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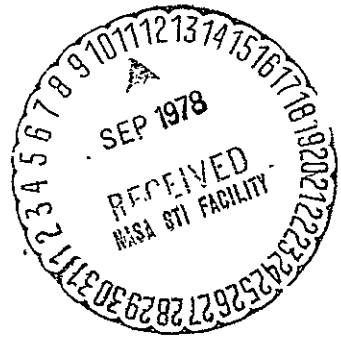
ATLAS OF SELECTED CROP SPECTRA IMPERIAL VALLEY, CALIFORNIA

Prepared By

S. G. Ungar, W. Collins, J. Coiner, et al.

June, 1977



GODDARD SPACE FLIGHT CENTER

ATLAS OF SELECTED CROP SPECTRA
IMPERIAL VALLEY, CALIFORNIA

JUNE 1977

Prepared By

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CHAPTER I.

Introduction and Key to Atlas

The purpose of this publication is to make available to interested investigators high spectral resolution reflected radiance data for representative agricultural landscapes. These spectral data are accompanied by supporting ground observations and interpretation details from simultaneously acquired aerial photographs. Thus, this Atlas provides a single reference source for representative spectral reflectance data covering a variety of precisely described agricultural crops, crop conditions and tillage states.

The spectral reflectance data represent measured solar radiant energy reflected from the crop surface (acquired at nadir and averaged over an 18 by 18 meter area) throughout the visible and near infrared portion of the electromagnetic spectrum (from 430 to 1000 nanometer wavelength in 410 bands of 1.4 nm width). These data are presented graphically, with each set of plots representing a homogeneous ground surface type.

Spectra of agricultural landscapes presented in this Atlas were selected from a larger data set. Each set of spectra describes a specific homogeneous crop, crop condition or tillage state. To meet the criterion of homogeneity, roads,

fence lines, homesteads and other such landscape elements were avoided.

Each page of the Atlas presents a set of spectra representing a single homogeneous agricultural landscape. In principle,spectra from different fields can be aggregated to create a single Atlas entry for a specific crop, crop condition or tillage state. However, difficulties in aggregating spectra acquired under different observing conditions (e.g., sun elevation, aircraft attitude) have constrained the agricultural landscapes presented here to parts of fields. In some cases, more than one set of spectra appear in the Atlas for a specific crop state. In these instances, differences are attributable entirely to changes in observing conditions and each spectra-set is equally representative of the agricultural landscape described. In all cases, the measured standard deviation within a set of spectra is less than ten percent of the mean value at all wavelengths.

The spectral plots constitute the bulk of this Atlas. Appendices provide detailed information to the reader interested in specific aspects of data acquisition and analysis procedure. Appendix A describes the airborne spectroradiometer instrument and associated calibration procedures used in acquiring the data. All data contained in the Atlas were acquired during the 1975 growing season (May and September) from ground sites in Imperial Valley, California. These sites and data acquisition flight parameters are discussed in Ap-

pendix B. Collection of supporting ground information is the subject of Appendix C. Additional surface condition information was derived from photo interpretation of 35 mm color aerial photography collected simultaneously with the spectroradiometer data. The method of interpretation and definitions of descriptive terms comprise Appendix D. Appendix E discusses availability of the spectral data on computer compatible tape and availability of supporting aerial photography.

The following description provides a brief key to the sample Atlas page shown in Figure 1. For more details about specific aspects of the data acquisition and analysis procedure the reader is referred to the appropriate appendices.

a. The title indicates the crop type and its growth stage as shown in Table 1.

b. The field description incorporates ground observations and soils data. Details of how this information was obtained are given in Appendix C.

c. The results of photo interpretation are presented in the form of a set of keywords as described in Table 2. A complete discussion of the photo interpretation keywords is included in Appendix D.

d. This plot is a representative spectrum of the

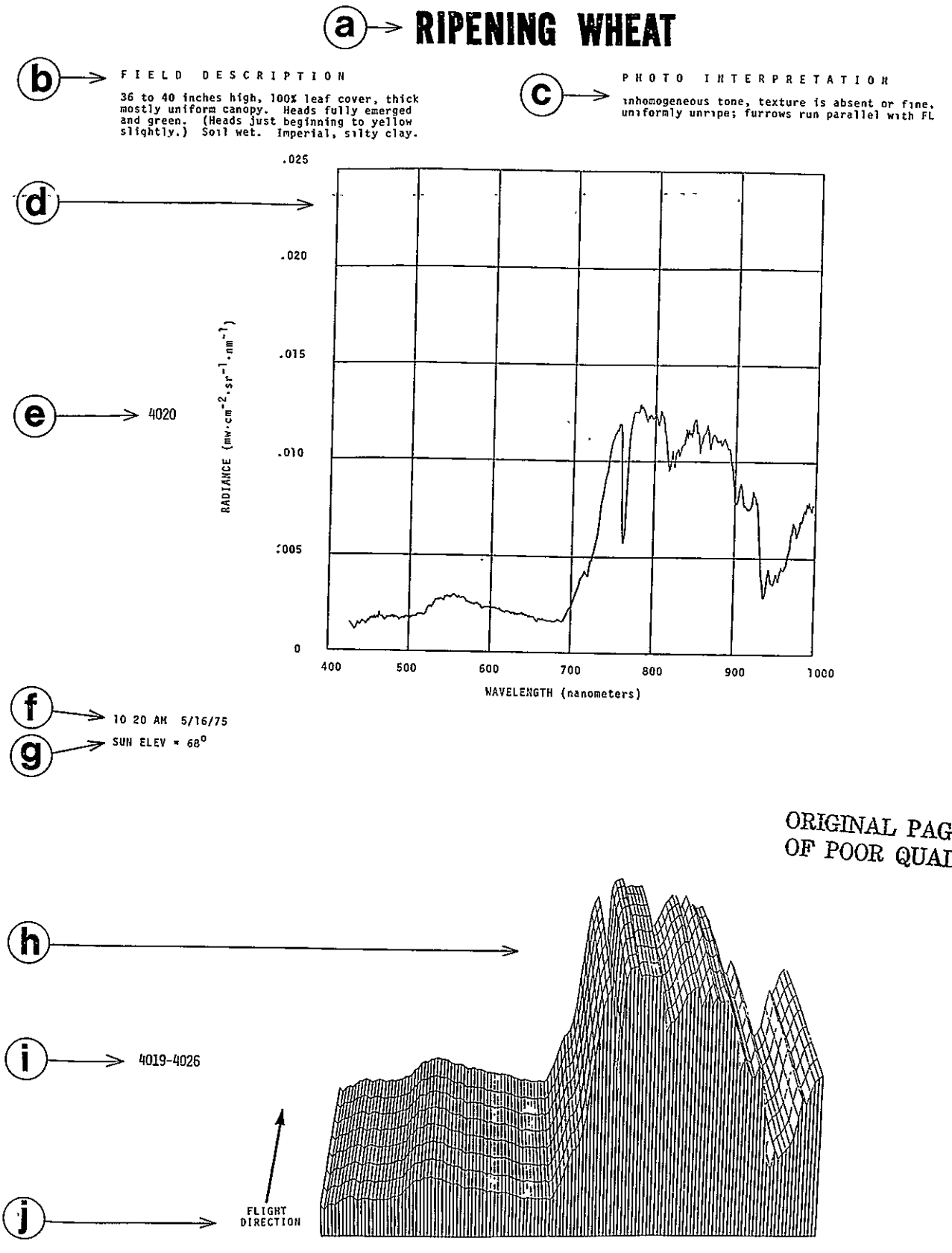


Figure 1. Sample Atlas page

TABLE 1. CROP GROWTH STAGE CHARACTERISTICS

Crop	Growth Stage	Characteristics
Alfalfa	Maturing	6 inches to 20 inches high
	Mature	20 inches high and above
	Harvested	less than 6 inches high
Asparagus		
Bare Soil		
Barley	Ripe	
Carrots	Harvested	
Cotton	Emergent	6 inches high or less
	Mature	blossoms and balls, balls closed
	Ripening	balls opening
Melons		
Sorghum	Emergent	8 inches high or less
	Headed	heads present
Sugar Beets	Emergent	6 inches to 12 inches high
	Thinned	12 inches high
	Mature	24 inches to 36 inches high
	Harvested	plant litter in field
Wheat	Booted	established, no heads
	Headed	heads present and green
	Ripening	fully headed, turning yellow
	Ripe	turned yellow

TABLE 2. PHOTO INTERPRETATION IMAGE CHARACTERISTICS

Tone	homogeneous inhomogeneous
Texture	none or absent fine medium coarse differential--range
Density	bare soil low medium high differential--range
Cover	bare soil little 1/3 2/3 near total total
Crop Status	growth stage, unusual patterns or conditions, and ripening description for wheat and barley fields
Furrow Direction	parallel or perpendicular to Flight Line

agricultural landscape being described. The arithmetic average is calculated for the spectra-set at all wavelengths. The representative spectrum is the spectrum within the set which has the minimum RMS (root mean square) difference from the average when summed over all wavelengths.

e. This number is the catalog spectrum number of the representative spectrum shown in the plot.

f. The spectra acquisition date and time (PDT) are taken from the flight logs and reflect the time at the start of a flight line. No single flight line was longer than five minutes in duration.

g. The sun elevation angle measured from the horizon plane was calculated for the time, date, and location of each set of observations.

h. The second plot on each data sheet is a three-dimensional representation of sequentially acquired spectra which make up the homogeneous unit of crop, crop condition or tillage state. The spectra are plotted one behind the other in the sequence in which they were acquired along the flight line. The horizontal and vertical axes are wavelength and radiance respectively as in the representative spectrum (d). To provide an

interpretable display, the number of points plotted on the x-axis was reduced by averaging the radiance values for three wavelength bands or channels at a time.

i. The catalog spectrum numbers for the first and last spectra in each set are given for reference.

j. The flight direction indicates the order of acquisition for each set of spectra.

This Atlas is a product of the research activities of several groups which comprise the Earth Resources Program at the NASA Goddard Institute for Space Studies.

Instrumentation was developed and flown by Dr. William Collins, Columbia Univeristy, Department of Geology. Dr. Hong-Yee Chiu, Goddard Institute for Space Studies assisted in instrument design. Data processing methods were developed by Dr. Stephen G. Ungar, Goddard Institute for Space Studies. Photo interpretation and production support was provided by Columbia University, Department of Geography, under the direction of Dr. Jerry C. Coiner. Preliminary data processing was performed at Dartmouth College by William Beck and Nancy Wasserman.

CHAPTER II.

Atlas of Spectra

MATURING ALFALFA

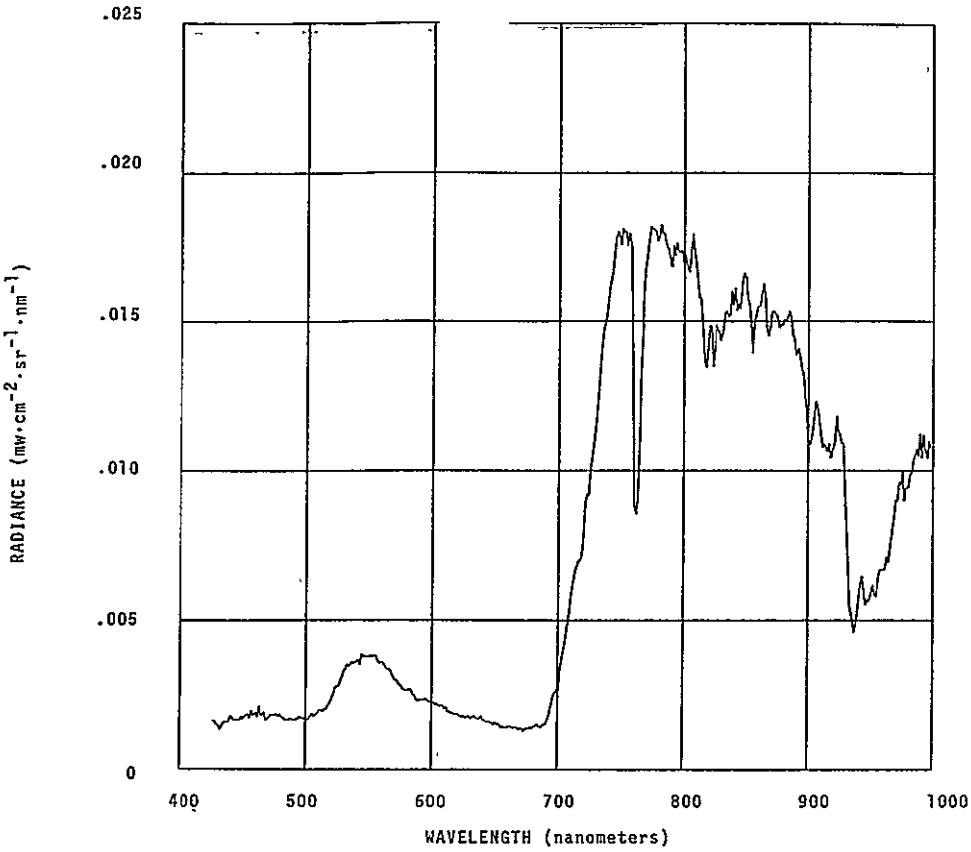
FIELD DESCRIPTION

8 to 12 inches high, 80% leaf cover, moderately thick uniform canopy. Recently cut. 1st year crop. Soil dry. Imperial, light brown silty clay (7.5YR 6/4).

PHOTO INTERPRETATION

homogeneous tone except for slight furrow detection; fine texture; high density; total cover; furrows run parallel with FL.

7



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SUN ELEV = 58°

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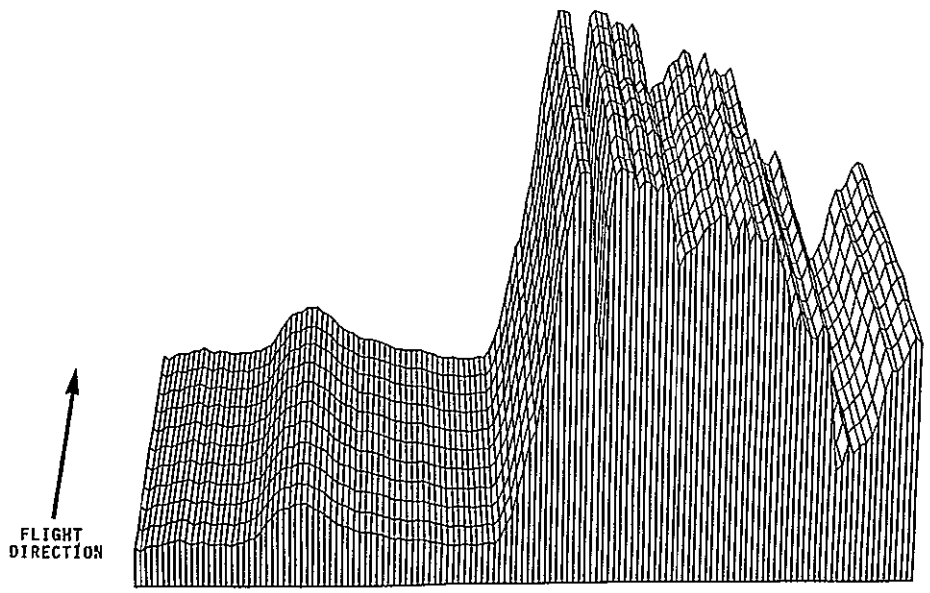
1- 11



MATURING ALFALFA

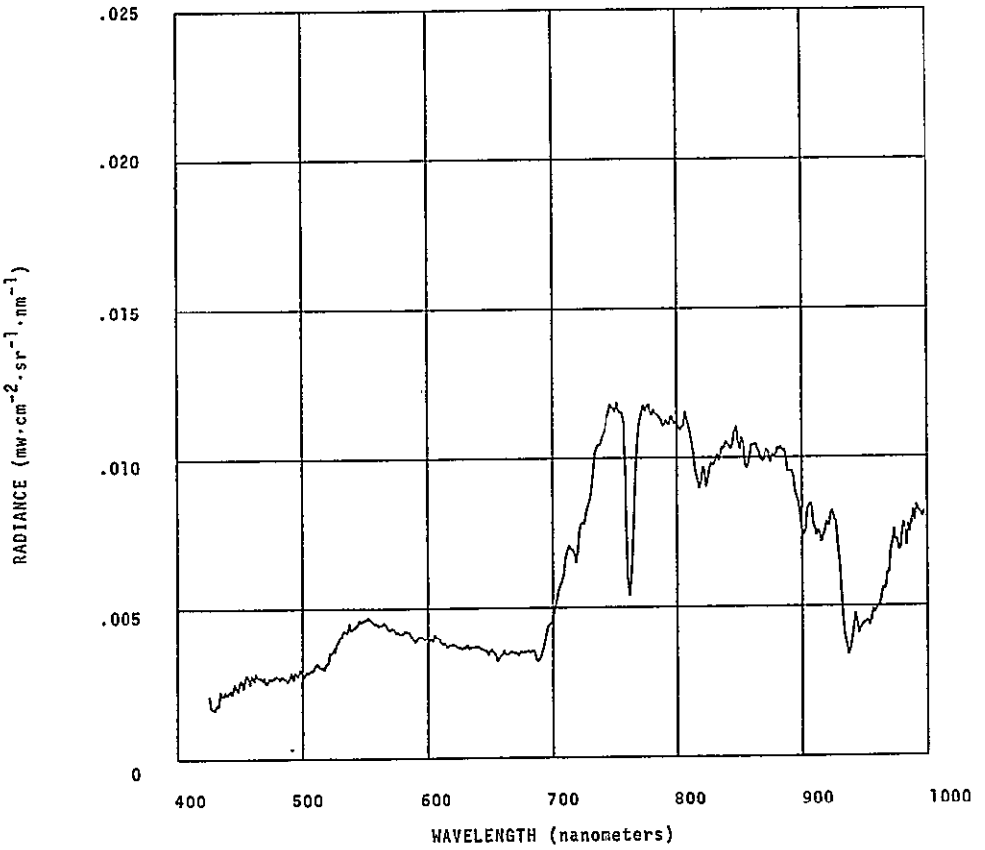
FIELD DESCRIPTION

12 inches high, 80% leaf cover, moderately thick uniform canopy. 2nd year crop. Soil moist. Imperial, silty clay.

PHOTO INTERPRETATION

inhomogeneous tone; coarse texture; differential densities ranging from high to low occurring in alternating rows (harvesting pattern); near total cover; furrows run perpendicular to FL.

17



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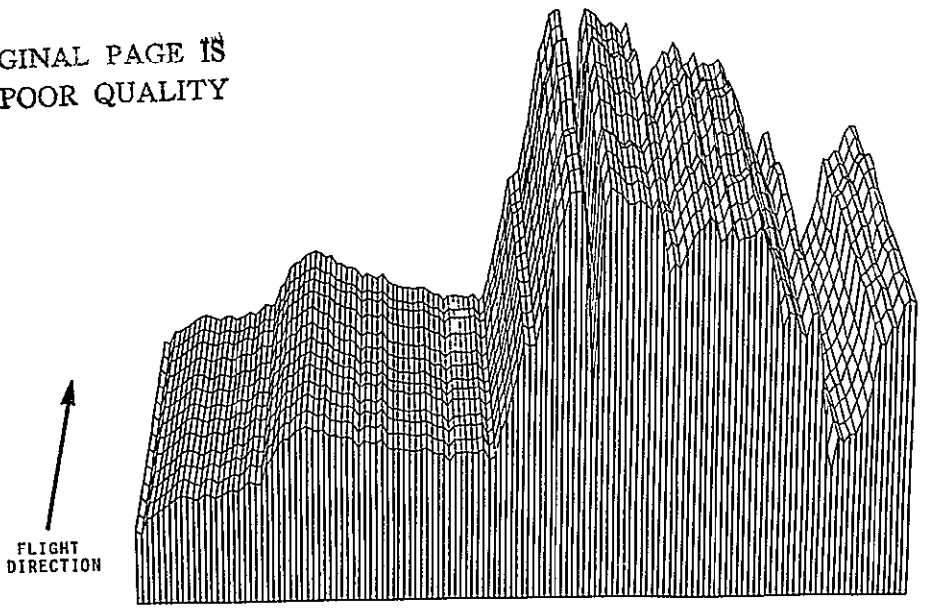
SUN ELEV = 69°

12- 24



MATURING ALFALFA

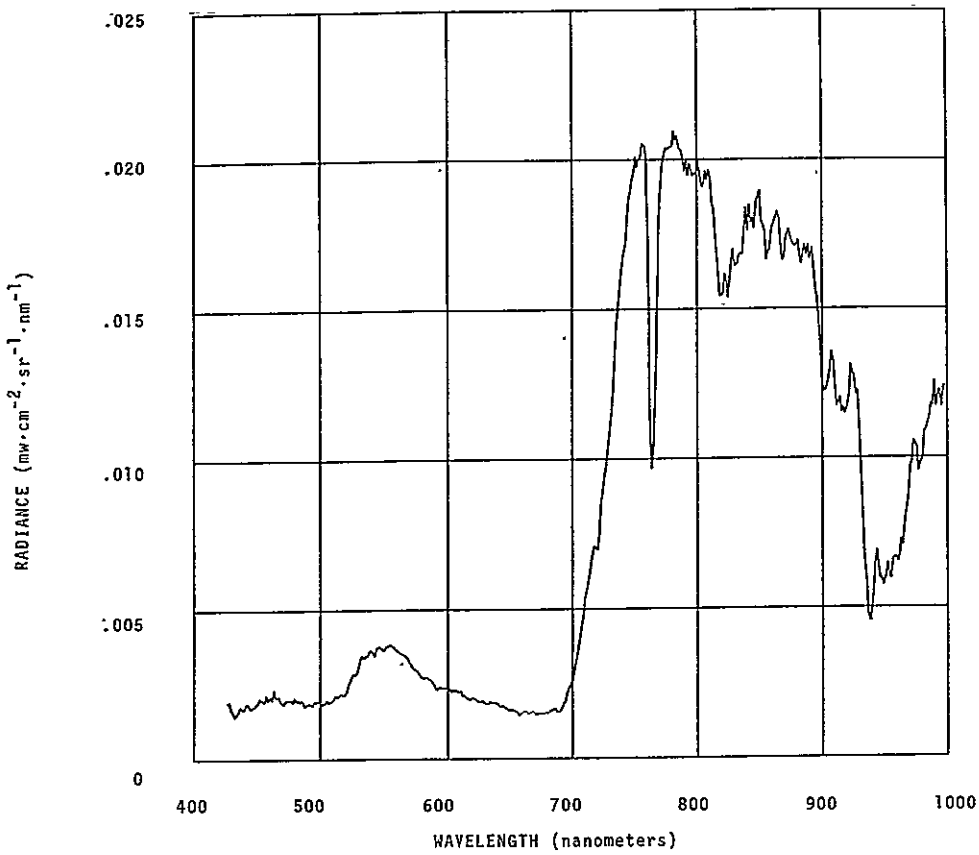
FIELD DESCRIPTION

12 inches high, 100% leaf cover, thick uniform canopy. Purple flowers, 1 to 3% of alfalfa plants. 4th year crop. Soil wet. Imperial, silty clay.

PHOTO INTERPRETATION

homogeneous tone except furrows are slightly detectable; texture is absent or fine; high density; total cover; furrows run parallel with FL.

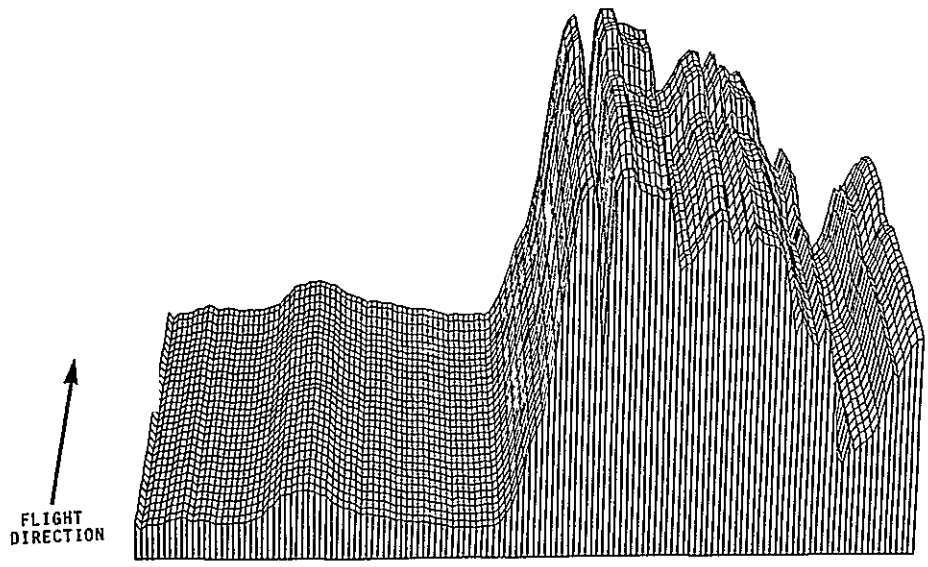
29



10:55 AM 5/16/75

SUN ELEV = 73°

25- 55



MATURING ALFALFA

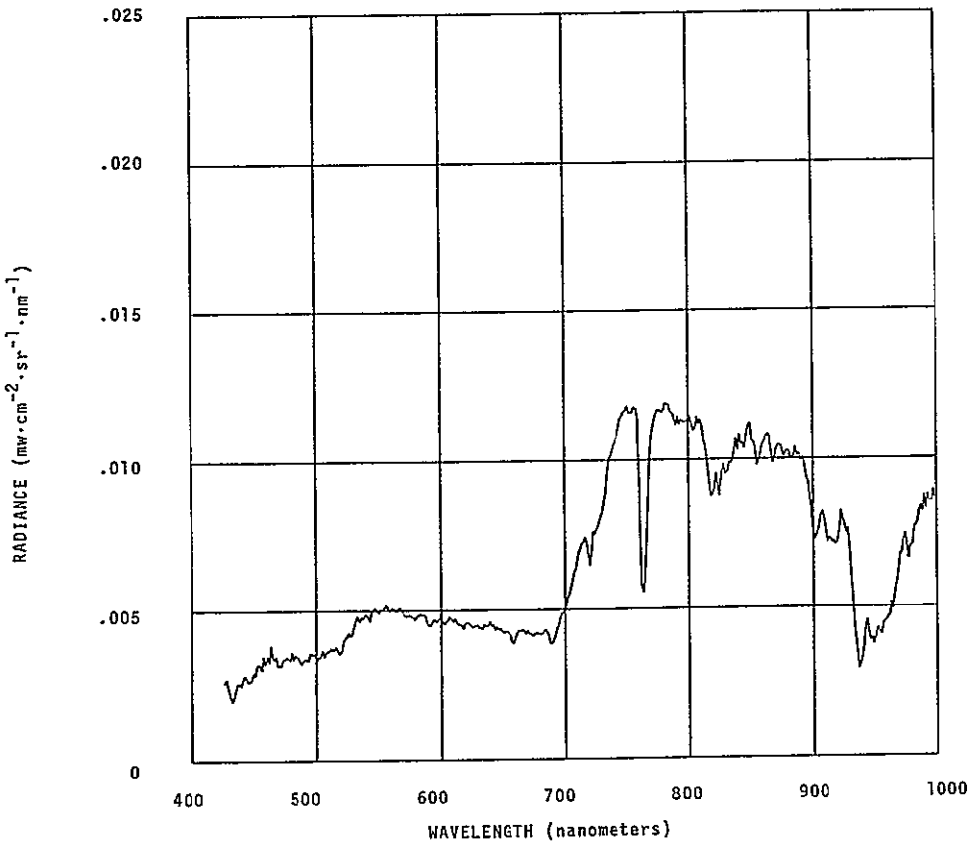
FIELD DESCRIPTION

12 to 14 inches high, 70 to 80% leaf cover, moderately thin uniform canopy. 4th year crop. Field being flooded, wet to dry with some standing water. Imperial, silty clay.

PHOTO INTERPRETATION

inhomogeneous tone, striated parallel with FL; coarse texture; differential density, low and high in alternating rows (harvesting pattern); furrows run parallel with FL.

63



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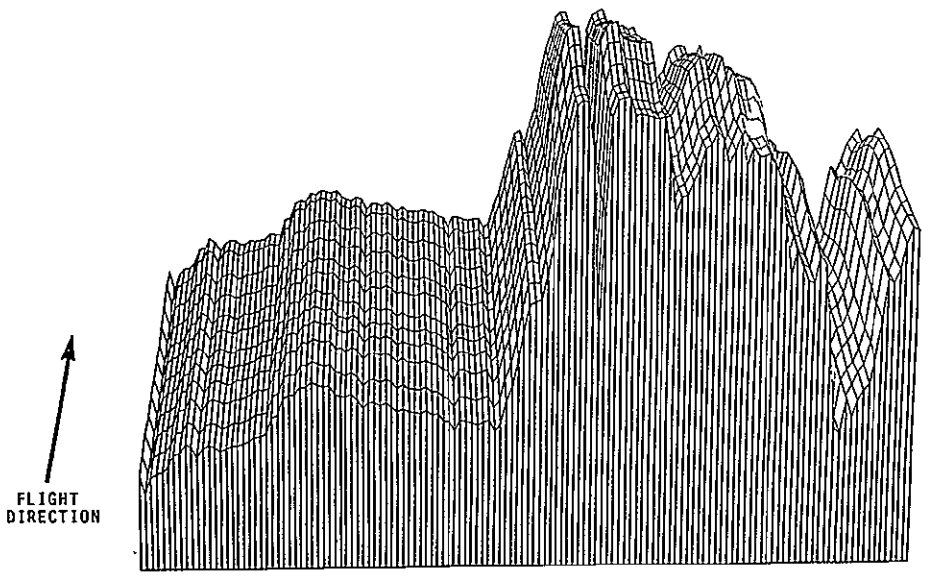
SUN ELEV = 73°

56- 67



MATURING ALFALFA

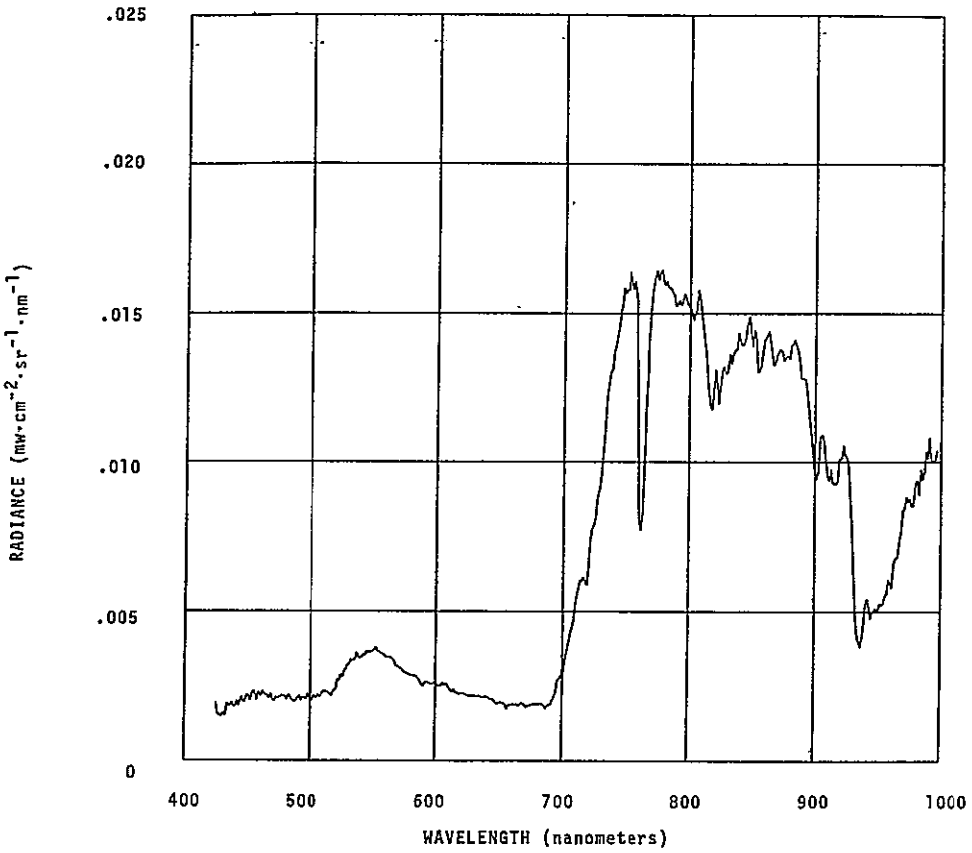
FIELD DESCRIPTION

12 to 14 inches high, 95 to 100% leaf cover, thick uniform canopy. 3rd year crop. Soil dry. Imperial, light brown silty clay (7.5YR 6/4).

PHOTO INTERPRETATION

homogeneous tone except furrows are detectable; fine texture; high density; near total cover; furrows run parallel with FL.

80



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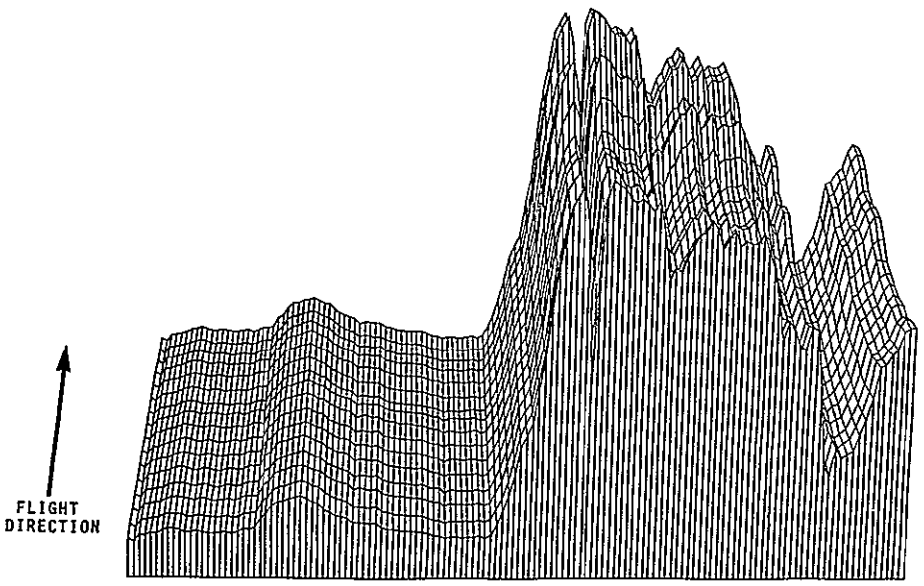
SUN ELEV = 74°

68- 83



MATURING ALFALFA

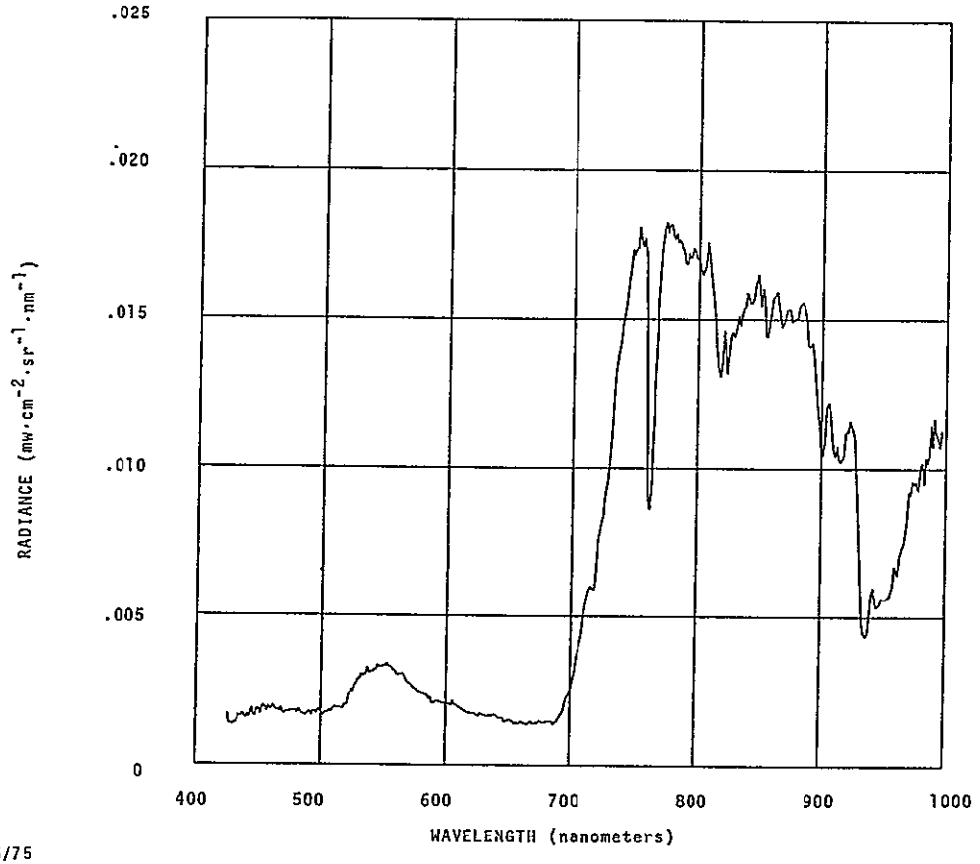
FIELD DESCRIPTION

12 to 14 inches high, 95 to 100% leaf cover, thick uniform canopy. 3rd year crop. Soil wet. Imperial, silty clay.

PHOTO INTERPRETATION

homogeneous tone except furrows are detectable; fine texture; high density; near total cover; furrows run parallel with FL.

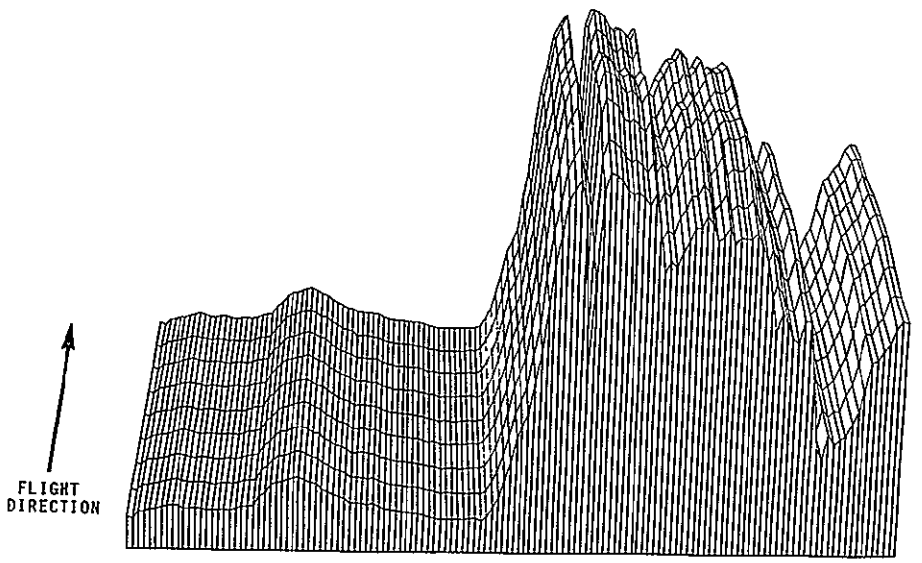
90



11:03 AM 5/16/75

SUN ELEV = 74°

84- 92



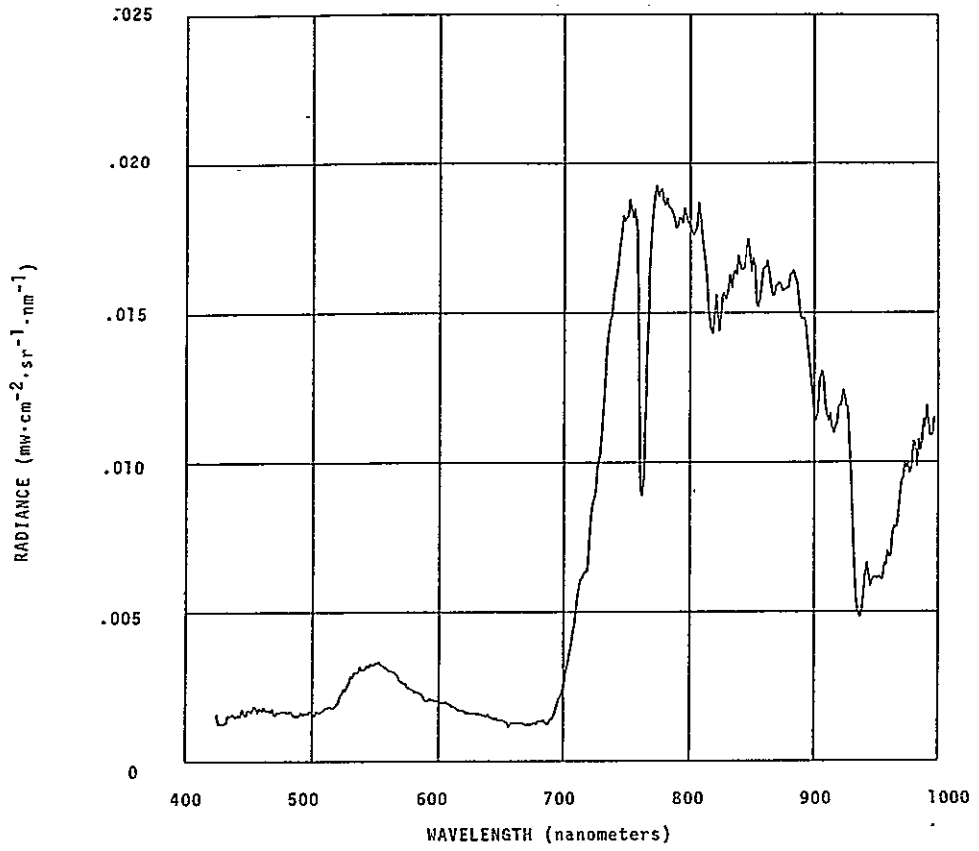
MATURING ALFALFA

FIELD DESCRIPTION

12 to 14 inches high, 100% leaf cover, thick uniform canopy. 2nd year crop. Soil wet. Imperial, silty clay.

PHOTO INTERPRETATION

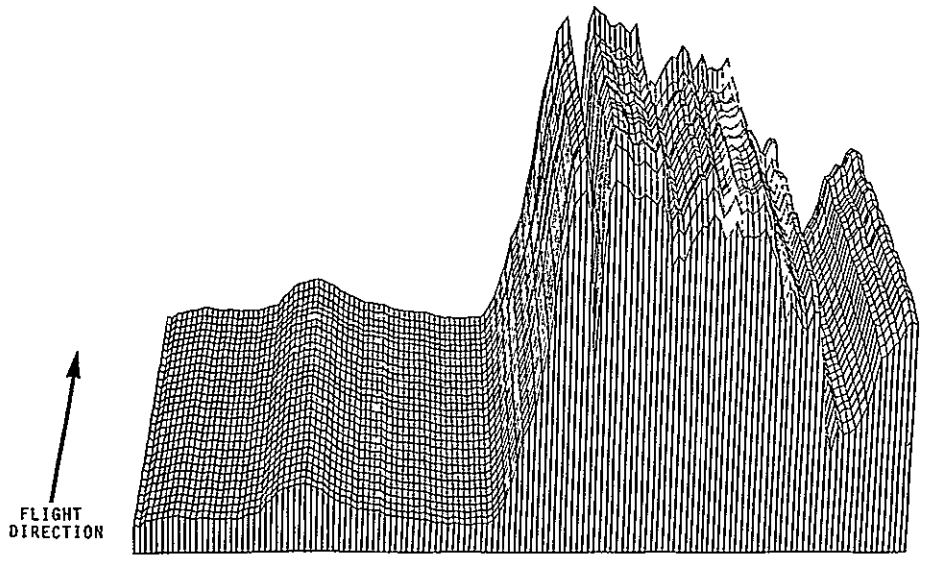
homogeneous tone; no texture, high density; total cover.



108

10:04 AM 5/15/75

SUN ELEV = 65°



93- 121

MATURING ALFALFA

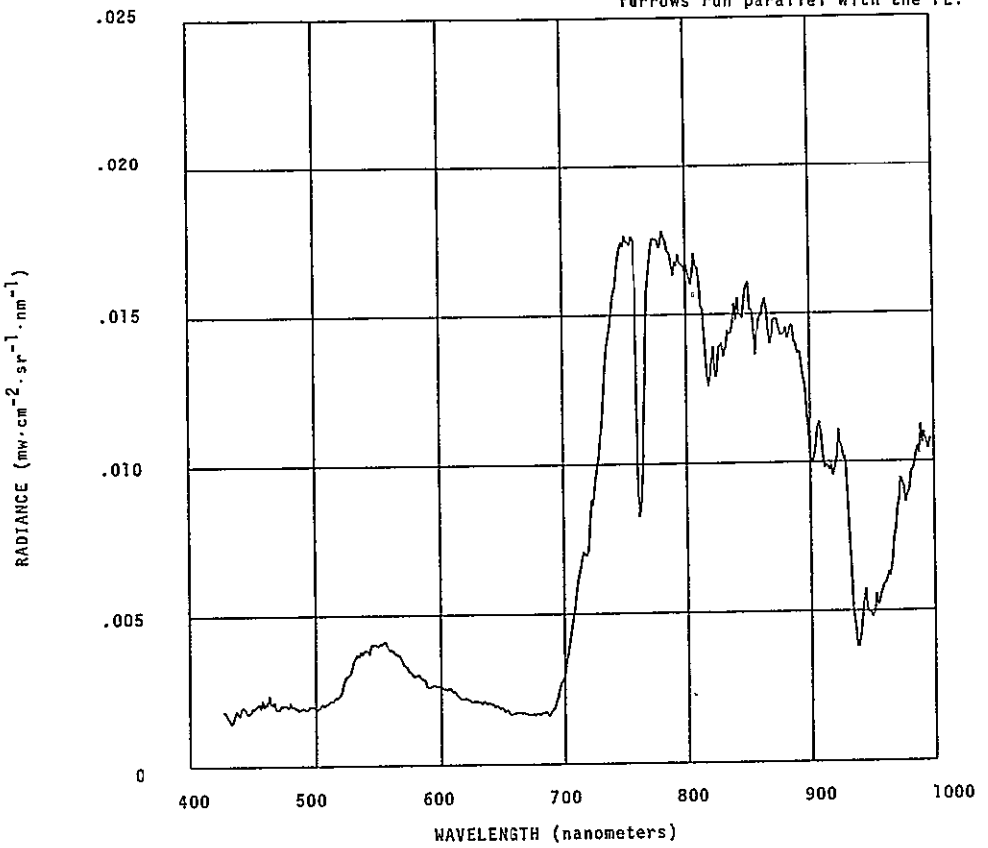
FIELD DESCRIPTION

14 inches high, 80 to 100% leaf cover, moderately thick patchy canopy. 3rd year crop. Soil dry. Imperial, light brown silty clay (7.5YR 6/4).

