LACIE-00469

JSC-13734

LARGE AREA CROP INVENTORY EXPERIMENT (LACIE)

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Crop Spectra from LACIE Field Measurements

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Crop Spectra from LACIE Field Measurements

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FOREWORD

The LACIE Field Measurements project has acquired and assembled one of the most comprehensive data sets for agricultural remote sensing research. The purpose of this document is to briefly describe the data sets and to introduce potential investigators to the spectral data through a series of examples illustrating major sources of variation in the reflectance of wheat and several of its confusion crops.

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I. Introduction

CROP SPECTRA FROM LACIE FIELD MEASUREMENTS

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 crops, soils, and other earth surface features. With the initiation of experiments such as the Large Area Crop Inventory Experiment (LACIE), the technology is moving rapidly toward operational applications (1). There is, however, a continuing need for quantitative studies of the multispectral characterisitcs of crops and soils if further advancements in the technology are to be made. In the past, many such studies were made in the laboratory because of a lack of instrumentation suitable for field studies. However, the applicability of such studies is generally limited. The development of sensor systems capable of collecting high quality spectral measurements under field conditions has made it possible to pursue investigations which would not have been possible a few years ago.

A major effort was initiated in the fall of 1974 by the NASA/Johnson Space Center, Purdue University/Laboratory for Applications of Remote Sensing, and the U.S. Department of Agriculture to acquire fully annotated and calibrated multitemporal sets of spectral measurements and supporting agronomic and meteorological data. Spectral, agronomic, and meteorological measurements have been made on LACIE test sites in Kansas and North Dakota for three years and in South Dakota for two years. The remote sensing measurements include data acquired by three truck-mounted spectrometers, a helicopter-borne spectrometer, two air-borne multispectral scanners, and the Landsat-1 and -2 multispectral scanners. These data are supplemented by an extensive set of agronomic and meteorological data acquired during each remote sensing data collection mission. The data collection program is illustrated in Figure 1.

The LACIE Field Measurements data form one of the most complete and best documented data sets ever acquired for remote sensing research. Thus, they are well suited to serve as a data base for research to (1) quantitatively determine the relationship of spectral to agronomic characteristics of crops, (2) define future sensor systems, and (3) develop advanced data analysis techniques. The data base is undoubtedly the largest of its type

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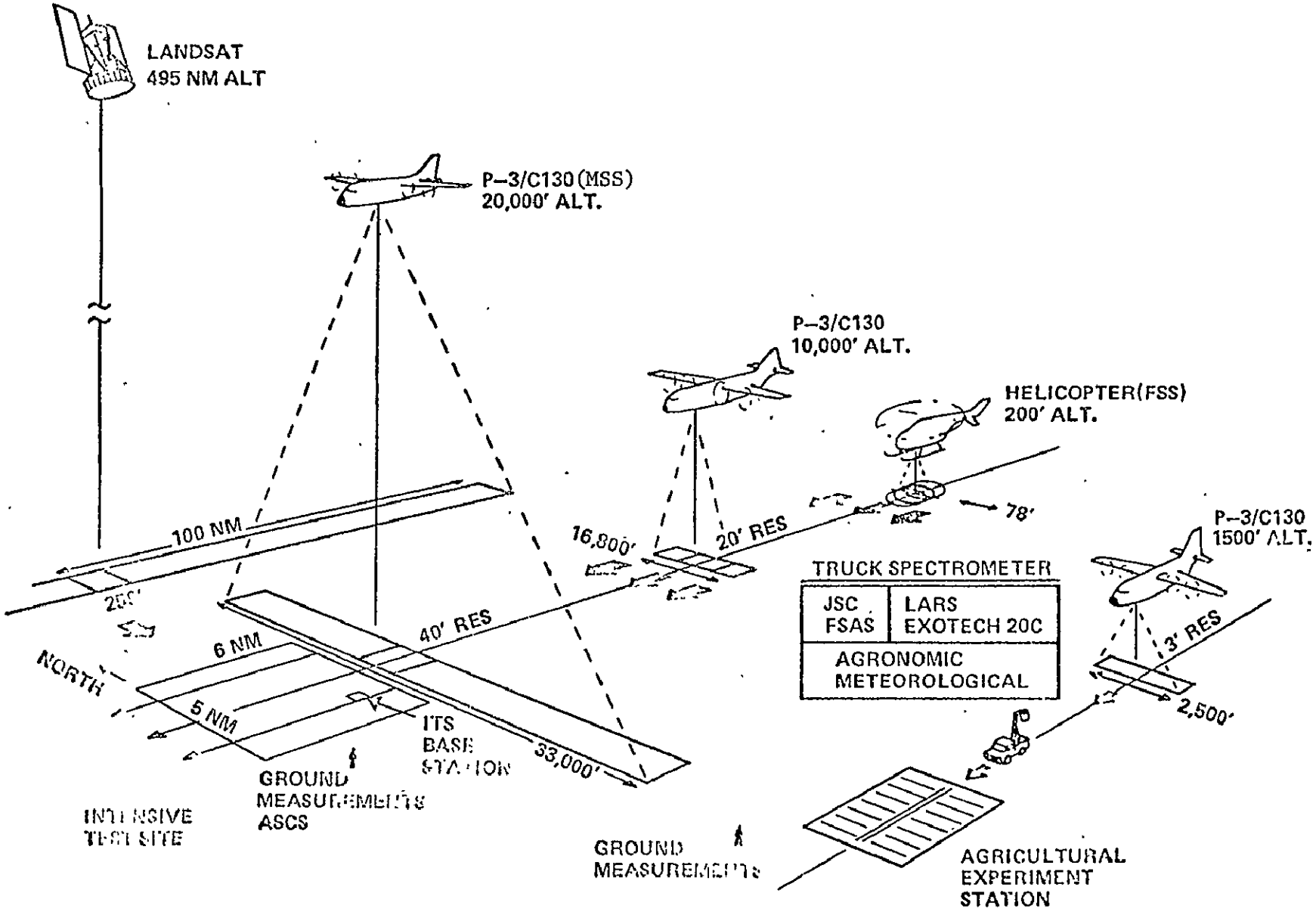

Figure 1. Schematic Illustration of LACIE Field Measurements Data Acquisition.

now available for research purposes. It is unparalled in its comprehensiveness in terms of sensors and missions over the same sites throughout the growing season. The calibration of all multispectral data to a common standard is unique. Finally, the kind and quantity of supporting agronomic and meteorological data are extensive compared to most remote sensing experiments. The data acquisition was planned and monitored by researchers planning to analyze the data and the data sets are documented for use by multiple investigations.

A. Description of Data

The field measurements test sites are located in Finney County, Kansas; Williams County, North Dakota; and Hand County, South Dakota (Figure 2). The test sites were chosen to represent as wide a range of important wheat production areas as possible, Kansas for winter wheat, North Dakota for spring wheat, and South Dakota for the winter-spring wheat transition area. Each site consists of a LACIE intensive test site (ITS), 5 x 6 miles in size; and in Kansas and North Dakota, an agricultural experiment station. The crop, soil, and climatic characteristics of each site are described more fully in the Project Plan (2).

This report presents examples of the data from the high spectral resolution spectrometers. These data have been considered as the primary spectral data from the project since they are the most complete and detailed in terms of number of missions, spatial resolution, spectral wavelength coverage and resolution, and signal/noise ratio. Spectral data and associated agronomic and meteorological data acquired by all instruments (Landsat MSS, airborne MSS, high resolution spectrometers, and Landsat-band radiometers) are available from the LACIE Field Measurements data library located at Purdue/LARS. The major characteristics of the spectrometer systems are described briefly here and in Table 1. More complete descriptions of the sensors, as well as descriptions of the agronomic and meteorological data are presented in the Project Plan (2).

The Field Spectrometer System (FSS) is mounted on a helicopter and acquires data over farmers' fields in a series of three flightlines over the LACIE intensive test sites (ITS) in each of the three counties indicated in Figure 2. The FSS is a modified version of the S-191 spectrometer used on Skylab. It acquires data at wavelengths 0.4-2.4 μm and 8-14 μm. These data

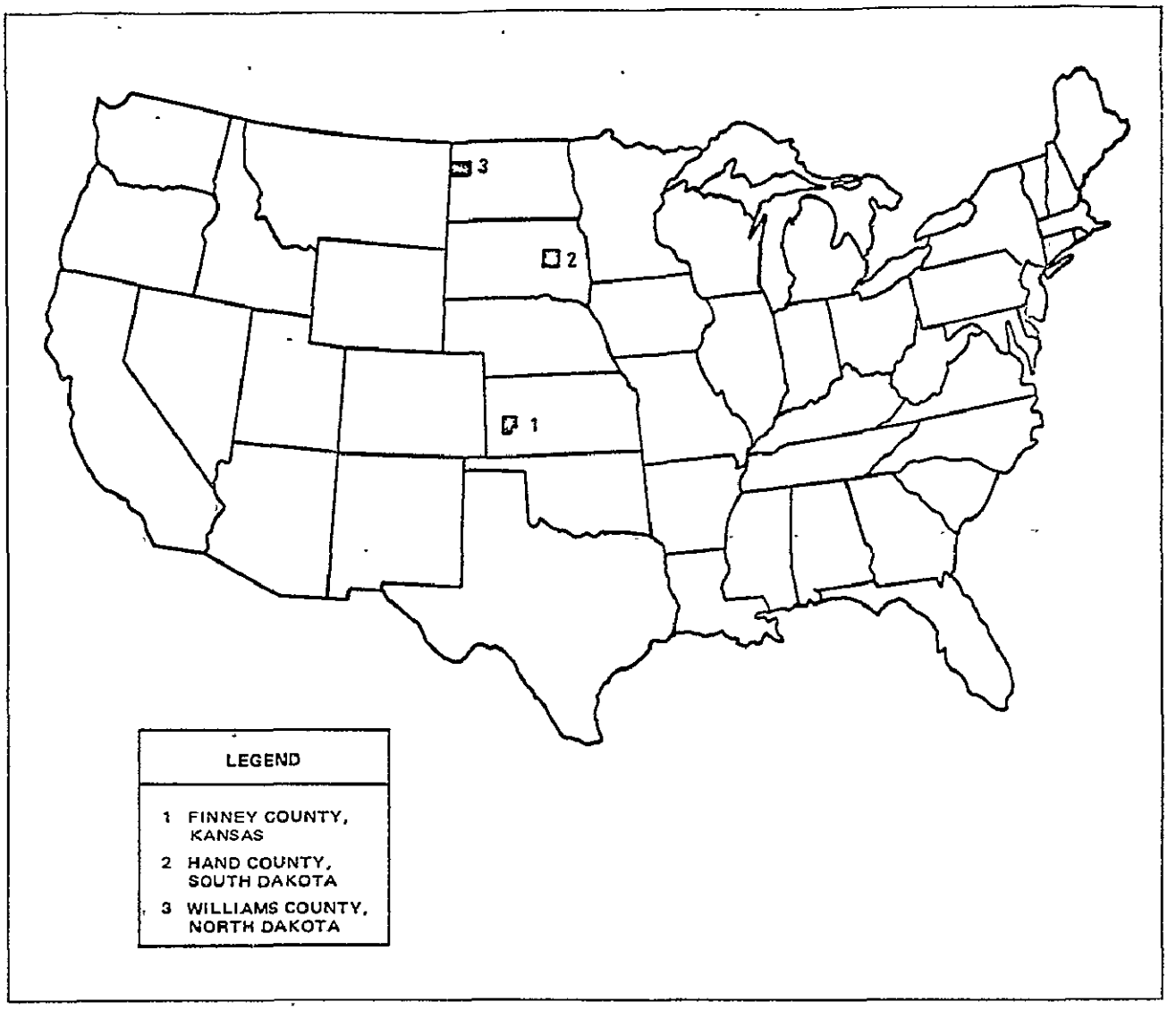

Figure 2. Location of LACIE Field Measurements Test Sites.

Table 1. Characteristics of the Spectrometer Systems.

Characteristic	NASA/JSC FSS	Purdue/LARS Exotech 20C & NASA/ERL Exotech 20D	NASA/JSC FSAS
Spectral Range (μm)	0.4-2.5, 6.0-16.0	0.4-2.4, 2.8-13.4	0.4-2.5, 3-14
Spectral Resolution @ 1.0 (μm)	.025	.025	.0064
Scan Time (scan/sec)	1	.033-2.0	10
Field of View (degrees)	22	15 and 3/4	11
Boom Length (m)	-	8,8	13,11
Normal Operational Altitude (m)	60	6	6

provide a measure of the natural variation in the temporal-spectral characteristics of wheat and surrounding cover types.

The truck-mounted spectrometers collected spectra of controlled plots at agricultural experiment stations (AES) near the ITS at Garden City, Kansas, and Williston, North Dakota. The sensors, which acquire data at wavelengths 0.4-2.4 μm, are the Field Signature Acquisition System (FSAS) operated by NASA/JSC, Exotech Model 20C operated by Purdue/LARS, and Exotech Model 20D operated by NASA/ERL. These data combined with the more detailed and quantitative measurements of crop and soil conditions which were made on the AES plots enable analysts to establish the relation of reflectance to such factors as leaf area index and biomass.

The spectral reflectance data are presented in terms of bidirectional reflectance factor which is a physical property of the scene or target, rather than as radiance which is dependent on the irradiance. The data have been calibrated by comparing the response of the instrument viewing the target (field) to its response viewing a level reference standard. These measurements are in turn related to a laboratory standard of pressed barium sulphate having known reflective properties. This approach to calibration provides data for which valid mission-to-mission and sensor-to-sensor comparisons can be made (3).

B. Introduction to Example Spectra

The spectral examples presented illustrate important sources of variability in the multispectral reflectance of wheat and differences in the spectral response between wheat and its major confusion crops.* Some of the factors affecting multispectral reflectance which are included in the examples are: maturity stage, amount of vegetation (biomass, leaf area index, percent ground cover), soil type, surface soil moisture, irrigated vs. dryland, fallow vs. recrop, and nitrogen fertilization.

In addition to indicating the sources of variability, the curves illustrate the manner in which various factors affect spectral response.

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* Thermal measurements were collected by the FSS, but are not included in the examples because they cannot be combined and averaged in the same manner as reflective spectra.

The spectral reflectance curves are mean values-- the average of several individual spectra from different locations within a field or test plot, and, in most cases, the average of several fields. With the exception of the graphs illustrating the variability within and among wheat fields, variance information is not presented. The spectral curves, therefore, are intended to provide a general representation of scene variability and it would be inappropriate to use the spectral curves to assess, for example, the discriminability of wheat from other cover types because only first order (mean) statistics are shown. A more sophisticated model involving second order (variance, covariance, and correlation) multivariate statistics should be used for this problem (4). Quantitative analyses of the data using techniques involving second order statistics are currently being conducted by several investigators (3, 5).

Spectra of agricultural cover types presented in this report were selected from a much larger data set (Table 2). During the three years of data collection approximately 100,000 individual spectra over more than 1000 fields or test plots were acquired. There were typically seven to ten missions for each test site during each growing season. Thus, the data selected for this document represent only a small fraction of the total data set. The Data Library Catalog contains information on the location, date, scene type, sensor, and identifying observation number of all data (6).

Investigators are encouraged to obtain copies of the computer-compatible digital tapes for analysis. In addition to the spectral data, the digital tapes include complete information describing the conditions of the mission (e.g., date, time, heading, altitude, solar elevation, and azimuth angles), meteorological measurements, and agronomic observations and measurements of the crop-soil condition. The digital data are supplemented by ground-level photographic views of fields and plots, as well as aerial photography acquired simultaneously with the spectral reflectance measurements.

Table 2. Approximate growth stages of wheat at missions when truck- and helicopter-borne spectrometer data were acquired.

Year	Site/Crop	Mission	Wheat Growth Stage
1974-75 Crop	Finney County, Kansas Winter Wheat	Oct 17-20	Seedling
		Nov 4-7	Tillering
		Nov 23-25	Tillering
		Mar 19-22	Tillering
		Apr 6-9	Jointing
		Apr 24-27	Jointing
		May 13-16	Boot
		May 21-24	Heading
		May 30-Jun 2	Milk
		Jun 8-11	Dough
		Jun 17-20	Ripening
		Jun 25-28	Mature
		Jul 5-8	Post Harvest
1975 Crop	Williams County, N.D. Spring Wheat	Jun 3-7	Seedling
		Jun 21-24	Tillering
		Jul 9-12	Boot
		Jul 18-21	Heading
		Jul 27-30	Headed
		Aug 5-8	Milk-dough
		Aug 14-17	Ripening
		Aug 23-27	Mature
		Sep 1-4	Post Harvest
1975-76 Crop	Finney County, Kansas Winter Wheat	Sep 14-17	Pre-emergence
		Oct 2-6	Seedling
		Oct 20-23	Seedling
		Nov 11-12	Tillering
		Mar 13-19	Tillering
		Mar 30-Apr 2	Tillering
		Apr 18-21	Jointing
		May 4-7	Pre-Boot
		May 14-16	Boot
		May 24-27	Heading
		Jun 11-13	Dough
		Jun 20-21	Ripening
		Jun 29-Jul 2	Mature to Post harvest

Table 2. (continued)

Year	Site/Crop	Mission	Wheat Growth Stage
1976 Crop	Williams County, N.D. Spring Wheat	May 10-14	Emergence
		May 28-30	Seedling
		Jun 15-17	Jointing
		Jun 25-27	Boot
		Jul 4-8	Heading
		Jul 13-17	Dough
		Jul 20-23	Ripening
		Jul 28-31	Mature
		Aug 6-12	Harvest
		Aug 17-20	Post Harvest
1975-76 Crop	Hand County, S.D. Winter Wheat	Oct 15-16	Emergence
		Oct 22-30	Seedling
		Nov 5-6	Tillering
		May 10-16	Stem Extension
		Jun 1-4	Heading
		Jun 19-23	Dough
		Jul 8-10	Harvest
		Jul 31-Aug 4	Post Harvest
1975-76 Crop	Hand County, S.D. Spring Wheat	Oct 15-16	Not planted
		Oct 22-30	Not planted
		Nov 5-6	Not planted
		May 10-16	Tillering
		Jun 1-4	Boot
		Jun 19-23	Headed
		Jul 8-10	Ripening-Ripe
		Jul 31-Aug 4	Post Harvest

C. References

1. MacDonald, R.B. and F.G. Hall. 1977. LACIE: A Look to the Future. Proceedings Eleventh Int'l. Symp. on Remote Sensing of Environment. Ann Arbor, Michigan. April 25-29, 1977.

2. LACIE Field Measurements, Project Plan, 1974-75 and 1975-76; Revised and re-issued 1976-77.

3. Bauer, M.E. et. al. 1977. Agricultural Scene Understanding: LACIE Field Measurements. LARS Contract Report 112677, Laboratory for Applications of Remote Sensing, Purdue University, West Lafayette, Indiana.

4. D.A. Landgrebe. An Essay on the Discrimination of Crop Spectra. In Crop Spectra Workshop Report, February 1-3, 1977, Sterling, Virginia.

5. Malila, W.A. and J.M. Gleason. 1977. Investigations of Spectral Separability of Small Grains, Early Season Wheat Detection, and Multicrop Inventory Planning. ERIM Report 122700-34-F. Environmental Research Institute of Michigan, Ann Arbor, Michigan.

6. LACIE Field Measurements, Data Library Catalog: Volume I, 1974-75 Data; Volume II, 1975-76 Data; and Volume III, 1976-77 Data.

Table 2. (continued)

Year	Site/Crop	Mission	Wheat Growth Stage
1976 Crop	Williams County, N.D. Spring Wheat	May 10-14	Emergence
		May 28-30	Seedling
		Jun 15-17	Jointing
		Jun 25-27	Boot
		Jul 4-8	Heading
		Jul 13-17	Dough
		Jul 20-23	Ripening
		Jul 28-31	Mature
		Aug 6-12	Harvest
		Aug 17-20	Post Harvest
1975-76 Crop	Hand County, S.D. Winter Wheat	Oct 15-16	Emergence
		Oct 22-30	Seedling
		Nov 5-6	Tillering
		May 10-16	Stem Extension
		Jun 1-4	Heading
		Jun 19-23	Dough
		Jul 8-10	Harvest
		Jul 31-Aug 4	Post Harvest
1975-76 Crop	Hand County, S.D. Spring Wheat	Oct 15-16	Not planted
		Oct 22-30	Not planted
		Nov 5-6	Not planted
		May 10-16	Tillering
		Jun 1-4	Boot
		Jun 19-23	Headed
		Jul 8-10	Ripening-Ripe
		Jul 31-Aug 4	Post Harvest

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1. MacDonald, R.B. and F.G. Hall. 1977. LACIE: A Look to the Future. Proceedings Eleventh Int'l. Symp. on Remote Sensing of Environment. Ann Arbor, Michigan. April 25-29, 1977.

2. LACIE Field Measurements, Project Plan, 1974-75 and 1975-76; Revised and re-issued 1976-77.

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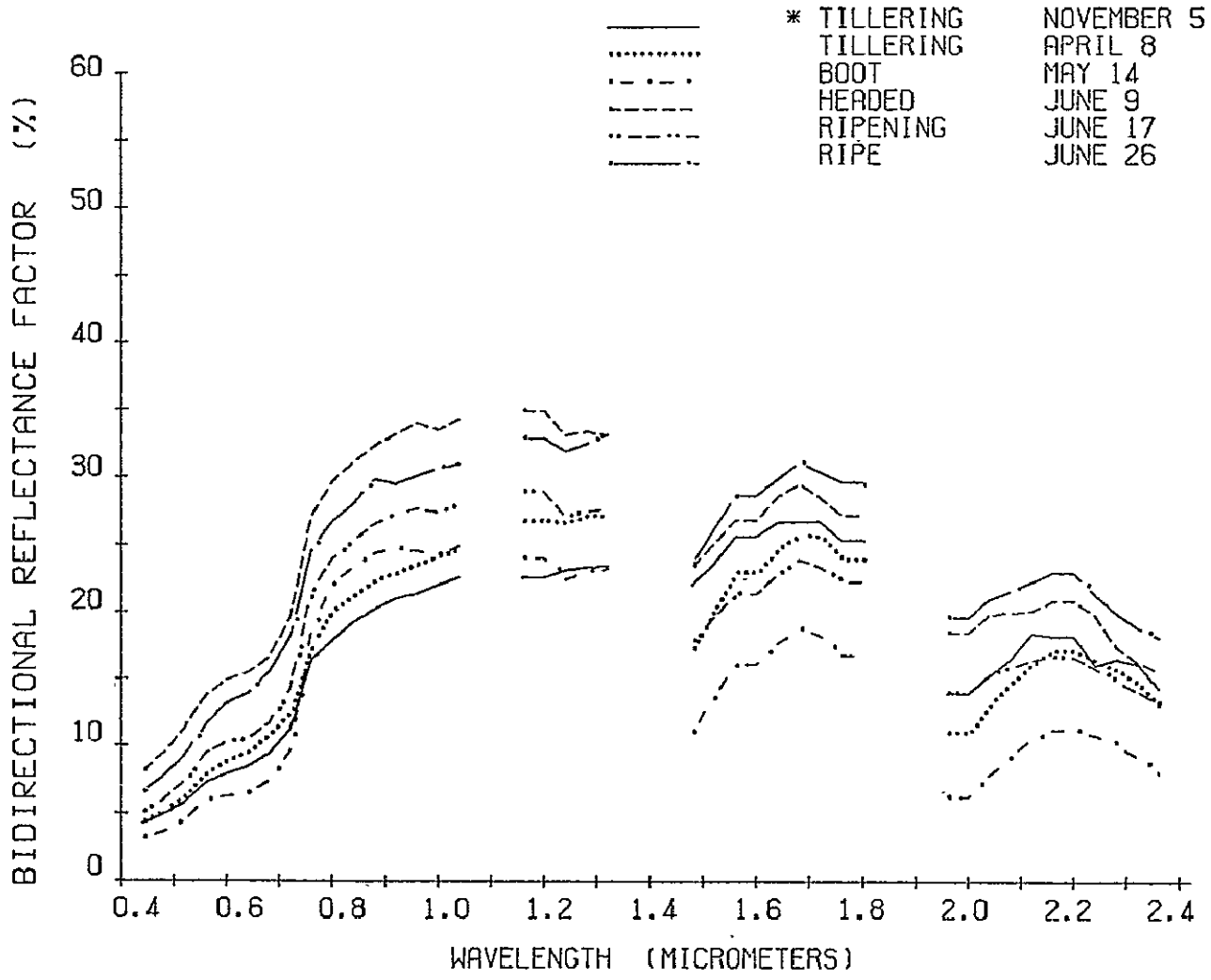
6. LACIE Field Measurements, Data Library Catalog: Volume I, 1974-75 Data; Volume II, 1975-76 Data; and Volume III, 1976-77 Data.

II. Kansas Winter Wheat Examples

A. Variation Within Winter Wheat

REFLECTANCE OF IRRIGATED WINTER WHEAT AT DIFFERENT MATURITY STAGES

LOCATION: FINNEY COUNTY, KANSAS
SENSOR: FSS DATE: 1974-75



* AVERAGE OF 10 FIELDS.

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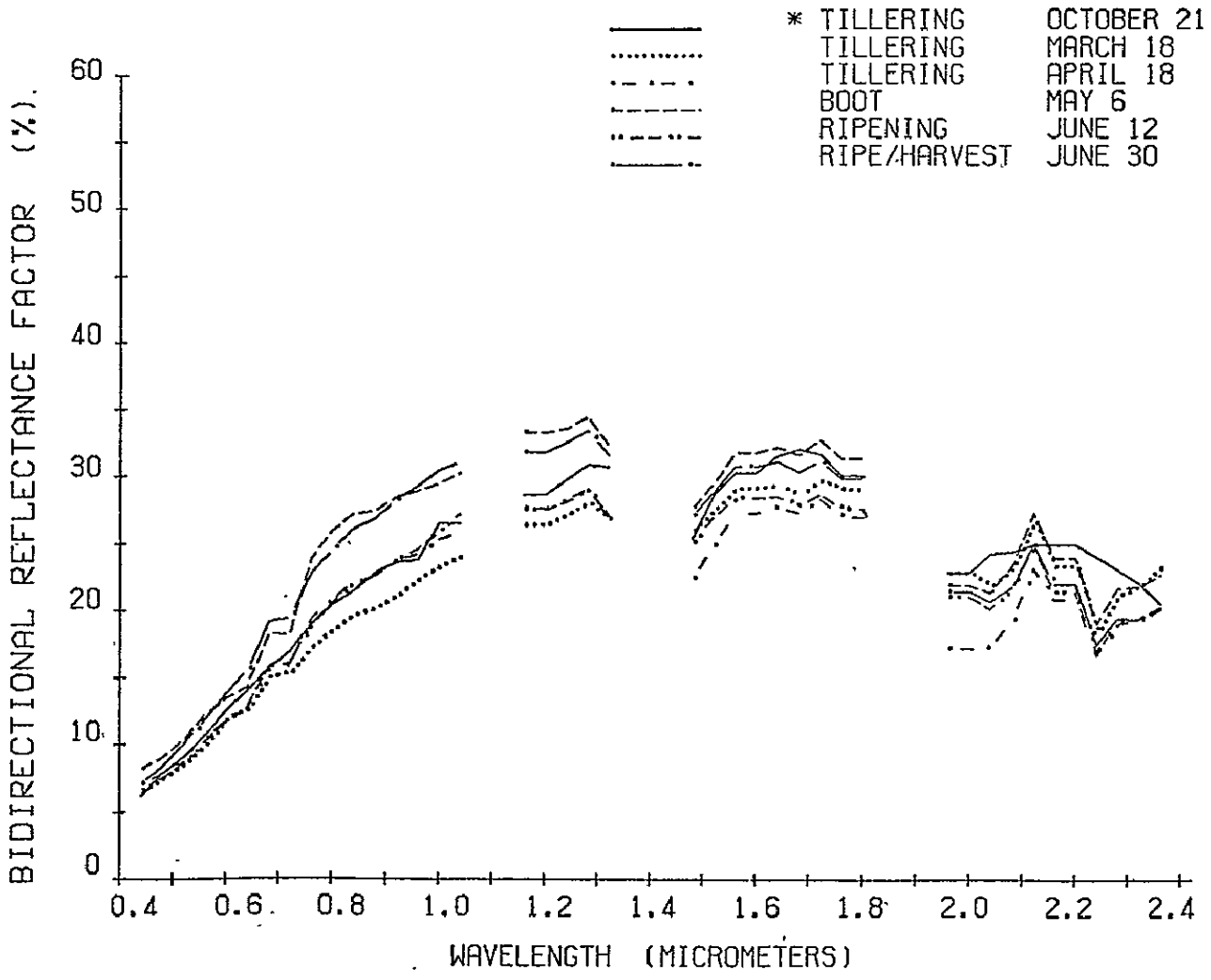
REFLECTANCE OF DRYLAND WINTER WHEAT AT DIFFERENT MATURITY STAGES

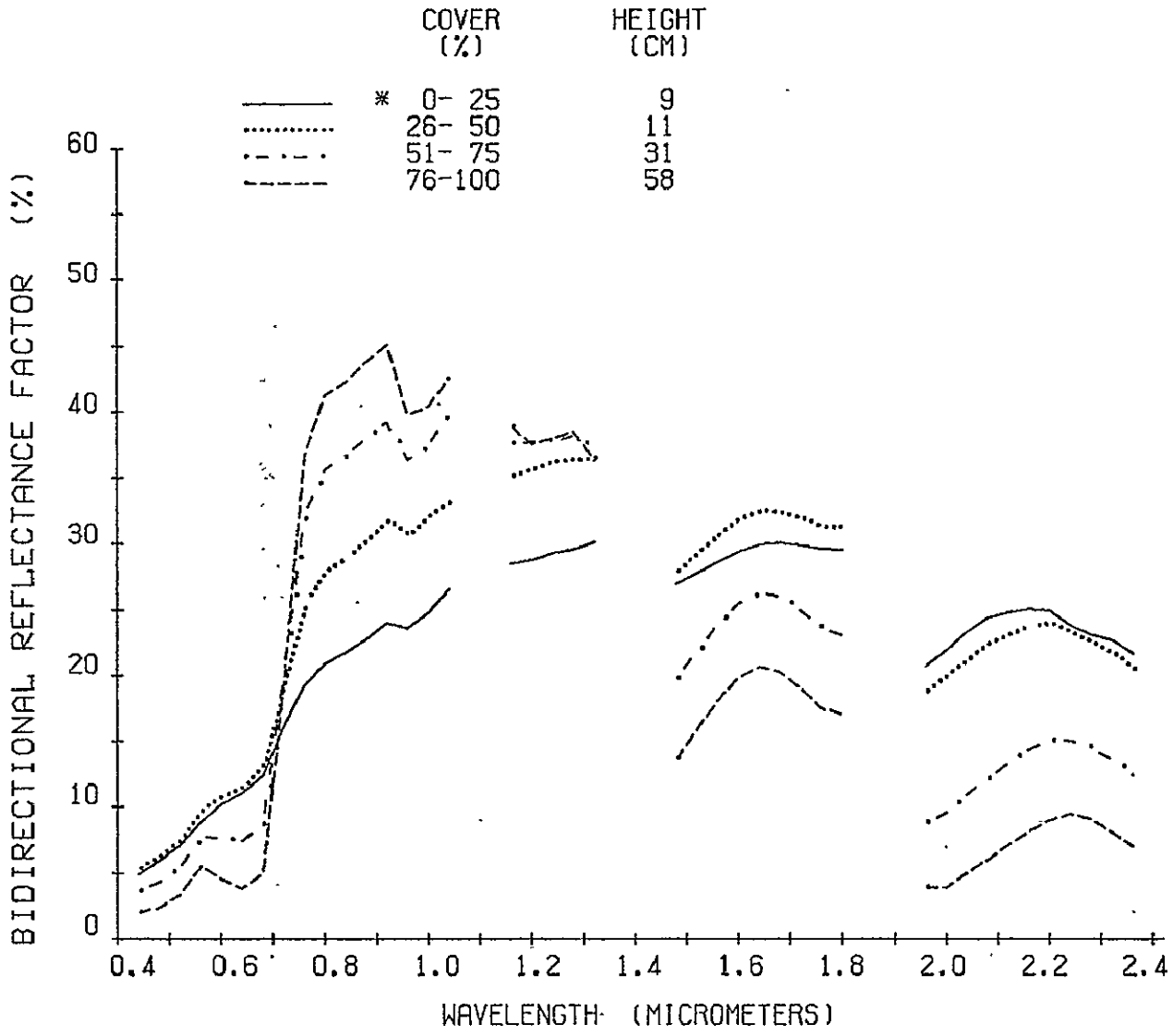
LOCATION: FINNEY COUNTY, KANSAS
SENSOR: FSS DATE: 1975-76



* AVERAGE OF 9 FIELDS.

REFLECTANCE OF WINTER WHEAT PLOTS WITH DIFFERENT GROUND COVERS

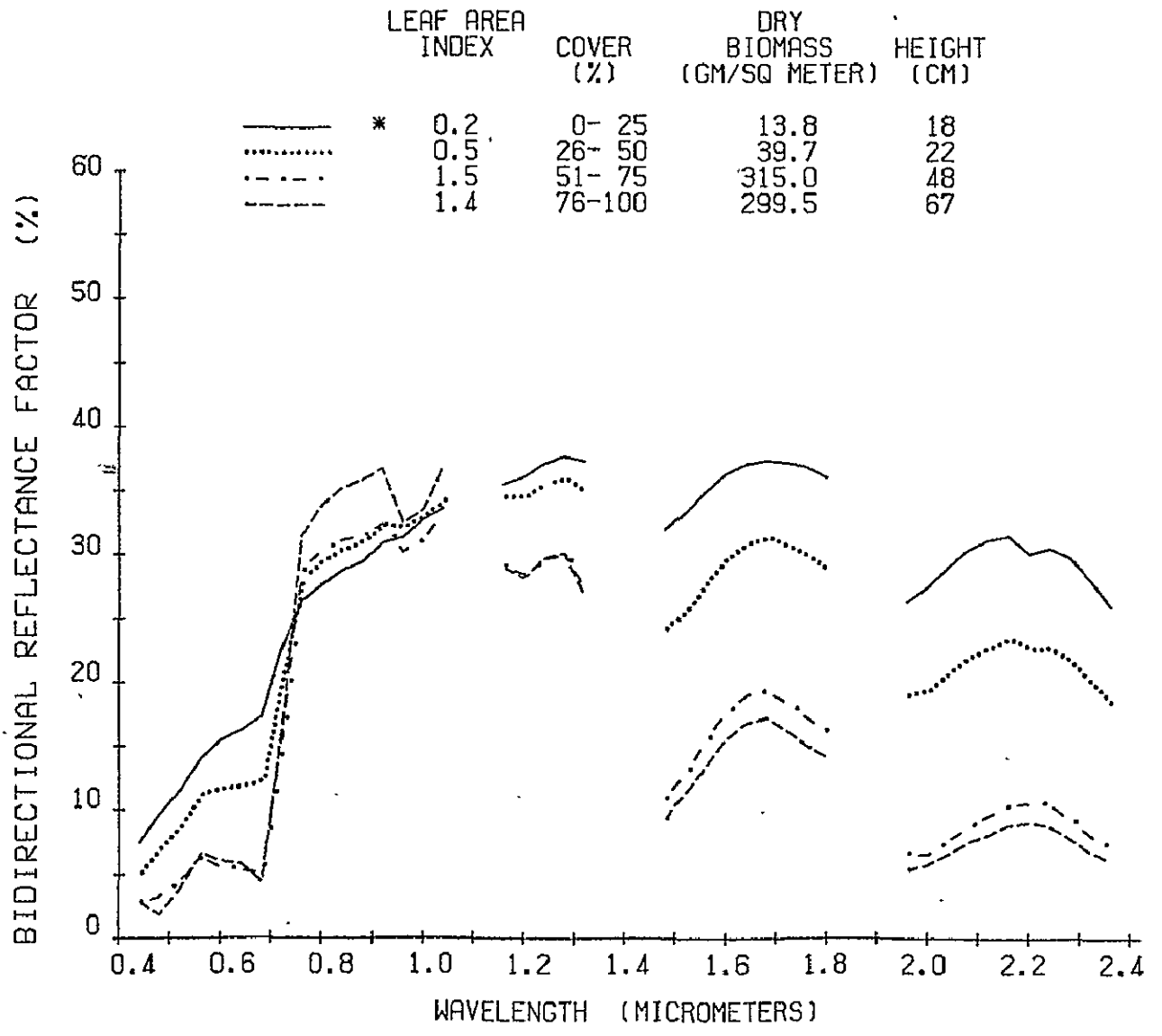
LOCATION: GARDEN CITY, KANSAS
SENSOR: EXOTECH MODEL 20D DATE: 1975



* AVERAGES OF 7, 10, 10, AND 10 PLOTS, RESPECTIVELY.

REFLECTANCE OF WINTER WHEAT PLOTS WITH DIFFERENT GROUND COVERS

LOCATION: GARDEN CITY, KANSAS
SENSOR: FSAS DATE: 1976



-* AVERAGES OF 8, 9, 10, AND 1 PLOTS, RESPECTIVELY.

REFLECTANCE OF WINTER WHEAT PLOTS WITH DIFFERENT LEAF AREAS

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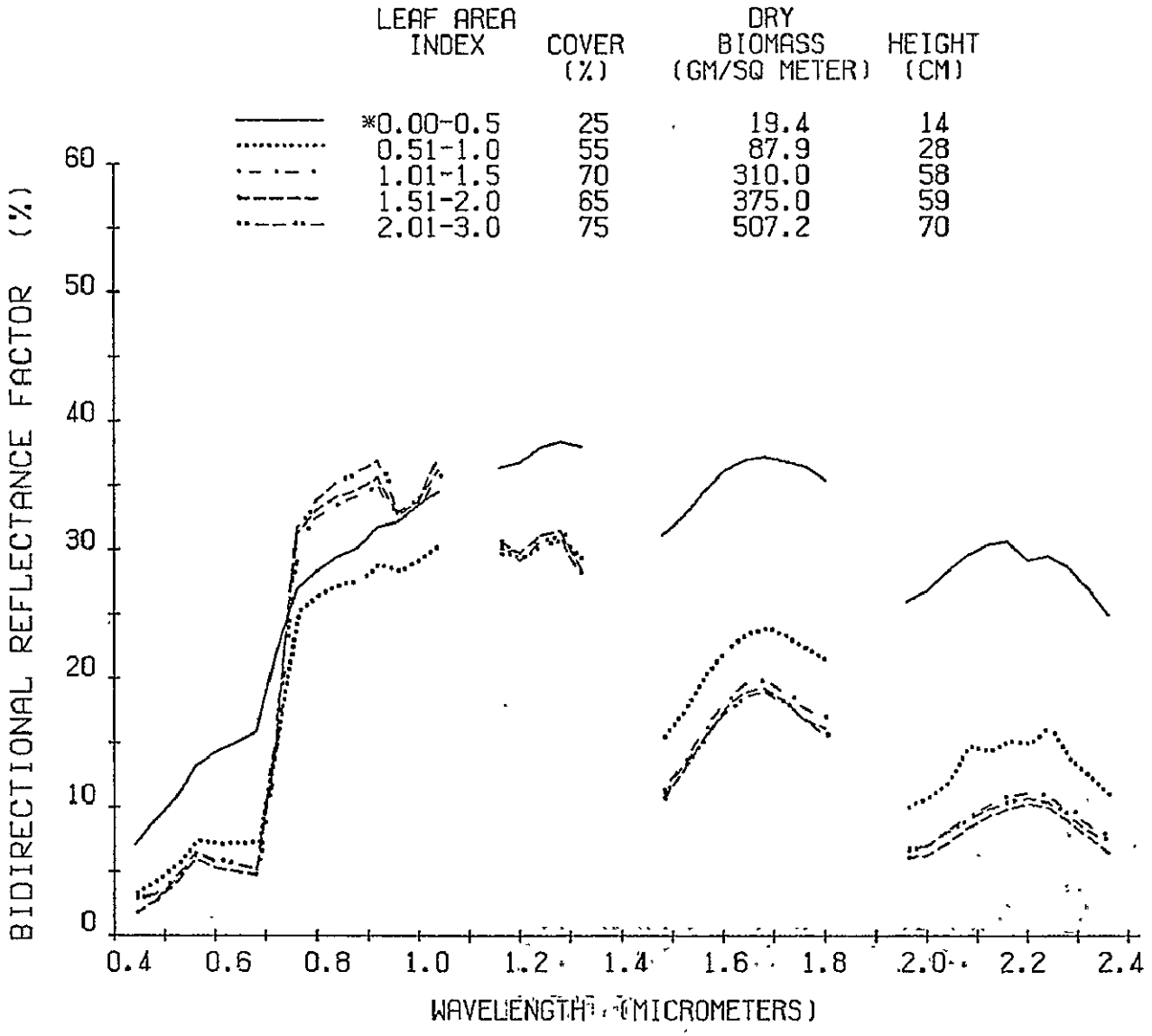
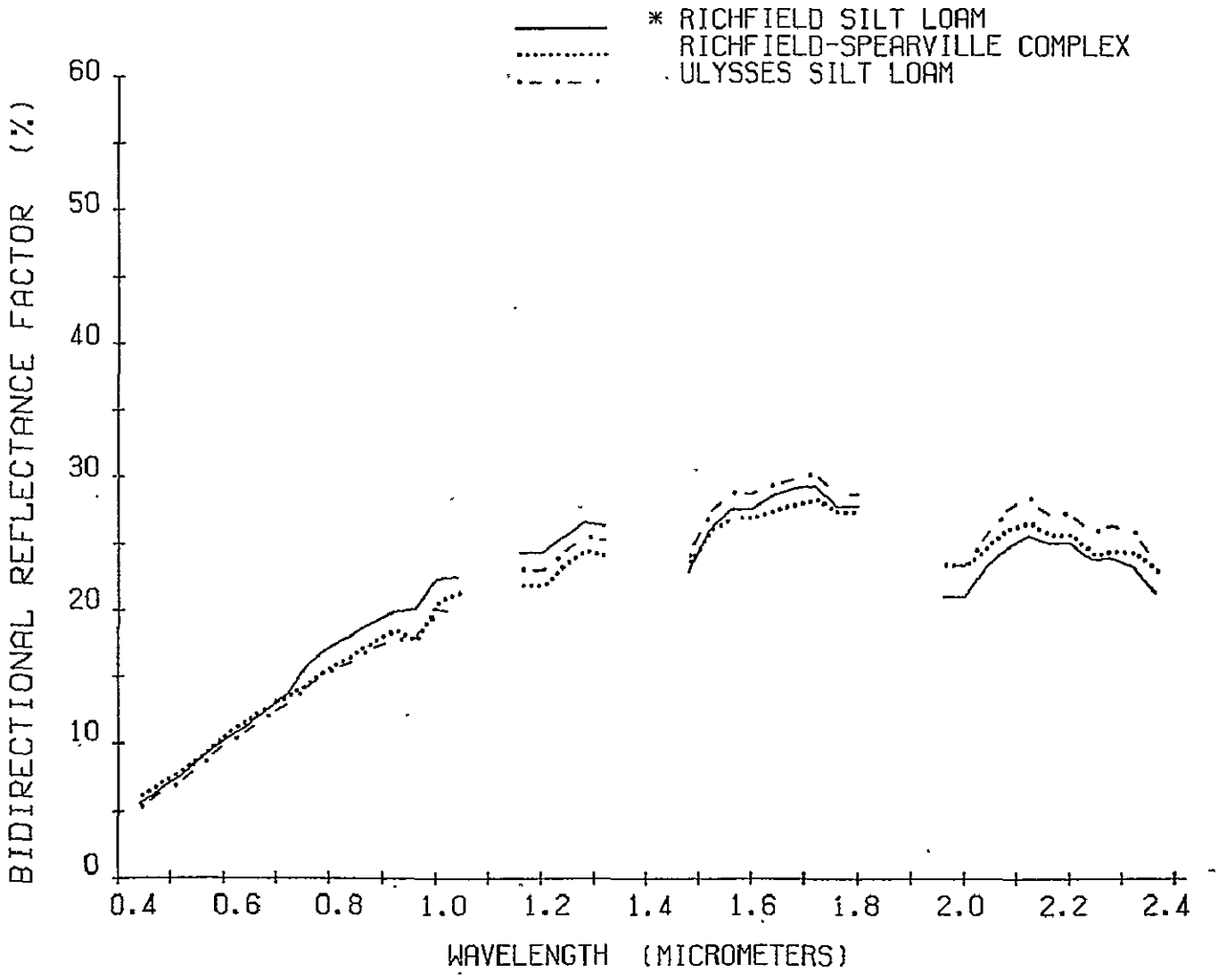
SENSOR: FSAS DATE: 1976



* AVERAGES OF 7, 7, 7, 7, AND 2 PLOTS, RESPECTIVELY.

REFLECTANCE OF WHEAT FIELDS WITH DIFFERENT SOIL TYPES

LOCATION: FINNEY COUNTY, KANSAS
SENSOR: FSS DATE: OCTOBER 21, 1975



* AVERAGES OF 6, 2, AND 1 FIELD, RESPECTIVELY.

REFLECTANCE OF WHEAT FIELDS WITH DIFFERENT SOIL MOISTURE

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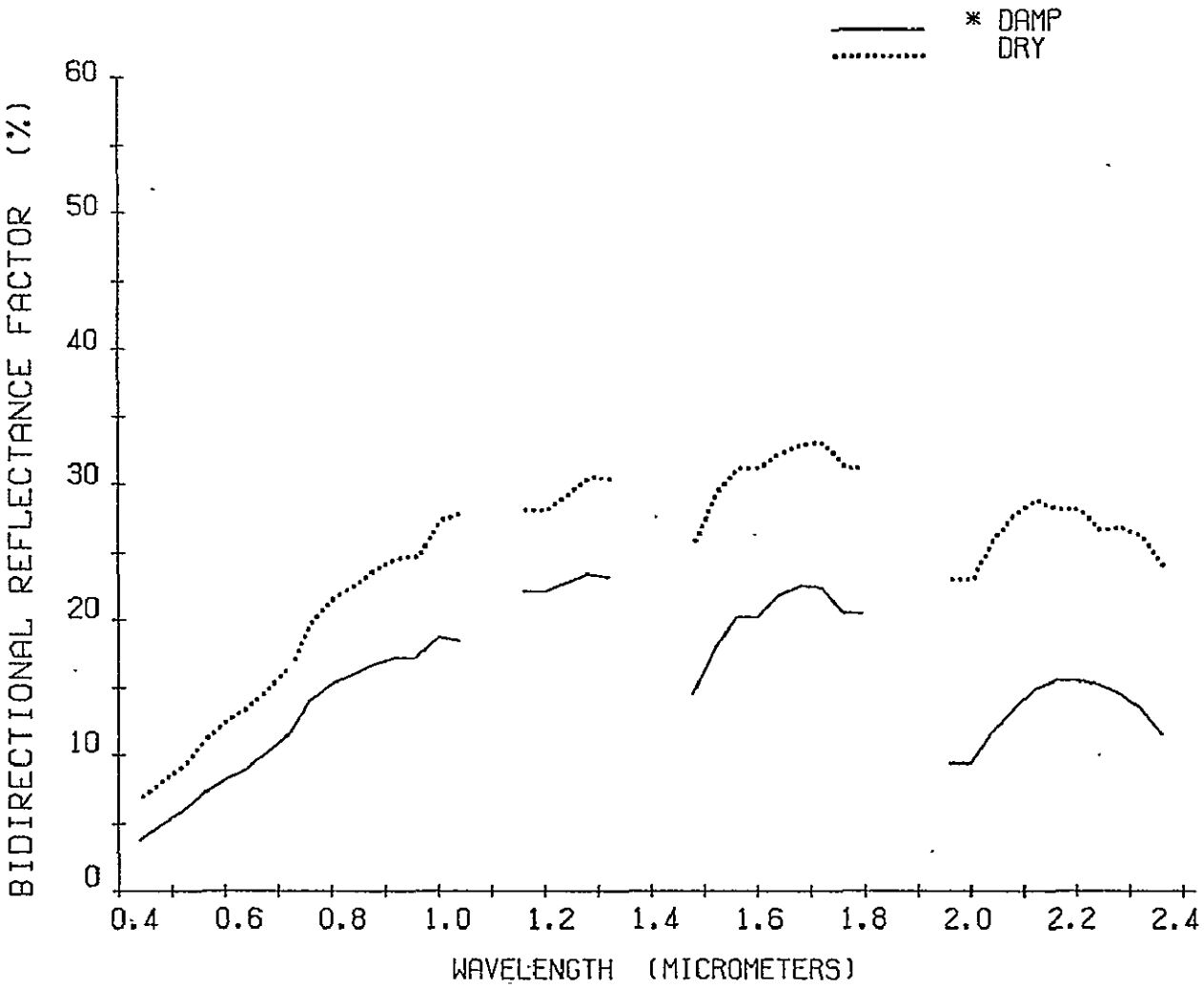
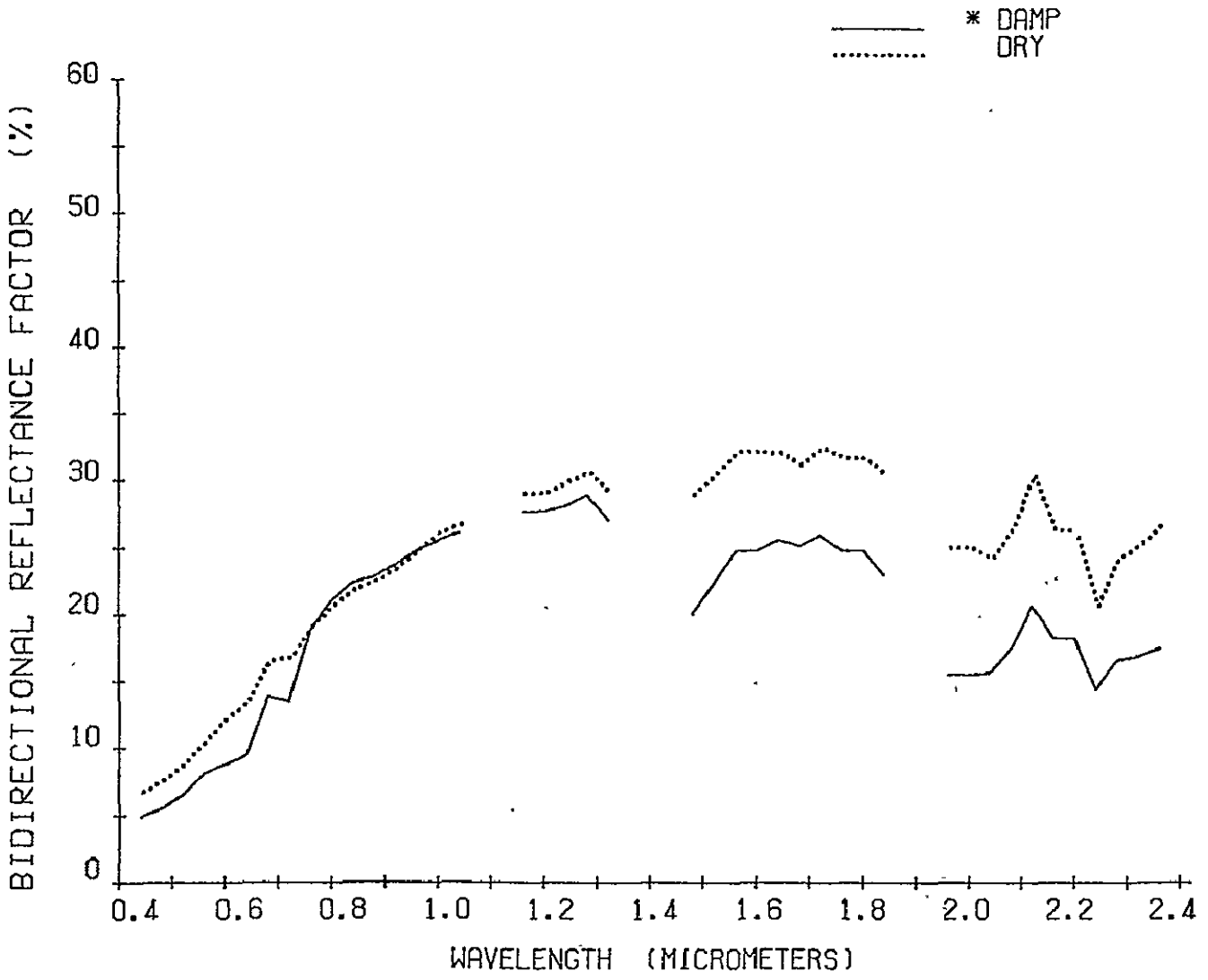
SENSOR: FSS DATE: OCTOBER 21, 1975



* AVERAGES OF 2 FIELDS.

REFLECTANCE OF WHEAT FIELDS WITH DIFFERENT SOIL MOISTURE

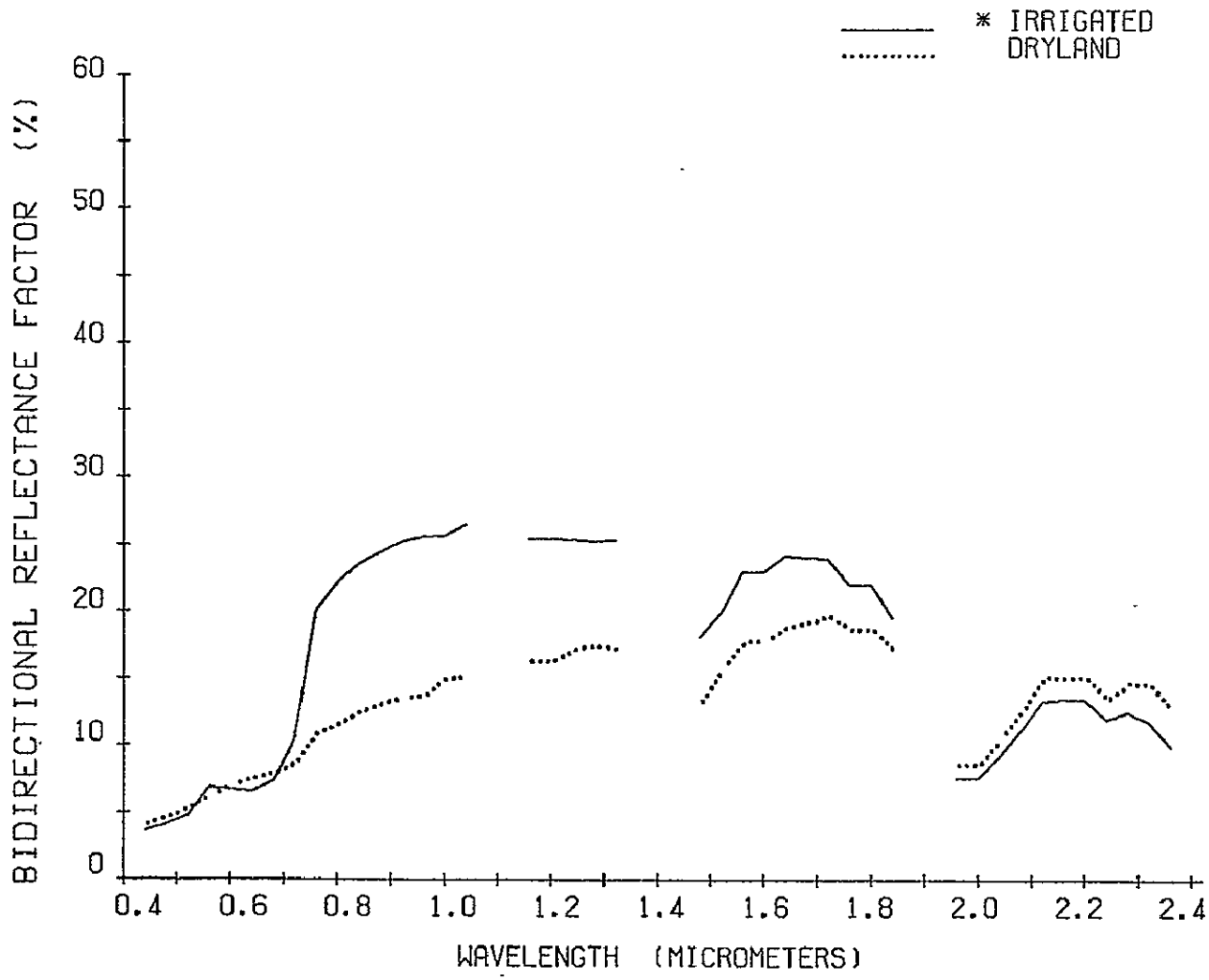
LOCATION: FINNEY COUNTY, KANSAS
SENSOR: .FSS DATE: MARCH 18, 1976



* AVERAGES OF 2 FIELDS.

DIFFERENCE IN REFLECTANCE OF WINTER WHEAT DUE TO IRRIGATION PRACTICES

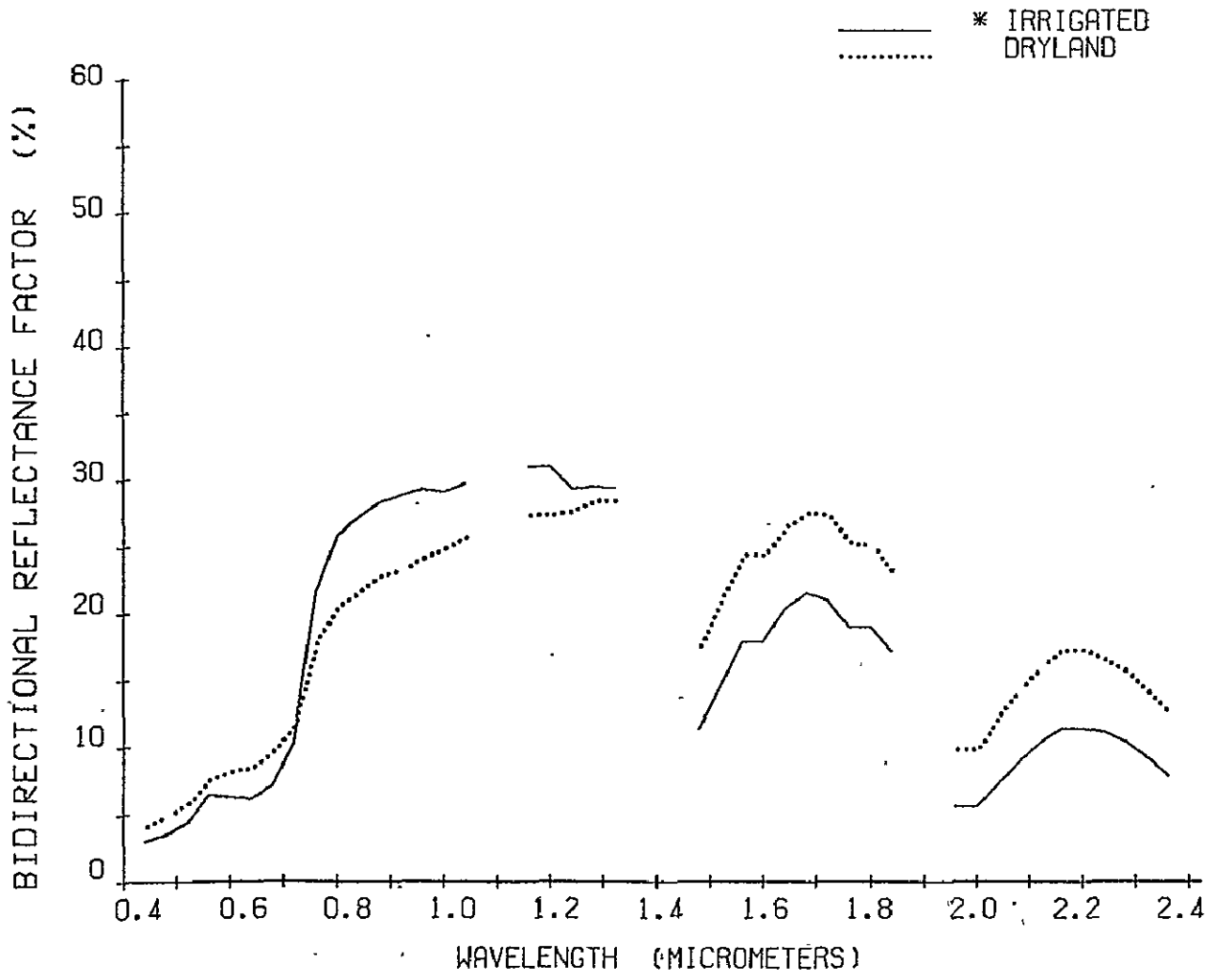
LOCATION: FINNEY COUNTY, KANSAS
SENSOR: FSS DATE: NOVEMBER 5, 1974



* AVERAGES OF 10 AND 2 FIELDS, RESPECTIVELY.

DIFFERENCE IN REFLECTANCE OF WINTER WHEAT DUE TO IRRIGATION PRACTICES

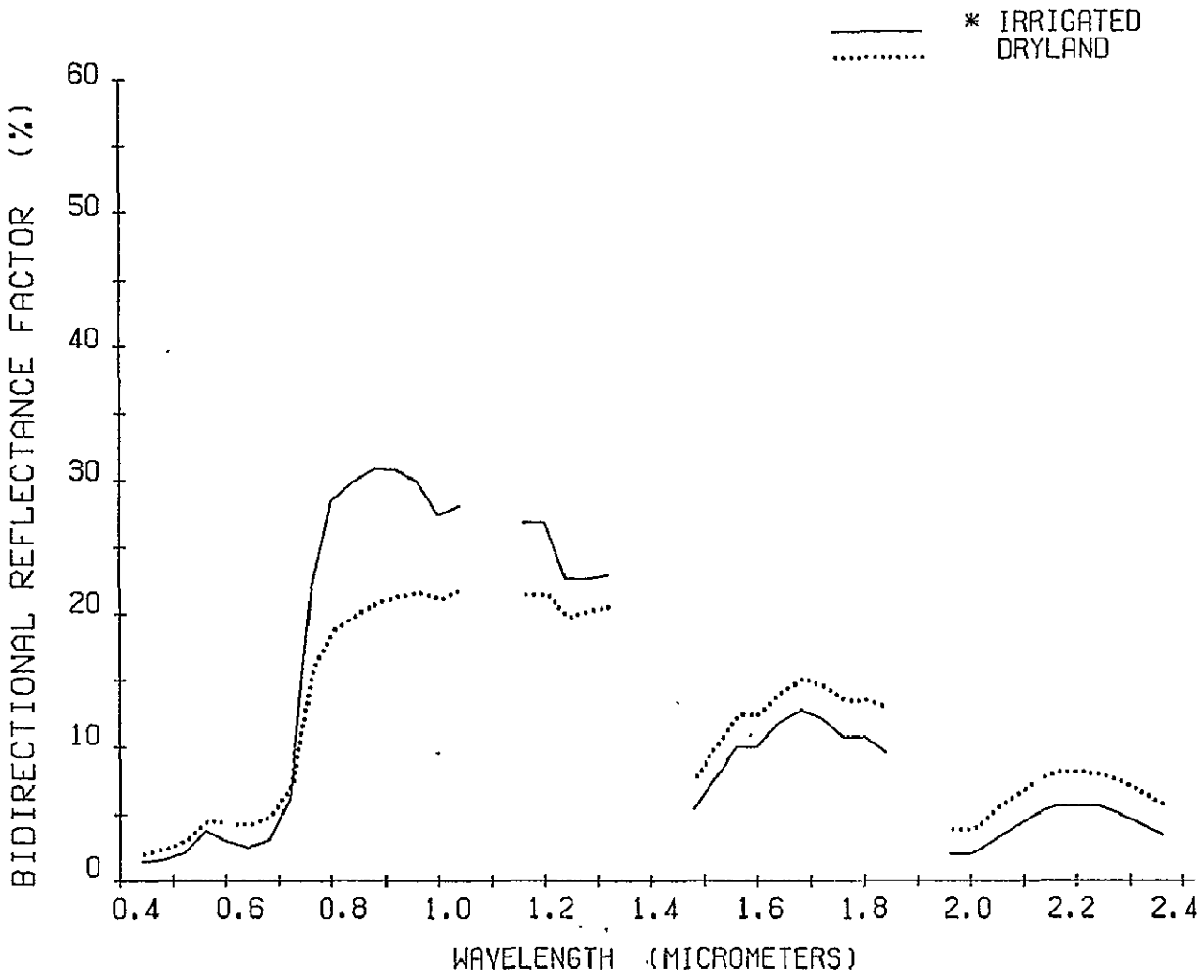
LOCATION: FINNEY COUNTY, KANSAS
SENSOR: FSS DATE: APRIL 8, 1975



* AVERAGES OF 10 AND 2 FIELDS, RESPECTIVELY.

DIFFERENCE IN REFLECTANCE OF WINTER WHEAT DUE TO IRRIGATION PRACTICES

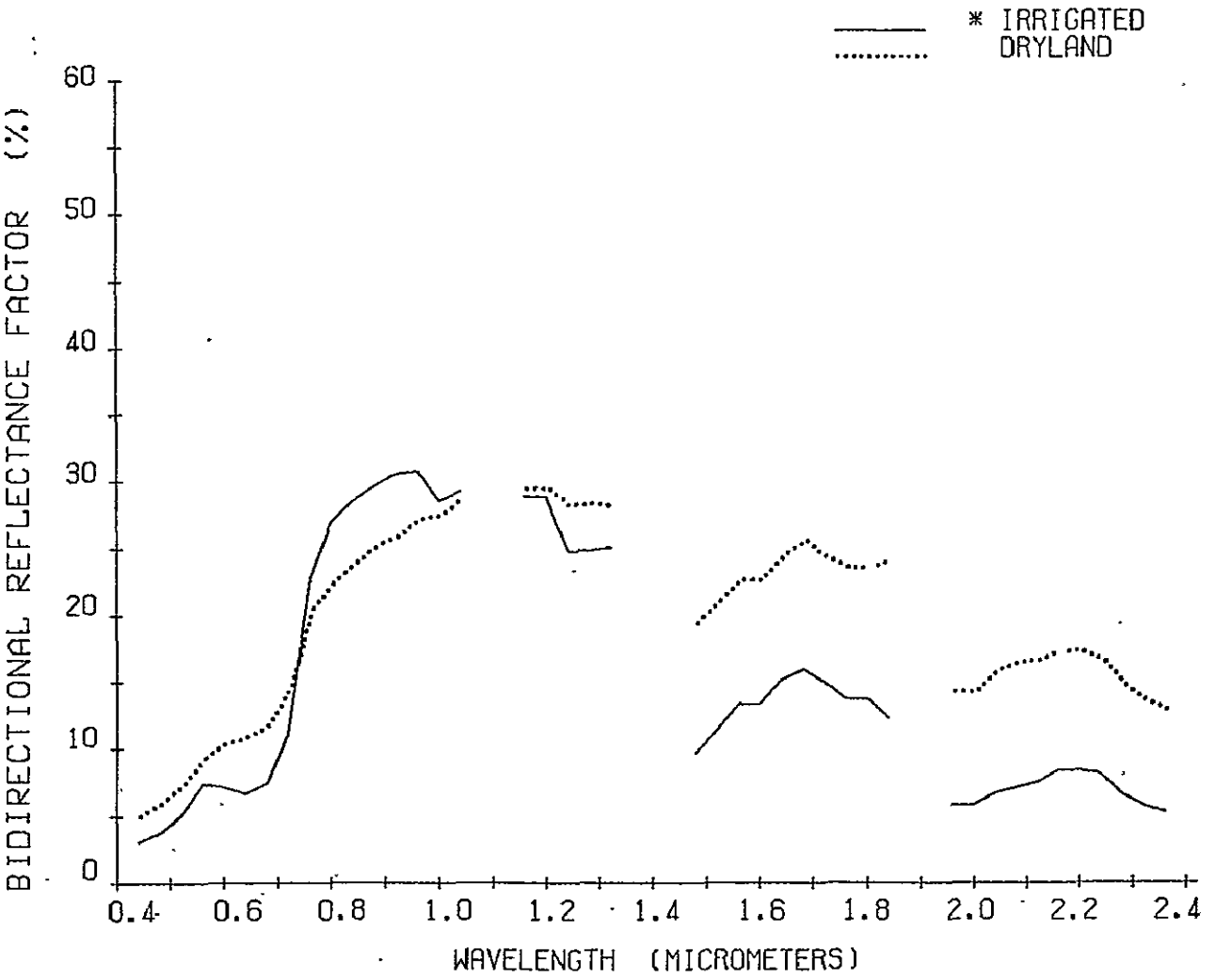
LOCATION: FINNEY COUNTY, KANSAS
SENSOR: FSS DATE: MAY 14, 1975



* AVERAGES OF 10 AND 2 FIELDS, RESPECTIVELY.

DIFFERENCE IN REFLECTANCE OF WINTER WHEAT DUE TO IRRIGATION PRACTICES

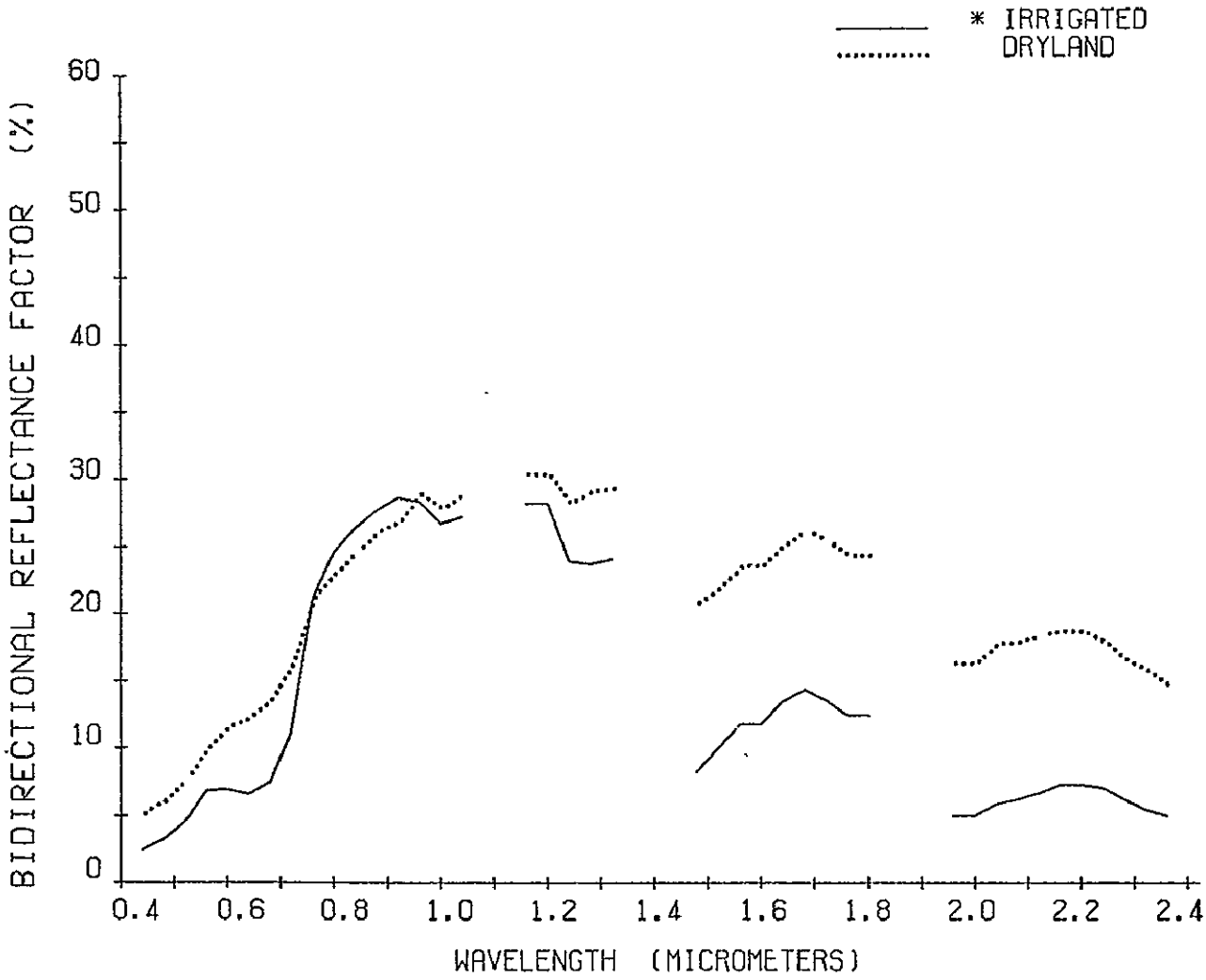
LOCATION: FINNEY COUNTY, KANSAS
SENSOR: FSS DATE: JUNE 9, 1975



* AVERAGES OF 10 AND 2 FIELDS, RESPECTIVELY.

DIFFERENCE IN REFLECTANCE OF WINTER WHEAT DUE TO IRRIGATION PRACTICES

LOCATION: FINNEY COUNTY, KANSAS
SENSOR: FSS DATE: JUNE 17, 1975



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DIFFERENCE IN REFLECTANCE OF WINTER WHEAT DUE TO IRRIGATION PRACTICES

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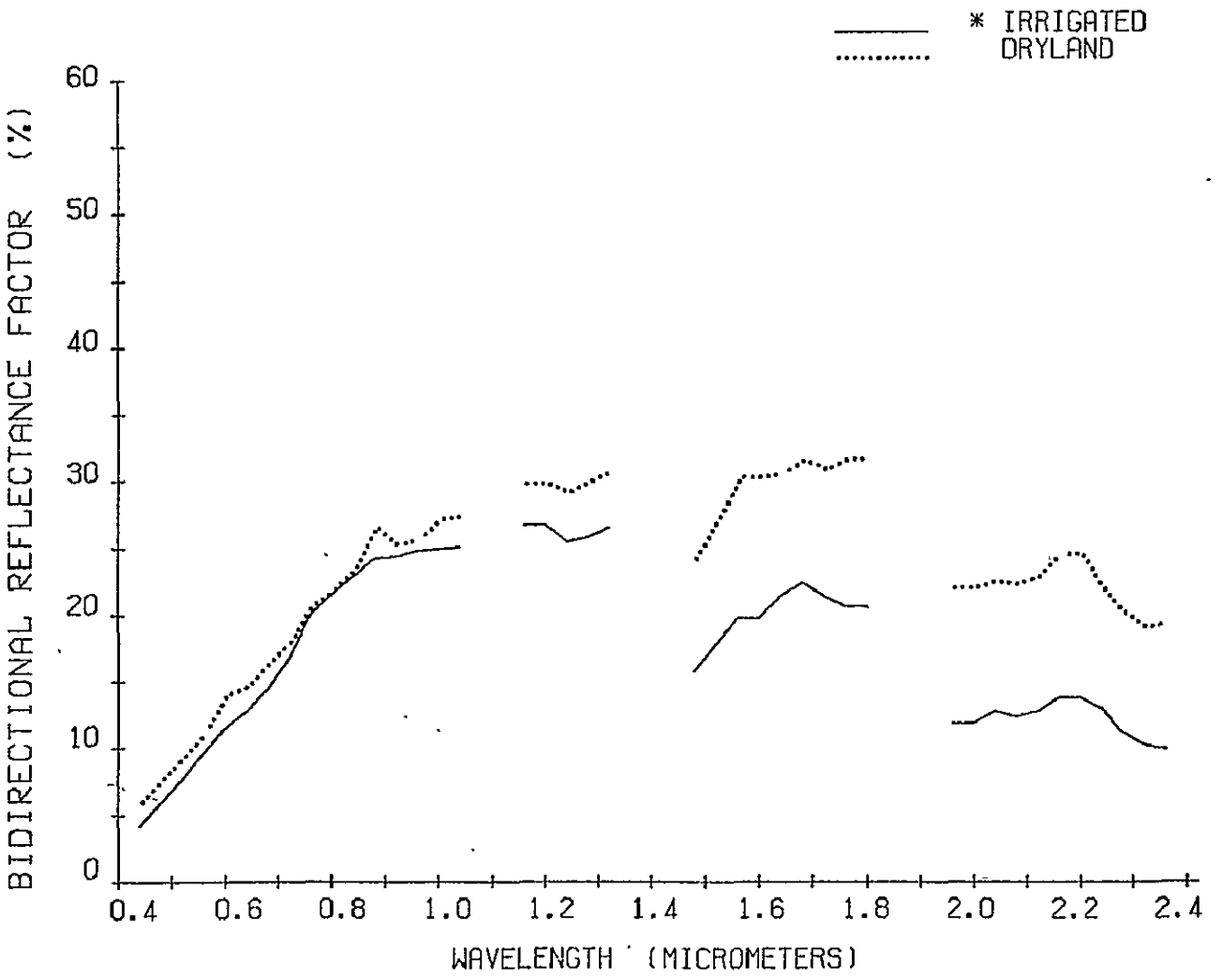

* AVERAGES OF 10 AND 2 FIELDS, RESPECTIVELY.

DIFFERENCE IN REFLECTANCE OF WINTER WHEAT DUE TO IRRIGATION PRACTICES

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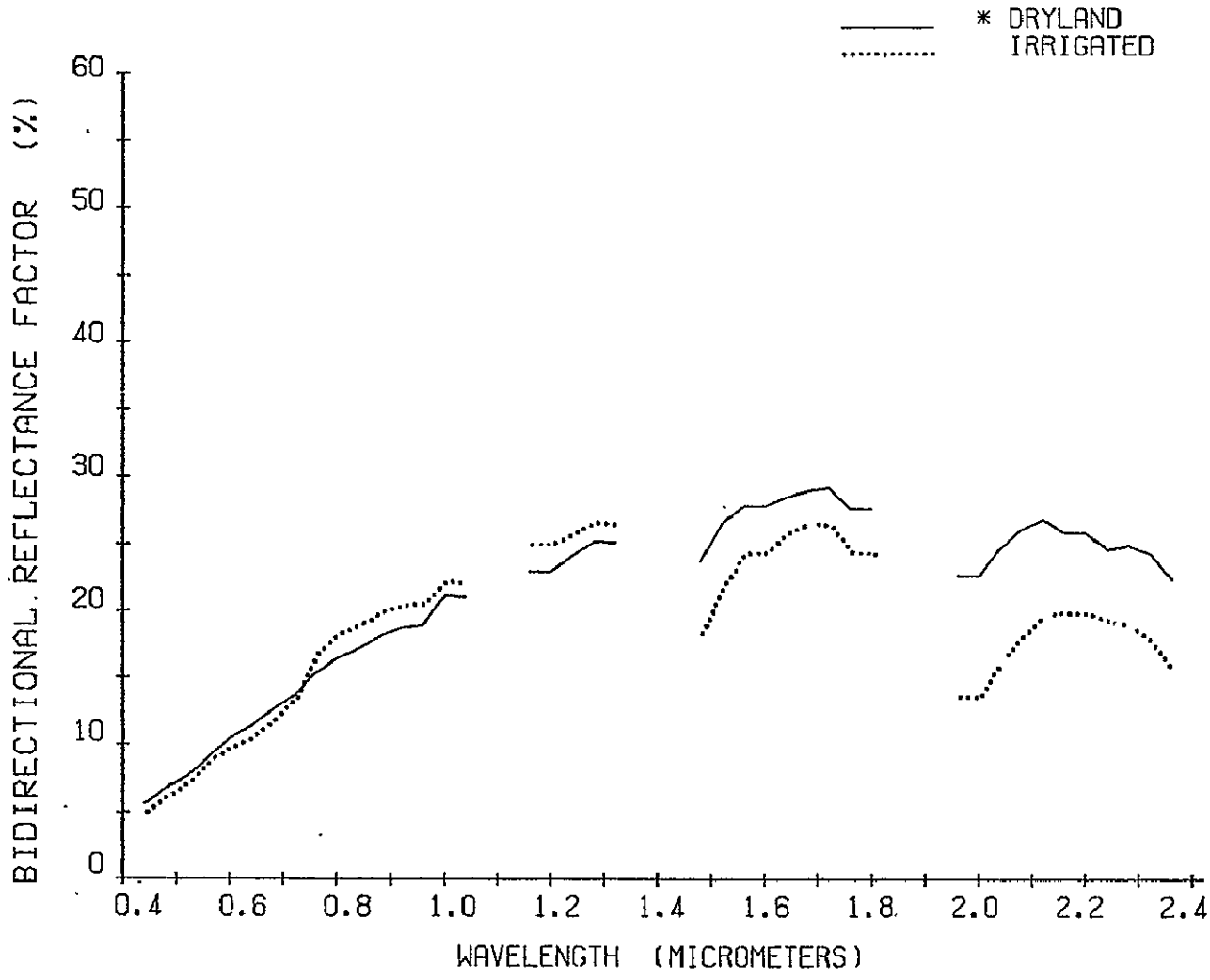
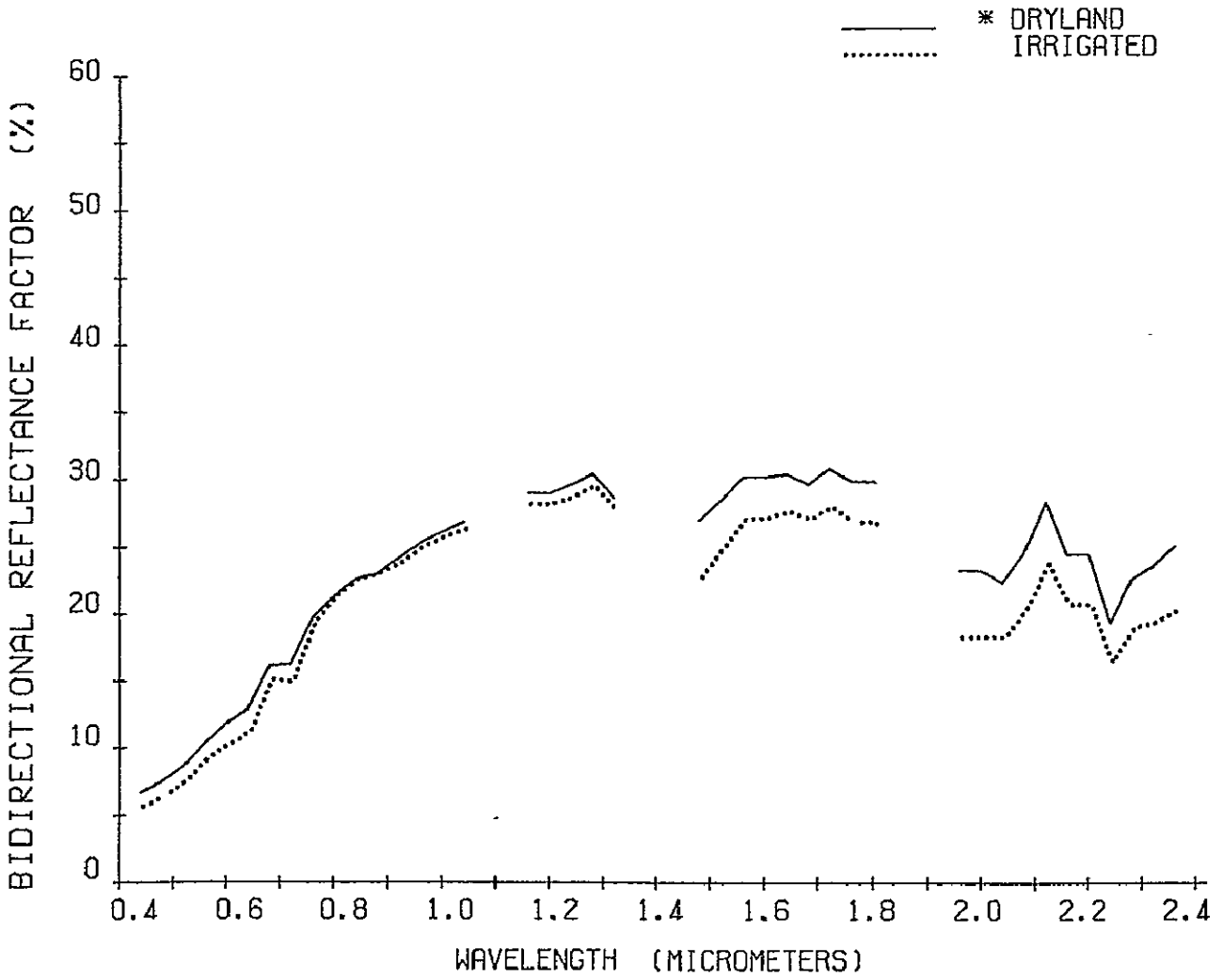


* AVERAGES OF 9 AND 3 FIELDS, RESPECTIVELY.

