One-Year Evaluation of Pacific Technical Services Bio-Feed Products Applied on Tall Fescue in Riverside, California: 1996-1997

Final Report

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and

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1996-97 PACIFIC TECHNICAL SERVICES PROJECT ON TALL FESCUE

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Objectives:
To evaluate the performance of Bio-Feed fertilizers when applied to tall fescue for one year, in terms of visual quality ratings, clipping yields, clipping elemental analyses, root mass density, and soil elemental and physical analyses.

Cultivar: Bonsai tall fescue.

Experimental Site:
A mature plot established at the UCR Turfgrass Field Research Center, Riverside, CA on September 28, 1993. The root zone is a native soil which is classified as a Hanford fine sandy loam. See soil analyses tables for soil conditions during the study (all analyses were conducted by the DANR Analytical Laboratory).

Experimental Design: Randomized complete block design with four replications. Plot size 6.5 x 10.0 ft. with 21.0-inch borders. Overall analysis of variance (ANOVA) conducted via a repeated measured design with fertilizer treatments forming main plots and date of measurement forming subplots.

Mowing: Once per week with a walk-behind rotary mower set at 1.5 inches. Clippings collected.

Irrigation: Plots irrigated to prevent visual drought symptoms. Please see separate page for irrigation water analyses.

Fertilizer Treatments *(see protocol for specific dates)*:
- Annual N rate set at 6 pounds / 1000 ft^2.
- Test ran from May 1996 to May 1997.

Measurements:
Visual turfgrass quality ratings were estimated once every two weeks beginning two weeks after initial fertilizer treatment applications, using a 1 to 9 scale (1=poorest, 5=minimally acceptable, 9=best tall fescue).

Clipping yields were collected once every two weeks beginning three weeks after initial fertilizer treatment applications. Yields included seven days of growth, and were collected with the same mower used for routine mowing. Clippings were dried for 48 hours in a forced-air oven maintained at 60°C, then weighed on an analytical balance. Clippings collected represented a 27% subsample of the 65.0 ft^2 plot.

Clipping tissue samples for elemental analyses were collected on selected dates (see measurement schedule) with the same mower used for clipping yield collections. Sufficient tissue was collected to provide a minimum of 20 g of dried clipping tissue. Samples were dried for 48 hours in a forced-air oven maintained at 60ºC, then ground to pass through a 40 mesh sieve. Analysis of total S, Na, Ca, Mg, Cu, Fe, Mn, N, P, Mo and Zn was conducted by the DANR laboratory (see DANR protocol information sheet for more specific information about how these analyses were conducted). Please note that since there was insufficient growth on the no-fertilizer check plots for the May 1997 collection date, samples from these plots were collected five times over the course of six weeks (1-2 weeks apart), until there was approximately 15 g of dried clipping tissue per plot.

Root mass density was determined on selected dates (see measurement schedule) from four cores per plot and two depths. Core diameter was 2.28 inches; depths were 0-3 inches and 3-6 inches. Total volume of each six-inch-deep core was 24.5 in^3 (402.6 cm^3). Total volume for each root sample (four 3-inch cores pooled together for each plot) was 49.0 in^3 (803.2 cm^3). Root samples were washed, placed into a forced-air oven maintained at 60ºC for 48 hours, then weighed on an analytical balance. Root mass density reported as mg dried roots/cm^3 soil for both the 0-3-inch and 3-6-inch deep soil zones.

Soil physical and chemical element analysis was determined on selected dates (see measurement protocol) from four cores (pooled together) per plot. Core diameter was 2.28 inches and core depth was 3.0 inches. Soil samples were dried for a minimum of 72 hours in a forced-air oven maintained at 60ºC, then ground to pass through a 32 mesh sieve until a minimum sample of 300 grams was obtained. Analysis of pH, SAR, EC, ESP, particle size analysis, OM, CEC, soluble Ca, Mg, Na, B, Cl, HCO_3, CO_3, and exchangeable potassium, calcium, magnesium, sodium, Fe (only for May 1997), and Olsen-P was conducted by the DANR laboratory (see DANR protocol information sheet for more specific information about how these analyses were conducted).

1996-97 PACIFIC TECHNICAL SERVICES PROJECT ON TALL FESCUE

Findings:

1. The difference among treatments for visual turfgrass quality ratings were significant. The Bio-Feed treatments performed very well through January 1997. However, after the application of the Micro-H along with the regular Bio-Feed application on January 24, there was a dramatic decline in visual turfgrass quality. Given that the plots required two months to recover from this decline, the overall quality ratings were substantially lower than they would have been if the trend from the first eight months of the study had held. Even taking this into account, however, the Bio-Feed treatments still performed as well as the UCR Check B treatment, and had a very good overall rating of 6.8.

2. There were, for most sample dates, significant differences among the treatments for clipping yields.

3. There were no significant differences among the treatments for root mass density.

4. There were very few differences in terms of soil salinity measurements, soil physical characteristics, and soil fertility measurements among the treatments in May 1997 (and none at all in September 1996). The exceptions in May 1997 were for Cl, OM, and exchangeable Mg.

5. There were no significant differences among treatments for plant tissue elemental analyses in September 1996, but there were in May 1997. In May 1997, all but Total Na and Cu had significant differences among treatments. These data suggest that the Bio-Feed treatments allowed the plant tissue to absorb significantly greater amounts of N, P, S, Ca, Mg, Zn, Mn, Fe and Mo.

