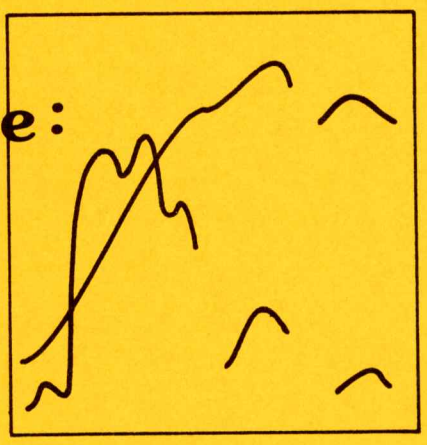
LARS Technical Report 042382
NASA-Johnson Space Center
Contract No. NAS9-16528

Vegetation and Soils Field Research Data Base: Experiment Summaries



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Star Information Form

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.

4. Title and Subtitle	5. Report Date
Vegetation and Soils Field Research Data Base: Experiment Summaries	May 1982, Dec. 1984
	6. Performing Organization Code

7. Author(s)	8. Performing Organization Report No.
L.L. Biehl, C.S.T. Daughtry, and M.E. Bauer	LARS 042382

9. Performing Organization Name and Address	10. Work Unit No.
Purdue University Laboratory for Applications of Remote Sensing 1291 Cumberland Ave. West Lafayette, IN 47906-1399	11. Contract or Grant No. NAS9-16528
	13. Type of Report and Period Covered

12. Sponsoring Agency Name and Address	14. Sponsoring Agency Code
NASA Johnson Space Center Earth Resources Research Division Houston, TX 77058	

15. Supplementary Notes

16. Abstract

Understanding of the relationships between the optical, spectral characteristics and important biological-physical parameters of earth-surface features can best be obtained by carefully controlled studies over fields and plots where complete data describing the condition of targets are attainable and where frequent, timely spectral measurement can be obtained. Development of a vegetation and soils field research data base was initiated in 1972 at Purdue University's Laboratory for Applications of Remote Sensing and expanded in the fall of 1974 by NASA as part of LACIE. Since then, over 250,000 truck-mounted and helicopter-borne spectrometer/multiband radiometer observations have been obtained of more than 250 soil series and 20 species of crops, grasses, and trees. These data are supplemented by an extensive set of biophysical and meteorological data acquired during each mission.

The field research data form one of the most complete and best-documented data sets acquired for agricultural remote sensing research. Thus, they are well-suited to serve as a data base for research to: (1) quantitatively determine the relationships of spectral and biophysical characteristics of vegetation, (2) define future sensor systems, and (3) develop advanced data analysis techniques.

17. Key Words (Suggested by Author(s))	18. Distribution Statement
Remote sensing, data base, spectrometer, radiometer	

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified		

*For sale by the National Technical Information Service, Springfield, Virginia 22161

NASA - JSC

LARS 042382
NAS9-16528

VEGETATION AND SOILS FIELD RESEARCH DATA BASE:

EXPERIMENT SUMMARIES

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July 1982

Revised December 1984

Reproduced by Printing Services, Purdue University

VEGETATION AND SOILS FIELD RESEARCH DATA BASE:

EXPERIMENT SUMMARIES

Major advancements have been made in recent years in the capability to acquire, process, and interpret remotely sensed multispectral measurements of the energy reflected and emitted from vegetation, soils, and other earth surface features. As a result of programs such as the Large Area Crop Inventory Experiment (LACIE) and AgRISTARS, the technology is moving rapidly toward operational applications. There is, however a continuing need for more quantitative knowledge of the multispectral characteristics of vegetation and soils if further advancements in technology development and application are to be made.

Understanding of the relationships between the optical, spectral characteristics and important biological-physical parameters of earth surface features can best be obtained by carefully controlled studies over fields and plots where complete data describing the condition of targets are attainable and where frequent, timely spectral measurement can be obtained. It is these attributes which distinguish field research from other remote sensing research activities.

