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CONSUMPTIVE USE AND YIELDS OF CROPS IN NEW MEXICO

Technical Completion Report

Project No. B-054-NMEX

CONSUMPTIVE USE AND YIELDS OF CROPS IN NEW MEXICO

by

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COMPLETION REPORT
PROJECT NO. B-054-NMEX

New Mexico Water Resources Research Institute
in cooperation with
Department of Agricultural Engineering,
Department of Agronomy,
Department of Horticulture,
and
New Mexico Agricultural Experiment Station
New Mexico State University
Las Cruces, New Mexico

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ERRATA SHEET
WRRI Report 115

p. 56
Table 12. The Figure Numbers in the first column should all be followed by a D instead of a B

p. 101
Equation (2) should read:

$$Ea = 15.36\ (1.0 + 0.0062U_2)\ (e_s - e)\ (L - 1)$$

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INTRODUCTION

Irrigation agriculture uses about 87 percent of the water supply in New Mexico. Essentially all the surface water supplies in the state are appropriated and essentially all of the groundwater aquifers are being mined. Most of the groundwater aquifers are controlled and regulated in declared groundwater basins. In the future, water supplies for all uses will become more competitive as demand on existing water supplies increases.

As water is transferred to a higher economic base use by industry and urban development, higher efficiency of water use on agricultural lands will be imperative. Information is needed to determine more accurately the influence of consumptive use on yield of crops grown through the state's agricultural lands. Better information is also needed to predict the short-term consumptive use for scheduling irrigations based upon meteorological variables that can be readily measured.

OBJECTIVES

The main objective of the research was to determine the consumptive use throughout the growing season of selected crops at Los Lunas, Las Cruces, Farmington, Artesia, and Clovis (Figure 1) and to relate consumptive-use data to climatological data in order to determine coefficients that may be used with different meteorological models to estimate future consumptive-use requirements. Specific objectives were:

1. To determine the quantity and rate of moisture depletion by consumptive use throughout the growing season of selected crops grown in Eddy, Curry, Dona Ana, San Juan, and Valencia Counties;

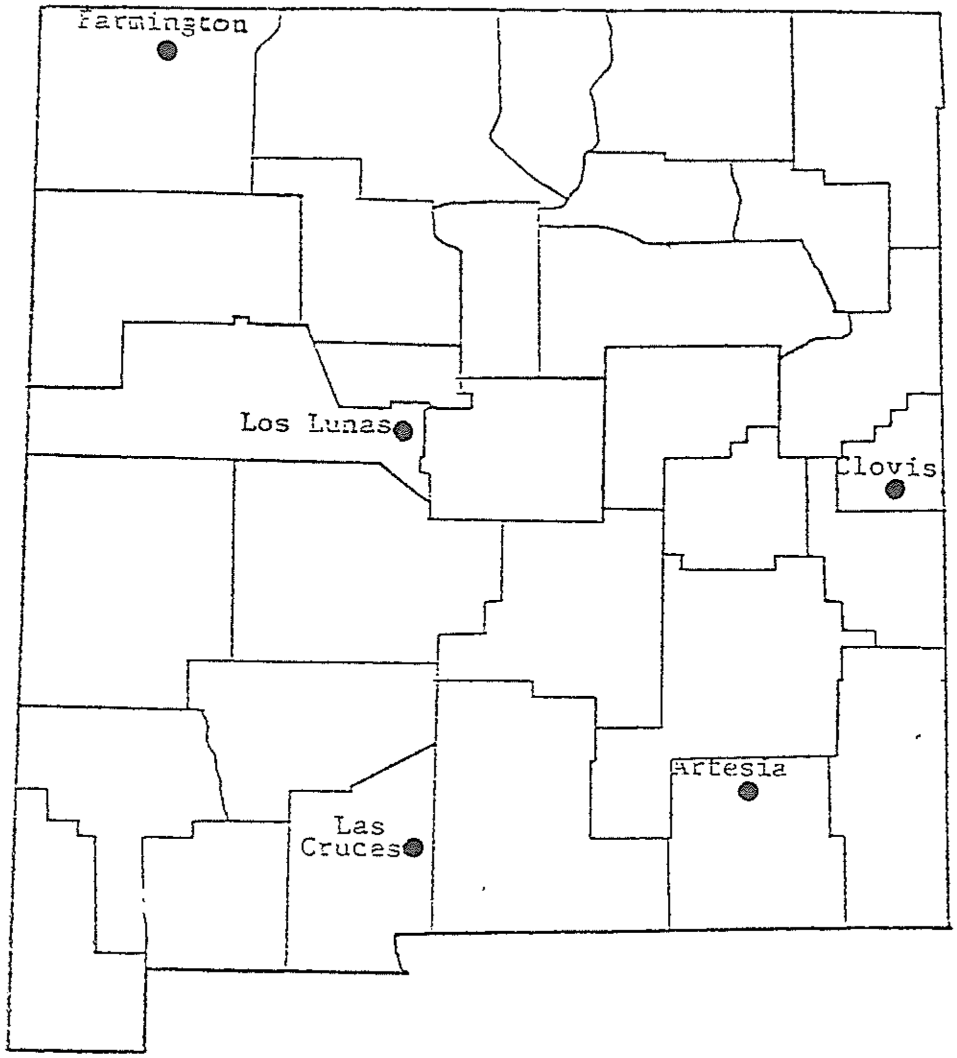

Figure 1. A map showing the locations where evapotranspiration measurements are being conducted on selected crops in New Mexico.

2. To concurrently measure pan evaporation, temperature, solar radiation, precipitation, wind movement, and humidity at sites where consumptive use is being determined;

3. To use these data to refine coefficients presently used in the Blaney-Criddle method and extend the application of this formula in consumptive use estimates;

4. To examine other methods of estimating consumptive use of irrigated crops such as methods developed by Priestly-Taylor, Jensen-Haise, Penman, and others.

METHODS

Meteorological stations, operated in cooperation with the Weather Bureau, exist at each of the study sites. The climatological data obtained at each station include daily max-min humidity taken from hygrothermographs, psychrometric reading at 8 o'clock in the morning, 24-hour solar radiation measured by a star pyranometer and an integrator, 24-hour total wind run measured at the 2-meter height using a cup anemometer, evaporation from Class A evaporation pans, and precipitation using a standard 8" rain gauge.

For a selected day during the summer months of 1977, hourly measurements of net radiation using a Fritschen Net Radiometer and the star pyranometer were made over sorghum, alfalfa, and cotton.

Description of the Sites

Figure 2 is a map of the study sites and the surrounding fields used in 1976 to 1977. Figure 3 is a map of the site used in 1978. Table 1 presents the various crops grown at the study sites throughout the state. For the

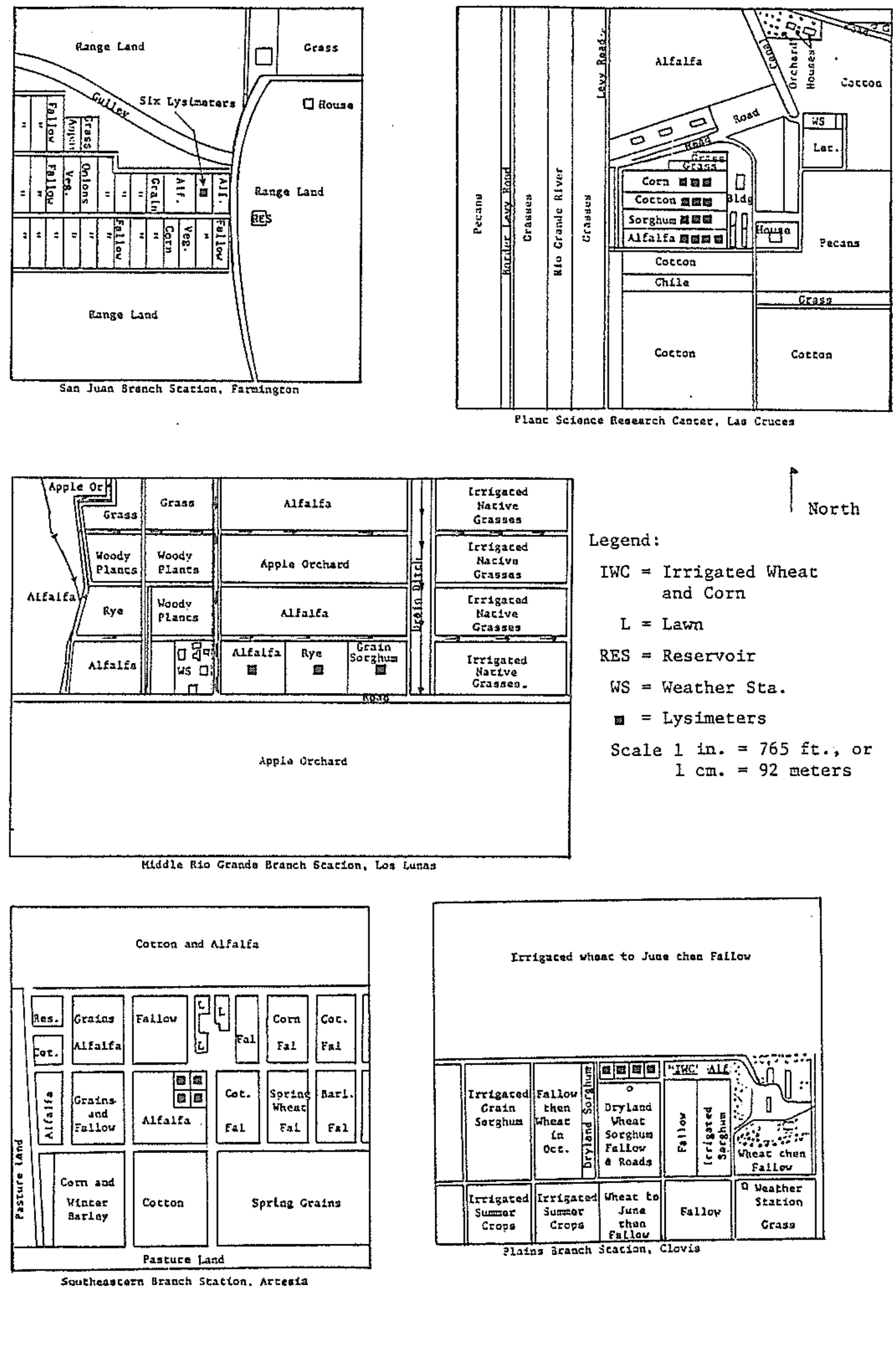

Figure 2. Study sites and surrounding fields, 1976 and 1977.

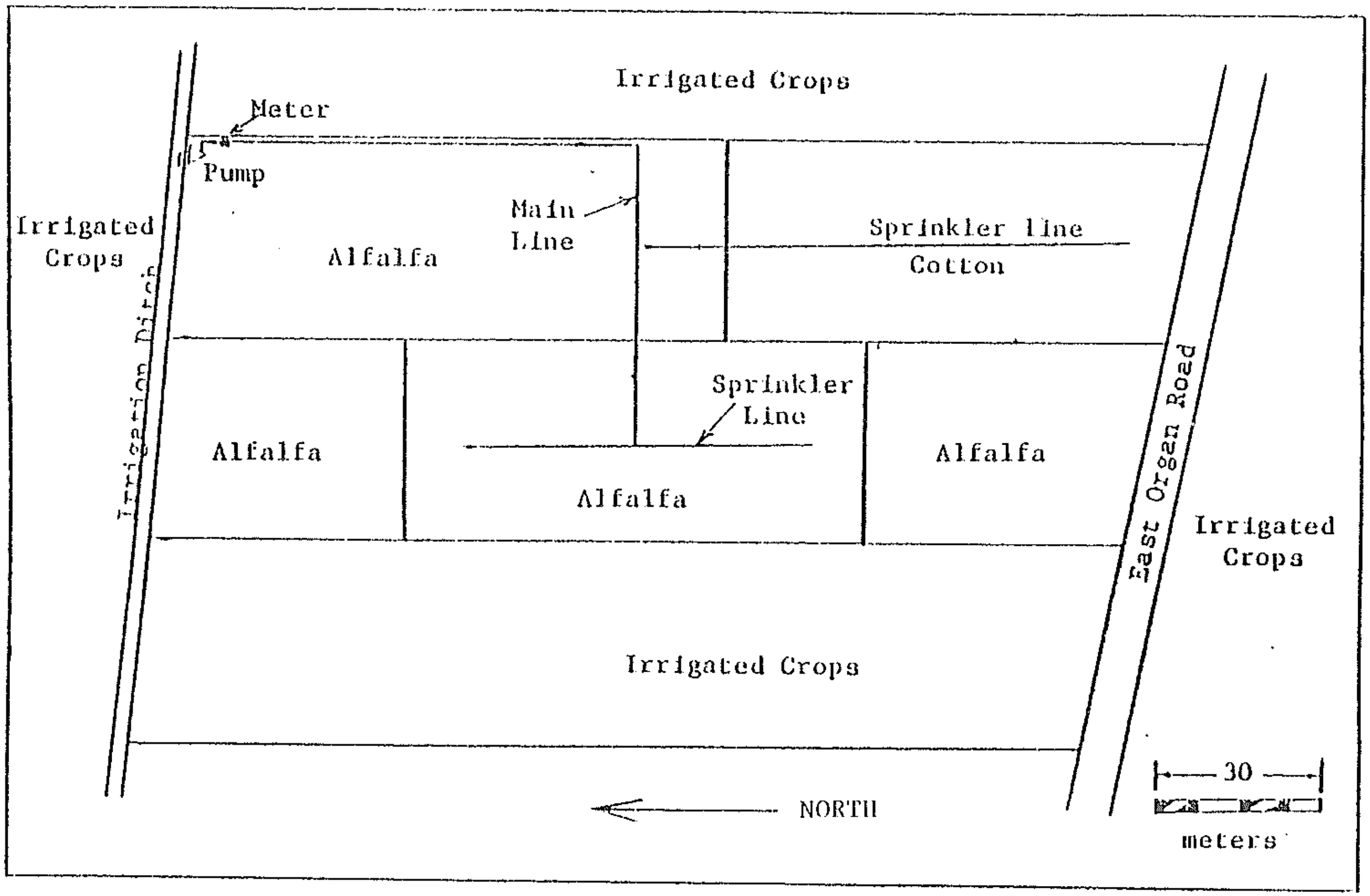

Figure 3. Schematic diagram of the alfalfa and cotton plots irrigated by sprinklers. 1978

Table 1. Crops grown at stations.

Location	1976 1/	1977 1/	1978 2/
Las Cruces - Plant Science Research Center	Alfalfa, Mesilla Sorghum, RS671 3/ Cotton, 1517V	Alfalfa, Mesilla Sorghum, RS671 3/ Cotton, 1517V Barley Sudangrass	Alfalfa, Hairy Peruvian Cotton, 1517-75
Artesia - Southeastern Branch Station	Alfalfa, Mesilla Barley, Penasco Sorghum, RS671 Cotton, 1517V	Alfalfa, Mesilla Barley, Penasco Sorghum, RS671 Cotton, 1517V	
Los Lunas - Middle Rio Grande	Alfalfa, Mesilla Sorghum, RS671 Bluegrass, Newport	Alfalfa, Mesilla Sorghum, RS671 Bluegrass, Newport Rye, TP	
Clovis - Plains Branch Station	Alfalfa, Mesilla Sorghum, DeKalb E59+ Corn, Pfizer TXS-115A Wheat, Centurk	Alfalfa, Mesilla Sorghum, De Kalb E59+ Corn, Pfizer TXS-115A Wheat, Centurk	
Farmington - San Juan Branch Station	Alfalfa, Mesilla Sorghum, RS671 Barley, Steptoe Corn, PX610	Alfalfa, Mesilla Sorghum, RS671 Barley, Steptoe Corn, PX74	

1/ Crops grown in lysimeters with surface flooding.

2/ Crops grown in field plots with sprinkler irrigation.

3/ Crop yields were omitted due to damage by birds.

research in 1976 and 1977 the evapotranspiration (ET) rate or consumptive use was measured for each crop with a non-weighing type lysimeter and a water-balance technique.

$$ET = I + R - D \pm \Delta SM \quad (1)$$

where I = Irrigation

R = Rainfall

D = Drainage

ΔSM = Change in soil moisture

Lysimeters were installed at sites shown in Figure 2 in field plots for each crop. The lysimeters were 1.8 x 1.8 meters wide and 1.21 meters deep. The plans for their construction are presented in Figure 4. A hole was dug by hand with the soil moved from the hole stored according to the order in which it was removed. Plywood 1.9 cm thick (3/4 inch) was then used to line the hole and five layers of 4 mil black plastic were laid on the inside. Suction candles and drainage pipe 1.27 cm in diameter (½ inch) were installed at the bottom. The lysimeters were filled with 15 cm of sand and then backfilled with the original soil material in the order that it was removed. Neutron access tubes were installed in the lysimeters to measure, with a neutron probe, the changes in soil moisture at every 15 cm of depth. Soil moisture measurements were made weekly. Rainfall on the lysimeters was measured at a nearby weather station, and irrigation water was measured and applied from 189 liter (50-gallon) barrels. Water was applied to the lysimeters by surface flooding so that drainage water generally occurred, indicating that the soil profile in the lysimeters had been brought to field capacity and the plants were not undergoing soil-moisture stress conditions. The drainage water was pumped out using a vacuum pump during several days following irrigations.

Irrigations were generally applied weekly during peak consumptive use months to assure that crop growth and yields would not be limited by inadequate

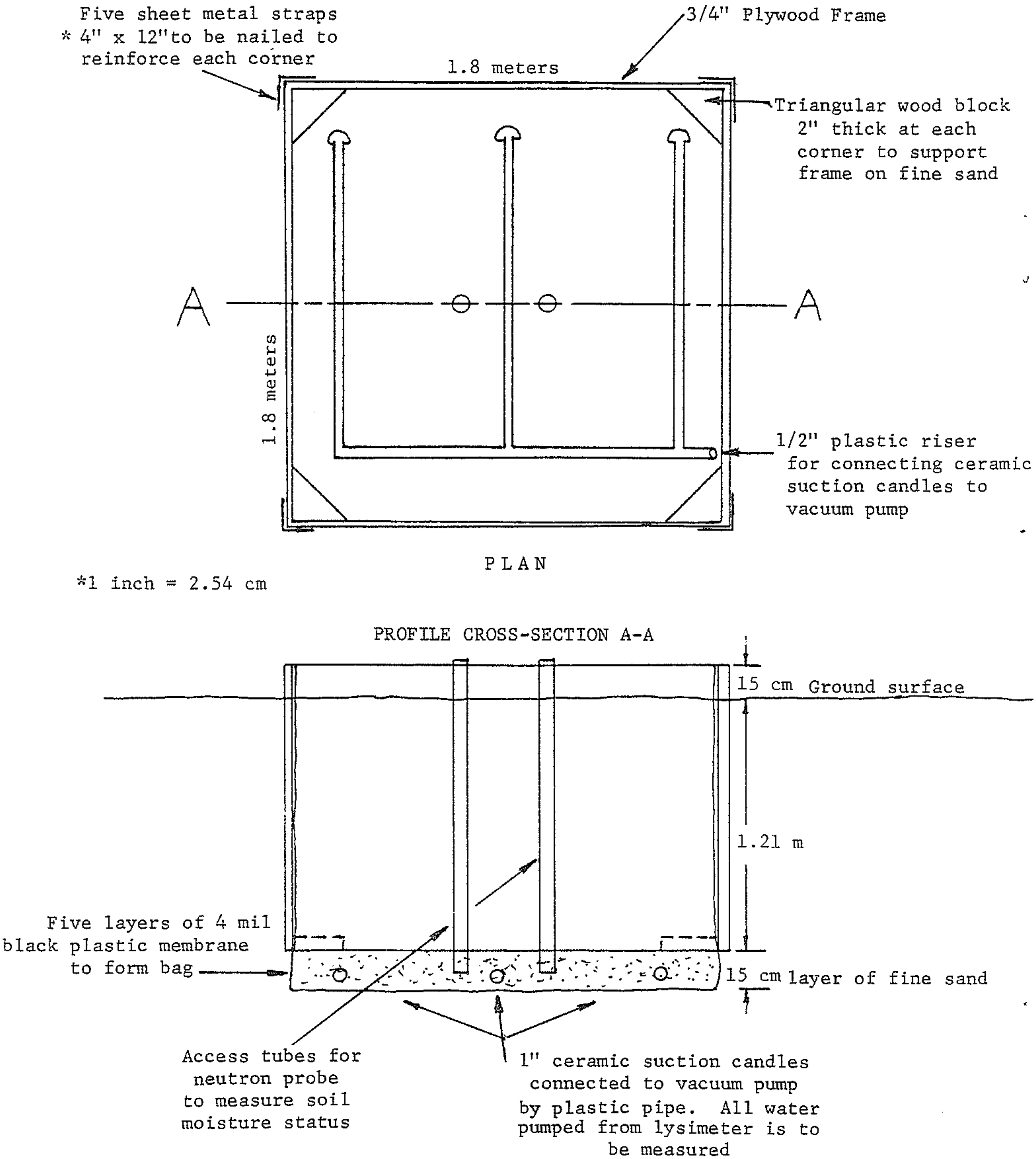

Figure 4. Plan and profile of drainage type lysimeters.

water. The quality of water applied is given in Table 2. Fertilizer was applied as necessary so that deficiencies would not limit growth and evapotranspiration rates. The rates applied followed the recommendations by the New Mexico State University Cooperative Extension Service presented in Appendix A.

Yield was measured from the lysimeters and adjacent field at harvest time.

The study sites (Figure 2) had limited fetch distance at Clovis and Farmington, where the Experiment Station facilities were closely adjacent to fallow land or rangeland. Therefore, the measured evapotranspiration for these sites was expected to be more representative of the evapotranspiration from the desert edge of large, irrigated fields and not the evapotranspiration rates that would be measured in the center of a large, irrigated block of land.

For the 1978 research, the site near Las Cruces was located 5 kilometers east of the Plant Science Research Center, where alfalfa and cotton were grown using a sprinkler-line source (13)*. Figure 3 is a map of the study site and the surrounding fields. The alfalfa and cotton plots were each approximately 30 meters wide and 50 meters long. The plots were irrigated using a sprinkler-line source without stressing the crop near the sprinkler line through each stage of the growing season, but applying a decreasing total water application away from the line as shown in Figures 5 and 6. The sprinklers were spaced every 6.1 meters along the sprinkler line and operated at 3 bars pressure, producing an effective radius of 15 meters. Each sprinkler discharged 0.5 liters per second.

The system was operated early in the morning when wind speeds were less than 3 kilometers per hour at right angles to the line and 8 kilometers per hour parallel to the line.

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*Number in parentheses refers to literature cited in references.

Table 2. The soil type and irrigation water quality at the study sites in Figure 2.

Location	Soil Type	Water Quality EC x 10^{-3} mmhos/cm
Las Cruces	Sandy Loam	1.23
Artesia	Karro Loam	1.61
Los Lunas	Clay Loam	1.45
Clovis	Pullman Silty Clay Loam	.43
Farmington	Fine Sandy Loam	.46

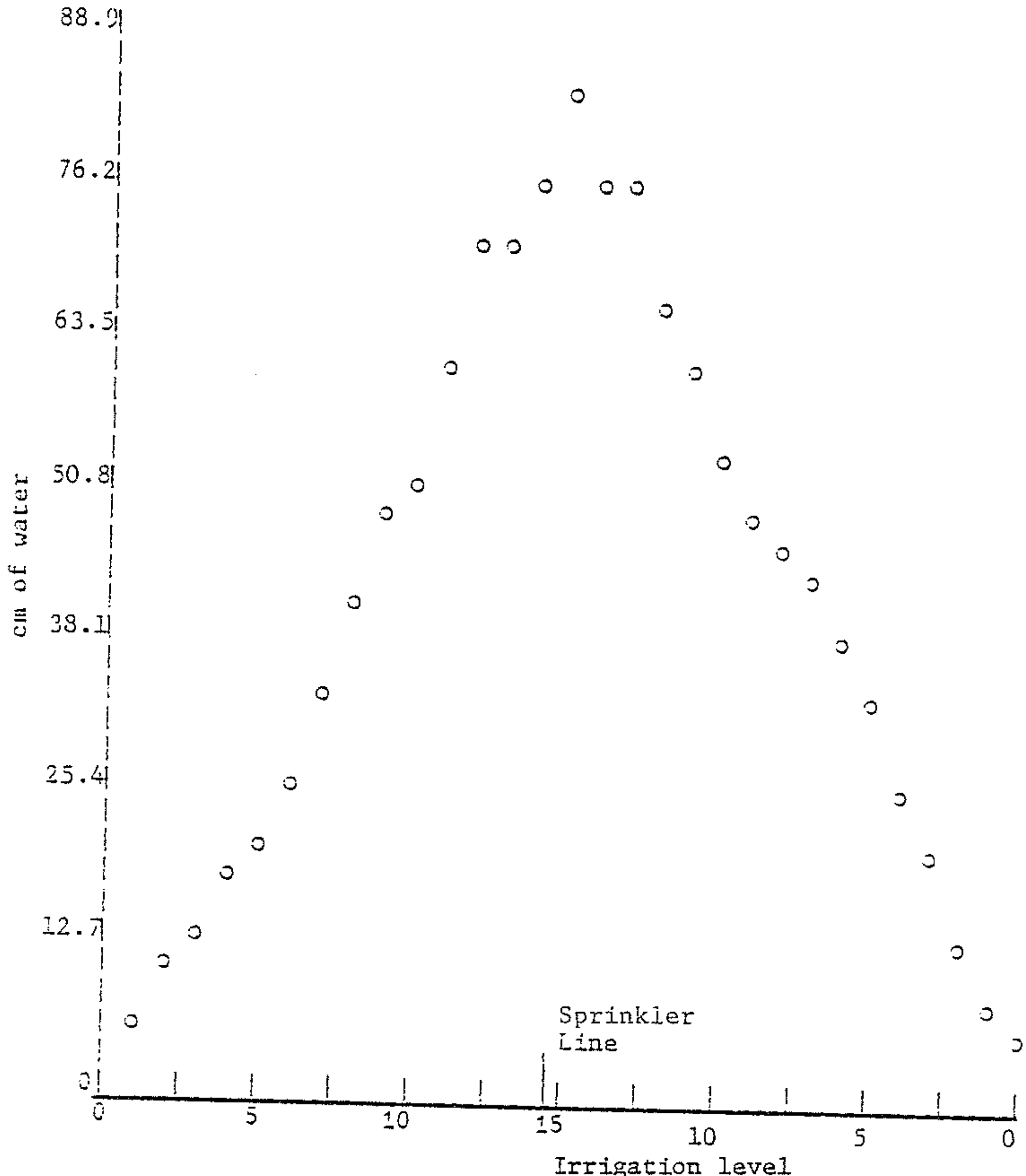


Figure 5 . Total seasonal applied water to the alfalfa plot (1978) using a sprinkler-line source. Excludes 18 cms (7.1 ins) of rainfall.

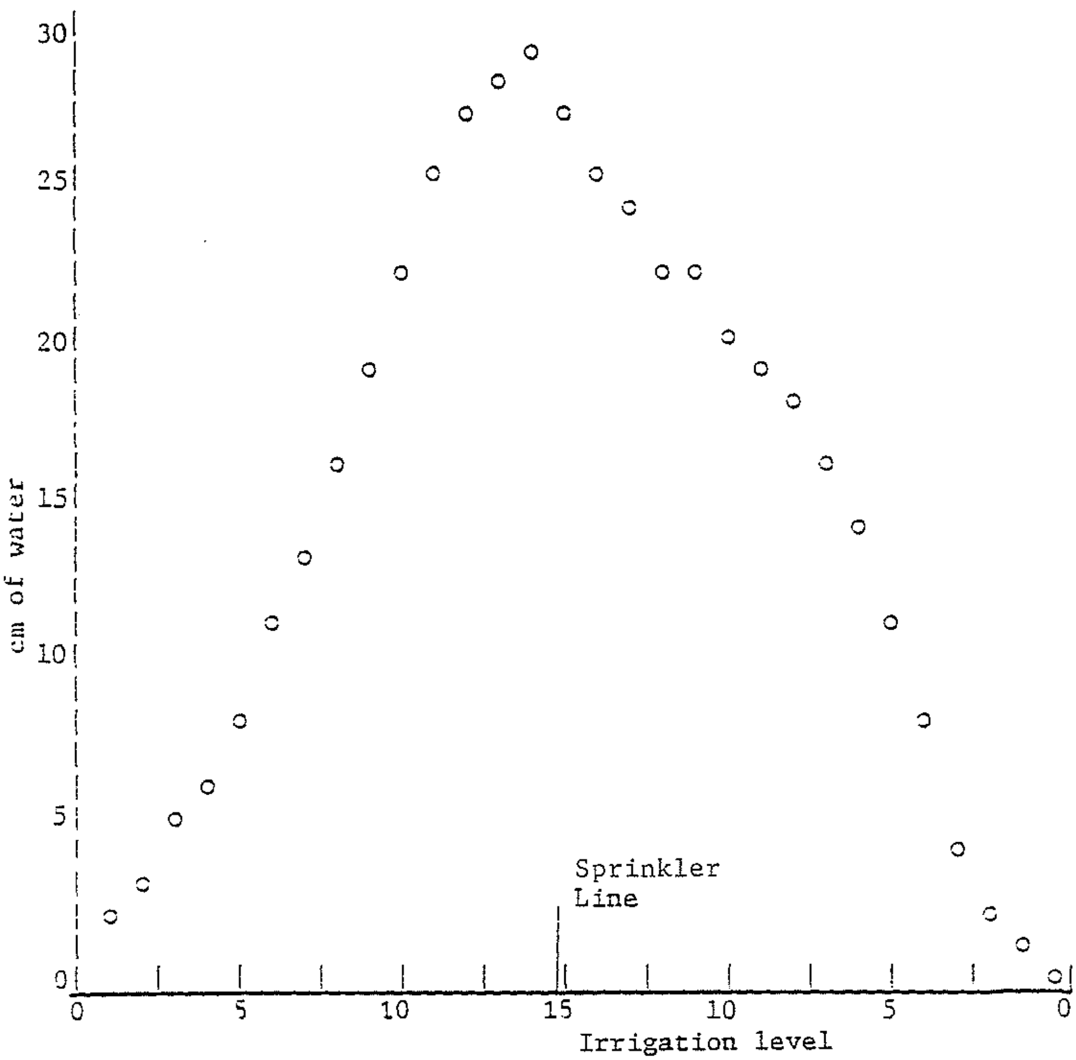


Figure 6. Total seasonal applied water to the cotton plot (1978) using a sprinkler-line source. Excludes 16.9 cms (6.7 ins) of rainfall.

The alfalfa plot was planted in October 1977 with the Hairy Peruvian variety and was fertilized with 40 kg/ha of nitrogen and 103 kg/ha of phosphorous. The alfalfa was not irrigated in 1978 until May, using the sprinkler-line source. The alfalfa plot was harvested five times. The first cutting occurred before the irrigation measurements were started on May 1. This cutting consisted of mustard plants, flixweed, (*Descurainia sophia*) which had overgrown the emerging alfalfa plants. Four cuttings from which yield was measured were on June 18, July 12, August 28, and October 14. At the time of each cutting, three subplots were harvested in strips 1 meter wide and 10 meters long parallel to the sprinkler line at selected distances from the west side of the line giving repetitive measurements along the line. Evapotranspiration was measured at selected distances from the line throughout the growing season by measuring applied water with catchment cans and the change in soil moisture with neutron access tubes. Fifteen access tubes were installed at 1-meter increments going west from the sprinkler-line at the center of the field. The irrigation system was operated so that deep drainage was minimized at the sprinkler-line when a maximum amount of water was applied and zero deep drainage occurred at distances from the line. Runoff was negligible because the water application rate was not in excess of the infiltration rate. The groundwater table at the site was 6 meters deep and upward flow was considered to be negligible during the growing season.

The cotton field had access tubes installed in each row on the west side of the sprinkler line and yield data were taken only on the west side due to poor stand establishment on the east side of the field. Cotton was planted May 5, 1978 with Acala 1517-75. The late planting resulted in delayed germination. The cotton was planted in rows spaced at 101 cm and the cotton plot was subdivided into three plots, each 10 meters long, parallel to the direction of the sprinkler line. The cotton was harvested by hand in two pickings at the end of the growing season: one October 18, 1978 and another January 12, 1979.

Measurements of soil moisture were taken on the cotton and alfalfa plots at two-week intervals throughout the growing season. The water applied to the plots was measured with catchment cans spaced every meter away from the sprinkler-line source. The cans were raised in height as the plants grew so that their level was the same as the canopy level.

The cotton plot was pre-irrigated for germination. Post-planting irrigations were on June 23; July 15, 26, 27; August 3, 6, 7, and 16. Evapotranspiration measurements were made from planting through October 10, 1978. Precipitation occurring during the cotton growing season was 16.9 cm, which is included in the total evapotranspiration. Precipitation is excluded from the total water applied as shown in Figure 6.