DIFFERENCE IN REFLECTANCE OF WINTER WHEAT DUE TO IRRIGATION PRACTICES

LOCATION: FINNEY COUNTY, KANSAS
SENSOR: FSS DATE: MARCH 18, 1976



* AVERAGES OF 9 AND 3 FIELDS, RESPECTIVELY.

DIFFERENCE IN REFLECTANCE OF WINTER WHEAT DUE TO IRRIGATION PRACTICES

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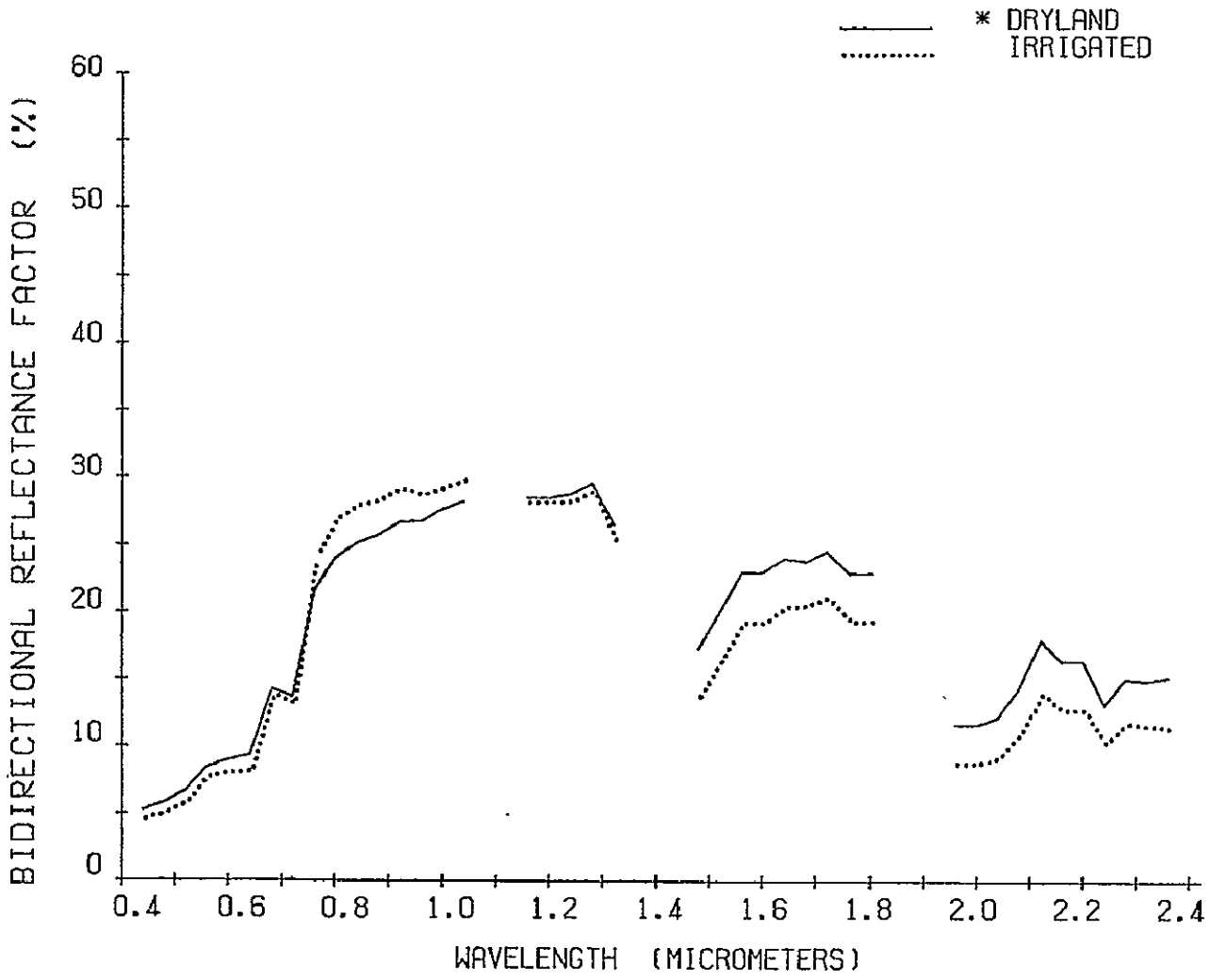
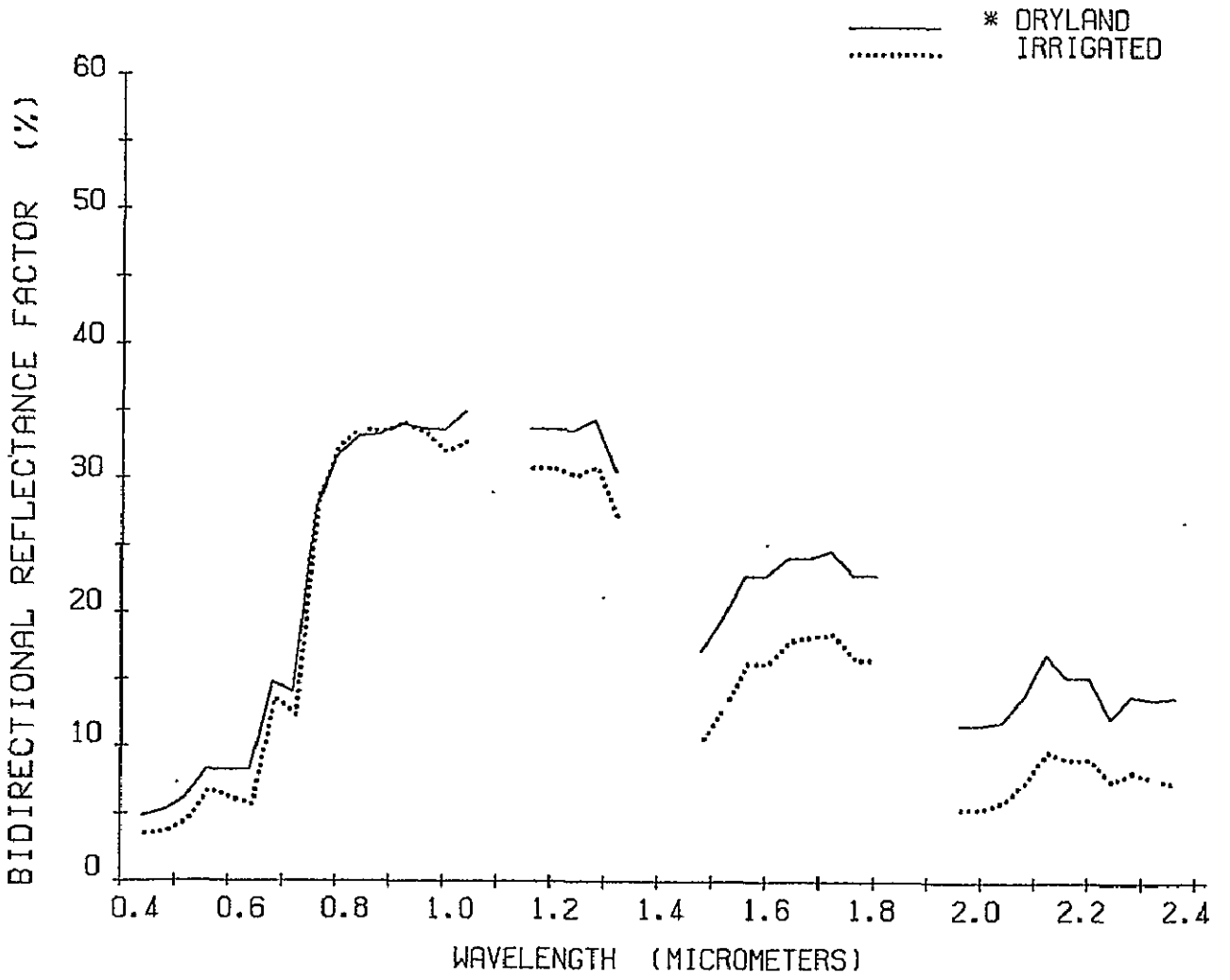


* AVERAGES OF 9 AND 3 FIELDS, RESPECTIVELY.

DIFFERENCE IN REFLECTANCE OF WINTER WHEAT DUE TO IRRIGATION PRACTICES

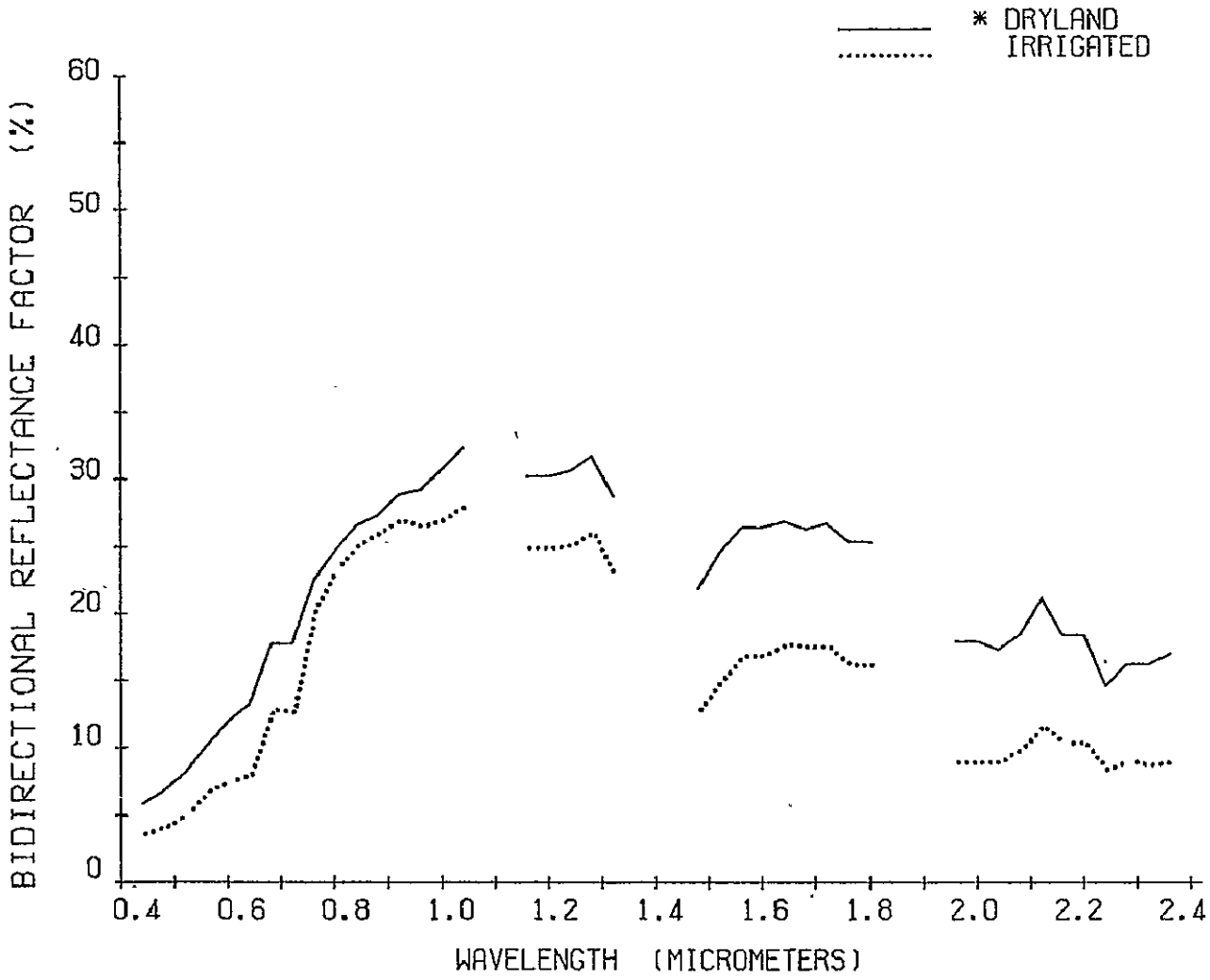
LOCATION: FINNEY COUNTY, KANSAS
SENSOR: FSS DATE: MAY 6, 1976



* AVERAGES OF 9 AND 3 FIELDS, RESPECTIVELY.

DIFFERENCE IN REFLECTANCE OF WINTER WHEAT DUE TO IRRIGATION PRACTICES

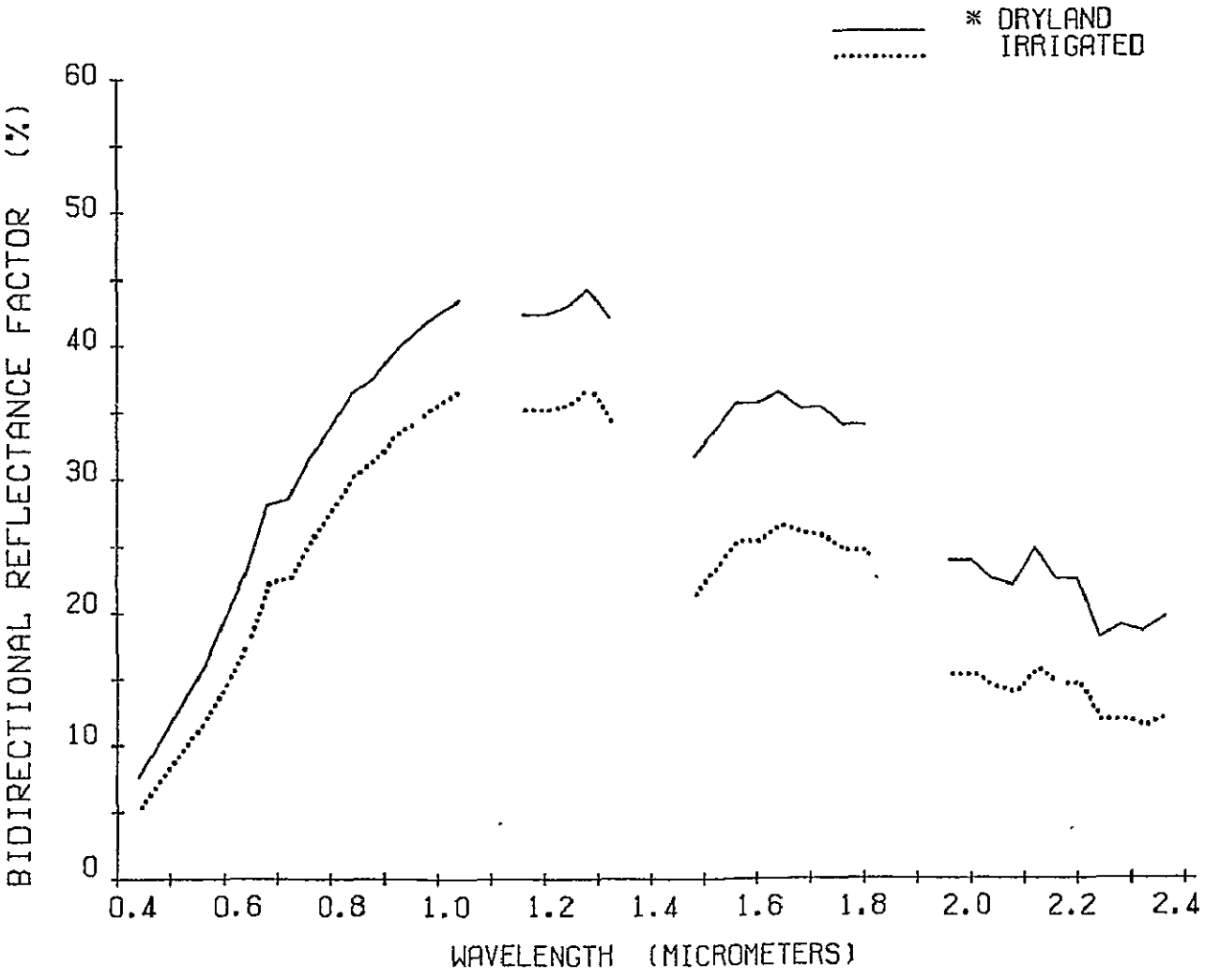
LOCATION: FINNEY COUNTY, KANSAS
SENSOR: FSS DATE: JUNE 12, 1976



* AVERAGES OF 9 AND 3 FIELDS, RESPECTIVELY.

DIFFERENCE IN REFLECTANCE OF WINTER WHEAT DUE TO IRRIGATION PRACTICES

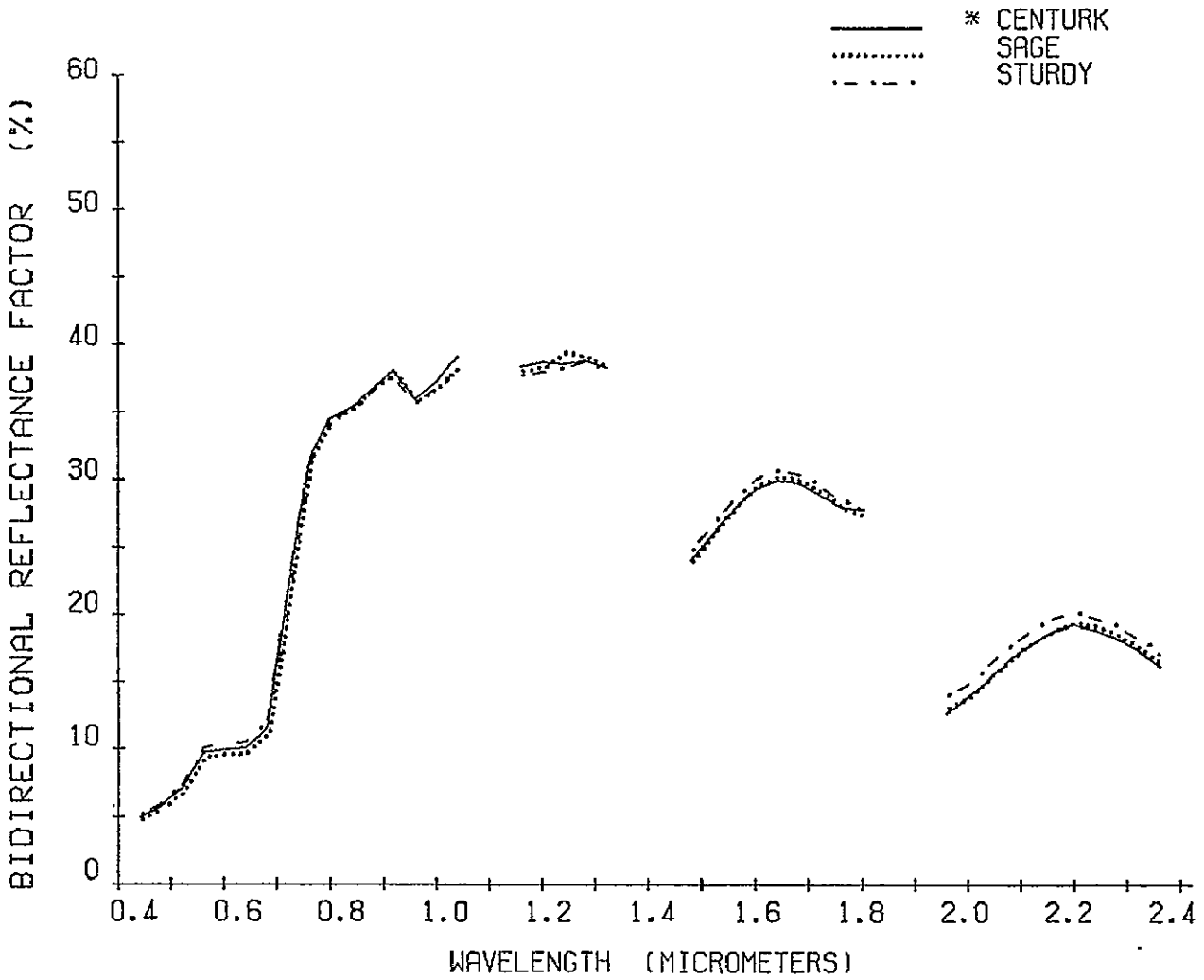
LOCATION: FINNEY COUNTY, KANSAS
SENSOR: FSS DATE: JUNE 30, 1976



* AVERAGES OF 9 AND 3 FIELDS, RESPECTIVELY.

REFLECTANCE OF SEVERAL VARIETIES OF WINTER WHEAT

LOCATION: FINNEY COUNTY, KANSAS
SENSOR: EXOTECH MODEL 20D DATE: APRIL 16, 1975

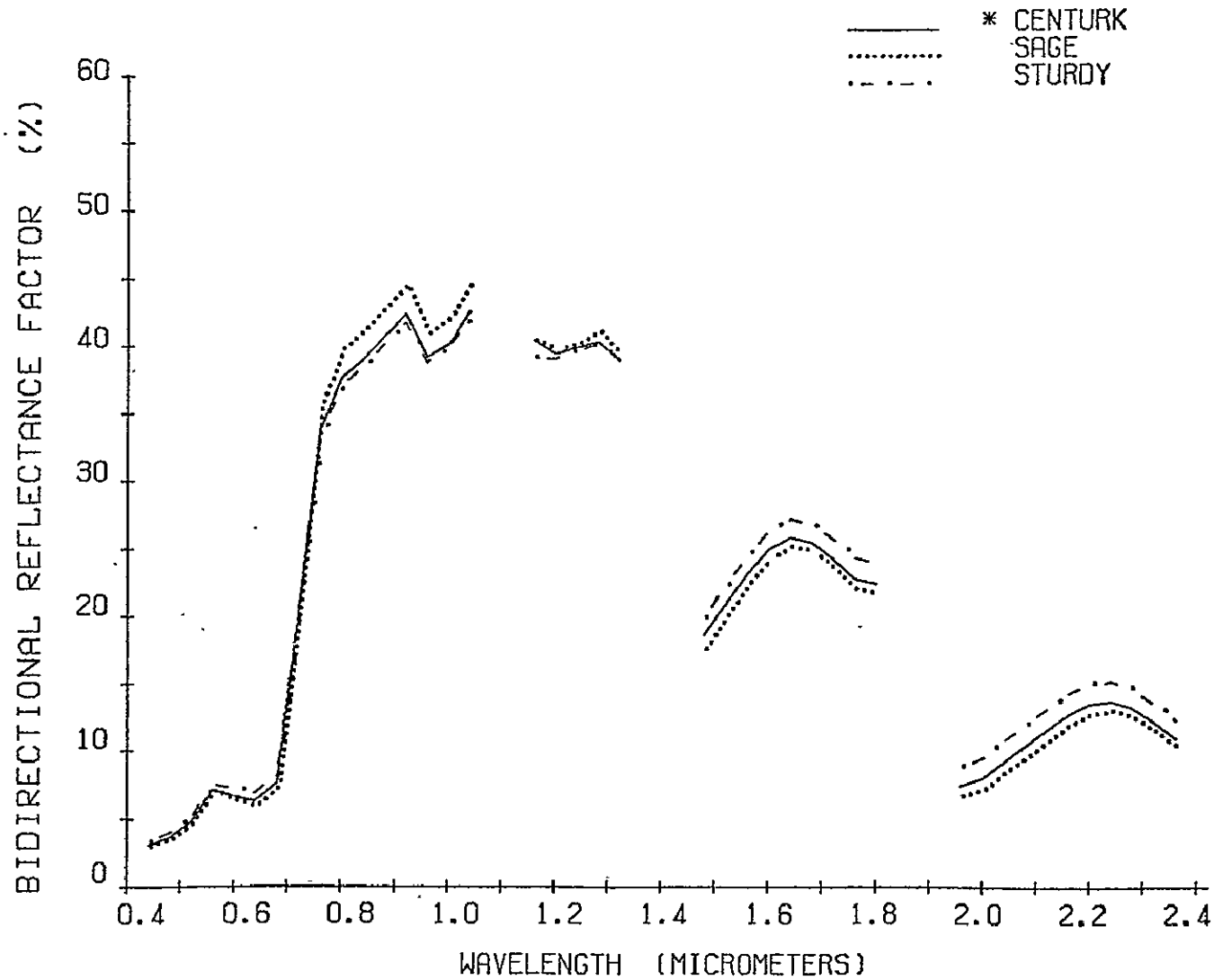


* AVERAGES OF 3 PLOTS.

REFLECTANCE OF SEVERAL VARIETIES OF WINTER WHEAT

LOCATION: GARDEN CITY, KANSAS

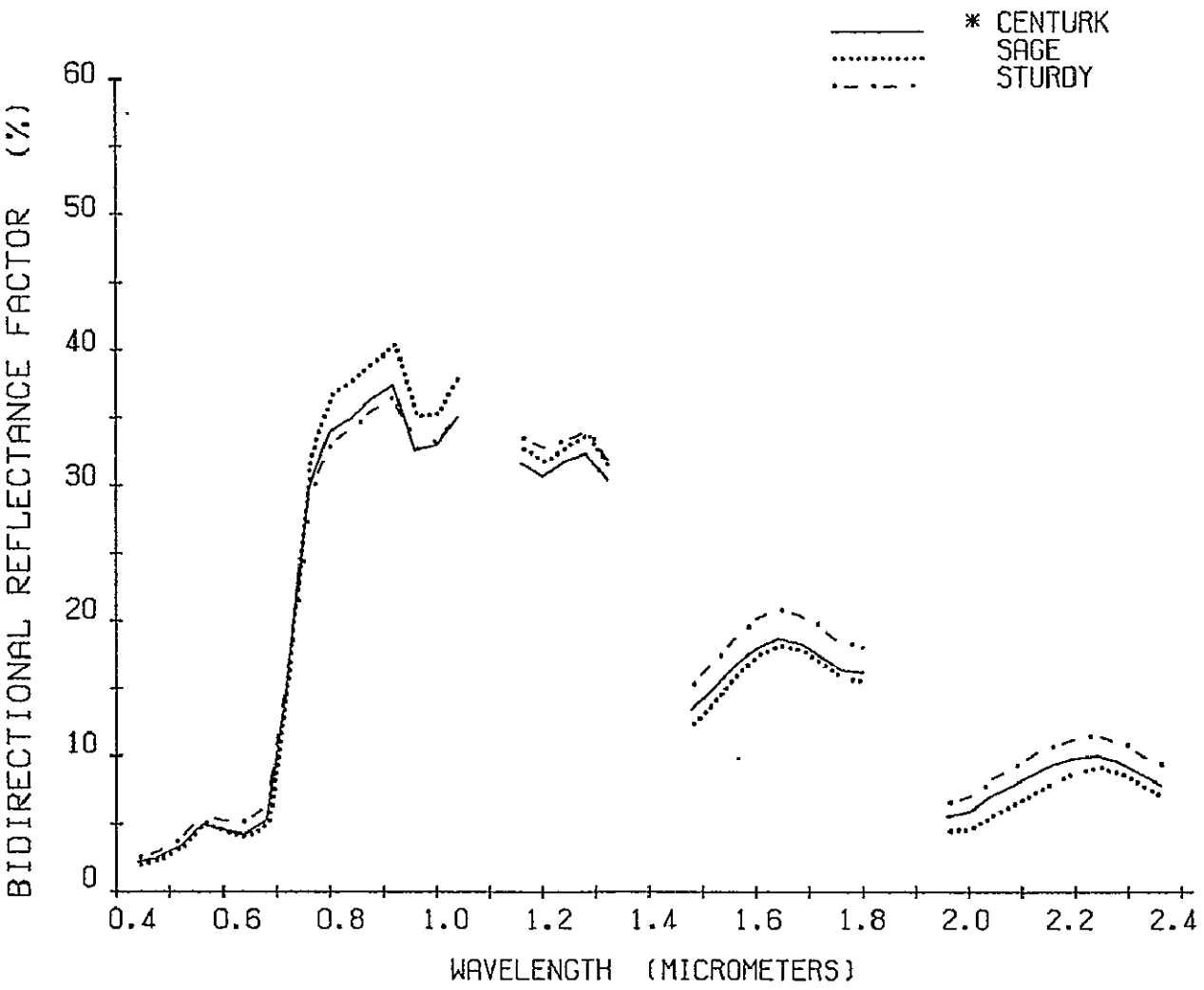
SENSOR: EXOTECH MODEL 20D DATE: APRIL 29, 1975



* AVERAGES OF 3 PLOTS.

REFLECTANCE OF SEVERAL VARIETIES OF WINTER WHEAT

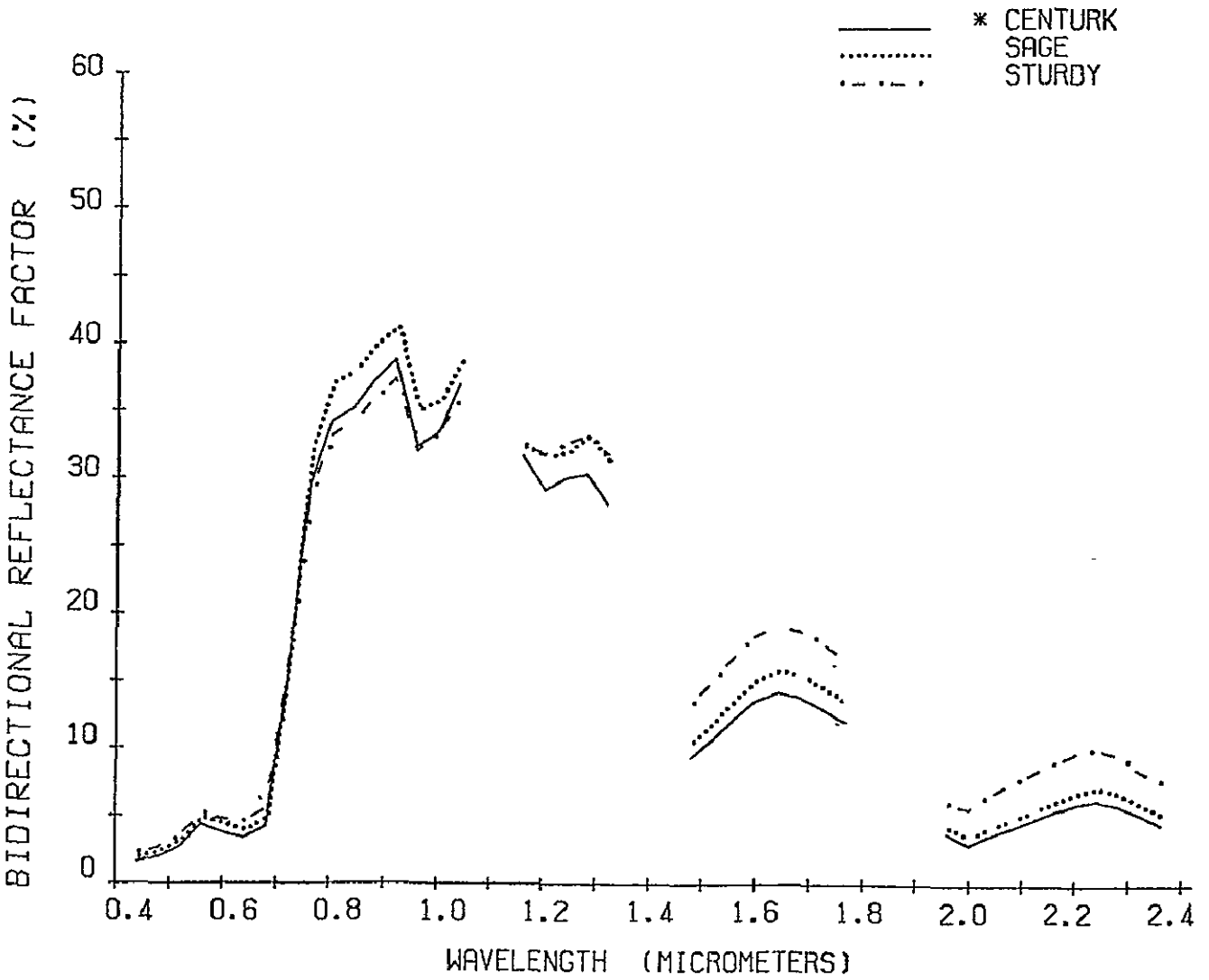
LOCATION: GARDEN CITY, KANSAS
SENSOR: EXOTECH MODEL 20D DATE: MAY 20, 1975



* AVERAGES OF 3, 2, AND 3 PLOTS, RESPECTIVELY.

REFLECTANCE OF SEVERAL VARIETIES OF WINTER WHEAT

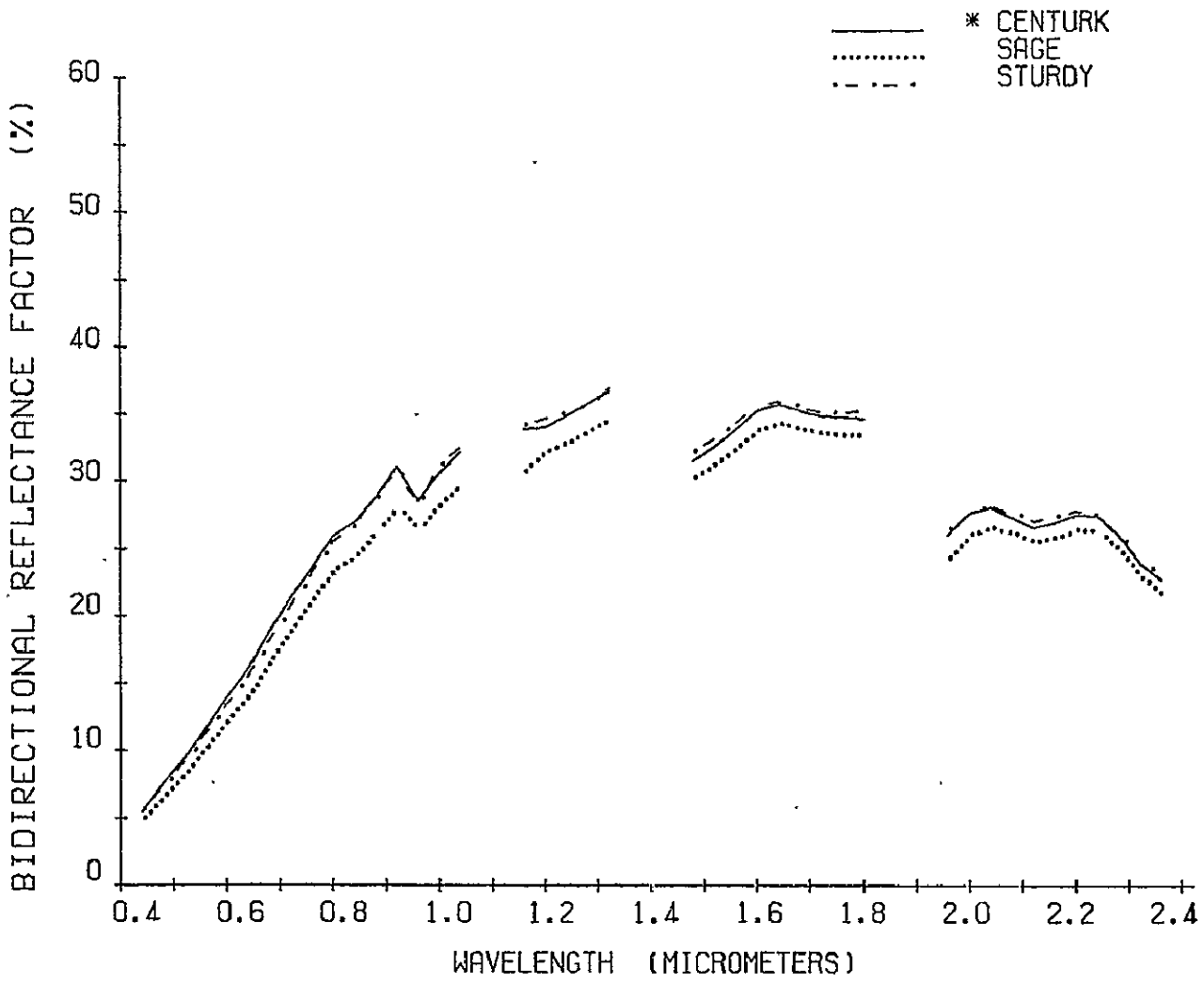
LOCATION: GARDEN CITY, KANSAS
SENSOR: EXOTECH MODEL 20D DATE: JUNE 4, 1975



* AVERAGES OF 2, 3, AND 3 PLOTS, RESPECTIVELY.

REFLECTANCE OF SEVERAL VARIETIES OF WINTER WHEAT

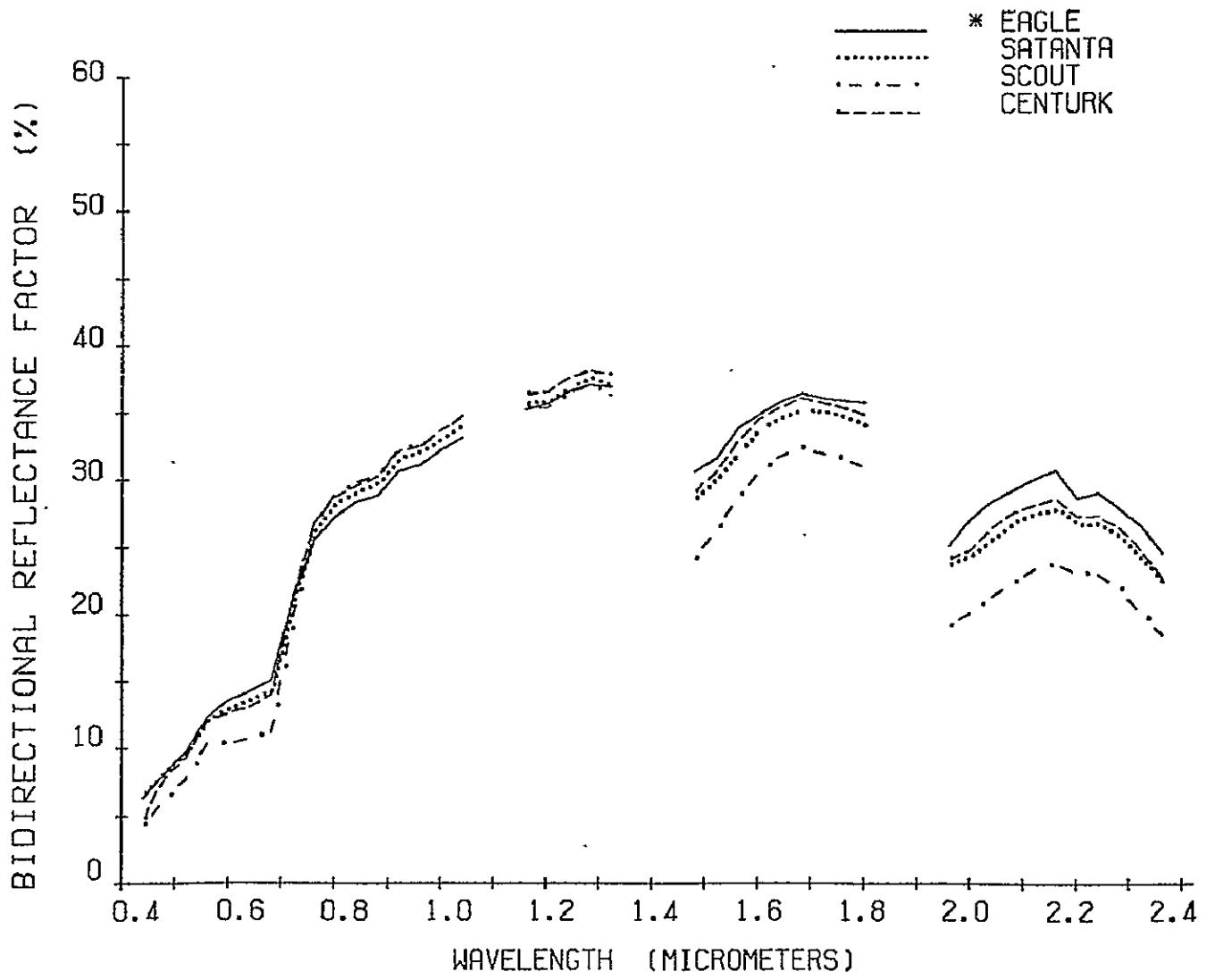
LOCATION: GARDEN CITY, KANSAS
SENSOR: EXOTECH MODEL 20D DATE: JULY 4, 1975



* AVERAGES OF 2, 3, AND 3 PLOTS, RESPECTIVELY.

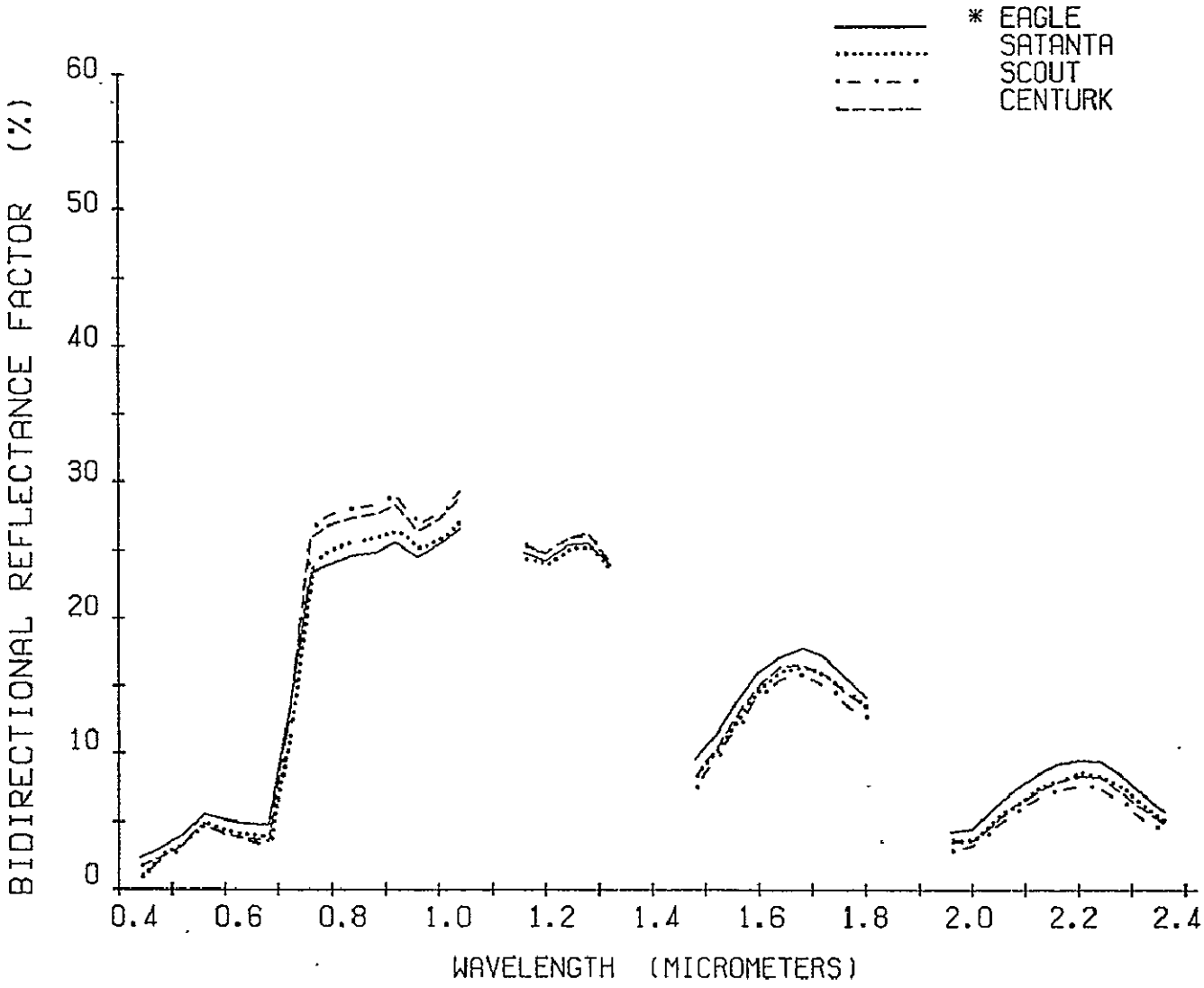
REFLECTANCE OF SEVERAL VARIETIES OF WINTER WHEAT

LOCATION: GARDEN CITY, KANSAS
SENSOR: FSAS DATE: APRIL 1, 1976



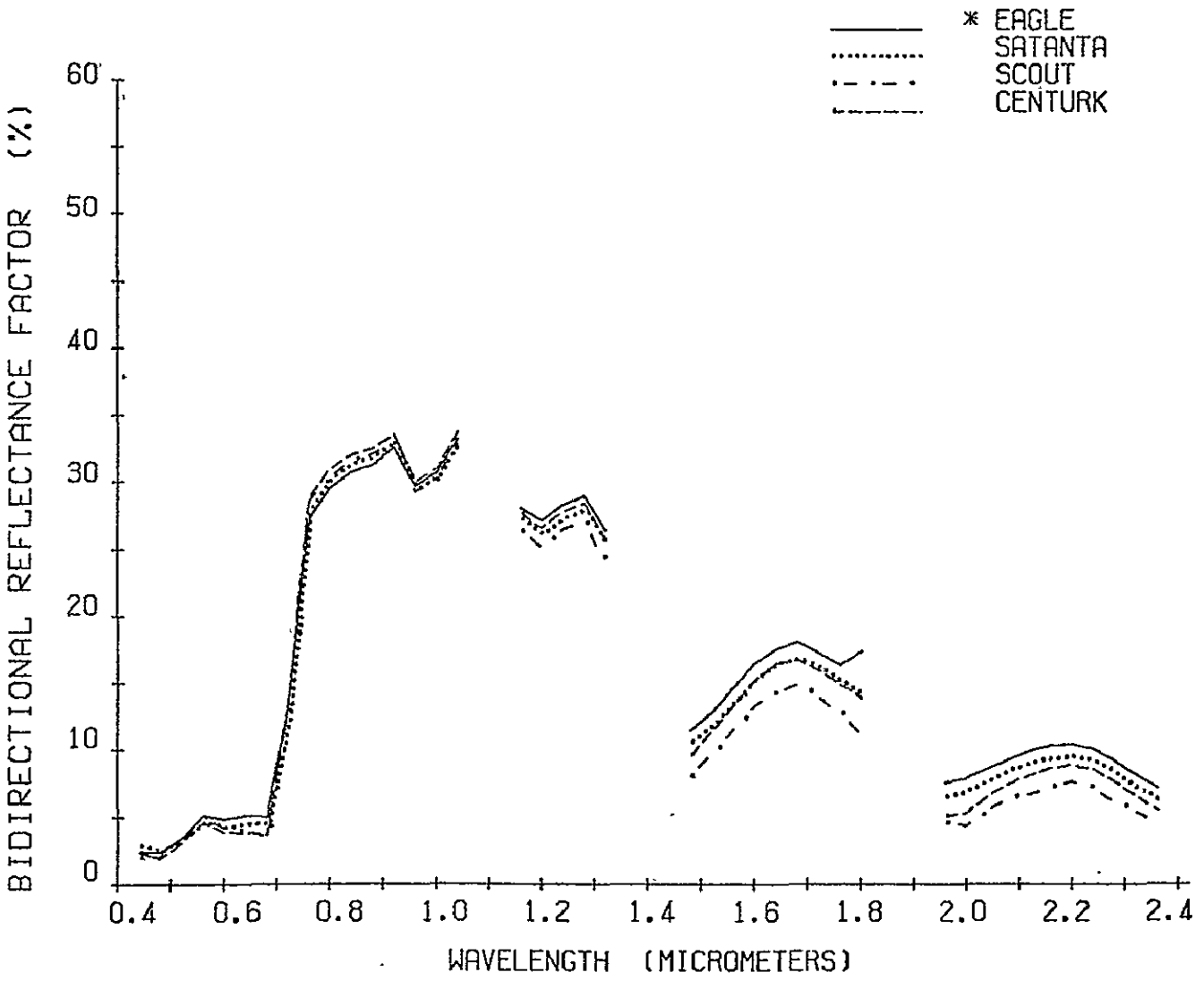
REFLECTANCE OF SEVERAL VARIETIES OF WINTER WHEAT

LOCATION: GARDEN CITY, KANSAS
SENSOR: FSAS DATE: MAY 1, 1976



REFLECTANCE OF SEVERAL VARIETIES OF WINTER WHEAT

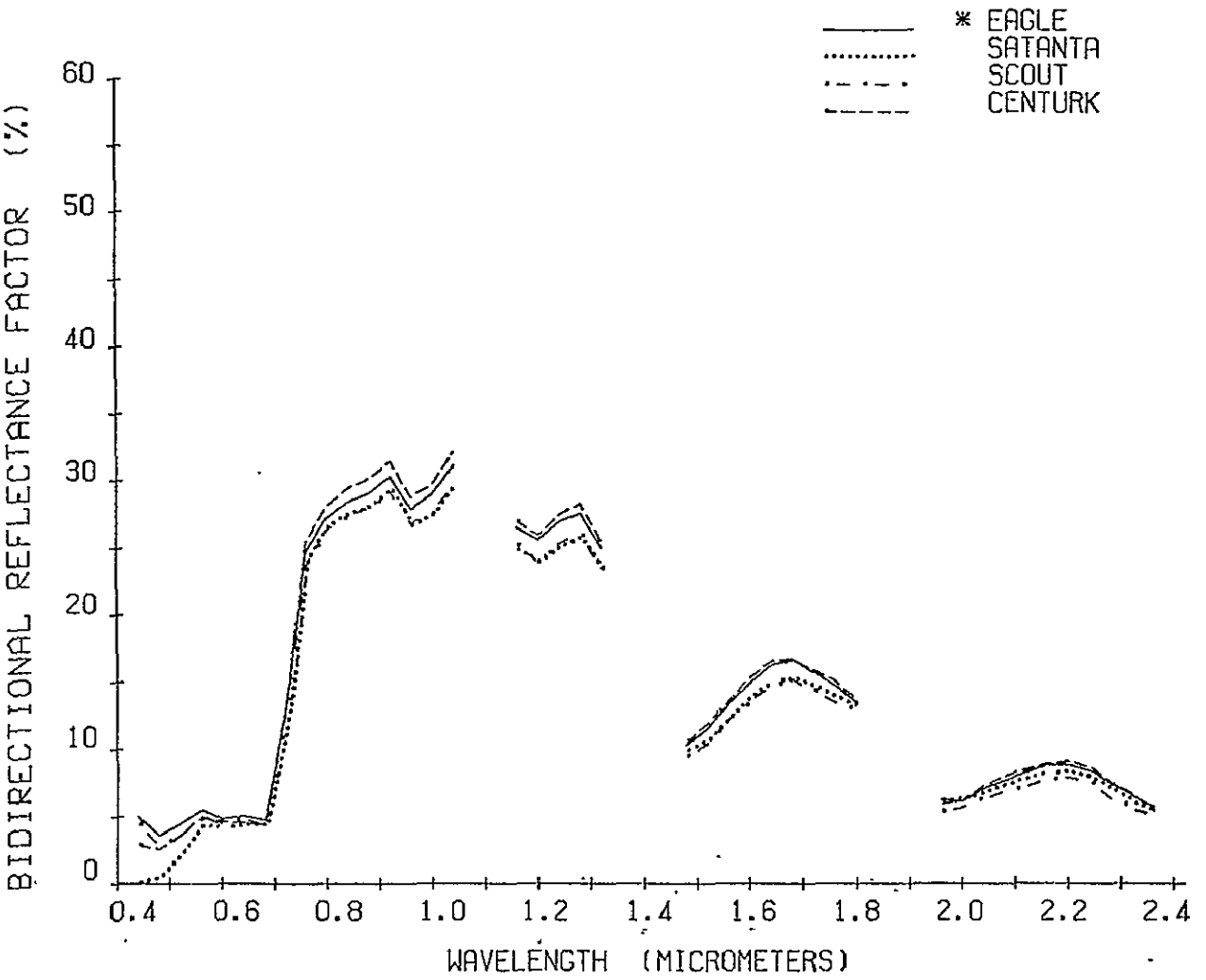
LOCATION: GARDEN CITY, KANSAS
SENSOR: FSAS DATE: MAY 17, 1976



* AVERAGES OF 2, 2, 1, AND 2 PLOTS, RESPECTIVELY.

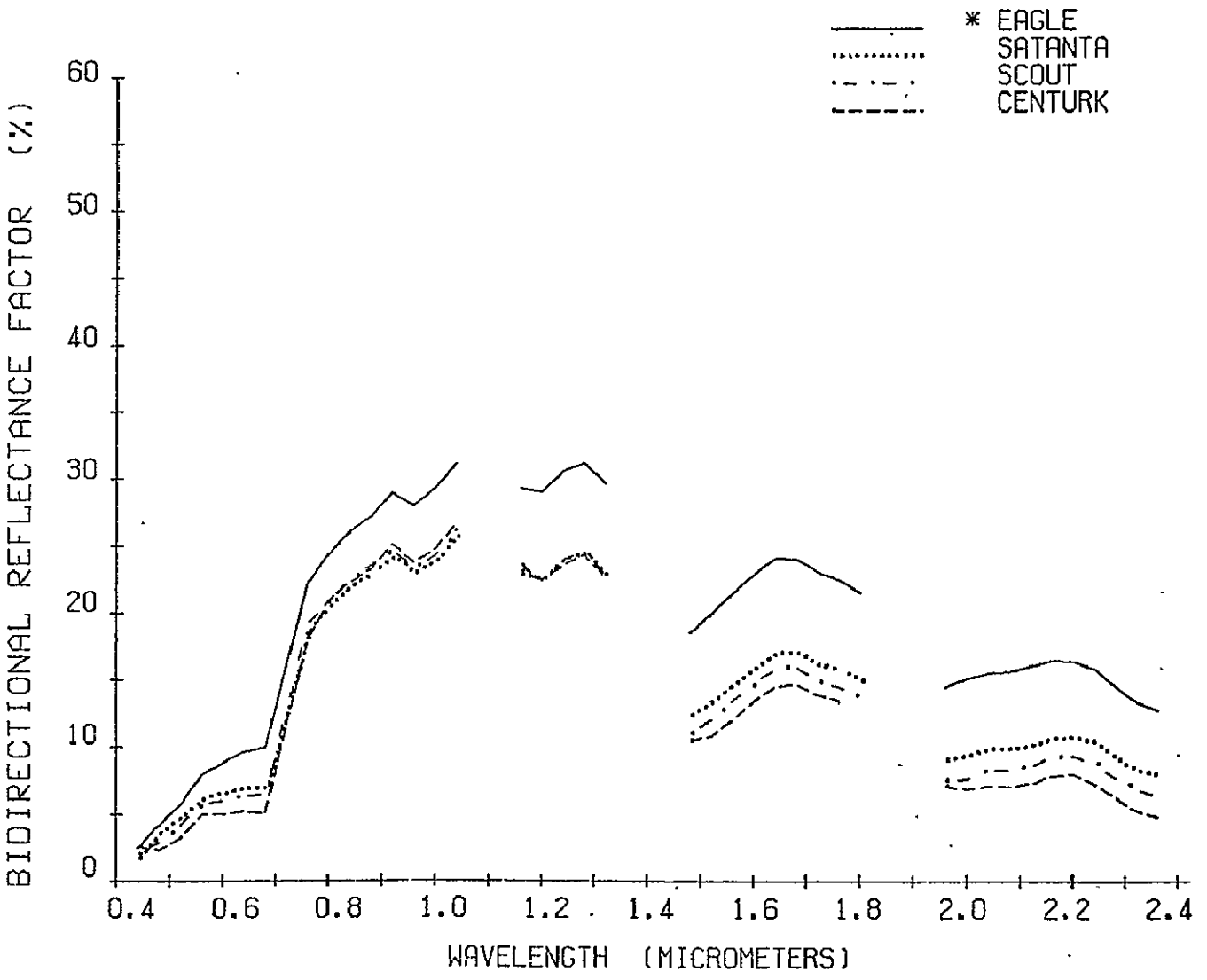
REFLECTANCE OF SEVERAL VARIETIES OF WINTER WHEAT

LOCATION: GARDEN CITY, KANSAS
SENSOR: FSAS DATE: MAY 29, 1976



REFLECTANCE OF SEVERAL VARIETIES OF WINTER WHEAT

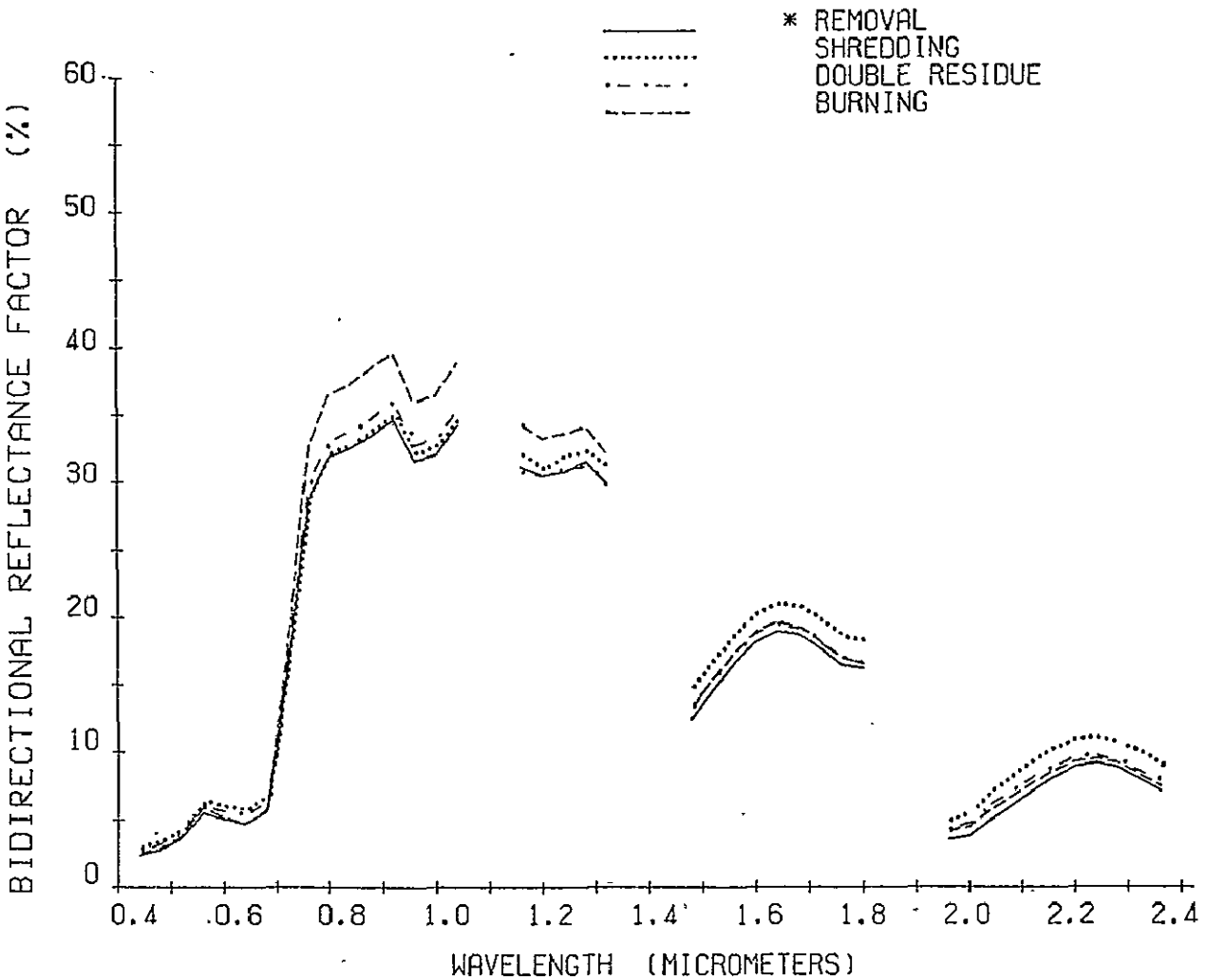
LOCATION: GARDEN CITY, KANSAS
SENSOR: FSAS DATE: JUNE 10, 1976



*AVERAGES OF 2 PLOTS.

DIFFERENCE IN REFLECTANCE OF WINTER WHEAT DUE TO RESIDUE MANAGEMENT

LOCATION: GARDEN CITY, KANSAS
SENSOR: EXOTECH MODEL 20D DATE: APRIL 17, 1975

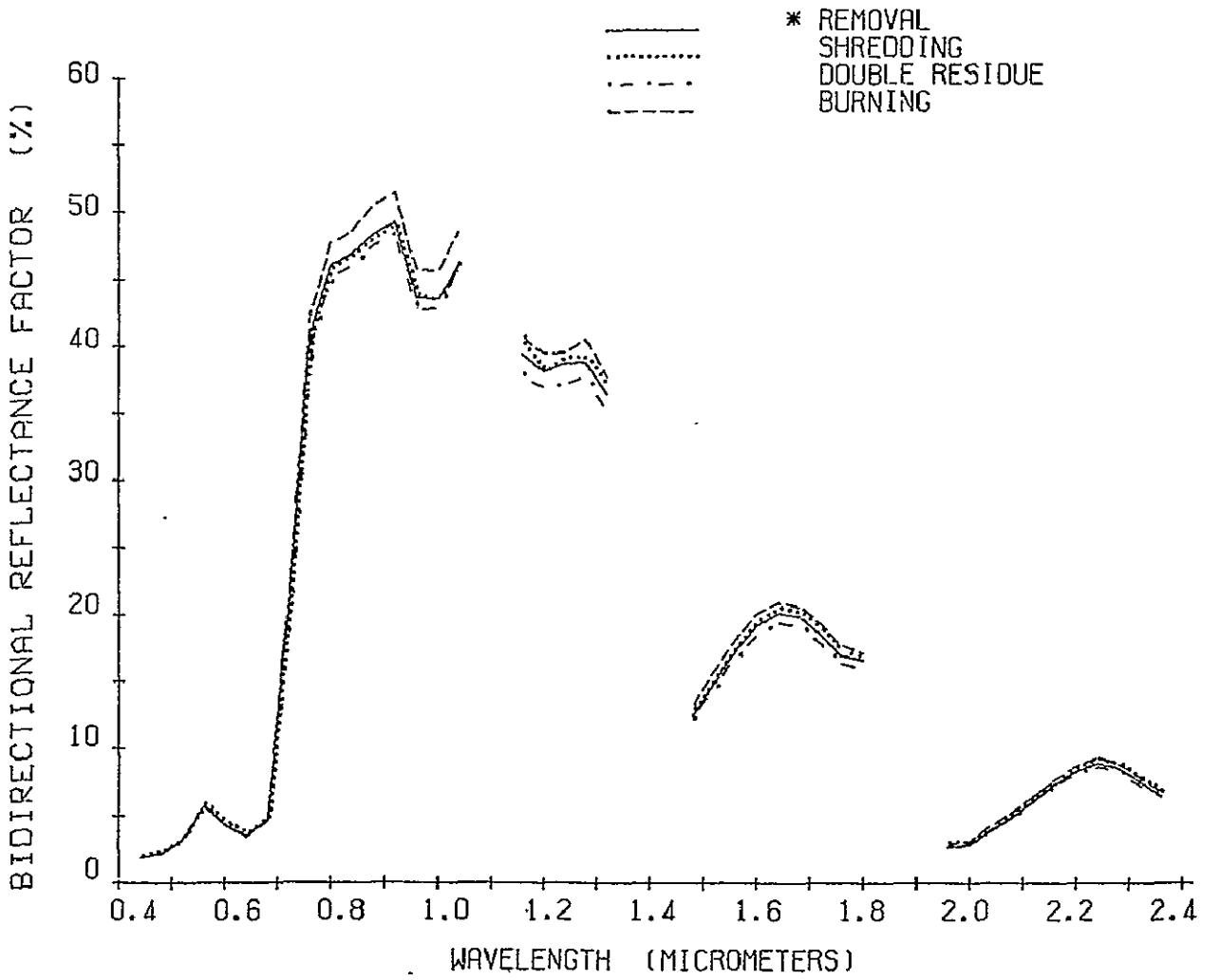


* AVERAGES OF 2 PLOTS.

DIFFERENCE IN REFLECTANCE OF WINTER WHEAT DUE TO RESIDUE MANAGEMENT

LOCATION: GARDEN CITY, KANSAS

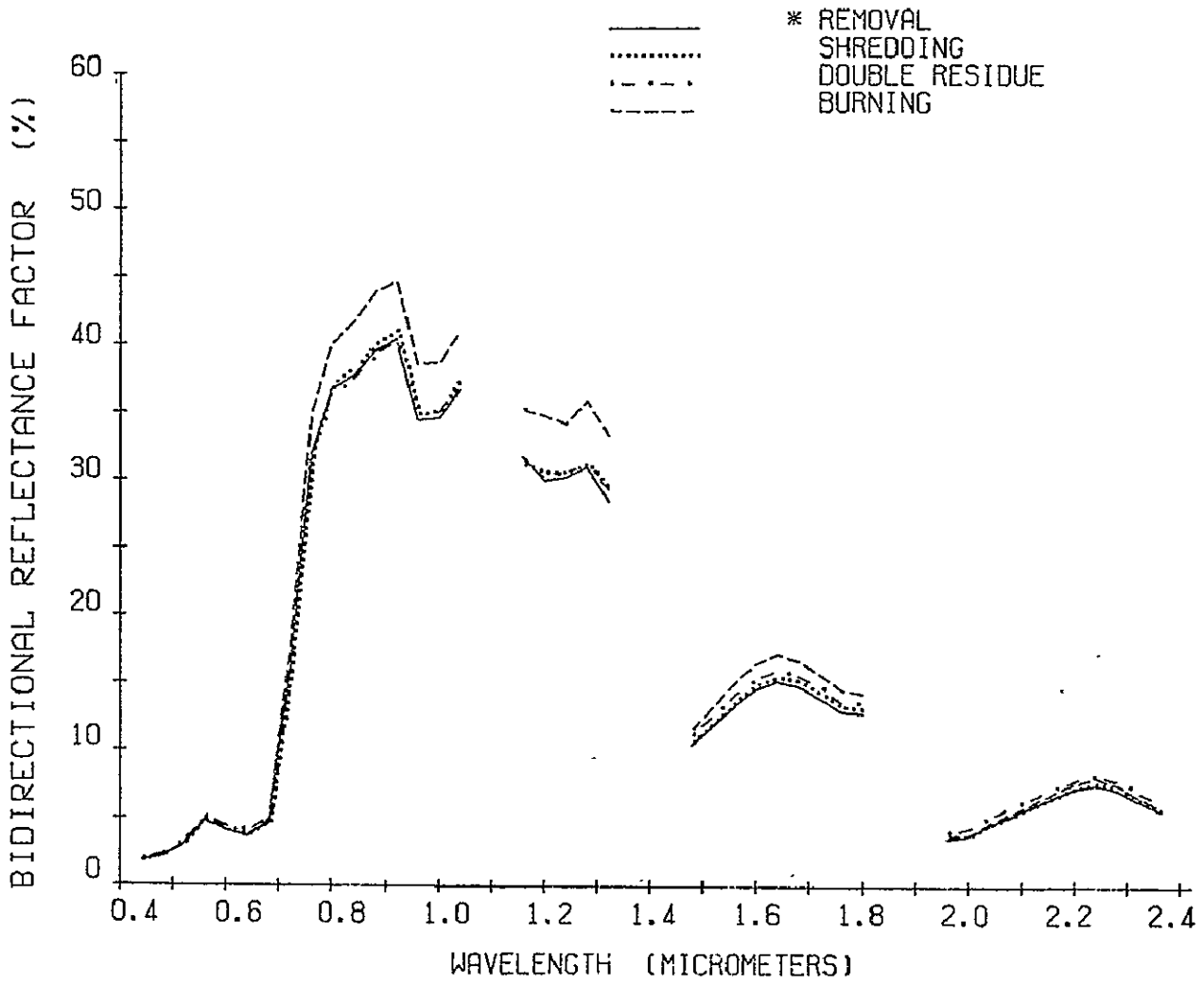
SENSOR: EXOTECH MODEL 20D DATE: APRIL 30, 1975



* AVERAGES OF 2 PLOTS.

DIFFERENCE IN REFLECTANCE OF WINTER WHEAT DUE TO RESIDUE MANAGEMENT

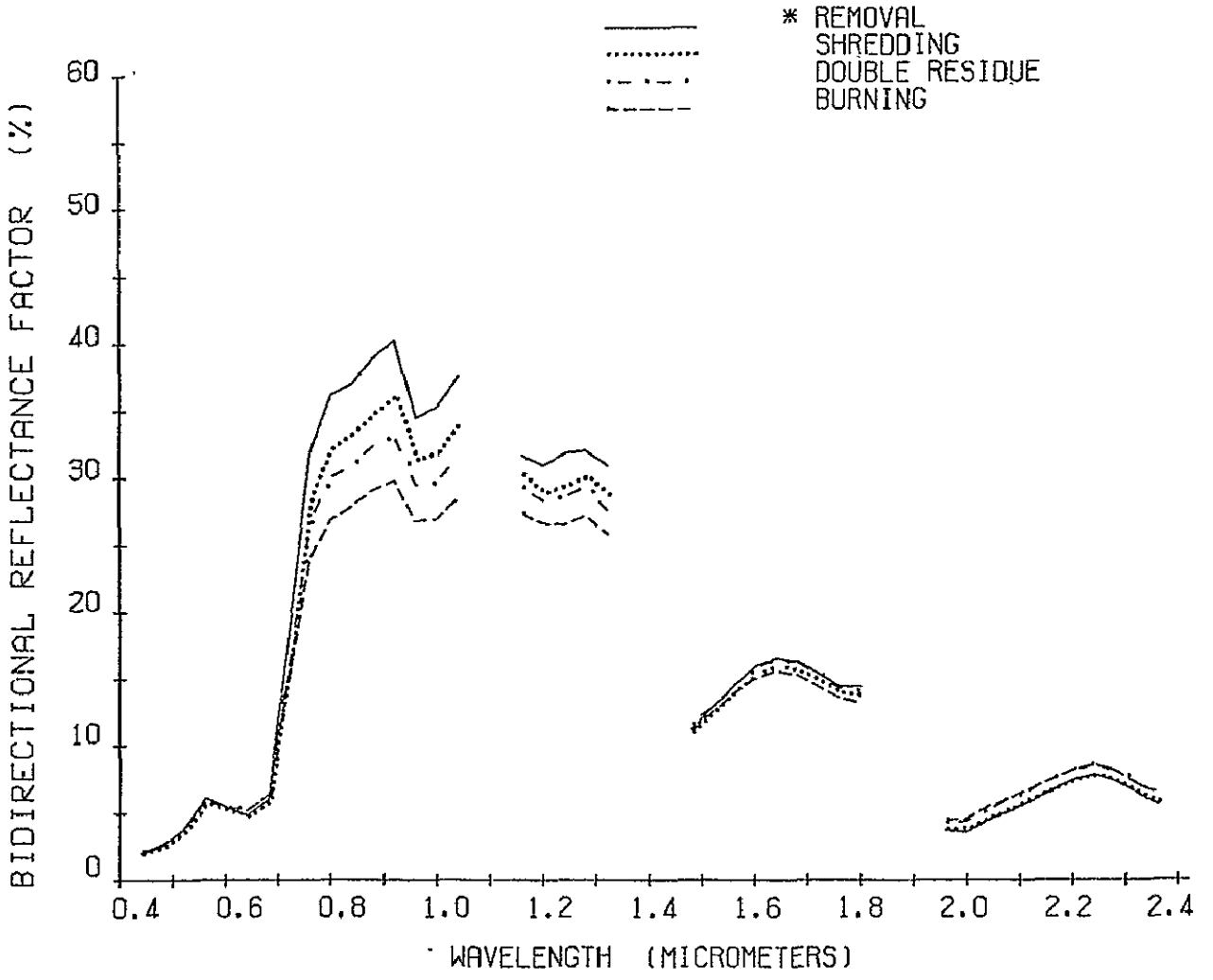
LOCATION: GARDEN CITY, KANSAS
SENSOR: EXOTECH MODEL 20D DATE: MAY 26, 1975



* AVERAGES OF 2 PLOTS.

DIFFERENCE IN REFLECTANCE OF WINTER WHEAT DUE TO RESIDUE MANAGEMENT

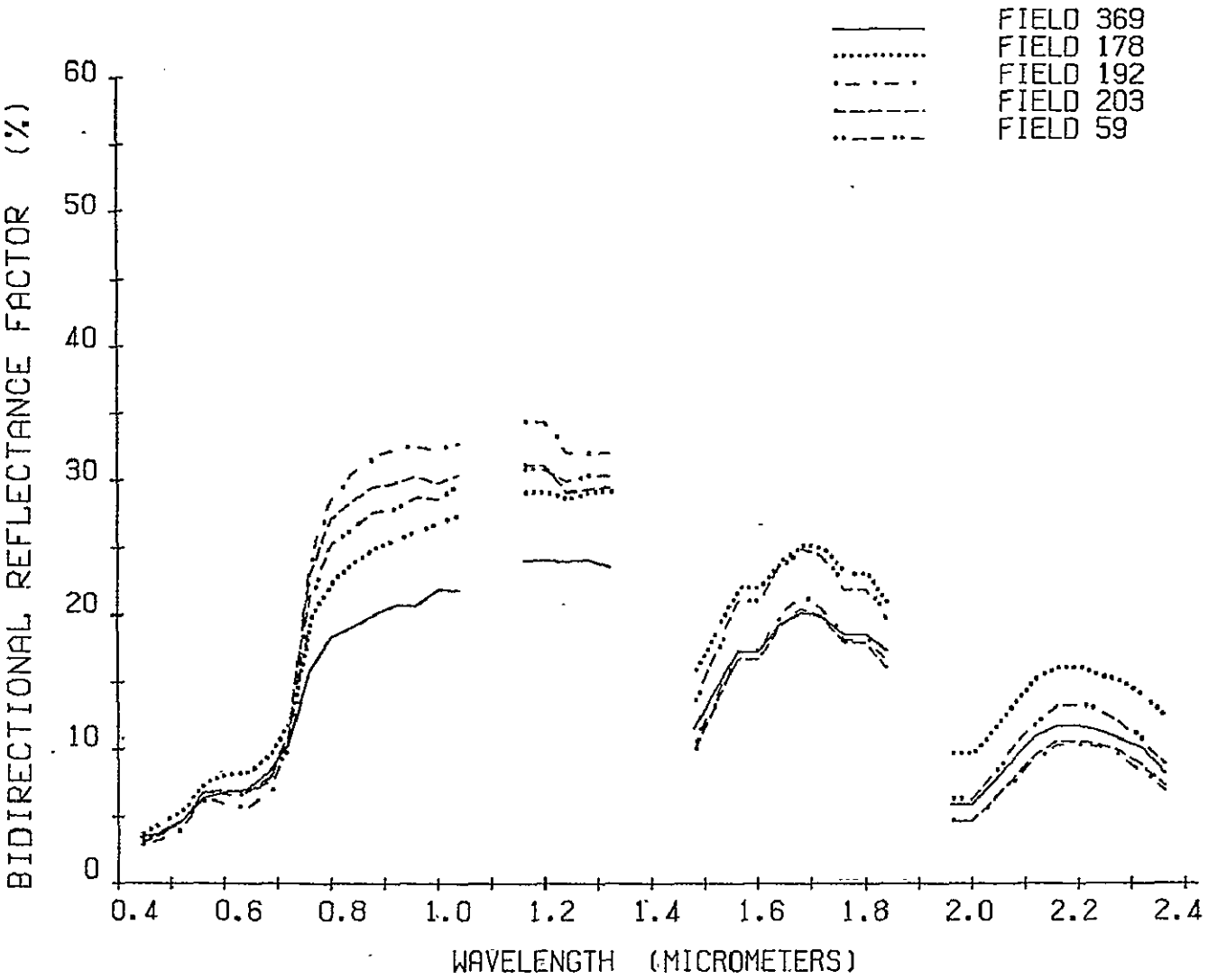
LOCATION: GARDEN CITY, KANSAS
SENSOR: EXOTECH MODEL 20D . DATE: JUNE 11, 1975



* AVERAGES OF 2 PLOTS.