PROTOCOL FOR THE 1996-97 PACIFIC TECHNICAL SERVICES PROJECT ON TALL FESCUE

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FERTILIZER APPLICATIONS

Treatments	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	Total N/ 1000ft^2/ year
Bio-Feed *Combinations applied first of month*[z] (lb. N/1000ft^2)	Soil+ Turf+ Iron+ Ferta+ (0.5)	Soil+ Turf+ Iron+ Ferta+ (0.5)	Soil+ Turf+ Iron+ (0.5)	Soil+ Turf+ Iron+ (0.5)	Soil+ Turf+ Iron+ Ferta+ (0.5)	Soil+ Turf+ Iron+ Ferta+ (0.5)	Iron+ Ferta+ (0.5)	Iron+ Ferta + (0.5)	Iron+ Soil+ Micro H (0.5)	Iron+ Soil+ (0.5)	Iron+ Soil+ Turf+ (0.5)	Soil+ Turf+ Iron+ Ferta+ (0.5)	6.0
UCR Check A[y] (lb. N/1000ft^2)	5/1/96 Turf Supreme (1.0)	--	7/1/96 Turf Supreme (1.0)	--	9/1/96 Turf Supreme (1.0)	--	11/1/96 Nitra King (1.5)	--	--	2/1/97 Nitra King (1.5)	--	--	6.0
UCR Check B[x] (lb. N/1000ft^2)	5/1/96 TriKote (1.5)	--	7/15/96 TriKote (1.5)	--	--	9/15/96 Par EX IBDU (2.0)	--	--	1/15/97 Par Ex IBDU (1.0)	--	--	--	6.0
Check													0.0

[z] Soil+ = 6-0-0; Turf+ = 16-4-4; Iron+ = 10-0-0-6 Fe; Ferta+ = 8-10-5 (all analyses w/v). Micro H is a micro-nutrient complex, including 4% S, 3% Fe, 2% Zn, 1% Mn, 0.05% Cu, and 0.02% of both Mo and Co.
[y] Turf Supreme = 16-6-8; Nitra King = 22-3-9.
[x] TriKote = 42-0-0; Par Ex IBDU = 18-3-18.

MEASUREMENT SCHEDULE

Treatments	Visual Quality; Clipping Yield	Root Mass Density	Chemical Analysis of Clippings[z]	Chemical and Physical Analysis of Soil[y]
Bio-Feed	Every 2 weeks	5/96, 9/96, 5/97	5/96, 9/96, 5/97	5/96, 9/96, 5/97
UCR Check A		9/96, 5/97	9/96, 5/97	9/96, 5/97
UCR Check B				
Check				

[z] Clippings chemical analysis included: Total S, Na, Ca, Mg, Cu, Fe, Mn, N, P, Mo, and Zn. Analysis was conducted by the DANR Analytical Laboratory.
[y] Soil chemical and physical analysis included: pH, SAR, EC, ESP, particle size analysis, OM, CEC, soluble Ca, Mg, Na, B, Cl, HCO_3, CO_3, and exchangeable potassium, calcium, magnesium, and sodium, Fe (only for May 1997) and Olsen-P. Analysis was conducted by the DANR Analytical Laboratory.

Pacific Technical Services Project on Tall Fescue

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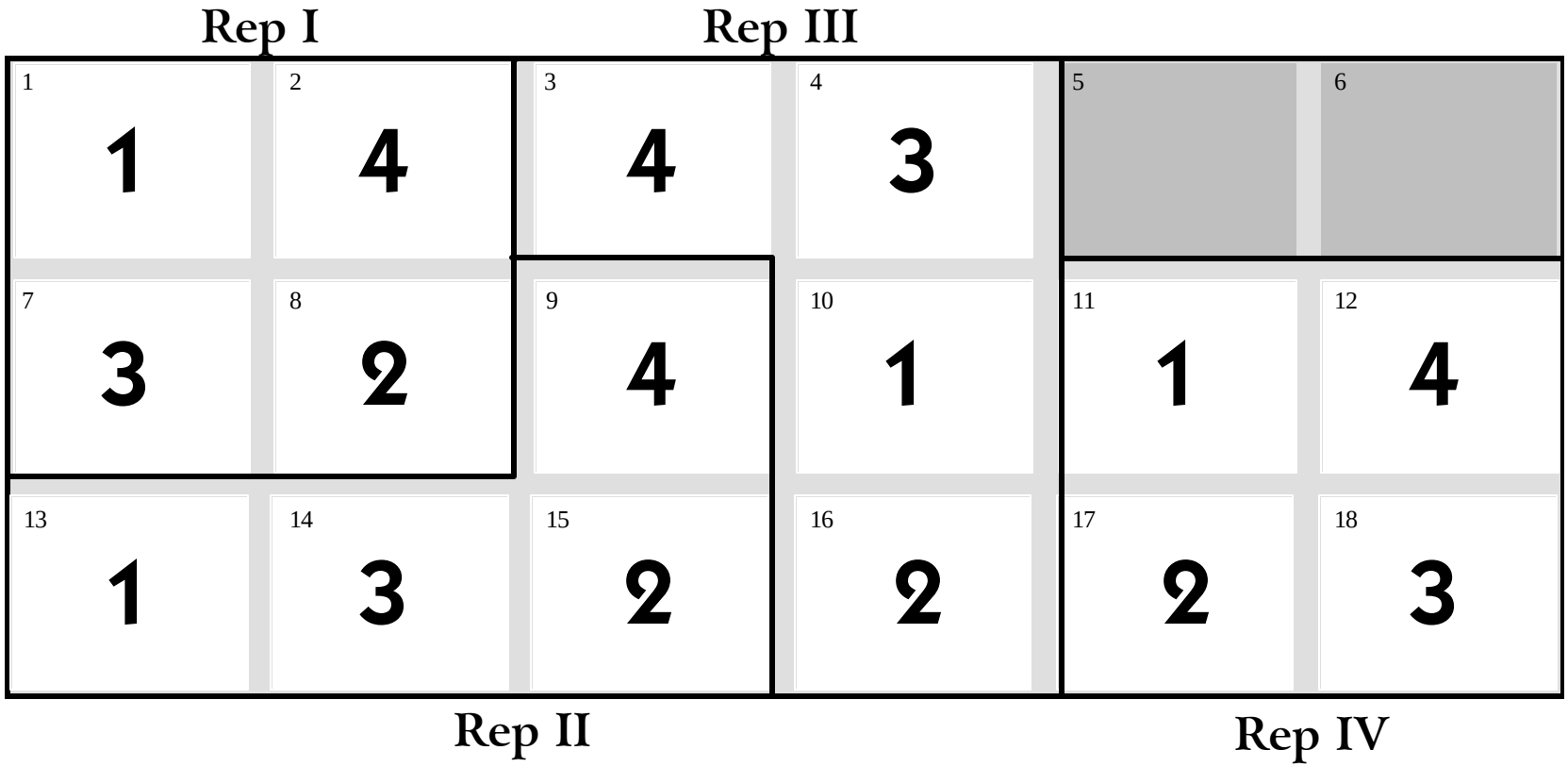


