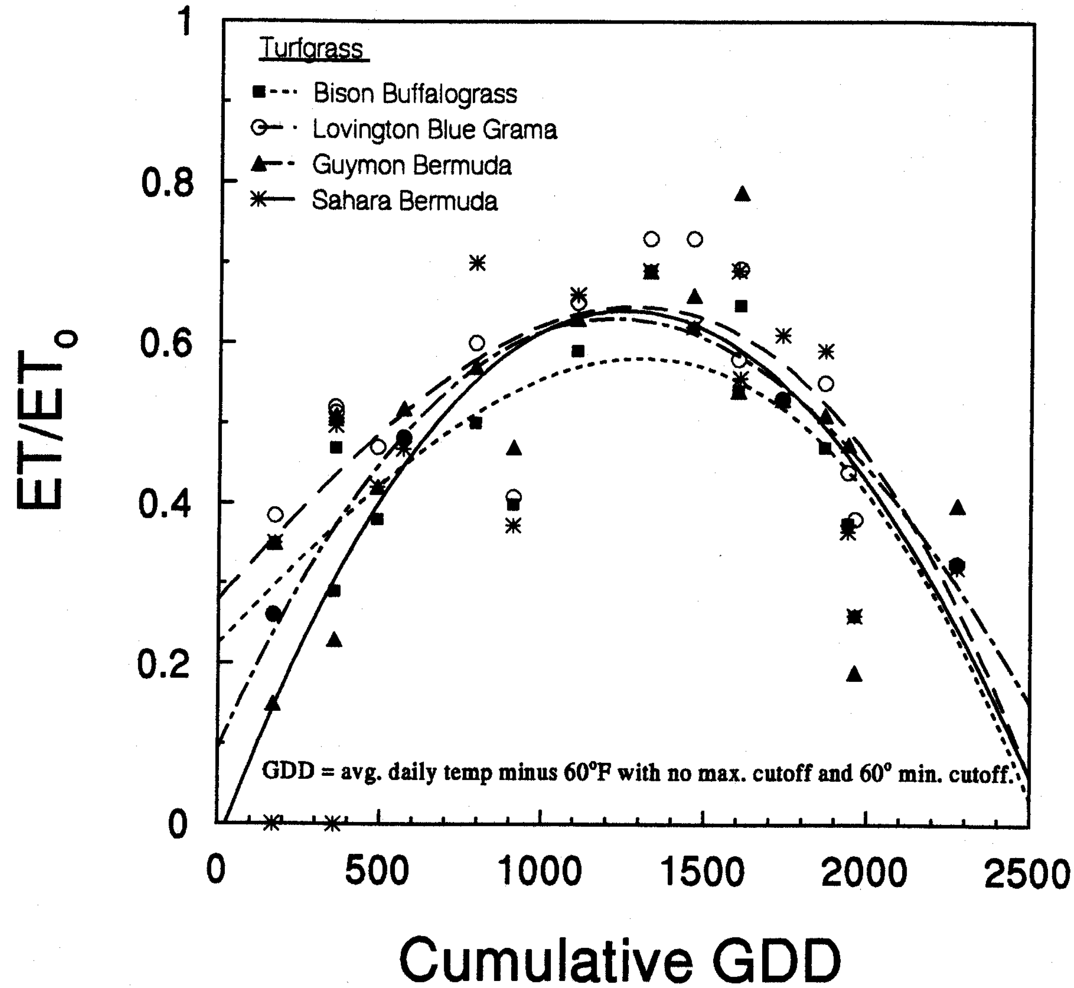


Fig. 8. Seasonal crop-coefficients for four warm season turfgrasses at Farminton NM based on data collected at subplots in a line-source that received the lowest irrigation treatment exhibiting acceptable quality turf.

APPENDIX A:

Cultural Management – Turfgrass, Farmington, NM

Tables 1-5

Table 1. Cultivars and planting rates of warm and cool season turfgrass varieties. NMSU Agricultural Science Center at Farmington, NM, 1999.

Cultivars	Planting Rate (lbs seed/1000 ft^2)
Warm Season Turf	
Bison Buffalograss	5.1
Tatanka Buffalograss	5.3
Texoka Buffalograss	5.4
Guymon Bermudagrass	2.8
N.M. Sahara Bermudagrass	1.5
Lovington Blue Gramagrass	2.3
Mix: Grama & Texoka	5.0
Cool Season Turf	
Adelphi Bluegrass	3.7
Ascot Bluegrass	3.3
Coventry Bluegrass	3.8
Goldrush Bluegrass	3.6
Park Bluegrass	3.5
Seville Perennial Ryegrass	10.5
Shenandoah Tall Fescue	9.8

Planting dates:
Warm-season grasses: July 7-11, 1997
Cool-season grasses: September 9, 1997

Table 2. Fertilization summary for warm and cool season turfgrasses, NMSU Agricultural Science Center at Farmington, NM, 1997, 1998, and 1999. Unless otherwise noted, all fertilizers were broadcast dry to surface and irrigated in.

1997 Preplant Fertilization (broadcast and roto-tilled)					
Date	**Product**	**N**	**P_2O_5**	**K_2O**	**Fe**
		(lb/1000 ft^2)			
Warm season grasses					
June 30, 1997	11-52-0	0.4	1.7	---	---
	0-0-60	----	---	1.6	---
	34-0-0	1.4	---	---	---
Total		**1.8**	**1.7**	**1.6**	**---**
Cool season grasses					
Sept. 3, 1997	11-52-0	0.4	2.0	---	---
	0-0-60	---	---	2.1	---
	34-0-0	2.6	---	---	---
Total		**3.0**	**2.0**	**2.1**	**---**

1998 Fertilizer summary					
Date	**Product**	**N**	**P_2O_5**	**K_2O**	**Fe**
		(lb/1000 ft^2)			
Warm season grasses					
May 18, 1998	16-16-8	0.83	0.83	0.41	---
May 29, 1998	16-16-8	0.48	0.48	0.23	---
Jun 17, 1998	32-0-0*	0.20	---	---	---
Jul 13, 1998	16-16-8	0.80	0.80	0.40	---
Aug 11, 1998	16-16-8	1.50	1.50	0.75	---
Total		**3.80**	**3.61**	**1.79**	**---**

Other: Jun 17, 1998 – 0.02 lb/1000 ft2 of Microplex. (0.5% B, 0.05% Co, 1.5% Cu, 4.0% Fe, 5.43% Mg, 4.0% Mn, 0.1% Mo, 1.5% Zn) injected into sprinkler system uniformly
*32-0-0 (urea ammonium nitrate) was applied uniformly to all plots by injection into the sprinkler system
August 25, 1998 – 4.4 lb/1000 ft2 of Ironite (1.5% N, 4.5% S, 1.75% Fe, 0.1% Zn)