PHOTO INTERPRETATION

inhomogeneous tone; texture is differential and ranges from fine to medium; density is differential, ranging from medium to high with small areas of bare soil along what appears to be a previous field boundary; near total cover; furrows run parallel with the FL.

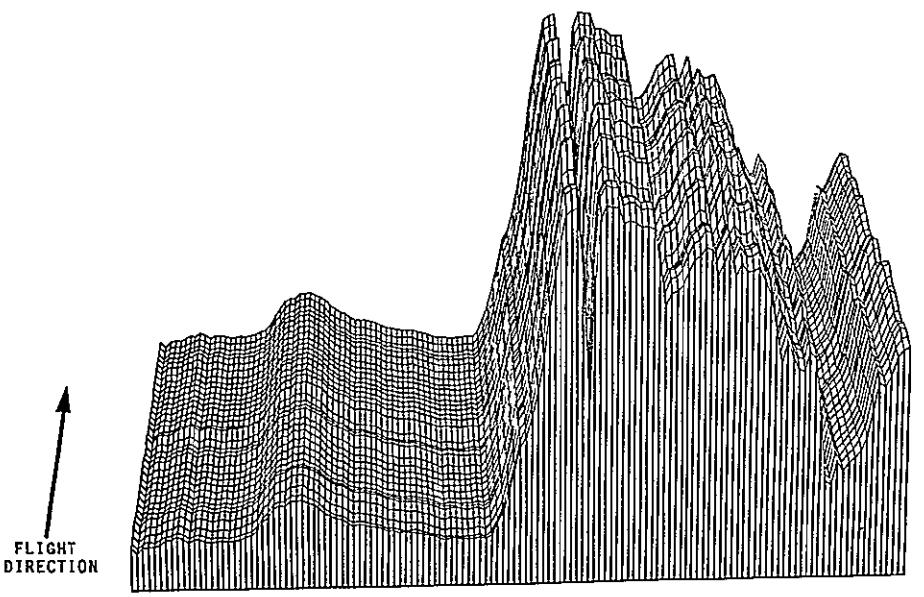
147



10:03 AM 5/16/75

SUN ELEV = 65°

122- 156



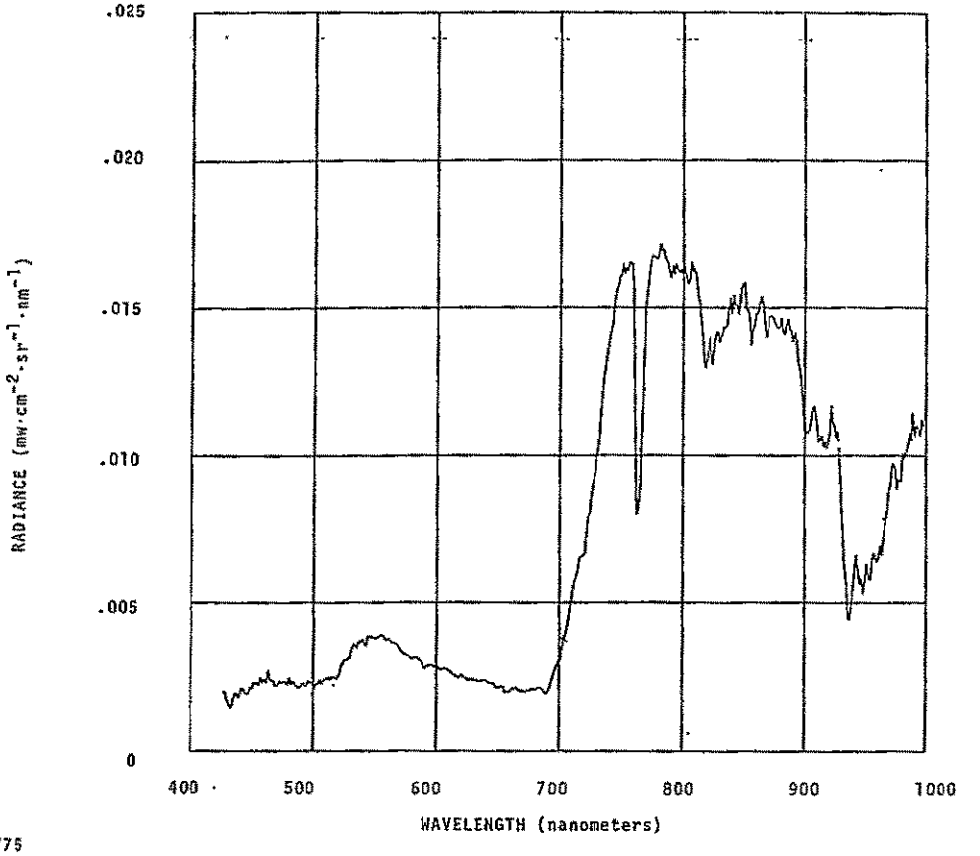
MATURING ALFALFA

FIELD DESCRIPTION

14 to 16 inches high, 90 to 95% leaf cover (2 to 5% weeds), moderately thick uniform canopy. Soil dry. Imperial, light brown silty clay (7.5YR 6/4).

PHOTO INTERPRETATION

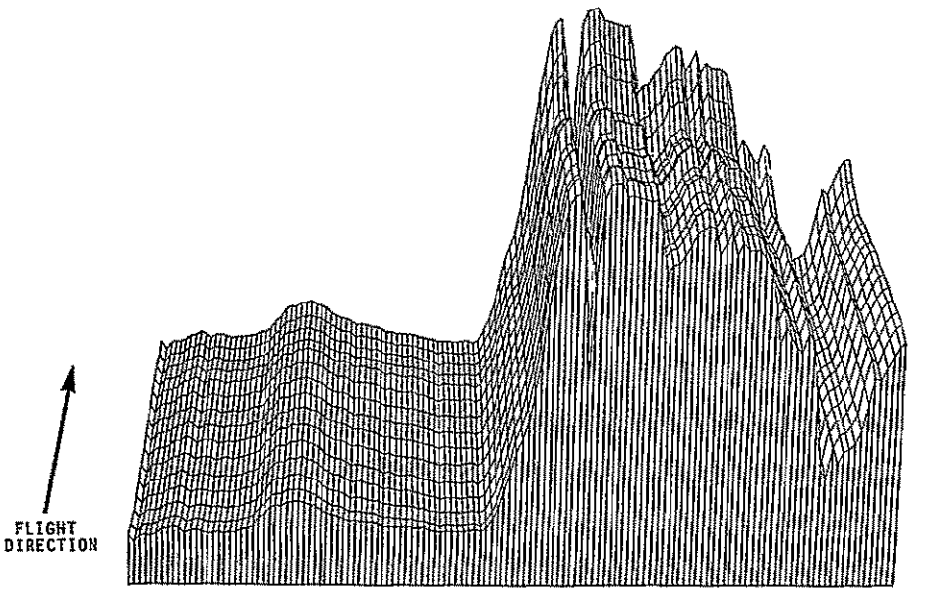
homogeneous tone except furrows are detectable; fine texture; high density; total cover; furrows run parallel to FL.



162

10:10 AM 5/15/75

SUN ELEV = 66°



157- 171

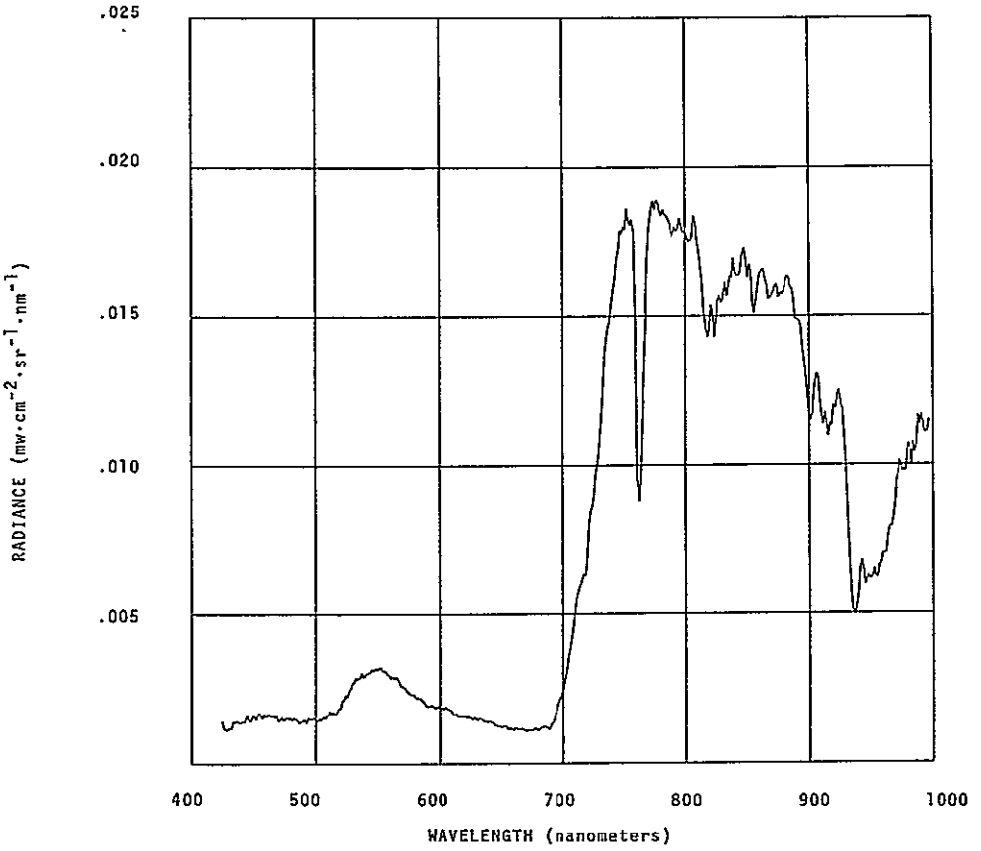
MATURING ALFALFA

FIELD DESCRIPTION

15 to 20 inches high, 100% leaf cover, thick uniform canopy. 2nd to 3rd year crop. Soil dry. Imperial, light brown silty clay (7.5YR 6/4).

PHOTO INTERPRETATION

homogeneous tone except furrows are slightly detectable; texture is absent or fine; high density; total cover.



186

10:17 AM 5/15/75

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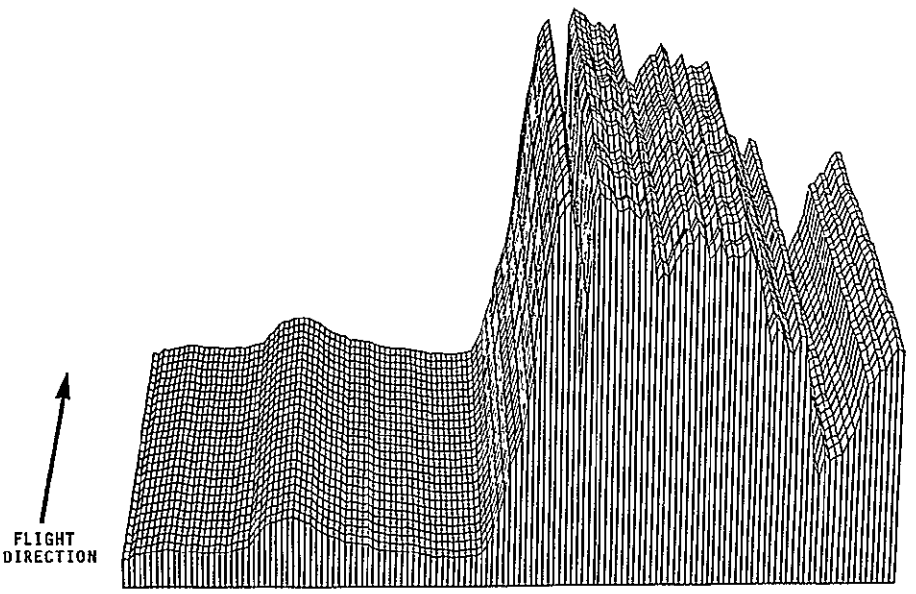


172- 198

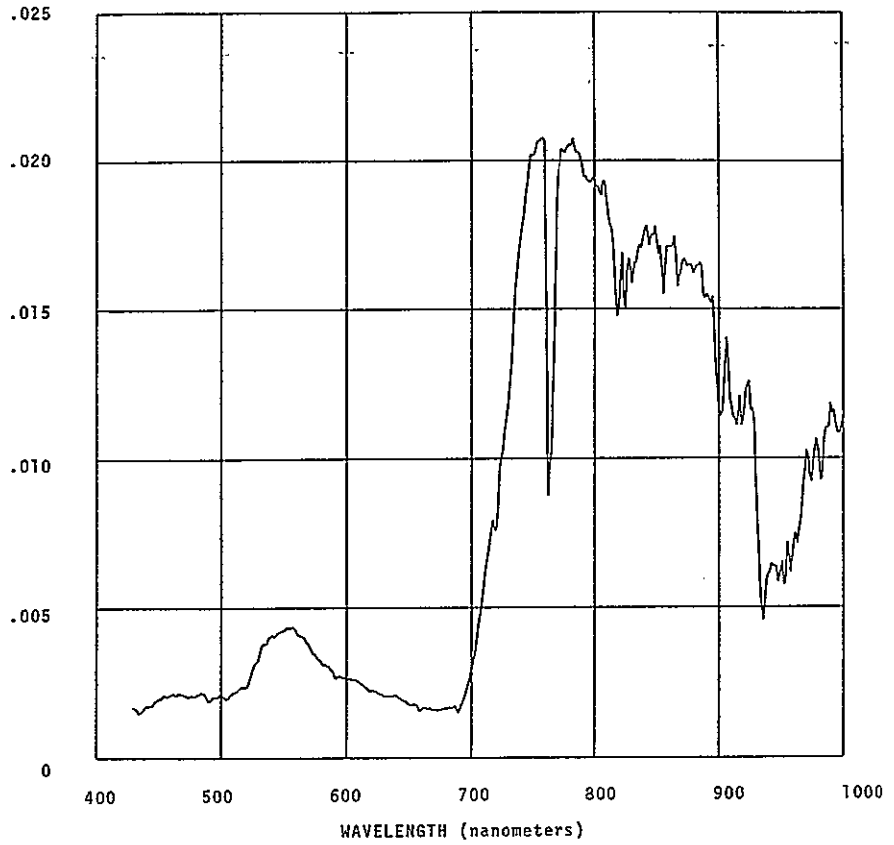
MATURING ALFALFA

FIELD DESCRIPTION

16 inches high, 100% leaf cover, uniform canopy. 1 to 3% purple flowers on alfalfa plants. 1st year crop. Soil dry. Imperial, light brown silty clay (7.5YR 6/4).

PHOTO INTERPRETATION

homogeneous tone except furrows are detectable; fine texture; high density; total cover; furrows run parallel with FL.



204

10:44 AM 9/23/75

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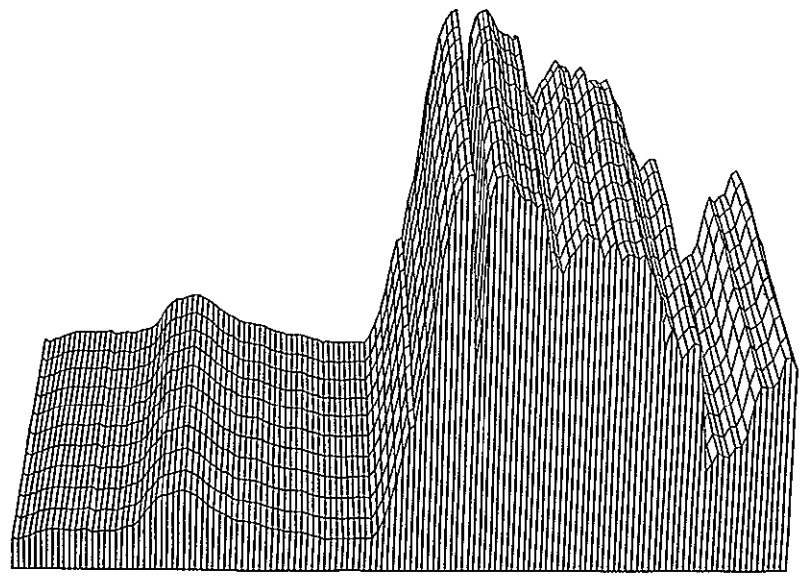


199- 209

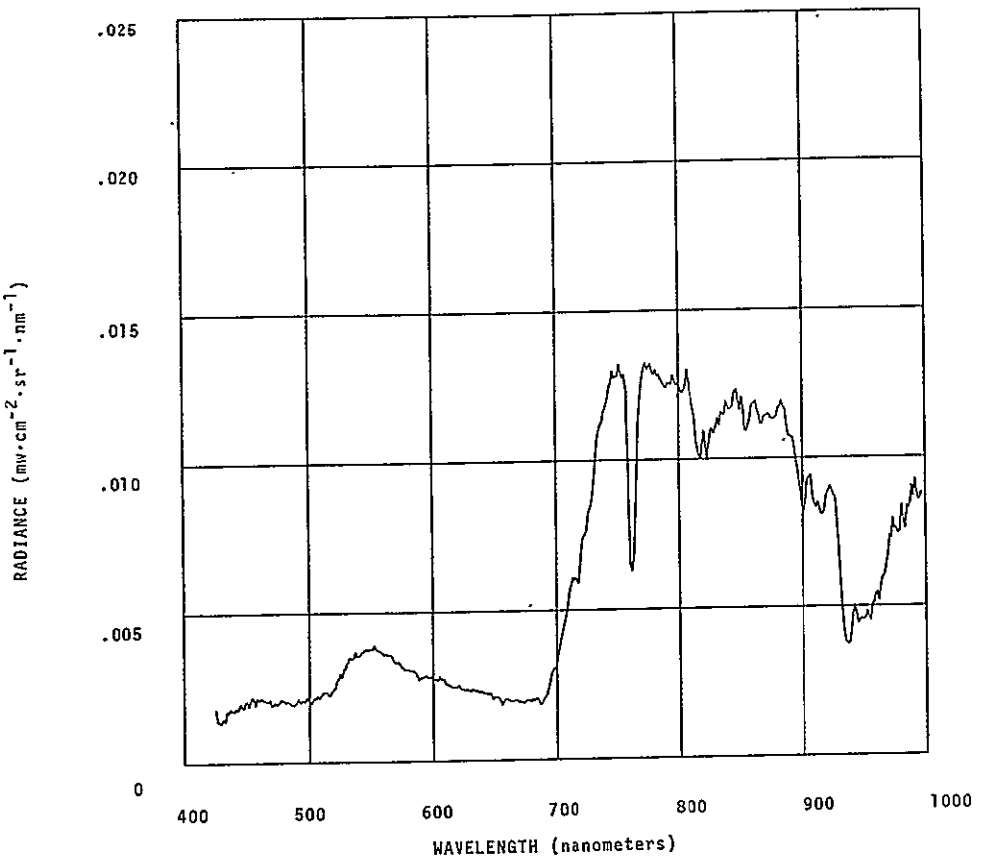
MATURING ALFALFA

FIELD DESCRIPTION

16 to 18 inches high, 100% leaf cover (10 to 20% white weeds), thick variable canopy. Purple flowers, 1 to 3% of alfalfa plants. 1st year crop. Soil moist. Imperial, silty clay.

PHOTO INTERPRETATION

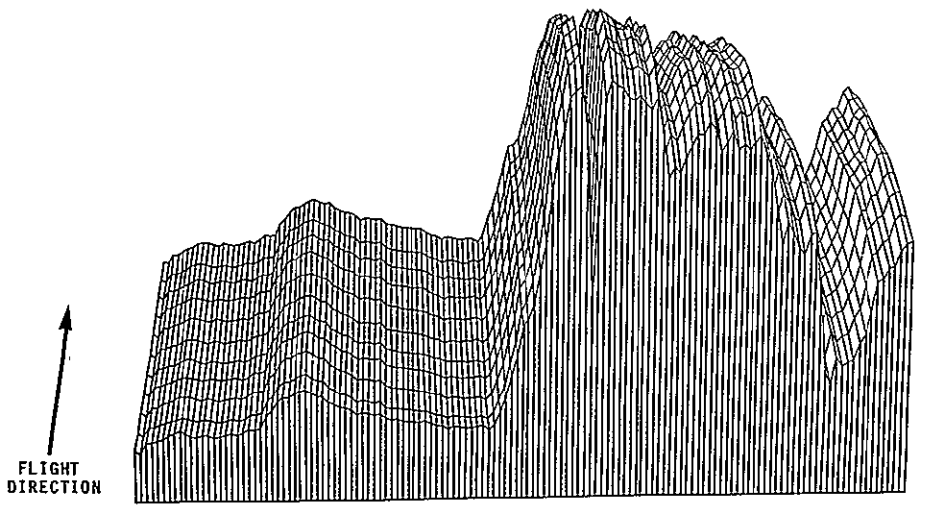
homogeneous tone except furrows are detectable; fine texture; high density; total cover; furrows run parallel with FL



216

10:04 AM 5/15/75

SUN ELEV = 65°



210- 220

MATURING ALFALFA

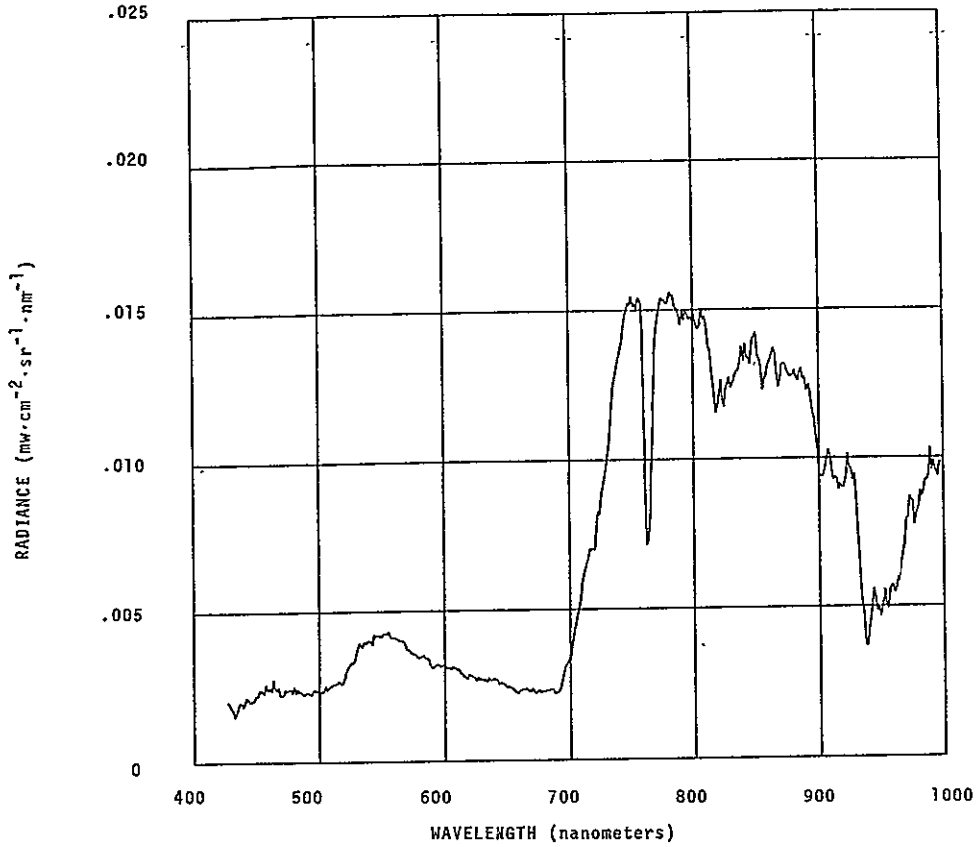
FIELD DESCRIPTION

16 to 18 inches high, 100% leaf cover (10 to 20% white weeds), thick variable canopy. Purple flowers, 1 to 3% of alfalfa plants. 1st year crop. Soil moist. Imperial, silty clay.

PHOTO INTERPRETATION

homogeneous tone; medium texture; medium density, a few very small scattered areas lighter tone; near total cover; furrows run parallel with FL.

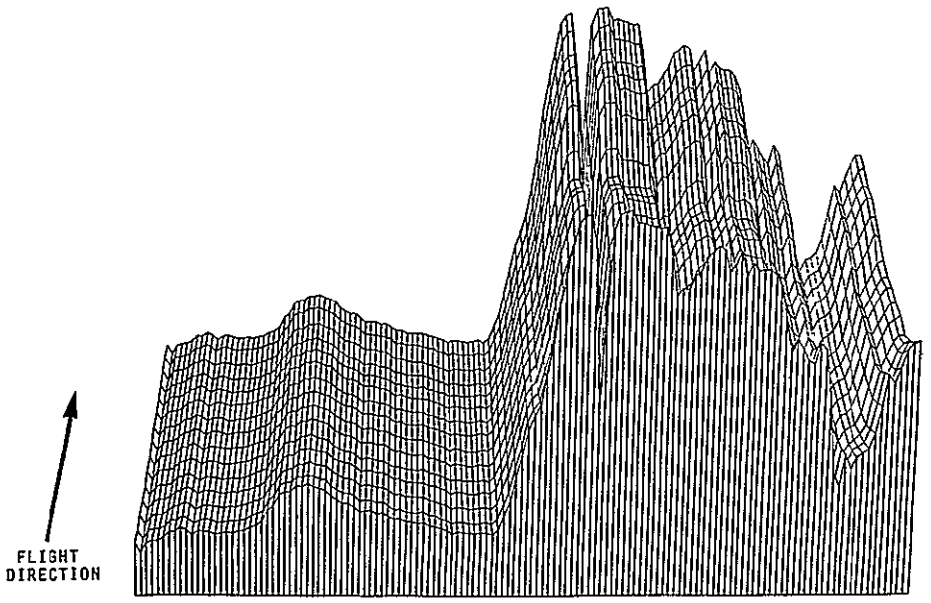
230



10:10 AM 5/15/75

SUN ELEV = 66°

221- 235



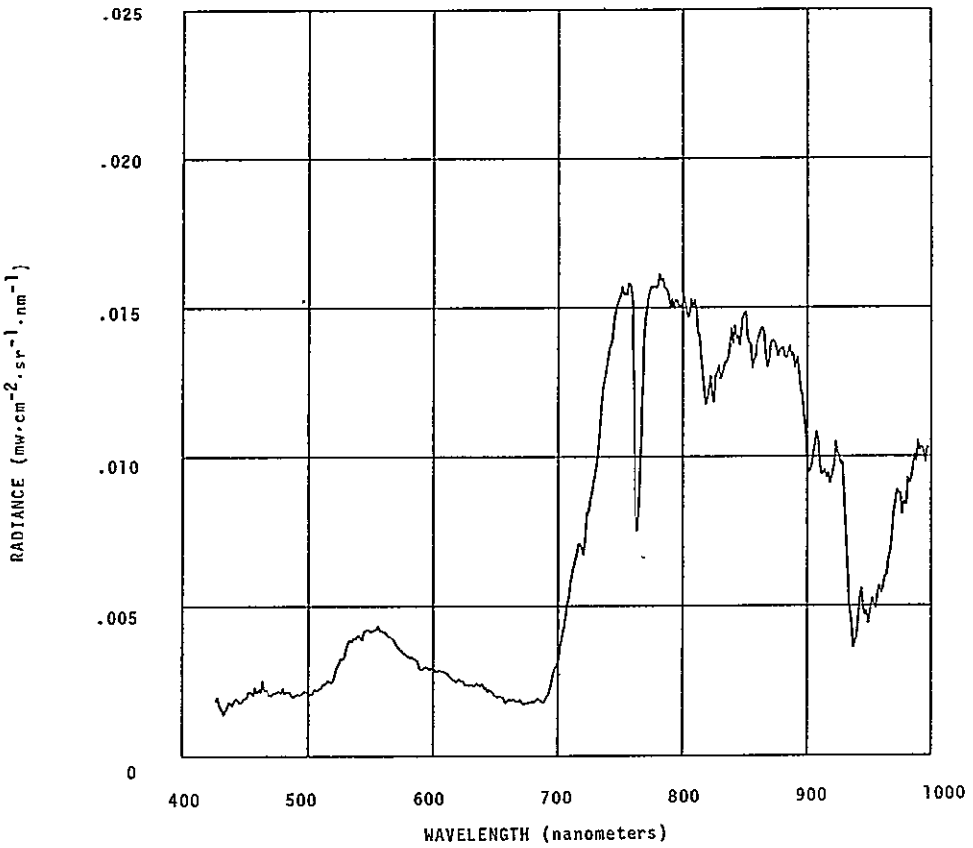
MATURING ALFALFA

F I E L D D E S C R I P T I O N

16 to 18 inches high (30% weeds 26 to 30 inches high), 100% leaf cover, thick uniform canopy. 1st year crop. Soil dry. Imperial, light brown silty clay (7.5YR 6/4).

P H O T O I N T E R P R E T A T I O N

homogeneous tone except furrows are detectable; fine texture; high density; total cover; furrows run parallel with FL.



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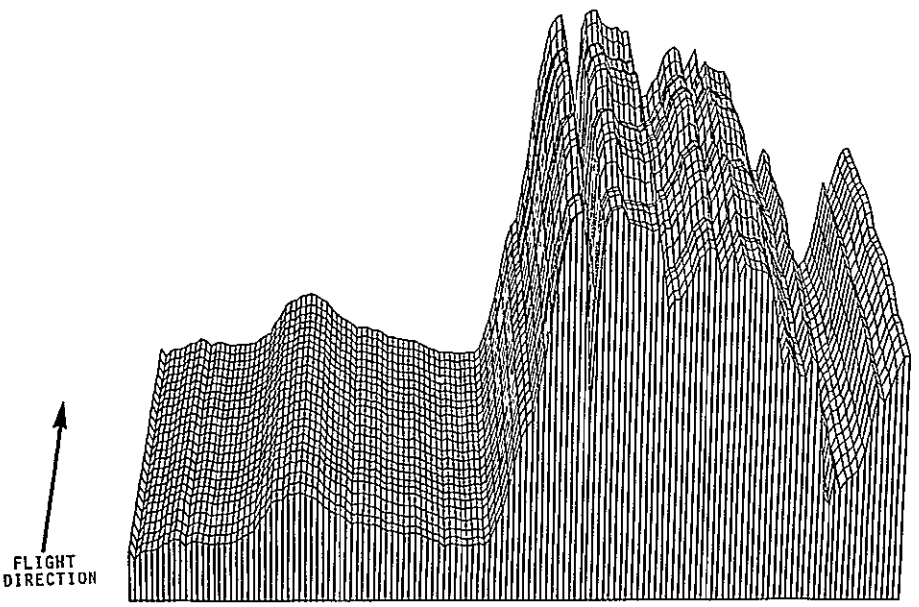
SUN ELEV = 73°



236- 260

MATURING ALFALFA

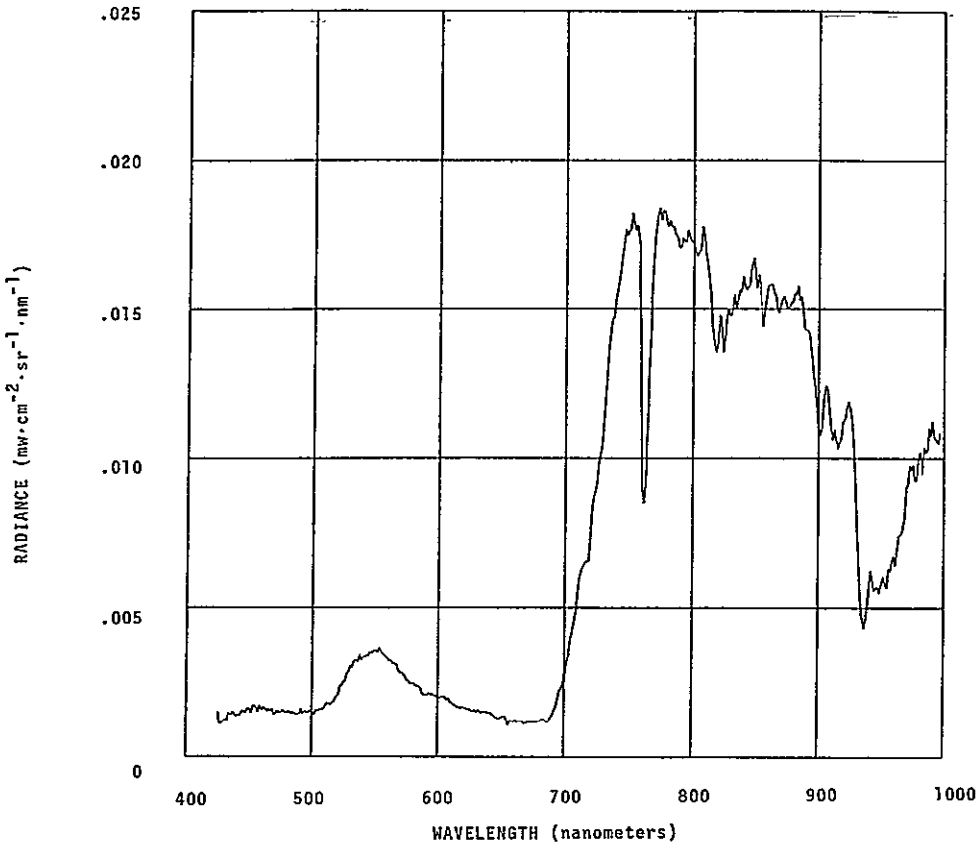
FIELD DESCRIPTION

18 inches high, 100% leaf cover, thick uniform canopy. 1st year crop. Soil moist. Imperial, silty clay.

PHOTO INTERPRETATION

homogeneous tone except furrows are detectable; fine texture; high density; near total cover; furrows run parallel with FL.

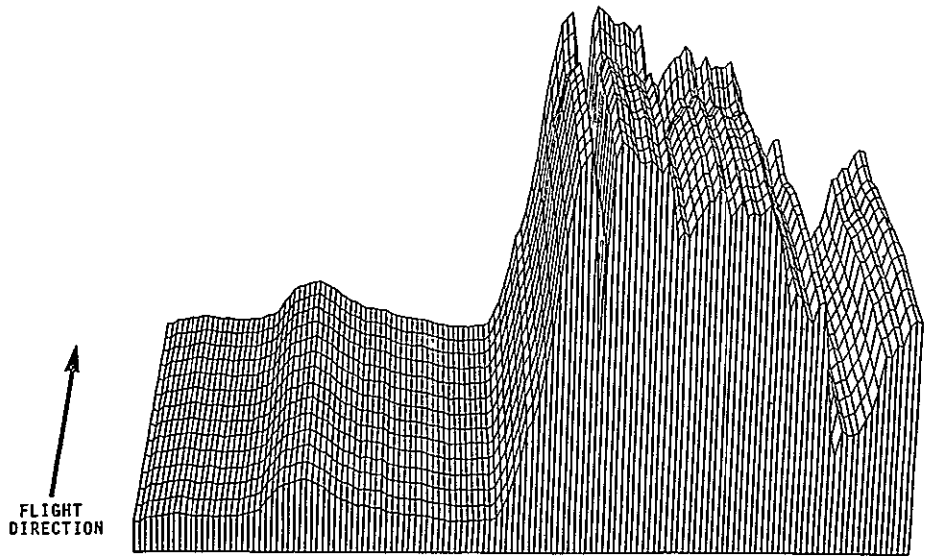
269.



9:51 AM 5/15/75

SUN ELEV = 62°

261- 274



MATURING ALFALFA

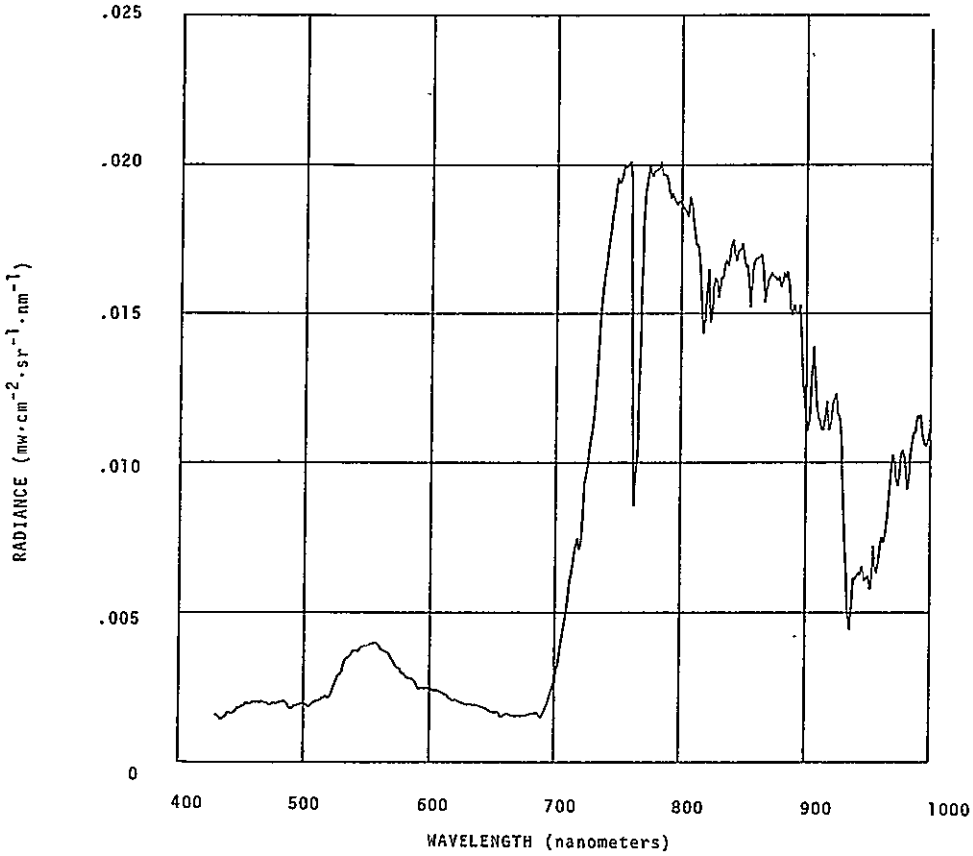
FIELD DESCRIPTION

18 inches high, 100% leaf cover, thick uniform canopy. 1st to 2nd year crop. Soil dry. Imperial, light brown silty clay (7.5YR 6/4).

PHOTO INTERPRETATION

homogeneous tone, except furrows are detectable; fine texture; high density; total cover; furrows run parallel with FL.

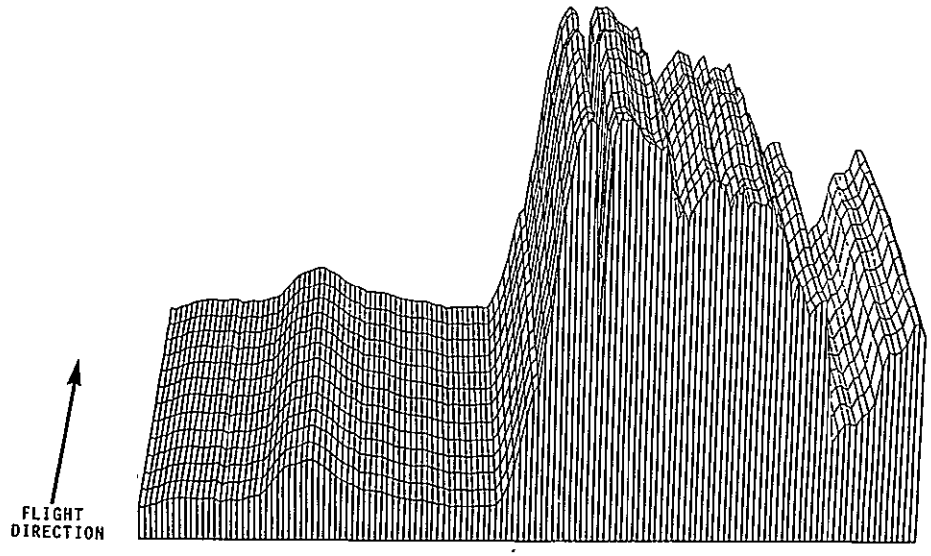
278



10:32 AM 9/23/75

SUN ELEV = 54°

275- 287



MATURING ALFALFA

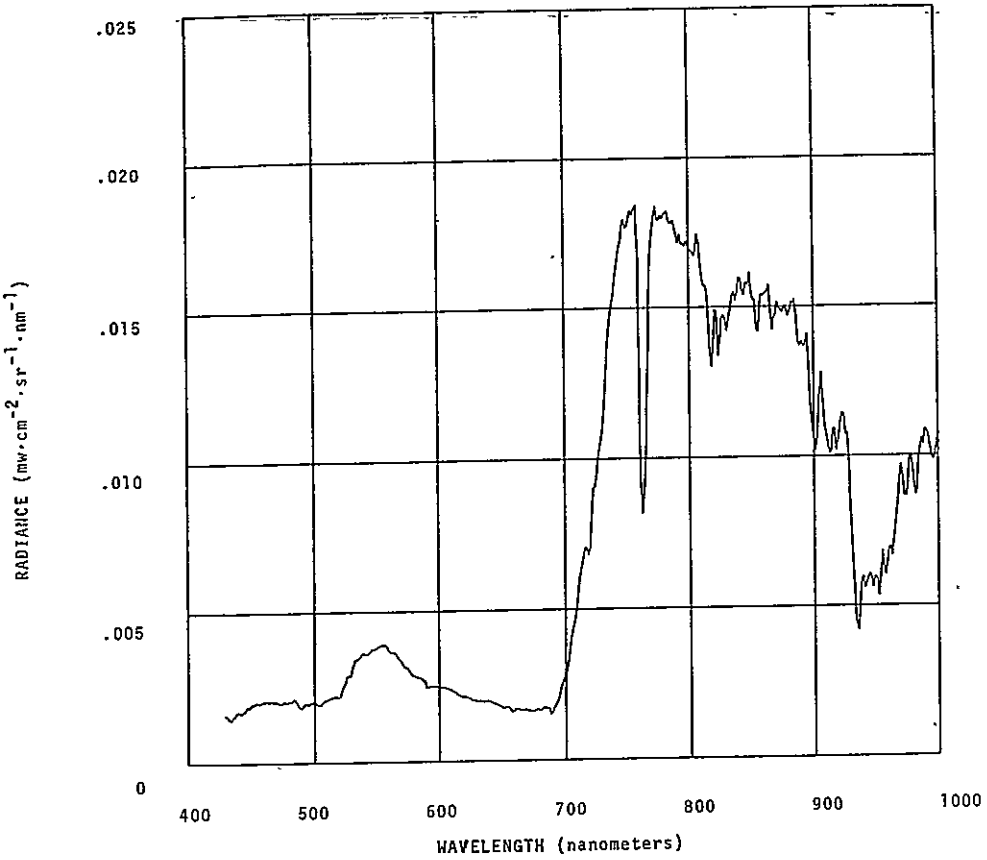
FIELD DESCRIPTION

18 inches high, 100% leaf cover, thick uniform canopy. 1st to 2nd year crop. Soil dry. Imperial, light brown silty clay (7.5YR 6/4).

PHOTO INTERPRETATION

inhomogeneous tone; medium texture; density is high with the exception of scattered small sparse areas; near total cover; furrows run parallel with FL.