TREATMENTS

1. Bio-Feed (Soil Plus, Turf Plus, Iron Plus, Ferta Plus)
2. UCR Check A (Turf Supreme; Nitra King)
3. UCR Check B (TriKote; IBDU)
4. Check

Plot Dimensions:
6.5 ft x 10.0 ft

Borders:
21 inches

Calendar of the 1996-1997 P.T.S. Bio-Feed Study

Date	Activity
April 3, 1996	Plot mowing schedule set at once a week at 1.5"; clippings removed.
April 9, 1996	Plots aerated and overseeded.
May 6, 1996	Core samples taken from Bio-Feed plots for soil and root analysis.
May 8, 1996	Clipping samples taken from Bio-Feed plots for tissue analysis.
May 9, 1996	Initial Bio-Feed application.
May 10, 1996	Initial UCR Check A and B applications.
May 22, 1996	Initiated the biweekly ratings of visual turfgrass quality.
June 5, 1996	Initiated the biweekly measurements of clipping yields taken.
June 7, 1996	Bio-Feed application.
July 8, 1996	UCR Check A and B applications.
July 15, 1996	Bio-Feed application.
August 5, 1996	Bio-Feed application
September 9, 1996	Bio-Feed application
September 11, 1996	Clipping samples taken from all plots for tissue analysis.
September 13, 1996	Core samples taken from all plots for soil and root analysis.
September 23, 1996	UCR Check A application.
October 14, 1996	Bio-Feed application.
October 23, 1996	UCR Check B application.
November 25, 1996	Bio-Feed and UCR Check A applications.
December 23, 1996	Bio-Feed application.
January 16, 1997	Final UCR Check B application.
January 27, 1997	Bio-Feed application.
February 7, 1997	Final UCR Check A application.
February 28, 1997	Bio-Feed application.
March 27, 1997	Bio-Feed application.
April 28, 1997	Final Bio-Feed application.
May 14, 1997	Clipping samples taken from all plots for tissue analysis. Insufficient amount for analysis was taken from check plots.
May 16, 1997	Core samples taken from all plots for soil and root analysis.
May 30, 1997 and June 11, 1997 and June 18, 1997 and June 25, 1997	Additional clipping samples taken from check plots for analysis. Samples were taken until there was a sufficient amount for DANR laboratory analysis.

1996 Pacific Technical Services Bio-Feed Fertility Study: Visual Quality Ratings

Scale: 1-9 (1=poorest; 5=min. accept.; 9=best tall fescue)

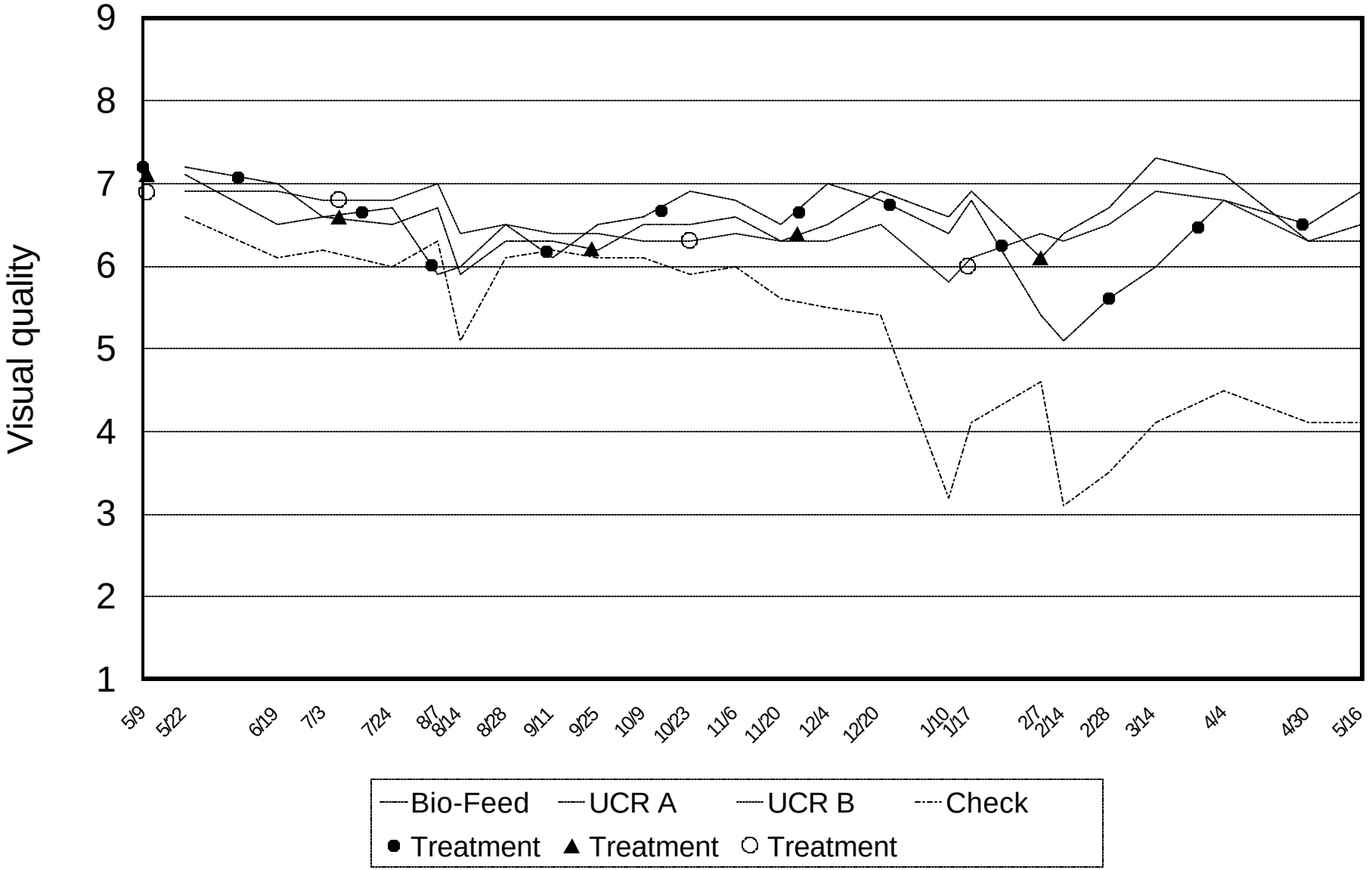
Treatments	05/22/96	06/19/96	07/03/96	07/24/96	08/07/96	08/14/96	08/28/96	09/11/96	09/25/96	10/09/96	10/23/96
Bio-Feed	7.2	7.0	6.6	6.7	5.9	6.0	6.5	6.1	6.5	6.6	6.9
UCR Check A	7.1	6.5	6.6	6.5	6.7	5.9	6.3	6.3	6.2	6.5	6.5
UCR Check B	6.9	6.9	6.8	6.8	7.0	6.4	6.5	6.4	6.4	6.3	6.3
Check	6.6	6.1	6.2	6.0	6.3	5.1	6.1	6.2	6.1	6.1	5.9
LSD P=0.05	NS	0.4	0.3	0.3	0.4	0.6	0.2	0.2	0.2	0.3	0.2