1998 Fertilizer summary					
Date	**Product**	**N**	**P_2O_5**	**K_2O**	**Fe**
		———— (lb/1000 ft^2) ————			
Cool season grasses					
Oct 6, 1998	11-52-0	1.03	5.17	---	---
Feb 12, 1998	16-16-8	0.96	0.96	0.48	---
Apr 28, 1998	16-16-8	0.39	0.39	0.20	---
Jun 17, 1998	32-0-0	0.20	---	---	---
Aug 11, 1998	16-16-8	0.48	0.48	0.23	---
Aug 31, 1998	21-0-0	0.80	---	---	---
Sep 22, 1998	32-0-0	0.20	---	---	---
Total		**4.06**	**7.00**	**0.912**	**---**

Other: Other: Jun 17, 1998 – 0.02 lb/1000 ft2 of Microplex. (0.5% B, 0.05% Co, 1.5% Cu, 4.0% Fe, 5.43% Mg, 4.0% Mn, 0.1% Mo, 1.5% Zn) injected into sprinkler system uniformly
*32-0-0 (urea ammonium nitrate) was applied uniformly to all plots by injection into the sprinkler system
June 29, 1998 – 0.32 pt/1000 ft2 of Trigger. (0.5% Mg, 0.03% B, 0.1% Fe, 0.05% Mn, 0.1% Mo, 0/05% Zn)
August 25, 1998 – 2.8 lb/1000 ft2 of Ironite (1.5% N, 4.5% S, 1.75% Fe, 0.1% Zn)

1999 Fertilizer Summary					
Date	**Product**	**N**	**P_2O_5**	**K_2O**	**Fe**
		———— (lb/1000 ft^2) ————			
Warm season grasses					
May 20, 1999	16-16-8	0.29	0.29	0.15	---
May 20, 1999	20-0-0	0.61	---	---	---
Jun 08, 1999	25-5-10+Fe	0.90	0.17	0.34	0.17
Jun18, 1999	32-0-0*	0.52	---	---	---
Jul 13, 1999	32-0-0*	0.76	---	---	---
Jul 28, 1999	25-5-10+Fe	1.50	0.30	0.60	0.29
Total		**4.58**	**0.76**	**1.09**	**0.46**
Other: May 20, 1999 – 1.5 lb/1000 ft2 of Ironite (1.5% N, 4.5% S, 1.75% Fe, 0.1% Zn)					
Cool season grasses					
Apr 27, 1999	16-16-8	1.06	1.06	0.53	---
Jun 08, 1999	25-5-10+Fe	0.90	0.17	0.34	0.17
Jun 18, 1999	32-0-0*	0.52	---	---	---
Jul 13, 1999	32-0-0*	0.76	---	---	---
Jul 29, 1999	32-0-0*	0.38	---	---	---

1999 Fertilizer Summary					
Date	**Product**	**N**	**P_2O_5**	**K_2O**	**Fe**
		————————	**(lb/1000 ft^2)**	————————	
Aug 27, 1999	16-16-8	0.70	0.70	0.35	---
Sep 29, 1999	25-5-10+Fe	0.93	0.19	0.37	0.18
Total		**5.25**	**2.12**	**1.59**	**0.35**

Other: July 29, 1999 – 0.05 lb/1000 ft2 of Microplex. (0.5% B, 0.05% Co, 1.5% Cu, 4.0% Fe, 5.43% Mg, 4.0% Mn, 0.1% Mo, 1.5% Zn) injected into sprinkler system uniformly *32-0-0 (urea ammonium nitrate) was applied uniformly to all plots by injection into the sprinkler system.

Table 3. Herbicides applied to warm and cool season turfgrass, NMSU Agricultural Science Center at Farmington, NM, 1998 and 1999.

1998 Herbicide Summary		
Date	**Product**	**Rate**
Warm Season Turf		
Apr 7, 1998	2-4-D LV6	0.25 pts/acre
	Banvel	0.10 pts/acre
May 29, 1998	2-4-D LV6	0.25 pts/acre
	Banvel	0.25 pts/acre
Aug 12, 1998	2-4-D LV6	0.25 pts/acre
	Banvel	0.25 pts/acre
Cool Season Turf		
Mar 5, 1998	2-4-D LV6	0.25 pts/acre
May 29, 1998	2-4-D LV6	0.25 pts/acre
	Banvel	0.25 pts/acre
Aug 12, 1998	2-4-D LV6	0.25 pts/acre
	Banvel	0.25 pts/acre

1999 Herbicide Summary		
Date	**Product**	**Rate**
Warm Season Turf		
Feb 02, 1999	Balan	0.3.9 lbs/1000 ft^2
Mar 15, 1999	Roundup	spot treatment
Mar 07, 1999	2-4-D LV6	0.63 pts/acre
Cool Season Turf		

Feb 02, 1999	Balan	at 0.3.9 lbs/1000 ft^2
Mar 15, 1999	Roundup	spot treatment

Table 4. Fungicides applied to cool season turfgrass, NMSU Agricultural Science Center at Farmington, NM, 1999.

Date	Product	Rate	Control
Warm Season Turf			
None required			
Cool Season Turf			
Aug 03, 1999	Bayleton 50WP	2 oz product per 1000 ft^2	Curvularia; Fusarium; and Bipolaris

Table 5. Insecticides applied to warm and cool season turfgrass, NMSU Agricultural Science Center at Farmington, NM, 1998 and 1999.

1998 Insecticide Summary				
Date	**Product**	**Rate**	**Control**	**Method**
Warm Season Turf				
None required				
Cool Season Turf				
May 13, 1998	Dylox	1.7 pt/acre	Cutworms	Injected into irrigation
Jun 29, 1998	Sevin	1 lbs ai/acre	Leafhoppers	Injected into irrigation

1999 Insecticide Summary				
Date	**Product**	**Rate**	**Control**	**Method**
Warm Season Turf				
Jun 18, 1999	Sevin	1.2 lbs ai/acre	Leafhoppers	Injected into irrigation
Cool Season Turf				
Jun 19, 1999	Sevin	1.2 lbs ai/acre	Leafhoppers	Injected into irrigation
Jul 29, 1999	Sevin	1.2 lbs ai/acre	Leafhoppers	Injected into irrigation
Aug 31, 1999	Dylox	3 oz ai/acre	Grubs	Injected into irrigation

APPENDIX B

Irrigation and Precipitation Data

Tables 6 and 7

Table 6. Dates and amounts of irrigation and precipitation applied to cool season turf grasses, NMSU Agricultural Science Center at Farmington, NM, 1998 and 1999.