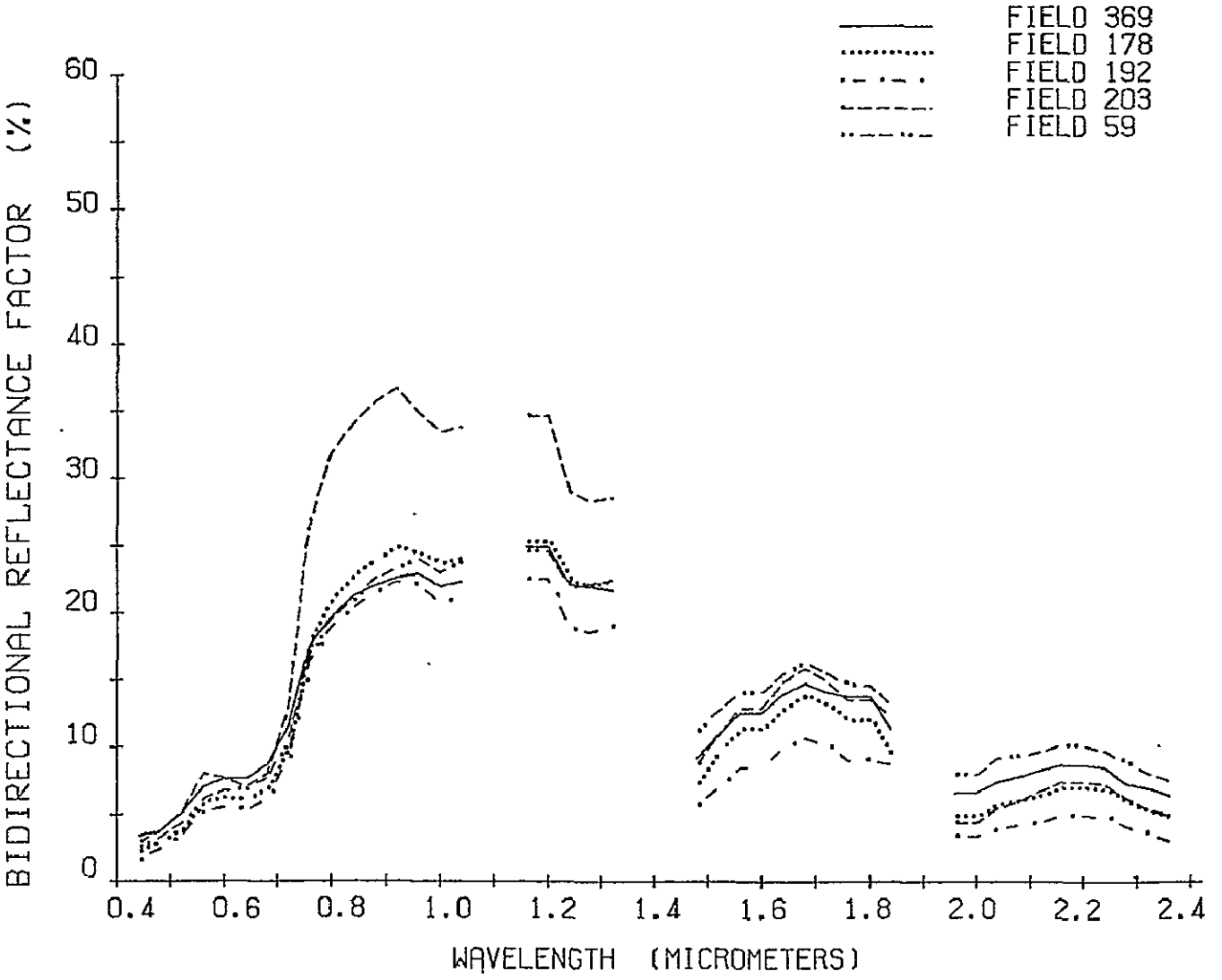
VARIABILITY IN REFLECTANCE AMONG WINTER WHEAT FIELDS

LOCATION: FINNEY COUNTY, KANSAS
SENSOR: FSS DATE: APRIL 8, 1975



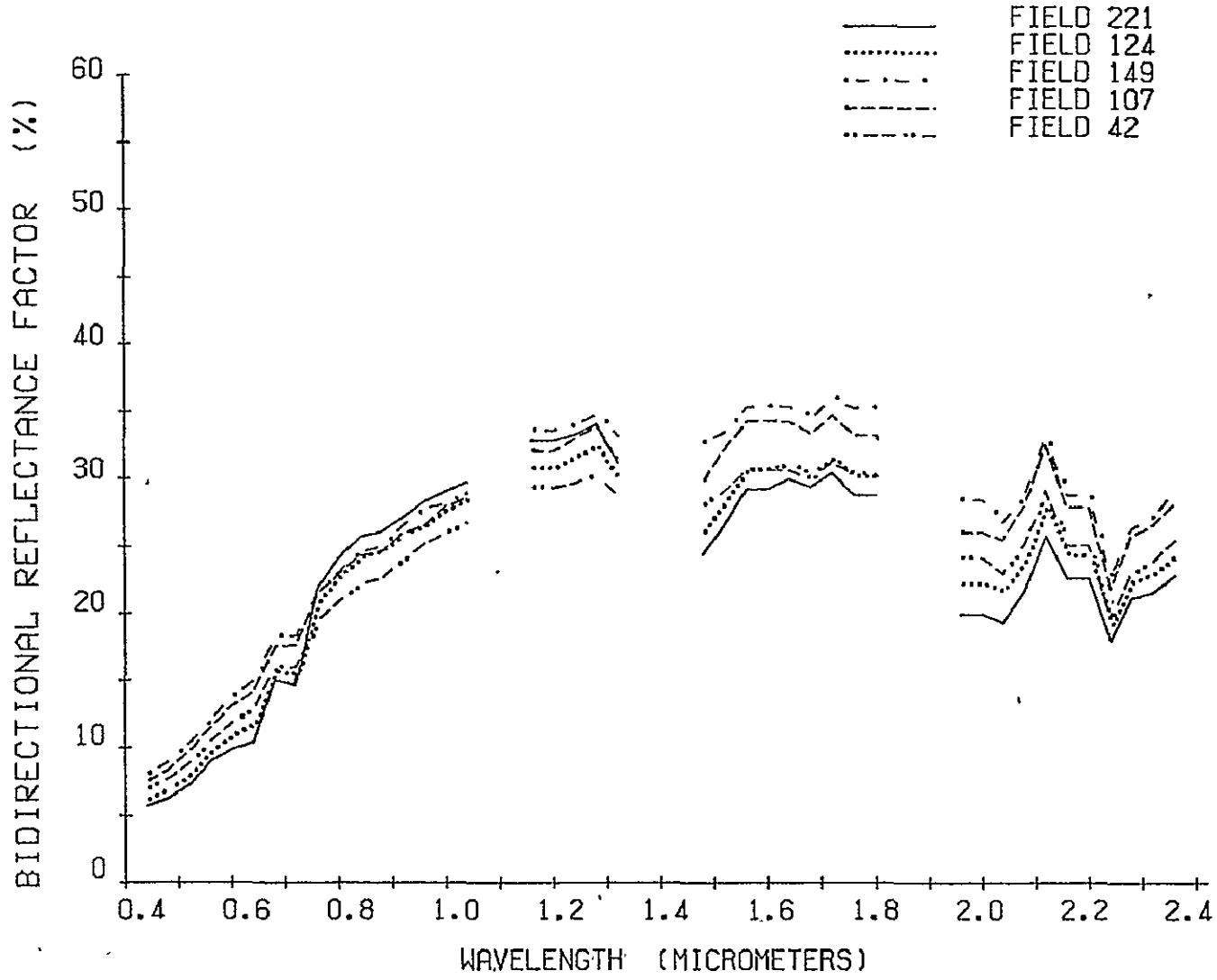
VARIABILITY IN REFLECTANCE AMONG WINTER WHEAT FIELDS

LOCATION: FINNEY COUNTY, KANSAS
SENSOR: FSS DATE: JUNE 17, 1975



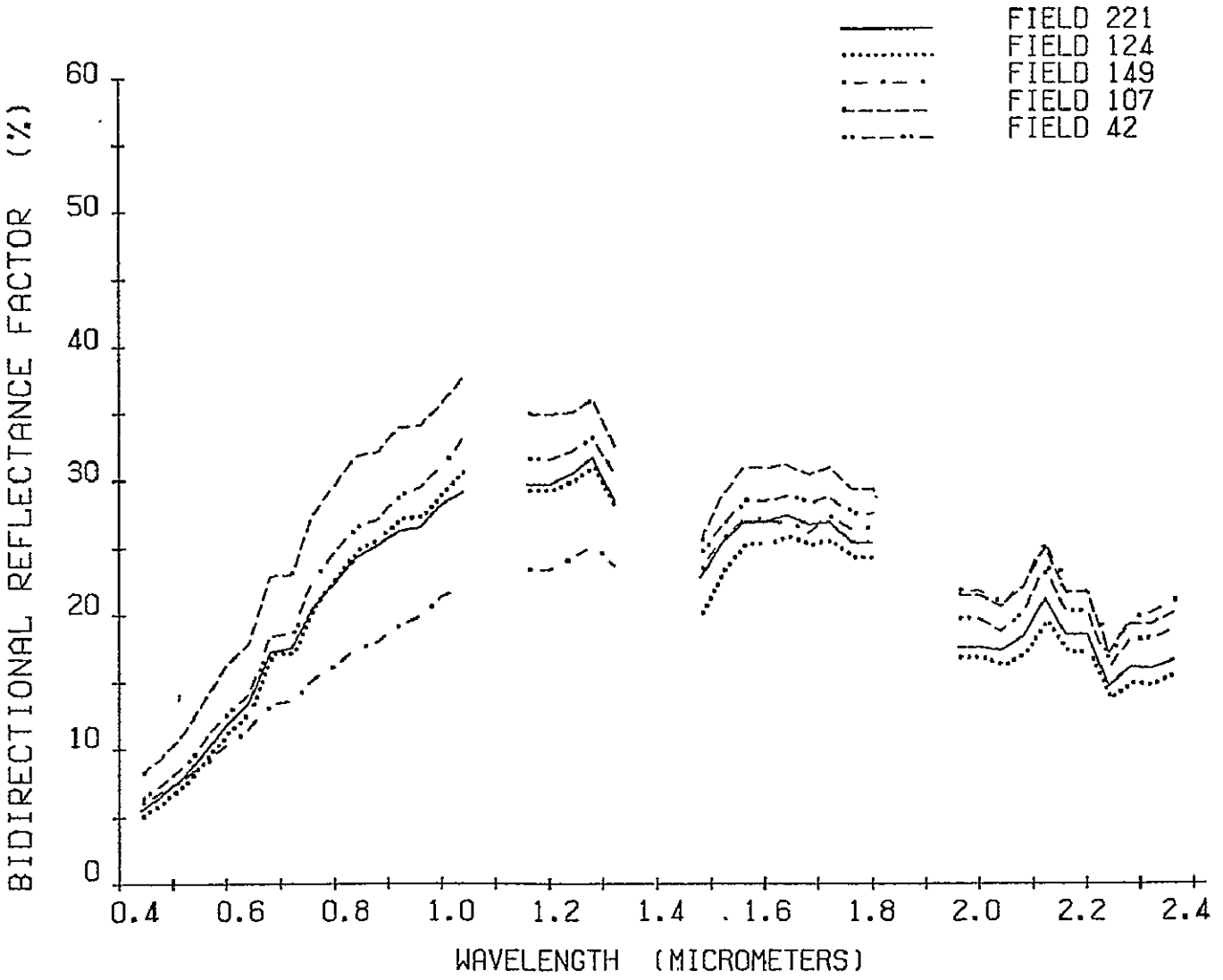
VARIABILITY IN REFLECTANCE AMONG WINTER WHEAT FIELDS

LOCATION: FINNEY COUNTY, KANSAS
SENSOR: FSS DATE: MARCH 31, 1976



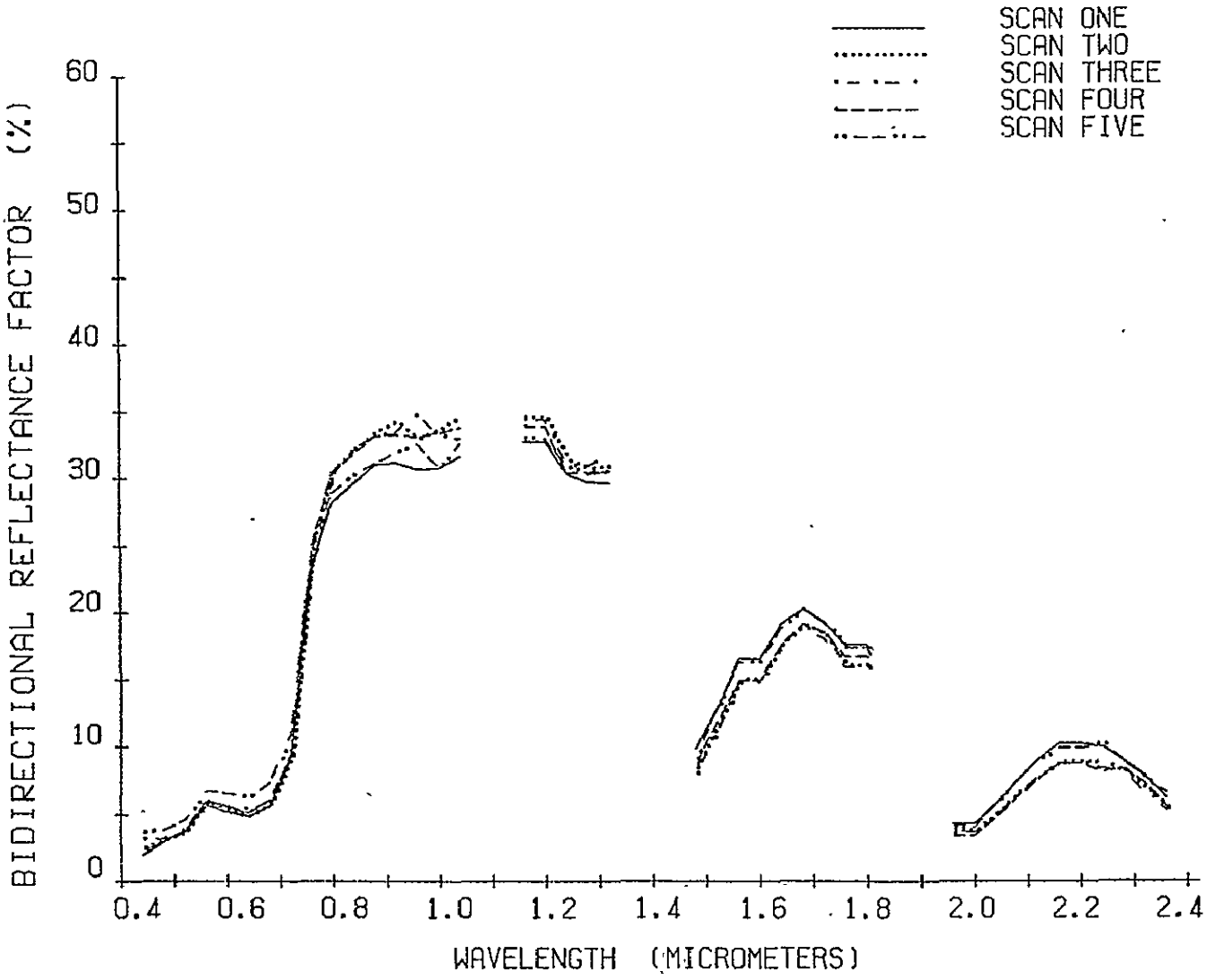
VARIABILITY IN REFLECTANCE AMONG WINTER WHEAT FIELDS

LOCATION: FINNEY COUNTY, KANSAS
SENSOR: FSS DATE: JUNE 12, 1976



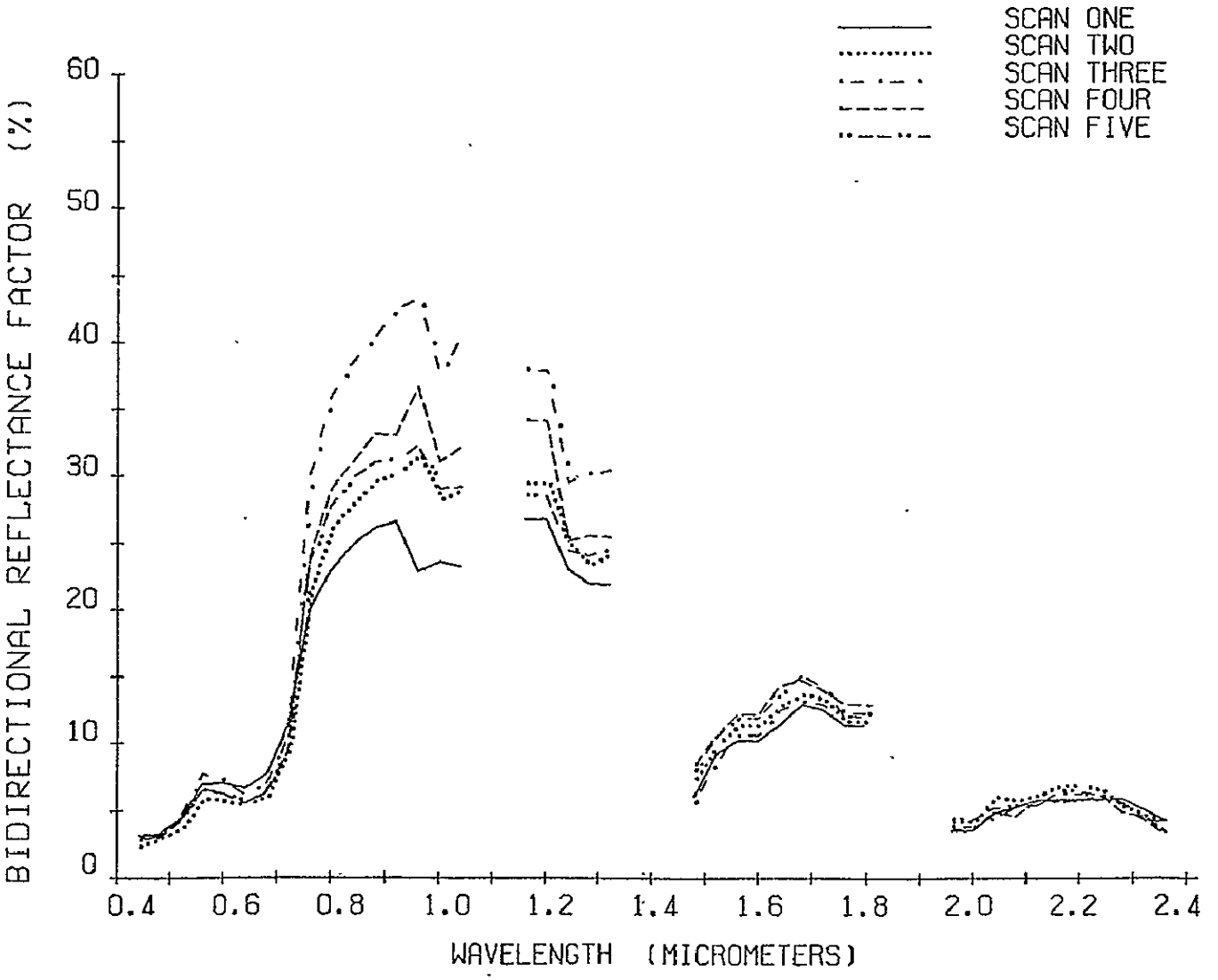
VARIABILITY IN REFLECTANCE WITHIN A WINTER WHEAT FIELD

LOCATION: FINNEY COUNTY, KANSAS
SENSOR: FSS DATE: APRIL 8, 1975
FIELD: .203



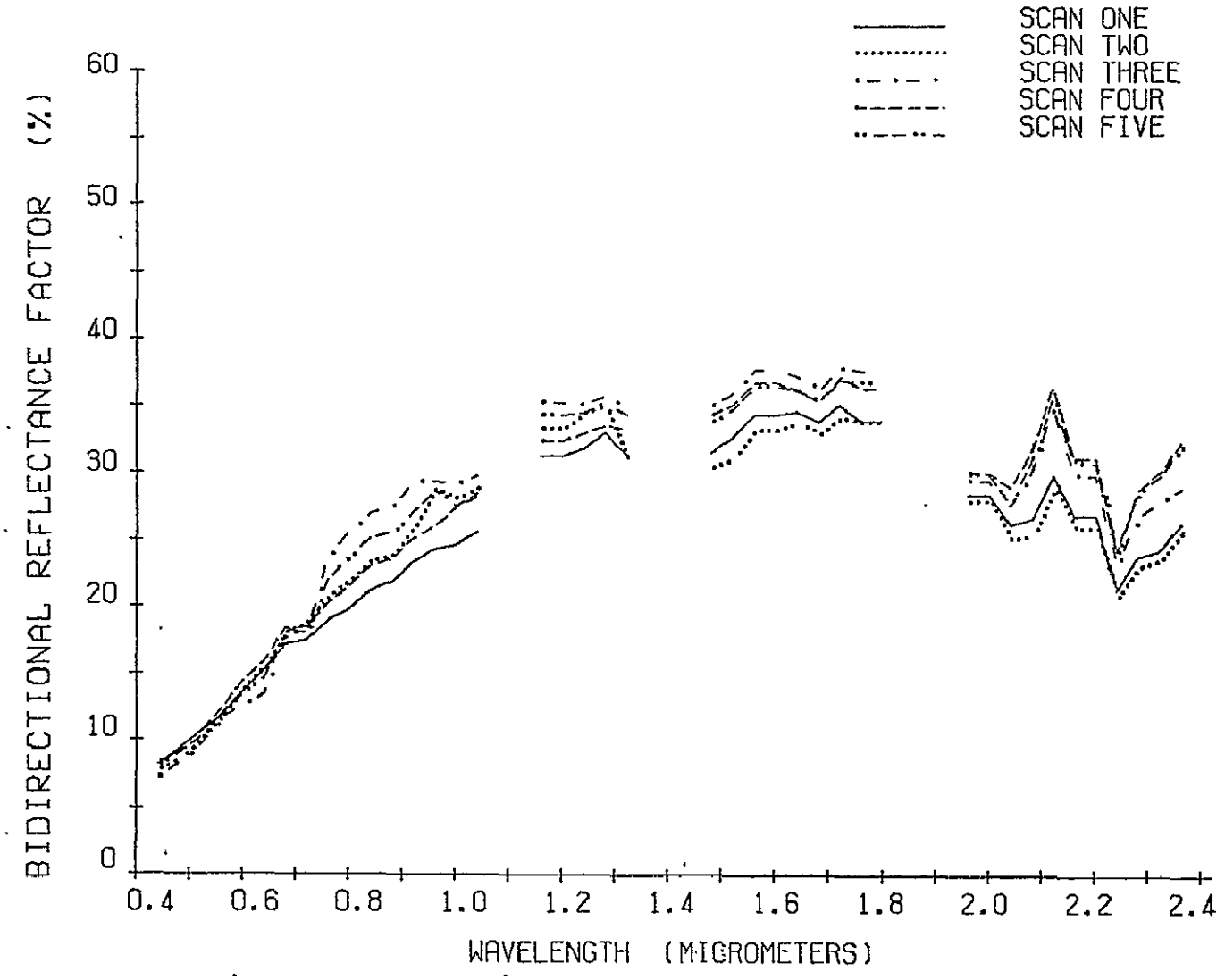
VARIABILITY IN REFLECTANCE WITHIN A WINTER WHEAT FIELD

LOCATION: FINNEY COUNTY, KANSAS
SENSOR: FSS DATE: JUNE 17, 1975
FIELD: 203



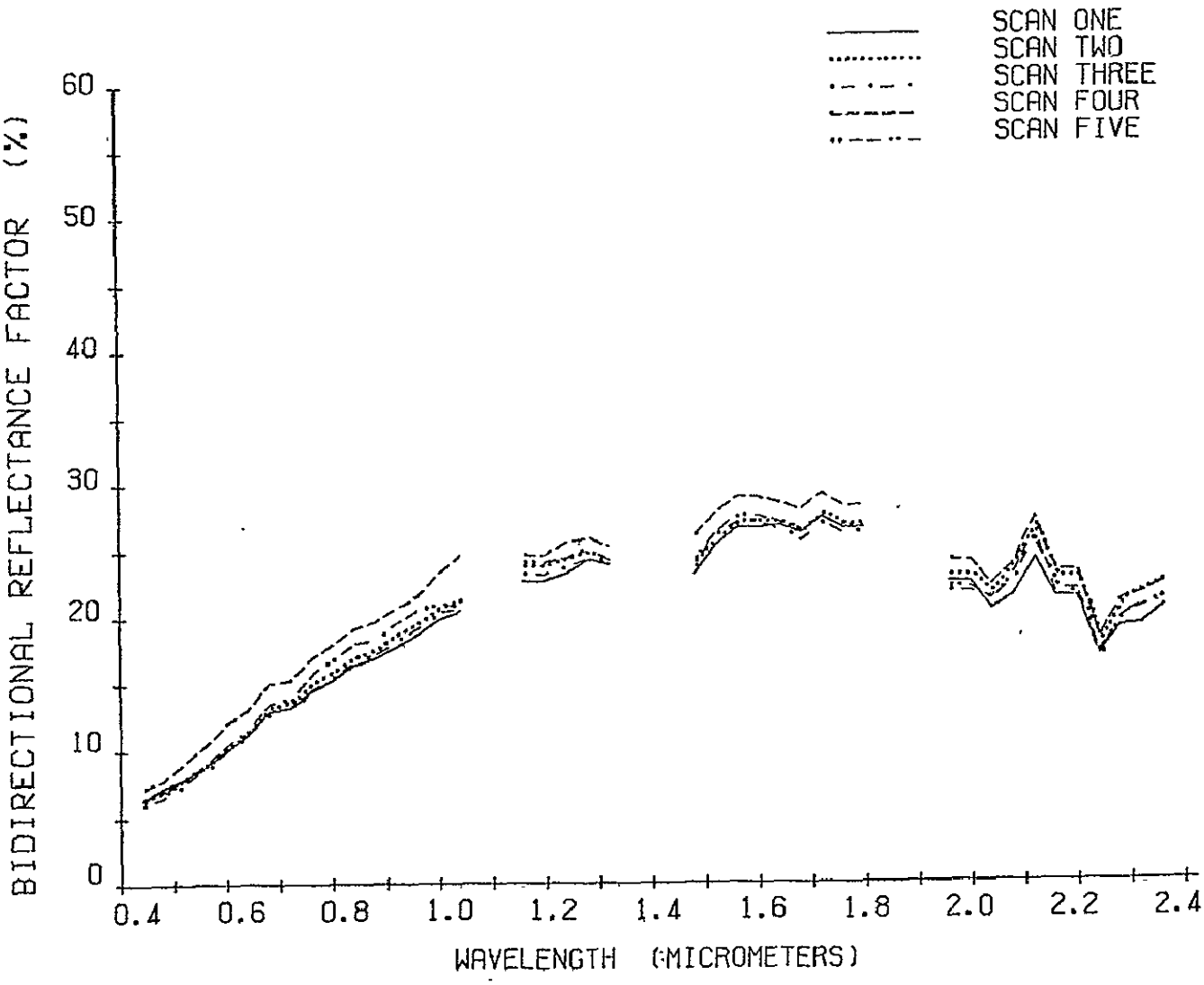
VARIABILITY IN REFLECTANCE WITHIN A WINTER WHEAT FIELD

LOCATION: FINNEY COUNTY, KANSAS
SENSOR: FSS DATE: MARCH 31, 1976
FIELD 149



VARIABILITY IN REFLECTANCE WITHIN A WINTER WHEAT FIELD

LOCATION: FINNEY COUNTY, KANSAS
SENSOR: FSS DATE: JUNE 12, 1976
FIELD 149



II. Kansas Winter Wheat Examples

B. Variation Between Winter Wheat and Other Crops

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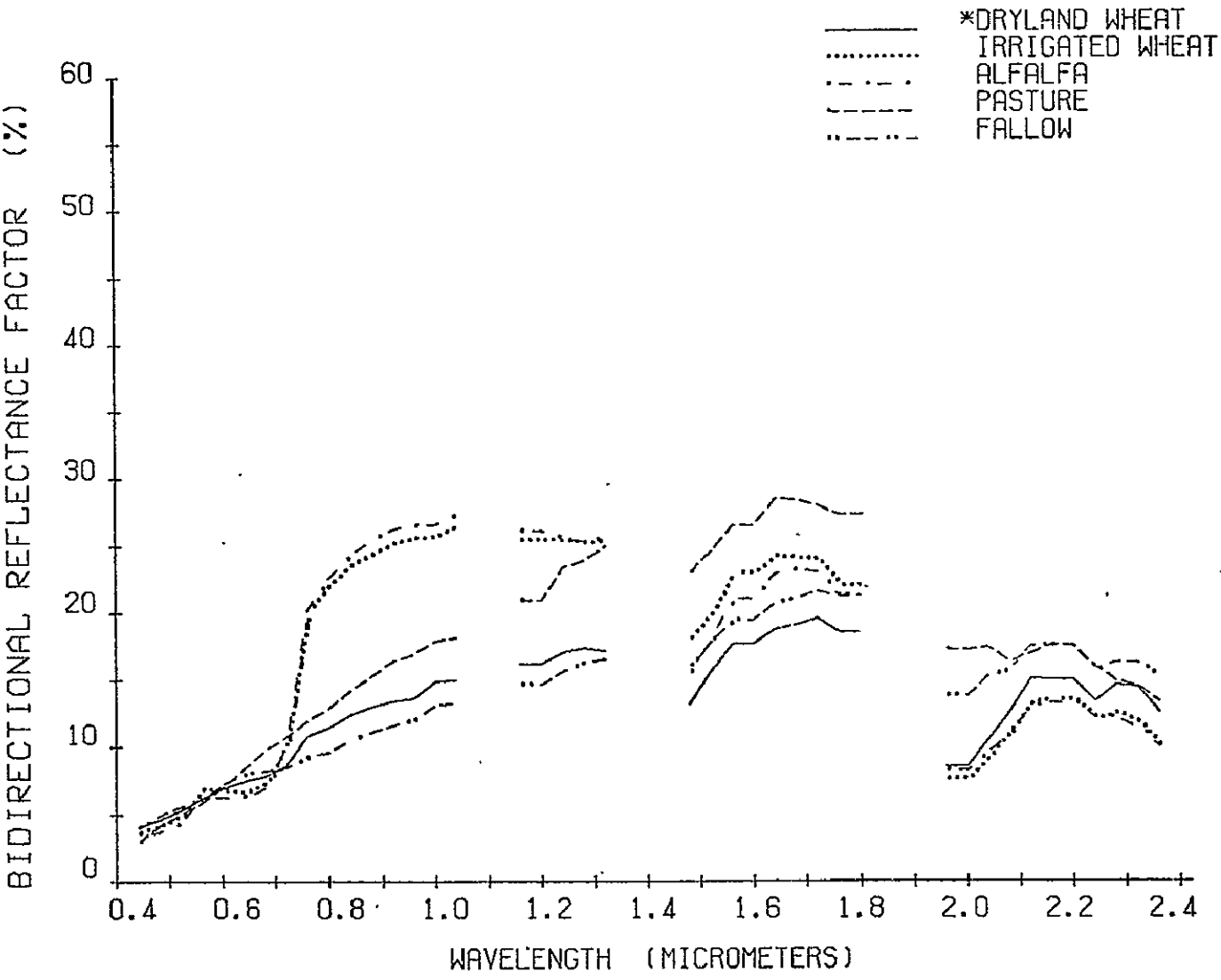
DIFFERENCE IN REFLECTANCE DUE TO COVER TYPE

LOCATION: FINNEY COUNTY, KANSAS
SENSOR: FSS DATE: NOVEMBER 5, 1974



* AVERAGES OF 2, 10, 3, 1, AND 2 FIELDS, RESPECTIVELY.

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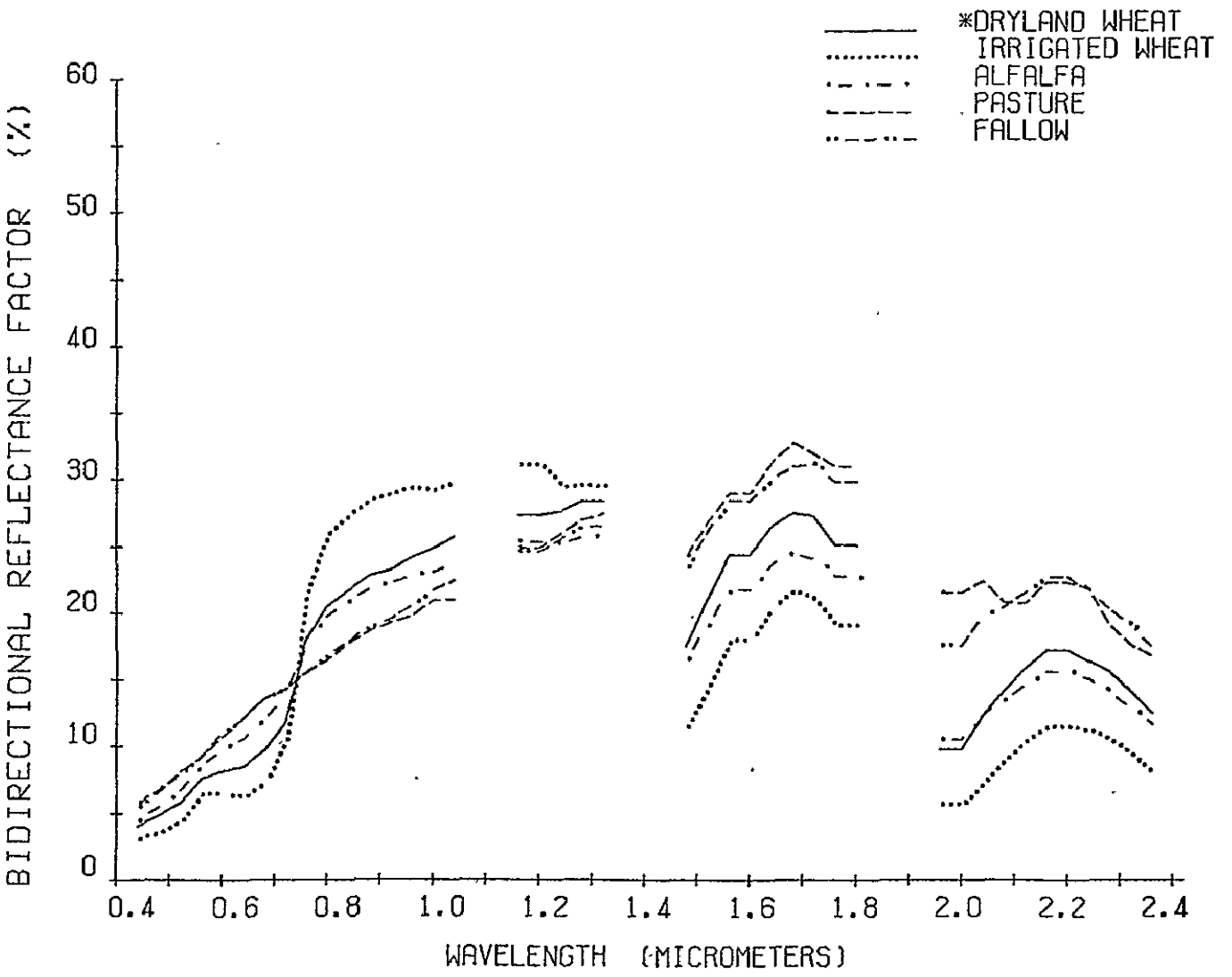
DIFFERENCE IN REFLECTANCE DUE TO COVER TYPE

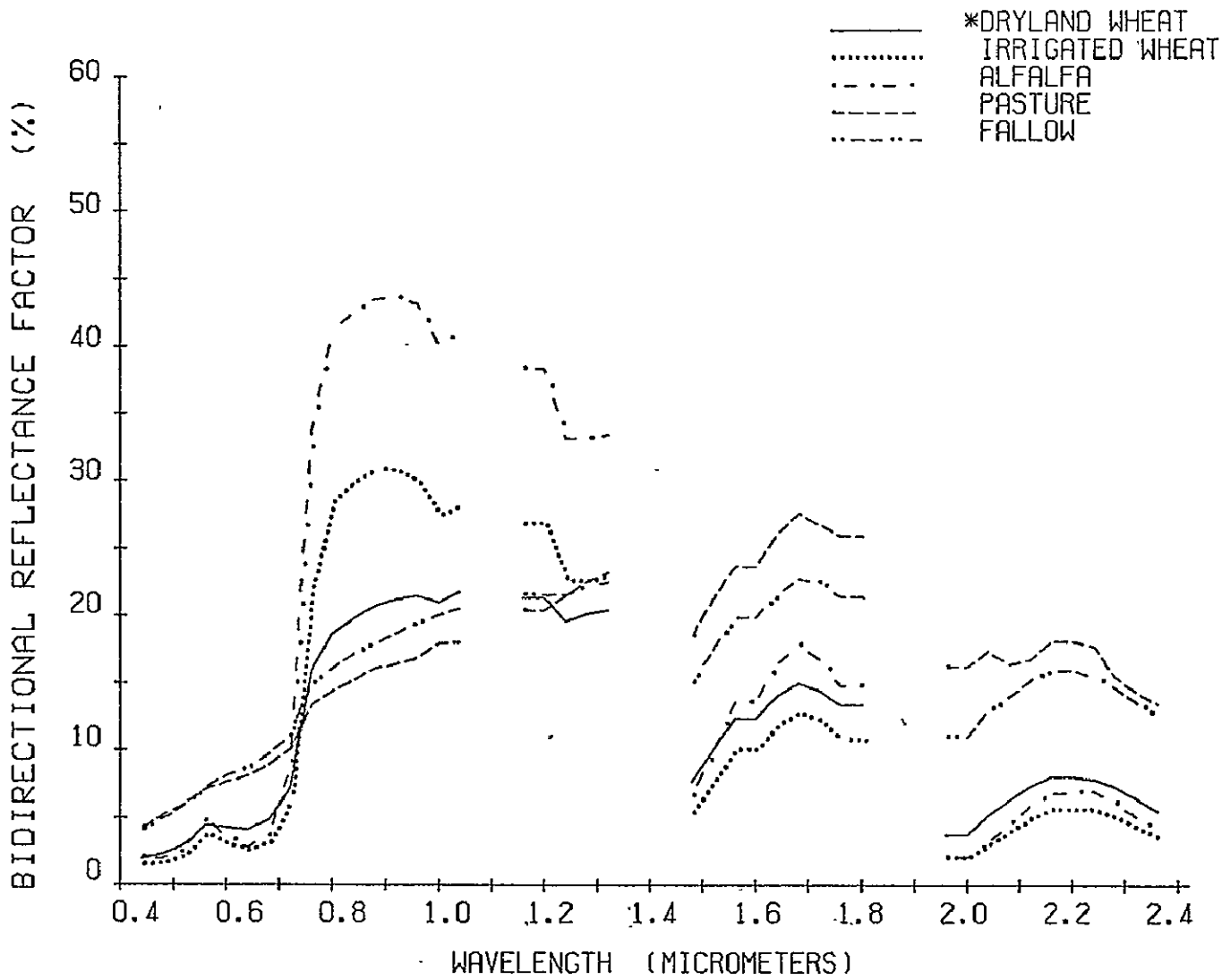
LOCATION: FINNEY COUNTY, KANSAS
SENSOR: FSS DATE: APRIL 8, 1975



* AVERAGES OF 2, 10, 3, 1, AND 3 FIELDS, RESPECTIVELY.

DIFFERENCE IN REFLECTANCE DUE TO COVER TYPE

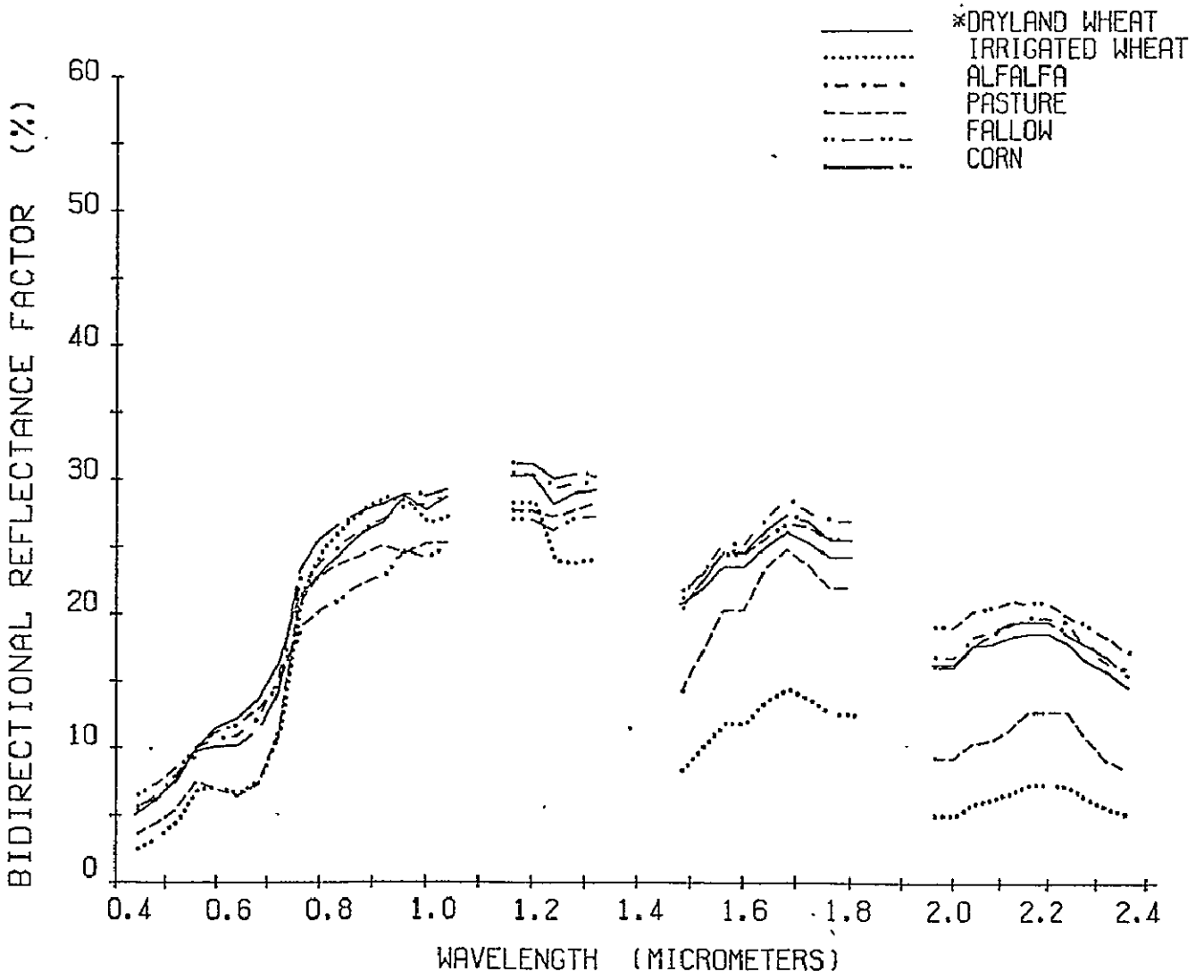
LOCATION: FINNEY COUNTY, KANSAS
SENSOR: FSS DATE: MAY 14, 1975



* AVERAGES OF 2, 10, 3, 1, AND 3 FIELDS, RESPECTIVELY.

DIFFERENCE IN REFLECTANCE DUE TO COVER TYPE

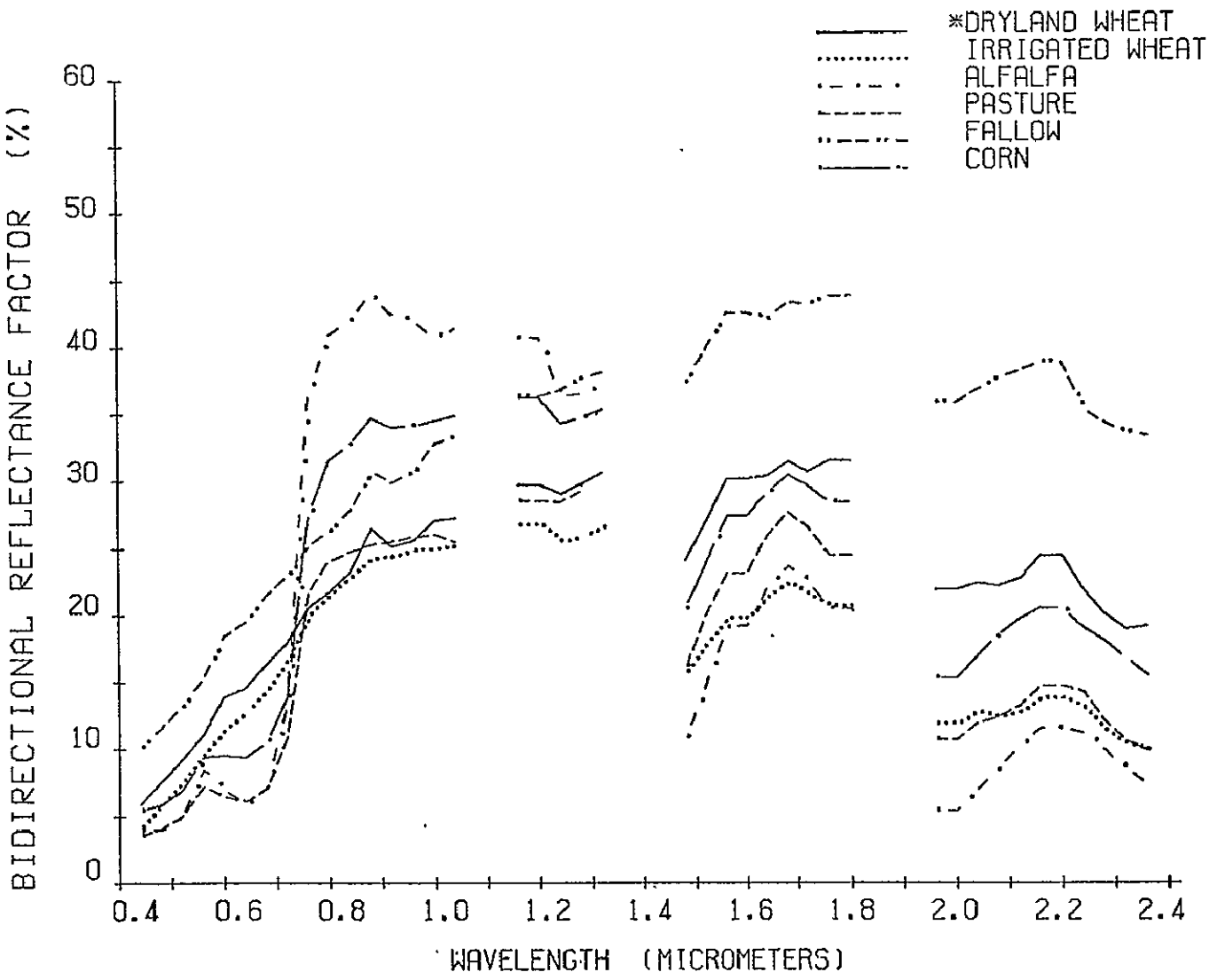
LOCATION: FINNEY COUNTY, KANSAS
SENSOR: FSS DATE: JUNE 17, 1975



* AVERAGES OF 2, 10, 3, 1, 3, AND 10 FIELDS, RESPECTIVELY.

DIFFERENCE IN REFLECTANCE DUE TO COVER TYPE

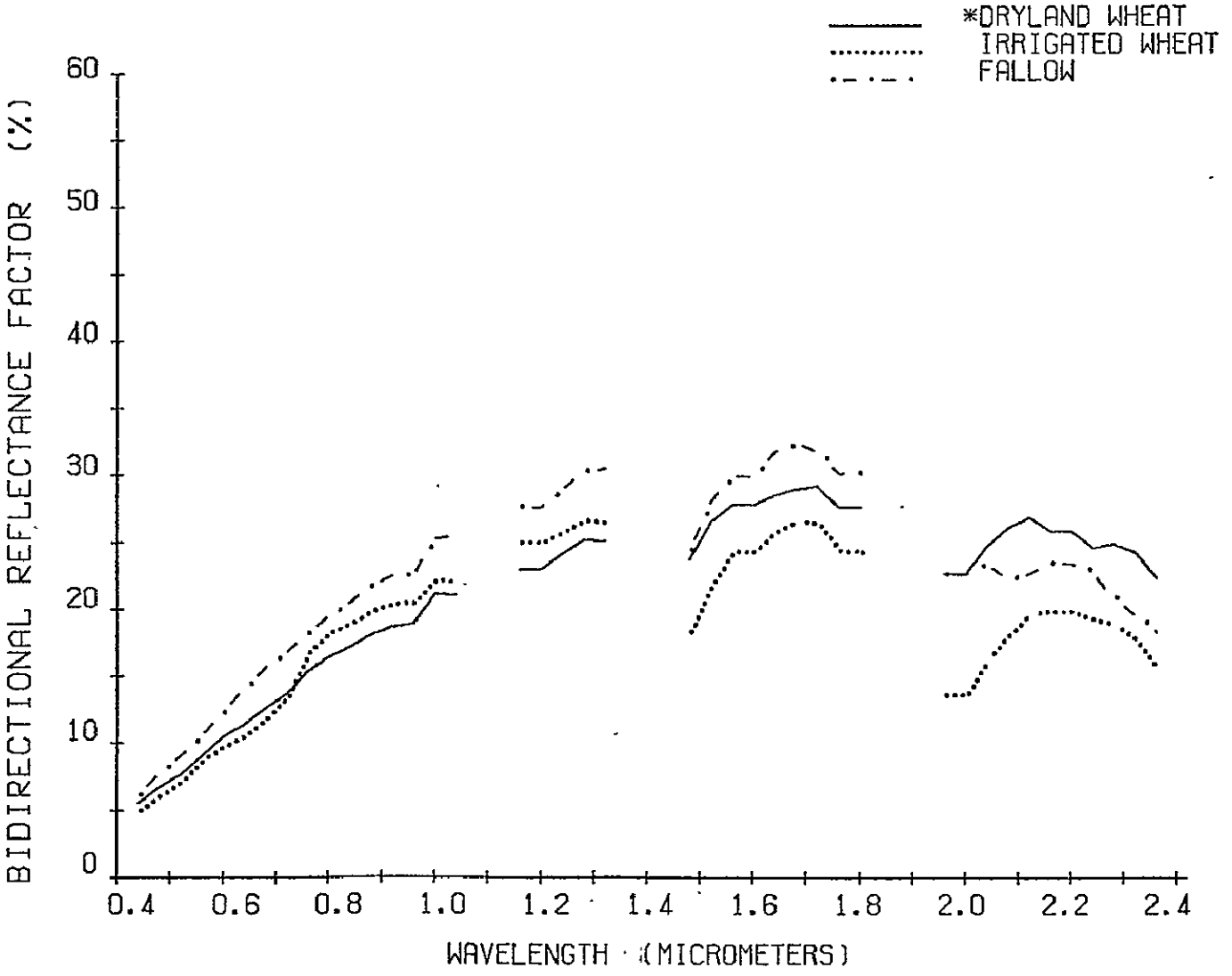
LOCATION: FINNEY COUNTY, KANSAS
SENSOR: FSS DATE: JUNE 26, 1975



* AVERAGES OF 2, 10, 3, 1, 3, AND 10 FIELDS, RESPECTIVELY.

DIFFERENCE IN REFLECTANCE DUE TO COVER TYPE

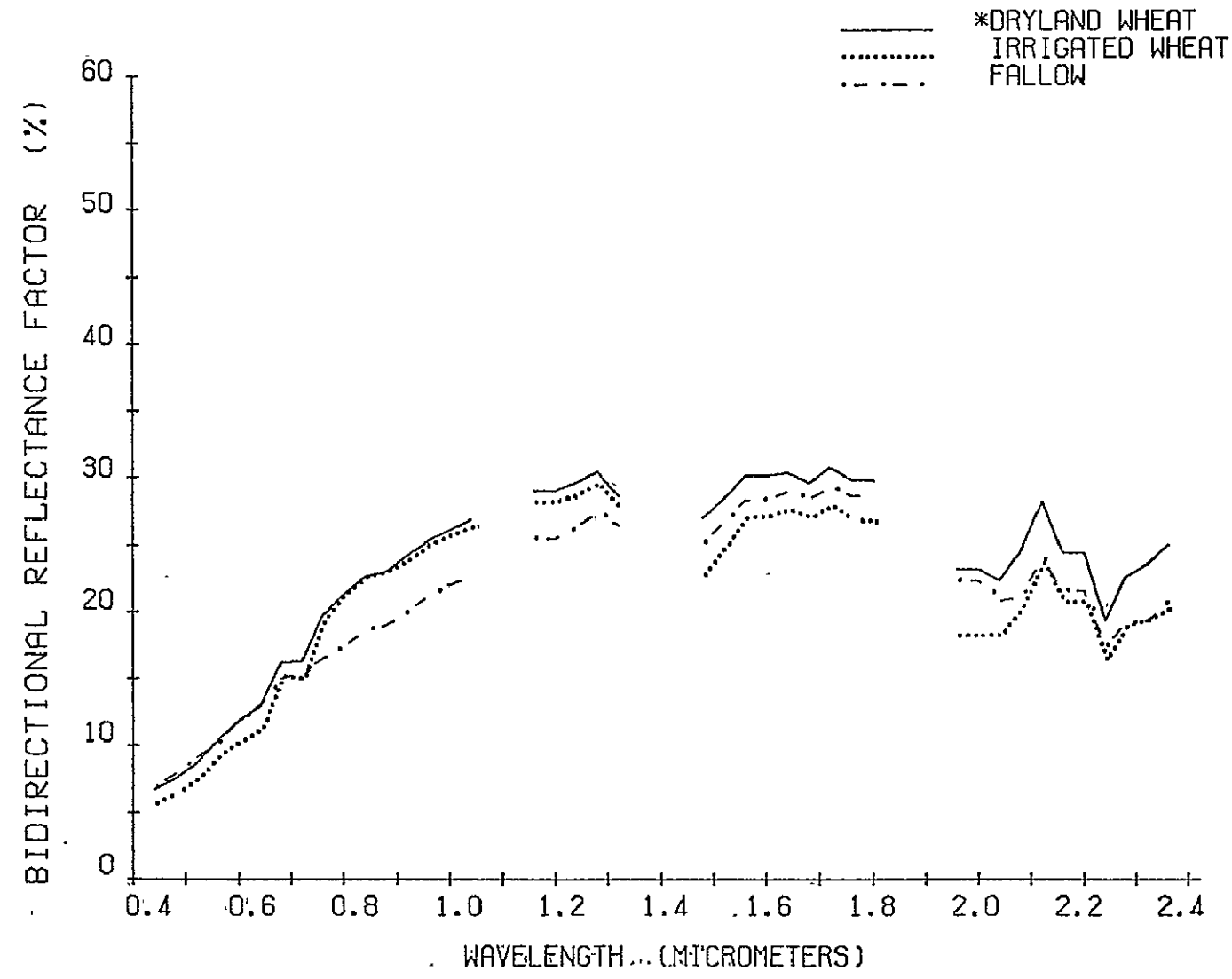
LOCATION: FINNEY COUNTY, KANSAS
SENSOR: FSS DATE: OCTOBER 21, 1975



* AVERAGES OF 9, 3, AND 10 FIELDS, RESPECTIVELY

DIFFERENCE IN REFLECTANCE DUE TO COVER TYPE

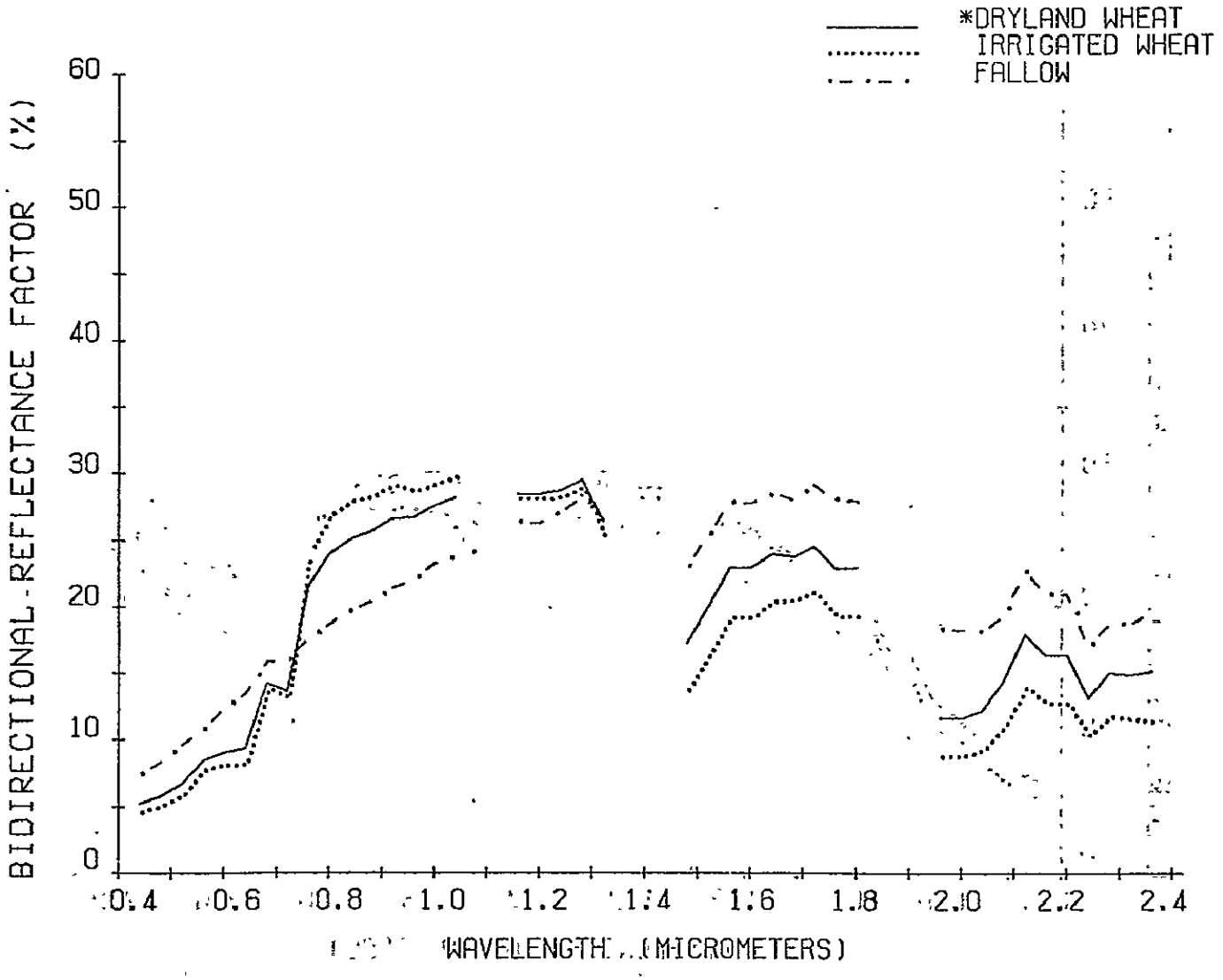
LOCATION: FINNEY COUNTY, KANSAS
SENSOR: FSS DATE: MARCH 18, 1976



* AVERAGES OF 9, 3, AND 10 FIELDS, RESPECTIVELY.

DIFFERENCE IN REFLECTANCE DUE TO COVER TYPE

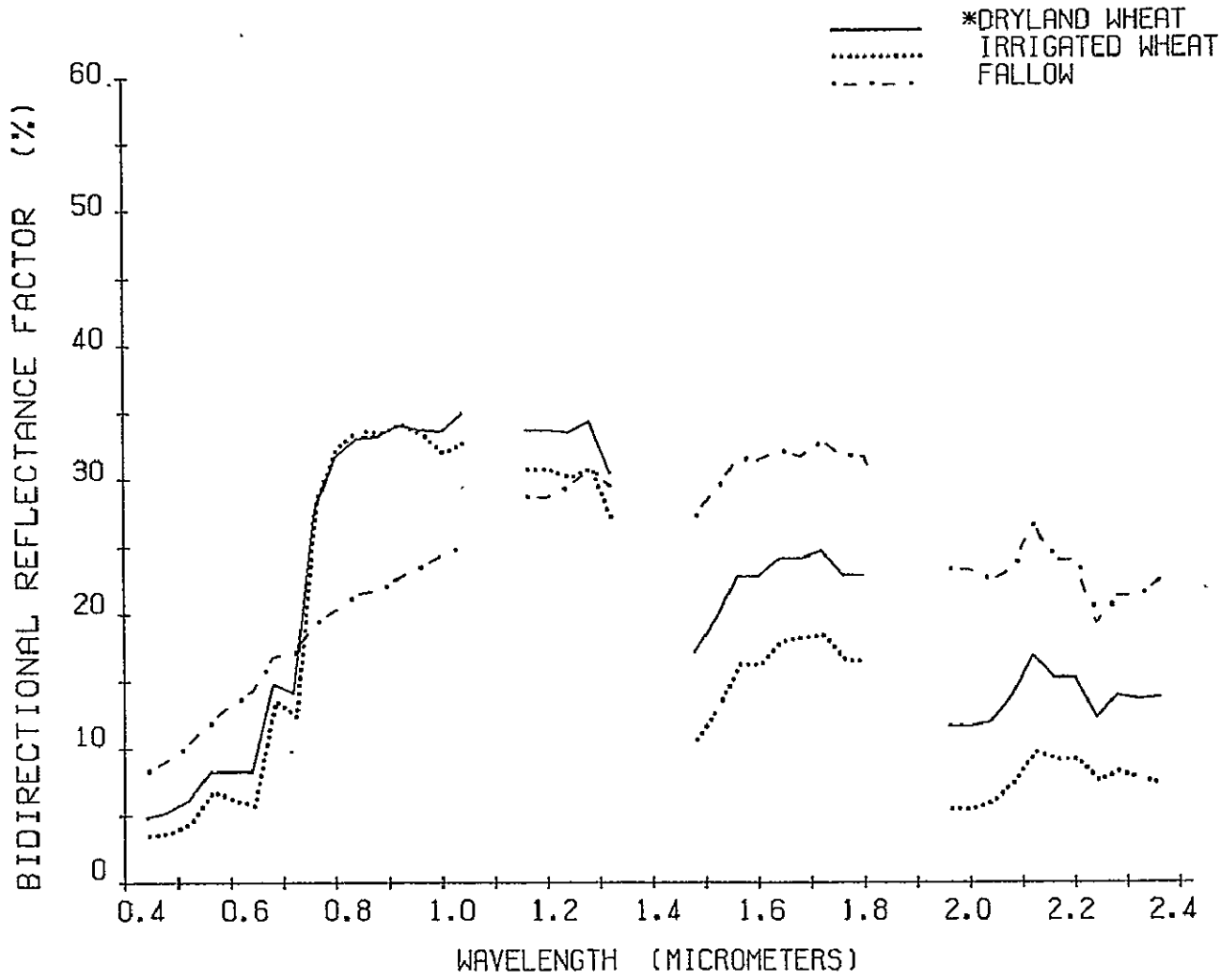
LOCATION: FINNEY COUNTY, KANSAS
SENSOR: FSS DATE: APRIL 18, 1976



* AVERAGES OF 9, 3, AND 10 FIELDS, RESPECTIVELY.

DIFFERENCE IN REFLECTANCE DUE TO COVER TYPE

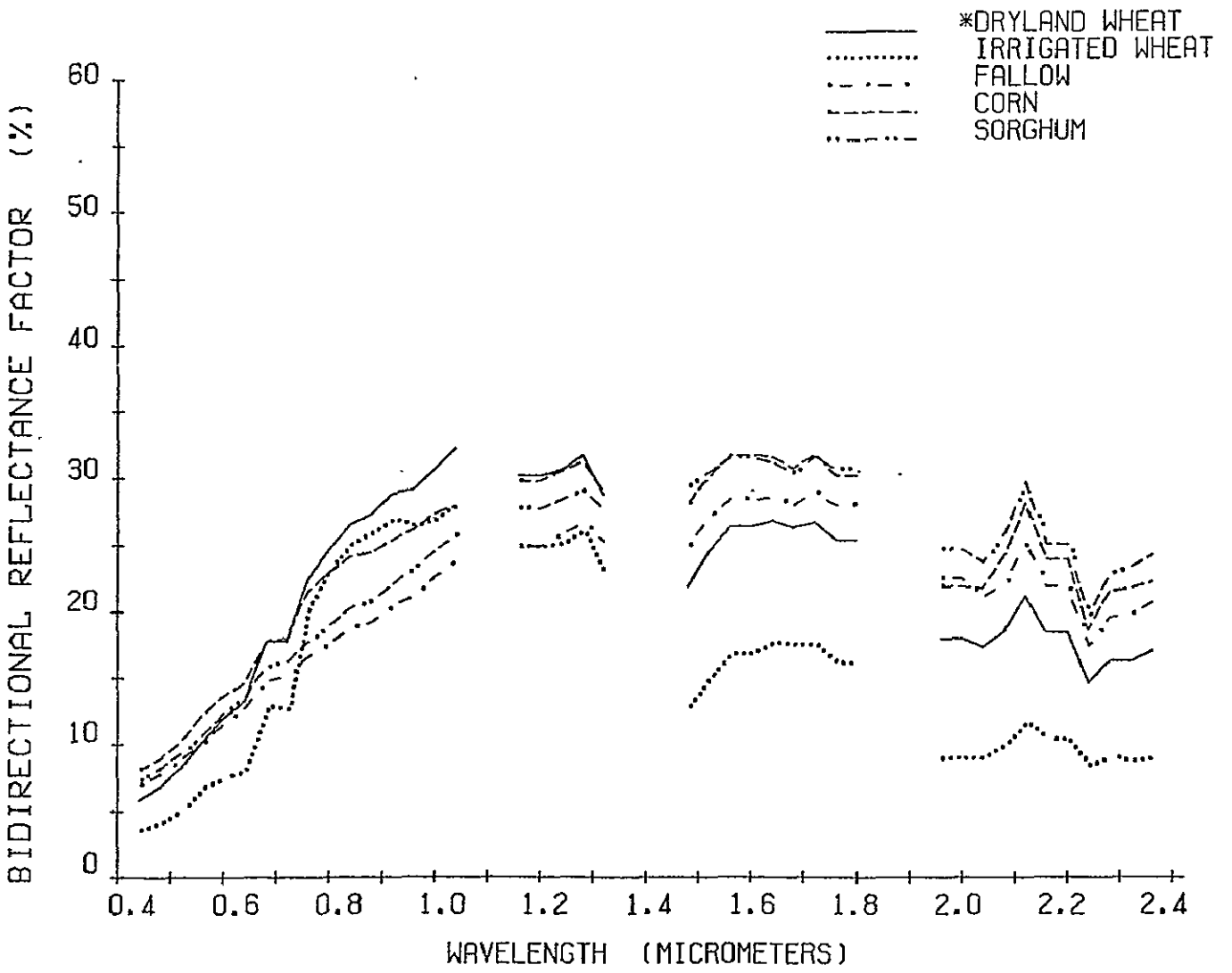
LOCATION: FINNEY COUNTY, KANSAS
SENSOR: FSS DATE: MAY 6, 1976



* AVERAGES OF 9, 3, AND 10 FIELDS, RESPECTIVELY.

DIFFERENCE IN REFLECTANCE DUE TO COVER TYPE

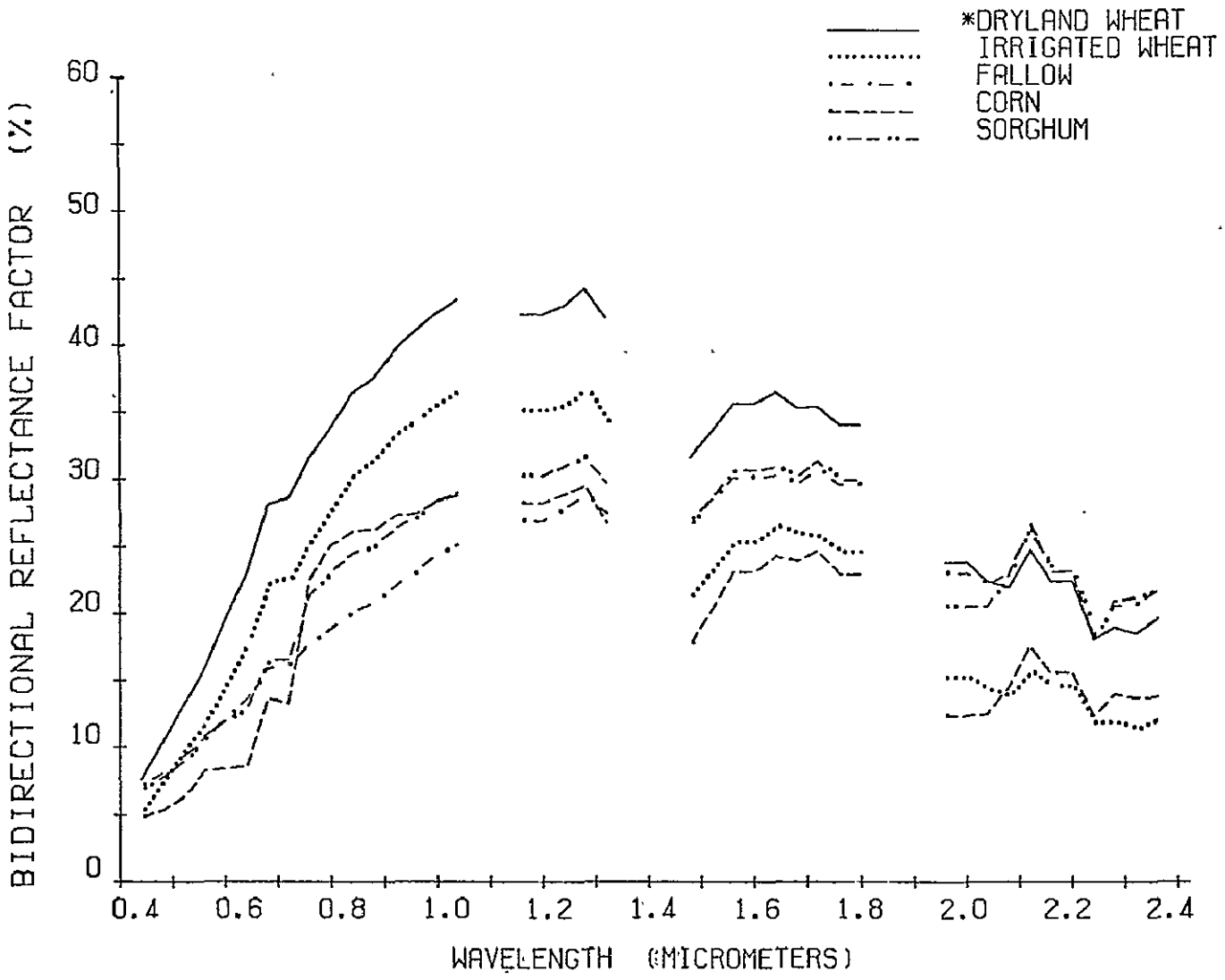
LOCATION: FINNEY COUNTY, KANSAS
SENSOR: FSS DATE: JUNE 12, 1976



* AVERAGES OF 9, 3, 10, 3, AND 7 FIELDS, RESPECTIVELY.

DIFFERENCE IN REFLECTANCE DUE TO COVER TYPE

LOCATION: FINNEY COUNTY, KANSAS
SENSOR: FSS DATE: JUNE 30, 1976

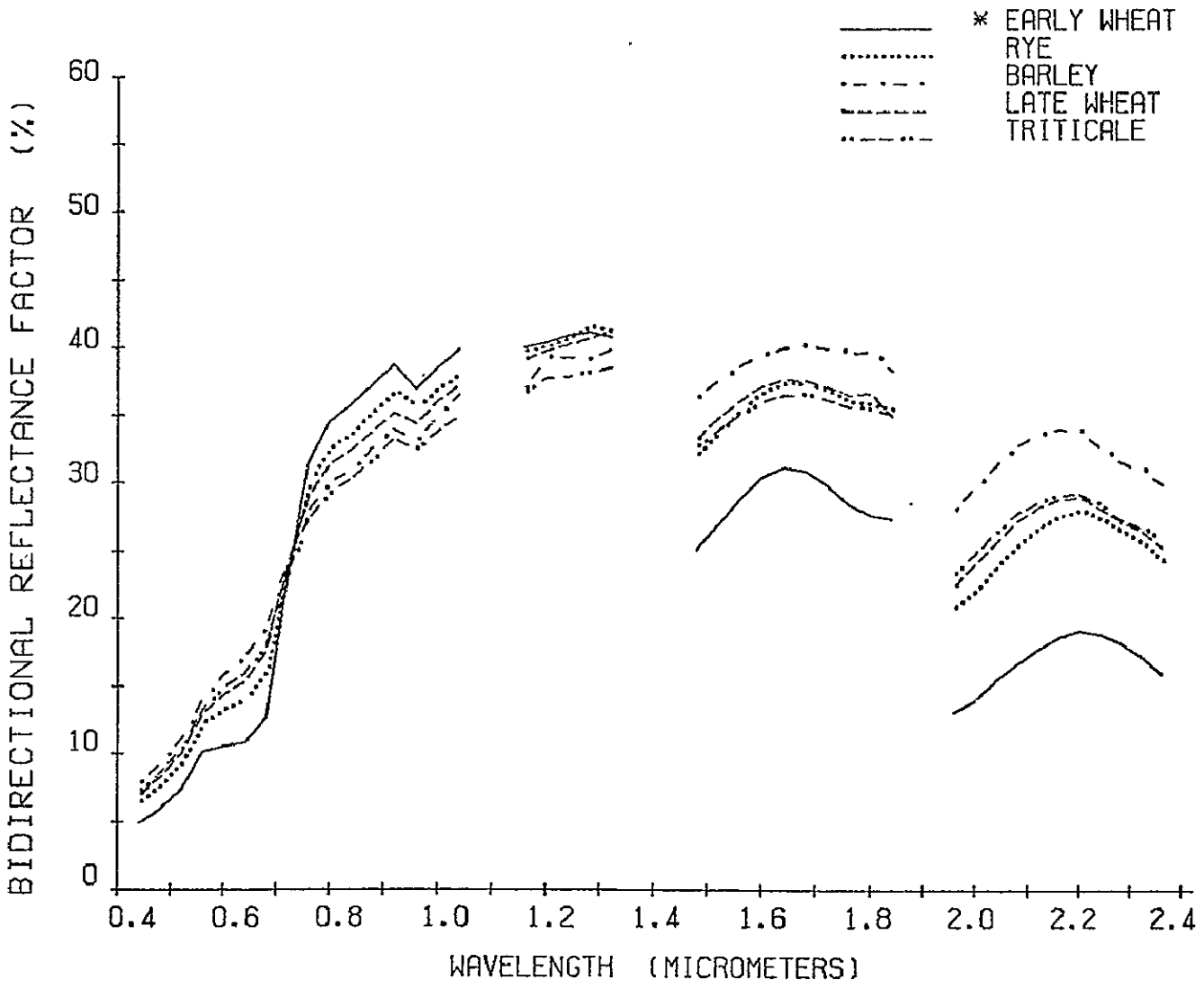


* AVERAGES OF 9, 3, 10, 3, AND 7 FIELDS, RESPECTIVELY.

REFLECTANCE OF WINTER WHEAT AND OTHER SMALL GRAINS

LOCATION: GARDEN CITY, KANSAS

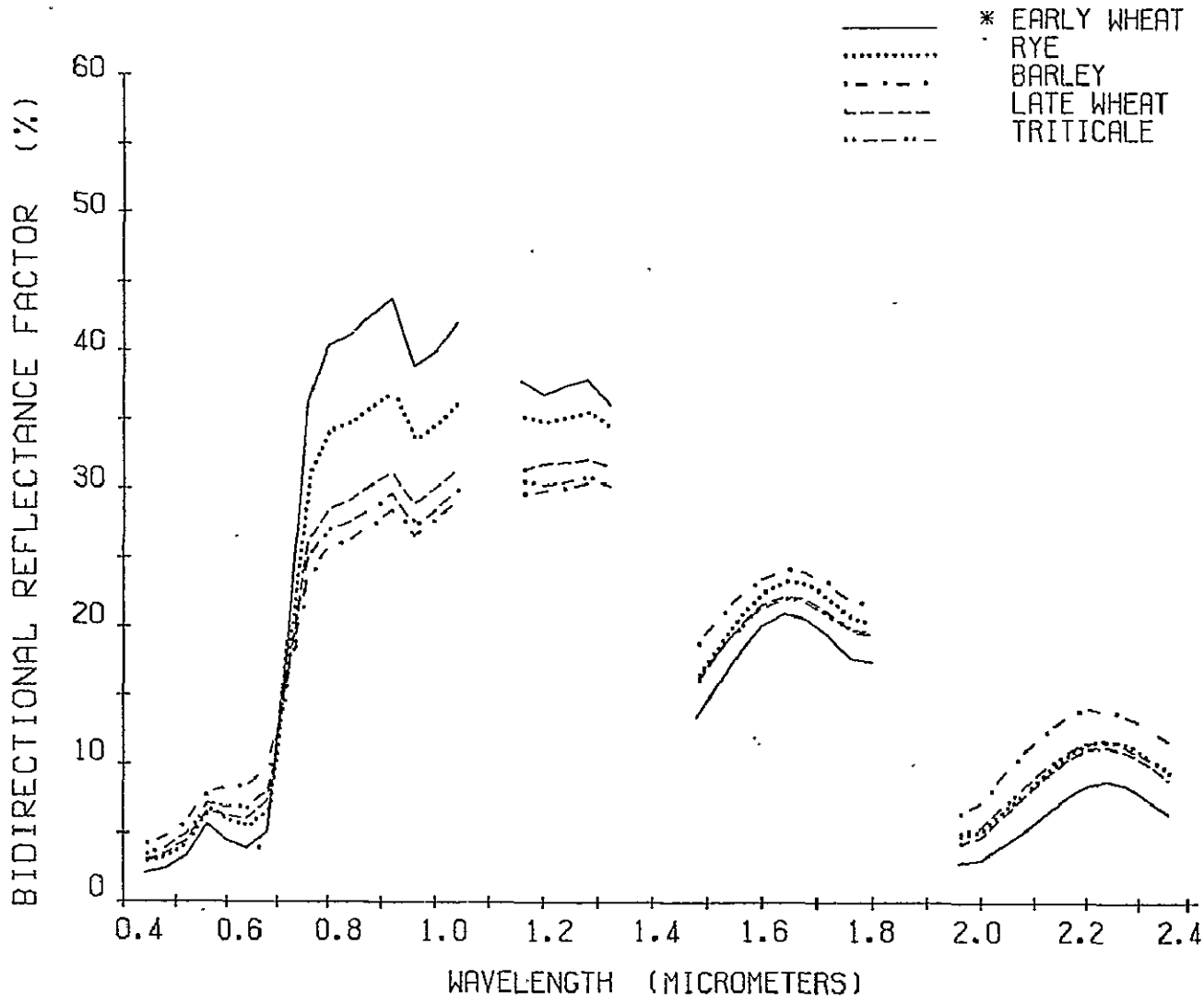
SENSOR: EXOTECH MODEL 20D DATE: APRIL 9, 1975



REFLECTANCE OF WINTER WHEAT AND OTHER SMALL GRAINS

LOCATION: GARDEN CITY, KANSAS

SENSOR: EXOTECH MODEL 20D . DATE: APRIL 23, 1975 .

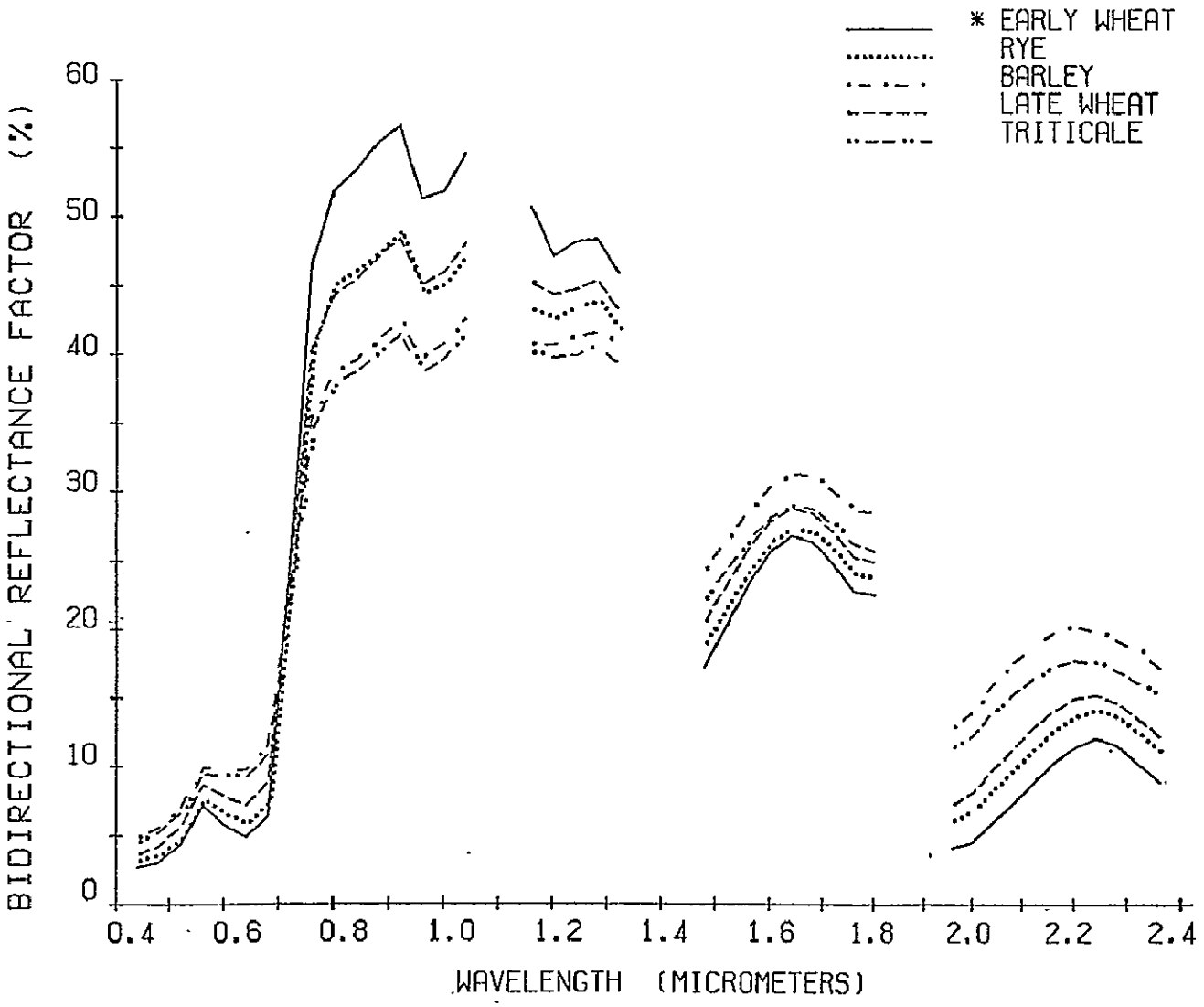


* AVERAGES OF 2 PLOTS.

REFLECTANCE OF WINTER WHEAT AND OTHER SMALL GRAINS

LOCATION: GARDEN CITY, KANSAS

SENSOR: EXOTECH MODEL 20D DATE: APRIL 28, 1975

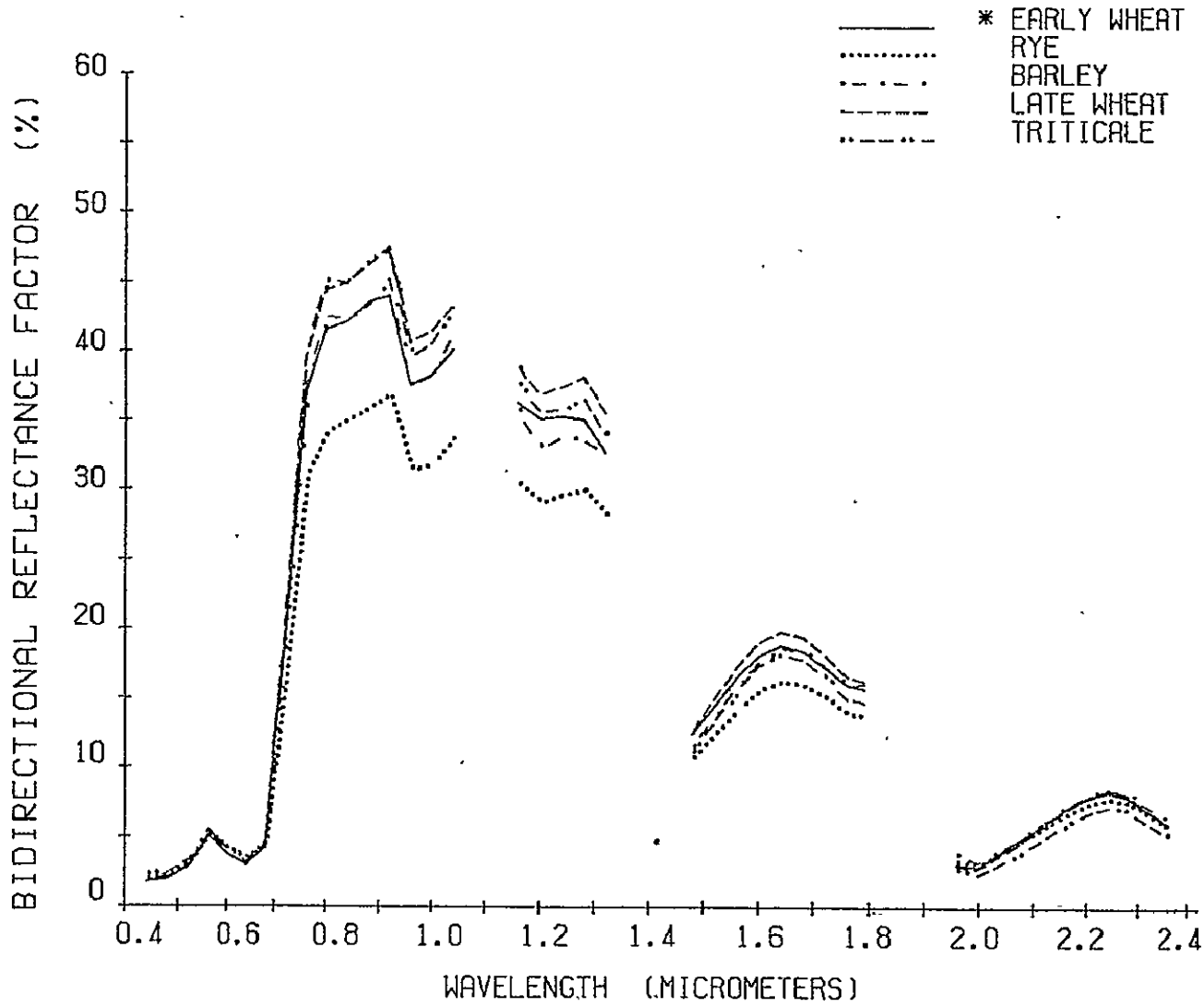


* AVERAGES OF 2 PLOTS.