Treatments	11/06/96	11/20/96	12/04/96	12/20/96	01/10/97	01/17/97	02/07/97	02/14/97	02/28/97	03/14/97	04/04/97
Bio-Feed	6.8	6.5	7.0	6.8	6.4	6.8	5.4	5.1	5.6	6.0	6.8
UCR Check A	6.6	6.3	6.5	6.9	6.6	6.9	6.1	6.4	6.7	7.3	7.1
UCR Check B	6.4	6.3	6.3	6.5	5.8	6.1	6.4	6.3	6.5	6.9	6.8
Check	6.0	5.6	5.5	5.4	3.2	4.1	4.6	3.1	3.5	4.1	4.5
LSD P=0.05[z]	0.2	0.2	0.4	0.2	0.2	0.4	0.2	0.4	0.2	0.4	0.2

Treatments	04/30/97	05/16/97	Overall
Bio-Feed	6.5	6.9	6.4
UCR Check A	6.3	6.5	6.5
UCR Check B	6.3	6.3	6.5
Check	4.1	4.1	5.2
LSD P=0.05[z]	0.2	0.2	0.1

[z] LSD is the least significant difference at P= 0.05. NS refers to the main treatment effect not being significant at $P \leq 0.05$.

1996-97 Pacific Technical Services Bio-Feed Study
Visual Quality Ratings (Scale 1-9, 9=best tall fescue)



1996 Pacific Technical Services Bio-Feed Fertility Study: Clipping Yields

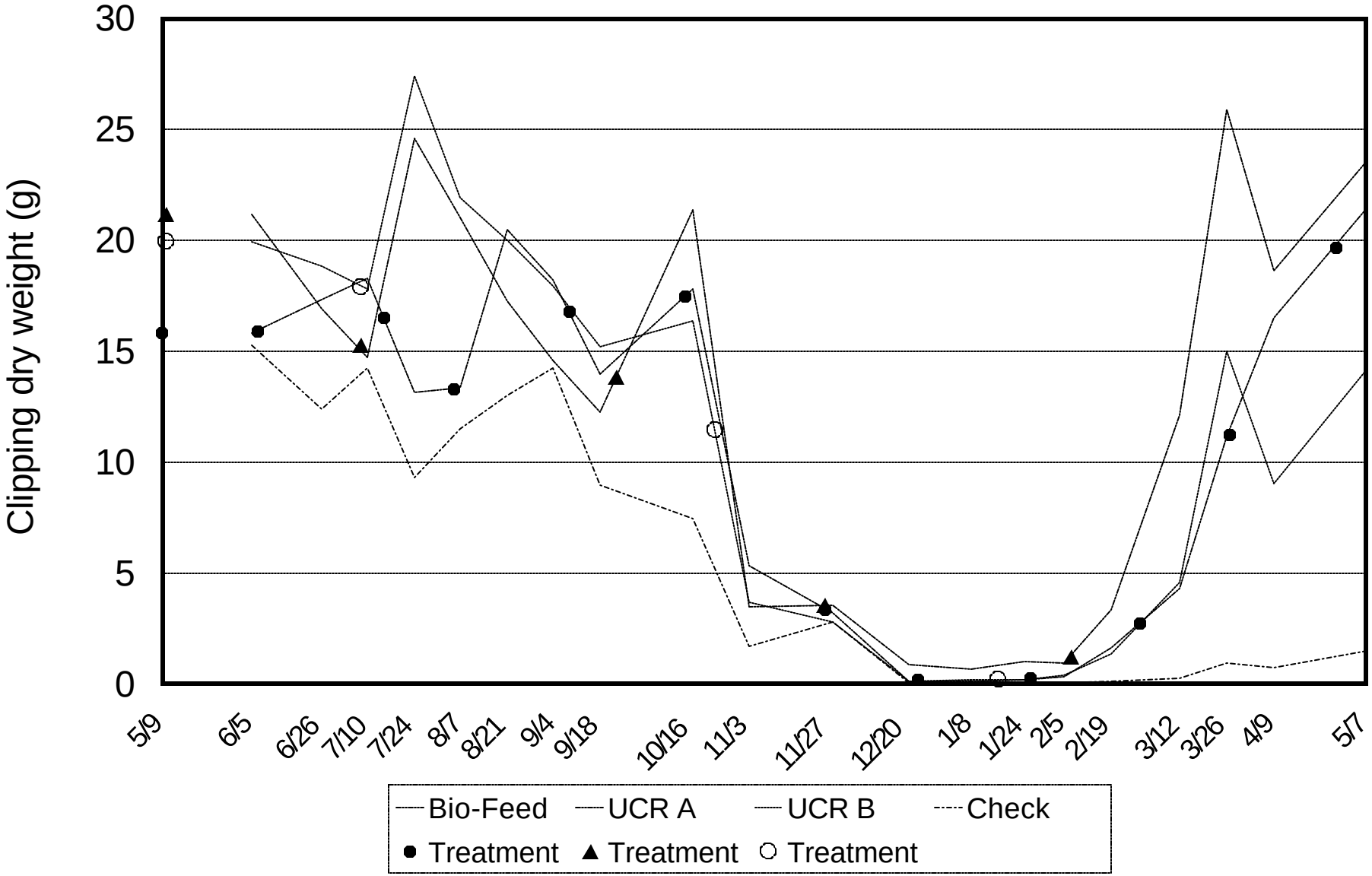
(g dry clippings / 17.55 ft^2 per 7 days)