Development of a vegetation and soils field research data base was initiated in 1972 at Purdue University's Laboratory for Applications of Remote Sensing (LARS) and expanded in the fall of 1974 by NASA as part of LACIE. Spectral, agronomic, and meteorological measurements were made for three years at LACIE test sites in Kansas, South Dakota and North Dakota. The data were preprocessed into comparable formats, analyzed by researchers and stored in the NASA/JSC field research data base. The data base was expanded in 1978 to include data collected for corn and soybean experiments in Indiana, Iowa, and Nebraska, as well as from a major U.S. soils experiment. In 1980 the data base was expanded again to include data collected for spring wheat, barley, sunflowers, and soybeans in North Dakota and cotton, rice, and soybeans in Texas. Data were obtained for boreal forest species in 1983 and 1984. The remote sensing measurements include over 250,000 truck-mounted and helicopter-borne spectrometer/multiband radiometer observations and 400 flight lines of aircraft scanner data. These data are supplemented by an extensive set of biophysical and meteorological data acquired during each mission.

The field research data form one of the most complete and best documented data sets acquired for agricultural remote sensing research.

Thus, they are well-suited to serve as a data base for research to: (1) quantitatively determine the relationships of spectral and biophysical characteristics of vegetation, (2) define future sensor systems, and (3) develop advanced data analysis techniques. The data base, which became an integral part of AgRISTARS Supporting Research Project data base, is unique in the comprehensiveness of sensors and missions over the same sites throughout several growing seasons and in the calibration of all multispectral data to a common standard.

The specifications of the spectroradiometers and multiband radiometers used for obtaining the spectral data for the data base are summarized in Table 1. The vegetation for which spectral data have been acquired is given in Table 2. Additional spectral data, primarily Barnes 12-1000 data, have been acquired by researchers at the University of Nebraska, Kansas State University, Oregon State University, South Dakota State University, Texas A&M University, University of Minnesota, University of Kansas, and CIMMYT of Mexico as part of the AgRISTARS supporting research program.

The experiment summaries identify each experiment for which truck-mounted or helicopter-mounted spectroradiometer or multiband radiometer data were collected. See Table 3. The summary for an experiment includes:

- Experiment Name and Number
- Location
- Spectral Instrument(s)
- Library Tape(s)
- Experiment description
- Dates data collected
- Number of spectral observations
- Illumination conditions
- LARSPEC Identification Record Codes

There are summaries for most experiments. Additional experiment summaries are added each year as new data are collected.

Since the entire report is quite voluminous, more than 400 pages, description and data for only one experiment (see Appendix, p. 15) are presented as an example of the information that is available. Complete description or information about other experiments listed in this report can be obtained by contacting Larry Biehl or Craig Daughtry at Purdue University/LARS, 1291 Cumberland Ave., West Lafayette, IN 47906-1399; ph. 317/494-6305.

RELATED REFERENCES

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INDEX TO TABLES AND APPENDIX

Table 1. Summary of major non-imaging sensor systems used for acquisition of data for vegetation and soils scene radiation research data base.

Platform and Sensor	Spectral Range	Spectral Band Width	No. of Observations
	μm	μm	
Helicopter-mounted spectroradiometer			
NASA/JSC field spectrometer system (FSS)	0.40- 1.10	0.02	204,605
	1.10- 2.40	0.05	
	8.00-14.00	0.50	
Helicopter-mounted multiband radiometer			
NASA/JSC Barnes 12-1000 MMR	0 45-12.50	TM	9,300
Truck-mounted spectroradiometers			
Purdue/LARS Exotech 20C	0.40- 2.40	0.01	9,165
Purdue/LARS Exotech 20C	0.40- 0.63	0.0007	9,165
	0.44- 0.86	0.0009	
	0.69- 1.36	0.0015	
	1.28- 2.32	0.0024	
NASA/JSC Field Signature Acquisition System (FSAS)	0.40- 2.40	0.01	813
NASA/ERL Exotech 20D	0.40- 2.40	0.01	644
Truck-mounted multiband radiometers			
Purdue/LARS Exotech 100 (X100)	0.50- 1.10	MSS	31,680
Purdue/LARS Barnes 12-1000 (MMR)	0.45-12.50	TM	29,615
Laboratory Spectroradiometer			
Purdue/LARS Exotech 20C	0.40- 2.40	0.01	746
Purdue/LARS Exotech 20C	0.40- 0.63	0.0007	746
	0.44- 0.86	0.0009	
	0.69- 1.36	0.0015	
	1.28- 2.32	0.0024	

TM - Thematic Mapper bands plus 1.15-1.30 μm.