The alfalfa plot was irrigated on May 13, 18, 26; June 5, 12, 23; July 3, 7, 27; August 2, 10, 17; and September 13. The total precipitation measured at the plot during May 6 to October 13, 1978 was 18 cm. This is included in the total evapotranspiration, but is excluded from the total water applied as shown in Figure 5.

Salinity of the applied water was 2400 ppm at the end of the growing season.

RESULTS AND DISCUSSIONS

Seasonal Consumptive Use

Consumptive use measurements and yields from lysimeters and sprinkler plots are presented in Tables 3 and 4 by crops. Also shown in Table 3 is the duration of the season in which the measurements were made, average yields in the county, and yields from selected fields containing the lysimeters. The average yields of the county irrigated cropland were used with crop-production functions (discussed later) to estimate the average county cropland consumptive use. Estimates of consumptive use in Technical Report 32 (4) for crops in New Mexico are also included in Table 3 for comparison with these research results.

Table 3. Yield and evapotranspiration of selected crops grown in lysimeters, 1976 and 1977

Crop and Location	Year	Planting Date	Harvest Date	Yield Lysimeter	Yield Field	Yield County	Evapotranspiration Measured Amount	Time Duration	Evapotranspiration Technical Report 32[1]	Average County Cropland ET[2]
							(cm)		(cm)	(cm)
ARTESIA										
Alfalfa (New)	1976	8/29/75	5/13/76	5.54 t/ha		11.66 t/ha	189.7	1/21-12/31	96.3	94[7]
			6/10/76	5.65 t/ha						
			7/16/76	4.73 t/ha						
			8/20/76	4.03 t/ha						
			9/30/76	2.51 t/ha						
				22.46 t/ha[3]						
Alfalfa Mature	1977	12/03/76	5/02/77	7.53 t/ha		13.45 t/ha	184.6	1/01-12/19	96.3	105[7]
			6/07/77	3.27 t/ha						
			7/05/77	3.56 t/ha						
			8/04/77	3.88 t/ha						
			9/07/77	2.47 t/ha						
			10/19/77	2.67 t/ha						
				23.38 t/ha[3]						
CLOVIS										
Alfalfa (New)	1976	3/24/76	5/27/76	1.02 t/ha		10.76 t/ha	125.6	4/26-12/31	88.2	87[7]
			6/29/76	2.46 t/ha						
			7/26/76	3.15 t/ha						
			8/26/76	3.06 t/ha						
			11/09/76	.66 t/ha						
				10.35 t/ha[3]						
Alfalfa Mature	1977	3/24/76	5/31/77	2.75 t/ha		12.78 t/ha	169.7	1/01-12/08	88.2	101[7]
			7/01/77	4.16 t/ha						
			8/01/77	4.40 t/ha						
			9/01/77	2.88 t/ha						
			10/14/77	1.68 t/ha						
				15.87 t/ha[3]						
FARMINGTON										
Alfalfa (New) North Site	1976	4/13/76	7/12/76	2.80 t/ha		6.05 t/ha	107.5	4/26-11/12	67.3	56[7]
			8/11/76	3.56 t/ha						
			9/23/76	3.43 t/ha						
				9.80 t/ha[3]						
Alfalfa Mature South Site	1976	Spring 75	6/--/76	2.25 t/ha		6.05 t/ha	166.1	4/26-11/12	67.3	56[7]
			7/12/76	3.92 t/ha						
			8/11/76	5.49 t/ha						
			9/23/76	4.77 t/ha						
				19.23 t/ha[3]						

Table 3 (continued). Yield and evapotranspiration of selected crops.

Crop and Location	Year	Planting Date	Harvest Date	Yield Lysimeter	Yield Field	Yield County	Evapotranspiration Measured Amount	Time Duration	Evapotranspiration Technical Report 32[1]	Average County Cropland ET[2]
							(cm)		(cm)	(cm)
FARMINGTON (cont')										
Alfalfa Mature South Site	1977	Spring 75	6/08/77 7/12/77 8/16/77 9/29/77	3.88 t/ha 4.55 t/ha 2.41 t/ha 3.83 t/ha 14.73 t/ha[3]		6.72 t/ha	157.7	3/24-11/21	67.3	60[7]
Alfalfa Mature North Site	1977	4/13/76	6/08/77 7/12/77 8/16/77 9/29/77	4.93 t/ha 4.44 t/ha 3.41 t/ha 4.06 t/ha 16.83 t/ha[3]		6.72 t/ha	124.2	3/24-11/21	67.3	60[7]
LAS CRUCES										
Alfalfa Mature Site B	1976	11/5/75	5/24/76 6/28/76 8/04/76 9/15/76 10/20/76	3.05 t/ha 3.83 t/ha 8.12 t/ha 4.80 t/ha 2.11 t/ha 21.90 t/ha[3]		11.43 t/ha	171.6	1/01-10/29	92.5	92[7]
Alfalfa (New) Site A	1976	2/04/76	5/24/76 6/28/76 8/04/76 9/15/76 10/20/76	1.12 t/ha 1.88 t/ha 4.60 t/ha 3.23 t/ha 2.44 t/ha 13.27 t/ha[3]		11.43 t/ha	156.5	2/09-12/06	92.5	92[7]
Alfalfa (New) Site C	1976	2/09/76	5/24/76 6/25/76 8/04/76 9/15/76 10/20/76	2.42 t/ha 5.16 t/ha 6.03 t/ha 4.26 t/ha 3.59 t/ha 21.46 t/ha[3]		11.43 t/ha	165.4	2/09-12/06	92.5	92[7]
Alfalfa Mature Site B	1977	11/05/75	5/16/77 6/20/77 7/21/77 8/23/77 10/14/77	3.68 t/ha 5.47 t/ha 7.51 t/ha 3.63 t/ha 2.26 t/ha 22.55 t/ha[3]		12.10 t/ha	157.5	1/05-12/13	92.5	96[7]

Table 3 (continued). Yield and evapotranspiration of selected crops.

Crop and Location	Year	Planting Date	Harvest Date	Lysimeter	Yield Field	County	Evapotranspiration Measured Amount	Time Duration	Evapotranspiration Technical Report 32[1]	County Cropland ET[2]
							(cm)		(cm)	(cm)
LAS CRUCES (cont')										
Alfalfa	1977	2/04/76	5/16/77	4.21 t/ha		12.10 t/ha	174.9	1/05-12/13	92.5	96[7]
Mature			6/20/77	6.52 t/ha						
Site A			7/21/77	8.11 t/ha						
			8/23/77	4.01 t/ha						
			10/14/77	2.73 t/ha						
				25.60 t/ha[3]						
Alfalfa	1977	2/09/76	5/16/77	3.77 t/ha		12.10 t/ha	173.9	1/05-12/13	92.5	96[7]
Mature			6/20/77	6.03 t/ha						
Site C			7/21/77	7.53 t/ha						
			8/23/77	3.21 t/ha						
			10/14/77	1.50 t/ha						
				22.04 t/ha[3]						
LOS LUNAS										
Alfalfa (New)	1976	6/29/76	8/10/76	5.16 t/ha[3]	8.97 t/ha	8.74 t/ha	41.7	7/28-11/16	75.5	74[7]
Alfalfa	1977	11/16/76	5/14/77	5.55 t/ha	3.00 t/ha	10.5 t/ha	151.8	1/18-12/21	75.5	86[7]
Mature			6/23/77	7.82 t/ha	2.91 t/ha					
			8/10/77	3.05 t/ha	2.51 t/ha					
			9/20/77	2.44 t/ha	1.16 t/ha					
			10/27/77	.34 t/ha	.74 t/ha					
				18.16 t/ha[3]	10.42 t/ha					
ARTESIA										
Winter Barley	1976	9/15/75	6/07/76	6206 kg/ha[4] (grain)	4032 kg/ha	2208 kg/ha	82.8	1/21-6/07		
Winter Barley	1977	9/15/76	5/23/77	4575 kg/ha[4] (grain)	4032 kg/ha	2208 kg/ha	87.4	9/15-5/23		
			12/08/76	10.09 t/ha (green forage clippings)						
FARMINGTON										
Spring Barley South Site	1976	4/13/76	8/11/76	2998 kg/ha[4] (grain)		2732 kg/ha	53.0	4/26-8/11		
Spring Barley South Site	1977	4/11/77	8/08/77	3932 kg/ha[4] (grain)			55.5			
Spring Barley North Site	1977	4/11/77	8/08/77	3208 kg/ha[4] (grain)		386 kg/ha	63.0			

Table 3 (continued). Yield and evapotranspiration of selected crops.

Crop and Location	Year	Planting Date	Harvest Date	Yield Lysimeter	Yield Field	Yield County	Evapotranspiration Measured Amount (cm)	Time Duration	Evapotranspiration Technical Report 32[1/] (cm)	Average County Cropland ET[2/] (cm)
LOS LUNAS										
Blue Grass (New)	1976	6/25/76 (sod)					54.9	6/24-12/22		
Blue Grass Mature	1977	12/22/76	12/21/76	2.69 t/ha			102.0	1/18-12/06		
CLOVIS										
Corn	1976	4/07/76	10/08/76	15658 kg/ha[5/] (grain) 2237 kg/ha (cobs) 9853 kg/ha (stover)	12278 kg/ha	8055 kg/ha	100.5	4/22-10/08	56.4	68
Corn	1977	4/07/77	9/21/77	9920 kg/ha[5/] (grain) 6.79 t/ha (cobs)		5462 kg/ha	91.6	4/07-09/21	56.4	38
FARMINGTON										
Corn South Site	1976	5/10/76	10/21/76	10388 kg/ha[5/] (grain)	9182 kg/ha	5220 kg/ha	103.1	5/10-10/22	55.1	35
Corn North Site	1976	5/10/76	10/21/76	12367 kg/ha[5/] (grain)	7308 kg/ha	5220 kg/ha	101.4	5/10-10/22	55.1	35
Corn South Site	1977	5/09/77	10/13/77	9082 kg/ha[5/] (grain)		5336 kg/ha	77.8	5/09-10/10	55.1	37
Corn North Site	1977	5/09/77	10/13/77	9891 kg/ha[5/] (grain)		5336 kg/ha	72.5	5/09-10/10	55.1	37
ARTESIA										
Cotton	1976	4/13/76	10/21/76	1006 kg/ha (lint) 1403 kg/ha (seed)	1634 kg/ha 1045 kg/ha	489 kg/ha	70.2	4/12-10/25	69.7	25
Cotton	1977	4/20/77	10/13/77	1491 kg/ha (lint)		705 kg/ha	111.2	4/25-10/17	69.7	39
LAS CRUCES										
Cotton Site A	1976	5/06/76	10/27/76	861 kg/ha (lint) 3.61 t/ha (seed)		809 kg/ha	87.0	5/04-10/30	66.9	46

Table 3 (continued). Yield and evapotranspiration of selected crops.

Crop and Location	Year	Planting Date	Harvest Date	Yield Lysimeter	Yield Field	Yield County	Evapotranspiration Measured Amount	Time Duration	Evapotranspiration Technical Report 32[1]	Average County Cropland ET[2]
							(cm)		(cm)	(cm)
LAS CRUCES (cont')										
Cotton Site B	1976	5/06/76	10/27/76	1044 kg/ha (lint) 3 68 t/ha (seed)		809 kg/ha	84.1	5/04-10/30	66.9	46
Cotton Site C	1976	5/06/76	10/27/76	960 kg/ha (lint) 3.43 t/ha (seed)		809 kg/ha	80.2	5/04-10/30	66.9	46
Cotton Site A	1977	4/22/77	10/23/77	2063 kg/ha (lint) 2872 kg/ha (seed)	2110 kg/ha (lint) 2895 kg/ha (seed)	777 kg/ha	83.0	4/23-10/25	66.9	44
Cotton Site B	1977	4/22/77	10/23/77	2134 kg/ha (lint) 2970 kg/ha (seed)		777 kg/ha	85.8	4/23-10/25	66.9	44
Cotton Site C	1977	4/22/77	10/23/77	1522 kg/ha (lint) 2152 kg/ha (seed)		777 kg/ha	78.7	4/23-10/25	66.9	44
LOS LUNAS										
Rye	1977	3/15/77	7/14/77	2374 kg/ha (grain)	2219 kg/ha		59.9	3/14-7/13	38.4	
ARTESIA										
Sorghum	1976	5/18/76	10/01/76	8.79 t/ha (stover)		3100 kg/ha	65.0	5/17-10/01	59.6	31
Sorghum	1977	5/17/77	9/27/77	12759 kg/ha[4] (grain) 23.67 t/ha (stover)		4260 kg/ha	86.9	5/16-09/27	59.6	42
CLOVIS										
Sorghum	1976	5/03/76	10/20/76	5797 kg/ha[4] (grain) 9470 kg/ha (stover)	7263 kg/ha	4957 kg/ha	87.5	5/03-10/20	59.8	48

Table 3 (continued). Yield and evapotranspiration of selected crops.

Crop and Location	Year	Planting Date	Harvest Date	Lysimeter	Yield Field	County	Evapotranspiration Measured Amount	Time Duration	Evapotranspiration Technical Report 32 1/	Average County Cropland ET 2/
							(cm)		(cm)	(cm)
CLOVIS (cont')										
Sorghum	1977	5/19/77	10/14/77	3291 kg/ha 4/ (grain) 8.52 t/ha (stover)		5157 kg/ha	65.8	5/20-10/14	59.8	50
FARMINGTON										
Sorghum South Site	1976	5/20/76	10/21/76	7432 kg/ha 4/ (grain)	7581 kg/ha	2107 kg/ha	72.8	5/20-10/22	50.7	22
Sorghum North Site	1976	5/20/76	10/21/76	9155 kg/ha (grain)	8341 kg/ha	2107 kg/ha	78.8	5/24-10/22	50.7	22
Sorghum South Site	1977	5/20/77	11/12/76	6369 kg/ha 4/ (grain)		2410 kg/ha	48.5	5/16-11/15	50.7	25
Sorghum North Site	1977	5/20/77	11/12/76	6234 kg/ha 4/ (grain)		2410 kg/ha	61.3	5/16-11/15	50.7	25
LAS CRUCES										
Sorghum Site A	1976	5/25/76	9/18/76	20.07 t/ha (stover)	13.90 t/ha	4273 kg/ha	55.0	5/28-9/21	57.6	42
Sorghum Site C	1976	5/25/76	9/18/76	23.88 t/ha (stover)	18.44 t/ha	4273 kg/ha	62.2	5/28-9/21	57.6	42
Sorghum Site A	1977	5/18/77	11/23/77	642 kg/ha 4/ (grain) (13.6 t/ha) (stover)	1597 kg/ha	4507 kg/ha	47.7	5/20-9/16	57.6	44
Sorghum Site B	1977	5/18/77	11/23/77	2119 kg/ha 4/ (grain) (10.8 t/ha) (stover)		4507 kg/ha	51.0	5/20-9/16	57.6	44
Sorghum Site C	1977	5/18/77	11/23/77	1316 kg/ha 4/ (grain) (12.7 t/ha) (stover)		4507 kg/ha	47.9	5/20-9/16	57.6	44
LOS LUNAS										
Sorghum	1976	6/03/76	Bird Damage	--	5936 kg/ha	2634 kg/ha	--	7/22-10/22	53.5	27
Sorghum	1977	5/30/77	11/09/77	7119 kg/ha 4/ (grain)	6310 kg/ha	3419 kg/ha	64.9	6/08-11/08	53.5	34

Table 3 (continued). Yield and evapotranspiration of selected crops.

Crop and Location	Year	Planting Date	Harvest Date	Yield Lysimeter	Yield Field	Yield County	Evapotranspiration Measured Amount (cm)	Time Duration	Evapotranspiration Technical Report 32[1/] (cm)	Average County Cropland ET[2/] (cm)
LAS CRUCES Sudan Grass Site A	1977	6/13/77	8/22/77	11.30 t/ha[6/]			49.8	6/17-8/26		
Sudan Grass Site B	1977	6/13/77	8/22/77	17.13 t/ha[6/]			57.4	6/17-8/26		
Sudan Grass Site C	1977	6/13/77	8/22/77	12.17 t/ha[6/]			54.3	6/17-8/26		
CLOVIS Wheat	1976	9/01/75	6/28/76	2793 kg/ha[4/] (grain)		2099 kg/ha	115.9	3/22-6/28		
Wheat	1977	8/25/76	6/23/77	1569 kg/ha[4/] (grain) 7.11 t/ha (straw)		1622 kg/ha	92.6	8/25-6/23		

1/ Technical Report 32, Blaney, Hanson (4)
2/ Evapotranspiration estimated using county average yields (1) of alfalfa, cotton, corn and sorghum, and crop production functions in Figures 7, 8, 9 and 10.
3/ Dry weight (oven dried, near zero percent moisture)
4/ Moisture content 14%
5/ Moisture content 15.5%
6/ Total biomass
7/ Average alfalfa county yields were reduced to near zero percent moisture in order to compute evapotranspiration with the crop-production function in Figure 7.

Table 4. Yield and evapotranspiration of alfalfa and cotton growth with line source sprinkler irrigation, 1978.

Cotton			Alfalfa		
Irrigation Level 1/	Evapotranspiration	Lint Yield kg/ha	Irrigation Level 2/	Evapotranspiration	Alfalfa Yield @ Zero Moisture Percent Tons/ha 3/
	cm			cm	
1	16.87	376.60	5	54.66	4.27
2	20.19	380.87	6	60.96	5.45
3	24.52	418.72	7	63.85	6.40
5	32.55	540.80	8	81.2	7.75
6	27.27	582.91	9	79.67	9.03
7	33.59	658.60	10	89.99	10.19
8	34.18	617.70	11	92.61	11.40
10	42.14	747.71	12	104.67	11.78
11	44.36	780.06	14	115.01	14.49
12	46.68	824.62	--	---	---

1/ Irrigation levels were measured on the west (left) side of the sprinkler line shown in Figure 6.

2/ Irrigation levels were measured on the west (left) side of the sprinkler line shown in Figure 5.

3/ Alfalfa oven dried; near zero percent moisture.

The lysimeter consumptive-use measurements and crop yields were considerably higher in general than values in Technical Report 32 for corresponding crops. The higher consumptive-use values may largely be attributed to higher yields and larger plants as compared to those of the surrounding field. The higher yields probably resulted from deep-plowing effects of the soil in the lysimeters, which were excavated and backfilled during construction, from maintaining high soil-moisture levels in the lysimeters, and from some advective energy effects within the lysimeters due to a 15 cm. ridge which was maintained at the edges of all lysimeters to prevent water from flowing into the lysimeters during irrigation of the surrounding cropland.

Crop-Production Functions

Consumptive use and yields from lysimeters in 1976 and 1977 and from line source sprinkler plots in 1978 have been plotted in Figures 7 to 10. Also included in Figures 8, 9, and 10 are some additional water applied and yield data from selected irrigation research projects in the state which were conducted earlier by Gregory (12), Finkner and Malm (10), and Hanson (14). The crop-production functions are quite linear as shown in Figures 7 to 10. Although the "water applied" measurements of earlier research projects by Gregory, et al., may not be strictly consumptive use, they are close estimates inasmuch as they represent irrigation treatments of reasonable light irrigations where deep drainage was minimal. The "centimeters of water" in the figures include rainfall.

The sprinkler-line source data are combined with the lysimeter data in Figure 7 for alfalfa and Figure 8 for cotton. The crop-production function for alfalfa, using only the sprinkler-line source data, has a Coefficient of Determination of 0.97. When the sprinkler-line source data are combined with the lysimeters data, the Coefficient of Determination is 0.89. In the range of normal production on farms the results from both curves will not vary more

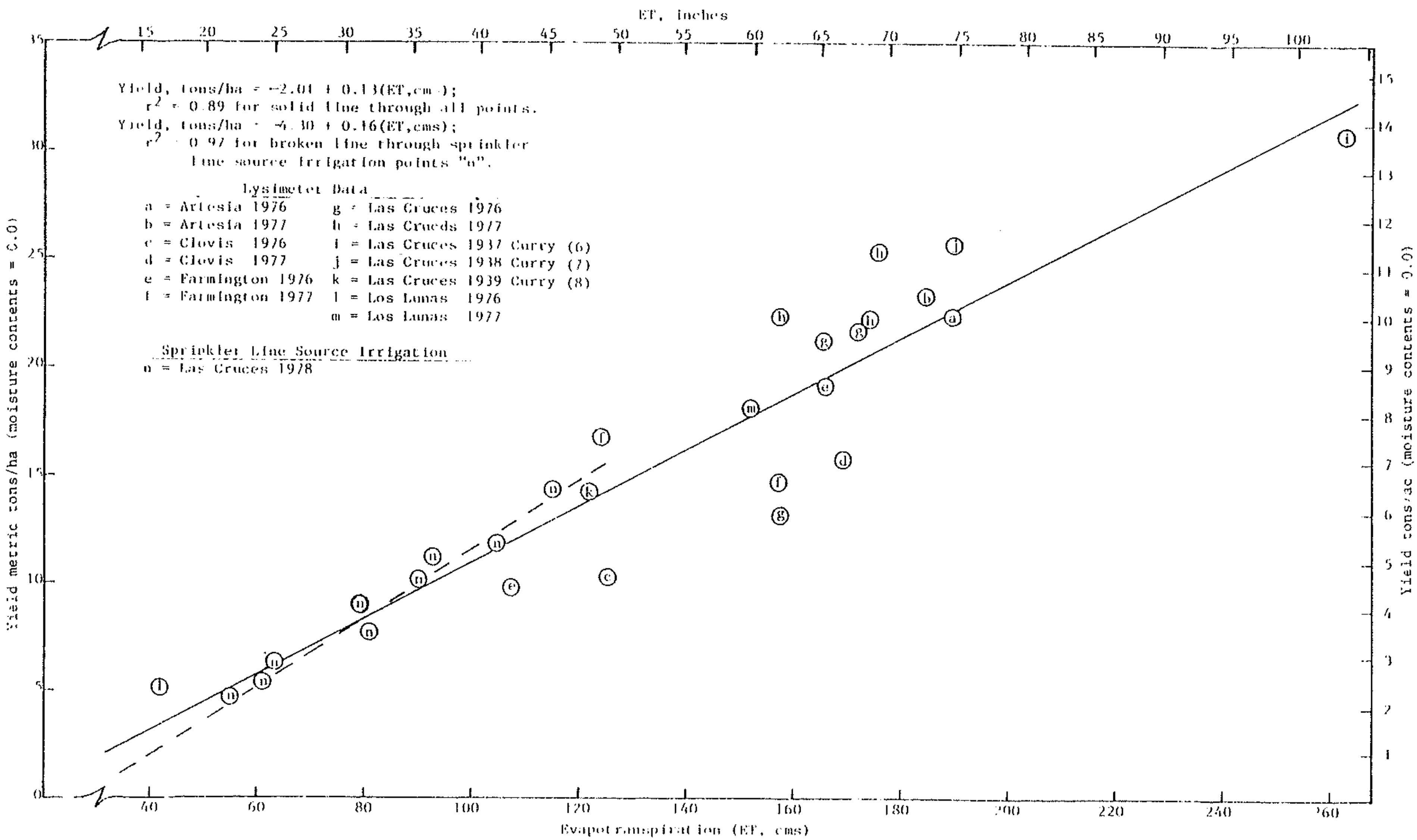


Figure 7. Crop-production function for alfalfa.

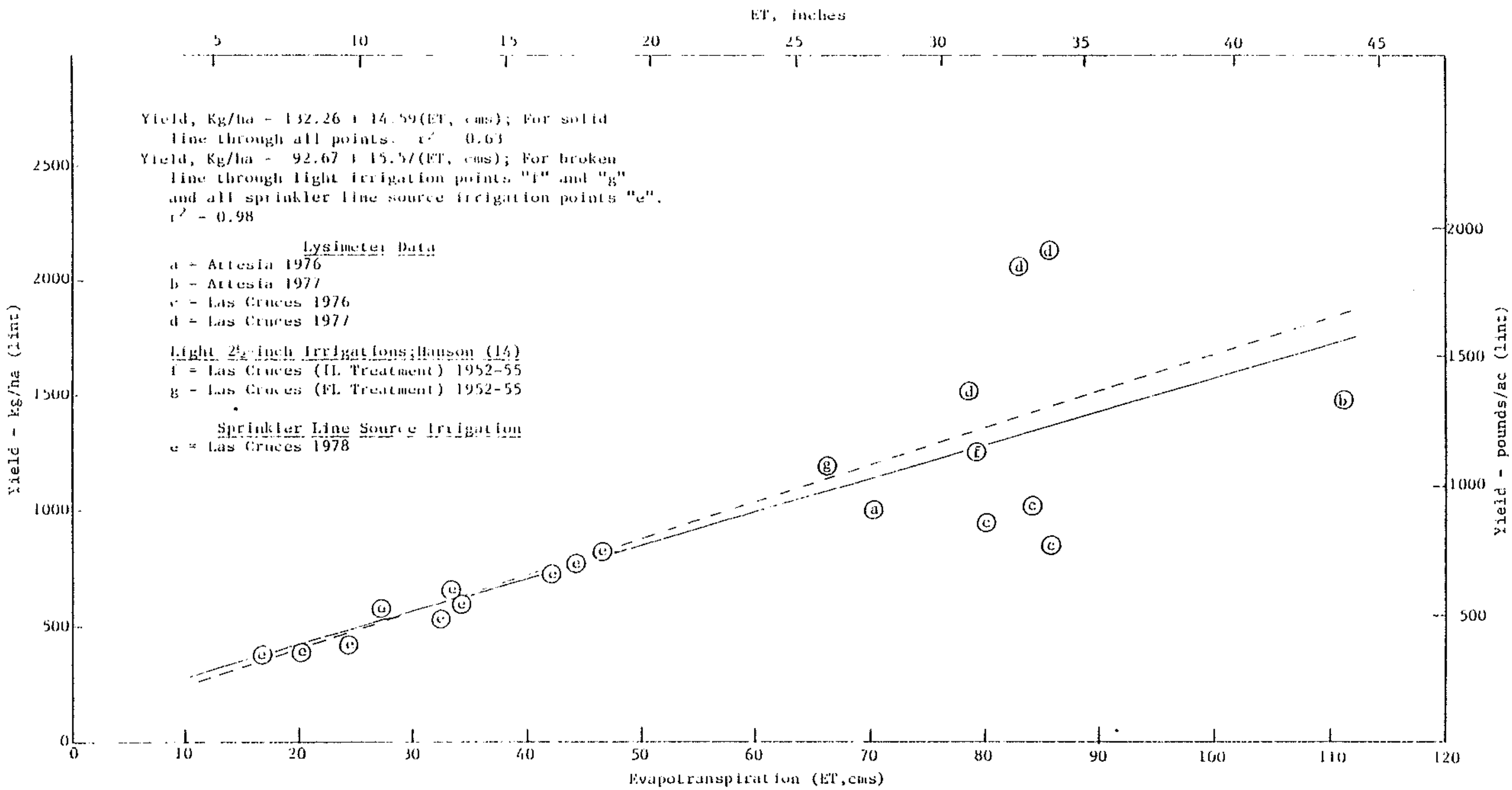


Figure 8. Crop-production function for cotton.

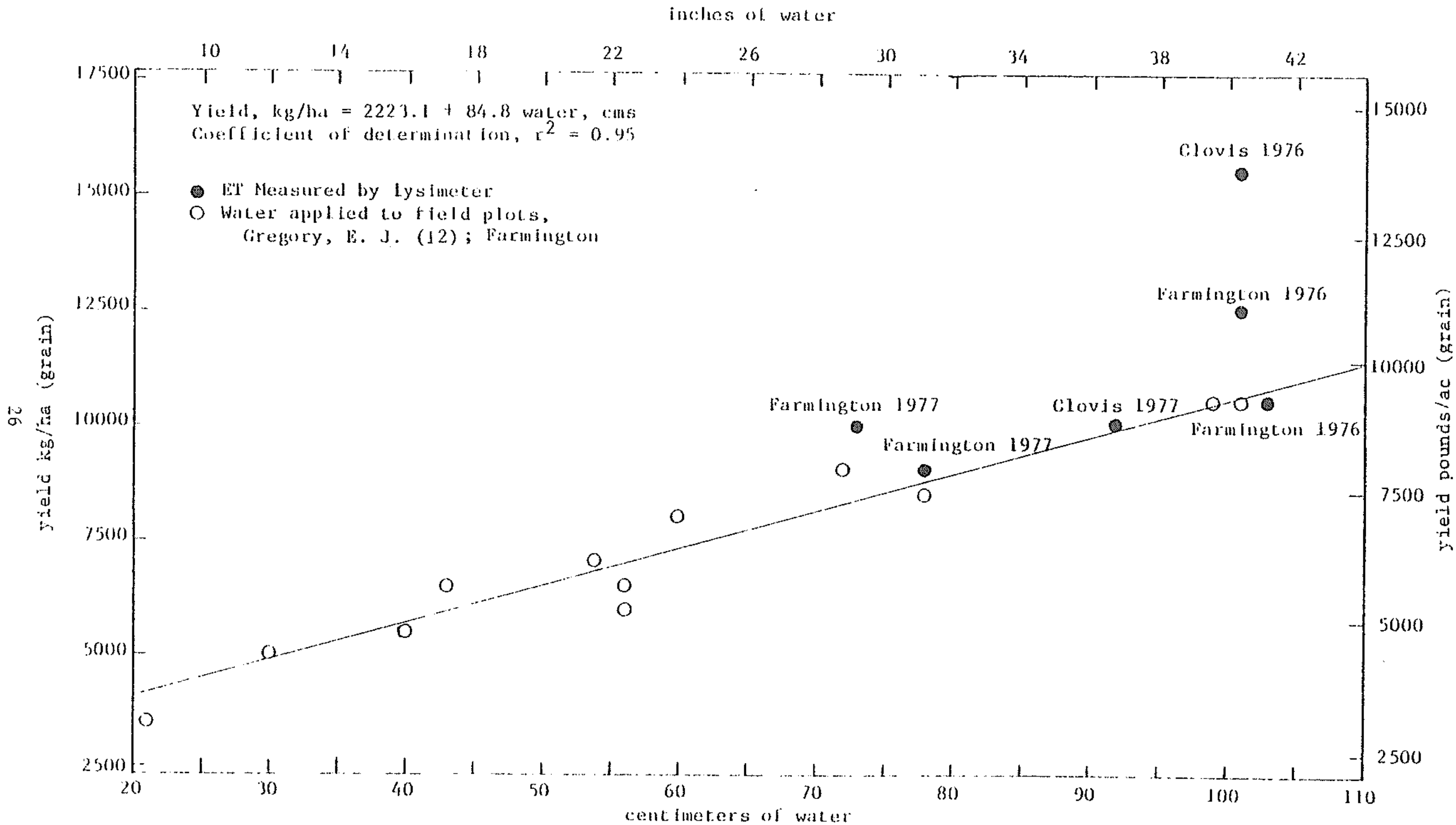


Figure 9. Crop-production function for grain corn.

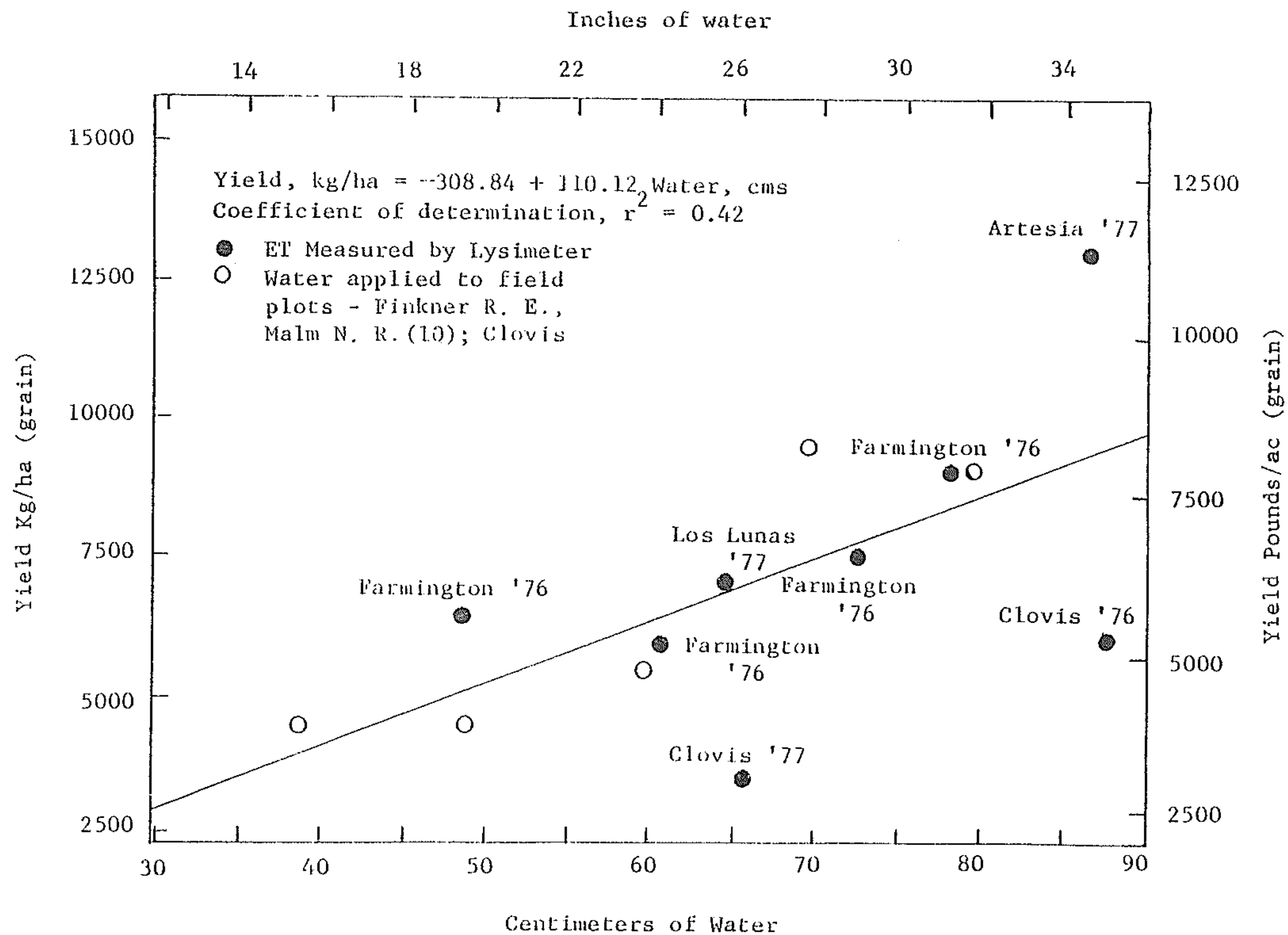


Figure 10. Crop-production function for grain sorghum.

than six percent. Using all of the points is considered to give the best results for the alfalfa crop-production functions for the whole state. The sprinkler-line source data are on the low end of the crop-production functions. None of the water applied by the sprinkler-line source appears to have been lost by deep percolation. Even the highest sprinkler applications which were measured near the sprinkler line are close to or are above the production functions in Figures 7 and 8. If there had been appreciable deep percolation, the points for the higher sprinkler applications would have deviated to the right and to a position below the production function.