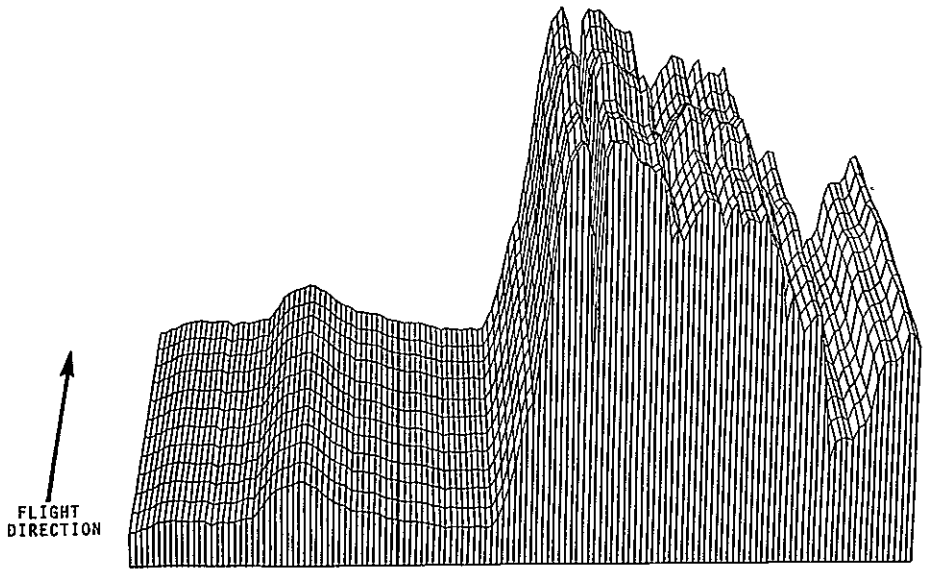
292



10:26 AM 9/23/75

SUN ELEV = 54°

288- 299



MATURING ALFALFA

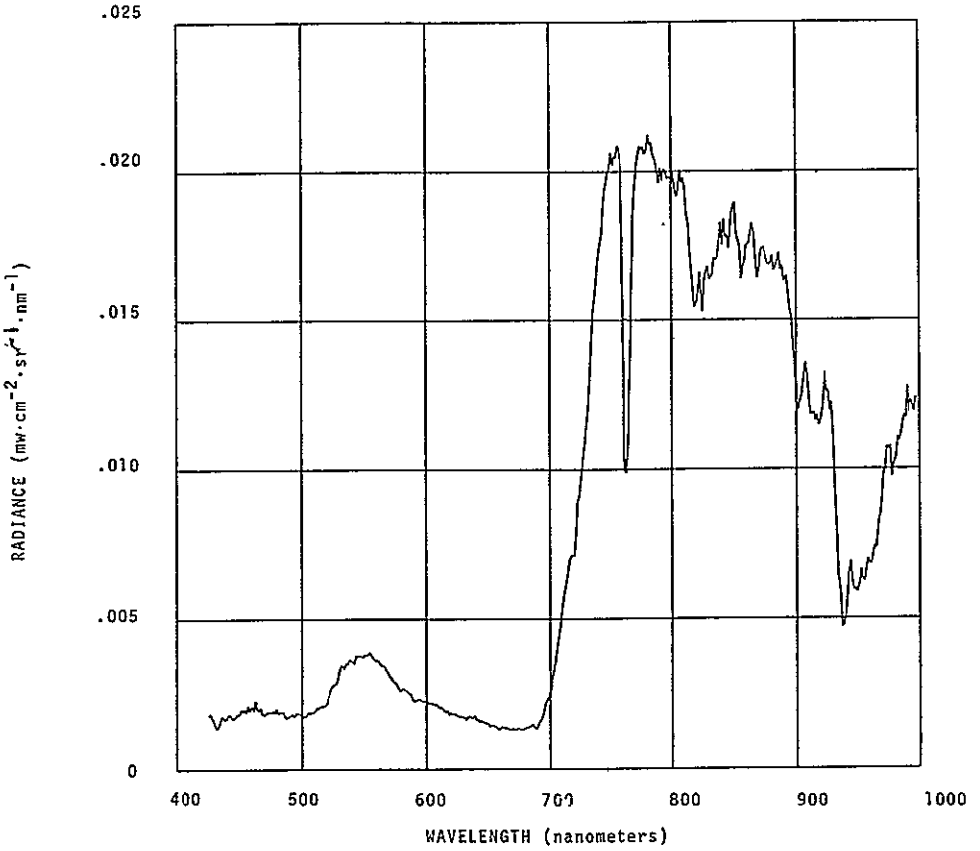
FIELD DESCRIPTION

18 to 20 inches high, 100% leaf cover, thick uniform canopy. Soil wet. Imperial, silty clay.

PHOTO INTERPRETATION

homogeneous tone; no texture; high density; total cover.

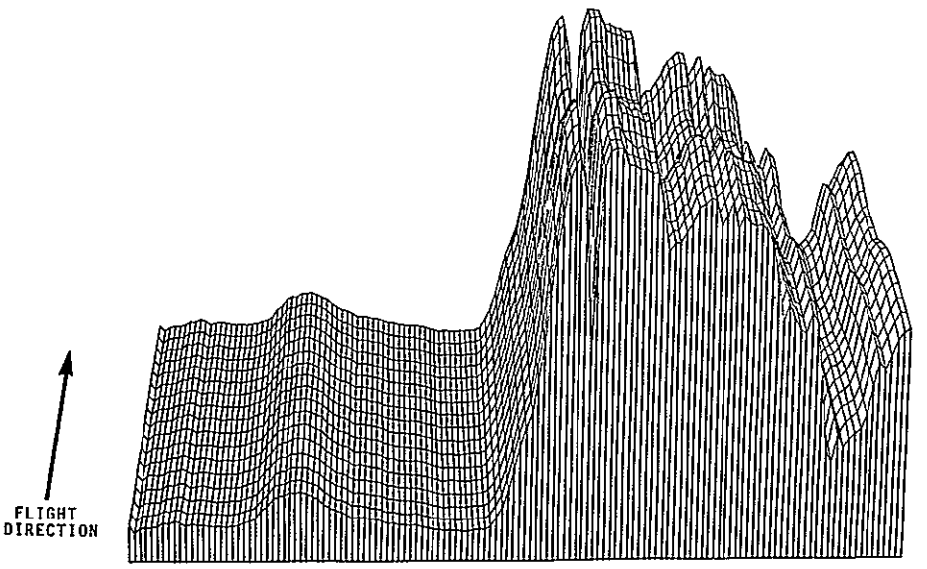
312



10:34 AM 5/16/75

SUN ELEV = 70°

300- 316



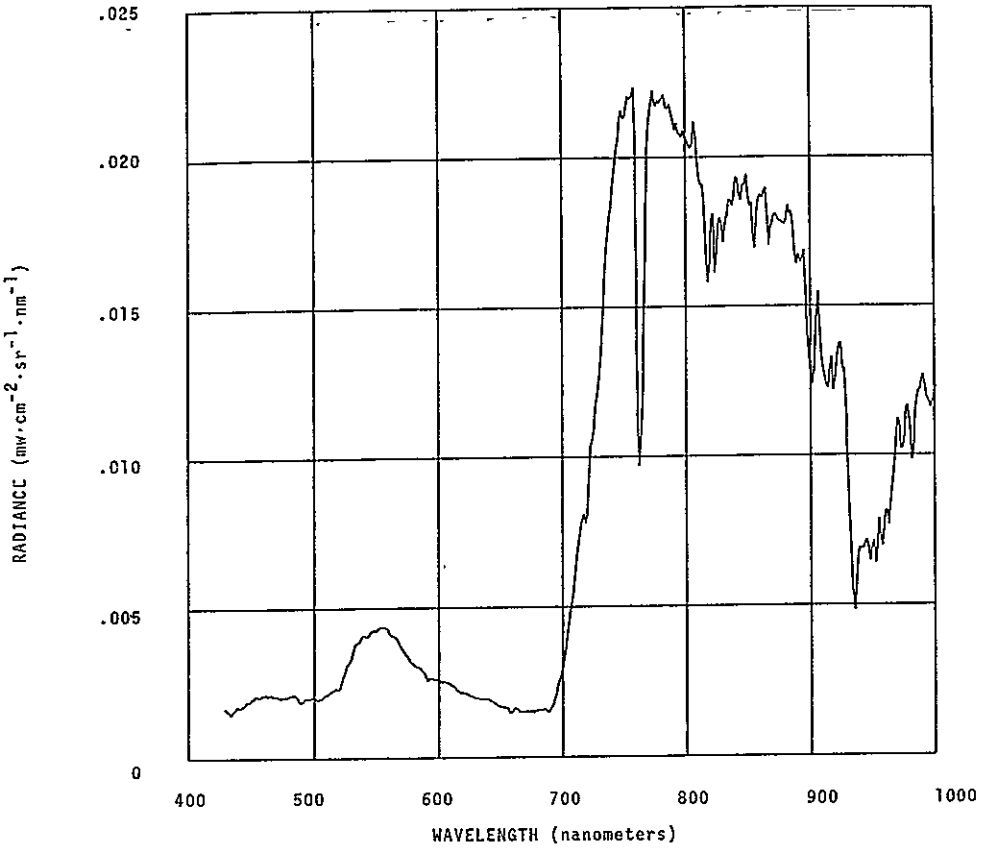
MATURE ALFALFA

FIELD DESCRIPTION

20 inches high, 100% leaf cover, thick uniform canopy. 1 to 3% purple flowers on alfalfa plants. 2nd year crop. Soil dry. Imperial, light brown silty clay (7.5YR 6/4).

PHOTO INTERPRETATION

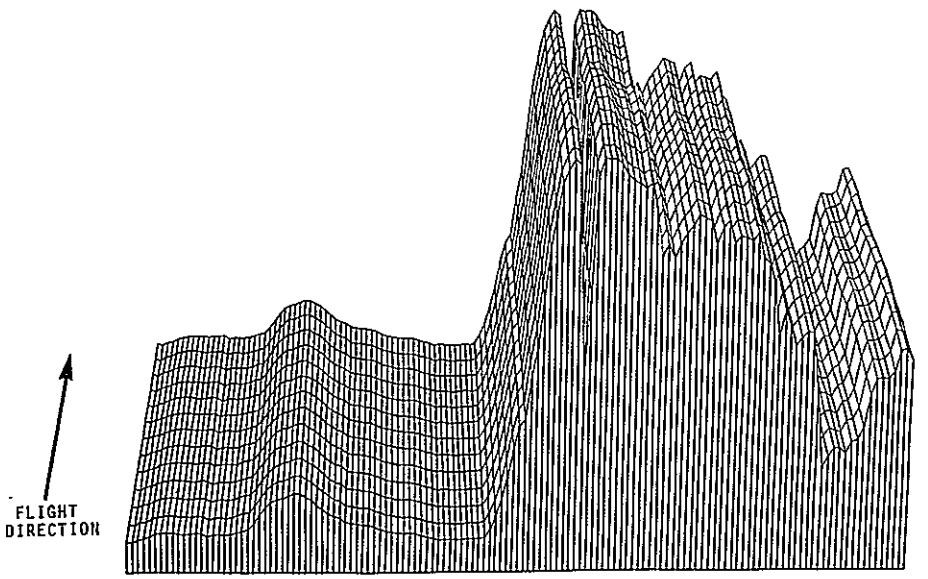
homogeneous tone except furrows are slightly detectable; fine texture; high density; total cover; furrows run parallel with FL.



324

10:32 AM 9/23/75

SUN ELEV = 54°



317- 329

MATURE ALFALFA

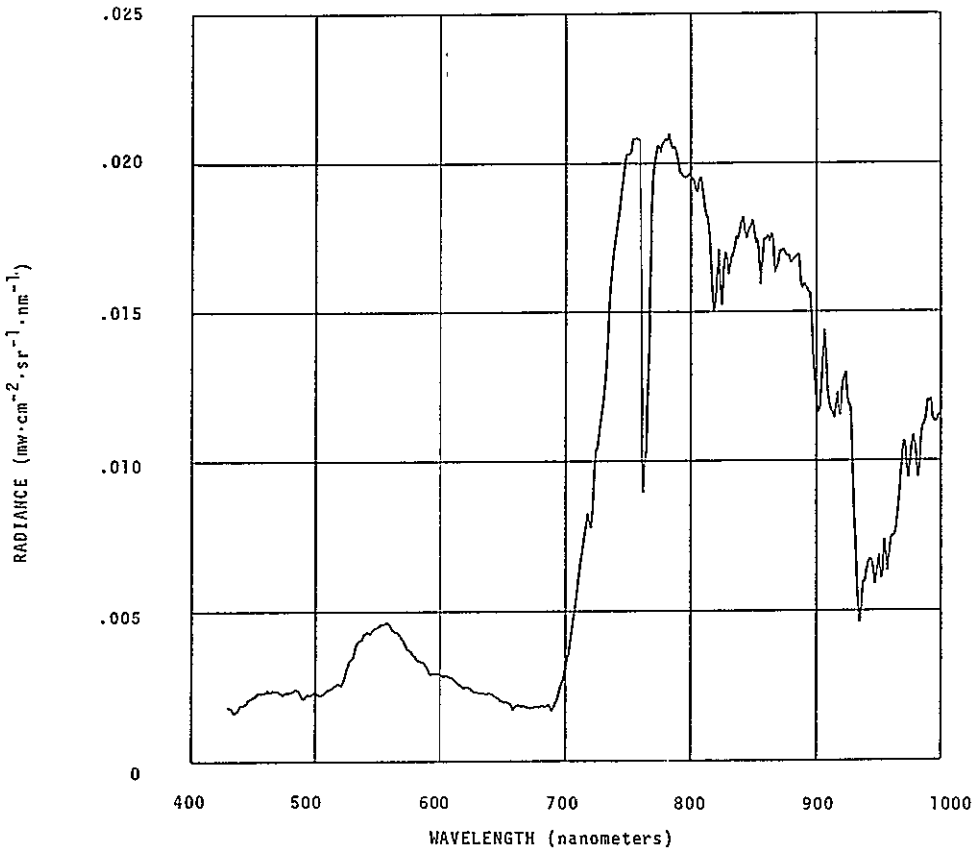
FIELD DESCRIPTION

20 inches high, 100% leaf cover, uniform canopy. 1 to 3% purple flowers on alfalfa plants. 2nd year crop. Soil dry. Imperial, light brown silty clay (7.5YR 6/4).

PHOTO INTERPRETATION

homogeneous tone except furrows are detectable, fine texture; high density; total cover; furrows run parallel with FL.

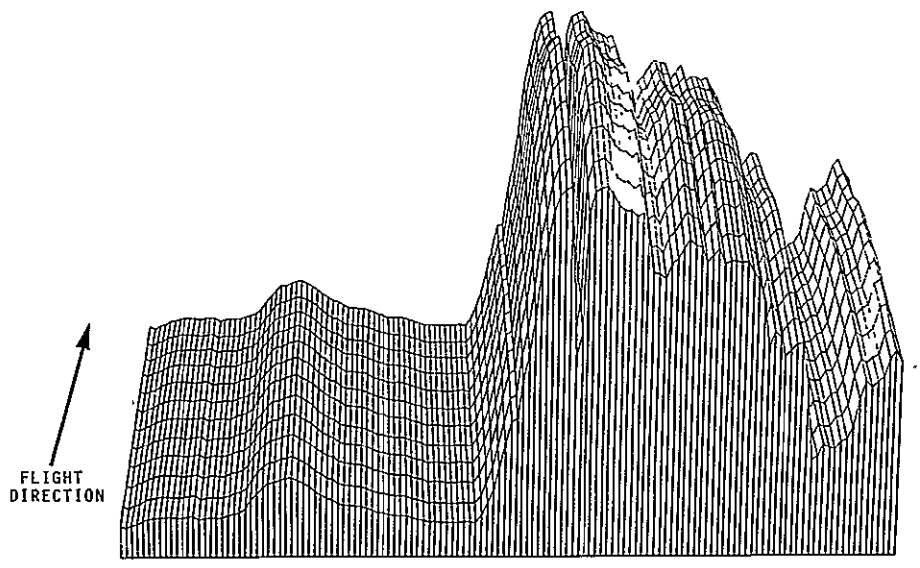
338



10·44 AM 9/23/75

SUN ELEV = 55°

330- 341



MATURE ALFALFA

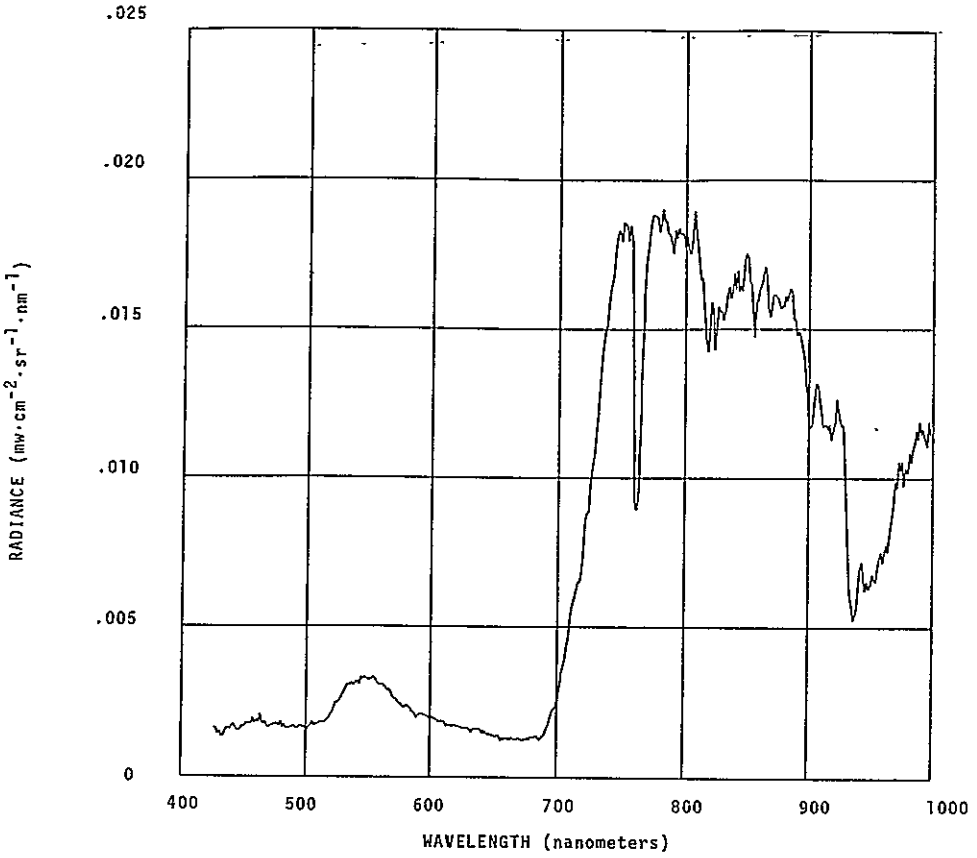
FIELD DESCRIPTION

20 inches high, 100% leaf cover, thick uniform canopy. 2nd to 3rd year crop. Soil dry. Imperial, light brown silty clay (7.5YR 6/4).

PHOTO INTERPRETATION

homogeneous tone except for slight furrow detection; fine texture; high density; total cover; furrows run parallel with FL.

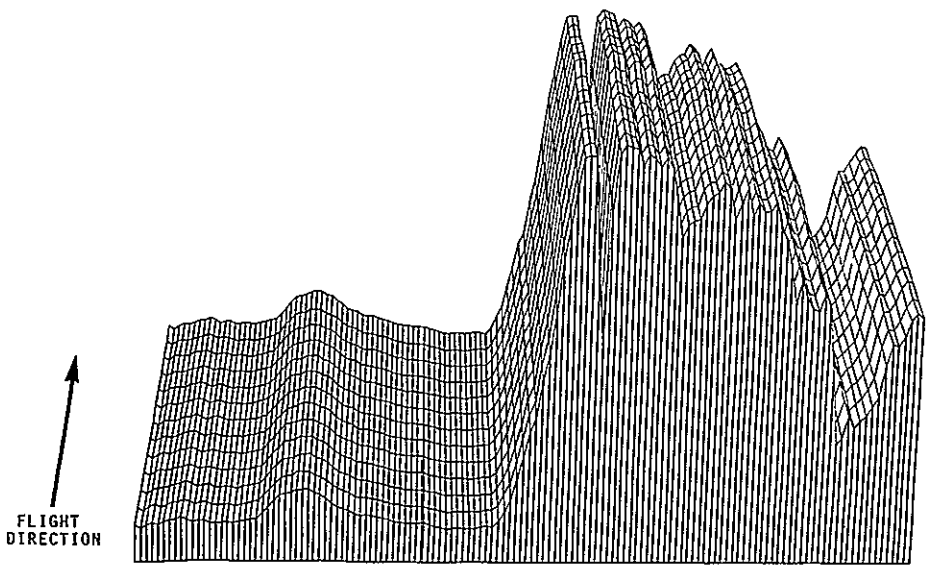
347



9:28 AM 5/15/75

SUN ELEV = 58°

342- 354



MATURE ALFALFA

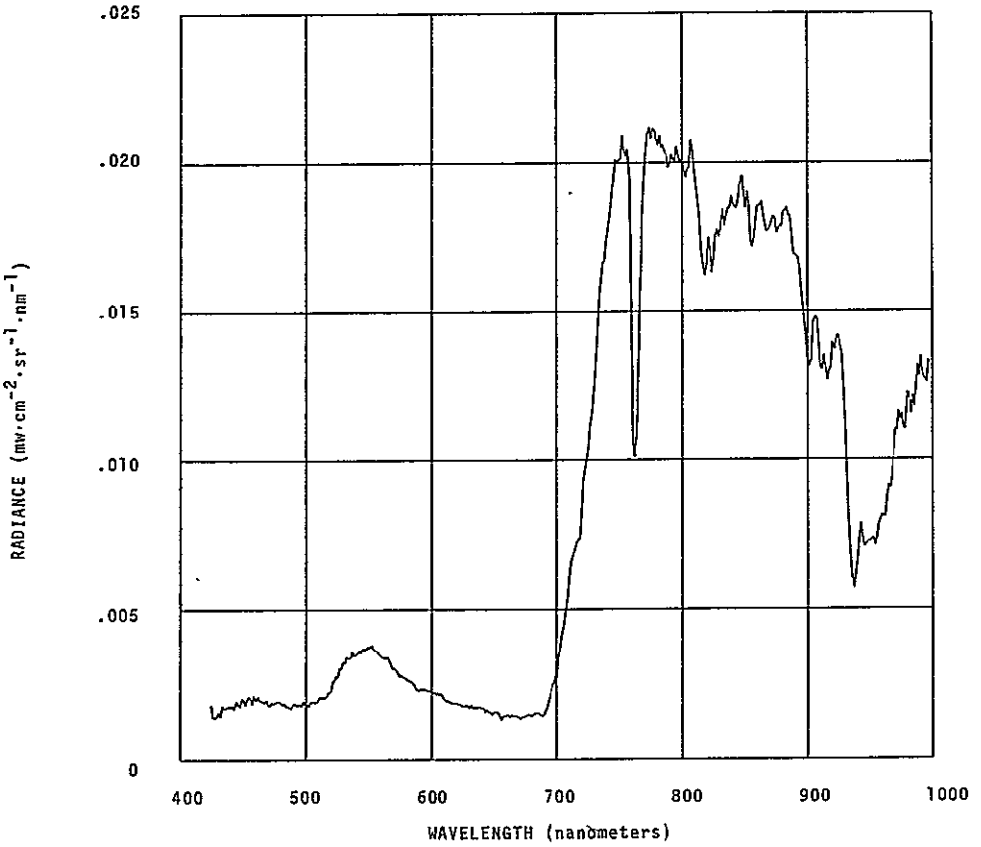
FIELD DESCRIPTION

20 inches high, 100% leaf cover, thick uniform canopy. 2nd to 3rd year crop. Soil dry. Imperial, light brown silty clay (7.5YR 6/4).

PHOTO INTERPRETATION

homogeneous tone, except furrows are detectable; fine texture; high density; total cover; furrows run parallel with FL.

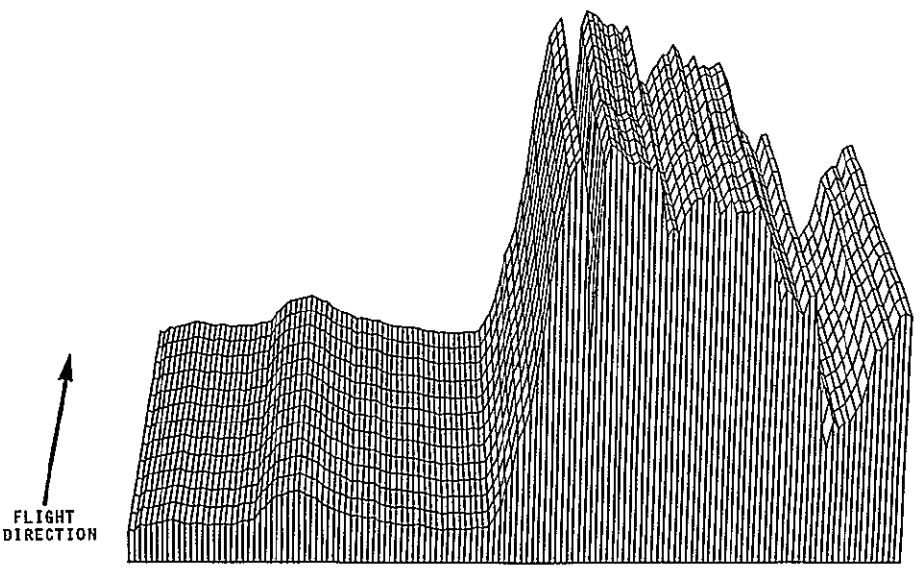
359



10:42 AM 5/15/75

SUN ELEV = 71°

355- 367



MATURE ALFALFA

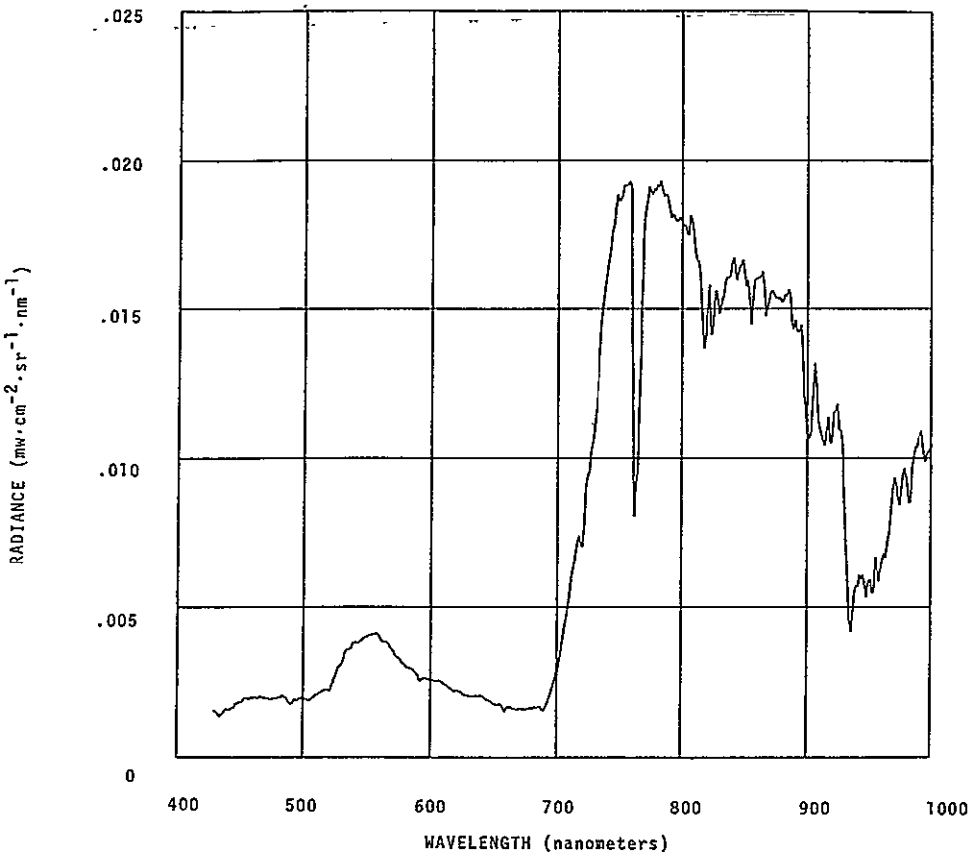
FIELD DESCRIPTION

20 inches high, 100% leaf cover, uniform canopy. 1 to 3% purple flowers on alfalfa plants. 3rd year crop. Soil dry. Imperial, light brown silty clay (7.5YR 6/4).

PHOTO INTERPRETATION

homogeneous tone except furrows are slightly detectable; high density; total cover; furrows run perpendicular to FL.

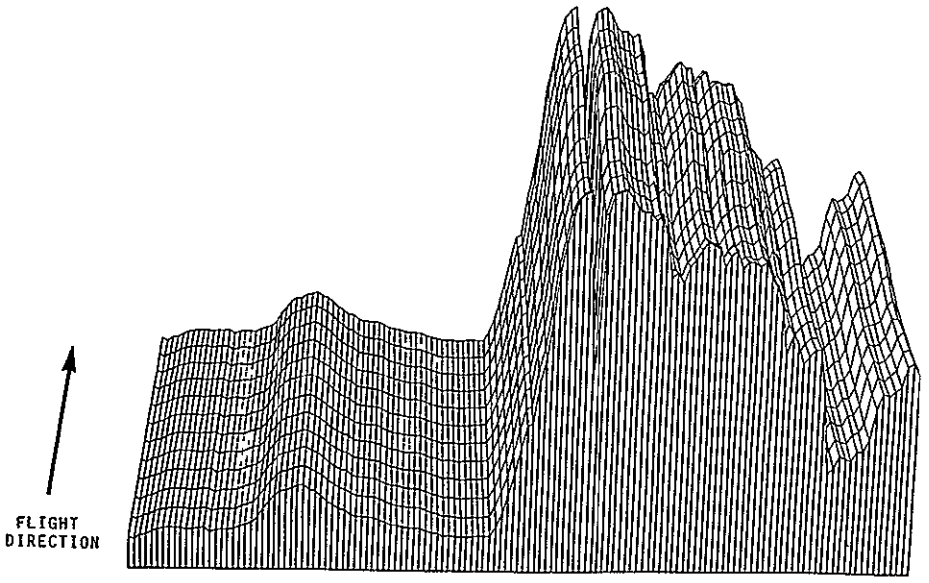
373



10:37 AM 9/23/75

SUN ELEV = 55°

368- 379



MATURE ALFALFA

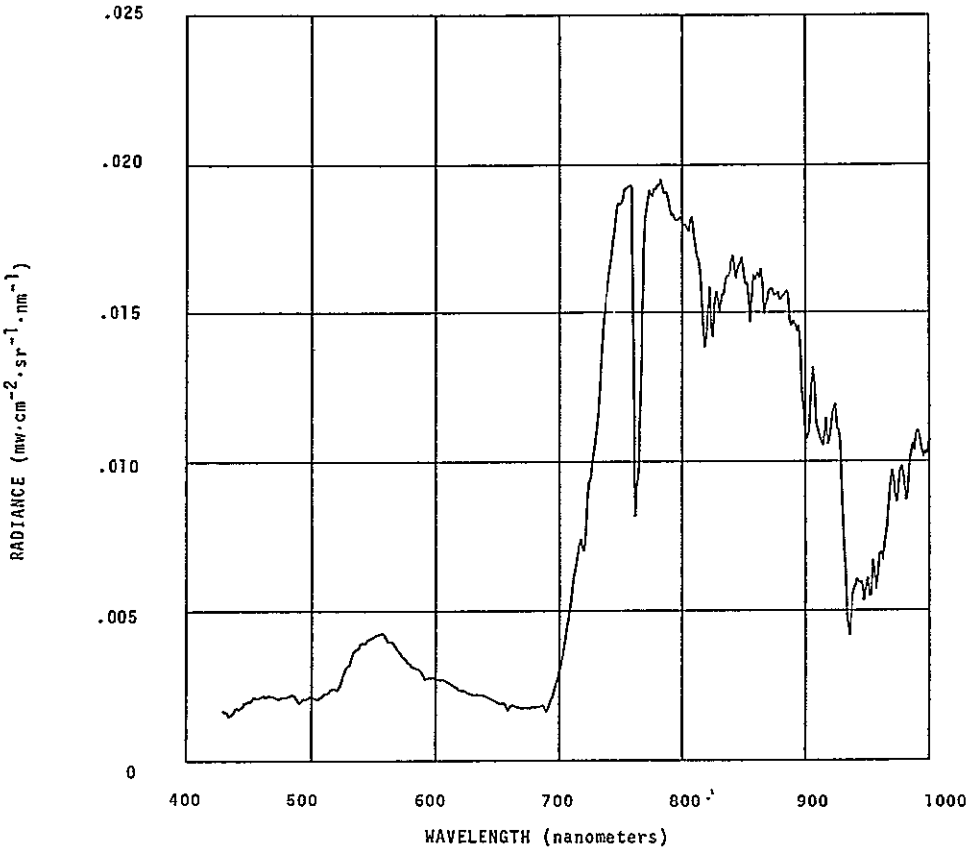
FIELD DESCRIPTION

20 inches high, 100% leaf cover, uniform canopy. 1 to 3% purple flowers on alfalfa plants. 3rd year crop. Soil dry. Imperial, light brown silty clay (7.5YR 6/4).

PHOTO INTERPRETATION

homogeneous tone except furrows are detectable; medium texture; high density; total cover; furrows run perpendicular to FL.

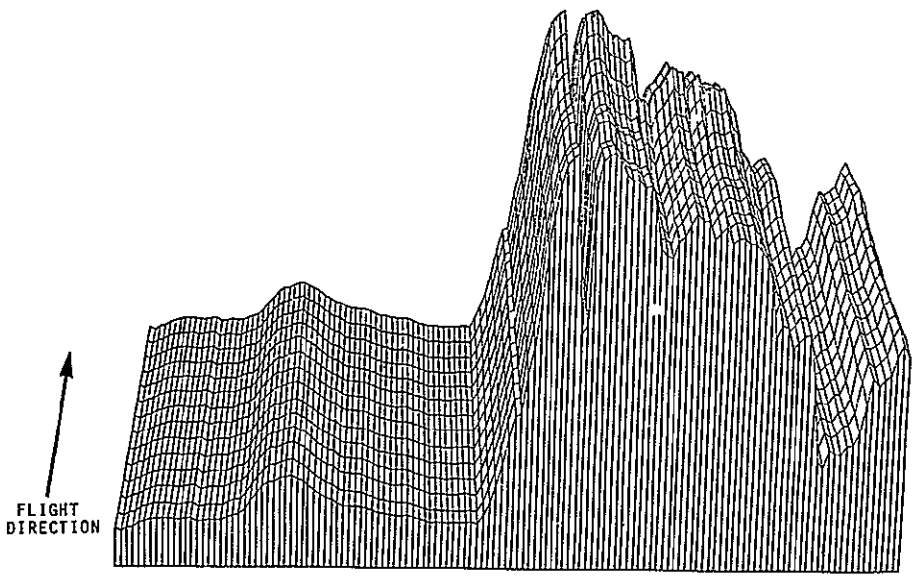
384



10:44 AM 9/23/75

SUN ELEV = 55°

380- 393



MATURE ALFALFA

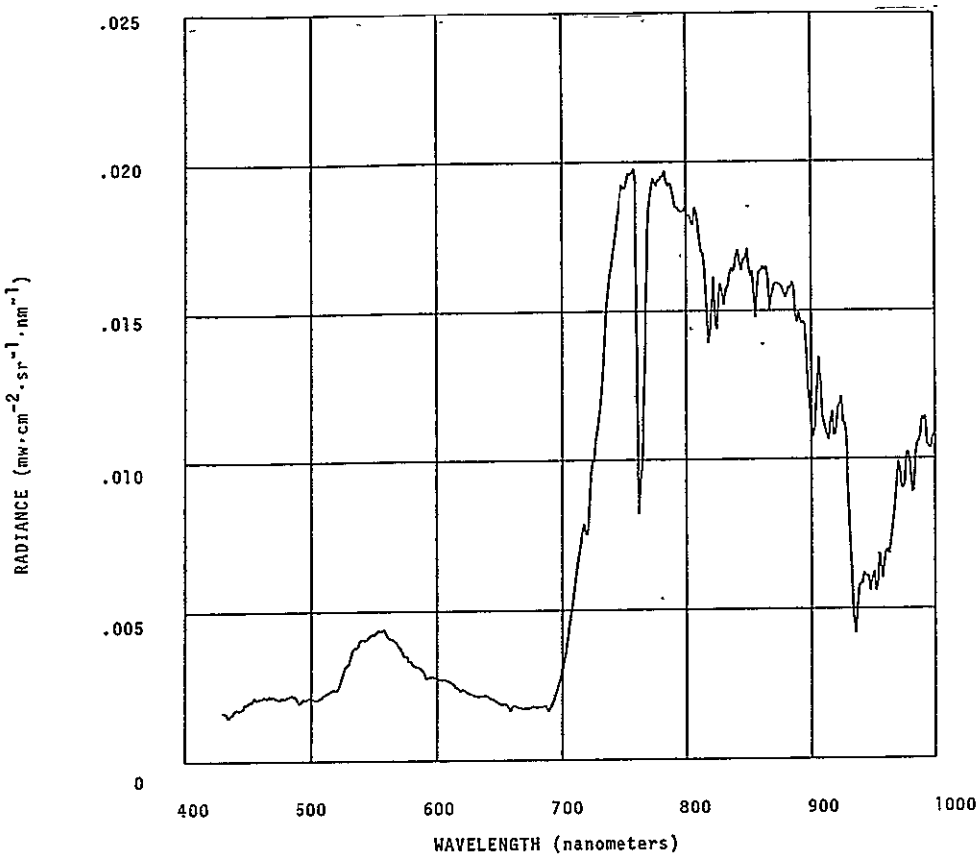
FIELD DESCRIPTION

20 inches high, 100% leaf cover, uniform canopy. 1 to 3% purple flowers on alfalfa plants. 2nd year crop. Soil dry. Imperial, light brown silty clay (7.5YR 6/4).

PHOTO INTERPRETATION

homogeneous tone except furrows are detectable; fine texture; high density; total cover; furrows run parallel with FL.

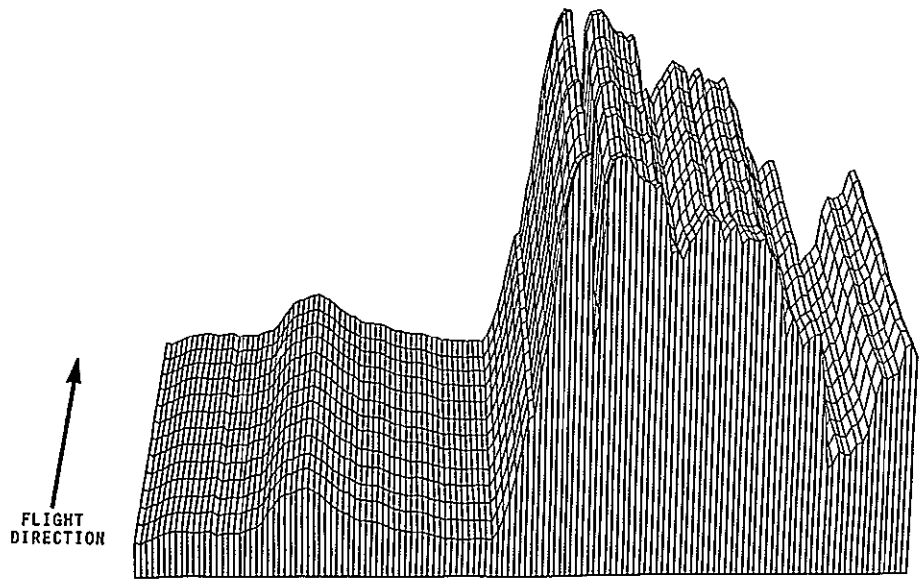
398



10:37 AM 9/23/75

SUN ELEV = 55°

394- 406



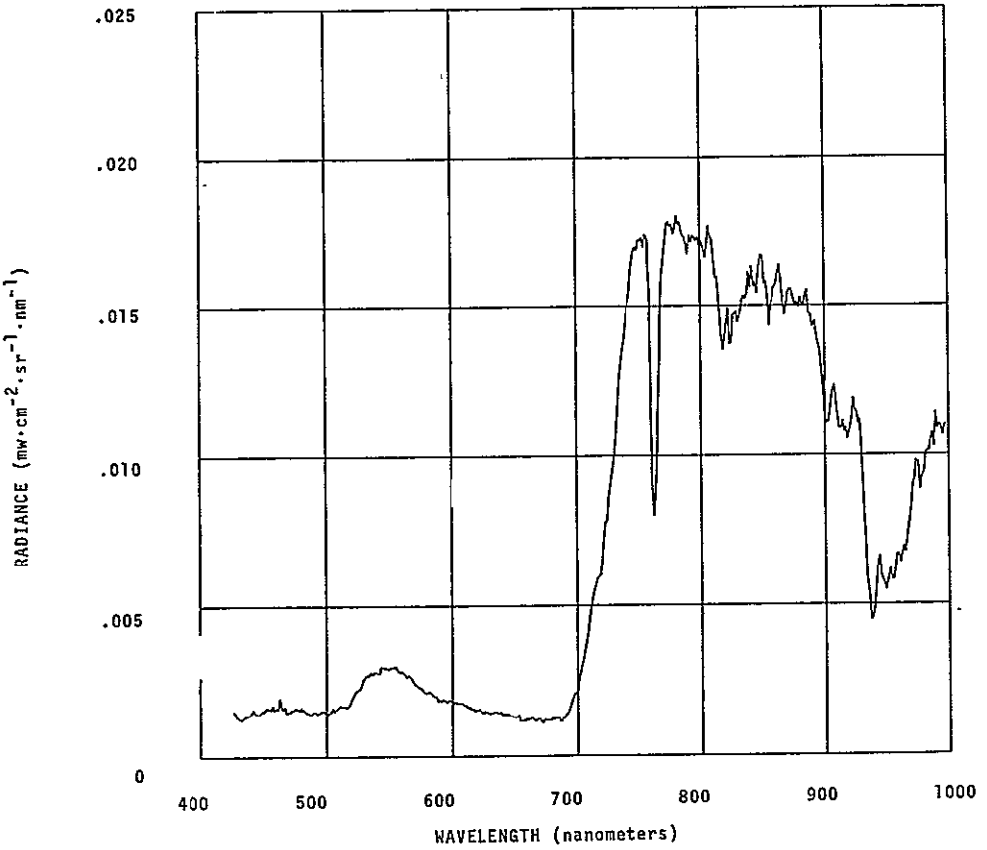
MATURE ALFALFA

FIELD DESCRIPTION

20 inches high, 100% leaf cover, thick uniform canopy. 2nd to 3rd year crop. Soil dry. Imperial, light brown silty clay (7.5YR 6/4).

PHOTO INTERPRETATION

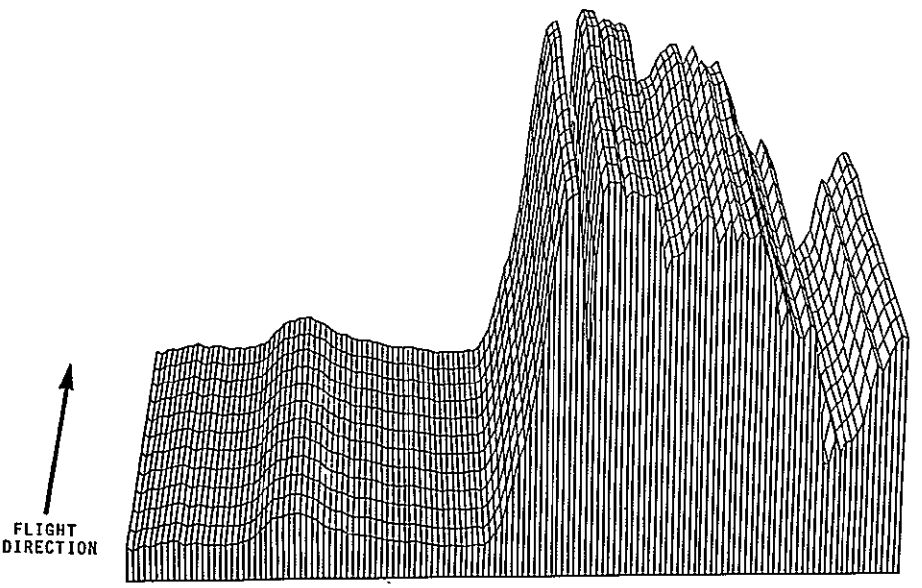
homogeneous tone; fine texture; high density; total cover.



413

9:37 AM 5/15/75

SUN ELEV = 59°



407- 418

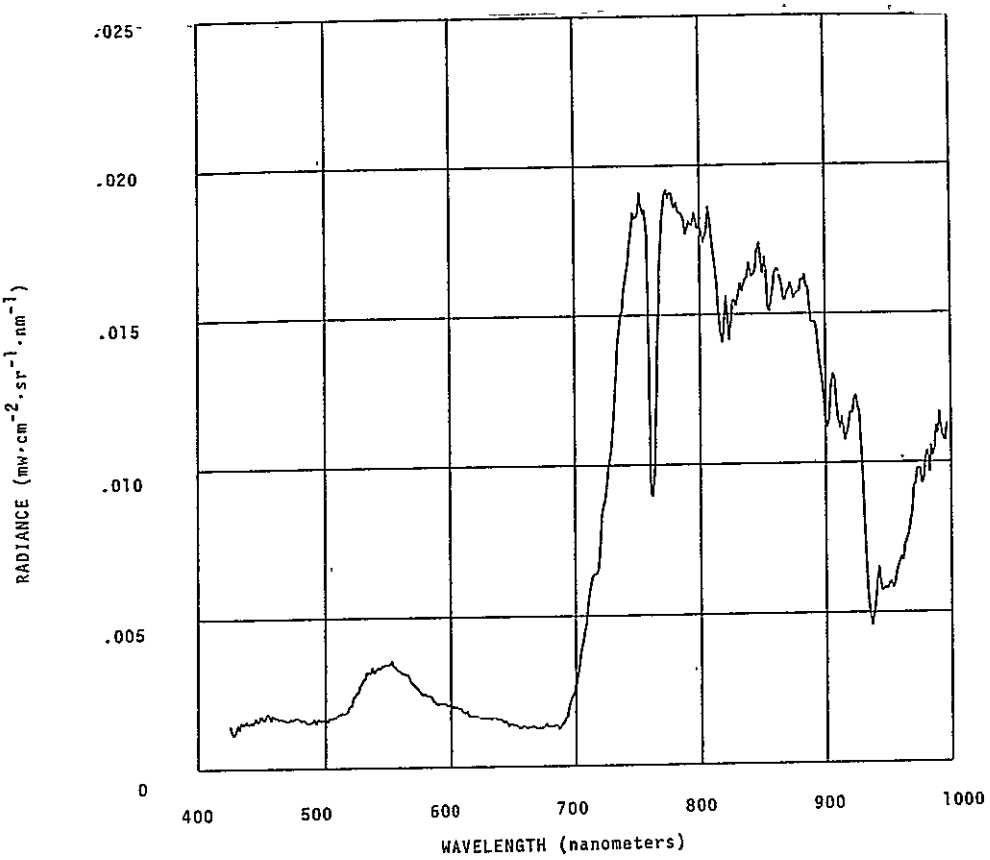
MATURE ALFALFA

FIELD DESCRIPTION

20 to 24 inches high, 100% leaf cover, thick uniform canopy. 1st year crop. Soil dry. Imperial, light brown silty clay (7.5YR 6/4).