Treatments	06/05/96	06/26/96	07/10/96	07/24/96	08/07/96	08/21/96	09/04/96	09/18/96	10/16/96	11/13/96	11/27/96
Bio-Feed	15.82	17.32	18.34	13.13	13.37	20.47	18.25	13.98	17.84	5.31	3.22
UCR Check A	21.16	16.94	14.74	24.64	21.07	17.27	14.57	12.24	21.38	3.51	3.56
UCR Check B	19.95	18.87	17.84	27.41	21.91	20.04	17.93	15.20	16.41	3.73	2.83
Check	15.30	12.42	14.27	9.30	11.48	13.05	14.23	8.97	7.47	1.71	2.83
LSD P=0.05[z]	4.37	NS	NS	5.72	5.16	2.98	3.28	2.88	4.50	1.90	NS

Treatments	12/20/96	01/08/97	01/24/97	02/05/97	02/19/97	03/12/97	03/26/97	04/09/97	05/07/97	Accum.
Bio-Feed	0.14	0.14	0.22	0.35	1.65	4.32	11.17	16.51	21.43	209.90
UCR Check A	0.85	0.68	0.99	0.93	3.34	12.10	25.91	18.67	23.56	255.40
UCR Check B	0.11	0.20	0.18	0.42	1.38	4.59	15.04	9.02	14.22	224.56
Check	0.06	0.06	0.05	0.05	0.10	0.29	0.96	0.75	1.47	112.05
LSD P=0.05[z]	0.39	0.33	0.38	0.44	0.74	5.10	3.97	6.01	6.72	n/a

[z] LSD is the least significant difference at P= 0.05. NS refers to the main treatment effect not being significant at $P \leq 0.05$.

1996-97 Pacific Technical Services Bio-Feed Study
Clipping Yields (grams dry clippings / 7 days / 17.55 ft²)



Root Mass Density (mg/cm^3): May 1996 Sample (Bio-Feed plots only)

Depth	Average	Standard Error
0-3 in.	2.3933	0.2017
3-6 in.	0.4394	0.0988

Root Mass Density (mg/cm^3): September 1996 Sample (All plots)

Treatments	0-3 in.	3-6 in.	Total	% Total in 0-3 in.
Bio-Feed	0.6998	0.3076	1.0072	69.5
UCR Check A	0.8062	0.4068	1.2131	66.2
UCR Check B	0.6988	0.3252	1.0239	67.6
Check	0.7664	0.3976	1.1640	65.5
LSD P=0.05[z]	NS	NS	NS	NS

Root Mass Density (mg/cm^3): May 1997 Sample (All plots)

Treatments	0-3 in.	3-6 in.	Total	% Total in 0-3 in.
Bio-Feed	3.5852	0.5456	4.1308	86.7
UCR Check A	3.4451	0.5725	4.0176	85.8
UCR Check B	3.9765	0.6200	4.5965	86.0
Check	3.7745	0.8095	4.5838	82.5
LSD P=0.05[z]	NS	NS	NS	NS

Note: Data for each depth represents root mass from a total sample volume of 803 cm^3.

[z] LSD is the least significant difference at P= 0.05. NS refers to the main treatment effect not being significant at $P \leq 0.05$.

Soil analysis for the 1996-97 Pacific Technical Service Bio-Feed Trial

SOIL SALINITY (all in soluble form)

Treat.	B (ppm)				Ca (meq/L)				Cl (meq/L)				CO_3 (meq/L)				EC (mmhos/cm)				ESP (%)			
	May 96		*Sep 97*	*May 97*	*May 96*		*Sep 97*	*May 97*	*May 96*		*Sep 97*	*May 97*	*May 96*		*Sep 97*	*May 97*	*May 96*		*Sep 97*	*May 97*	*May 96*		*Sep 97*	*May 97*
	$\bar{x}$	SE			$\bar{x}$	SE			$\bar{x}$	SE			$\bar{x}$	SE			$\bar{x}$	SE			$\bar{x}$	SE		
PTS	0.5	0.1	0.1	0.4	6.8	0.5	6.4	5.7	3.3	0.2	1.7	2.1	<0.1	--	<0.1	<0.1	1.25	0.06	0.99	1.06	2	0	2	2
UCR A	--	--	0.1	0.4	--	--	6.1	5.5	--	--	1.5	1.9	--	--	<0.1	<0.1	--	--	0.93	1.00	--	--	2	2
UCR B	--	--	0.1	0.4	--	--	6.4	5.9	--	--	1.6	2.2	--	--	<0.1	<0.1	--	--	0.99	1.07	--	--	2	2
Check	--	--	0.1	0.4	--	--	6.3	5.9	--	--	1.8	2.6	--	--	<0.1	<0.1	--	--	1.01	1.10	--	--	2	2
LSD[z] P=0.05	--	--	NS	NS	--	--	NS	NS	--	--	NS	0.3	--	--	--	--	--	--	NS	NS	--	--	NS	NS

SOIL SALINITY (all in soluble form)

Treat.	HCO_3 (meq/L)				Mg (meq/L)				Na (meq/L)				SAR			
	May 96		*Sep 97*	*May 97*	*May 96*		*Sep 97*	*May 97*	*May 96*		*Sep 97*	*May 97*	*May 96*		*Sep 97*	*May 97*
	$\bar{x}$	SE			$\bar{x}$	SE			$\bar{x}$	SE			$\bar{x}$	SE		
PTS	0.6	0.0	4.2	2.7	2.5	0.2	2.0	2.0	5.0	0.2	4.8	4.4	2	0	2	2
UCR A	--	--	4.6	2.9	--	--	1.9	2.0	--	--	4.1	4.2	--	--	2	2
UCR B	--	--	4.9	2.9	--	--	2.1	2.1	--	--	4.4	4.4	--	--	2	2
Check	--	--	5.0	2.6	--	--	2.1	2.1	--	--	4.7	4.2	--	--	2	2
LSD[z] P=0.05	--	--	NS	NS	--	--	NS	NS	--	--	NS	NS	--	--	NS	NS

[z] LSD is the least significant difference at P= 0.05. NS refers to the main treatment effect not being significant at P≤0.05.