The cotton data using the sprinkler-line source have a Coefficient of Determination of 0.98. When those data are included with the lysimeter data, which have considerable scatter, the Coefficient of Determination drops to 0.63. Again, as with the alfalfa, the slope of a curve through the sprinkler-line source data is very similar to the slope of a curve through all the combined points. Even though the cotton production function for only the sprinkler-line source data has the highest coefficient of determination, the function for all points in the figure is considered to be most appropriate for use in estimating consumptive use with yield. In the range of normal production on farms, the results from both curves will not vary more than four percent.

In Figure 9, the corn data measured at Farmington in an applied water study by Gregory (12) and the lysimeter data are close to the function. The 1977 lysimeter data from Clovis are close to the line. One of the lysimeters in 1976 is considerably higher in yield than predicted by the crop-production function.

Additional studies need to be done on corn in other areas to determine the reliability of transferring the crop-production function around the state.

The data for grain sorghum have lower correlation and additional studies need to be made before any large amount of confidence can be put on the crop-production function in Figure 10.

It should be noted that the crop-production functions for alfalfa, cotton, grain sorghum, and corn represent studies at more than one location within the state. It appears that as an initial estimate the crop-production function for alfalfa can be used throughout the state. Any variable that causes a reduction in alfalfa evapotranspiration causes a corresponding reduction in yield. Evapotranspiration reductions may be due to limitations of water, solar radiation, temperature, management, insect infestations, or an increase in soil salinity. Salinity effects may be observed in Curry's data (6, 7, 8) of 1937, 1938, and 1939. These data shown in Figure 7 were collected using lysimeters that were operated by Curry to maintain a water table at approximately 90 cm (36 inches) below the ground surface. An increase in salt in the soil profile from one year to the next is inevitable with this type of lysimeter. Although there were no measurements of the amount of salt increase, approximate computations indicate that soil salt could have increased as much as 0.4 percent. This could have caused the yields and evapotranspiration to decrease during 1938 and 1939.

The evapotranspiration for average county cropland by crops in Table 3 was computed using the crop-production functions in Figures 7 to 10 and the average county yield (1).

Discussion

Researchers have been cognizant of the relationship between crop yield and consumptive use for an extended period of time. Downey (9) reviewed previous information on this subject area and presented physiological reasons for the variation in water yield production functions for different crops.

As a general principle, as transpiration declines, so does photosynthesis; thus, total dry-matter production tends to be a direct function of transpiration until the maximum growth rate or minimum moisture stress is reached. This is also true when other growth factors are not limiting. Stewart and Hagan (18) presented findings showing that yield is a linear function of evapotranspiration with no evidence, for alfalfa or other forage crops, that any growth stage was particularly more sensitive to water stress. Stewart et al. (20) also show that evapotranspiration vs. yield of corn dry matter and grain is a linear function.

In general, research shows that cereals and other nonforage crops have growth stages at which they are particularly susceptible to water stress (Stewart and Hagan (19); Finkner and Malm (10)). The most critical time for grain sorghum is during the bloom stage and in the soft-dough stage. Early stress to moisture has a tendency to produce smaller plants but is not as sensitive in reducing total grain yield as stressing in the bloom or soft-dough stage. Consequently, there is a large amount of variability when trying to plot seasonal evapotranspiration and yield for grain crops.

Consumptive Use by Crop-Production Function Compared to the Blaney-Criddle Method

The crop-production functions show that it is unreasonable to consider consumptive use as a fixed value which has been the situation with much of the consumptive-use information that has been published in previous years.

With consumptive use varying so markedly with irrigation practices and yields, curves could be computed and plotted showing a varying relationship between yield and the consumptive-use coefficients, k or K, in the Blaney-Criddle (3) formula

$$u = kf \text{ or } U = KF = K\Sigma \frac{pt}{100} \qquad (2)$$

where u = monthly consumptive use, inches depth

$f = \frac{t \times p}{100}$ = monthly consumptive-use factor

k = empirical consumptive-use crop coefficient for the month

t = mean monthly temperature in degrees Fahrenheit

p = monthly percentage of annual daytime hours

U = consumptive use, in inches, for the season or period

K = empirical consumptive-use crop coefficient for the season or period

F = sum of the monthly consumptive-use factors for the season or period

No attempt has been made in this research to plot a relationship between consumptive-use coefficients and yield inasmuch as additional research data are needed. This is obvious in Figures 7 to 10 where some of the coefficients of determination are low. Additional research is continuing in New Mexico and other states to obtain additional data for crop-production functions. When these data become available, a more realistic value of K may be established for the average crop yields in a given area, or the level of yield that would be advisable for optimum utilization of water considering the availability of water supply and the economic conditions.

The differences of estimated consumptive use, using the crop-production functions with average county yields and the Blaney-Criddle method using the current crop coefficients from Technical Report 32 (4), may be observed for 1959-1977 average yields in Tables 5 to 8 for alfalfa, cotton, corn, and sorghum. For alfalfa, the consumptive use computed using the crop-production function pertains to annual 12-month periods. The Blaney-Criddle consumptive use has been computed for the frost-free season with adjustments presented in Appendix B. Consumptive use computed by the Blaney-Criddle method is considerably higher than that computed by the crop-production functions for cotton, corn, and sorghum. For alfalfa, the consumptive use is approximately the same by the two methods with the Blaney-Criddle method having slightly higher values. Yields for 1959-1977 are included in Appendix C in order to observe some of the changes which have occurred since Technical Report 32 was written in 1963-1964. There has been a

Table 5. Comparison of consumptive use of alfalfa computed by the Blaney-Criddle Method with consumptive use computed by the crop-production function for 1959 to 1977 average yields in counties near research sites.

	Average County Yield			Annual Consumptive Use Computed by the Crop-Production Function[3/]		Blaney-Criddle Consumptive Use for the Growing Season[4/]	
	Field Dried[1/]		Oven Dried[2/]				
	tons/ac	tons/ha	tons/ha	cm	in	cm	in
Artesia	5.34	11.97	10.41	95.5	37.6	103.7	40.8
Clovis	4.46	10.00	8.70	82.3	32.4	93.7	36.9
Farmington	3.27	7.33	6.37	64.5	25.4	80.8	31.8
Las Cruces	5.00	11.21	9.75	90.4	35.6	99.6	39.2
Los Lunas	3.86	8.65	7.52	73.4	28.9	83.3	32.8
Taos[5/]	1.77	3.97	3.45	41.9	16.5	63.2	24.9

1/ Yields reported in New Mex. Agric. Statistics (1) as tabulated in Appendix C.

2/ Computed oven-dried yield with moisture percent near zero. To be used in computing ET, cms by the crop-production function in Figure 7. Alfalfa is assumed to have had 15 percent moisture when harvested after field drying.

3/ Computed by the solid-line crop-production function, Figure 7.

4/ Computed in Technical Report 32 (4) as adjusted in Appendix B.

5/ Not near a research site. Taos is included for a comparison in the report.

Table 6. Comparison of consumptive use of Upland lint cotton computed by the Blaney-Criddle Method with consumptive use computed by the crop-production function for 1959 to 1977 average yields in counties near research sites.

	Average County Yield 1/		Growing Season Consumptive Use Computed by the Crop-Production Function 2/		Blaney-Criddle Consumptive Use for the Growing Season 3/	
	lbs/ac	kg/ha	cm	in	cm	in
Artesia	653	732	41.1	16.2	72.1	28.4
Las Cruces	681	763	43.2	17.0	69.3	27.3

1/ Yields reported in New Mex. Agric. Statistics (1) as tabulated in Appendix C.

2/ Computed by the solid-line crop-production function in Figure 8.

3/ Computed in Technical Report 32 (4) as adjusted in Appendix B.

Table 7. Comparison of consumptive use of grain corn computed by the Blaney-Criddle Method with consumptive use computed by the crop-production function for 1959 to 1977 average yields in counties near research sites.

	Average County Yield 1/		Growing Season Consumptive Use Computed by the Crop-Production Function 2/		Blaney-Criddle Consumptive Use for the Growing Season 3/	
	lbs/ac	kg/ha	cm	in	cm	in
Clovis	4206	4714	29.5	11.6	56.4	22.2
Farmington	3422	3836	19.0	7.5	55.1	21.7

1/ Yields reported in New Mex. Agric. Statistics (1) as tabulated in Appendix C.

2/ Computed by the crop-production function in Figure 9.

3/ Computed in Technical Report 32 (4).

Table 8. Comparison of consumptive use of grain sorghum computed by the Blaney-Criddle Method with consumptive use computed by the crop-production function for 1959 to 1977 average yields in counties near research sites.

	Average County Yield 1/		Growing Season Consumptive Use Computed by the Crop-Production Function 2/		Blaney-Criddle Consumptive Use for the Growing Season 3/	
	lbs/ac	kg/ha	cm	in	cm	in
Artesia	3400	3811	37.4	14.7	59.7	23.5
Clovis	4850	5437	52.2	20.6	59.9	23.6
Farmington	1800	2107	21.9	8.6	50.8	20.0
Los Lunas	2655	2976	29.8	11.7	53.6	21.1

1/ Yields reported in New Mex. Statistics (1) as tabulated in Appendix C.

2/ Computed by the crop-production function in Figure 10.

3/ Computed in Technical Report 32 (4).

slight increase in alfalfa yield at most of the stations. Considerable changes have occurred in grain and cotton yields at some of the stations.

Limitations in Estimating Consumptive Use by the Crop-Production Functions

It is much easier to farm small lysimeters and small experimental plots to obtain high yields than to farm large acreages. Higher yields and higher consumptive use may occur in lysimeters where the soil has been excavated and replaced during the lysimeter construction. This in effect is "deep plowing" which will break up impermeable layers or plow pans which may exist in the fields. The lysimeters used in this research had a 15 cm (6-inch) ridge projecting above the ground surface to keep out water during furrow or flood irrigations of adjacent fields. The ridge provided somewhat of a shelter and extra advective energy thus causing some "hot house" effects. The results of these effects were observed in some lysimeters where the plants within the lysimeters grew faster and larger and required more frequent irrigation as compared to crops on adjacent farmland to prevent wilting. This resulted in higher consumptive use.

With respect to crop-production functions, the advective energy and deep plowing effects probably do not distort the yield-consumptive use relationship. Where these factors cause higher consumptive use there also appears to be an overall corresponding increase in yield, thus keeping the slope of the functions quite constant.

In managing small plots for growing alfalfa, for example, alfalfa harvesting can be accomplished in one day with irrigation water being applied the next day. With large-scale farm operations, it may require a week or 10 days to remove the harvested bales before the next irrigation water may be applied. Delaying the irrigation after alfalfa cuttings may restrict consumptive use and alfalfa yield in many types of soils.

Research on experimental plots may show potentials which will be achieved if it is possible to overcome large-area management problems. Economics of large-scale farming place a limit on achieving potential yields with present equipment and costs.

There appears to be more direct and stable correlation between yield and consumptive use of alfalfa than that for grain crops. With alfalfa, the entire plant is harvested, which will give a better measure of yield than a seed crop will provide for relating yield to consumptive use. With grain crops, there may be low yield of grain due to weather conditions, cultural practices, or damage by birds or insects, even though the plants may be large and may require a relatively high consumptive use. Consequently, using average county yields of grain crops to compute the consumptive use using the crop-production function may be misleading. One approach would be to use the yields from fields having relatively high yields for that county. This would represent the consumptive use for the crop under proper management conditions.

Caution must be used when using the crop-production functions to make sure that the yield published in agricultural statistics represents the total yield. Where some of the alfalfa may have been grazed by animals, as in Taos County, the yield published in statistics will be low.

Data for Taos which are included in Table 5 show that the relative consumptive use determined by the crop-production function is considerably lower than that for the other areas in the Table.

The use of crop-production functions, having high coefficients of determination, appears to be one of the better methods of estimating consumptive use in an area, provided reasonable estimates of yields can be determined for that area.

The results of this research show that more work is needed with these and other crops, especially with seed crops, to have data with adequate coefficients of determination.

Variation of the Blaney-Criddle Coefficient, K, with Evapotranspiration and Yield

Table 9 presents ranges of Blaney-Criddle coefficients that have been computed for alfalfa with evapotranspiration values selected to represent the estimated maximum and minimum alfalfa yields obtainable in fields or lysimeters near research stations. Evapotranspiration computed for the average county yields and that computed by the Blaney-Criddle method with K = 0.85 have also been included for comparison. The computed coefficients, K, range between 0.71 - 0.76 for average county yields in all areas except the Farmington (Bloomfield) area where K is 0.65. The authors of the Blaney-Criddle Method have generally recommended that 0.85 be used as the coefficient for alfalfa. In all five research areas in New Mexico, computed values using the Blaney-Criddle method with K = 0.85 have exceeded ET values determined with the crop-production function for average county yields.

Discussion

Through years of using the Blaney-Criddle method there has been considerable discussion to the effect that values computed by the method have been too low. Much of the discussion has been in relation to research results at experiment stations where evapotranspiration measurements have greatly exceeded values conventionally obtained by the Blaney-Criddle method. The reason for the differences becomes more evident when the crop-production functions are considered. This is shown in Figure 11 where the data for Las Cruces in Table 9 are plotted with the alfalfa production function of Figure 7, which has been modified to include a function pertaining to field-dried alfalfa at 15 percent moisture.

Evapotranspiration values ranging between 20 and 70 inches have been used in Table 9 to compute the K coefficients which range between 0.51 to 1.54. The higher values will generally pertain to results at experiment stations where small plots and lysimeters may be farmed with relatively high efficiency to obtain high yields and correspondingly high water use by plants.

Table 9. Range of frost-free seasonal K values for areas near research stations using selected ET-values and yields obtained by the crop-production function for alfalfa, and computations with the Blaney-Criddle method.

Area	Total ET	Yield	Frost-free period, long term Duration	ET	Factor F	Seasonal K
	in.	Tons/acre[1]		in.[2]		
Artesia	30.00	4.05	Apr. 8 - Nov. 2	27.00	44.64	0.60
	37.60	5.34[3]		33.80	44.64	0.76
	40.00	5.74		36.00	44.64	0.81
	40.84[4]	5.89		37.94[4]	44.64	0.85
	50.00	7.44		45.00	44.64	1.01
	60.00	9.13		54.00	44.64	1.21
	70.00	10.83		63.00	44.64	1.41
Clovis	25.00	3.20	Apr. 16 - Oct. 26	22.50	40.86	0.55
	30.00	4.05		27.00	40.86	0.66
	32.40	4.46[3]		29.20	40.86	0.71
	36.89[4]	5.21		34.73[4]	40.86	0.85
	40.00	5.74		36.00	40.86	0.88
	50.00	7.44		45.00	40.86	1.10
	60.00	9.13		54.00	40.86	1.32
Farmington (Bloomfield weather data used)	20.00	2.36	May 1 - Oct. 19	18.00	35.36	0.51
	25.00	3.20		22.50	35.36	0.64
	25.40	3.27[3]		22.90	35.36	0.65
	30.00	4.05		27.00	35.36	0.76
	31.82[4]	4.36		30.06[4]	35.36	0.85
	40.00	5.74		36.00	35.36	1.02
	50.00	7.44		45.00	35.36	1.27
	60.00	9.13		54.00	35.36	1.53
Las Cruces	30.00	4.05	Apr. 9 - Oct. 28	27.00	42.82	0.63
	35.60	5.00[3]		32.00	42.82	0.75
	39.22[4]	5.60		36.40[4]	42.82	0.85
	40.00	5.74		36.00	42.82	0.84
	50.00	7.44		45.00	42.82	1.05
	60.00	9.13		54.00	42.82	1.26
	70.00	10.83		63.00	42.82	1.47

Table 9 (continued). Range of frost-free seasonal K values for areas near research stations using selected ET-values and yields obtained by the crop-production function for alfalfa, and computations with the Blaney-Criddle method.

Area	Total ET	Yield	Frost-free period, long term			
			Duration	ET	Factor F	Seasonal K
	in.	Tons/acre 1/		in. 2/		
Los Lunas	20.00	2.36	May 3 - Oct. 15	18.00	34.97	0.51
	25.00	3.20		22.50	34.97	0.64
	28.90	3.86 3/		26.00	34.97	0.74
	30.00	4.05		27.00	34.97	0.77
	32.86 4/	4.53		29.72 4/	34.97	0.85
	40.00	5.74		36.00	34.97	1.03
	50.00	7.44		45.00	34.97	1.29
	60.00	9.13		54.00	34.97	1.54

1/ Field-dried alfalfa at 15 percent moisture. Includes winter growth.

2/ Total ET less 10 percent. The 10 percent estimate to exclude ET outside of the frost-free period was computed with data in Figure 7D of Appendix D.

3/ Average county yield, Table 5.

4/ Blaney-Criddle computation with K = 0.85 as presented in Table 1B, Appendix B.

Note: The metric system is omitted from the table inasmuch as the Blaney-Criddle formula is expressed in English units.

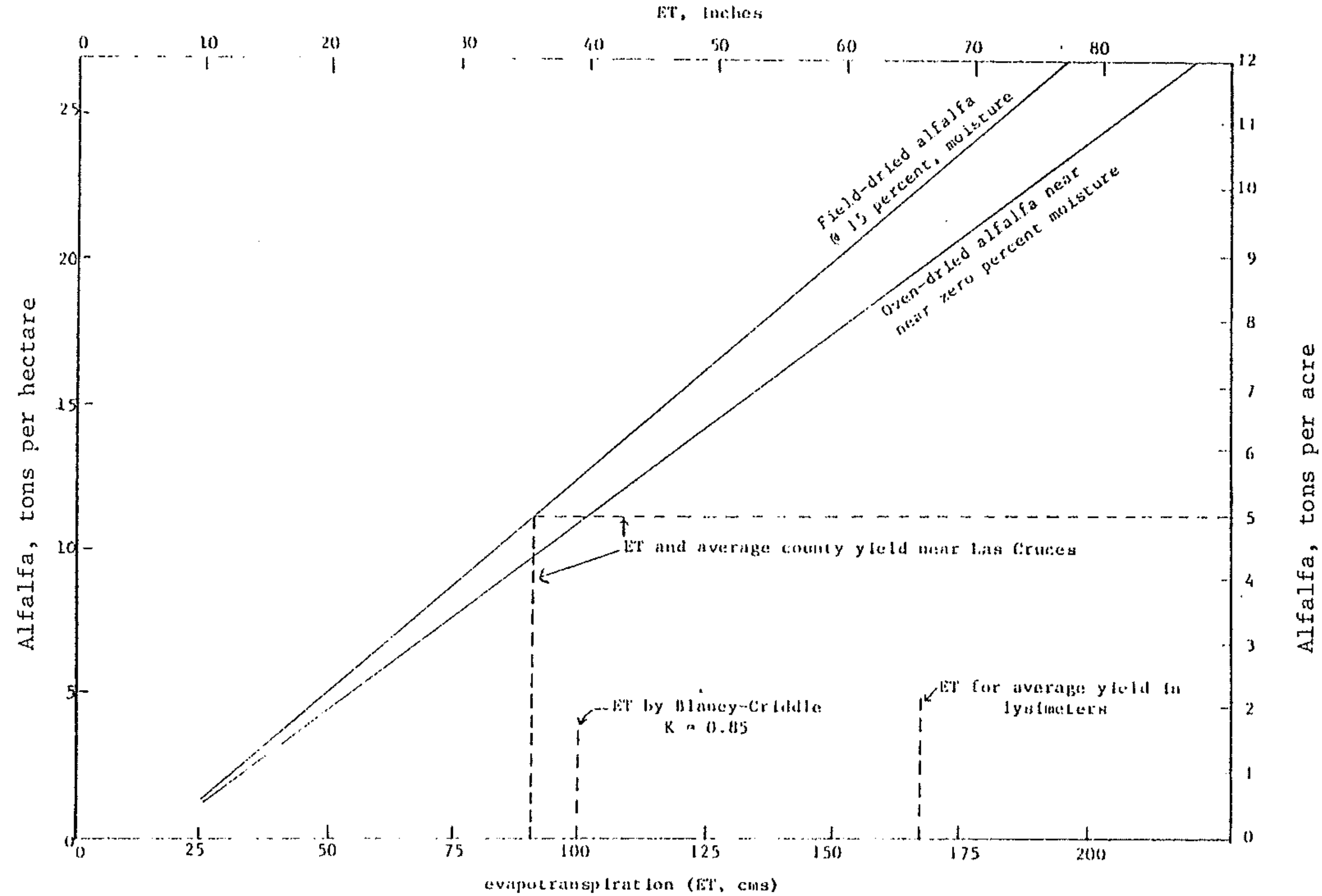


Figure 11. Crop-production function for alfalfa showing the average evapotranspiration measured in lysimeters at Las Cruces as compared to that of the average county yield and the Blaney-Criddle method.

Throughout the years of criticism of the low values computed conventionally by the Blaney-Criddle Method, many have failed to realize that the method was originally intended to pertain to large area or valley consumptive use with crops growing under normal conditions with average or slightly higher than average yields being produced.

With the county average representing a spectrum of higher and lower yields, some high-producing farms will have greater consumptive use.

Potential Evapotranspiration (PET)

Annual potential evapotranspiration has been computed by five methods (16, 17) for the selected study areas shown in Table 10. Appendix E gives the equations used to compute the potential evapotranspiration values. Figures 12 to 20 present curves showing daily PET curves which have been computed by the Penman method. Computations by the other methods for monthly and annual PET are also included with the figures. The annual Penman PET compares quite consistently with the Van Bavel PET at Artesia, Clovis, and Farmington (Table 10), but there are no consistent trends with respect to PET pertaining to other stations and methods.

Solar Radiation vs. Net Radiation

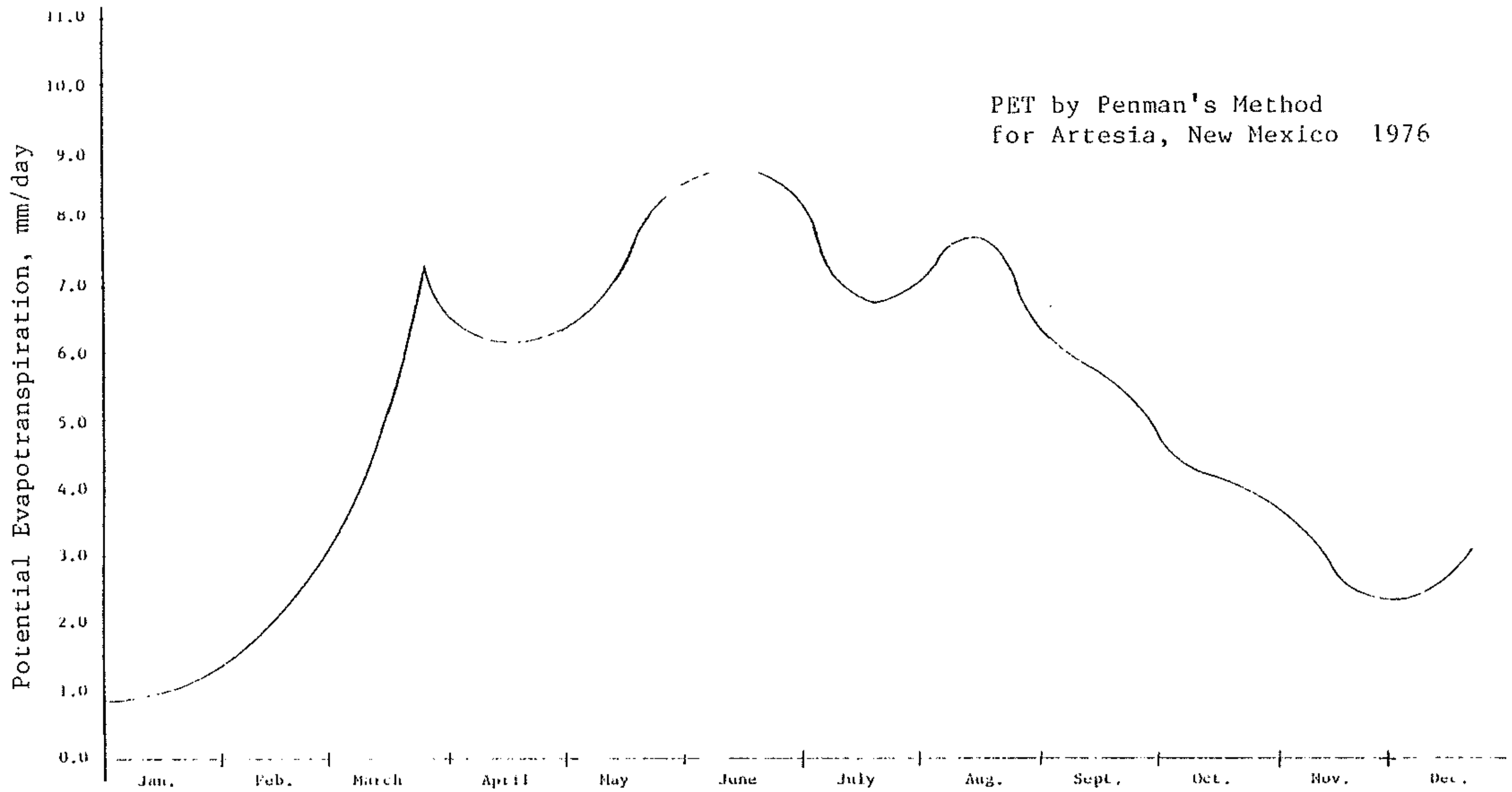
Potential evapotranspiration equations of Priestly and Taylor (17), Penman (16), Van Bavel (16), and Jensen-Haise (16) require a net radiation term. Figure 21 shows a composite relationship between net solar radiation and net radiation as measured at Las Cruces with alfalfa, cotton, and sorghum. Coefficients of determination ranging between 0.990 and 0.996 for measurements of each crop are shown in Table 11. Using these data as a composite in Figure 21 reduces the coefficient to 0.94.

Inasmuch as the composite equation has a high coefficient of determination, $r^2 = 0.94$, it was used to convert solar radiation to net radiation at all locations in New Mexico. Coefficients determined in this research are very similar to those reported by Gay (11) for cotton.

Table 10. Annual potential evapotranspiration computed by selected methods for five areas in New Mexico.

Method	Artesia		Clovis		Farmington		Las Cruces		Los Lunas
	1976	1977	1976	1977	1976	1977	1976	1977	1977
	cm	cm	cm	cm	cm	cm	cm	cm	cm
Penman	192.5	229.2	223.2	222.0	213.5	193.6	192.1	199.6	184.9
Jensen-Haise	178.0	185.3	165.2	166.5	165.3	159.3	185.7	182.3	185.4
Van Bavel	190.0	226.1	233.2	230.7	210.9	189.5	180.3	184.7	155.1
Priestly-Taylor	171.8	172.4	160.9	159.5	166.2	155.8	179.3	170.0	188.0
Net Radiation	184.3	179.9	175.2	172.6	184.2	171.2	191.4	178.2	207.3
Average	183.3	198.6	191.5	190.3	188.0	173.9	185.8	183.0	184.1
Modified Pan[1/]	183.2	223.2	172.3	161.1	151.4	158.7	181.3	193.6	147.1
Pan	229.0	279.0	215.4	201.3	189.2	198.3	226.6	242.1	183.8

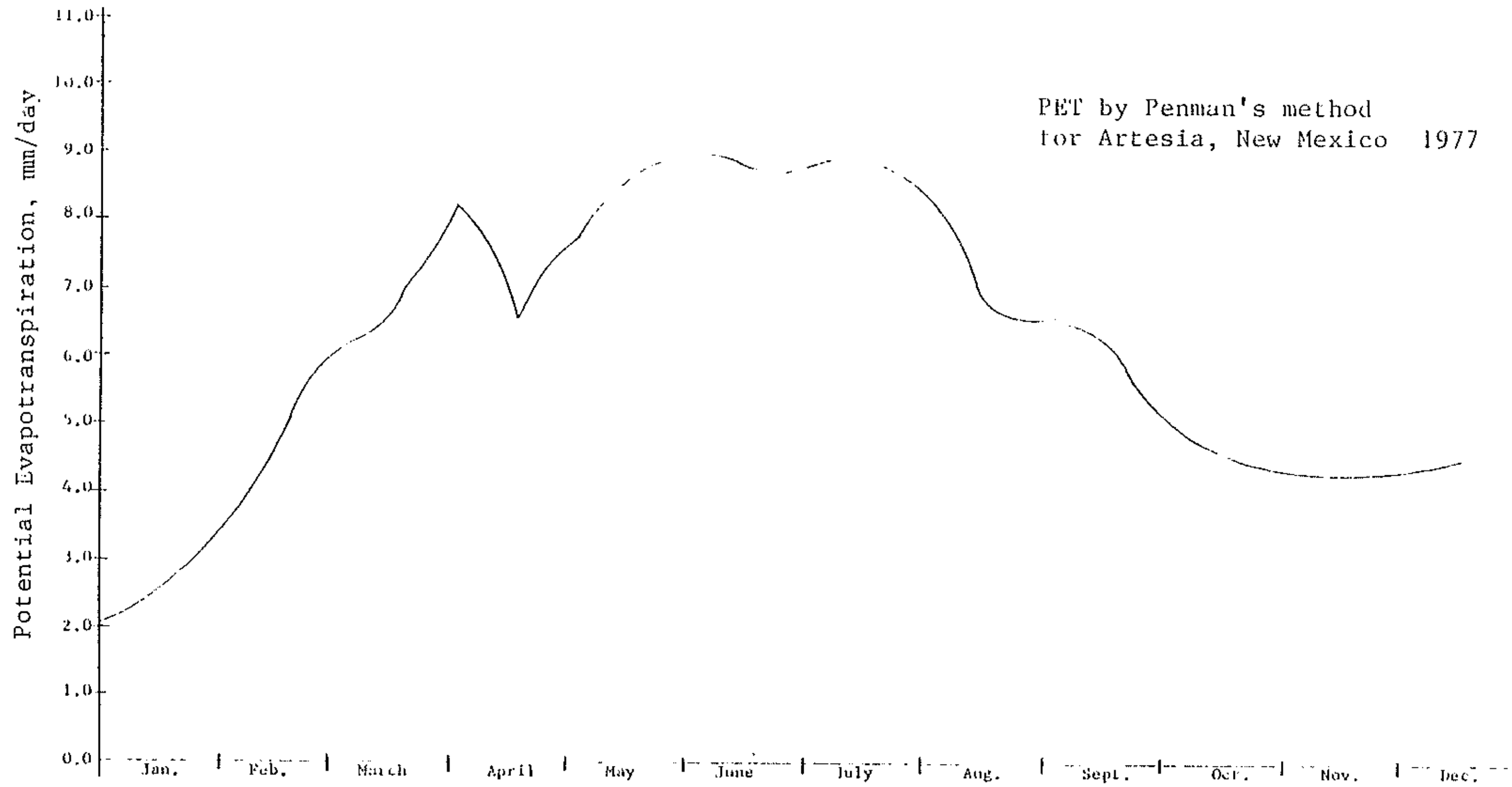
[1/] Modified pan = 0.8 x pan evaporation.