MSS - Landsat MSS bands.

Table 2. Summary of vegetation for which non-imaging spectral data have been acquired.

Vegetation Cover	Sensor System					
	FSS	20C	FSAS	20D	X100	MMR
Alfalfa	X	X	X	X	X	X
Barley	X	X	X	X	X	-
Corn	X	X	X	-	X	X
Corn, sun-view	-	-	-	-	-	X
Dry Bean	X	-	-	-	-	-
Durum Wheat	X	X	-	-	-	-
Flax	X	-	-	-	-	-
Millet	X	-	-	-	-	-
N. Dakota Native Grass	-	X	-	-	-	-
Oats	X	X	-	-	X	-
Pasture	X	-	-	-	-	-
Rye	X	-	X	X	-	-
Safflower	X	-	-	-	-	-
'Skylight'	-	X	-	-	-	X
Soil	X	X	X	-	X	-
Soil Residue	-	-	-	-	X	X
Sorghum (grain)	X	X	X	-	X	X
Sorghum, sun view polarization	-	-	-	-	-	X
S. Dakota Native Grass	X	-	-	-	-	-
Soybeans	X	X	X	X	X	X
Soybeans, sun view	-	-	-	-	X	-
Spring Wheat	X	X	-	-	X	-
Spring Wheat, sun view	-	X	-	-	-	-
Spring wheat, sun view polarization	-	X	-	-	-	-
Sudan Grass	X	-	-	-	-	-
Sugar Beets	X	X	X	X		-
Sunflower	X	X	-	-	X	X
Trees, Aspen	-	-	-	-	-	X
Trees, Balsam Fir	-	-	-	-	-	X
Trees, Black Spruce	-	-	-	-	-	X
Trees/Brush	X	-	-	-	-	-
Trees, Hardwood	X	-	-	-	-	-
Triticale	-	-	X	X	-	-
Winter Wheat	X	X	X	X	X	-
Winter Wheat, sun view	-	-	-	-	-	X

Table 3. Field Research Experiment Summary Table of Contents. The fourth and fifth digits of the experiment number identify the spectral sensor system:

00:	Exotech 20C	03:	FSAS
01:	Exotech 20D	04,05:	Exotech 100
02:	FSS	09-24:	Barnes 12-1000

Table 3. Field Research Experiment Summary

Table of Contents (cont.)

Table 3. Field Research Experiment Summary

Table of Contents (cont.)

Table 3. Field Research Experiment Summary

Table of Contents (cont.)

Table 3. Field Research Experiment Summary

Table of Contents (cont.)

Table 3. Field Research Experiment Summary

Table of Contents (cont.)

Table 3. Field Research Experiment Summary

Table of Contents (cont.)

Table 3. Field Research Experiment Summary

Table of Contents (concl.)

APPENDIX

119. 1980 Purdue Agronomy Farm Corn Cultural Practices Experiment:

Experiment Number: 80105803

Experimenter: Craig Daughtry

Location: Purdue Agronomy Farm
West Lafayette, Indiana

Instrument: Purdue/LARS Exotech 100

Library Tapes: 4857, 4868

Purpose of Experiment

1980 is the second year for this experiment (see 79105803, Table 3, Page 10). The objectives of this experiment are to determine (1) the threshold of early season spectral detection of corn; (2) the spectral response of corn as a function of growth stage and amount of vegetation; and (3) the effect of soil background differences, particularly soil color, on the spectral response and early detection of corn. The treatments were as follows:

7 Planting Dates (May 7, 16, 22, 29; June 11, 18; and July 2
3 Plant Populations (25,000, 50,000, and 75,000 plants per hectare)
2 Soil Types (Chalmers, darker; Fincastle, lighter)

A split-plot design with two replications was used (Fig. 119.1). Spectral measurements, along with agronomic characterizations of the canopies and surface soil, were made at approximately weekly intervals throughout the growing season.

The spectral reflectance measurements were made with a Landsat band radiometer (Exotech Model 100). Radiant temperatures and overhead color photographs of the canopies were obtained simultaneously with the reflectance measurements. The major agronomic measurements of the plots included growth stage, percent soil cover, height, leaf area index, biomass, and surface soil moisture and condition. Grain yields were measured at harvest time.