A. 1998 Cool Season Irrigation and Precipitation Summary							
	Distance from Line Source (ft)						
Application Date	41.1	32.6	24.1	15.6	7.1	Precipitation date	Amount
	Application Amount (in)						(in)
0413	0.61	0.62	0.58	0.62	0.72	0308	0.09
0420	0.52	0.52	0.51	0.55	0.55	0317	0.09
0424	0.39	0.30	0.35	0.39	0.39	0326	0.29
0428	0.34	0.32	0.33	0.34	0.36	0327	0.01
0501	0.28	0.41	0.38	0.41	0.46	0328	0.16
0504	0.84	0.79	0.83	0.83	0.83	0330	0.01
0508	0.73	0.73	0.72	0.68	0.67	0401	0.10
0513	1.19	1.19	1.19	1.19	1.19	0406	0.03
0518	1.02	0.85	0.94	1.04	1.22	0407	0.08
0521	0.49	0.50	0.52	0.57	0.45	0412	0.09
0522	0.77	0.78	0.74	0.81	0.86	0415	0.01
0526	1.69	1.79	1.69	1.76	1.56	0416	0.04
0529	0.56	0.54	0.54	0.55	0.60	0417	0.01
0602	0.17	0.30	0.39	0.56	0.60	0426	0.37
0605	0.67	0.62	0.64	0.68	0.81	0513	0.01
0608	0.61	0.64	0.62	0.63	0.58	0520	0.02
0611	0.50	0.51	0.48	0.48	0.49	0604	0.01
0615	0.44	0.35	0.44	0.46	0.67	0616	0.01
0617	0.73	0.83	0.79	0.74	0.71	0705	0.01
0619	0.20	0.31	0.44	0.65	0.79	0706	0.16
0622	0.54	0.44	0.44	0.53	0.62	0707	0.03
0625	0.84	0.85	0.85	0.86	0.88	0709	0.19
0626	0.55	0.55	0.54	0.62	0.65	0716	0.02
0629	0.54	0.54	0.54	0.54	0.54	0723	0.03
0701	0.04	0.27	0.52	0.69	0.81	0724	0.53
0702	0.09	0.13	0.18	0.25	0.29	0726	0.25
0705	0.10	0.16	0.23	0.32	0.40	0727	0.13
0706	0.08	0.15	0.23	0.30	0.35	0728	0.03
0708	0.29	0.42	0.48	0.69	0.75	0731	0.01
0714	0.16	0.26	0.36	0.51	0.66	0801	0.02
0715	0.12	0.17	0.22	0.30	0.35	0804	0.12
0717	0.12	0.22	0.31	0.41	0.50	0818	0.07
0720	0.17	0.28	0.39	0.56	0.67	0820	1.10

A. 1998 Cool Season Irrigation and Precipitation Summary							
	Distance from Line Source (ft)						
Application Date	**41.1**	**32.6**	**24.1**	**15.6**	**7.1**	**Precipitation date**	**Amount**
	Application Amount (in)						**(in)**
0722	0.08	0.15	0.22	0.29	0.35	0821	0.02
0724	0.57	0.84	1.10	1.34	1.63	0823	0.04
0730	0.21	0.42	0.59	0.81	0.92	0825	0.04
0731	0.35	0.59	0.81	1.13	1.36	0830	0.06
0803	0.66	0.95	1.17	1.49	1.67	0831	0.10
0805	0.34	0.60	0.83	1.16	1.40	0901	0.01
0807	0.32	0.48	0.64	0.88	1.00	0911	0.03
0810	0.48	0.85	1.30	1.63	1.84	0912	0.42
0812	1.85	1.95	1.91	1.89	1.82	0929	0.12
0817	0.50	0.78	1.04	1.38	1.59	1003	0.12
0825	0.34	0.36	0.36	0.36	0.32	1016	0.11
0828	0.18	0.31	0.44	0.60	0.72	1019	0.14
0831	0.34	0.38	0.42	0.49	0.56	1020	0.05
0902	0.13	0.20	0.27	0.36	0.41	1021	0.21
0906	0.62	0.54	0.54	0.64	0.81	1022	0.09
0910	0.07	0.27	0.51	0.71	0.79	1025	0.78
0911	0.07	0.11	0.15	0.23	0.27	1026	0.12
0916	0.11	0.17	0.23	0.28	0.36	1027	0.27
0918	0.17	0.23	0.29	0.36	0.42		
0922	0.44	0.45	0.46	0.49	0.56		
0925	0.11	0.17	0.23	0.31	0.39		
0928	0.13	0.17	0.23	0.29	0.34		
1002	0.17	0.24	0.31	0.39	0.48		
1006	0.13	0.23	0.31	0.42	0.54		
1009	0.12	0.20	0.29	0.40	0.46		
1014	0.17	0.29	0.39	0.48	0.54		
Total	**25.10**	**29.30**	**33.50**	**39.30**	**43.50**		**6.90**

B. 1999 Cool Season Irrigation and Precipitation Summary							
	Distance from Line Source (ft)						
Application Date	41.1	32.6	24.1	15.6	7.1	Precipitation date	Amount
	Application Amount (in)						(in)
16-Apr	0.95	0.72	0.78	0.83	1.09	1-Apr	0.03
20-Apr	0.21	0.22	0.20	0.20	0.24	2-Apr	0.01
27-Apr	0.33	0.28	0.28	0.30	0.38	3-Apr	0.03
30-Apr	0.30	0.32	0.31	0.30	0.28	4-Apr	0.18
7-May	0.13	0.22	0.26	0.32	0.36	13-Apr	0.01
11-May	0.30	0.30	0.32	0.35	0.45	20-Apr	0.05
14-May	0.49	0.40	0.40	0.50	0.69	21-Apr	0.53
17-May	0.06	0.07	0.11	0.16	0.25	22-Apr	0.13
18-May	0.04	0.15	0.30	0.43	0.53	24-Apr	0.22
20-May	0.10	0.17	0.25	0.32	0.42	25-Apr	0.01
21-May	0.10	0.14	0.21	0.33	0.45	28-Apr	0.01
27-May	0.09	0.12	0.19	0.26	0.33	30-Apr	0.12
28-May	0.12	0.21	0.29	0.40	0.49	1-May	0.21
1-Jun	0.11	0.18	0.27	0.36	0.49	3-May	0.40
3-Jun	0.64	0.69	0.71	0.68	0.70	23-May	0.50
4-Jun	0.11	0.15	0.23	0.35	0.46	24-May	0.02
7-Jun	0.05	0.08	0.17	0.27	0.37	25-May	0.01
8-Jun	0.28	0.27	0.27	0.26	0.26	2-Jun	0.04
10-Jun	0.10	0.14	0.18	0.23	0.27	16-Jun	0.05
11-Jun	0.10	0.18	0.20	0.27	0.31	17-Jun	0.09
14-Jun	0.09	0.19	0.36	0.56	0.69	19-Jun	0.02
16-Jun	0.18	0.28	0.39	0.50	0.60	20-Jun	0.09
18-Jun	0.79	0.79	0.79	0.79	0.79	26-Jun	0.15
22-Jun	0.08	0.13	0.20	0.29	0.40	3-Jul	0.08
24-Jun	0.12	0.19	0.25	0.31	0.35	5-Jul	0.04
25-Jun	0.15	0.24	0.32	0.41	0.45	8-Jul	0.56
28-Jun	0.04	0.08	0.17	0.24	0.31	9-Jul	0.52
30-Jun	0.01	0.03	0.06	0.09	0.15	17-Jul	0.03
2-Jul	0.20	0.30	0.41	0.52	0.59	18-Jul	0.15
5-Jul	0.08	0.13	0.22	0.32	0.40	19-Jul	0.02
6-Jul	0.02	0.06	0.11	0.19	0.25	21-Jul	0.18
7-Jul	0.06	0.12	0.18	0.31	0.35	23-Jul	0.14
11-Jul	0.18	0.29	0.40	0.56	0.68	25-Jul	0.19
13-Jul	0.56	0.56	0.56	0.59	0.73	26-Jul	0.10
16-Jul	0.18	0.26	0.35	0.44	0.50	27-Jul	0.08
20-Jul	0.13	0.21	0.30	0.39	0.45	28-Jul	0.17
23-Jul	0.15	0.21	0.30	0.39	0.43	29-Jul	0.06
26-Jul	0.07	0.15	0.23	0.32	0.37	30-Jul	0.19