Monthly PET (cm)

	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
PENMAN	4.1	6.7	20.0	19.9	24.2	26.7	21.7	23.0	15.4	13.0	8.1	9.7	192.5
JENSEN-HAISE	5.0	8.7	13.5	17.1	22.6	26.1	24.3	24.6	16.7	9.9	5.4	4.1	178.0
VAN BAVEL	4.1	6.7	21.6	19.6	23.9	27.0	21.2	22.2	14.4	12.4	7.8	9.0	190.0
PREISTLY-TAYLOR	5.8	9.4	15.1	17.6	22.5	23.2	21.4	21.6	14.8	10.0	5.9	4.6	171.8
NET RADIATION	8.4	11.6	18.1	19.1	23.1	21.8	20.3	20.4	14.7	11.7	8.1	6.8	184.3
MODIFIED PAN	6.6	13.0	18.8	18.3	20.8	27.5	20.6	22.1	14.4	11.1	5.0	5.1	183.2
PAN	8.2	16.3	23.5	22.8	26.0	34.3	25.7	27.7	18.0	13.8	6.2	6.4	229.0

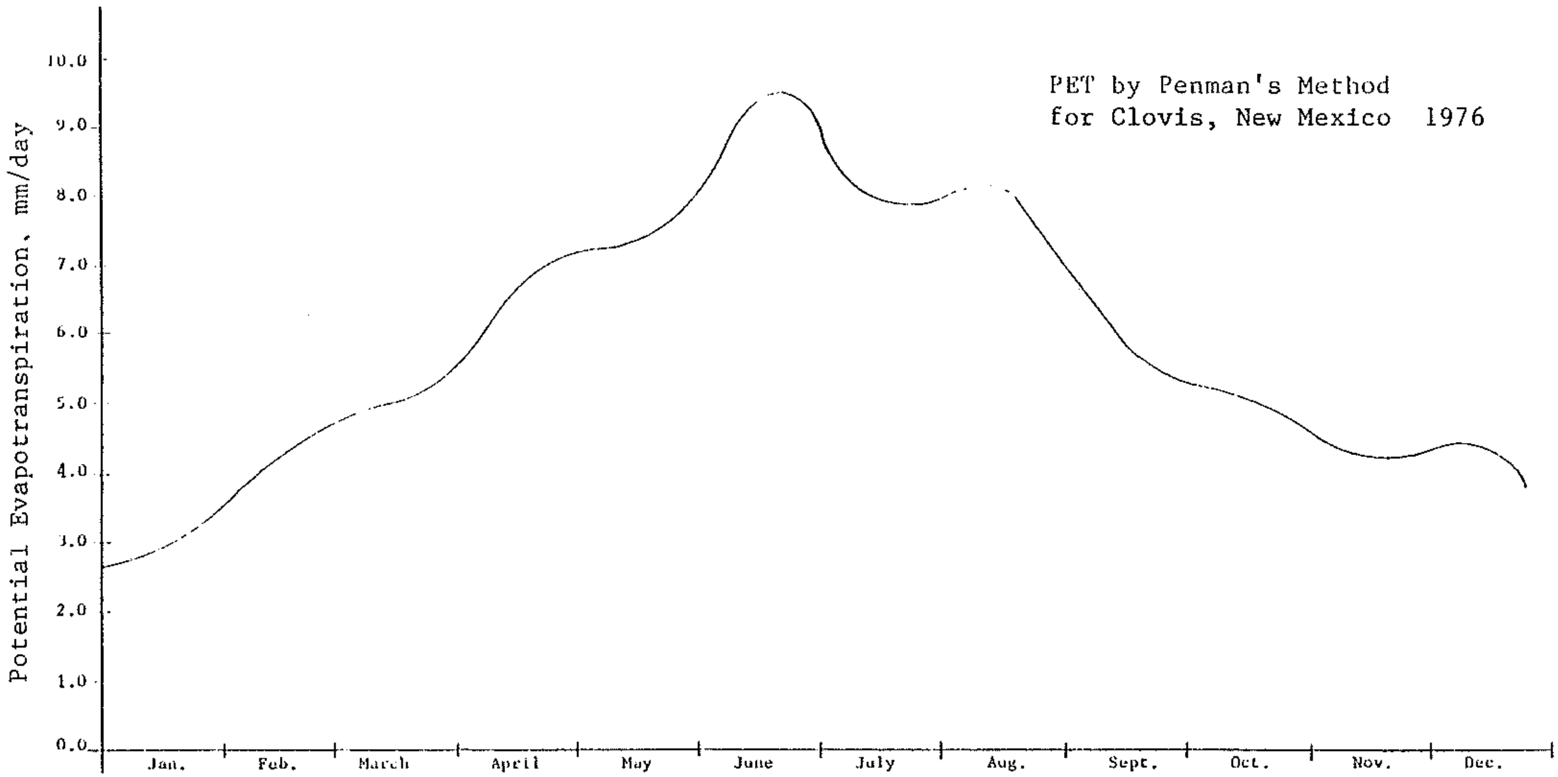
Figure 12. Daily and monthly potential evaporation (PET) for Artesia, New Mexico, 1976.



Monthly PET (cm)

	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
PENMAN	8.9	14.7	21.3	22.4	27.1	26.5	27.4	23.0	19.7	13.3	12.7	12.3	229.2
JENSEN-HAISE	3.9	6.8	10.4	16.4	23.1	27.1	29.9	25.0	18.8	11.1	7.6	5.2	185.3
VAN BAVEL	8.4	15.4	23.0	22.4	27.6	25.6	26.5	22.0	18.2	12.0	12.0	12.8	226.1
PREISTLY-TAYLOR	4.5	7.4	11.6	16.6	21.8	24.0	26.3	21.2	16.2	10.0	7.6	5.1	172.4
NET RADIATION	6.9	9.7	14.5	18.1	21.6	22.5	24.3	19.6	15.6	10.9	9.5	6.7	179.9
MODIFIED PAN	6.6	11.3	19.1	18.0	25.7	26.8	27.9	26.1	24.9	11.7	11.9	13.4	223.2
PAN	8.2	14.1	23.9	22.5	32.1	33.4	34.8	32.6	31.1	14.6	14.8	16.8	279.0

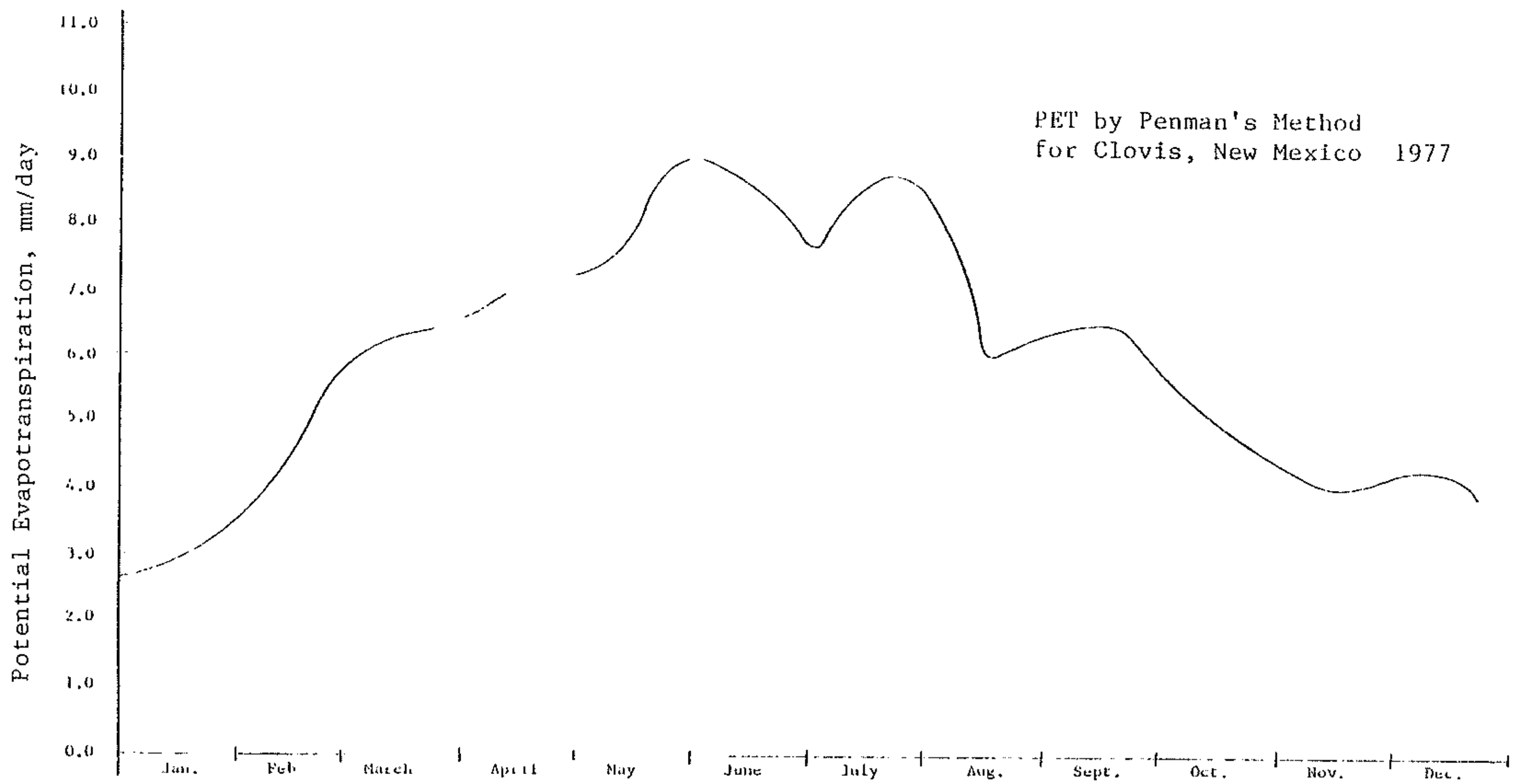
Figure 13. Daily and monthly potential evaporation (PET) for Artesia, New Mexico, 1977.



Monthly PET (cm)

	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
PENMAN	10.2	12.7	19.4	20.8	24.0	29.0	24.8	24.8	17.5	15.9	11.2	12.7	223.2
JENSEN-HAISE	3.7	5.5	10.1	15.5	20.5	25.8	24.5	23.1	15.9	10.2	5.6	5.0	165.2
VAN BAVEL	11.3	14.0	21.1	21.7	24.4	30.0	25.3	25.2	17.5	16.5	11.7	14.6	233.2
PREISTLY-TAYLOR	4.6	5.8	11.7	16.5	21.3	24.1	22.3	20.9	14.2	9.6	5.0	4.8	160.9
NET RADIATION	7.3	7.7	15.1	18.7	23.0	23.5	21.5	20.2	14.3	10.9	6.3	6.5	175.2
MODIFIED PAN	3.7	7.8	15.1	16.4	19.2	26.5	22.1	20.6	13.1	12.6	8.9	6.4	172.3
PAN	4.6	9.7	18.9	20.5	24.0	33.1	27.6	25.8	16.4	15.7	11.1	7.9	215.4

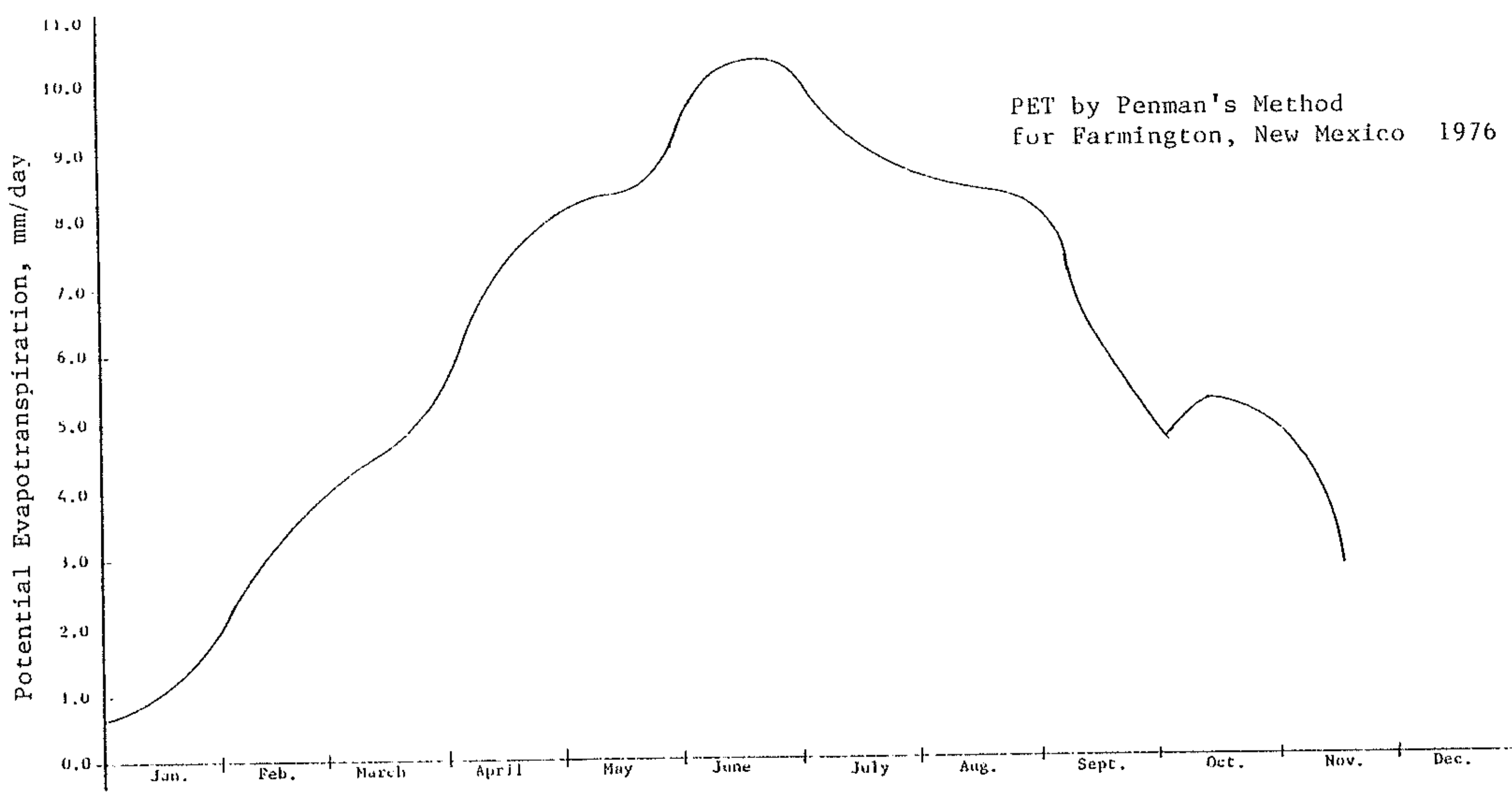
Figure 14. Daily and monthly potential evaporation (PET) for Clovis, New Mexico, 1976.



Monthly PET (cm)

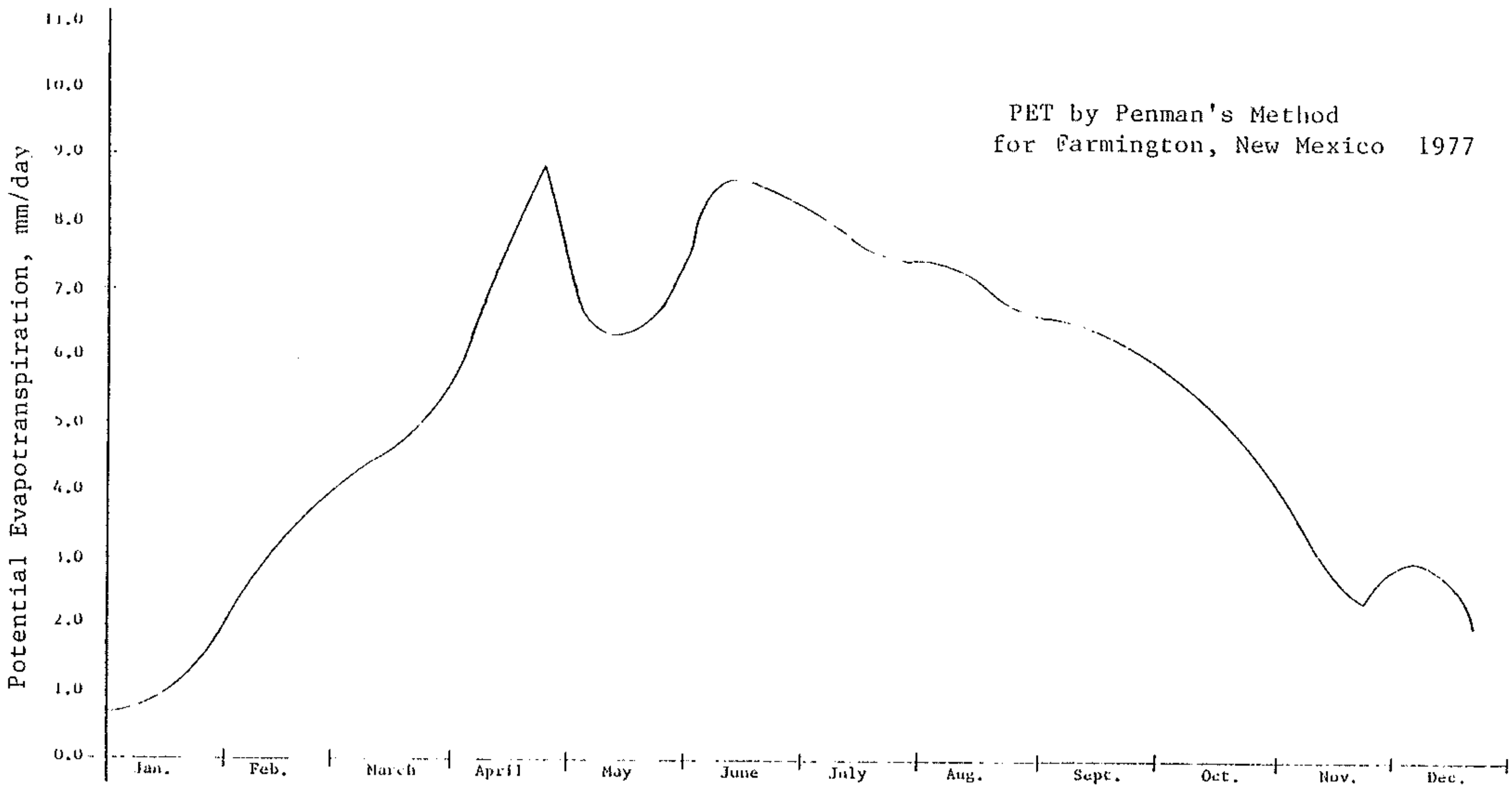
	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
PENMAN	10.2	12.7	20.1	20.9	26.5	25.4	25.6	21.5	20.5	14.6	11.2	12.7	222.0
JENSEN-HAISE	3.7	5.5	9.0	14.8	22.2	24.9	26.3	21.5	18.1	9.9	5.6	5.0	166.5
VAN BAVEL	11.3	14.0	22.7	21.7	27.9	25.1	25.4	21.4	20.0	14.9	11.7	14.6	230.7
PREISTLY-TAYLOR	4.6	5.8	10.3	15.2	21.7	22.9	24.0	19.5	16.9	8.9	5.0	4.8	159.5
NET RADIATION	7.3	7.7	13.4	16.9	22.1	22.4	23.1	19.5	17.4	10.0	6.3	6.5	172.6
MODIFIED PAN	3.7	7.8	15.4	13.2	16.4	19.3	21.6	18.0	18.7	11.8	8.9	6.4	161.1
PAN	4.6	9.7	19.3	16.5	20.5	24.1	27.0	22.5	23.3	14.7	11.1	7.9	201.3

Figure 15. Daily and monthly potential evaporation (PET) for Clovis, New Mexico, 1977.



	Monthly PET (cm)												
	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
PENMAN	3.9	9.4	14.7	23.3	26.7	30.9	28.8	26.3	18.3	15.8	8.8	6.7	213.5
JENSEN-HAISE	1.6	4.4	7.2	17.6	21.5	25.7	28.2	23.8	15.6	11.4	4.8	3.4	165.3
VAN BAVEL	3.7	9.3	15.4	23.9	26.3	31.1	28.1	25.7	17.7	14.9	8.3	6.3	210.9
PREISTLY-TAYLOR	2.6	5.5	9.3	19.8	22.5	24.8	25.0	21.4	14.1	12.4	5.0	3.6	166.2
NET RADIATION	5.1	8.3	13.3	22.7	24.2	24.7	23.4	20.6	14.4	15.0	6.7	5.5	184.2
MODIFIED PAN	0.0	0.0	3.3	18.5	22.8	30.9	27.2	24.2	14.3	10.2	0.0	0.0	151.4
PAN	0.0	0.0	4.1	23.1	28.5	38.6	34.0	30.3	17.9	12.7	0.0	0.0	189.2

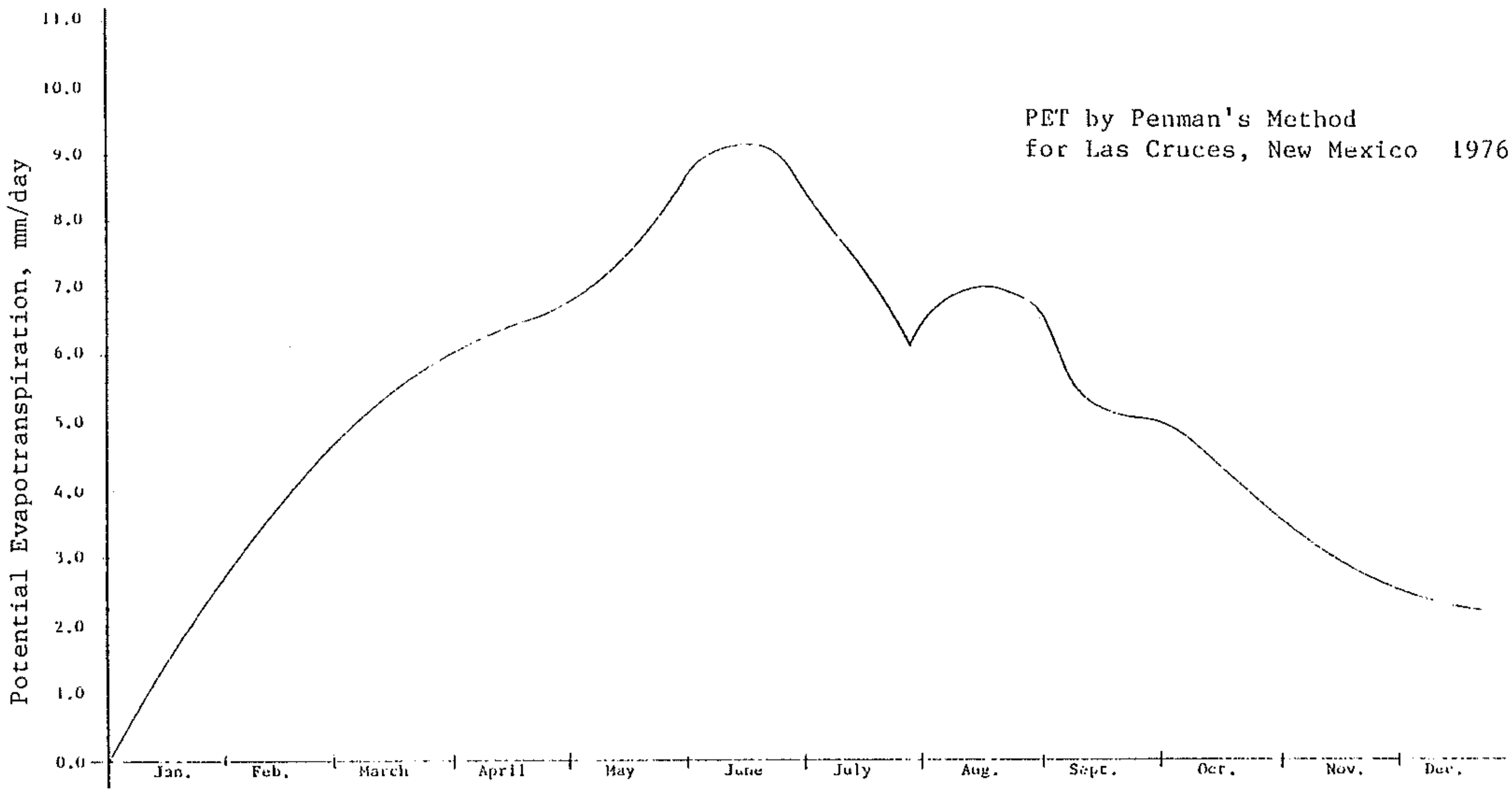
Figure 16. Daily and monthly potential evaporation (PET) for Farmington, New Mexico, 1976.



Monthly PET (cm)

	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
PENMAN	3.9	9.4	14.7	23.4	20.2	26.5	23.8	22.0	19.0	14.8	9.2	6.8	193.6
JENSEN-HAISE	1.6	4.4	7.2	17.9	16.4	25.0	26.3	23.7	17.3	11.1	4.9	3.5	159.3
VAN BAVEL	3.7	9.4	15.4	24.1	20.2	26.1	22.8	20.5	18.7	13.0	9.1	6.5	189.5
PREISTLY-TAYLOR	2.6	5.5	9.3	19.9	16.4	22.6	23.3	20.9	15.7	10.8	4.9	3.8	155.8
NET RADIATION	5.1	8.3	13.3	22.7	17.5	21.6	22.0	19.8	15.8	12.3	6.8	5.7	171.2
MODIFIED PAN	0.0	0.0	3.3	18.9	23.8	30.7	26.4	24.7	19.4	11.5	0.0	0.0	158.7
PAN	0.0	0.0	4.1	23.6	29.7	38.4	33.0	30.8	24.3	14.4	0.0	0.0	198.3

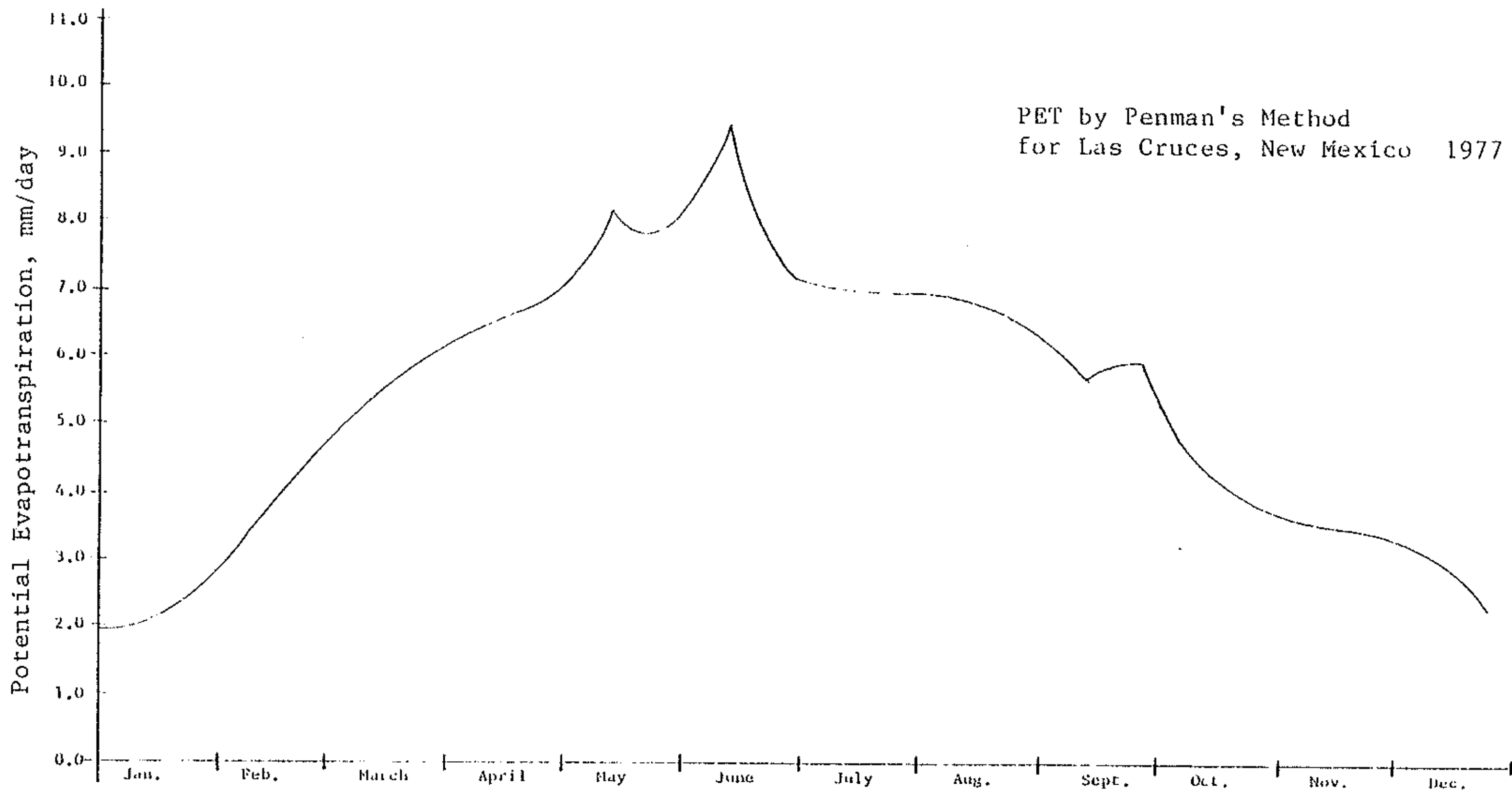
Figure 17. Daily and monthly potential evaporation (PET) for Farmington, New Mexico, 1977.



Monthly PET (cm)

	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
PENMAN	8.4	11.3	15.8	19.7	23.7	26.8	20.6	21.8	15.5	12.7	8.4	7.4	192.1
JENSEN-HAISE	5.9	8.3	12.1	17.5	23.1	28.9	25.0	25.1	17.7	11.8	5.8	4.5	185.7
VAN BAVEL	7.5	10.6	15.3	19.2	23.0	25.8	19.5	20.1	14.4	11.3	7.5	6.1	180.3
PREISTLY-TAYLOR	7.0	8.8	13.2	18.0	23.1	26.5	21.7	22.1	15.9	11.8	6.2	5.0	179.3
NET RADIATION	9.9	11.0	15.8	19.7	23.8	25.2	20.3	20.8	15.8	13.4	8.3	7.3	191.4
MODIFIED PAN	6.4	10.4	14.8	18.9	24.2	27.8	25.0	20.1	13.6	9.9	5.4	4.5	181.3
PAN	8.0	13.0	18.5	23.6	30.3	34.8	31.2	25.2	17.0	12.3	6.8	5.6	226.6

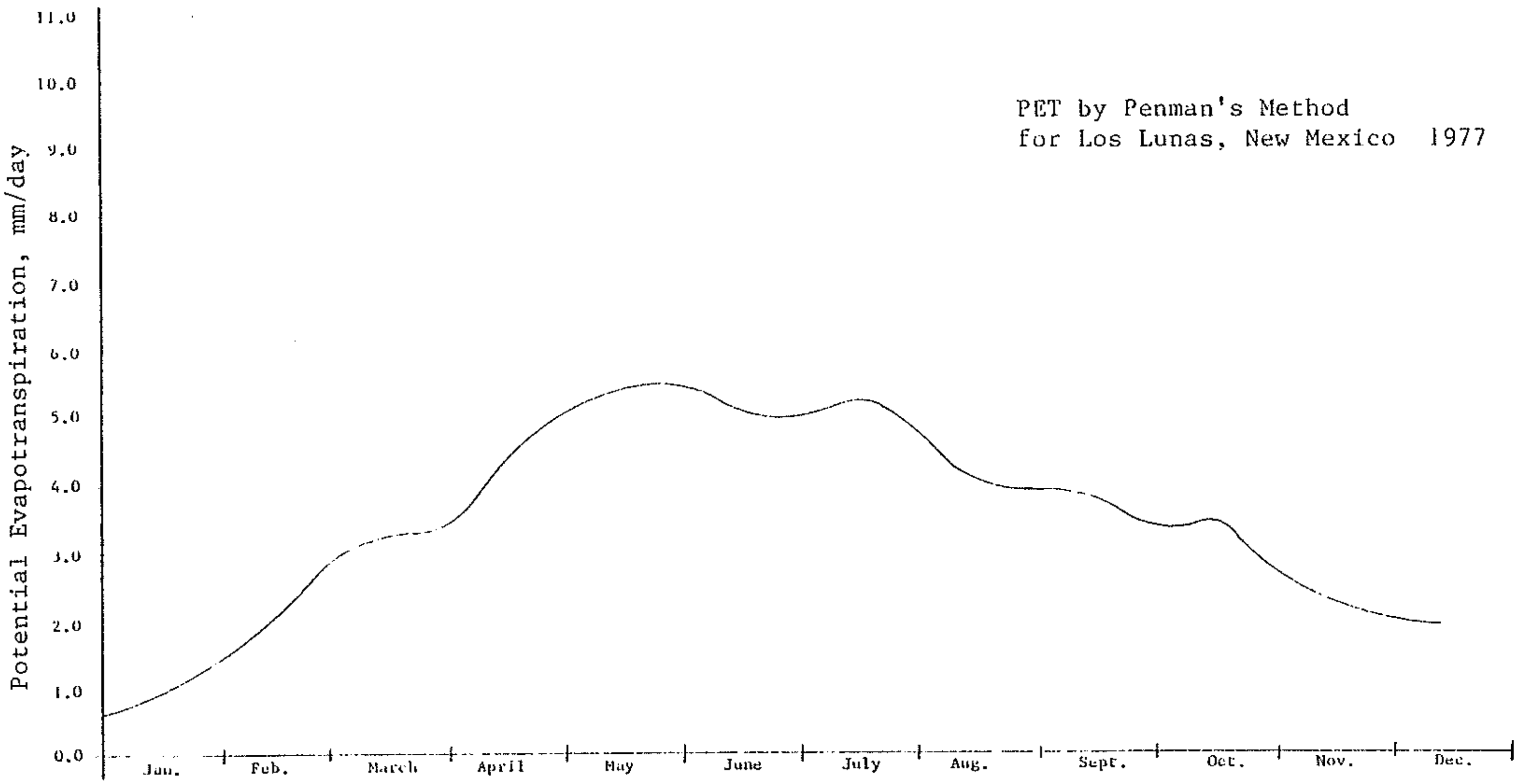
Figure 18. Daily and monthly potential evaporation (PET) for Las Cruces, New Mexico, 1976.