Soil analysis for the 1996-97 Pacific Technical Service Bio-Feed Trial

SOIL PHYSICAL CHARACTERISTICS																				
Treat.	**CEC (meq/100 g)**				**OM (%)**				**Sand (%)**				**Silt (%)**				**Clay (%)**			
	May 96		***Sep 97***	***May 97***	***May 96***		***Sep 97***	***May 97***	***May 96***		***Sep 97***	***May 97***	***May 96***		***Sep 97***	***May 97***	***May 96***		***Sep 97***	***May 97***
	$\bar{x}$	SE			$\bar{x}$	SE			$\bar{x}$	SE			$\bar{x}$	SE			$\bar{x}$	SE		
PTS	11.7	0.1	13.1	14.7	1.51	0.05	1.44	2.20	51	0	51	55	40	0	37	37	9	0	12	8
UCR A	--	--	12.2	15.1	--	--	1.44	2.38	--	--	50	54	--	--	37	38	--	--	12	8
UCR B	--	--	12.5	14.9	--	--	1.54	2.36	--	--	50	54	--	--	37	38	--	--	12	8
Check	--	--	12.7	14.6	--	--	1.45	1.93	--	--	50	55	--	--	37	37	--	--	12	8
LSD[z] P=0.05	--	--	NS	NS	--	--	NS	0.33	--	--	NS	NS	--	--	NS	NS	--	--	NS	NS

[z] LSD is the least significant difference at P= 0.05. NS refers to the main treatment effect not being significant at P≤0.05.

Soil analysis for the 1996-97 Pacific Technical Service Bio-Feed Trial

SOIL FERTILITY																								
Treat.	Fe (ppm)				Olsen-P (ppm)				pH				X-Ca (meq/100 g)				X-K (meq/100 g)				X-Mg (meq/100 g)			
	May 96		*Sep 97*	*May 97*	*May 96*		*Sep 97*	*May 97*	*May 96*		*Sep 97*	*May 97*	*May 96*		*Sep 97*	*May 97*	*May 96*		*Sep 97*	*May 97*	*May 96*		*Sep 97*	*May 97*
	$\bar{x}$	SE			$\bar{x}$	SE			$\bar{x}$	SE			$\bar{x}$	SE			$\bar{x}$	SE			$\bar{x}$	SE		
PTS	--	--	--	43	22	2	15	29	7.0	0.1	7.6	7.0	6.6	0.2	7.1	8.2	0.3	0.0	0.3	0.4	1.6	0.0	1.5	1.8
UCR A	--	--	--	38	--	--	19	27	--	--	7.5	7.0	--	--	7.2	8.2	--	--	0.3	0.4	--	--	1.5	1.9
UCR B	--	--	--	39	--	--	18	28	--	--	7.6	7.0	--	--	7.4	8.4	--	--	0.3	0.4	--	--	1.5	1.9
Check	--	--	--	39	--	--	16	29	--	--	7.5	6.9	--	--	6.9	7.5	--	--	0.4	0.4	--	--	1.5	1.7
LSD[z] P=0.05	--	--	--	NS	--	--	NS	NS	--	--	NS	NS	--	--	NS	NS	--	--	NS	NS	--	--	NS	0.1

SOIL FERTILITY				
Treat.	X-Na (meq/100 g)			
	May 96		*Sep 97*	*May 97*
	$\bar{x}$	SE		
PTS	0.5	0.0	0.4	0.4
UCR A	--	--	0.4	0.4
UCR B	--	--	0.4	0.4
Check	--	--	0.3	0.4
LSD[z] P=0.05	--	--	NS	NS

[z] LSD is the least significant difference at P= 0.05. NS refers to the main treatment effect not being significant at P≤0.05.

Plant tissue analysis for the 1996-97 Pacific Technical Service Bio-Feed Trial

TOTAL ELEMENTAL ANALYSIS OF PLANT TISSUE																								
Treat.	N (%)				P (%)				S (ppm)				Ca (%)				Mg (%)				Na (ppm)			
	May 96		*Sep 97*	*May 97*	*May 96*		*Sep 97*	*May 97*	*May 96*		*Sep 97*	*May 97*	*May 96*		*Sep 97*	*May 97*	*May 96*		*Sep 97*	*May 97*	*May 96*		*Sep 97*	*May 97*
	$\bar{x}$	SE			$\bar{x}$	SE			$\bar{x}$	SE			$\bar{x}$	SE			$\bar{x}$	SE			$\bar{x}$	SE		
PTS	3.44	0.03	4.13	3.45	0.45	0.02	0.63	0.48	3365	90	3580	3575	0.41	0.03	0.55	0.55	0.23	0.01	0.25	0.28	1490	53	1447	1537
UCR A	--	--	4.29	3.30	--	--	0.64	0.45	--	--	3812	3082	--	--	0.55	0.53	--	--	0.25	0.27	--	--	1537	1507
UCR B	--	--	4.18	3.10	--	--	0.64	0.43	--	--	3732	3140	--	--	0.57	0.57	--	--	0.26	0.28	--	--	1410	1555
Check	--	--	4.13	2.22	--	--	0.60	0.43	--	--	3775	2865	--	--	0.53	0.75	--	--	0.23	0.29	--	--	1597	1337
LSD[z] P=0.05	--	--	NS	0.12	--	--	NS	0.02	--	--	NS	162	--	--	NS	0.06	--	--	NS	0.02	--	--	NS	NS