B. 1999 Cool Season Irrigation and Precipitation Summary							
	Distance from Line Source (ft)						
Application Date	41.1	32.6	24.1	15.6	7.1	Precipitation date	Amount
	Application Amount (in)						(in)
29-Jul	0.65	0.65	0.65	0.65	0.65	2-Aug	0.26
30-Jul	0.07	0.12	0.18	0.23	0.29	3-Aug	0.66
10-Aug	0.15	0.21	0.26	0.33	0.39	5-Aug	0.34
13-Aug	0.13	0.21	0.31	0.41	0.50	8-Aug	0.02
18-Aug	0.08	0.15	0.22	0.30	0.33	9-Aug	0.01
24-Aug	0.14	0.25	0.37	0.50	0.59	10-Aug	0.01
26-Aug	0.48	0.50	0.55	0.62	0.71	14-Aug	0.59
30-Aug	0.42	0.46	0.47	0.45	0.43	15-Aug	0.03
31-Aug	0.40	0.40	0.40	0.40	0.40	16-Aug	0.16
6-Sep	0.18	0.26	0.39	0.57	0.76	17-Aug	0.01
9-Sep	0.10	0.18	0.28	0.40	0.50	18-Aug	0.01
13-Sep	0.19	0.30	0.41	0.53	0.64	19-Aug	0.57
16-Sep	0.12	0.18	0.25	0.32	0.37	20-Aug	0.11
17-Sep	0.10	0.20	0.29	0.38	0.41	26-Aug	0.04
21-Sep	0.35	0.32	0.33	0.34	0.45	29-Aug	0.15
24-Sep	0.14	0.20	0.29	0.39	0.51	30-Aug	0.02
29-Sep	0.54	0.54	0.60	0.69	0.87	31-Aug	0.02
4-Oct	0.09	0.13	0.16	0.23	0.27	1-Sep	0.05
7-Oct	0.06	0.09	0.13	0.19	0.26	2-Sep	0.03
8-Oct	0.14	0.17	0.22	0.33	0.36	10-Sep	0.08
11-Oct	0.10	0.14	0.22	0.33	0.40	16-Sep	0.01
15-Oct	1.12	1.01	1.02	1.09	1.22	22-Sep	0.02
						23-Sep	0.04
Total	**14.3**	**16.9**	**20.4**	**24.9**	**29.6**		**8.7**

Table 7. Dates and amounts of irrigation and precipitation applied to warm season turf grasses, NMSU Agricultural Science Center at Farmington, NM, 1998 and 1999.

A. 1998 Warm Season Irrigation and Precipitation Summary							
	Distance from Line Source (ft)						
Application Date	41.1	32.6	24.1	15.6	7.1	Precipitation date	Amount
	Application Amount (in)						(in)
0428	0.54	0.50	0.54	0.58	0.63	0426	0.37
0505	0.43	0.45	0.44	0.45	0.45	0513	0.01
0508	0.45	0.37	0.45	0.52	0.58	0520	0.02
0514	0.33	0.36	0.32	0.35	0.35	0604	0.01
0518	0.86	0.76	0.74	0.84	0.99	0616	0.01
0522	0.81	0.69	0.68	0.74	0.88	0705	0.01
0526	1.84	1.71	1.61	1.74	1.78	0706	0.16
0529	0.29	0.29	0.28	0.28	0.27	0707	0.03
0602	0.21	0.31	0.47	0.66	0.76	0709	0.19
0605	0.67	0.56	0.56	0.65	0.79	0716	0.02
0610	0.05	0.11	0.20	0.28	0.32	0723	0.03
0615	0.48	0.38	0.42	0.50	0.67	0724	0.53
0617	0.70	0.83	0.81	0.80	0.75	0726	0.25
0619	0.23	0.34	0.51	0.71	0.87	0727	0.13
0622	0.12	0.14	0.21	0.36	0.48	0728	0.03
0623	0.19	0.28	0.41	0.53	0.63	0731	0.01
0625	0.14	0.20	0.28	0.38	0.49	0801	0.02
0626	0.12	0.18	0.26	0.33	0.52	0804	0.12
0629	0.16	0.25	0.35	0.46	0.58	0818	0.07
0701	0.03	0.22	0.41	0.67	0.79	0820	1.10
0702	0.08	0.14	0.19	0.26	0.31	0821	0.02
0705	0.09	0.14	0.23	0.35	0.43	0823	0.04
0709	0.09	0.12	0.22	0.30	0.42	0825	0.04
0714	0.37	0.51	0.46	0.65	0.77	0830	0.06
0715	0.08	0.15	1.24	0.25	1.39	0831	0.10
0717	0.18	0.30	0.45	0.44	0.68	0901	0.01
0721	0.21	0.32	0.42	0.56	0.63	0911	0.03
0722	0.34	0.55	0.79	1.07	1.31	0912	0.42
0730	0.19	0.42	0.65	1.88	1.00	0929	0.12
0731	0.32	0.59	0.86	1.21	1.47	1003	0.12
0804	0.46	0.81	1.18	1.60	1.91		
0806	0.50	0.83	1.13	1.56	1.84		
0810	0.53	0.94	1.35	1.75	2.05		
0812	0.99	1.05	1.06	1.05	0.99		
0818	0.46	0.67	0.92	1.22	1.46		
0825	0.24	0.25	0.25	0.26	0.23		