Monthly PET (cm)

	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
PENMAN	8.0	12.0	16.8	20.3	25.0	25.3	22.4	21.2	18.1	12.1	10.4	7.9	199.6
JENSEN-HAISE	4.7	6.9	10.2	16.2	23.1	27.0	25.9	24.5	19.6	11.5	7.6	5.1	182.3
VAN BAVEL	7.2	11.5	17.0	19.4	23.2	23.0	20.7	19.3	16.2	10.6	9.0	7.3	184.7
PREISTLY-TAYLOR	5.0	7.7	11.2	16.3	22.9	24.3	22.1	20.6	17.3	10.4	7.5	4.7	170.0
NET RADIATION	7.0	10.1	13.9	17.7	23.6	23.0	20.5	19.0	16.8	11.2	9.2	6.1	178.2
MODIFIED PAN	5.6	11.6	19.5	19.1	22.3	23.5	23.5	22.4	17.9	10.6	9.2	8.3	193.6
PAN	7.0	14.6	24.3	23.9	27.9	29.4	29.4	27.9	22.4	13.3	11.5	10.4	242.1

Figure 19. Daily and monthly potential evaporation (PET) for Las Cruces, New Mexico, 1977.



Monthly PET (cm)

	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
PENMAN	5.1	8.8	14.1	18.2	23.8	24.2	24.9	21.5	16.1	13.3	8.9	5.9	184.9
JENSEN-HAISE	3.3	6.3	10.2	17.5	23.4	27.1	30.1	26.3	18.3	12.4	6.5	4.0	185.4
VAN BAVEL	4.0	7.1	12.3	15.7	20.9	20.8	21.6	18.5	13.3	10.3	6.4	4.1	155.1
PREISTLY-TAYLOR	4.8	8.0	13.1	19.2	24.8	25.7	27.7	23.7	17.0	12.7	7.1	4.1	188.0
NET RADIATION	8.2	11.4	17.8	21.8	26.5	25.2	26.3	22.5	17.2	14.7	9.5	6.0	207.3
MODIFIED PAN	3.6	6.1	12.2	13.8	20.4	20.7	19.7	17.3	12.7	9.6	6.3	4.5	147.1
PAN	4.5	7.6	15.2	17.3	25.5	25.9	24.6	21.6	15.9	12.0	7.9	5.7	183.8

Figure 20. Daily and monthly potential evaporation (PET) for Los Lunas, New Mexico, 1977.

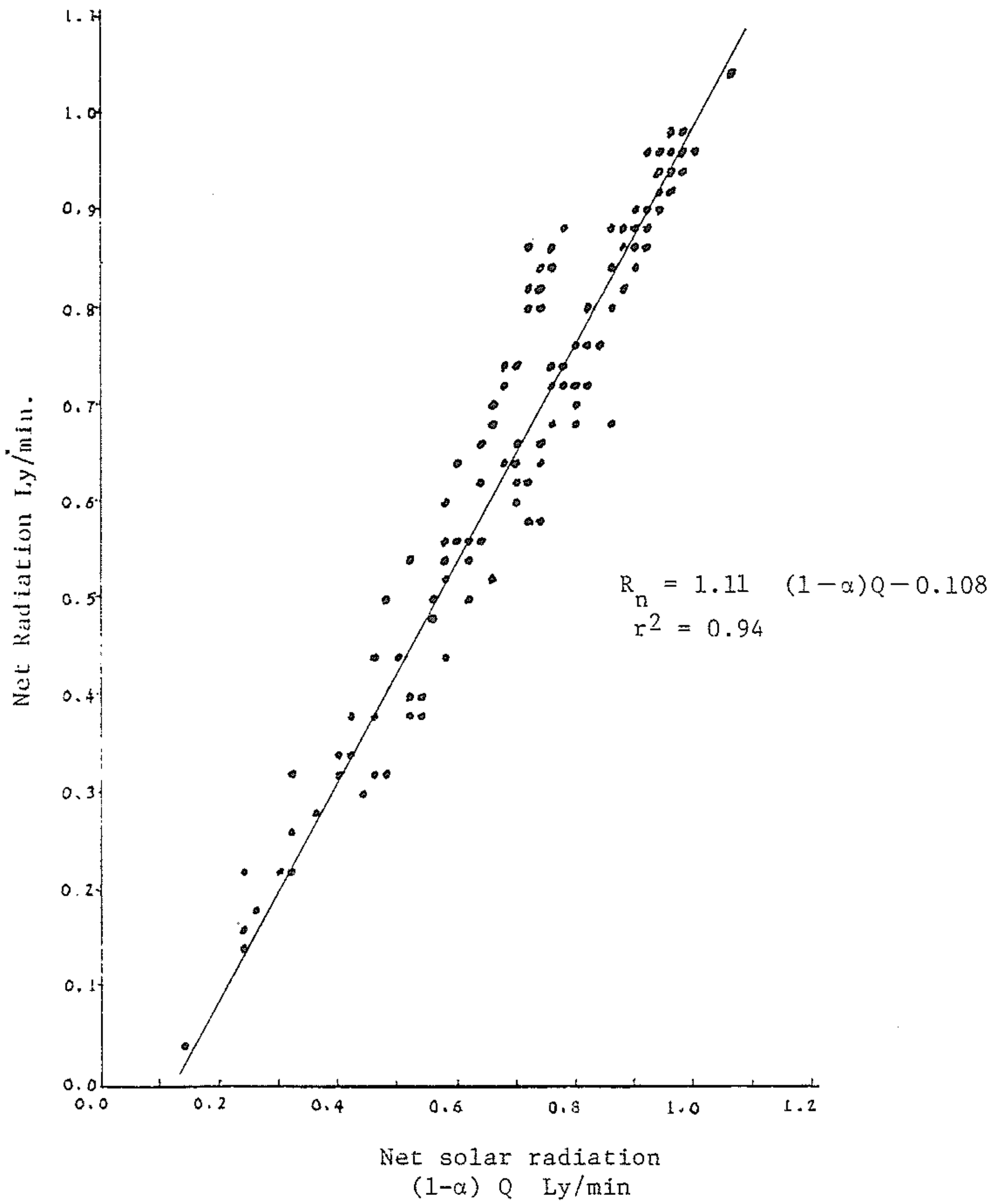


Figure 21. Relationship of net radiation to net solar radiation for alfalfa, cotton, and sorghum at Las Cruces, New Mexico.

Table 11. Coefficients of determination of net radiation vs. net solar radiation for selected crops at Las Cruces, New Mexico.

Crop	Year	Equation a	Equation b	Coefficient of determination r^2
Sorghum	7/76	1.06	.090	0.996
Alfalfa	7/77	1.14	.156	0.990
Cotton	7/77	1.13	.146	0.992

Equation: $Rn = a\ (1 - \alpha)\ Q - b$

R_n = net radiation ly/min

Q = solar radiation ly/min

α = albedo of crop ($\simeq$.21)

The equation which represents the data in Figure 21 is:

$$R_n - a(1 - \alpha) Q - b \qquad (3)$$

where R_n = net radiation ly/min

Q = solar radiation ly/min

α = albedo of crop ≃ 0.21

a = 1.11

b - 0.11

Daily and Monthly Consumptive Use

Table 12 presents the average daily peak consumptive use during months of maximum evapotranspiration. This information was obtained from Appendix D which presents data for all crops in the lysimeters relative to daily and monthly use throughout the season, and monthly ratios of consumptive use to potential evapotranspiration.

The data in Appendix D represent an average of measured monthly and annual evapotranspiration by crops. The data obtained by measurements are listed in Appendix F.

Extimates of consumptive use, ET, may be computed from potential evapotranspiration, PET, by using the crop coefficient k' in the formula:

$$ET = k' \times PET$$

The crop coefficient, k', is defined as the ratio of measured consumptive use to measured potential evapotranspiration. The ratios by months and seasons for each crop in Appendix D represent smoothed data. Consumptive use estimates computed with these ratios will generally be well above average as they represent non-limiting soil-moisture conditions which are conducive to high crop yields. These conditions also resulted in relatively high Blaney-Criddle (3) coefficients which are also presented in Appendix D.

Advective Energy

Table 13, which presents ratios of mature alfalfa evapotranspiration to net radiation for the five study areas in New Mexico, has been prepared to

Table 12. Peak consumptive use of water by crops, location, and month of occurrence.

Appendix B figures	Crops	Location	Peak Consumptive Use m.m/day	inches/day	Month
1B	New Alfalfa	Artesia	10.2	0.40	June
2B	Mature Alfalfa	Artesia	8.7	0.34	July
3B	New Alfalfa	Clovis	9.8	0.39	June
4B	Mature Alfalfa	Clovis	10.3	0.41	July
5B	New Alfalfa	Farmington	9.4	0.37	July
6B	Mature Alfalfa	Farmington	9.5	0.37	August
7B	Mature Alfalfa	Las Cruces	10.6	0.42	June
8B	Mature Alfalfa	Los Lunas	9.4	0.37	July
9B	Barley	Artesia	7.9	0.31	April
10B	Barley	Farmington	9.5	0.37	June
11B	Bluegrass	Los Lunas	5.5	0.22	June
12B	Corn	Clovis	9.6	0.38	July
13B	Corn	Farmington	10.1	0.40	July
14B	Cotton	Artesia	8.8	0.34	July
15B	Cotton	Las Cruces	8.7	0.35	August
16B	Rye	Los Lunas	6.8	0.27	May
17B	Sorghum	Artesia	8.8	0.36	July
18B	Sorghum	Clovis	8.4	0.33	July
19B	Sorghum	Farmington	7.8	0.31	July
20B	Sorghum	Las Cruces	7.0	0.28	July
21B	Sorghum	Los Lunas	6.4	0.25	August
22B	Sudan Grass	Las Cruces	7.4	0.31	August
23B	Wheat	Clovis	9.0	0.36	May

evaluate relative advective energy conditions at the sites. The greater the advective energy in an area, the higher will be the ratios.

Table 13. Average ratios of mature alfalfa ET/(net radiation) for frost-free months at five areas in New Mexico.

	Artesia	Clovis	Farmington	Las Cruces	Los Lunas
ET/(net radiation)	1.14	1.15	1.32	1.10	0.91

The ratios in the table indicate that Artesia, Clovis, and Farmington sites had an appreciable amount of advective energy as compared to Las Cruces. Advective energy was minimal at Los Lunas. No attempt has been made to adjust the consumptive-use measurements at the different sites to account for the different advective energy conditions. Theoretically, this would be possible but a corresponding adjustment in yield would be required for which relationships have not been determined.

Discussion

The potential evapotranspiration is limited by the total amount of energy available. When advective energy is available, supplying energy in the evapotranspiration process, evapotranspiration rates may exceed net radiation. Advective energy is available when the temperature gradient in the atmosphere is reversed and heat is transferred from the air masses to the ground surface.

There are two types of advective energy: local and large-scale. Advective energy transfer may be large-scale (regional) and small-scale (local) in nature. The terms "small-scale" and "large-scale" are used in an attempt to identify sources of preconditioned air. Large-scale occurs when warm, dry air masses are generated over large, hot, dry regions and move across wetter, cooler surfaces in other regions. Small-scale occurs when wind blows across a surface discontinuity (i.e., the leading edge) in temperature, humidity, or roughness, as from a dry field to an adjacent wetter, cooler field. Both types influence the evapotranspiration process.

At the Clovis and Farmington areas, the fetch distances were insufficient to be certain that local advection could not occur. In order to know what the percentage of local advection might be, it would have been necessary to make a complete energy budget throughout the growing season on the evapotranspiration process.

An estimate of the maximum percentage of evapotranspiration that might be occurring in the central plains from local advective energy could be as much as 14 percent after the plants had reached a 100 percent cover (Brakke 5). During the development stage of a plant, small local advection normally occurs from the dry, inner spaces of the rows to the bed where the plants are growing. This type of local advection is there regardless of the surrounding field conditions.

The amount of energy that is available for large-scale advection would affect all crops in the area regardless of the condition of the adjacent fields, and this might account for as much as 40 percent of the energy for short-time periods needed for the evapotranspiration process (Brakke 5). Advective energy supplied about 20 percent of the total energy consumed by alfalfa during the summer months in the east central plains in a study by Blad and Rosenberg (2).

As long as energy is available, evapotranspiration increases with an increase in growth and yield when moisture and fertilizer are not a limiting factor.

SUMMARY AND CONCLUSIONS

Alfalfa, barley, bluegrass, corn, cotton, rye, grain sorghum, and sudangrass were grown at selected locations throughout the state of New Mexico including Las Cruces, Artesia, Los Lunas, Clovis, and Farmington.

Lysimeters were installed in the center of the fields, and yields with monthly and yearly evapotranspiration rates were measured in 1976 and 1977. In 1978 a sprinkler-line source was used to irrigate alfalfa and cotton in field plots for the measurement of yields and evapotranspiration. These data and data from other irrigation projects were used to derive crop-production functions for alfalfa, corn, cotton, and grain sorghum. Additional data are needed to establish or refine the crop-production functions for most of the crops. The coefficient of determination, r^2, ranged from 0.97 for alfalfa to 0.42 for grain sorghum.

Potential evapotranspiration (PET) was determined at each of the study areas using the methods of Penman, Jensen-Haise, Van Bavel, Priestly-Taylor, net radiation, modified pan, and pan evaporation. These data were combined with the evapotranspiration measured in lysimeters growing each crop to determine a monthly and yearly crop coefficient by each method used to compute PET.

The ratio ET/Rn, pertaining to advective energy, ranged from 0.91 at Los Lunas to 1.32 at Farmington. Evapotranspiration exceeded available net radiation at four locations indicating that advective energy was available for the evapotranspiration process.

The maximum daily evapotranspiration rate ranged from 5.5 mm/day for bluegrass in June at Los Lunas to 10.6 mm/day for mature alfalfa in June at Las Cruces. The seasonal evapotranspiration values computed for cotton, corn and sorghum are appreciably higher by the Blaney-Criddle method using the coefficients presented in Technical Report 32 (4) than they are by the crop-production-function method using average county yields. For alfalfa, using the average county yield, the results by the two methods are approximately the same. These results are supportive of the Blaney-Criddle formula as a method to estimate evapotranspiration which will be adequate for average county or valley yields. Caution must be used in using county average yields of grain crops due to the high variability in county yields. Also, in areas where alfalfa is grazed, part of the yield will not be included in agricultural statistics for use with the crop-production function.

For high yields and evapotranspiration measured in lysimeters, the Blaney-Criddle coefficient, K, ranges approximately 30 to 60 percent greater than the coefficients used conventionally for normal consumptive use.

DEFINITION OF TERMS

Consumptive use - The quantity of water transpired by plants, retained in plant tissue, and evaporated from adjacent soil surfaces in a specified time period. Usually expressed in depth of water. As used herein, consumptive use is synonymous with evapotranspiration.

Consumptive irrigation requirement - The depth of irrigation water, exclusive of precipitation, stored soil moisture, or ground water, that is required consumptively for crop production.

Crop production function - The relationship between yield and seasonal consumptive use of a crop.

Crop coefficient - The ratio of evapotranspiration to potential evapotranspiration.

Evapotranspiration (ET) - See consumptive use.

Neutron Probe - An instrument, based upon the principle of neutron moderation, for determination of soil-moisture content.

Potential evapotranspiration (PET) - The rate of evaporation from an extended surface of a short green crop actively growing, completely shading the ground and growing with non-limiting soil moisture conditions.

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APPENDICES

Appendix D (continued)

Appendix D (continued)

APPENDIX A

Applications of fertilizer nutrients for irrigated crops.

Appendix A

APPLICATIONS OF FERTILIZER NUTRIENTS FOR IRRIGATED CROPS[1/]

Crop	Pounds per acre			Remarks
	N[2/]	P[3/]	(or P_2O_5)[4/]	
Alfalfa New seeding	0-20	53	(120)	Drill 3 to 4 inches deep at seeding or broadcast and disk in before seeding.
Established stands	0	53	(120)	Top-dress before first spring irrigation or between cuttings. Need not be applied the first spring after a fertilized fall seeding.
Barley Spring	120	27	(60)	Apply at planting time.
Winter	120	27	(60)	Apply all P at planting. Applications of N are usually split, with ½ N at planting and remainder in early spring or when grazing is stopped.
Bluegrass	200	27	(60)	Use split applications of N.
Corn--field and sweet	200	35	(80)	Side-dress[5/] at planting. On light soils apply ½ N at planting and side-dress the remainder at last cultivation.
Cotton Upland	120	35	(80)	Southern New Mexico: ½ P and ½ N at planting. Side-dress remaining P and N at time of first squares. East-central New Mexico: Apply all P and N at planting.
Sorghum Grain (36"-40" rows)	150	35	(80)	Same as corn. Increase N 25% if planting double rows on bed.
Sudan-grass	200	27	(60)	Apply ½ N preplant and remainder after cutting or as needed if grazed.
Wheat Winter	100	20	(45)	Same as winter barley.
Spring	100	18	(40)	Apply at planting time.

1/ Extracted from "Fertilizer Guide for New Mexico", Coop. Ext. Serv., Cir. 478, New Mexico State University, Las Cruces, New Mexico, 88003.
2/ Nitrogen
3/ Phosphorus
4/ Phosphoric acid
5/ Triple pre-plant rates of P if broadcast. Double pre-plant rates of N if broadcast.

APPENDIX B

Consumptive use of alfalfa and cotton computed for areas near research sites using the Blaney-Criddle Method with adjustments for preplanting water use or use outside of the frost-free period. Adjustments were made using the U.S.D.A. Method in SCS TR 21 (20) as presented in Bul. 531 (15).

Table 1B. Consumptive use of alfalfa computed for areas near research sites by the Blaney-Criddle Method with adjustments for water use outside of the frost-free period.

Location	Consumptive Use, inches, With cms in Parentheses				
Col. 1	Col. 2	Col. 2	Col. 4	Col. 5	Col. 6
	During Frost-Free Period1/	Outside Frost-Free Period2/	Total for Season3/ U	Effective Rainfall2/ R	Consumptive Irrigation Requirements2/ U-R
Artesia	37.9 (96.3)	2.9 (7.4)	40.8 (103.7)	9.1 (23.0)	31.7 (80.7)
Clovis	34.7 (88.1)	2.2 (5.6)	36.9 (93.7)	13.8 (35.1)	23.1 (58.6)
Farmington4/	30.0 (76.2)	1.8 (4.6)	31.8 (80.8)	4.8 (12.2)	27.0 (68.6)
Las Cruces	36.4 (92.5)	2.8 (7.1)	39.2 (99.6)	5.8 (14.7)	33.4 (84.9)
Los Lunas	29.7 (75.4)	3.1 (7.9)	32.8 (83.3)	4.6 (11.7)	28.2 (71.6)
Taos5/	21.7 (55.1)	3.2 (8.1)	24.9 (63.2)	6.6 (16.8)	18.3 (46.4)

1/ Computed in Technical Report 32 (4). Blaney-Criddle K = 0.85.

2/ Computed with USDA Method in SCS TR21 (21) as presented in Bul. 531 (15).

3/ Total = Col. 2 + Col. 3, or Col. 5 + Col. 6.

4/ Bloomfield weather station records were used.

5/ Not near a research site. Taos is included for a comparison in the report.

Table 2B. Consumptive use of cotton computed for areas near research sites with adjustments for water use between dates of the preplanting irrigation and planting.

Location	Consumptive Use, inches, With cms in Parentheses				
Col. 1	Col. 2	Col. 3	Col. 4	Col. 5	Col. 6
	From Planting to Harvest[1/]	Preplanting[2/]	Total[3/] U	Effective Rainfall R	Consumptive Irrigation Requirements U-R
Artesia	27.4 (69.6)	1.0 (2.6)	28.4 (72.2)	8.8 (22.4)	19.6 (49.8)
Las Cruces	26.3 (66.8)	1.0 (2.6)	27.3 (69.4)	5.6 (14.2)	21.8 (55.2)

1/ Computed in Technical Report 32 (4). Blaney-Criddle K = 0.62.

2/ Consumptive use between dates of preplanting irrigation and planting.

3/ Total = Col. 2 + Col. 3, or Col. 5 + Col. 6.

APPENDIX C

Tabulation of yields of alfalfa, cotton, grain corn and grain sorghum for 1959 to 1977 for counties where experiment stations are located. For Los Lunas, yields from Bernalillo County were used. Yields were obtained from New Mexico Agricultural Statistics (1).

Table 1C. Alfalfa yields, 1959-1977, in counties near research sites.

	Artesia	Clovis	Farming-ton	Las Cruces	Los Lunas[1/]	Taos[2/]
	tons/acre					
1959	4.7	3.0	2.6	4.5	3.2	1.7
1960	4.9	3.3	3.0	4.5	3.8	1.9
1961	5.0	3.3	3.4	4.5	3.5	2.0
1962	5.9	5.0	3.5	4.7	3.5	1.9
1963	5.0	5.5	3.6	5.1	4.0	1.8
1964	4.0	5.0	3.5	5.0	4.0	1.2
1965	4.1	3.0	3.2	4.0	3.4	1.9
1966	5.5	4.0	3.3	4.5	3.5	1.8
1967	5.6	5.0	3.5	5.0	3.6	1.7
1968	6.1	6.2	3.3	5.4	3.8	1.8
1969	5.8	5.3	3.8	5.1	3.8	2.1
1970	5.3	4.9	3.2	5.2	4.0	2.0
1971	5.9	4.3	3.9	5.8	3.5	0.8
1972	6.1	4.2	3.3	5.2	3.5	1.2
1973	5.7	3.2	3.0	5.2	4.0	2.0
1974	5.2	4.1	3.3	5.0	4.4	3.0
1975	5.4	5.0	3.0	5.8	4.6	2.0
1976	5.2	4.8	2.7	5.1	4.5	1.4
1977	6.0	5.7	3.0	5.4	4.7	1.4
Average	5.34	4.46	3.27	5.00	3.86	1.77
	(11.97)[3/]	(10.00)	(7.33)	(11.21)	(8.65)	(3.97)

1/ Bernalillo County yields.

2/ Not near a research site. Taos is included for a comparison in the report.

3/ Numbers in parentheses are average metric tons per hectare, t/ha.

Table 2C. Upland cotton and grain corn yields, 1959-1977 in counties near research sites.

	Upland Cotton		Grain Corn	
	Artesia	Las Cruces	Clovis	Farmington
	lbs/acre		bushel/acre	
1959	908	761	38.0	40.5
1960	742	822	60.0	58.9
1961	883	832	50.0	49.4
1962	610	679	61.1	59.3
1963	702	769	66.4	59.2
1964	697	807	70.0	73.5
1965	697	688	60.0	47.0
1966	643	739	50.0	55.0
1967	724	720	50.0	60.0
1968	649	662	80.0	60.0
1969	610	466	85.0	72.0
1970	536	604	80.0	60.0
1971	605	605	80.0	45.0
1972	609	696	90.0	58.0
1973	726	567	88.0	50.0
1974	521	645	88.0	87.0
1975	476	458	119.0	60.0
1976	437	722	125.0	81.0
1977	630	694	87.0	85.0
Average	652.9	680.8	75.1	61.1
			(4205.6) 1/	(3421.6) 1/
	(731.9) 2/	(763.2) 2/	(4714.5) 2/	(3835.6) 2/

1/ Average yield is lbs/ac. Conversion factor: 1 bu. = 56 lbs.

2/ Average yield is kg/ha.

Table 3C. Grain sorghum yields, 1959-1977, in counties near research sites.

	Artesia	Clovis	Farmington	Los Lunas[1/]
	bushel/acre			
1959	45.5	70.5	-	50.0
1960	60.0	83.4	-	50.0
1961	65.3	94.8	-	45.0
1962	84.0	92.4	-	70.0
1963	78.0	100.6	-	60.0
1964	76.0	105.0	-	-
1965	71.0	88.0	26.0	-
1966	71.0	100.0	39.0	25.0
1967	82.0	110.0	36.0	35.0
1968	90.0	98.0	40.0	30.0
1969	94.0	101.0	40.0	70.0
1970	55.0	104.0	40.0	64.0
1971	70.0	110.0	40.0	50.0
1972	68.0	112.0	40.0	45.0
1973	47.0	104.0	35.0	49.0
1974	45.0	87.0	-	92.0
1975	61.0	93.0	36.0	61.0
1976	53.0	98.0	36.0	-
1977	76.0	92.0	43.0	-
Average	68.0	97.0	37.6	53.1
	(3400.0)[2/]	(4850.0)[2/]	(1880.0)[2/]	(2655.0)[2/]
	(3811.4)[3/]	(5436.8)[3/]	(2107.5)[3/]	(2976.3)[3/]

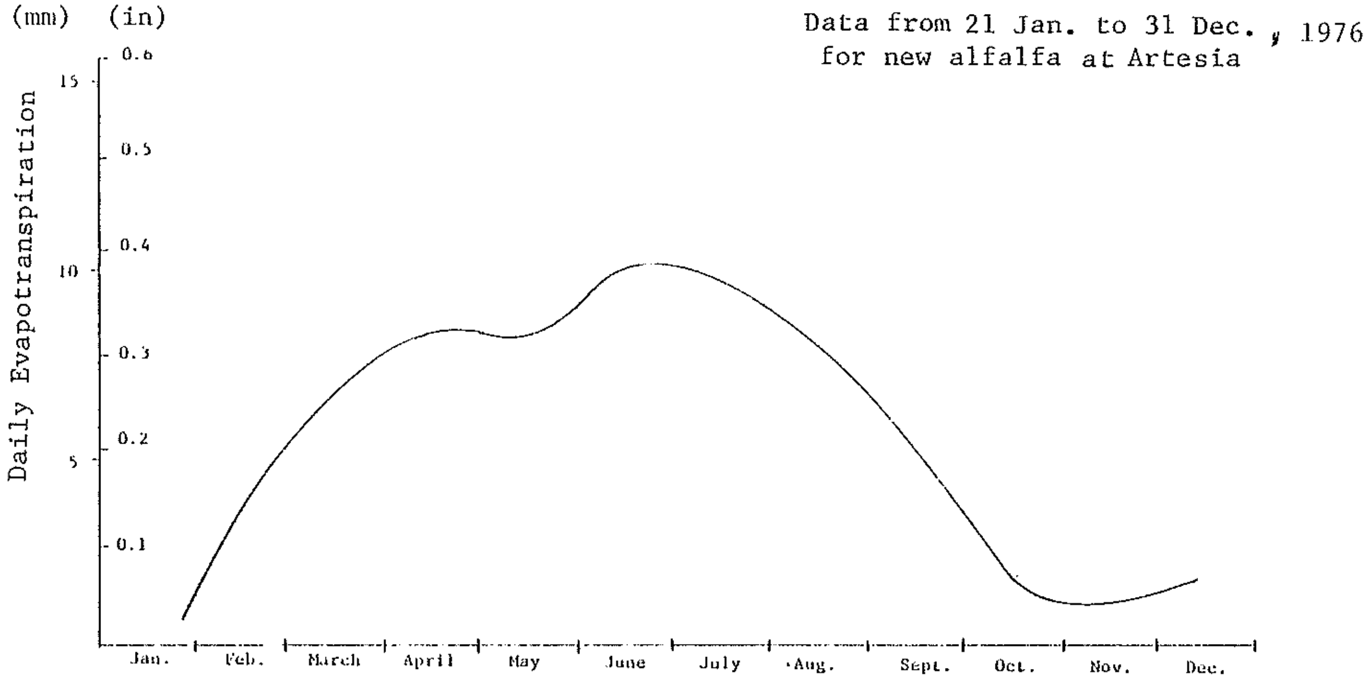
1/ Bernalillo County yields.

2/ lbs/ac. Conversion factor: 1 bu. = 50 lbs.

3/ kg/ha.

APPENDIX D

Daily and Monthly ET, Monthly ET/PET ratios, and
Seasonal Blaney-Criddle Coefficients for
Crops in New Mexico

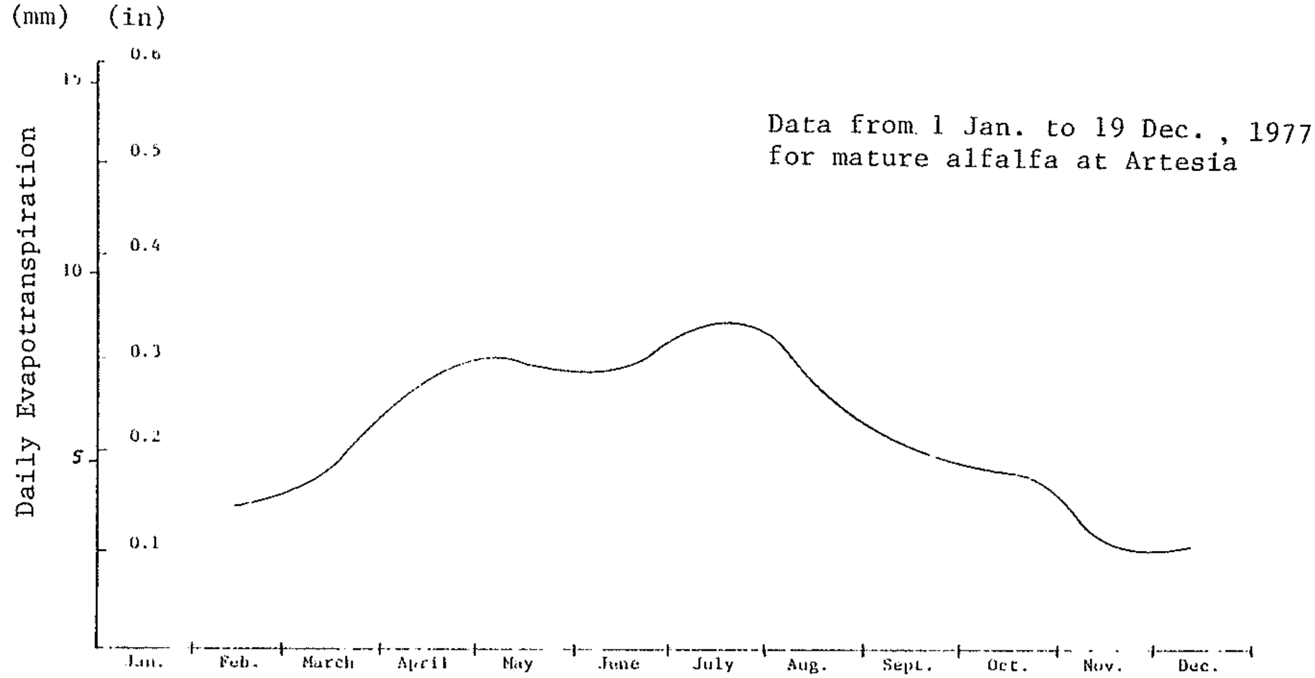


	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
Monthly ET (cm)	0.9	8.8	18.1	24.7	24.7	30.5	28.1	23.7	15.6	5.7	3.4	5.3	189.7
Monthly ET (in)	0.4	3.5	7.1	9.7	9.7	12.0	11.1	9.3	6.1	2.2	1.3	2.0	74.7

Monthly ET/PET Ratio

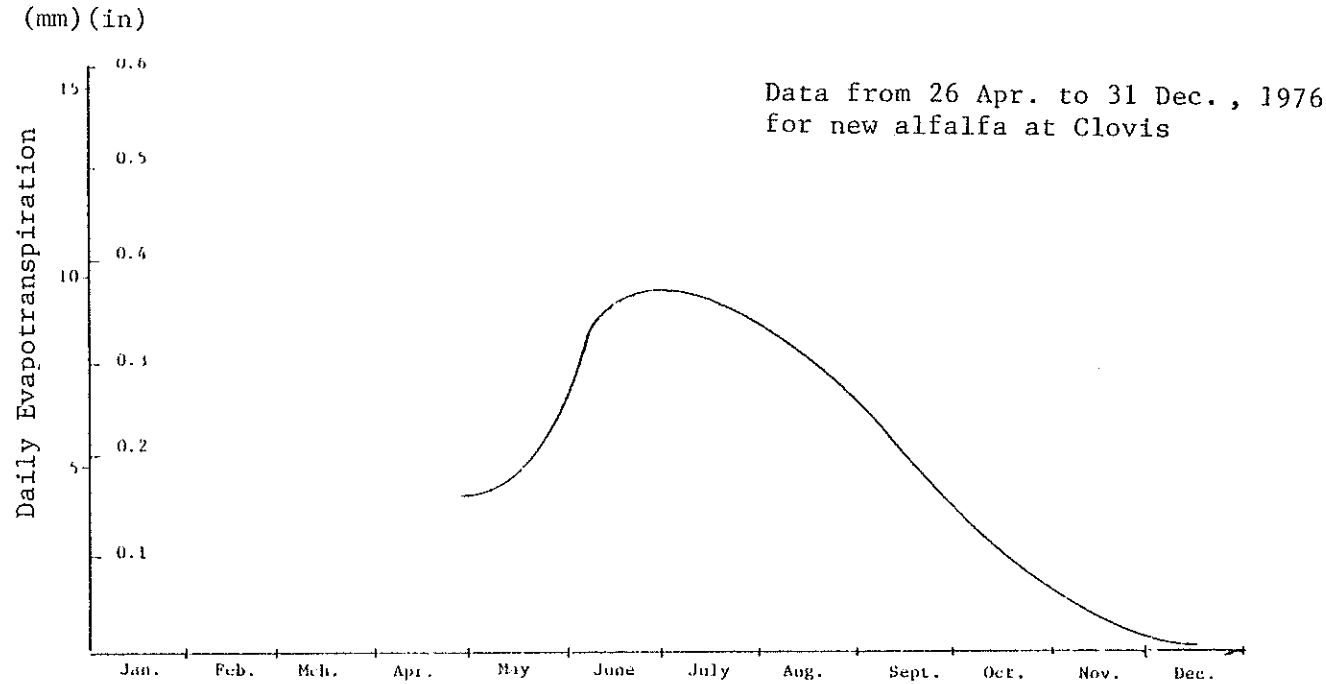
	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
PENMAN	0.56	1.32	0.91	1.25	1.02	1.14	1.30	1.03	1.02	0.44	0.42	0.55	1.00
JENSEN-HAISE	0.45	1.01	1.35	1.44	1.09	1.17	1.16	0.97	0.94	0.57	0.64	1.31	1.08
VAN BAVEL	0.56	1.32	0.84	1.26	1.03	1.13	1.33	1.07	1.08	0.46	0.44	0.59	1.01
PREISTLY-TAYLOR	0.40	0.94	1.20	1.41	1.10	1.32	1.31	1.10	1.05	0.57	0.58	1.17	1.13
NET RADIATION	0.29	0.76	1.00	1.29	1.07	1.40	1.39	1.17	1.06	0.49	0.42	0.79	1.06
MODIFIED PAN	0.37	0.68	0.96	1.36	1.19	1.11	1.37	1.07	1.08	0.51	0.69	1.04	1.06
PAN	0.29	0.54	0.77	1.08	0.95	0.89	1.09	0.86	0.87	0.41	0.55	0.83	0.85
BLANEY-CRIDDLE	(Frost-free period)												1.29

Figure 1D. Daily and monthly ET, monthly ET/PET ratios (smoothed using a polynomial technique), and seasonal Blaney-Criddle coefficients for new alfalfa at Artesia, New Mexico. 1976.