PHOTO INTERPRETATION

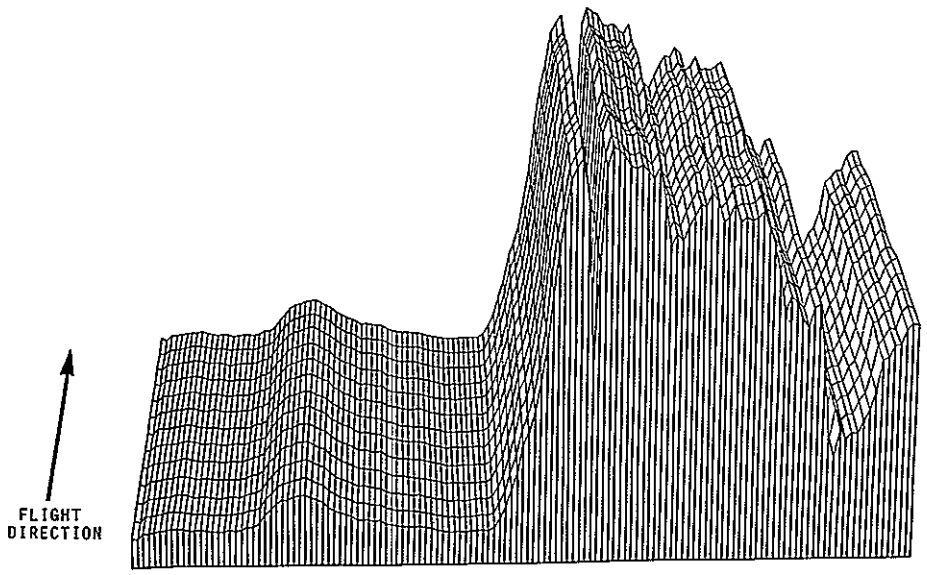
homogeneous tone except furrows are slightly detectable; fine texture; high density; total cover; furrows run parallel with FL.



426

9:51 AM 5/15/75

SUN ELEV = 62°



419- 431

MATURE ALFALFA

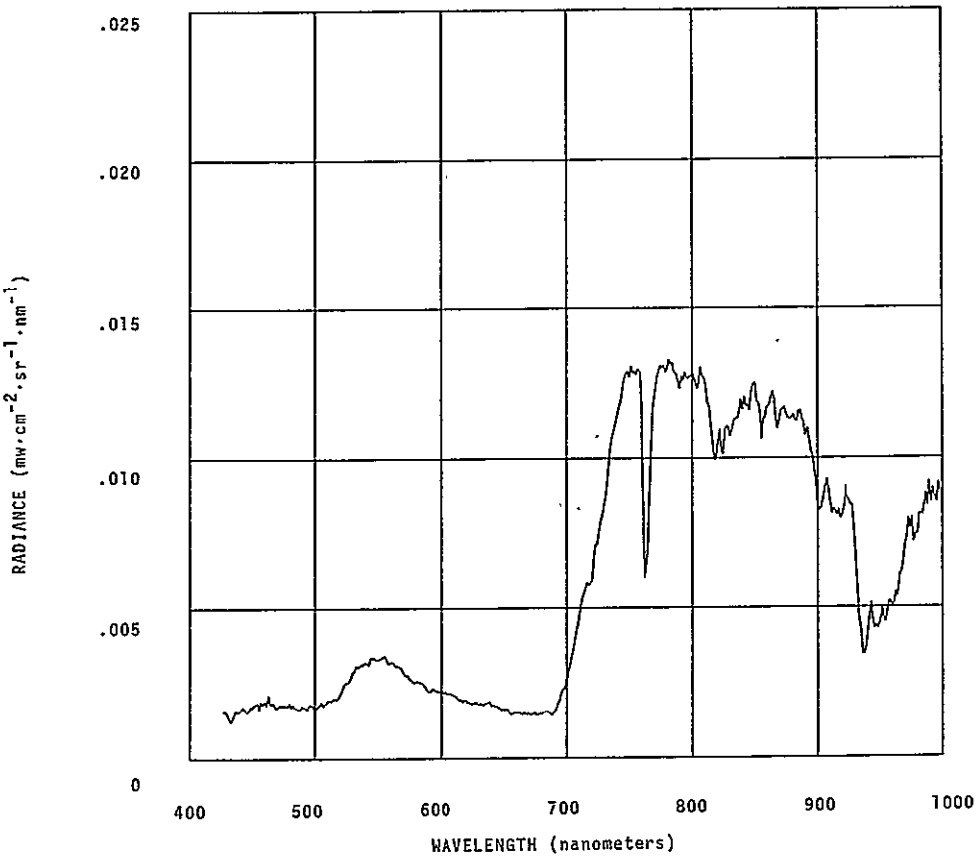
FIELD DESCRIPTION

20 to 24 inches high, 100% leaf cover, thick uniform canopy. 2nd year crop. Soil dry. Imperial, light brown silty clay (7.5 YR 6/4).

PHOTO INTERPRETATION

homogeneous tone except furrows are slightly detectable; fine texture; high density; total cover; furrows run perpendicular to FL.

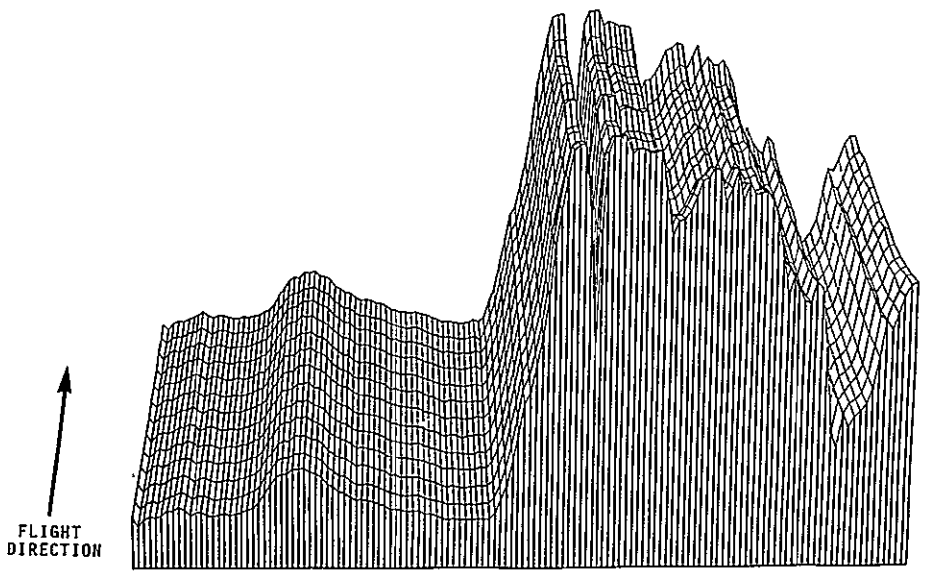
436



9:43 AM 5/15/75

SUN ELEV = 61°

432- 444



MATURE ALFALFA

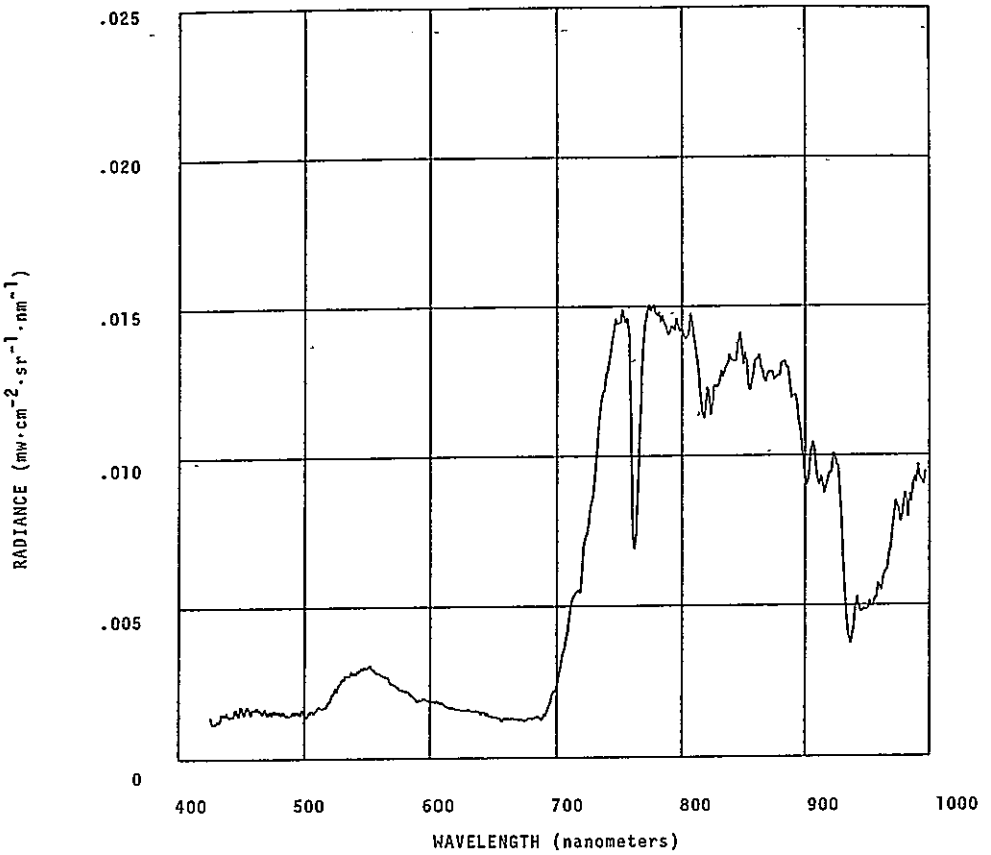
FIELD DESCRIPTION

20 to 24 inches high, 100% leaf cover, thick uniform canopy. 2nd year crop. Soil dry. Imperial, light brown silty clay (7.5YR 6/4).

PHOTO INTERPRETATION

homogeneous tone except furrows are slightly detectable, fine texture; high density; total cover; furrows run perpendicular to FL.

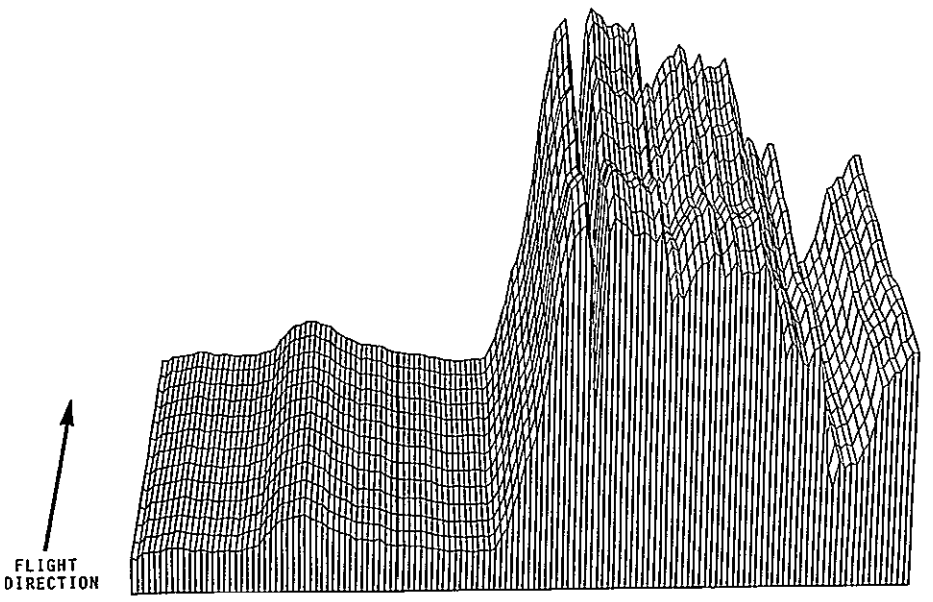
447



9:51 AM 5/15/75

SUN ELEV = 62°

445- 457



MATURE ALFALFA

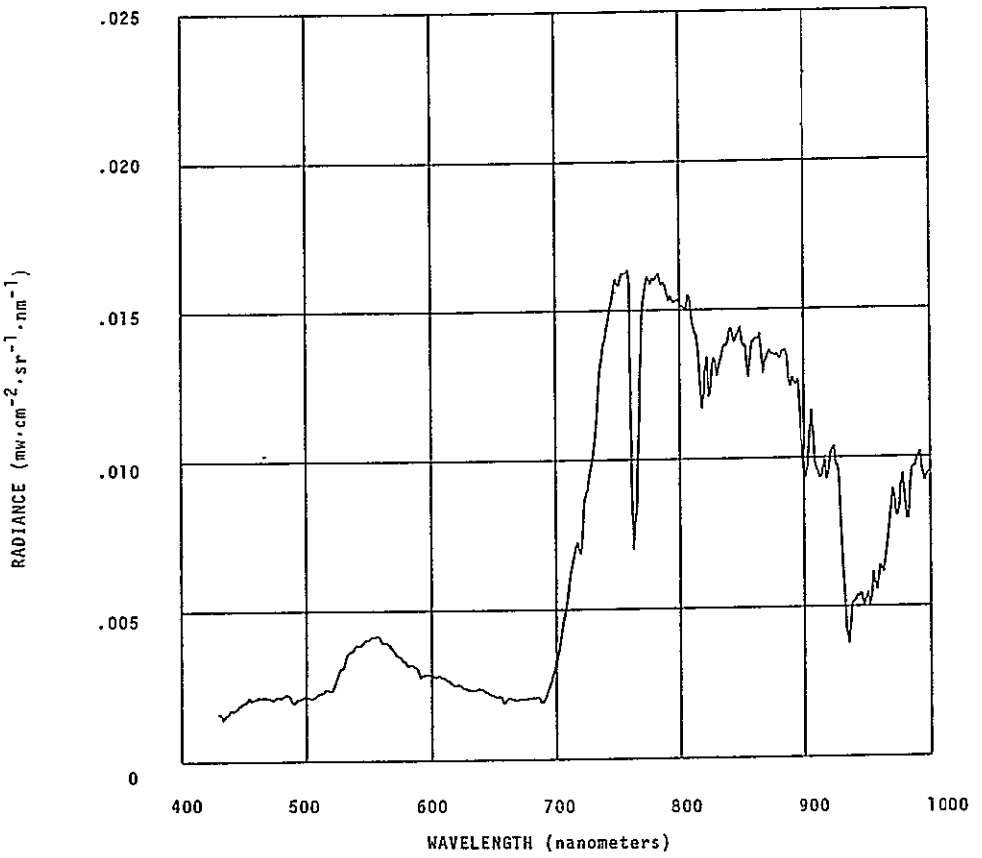
FIELD DESCRIPTION

22 inches high, 95% leaf cover, thick uniform canopy. 1 to 3% purple flowers on alfalfa plants. 2nd year crop. Soil dry. Imperial, light brown silty clay (7.5YR 6/4).

PHOTO INTERPRETATION

inhonogeneous tone; coarse texture; nonuniform differential densities ranging from low to high; 2/3 cover; furrows run perpendicular to FL.

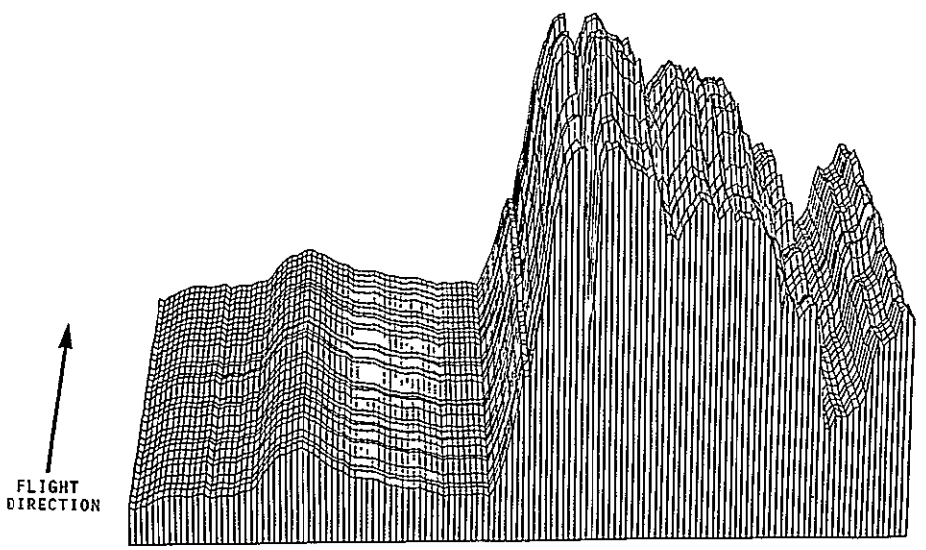
461



10:37 AM 9/23/75

SUN ELEV = 55°

458- 489



MATURE ALFALFA

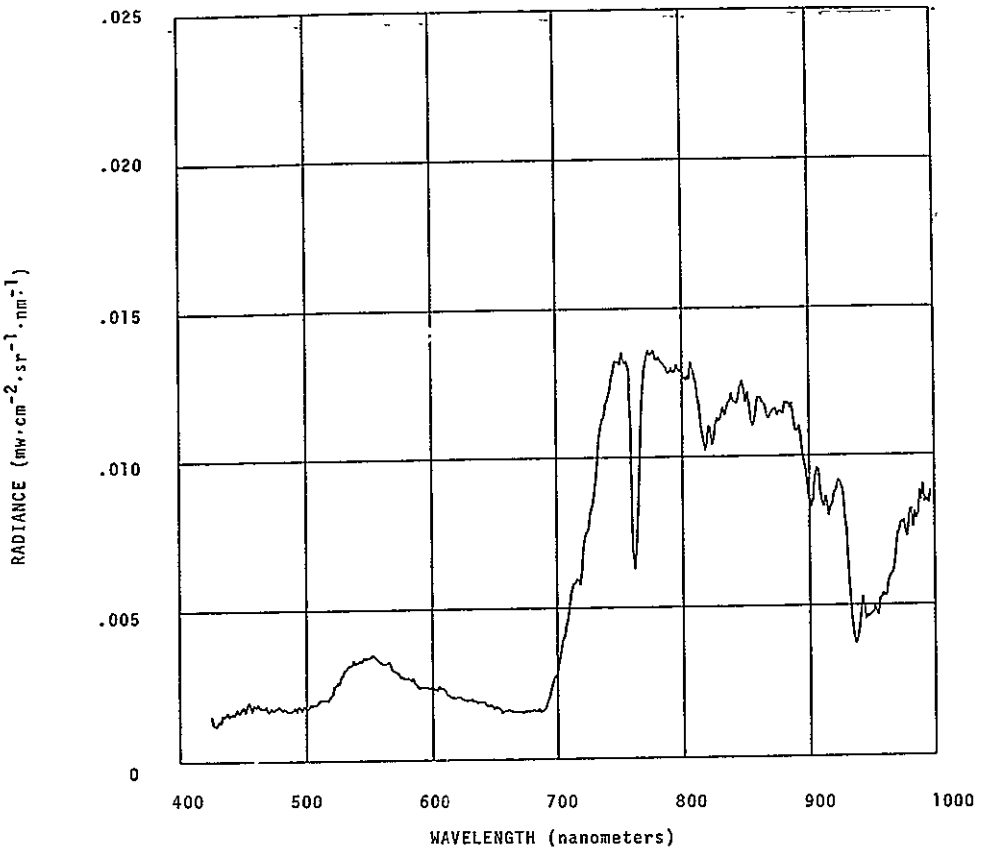
FIELD DESCRIPTION

24 to 30 inches high, 95 to 100% leaf cover, thick uniform canopy. 2nd year crop. Soil wet. Imperial, silty clay.

PHOTO INTERPRETATION

homogeneous tone except furrows are slightly detectable; fine texture; high density; total cover: furrows run perpendicular to FL.

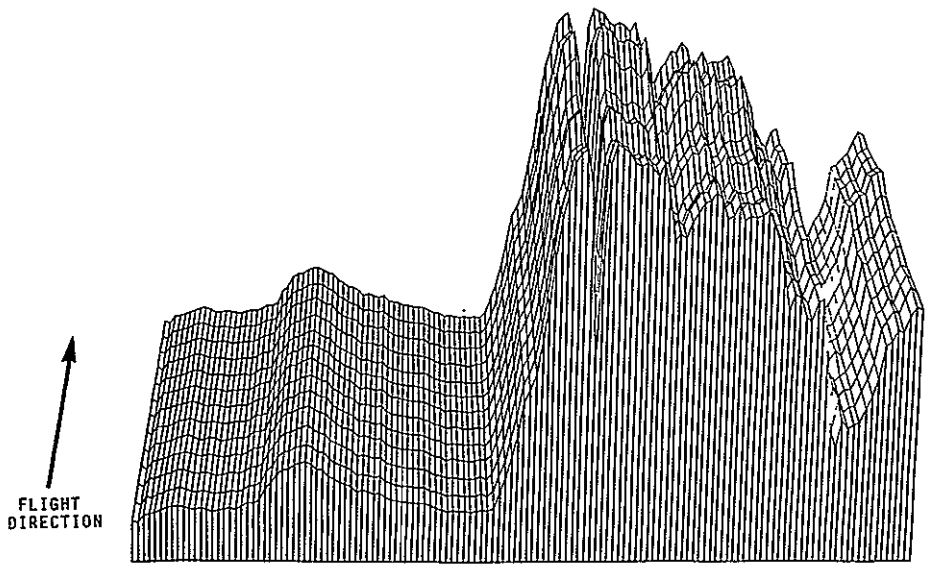
500



10:30 AM 5/15/75

SUN ELEV = 69°

490- 502



MATURE ALFALFA

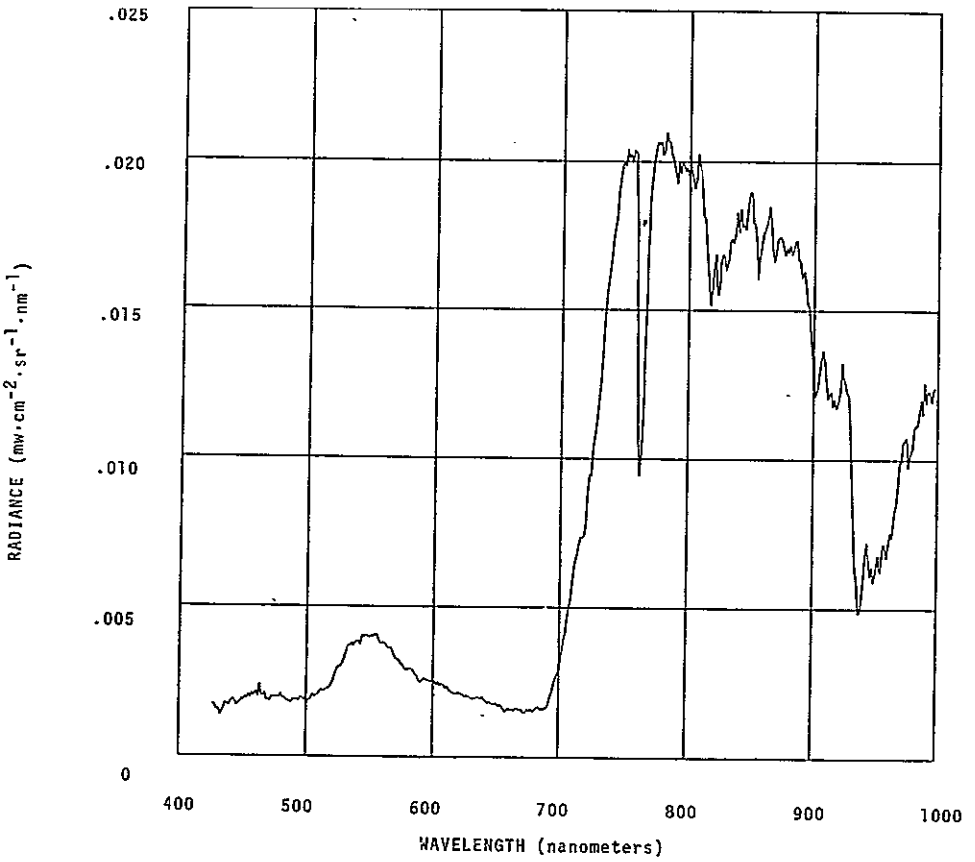
FIELD DESCRIPTION

24 to 30 inches high, 100% leaf cover, thick uniform canopy. 1st year crop. Soil moist. Imperial, silty clay.

PHOTO INTERPRETATION

homogeneous tone except furrows are slightly detectable; fine texture; high density; total cover; furrows run parallel with FL.

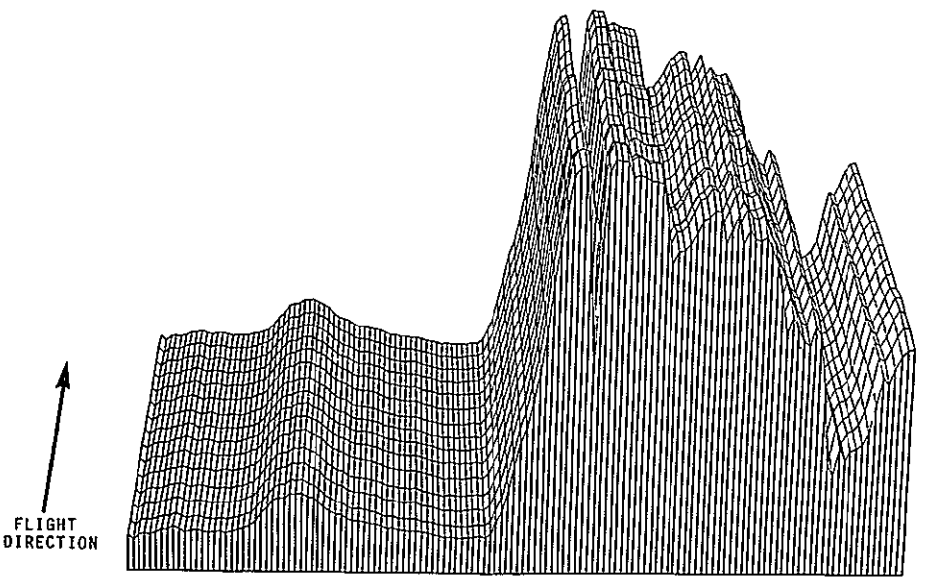
509



9:43 AM 5/15/75

SUN ELEV = 61°

503- 517



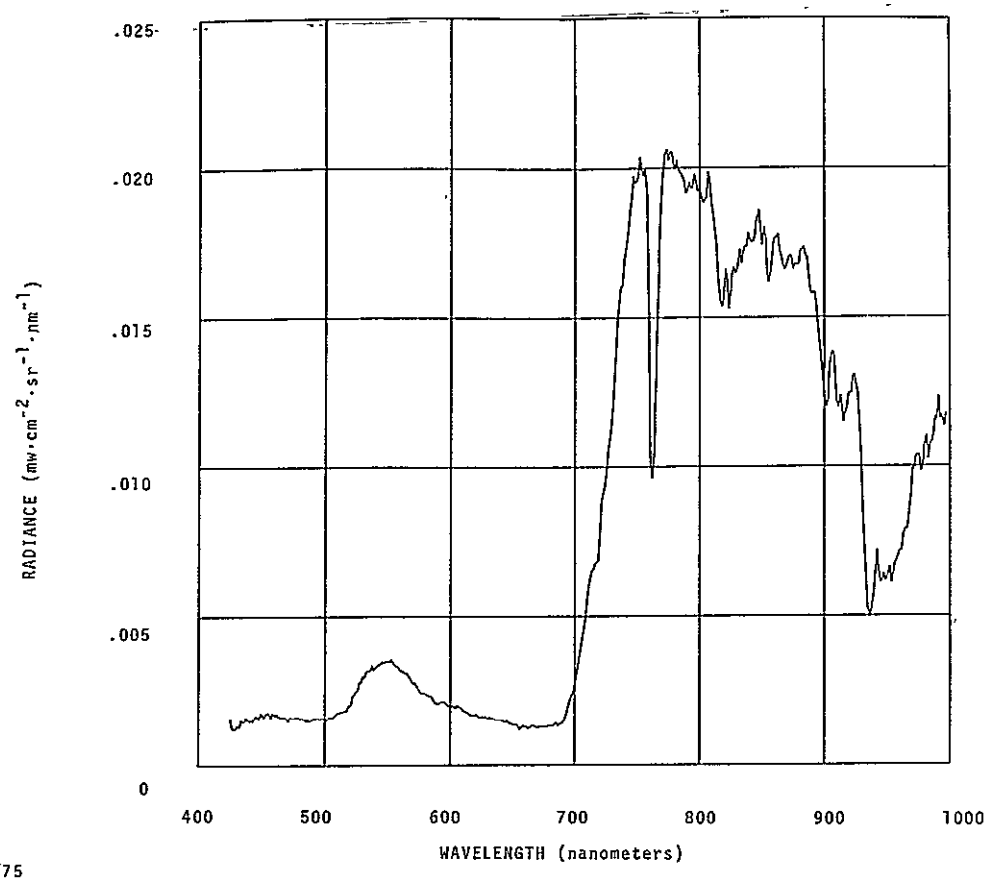
MATURE ALFALFA

FIELD DESCRIPTION

24 to 30 inches high, 100% leaf cover, thick uniform canopy. 1st year crop. Soil moist. Imperial, silty clay.

PHOTO INTERPRETATION

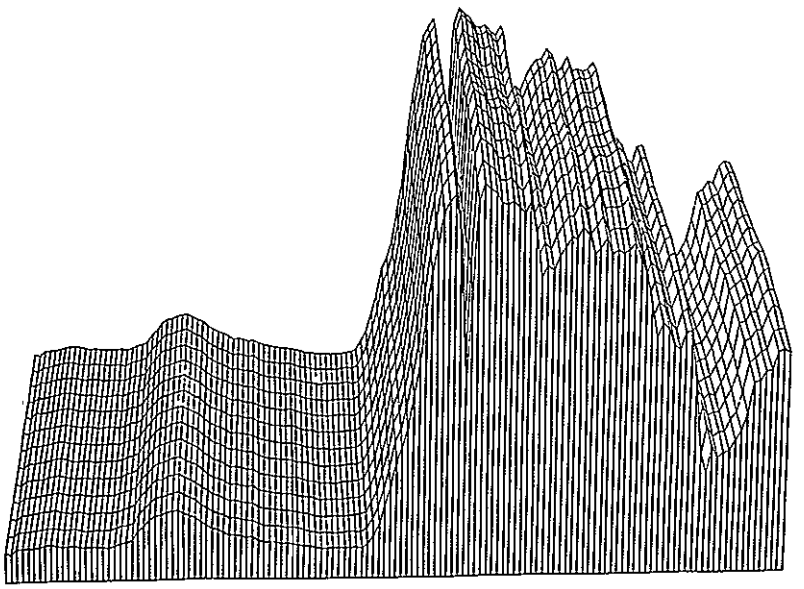
homogeneous tone except furrows are detectable; fine texture; high density; total cover, furrows run parallel with FL.



520

9:51 AM 5/15/75

SUN ELEV = 62°



518- 530

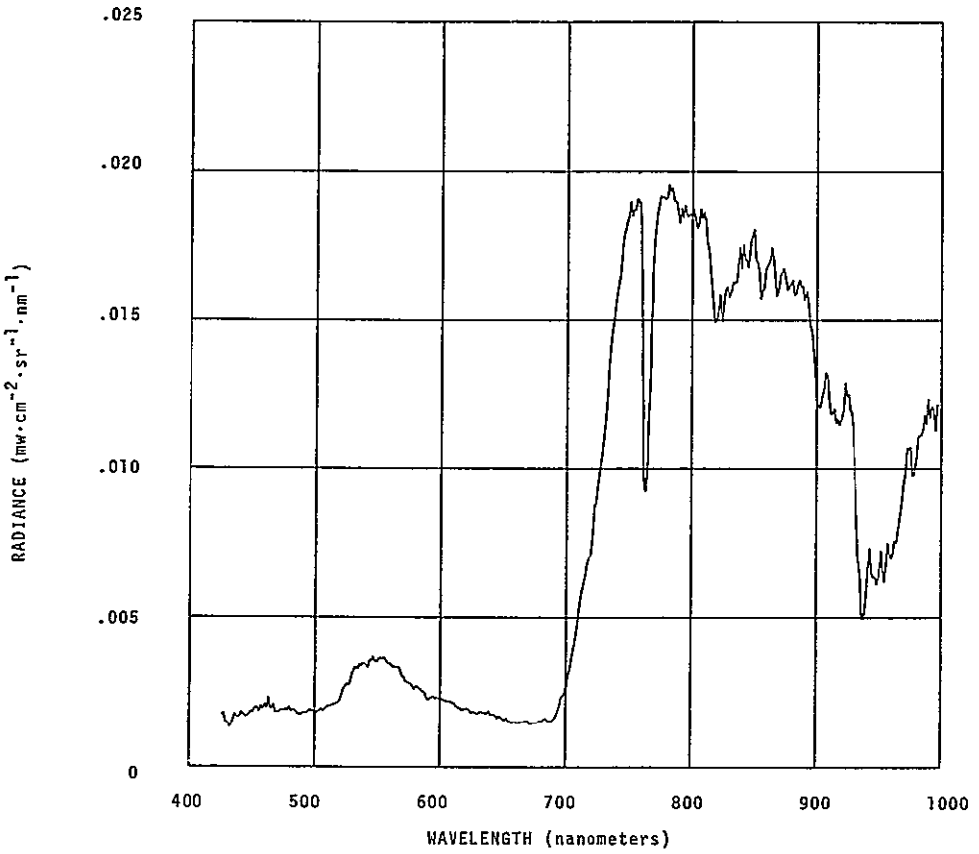
MATURE ALFALFA

FIELD DESCRIPTION

24 to 30 inches high, 100% leaf cover, thick uniform canopy. Soil dry. Imperial, light brown silty clay (7.5YR 6/4).

PHOTO INTERPRETATION

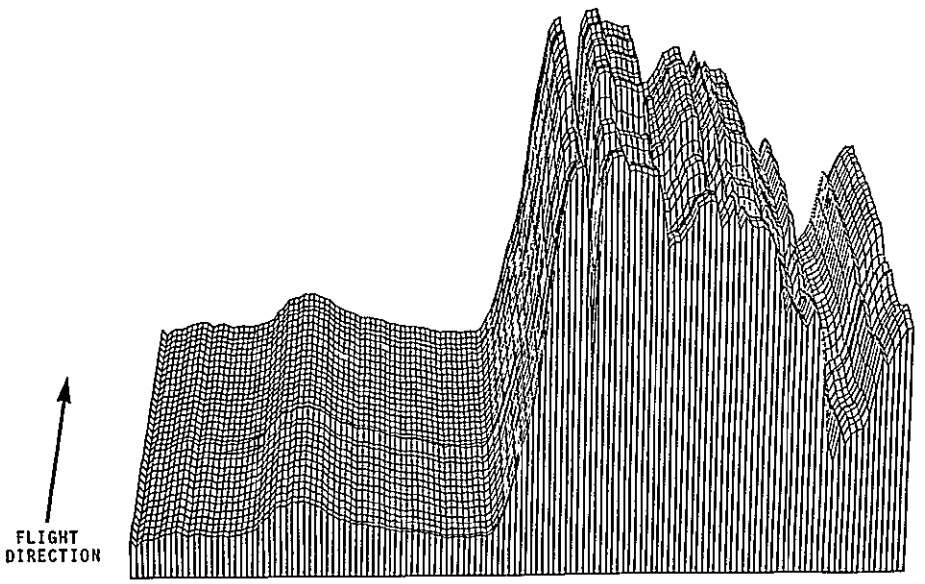
Inhomogeneous tone; fine texture; nonuniform differential density ranging from high to medium; near total cover; furrows run perpendicular to FL.



535

10:24 AM 5/15/75

SUN ELEV = 68°



531- 564

MATURE ALFALFA

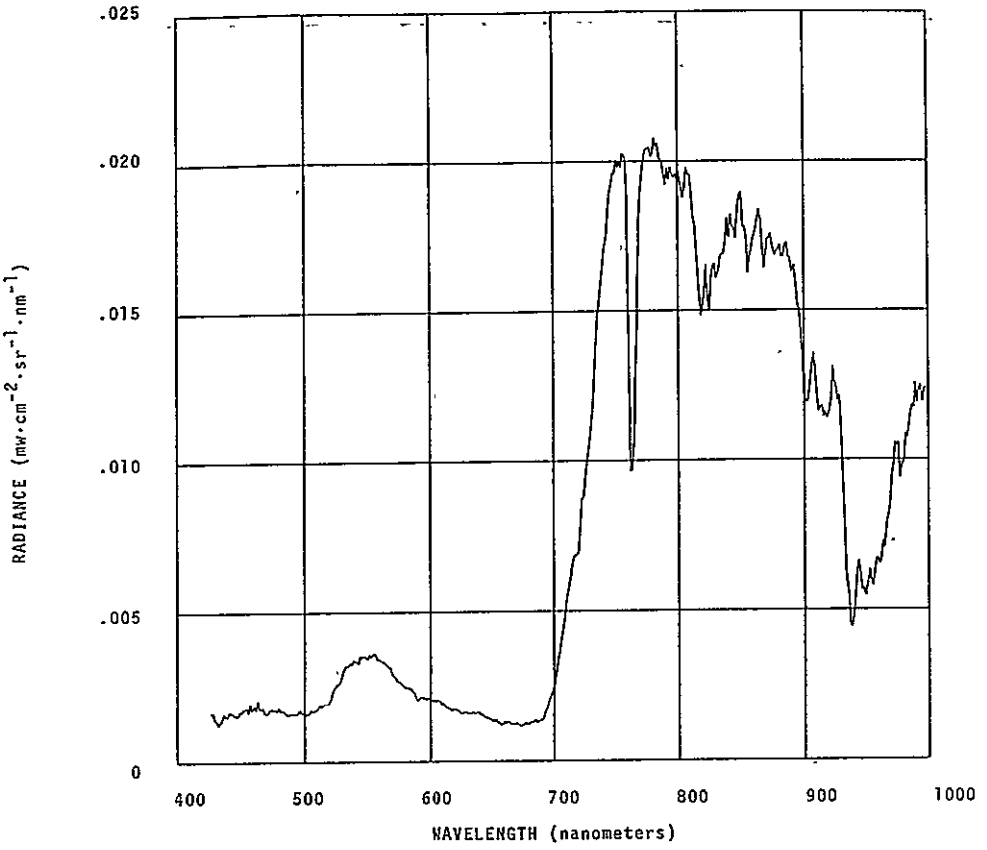
FIELD DESCRIPTION

24 to 30 inches high, 100% leaf cover, thick uniform canopy. 3rd year crop. Soil wet. Imperial, silty clay.

PHOTO INTERPRETATION

homogeneous tone; no texture; high density; total cover.

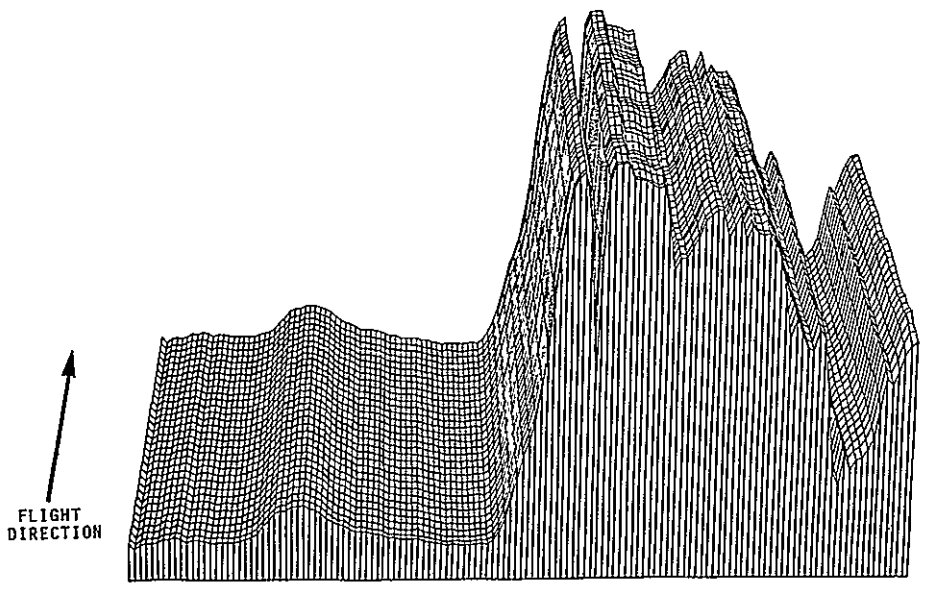
576



10:15 AM 5/16/75

SUN ELEV = 67°

565- 596



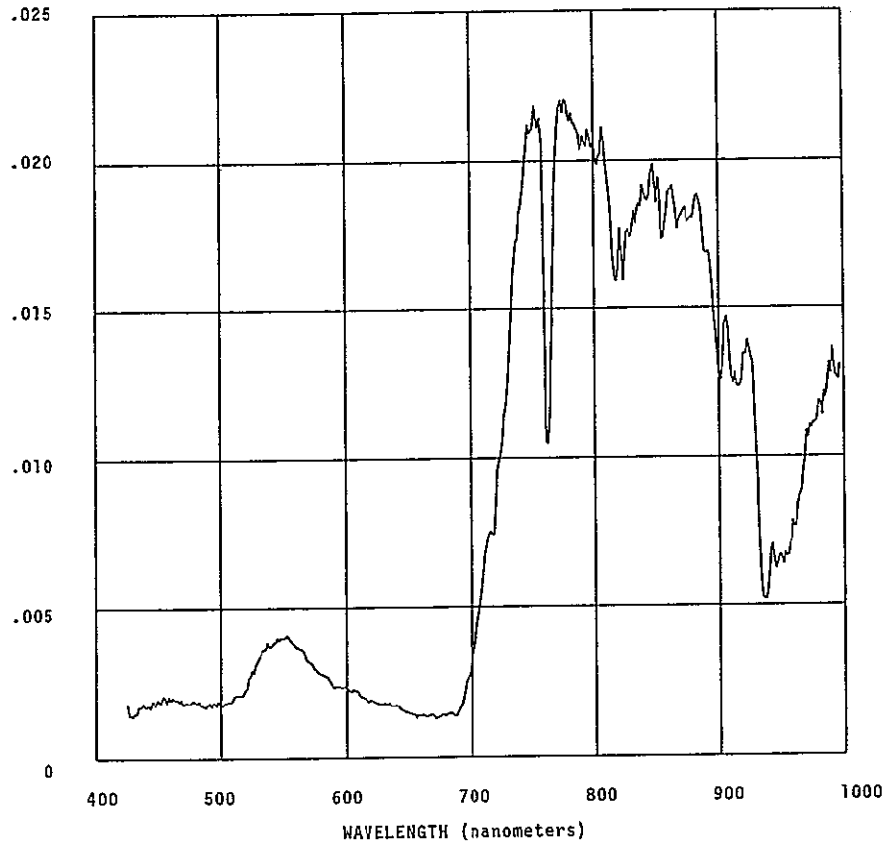
MATURE ALFALFA

FIELD DESCRIPTION

24 to 30 inches high, 100% leaf cover, thick uniform canopy. 3rd year crop. Soil wet. Imperial, silty clay.

PHOTO INTERPRETATION

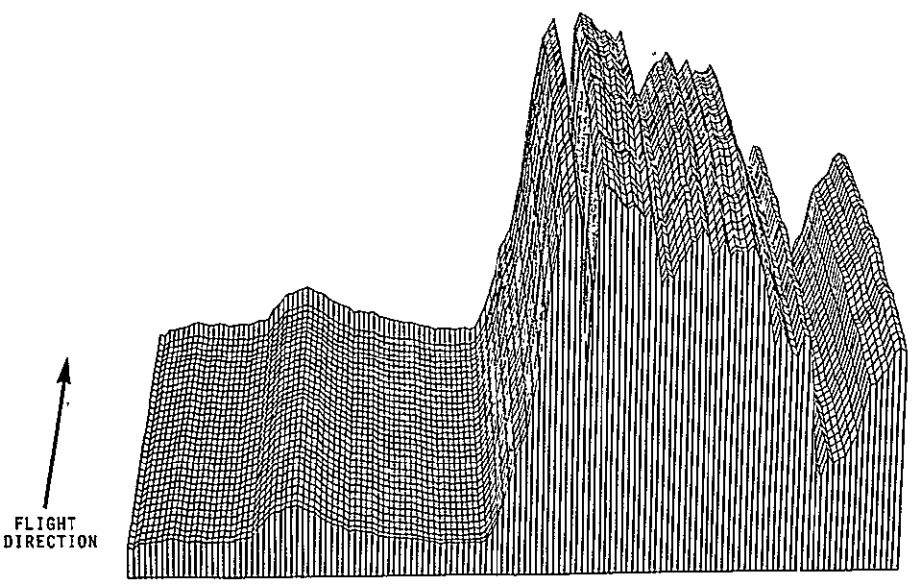
homogeneous tone; no texture; high density; total cover.