A. 1998 Warm Season Irrigation and Precipitation Summary							
	Distance from Line Source (ft)						
Application Date	41.1	32.6	24.1	15.6	7.1	Precipitation date	Amount
	Application Amount (in)						(in)
0828	0.08	0.15	0.24	0.32	0.39		
0831	0.09	0.16	0.24	0.30	0.38		
0902	0.10	0.17	0.24	0.31	0.35		
0906	0.48	0.46	0.49	0.56	0.74		
0910	0.04	0.16	0.31	0.47	0.50		
0911	0.12	0.20	0.29	0.39	0.49		
0916	0.09	0.17	0.24	0.32	0.39		
0918	0.14	0.21	0.25	0.33	0.36		
0922	0.14	0.19	0.24	0.29	0.34		
0925	0.07	0.12	0.16	0.22	0.29		
0928	0.12	1.17	1.22	1.29	1.33		
1002	0.17	0.27	0.34	0.46	0.54		
1006	0.11	0.19	0.25	0.37	0.43		
1009	0.04	0.11	0.15	0.22	0.27		
1014	0.19	0.28	0.37	0.49	0.55		
Total	**15.80**	**19.70**	**24.40**	**30.60**	**35.80**		**4.08**

B. 1999 Warm Season Irrigation and Precipitation Summary							
	Distance from Line Source (ft)						
Application Date	41.1	32.6	24.1	15.6	7.1	Precipitation date	Amount
	Application Amount (in)						(in)
16-Apr	0.59	0.49	0.47	0.59	0.76	1-Apr	0.03
11-May	0.25	0.24	0.24	0.27	0.32	2-Apr	0.01
14-May	0.24	0.20	0.17	0.21	0.29	3-Apr	0.03
18-May	0.05	0.13	0.23	0.29	0.36	4-Apr	0.18
20-May	0.43	0.40	0.39	0.40	0.45	13-Apr	0.01
21-May	0.05	0.08	0.13	0.17	0.22	20-Apr	0.05
28-May	0.04	0.10	0.18	0.25	0.35	21-Apr	0.53
1-Jun	0.03	0.05	0.07	0.11	0.15	22-Apr	0.13
3-Jun	0.33	0.35	0.32	0.34	0.40	24-Apr	0.22
4-Jun	0.09	0.14	0.24	0.35	0.46	25-Apr	0.01
8-Jun	0.23	0.27	0.35	0.53	0.63	28-Apr	0.01
11-Jun	0.13	0.18	0.23	0.30	0.34	30-Apr	0.12
14-Jun	0.08	0.16	0.30	0.43	0.56	1-May	0.21
16-Jun	0.15	0.24	0.33	0.43	0.52	3-May	0.40
18-Jun	0.80	0.80	0.80	0.80	0.80	23-May	0.50
22-Jun	0.04	0.05	0.08	0.11	0.15	24-May	0.02
23-Jun	0.18	0.28	0.37	0.47	0.53	25-May	0.01
25-Jun	0.16	0.25	0.34	0.46	0.49	2-Jun	0.04
28-Jun	0.13	0.20	0.30	0.47	0.54	16-Jun	0.05
30-Jun	0.01	0.02	0.05	0.07	0.12	17-Jun	0.09
2-Jul	0.16	0.27	0.35	0.46	0.56	19-Jun	0.02
5-Jul	0.09	0.15	0.23	0.33	0.43	20-Jun	0.09
7-Jul	0.05	0.12	0.20	0.28	0.35	26-Jun	0.15
13-Jul	0.50	0.51	0.58	0.65	0.78	3-Jul	0.08
16-Jul	0.14	0.19	0.24	0.30	0.36	5-Jul	0.04
20-Jul	0.09	0.13	0.18	0.25	0.28	8-Jul	0.56
23-Jul	0.19	0.28	0.35	0.46	0.53	9-Jul	0.52
26-Jul	0.17	0.27	0.38	0.49	0.60	17-Jul	0.03
28-Jul	0.55	0.55	0.59	0.60	0.60	18-Jul	0.15
30-Jul	0.16	0.23	0.30	0.36	0.41	19-Jul	0.02
11-Aug	0.16	0.22	0.27	0.35	0.39	21-Jul	0.18
13-Aug	0.13	0.22	0.31	0.42	0.50	23-Jul	0.14
24-Aug	0.13	0.24	0.36	0.51	0.60	25-Jul	0.19
26-Aug	0.36	0.43	0.46	0.53	0.52	26-Jul	0.10
31-Aug	0.14	0.19	0.25	0.33	0.37	27-Jul	0.08
6-Sep	0.16	0.23	0.39	0.54	0.74	28-Jul	0.17
9-Sep	0.17	0.27	0.40	0.51	0.59	29-Jul	0.06