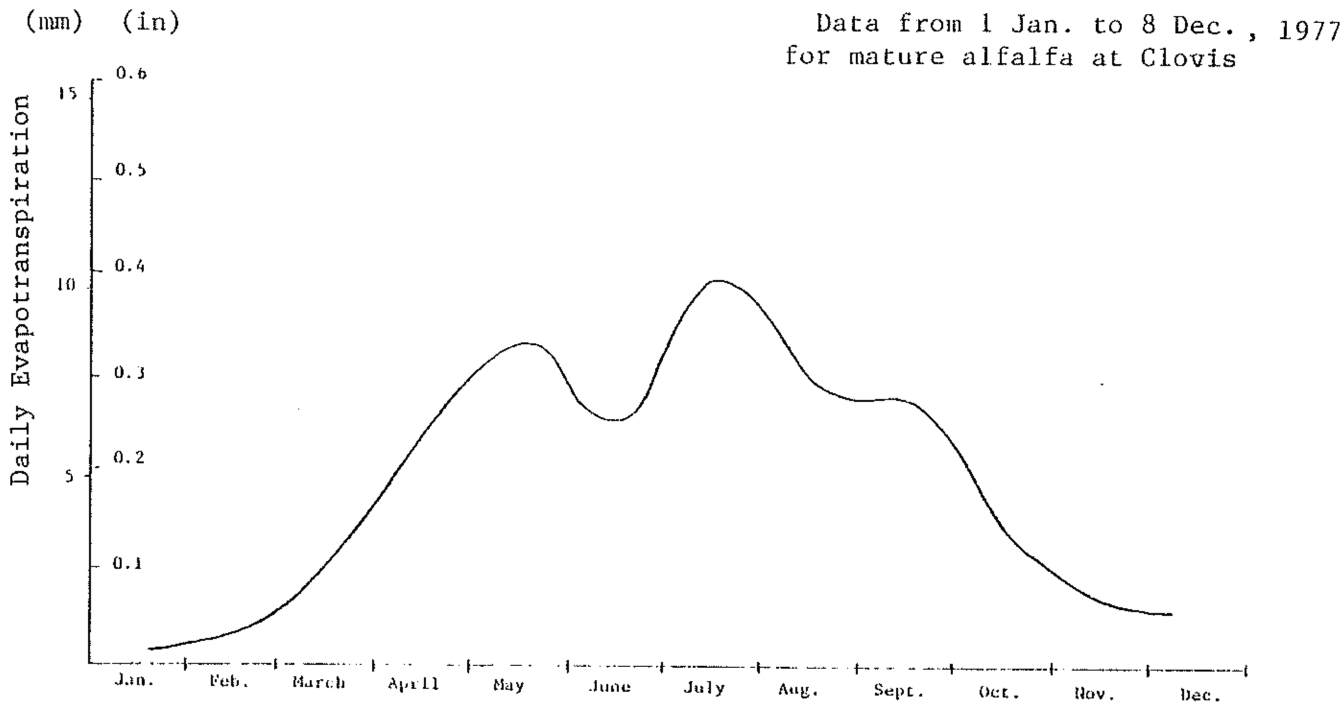
	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
Monthly ET (cm)	0.4	10.4	14.1	24.2	23.4	21.0	27.0	21.2	16.3	15.4	5.8	5.4	184.6
Monthly ET (in)	0.2	4.1	5.6	9.5	9.2	8.3	10.6	8.3	6.4	6.1	2.3	2.1	72.7
						Monthly ET/PET Ratio							
PENMAN	0.05	0.71	0.66	1.08	0.86	0.79	0.99	0.92	0.83	1.16	0.46	0.62	0.82
JENSEN-HAISE	0.10	1.54	1.35	1.48	1.01	0.78	0.90	0.85	0.87	1.39	0.76	1.46	1.00
VAN BAVEL	0.05	0.67	0.61	1.08	0.85	0.82	1.02	0.96	0.89	1.28	0.48	0.59	0.83
PREISTLY-TAYLOR	0.09	1.40	1.21	1.46	1.07	0.87	1.03	1.00	1.01	1.54	0.76	1.48	1.08
NET RADIATION	0.06	1.07	0.97	1.34	1.08	0.93	1.11	1.08	1.04	1.41	0.61	1.15	1.04
MODIFIED PAN	0.06	0.92	0.74	1.35	0.91	0.79	0.97	0.81	0.66	1.32	0.49	0.66	0.85
PAN	0.05	0.73	0.59	1.08	0.73	0.63	0.78	0.65	0.52	1.05	0.39	0.53	0.68
BLANEY-CRIDDLE	(Frost-free period)												1.26

Figure 2D. Daily and monthly ET, monthly ET/PET ratios (smoothed using a polynomial technique), and seasonal Blaney-Criddle coefficients for mature alfalfa at Artesia, New Mexico. 1977.



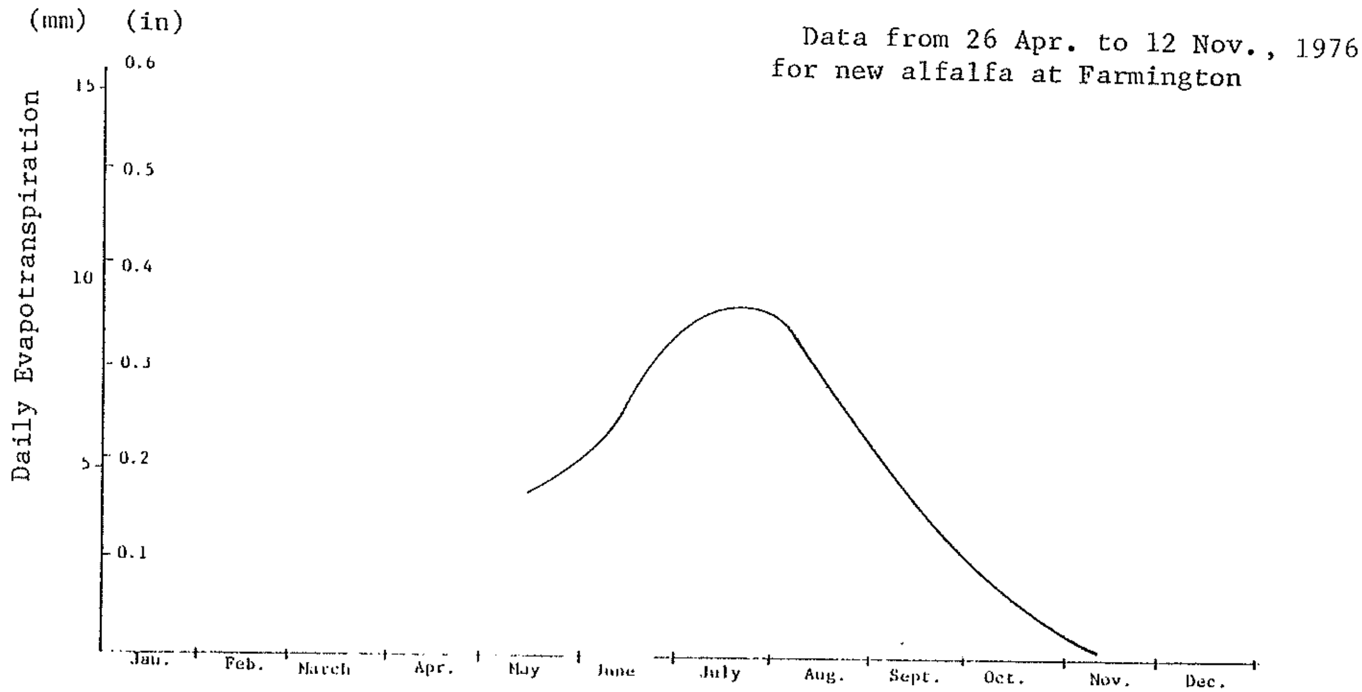
	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
Monthly ET (cm)				2.1	14.5	29.5	26.5	25.9	14.5	9.7	2.6	0.3	125.6
Monthly ET (in)				0.8	5.7	11.6	10.4	10.2	5.7	3.8	1.0	0.1	49.4
						Monthly ET/PET Ratio							
PENMAN				0.83	0.60	1.02	1.07	1.04	0.83	0.61	0.23	0.03	0.77
JENSEN-HAISE				1.02	0.71	1.15	1.08	1.12	0.91	0.95	0.46	0.07	0.95
VAN BAVEL				0.79	0.60	0.99	1.05	1.03	0.82	0.59	0.22	0.02	0.75
PREISTLY-TAYLOR				1.07	0.68	1.22	1.19	1.24	1.02	1.01	0.52	0.07	1.01
NET RADIATION				0.97	0.63	1.26	1.23	1.28	1.01	0.89	0.41	0.05	0.98
MODIFIED PAN				1.04	0.75	1.12	1.20	1.26	1.10	0.77	0.30	0.05	0.96
PAN				0.83	0.60	0.89	0.96	1.01	0.88	0.62	0.24	0.04	0.77
BLANEY-CRIDDLE (Frost-free period)													1.15

Figure 3D. Daily and monthly ET, monthly ET/PET ratios (smoothed using a polynomial technique), and seasonal Blaney-Criddle coefficients for new alfalfa at Clovis, New Mexico. 1976.



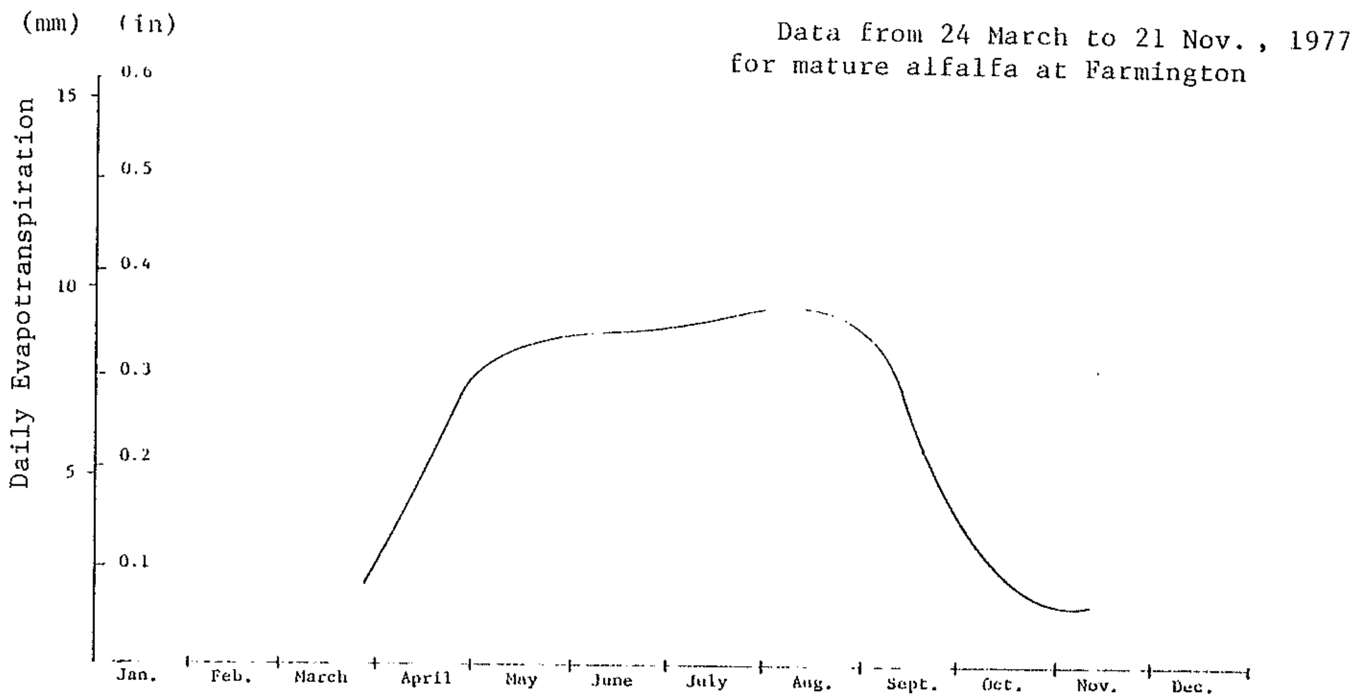
	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
Monthly ET (cm)	1.1	2.1	8.2	17.9	26.3	19.7	32.0	23.8	20.9	11.0	5.6	1.1	169.7
Monthly ET (in)	0.4	0.8	3.2	7.0	10.4	7.8	12.6	9.4	8.2	4.3	2.2	0.4	66.8
						Monthly ET/PET Ratio							
PENMAN	0.11	0.17	0.41	0.86	0.99	0.77	1.25	1.11	1.02	0.75	0.51	0.31	0.80
JENSEN-HAISE	0.30	0.39	0.91	1.21	1.18	0,79	1.22	1.11	1.16	1.11	1.00	0.73	1.04
VAN BAVEL	0.10	0.15	0.36	0.82	0.94	0.78	1.26	1.11	1.05	0.74	0.48	0.27	0.77
PREISTLY-TAYLOR	0.24	0.37	0.79	1.18	1.22	0.86	1.34	1.22	1.24	1.24	1.13	0.79	1.09
NET RADIATION	0.15	0.28	0.61	1.06	1.19	0.88	1.38	1.22	1.20	1.10	0.89	0.64	1.01
MODIFIED PAN	0.30	0.27	0.53	1.36	1.60	1.02	1.48	1.32	1.12	0.93	0.64	0.45	1.08
PAN	0.24	0.22	0.43	1.09	1.28	0.82	1.18	1.06	0.90	0.75	0.51	0.36	0.86
BLANEY-CRIDDLE	(Frost-free period)												1.31

Figure 4D. Daily and monthly ET, monthly ET/PET ratios (smoothed using a polynomial tecnnique), and seasonal Blaney-Criddle coefficients for mature alfalfa at Clovis, New Mexico. 1977.



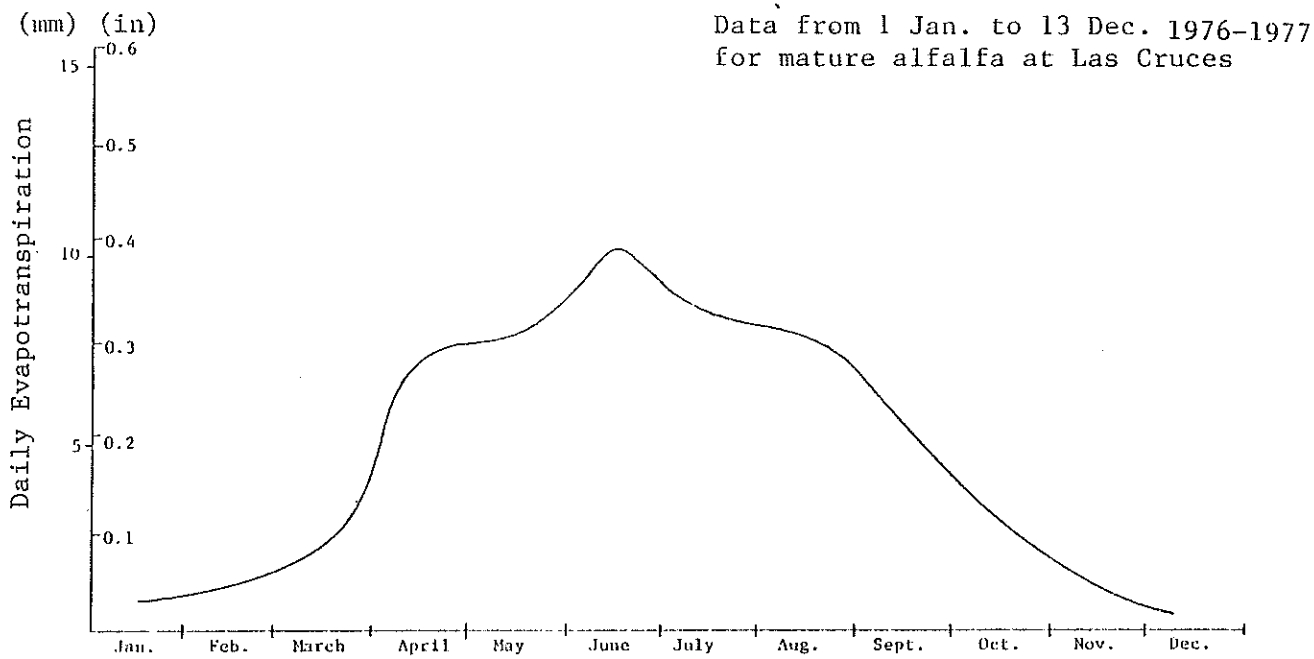
	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
Monthly ET (cm)					13.6	19.2	29.1	22.8	16.2	5.1	1.5		107.5
Monthly ET (in)					5.4	7.6	11.5	9.0	6.4	2.0	0.6		42.3
Monthly ET/PET Ratio													
PENMAN					0.51	0.62	1.01	0.87	0.89	0.32	0.29		0.69
JENSEN-HAISE					0.63	0.75	1.03	0.96	1.04	0.44	0.46		0.81
VAN BAVEL					0.52	0.62	1.04	0.89	0.92	0.34	0.30		0.70
PREISTLY-TAYLOR					0.61	0.78	1.16	1.06	1.15	0.41	0.43		0.84
NET RADIATION					0.56	0.78	1.24	1.10	1.13	0.34	0.34		0.82
MODIFIED PAN					0.60	0.62	1.07	0.94	1.13	0.50			0.81
PAN					0.48	0.50	0.86	0.75	0.90	0.40			0.65
BLANEY-CRIDDLE (Frost-free period)													1.23

Figure 5D. Daily and monthly ET, monthly ET/PET ratios (smoothed using a polynomial technique), and seasonal Blaney-Criddle coefficients for new alfalfa at Farmington, New Mexico. 1976.



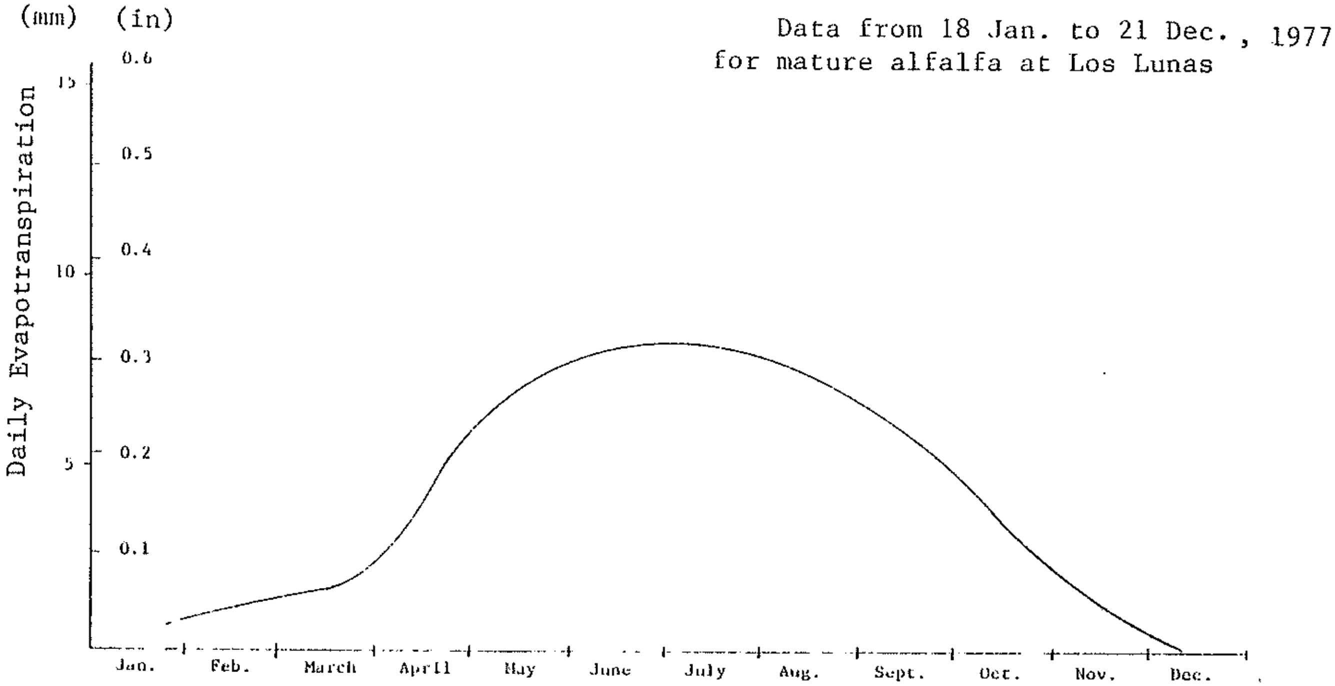
	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
Monthly ET (cm)			1.6	16.4	26.7	26.2	27.0	29.5	18.7	7.2	3.4		149.3
Monthly ET (in)			0.6	6.5	10.5	10.3	10.6	11.6	7.4	2.8	1.3		58.8
Monthly ET/PET Ratio													
PENMAN			0.42	0.69	1.18	0.94	1.10	1.27	1.07	0.49	0.51		0.97
JENSEN-HAISE			0.83	0.92	1.46	1.07	1.07	1.28	1.23	0.67	0.83		1.12
VAN BAVEL			0.40	0.68	1.19	0.95	1.13	1.33	1.11	0.54	0.52		1.00
PREISTLY-TAYLOR			0.62	0.82	1.42	1.15	1.20	1.44	1.36	0.64	0.78		1.17
NET RADIATION			0.42	0.72	1.33	1.17	1.28	1.51	1.33	0.55	0.61		1.13
MODIFIED PAN			0.49	0.86	1.18	0.88	1.08	1.25	1.24	0.70			1.07
PAN			0.39	0.69	0.94	0.71	0.87	1.00	1.00	0.56			0.86
BLANEY-CRIDDLE (Frost-free period)													1.50

Figure 6D. Daily and monthly ET, monthly ET/PET ratios (smoothed using a polynomial technique), and seasonal Blaney-Criddle coefficients for mature alfalfa at Farmington, New Mexico. 1977.



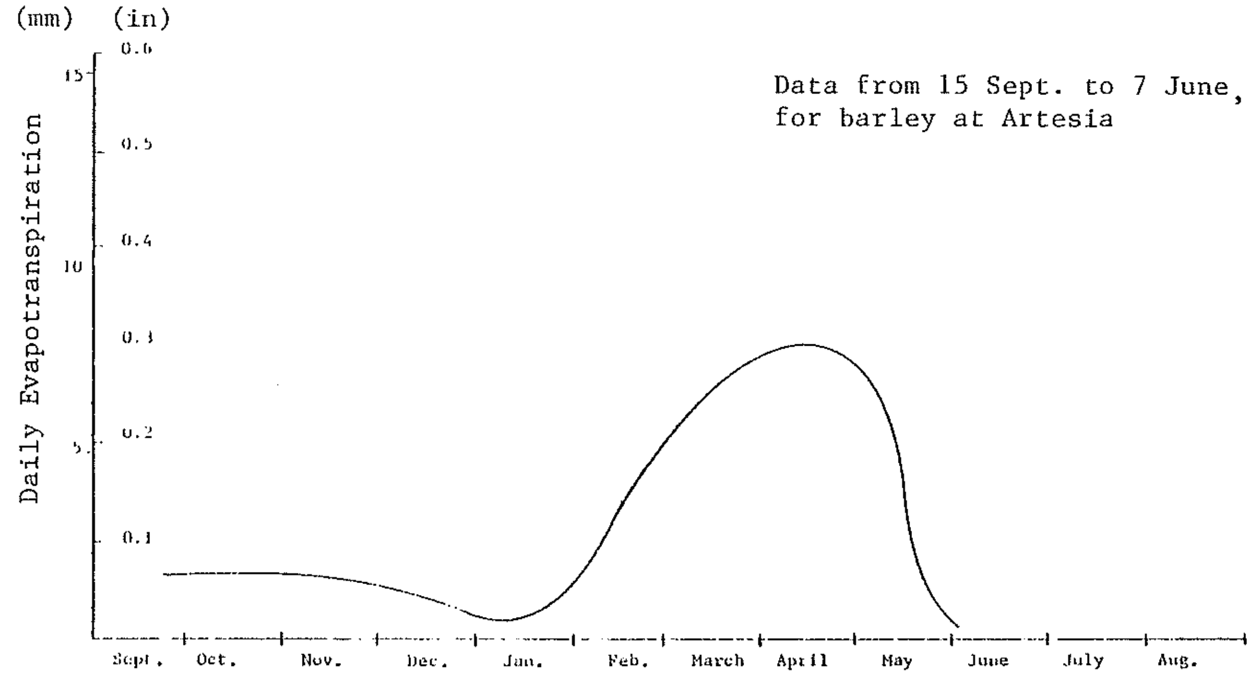
	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
Monthly ET (cm)	2.3	4.8	6.2	21.6	22.8	31.7	26.2	24.7	16.8	9.0	4.2	0.6	169.5
Monthly ET (in)	0.9	1.9	2.4	8.5	9.0	12.5	10.3	9.7	6.6	3.5	1.7	0.2	66.7
Monthly ET/PET Ratio													
PENMAN	0.32	0.59	0.42	1.06	0.97	1.22	1.15	1.11	1.00	0.83	0.41	0.14	0.92
JENSEN-HAISE	0.49	0.85	0.60	1.27	1.02	1.14	0.98	0.96	0.90	0.88	0.56	0.23	0.96
VAN BAVEL	0.36	0.63	0.43	1.10	1.02	1.30	1.24	1.21	1.09	0.94	0.47	0.15	0.99
PREISTLY-TAYLOR	0.44	0.79	0.56	1.24	1.03	1.25	1.14	1.12	1.01	0.92	0.57	0.24	1.02
NET RADIATION	0.31	0.62	0.45	1.14	1.00	1.31	1.22	1.20	1.03	0.83	0.46	0.19	0.97
MODIFIED PAN	0.44	0.64	0.42	1.12	1.01	1.24	1.03	1.12	1.08	1.01	0.46	0.13	0.95
PAN	0.35	0.51	0.33	0.90	0.81	0.99	0.82	0.89	0.86	0.80	0.37	0.10	0.76
BLANEY-CRIDDLE	(Frost-free period)												1.34

Figure 7D. Daily and monthly ET, monthly ET/PET ratios (smoothed using a polynomial technique), and seasonal Blaney-Criddle coefficients for mature alfalfa at Las Cruces, New Mexico. 1976-1977 average.



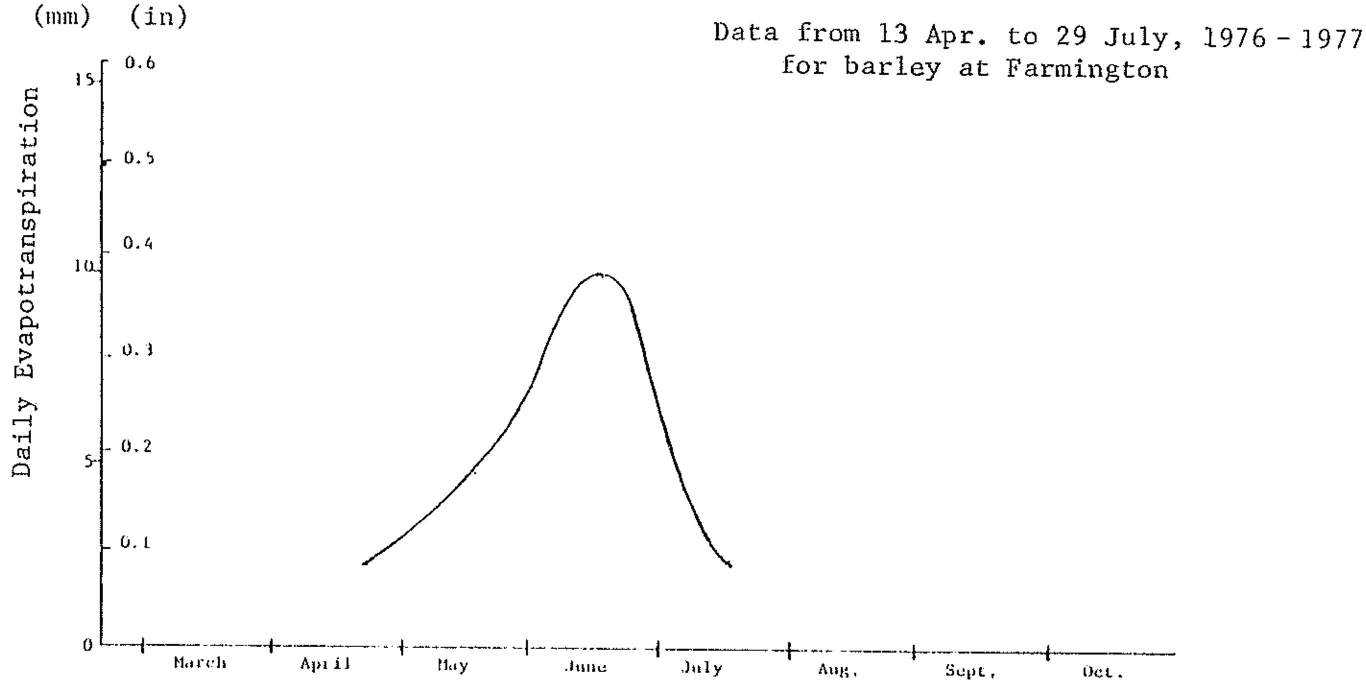
	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
Monthly ET (cm)	0.7	3.1	5.1	16.3	22.0	23.2	29.2	20.3	18.2	9.9	3.4	0.5	151.8
Monthly ET (in)	0.3	1.2	2.0	6.4	8.7	9.1	11.5	8.0	7.2	3.9	1.3	0.2	59.8
						Monthly ET/PET Ratio							
PENMAN	0.27	0.34	0.36	0.90	0.92	0.96	1.17	0.92	1.13	0.74	0.39	0.09	0.84
JENSEN-HAISE	0.37	0.48	0.50	0.93	0.94	0.86	0.97	0.77	0.99	0.79	0.53	0.14	0.83
VAN BAVEL	0.36	0.43	0.42	1.04	1.05	1.11	1.35	1.10	1.36	0.96	0.54	0.13	1.00
PREISTLY-TAYLOR	0.30	0.38	0.39	0.85	0.89	0.90	1.06	0.86	1.07	0.77	0.48	0.13	0.82
NET RADIATION	0.19	0.27	0.29	0.75	0.83	0.92	1.11	0.90	1.05	0.67	0.36	0.09	0.75
MODIFIED PAN	0.36	0.50	0.42	1.18	1.08	1.12	1.49	1.18	1.43	1.02	0.55	0.12	1.05
PAN	0.29	0.40	0.33	0.95	0.86	0.89	1.19	0.94	1.15	0.82	0.44	0.10	0.84
BLANEY-CRIDDLE	(Frost-free period)												1.30

Figure 8D. Daily and monthly ET, monthly ET/PET ratios (smoothed using a polynomial technique), and seasonal Blaney-Criddle coefficients for mature alfalfa at Los Lunas, New Mexico. 1977.