TOTAL ELEMENTAL ANALYSIS OF PLANT TISSUE																				
Treat.	Zn (ppm)				Mn (ppm)				Fe (ppm)				Cu (ppm)				Mo (ppm)			
	May 96		*Sep 97*	*May 97*	*May 96*		*Sep 97*	*May 97*	*May 96*		*Sep 97*	*May 97*	*May 96*		*Sep 97*	*May 97*	*May 96*		*Sep 97*	*May 97*
	$\bar{x}$	SE			$\bar{x}$	SE			$\bar{x}$	SE			$\bar{x}$	SE			$\bar{x}$	SE		
PTS	35	2	30	26	141	14	49	31	996	216	1066	187	11.0	0.5	11.3	8.7	5.6	0.8	4.9	5.0
UCR A	--	--	31	23	--	--	44	22	--	--	687	151	--	--	11.7	8.0	--	--	3.7	4.7
UCR B	--	--	32	22	--	--	45	30	--	--	394	131	--	--	11.4	7.4	--	--	3.8	5.4
Check	--	--	31	52	--	--	51	65	--	--	871	873	--	--	11.8	7.6	--	--	5.3	7.0
LSD[z] P=0.05	--	--	NS	9	--	--	NS	10	--	--	NS	4	--	--	NS	NS	--	--	NS	0.6

[z] LSD is the least significant difference at P= 0.05. NS refers to the main treatment effect not being significant at P≤0.05.

Irrigation Water Analysis for the 1996-97 Pacific Technical Service Bio-Feed Trial

IRRIGATION WATER (RESERVOIR)											
pH	**EC (mmhos/cm)**	**Ca (meq/L)**	**Mg (meq/L)**	**Na (meq/L)**	**SAR**	**ESP (%)**	**Cl (meq/L)**	**B (ppm)**	**HCO_3 (meq/L)**	**CO_3 (meq/L)**	**SO_4-S (ppm)**
8.4	0.53	3.1	1.1	1.5	1	<1	8.8	0.1	3.2	<0.1	23.5

Weather measurements collected[z] from March 31, 1996 to June 28, 1997 in Riverside, CA.

Date	Accumulative Weekly ET_o[y] (mm/week)	Accumulative Weekly Precipitation (mm/week)	Average Solar Radiation (W/m^2/day)	Average Daily Temperature (ºC)	(ºF)	Average Daily Relative Humidity (%)	Average Daily Soil Temperature at 10.2 cm Depth (ºC)	(ºF)
03/31/96 - 04/06	39.91	1.00	266	17	63	36	17	63
04/07 - 04/13	33.19	0.00	253	16	61	45	18	64
04/14 - 04/20	34.83	3.00	255	17	63	42	18	64
04/21 - 04/27	42.60	0.00	291	21	70	39	20	68
04/28 - 05/04	44.83	0.00	292	22	72	38	21	70
05/05 - 05/11	42.51	0.00	302	21	70	44	22	72
05/12 - 05/18	40.81	0.00	287	21	70	47	23	73
05/19 - 05/25	36.60	0.00	270	17	63	50	22	72
05/26 - 06/01	36.71	0.00	273	18	64	50	21	70
06/02 - 06/08	44.63	0.00	304	24	75	43	24	75
06/09 - 06/15	41.47	0.00	294	21	70	48	24	75
06/16 - 06/22	41.51	0.00	296	21	70	47	24	75
06/23 - 06/29	37.52	0.00	274	20	68	47	22	72
06/30 - 07/06	46.34	0.00	303	28	82	36	25	77
07/07 - 07/13	43.31	0.00	298	24	75	45	25	77
07/14 - 07/20	41.98	0.00	293	23	73	48	25	77
07/21 - 07/27	43.23	0.00	284	26	79	42	26	79
07/28 - 08/03	45.29	0.00	291	27	81	43	27	81
08/04 - 08/10	39.72	0.00	275	23	73	50	26	79
08/11 - 08/17	41.62	0.00	263	27	81	44	27	81
08/18 - 08/24	39.62	0.00	259	25	77	41	25	77
08/25 - 08/31	41.69	0.00	265	27	81	33	25	77
09/01 - 09/07	35.64	0.00	249	24	75	49	25	77
09/08 - 09/14	33.65	0.00	245	23	73	46	24	75
09/15 - 09/21	30.13	0.00	224	21	70	50	23	73

[z] Weather data collected from an on-site CIMIS weather station.

[y] ET_o = Reference evapotranspiration.

Weather measurements collected[z] from March 31, 1996 to June 28, 1997 in Riverside, CA.

Date	Accumulative Weekly ET_o[y] (mm/week)	Accumulative Weekly Precipitation (mm/week)	Average Solar Radiation (W/m^2/day)	Average Daily Temperature (ºC)	(ºF)	Average Daily Relative Humidity (%)	Average Daily Soil Temperature at 10.2 cm Depth (ºC)	(ºF)
09/22 - 09/28	22.16	0.00	205	20	68	71	23	73
09/29 - 10/05	22.39	0.00	199	22	72	79	22	72
10/06 - 10/12	24.60	0.00	208	24	75	72	22	72
10/13 - 10/19	15.50	0.00	162	18	64	83	21	70
10/20 - 10/26	20.86	1.00	172	15	59	63	17	63
10/27 - 11/02	12.55	2.00	99	12	54	68	14	57
11/03 - 11/09	23.31	0.00	157	16	61	40	15	59
11/10 - 11/16	16.18	0.00	132	17	63	49	16	61
11/17 - 11/23	11.44	41.00	114	14	57	61	16	61
11/24 - 11/30	21.39	0.00	142	15	59	41	14	57
12/01 - 12/07	12.36	6.00	124	12	54	55	12	54
12/08 - 12/14	9.86	14.00	82	14	57	65	14	57
12/15 - 12/21	16.21	0.00	121	12	54	41	12	54
12/22 - 12/28	8.59	7.00	79	12	54	61	12	54
12/29 - 01/04/97	5.71	12.00	65	14	57	70	14	57
01/05 - 01/11	15.20	5.00	108	11	52	49	12	54
01/12 - 01/18	9.54	57.00	92	10	50	59	11	52
01/19 - 01/25	7.14	19.00	82	11	52	68	12	54
01/26 - 02/01	17.22	19.00	147	15	59	55	14	57
02/02 - 02/08	15.87	0.00	155	11	52	58	13	55
02/09 - 02/15	17.44	5.00	142	13	55	56	12	54
02/16 - 02/22	23.83	0.00	195	16	61	50	13	55
02/23 - 03/01	24.12	2.00	177	12	54	49	12	54
03/02 - 03/08	25.36	0.00	224	14	57	50	13	55

[z] Weather data collected from an on-site CIMIS weather station.