REFLECTANCE OF WINTER WHEAT AND OTHER SMALL GRAINS

LOCATION: GARDEN CITY, KANSAS

SENSOR: EXOTECH MODEL 20D DATE: MAY 15, 1975

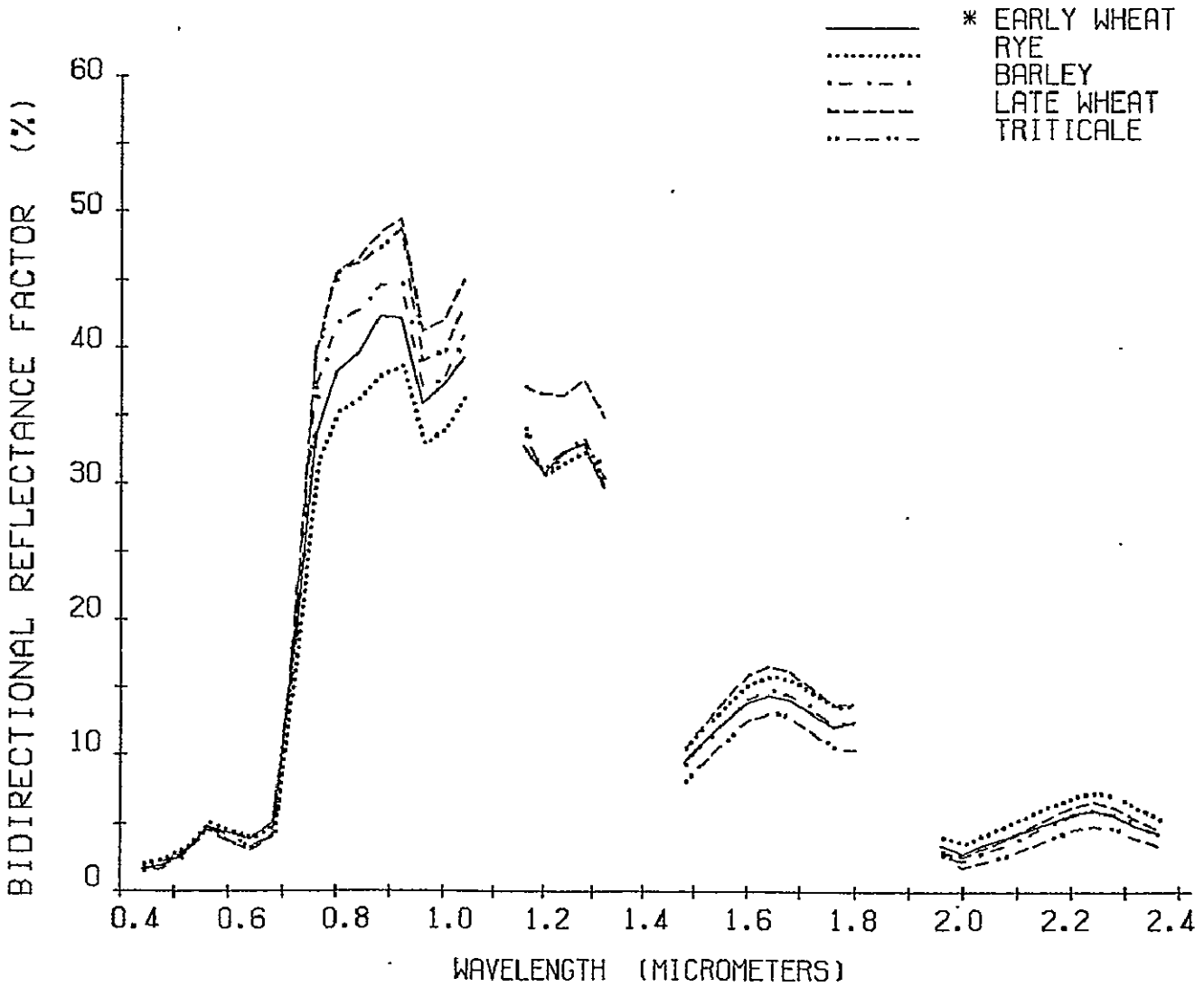


* AVERAGES OF 2, 2, 1, 2, AND 2 PLOTS, RESPECTIVELY.

REFLECTANCE OF WINTER WHEAT AND OTHER SMALL GRAINS

LOCATION: GARDEN CITY, KANSAS

SENSOR: EXOTECH MODEL 20D DATE: JUNE 3, 1975

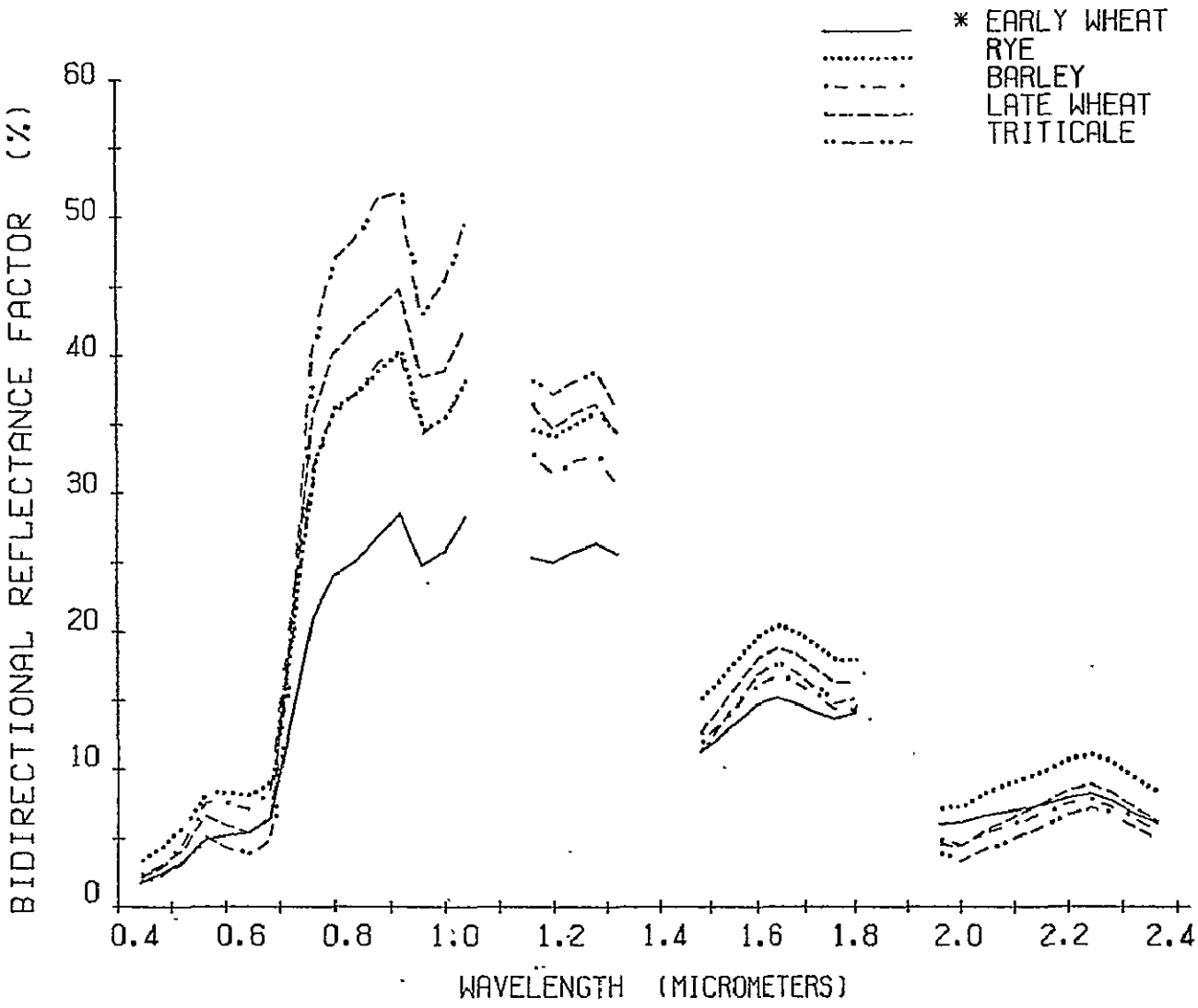


* AVERAGES OF 2, 2, 1, 2, AND 2 PLOTS, RESPECTIVELY.

REFLECTANCE OF WINTER WHEAT AND OTHER SMALL GRAINS

LOCATION: GARDEN CITY, KANSAS

SENSOR: EXOTECH MODEL 20D DATE: JUNE 15, 1975

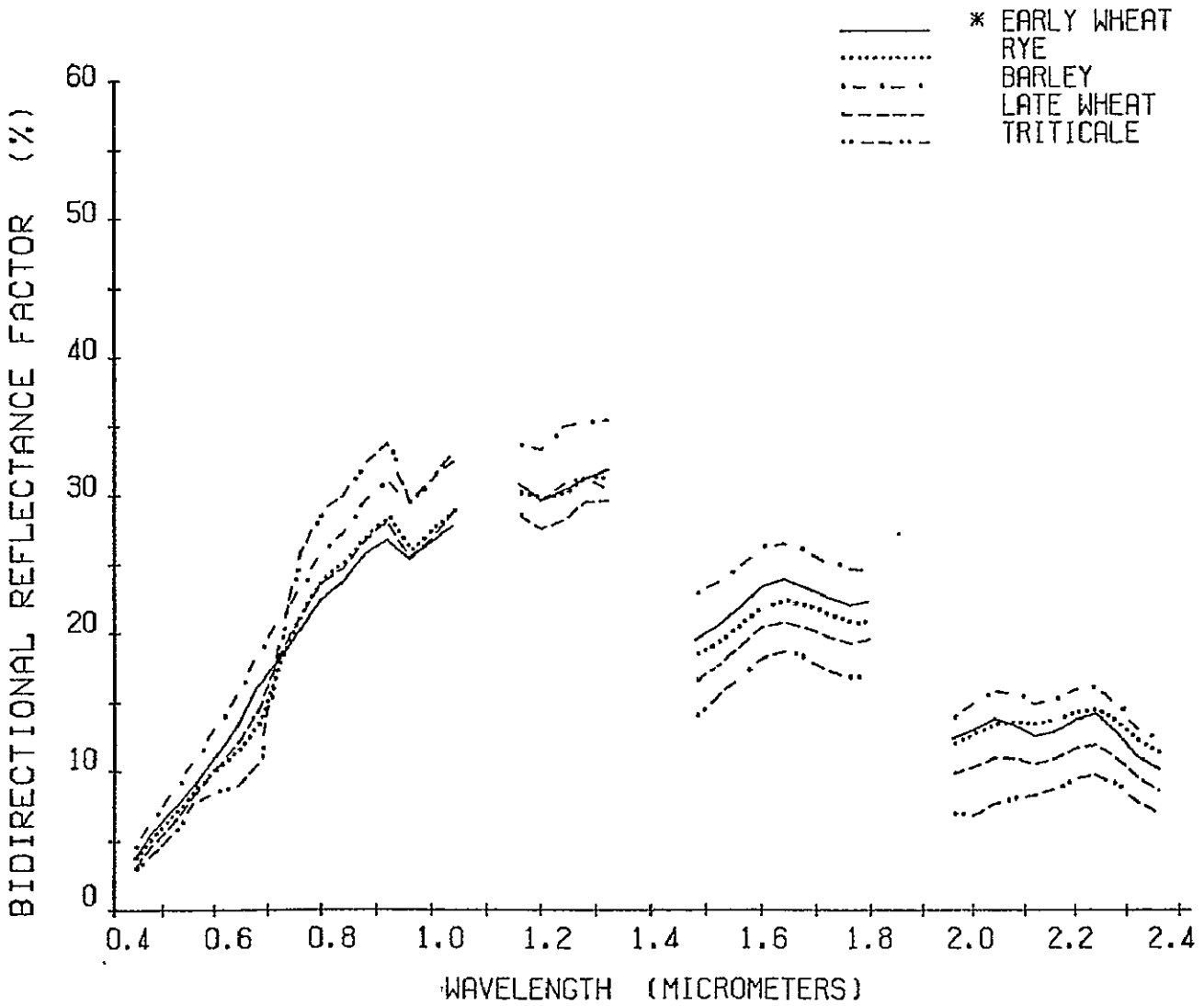


* AVERAGES OF 2, 2, 1, 1, AND 2 PLOTS, RESPECTIVELY.

REFLECTANCE OF WINTER WHEAT AND OTHER SMALL GRAINS

LOCATION: GARDEN CITY, KANSAS

SENSOR: EXOTECH MODEL 20D DATE: JUNE 29, 1975

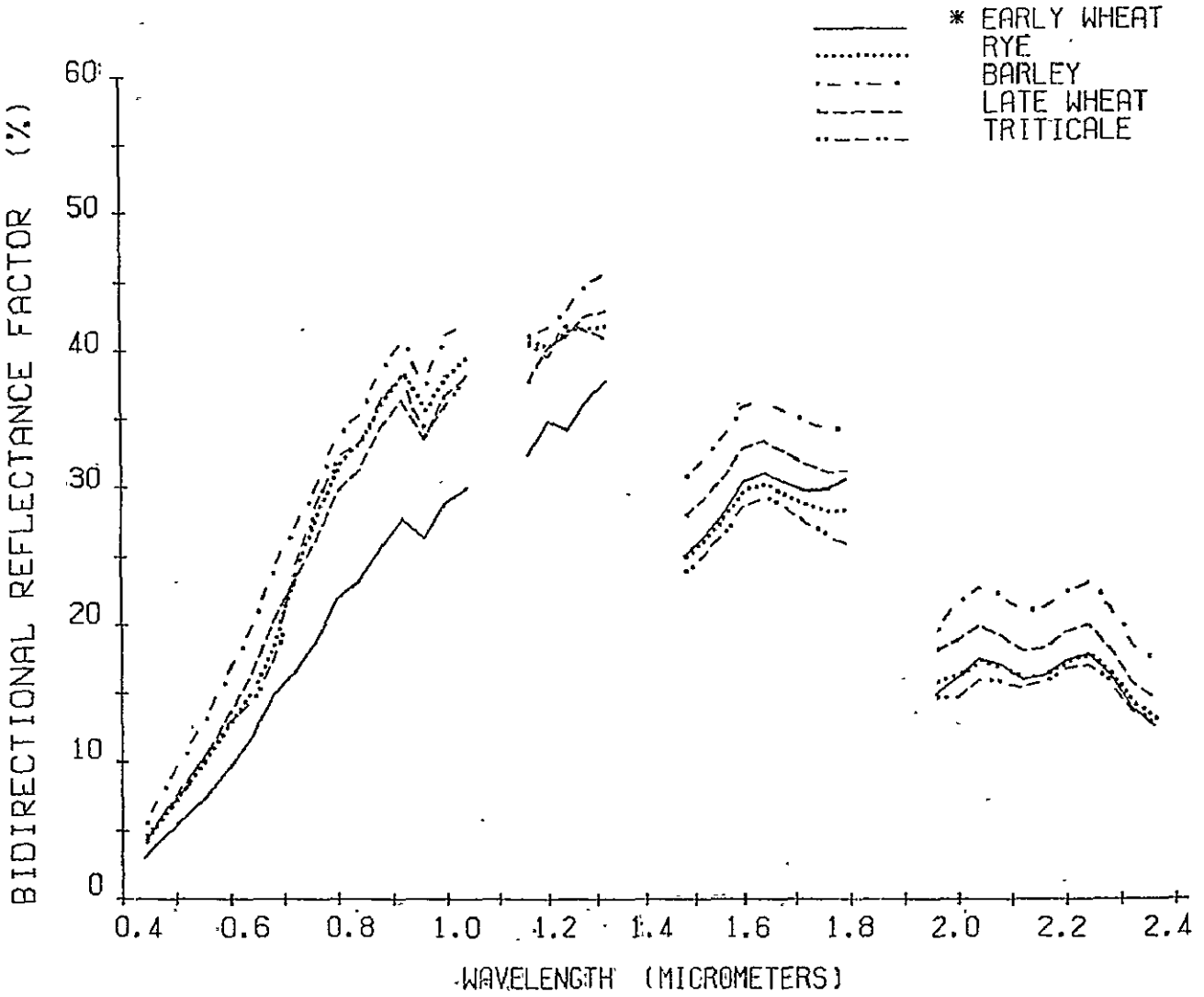


* AVERAGES OF 2 PLOTS.

REFLECTANCE OF WINTER WHEAT AND OTHER SMALL GRAINS

LOCATION: GARDEN CITY, KANSAS

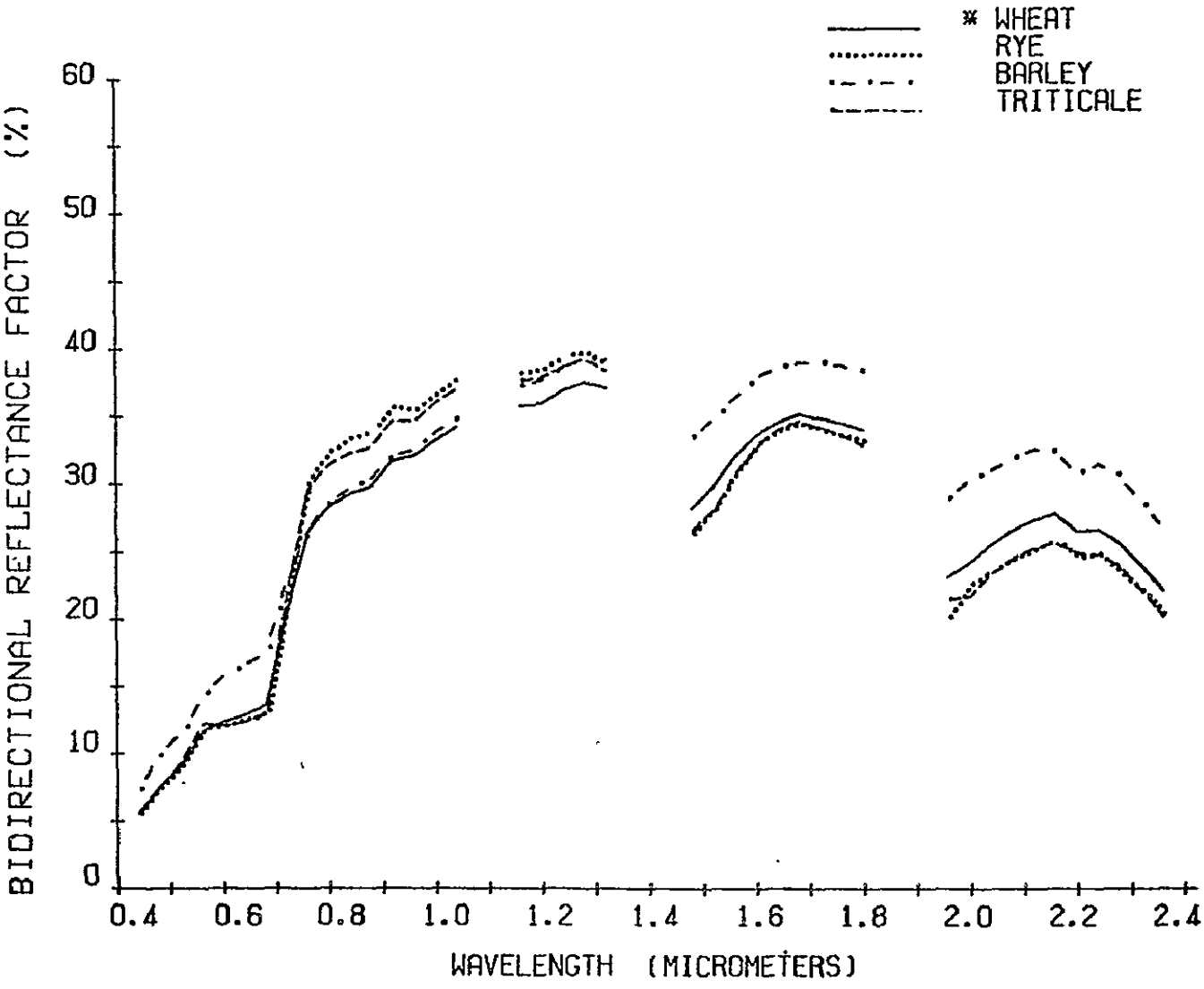
SENSOR: EXOTECH MODEL 20D DATE: JULY 4, 1975



* AVERAGES OF 2 PLOTS.

REFLECTANCE OF WINTER WHEAT AND OTHER SMALL GRAINS

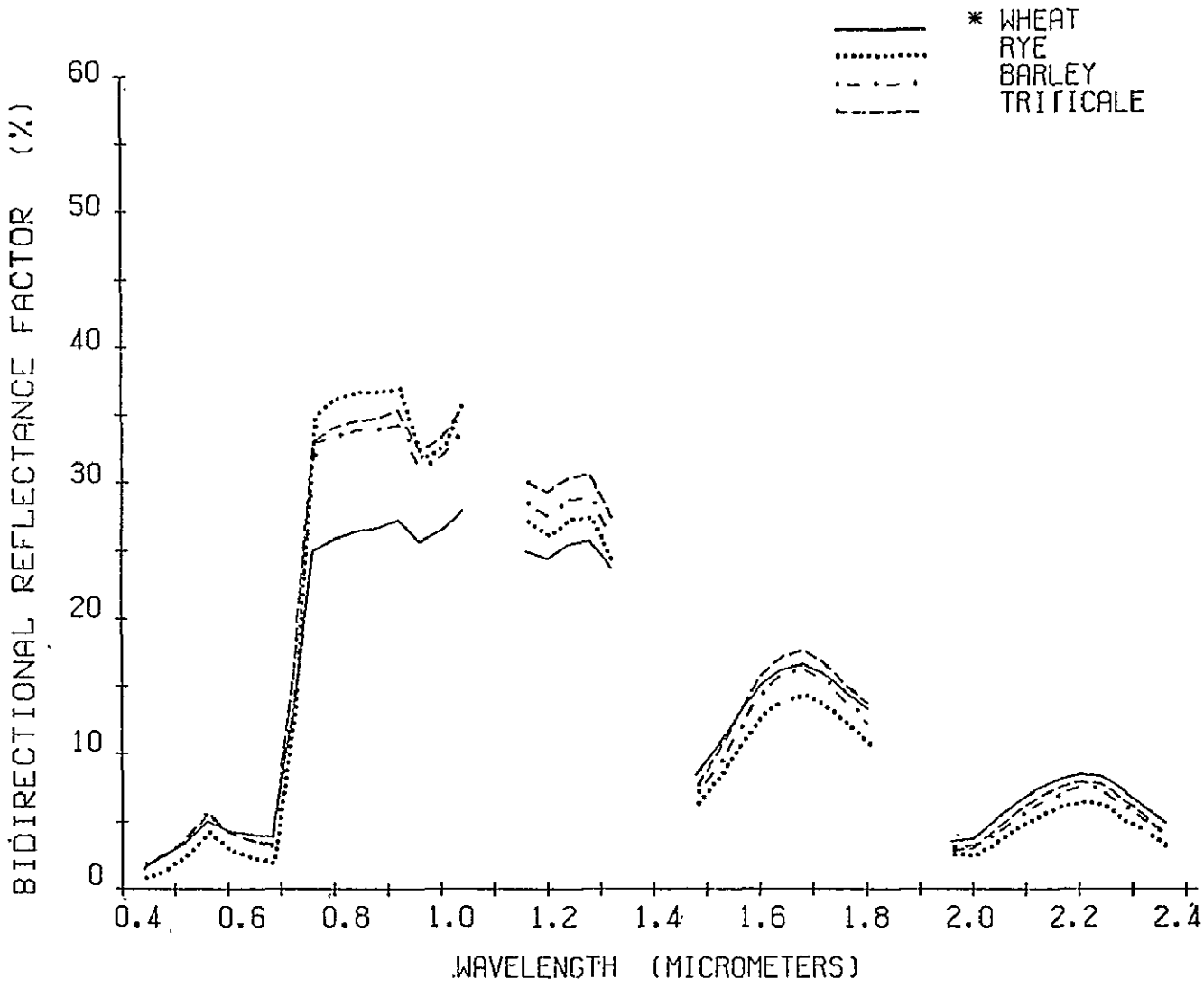
LOCATION: GARDEN CITY, KANSAS
SENSOR: FSAS DATE: APRIL 1, 1976



* AVERAGES OF 3, 1, 1, AND 1 PLOTS, RESPECTIVELY.

REFLECTANCE OF WINTER WHEAT AND OTHER SMALL GRAINS

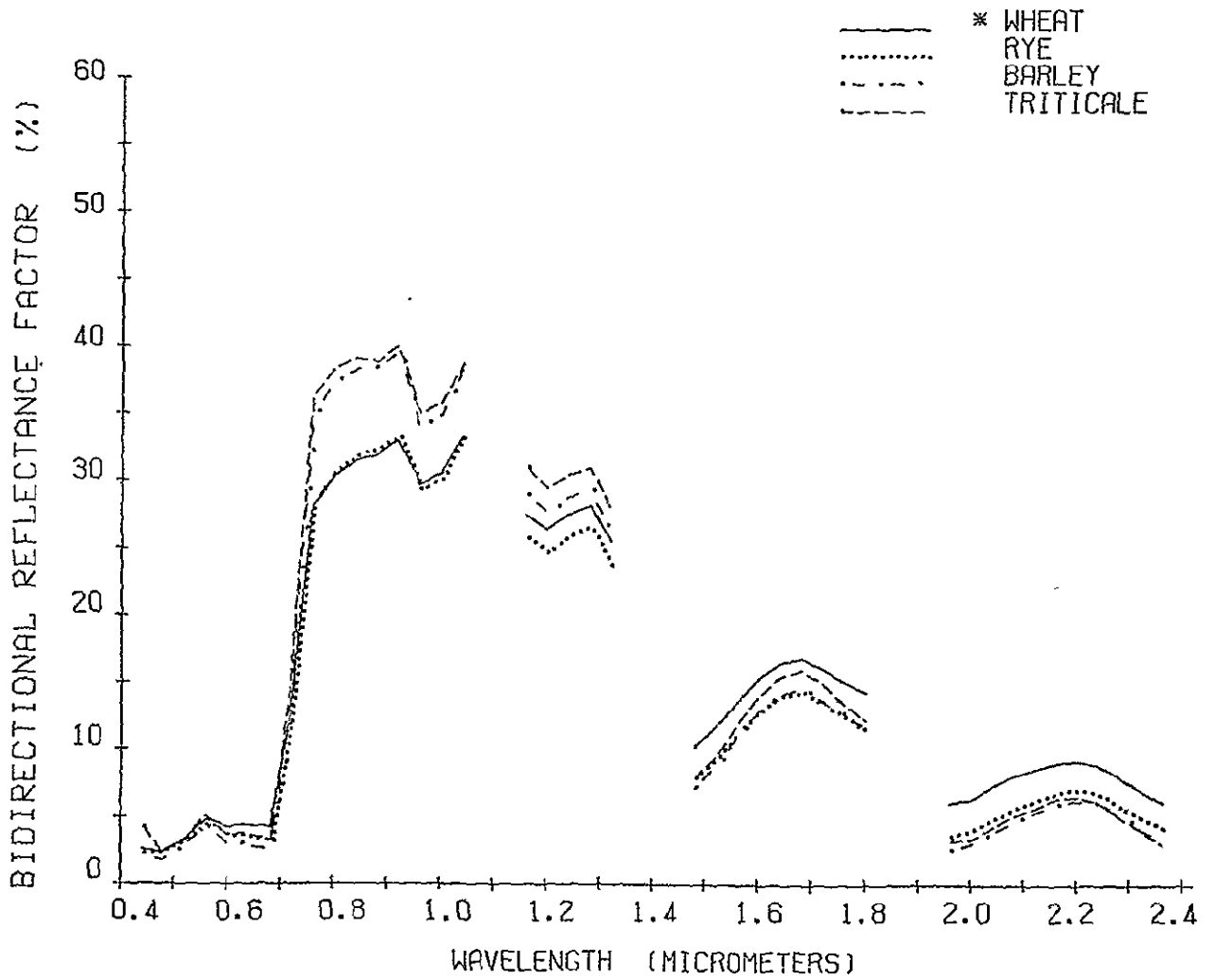
LOCATION: GARDEN CITY, KANSAS
SENSOR: FSAS DATE: MAY 1, 1976



* AVERAGES OF 4, 1, 1, AND 1 PLOTS, RESPECTIVELY.

REFLECTANCE OF WINTER WHEAT AND OTHER SMALL GRAINS

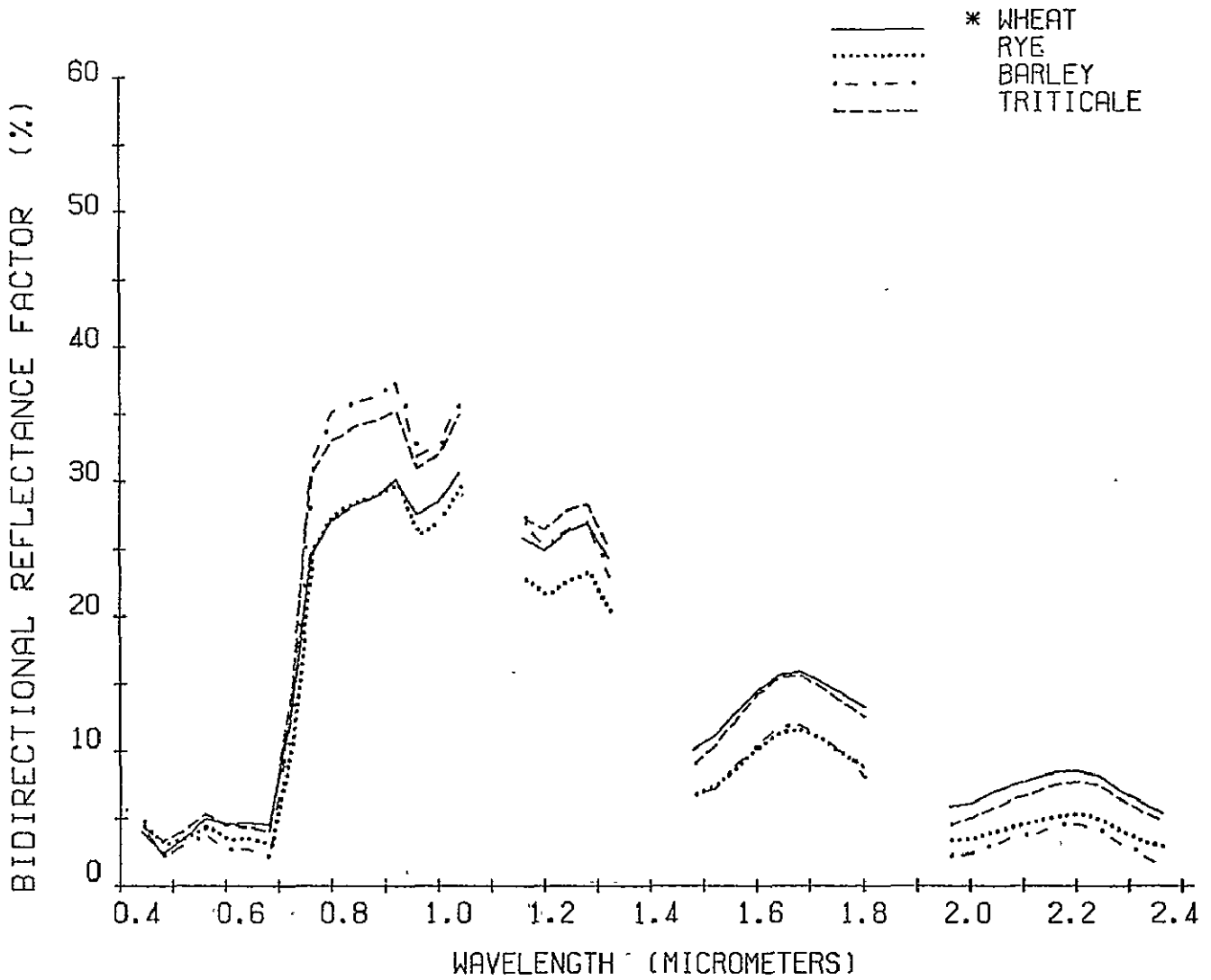
LOCATION: GARDEN CITY, KANSAS
SENSOR: FSAS DATE: MAY 17, 1976



* AVERAGES OF 7, 1, 2, AND 2 PLOTS, RESPECTIVELY.

REFLECTANCE OF WINTER WHEAT AND OTHER SMALL GRAINS

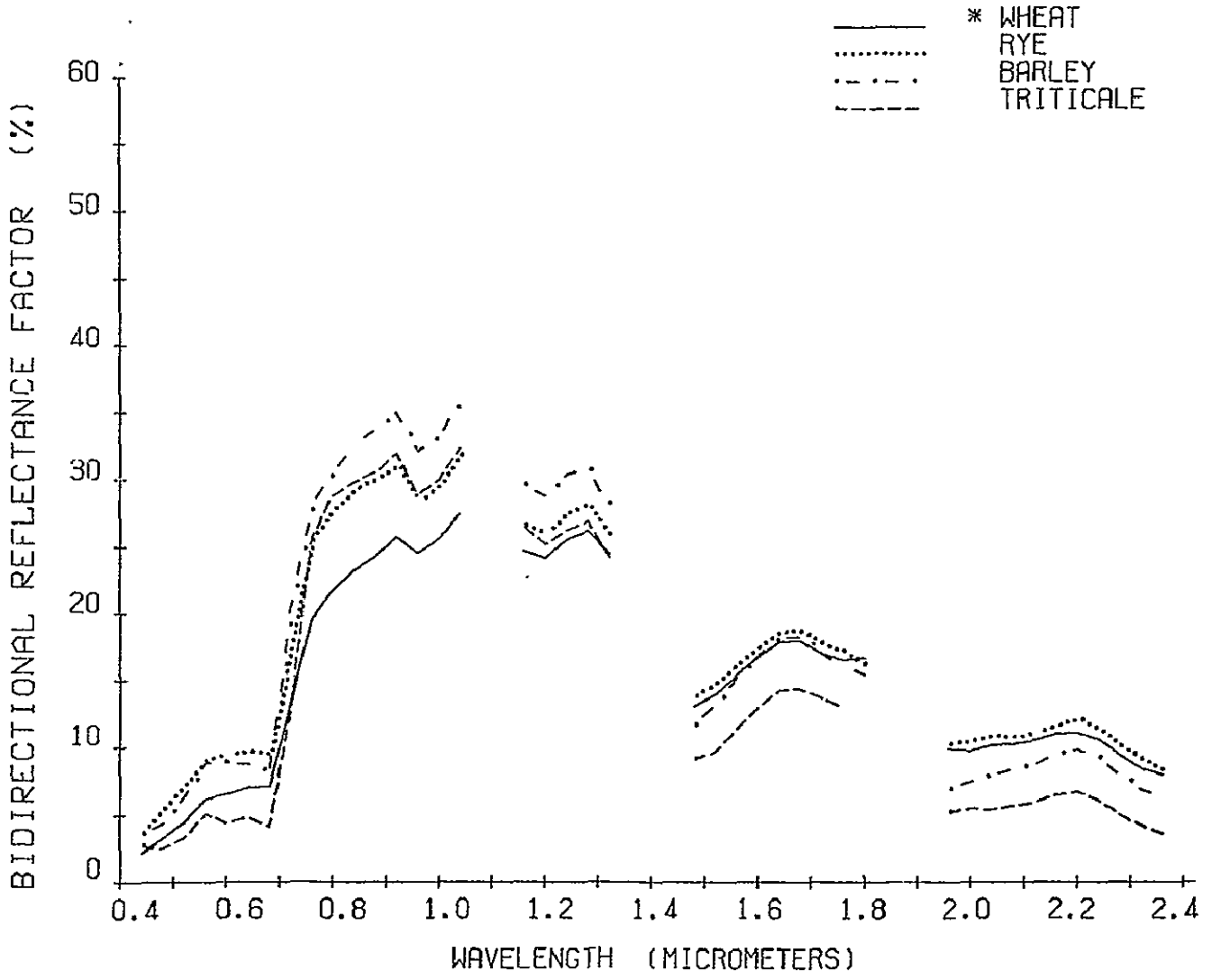
LOCATION: GARDEN CITY, KANSAS
SENSOR: FSAS DATE: MAY 29, 1976



* AVERAGES OF 4, 1, 1, AND 1 PLOTS, RESPECTIVELY.

REFLECTANCE OF WINTER WHEAT AND OTHER SMALL GRAINS

LOCATION: GARDEN CITY, KANSAS
SENSOR: FSAS DATE: JUNE 10, 1976



* AVERAGES OF 4, 1, 1, AND 1 PLOTS, RESPECTIVELY.

III. North Dakota Spring Wheat Examples

A. Variation Within Spring Wheat

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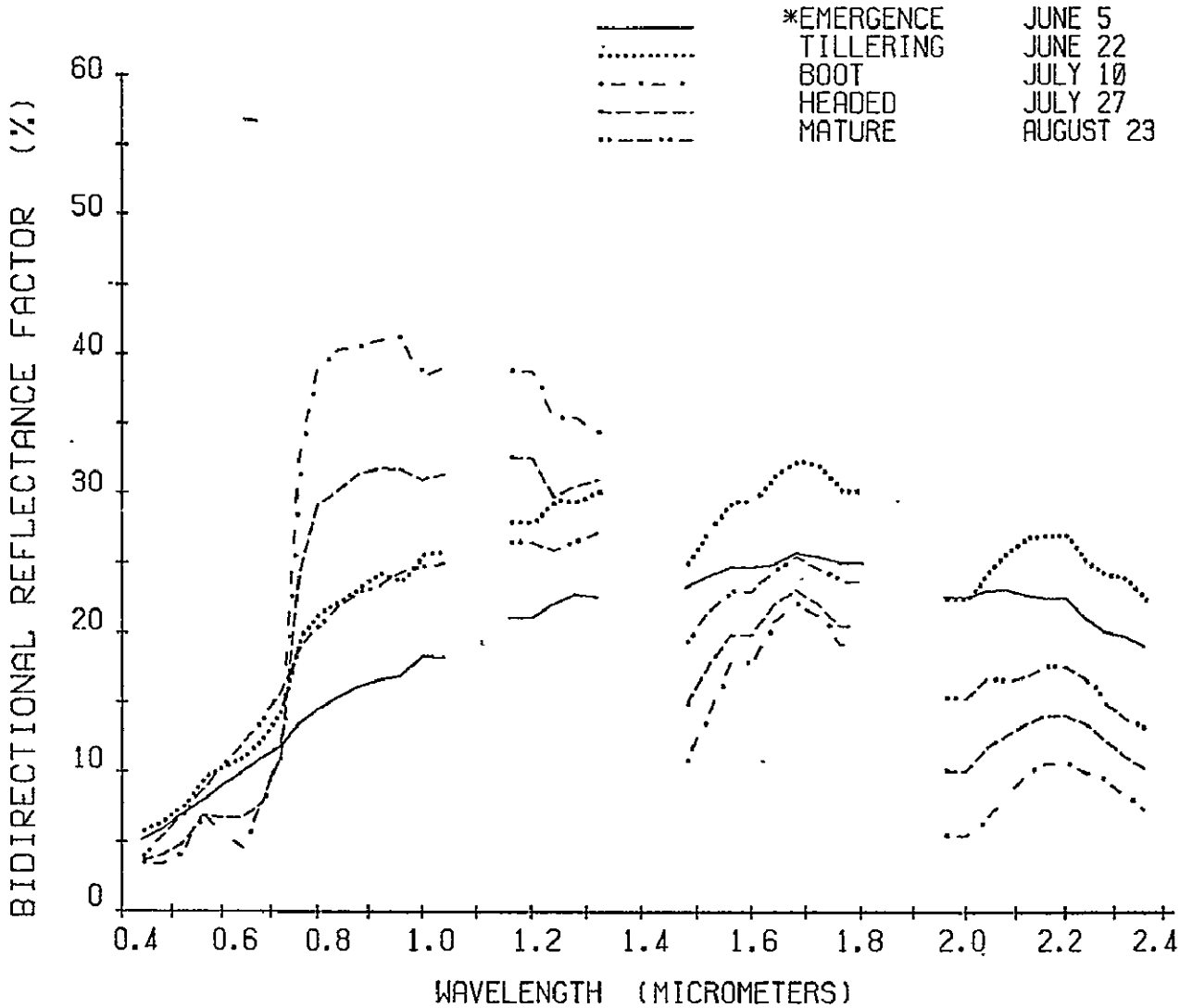
REFLECTANCE OF SPRING WHEAT AT DIFFERENT MATURITY STAGES

LOCATION: WILLIAMS COUNTY, NORTH DAKOTA
SENSOR: FSS DATE: 1975



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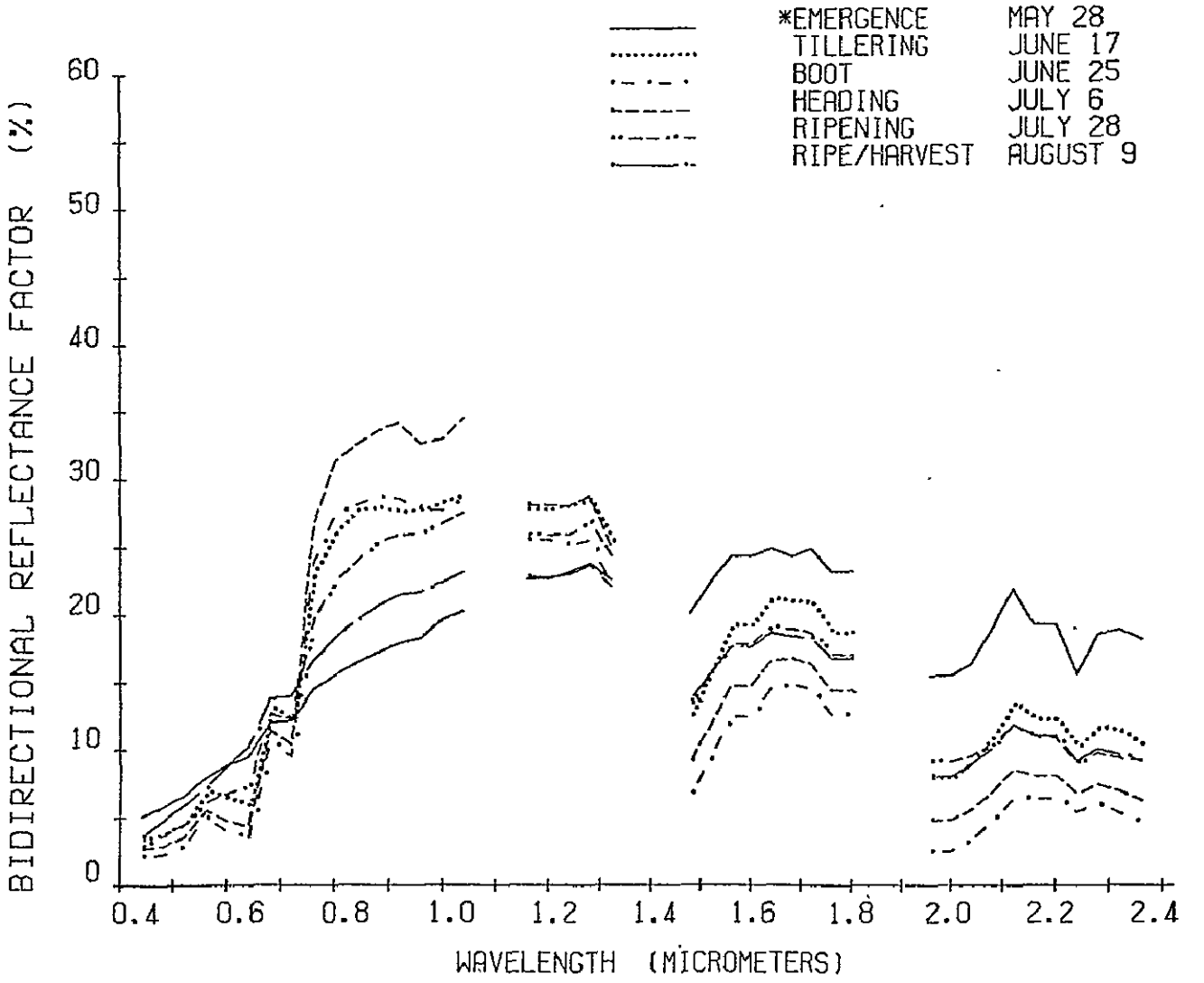
* AVERAGES OF 8, 9, 9, 5, AND 9 FIELDS, RESPECTIVELY.

REFLECTANCE OF SPRING WHEAT AT DIFFERENT MATURITY STAGES

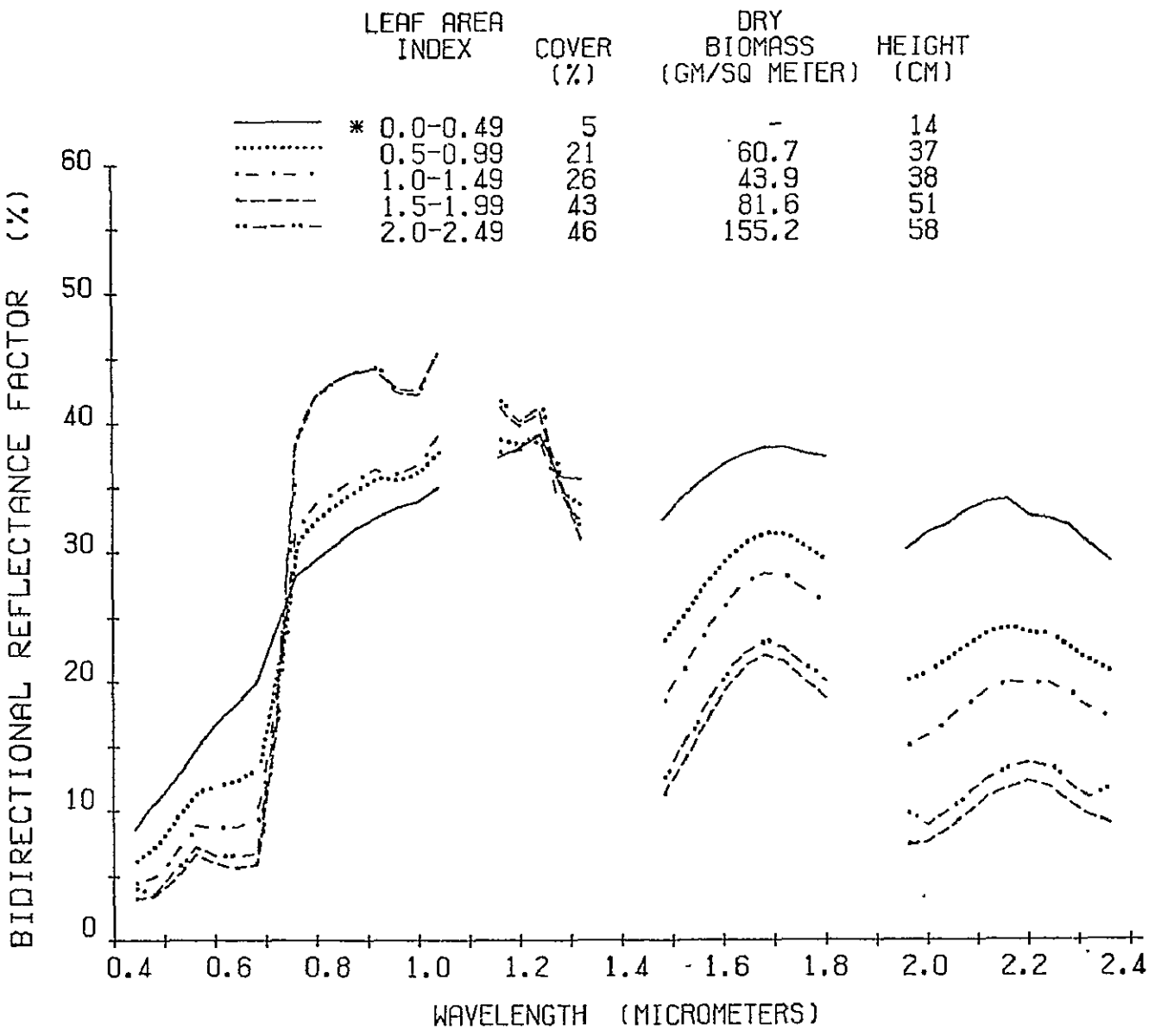
LOCATION: WILLIAMS COUNTY, NORTH DAKOTA
SENSOR: FSS DATE: 1976



* AVERAGE OF 9 FIELDS.

REFLECTANCE OF SPRING WHEAT PLOTS WITH DIFFERENT LEAF AREAS

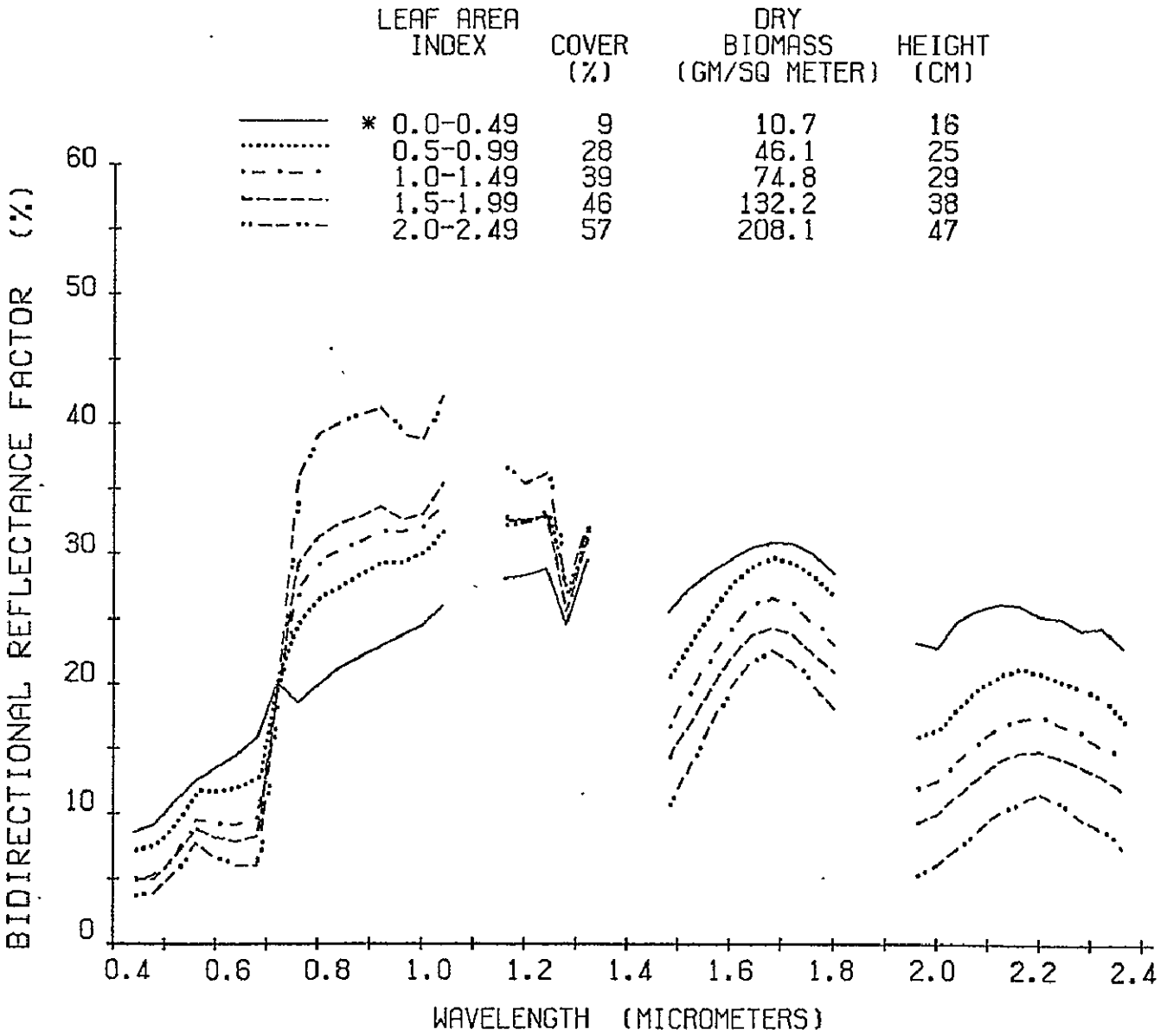
LOCATION: WILLISTON, NORTH DAKOTA
SENSOR: EXOTECH MODEL 20C DATE: 1975



*AVERAGES OF 7, 7, 7, 7, AND 4 PLOTS, RESPECTIVELY.

REFLECTANCE OF SPRING WHEAT PLOTS WITH DIFFERENT LEAF AREAS

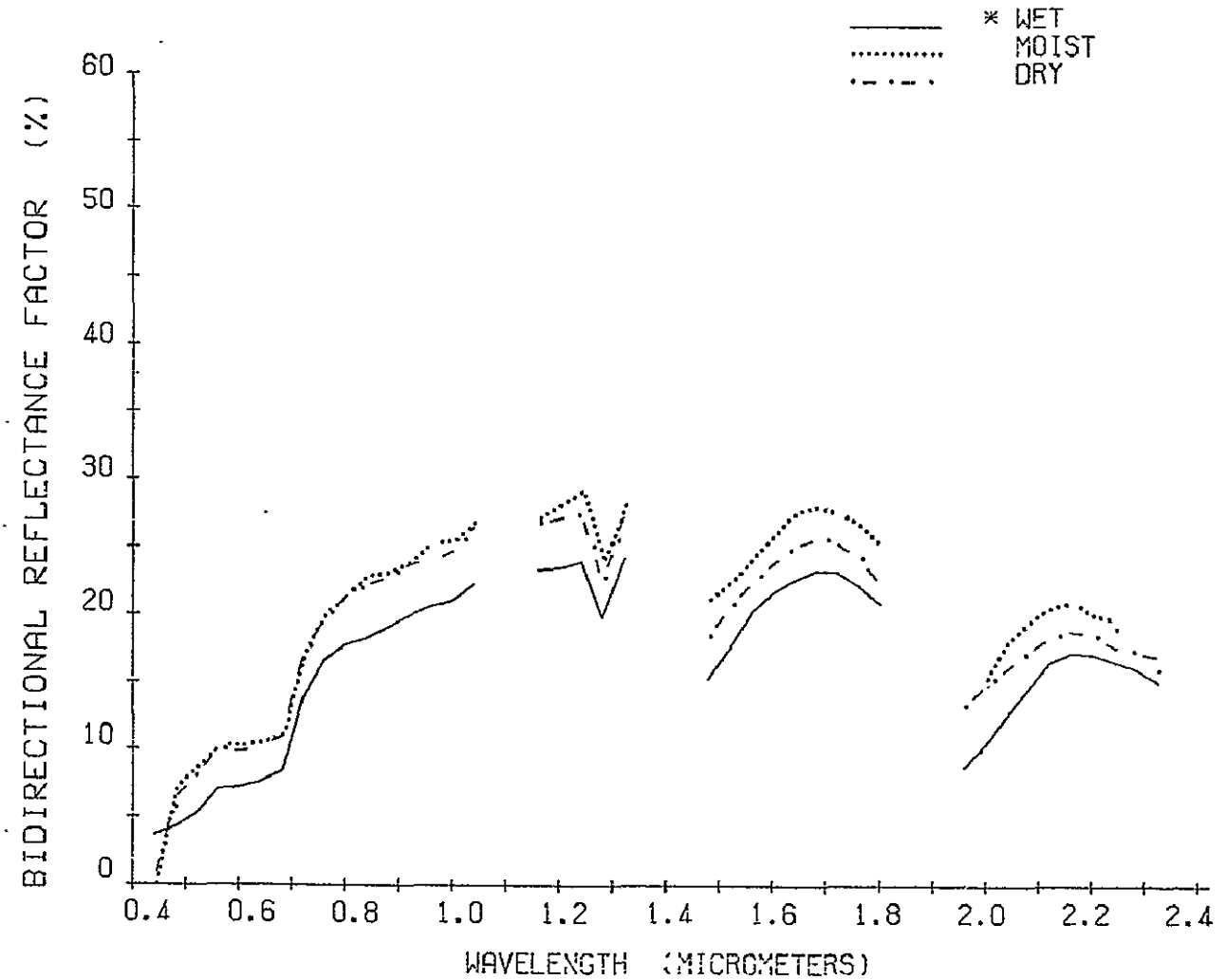
LOCATION: WILLISTON, NORTH DAKOTA
SENSOR: EXOTECH MODEL 20C DATE: 1976



*AVERAGES OF 7 PLOTS.

DIFFERENCE IN REFLECTANCE OF SPRING WHEAT AS SOIL DRIES AFTER A RAIN

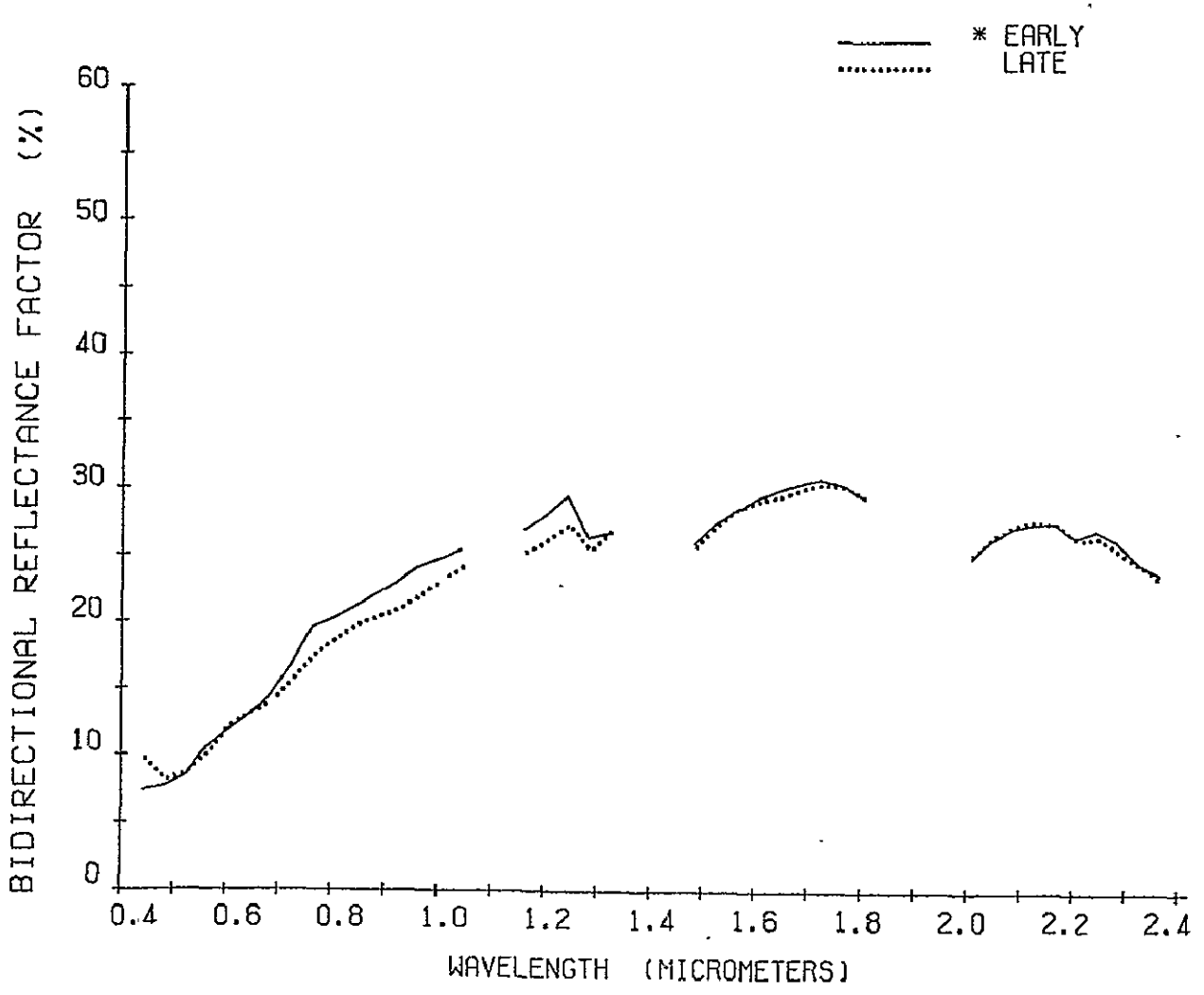
LOCATION: WILLISTON, NORTH DAKOTA
SENSSOR: EXOTECH MODEL 20C DATE: JUNE 3-4, 1976



* AVERAGES OF 2 PLOTS.

DIFFERENCE IN REFLECTANCE OF SPRING WHEAT DUE TO PLANTING DATE

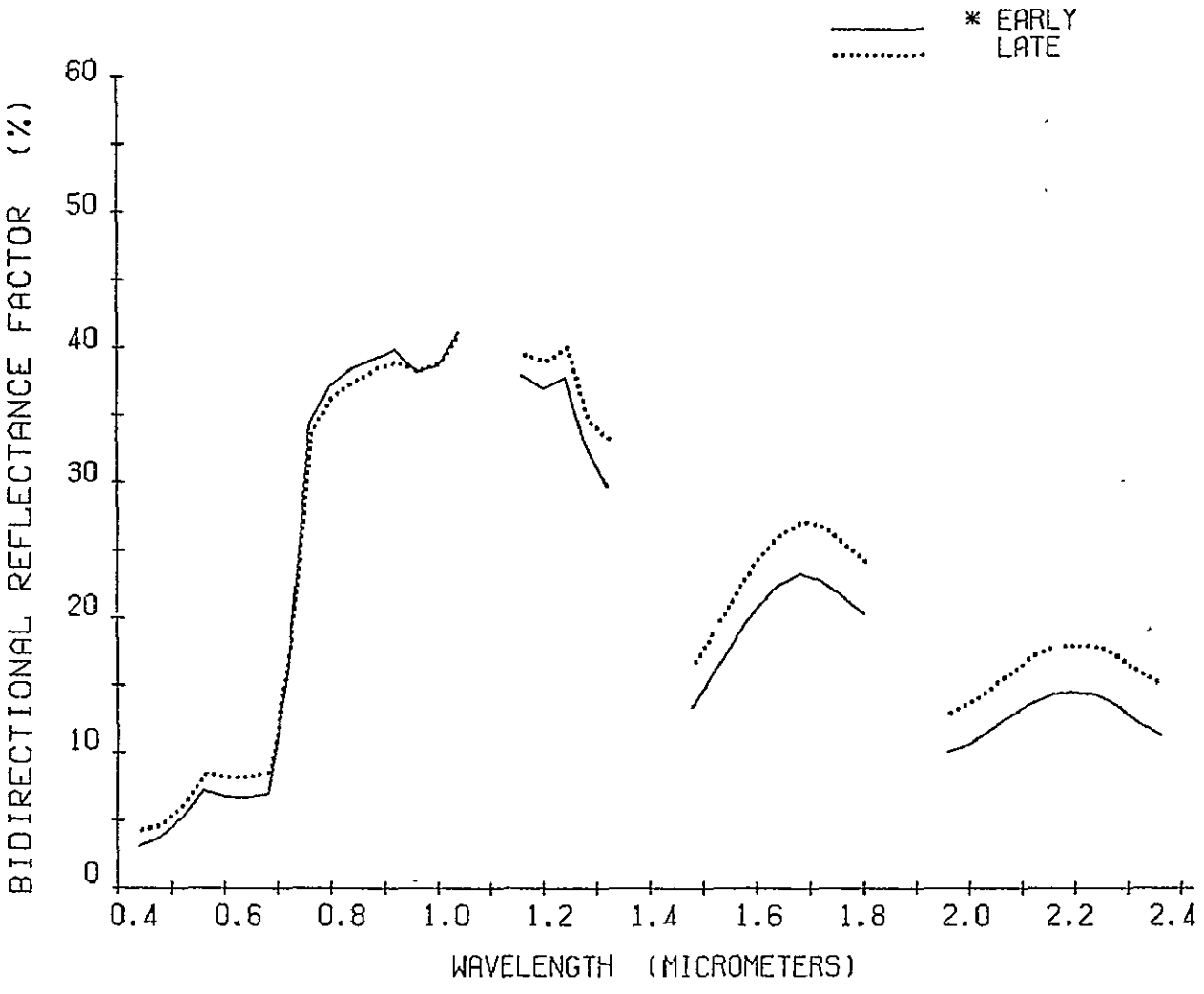
LOCATION: WILLISTON, NORTH DAKOTA
SENSOR: EXOTECH MODEL 20C DATE: JUNE 7, 1975



* AVERAGES OF 4 PLOTS.

DIFFERENCE IN REFLECTANCE OF SPRING WHEAT DUE TO PLANTING DATE

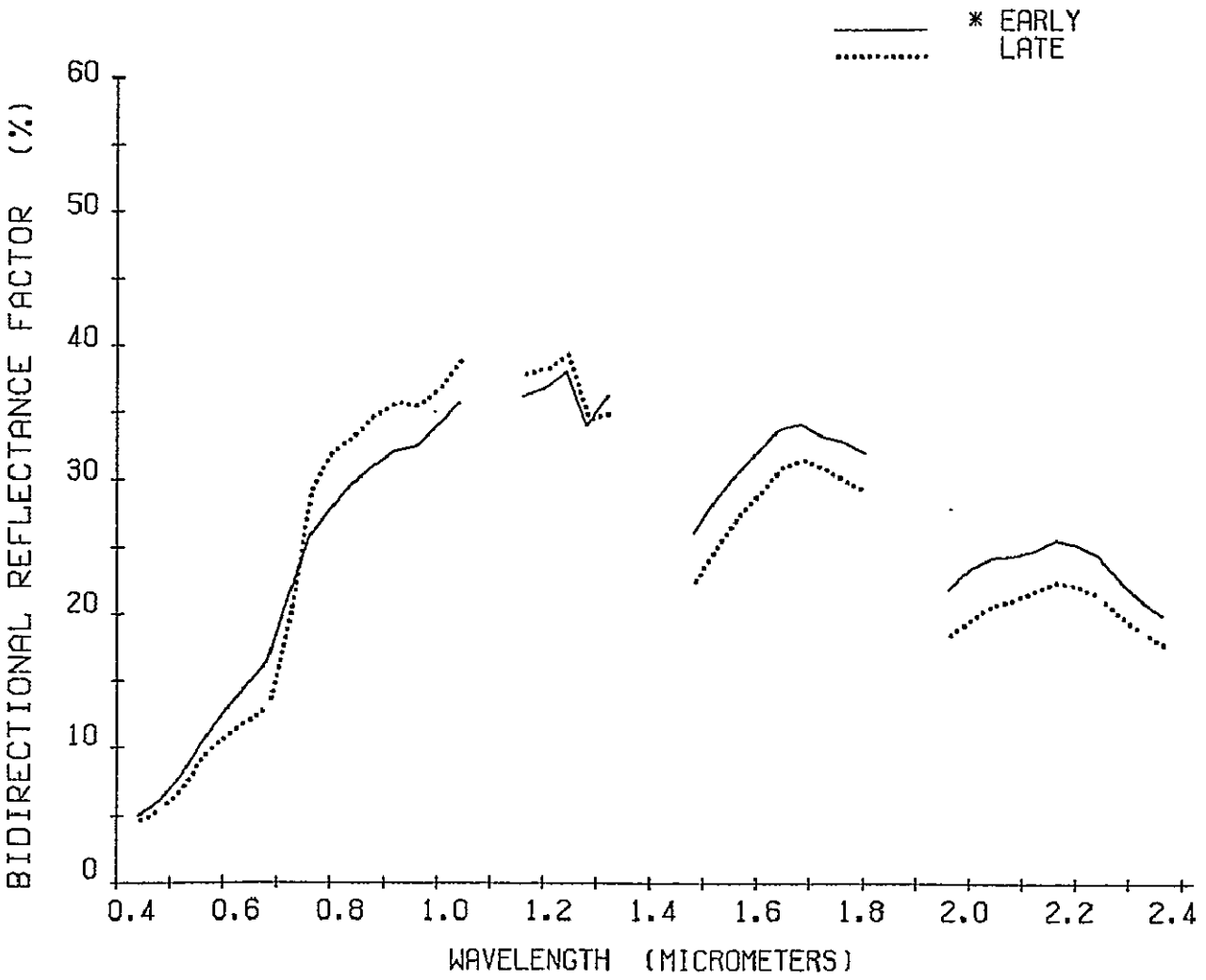
LOCATION: WILLISTON, NORTH DAKOTA
SENSOR: EXOTECH MODEL 20C DATE: JULY 10, 1975



* AVERAGES OF 16 PLOTS.

DIFFERENCE IN REFLECTANCE OF SPRING WHEAT DUE TO PLANTING DATE

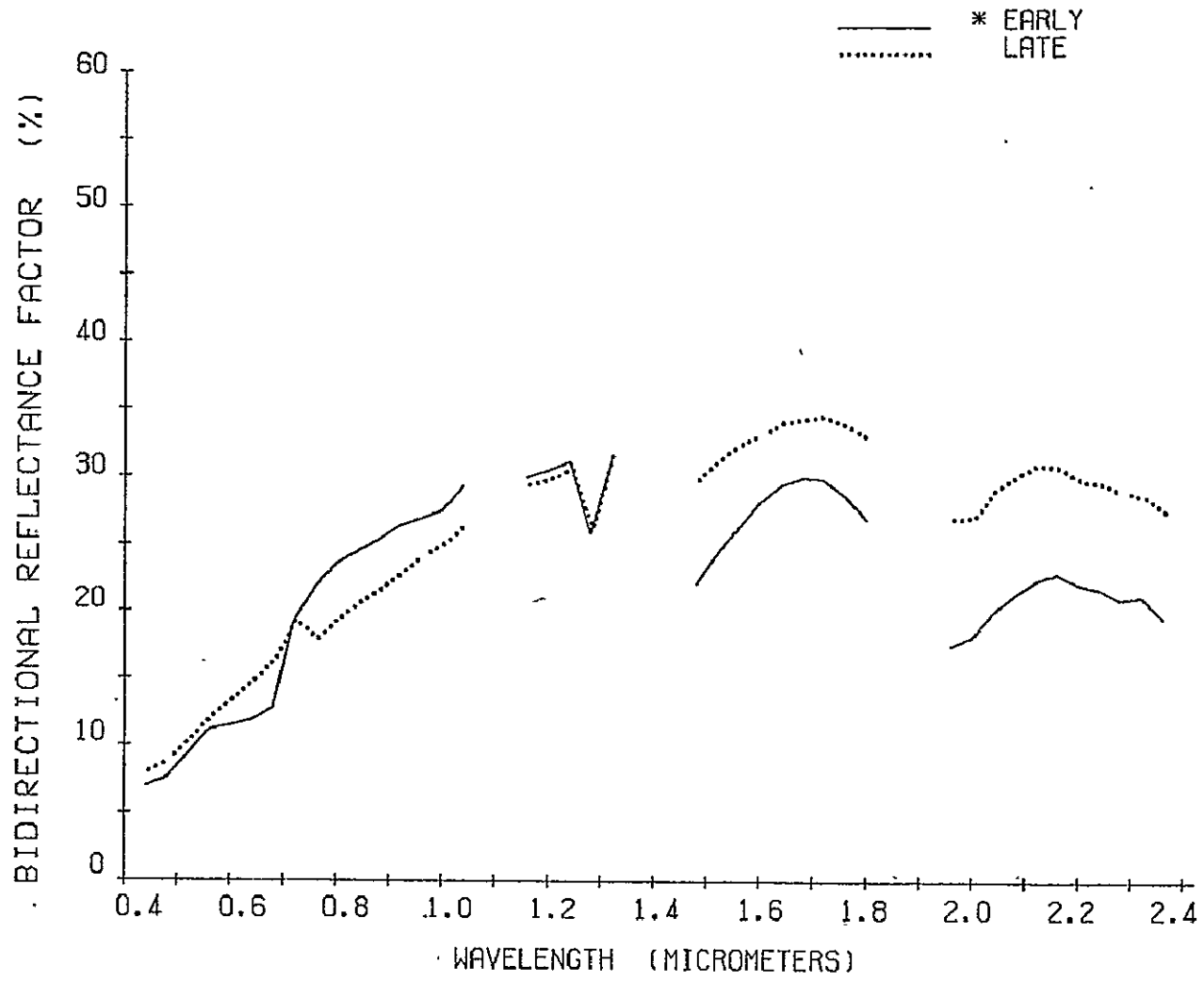
LOCATION: WILLISTON, NORTH DAKOTA
SENSOR: EXOTECH MODEL 20C DATE: AUGUST 12, 1975



* AVERAGES OF 8 PLOTS.

DIFFERENCE IN REFLECTANCE OF SPRING WHEAT DUE TO PLANTING DATE

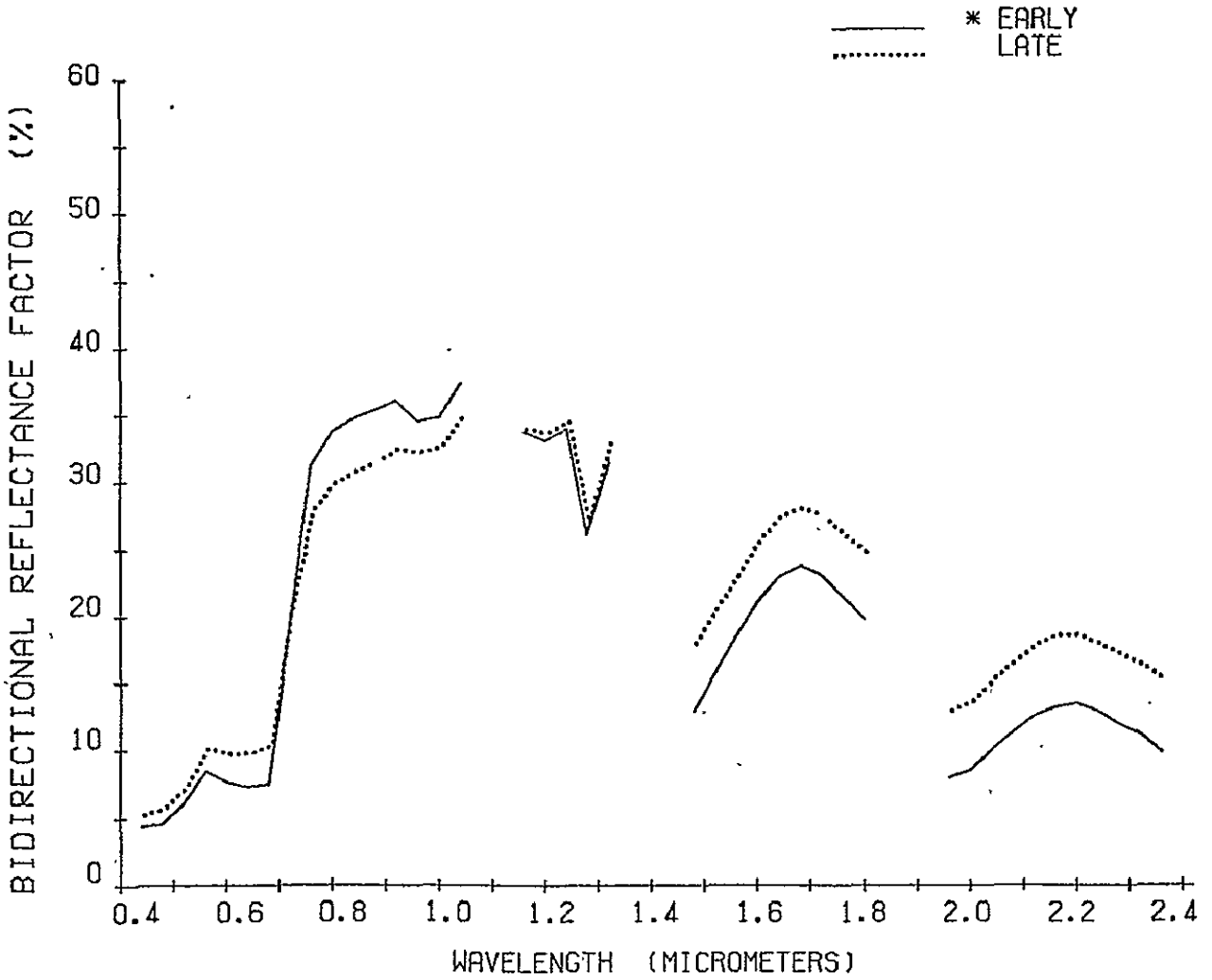
LOCATION: WILLISTON, NORTH DAKOTA
SENSOR: EXOTECH MODEL 20C DATE: JUNE 4, 1976



* AVERAGES OF 16 PLOTS.

DIFFERENCE IN REFLECTANCE OF SPRING WHEAT DUE TO PLANTING DATE

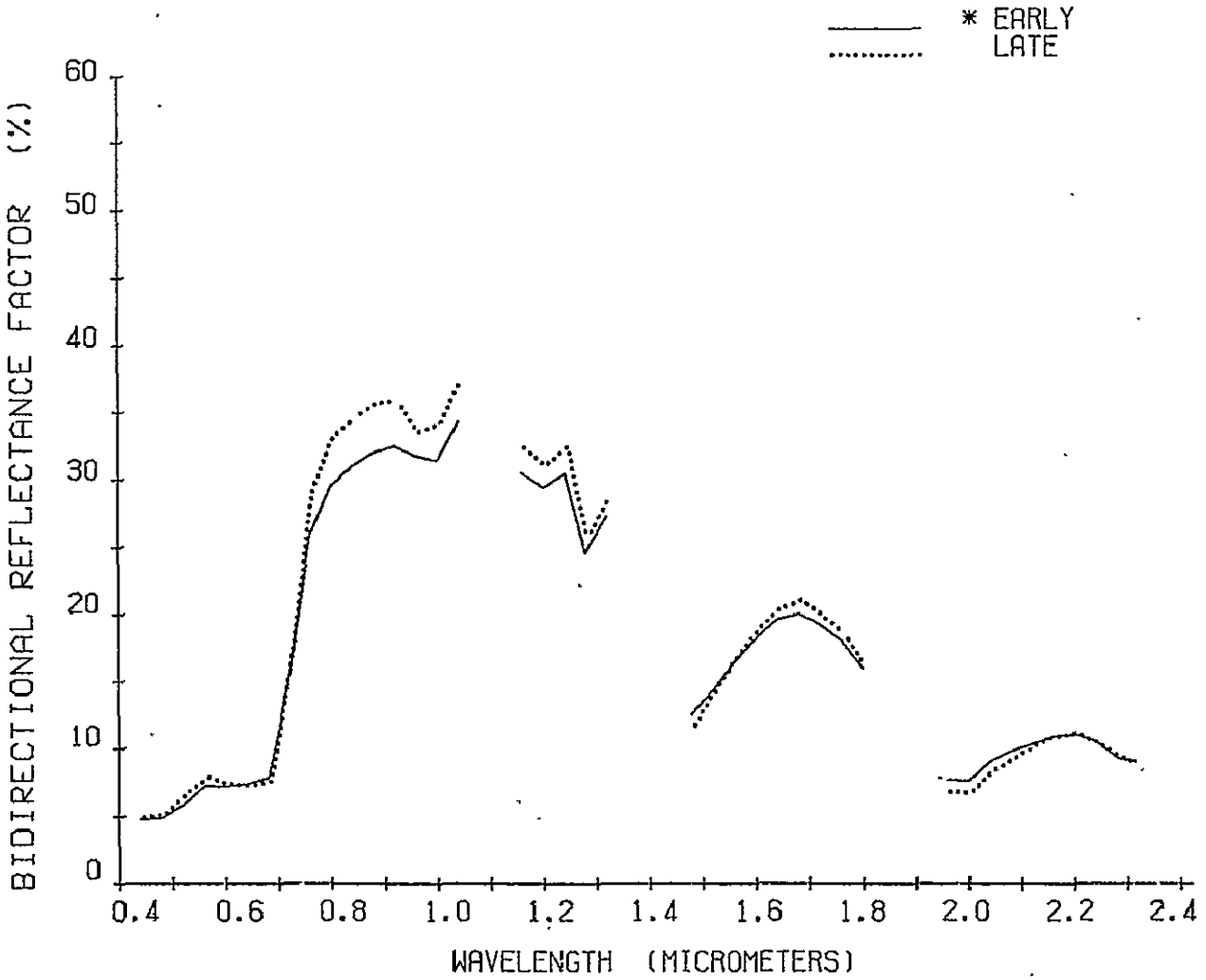
LOCATION: WILLISTON, NORTH DAKOTA
SENSOR: EXOTECH MODEL 20C DATE: JUNE 18, 1976



* AVERAGES OF 16 PLOTS.