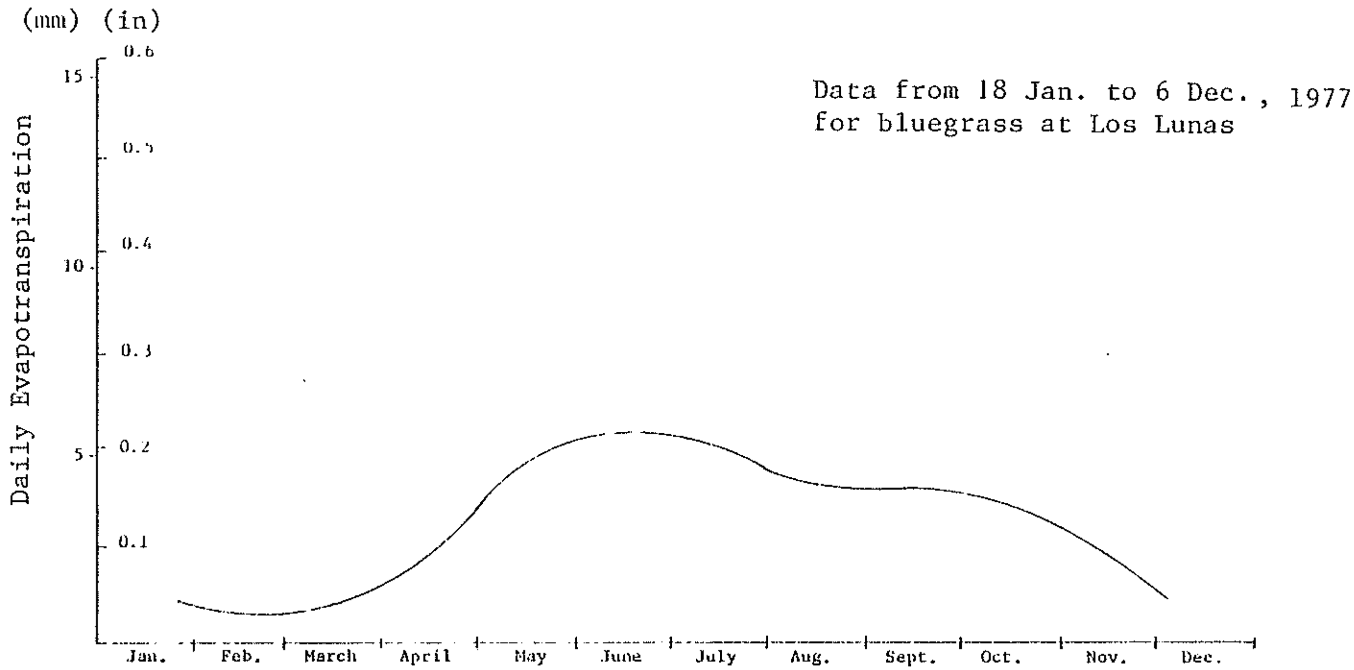
	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
Monthly ET (cm)	1.9	9.6	16.5	23.7	15.2	0.8			2.4	5.7	3.9	6.0	85.1
Monthly ET (in)	0.7	3.8	6.5	9.3	6.0	0.3			0.9	2.2	1.5	2.4	33.5
Monthly ET/PET Ratio													
PENMAN	0.45	0.83	1.04	0.97	0.64	0.23			0.32	0.40	0.51	0.62	0.70
JENSEN-HAISE	0.62	1.20	1.50	1.36	0.82	0.15			0.33	0.45	0.83	1.45	0.97
VAN BAVEL	0.45	0.81	1.01	0.95	0.63	0.24			0.34	0.42	0.54	0.66	0.71
PREISTLY-TAYLOR	0.54	1.09	1.40	1.29	0.81	0.20			0.37	0.45	0.76	1.30	0.95
NET RADIATION	0.34	0.88	1.19	1.15	0.76	0.24			0.35	0.39	0.57	0.86	0.81
MODIFIED PAN	0.33	0.82	1.11	1.07	0.73	0.27			0.30	0.49	0.81	1.17	0.82
PAN	0.26	0.65	0.88	0.86	0.58	0.22			0.24	0.39	0.64	0.94	0.65
BLANEY-CRIDDLE													0.87

Figure 9D. Daily and monthly ET, monthly ET/PET ratios (smoothed using a polynomial technique), and seasonal Blaney-Criddle coefficients for barley at Artesia, New Mexico. 1977.



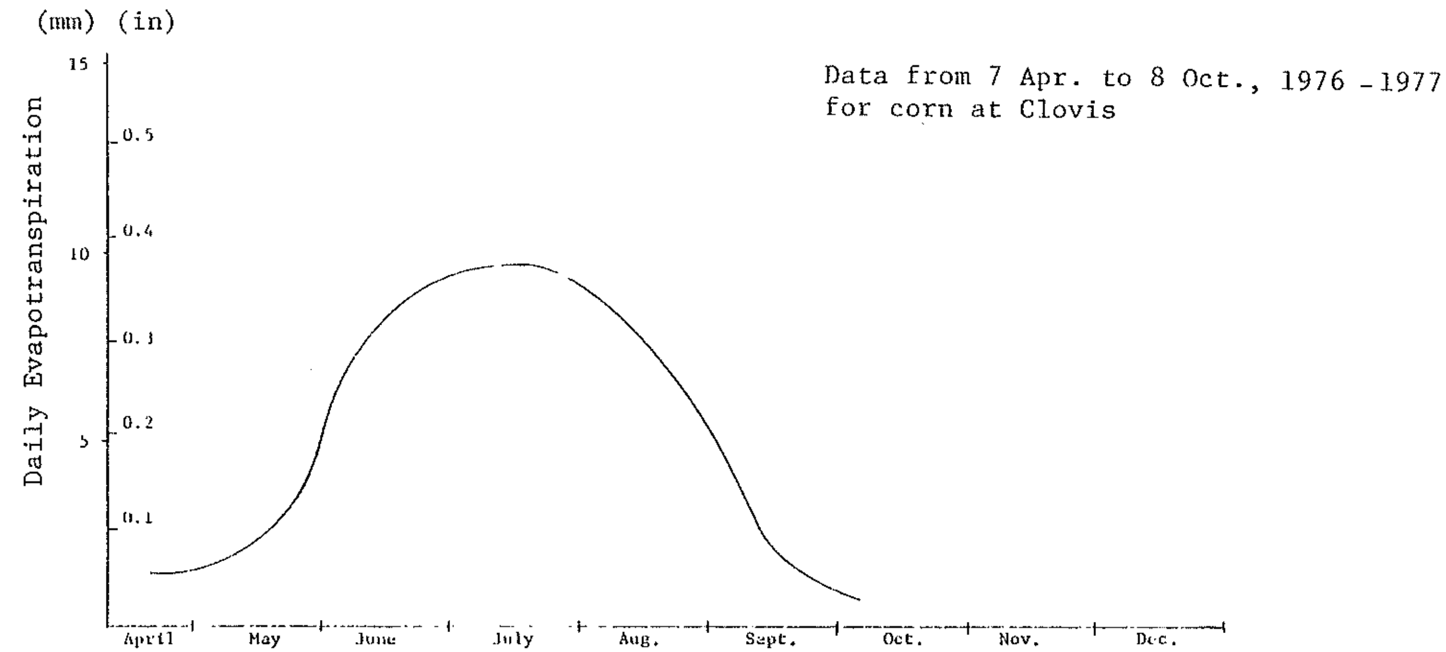
	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
Monthly ET (cm)				4.4	16.4	28.4	7.2	2.0					56.1
Monthly ET (in)				1.7	6.5	11.2	2.8	0.8					22.1
						Monthly ET/PET Ratio							
PENMAN				0.31	0.66	0.83	0.58	0.17					0.58
JENSEN-HAISE				0.41	0.78	0.94	0.63	0.14					0.64
VAN BAVEL				0.31	0.66	0.83	0.60	0.20					0.59
PREISTLY-TAYLOR				0.37	0.79	0.99	0.68	0.17					0.68
NET RADIATION				0.31	0.77	1.00	0.70	0.20					0.68
MODIFIED PAN				0.39	0.66	0.78	0.54	0.16					0.58
PAN				0.31	0.53	0.62	0.43	0.13					0.46
BLANEY-CRIDDLE													0.96

Figure 10D. Daily and monthly ET, monthly ET/PET ratios (smoothed using a polynomial technique), and seasonal Blaney-Criddle coefficients for barley at Farmington, New Mexico. 1976-1977 average.



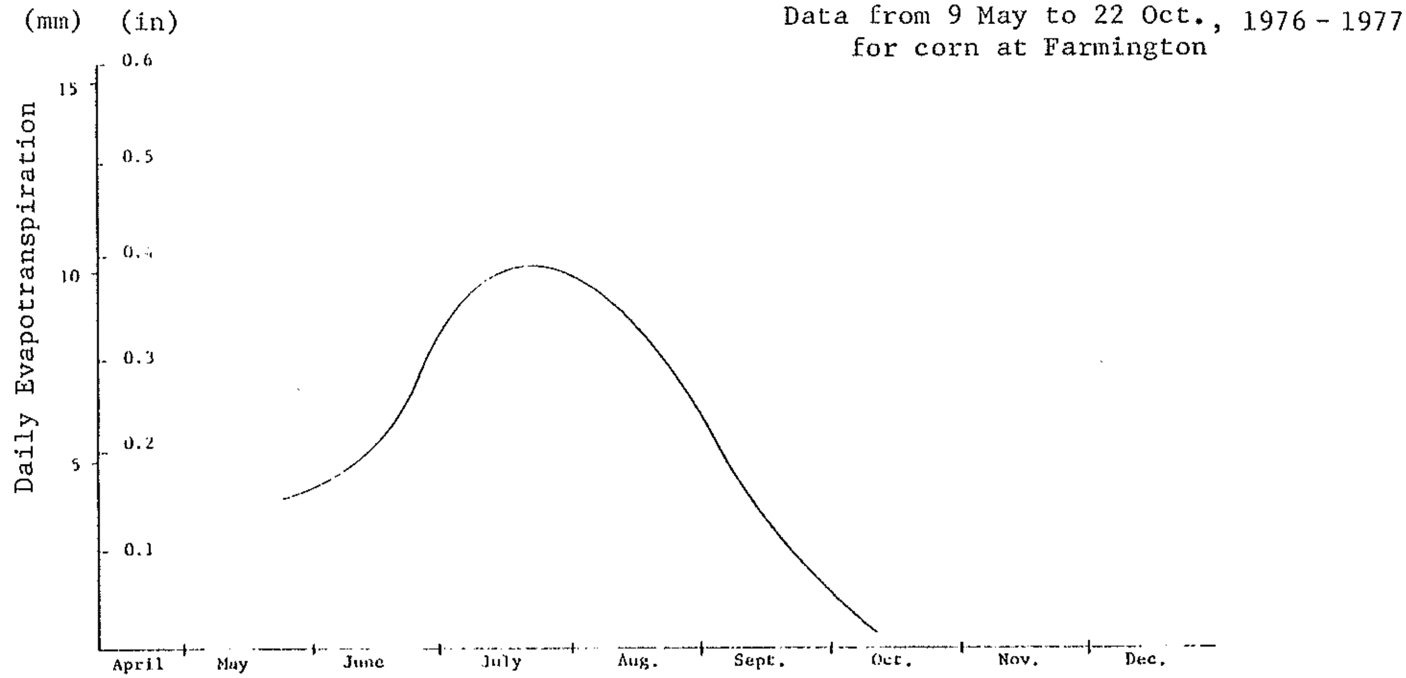
	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
Monthly ET (cm)	1.6	1.9	3.3	6.7	15.3	16.5	16.0	13.0	12.1	9.1	6.0	0.6	102.0
Monthly ET (in)	0.6	0.7	1.3	2.6	6.0	6.5	6.3	5.1	4.8	3.6	2.4	0.2	40.2
Monthly ET/PET Ratio													
PENMAN	0.60	0.21	0.23	0.37	0.64	0.68	0.64	0.61	0.75	0.69	0.68	0.36	0.57
JENSEN-HAISE	0.82	0.30	0.32	0.38	0.65	0.61	0.53	0.49	0.67	0.73	0.92	0.53	0.56
VAN BAVEL	0.80	0.27	0.27	0.42	0.73	0.79	0.74	0.70	0.91	0.88	0.94	0.48	0.68
PREISTLY-TAYLOR	0.66	0.24	0.25	0.35	0.62	0.64	0.58	0.55	0.71	0.71	0.84	0.51	0.56
NET RADIATION	0.42	0.17	0.18	0.31	0.58	0.65	0.61	0.58	0.70	0.62	0.63	0.38	0.51
MODIFIED PAN	0.80	0.31	0.27	0.48	0.75	0.80	0.81	0.75	0.96	0.94	0.95	0.36	0.72
PAN	0.64	0.25	0.21	0.39	0.60	0.64	0.65	0.60	0.77	0.76	0.76	0.29	0.57
BLANEY-CRIDDLE	(Frost-free period)												0.85

Figure 11D. Daily and monthly ET, monthly ET/PET ratios (smoothed using a polynomial technique), and seasonal Blaney-Criddle coefficients for bluegrass at Los Lunas, New Mexico. 1977.



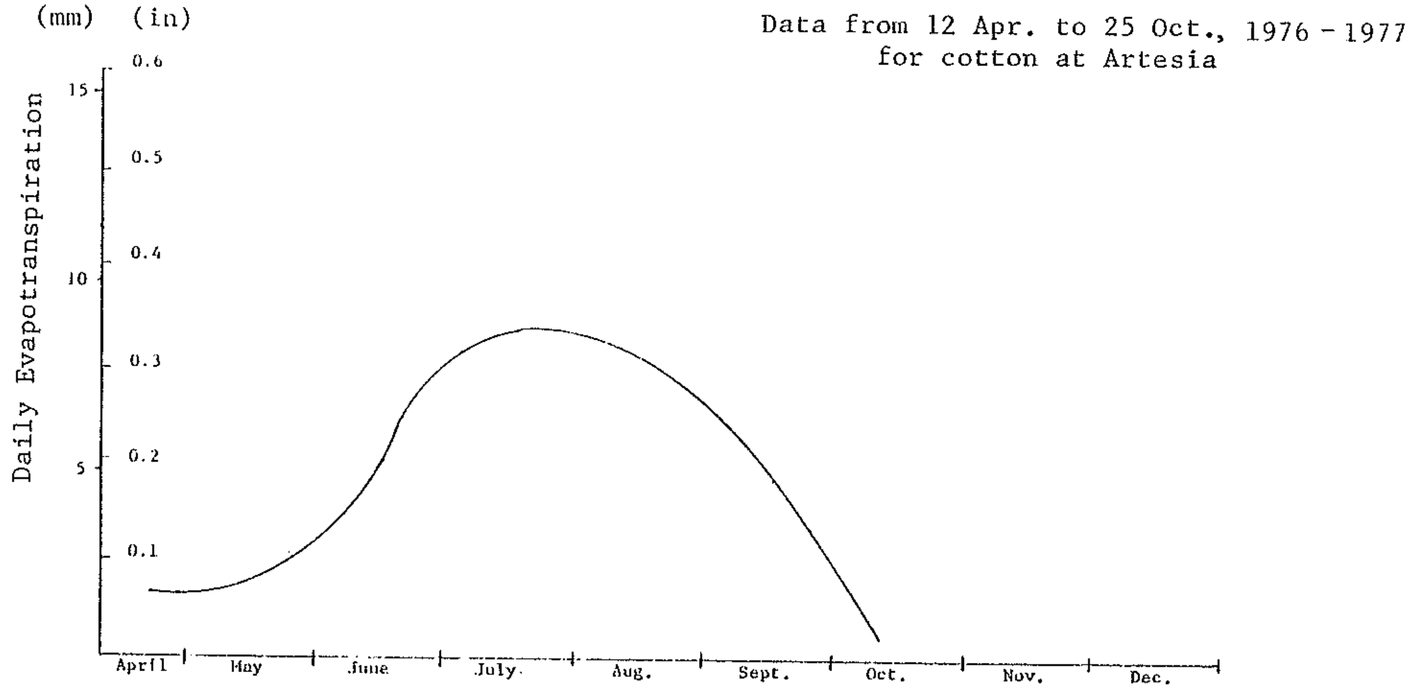
	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
MONTHLY ET (cm)				3.7	7.7	24.4	29.8	23.8	6.4	0.6			96.0
MONTHLY ET (in)				1.5	3.0	9.6	11.7	9.4	2.5	0.2			37.8
						Monthly ET/PET Ratio							
PENMAN				0.04	0.59	0.95	1.05	0.91	0.54	0.12			0.75
JENSEN-HAISE				0.13	0.65	0.99	1.07	0.94	0.59	0.18			0.82
VAN BAVEL				0.03	0.58	0.95	1.04	0.91	0.54	0.12			0.74
PREISTLY-TAYLOR				0.10	0.69	1.08	1.17	1.04	0.64	0.20			0.87
NET RADIATION				0.07	0.69	1.10	1.21	1.06	0.64	0.17			0.86
MODIFIED PAN				0.17	0.77	1.15	1.23	1.08	0.66	0.20			0.93
PAN				0.13	0.61	0.92	0.99	0.86	0.53	0.15			0.75
BLANEY-CRIDDLE													0.95

Figure 12D. Daily and monthly ET, monthly ET/PET ratios (smoothed using a polynomial technique), and seasonal Blaney-Criddle coefficients for corn at Clovis, New Mexico. 1976-1977 average.



	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
Monthly ET (cm)					6.5	14.8	31.2	25.9	9.9	1.1			88.7
Monthly ET (in)					2.6	5.8	12.3	10.2	3.9	0.4			34.9
					Monthly ET/PET Ratio								
PENMAN					0.29	0.78	1.05	0.99	0.59	0.07			0.72
JENSEN-HAISE					0.39	0.83	1.07	1.00	0.62	0.13			0.78
VAN BAVEL					0.29	0.80	1.09	1.03	0.61	0.07			0.74
PREISTLY-TAYLOR					0.38	0.90	1.19	1.13	0.69	0.13			0.85
NET RADIATION					0.35	0.93	1.25	1.19	0.71	0.10			0.86
MODIFIED PAN					0.25	0.75	1.04	1.01	0.63	0.13			0.73
PAN					0.20	0.60	0.83	0.80	0.50	0.10			0.58
BLANEY-CRIDDLE													1.04

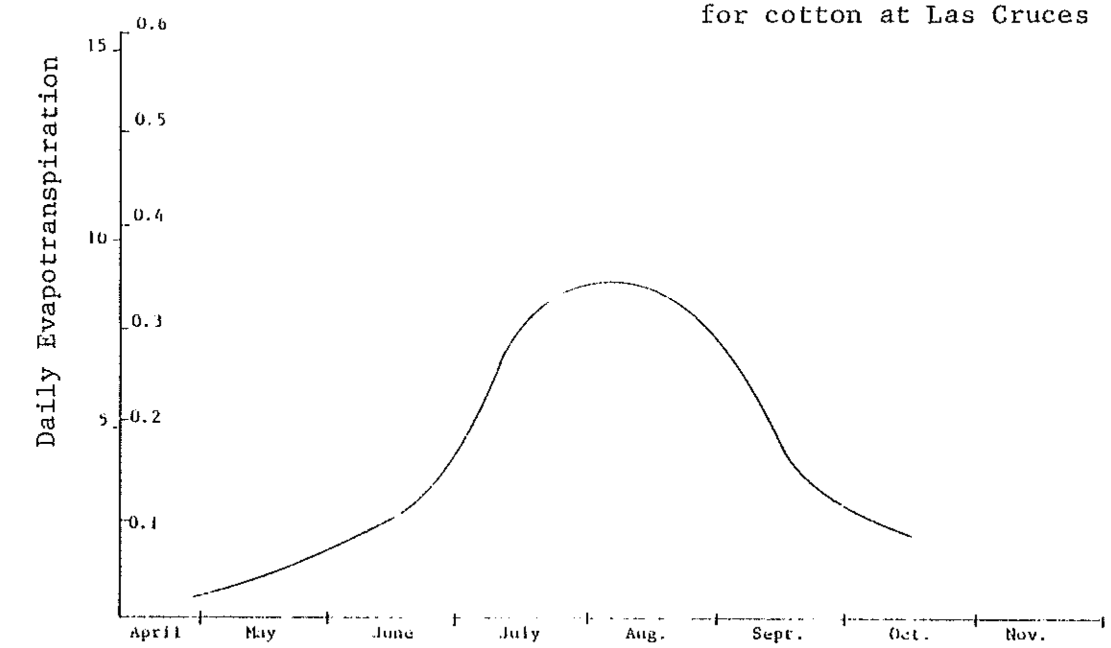
Figure 13D. Daily and monthly ET, monthly ET/PET ratios (smoothed using a polynomial technique), and seasonal Blaney-Criddle coefficients for corn at Farmington, New Mexico. 1976-1977 average.



	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
Monthly ET (cm)				3.4	6.5	15.7	27.3	20.6	14.7	4.2			90.7
Monthly ET (in)				1.3	2.6	6.2	10.7	8.1	5.8	1.7			35.7
Monthly ET/PET Ratio													
PENMAN				0.14	0.39	0.74	0.91	0.92	0.77	0.54			0.67
JENSEN-HAISE				0.20	0.40	0.68	0.83	0.87	0.78	0.64			0.68
VAN BAVEL				0.15	0.41	0.76	0.94	0.96	0.82	0.59			0.70
PREISTLY-TAYLOR				0.17	0.43	0.78	0.96	1.00	0.88	0.69			0.75
NET RADIATION				0.14	0.44	0.83	1.04	1.06	0.89	0.63			0.78
MODIFIED PAN				0.16	0.40	0.72	0.88	0.90	0.76	0.54			0.67
PAN				0.13	0.32	0.58	0.71	0.72	0.61	0.43			0.53
BLANEY-CRIDDLE													0.83

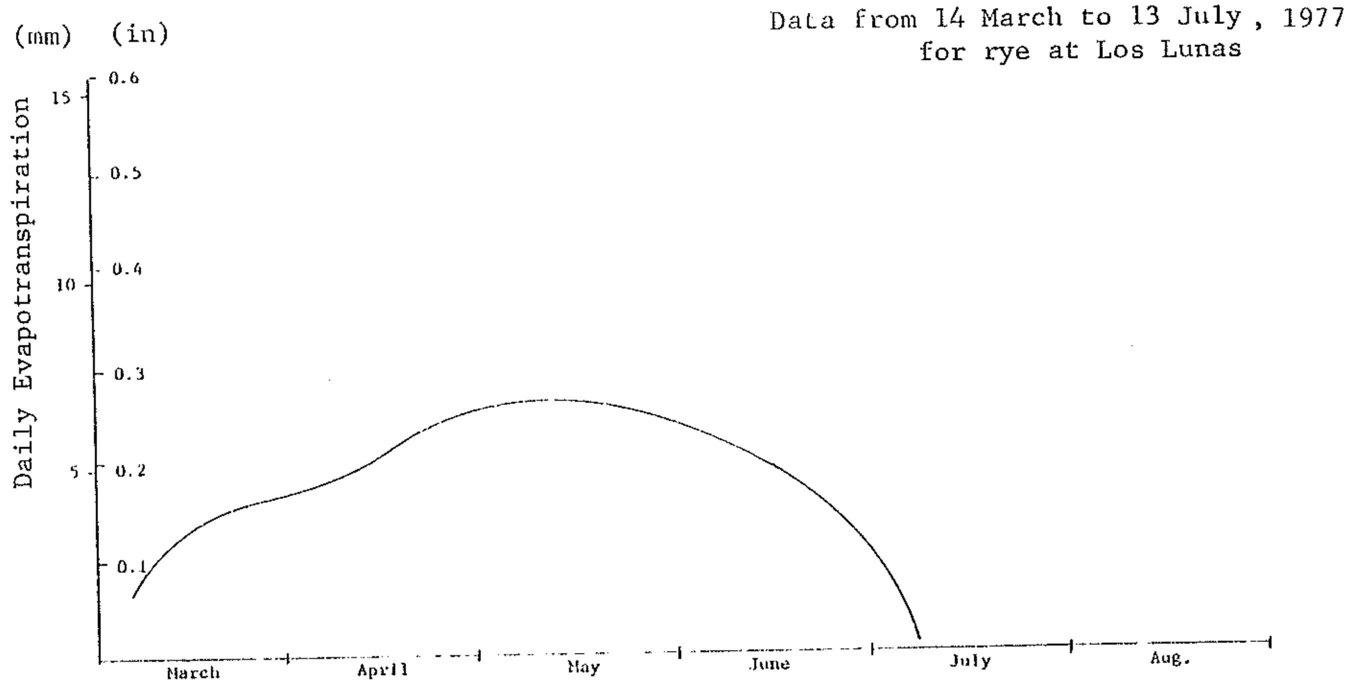
Figure 14D. Daily and monthly ET, monthly ET/PET ratios (smoothed using a polynomial technique), and seasonal Blaney-Criddle coefficients for cotton at Artesia, New Mexico. 1976-1977 average.

Data from 23 Apr. to 30 Oct., 1976 - 1977
for cotton at Las Cruces



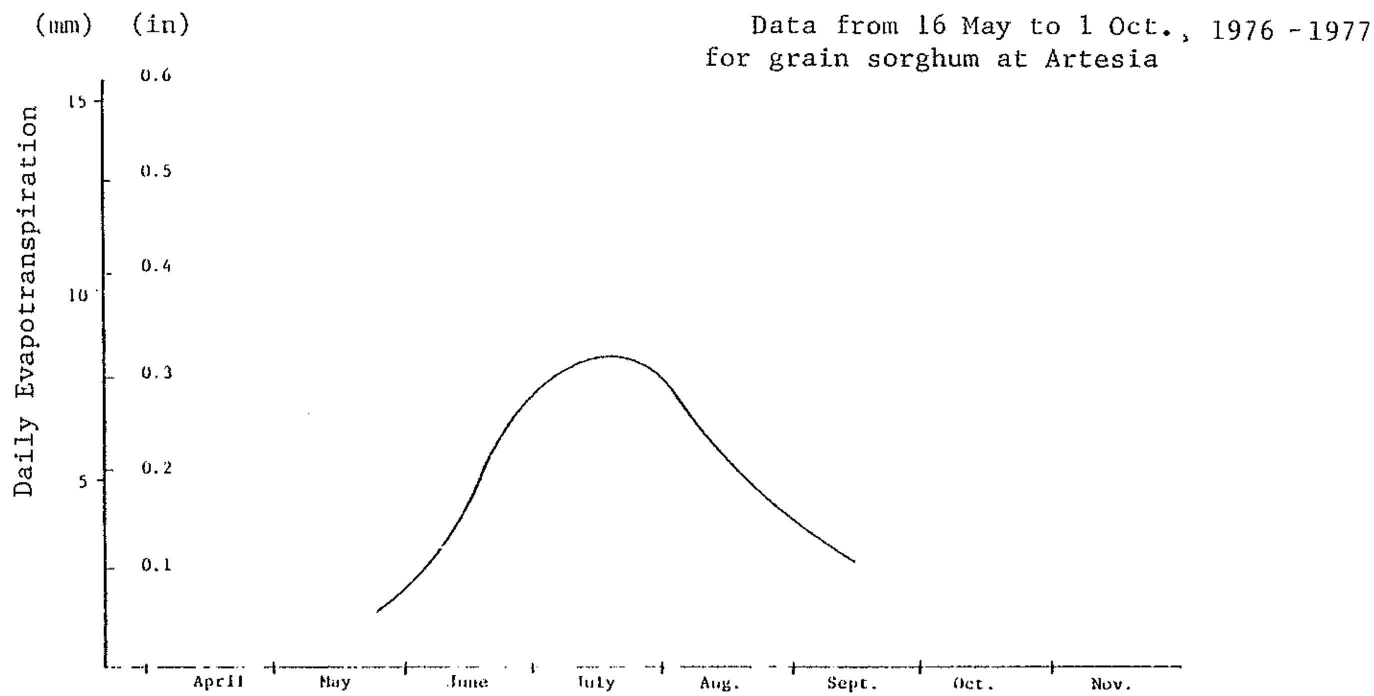
	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
Monthly ET (cm)				0.5	3.4	7.6	25.0	27.0	13.6	6.4			83.1
Monthly ET (in)				0.2	1.3	3.0	9.8	10.6	5.4	2.5			32.7
Monthly ET/PET Ratio													
PENMAN					0.26	0.69	0.95	1.02	0.90	0.62			0.68
JENSEN-HAISE					0.24	0.59	0.81	0.89	0.82	0.63			0.63
VAN BAVEL					0.28	0.74	1.02	1.11	0.99	0.69			0.73
PREISTLY-TAYLOR					0.27	0.69	0.94	1.02	0.92	0.66			0.69
NET RADIATION					0.28	0.74	1.01	1.08	0.94	0.61			0.71
MODIFIED PAN					0.25	0.65	0.90	1.01	0.96	0.77			0.69
PAN					0.20	0.52	0.72	0.81	0.77	0.61			0.55
BLANEY-CRIDDLE													0.80

Figure 15D. Daily and monthly ET, monthly ET/PET ratios (smoothed using a polynomial technique), and seasonal Blaney-Criddle coefficients for cotton at Las Cruces, New Mexico. 1976-1977 average.



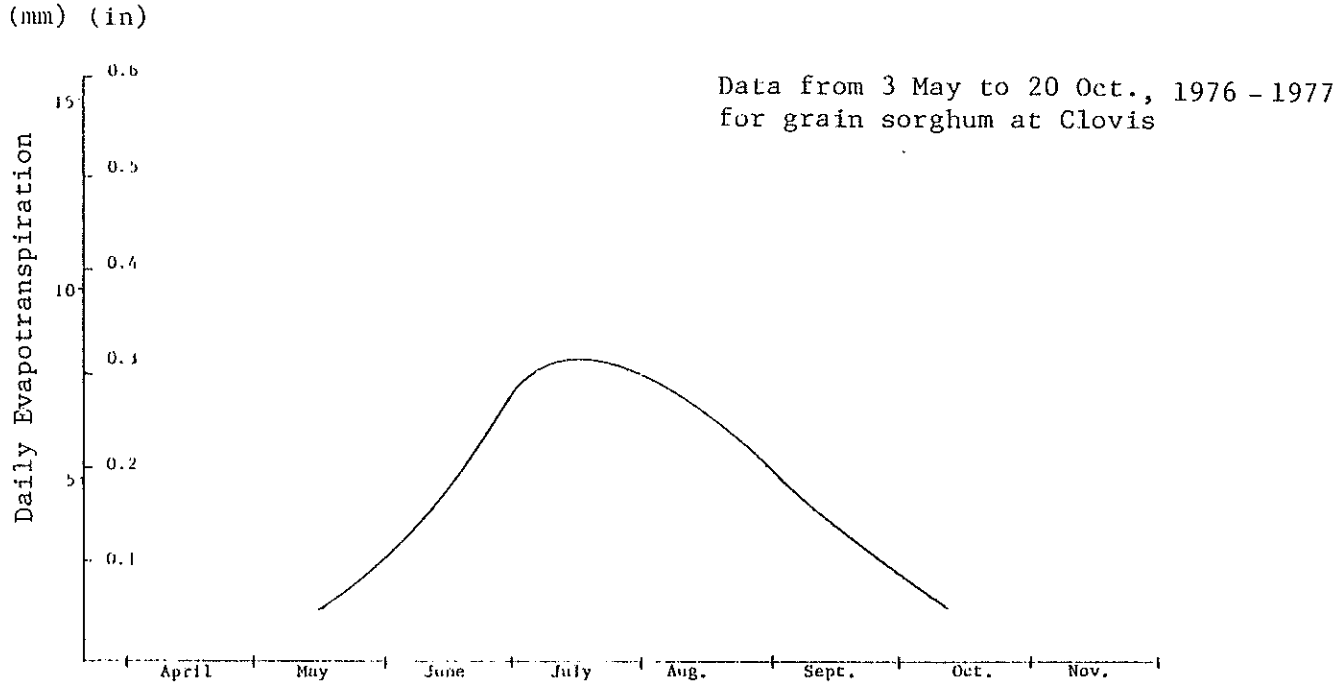
	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
Monthly ET (cm)			7.4	16.3	21.0	15.0	0.3						60.0
Monthly ET (in)			3.0	6.4	8.3	5.9	0.1						23.6
					Monthly ET/PET Ratio								
PENMAN			0.82	0.96	0.89	0.52	0.07						0.71
JENSEN-HAISE			1.12	1.07	0.86	0.47	0.08						0.69
VAN BAVEL			0.94	1.10	1.03	0.61	0.09						0.81
PREISTLY-TAYLOR			0.88	0.95	0.84	0.48	0.08						0.67
NET RADIATION			0.65	0.83	0.81	0.49	0.08						0.63
MODIFIED PAN			0.98	1.17	1.09	0.63	0.07						0.86
PAN			0.78	0.93	0.87	0.51	0.06						0.69
BLANEY-CRIDDLE													1.01

Figure 16D. Daily and monthly ET, monthly ET/PET ratios (smoothed using a polynomial technique), and seasonal Blaney-Criddle coefficients for rye at Los Lunas, New Mexico. 1977.