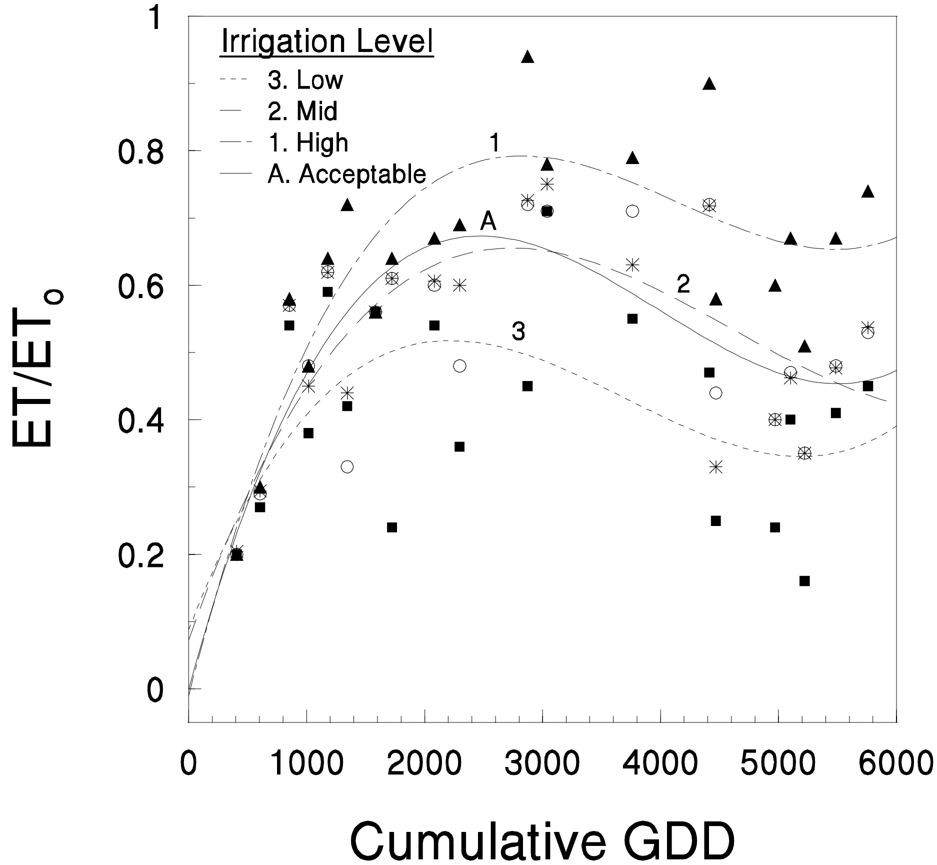
B. 1999 Warm Season Irrigation and Precipitation Summary							
	Distance from Line Source (ft)						
Application Date	41.1	32.6	24.1	15.6	7.1	Precipitation date	Amount
	Application Amount (in)						(in)
13-Sep	0.22	0.32	0.44	0.56	0.66	30-Jul	0.19
16-Sep	0.13	0.20	0.26	0.33	0.38	2-Aug	0.26
17-Sep	0.11	0.20	0.29	0.36	0.39	3-Aug	0.66
21-Sep	0.34	0.33	0.30	0.37	0.40	5-Aug	0.34
24-Sep	0.14	0.19	0.30	0.43	0.44	8-Aug	0.02
29-Sep	0.49	0.50	0.61	0.70	0.85	9-Aug	0.01
						10-Aug	0.01
						14-Aug	0.59
						15-Aug	0.03
						16-Aug	0.16
						17-Aug	0.01
						18-Aug	0.01
						19-Aug	0.57
						20-Aug	0.11
						26-Aug	0.04
						29-Aug	0.15
						30-Aug	0.02
						31-Aug	0.02
						1-Sep	0.05
						2-Sep	0.03
						10-Sep	0.08
						16-Sep	0.01
						22-Sep	0.02
						23-Sep	0.04
Total	**8.8**	**10.9**	**13.6**	**17.2**	**20.3**		**8.7**

Appendix C

Crop-coefficients at different irrigation levels

Figures C1-C6

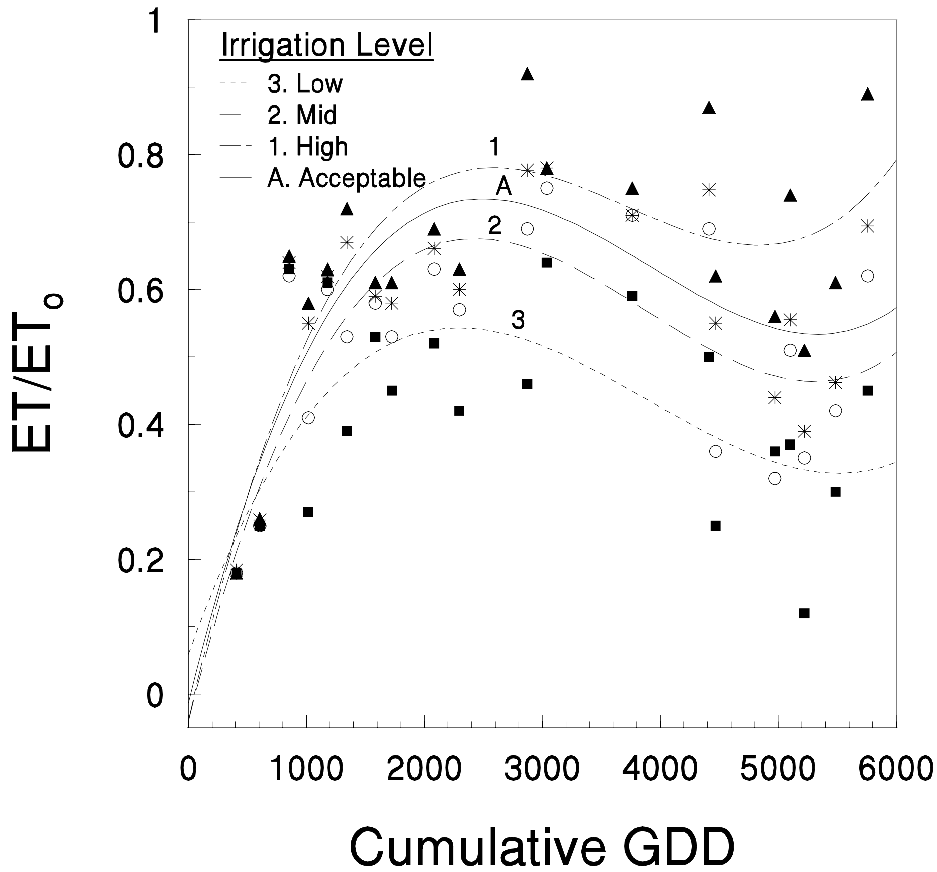
Fig. C1: Crop coefficients - Adelphi bluegrass



Coefficients for regression equation in form; $ET/ET_o = Y + Ax + Bx^2 + Cx^3$

Irrig. Level	Y	A	B	C
Low	**0.0880**	**4.5219×10^{-4}**	**-1.4558×10^{-7}**	**1.3102×10^{-11}**
Mid	**0.0723**	**4.9454×10^{-4}**	**-1.2823×10^{-7}**	**9.2616×10^{-12}**
High	**-0.0108**	**6.8673×10^{-4}**	**-1.8424×10^{-7}**	**1.4788×10^{-11}**
Acceptable	**-0.0011**	**6.4224×10^{-4}**	**-1.8842×10^{-7}**	**1.5760×10^{-11}**