DIFFERENCE IN REFLECTANCE OF SPRING WHEAT DUE TO PLANTING DATE

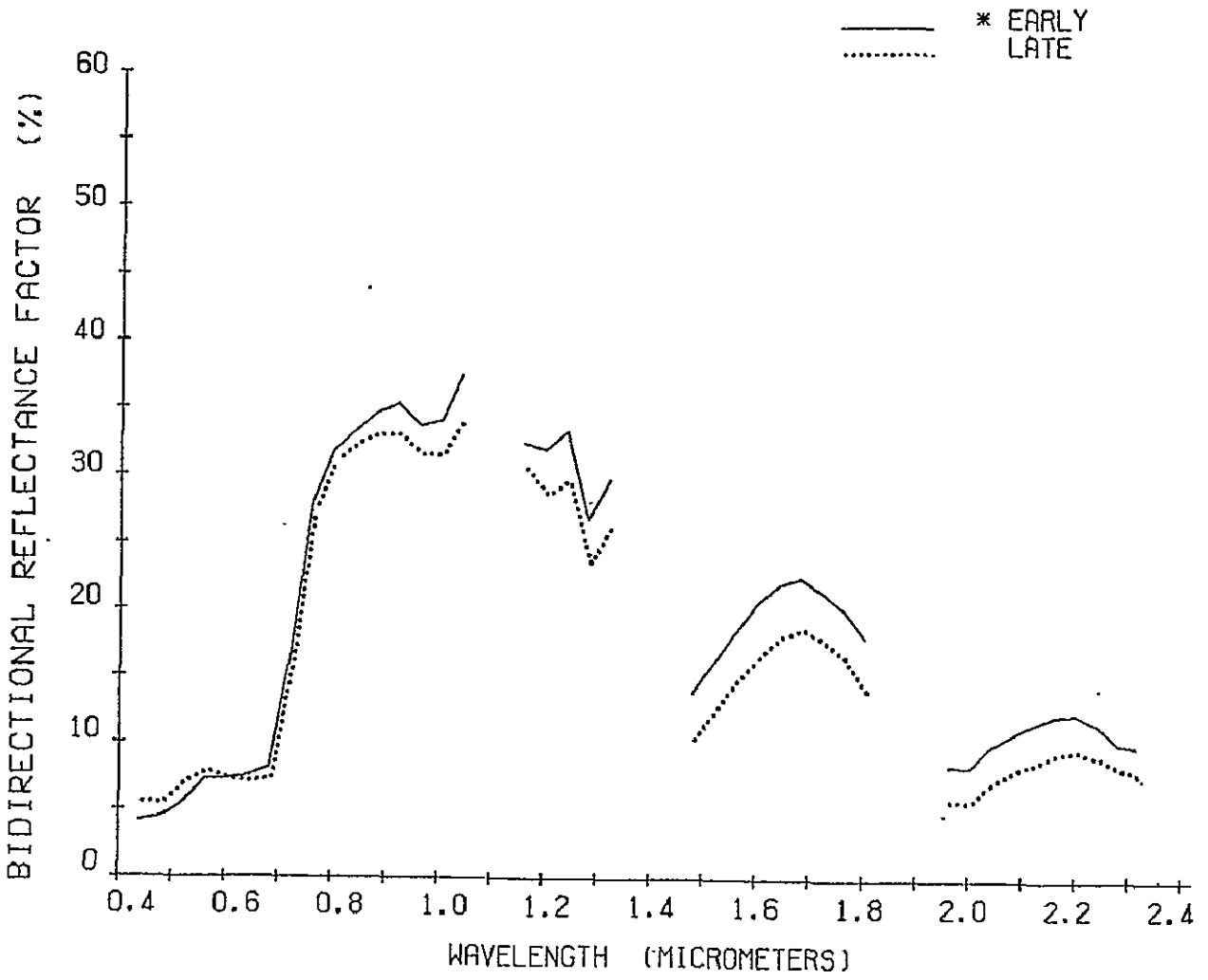
LOCATION: WILLISTON, NORTH DAKOTA
SENSOR: EXOTECH MODEL 20C DATE: JULY 8, 1976



* AVERAGES OF 8 PLOTS.

DIFFERENCE IN REFLECTANCE OF SPRING WHEAT DUE TO PLANTING DATE

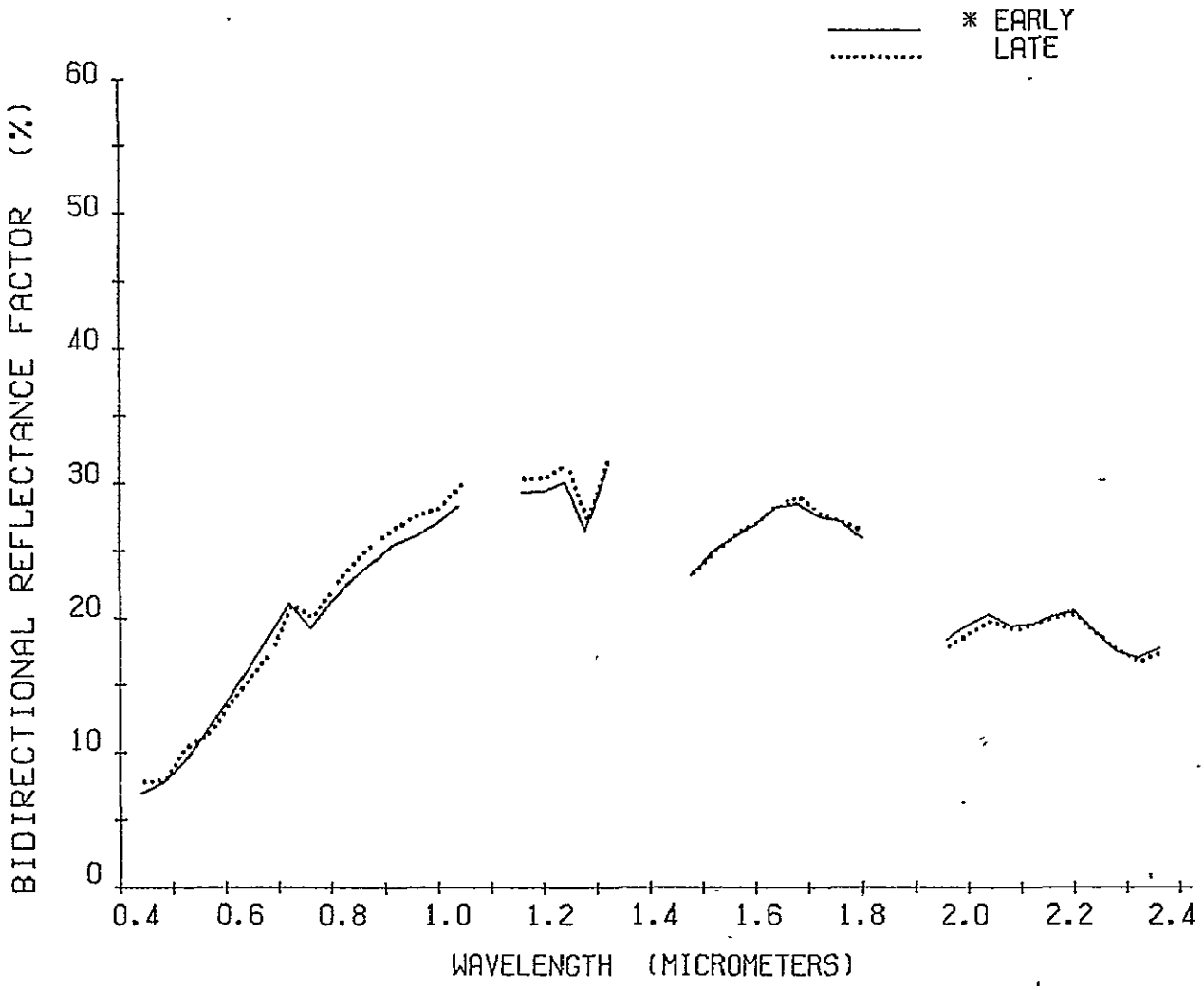
LOCATION: WILLISTON, NORTH DAKOTA
SENSOR: EXOTECH MODEL 20C DATE: JULY 16, 1976



* AVERAGES OF 16 PLOTS.

DIFFERENCE IN REFLECTANCE OF SPRING WHEAT DUE TO PLANTING DATE

LOCATION: WILLISTON, NORTH DAKOTA
SENSOR: EXOTECH MODEL 20C DATE: AUGUST 6, 1976

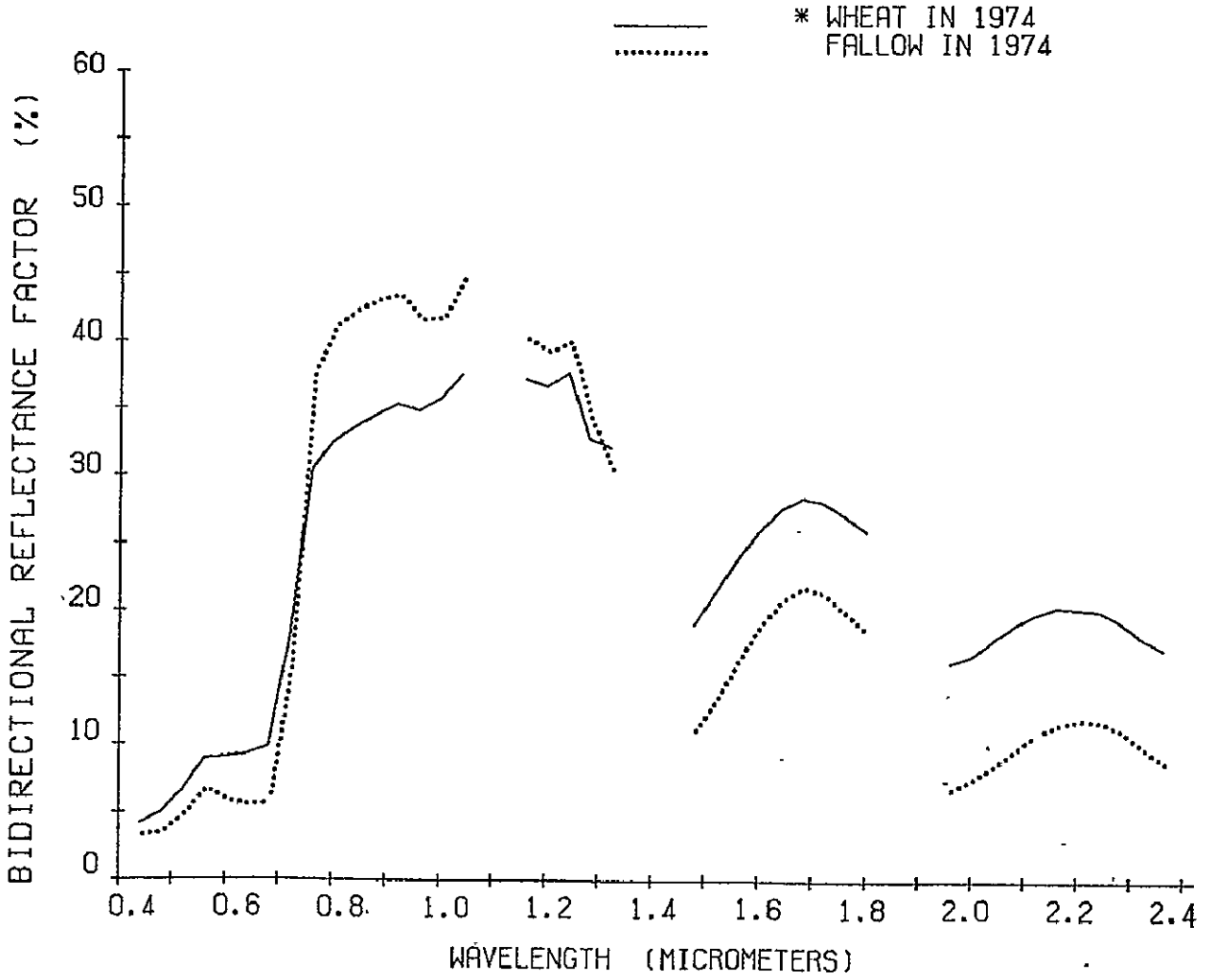


* AVERAGES OF 16 PLOTS.

C-2

DIFFERENCE IN REFLECTANCE OF SPRING WHEAT DUE TO SOIL MOISTURE

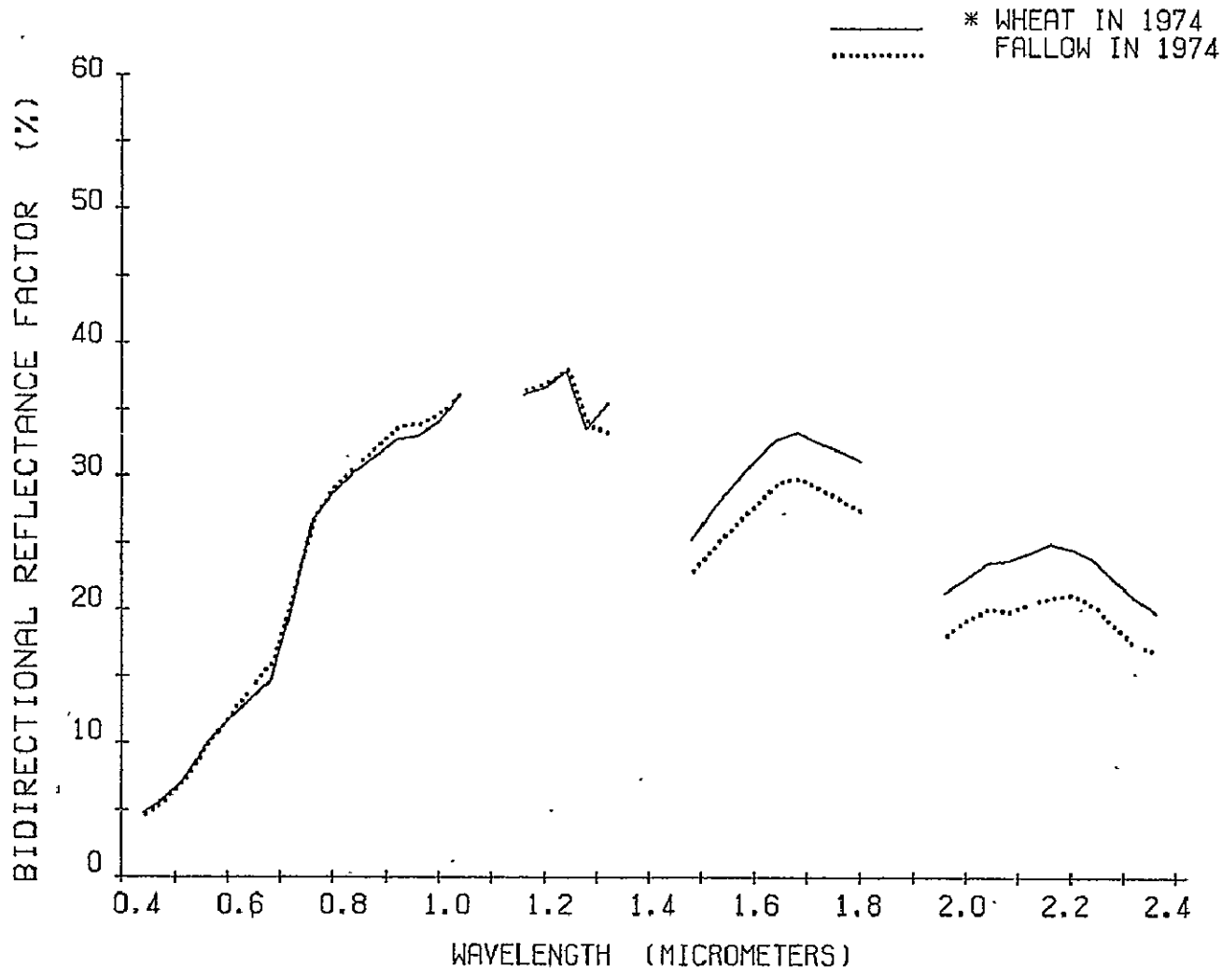
LOCATION: WILLISTON, NORTH DAKOTA
SENSOR: EXOTECH MODEL 20C DATE: JULY 10, 1975



* AVERAGES OF 16 PLOTS.

DIFFERENCE IN REFLECTANCE OF SPRING WHEAT DUE TO SOIL MOISTURE

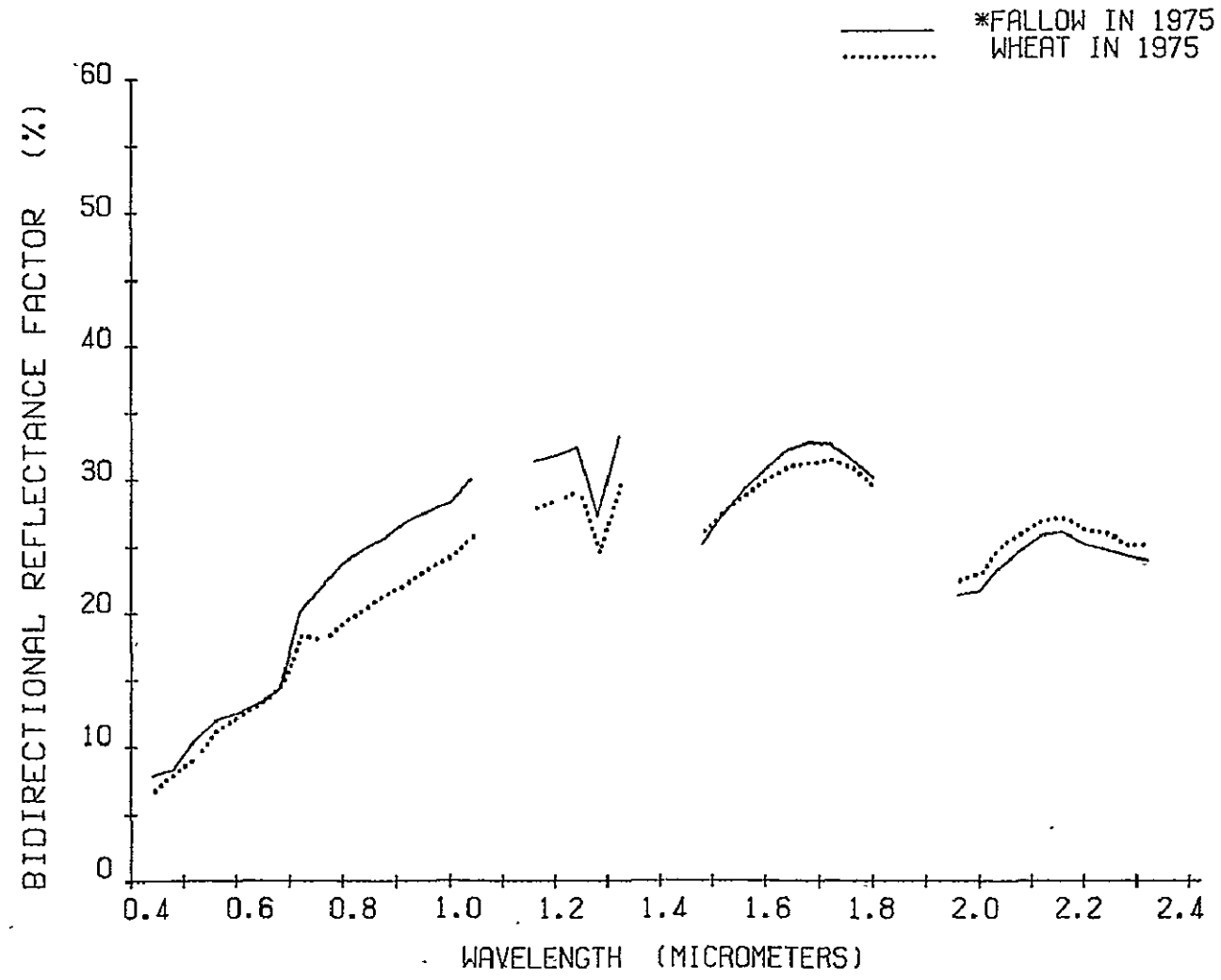
LOCATION: WILLISTON, NORTH DAKOTA
SENSOR: EXOTECH MODEL 20C DATE: AUGUST 12, 1975



* AVERAGES OF 8 PLOTS.

DIFFERENCE IN REFLECTANCE OF SPRING WHEAT DUE TO SOIL MOISTURE

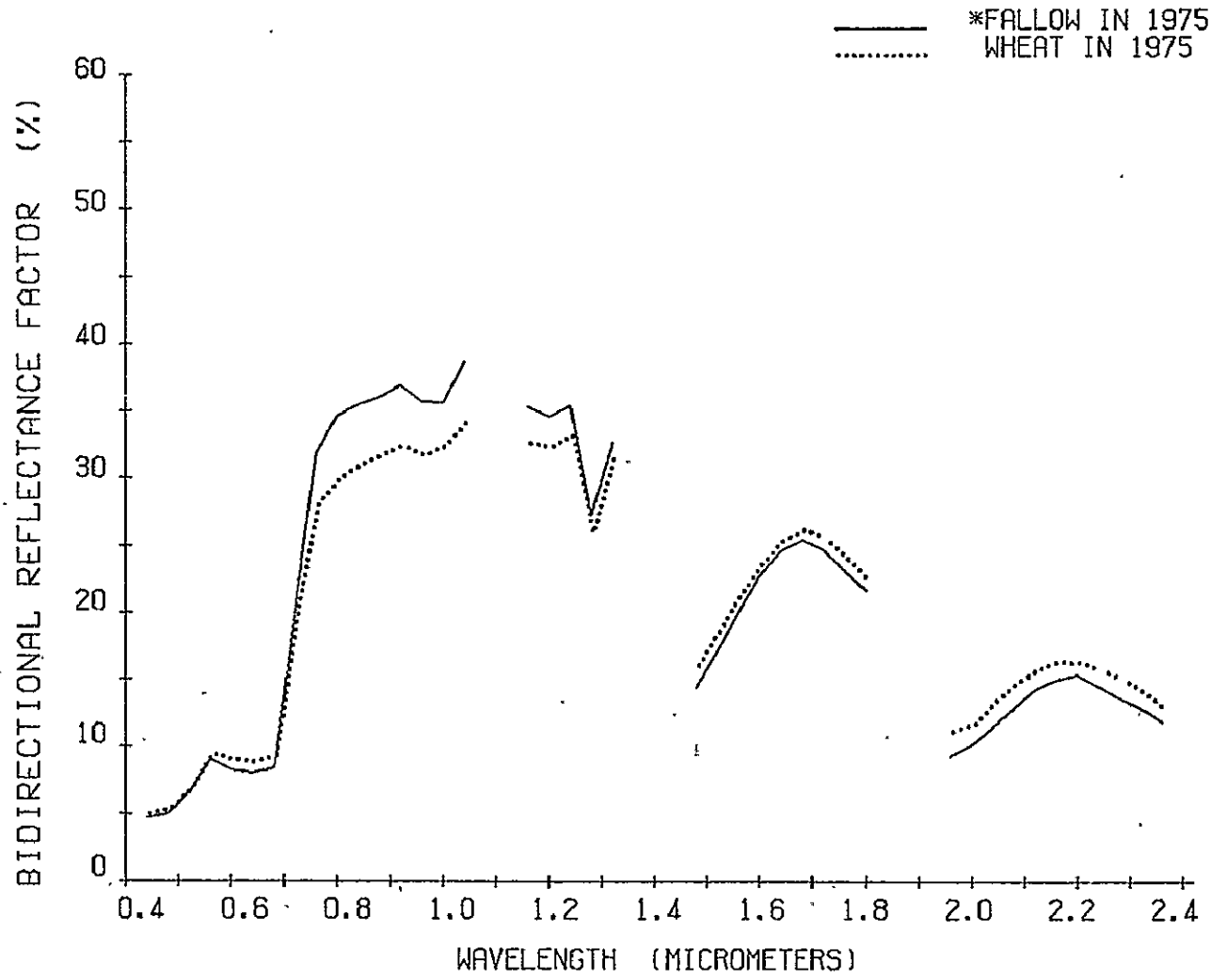
LOCATION: WILLISTON, NORTH DAKOTA
SENSOR: EXOTECH MODEL 20C DATE: JUNE 4, 1976



* AVERAGES OF 16 PLOTS.

DIFFERENCE IN REFLECTANCE OF SPRING WHEAT DUE TO SOIL MOISTURE

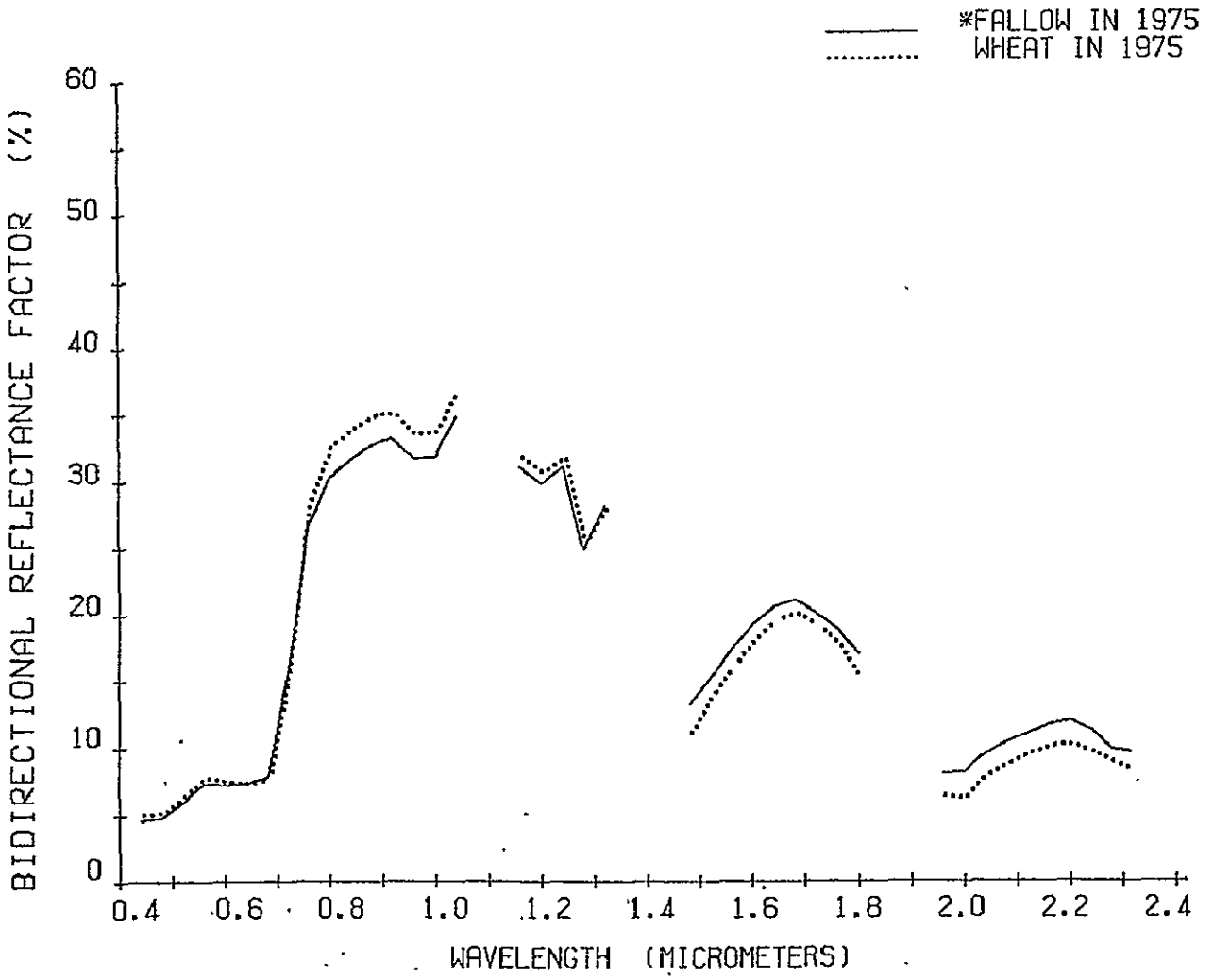
LOCATION: WILLISTON, NORTH DAKOTA
SENSOR: EXOTECH MODEL 20C DATE: JUNE 18, 1976



* AVERAGES OF 16 PLOTS.

DIFFERENCE IN REFLECTANCE OF SPRING WHEAT DUE TO SOIL MOISTURE

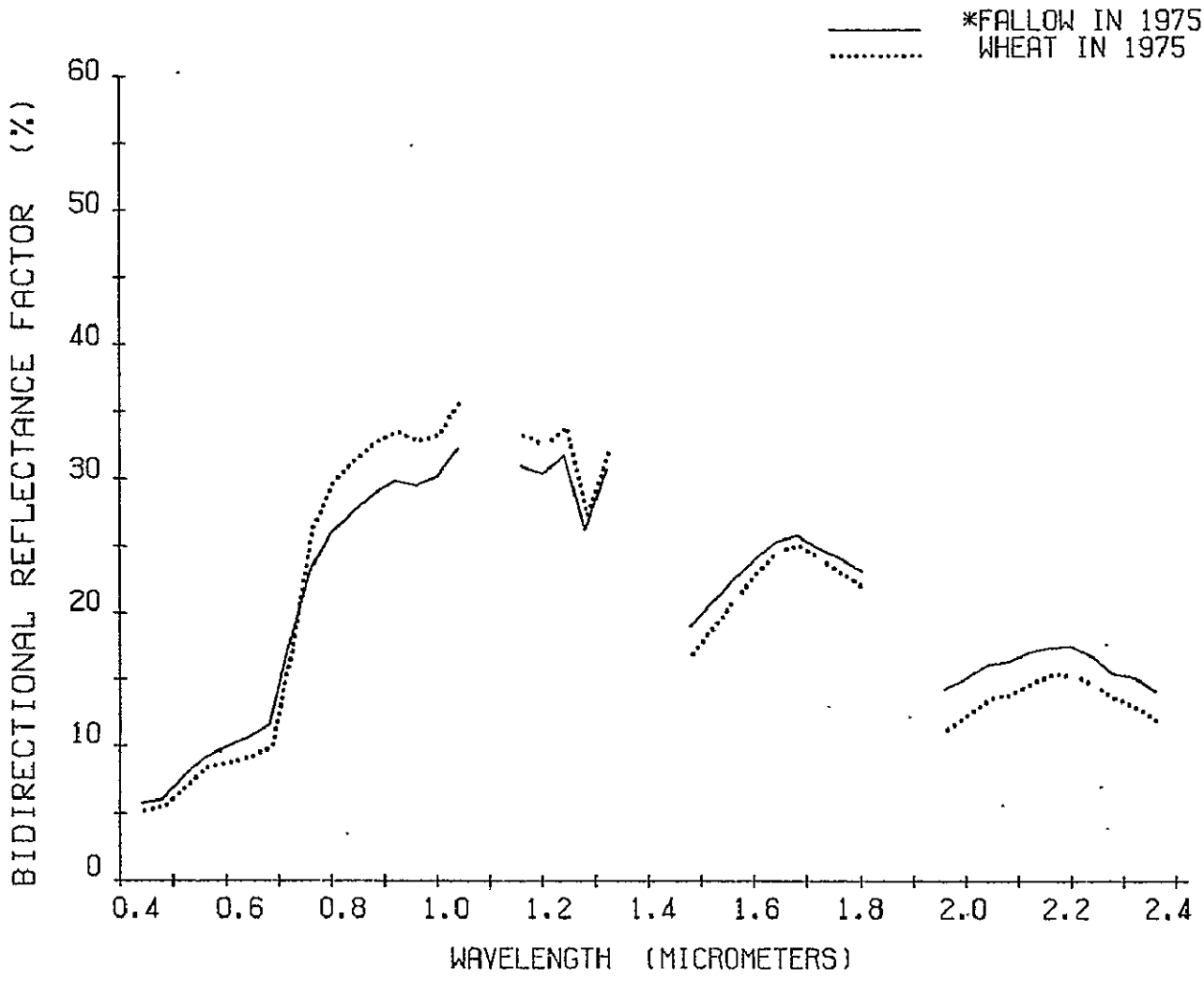
LOCATION: WILLISTON, NORTH DAKOTA
SENSOR: EXOTECH MODEL 20C DATE: JULY 8, 1976



* AVERAGES OF 8 PLOTS.

DIFFERENCE IN REFLECTANCE OF SPRING WHEAT DUE TO SOIL MOISTURE

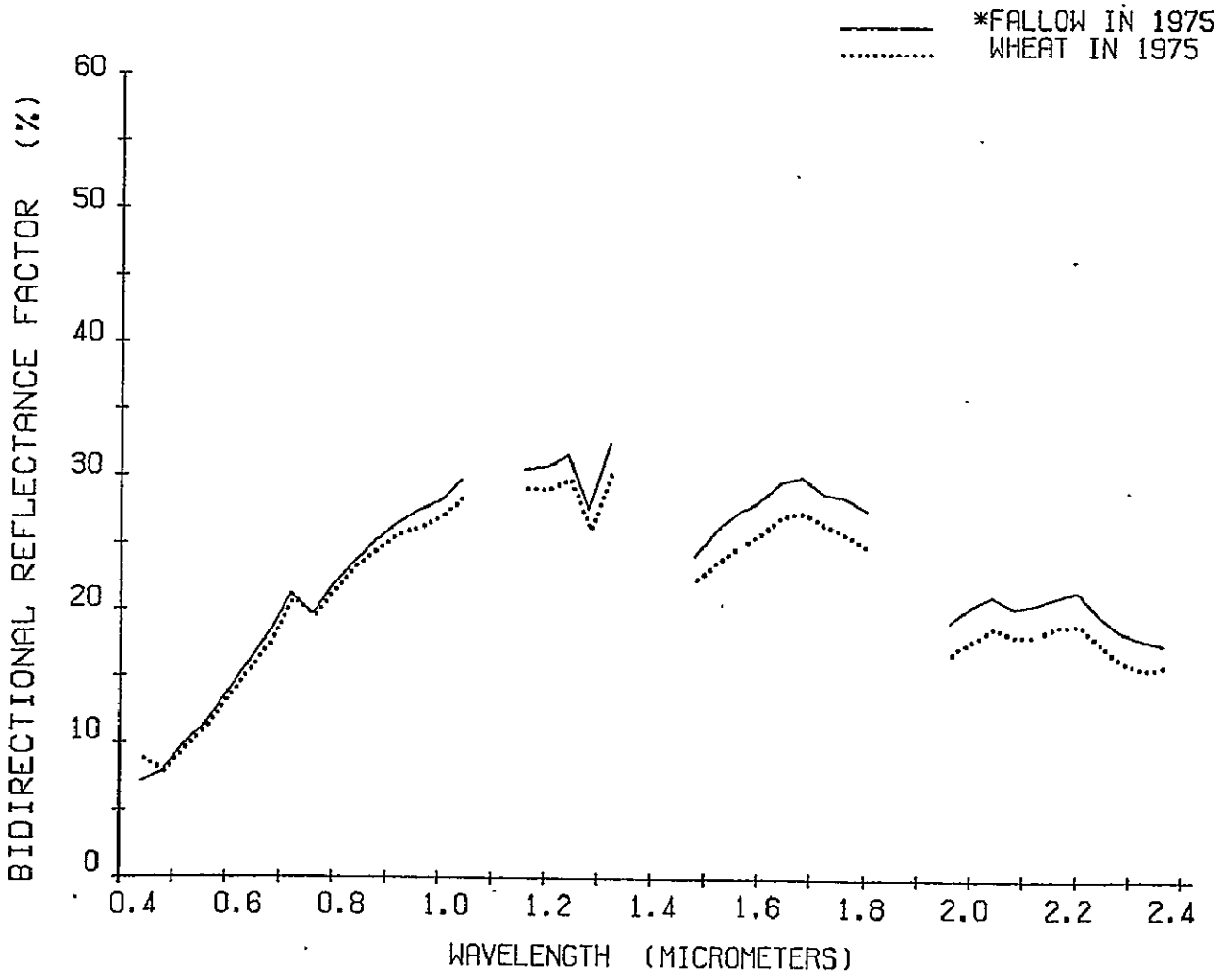
LOCATION: WILLISTON, NORTH DAKOTA
SENSOR: EXOTECH MODEL 20C DATE: JULY 16, 1976



* AVERAGES OF 16 PLOTS.

DIFFERENCE IN REFLECTANCE OF SPRING WHEAT DUE TO SOIL MOISTURE

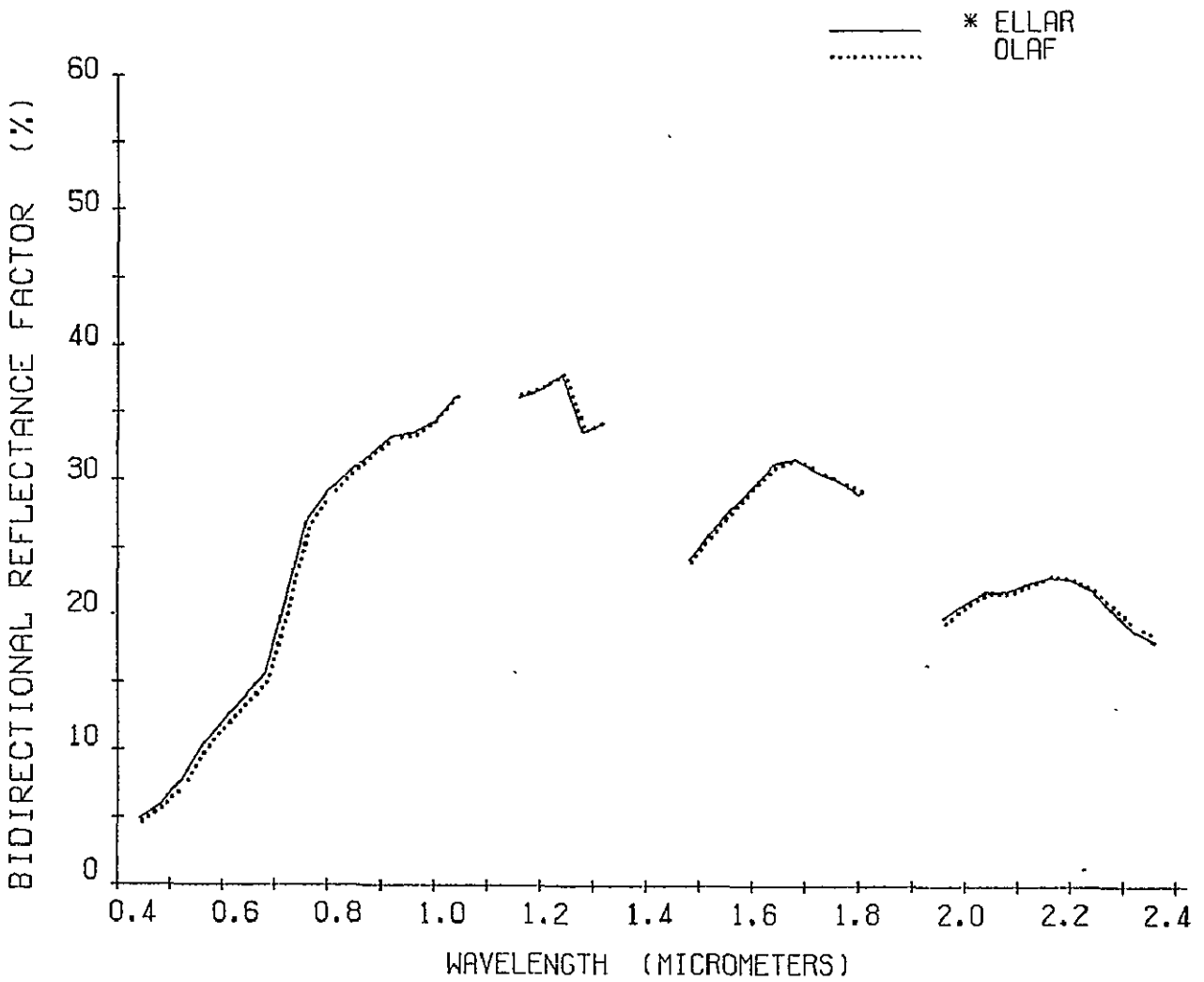
LOCATION: WILLISTON, NORTH DAKOTA
SENSOR: EXOTECH MODEL 20C DATE: AUGUST 6, 1976



* AVERAGES OF 16 PLOTS.

REFLECTANCE OF SEVERAL VARIETIES OF SPRING WHEAT

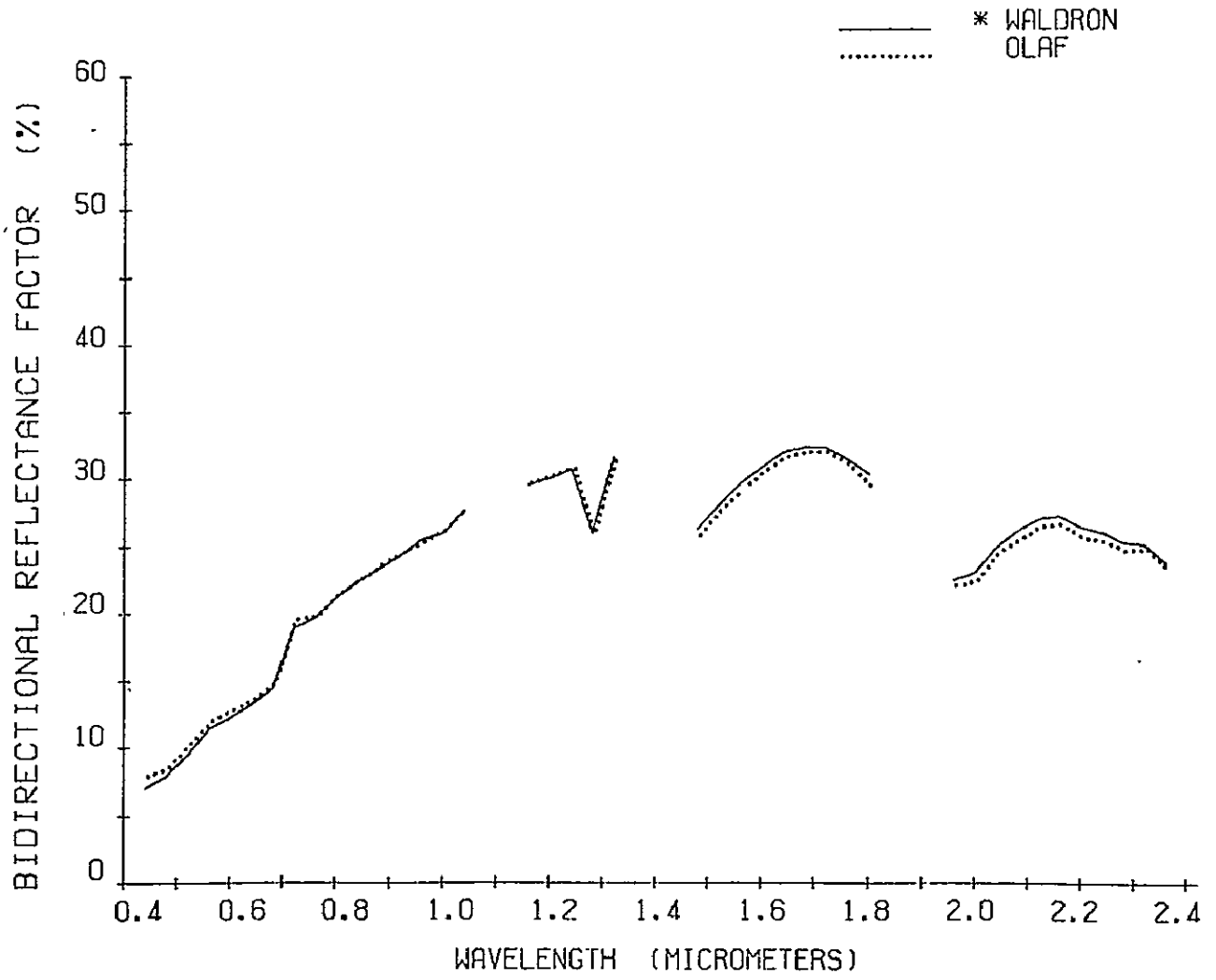
LOCATION: WILLISTON, NORTH DAKOTA
SENSOR: EXOTECH MODEL 20C DATE: AUGUST 12, 1975



* AVERAGES OF 8 PLOTS.

REFLECTANCE OF SEVERAL VARIETIES OF SPRING WHEAT

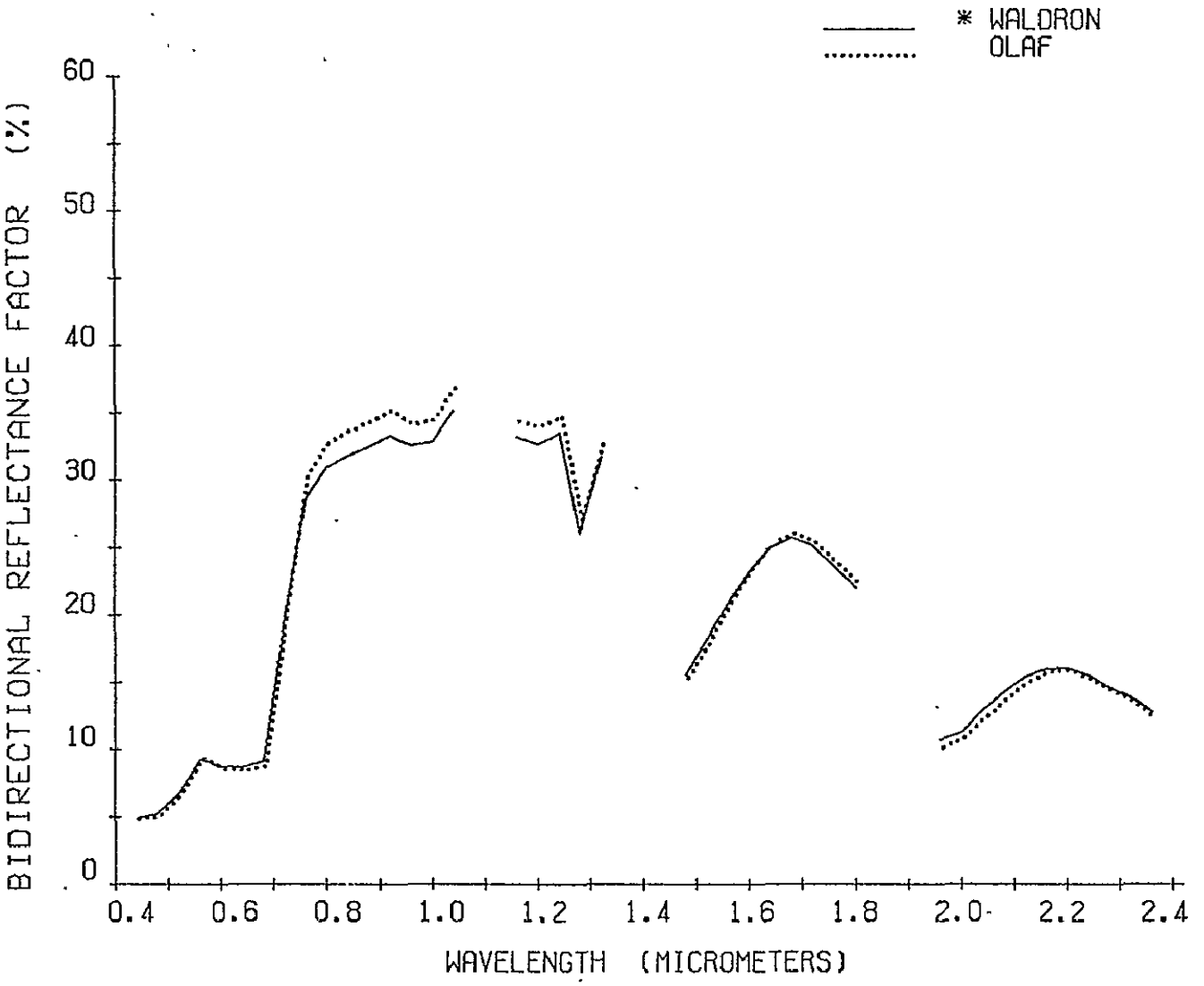
LOCATION: WILLISTON, NORTH DAKOTA
SENSOR: EXOTECH MODEL 20C DATE: JUNE 4, 1976



* AVERAGES OF 16 PLOTS.

REFLECTANCE OF SEVERAL VARIETIES OF SPRING WHEAT

LOCATION: WILLISTON, NORTH DAKOTA
SENSOR: EXOTECH MODEL 20C DATE: JUNE 18, 1976

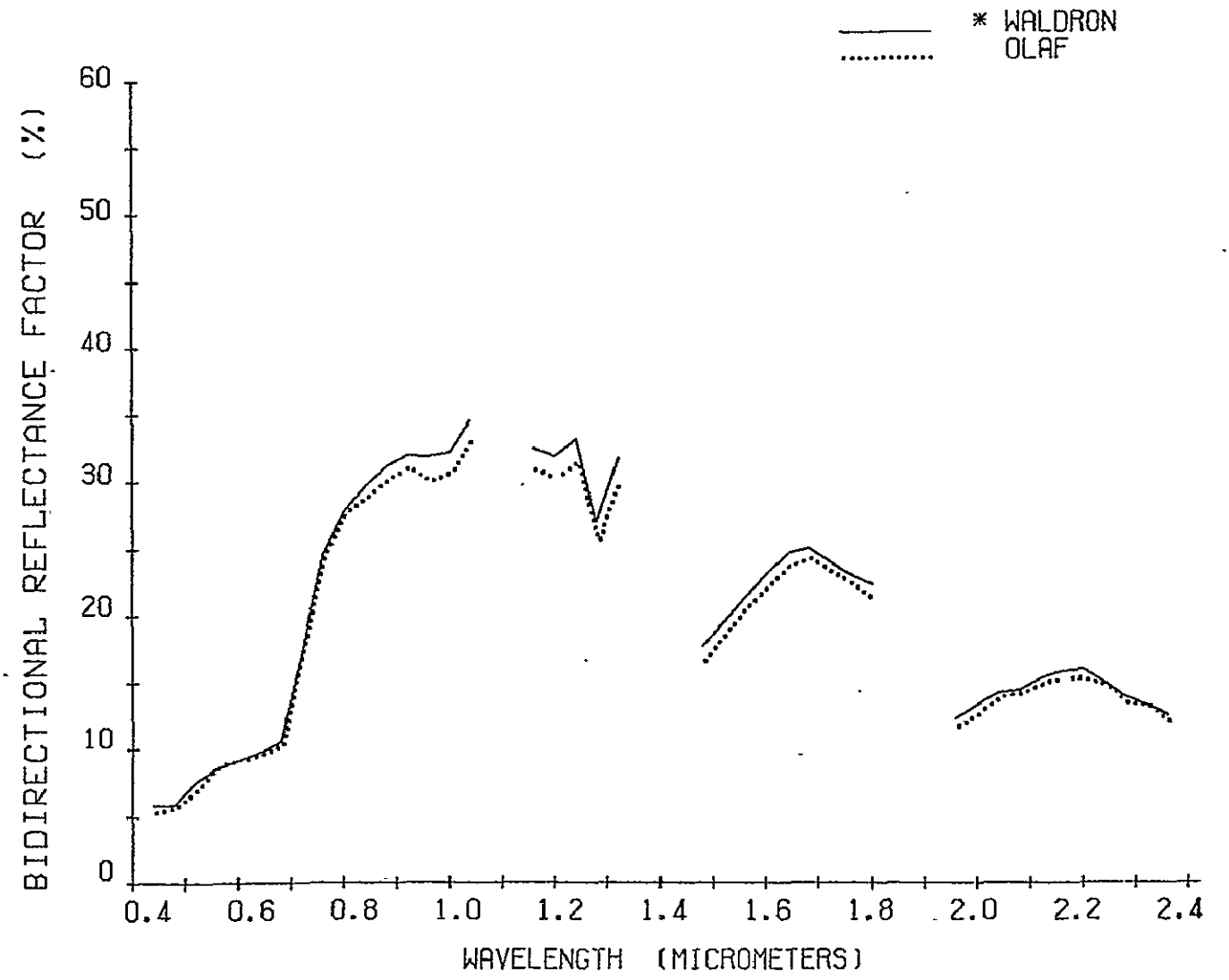


* AVERAGES OF 16 PLOTS.

REFLECTANCE OF SEVERAL VARIETIES OF SPRING WHEAT

LOCATION: WILLISTON, NORTH DAKOTA

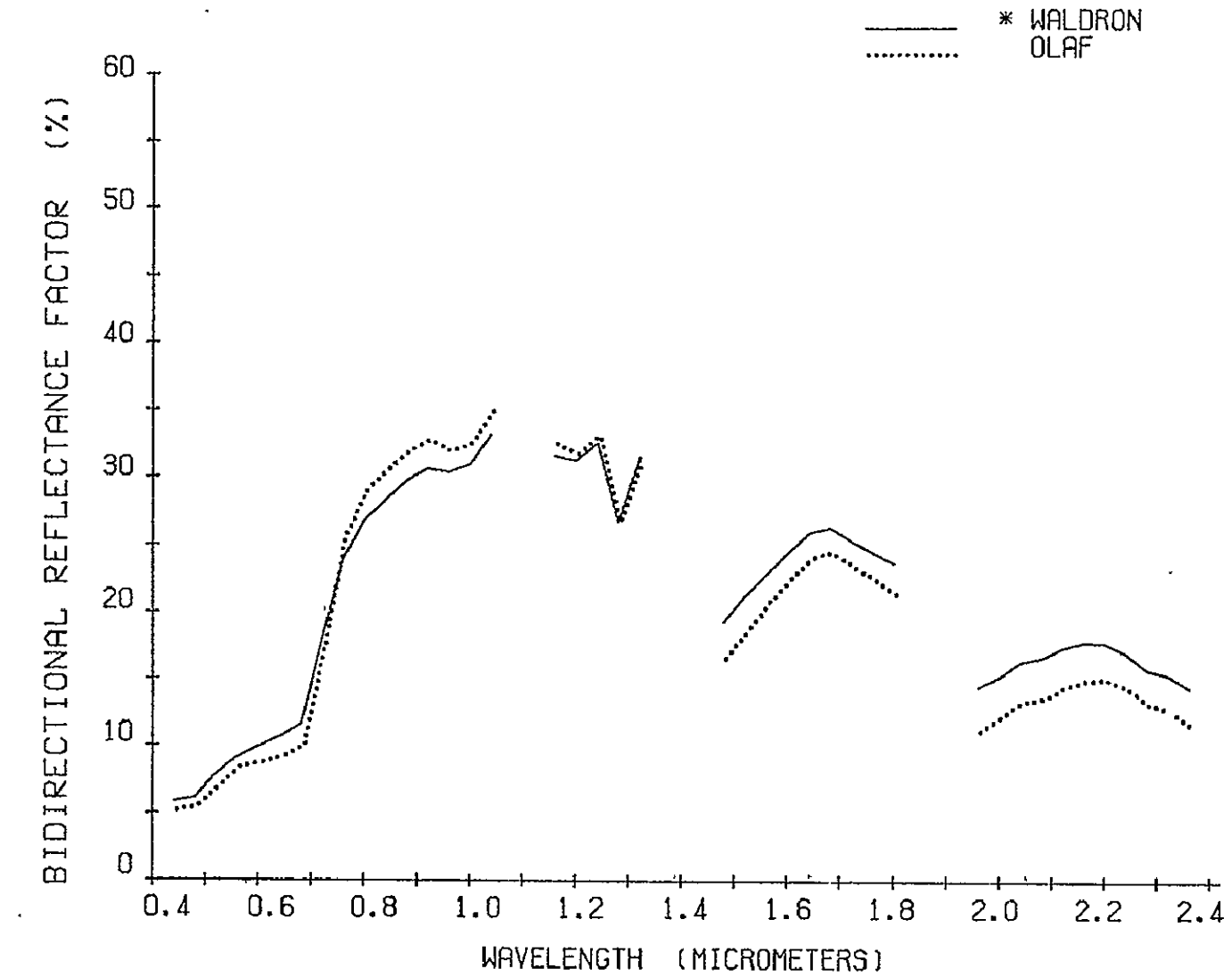
SENSOR: EXOTECH MODEL 20C DATE: JULY 8, 1976



* AVERAGES OF 8 PLOTS.

REFLECTANCE OF SEVERAL VARIETIES OF SPRING WHEAT

LOCATION: WILLISTON, NORTH DAKOTA
SENSOR: EXOTECH MODEL 20C DATE: JULY 16, 1976

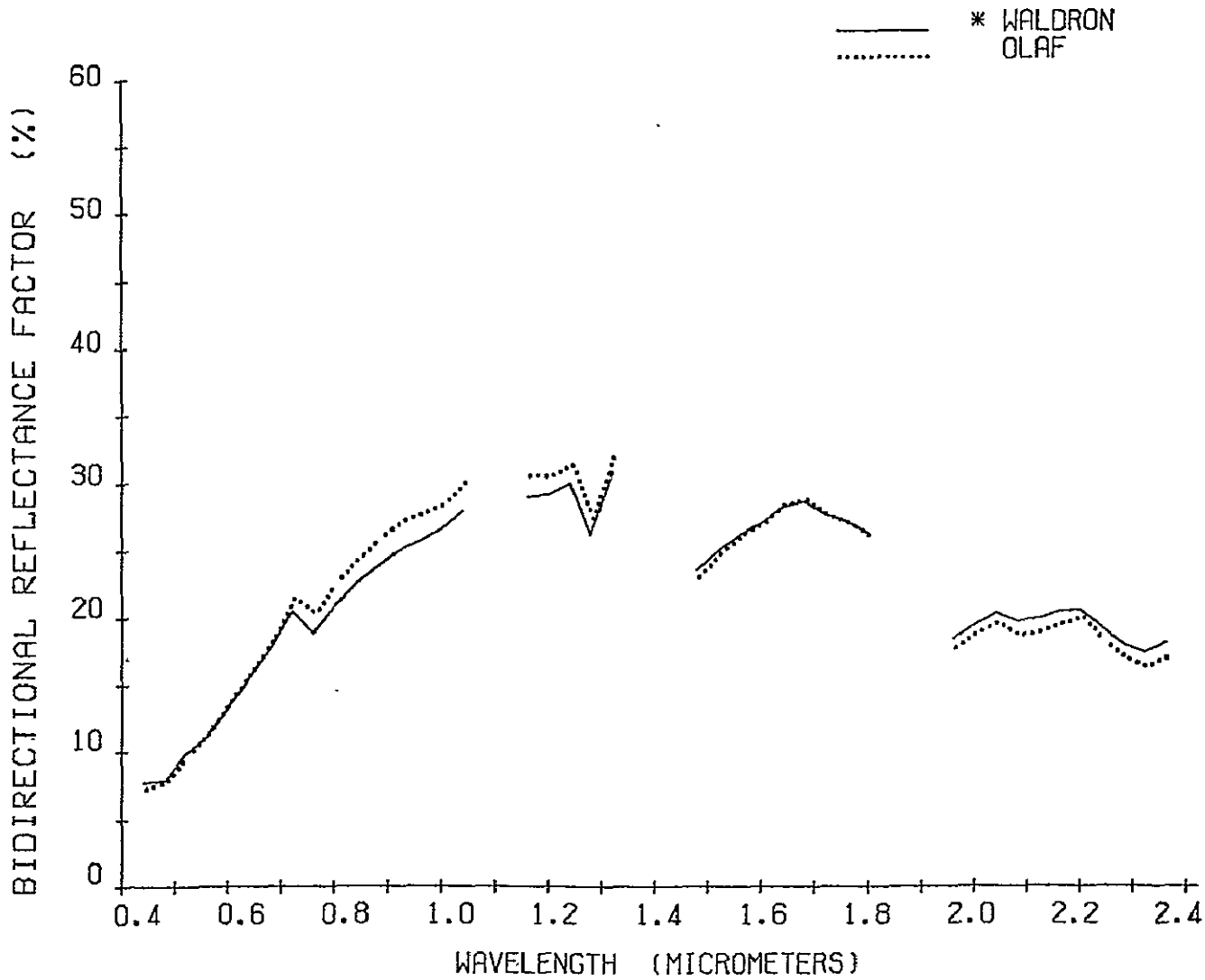


* AVERAGES OF 16 PLOTS.

REFLECTANCE OF SEVERAL VARIETIES OF SPRING WHEAT

LOCATION: WILLISTON, NORTH DAKOTA

SENSOR: EXOTECH MODEL 20C DATE: AUGUST 6, 1976

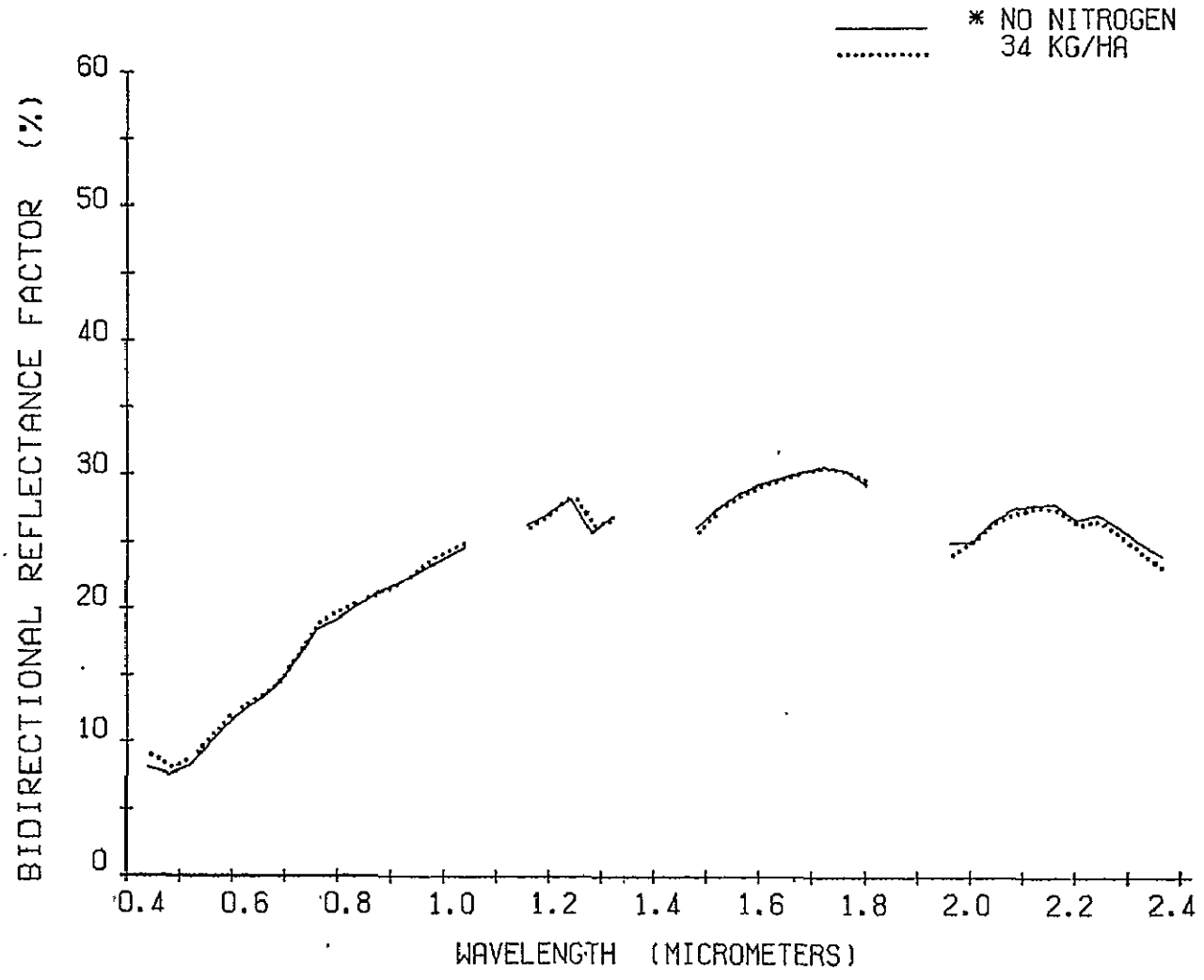


* AVERAGES OF 16 PLOTS.

DIFFERENCE IN REFLECTANCE OF SPRING WHEAT DUE TO NITROGEN LEVEL

LOCATION: WILLISTON, NORTH DAKOTA

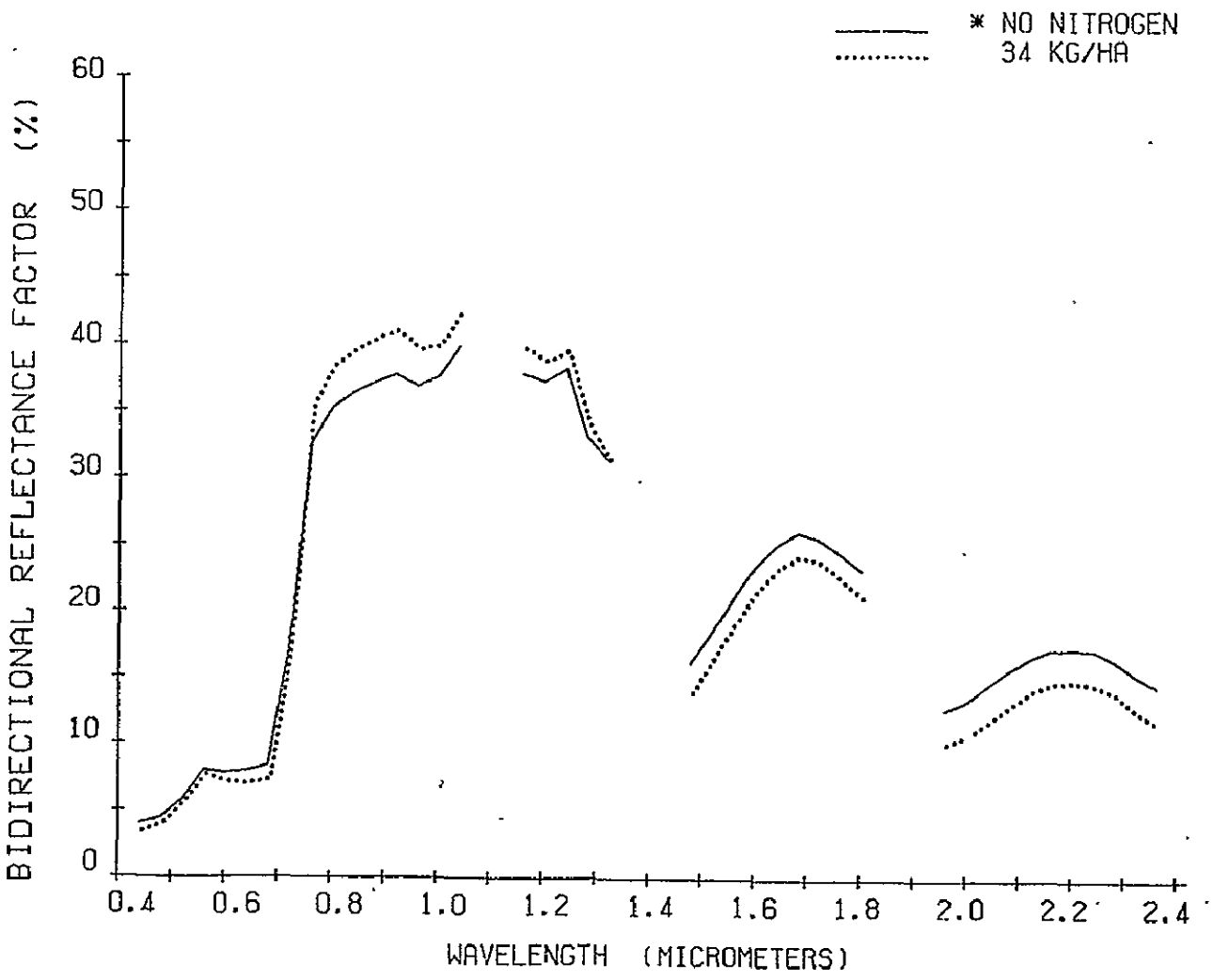
SENSOR: EXOTECH MODEL 20C DATE: JUNE 7, 1975



* AVERAGES OF 4 PLOTS.

DIFFERENCE IN REFLECTANCE OF SPRING WHEAT DUE TO NITROGEN LEVEL

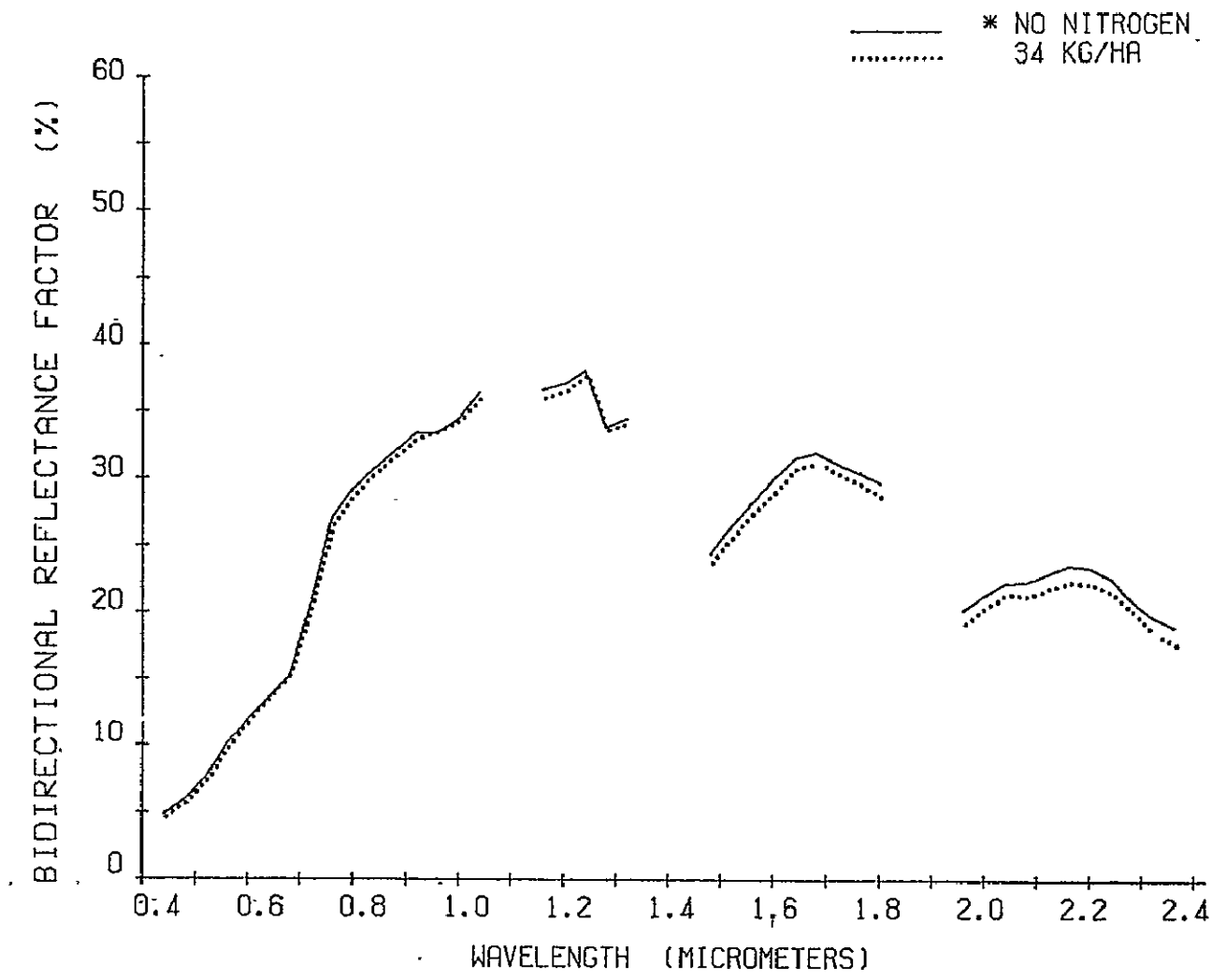
LOCATION: WILLISTON, NORTH DAKOTA
SENSOR: EXOTECH MODEL 20C DATE: JULY 10, 1975



* AVERAGES OF 16 PLOTS.

DIFFERENCE IN REFLECTANCE OF SPRING WHEAT DUE TO NITROGEN LEVEL

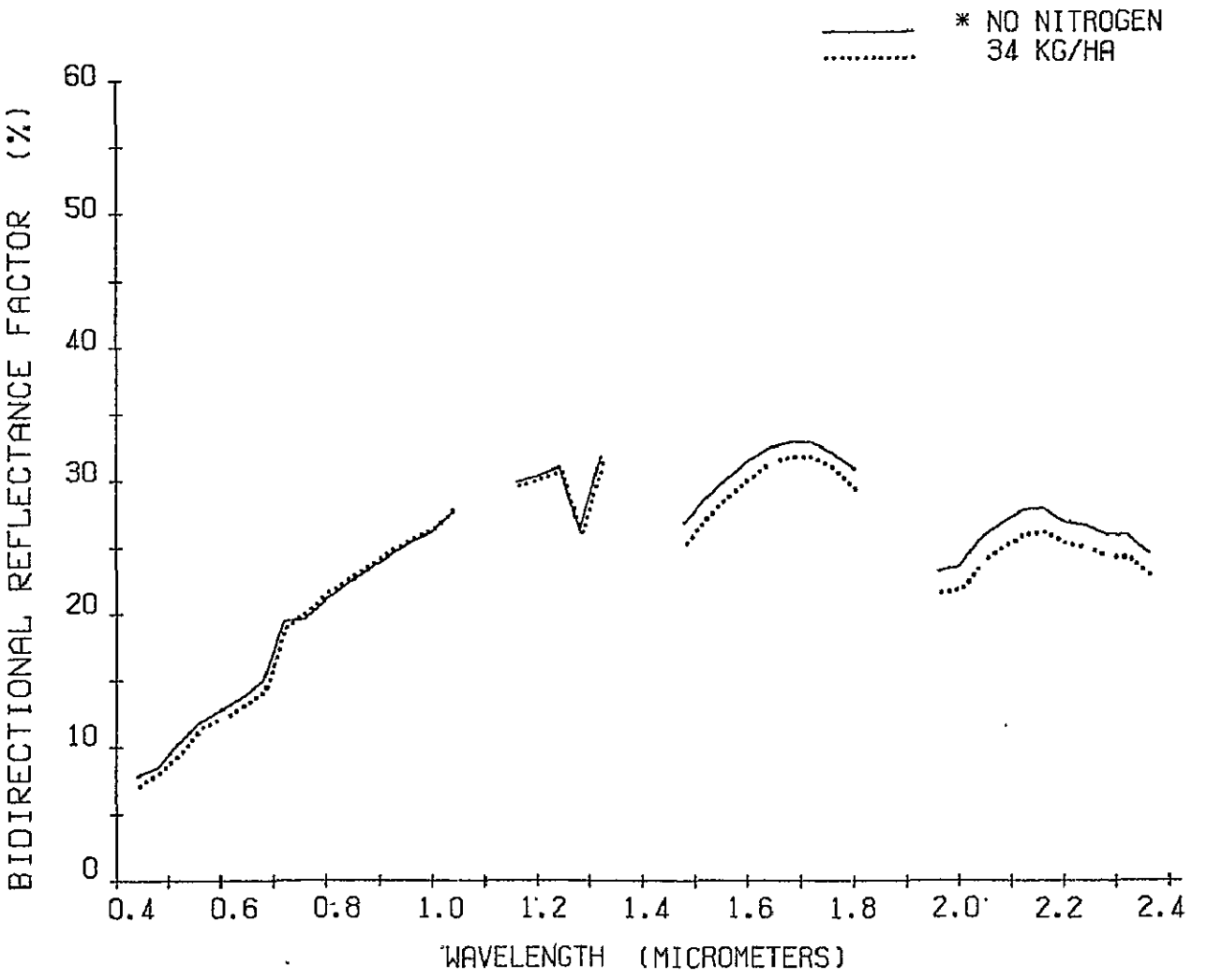
LOCATION: WILLISTON, NORTH DAKOTA
SENSOR: EXOTECH MODEL 20C DATE: AUGUST 12, 1975



* AVERAGES OF 8 PLOTS.

DIFFERENCE IN REFLECTANCE OF SPRING WHEAT DUE TO NITROGEN LEVEL

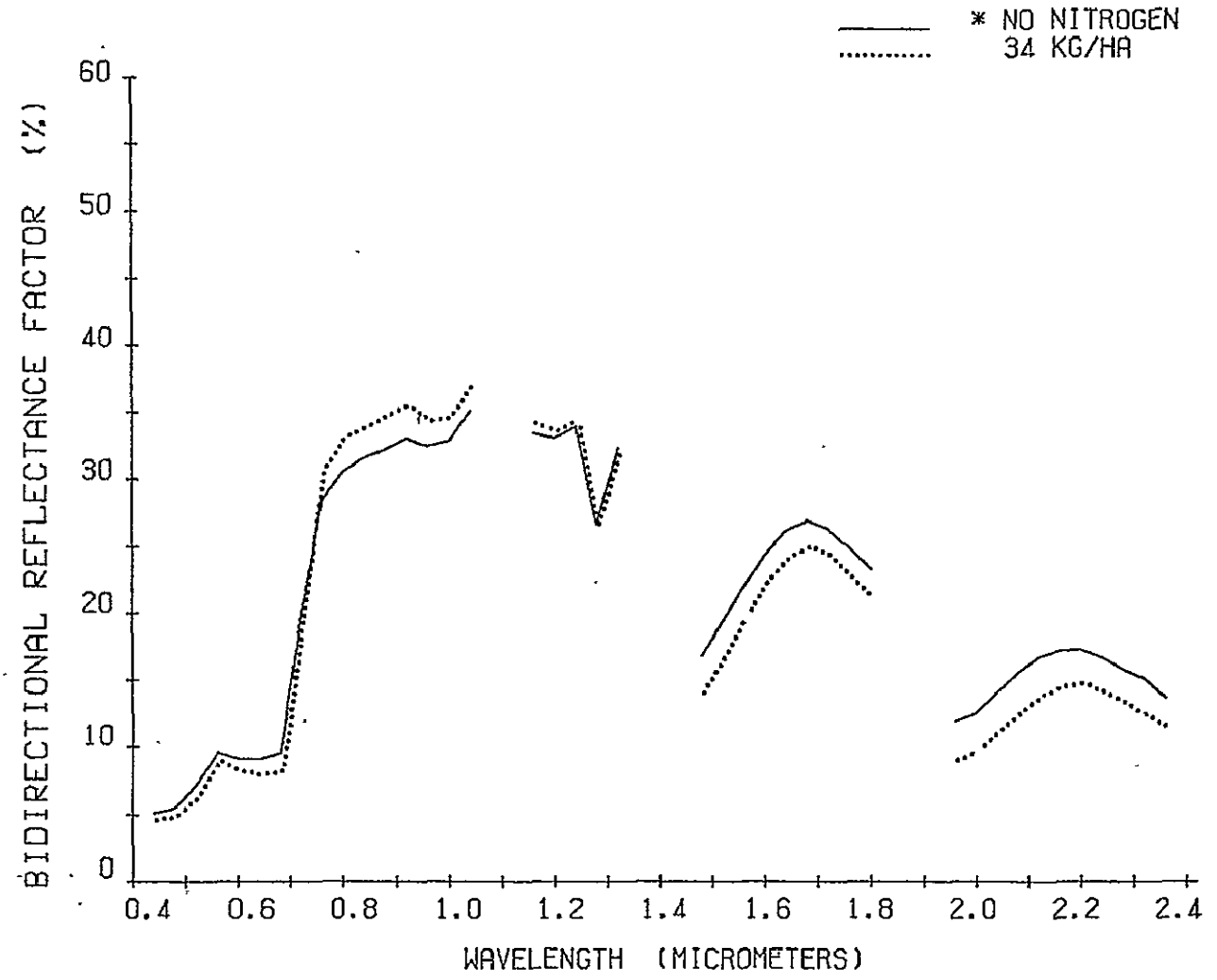
LOCATION: WILLISTON, NORTH DAKOTA
SENSOR: EXOTECH MODEL 20C DATE: JUNE 4, 1976



* AVERAGES OF 16 PLOTS.