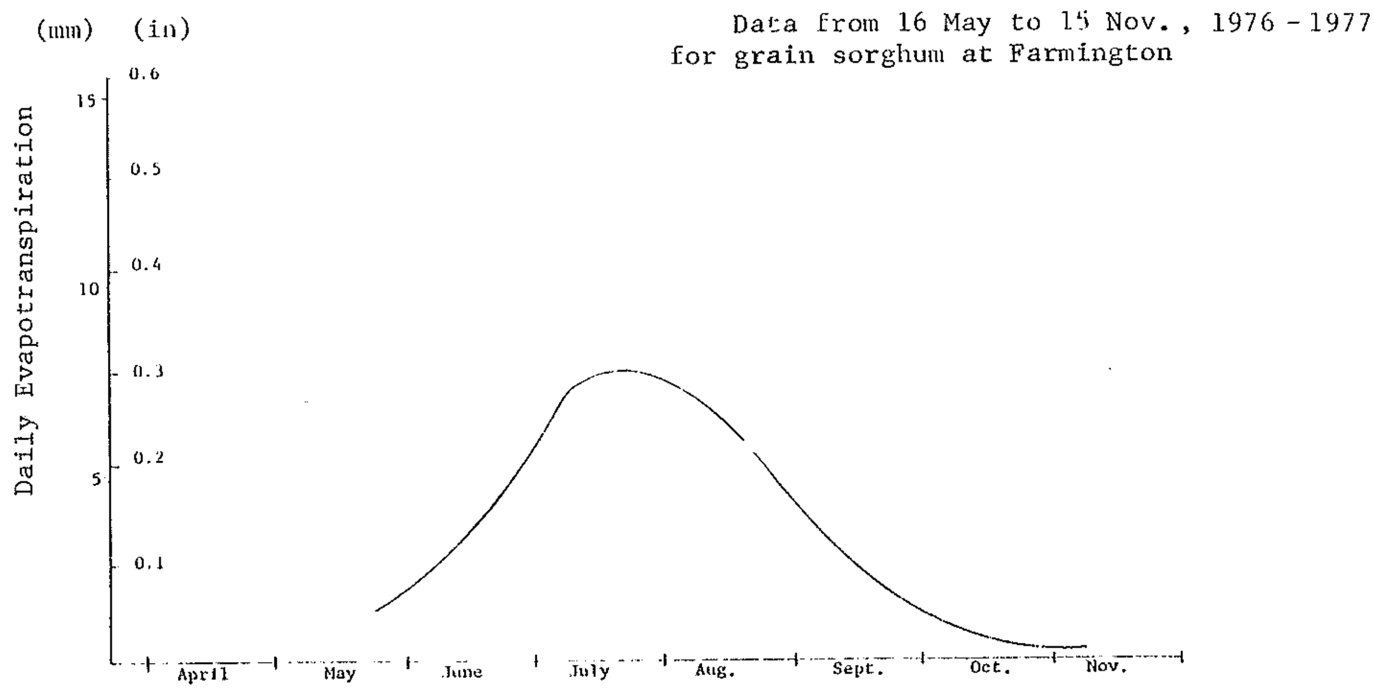
	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
Monthly ET (cm)					1.9	14.7	27.2	18.1	14.1				76.0
Monthly ET (in)					0.7	5.8	10.7	7.1	5.6				30.0
						Monthly ET/PET Ratio							
PENMAN					0.16	0.57	0.91	0.99	0.82				0.73
JENSEN-HAISE					0.19	0.53	0.83	0.93	0.82				0.70
VAN BAVEL					0.16	0.58	0.93	1.03	0.88				0.75
PREISTLY-TAYLOR					0.20	0.60	0.95	1.06	0.93				0.80
NET RADIATION					0.20	0.65	1.03	1.13	0.95				0.84
MODIFIED PAN					0.17	0.58	0.91	0.96	0.72				0.71
PAN					0.13	0.47	0.73	0.77	0.57				0.57
BLANEY-CRIDDLE													0.76

Figure 17D. Daily and monthly ET, monthly ET/PET ratios (smoothed using a polynomial technique), and seasonal Blaney-Criddle coefficients for sorghum at Artesia, New Mexico. 1976-1977 average.



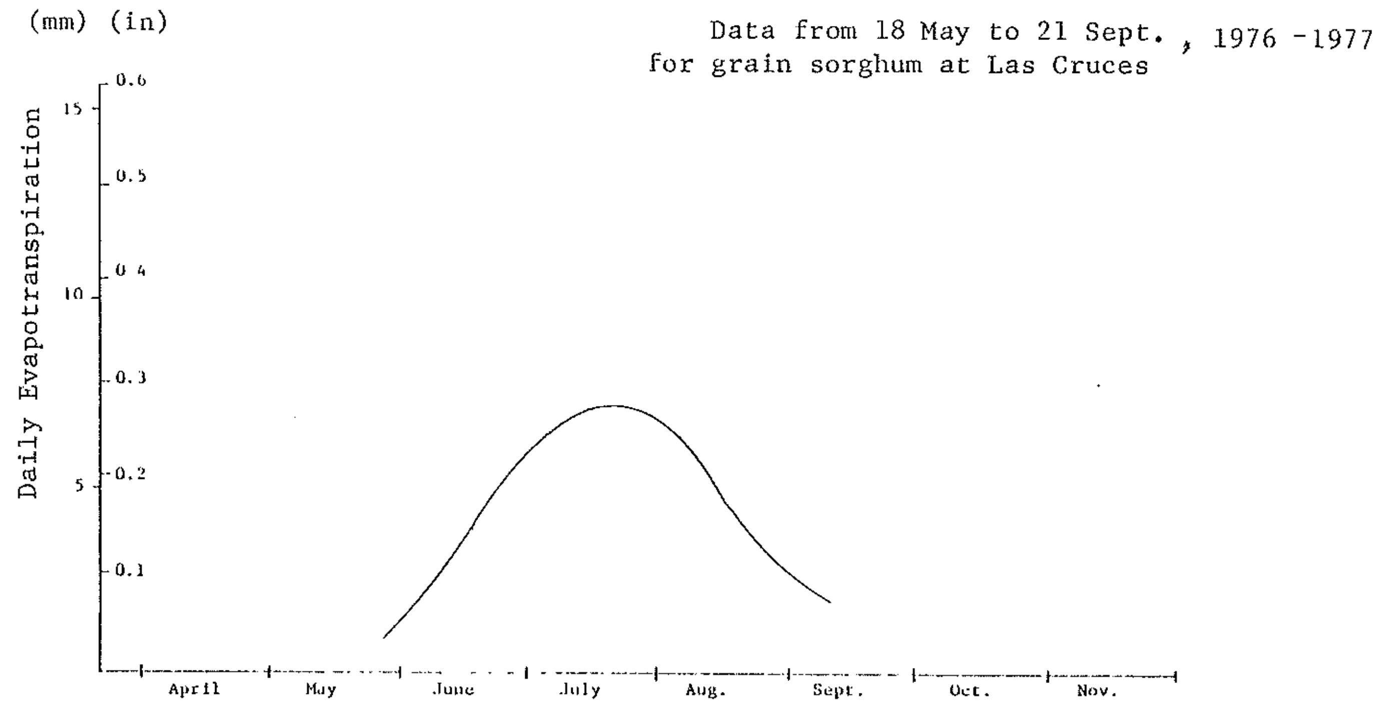
	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
MONTHLY ET (cm)					3.7	14.5	26.0	18.9	11.1	2.2			76.6
MONTHLY ET (in)					1.6	5.7	10.2	7.4	4.4	0.9			30.2
Monthly ET/PET Ratio													
PENMAN					0.20	0.66	0.92	0.83	0.61	0.28			0.64
JENSEN-HAISE					0.24	0.67	0.93	0.86	0.69	0.42			0.70
VAN BAVEL					0.19	0.65	0.92	0.83	0.61	0.27			0.64
PREISTLY-TAYLOR					0.23	0.73	1.03	0.95	0.76	0.43			0.74
NET RADIATION					0.22	0.75	1.06	0.97	0.74	0.38			0.74
MODIFIED PAN					0.27	0.78	1.08	0.99	0.76	0.42			0.78
PAN					0.21	0.62	0.86	0.79	0.61	0.33			0.62
BLANEY-CRIDDLE													0.82

Figure 18D. Daily and monthly ET, monthly ET/PET ratios (smoothed using a polynomial technique), and seasonal Blaney-Criddle coefficients for sorghum at Clovis, New Mexico. 1976-1977 average.



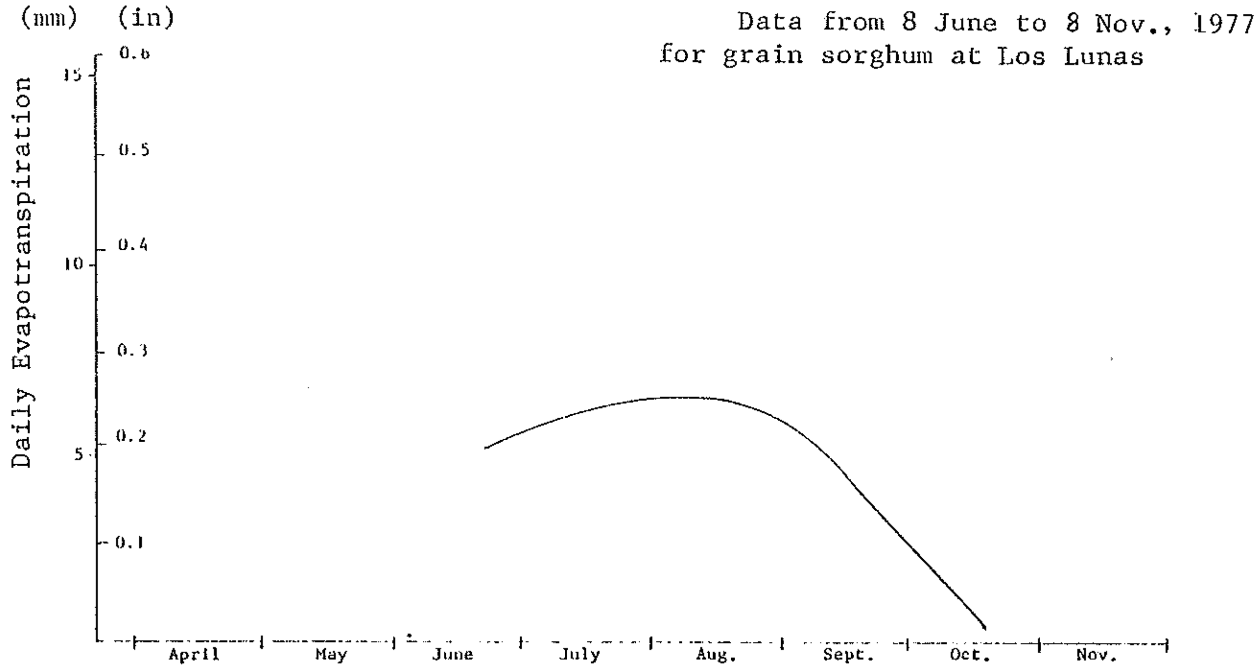
	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
Monthly ET (cm)					2.4	10.6	24.2	19.1	6.3	2.6	0.2		65.3
Monthly ET (in)					1.0	4.2	9.5	7.5	2.5	1.0	0.1		25.7
					Monthly ET/PET Ratio								
PENMAN					0.28	0.49	0.67	0.69	0.55	0.28			0.53
JENSEN-HAISE					0.31	0.52	0.69	0.72	0.58	0.31			0.58
VAN BAVEL					0.28	0.50	0.69	0.72	0.57	0.29			0.55
PREISTLY-TAYLOR					0.32	0.56	0.77	0.80	0.65	0.34			0.63
NET RADIATION					0.31	0.57	0.80	0.83	0.67	0.34			0.64
MODIFIED PAN					0.22	0.50	0.73	0.75	0.55	0.17			0.56
PAN					0.18	0.40	0.58	0.60	0.44	0.13			0.45
BLANEY-CRIDDLE													0.74

Figure 19D. Daily and monthly ET, monthly ET/PET ratios (smoothed using a polynomial technique), and seasonal Blaney-Criddle coefficients for sorghum at Farmington, New Mexico. 1976-1977 average.



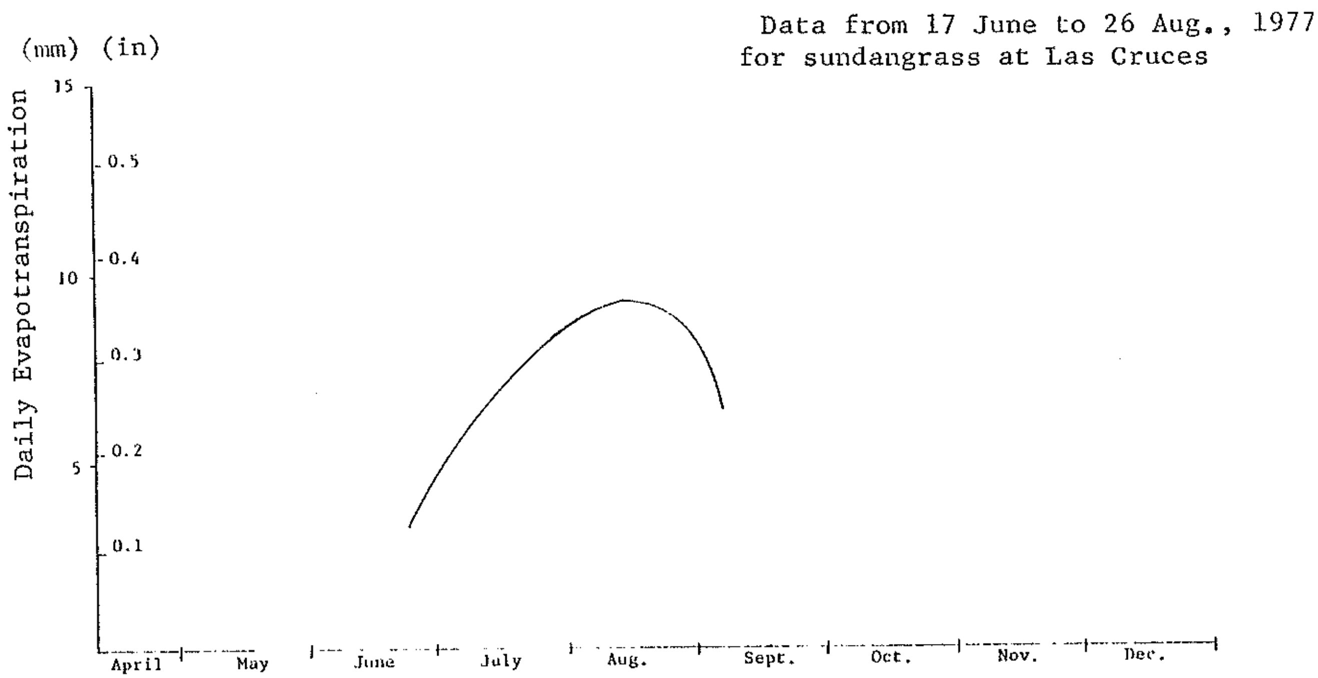
	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
Monthly ET (cm)					1.2	11.8	21.8	14.4	3.4				52.8
Monthly ET (in)					0.5	4.6	8.6	5.7	1.3				20.8
						Monthly ET/PET Ratio							
PENMAN					0.11	0.56	0.90	0.79	0.35				0.61
JENSEN-HAISE					0.12	0.50	0.78	0.68	0.30				0.55
VAN BAVEL					0.11	0.60	0.97	0.85	0.39				0.66
PREISTLY-TAYLOR					0.12	0.56	0.89	0.78	0.34				0.62
NET RADIATION					0.11	0.60	0.98	0.84	0.36				0.65
MODIFIED PAN					0.13	0.53	0.84	0.75	0.37				0.61
PAN					0.11	0.43	0.67	0.60	0.30				0.48
BLANEY-CRIDDLE													0.80

Figure 20D. Daily and monthly ET, monthly ET/PET ratios (smoothed using a polynomial technique), and seasonal Blaney-Criddle coefficients for sorghum at Las Cruces, New Mexico. 1976-1977 average.



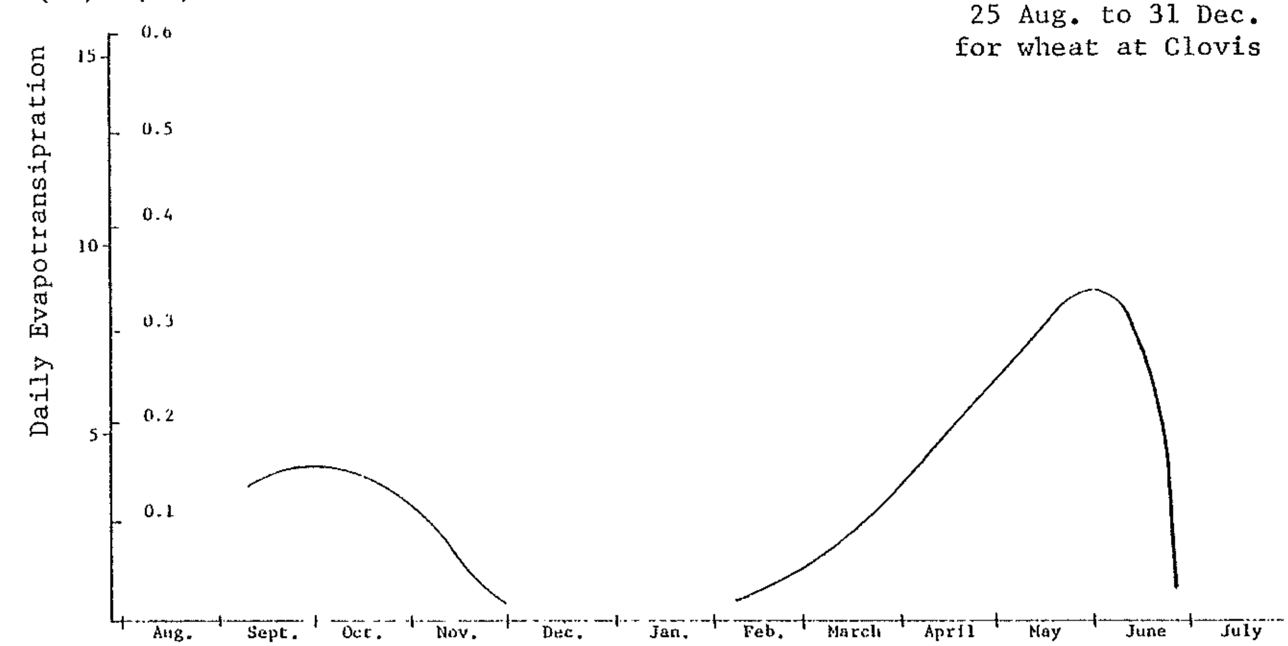
	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
Monthly ET (cm)						11.7	18.8	19.8	13.0	1.6			64.9
Monthly ET (in)						4.6	7.4	7.8	5.1	0.6			25.6
Monthly ET/PET Ratio													
PENMAN						0.57	0.86	0.93	0.70	0.17			0.67
JENSEN-HAISE						0.50	0.72	0.77	0.59	0.18			0.60
VAN BAVEL						0.66	1.00	1.09	0.83	0.23			0.80
PREISTLY-TAYLOR						0.54	0.79	0.85	0.65	0.19			0.63
NET RADIATION						0.55	0.82	0.88	0.66	0.16			0.64
MODIFIED PAN						0.70	1.07	1.17	0.89	0.23			0.86
PAN						0.55	0.86	0.94	0.71	0.18			0.68
BLANEY-CRIDDLE													0.84

Figure 21D. Daily and monthly ET, monthly ET/PET ratios (smoothed using a polynomial technique), and seasonal Blaney-Criddle coefficients for sorghum at Los Lunas, New Mexico. 1977.



	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
Monthly ET (cm)						9.2	21.8	22.8					53.8
Monthly ET (in)						3.6	8.6	9.0					21.2
Monthly ET/PET Ratio													
PENMAN						0.87	0.97	1.33					1.07
JENSEN-HAISE						0.85	0.84	1.14					0.95
VAN BAVEL						0.94	1.06	1.46					1.17
PREISTLY-TAYLOR						0.99	0.99	1.36					1.12
NET RADIATION						1.06	1.07	1.48					1.21
MODIFIED PAN						0.84	0.93	1.30					1.04
PAN						0.68	0.74	1.04					0.83
BLANEY-CRIDDLE													1.25

Figure 22D. Daily and monthly ET, monthly ET/PET ratios (smoothed using a polynomial technique), and seasonal Blaney-Criddle coefficients for sudan grass at Las Cruces, New Mexico. 1977.



	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
Monthly ET (cm)	2.5	2.2	6.2	18.6	28.0	18.8		1.9	13.6	9.5	5.2		103.7
Monthly ET (in)	1.0	0.9	2.4	7.3	11.0	7.4		0.7	5.4	3.7	2.0		40.8
					Monthly ET/PET Ratio								
PENMAN	0.09	0.39	0.66	0.79	0.90	0.93		0.45	0.64	0.70	0.44		0.69
JENSEN-HAISE	0.47	0.77	1.01	1.10	1.11	1.03		0.48	0.77	1.00	0.90		0.95
VAN BAVEL	0.08	0.37	0.63	0.76	0.87	0.92		0.44	0.63	0.69	0.42		0.65
PREISTLY-TAYLOR	0.36	0.67	0.92	1.04	1.10	1.08		0.53	0.83	1.08	1.01		0.98
NET RADIATION	0.20	0.50	0.78	0.92	1.04	1.09		0.54	0.81	0.98	0.79		0.89
MODIFIED PAN	0.42	0.67	0.91	1.04	1.16	1.23		0.53	0.81	0.92	0.54		0.92
PAN	0.33	0.53	0.72	0.83	0.93	0.98		0.43	0.65	0.73	0.43		0.74
BLANEY-CRIDDLE													0.83

Figure 23D. Daily and monthly ET, monthly ET/PET ratios (smoothed using a polynomial technique), and seasonal Blaney-Criddle coefficients for wheat at Clovis, New Mexico. 1976-1977 average.

APPENDIX E

Equations describing the computation of potential evapotranspiration used in the text

APPENDIX E

Equations describing the computation of potential evapotranspiration used in the text are as follows:

Method 1 -- Penman

$$E_o = \frac{\Delta Rn + \gamma Ea}{\Delta + \gamma} \quad (1)$$

$$Ea = 15.36\ (1.0 + 0.0062U_2)\ (e_s - e) \quad (2)$$

where

E_o is potential evaporation (cm/day)

Ea is an aerodynamic component

Δ is slope of the saturation vapor pressure vs. temperature curve at the air temperature (mb $^oC^{-1}$)

Rn is net radiation, expressed (ly day^{-1}) or (cal cm^{-2} day^{-1}); ly = cal cm^{-2}.

to convert Rn from cal cm^{-2} day^{-1} to cm day^{-1}, Rn is divided by L.

L is latent heat of vaporization (cal g^{-1})

U_2 is wind speed (km/day) at a height of 2 m

e_s is saturation vapor pressure (mb)

e is actual vapor pressure (mb)

γ is a psychrometric constant (mb $^oC^{-1}$)

$$\gamma = \frac{C_p P}{0.622L} \quad (3)$$

C_p is specific heat of air (cal g^{-1} $^oC^{-1}$)

P is atmospheric pressure (mb).

Method 2 -- Jensen-Haise

$$Eo = C_T\ (T - Tx)\ Rn \qquad (4)$$

$$C_T = \frac{1}{C_1 + C_2 \cdot CH} \qquad (5)$$

$$CH = \frac{50\ mb}{(e_2 - e_1)} \qquad (6)$$

where e_2 and e_1 are saturation vapor pressure at mean maximum and mean minimum temperatures, respectively, for the warmest month of the year in the area.

$$C_2 = 13^oF \quad or \quad 7.6^oC$$

$$C_1 = 68^oF - (3.6^oF \text{ x elev. in ft}/1000) \qquad (7)$$

$$C_1 = 38 - (2^oC \text{ x elev. in m}/305) \qquad (8)$$

$$Tx = 27.5^oF - (p.25\ (e_2 - e_1) - \text{elev. in ft}/1000) \qquad (9)$$

$$Tx = -2.5^oC - (0.14\ (e_2 - e_1) - \text{elev. in m}/550) \qquad (10)$$

T is average air temperature.

Method 3 -- Van Bavel

This equation is based on the earlier work of Penman:

$$E_o = \frac{[\Delta/\gamma]Rn + LBv\ (e_s - e)}{\Delta/\gamma + 1} \qquad (11)$$

$$Bv = \frac{\rho\varepsilon\kappa^2}{P} \cdot \frac{U_2}{[\ln(Z/Zo)]^2} \qquad (12)$$

where

Bv is turbulent transfer coefficient (g cm^{-2} day^{-1} mb^{-1})

ρ is density of air (g cm^{-3})

κ is Von Karman coefficient (0.41)

Z is elevation above surface at which variables are measured (200 cm)

Zo is roughness length (0.2 cm)

E = molecular weight of water to air E = 0.622

Method 4 -- Priestley-Taylor

$$Eo - \alpha(\frac{\Delta}{\Delta + \gamma}) \cdot Rn \quad (27)$$

where

Rn is net radiation expressed (cm/day)

α is a proportionality constant equal to 1.40 $\pm$ 0.10

Δ and γ are defined as in equation (1).

Method 5 -- Net Radiation

Eo = Rn

Rn is net radiation expressed (cm/day)

Method 6 -- Modified Pan

Eo - 0.8 Pan

Pan is evaporation in cm/day measured from a U.S. Weather Bureau Class A Pan.

Method 7 -- Pan

E_o = Pan

Pan is evaporation in cm/day measured from a U.S. Weather Bureau Class A Pan.

Method 8 -- Blaney-Criddle   Discussion on page 30 of text.

APPENDIX F

Summary of ET Measurements for all Crops
At all Locations by Year

Appendix F

SUMMARY OF ET MEASUREMENTS FOR ALL CROPS AT ALL LOCATIONS BY YEAR

	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
Mature Alfalfa													
Artesia 1977	0.4	10.4	14.0	24.2	23.4	21.0	27.0	21.2	16.3	15.4	5.8	5.4	184.6
Clovis 1977	1.1	2.1	8.2	17.9	26.3	19.7	32.0	23.8	20.9	11.0	5.6	1.1	169.7
Farmington 1976					30.1	30.4	35.7	33.8	23.8	8.3	4.1		166.1
Farmington 1977			2.7	14.6	26.7	27.9	26.3	29.7	21.8	8.7			157.7
			0.5	18.1	23.3	20.3	19.1	25.0	10.4	4.8	2.6		124.2
Las Cruces 1976	2.9	10.8	8.1	20.8	25.4	31.6	22.3	21.9	16.6	11.3			171.6
Las Cruces 1977	2.4	3.2	4.9	26.9	22.9	32.0	27.2	25.4	17.3	7.9	3.6	0.3	173.9
	2.3	3.8	7.1	23.2	23.1	32.6	26.8	27.1	16.9	8.3	3.4	0.3	174.9
	1.7	1.2	4.5	15.3	19.6	30.5	28.6	24.5	16.3	8.5	5.7	1.1	157.5
Los Lunas 1977	0.7	3.1	5.1	16.3	22.0	23.2	29.2	20.3	18.2	9.9	3.4	0.5	151.8
New Alfalfa													
Artesia 1976	0.9	8.8	18.1	24.7	24.7	30.5	28.1	23.7	15.6	5.7	3.4	5.3	189.7
Farmington 1976					13.6	19.2	29.1	22.8	16.2	5.1	1.5		107.5
Clovis 1976				2.1	14.5	29.5	26.5	25.9	14.5	9.7	2.6	0.3	125.6
Winter Barley													
Artesia 1976	0.8	7.6	15.8	19.7	20.1	0.8			2.4	5.7	3.9	6.0	82.8
Artesia 1977	3.0	11.6	17.2	27.4	10.1				2.4	5.7	3.9	6.0	87.4*
Spring Barley													
Farmington 1976					18.0	27.1	7.0	0.9					53.0
Farmington 1977				2.0	16.1	28.4	5.9	3.2					55.5
				6.8	13.7	30.7	8.7	3.0					63.0
Bluegrass													
Los Lunas 1977	1.6	1.9	3.3	6.7	15.3	16.5	16.0	13.0	12.1	9.1	6.0	0.6	102.0

* Fall data from 1976

Appendix F (Continued)

SUMMARY OF ET MEASUREMENTS FOR ALL CROPS AT ALL LOCATIONS BY YEAR

	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
Corn													
Clovis 1976				0.4	5.9	26.3	30.8	27.0	9.5	0.6			100.5
Clovis 1977				6.9	9.5	22.5	28.9	20.5	3.3				91.6
Farmington 1976					4.4	15.5	34.3	34.2	13.0				101.4
					6.7	17.6	41.5	27.3	8.6	1.4			103.1
Farmington 1977					7.2	11.0	25.0	21.9	8.3				72.5
					7.5	15.6	24.1	20.1	9.8	0.8			77.8
Cotton													
Artesia 1976				3.4	5.1	6.6	17.3	23.8	8.9	4.9			70.2
Artesia 1977					7.9	24.7	37.4	17.4	20.5	3.4			111.2
Las Cruces 1976					5.0	7.3	24.3	29.0	14.8	6.6			87.0
					5.2	3.5	26.8	28.7	14.0	5.8			84.1
					5.0	8.8	24.5	22.6	10.2	9.0			80.2
Las Cruces 1977				0.5	0.4	9.6	25.5	28.4	13.3	5.3			83.0
				0.5	1.6	8.6	25.7	29.4	14.7	5.4			85.8
				0.5	2.9	7.9	23.0	23.6	14.7	6.1			78.7
Rye													
Los Lunas 1977			7.4	16.3	21.0	15.0	0.3						59.9

Appendix F (Continued)

SUMMARY OF ET MEASUREMENTS FOR ALL CROPS AT ALL LOCATIONS BY YEAR

	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	YEAR
Sorghum													
Artesia 1976					2.9	14.7	18.1	19.9	9.5				65.0
Artesia 1977					0.9	14.7	36.3	16.3	18.7				86.9
Clovis 1976					4.6	14.8	29.4	23.5	13.4	1.8			87.5
Clovis 1977					2.8	14.2	22.7	14.4	9.0	2.7			65.8
Farmington 1976					0.6	12.5	29.7	23.8	5.7	0.5			72.8
					2.7	11.9	29.6	28.8	4.6	1.2			78.8
Farmington 1977					2.5	9.8	20.0	16.5	8.3	4.2	0.1		61.3
					3.7	8.5	17.3	7.2	7.1	4.6	0.2		48.5
Las Cruces 1976					0.7	9.4	22.7	18.1	4.1				55.0
					1.5	13.3	25.7	17.0	4.6				62.2
Las Cruces 1977					1.3	10.0	19.3	13.3	3.7				47.7
					0.8	11.4	20.0	11.3	4.3				47.9
					1.7	14.8	21.3	12.5	0.8				51.0
Los Lunas 1977						11.7	18.8	19.8	13.0	1.6			64.9
Sudangrass													
Las Cruces 1977						10.6	21.3	22.5					54.3
						9.2	21.0	27.1					57.4
						7.7	23.1	18.9					49.8
Wheat													
Clovis 1976			4.6	21.7	31.7	27.7		1.9	13.6	9.5	5.2		115.9
Clovis 1977	2.5	2.2	7.8	15.6	24.5	9.8		1.9	13.6	9.5	5.2		92.6*

* Fall data from 1976