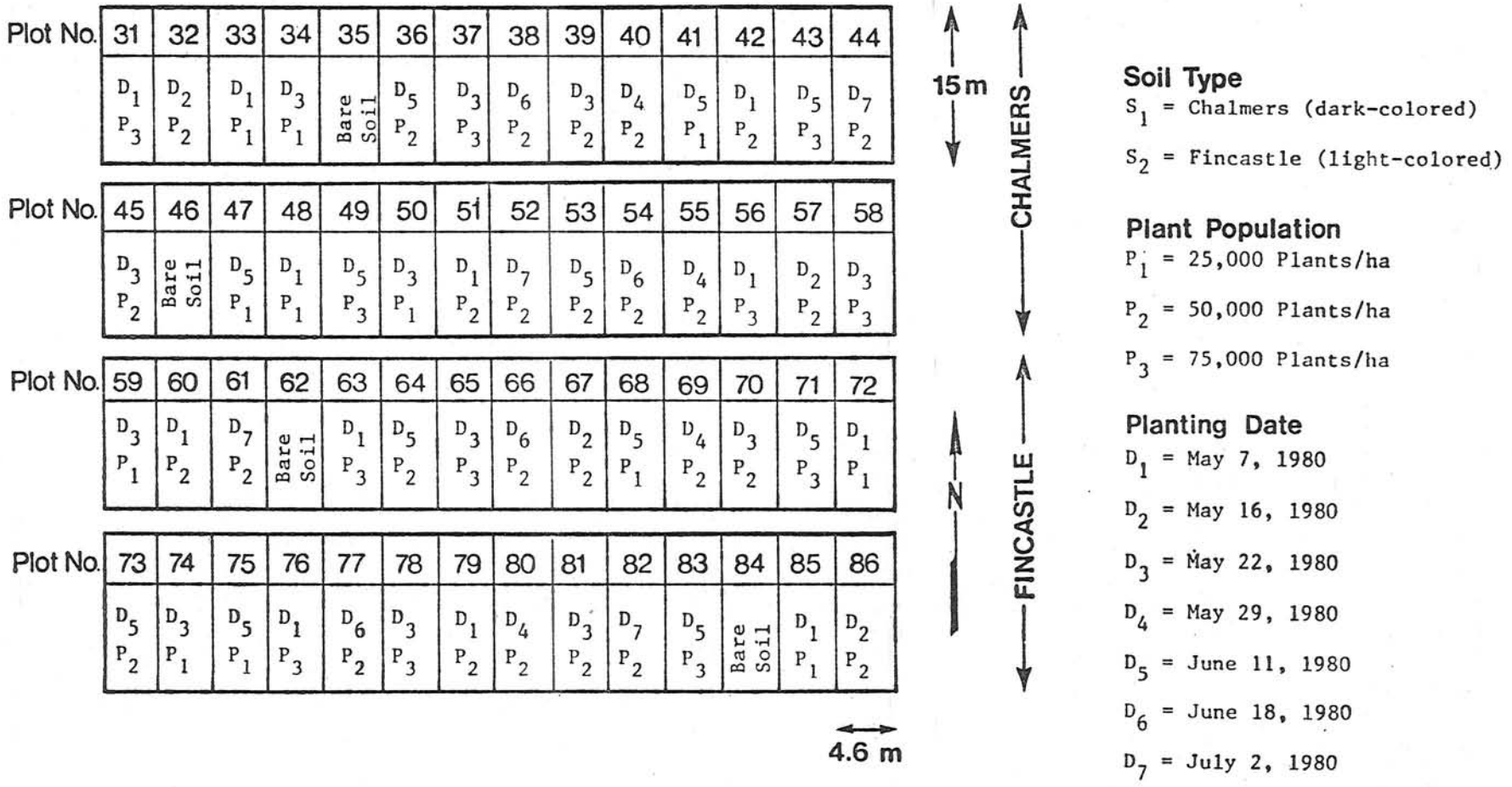

Figure 119.1. Design and treatment descriptions of the 1980 Purdue Agronomy Farm Corn Cultural Practices Experiment.