DIFFERENCE IN REFLECTANCE OF SPRING WHEAT DUE TO NITROGEN LEVEL

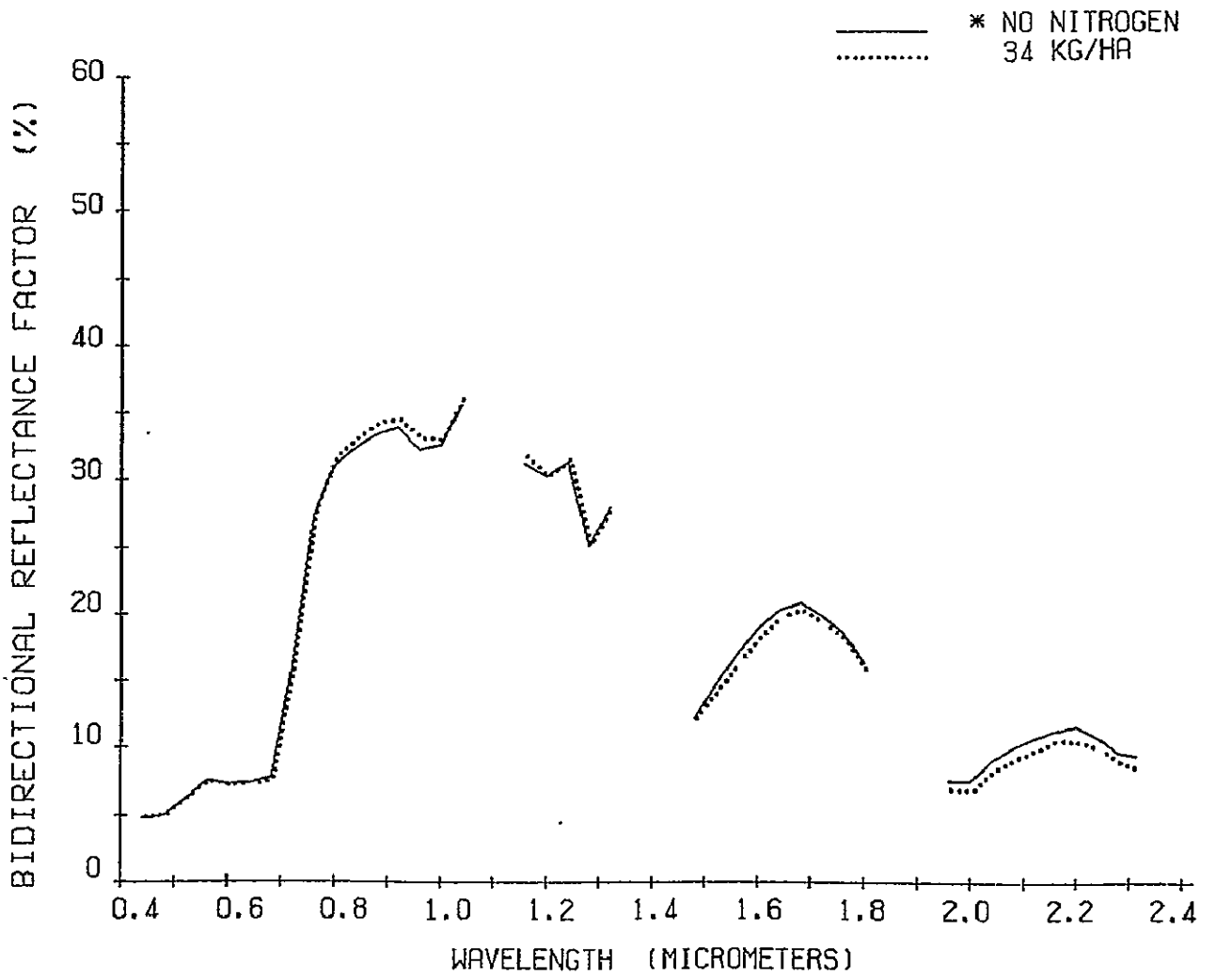
LOCATION: WILLISTON, NORTH DAKOTA
SENSOR: EXOTECH MODEL 20C DATE: JUNE 18, 1976



* AVERAGES OF 16 PLOTS.

DIFFERENCE IN REFLECTANCE OF SPRING WHEAT DUE TO NITROGEN LEVEL

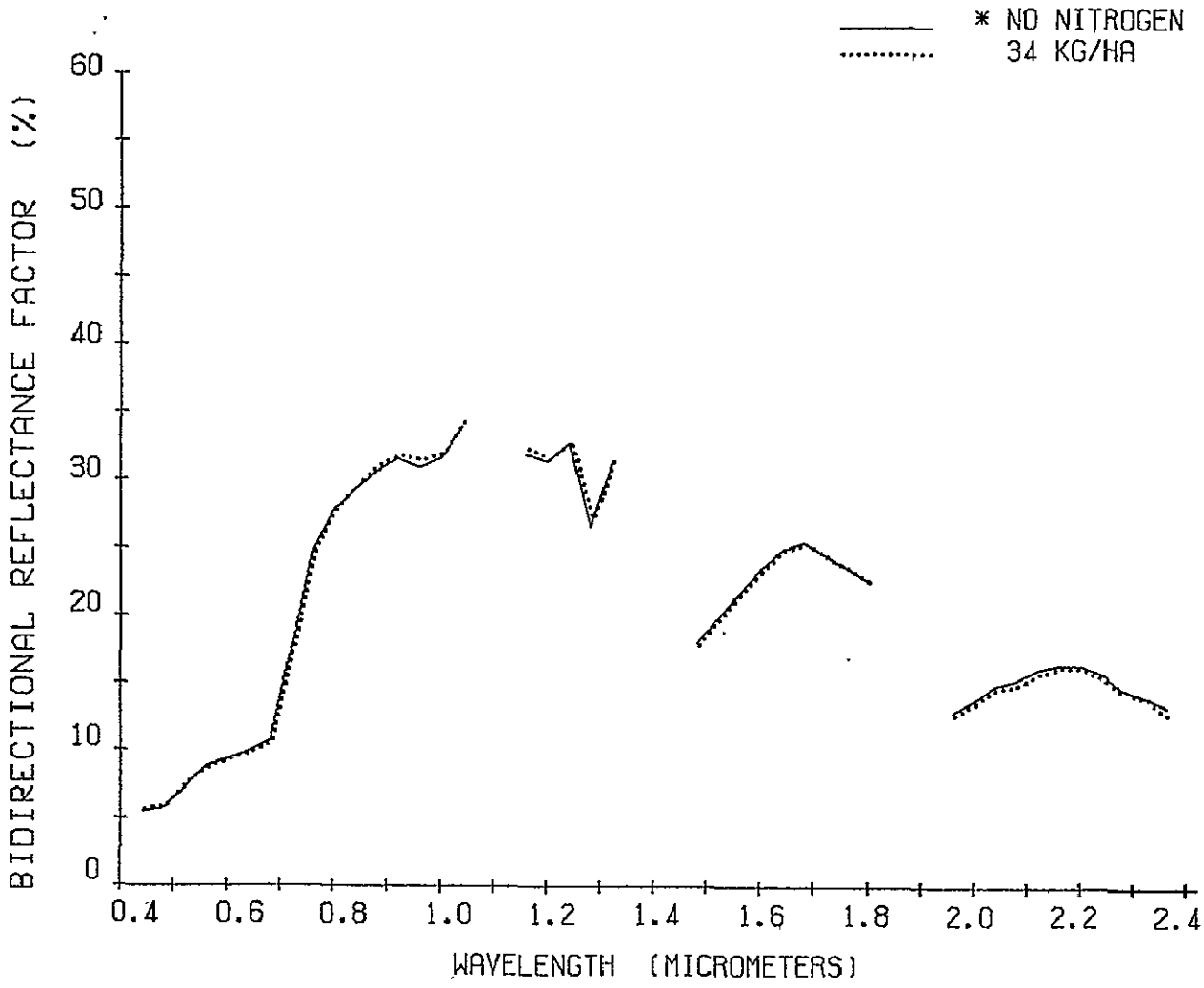
LOCATION: WILLISTON, NORTH DAKOTA
SENSOR: EXOTECH MODEL 20C DATE: JULY 8, 1976



* AVERAGES OF 8 PLOTS.

DIFFERENCE IN REFLECTANCE OF SPRING WHEAT DUE TO NITROGEN LEVEL

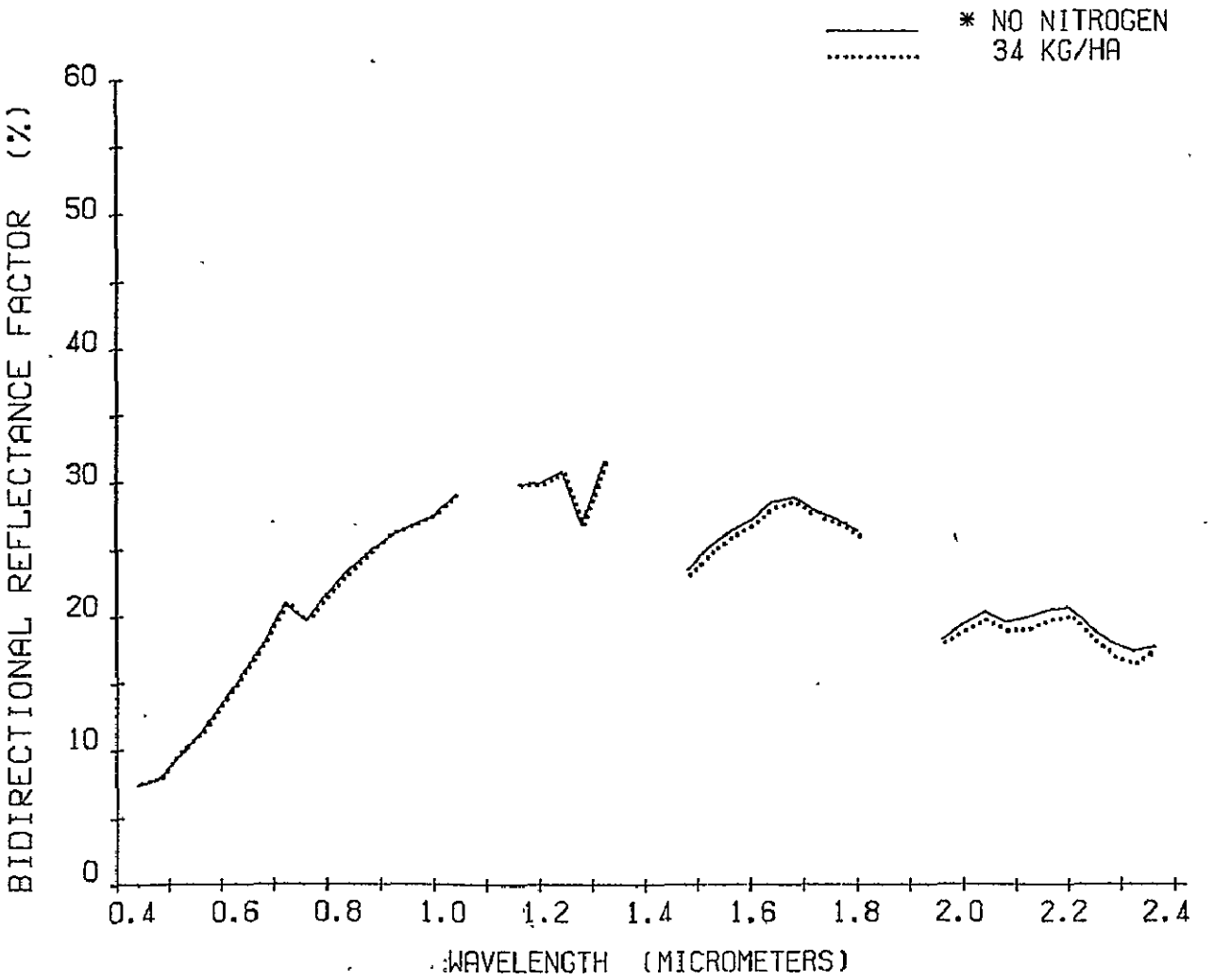
LOCATION: WILLISTON, NORTH DAKOTA
SENSOR: EXOTECH MODEL 20C DATE: JULY 16, 1976



* AVERAGES OF 16 PLOTS.

DIFFERENCE IN REFLECTANCE OF SPRING WHEAT DUE TO NITROGEN LEVEL

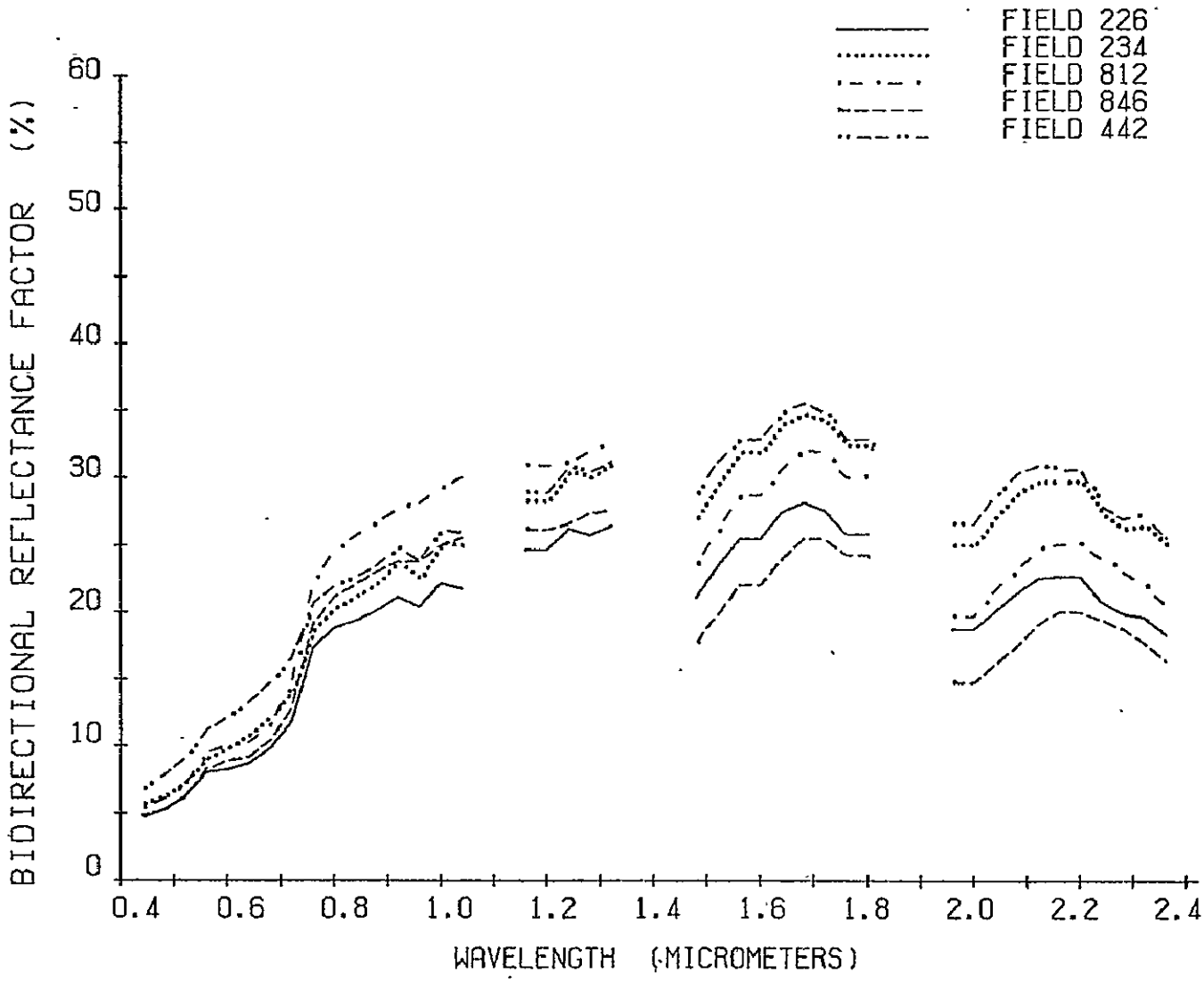
LOCATION: WILLISTON, NORTH DAKOTA
SENSOR: EXOTECH MODEL 20C DATE: AUGUST 6, 1976



* AVERAGES OF 16 PLOTS.

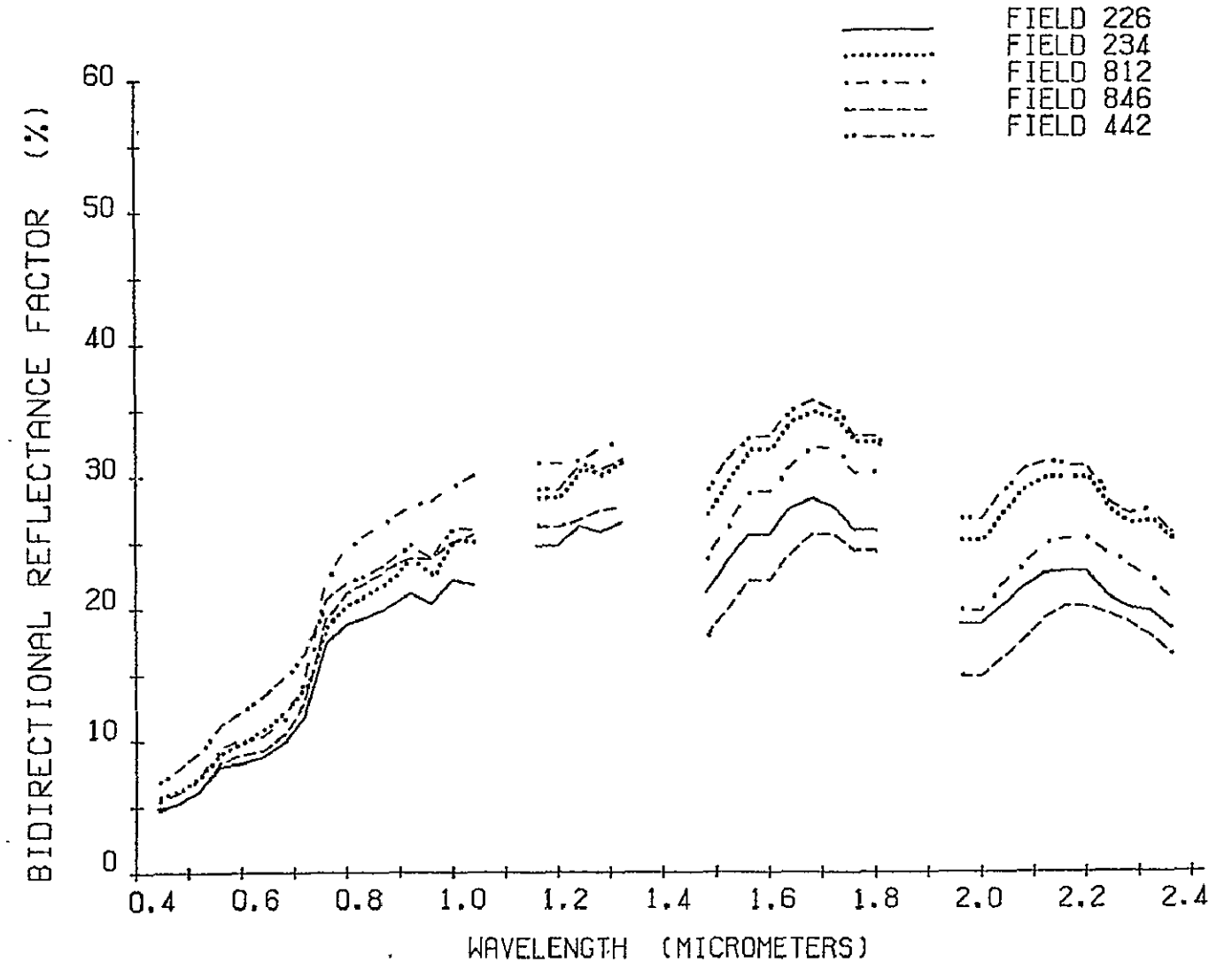
VARIABILITY IN REFLECTANCE AMONG SPRING WHEAT FIELDS

LOCATION: WILLIAMS COUNTY, NORTH DAKOTA
SENSOR: FSS DATE: JUNE 22, 1975



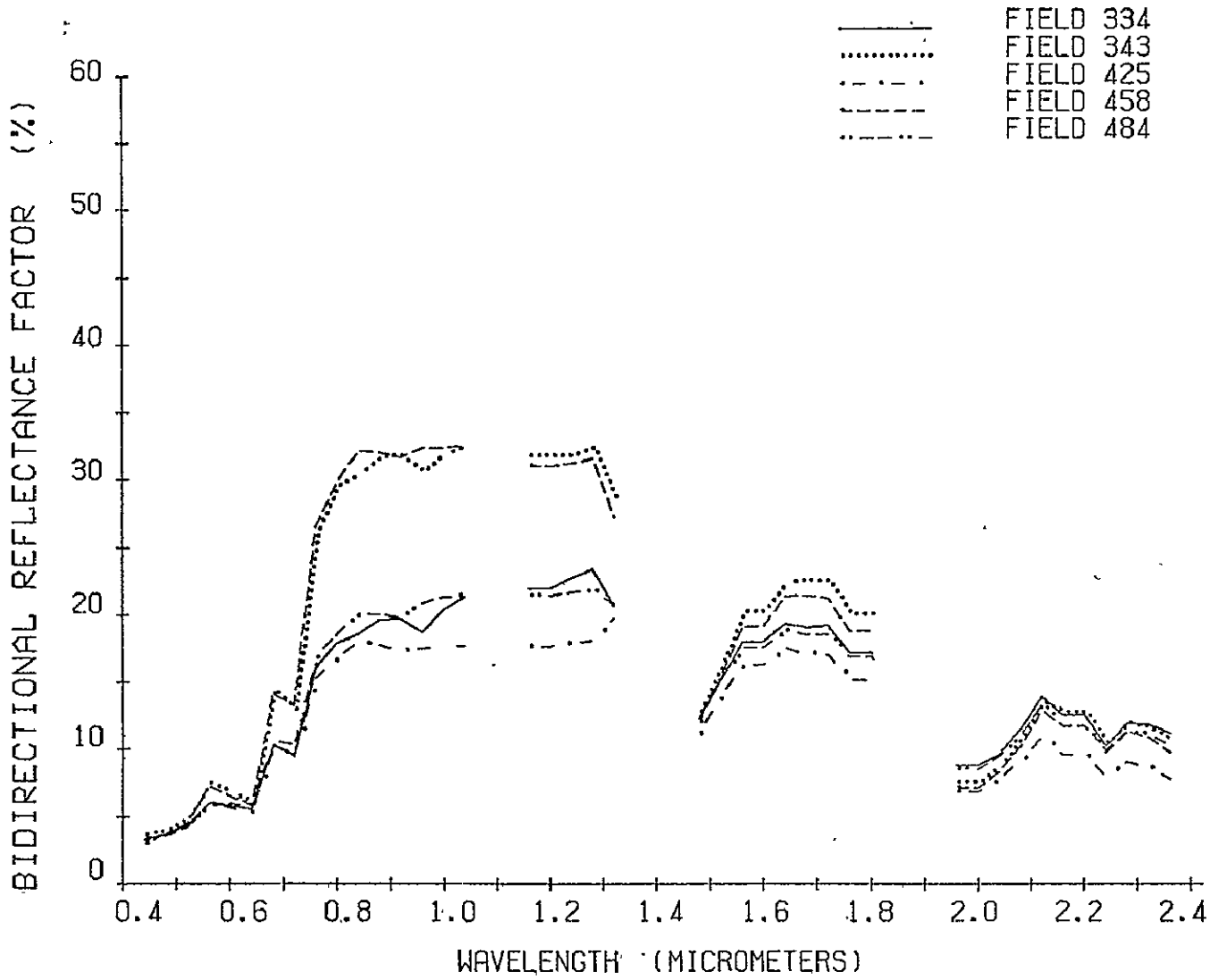
VARIABILITY IN REFLECTANCE AMONG SPRING WHEAT FIELDS

LOCATION: WILLIAMS COUNTY, NORTH DAKOTA
SENSOR: FSS DATE: JULY 27, 1975



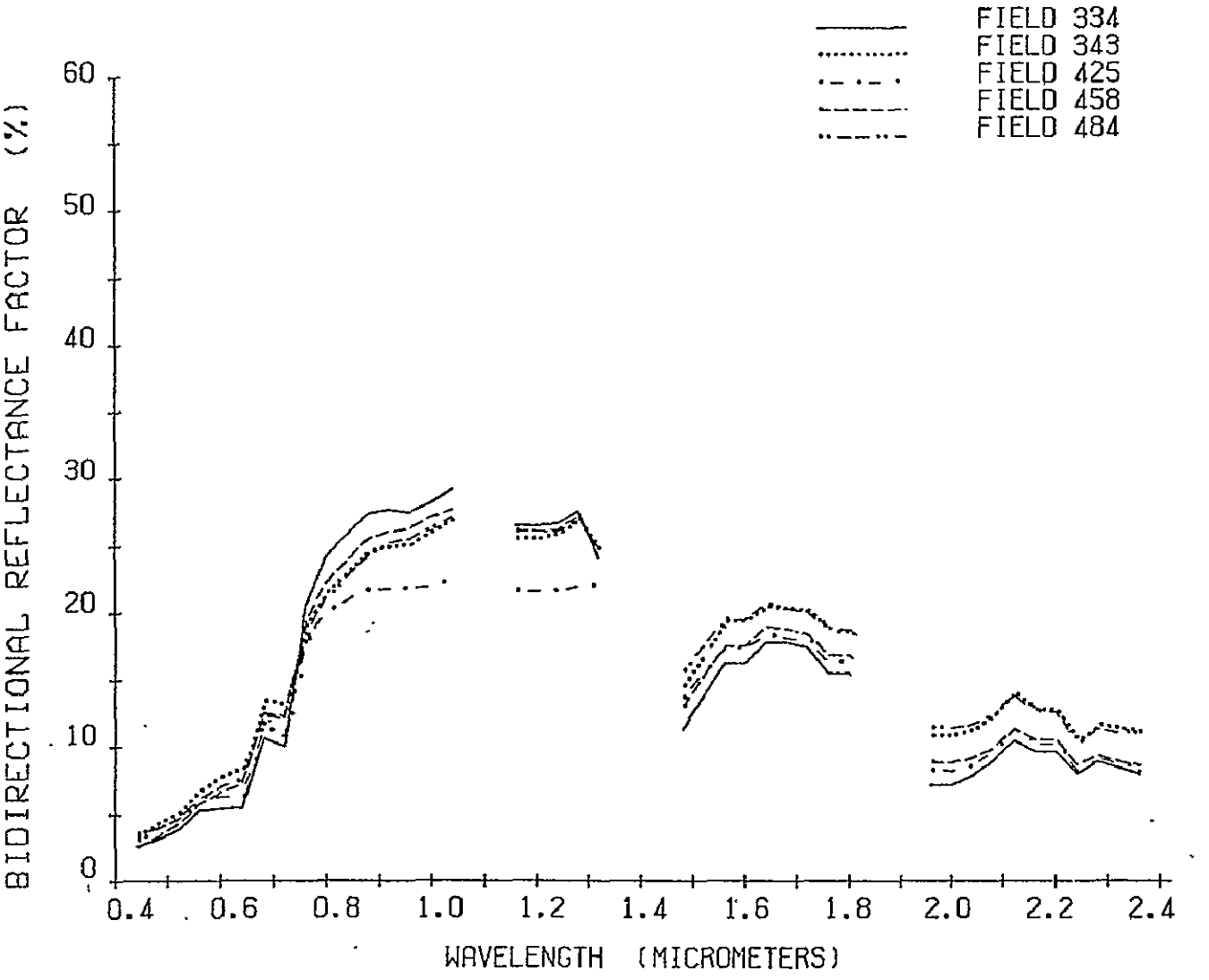
VARIABILITY IN REFLECTANCE AMONG SPRING WHEAT FIELDS

LOCATION: WILLIAMS COUNTY, NORTH DAKOTA
SENSOR: FSS DATE: JUNE 17, 1976



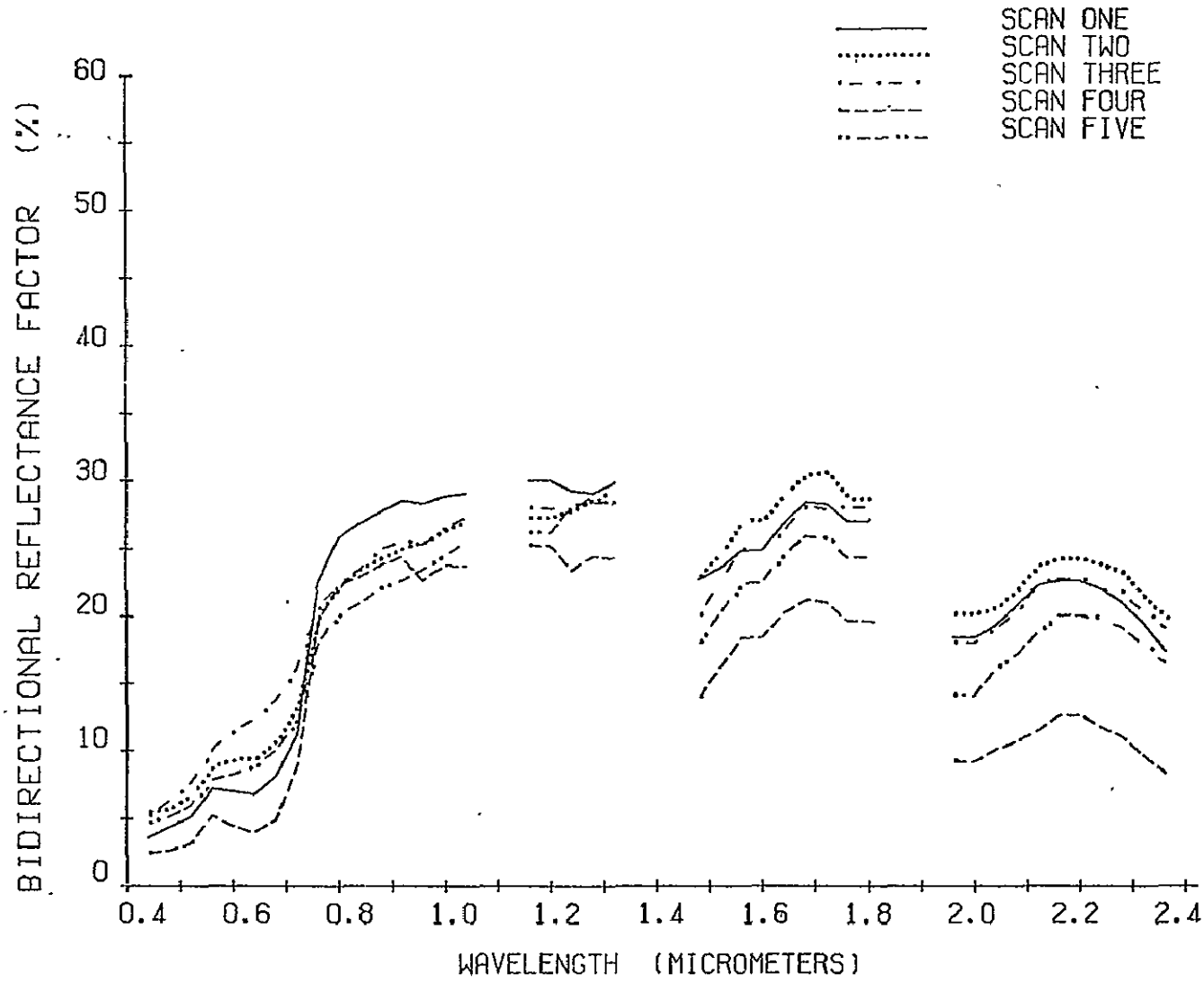
VARIABILITY IN REFLECTANCE AMONG SPRING WHEAT FIELDS

LOCATION: WILLIAMS COUNTY, NORTH DAKOTA
SENSOR: FSS DATE: JULY 28, 1976



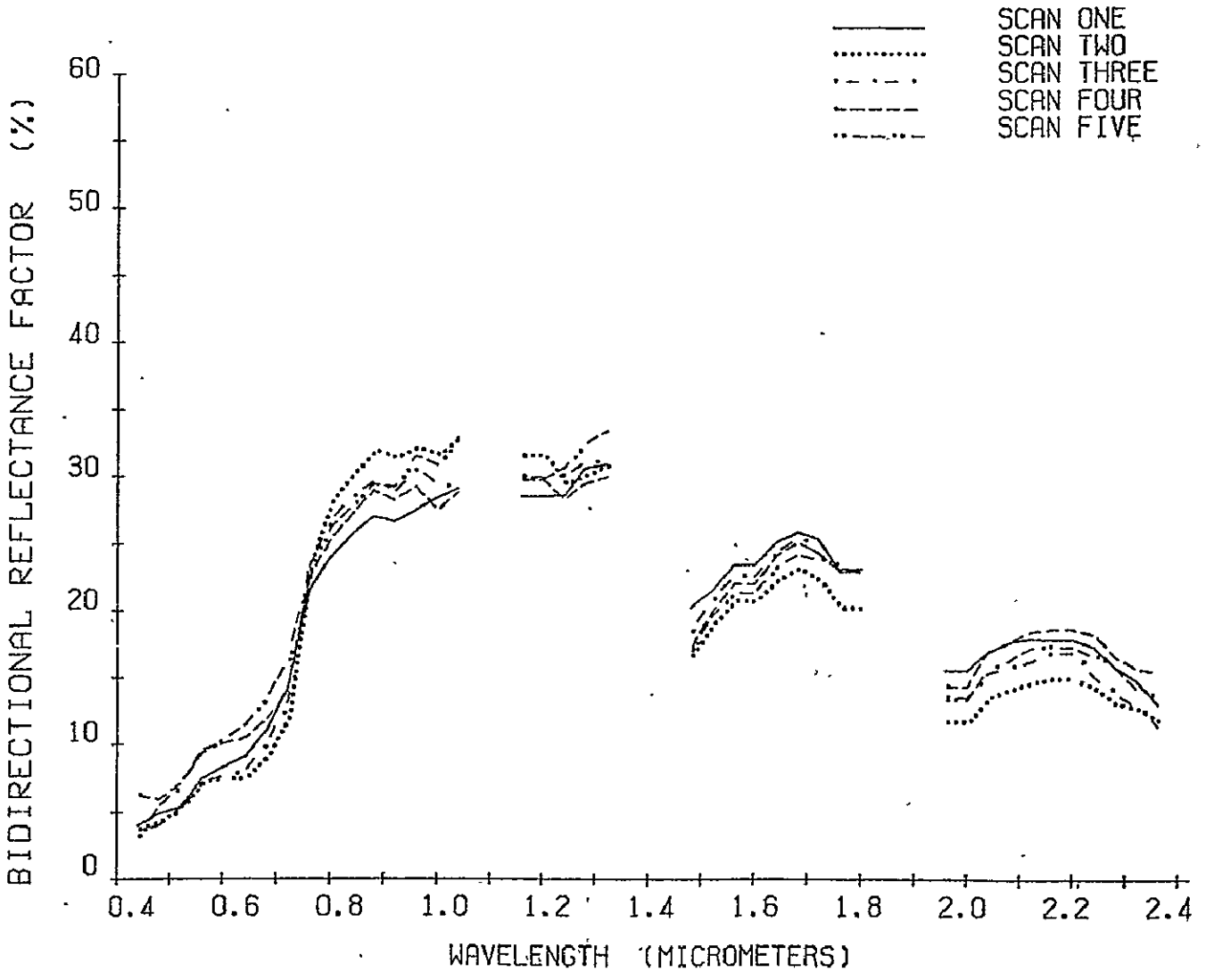
VARIABILITY IN REFLECTANCE WITHIN A SPRING WHEAT FIELD

LOCATION: WILLIAMS COUNTY, NORTH DAKOTA
SENSOR: FSS DATE: JUNE 22, 1975
FIELD: 846



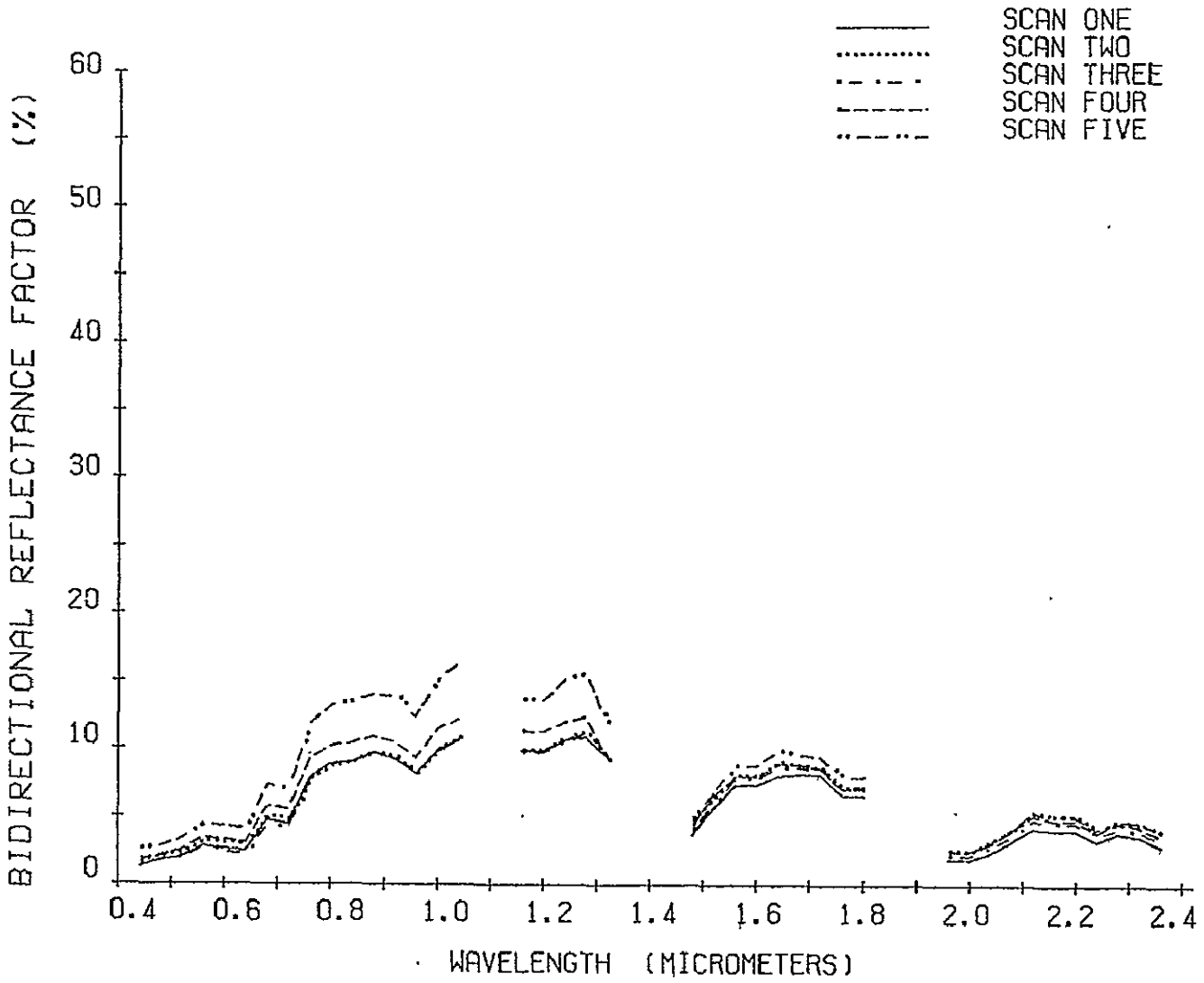
VARIABILITY IN REFLECTANCE WITHIN A SPRING WHEAT FIELD

LOCATION: WILLIAMS COUNTY, NORTH DAKOTA
SENSOR: FSS DATE: JULY 27, 1975
FIELD: 846



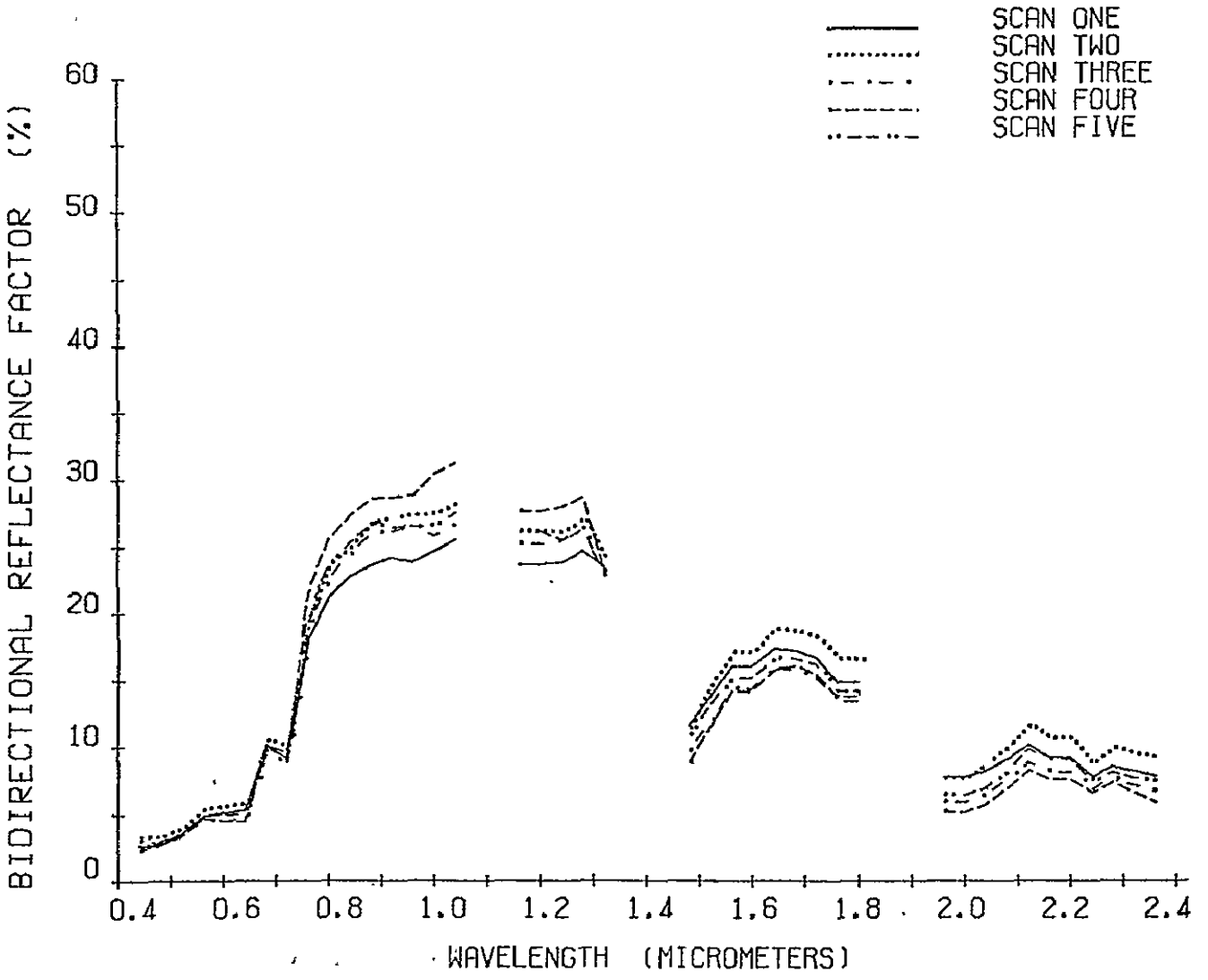
VARIABILITY IN REFLECTANCE WITHIN A SPRING WHEAT FIELD

LOCATION: WILLIAMS COUNTY, NORTH DAKOTA
SENSOR: FSS DATE: JUNE 17, 1976
FIELD: 334



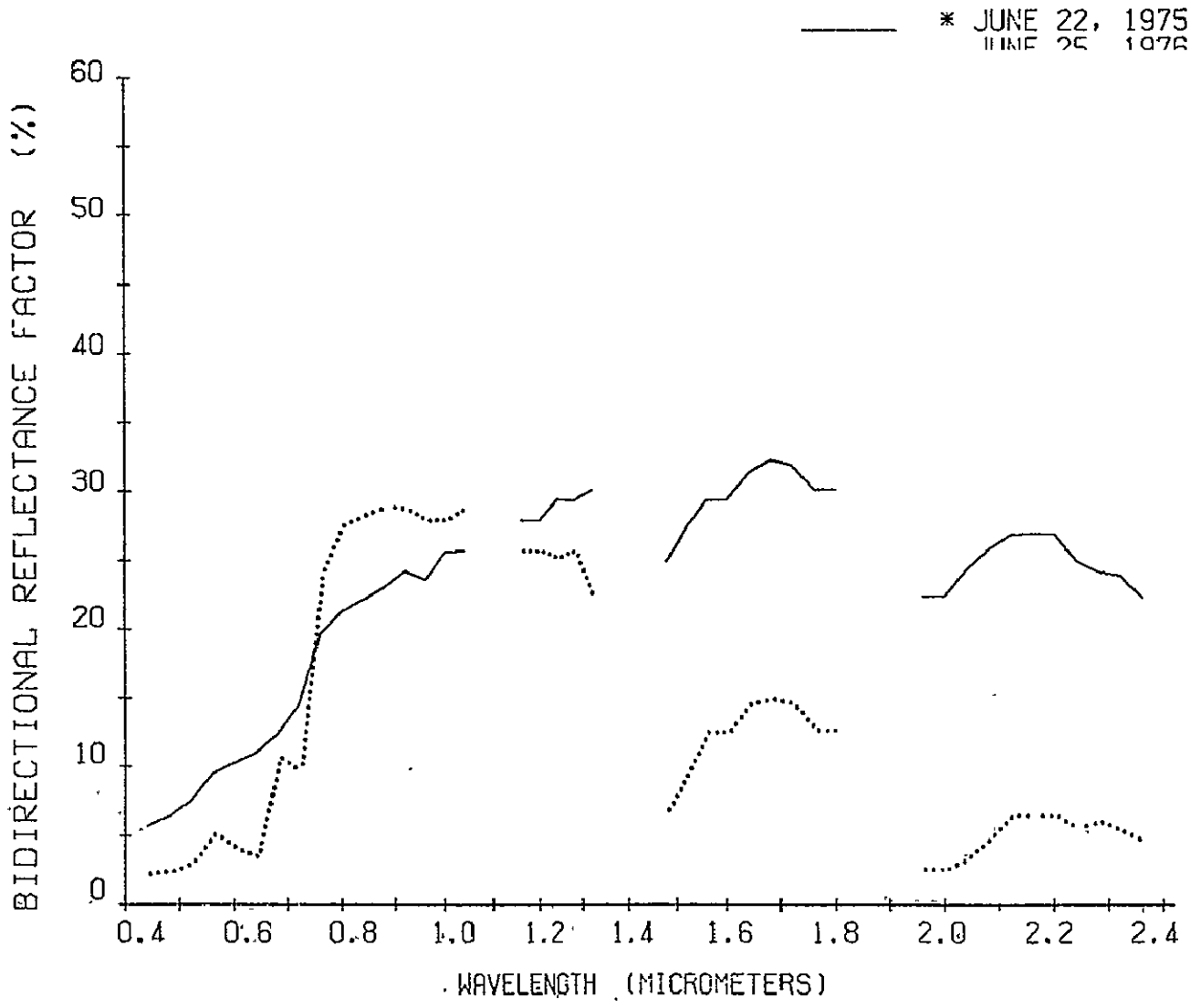
VARIABILITY IN REFLECTANCE WITHIN A SPRING WHEAT FIELD

LOCATION: WILLIAMS COUNTY, NORTH DAKOTA
SENSOR: FSS DATE: JULY 28, 1976
FIELD: 334



REFLECTANCE OF SPRING WHEAT AT THE SAME DATE IN TWO YEARS

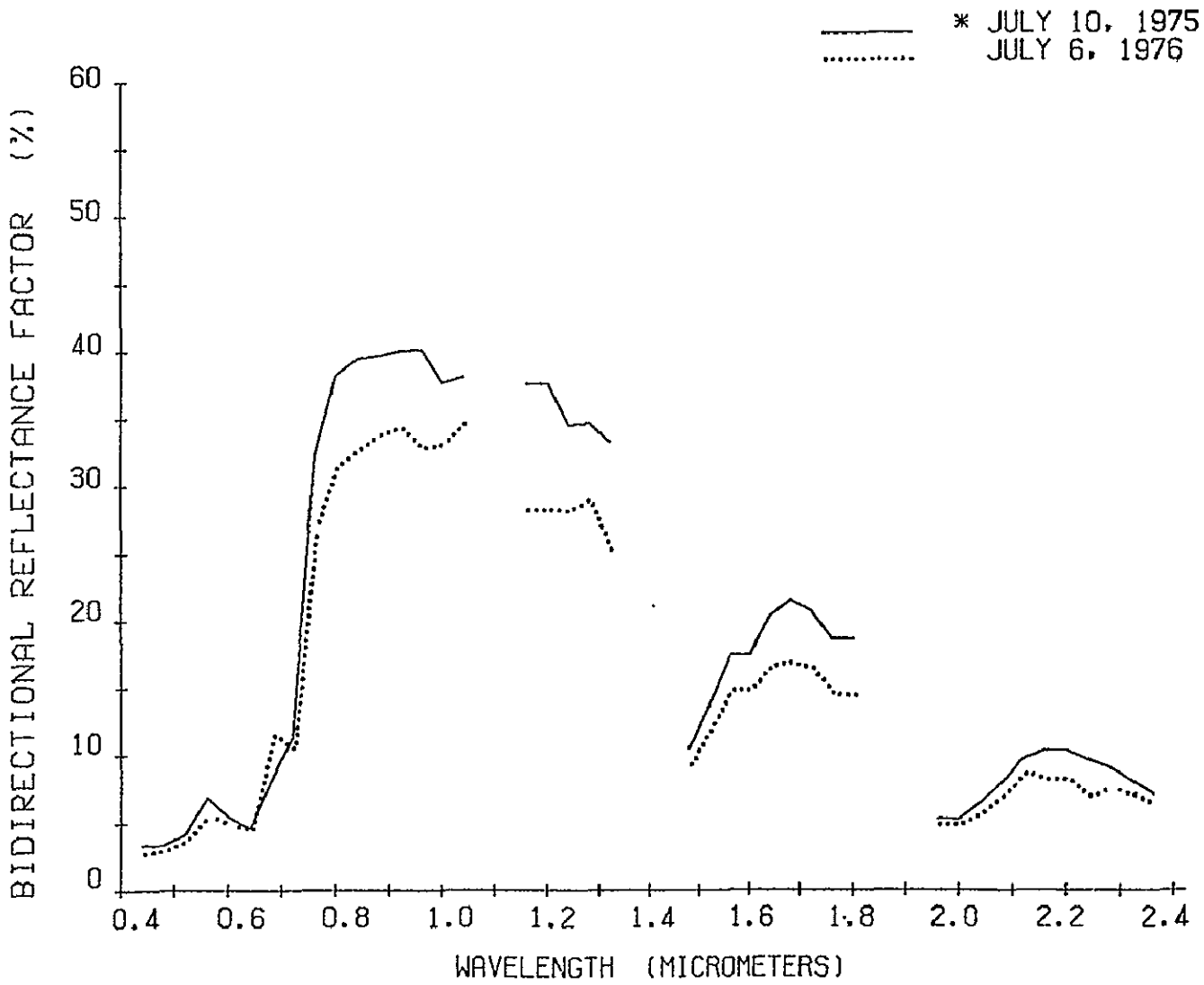
LOCATION: WILLIAMS COUNTY, NORTH DAKOTA
SENSOR: FSS



* AVERAGES OF 8 AND 9 FIELDS, RESPECTIVELY.

REFLECTANCE OF SPRING WHEAT AT THE SAME DATE IN TWO YEARS

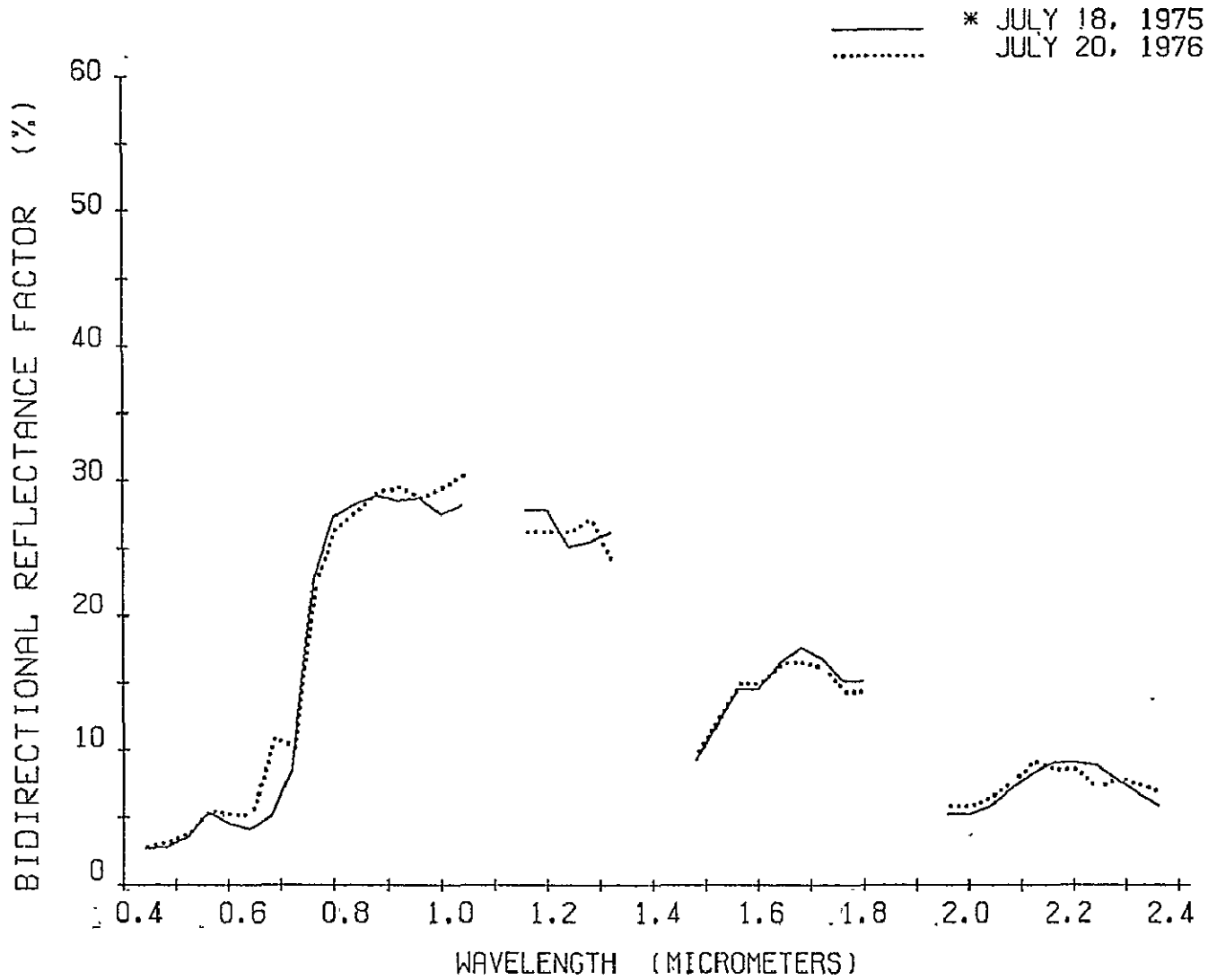
LOCATION: WILLIAMS COUNTY, NORTH DAKOTA
SENSOR: FSS



* AVERAGES OF 9 FIELDS.

REFLECTANCE OF SPRING WHEAT AT THE SAME DATE IN TWO YEARS

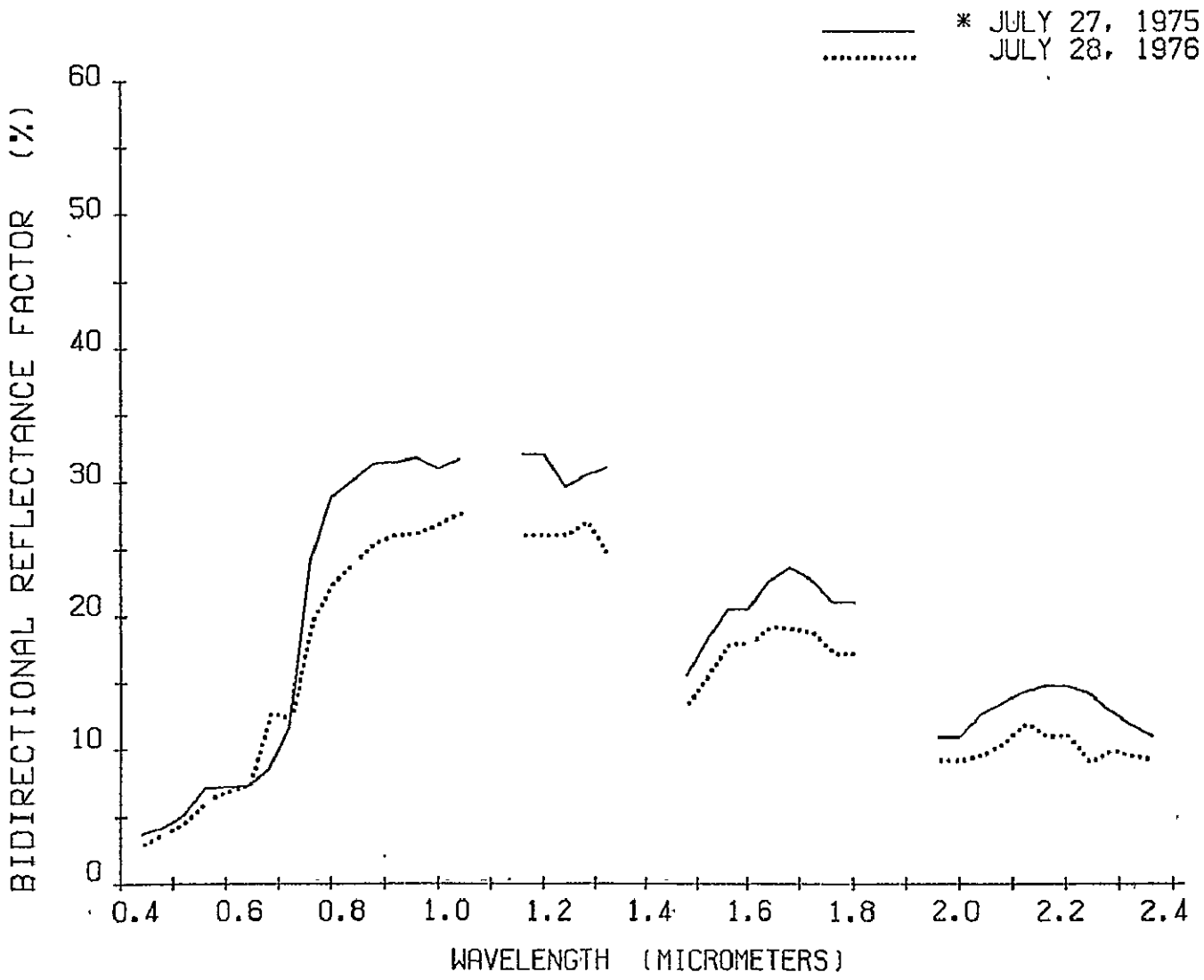
LOCATION: WILLIAMS COUNTY, NORTH DAKOTA
SENSOR: FSS



* AVERAGES OF 10 AND 9 FIELDS, RESPECTIVELY.

REFLECTANCE OF SPRING WHEAT AT THE SAME DATE IN TWO YEARS

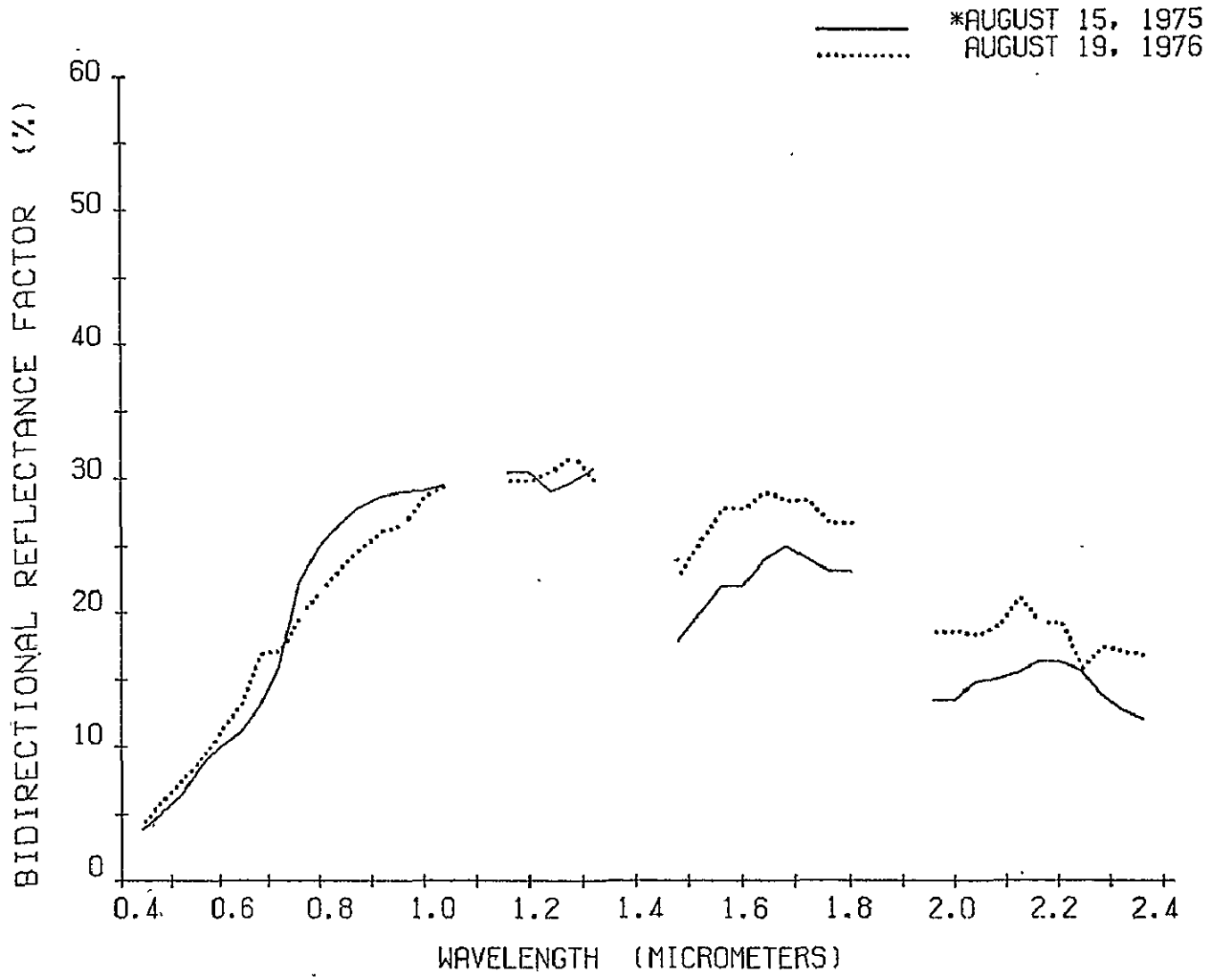
LOCATION: WILLIAMS COUNTY, NORTH DAKOTA
SENSOR: FSS



* AVERAGES OF 10 AND 9 FIELDS, RESPECTIVELY.

REFLECTANCE OF SPRING WHEAT AT THE SAME DATE IN TWO YEARS

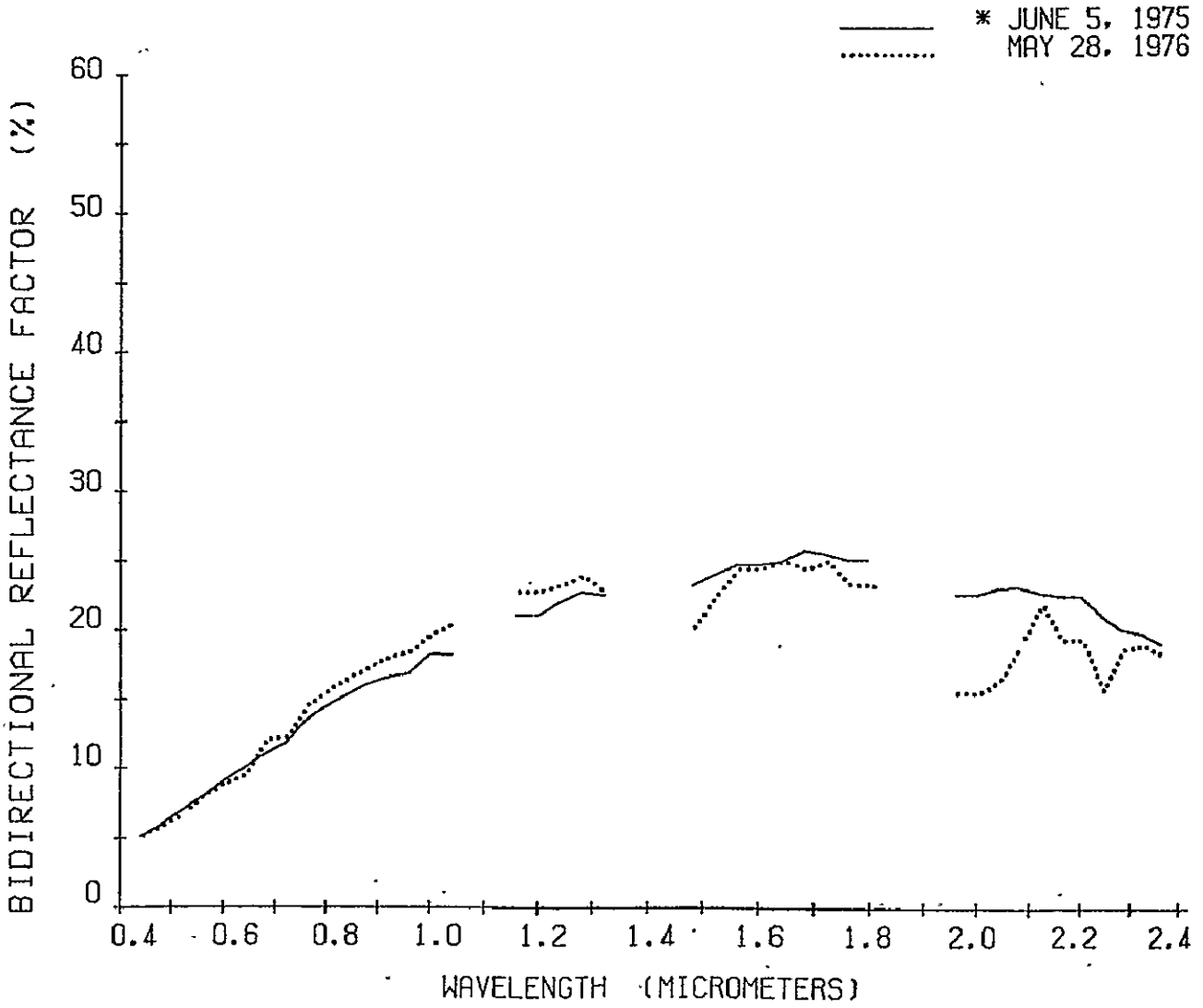
LOCATION: WILLIAMS COUNTY, NORTH DAKOTA
SENSOR: FSS



* AVERAGES OF 7 AND 9 FIELDS, RESPECTIVELY.

REFLECTANCE OF SPRING WHEAT AT THE SAME MATURITY STAGE

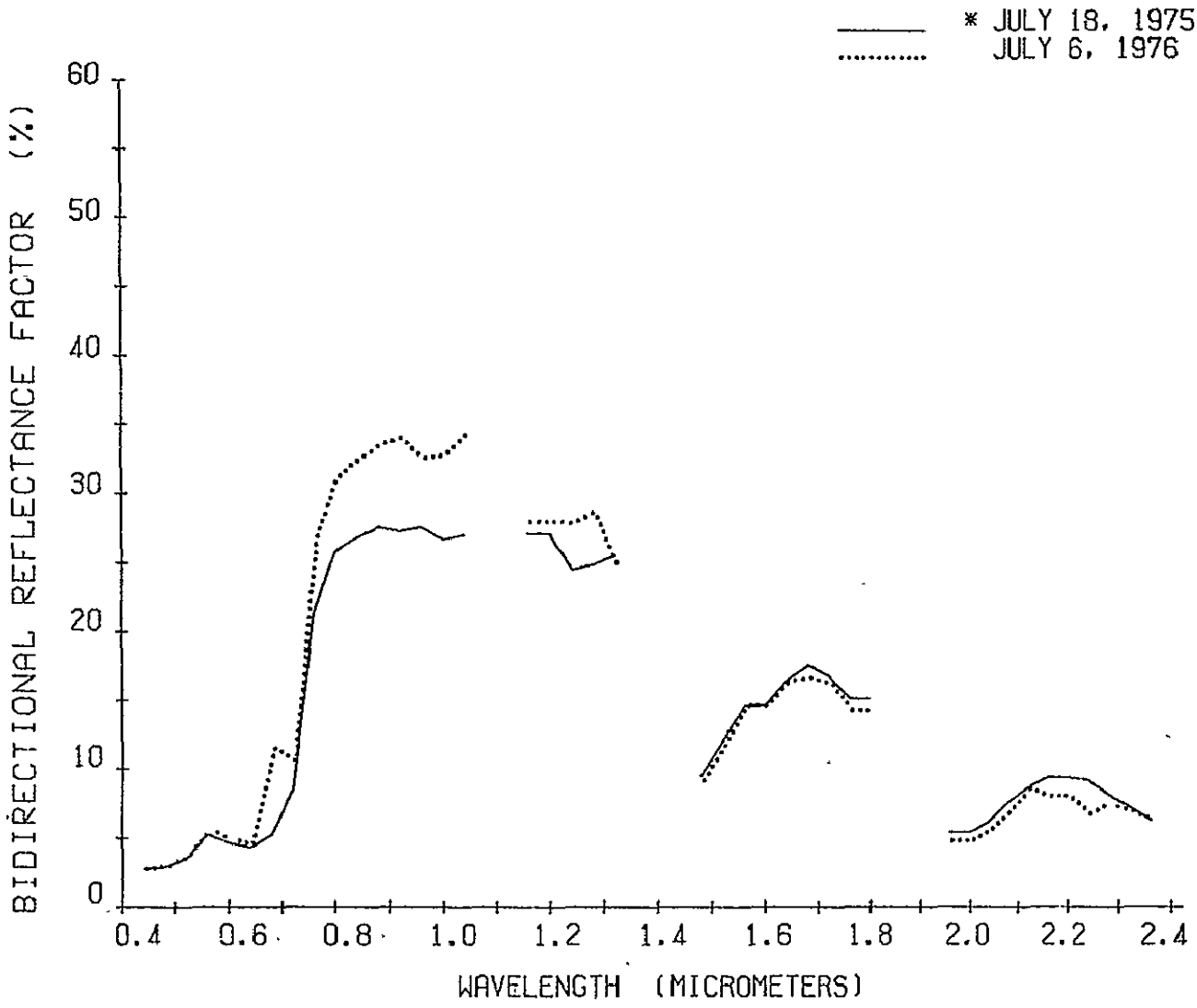
LOCATION: WILLIAMS COUNTY, NORTH DAKOTA
SENSOR: FSS MATURITY STAGE: EMERGENCE



* AVERAGES OF 8 AND 9 FIELDS, RESPECTIVELY.

REFLECTANCE OF SPRING WHEAT AT THE SAME MATURITY STAGE

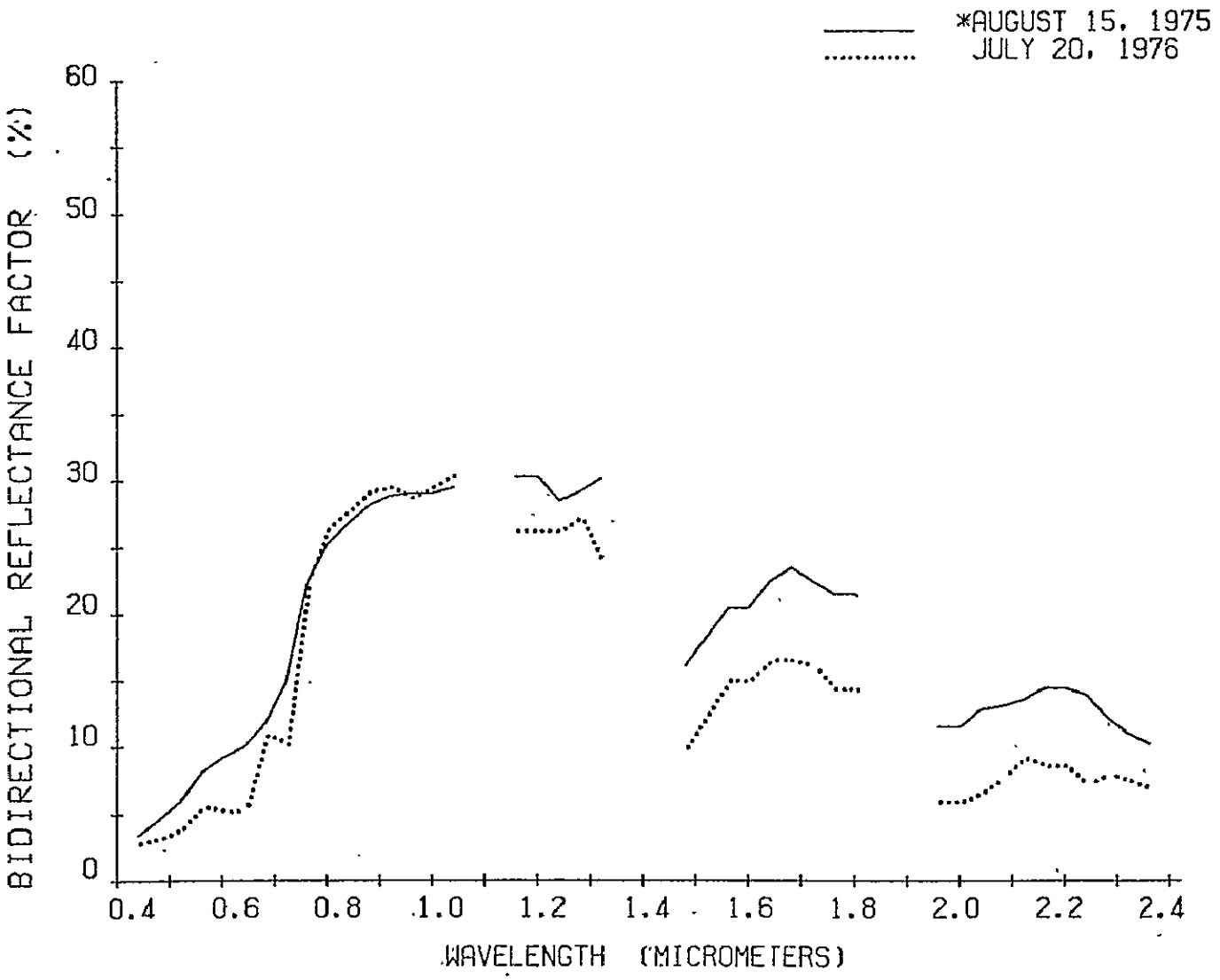
LOCATION: WILLIAMS COUNTY, NORTH DAKOTA
SENSOR: FSS MATURITY STAGE: HEADED



* AVERAGES OF 4 AND 8 FIELDS, RESPECTIVELY.

REFLECTANCE OF SPRING WHEAT AT THE SAME MATURITY STAGE

LOCATION: WILLIAMS COUNTY, NORTH DAKOTA
SENSOR: FSS MATURITY STAGE: RIPENING



* AVERAGES OF 7 AND 9 FIELDS, RESPECTIVELY.

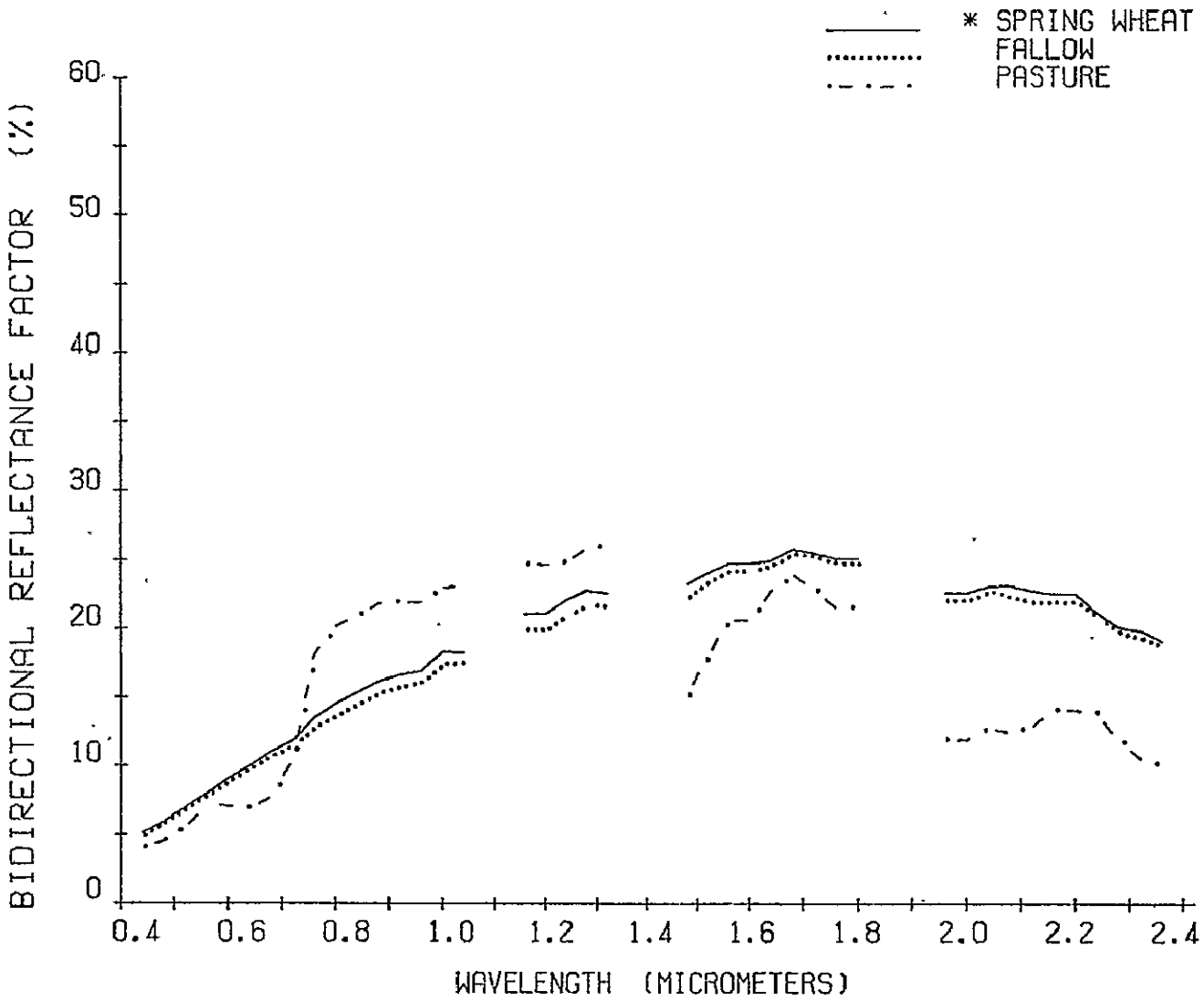
III. North Dakota Spring Wheat Examples

B. Variation Between Spring Wheat and Other Crops

PRECEDING

DIFFERENCE IN REFLECTANCE DUE TO COVER TYPE

LOCATION: WILLIAMS COUNTY, NORTH DAKOTA
SENSOR: FSS DATE: JUNE 5, 1975



* AVERAGES OF 8, 9, AND 6 FIELDS, RESPECTIVELY.