[y] ET_o = Reference evapotranspiration.

Weather measurements collected[z] from March 31, 1996 to June 28, 1997 in Riverside, CA.

Date	Accumulative ET_o (mm/week)	Accumulative Precipitation (mm/week)	Average Daily Solar Radiation (W/m^2/day)	Average Daily Temperature (^0C)		Average Daily Relative Humidity (%)	Average Daily Soil Temperature at 10.2 cm Depth (^0C)	
03/09 - 03/15	28.19	0.00	227	19	66	50	15	59
03/16 - 03/22	27.90	0.00	227	19	66	57	17	63
03/23 - 03/29	24.68	0.00	205	16	61	63	18	64
04/06 - 04/12	23.12	2.00	193	13	55	61	16	61
04/06 - 04/12	29.89	0.00	258	14	57	61	16	61
04/13 - 04/19	31.98	0.00	244	18	64	59	18	64
04/20 - 04/26	43.50	0.00	337	21	70	48	20	68
04/27 - 05/03	38.23	0.00	303	19	66	50	21	70
05/04 - 05/10	42.30	0.00	330	22	72	46	23	73
05/11 - 05/17	38.60	0.00	288	22	72	55	24	75
05/18 - 05/24	36.99	0.00	284	20	68	56	24	75
05/25 - 05/31	45.91	0.00	341	24	75	48	24	75
06/01 - 06/07	36.85	0.00	290	20	68	55	24	75
06/08 - 06/14	31.81	0.00	261	19	66	55	23	73
06/15 - 06/21	42.57	0.00	338	22	72	55	24	75
06/22 - 06/28	40.88	0.00	328	21	70	55	24	75

[z] Weather data collected from an on-site CIMIS weather station.

[y] ET_o = Reference evapotranspiration.

DANR Analytical Laboratory Soil and Plant Analysis Methods

Note: The following is excerpted from the DANR Analytical Laboratory methodology and citation handout dated 2/18/97.

SOIL SALINITY

pH Semi-quantifies soil pH using the saturated paste and pH meter. Determination: U.S. Salinity Laboratory Staff, 1954.

EC_e Semi-quantifies the amount of soluble salts in the saturation paste extract using conductivity meter. Determination: Rhoades, 1982.

HCO_3, CO_3 Quantification of the bicarbonate (HCO_3) and carbonate (CO_3) in the saturated paste extract by titration with 0.05 Normal H_2SO_4 acid. Determination: Nelson, 1982.

Cl Amount of chloride based on electrometric titration of the saturated paste extract by chloridometer. Determination: Rhoades, 1982.

B ICP-AES determination of amount of boron in saturated paste extract. Extraction: Rhoades, 1982; determination: Soltanpour, et al, 1982.

Ca, Mg Amounts of soluble calcium and magnesium in the saturated paste extract by inductively coupled plasmic atomic emission spectrometry. Extraction: Lanyon and Heald, 1982; determination, Soltanpour, et al, 1982.

Na, K(sol) Amounts of soluble potassium and sodium in the saturated paste extract by emission spectometry. Determination: Knudsen, Peterson and Pratt, 1982.

SAR Sodium Absorption Ratio estimated calculation from calcium, magnesium and sodium on saturated paste extract. Calculation: U.S. Salinity Laboratory, 1954.

ESP Estimated value for exchangeable sodium percentage. Calculated from SAR values. Calculation: U.S. Salinity Laboratory, 1954.

SOIL FERTILITY

X-K, X-Na, X-Ca, X-Mg Equilibrium extraction of soil for plant available exchangeable potassium, sodium, calcium and magnesium using 1 Normal ammonium acetate (pH 7.0) and subsequent determination by atomic absorption/emission spectrometry. Extraction: Knudsen, Peterson and Pratt, 1982 and Lanyon and Heald, 1982. Measurement of exchangeable minerals residing on the soil colloid exchange sites is by displacement with buffered ammonium acetate solution. Determination: Franson, 1985.

Cu, Zn Mn, Fe Equilibrium extraction of soil using DTPA and subsequent determination by atomic absorption spectrometry. Extraction: Lindsay and Norvell, 1978; determination: Franson, 1985.

Olsen-P Extractable phosphate based on alkaline extraction by 0.5 Normal $NaHCO_3$. Plant available phosphate for soil with pH greater than 6.5 by ascorbic acid reduction of phosphomolybdate complex and measurement by spectrophotometry. Extraction and determination: Olsen, et al, 1954.

SOIL PHYSIO-CHEMICAL ANALYSES

OM Organic Matter by potassium dichromate reduction of organic carbon and subsequent spectrophotometric measurement (modified Walkley-Black). Determination: Nelson and Sommers, 1982.

CEC Cation Exchange Capacity by barium acetate saturation and calcium replacement. Determination: Rible and Quick, 1960 and Janitzky, 1986.

PLANT TISSUE ANALYSES

N	Total Nitrogen by Nitrogen Gas Analyzer utilizing induction furnace and thermal conductivity (LECO FP-428). Sample size 100 mg, results corrected to 100% dry matter basis. Determination: Sweeney, 1989.
K	Total K, extraction by 2% acetic acid extraction. Quantitative determination by atomic emission spectrometry (AES). Extraction: Johnson and Ulrich, 1959; determination: Franson, 1985.
B, Ca, Mg, Mo, P, S	Totals, microwave acid digestion/dissolution of sample. Quantitative determination by atomic emission spectroscopy (ICP-AES). Digestion: Sah and Miller, 1992.
Na	Totals, microwave acid digestion/dissolution of sample. Quantitative determination by atomic emission spectrometry (AES). Digestion: Sah and Miller, 1992; determination, Franson, 1985.
Cu, Fe, Mn, Zn	Totals, microwave acid digestion/dissolution of sample. Quantitative determination by atomic emission spectrometry (AAS). Digestion: Sah and Miller, 1992; determination, Franson, 1985.

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