Dates Spectral Data Collected:

Plot Number	5/27	5/28	6/9	6/11	6/18	6/21	6/29	7/15	7/20
	← Number of Observations →								
31	2	2	4	4	2	2	2	2	2
32	2	2	4	4	2	2	2	2	2
33	2	2	4	4	2	2	2	2	2
34	2	2	4	4	2	2	2	2	2
35	2	2	4	4	2	2	2	2	2
36	2	2	4	4	2	2	2	2	2
37	2	2	4	4	2	2	2	2	2
38	2	2	4	4	2	2	2	2	2
39	2	2	4	4	2	2	2	2	2
40	2	2	4	4	2	2	2	2	2
41	2	2	4	4	2	2	2	2	2
42	2	2	4	4	2	2	2	2	2
43	2	2	4	4	2	2	2	2	2
44	2	2	4	4	2	2	2	2	2
45	2	2	–	4	2	2	–	2	2
46	2	2	–	4	2	2	–	2	2
47	2	2	–	4	2	2	–	2	2
48	2	2	–	4	2	2	–	2	2
49	2	2	–	4	2	2	–	2	2
50	2	2	–	4	2	2	–	2	2
51	2	2	–	4	2	2	–	2	2
52	2	2	–	4	2	2	–	2	2
53	2	2	–	4	2	2	–	2	2
54	2	2	–	4	2	2	–	2	2
55	2	2	–	4	2	2	–	2	2
56	2	2	–	4	2	2	–	2	2
57	2	2	–	4	2	2	–	2	2
58	2	2	–	4	2	2	–	2	2
59	–	2	–	4	2	2	–	2	2
60	2	2	–	4	2	2	–	2	2
61	–	2	–	4	2	2	–	2	2
62	–	2	–	4	2	2	–	2	2
63	2	2	–	4	2	2	–	2	2
64	–	2	–	4	2	2	–	2	2
65	–	2	–	4	2	2	–	2	2
66	–	2	–	4	2	2	–	2	2
67	2	2	–	4	2	2	–	2	2
68	2	2	–	4	2	2	–	2	2
69	–	2	–	4	2	2	–	2	2
70	–	2	–	4	2	2	–	2	2
71	–	2	–	4	2	2	–	2	2
72	2	2	–	4	2	2	–	2	2
73	–	2	–	4	2	2	–	2	2
74	–	2	–	4	2	2	–	2	2
75	–	2	–	4	2	2	–	2	2
76	2	2	–	4	2	2	–	2	2

Dates Spectral Data Collected (con't.)

Plot Number	7/24	8/22	8/23	9/3	9/18	9/26	10/2	10/7
				Number of Observations				
31	2	2	2	2	2	2	2	2
32	2	2	2	2	2	2	2	2
33	2	2	2	2	2	2	2	2
34	2	2	2	2	2	2	2	2
35	2	2	2	2	2	2	2	2
36	2	2	2	2	2	2	2	2
37	2	2	2	2	2	2	2	2
38	2	2	2	2	2	2	2	2
39	2	2	2	2	2	2	2	2
40	2	2	2	2	2	2	2	2
41	2	2	2	2	2	2	2	2
42	2	2	2	2	2	2	2	2
43	2	2	2	2	2	2	2	2
44	2	2	2	2	2	2	2	2
45	2	2	2	2	2	2	2	2
46	2	2	2	2	2	2	2	-
47	2	2	2	2	2	2	2	2
48	2	2	2	2	2	2	2	2
49	2	2	2	2	2	2	2	2
50	2	2	2	2	2	2	2	2
51	2	2	2	2	2	2	2	2
52	2	2	2	2	2	2	2	2
53	2	2	2	2	2	2	2	2
54	2	2	2	2	2	2	2	2
55	2	2	2	2	2	2	2	2
56	2	2	2	2	2	2	2	2
57	2	2	2	2	2	2	2	2
58	2	2	2	2	2	2	2	2
59	2	2	2	-	2	2	2	2
60	2	2	2	-	2	2	2	2
61	2	2	2	-	2	2	2	2
62	2	2	2	-	2	2	2	2
63	2	2	2	-	2	2	2	2
64	2	2	2	-	2	2	2	2
65	2	2	2	-	2	2	2	2
66	2	2	2	-	2	2	2	2
67	2	2	2	-	2	2	2	2
68	2	2	2	-	2	2	2	2
69	2	2	2	-	2	2	2	2
70	2	2	2	-	2	2	2	2
71	2	2	2	-	2	2	2	2
72	2	2	2	-	2	2	2	2
73	2	2	2	-	2	2	2	2
74	2	2	2	-	2	2	2	2
75	2	2	2	-	2	2	2	2
76	2	2	2	-	2	2	2	2