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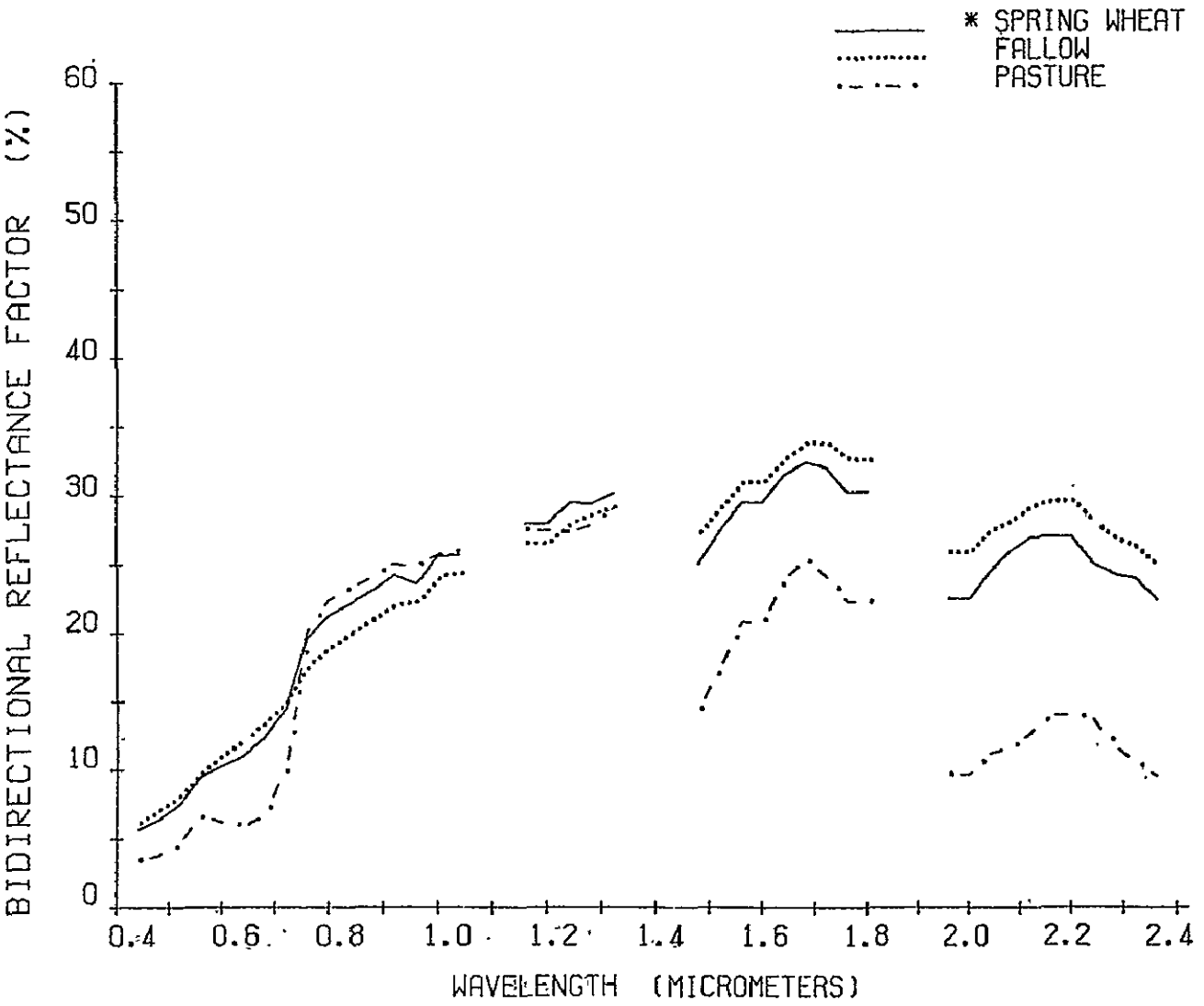
DIFFERENCE IN REFLECTANCE DUE TO COVER TYPE

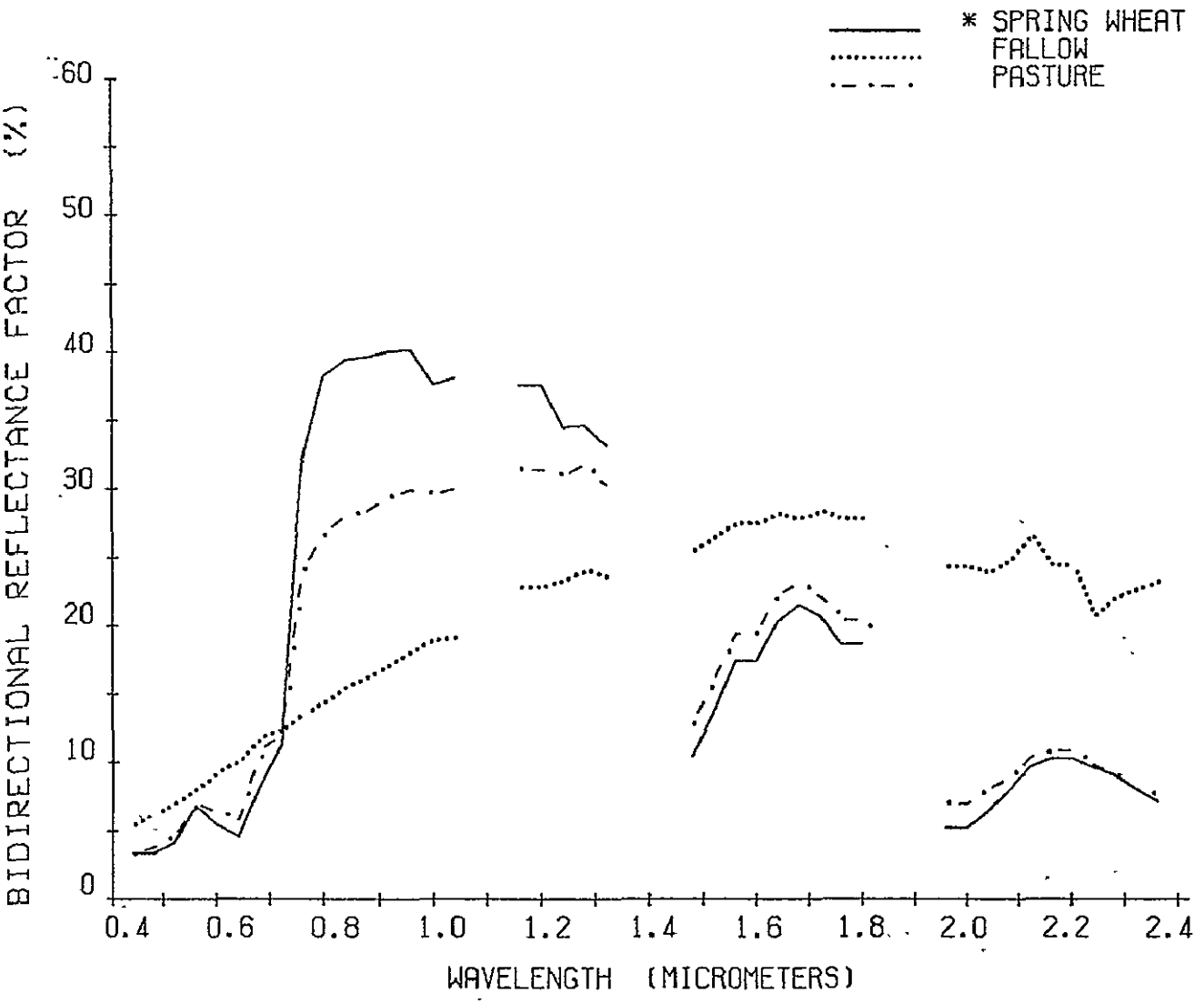
LOCATION: WILLIAMS COUNTY, NORTH DAKOTA
SENSOR: FSS DATE: JUNE 22, 1975



* AVERAGES OF 9, 8, AND 3 FIELDS, RESPECTIVELY.

DIFFERENCE IN REFLECTANCE DUE TO COVER TYPE

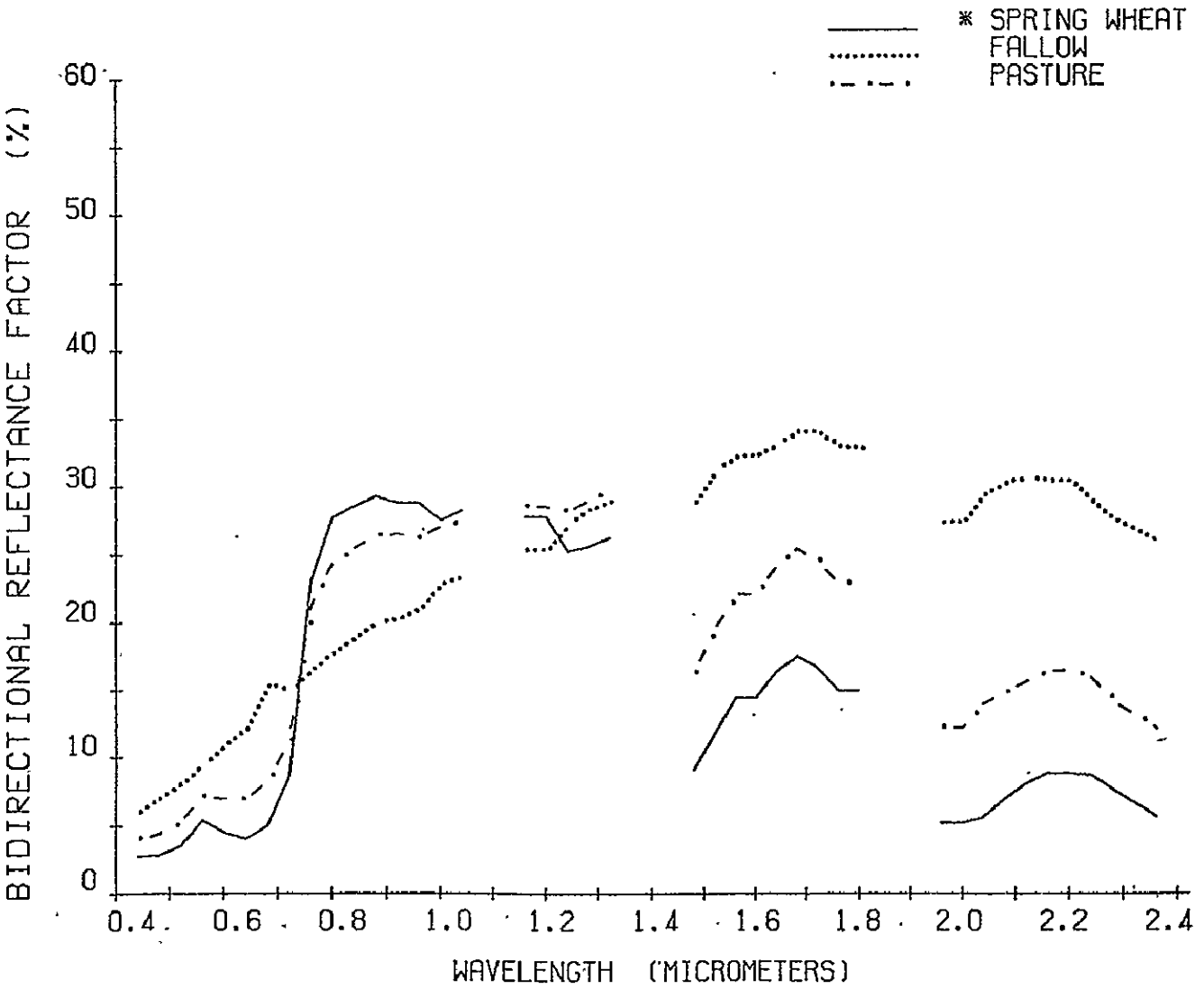
LOCATION: WILLIAMS COUNTY, NORTH DAKOTA
SENSOR: FSS DATE: JULY 10, 1975



* AVERAGES OF 10, 8, AND 3 FIELDS, RESPECTIVELY.

DIFFERENCE IN REFLECTANCE DUE TO COVER TYPE

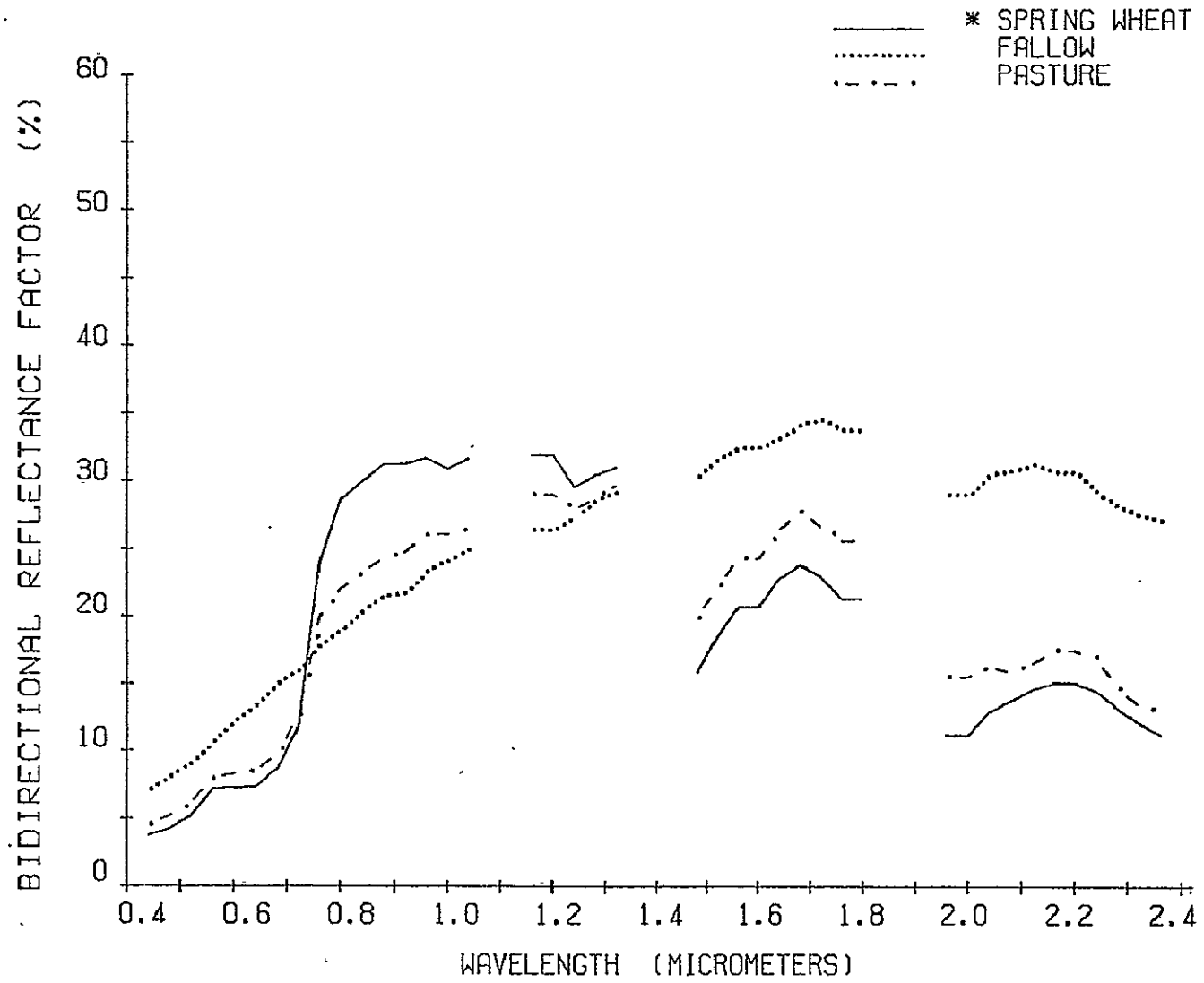
LOCATION: WILLIAMS COUNTY, NORTH DAKOTA
SENSOR: FSS DATE: JULY 18, 1975



* AVERAGES OF 9, 4, AND 4 FIELDS, RESPECTIVELY.

DIFFERENCE IN REFLECTANCE DUE TO COVER TYPE

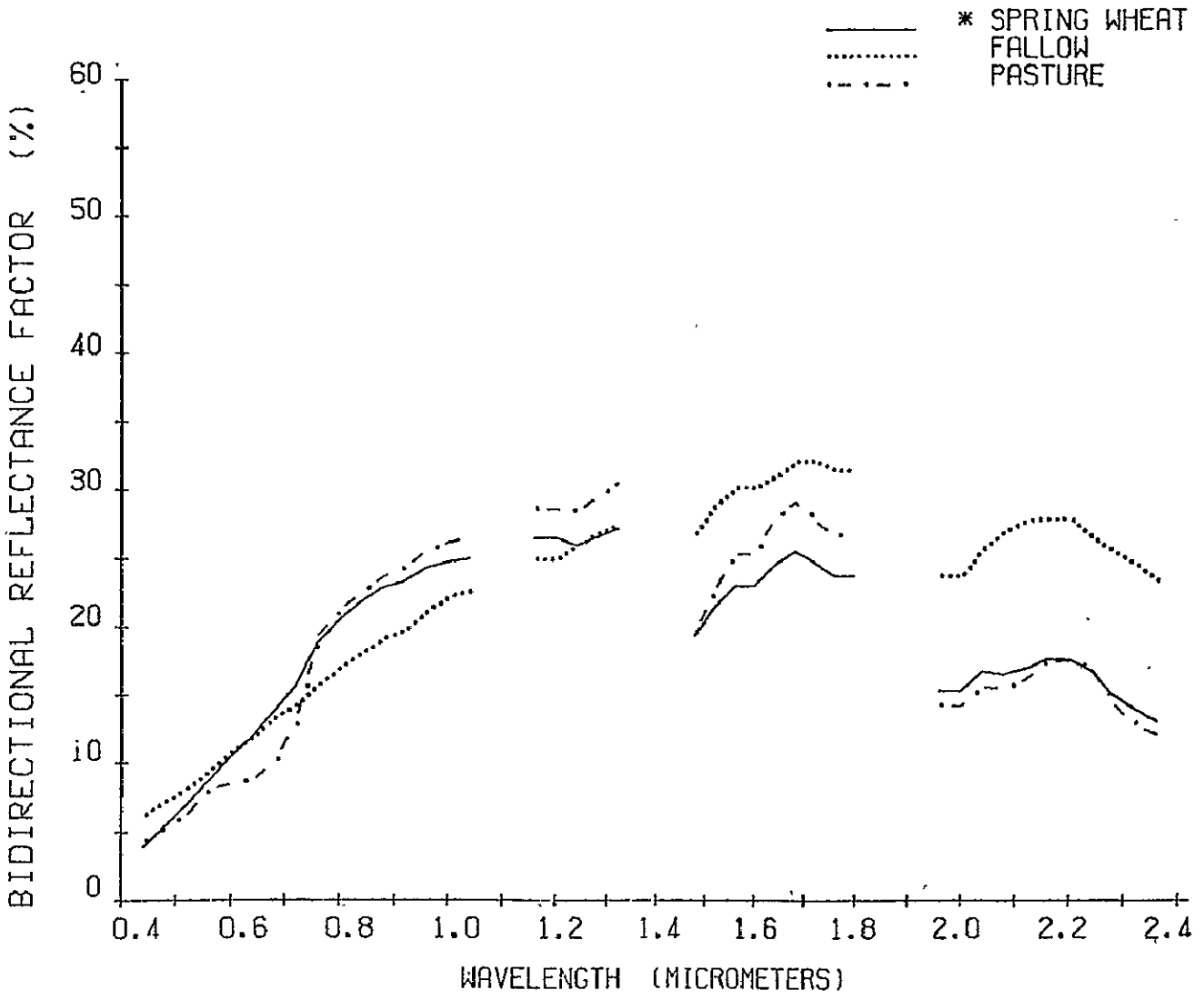
LOCATION: WILLIAMS COUNTY, NORTH DAKOTA
SENSOR: FSS DATE: JULY 27, 1975



* AVERAGES OF 8, 6, AND 6 FIELDS, RESPECTIVELY.

DIFFERENCE IN REFLECTANCE DUE TO COVER TYPE

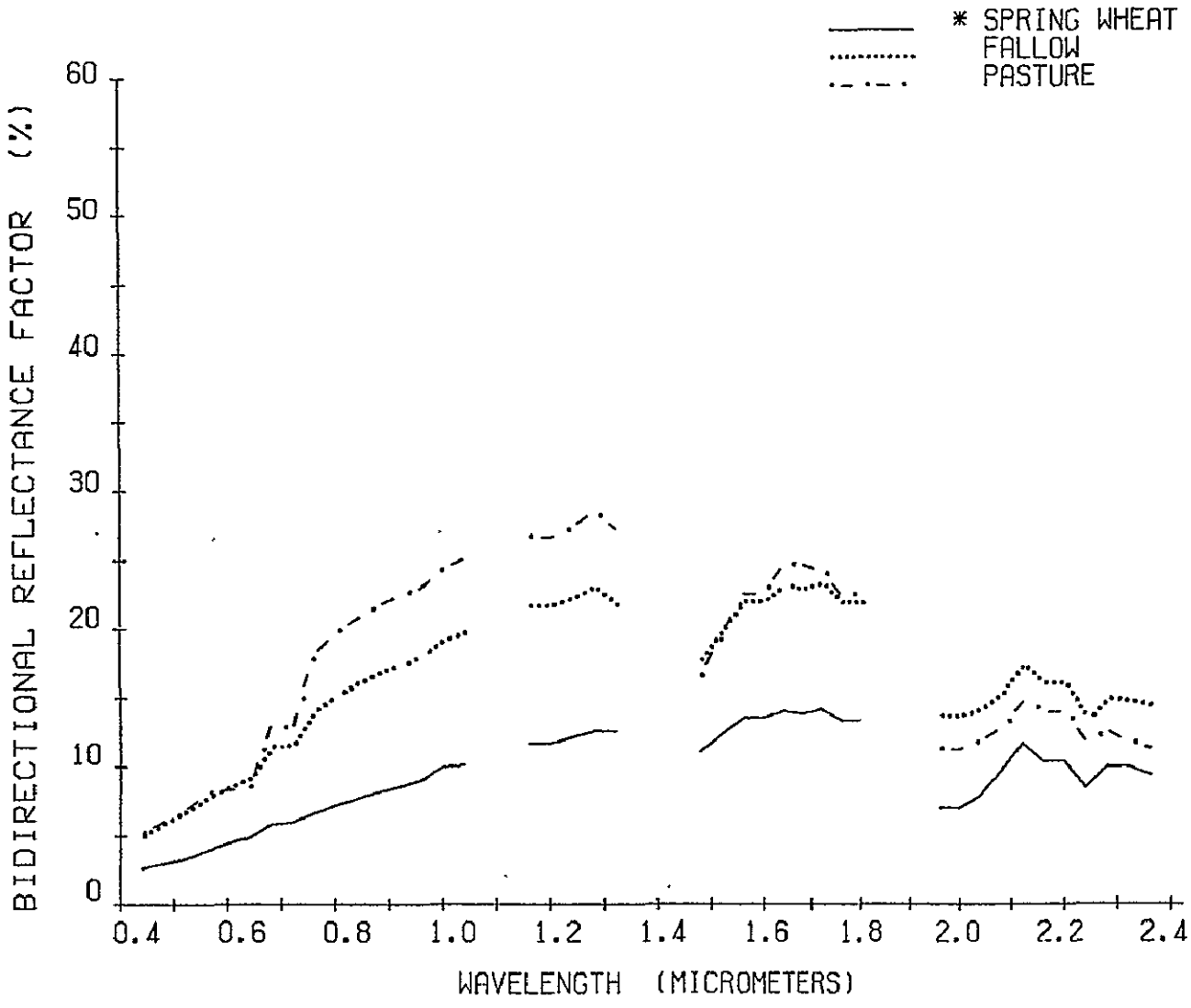
LOCATION: WILLIAMS COUNTY, NORTH DAKOTA
SENSOR: FSS DATE: AUGUST 23, 1975



* AVERAGES OF 9, 8, AND 6 FIELDS, RESPECTIVELY.

DIFFERENCE IN REFLECTANCE DUE TO COVER TYPE

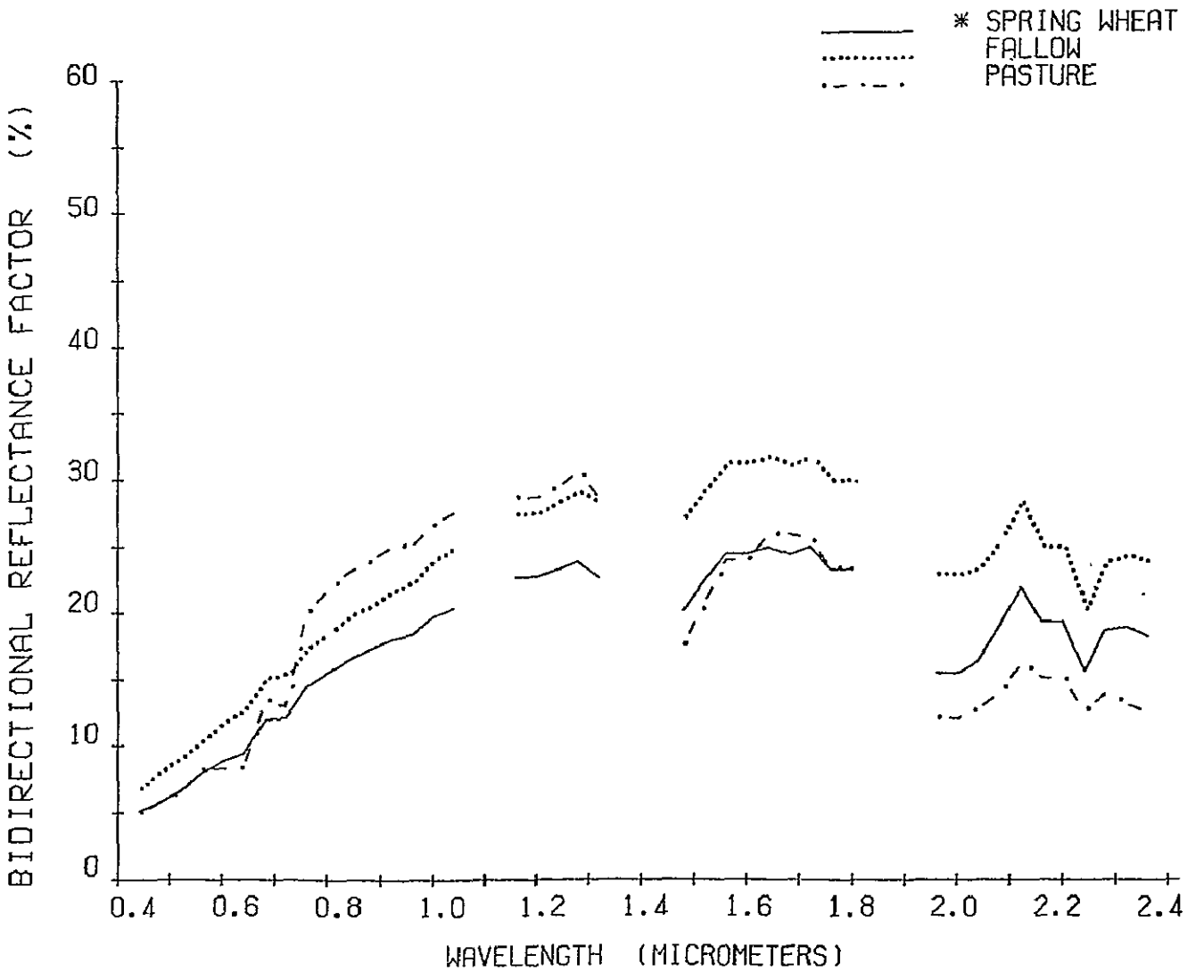
LOCATION: WILLIAMS COUNTY, NORTH DAKOTA
SENSOR: FSS DATE: MAY 13, 1976



* AVERAGES OF 9, 10, AND 6 FIELDS, RESPECTIVELY.

DIFFERENCE IN REFLECTANCE DUE TO COVER TYPE

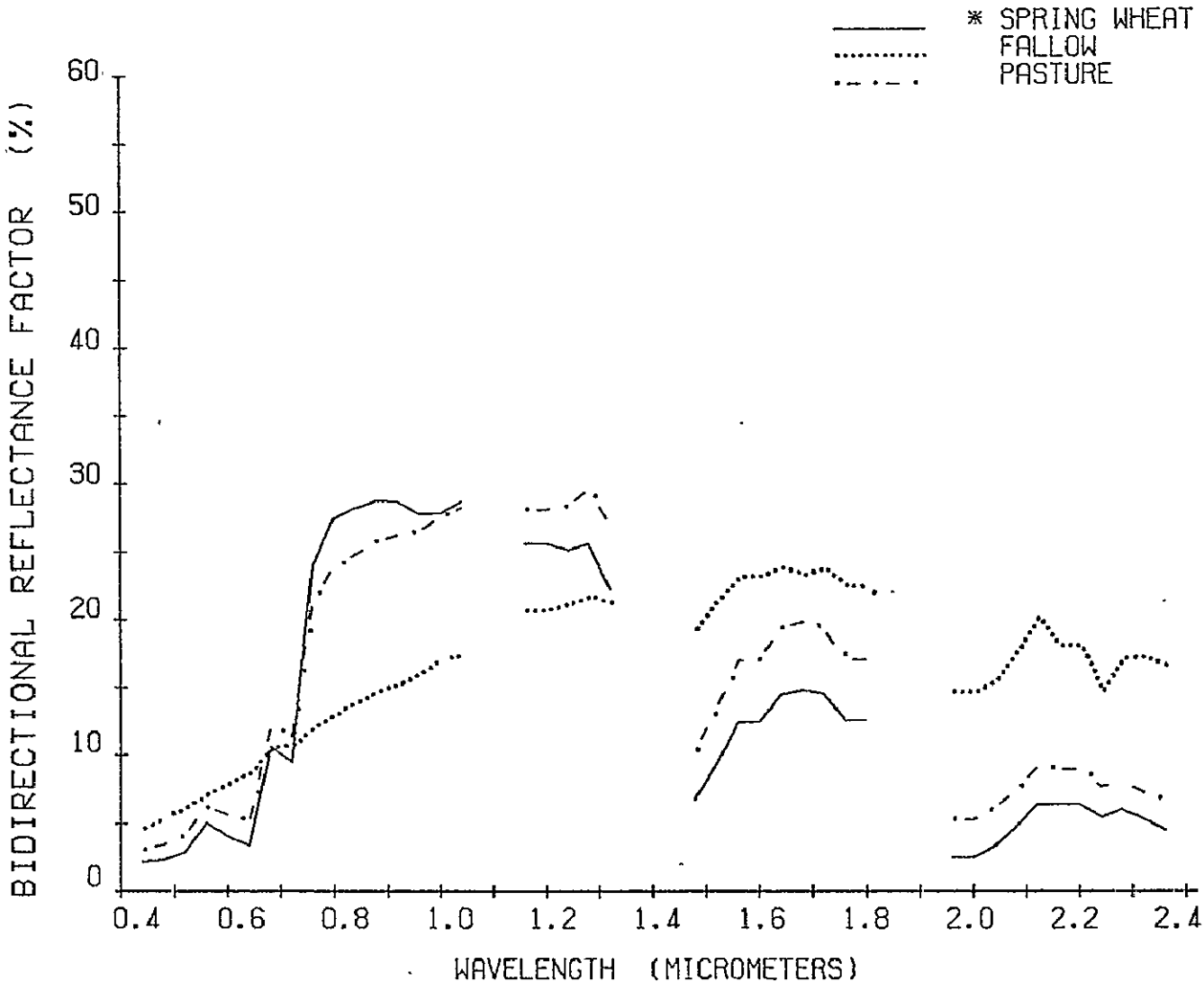
LOCATION: WILLIAMS COUNTY, NORTH DAKOTA
SENSOR: FSS DATE: MAY 28, 1976



* AVERAGES OF 9, 10, AND 6 FIELDS, RESPECTIVELY.

DIFFERENCE IN REFLECTANCE DUE TO COVER TYPE

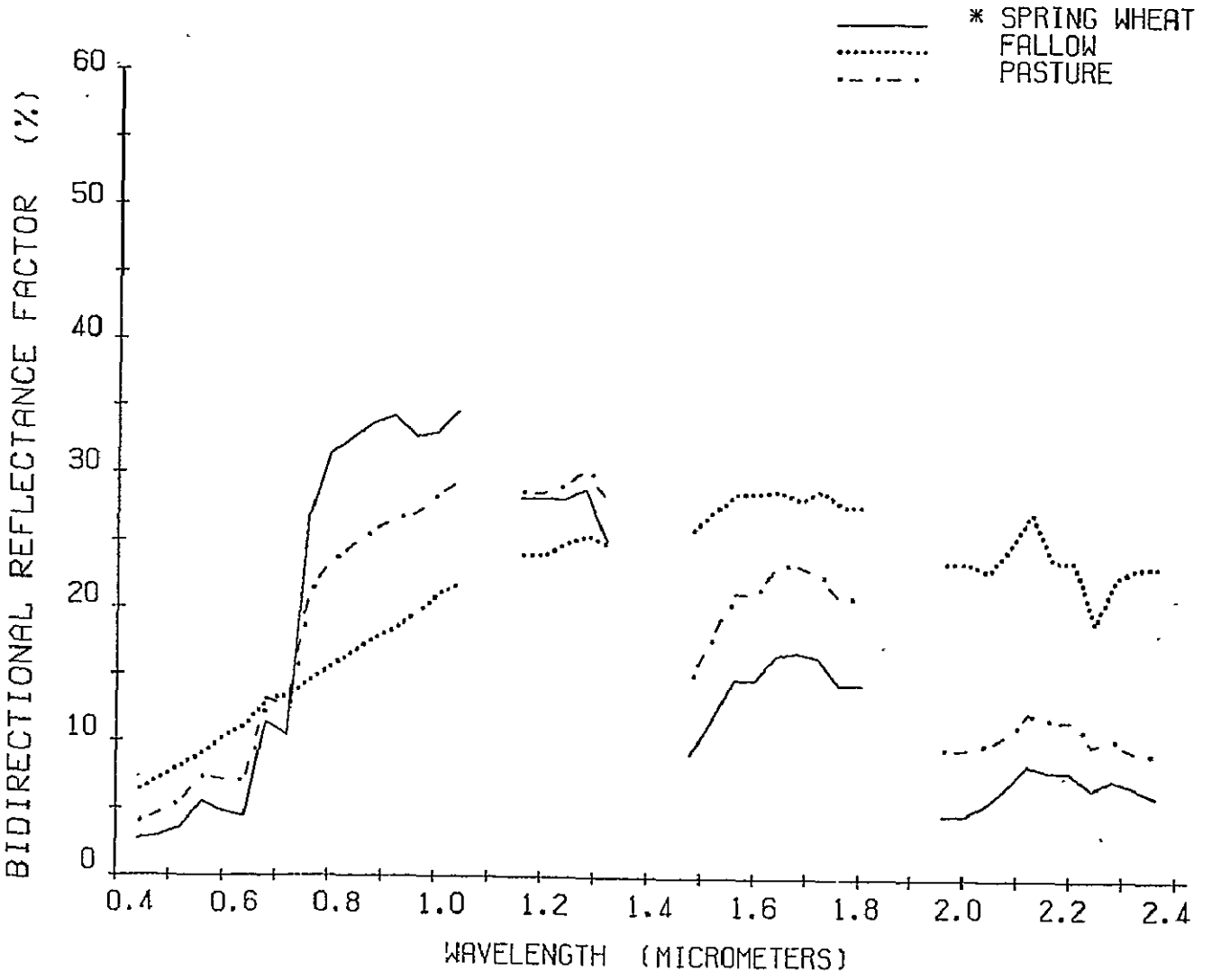
LOCATION: WILLIAMS COUNTY, NORTH DAKOTA
SENSOR: FSS DATE: JUNE 25, 1976



* AVERAGES OF 9, 10, AND 6 FIELDS, RESPECTIVELY.

DIFFERENCE IN REFLECTANCE DUE TO COVER TYPE

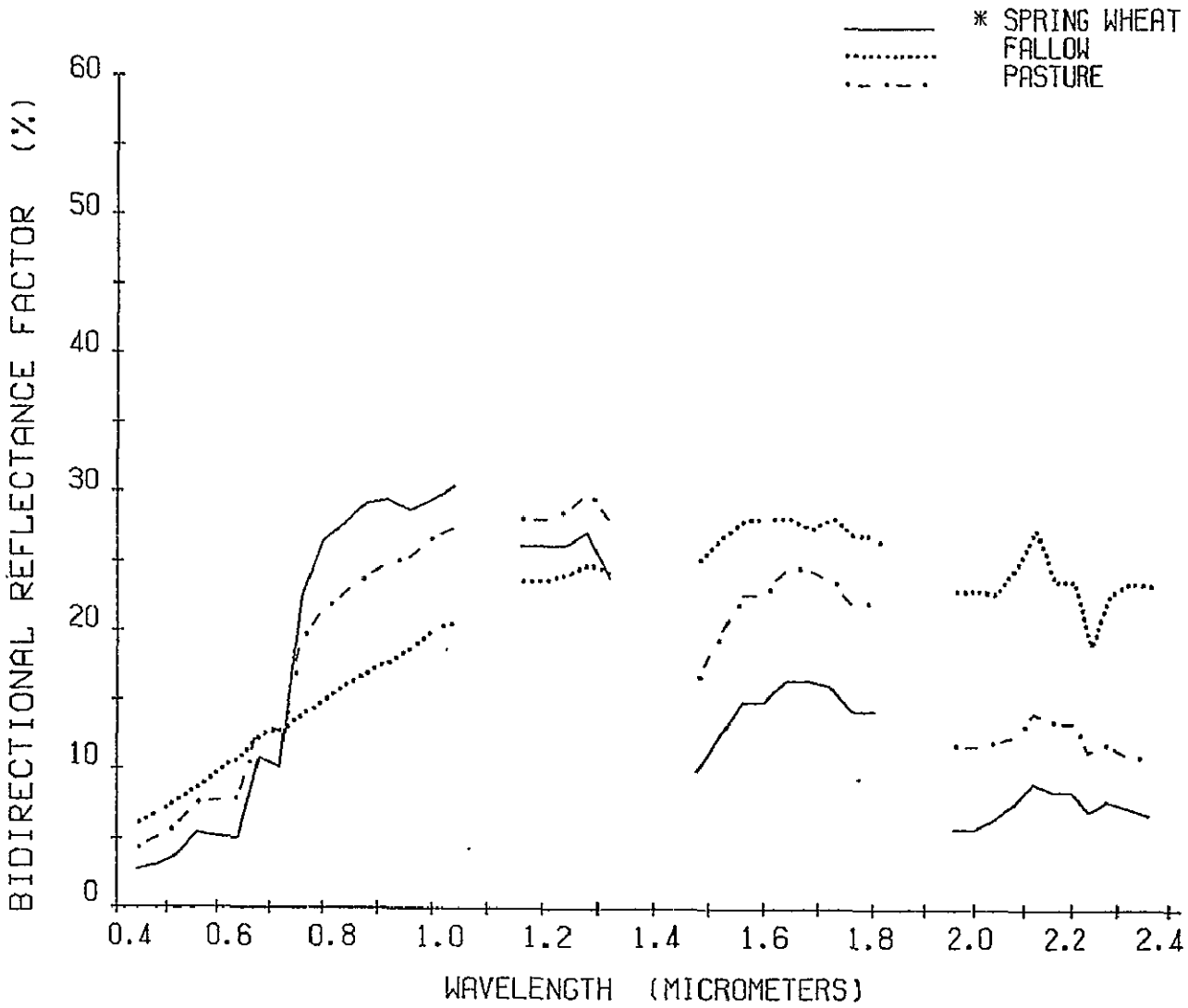
LOCATION: WILLIAMS COUNTY, NORTH DAKOTA
SENSOR: FSS DATE: JULY 6, 1976



* AVERAGES OF 9, 10, AND 6 FIELDS, RESPECTIVELY.

DIFFERENCE IN REFLECTANCE DUE TO COVER TYPE

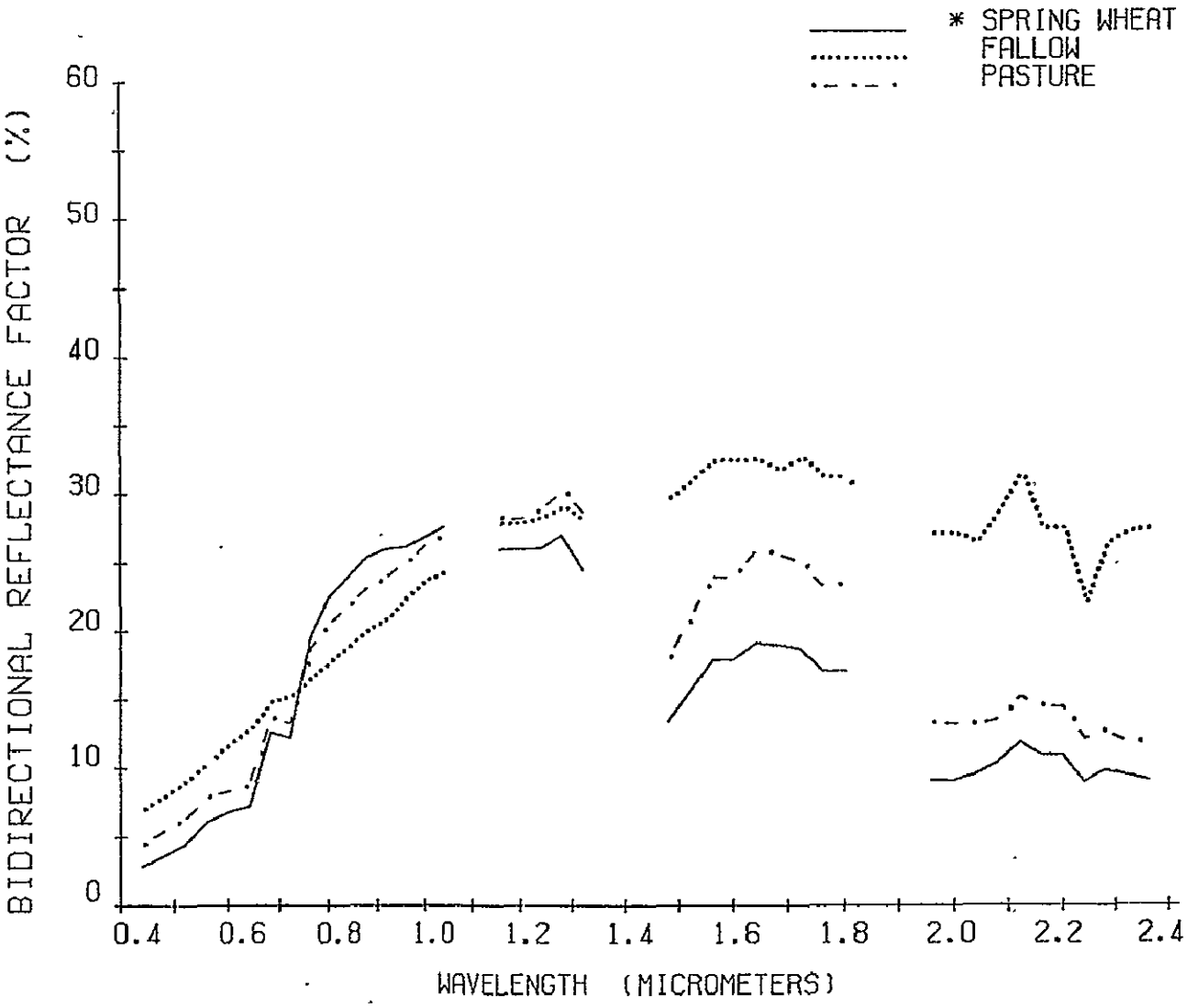
LOCATION: WILLIAMS COUNTY, NORTH DAKOTA
SENSOR: FSS DATE: JULY 20, 1976



* AVERAGES OF 9, 10, AND 6 FIELDS, RESPECTIVELY.

DIFFERENCE IN REFLECTANCE DUE TO COVER TYPE

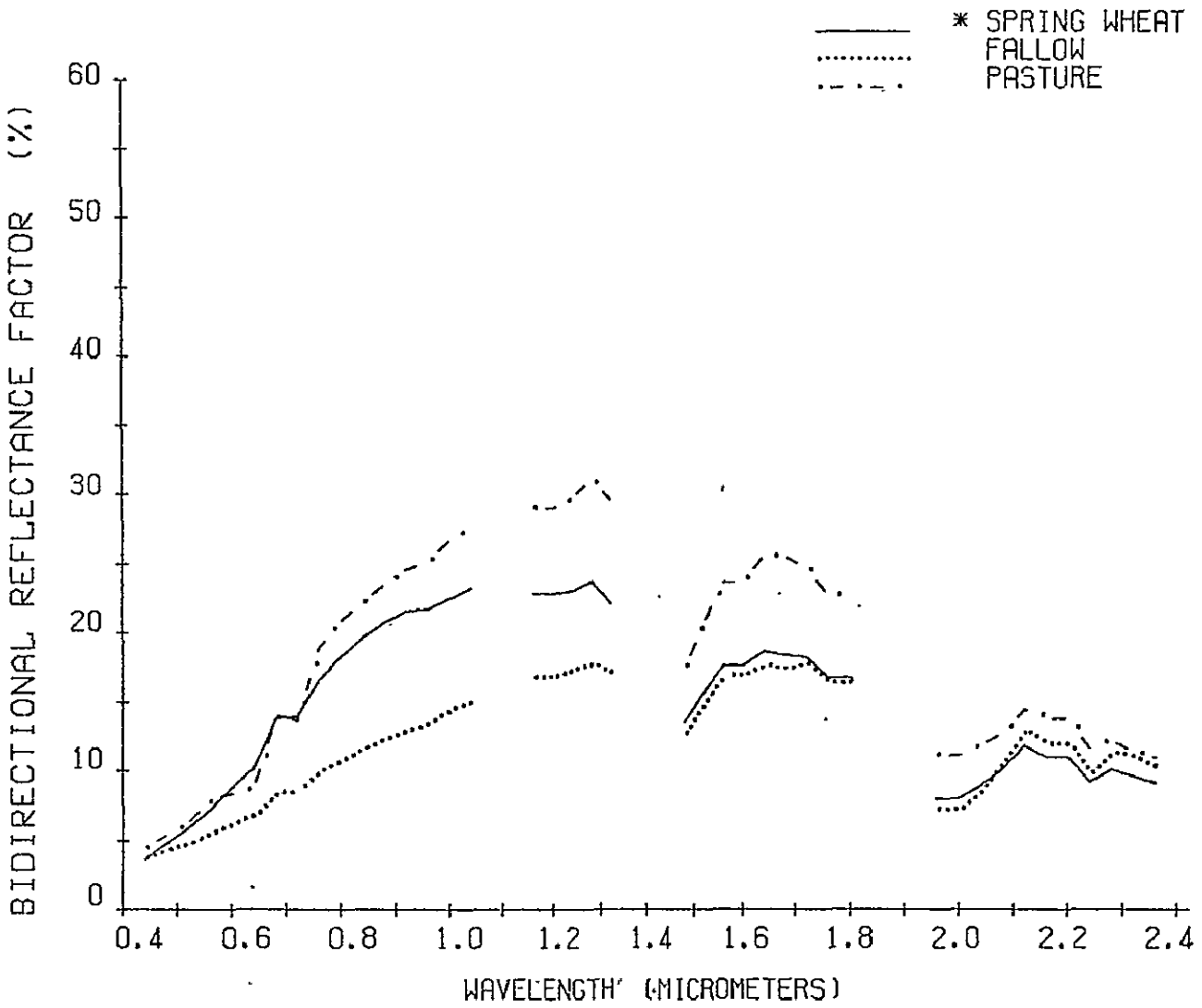
LOCATION: WILLIAMS COUNTY, NORTH DAKOTA
SENSOR: FSS DATE: JULY 28, 1976



* AVERAGES OF 9, 10, AND 6 FIELDS, RESPECTIVELY.

DIFFERENCE IN REFLECTANCE DUE TO COVER TYPE

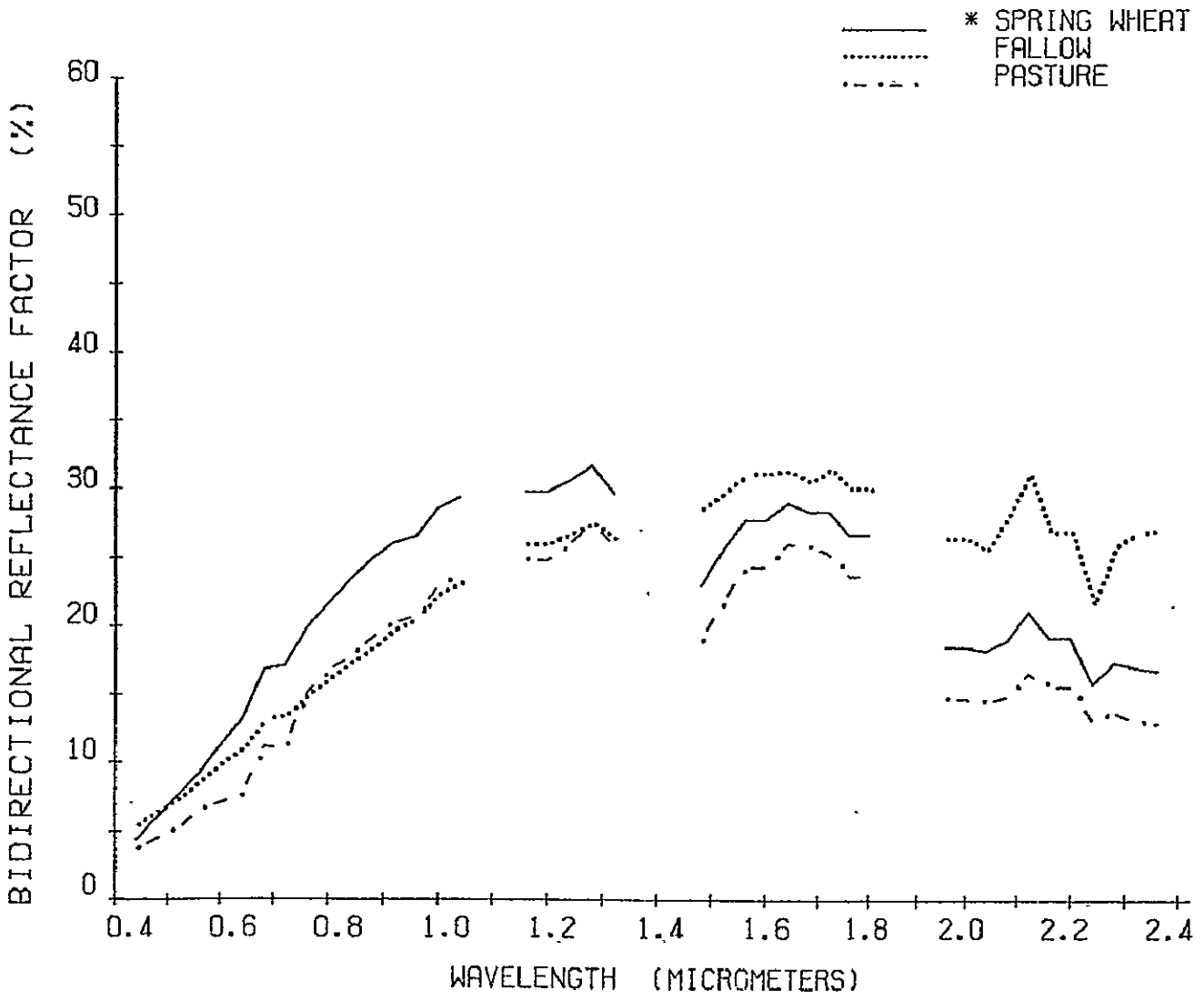
LOCATION: WILLIAMS COUNTY, NORTH DAKOTA
SENSOR: FSS DATE: AUGUST 9, 1976



* AVERAGES OF 9, 10, AND 6 FIELDS, RESPECTIVELY.

DIFFERENCE IN REFLECTANCE DUE TO COVER TYPE

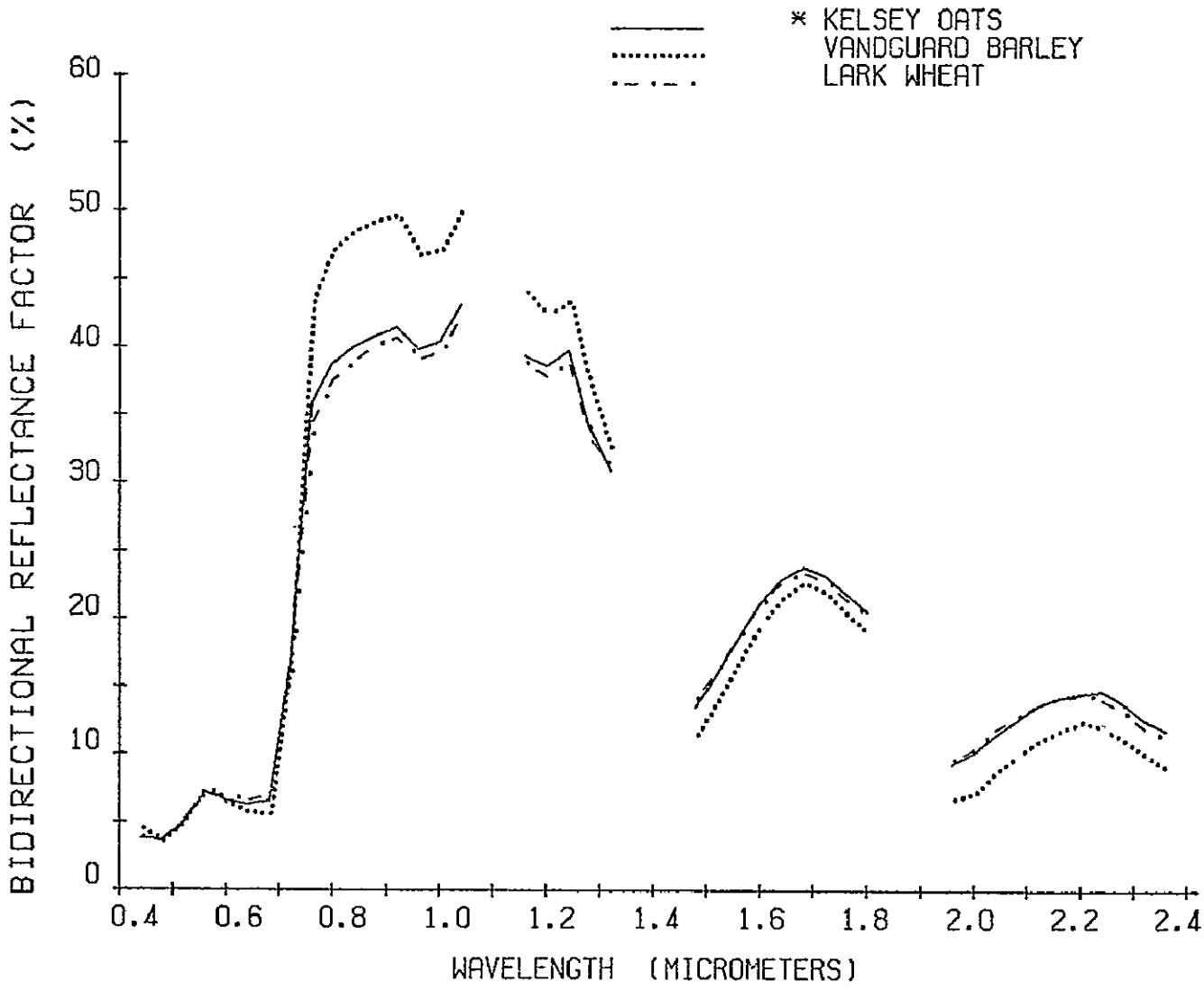
LOCATION: WILLIAMS COUNTY, NORTH DAKOTA
SENSOR: FSS DATE: AUGUST 19, 1976



* AVERAGES OF 9, 10, AND 6 FIELDS, RESPECTIVELY.

REFLECTANCE OF SPRING WHEAT AND OTHER SMALL GRAINS

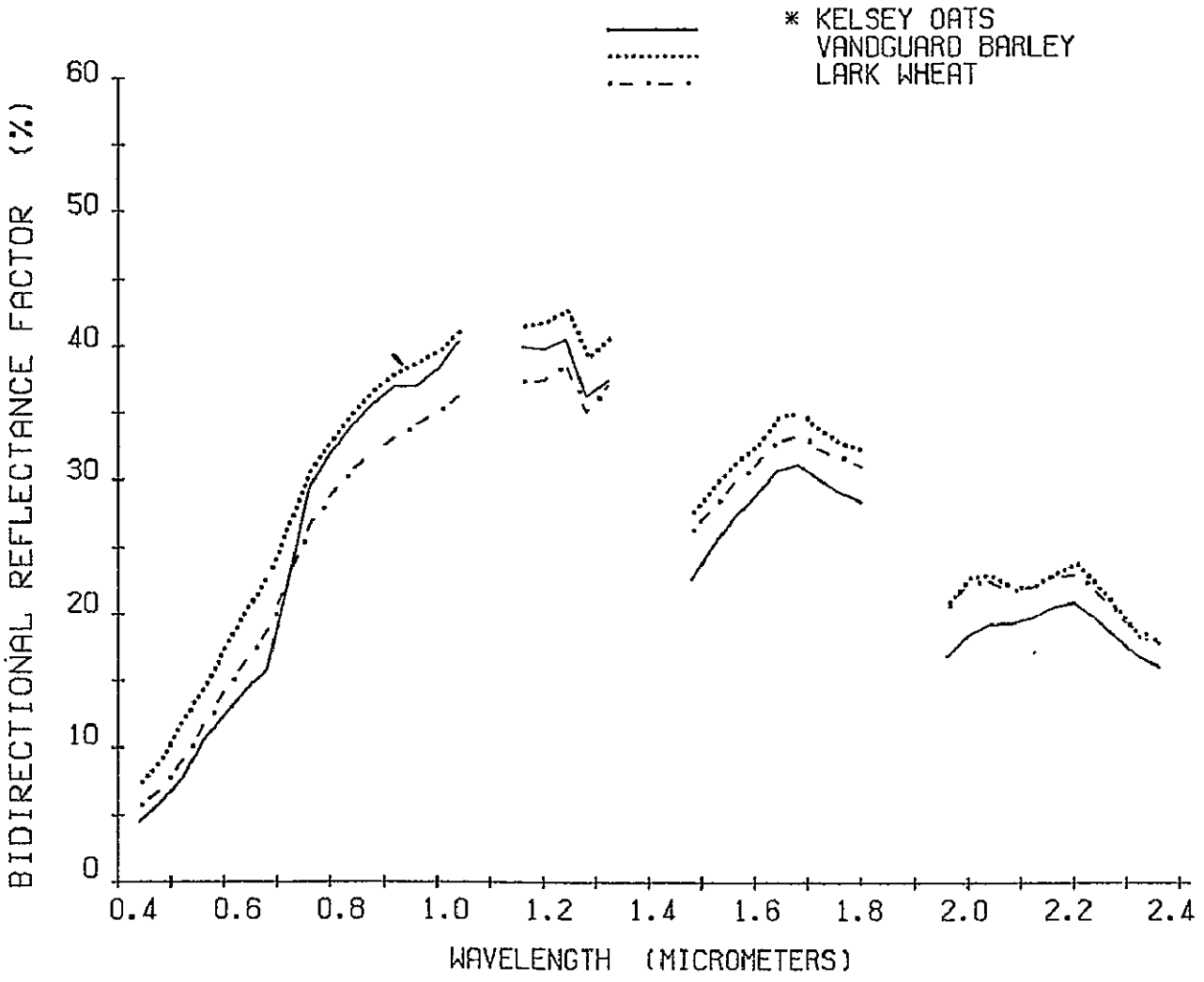
LOCATION: WILLISTON, NORTH DAKOTA
SENSOR: EXOTECH MODEL 20C DATE: JULY 10, 1975



* AVERAGES OF 4 PLOTS.

REFLECTANCE OF SPRING WHEAT AND OTHER SMALL GRAINS

LOCATION: WILLISTON, NORTH DAKOTA
SENSOR: EXOTECH MODEL 20C DATE: AUGUST 12, 1975

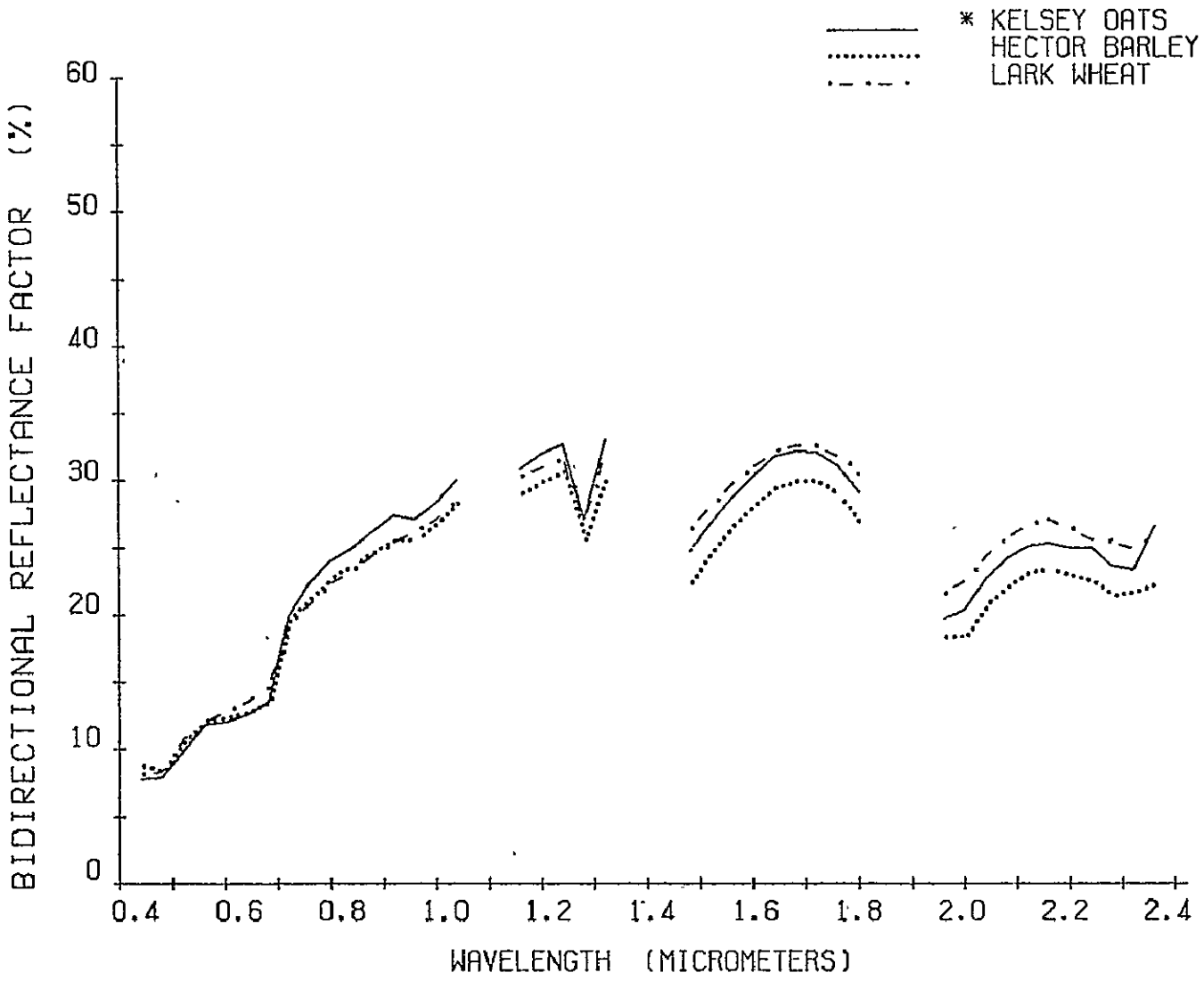


* AVERAGES OF 3 PLOTS.

REFLECTANCE OF SPRING WHEAT AND OTHER SMALL GRAINS

LOCATION: WILLISTON, NORTH DAKOTA.

SENSOR: EXOTECH MODEL 20C DATE: JUNE 4, 1976

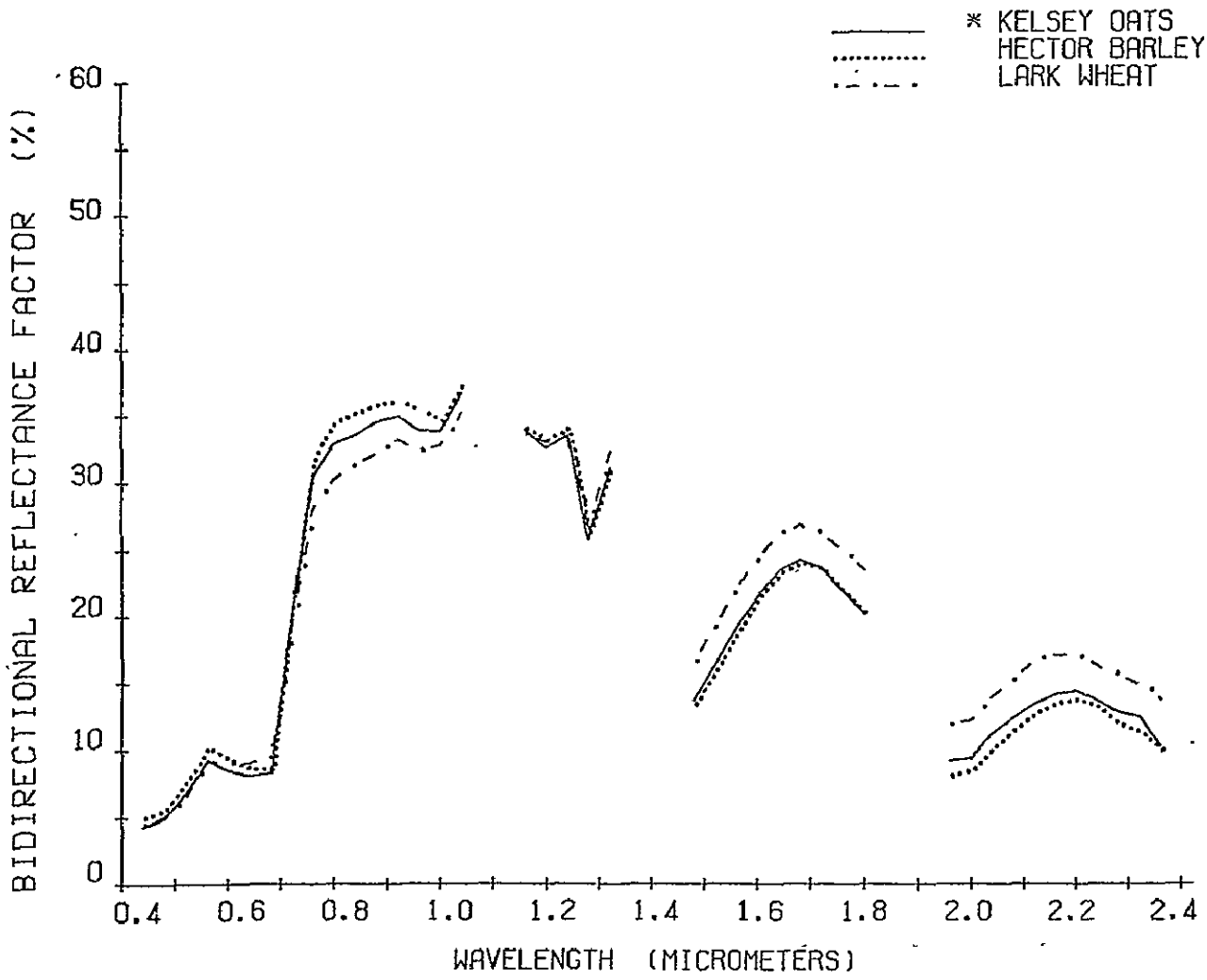


* AVERAGES OF 4 PLOTS.

REFLECTANCE OF SPRING WHEAT AND OTHER SMALL GRAINS

LOCATION: WILLISTON, NORTH DAKOTA

SENSOR: EXOTECH MODEL 20C DATE: JUNE 18, 1976

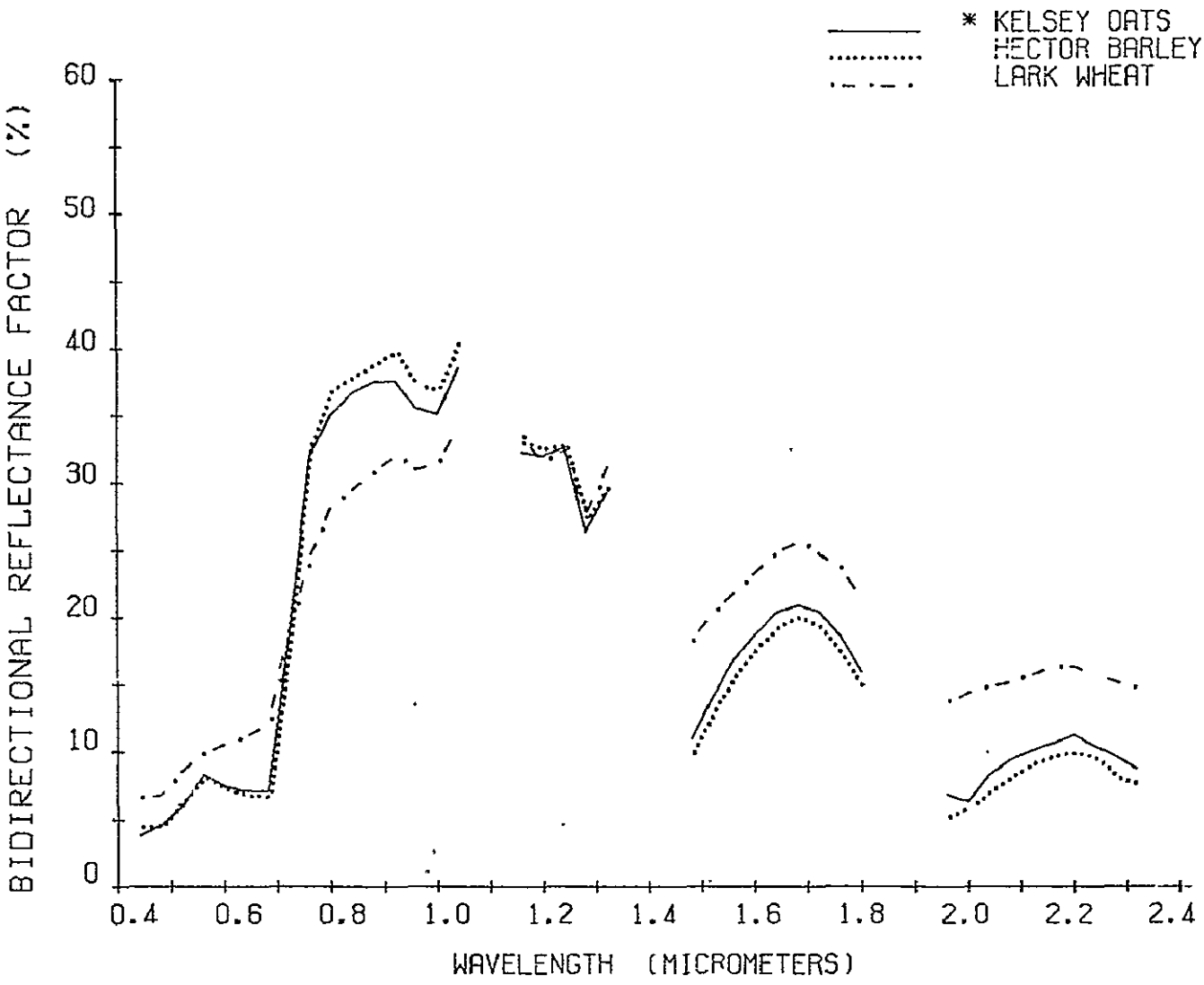


* AVERAGES OF 4 PLOTS.

REFLECTANCE OF SPRING WHEAT AND OTHER SMALL GRAINS

LOCATION: WILLISTON, NORTH DAKOTA

SENSOR: EXOTECH MODEL 20C DATE: JULY 8, 1976

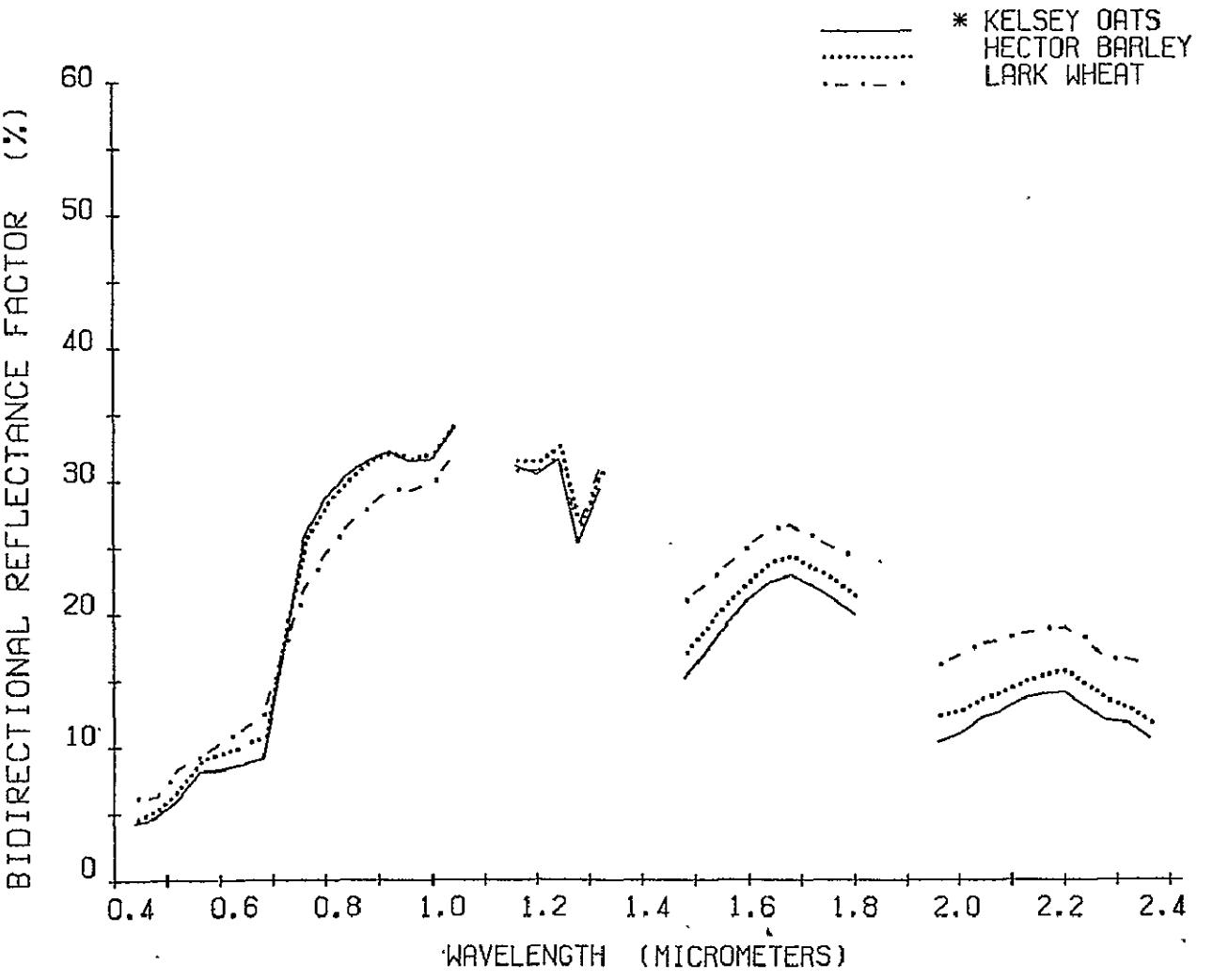


* AVERAGES OF 3 PLOTS.

REFLECTANCE OF SPRING WHEAT AND OTHER SMALL GRAINS.

LOCATION: WILLISTON, NORTH DAKOTA

SENSOR: EXOTECH MODEL 20C DATE: JULY 16, 1976

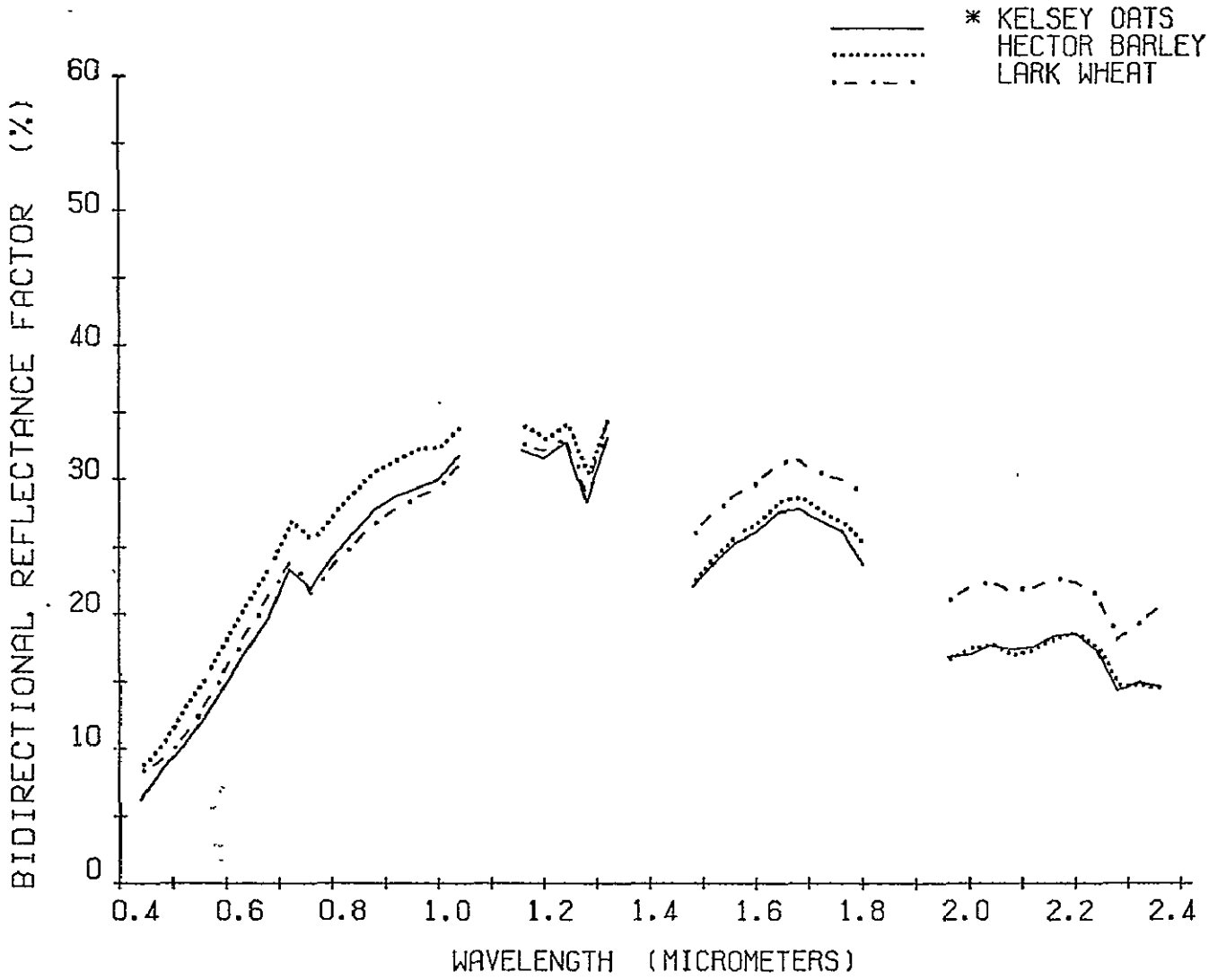


* AVERAGES OF 3 PLOTS.

REFLECTANCE OF SPRING WHEAT AND OTHER SMALL GRAINS

LOCATION: WILLISTON, NORTH DAKOTA

SENSOR: EXOTECH MODEL 20C DATE: AUGUST 6, 1976



* AVERAGES OF 4 PLOTS.

IV. South Dakota Spring and Winter Wheat Examples

A. Variation Within Spring and Winter Wheat

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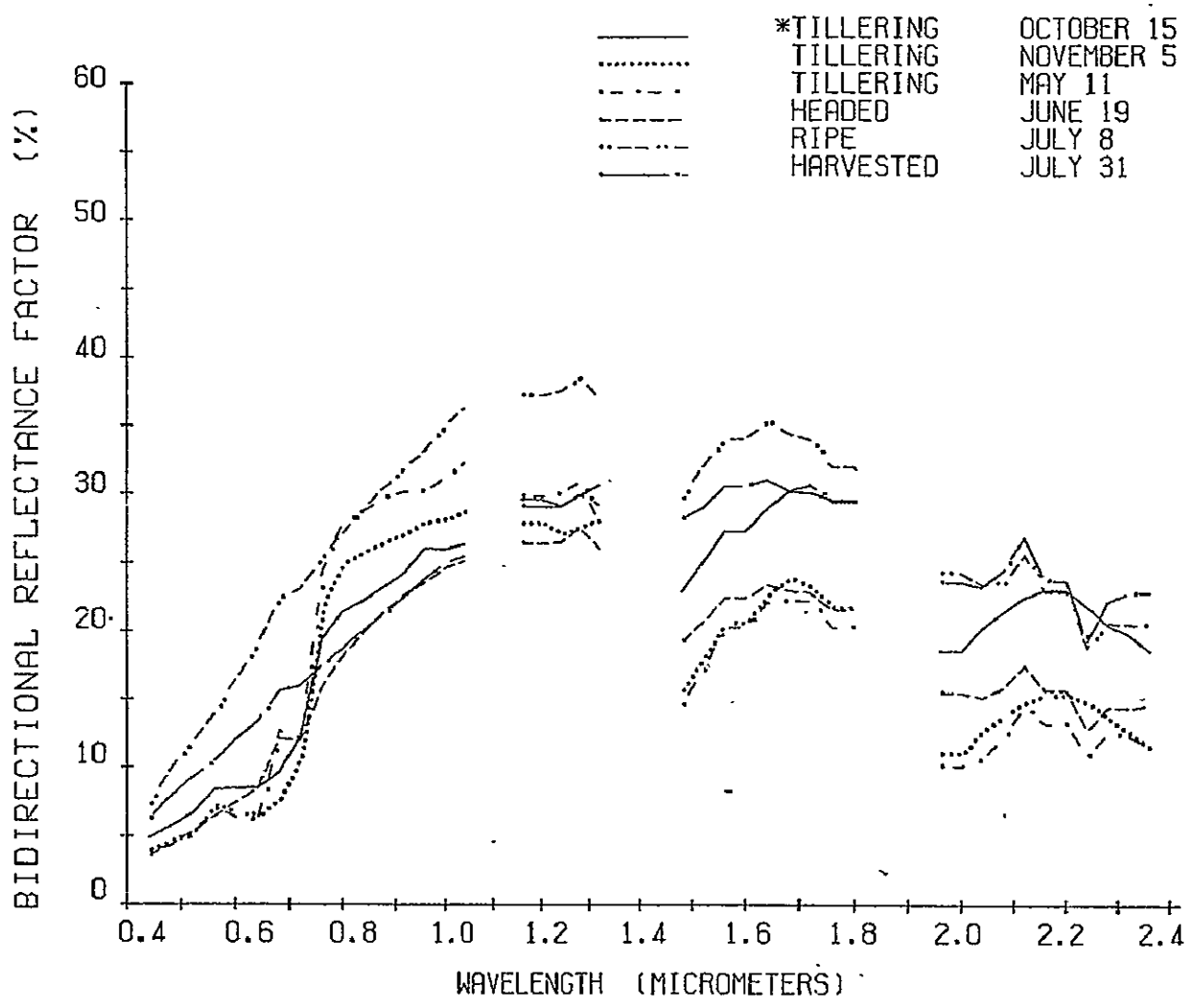
REFLECTANCE OF WINTER WHEAT AT DIFFERENT MATURITY STAGES

LOCATION: HAND COUNTY, SOUTH DAKOTA
SENSOR: FSS DATE: 1975-76



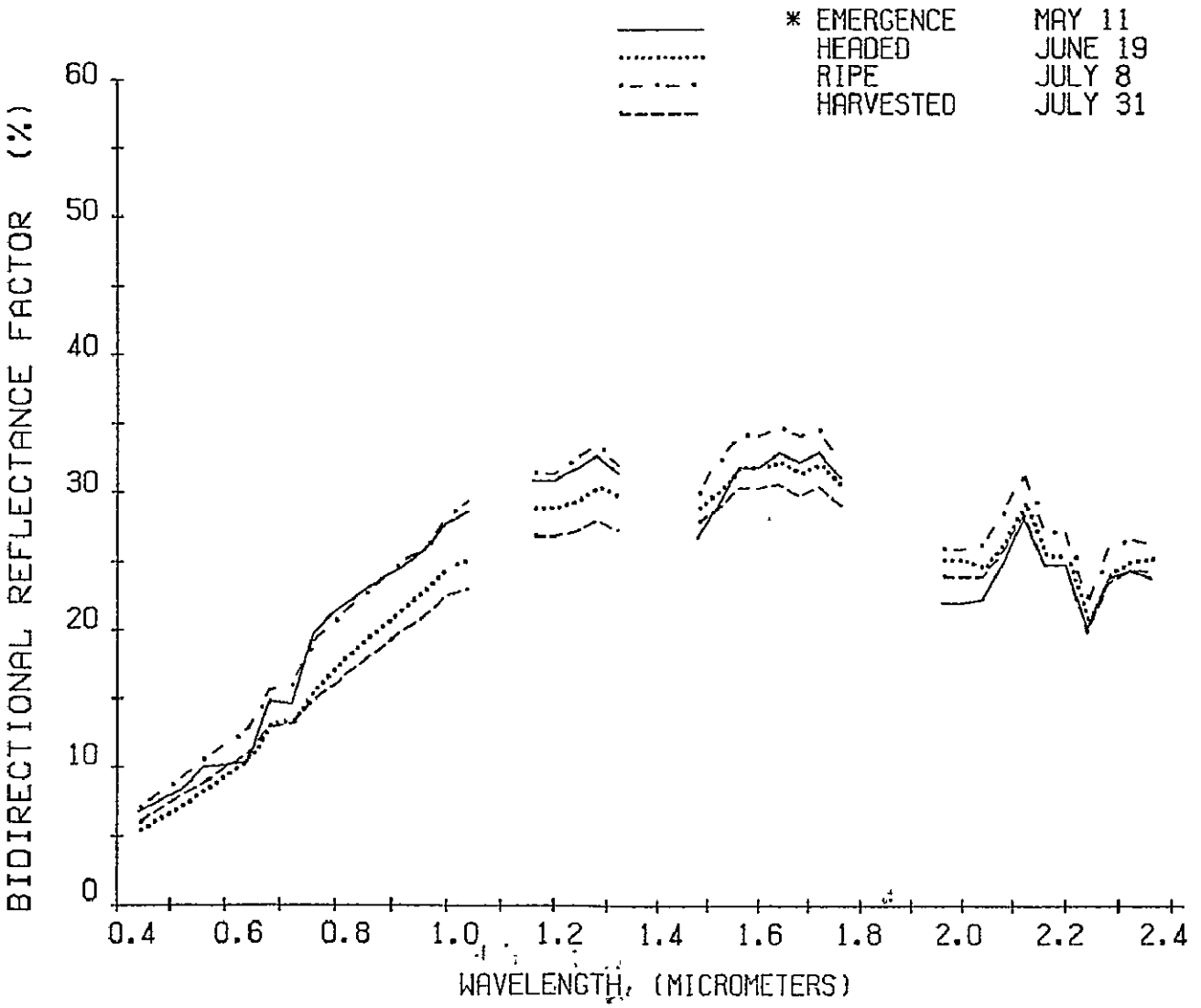
ORIGINAL PAGE IS
OF POOR QUALITY

* AVERAGE OF 10 FIELDS.