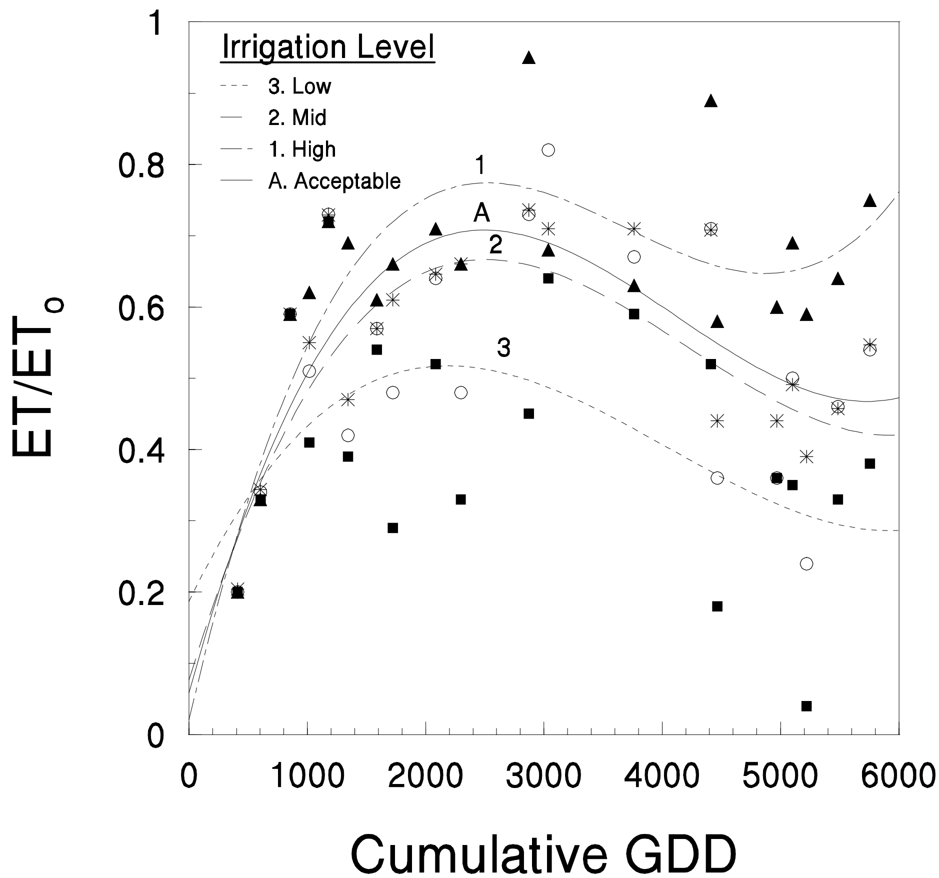
Fig. C2: Crop coefficients; Seville Perennial Ryegrass



Coefficients for regression equation in form; $ET/ET_o = Y + Ax + Bx^2 + Cx^3$

Irrig. Level	Y	A	B	C
Low	0.0592	4.9022×10^{-4}	-1.5140×10^{-7}	1.2935×10^{-11}
Mid	-0.0403	6.9387×10^{-4}	-2.0783×10^{-7}	1.7898×10^{-11}
High	-0.0391	7.6988×10^{-4}	-2.2812×10^{-7}	2.0485×10^{-11}
Acceptable	-0.0131	7.0860×10^{-4}	-2.0818×10^{-7}	1.7726×10^{-11}

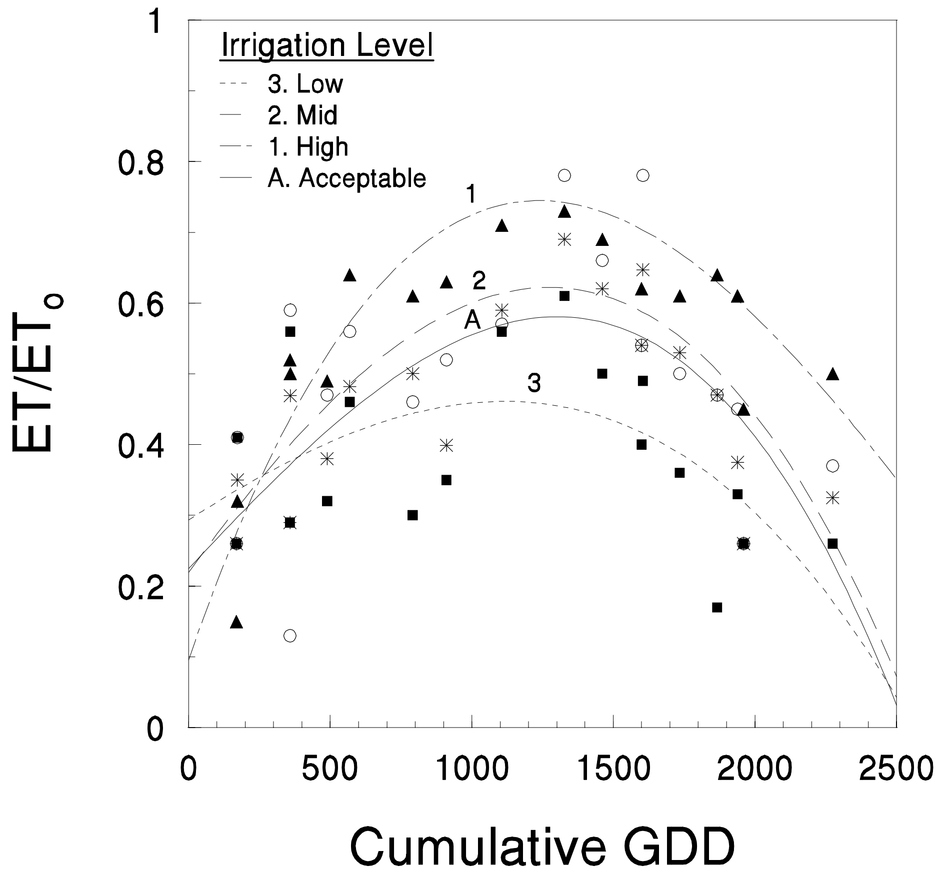
Fig. C3: Crop coefficients: Shenandoah Tall Fescue



Coefficients for regression equation in form; $ET/ET_o = Y + Ax + Bx^2 + Cx^3$

Irrig. Level	Y	A	B	C
Low	**0.1873**	**3.4453×10^{-4}**	**-1.0786×10^{-7}**	**8.8636×10^{-12}**
Mid	**0.0767**	**5.4756×10^{-4}**	**-1.5533×10^{-7}**	**1.2269×10^{-11}**
High	**0.0210**	**7.2101×10^{-4}**	**-2.1672×10^{-7}**	**1.9519×10^{-11}**
Acceptable	**0.0586**	**6.0893×10^{-4}**	**-1.7518×10^{-7}**	**1.4198×10^{-11}**