Dates Spectral Data Collected:

Plot Number	5/27	5/28	6/9	6/11	6/18	6/21	6/29	7/15	7/20
	← Number of Observations →								
77	–	2	–	4	2	2	–	2	2
78	–	2	–	4	2	2	–	2	2
79	2	2	–	4	2	2	–	2	2
80	–	2	–	3	2	2	–	2	2
81	–	2	–	5	2	2	–	2	2
82	–	2	–	4	2	2	–	2	2
83	–	2	–	4	2	2	–	2	2
84	–	2	–	4	2	2	–	2	2
85	2	2	–	4	2	2	–	2	2
86	2	2	–	4	2	2	–	2	2

Plot Number	7/24	8/22	8/23	9/3	9/18	9/26	10/2	10/7
	← Number of Observations →							
77	2	2	2	–	2	2	2	2
78	2	2	2	–	2	2	2	2
79	2	2	2	–	2	2	2	2
80	2	2	2	–	2	2	2	2
81	2	2	2	–	2	2	2	2
82	2	2	2	–	2	2	2	2
83	2	2	2	–	2	2	2	2
84	2	2	2	–	2	2	2	2
85	2	2	2	–	2	2	2	2
86	2	2	2	–	2	2	2	2

Illumination Conditions for Spectral Data Collection

Date	Day of Year	Time Period Start	Time Period Stop	Solar Zenith Angle Range max - min - max	Solar Azimuth Angle Range	Cloud Cover
		GMT		degrees	degrees	%
5/27	148	20:17	21:10	37 - 47	251-262	?
5/28	149	16:18	17:56	27 - 19 - 19	129-188	15
6/9	161	14:47	15:06	42 - 38	101-105	10
6/11	163	15:06	16:39	38 - 23	105-135	0-1
6/18	170	15:00	16:01	39 - 28	103-119	0
6/21	173	18:13	18:54	18 - 22	198-223	1
6/29	181	19:30	19:40	27 - 29	238-241	5
7/15	197	15:29	16:35	36 - 25	111-133	2
7/20	202	18:24	19:27	21 - 28	200-232	0
7/24	206	18:26	19:38	22 - 30	200-235	20-30
8/22	235	17:45	19:30	29 - 29 - 36	177-224	30-50
8/23	236	15:48	17:00	40 - 31	128-155	0
9/3	247	17:45	18:17	33 - 33 - 34	179-193	15
9/18	262	16:53	17:52	40 - 39 - 39	161-184	5
9/26	270	17:44	18:52	41 - 45	182-206	10-15
10/2	276	17:06	18:19	44 - 44 - 45	169-195	0-20
10/7	281	19:12	20:21	51 - 59	212-230	0

LARSPEC Identification Record Codes

1. Level of Factor Codes

Factor		Level	
Code	Description	Code	Description
1:	Planting date	0:	Bare Soil
		1:	May 7, 1980
		2:	May 16, 1980
		3:	May 22, 1980
		4:	May 29, 1980
		5:	June 11, 1980
		6:	June 18, 1980
		7:	July 2, 1980
2:	Plant population	0:	Bare Soil
		1:	25,000 plants/ha
		2:	50,000 plants/ha
		3:	75,000 plants/ha
3:	Soil	1:	Chalmers silty clay loam - "darker soil"
		2:	Fincastle silt loam - "lighter soil"
4:	Block or replication	1:	First block
		2:	Second block

2. Experiments Parameters

Experimenter parameter 09: Air temperature as measured by a probe attached to the boom supporting the multiband radiometer in degrees Celsius.

Experimenter parameter 10: Radiant temperature as measured by a precision radiation thermometer (PRT-5) obliquely viewing the top surface of the canopy in degrees Celsius.