624

11:03 AM 5/16/75

SUN ELEV = 74°



597- 631

MATURE ALFALFA

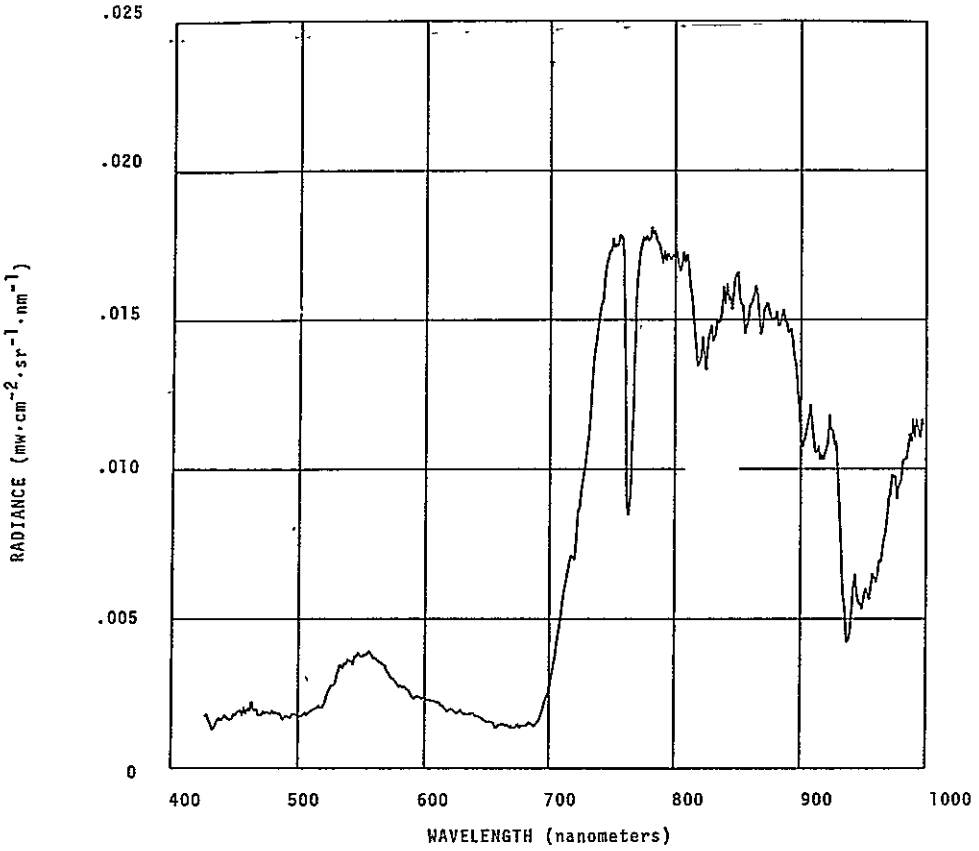
FIELD DESCRIPTION

30 inches high, 80 to 100% leaf cover, moderately thick canopy. 2nd year crop. Soil wet. Imperial, silty clay.

PHOTO INTERPRETATION

inhomogeneous tone; texture is fine; high density; near total cover; furrows run parallel with FL.

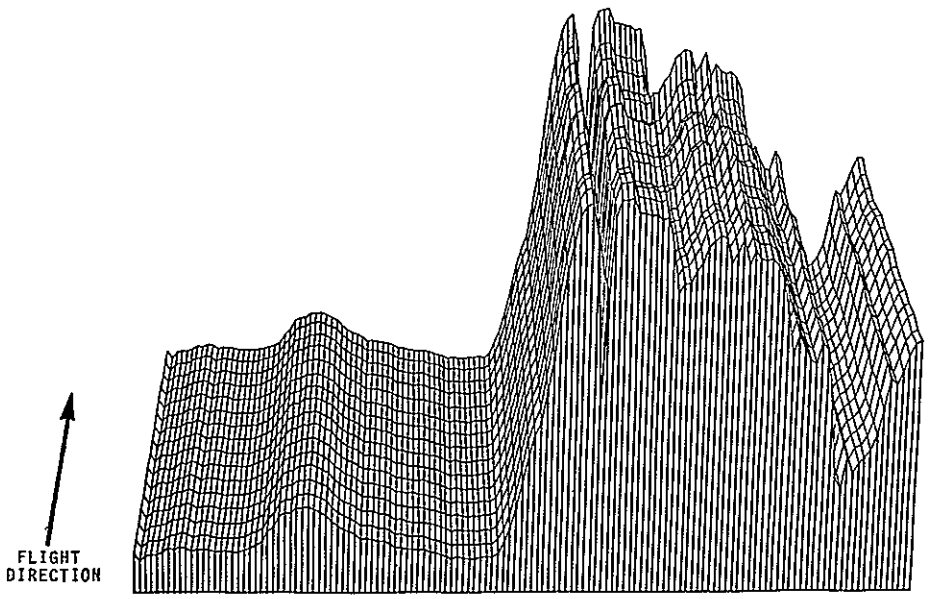
636



10:40 AM 5/16/75

SUN ELEV = 71°

632-647



MATURE ALFALFA

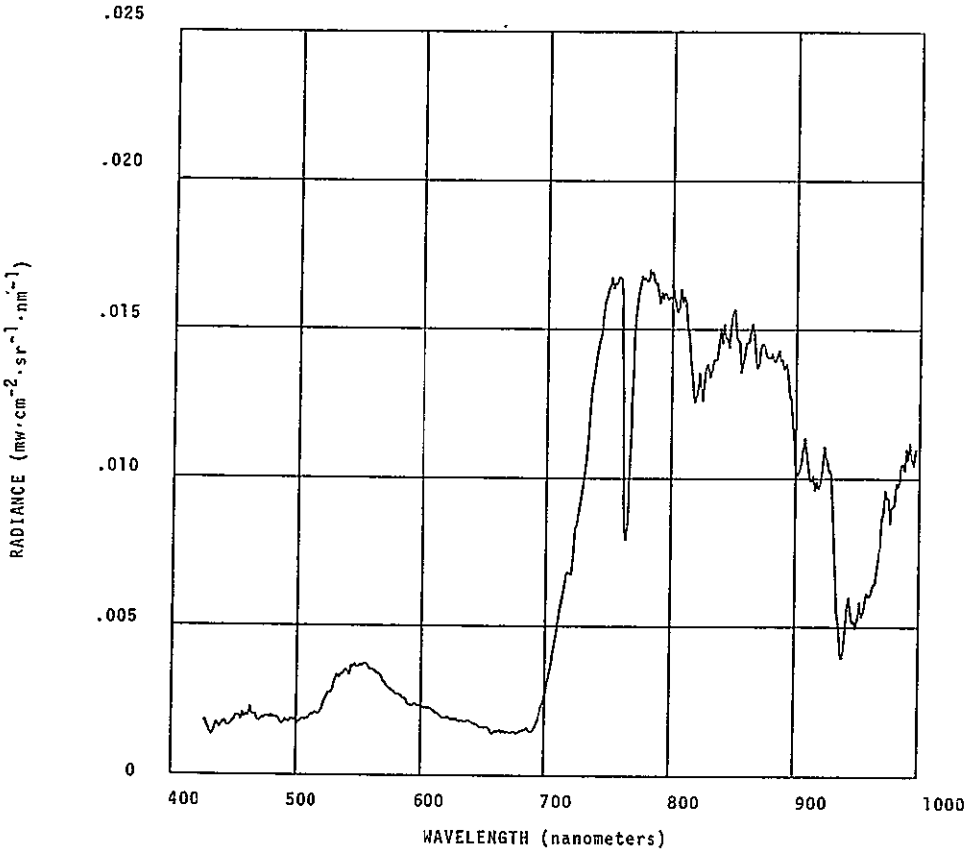
FIELD DESCRIPTION

30 inches high, 100% leaf cover, thick uniform canopy. Purple flowers, 1 to 3% of alfalfa plants. 3rd year crop. Soil wet. Imperial, silty clay.

PHOTO INTERPRETATION

homogeneous tone except furrows are slightly detectable; fine texture, high density; total cover; furrows run parallel with FL.

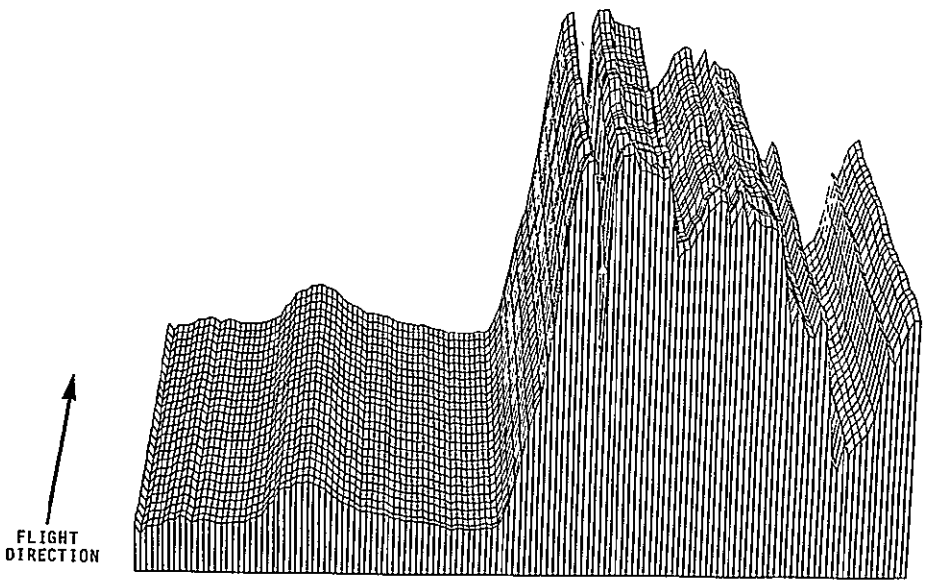
673



10:40 AM 5/16/75

SUN ELEV = 71°

648- 673



MATURE ALFALFA

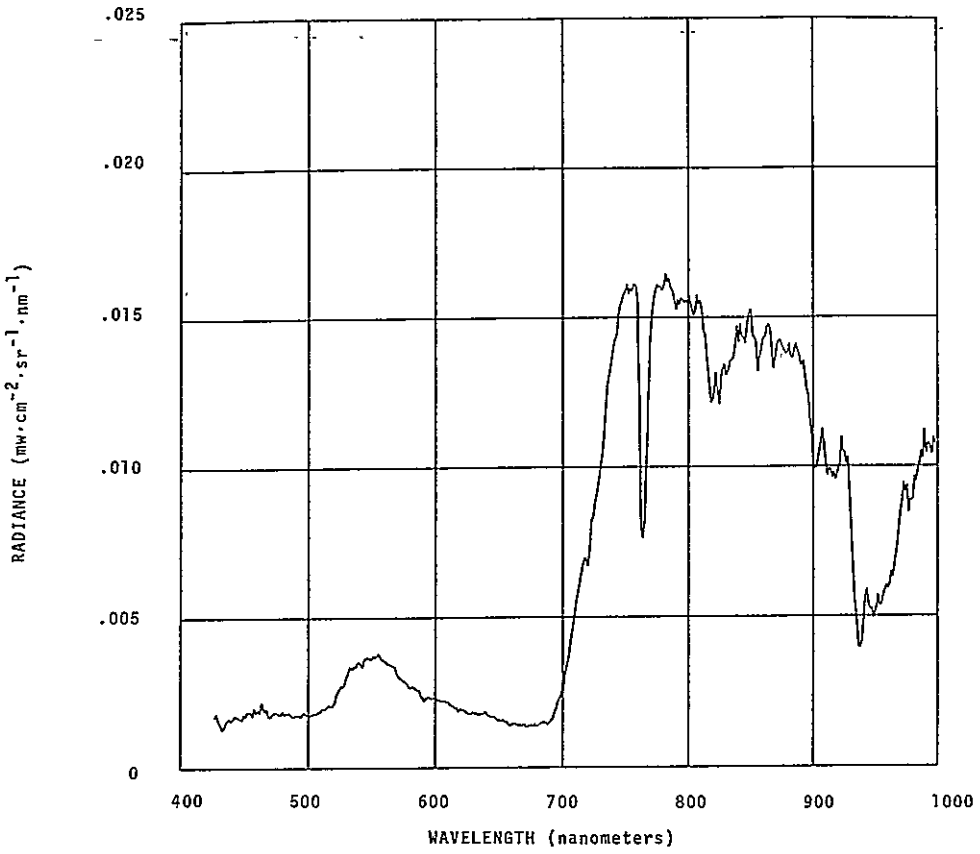
FIELD DESCRIPTION

30 inches high, 100% leaf cover, thick uniform canopy. Purple flowers, 1 to 3% of alfalfa plants. 2nd year crop. Soil dry. Imperial, light brown silty clay (7 5YR 6/4).

PHOTO INTERPRETATION

homogeneous tone except irrigation furrows are slightly detectable; fine texture; high density; total cover; irrigation furrows run parallel with FL.

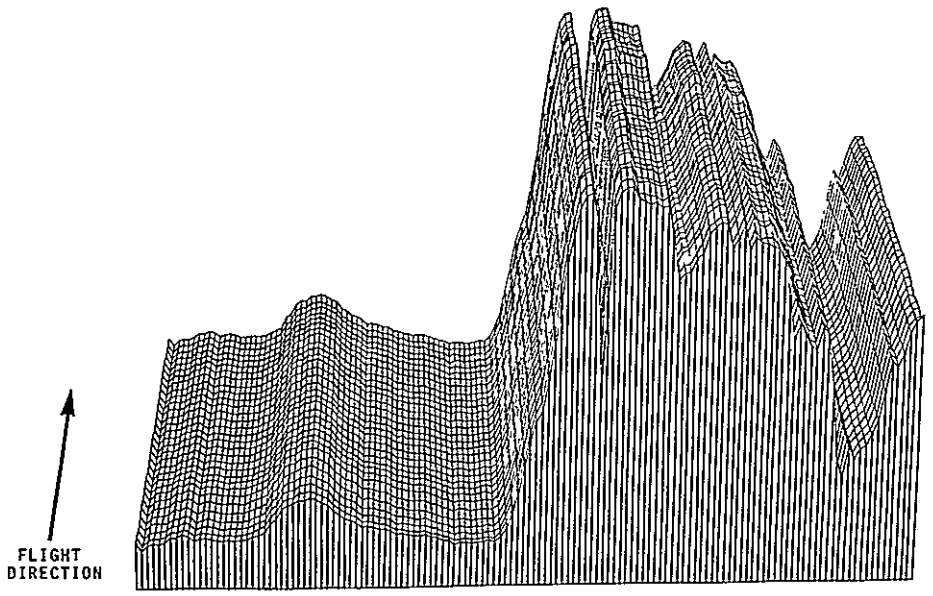
686



10:34 AM 5/16/75

SUN ELEV = 70°

674- 704



MATURE ALFALFA

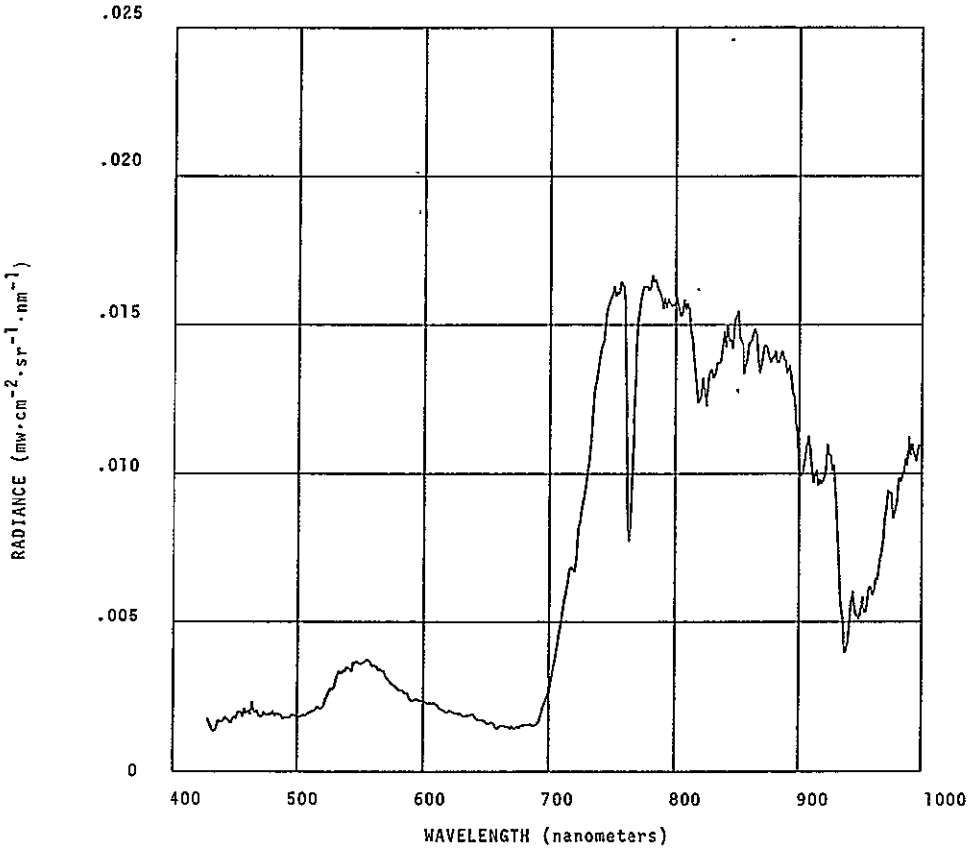
FIELD DESCRIPTION

30 inches high, 100% leaf cover, thick uniform canopy. Purple flowers, 1 to 3% of alfalfa plant. 2nd year crop. Soil dry. Imperial, light brown silty clay (7.5YR 6/4).

PHOTO INTERPRETATION

homogeneous tone except furrows are slightly detectable; fine texture; high density; total cover; furrows run parallel with FL.

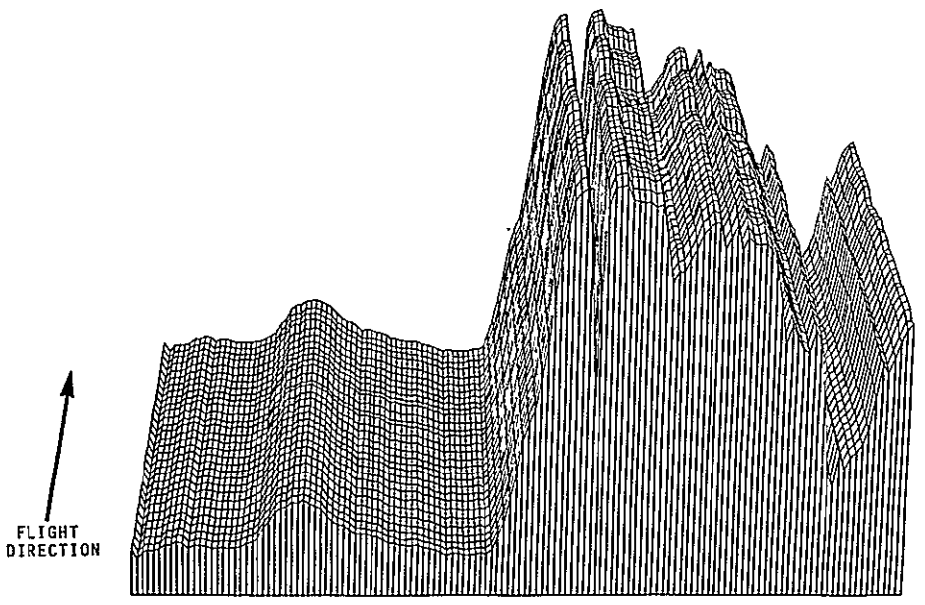
732



10:40 AM 5/16/75

SUN ELEV = 71°

705- 734



MATURE ALFALFA

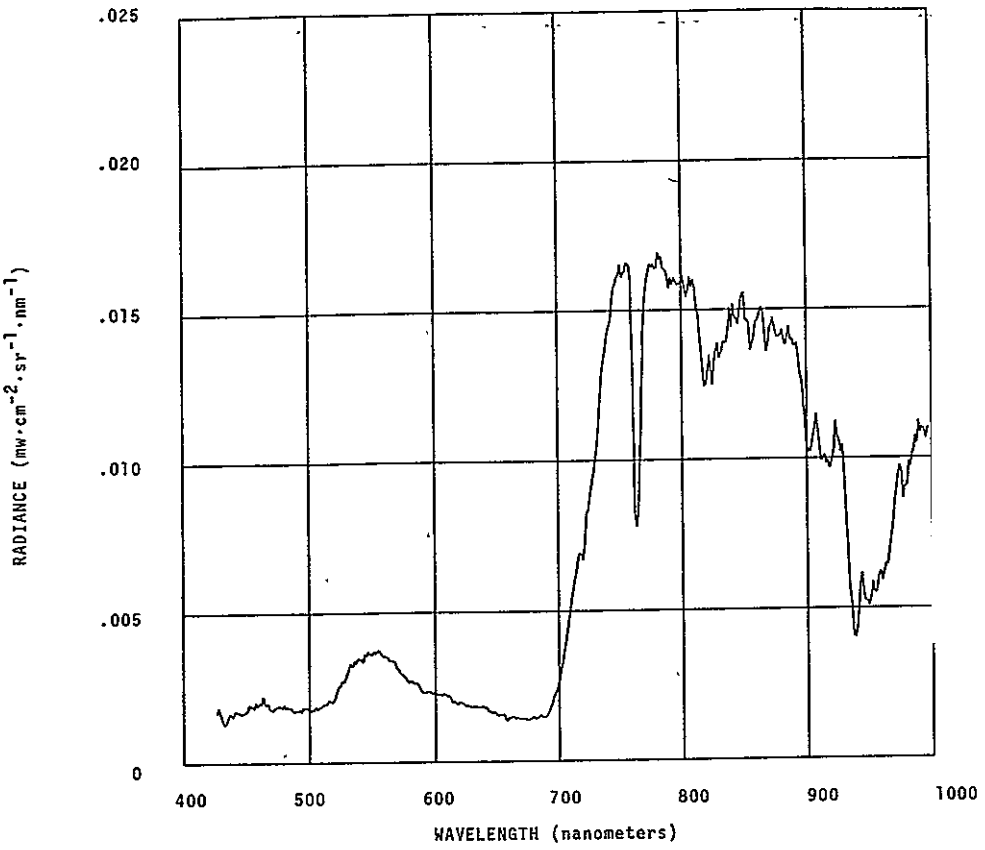
FIELD DESCRIPTION

30 inches high, 100% leaf cover, thick patchy canopy. Purple flowers, 1 to 3% of alfalfa plants. 3rd year crop. Soil wet. Imperial, silty clay.

PHOTO INTERPRETATION

homogeneous tone with the exception of the irrigation furrows; medium texture; high density; furrows run parallel with FL.

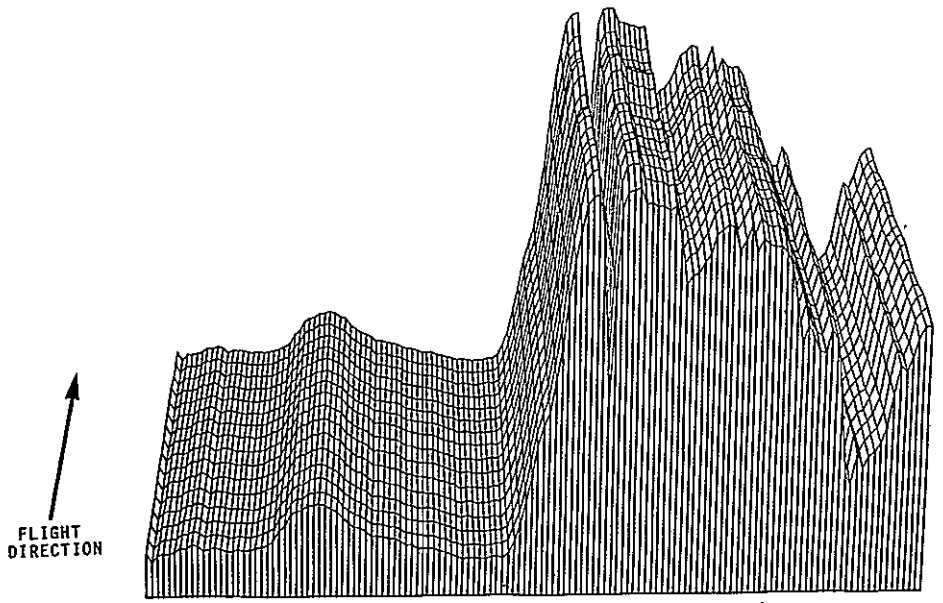
745



10:34 AM 5/16/75

SUN ELEV = 70°

735-750



MATURE ALFALFA

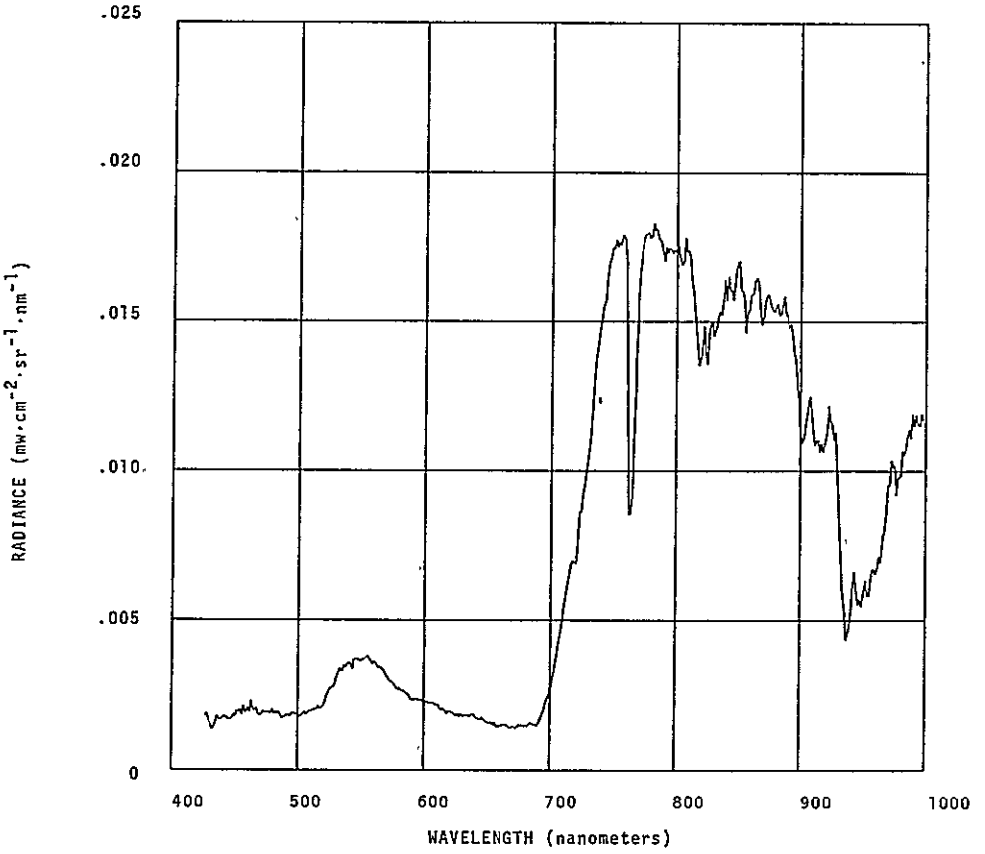
FIELD DESCRIPTION

30 inches high, 100% leaf cover, thick uniform canopy. Purple flowers, 1 to 3% of alfalfa plants. 3rd year crop. Soil wet. Imperial, silty clay.

PHOTO INTERPRETATION

homogeneous tone except furrows are detectable; fine texture; high density; total cover; furrows run parallel with FL.

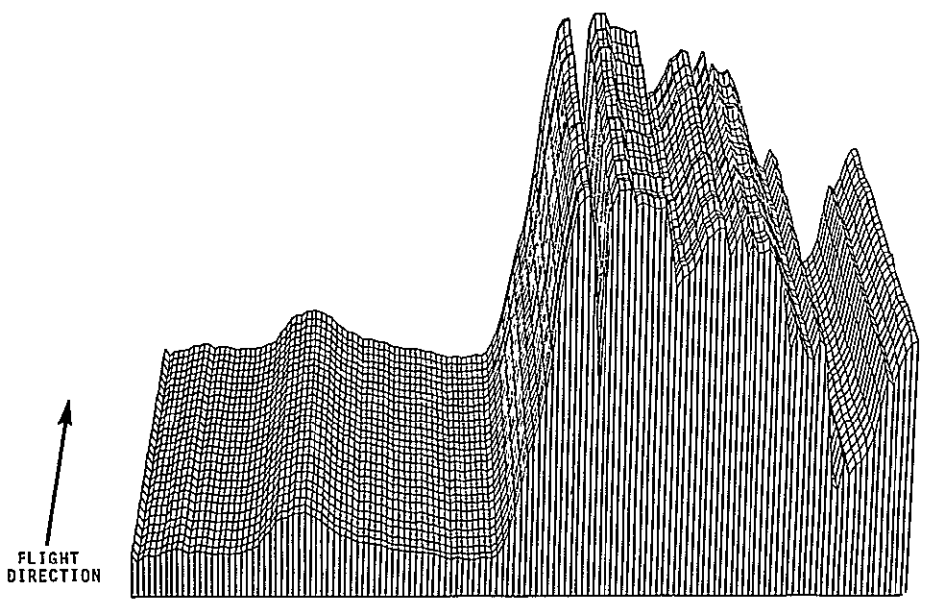
755



10·40 AM 5/16/75

SUN ELEV = 71°

751- 778



MATURE ALFALFA

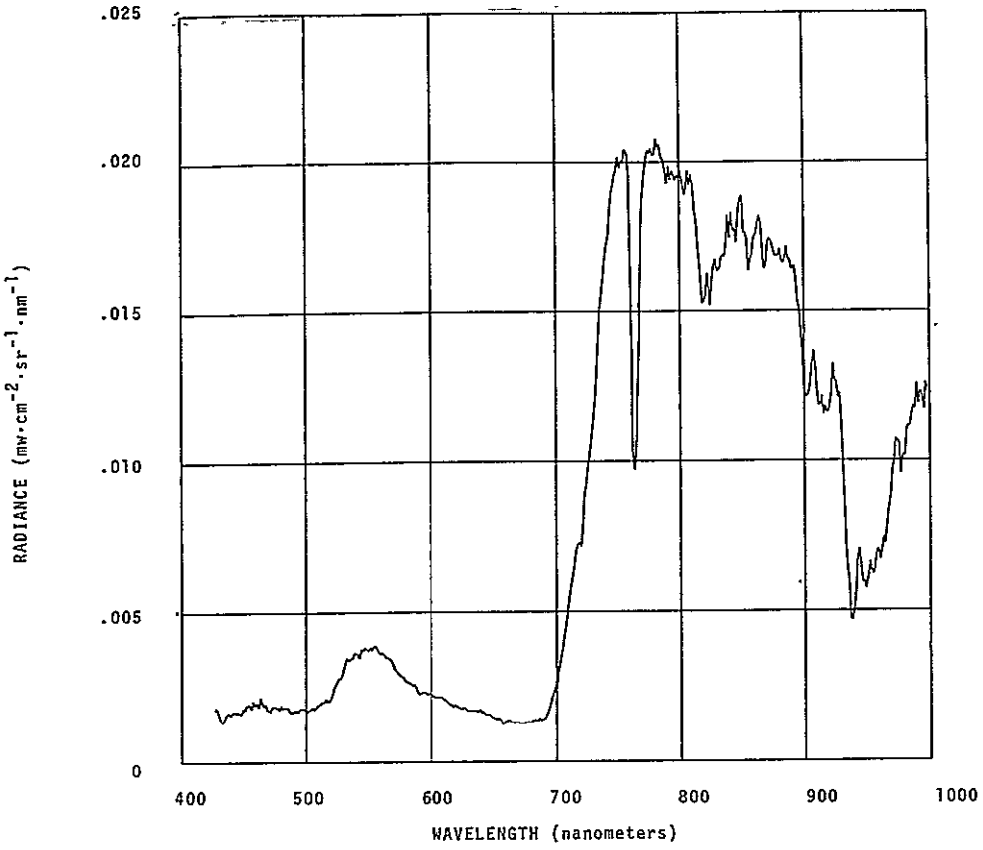
FIELD DESCRIPTION

30 to 34 inches high, 100% leaf cover, thick uniform canopy. Purple flowers, 1 to 3% of alfalfa plants. 2nd year crop. Soil dry. Imperial, light brown silty clay (7.5YR 6/4).

PHOTO INTERPRETATION

homogeneous tone, except furrows are slightly detectable; texture is absent or fine; high density; total cover; furrows run parallel with FL.

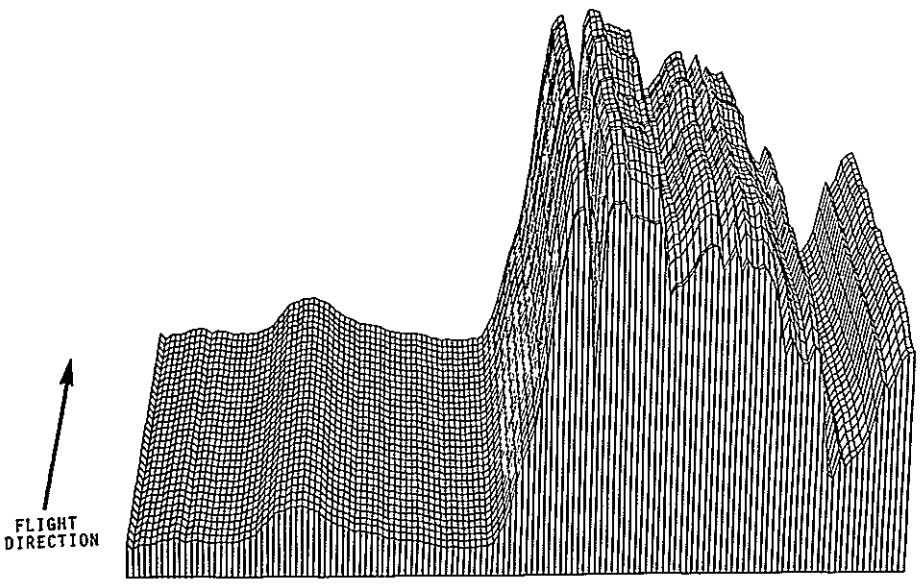
805



10:40 AM 5/16/75

SUN ELEV = 71°

779- 811



MATURE ALFALFA

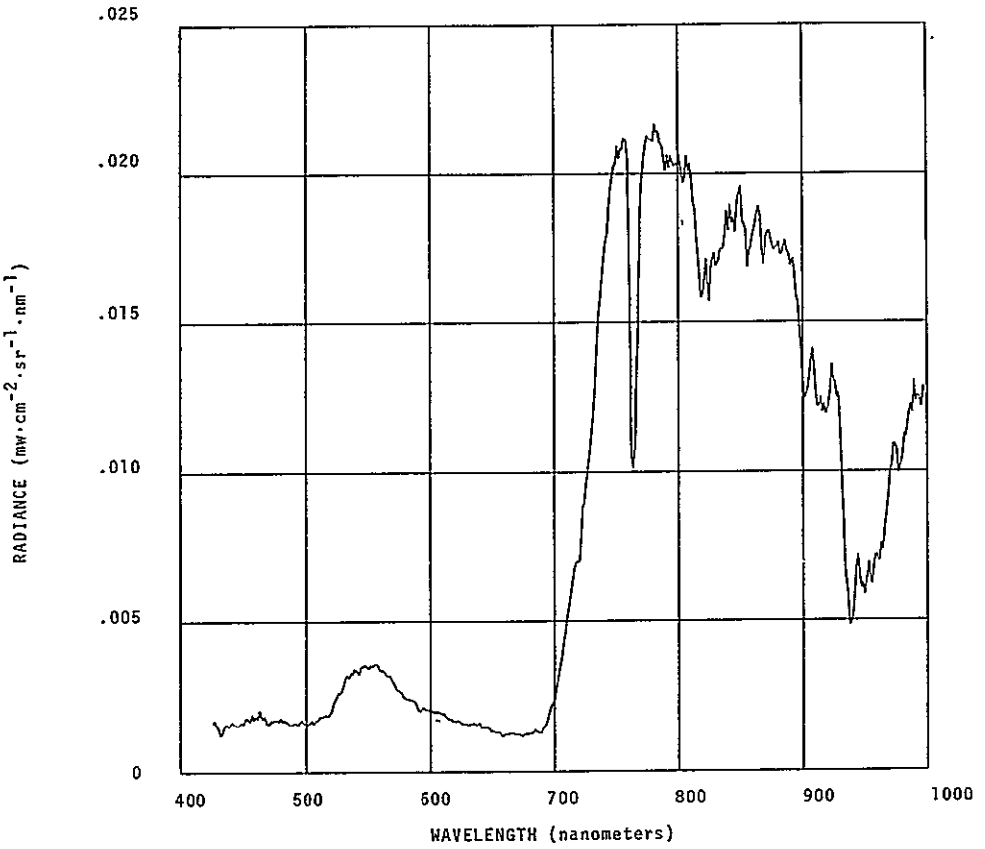
FIELD DESCRIPTION

30 to 34 inches high, 100% leaf cover, thick uniform canopy. Purple flowers, 1 to 3% of alfalfa plants. 2nd year crop. Soil dry. Imperial, light brown silty clay (7.5YR 6/4).

PHOTO INTERPRETATION

homogeneous tone; no texture; high density; near total cover; furrows run parallel with FL.

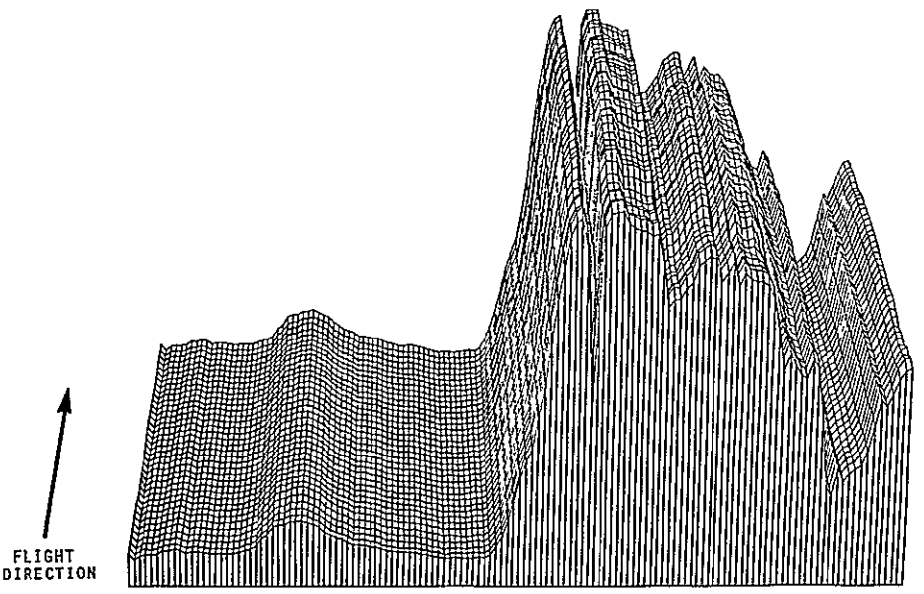
826



10:34 AM 5/16/75

SUN ELEV = 70°

812- 848



MATURE ALFALFA

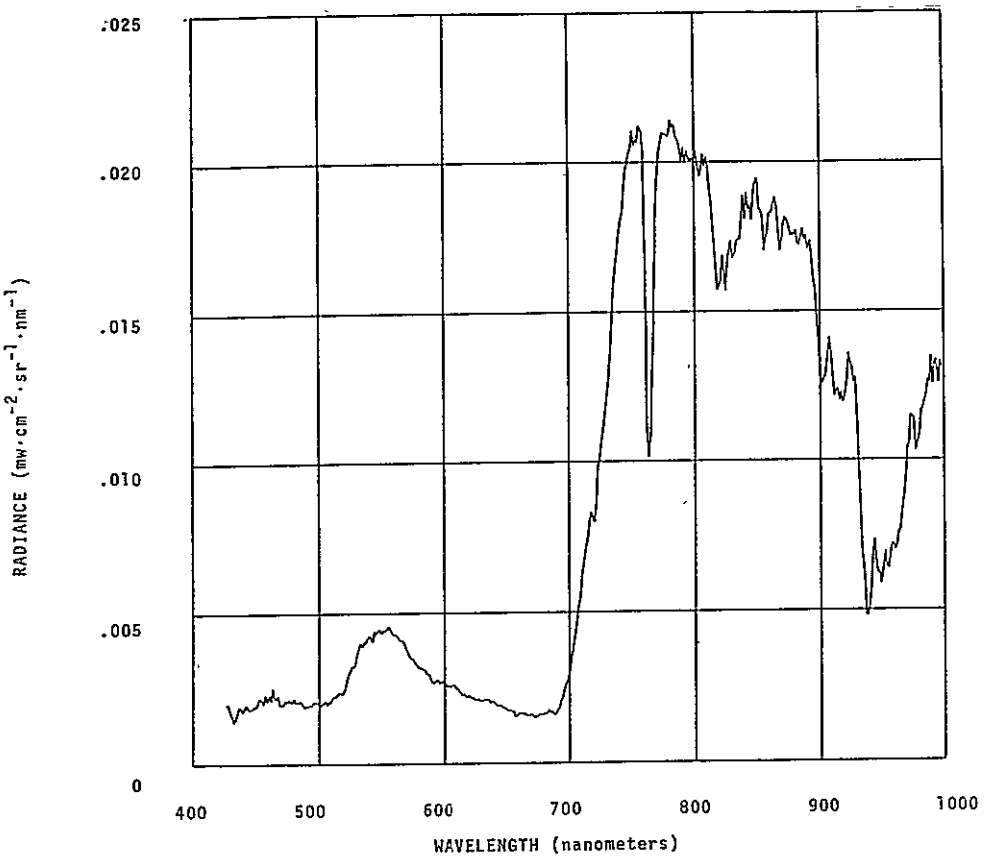
F I E L D D E S C R I P T I O N

30 to 36 inches high, 100% leaf cover, thick uniform canopy. 1st year crop. Soil wet. Imperial, silty clay.

P H O T O I N T E R P R E T A T I O N

homogeneous tone except furrows are detectable; fine texture; high density except an area 330 feet long which is slightly more sparse; near total cover; furrows run parallel with the FL.

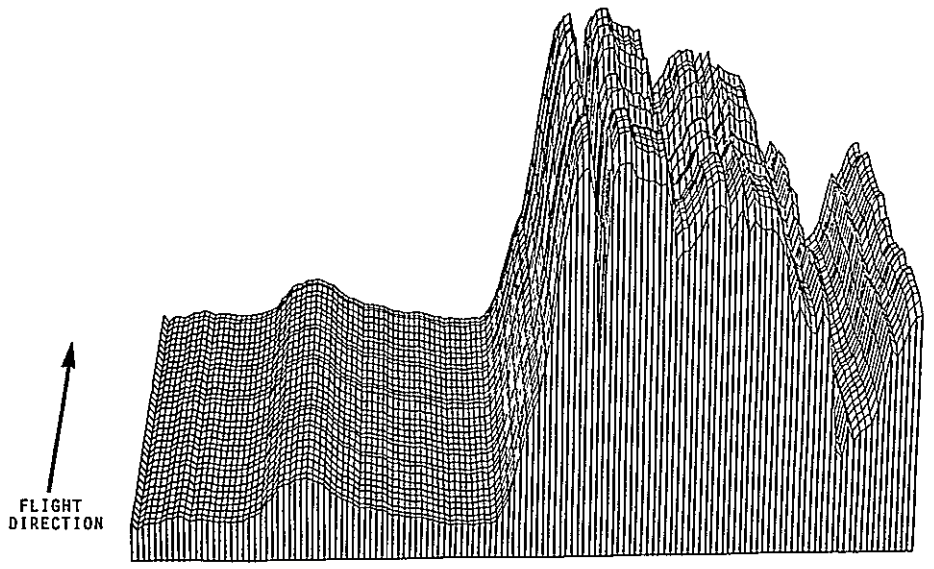
878



10:55 AM 5/16/75

SUN ELEV = 73°

849- 883



MATURE ALFALFA

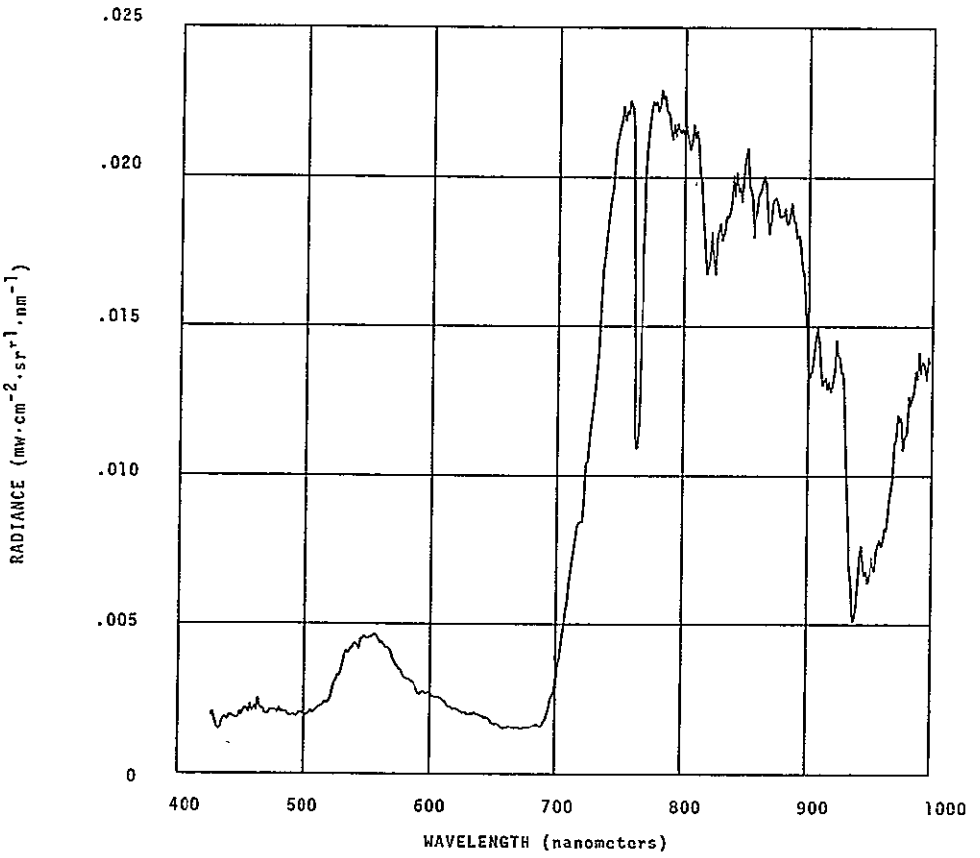
FIELD DESCRIPTION

30 to 36 inches high, 100% leaf cover, thick uniform canopy. 1st year crop. Soil wet. Imperial, silty clay.