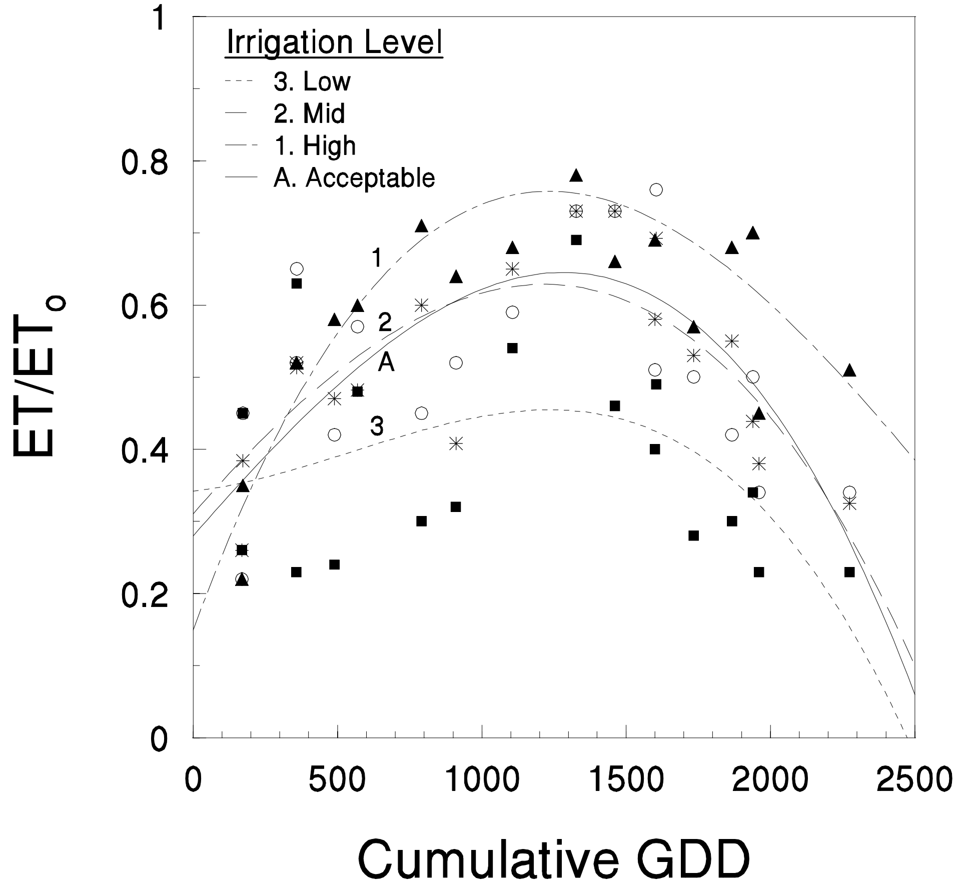
Fig. C4: Crop Coefficients; Bison Buffalograss



Coefficients for regression equation in form; $ET/ET_o = Y + Ax + Bx^2 + Cx^3$

Irrig. Level	Y	A	B	C
Low	0.2936	2.5850×10^{-4}	-5.9646×10^{-8}	-3.3530×10^{-11}
Mid	0.2192	5.5568×10^{-4}	-1.2767×10^{-7}	-4.7232×10^{-11}
High	0.0958	0.1155×10^{-2}	-5.9684×10^{-7}	7.0236×10^{-11}
Acceptable	0.2246	4.2910×10^{-4}	-2.9327×10^{-8}	-6.9284×10^{-11}

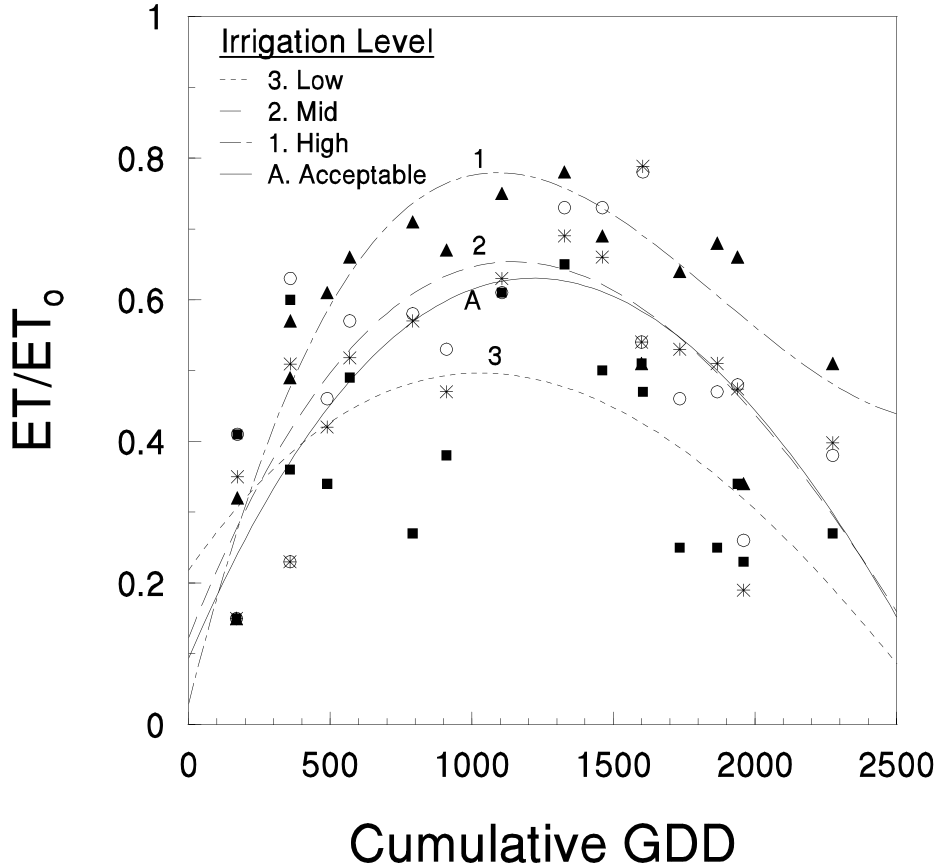
Fig. C5: Crop Coefficients; Lovington Blue Gramagrass



Coefficients for regression equation in form; $ET/ET_o = Y + Ax + Bx^2 + Cx^3$

Irrig. Level	Y	A	B	C
Low	**0.3418**	**4.5751×10^{-5}**	**1.4803×10^{-7}**	**-8.9929×10^{-11}**
Mid	**0.3104**	**4.6168×10^{-4}**	**-1.1322×10^{-7}**	**-4.2075×10^{-11}**
High	**0.1493**	**0.1090×10^{-2}**	**-5.6740×10^{-7}**	**6.7605×10^{-11}**
Acceptable	**0.2798**	**4.5737×10^{-4}**	**-4.6538×10^{-8}**	**-6.8664×10^{-11}**

Fig. C6: Crop Coefficients; Guymon Bermudagrass



Coefficients for regression equation in form; $ET/ET_o = Y + Ax + Bx^2 + Cx^3$

Irrig. Level	Y	A	B	C
Low	**0.2180**	**5.7184×10^{-4}**	**-3.2283×10^{-7}**	**2.9201×10^{-11}**
Mid	**0.1230**	**9.9681×10^{-4}**	**-5.2741×10^{-7}**	**5.3820×10^{-11}**
High	**0.0288**	**0.1596×10^{-2}**	**-1.0327×10^{-6}**	**1.8401×10^{-10}**
Acceptable	**0.0938**	**9.2390×10^{-4}**	**-4.3169×10^{-7}**	**2.8576×10^{-11}**