159, 160 ?
PAGE INTENTIONALLY BLANK

REFLECTANCE OF SPRING WHEAT AT DIFFERENT MATURITY STAGES

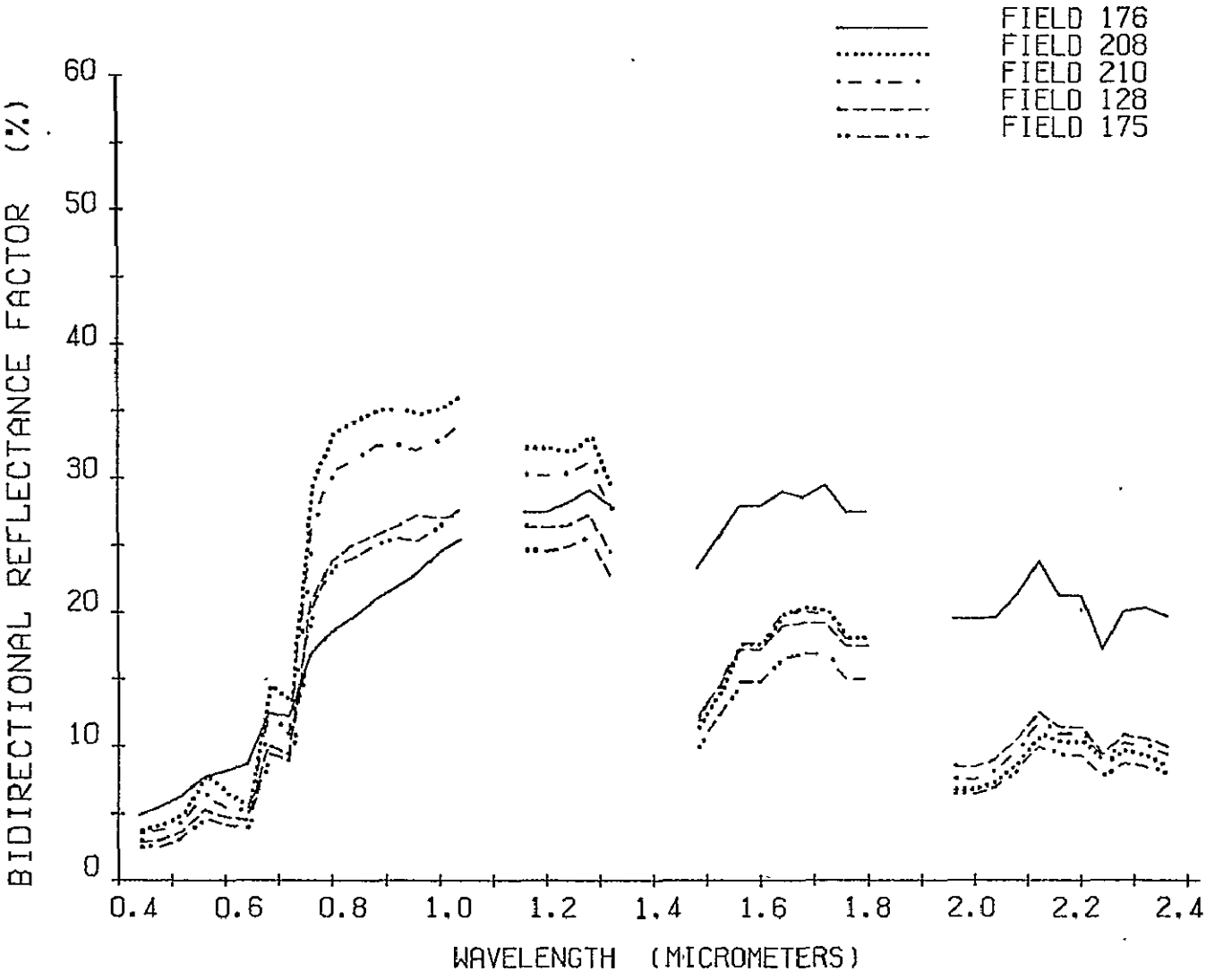
LOCATION: HAND COUNTY, SOUTH DAKOTA
SENSOR: FSS DATE: 1976



* AVERAGE OF 4 FIELDS.

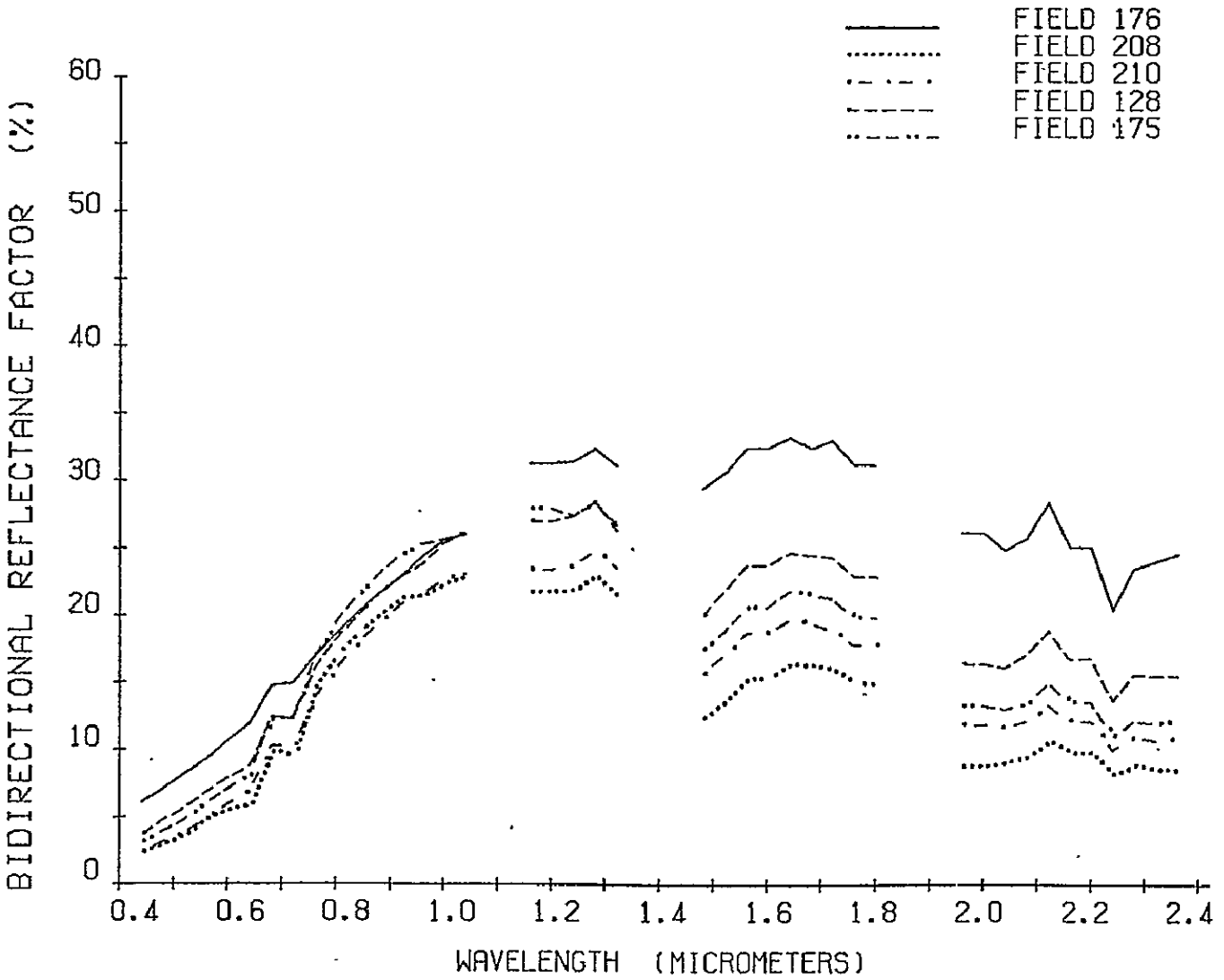
VARIABILITY IN REFLECTANCE AMONG WINTER WHEAT FIELDS

LOCATION: HAND COUNTY, SOUTH DAKOTA
SENSOR: FSS DATE: MAY 11, 1976



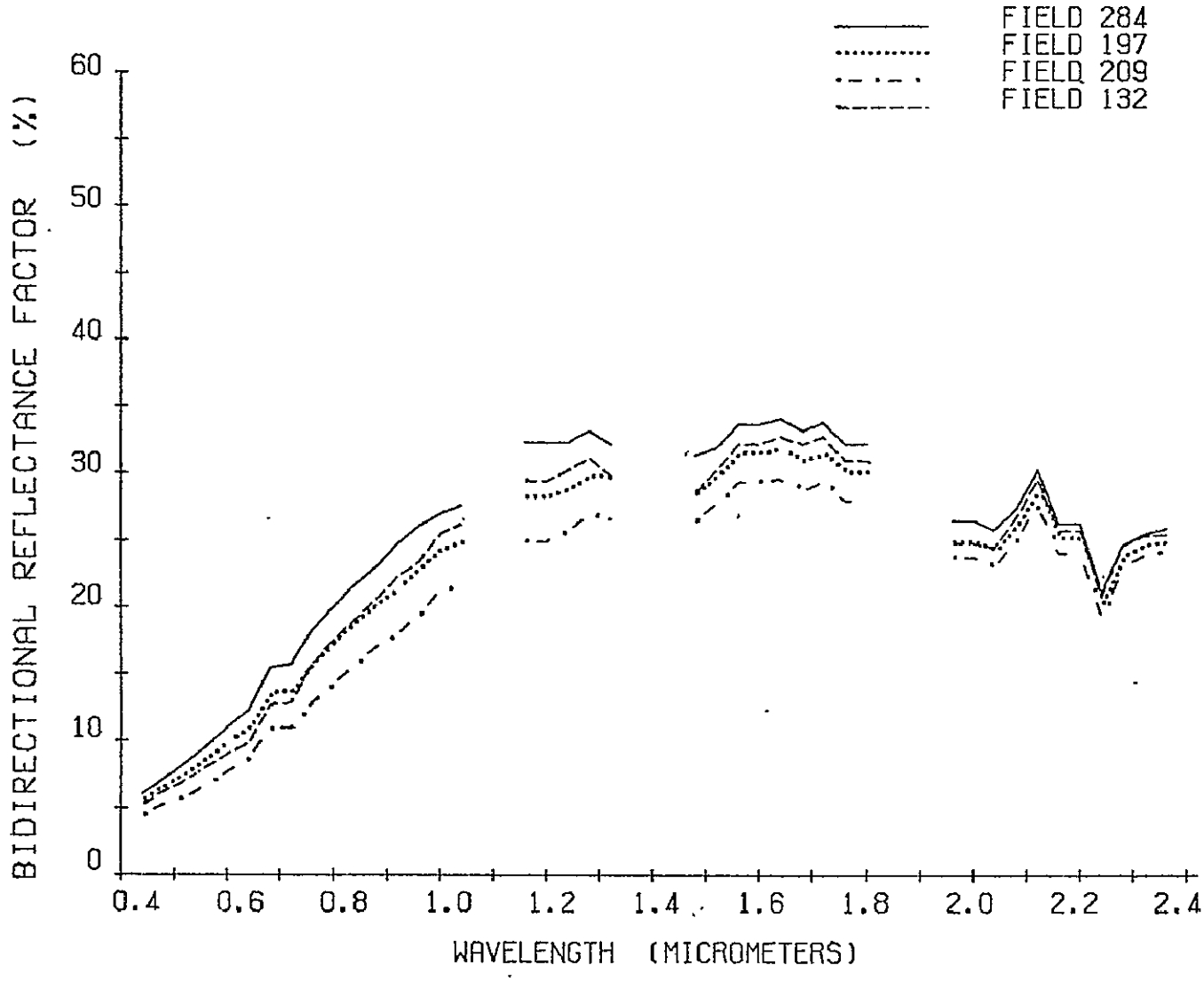
VARIABILITY IN REFLECTANCE AMONG WINTER WHEAT FIELDS

LOCATION: HAND COUNTY, SOUTH DAKOTA
SENSOR: FSS DATE: JUNE 19, 1976



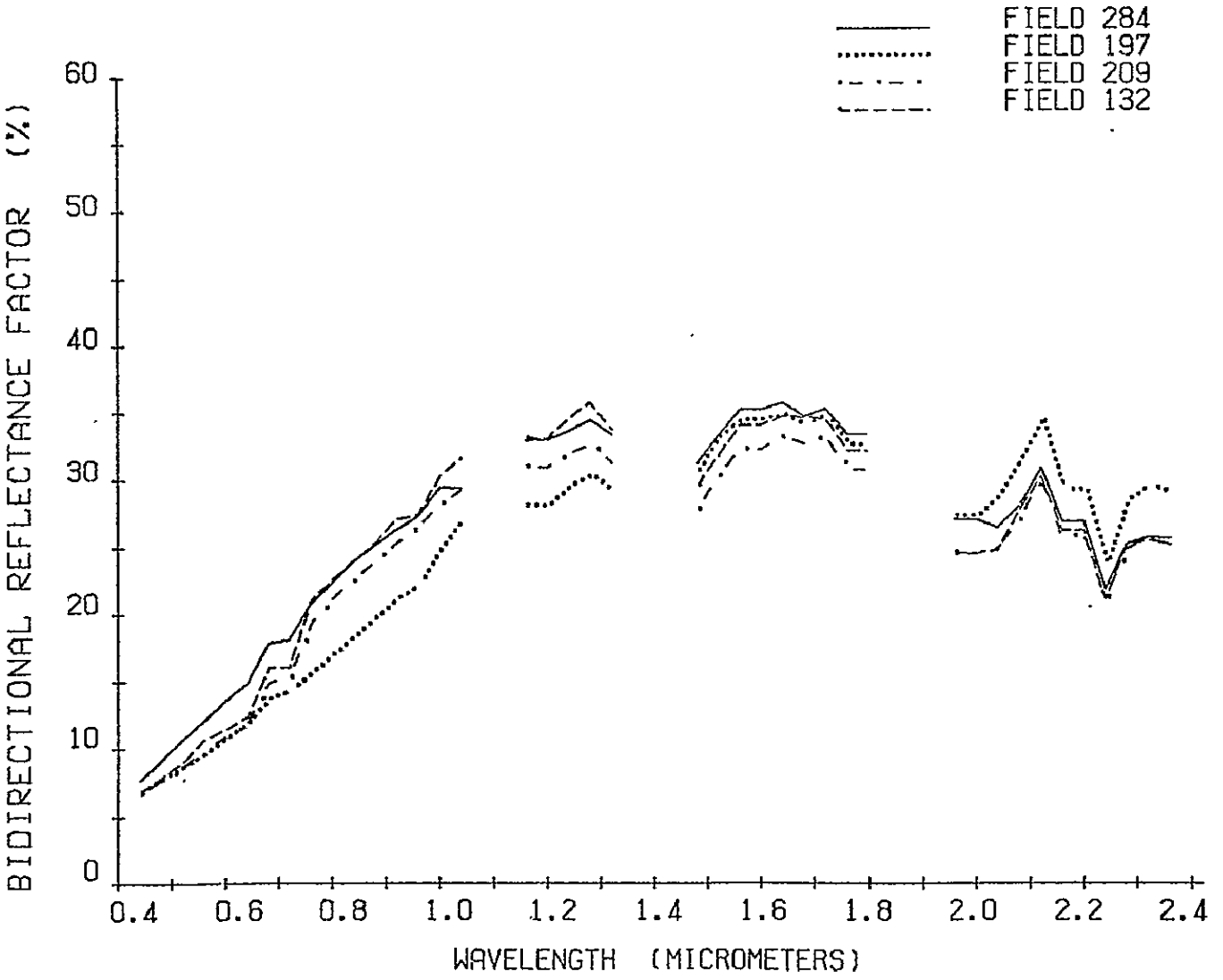
VARIABILITY IN REFLECTANCE AMONG SPRING WHEAT FIELDS

LOCATION: HAND COUNTY, SOUTH DAKOTA
SENSOR: FSS DATE: JUNE 19, 1976



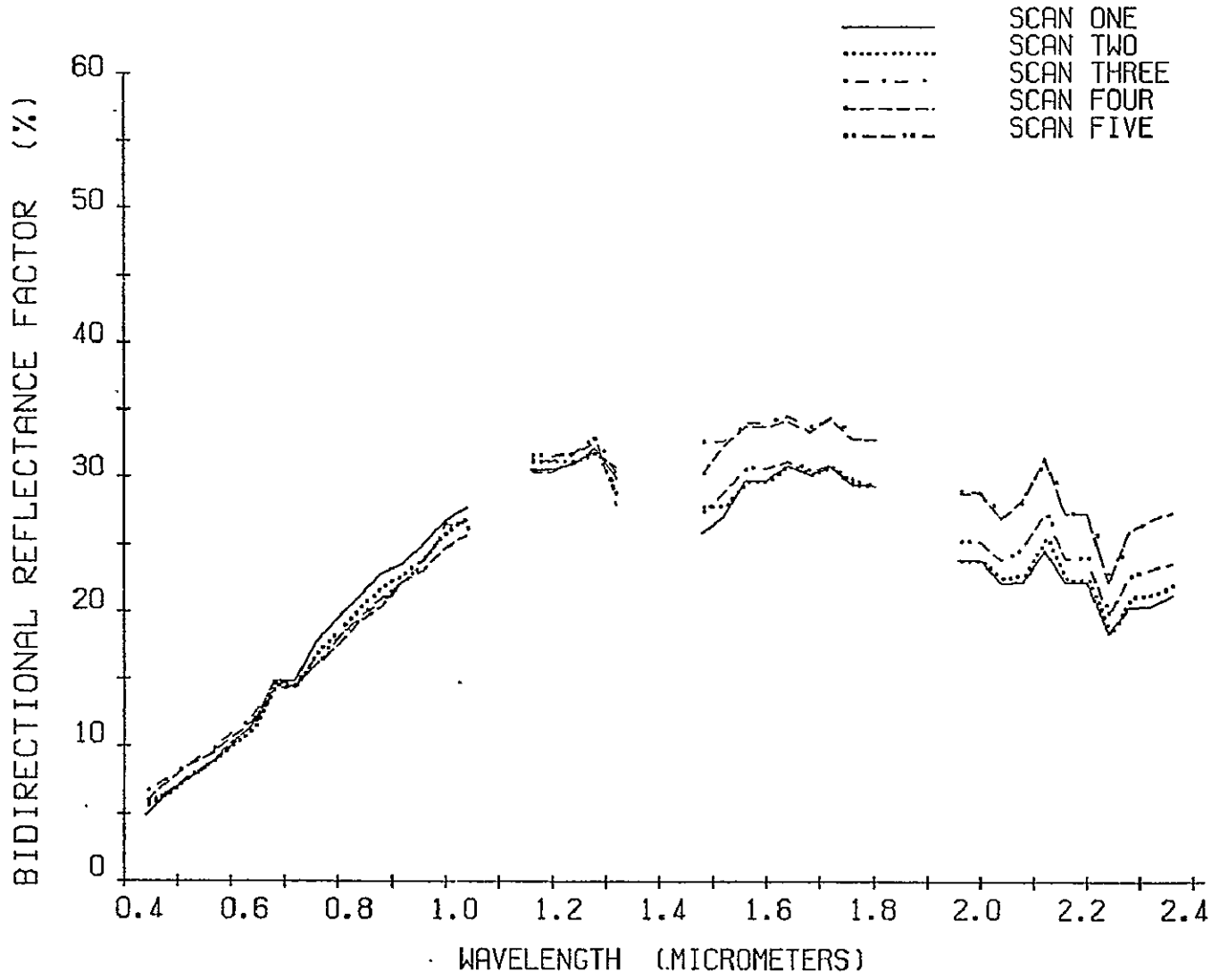
VARIABILITY IN REFLECTANCE AMONG SPRING WHEAT FIELDS

LOCATION: HAND COUNTY, SOUTH DAKOTA
SENSOR: FSS DATE: JULY 8, 1976



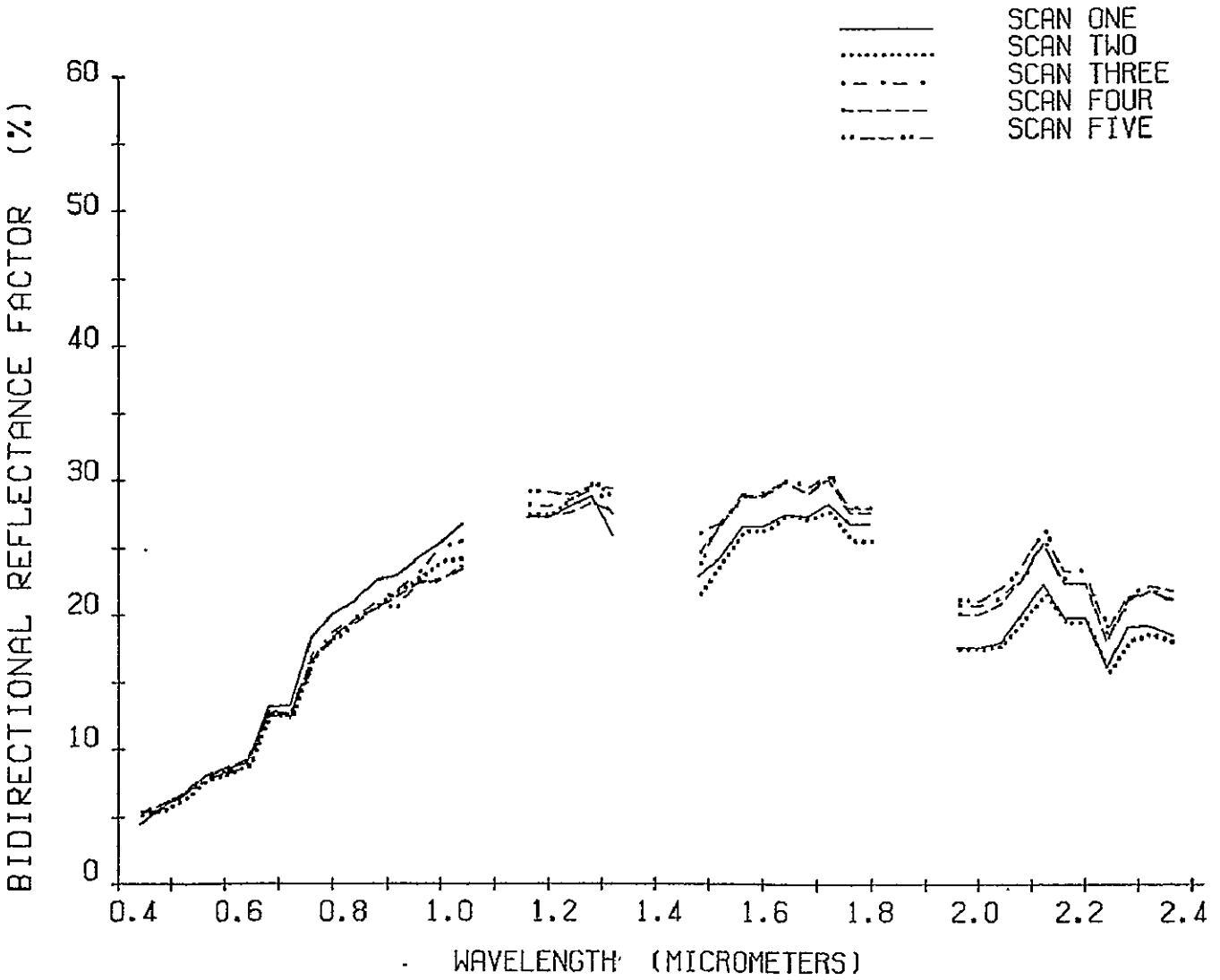
VARIABILITY IN REFLECTANCE WITHIN A WINTER WHEAT FIELD

LOCATION: HAND COUNTY, SOUTH DAKOTA
SENSOR: FSS DATE: MAY 11, 1976
FIELD: 176



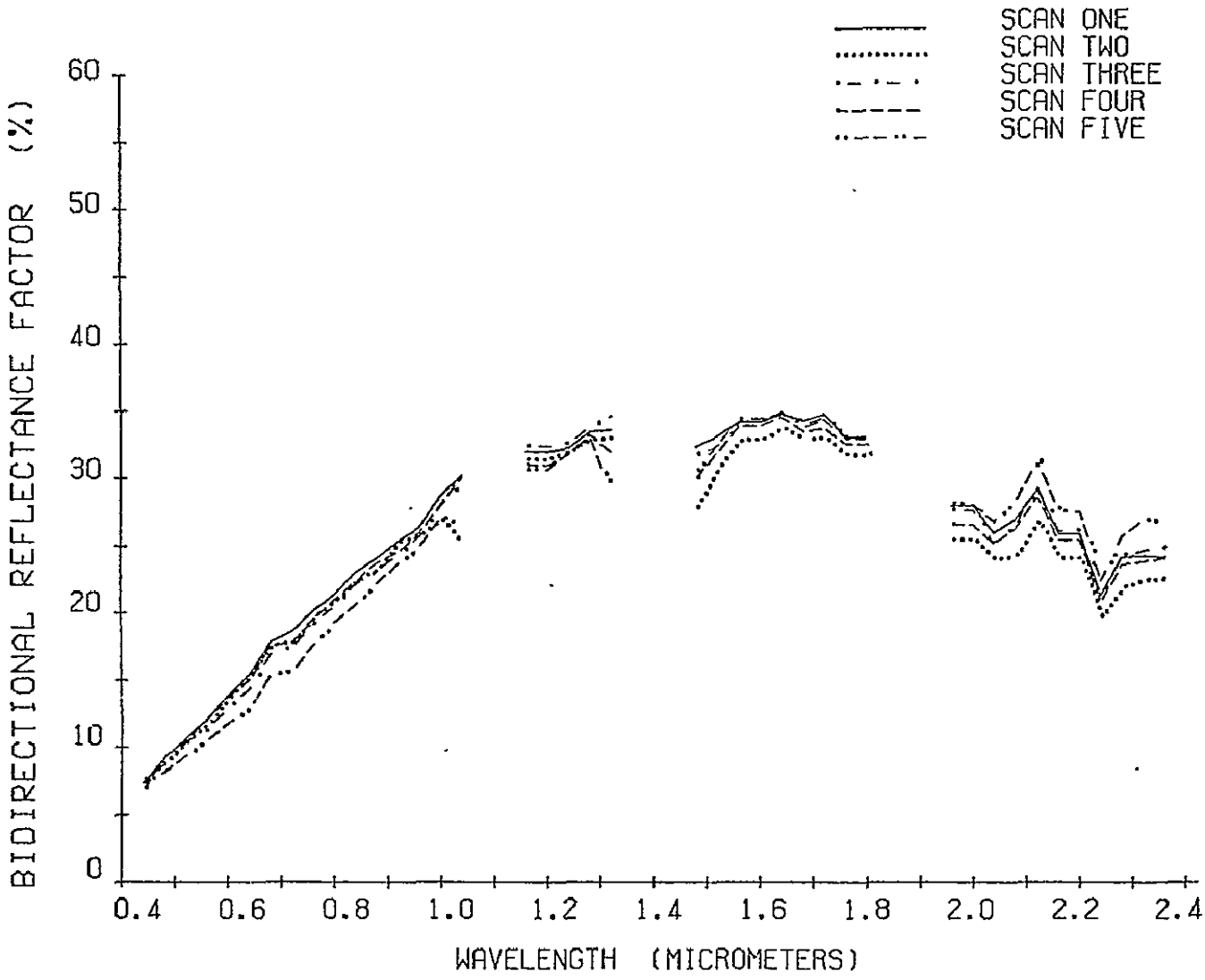
VARIABILITY IN REFLECTANCE WITHIN A WINTER WHEAT FIELD

LOCATION: HAND COUNTY, SOUTH DAKOTA
SENSOR: FSS DATE: JUNE 19, 1976
FIELD: 176



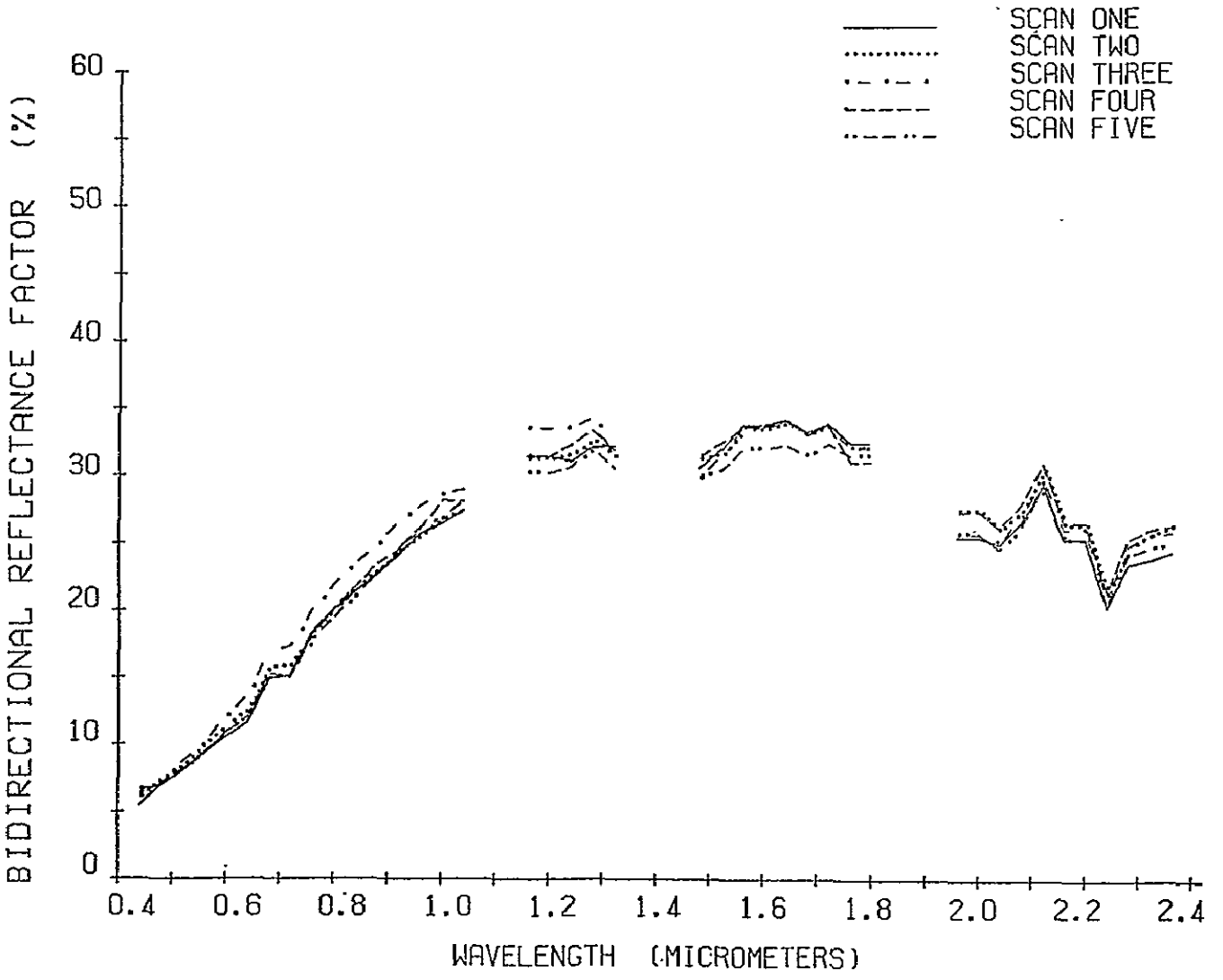
VARIABILITY IN REFLECTANCE WITHIN A WINTER WHEAT FIELD

LOCATION: HAND COUNTY, SOUTH DAKOTA
SENSOR: FSS DATE: JULY 8, 1976
FIELD: 176



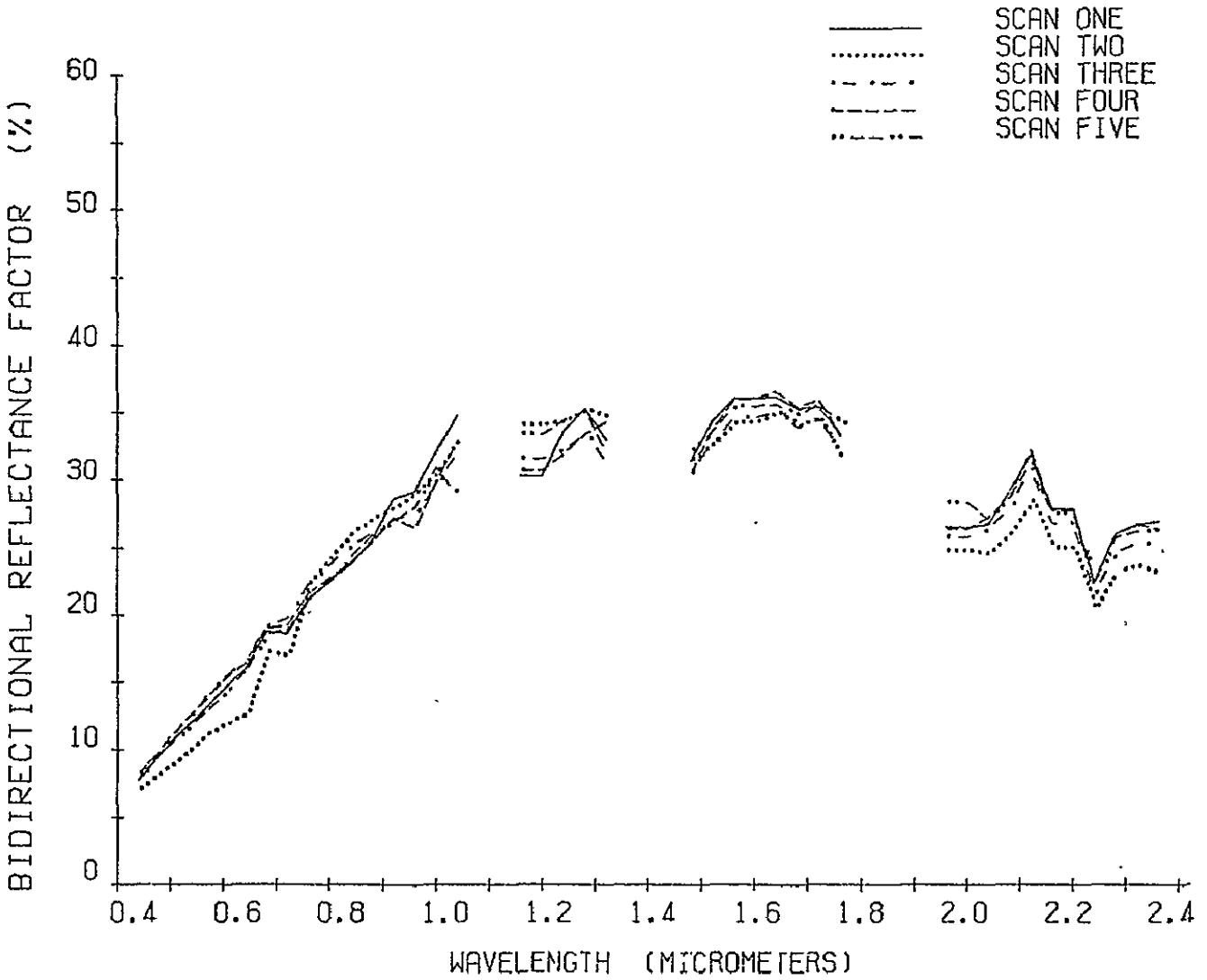
VARIABILITY IN REFLECTANCE WITHIN A SPRING WHEAT FIELD

LOCATION: HAND COUNTY, SOUTH DAKOTA
SENSOR: FSS DATE: MAY 11, 1976
FIELD: 284



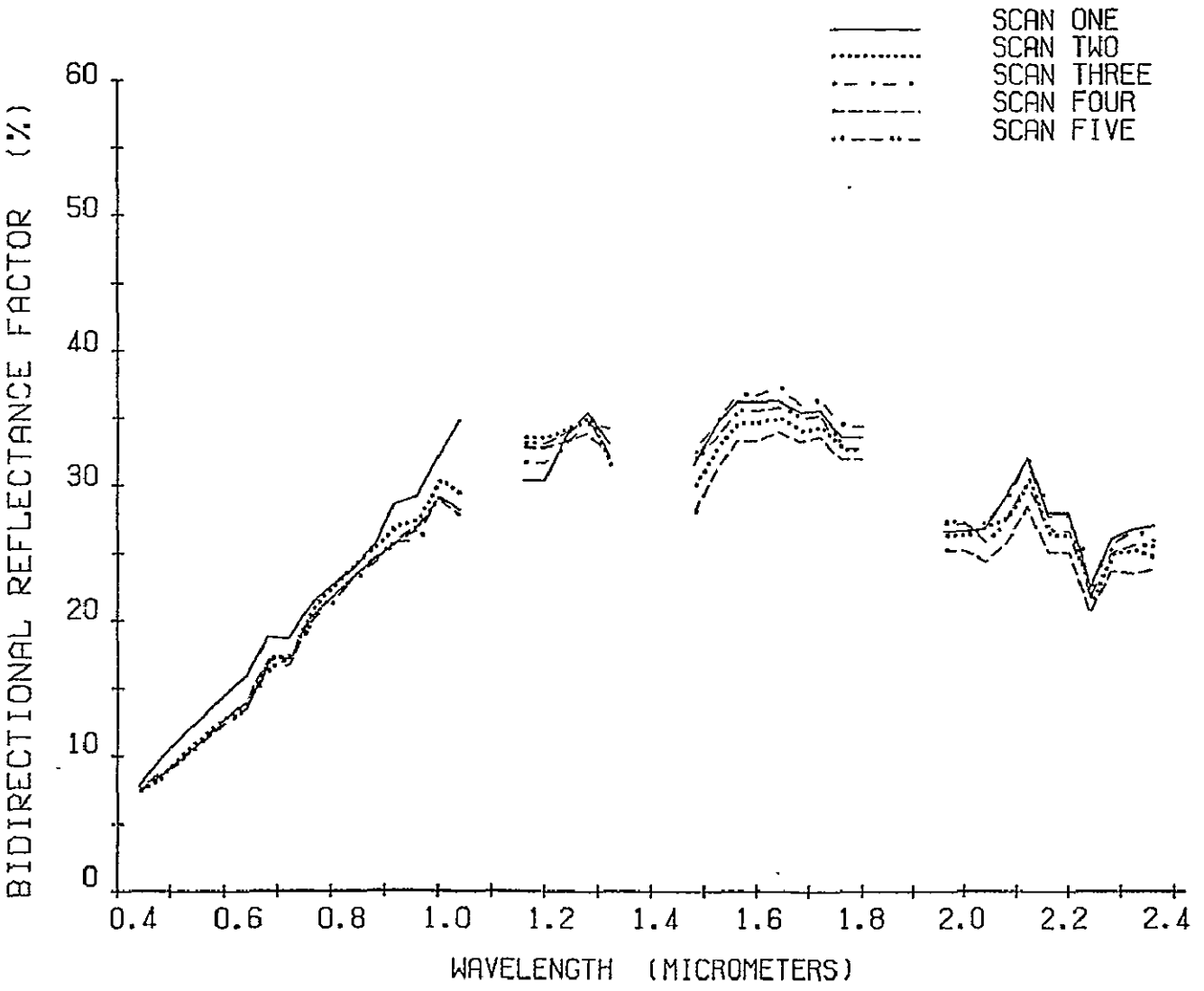
VARIABILITY IN REFLECTANCE WITHIN A SPRING WHEAT FIELD

LOCATION: HAND COUNTY, SOUTH DAKOTA
SENSOR: FSS DATE: JUNE 19, 1976
FIELD: 284



VARIABILITY IN REFLECTANCE WITHIN A SPRING WHEAT FIELD

LOCATION: HAND COUNTY, SOUTH DAKOTA
SENSOR: FSS DATE: JULY 8, 1976
FIELD: 284



IV. South Dakota Spring and Winter Wheat Examples

B. Variation Between Wheat and Other Crops

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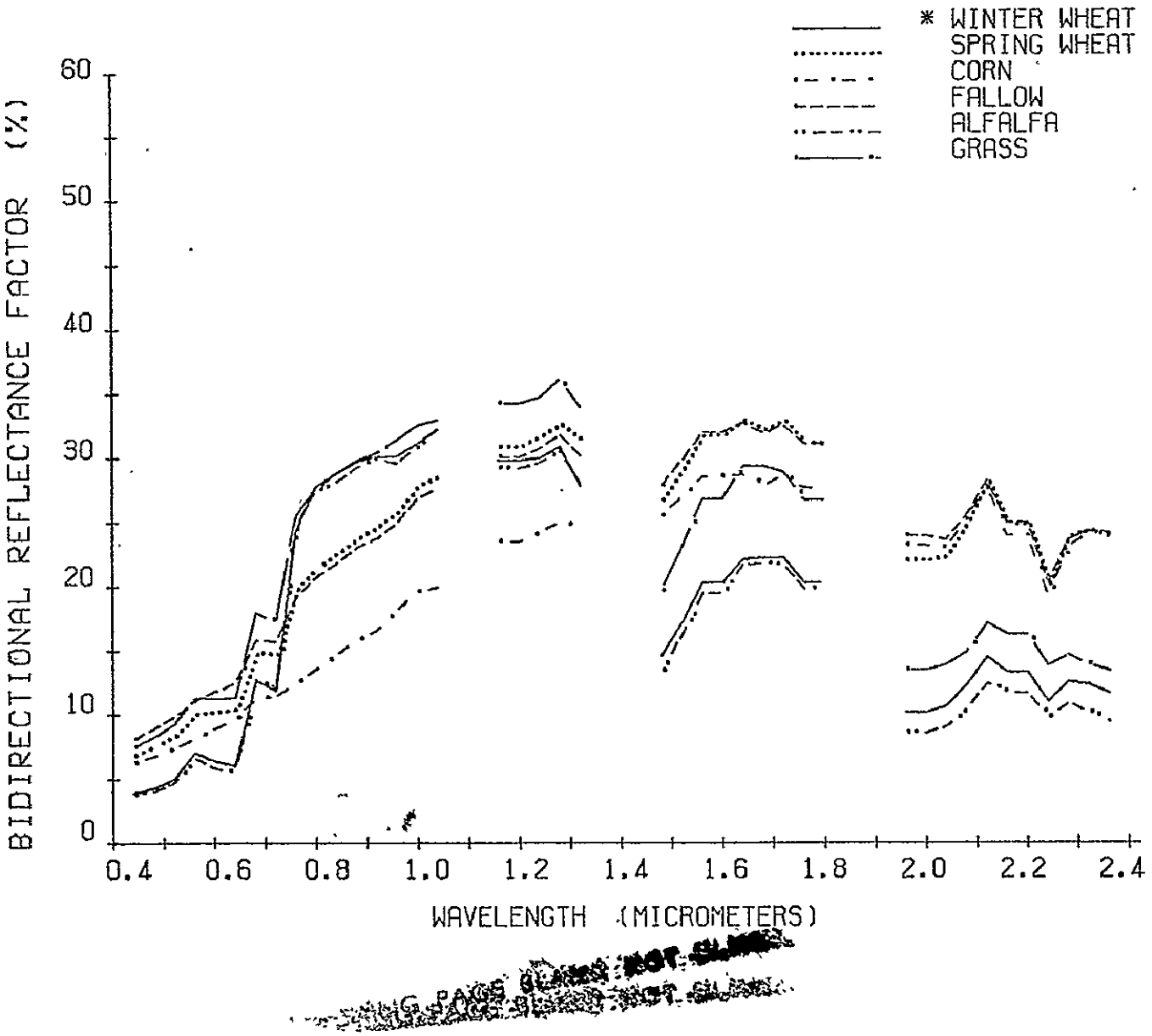
DIFFERENCE IN REFLECTANCE DUE TO COVER TYPE

LOCATION: HAND COUNTY, SOUTH DAKOTA
SENSOR: FSS DATE: MAY 11, 1976



* AVERAGES OF 10, 4, 2, 5, 2, AND 4 FIELDS, RESPECTIVELY.

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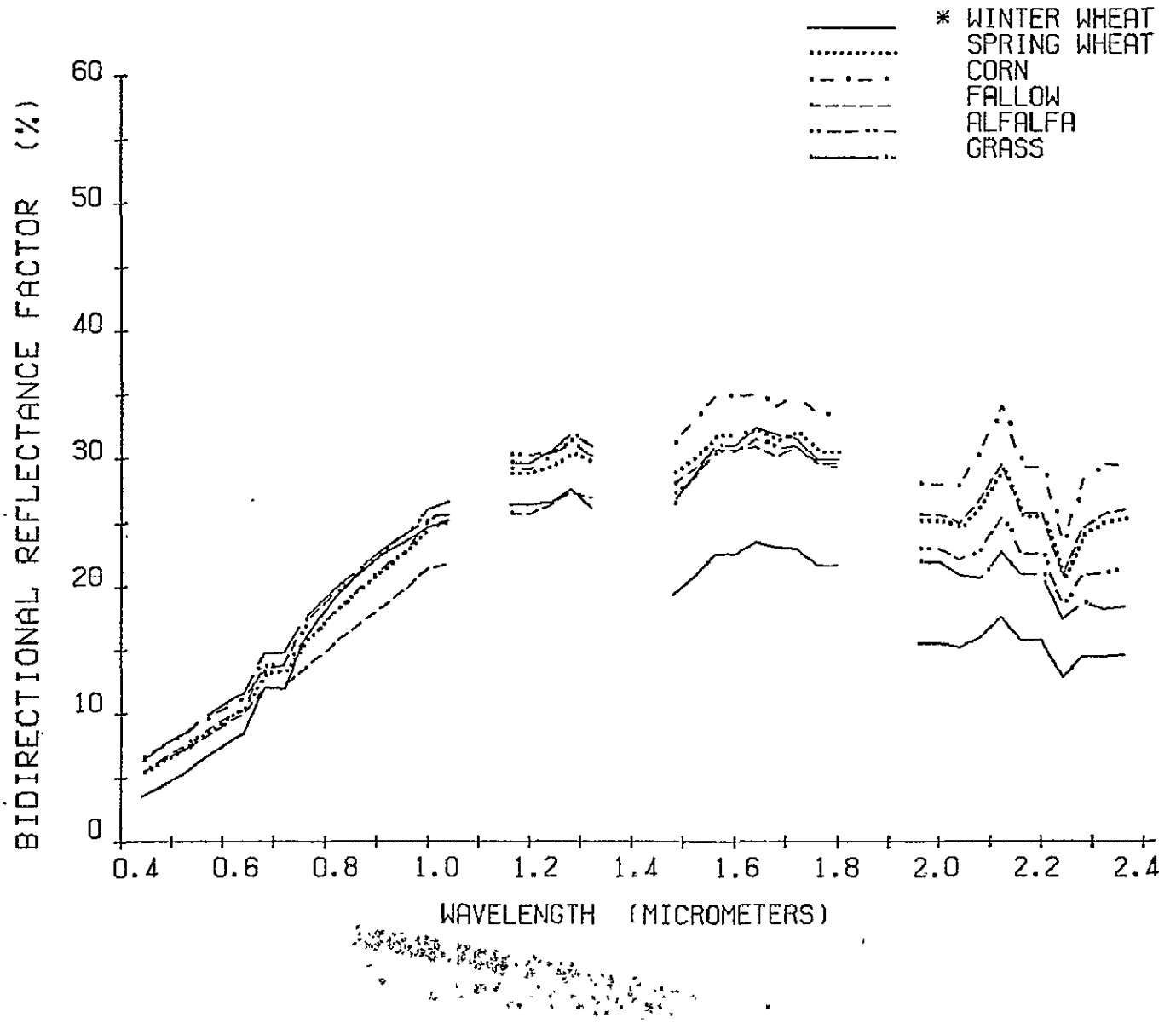
DIFFERENCE IN REFLECTANCE DUE TO COVER TYPE

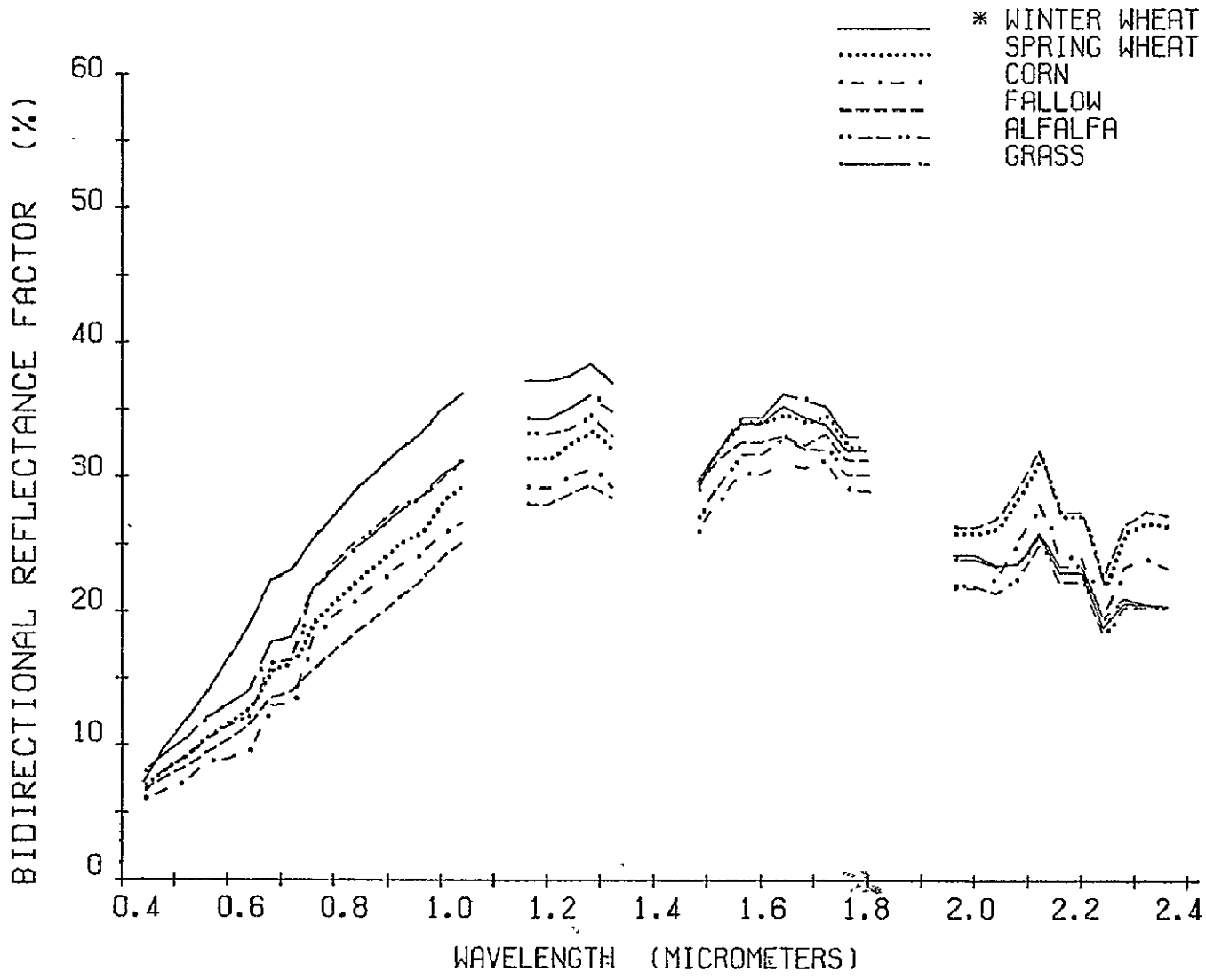
LOCATION: HAND COUNTY, SOUTH DAKOTA
SENSOR: FSS DATE: JUNE 19, 1976



* AVERAGES OF 10, 4, 2, 5, 2, AND 4 FIELDS, RESPECTIVELY.

DIFFERENCE IN REFLECTANCE DUE TO COVER TYPE

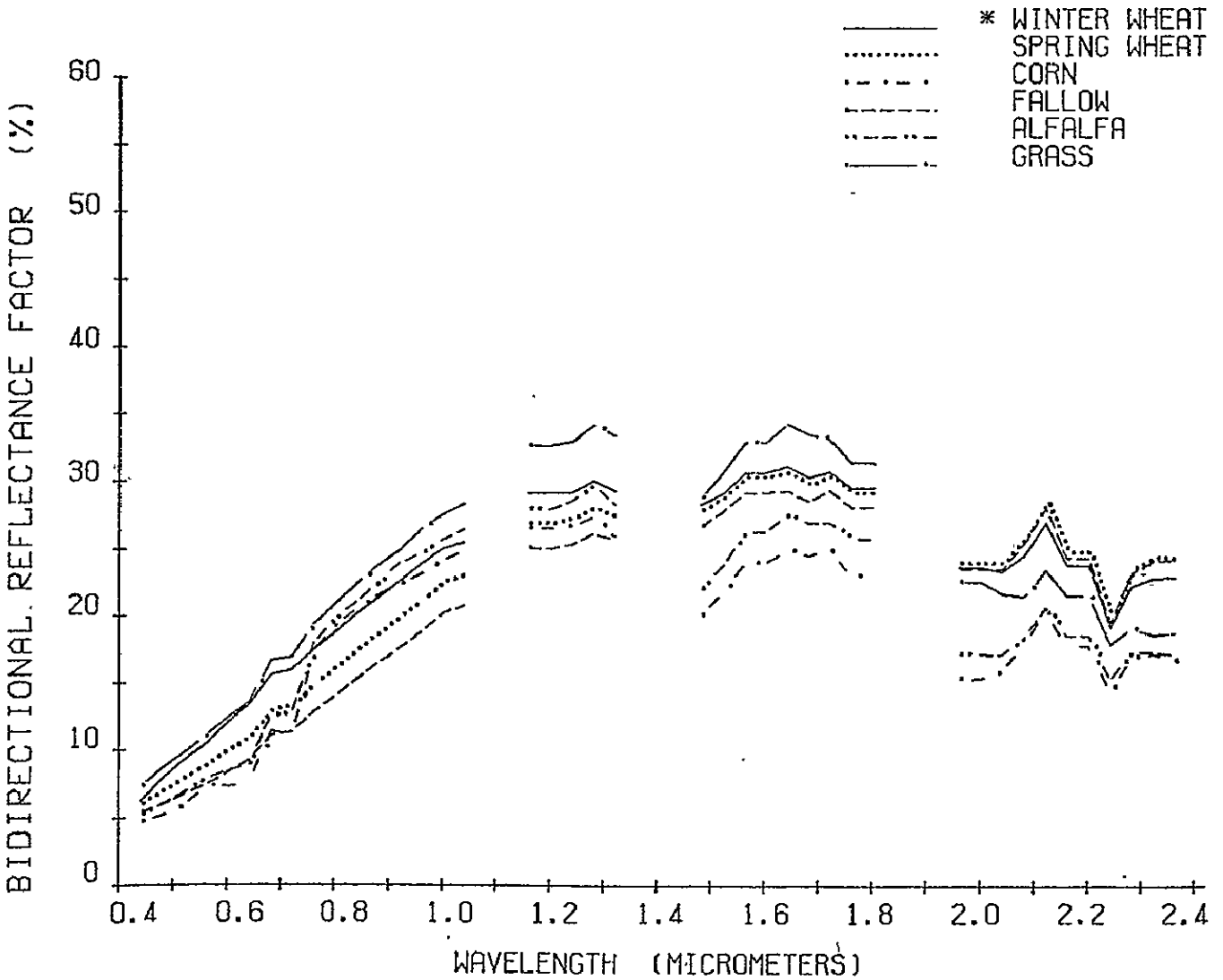
LOCATION: HAND COUNTY, SOUTH DAKOTA
SENSOR: FSS DATE: JULY 8, 1976



* AVERAGES OF 10, 4, 2, 5, 2, AND 4 FIELDS, RESPECTIVELY.

DIFFERENCE IN REFLECTANCE DUE TO COVER TYPE

LOCATION: HAND COUNTY, SOUTH DAKOTA
SENSOR: FSS DATE: JULY 31, 1976



* AVERAGES OF 10, 4, 2, 5, 2, AND 4 FIELDS, RESPECTIVELY.

Appendix: Documentation of Data Examples

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Appendix : Documentation of Data Examples.

Field averages were used for all graphs of FSS data except for those illustrating within-field variability.

Page Number	Location	Plot (Date)	Class	Field (or Run) Numbers
15	Kansas ITS[1]	Maturity Stage(75)	11/5/74	369,391,178,190,192,203, 216,59,67
			4/8/75	369,391,178,190,192,203, 216,59,67
			5/14/75	369,391,178,190,192,203, 216,59,67
			6/9/75	369,391,178,190,192,203, 216,59,67
			6/17/75	369,391,178,190,192,203, 216,59,67
			6/26/75	369,391,178,190,192,203, 216,59,67
16		Maturity Stage(76)	10/21/75	221,167,124,137,149,113, 107,99,42
			3/18/76	221,167,124,137,149,113, 107,99,42
			4/18/76	221,167,124,137,149,113, 107,99,42
			5/6/76	221,167,124,137,149,113, 107,99,42
			6/12/76	221,167,124,137,149,113, 107,99,42
			6/30/76	221,167,124,137,149,113, 107,99,42
17	Kansas AES	Amt. Vegetation(75)	0-25% GC	on 3/30:107 on 3/31:113,114 on 4/3:203,204,205,206

[1] 1975 Kansas data are from ITS-1960; 1976 Kansas data are from ITS-1988.

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Page Number	Location	Plot (Date)	Class	Field (or Run) Numbers
17		Amt. Vegetation(75) (cont.)	26-50% GC	on 3/30:101 on 3/31:119,120,201 on 4/3:202,313 on 4/9:113,114 on 4/16:318 on 4/23:114
			51-75% GC	on 4/9:119 on 4/16:303,307,316 on 4/23:114 on 4/28:113,206 on 4/29:312 on 5/6:215 on 5/16:205
			76-100% GC	on 4/29:302,303 on 4/30:416 on 5/3:408,413 on 5/14:301 on 5/15:108 on 5/19:102 on 6/3:205 on 6/4:309
18		Amt. Vegetation(76)	0-25% GC	on 4/1:4,5,6,26,27 on 4/18:5,6 on 5/1:4
			26-50% GC	on 4/1:7,9,12,28 on 4/16:22 on 5/1:5 on 5/14:4,6,24
			51-75% GC	on 4/1:30 on 4/18:17,29 on 5/1:7,12,14 on 5/14:23,27 on 5/29:5,8
			76-100% GC	on 5/14:25
19		Amt. Vegetation(76)	0-.50 LAI	on 4/1:5,6,7,8,29,30 on 4/18:6

Page Number	Location	Plot (Date)	Class	Field (or Run) Numbers
19		Amt. Vegetation(76) (cont.)	.51-1.0 LAI	on 4/1:9,13 on 4/16:22 on 4/18:8,16,28 on 5/1:7
			1.01-1.5 LAI	on 4/18:17 on 5/1:3 on 5/14:7,22,25,28,29
			1.51-2.0 LAI	on 4/17:19 on 5/1:13,14 on 5/14:26,27 on 5/29:28,30
			2.0 $\longrightarrow$ LAI	on 5/14:23,30
20	Kansas ITS	Soil Types (10/21/75)	Richfield Silt Loam	214,171,42,25,99,173
			Richfield-Spearville Complex	54,58
			Ulysses Silt Loam	185
21		Soil Moisture(10/21/75)	Damp	200,214
			Dry	141,25
22		Soil Moisture(3/18/76)	Damp	214,141
			Dry	200,25
24-29		Irrigation(75)	Irrigated	369,391,178,190,192,197, 203,216,59,67
			Dryland	53,56
30-34		Irrigation(76)	Dryland	221,167,124,137,149,113, 107,99,42
			Irrigated	200,214,141
35,36	Kansas AES	Varieties(4/16,29/75)	Centurk	*303,304,309,310,317,318
			Sage	301,302,311,312,315,316
			Sturdy	305,306,307,308,313,314

* Experiment station plot numbers are as shown on maps in the Project Plan

Page Number	Location	Plot (Date)	Class	Field (or Run) Numbers
37	Kansas AES	Varieties(5/20/75)	Centurk	303,309,317
			Sage	311,315
			Sturdy	305,307,313
38,39		Varieties(6/4,7/4/75)	Centurk	303,309
			Sage	301,311,315
			Sturdy	305,307,313
40,41		Varieties(4,5/1/76)	Eagle	9
			Satanta	12
			Scout	13
			Centurk	14
42		Varieties(5/17/76)	Eagle	9,19
			Satanta	12,17
			Scout	13
			Centurk	14,16
43		Varieties(5/29/76)	Eagle	9
			Satanta	12
			Scout	13
			Centurk	14
44		Varieties(6/10/76)	Eagle	9,19
			Satanta	12,17
			Scout	13,22
			Centurk	14,16
45		Residue(4/17/75)	Removal	401,402,403,404
			Shredding	405,406,407,408
			Double Residue	409,410,411,412
			Burning	413,414,415,416
46		Residue(4/30/75)	Removal	401,402,403,404
			Shredding	405,406,407,408
			Double Residue	409,410,411,412
			Burning	413,414,415,416

Page Number	Location	Plot (Date)	Class	Field (or Run) Numbers
47	Kansas AES	Residue(5/26/75)	Removal	401,402,403,404
			Shredding	405,406,407,408
			Double Residue	409,410,411,412
			Burning	414,415,416
48		Residue(6/11/75)	Removal	401,402,403,404
			Shredding	405,406,407,408
			Double Residue	409,410,411,412
			Burning	413,414,415,416
49,50	Kansas ITS	Among Fields(75)	Field 369	369
			Field 178	178
			Field 192	192
			Field 203	203
			Field 59	59
51,52		Among Fields(76)	Field 221	221
			Field 124	124
			Field 149	149
			Field 107	107
			Field 42	42
53		Within Fields(4/8/75)	Scan 1	(75533403)
			Scan 2	(75533405)
			Scan 3	(75533406)
			Scan 4	(75533407)
			Scan 5	(75533409)
54		Within Fields(6/17/75)	Scan 1	(75625503)
			Scan 2	(75625505)
			Scan 3	(75625506)
			Scan 4	(75625507)
			Scan 5	(75625509)

Page Number	Location	Plot (Date)	Class	Field (or Run) Numbers
55	Kansas ITS	Within Fields(3/31/76)	Scan 1	(76759904)
			Scan 2	(76759909)
			Scan 3	(76759914)
			Scan 4	(76759919)
			Scan 5	(76759924)
56		Within Fields(6/12/76)	Scan 1	(76785404)
			Scan 2	(76785406)
			Scan 3	(76785408)
			Scan 4	(76785410)
			Scan 5	(76785412)
59		Wheat,Other(11/5/74)	Dryland Winter Wheat	53,56
			Irrigated Winter Wheat	369,391,178,190,192,197, 203,216,59,67
			Alfalfa	69,193,387
			Pasture	186
			Fallow	61,80
60,61		Wheat,Other(4/8,5/14/75)	Dryland Winter Wheat	53,56
			Irrigated Winter Wheat	369,391,178,190,192,197, 203,216,59,67
			Alfalfa	69,193,387
			Pasture	186
			Fallow	61,80,374
62-63		Wheat,Other(6/17,6/26/75)	Dryland Winter Wheat	53,56
			Irrigated Winter Wheat	369,391,178,190,192,197, 203,216,59,67
			Alfalfa	69,193,387
			Pasture	186
			Fallow	61,80,374
			Corn	49,52,65,68,191,194,212, 371,541,543
64-67		Wheat,Other(10/21/75,3/18, 4/18,5/6/76)	Dryland Winter Wheat	221,167,124,137,149,113, 107,99,42
			Irrigated Winter Wheat	200,214,141
			Fallow	187,191,186,129,148,94, 112,50,38,33

Page Number	Location	Plot (Date)	Class	Field (or Run) Numbers
68,69		Wheat,Other(6/12,6/30/76)	Dryland Winter Wheat	221,167,124,137,149,113, 107,99,42
			Irrigated Winter Wheat	200,214,141
			Fallow	187,191,186,129,148,94, 112,50,38,33
			Corn	183,176,174
			Sorghum	181,179,169,165,152,27,26
70	Kansas AES	Wheat,Small Grains(4/9/75)	Early Wheat	119,120
			Rye	117,118
			Barley	115,116
			Late Wheat	113,114
			Triticale	111,112
71		Wheat,Small Grains(4/23/75)	Early Wheat	101,102,119
			Rye	103,104,117,118
			Barley	105,106,115,116
			Late Wheat	107,108,113,114
			Triticale	109,110,111,112
72		Wheat,Small Grains(4/28/75)	Early Wheat	101,102,119,120
			Rye	103,104,118
			Barley	105,106,115,116
			Late Wheat	107,108,113,114
			Triticale	109,110,111,112
73		Wheat,Small Grains(5/15/75)	Early Wheat	102,120
			Rye	104,118
			Barley	106
			Late Wheat	108,114
			Triticale	110,112
74		Wheat,Small Grains(6/3/75)	Early Wheat	102,120
			Rye	104,118
			Barley	106
			Late Wheat	108,114
			Triticale	110,112

Page Number	Location	Plot (Date)	Class	Field (or Run) Numbers
75	Kansas AES	*Wheat,Small Grains(6/15/75)	Early Wheat	102,120
			Rye	104,118
			Barley	106
			Late Wheat	108
			Triticale	110,112
76		*Wheat,Small Grains(6/29/75)	Early Wheat	102,120
			Rye	104,118
			Barley	106
			Late Wheat	108,114
			Triticale	110,112
77		*Wheat, Small Grains(7/4/75)	Early Wheat	102,120
			Rye	104,118
			Barley	106
			Late Wheat	108,114
			Triticale	110,112
78		Wheat,Small Grains(4/1/76)	Wheat	9,13,14
			Rye	10
			Barley	11
			Triticale	15
79		Wheat Small Grains(5/1/76)	Wheat	9,12,13,14
			Rye	10
			Barley	11
			Triticale	15
80		Wheat,Small Grains(5/17/76)	Wheat	9,12,13,14,16,17,19
			Rye	10
			Barley	11,18
			Triticale	15,20
81		Wheat,Small Grains(5/29/76)	Wheat	9,12,13,14
			Rye	10
			Barley	11
			Triticale	15
82		Wheat,Small Grains(6/10/76)	Wheat	9,12,13,14
			Rye	10
			Barley	11
			Triticale	15

Page Number	Location	Plot (Date)	Class	Field (or Run) Numbers
85	N. Dakota ITS[2]	Maturity Stage	6/5/75	226,227,234,235,800,812, 834,846
			6/22/75	226,227,234,235,812,834, 846,441,442
			7/10/75	226,227,234,235,800,812, 834,441,442
			7/27/75	226,234,800,441,442
			8/23/75	226,227,234,235,800,812, 846,441,442
86		Maturity Stage	5/28/76	288,334,343,423,425,441, 458,478,484
			6/17/76	288,334,343,423,425,441, 458,478,484
			6/25/76	288,334,343,423,425,441, 458,478,484
			7/6/75	288,334,343,423,425,441, 458,478,484
			7/28/76	288,334,343,423,425,441, 458,478,484
			8/9/76	288,334,343,423,425,441, 458,478,484
87	N. Dakota AES	Amt. Vegetation(75)	0-.49 LAI	on 6/23:39,40,41,42,49,50,52
			.5-.99 LAI	on 6/23:38,51,53
				on 7/9:38
				on 7/10:6,38,42
			1.0-1.49 LAI	on 7/9:37,39
				on 7/10:5,11,12,41,52
			1.5-1.99 LAI	on 7/10:19,23,49,54,56
				on 7/19:42,49
			2.0 $\longrightarrow$ LAI	on 7/10:26,53
				on 7/19:35,41
88		Amt. Vegetation(76)	0-.49 LAI	on 5/28:6,9,19
				on 6/2:7,41
				on 6/4:8,19

[2] 1975 and 1976 North Dakota data are from ITS-1966.

Page Number	Location	Plot (Date)	Class	Field (or Run) Numbers
88	N. Dakota AES	Amt. Vegetation(76) (cont.)	.5-.99 LAI	on 6/2:36,38 on 6/4:6,7 on 6/18:11,50,56
			1.0-1.49 LAI	on 6/18:19,20,21,23,40,42,54
			1.5-1.99 LAI	on 6/18:6,9,24,25,26,39,41
			2.0 LAI	on 6/18:5,7,8,35,36,37,38
89		Surface Soil Moisture	Wet	on 6/3(early):16,17
			Moist	on 6/3(late):16,17
			Dry	on 6/4:16,17
90		Planting Date(6/7/75)	Early	53,54,55,56
			Late	49,50,51,52
91		Planting Date(7/10/75)	Early	5,6,7,8,23,24,25,26,35,36,37,38,53,54,55,56
			Late	9,10,11,12,19,20,21,22,39,40,41,42,49,50,51,52
92		Planting Date(8/12/75)	Early	5,6,7,8,35,36,37,38
			Late	9,10,11,12,39,40,41,42
		Planting Date(6/4,6/18, 7/16,8/6/76)	Early	5,6,7,8,23,24,25,26,35,36,37,38,53,54,55,56
			Late	9,10,11,12,19,20,21,22,39,40,41,42,49,50,51,52
93,94,96,97		Planting Date(7/8/76)	Early	5,6,7,8,23,24,25,26
			Late	9,10,11,12,19,20,21,22
98		Fallow/Recrop(7/10/75)	Wheat(74)	5,6,7,8,9,10,11,12,35,36,37,38,39,40,41,42
			Fallow(74)	19,20,21,22,23,24,25,26,49,50,51,52,53,54,55,56
99		Fallow/Recrop(8/12/75)	Wheat(74)	35,36,37,38,39,40,41,42
			Fallow(74)	49,50,51,52,53,54,55,56
100,101,103,104		Fallow/Recrop(6/4,6/18, 7/16,8/6/76)	Fallow(75)	5,6,7,8,9,10,11,12,35,36,37,38,39,40,41,42
			Wheat(75)	19,20,21,22,23,24,25,26,49,50,51,52,53,54,55,56

Page Number	Location	Plot (Date)	Class	Field (or Run) Numbers
102	N. Dakota AES	Fallow/Recrop(7/8/76)	Fallow(75)	5,6,7,8,9,10,11,12
			Wheat(75)	19,20,21,22,23,24,25,26
105		Variety(8/12/75)	Ellar	36,38,40,42,50,52,54,56
			Olaf	35,37,39,41,49,51,53,55
106,107,109,110		Variety(6/4,6/18,7/16, 8/6/76)	Waldron	6,8,10,12,20,22,24,26,36, 38,40,42,50,52,54,56
			Olaf	5,7,9,11,19,21,23,25,35, 37,39,41,49,51,53,55
108		Variety(7/8/76)	Waldron	6,8,10,12,20,22,24,26
			Olaf	5,7,9,11,19,21,23,25
111		Nitrogen(6/7/75)	No Nitrogen	49,50,55,56
			30 lbs/acre	51,52,53,54
112		Nitrogen(7/10/75)	No Nitrogen	5,6,11,12,21,22,23,24,37, 38,39,40,49,50,55,56
			30 lbs/acre	7,8,9,10,19,20,25,26,35, 36,41,42,51,52,53,54
113		Nitrogen(8/12/75)	No Nitrogen	37,38,39,40,49,50,55,56
			30 lbs/acre	35,36,41,42,51,52,53,54
114,115,117,118		Nitrogen(6/4,6/18,7/16, 8/6/76)	No Nitrogen	5,6,11,12,21,22,23,24,37, 38,39,40,49,50,55,56
			30 lbs/acre	7,8,9,10,19,20,25,26,35, 36,41,42,51,52,53,54
116		Nitrogen(7/8/76)	No Nitrogen	5,6,11,12,21,22,23,24
			30 lbs/acre	7,8,9,10,19,20,25,26
119,120	N. Dakota ITS	Among Fields(75)	Field 226	226
			Field 234	234
			Field 812	812
			Field 846	846
			Field 442	442
121,122		Among Fields(76)	Field 334	334
			Field 343	343
			Field 425	425
			Field 458	458
			Field 484	484

Page Number	Location	Plot (Date)	Class	Field (or Run) Numbers
123	N. Dakota ITS	Within Fields(6/22/75)	Scan 1	(75804103)
			Scan 2	(75804105)
			Scan 3	(75804107)
			Scan 4	(75806704)
			Scan 5	(75806707)
124		Within Fields(7/27/75)	Scan 1	(75937603)
			Scan 2	(75937606)
			Scan 3	(75937609)
			Scan 4	(75940103)
			Scan 5	(75940107)
125		Within Fields(6/17/76)	Scan 1	(76824703)
			Scan 2	(76824707)
			Scan 3	(76824711)
			Scan 4	(76824717)
			Scan 5	(76824722)
126		Within Fields(7/28/76)	Scan 1	(76960704)
			Scan 2	(76960709)
			Scan 3	(76960714)
			Scan 4	(76960719)
			Scan 5	(76960724)
127		Between Years(Same Date)	June 22,1975	226,227,234,235,812,834, 846,441,442
			June 25,1976	288,334,343,423,425,441, 458,478,484
128		Between Years(Same Date)	July 10,1975	226,227,234,235,800,812, 834,441,442
			July 6,1976	288,334,343,423,425,441, 458,478,484
129		Between Years(Same Date)	July 18,1975	226,227,234,235,800,812, 834,846,441,442
			July 20,1976	288,334,343,423,425,441, 458,478,484
130		Between Years(Same Date)	July 27,1975	226,234,800,441,442
			July 28,1976	288,334,343,423,425,441, 458,478,484
131		Between Years(Same Date)	August 15,1975	226,227,234,235,800,812, 846,441,442

Page Number	Location	Plot (Date)	Class	Field (or Run) Numbers
131	N. Dakota ITS	Between Years (Same Date) (cont.)	August 19, 1976	288,334,343,423,425,441, 458,478,484
132		Between Years (Same Maturity)	June 5,1975	226,227,234,235,800,812, 834,846
			May 28,1976	288,334,343,423,425,441, 458,478,484
133		Between Years (Same Maturity)	July 18,1975	226,227,234,235,800,812, 834,846,441,442
			July 6,1976	288,334,343,423,425,441, 458,478,484
134		Between Years (Same Maturity)	August 15,1975	226,227,234,235,800,812, 846,441,442
			July 20,1976	288,334,343,423,425,441, 458,478,484
137		Wheat,Other(6/5/75)	Wheat	226,227,234,235,800,812, 834,846
			Fallow	444,446,674,676,799,810, 813,843,863
			Pasture	415,628,632,681,736,766
138		Wheat,Other(6/22/75)	Wheat	226,227,234,235,441,442, 812,834,846
			Pasture	444,446,837,799,810,813, 843,863
			Fallow	415,736,766
139		Wheat,Other(7/10/75)	Wheat	226,227,234,235,441,442, 800,812,834,846
			Fallow	444,446,799,810,813,863,837
			Pasture	415,736,766
140		Wheat,Other(7/18/75)	Wheat	226,227,234,235,441,442, 812,834,800
			Fallow	837,813,799,676
			Pasture	736,628,632,687
141		Wheat,Other(7/27/75)	Wheat	226,234,441,442,800,812, 834,846
			Fallow	799,810,863,837,674,843
			Pasture	415,736,766,628,632,681

Page Number	Location	Plot (Date)	Class	Field (or Run) Numbers
142	N. Dakota ITS	Wheat,Other(8/23/75)	Wheat	226,227,234,235,441,442, 800,812,846
			Fallow	799,444,863,446,674,843, 676,813
			Pasture	415,736,766,628,632,681
143-150		Wheat,Other(76)	Wheat	288,334,343,423,425,441, 458,478,484
			Fallow	138,152,163,165,166,169, 329,424,426,435
			Pasture	161,170,248,338,356,385
151	N. Dakota AES	Wheat,Small Grains(7/10/75)	Kelsey Oats	1,31,36,60
			Vandguard Barley	3,29,33,59
			Lark Wheat	4,27,34,57
152		Wheat,Small Grains(8/12/75)	Kelsey Oats	1,31,60
			Vandguard Barley	3,33,59
			Lark Wheat	4,34,58
153,154,157		Wheat,Small Grains(6/4, 6/18,8/6/76)	Kelsey Oats	1,30,31,60
			Hector Barley	2,29,32,59
			Lark Wheat	4,27,34,57
155		Wheat,Small Grains(7/8/76)	Kelsey Oats	1,30,31
			Hector Barley	2,29,32
			Lark Wheat	4,27,34
156		Wheat,Small Grains(7/16/76)	Kelsey Oats	1,30,35
			Hector Barley	2,29,36
			Lark Wheat	4,27,38

Page Number	Location	Plot (Date)	Class	Field (or Run) Numbers
161	S. Dakota ITS[3]	Maturity Stage (WW)	10/15/75	176,208,210,196,212,198, 175,172,182,128
			11/5/75	176,208,210,196,212,198, 175,172,182,128
			5/11/76	176,208,210,196,212,198, 175,172,182,128
			6/19/76	176,208,210,196,212,198, 175,172,182,128
			7/8/76	176,208,210,196,212,198, 175,172,182,128
			7/31/76	176,208,210,196,212,198, 175,172,182,128
162		Maturity Stage(SW)	5/11/76	284,197,209,132
			6/19/76	284,197,209,132
			7/8/76	284,197,209,132
			7/31/76	284,197,209,132
163		Between Fields(WW,5/11/76)	Field 176	176
			Field 208	208
			Field 210	210
			Field 128	128
			Field 175	175
164		Between Fields(WW,6/19/76)	Field 176	176
			Field 208	208
			Field 210	210
			Field 128	128
			Field 175	175
165		Between Fields(SW,6/19/76)	Field 284	284
			Field 197	197
			Field 209	209
			Field 132	132
166		Between Fields(SW,7/8/76)	Field 284	284
			Field 197	197
			Field 209	209
			Field 132	132

[3] South Dakota data are from ITS - 1687.

Page Number	Location	Plot (Date)	Class	Field (or Run) Numbers
167	S. Dakota ITS	Within Fields(WW,5/11/76)	Scan 1	(76833003)
			Scan 2	(76833005)
			Scan 3	(76833007)
			Scan 4	(76833009)
			Scan 5	(76833011)
168		Within Fields(WW,6/19/76)	Scan 1	(76848203)
			Scan 2	(76848206)
			Scan 3	(76848209)
			Scan 4	(76848212)
			Scan 5	(76848215)
169		Within Fields(WW,7/8/76)	Scan 1	(76943603)
			Scan 2	(76943606)
			Scan 3	(76943609)
			Scan 4	(76943612)
			Scan 5	(76943616)
170		Within Fields(SW,5/11/76)	Scan 1	(76832903)
			Scan 2	(76832906)
			Scan 3	(76832909)
			Scan 4	(76832913)
			Scan 5	(76832916)
171		Within Fields(SW,6/19/76)	Scan 1	(76848104)
			Scan 2	(76848107)
			Scan 3	(76848110)
			Scan 4	(76848118)
			Scan 5	(76848124)
172		Within Fields(SW,7/8/76)	Scan 1	(76943503)
			Scan 2	(76943507)
			Scan 3	(76943511)
			Scan 4	(76943515)
			Scan 5	(76943521)
175-178		Wheat,Other(76)	Winter Wheat	176,208,210,196,212,198, 175,172,182,128
			Spring Wheat	284,197,209,132
			Corn	136,232
			Fallow	177,283,207,223,197
			Alfalfa	171,174
			Grasses	235,221,211,131

* U.S. GOVERNMENT PRINTING OFFICE: 1978 — 771-083/1705

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