PHOTO INTERPRETATION

honogeneous tone except furrows are slightly detectable, fine texture; high density; total cover; furrows run parallel with FL.

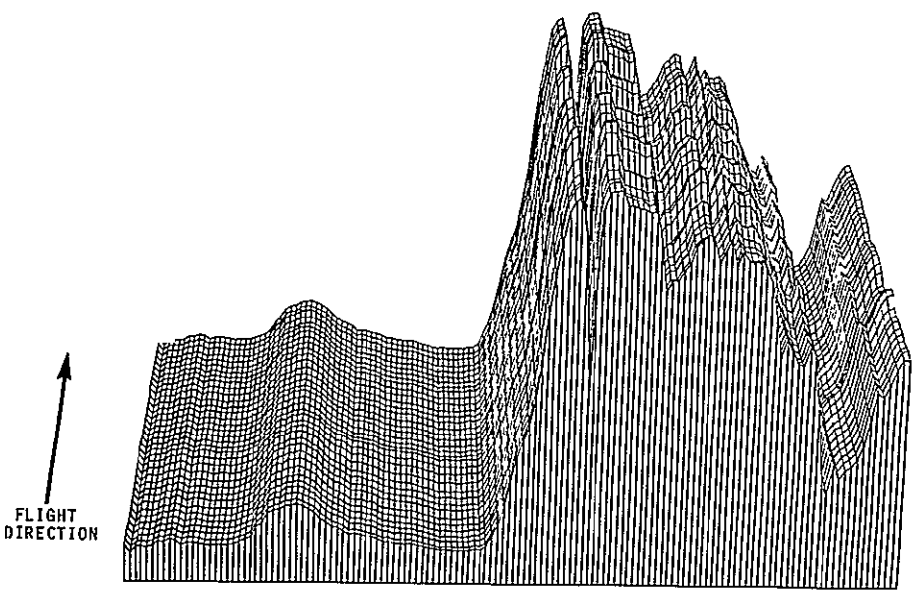
902



10:47 AM 5/16/75

SUN ELEV = 72°

884- 918



MATURE ALFALFA

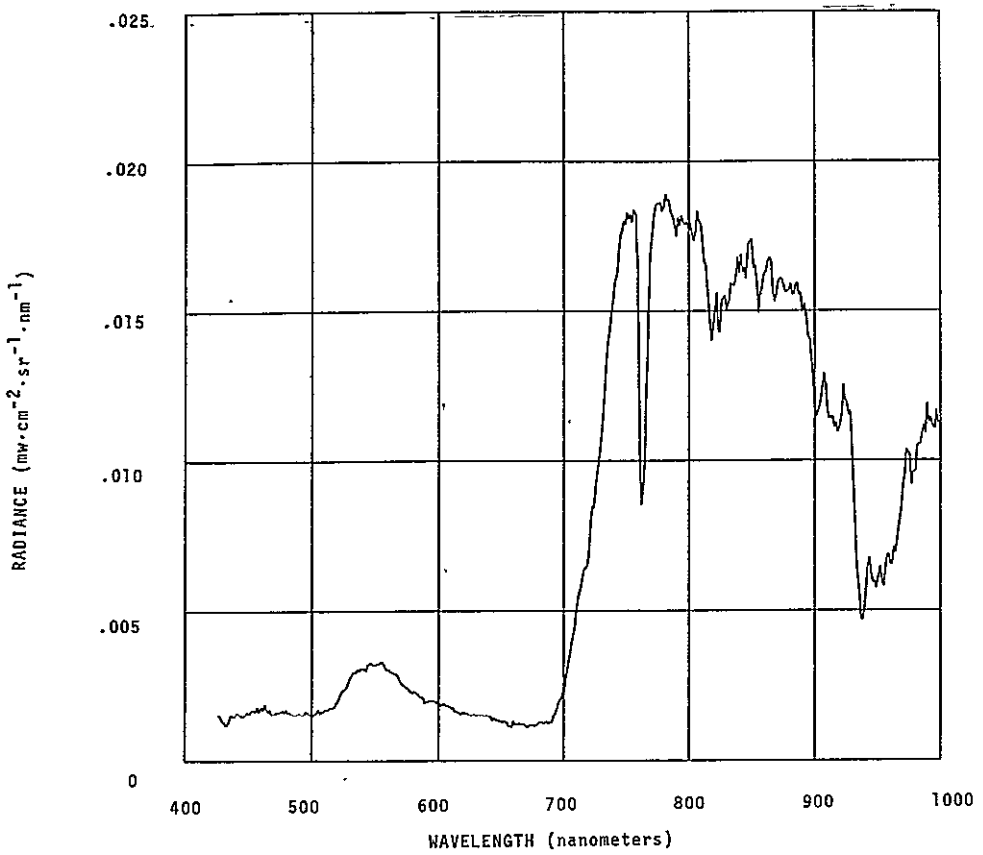
FIELD DESCRIPTION

30 to 36 inches high, 100% leaf cover, thick uniform canopy. 3rd year crop. Soil moist. Imperial, silty clay.

PHOTO INTERPRETATION

homogeneous tone except furrows are very slightly detectable; no texture; high density; total cover; furrows run perpendicular to FL.

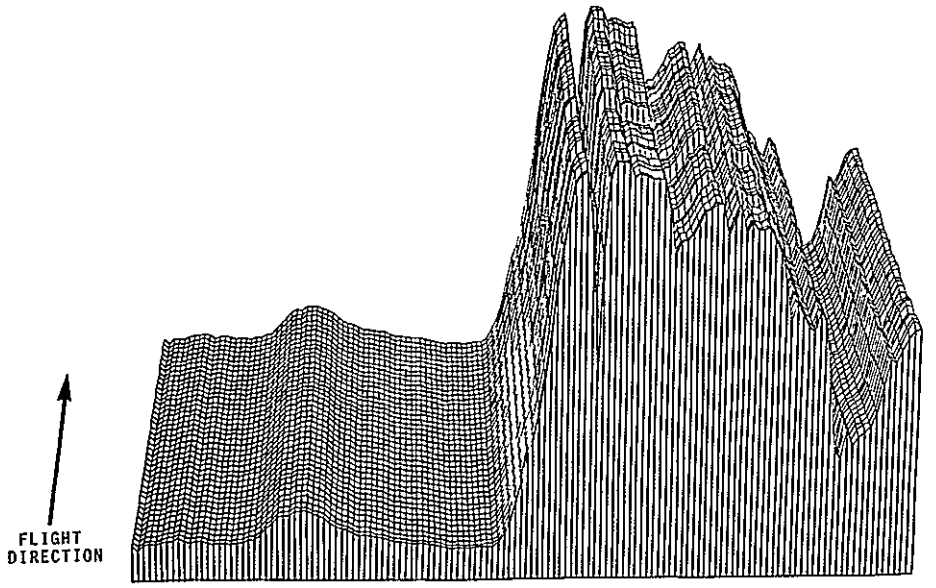
939



9:43 AM 5/15/75

SUN ELEV = 61°

919- 960



MATURE ALFALFA

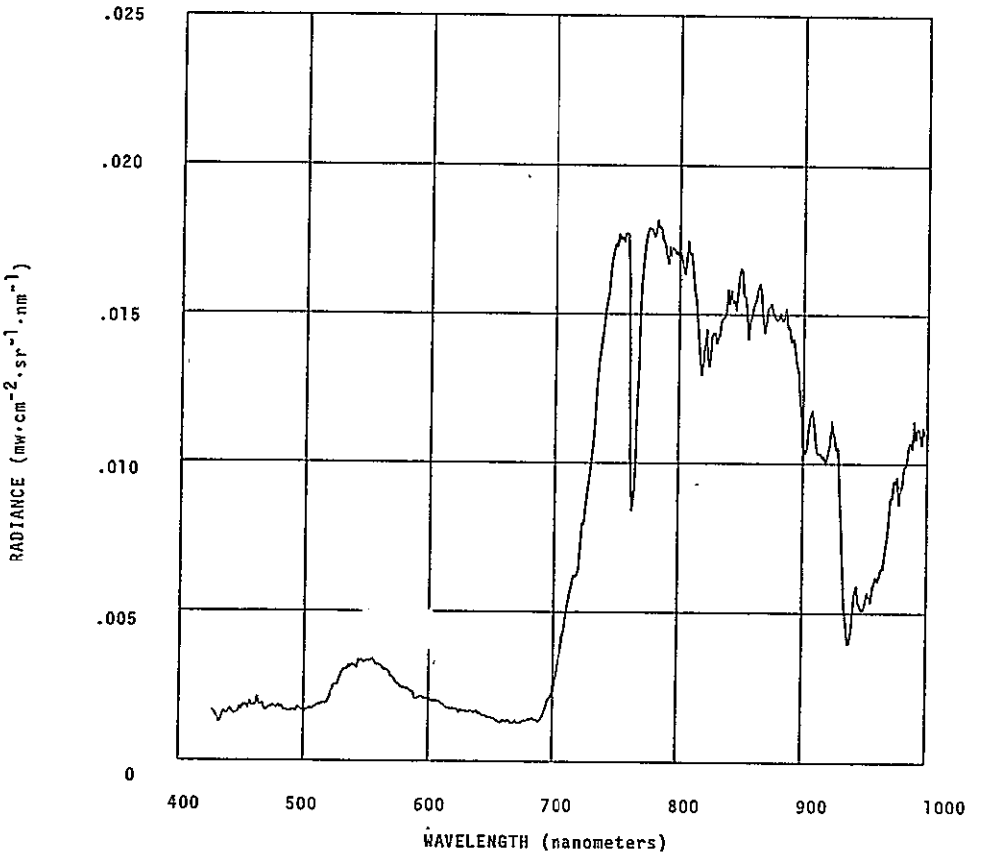
FIELD DESCRIPTION

30 to 36 inches high, 100% leaf cover, thick slightly patchy canopy. 3rd year crop. Soil dry. Imperial, light brown silty clay (7.5YR 6/4).

PHOTO INTERPRETATION

homogeneous tone except for very slight detection of furrows; texture is absent or fine; high density; total cover; furrows run parallel with FL.

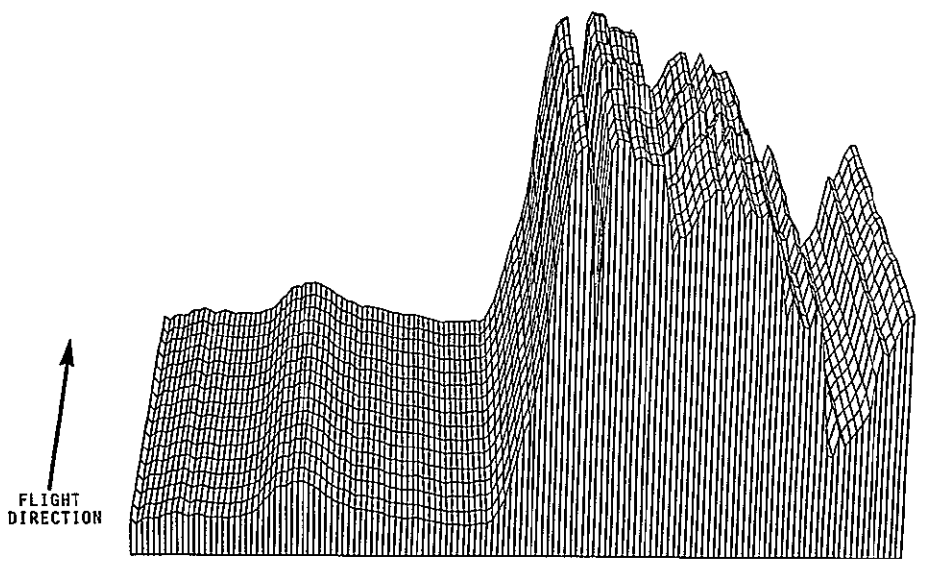
969



10:08 AM 5/16/75

SUN ELEV = 66°

961- 976



MATURE ALFALFA

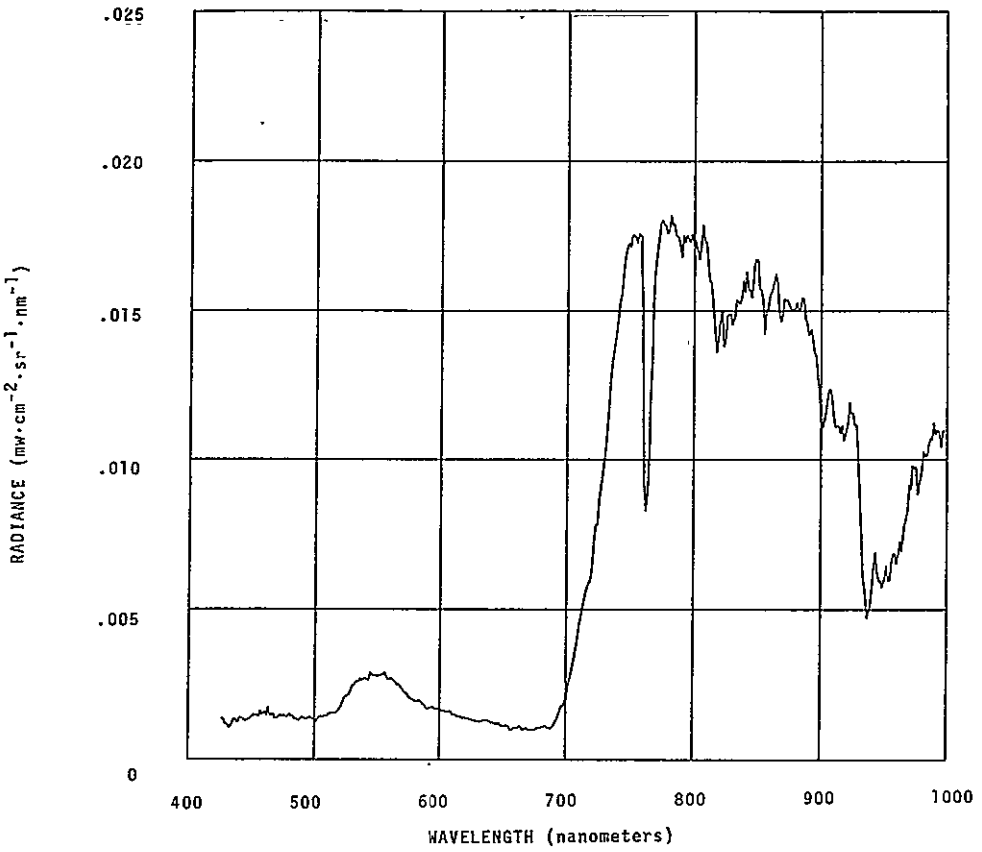
FIELD DESCRIPTION

30 to 36 inches high, 100% leaf cover, thick uniform canopy. 3rd to 4th year crop. Soil dry. Imperial, light brown silty clay (7.5YR 6/4).

PHOTO INTERPRETATION

homogeneous tone; no texture; high density; total cover.

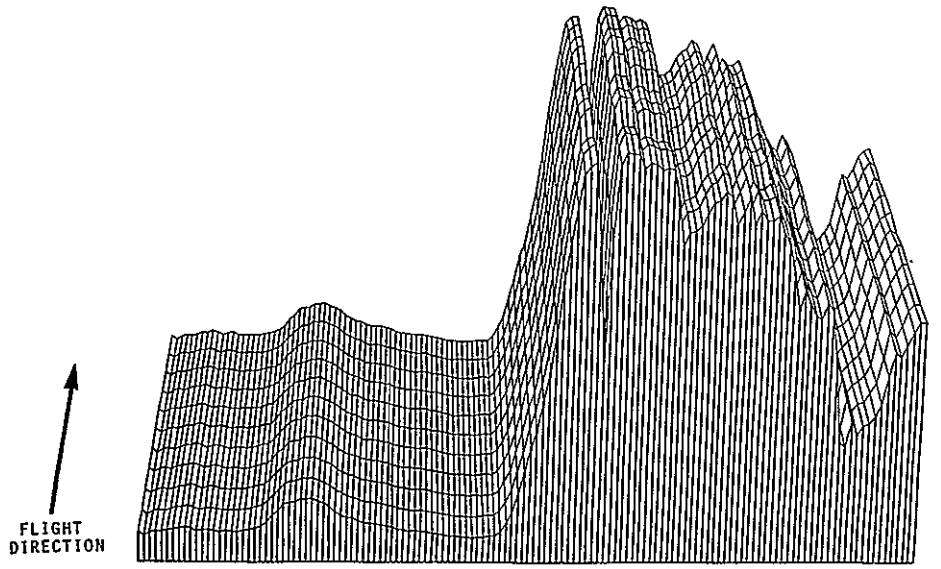
981



9:37 AM 5/15/75

SUN ELEV = 59°

977- 987



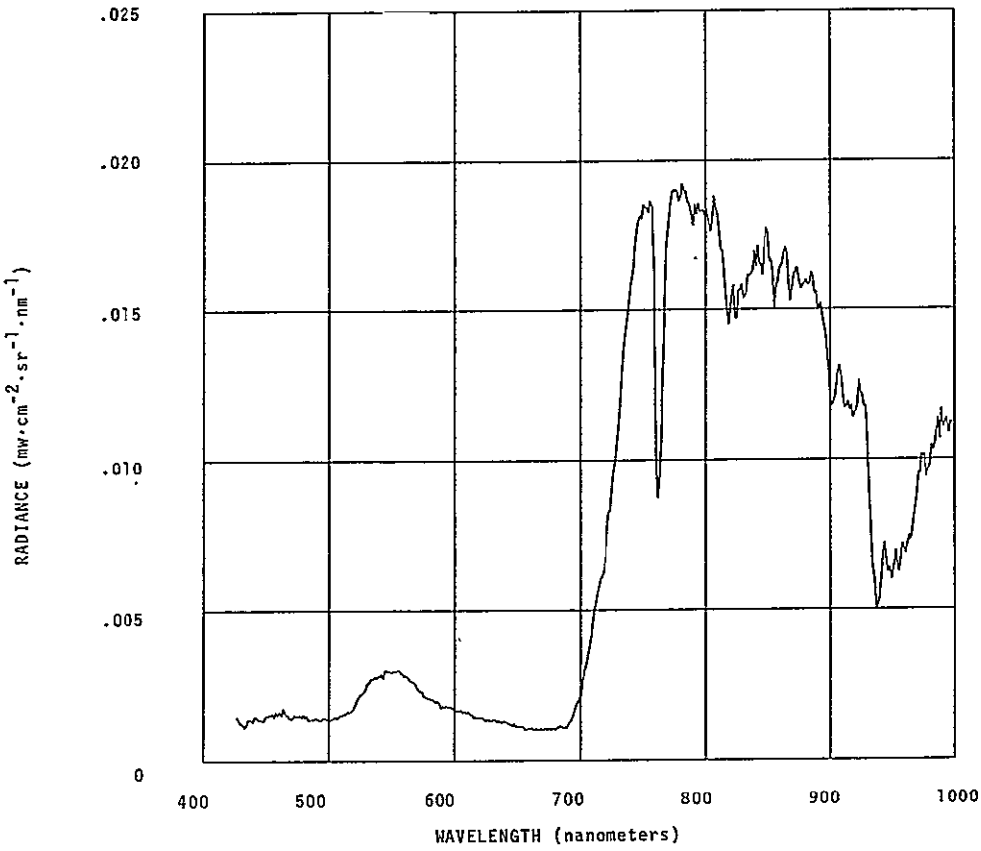
MATURE ALFALFA

FIELD DESCRIPTION

36 to 40 inches high, 100% leaf cover, thick uniform canopy. 4th year crop. Soil dry. Imperial, light brown silty clay (7.5YR 6/4).

PHOTO INTERPRETATION

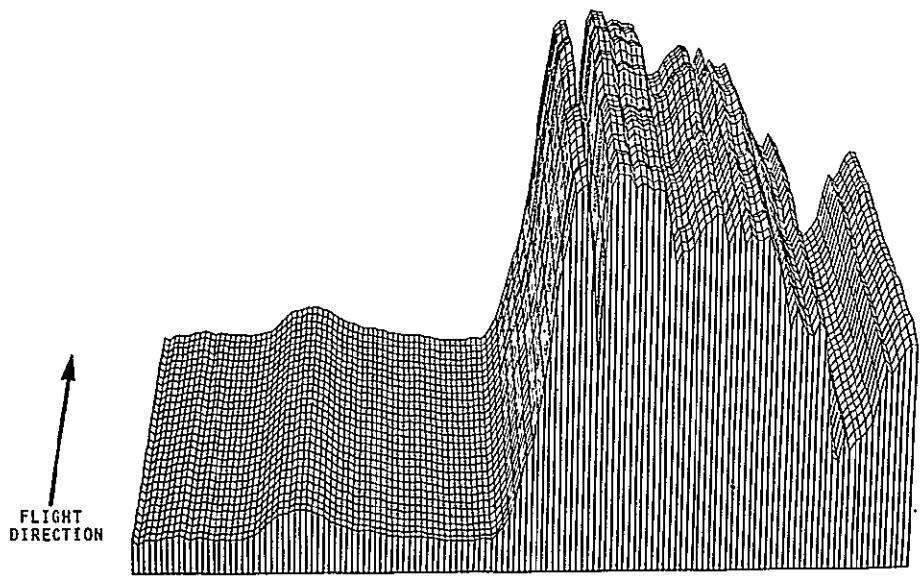
homogeneous tone; no texture; high density; total cover.



999

9:37 AM 5/15/75

SUN ELEV = 59°



988-1017

HARVESTED ALFALFA

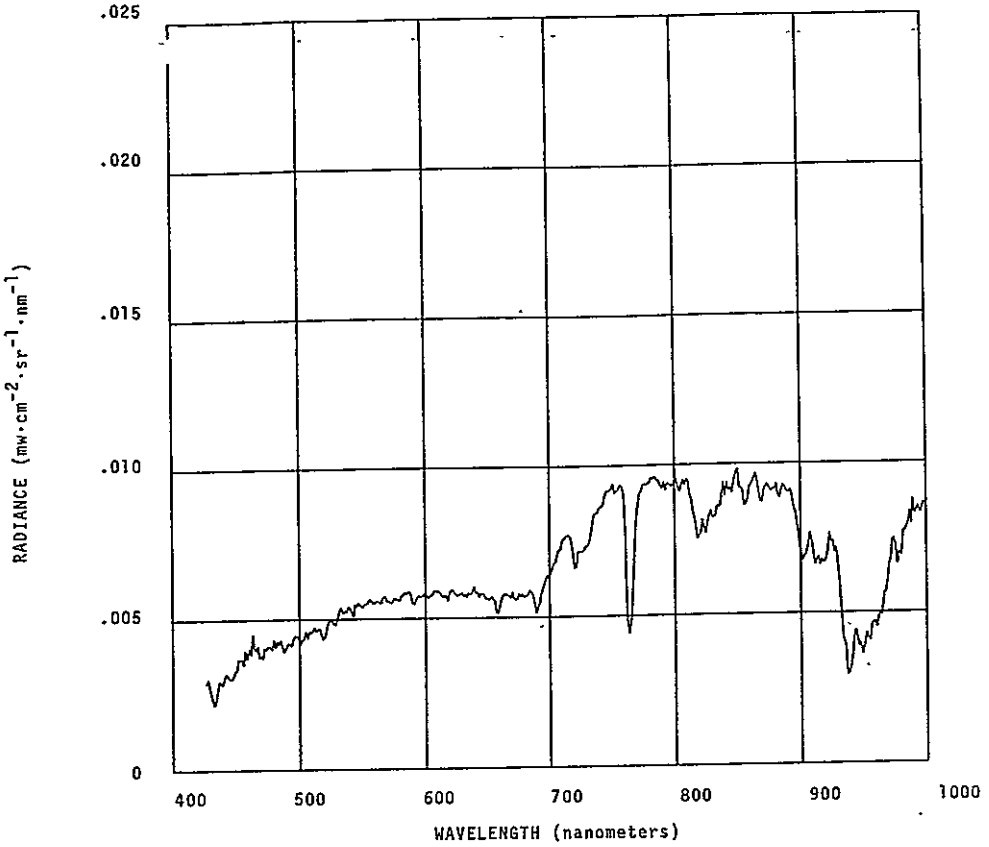
FIELD DESCRIPTION

2 to 3 inch stubble, 50% leaf cover, thin uniform canopy. Crop freshly cut and lying in windrows 4 feet wide 10 feet apart. 4th year crop. Soil dry. Imperial, light brown silty clay (7.5YR 6/4).

PHOTO INTERPRETATION

inhomogeneous tone; striated parallel with FL; coarse texture; differential densities ranging from high to low in alternating rows (harvesting pattern); 2/3 cover; furrows run parallel with FL.

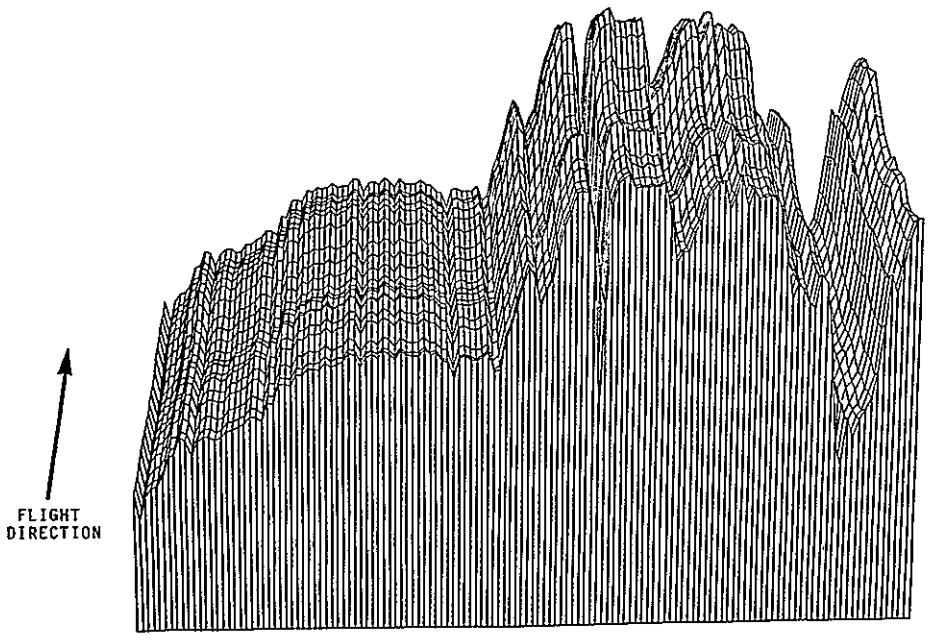
1024



10:40 AM 5/16/75

SUN ELEV = 71°

1018-1037



HARVESTED ALFALFA

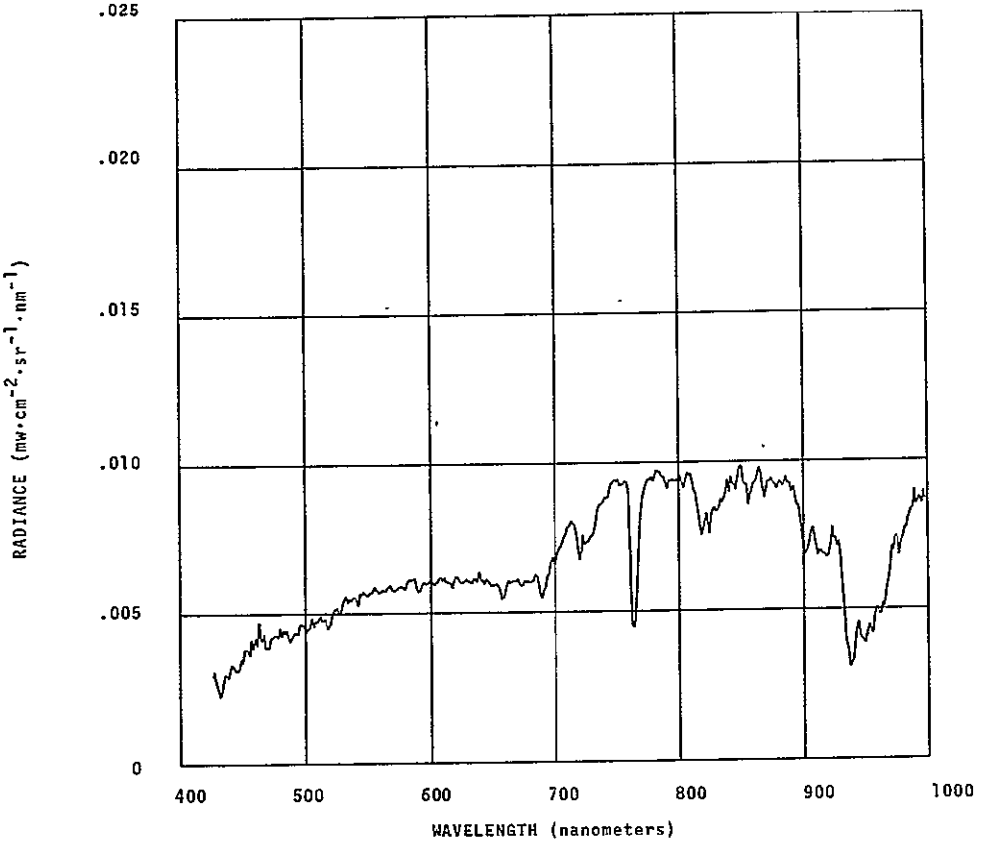
FIELD DESCRIPTION

2 to 3 inch stubble, 50% leaf cover, thin uniform canopy. Crop freshly cut and lying in windrows 4 feet wide 10 feet apart. 4th year crop. Soil dry. Imperial, light brown silty clay (7.5YR 6/4).

PHOTO INTERPRETATION

inhomogeneous tone, striated parallel with FL; coarse texture; differential density ranging from low to high in alternating rows (harvesting pattern); 2/3 cover; furrows run parallel with FL.

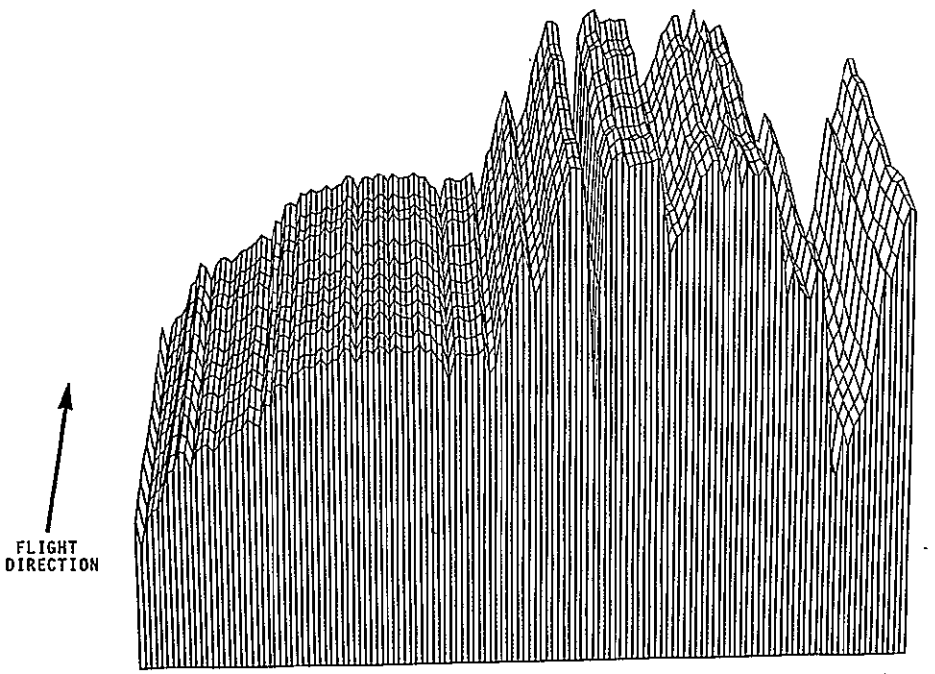
1047



10:34 AM 5/16/75

SUN ELEV = 70°

1038-1049



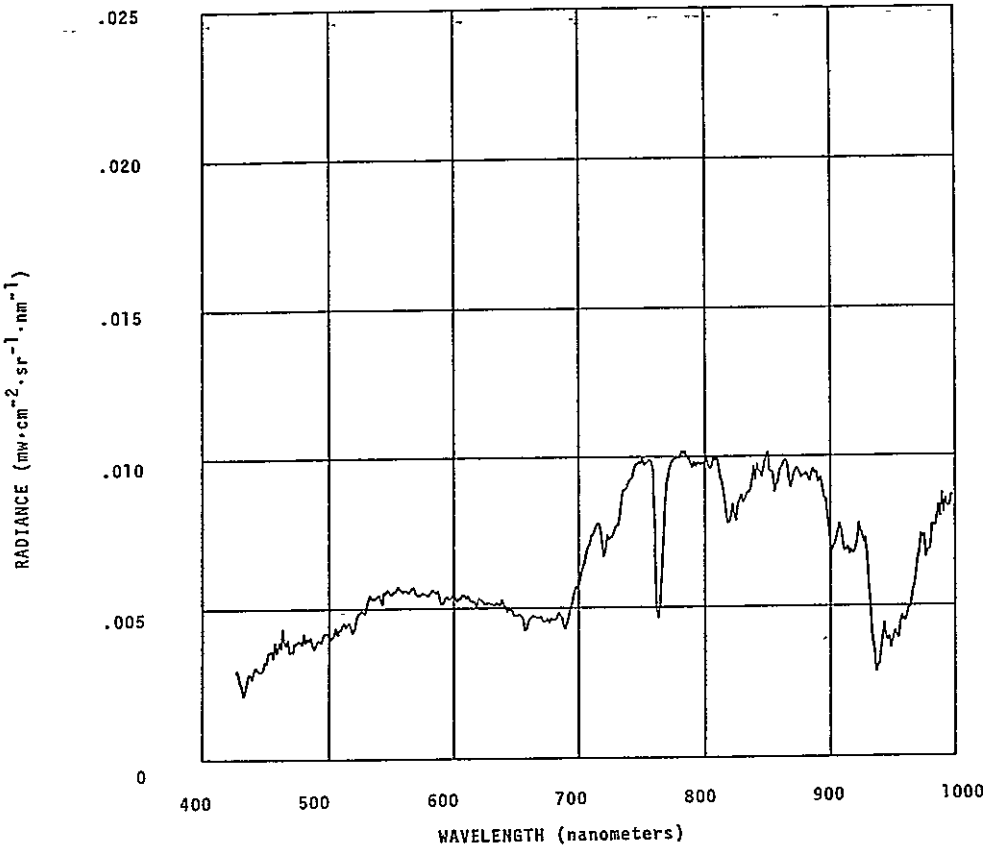
HARVESTED ALFALFA

FIELD DESCRIPTION

2 to 3 inch stubble, 50 to 60% leaf cover, moderately thin uniform canopy. Crop freshly cut and lying in windrows 3 feet wide, 6 feet apart. 1st year crop. Soil dry. Imperial, light brown silty clay (7.5YR 6/4).

PHOTO INTERPRETATION

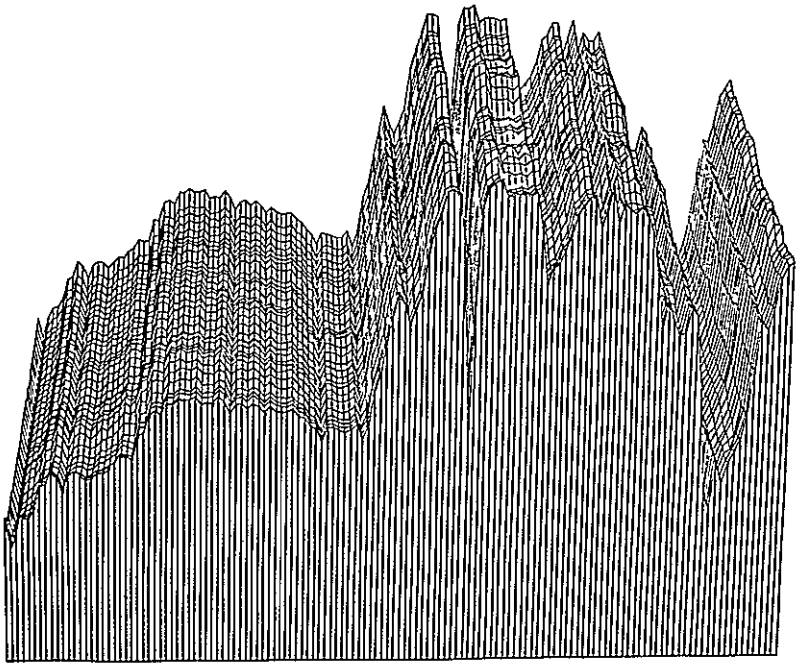
inhomogeneous tone; coarse texture; density is differential with alternating rows of high and low (harvesting pattern); 1/3 cover; furrows run parallel to FL.



1075

10:47 AM 5/16/75

SUN ELEV = 72°



1050-1083

HARVESTED ALFALFA

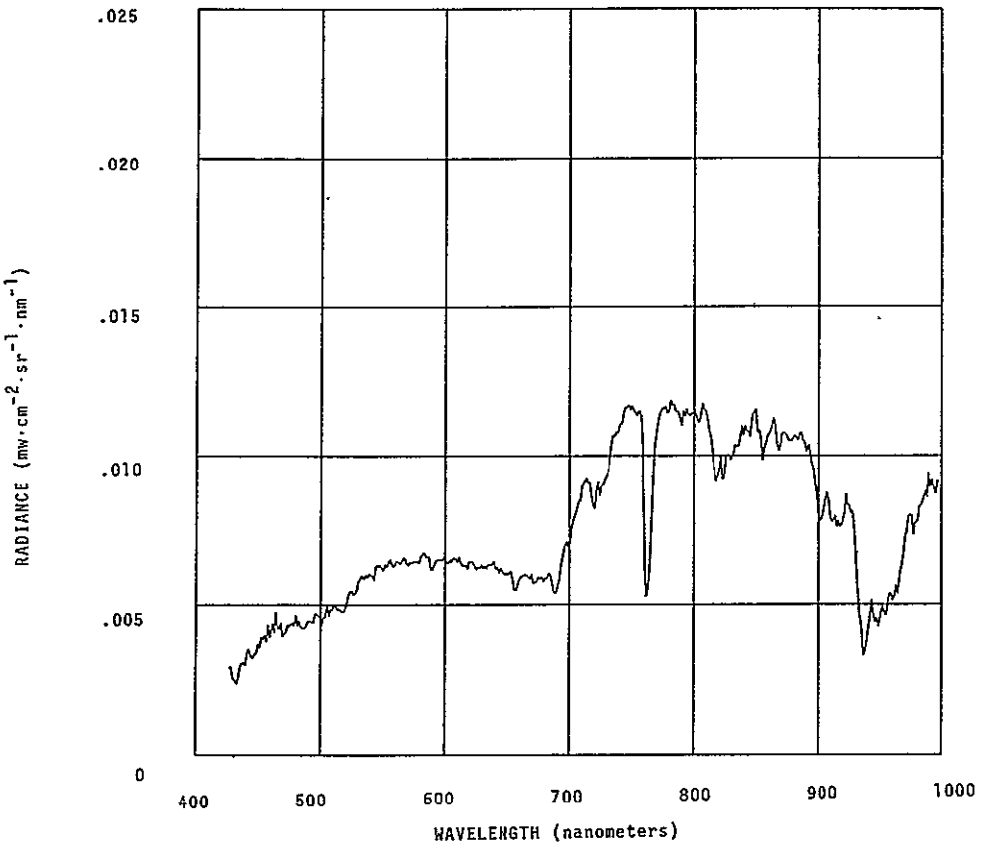
FIELD DESCRIPTION

4 to 6 inch stubble, 80% leaf cover, thin patchy canopy. Windrows of fresh cut material 4 feet wide and 30 feet apart. Soil dry. Imperial, light brown silty clay (7.5YR 6/4).

PHOTO INTERPRETATION

inhomogeneous tone, striated perpendicular to FL, coarse texture; alternating rows of medium and low density (harvesting pattern); 1/3 cover; furrows run perpendicular to FL.

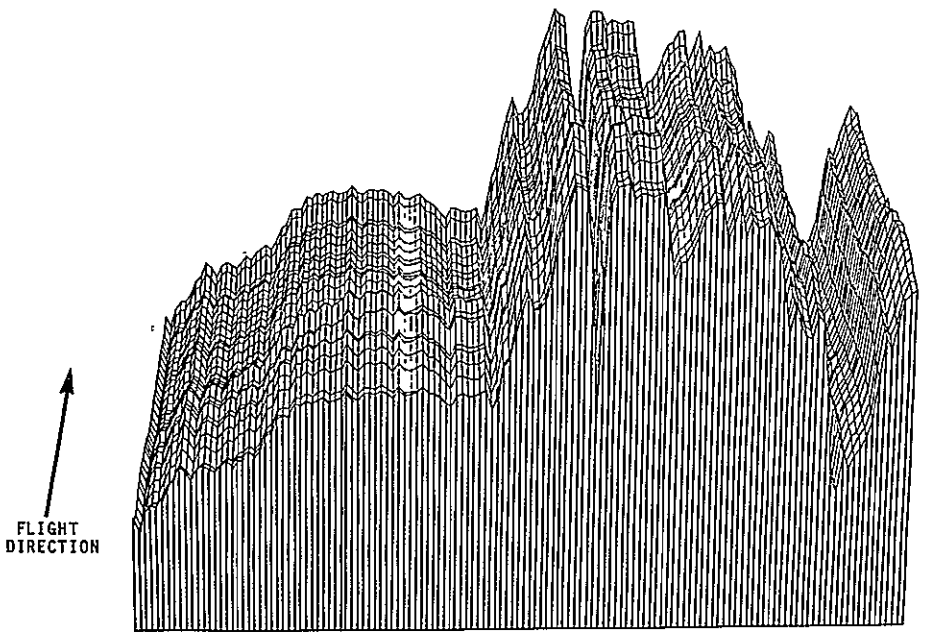
1111



9:43 AM 5/15/75

SUN ELEV = 61°

1084-1116



HARVESTED ALFALFA

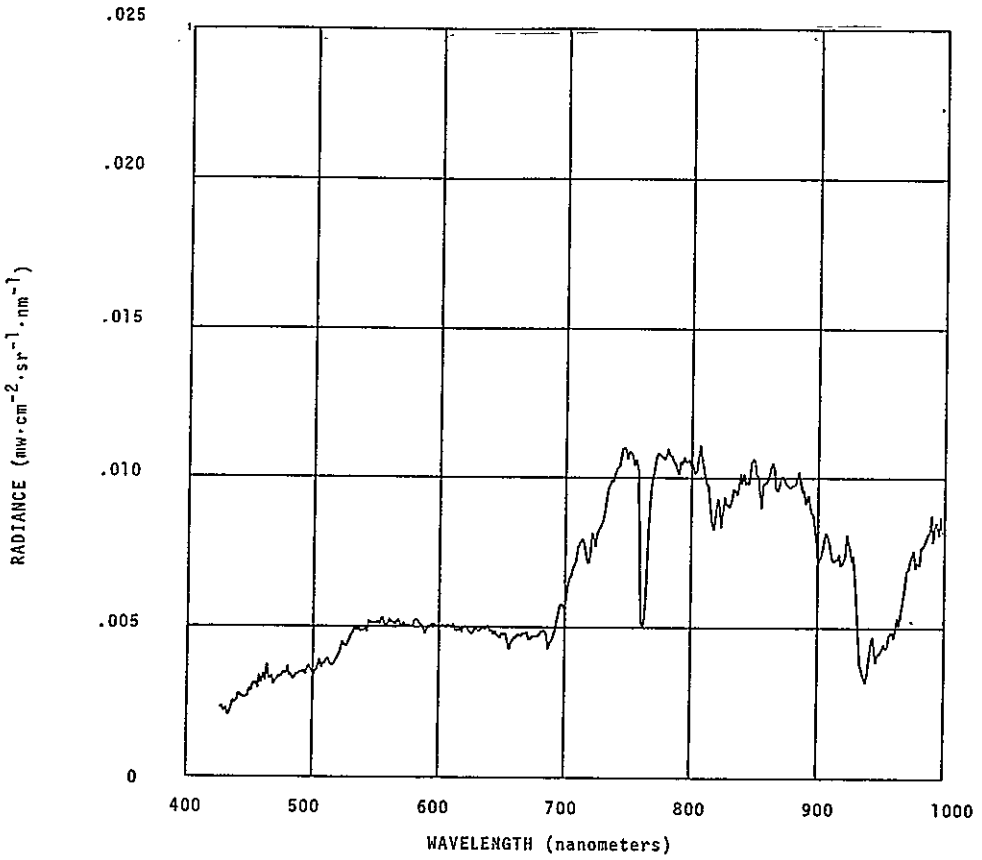
FIELD DESCRIPTION

4 to 6 inch stubble, 80% leaf cover, thin uniform canopy between windrows. Crop freshly cut and lying in windrows 4 feet wide, 10 feet apart. Soil dry. Imperial, light brown silty clay (7.5YR 6/4).

PHOTO INTERPRETATION

inhomogeneous tone; striated parallel with FL; coarse texture; high and medium density in alternating rows (harvesting pattern); near tot. cover; furrows run parallel with FL.

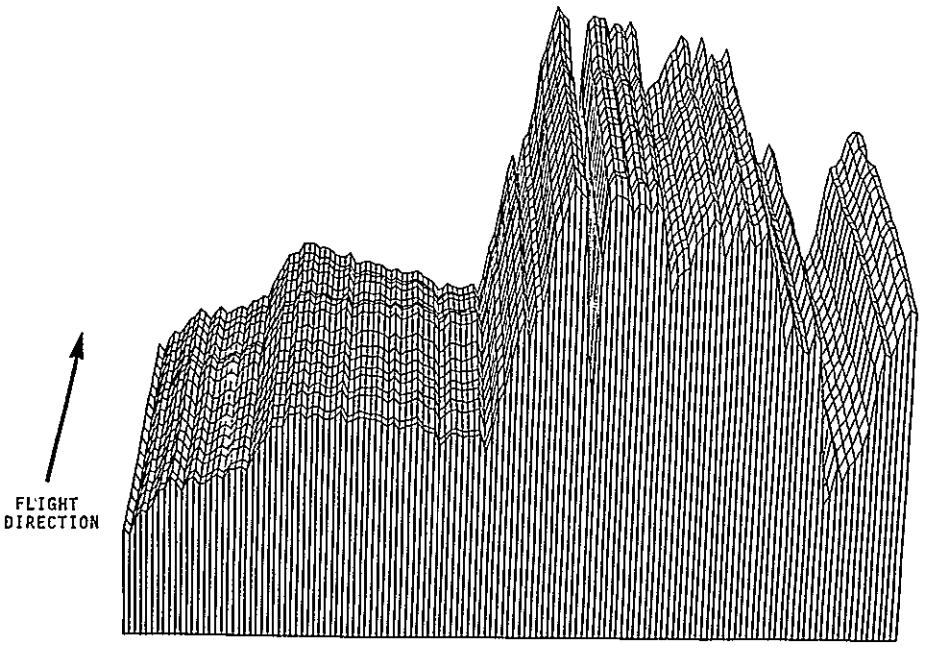
1124



9:28 AM 5/15/75

SUN ELEV = 58°

1117-1134



HARVESTED ALFALFA

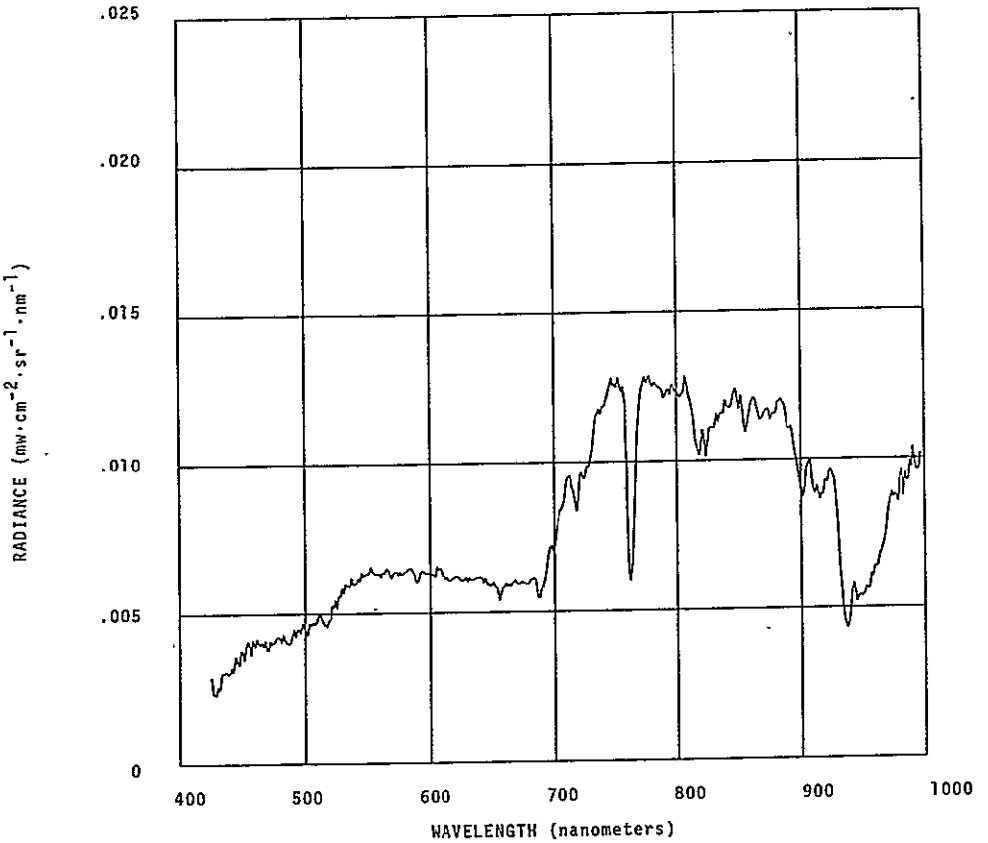
FIELD DESCRIPTION

4 to 6 inch stubble, 80% leaf cover, thin uniform canopy between windrows. Crop freshly cut and lying in windrows 4 feet wide 10 feet apart. Soil dry. Imperial, light brown silty clay (7.5YR 6/4).

PHOTO INTERPRETATION

inhomogeneous tone, striated parallel with FL; coarse texture; differential density ranging from high to low in alternating rows (harvesting pattern); near total cover; furrows run parallel with FL.

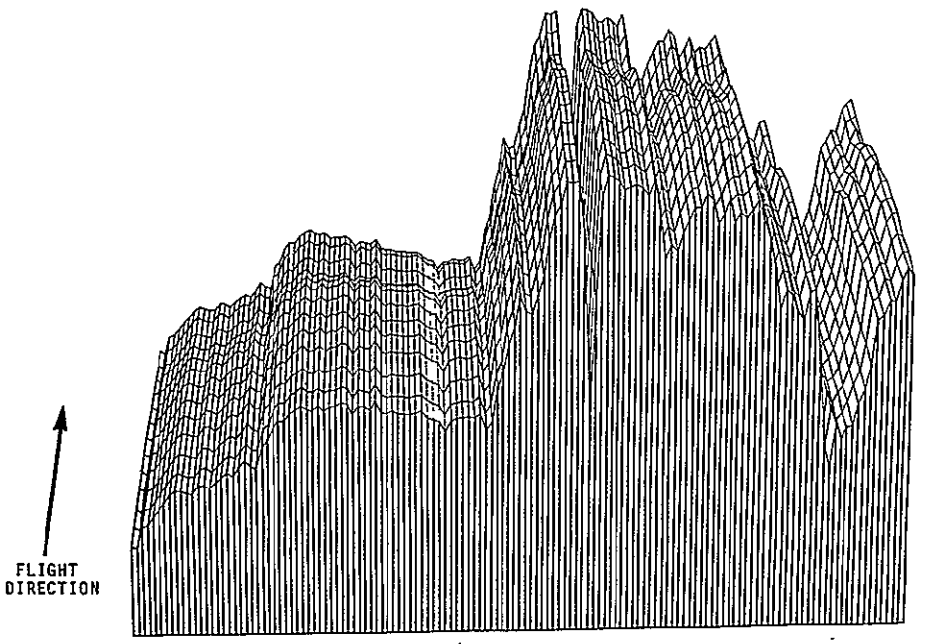
1136



10:42 AM 5/15/75

SUN ELEV = 71°

1135-1147



HARVESTED ALFALFA

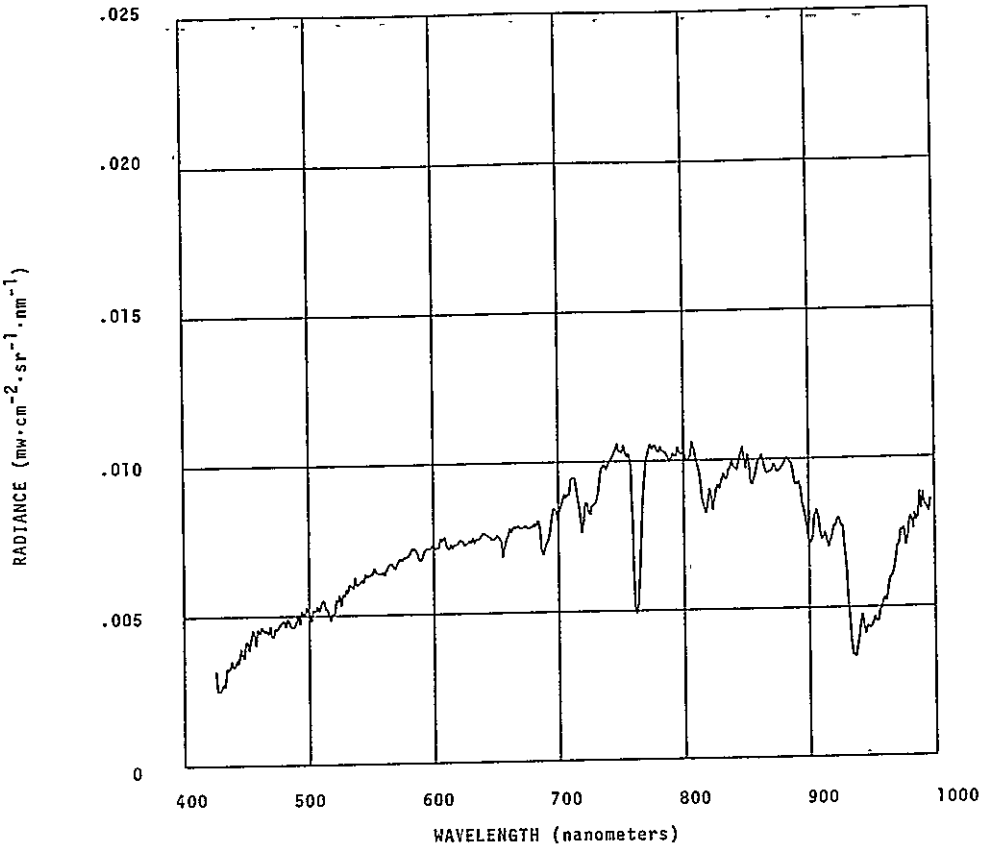
FIELD DESCRIPTION

6 to 8 inch stubble, 70% leaf cover, moderately thin patchy canopy. Windrows of fresh cut material 4 feet wide, 20 feet apart. 2nd year crop. Soil dry. Imperial, light brown silty clay (7.5YR 6/4).

PHOTO INTERPRETATION

inhomogeneous tone; coarse texture; differential densities in alternating rows of high, medium and low (harvesting pattern), 1/3 cover; furrows run perpendicular to FL.

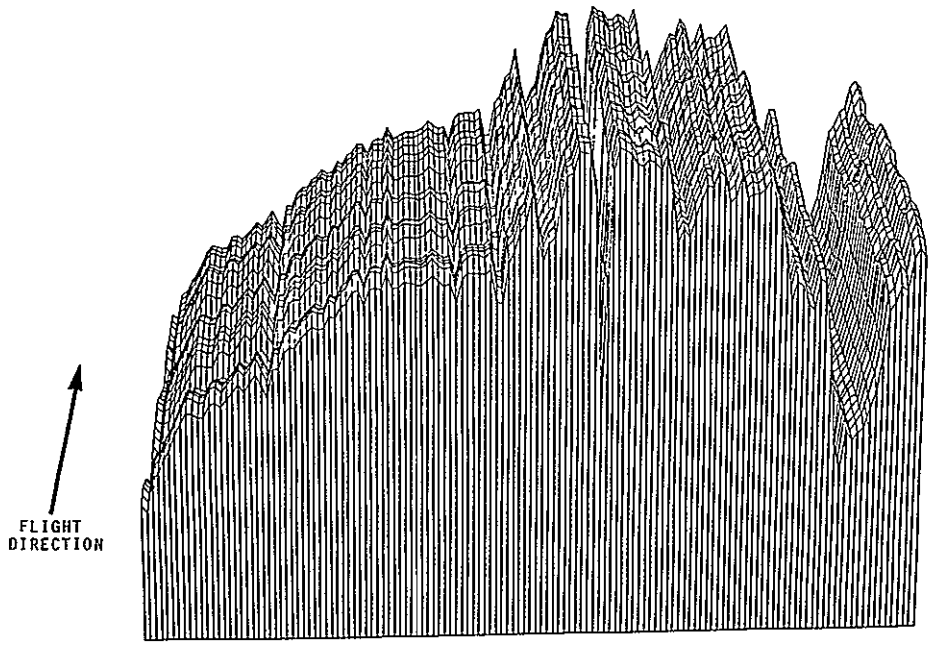
1178



10:17 AM 5/15/75

SUN ELEV = 67°

1148-1178



ASPARAGUS

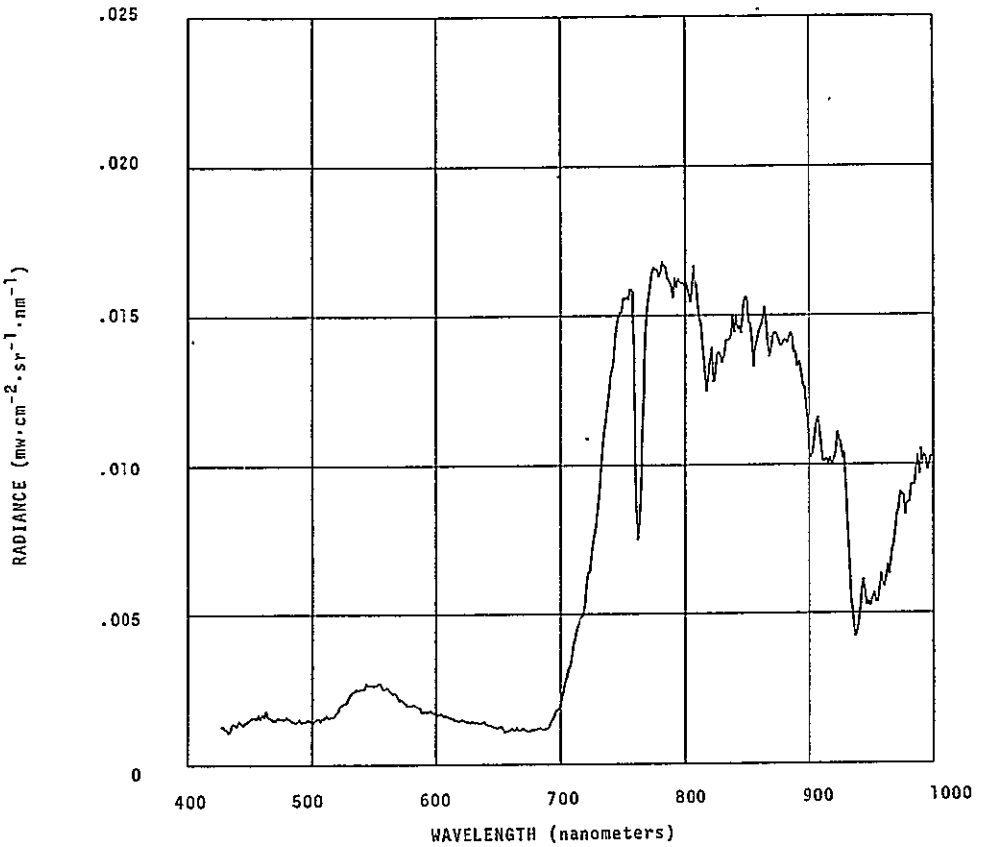
FIELD DESCRIPTION

36 inches high, 100% leaf cover, thick uniform canopy. Soil dry. Imperial, light brown silty clay (7.5YR 6/4).

PHOTO INTERPRETATION

homogeneous tone, no texture; high density; total cover.

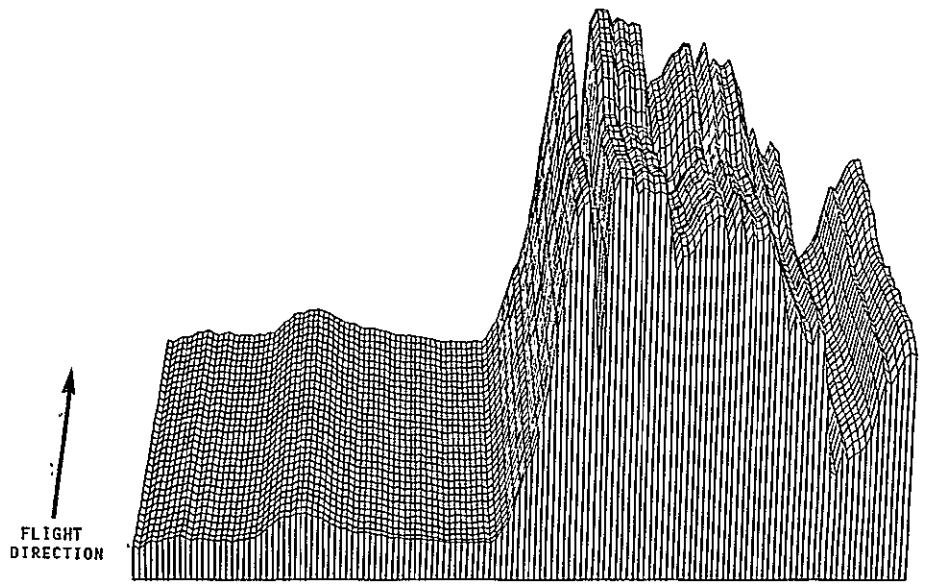
1185



9:37 AM 5/15/75

SUN ELEV = 59°

1179-1210



ASPARAGUS

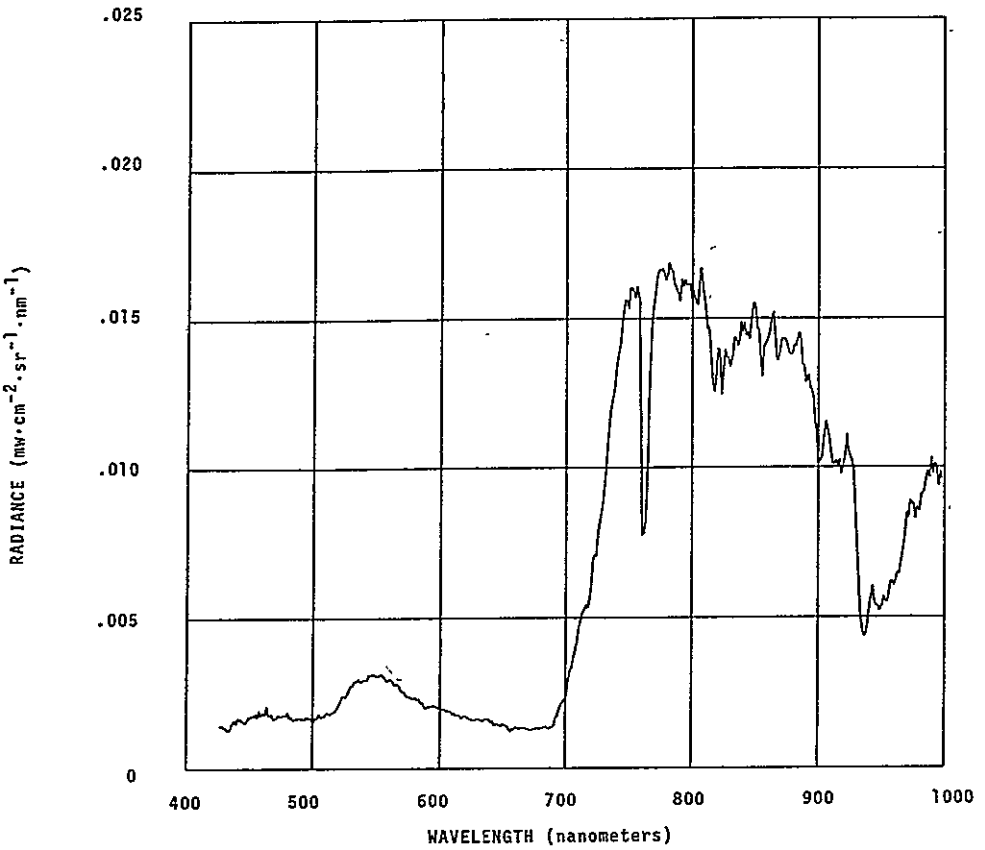
FIELD DESCRIPTION

36 inches high, 100% leaf cover, thick uniform canopy. Soil moist, muddy in furrows. Imperial, silty clay.

PHOTO INTERPRETATION

homogeneous tone; no texture; high density; total cover.

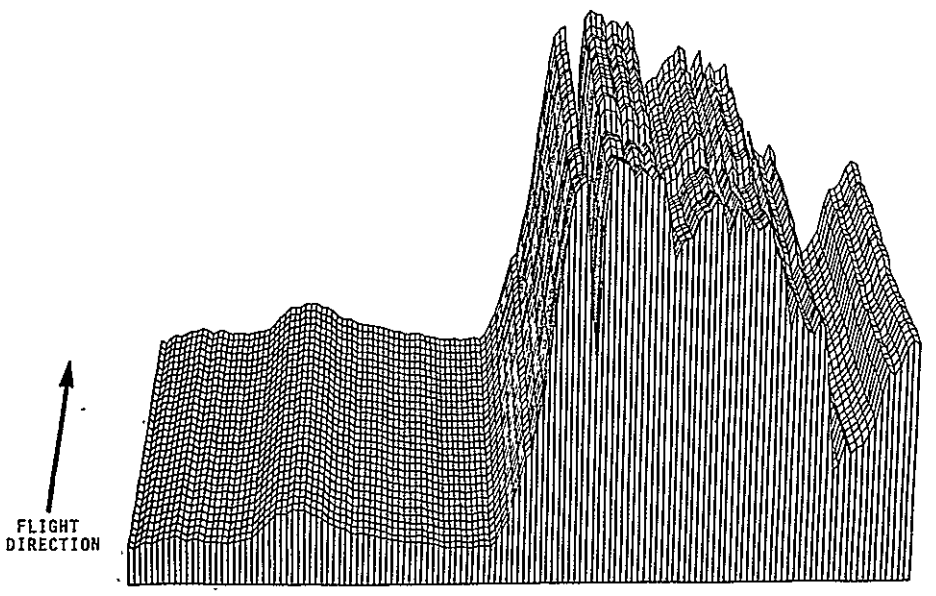
1234



9:28 AM 5/15/75

SUN-ELEV = 58°

1211-1241



ASPARAGUS

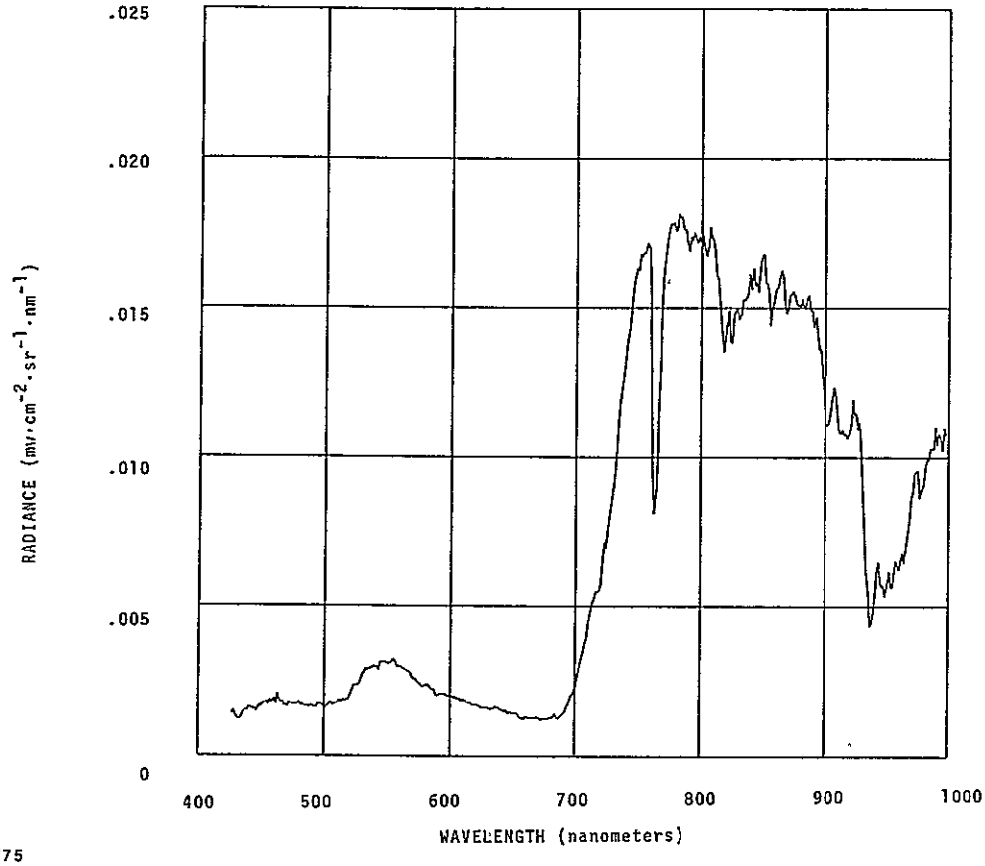
FIELD DESCRIPTION

36 inches high, 100% leaf cover, thick uniform canopy. Soil muddy, standing water in furrows. Imperial, silty clay.

PHOTO INTERPRETATION

homogeneous tone; no texture; high density; total cover.

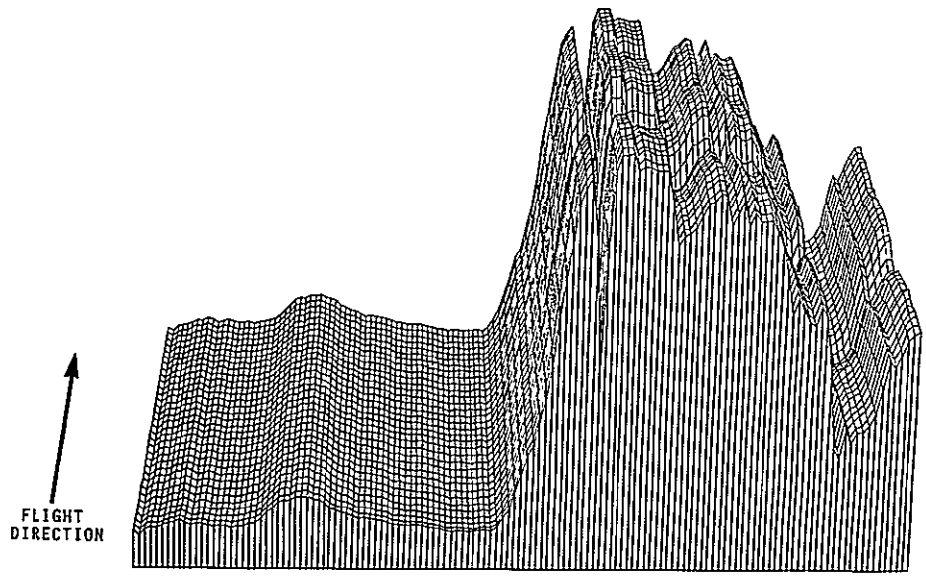
1251



9:43 AM 5/15/75

SUN ELEV = 61°

1242-1274



ASPARAGUS

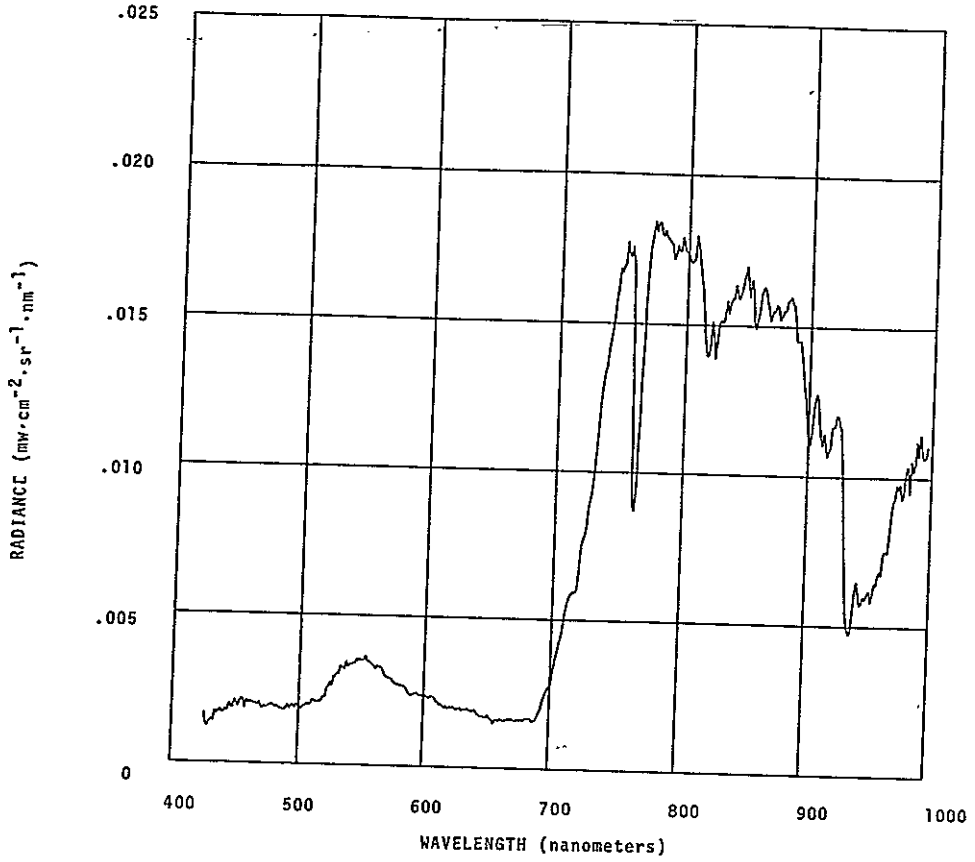
FIELD DESCRIPTION

36 inches high, 100% leaf cover, thick uniform canopy. Soil moist, muddy in furrows. Imperial, silty clay.

PHOTO INTERPRETATION

homogeneous tone; no texture; high density; total cover.

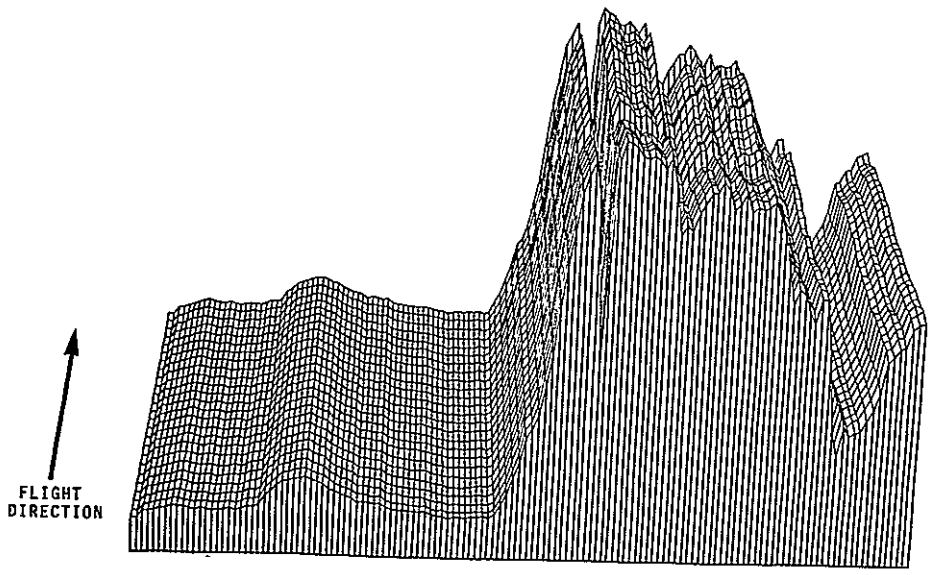
1294



10:42 AM 5/15/75

SUN ELEV = 71°

1275-1299



ASPARAGUS

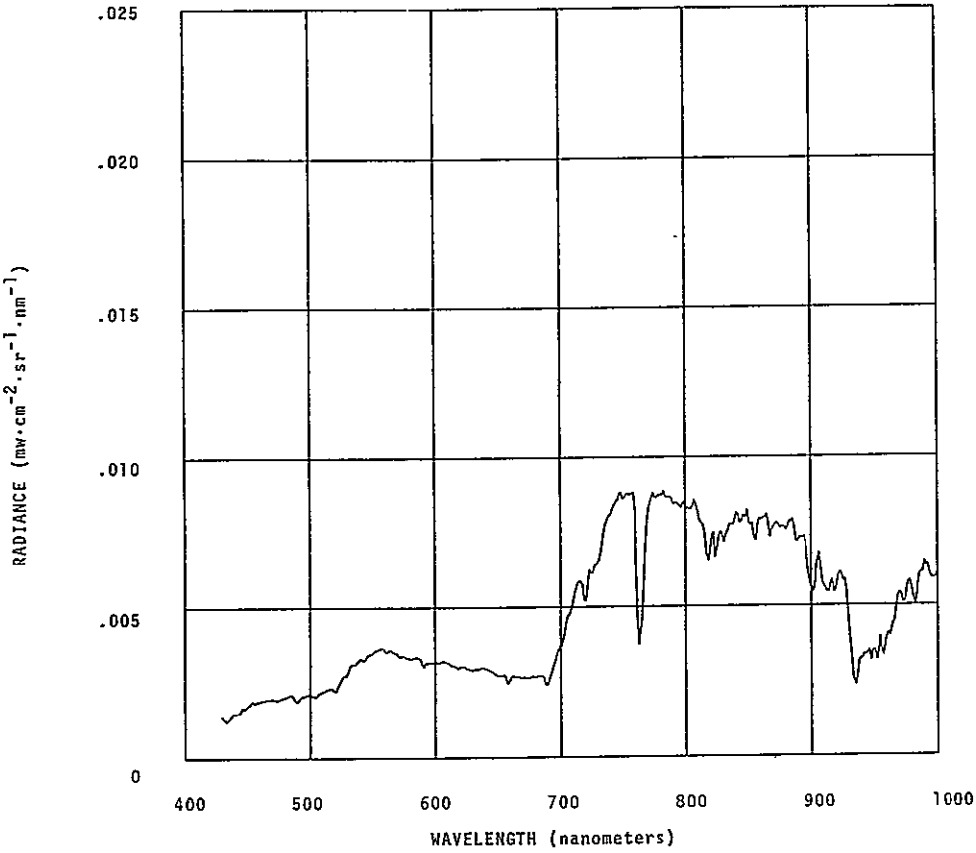
FIELD DESCRIPTION

4 feet high, 100% leaf cover, thick uniform canopy with mixed green to green-yellow coloration. Soil dry. Imperial, light brown silty clay (7.5YR 6/4).

PHOTO INTERPRETATION

homogeneous tone; medium texture; high density; total cover.

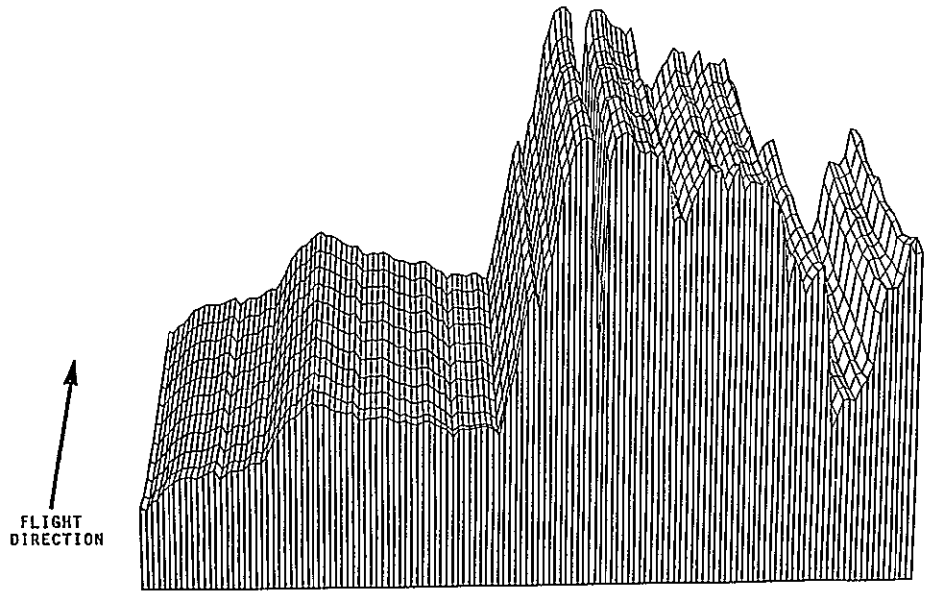
1304



10:32 AM 9/23/75

SUN ELEV = 54°

1300-1310



ASPARAGUS

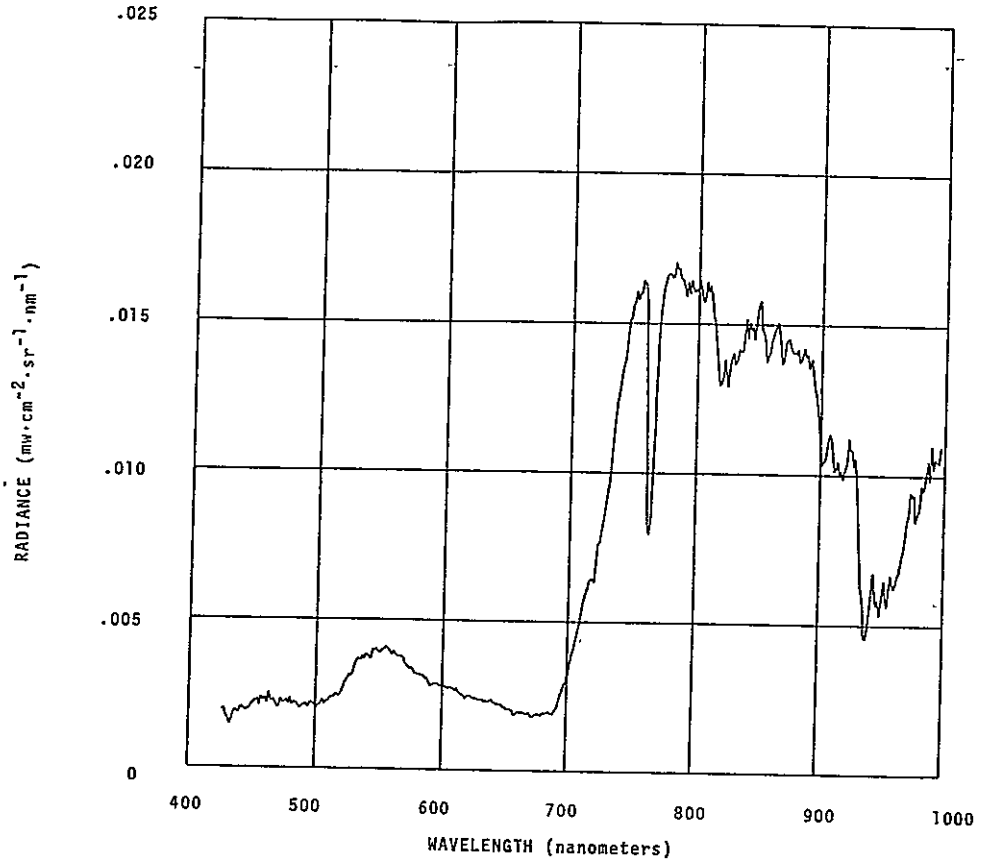
FIELD DESCRIPTION

5 feet high, 100% leaf cover, thick uniform canopy. Soil moist. Imperial, silty clay.

PHOTO INTERPRETATION

homogeneous tone; fine texture; high density; total cover.

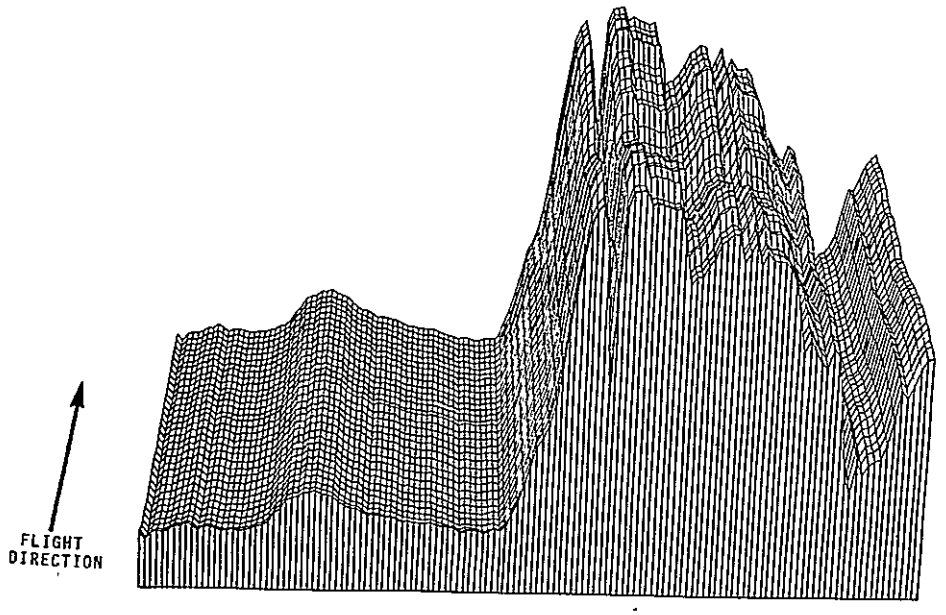
1332



9:58 AM 5/15/75

SUN ELEV = 63°

1311-1343



BARE SOIL

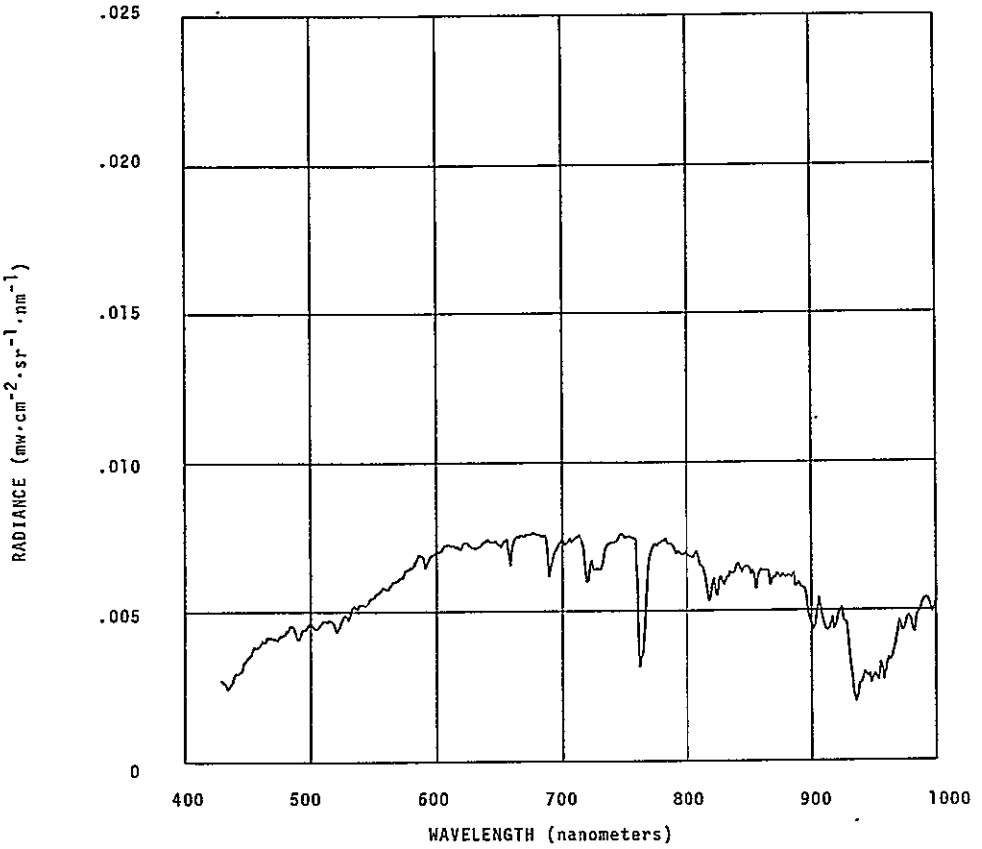
FIELD DESCRIPTION

furrows 8 inches high spaced 20 inches apart.
2 inch clods. Smooth surface. Soil wet.
Imperial, silty clay.

PHOTO INTERPRETATION

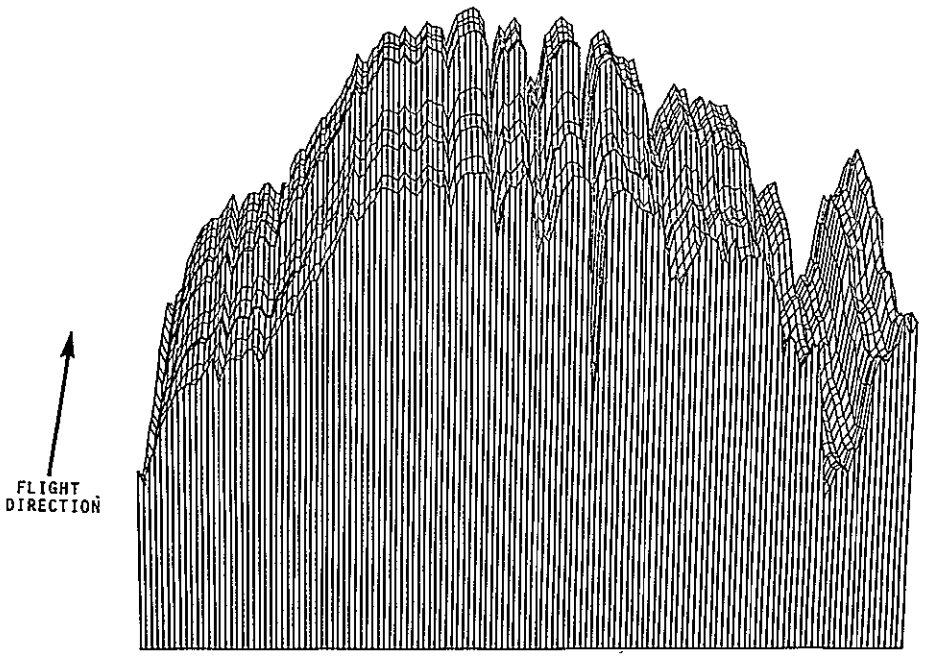
inhomogeneous tone; medium texture; bare soil;
tonal patterns caused by differential soil
moisture.

1364



10:44 AM 9/23/75
SUN ELEV = 55°

1344-1366



BARE SOIL

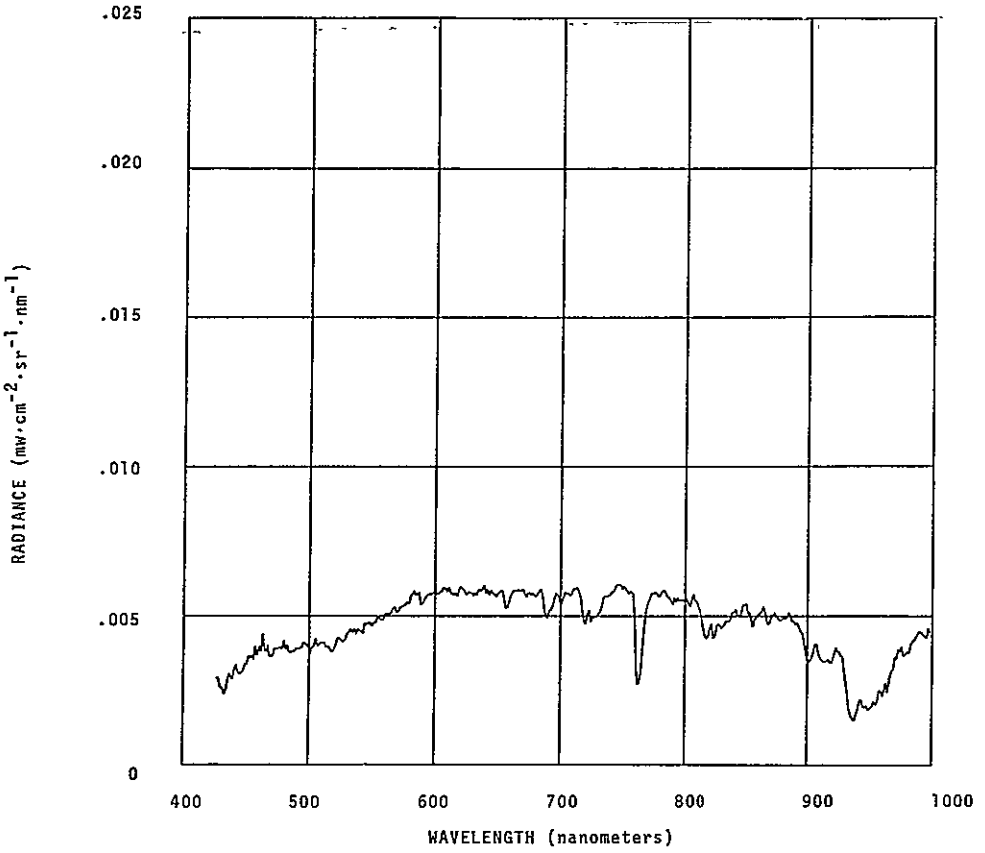
FIELD DESCRIPTION

furrows 12 inches deep spaced 2 feet apart. 1 to 3 inch clods of soil. Soil moist in furrows. Imperial, silty clay.

PHOTO INTERPRETATION

homogeneous tone; fine texture; bare soil.

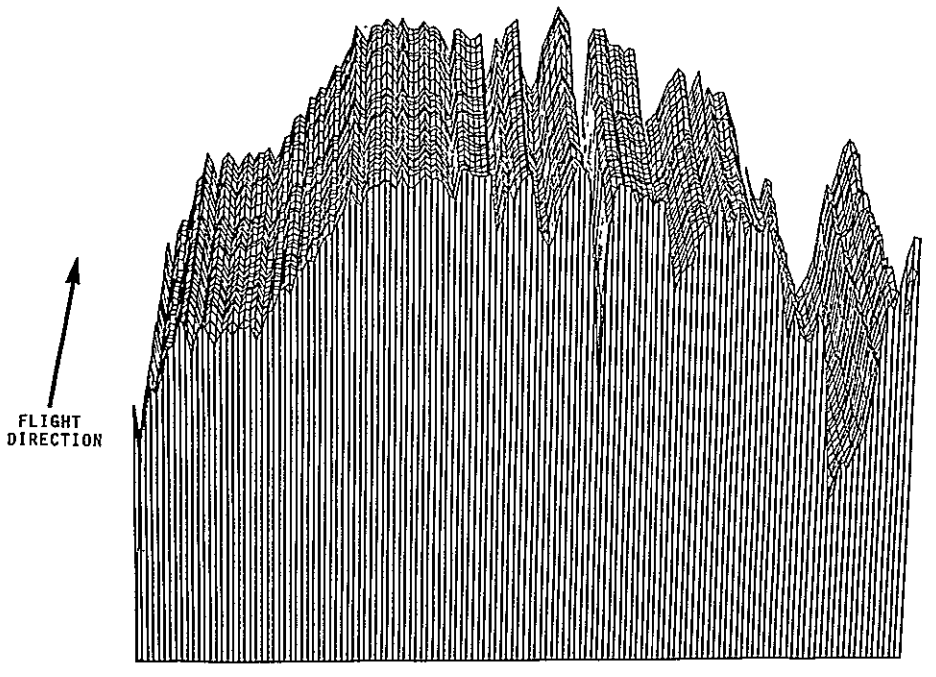
1398



9:54 AM 5/16/75

SUN ELEV = 63°

1367-1409



BARE SOIL

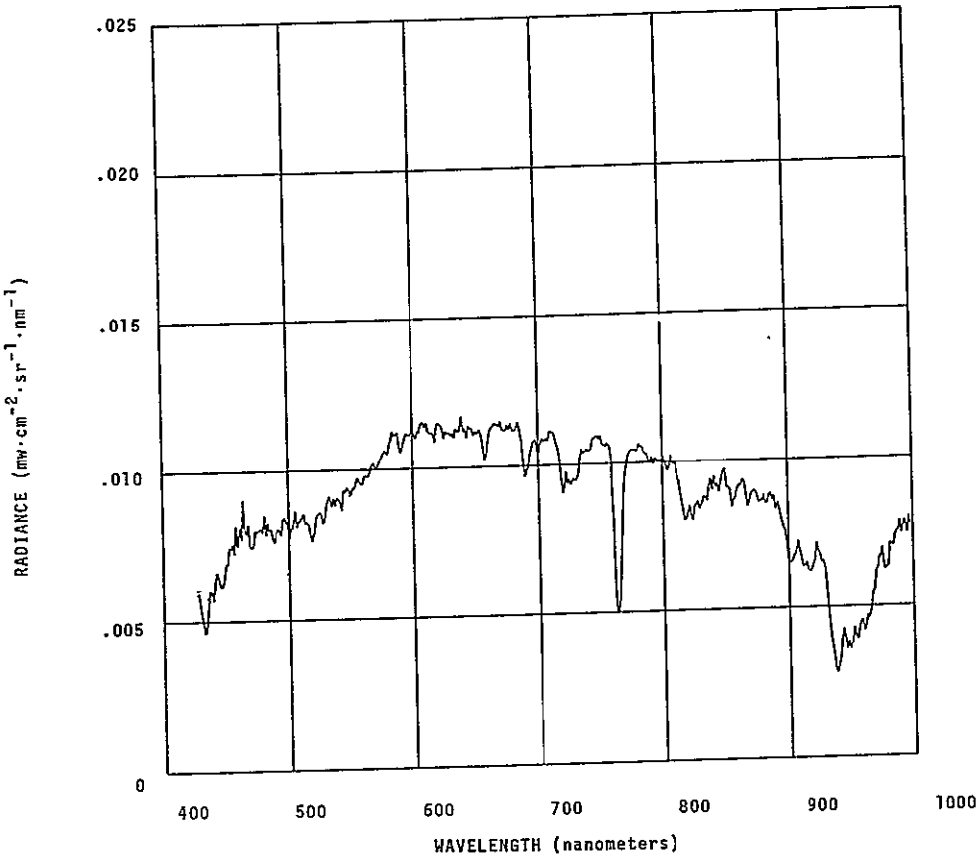
FIELD DESCRIPTION

furrows 8 inches deep, 3 feet apart, 1 to 6 inch clods of soil. Rough surface. Soil dry. Imperial, light brown silty clay (7.5YR 6/4).

PHOTO INTERPRETATION

homogeneous tone; fine texture; bare soil; furrows run parallel with FL.

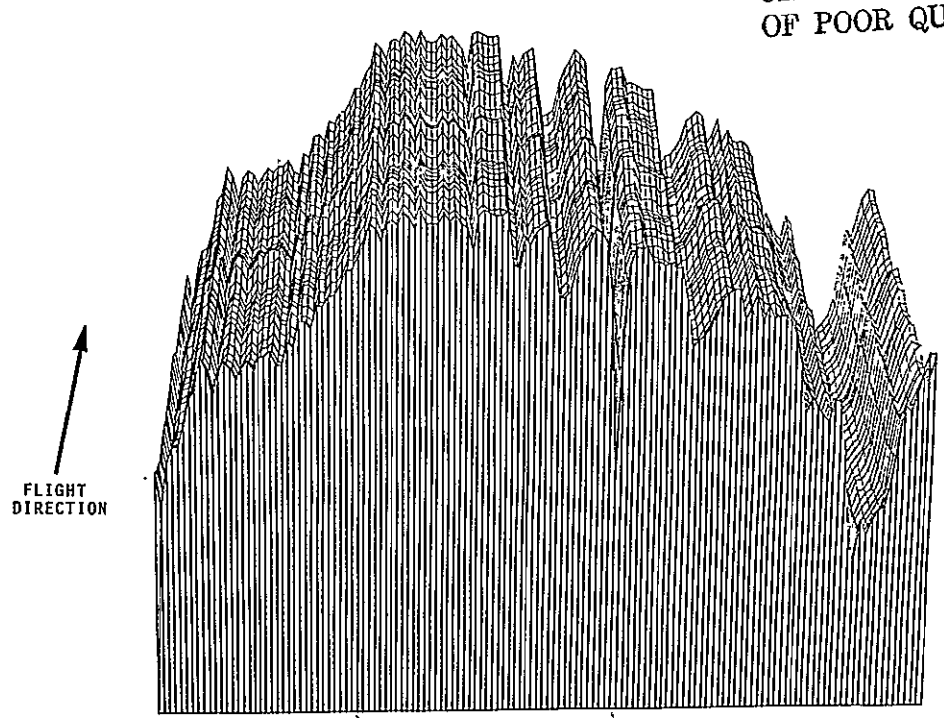
1428



10:24 AM 5/15/75

SUN ELEV = 68°

1410-1441



BARE SOIL

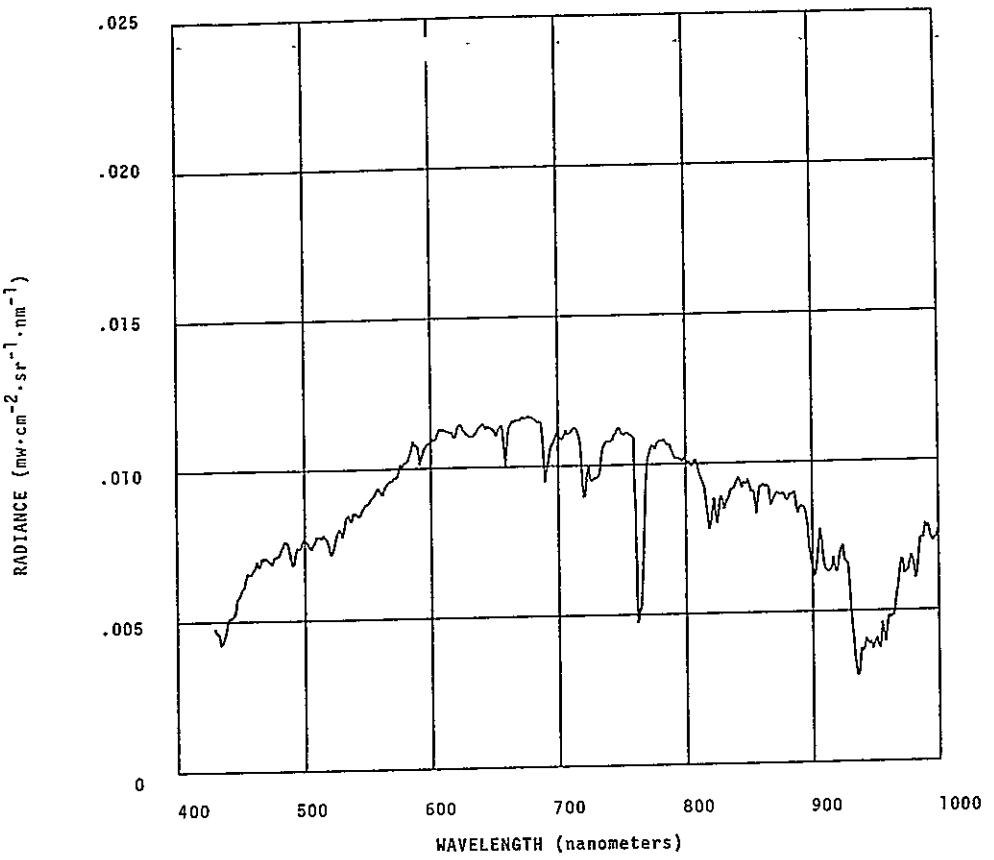
F I E L D D E S C R I P T I O N

2 to 6 inch clods. Moderately rough surface. Soil dry. Imperial, light brown silty clay (7.5YR 6/4).

P H O T O I N T E R P R E T A T I O N

homogeneous tone; fine texture; bare soil; plowing patterns are detectable.

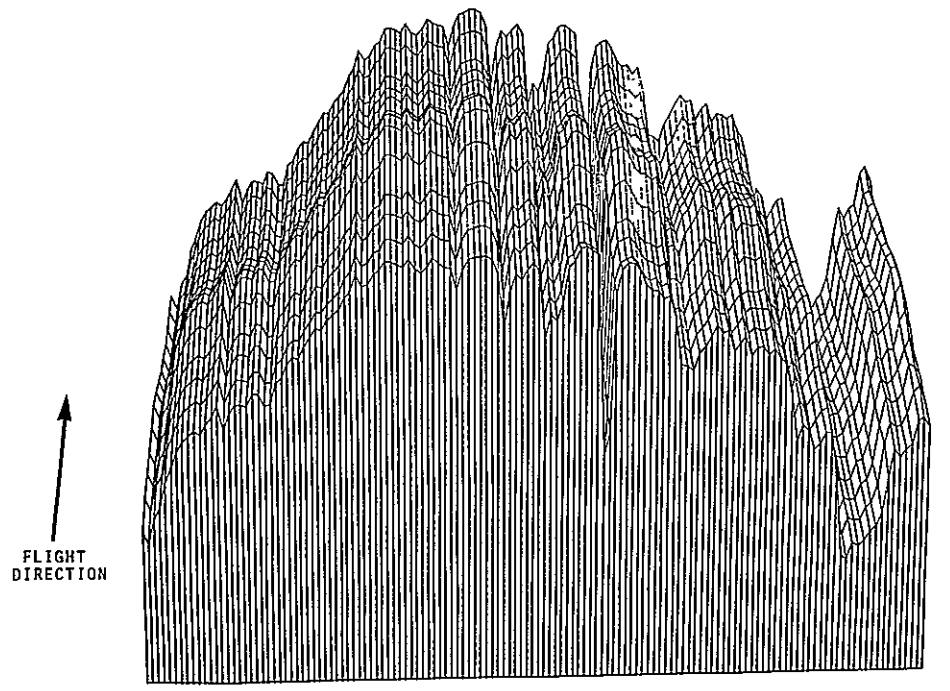
1453



10:44 AM 9/23/75

SUN ELEV = 55°

1442-1455



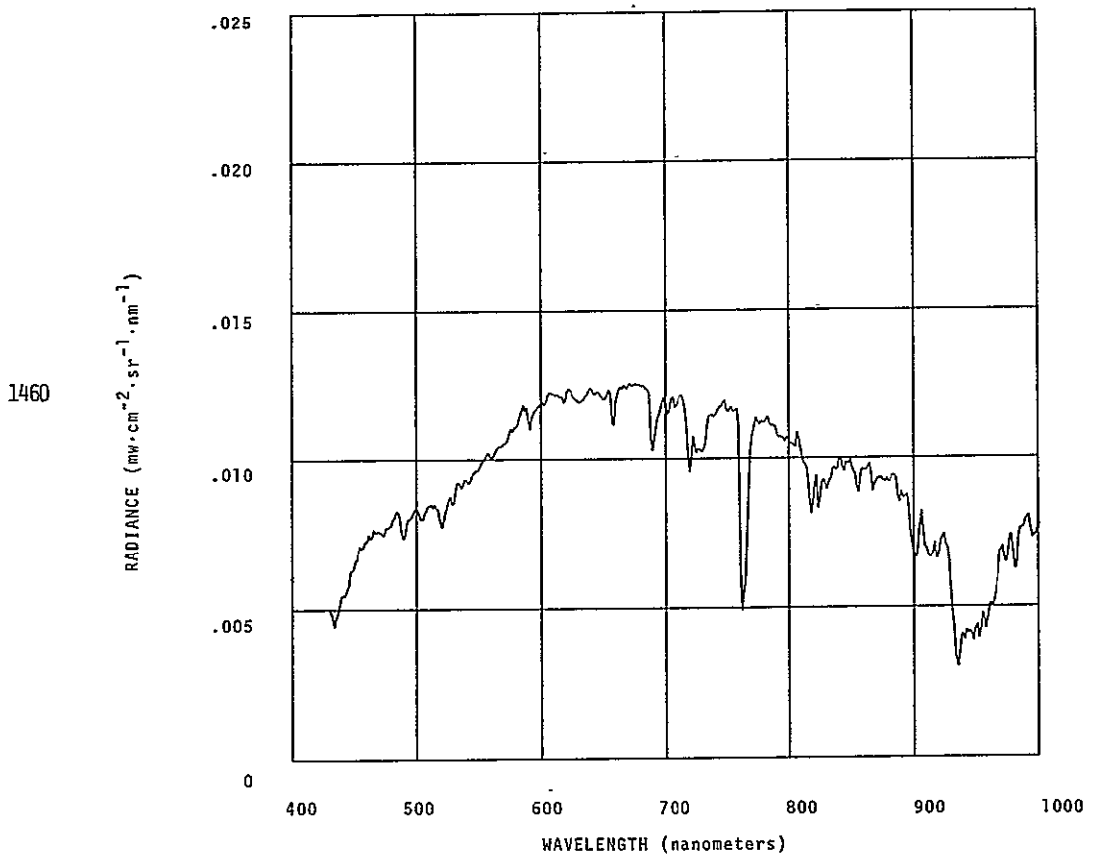
BARE SOIL

FIELD DESCRIPTION

4 to 8 inch clods, freshly plowed. Rough surface. Soil dry. Imperial, light brown silty clay (7.5YR 6/4).

PHOTO INTERPRETATION

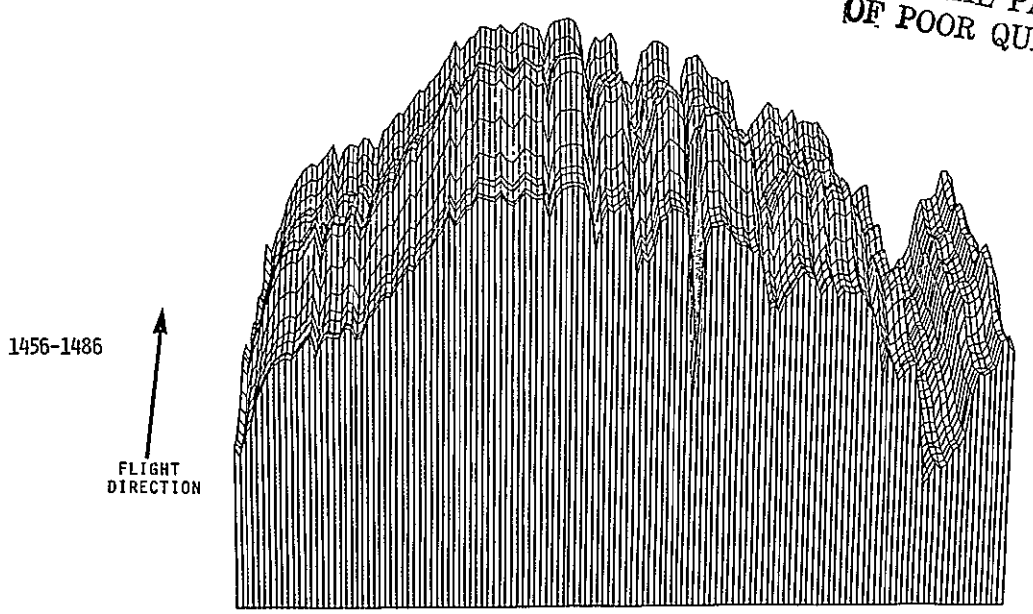
homogeneous tone; fine texture; bare soil.



1460

10:37 AM 9/23/75

SUN ELEV = 55°



1456-1486

FLIGHT DIRECTION

BARE SOIL

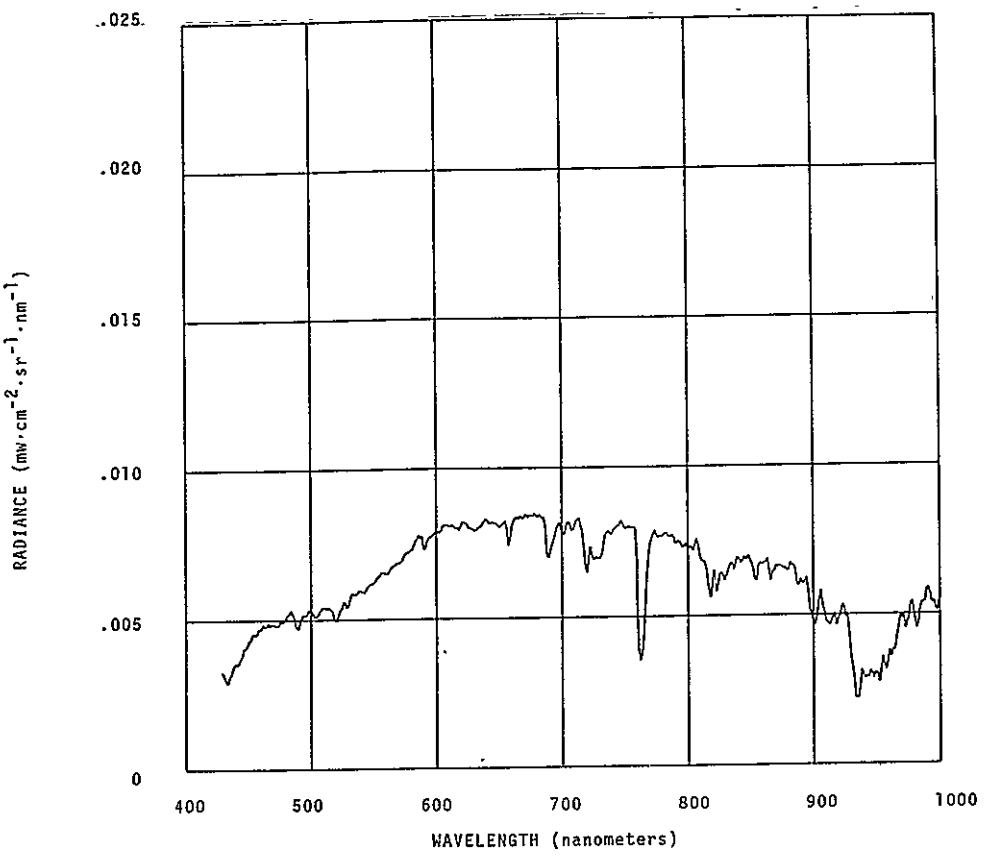
FIELD DESCRIPTION

6 inch clods, freshly plowed. Rough surface. Soil dry. Imperial, light brown silty clay (7.5YR 6/4).

PHOTO INTERPRETATION

homogeneous tone; medium texture; bare soil; furrows run perpendicular to FL.

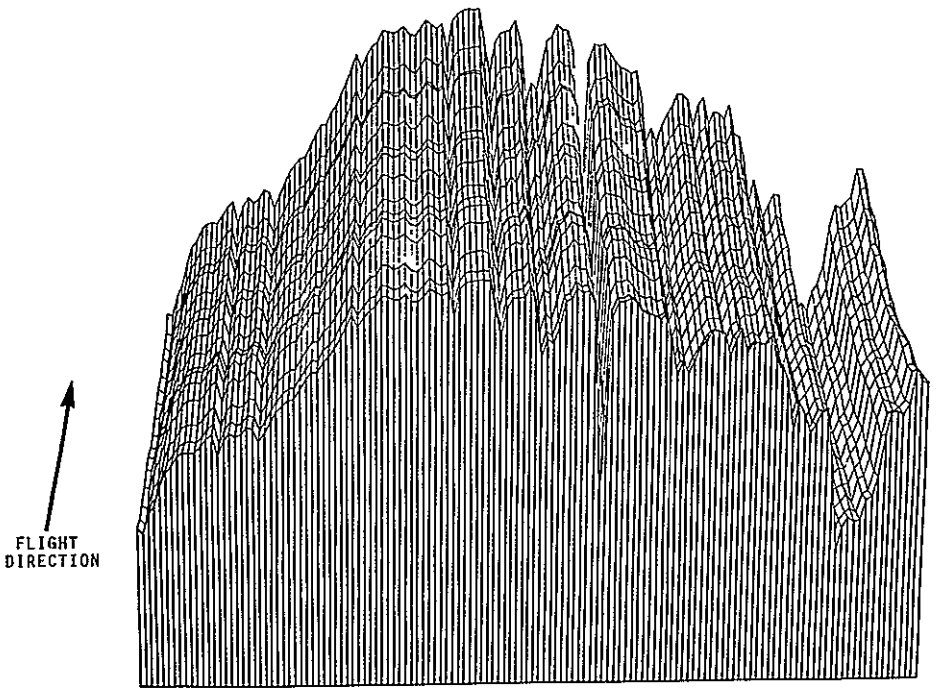
1496



10:26 AM 9/23/75

SUN ELEV = 54°

1487-1502



BARE SOIL

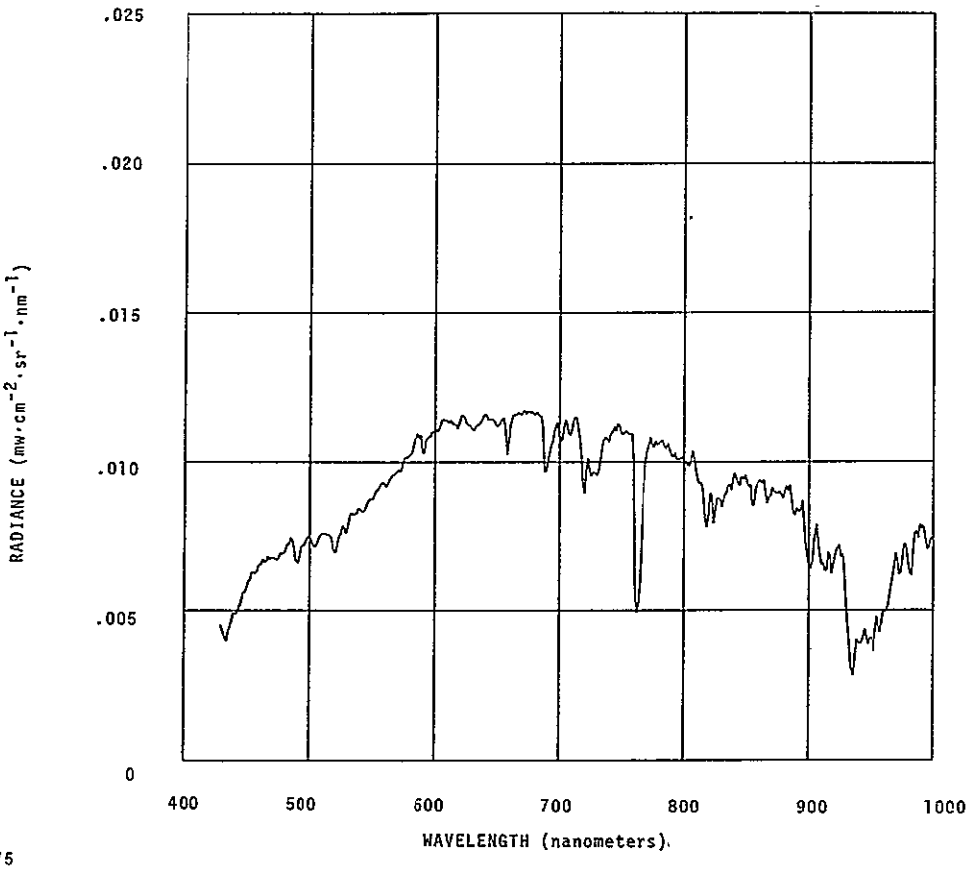
FIELD DESCRIPTION

6 inch clods, freshly plowed. Rough surface. Soil dry. Imperial, light brown silty clay (7.5YR 6/4).

PHOTO INTERPRETATION

homogeneous tone; fine texture; bare soil; furrows run perpendicular to FL.

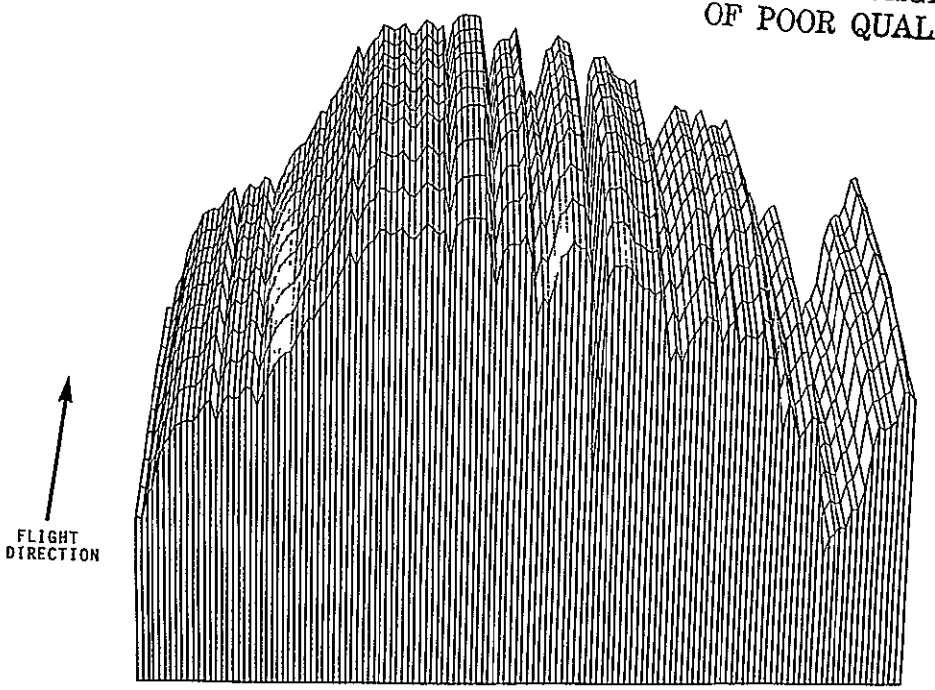
1512



10:26 AM 9/23/75

SUN ELEV = 54°

1503-1512



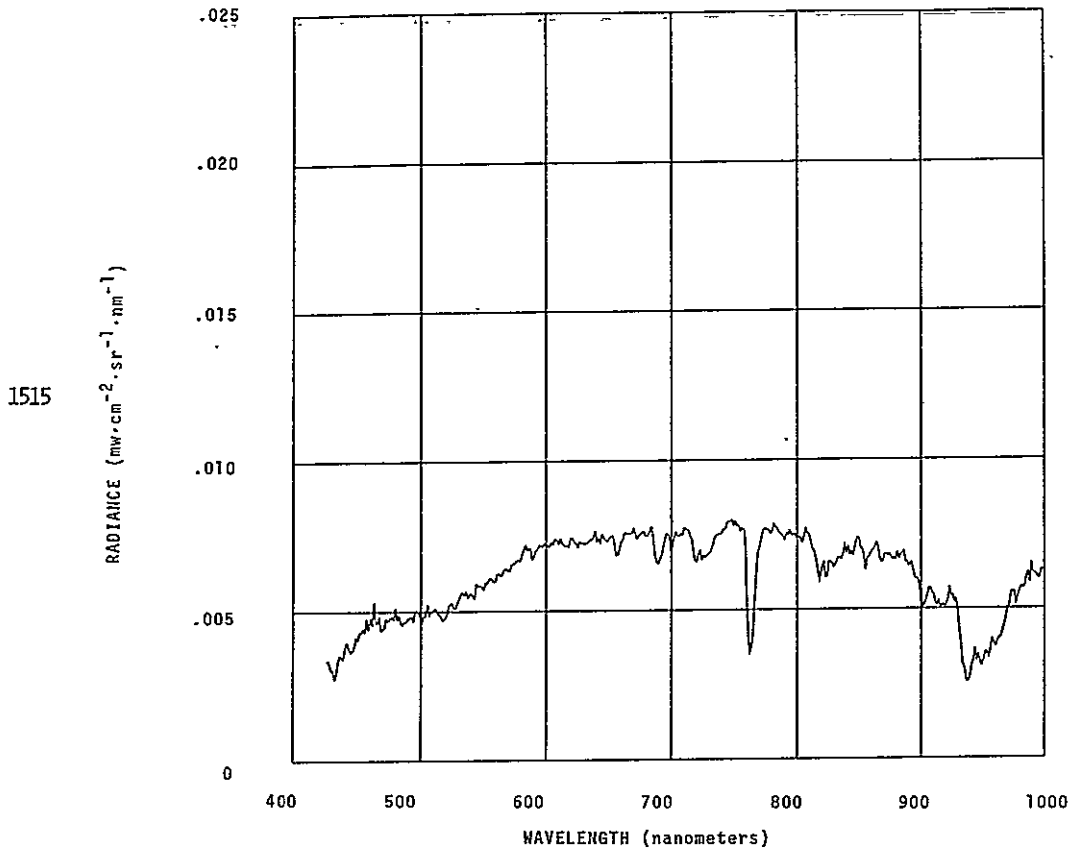
BARE SOIL

FIELD DESCRIPTION

clods up to 8 inches 2 to 5% of surface. Field freshly disked. Moderately smooth surface. Soil dry. Imperial, light brown silty clay (7.5YR 6/4).

PHOTO INTERPRETATION

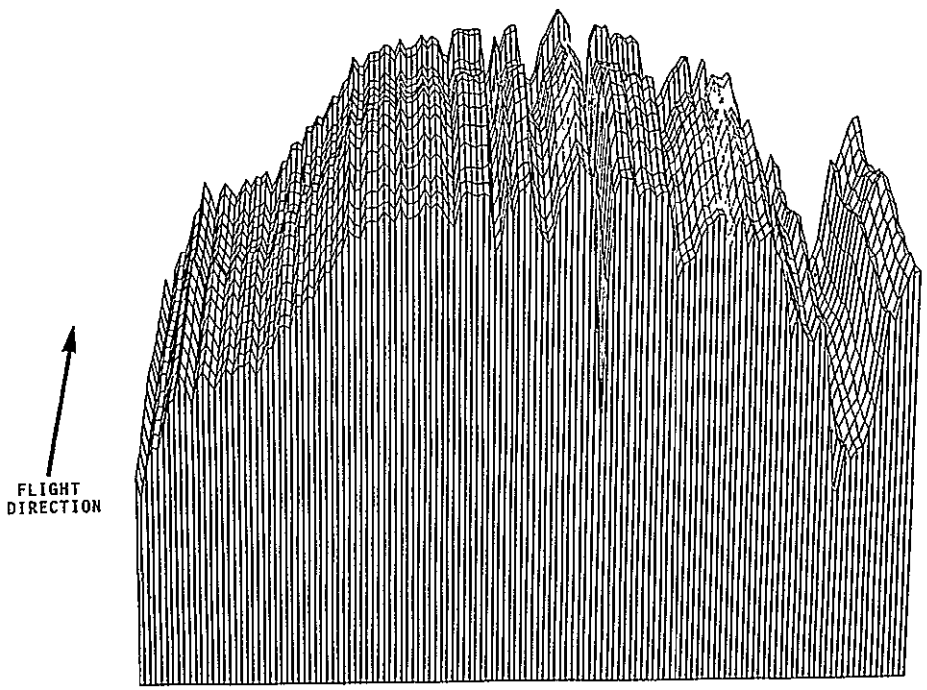
homogeneous tone; medium texture; bare soil; furrows run parallel with FL.



1515

9:37 AM 5/15/75

SUN ELEV = 59°



1513-1529

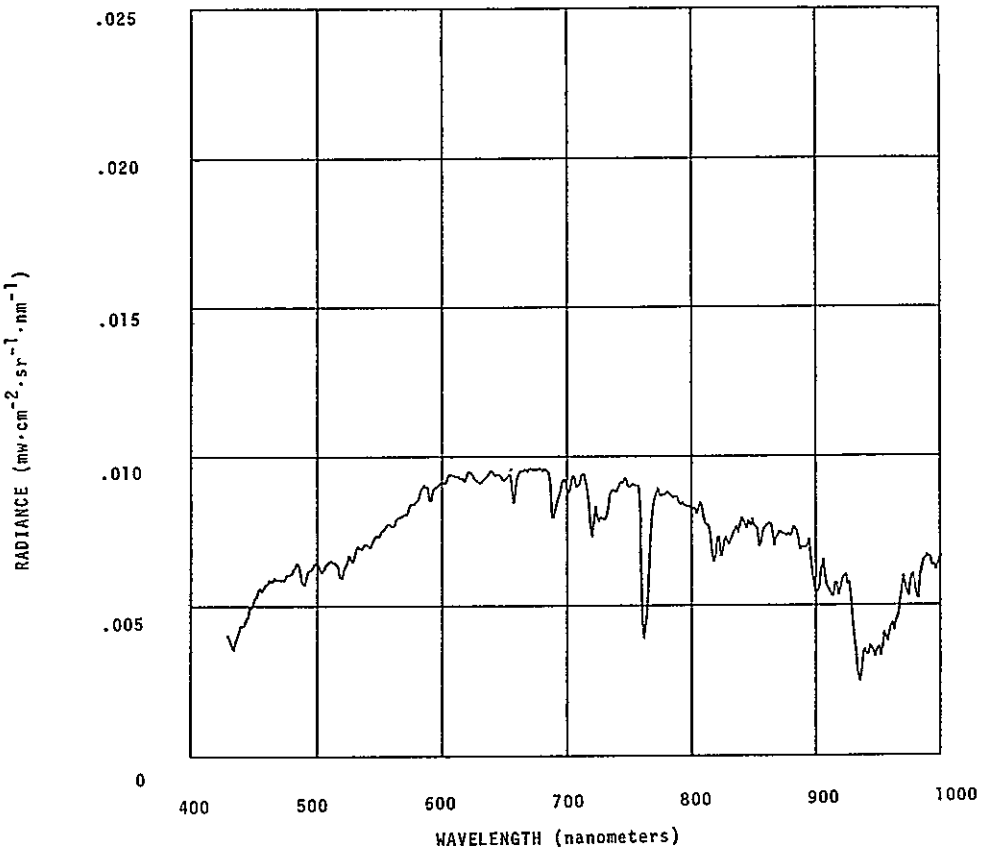
BARE SOIL

FIELD DESCRIPTION

furrows 8 inches deep spaced 20 inches apart. Smooth surface. Soil dry. Imperial, light brown silty clay (7.5YR 6/4).

PHOTO INTERPRETATION

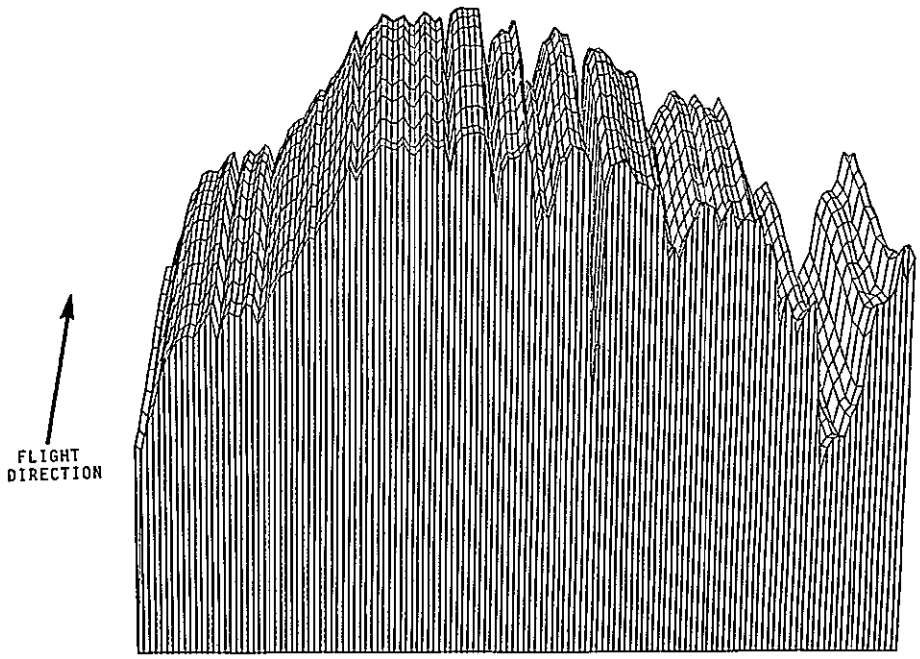
homogeneous tone; medium texture; bare soil; furrows run perpendicular to FL.



1533

10:26 AM 9/23/75

SUN ELEV = 54°



1530-1540

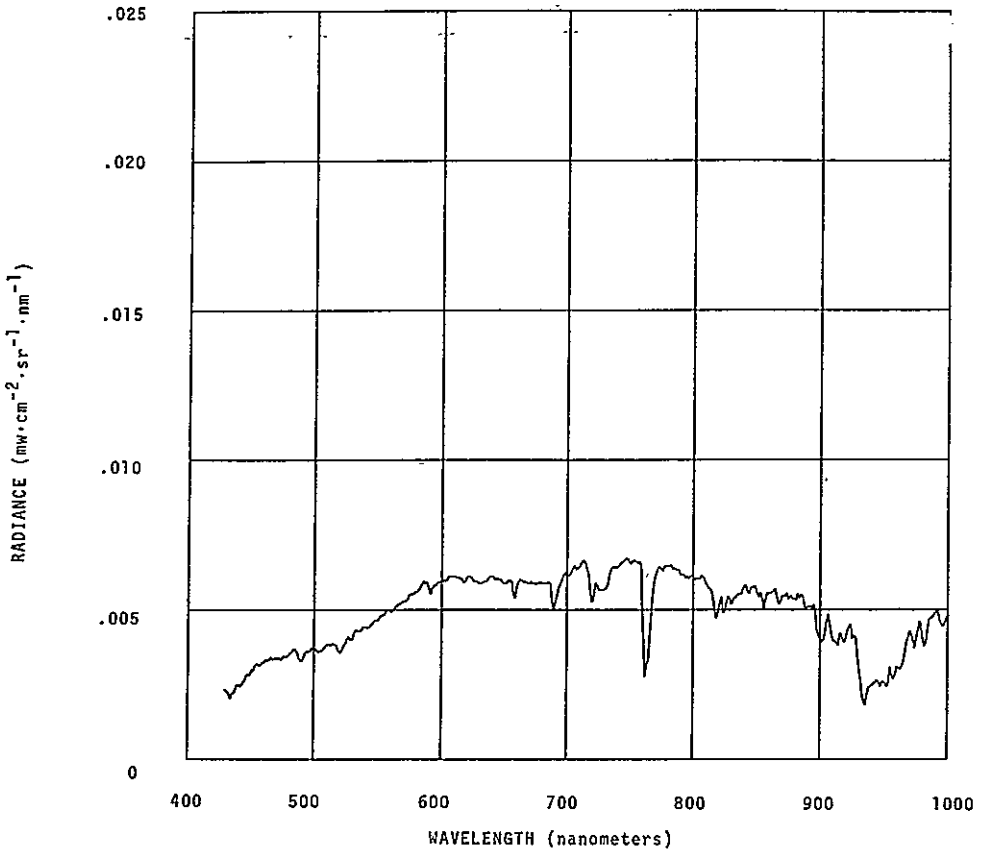
BARE SOIL

FIELD DESCRIPTION

furrows 8 inches deep spaced 20 inches apart. Smooth surface. Soil dry on furrow ridges, wet in troughs. Imperial, silty clay.

PHOTO INTERPRETATION

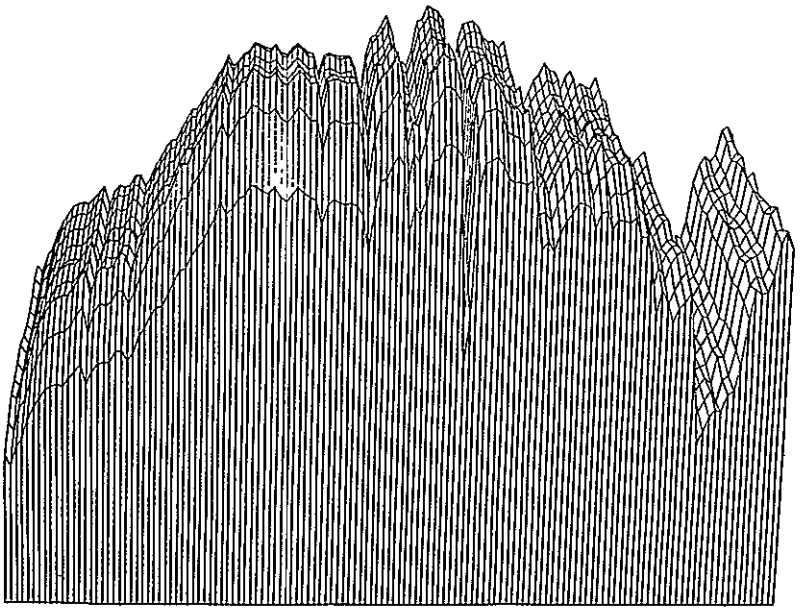
homogeneous tone; medium texture; bare soil; furrows run perpendicular to FL.



1547

10:32 AM 9/23/75

SUN ELEV = 54°



1541-1552

RIPE BARLEY

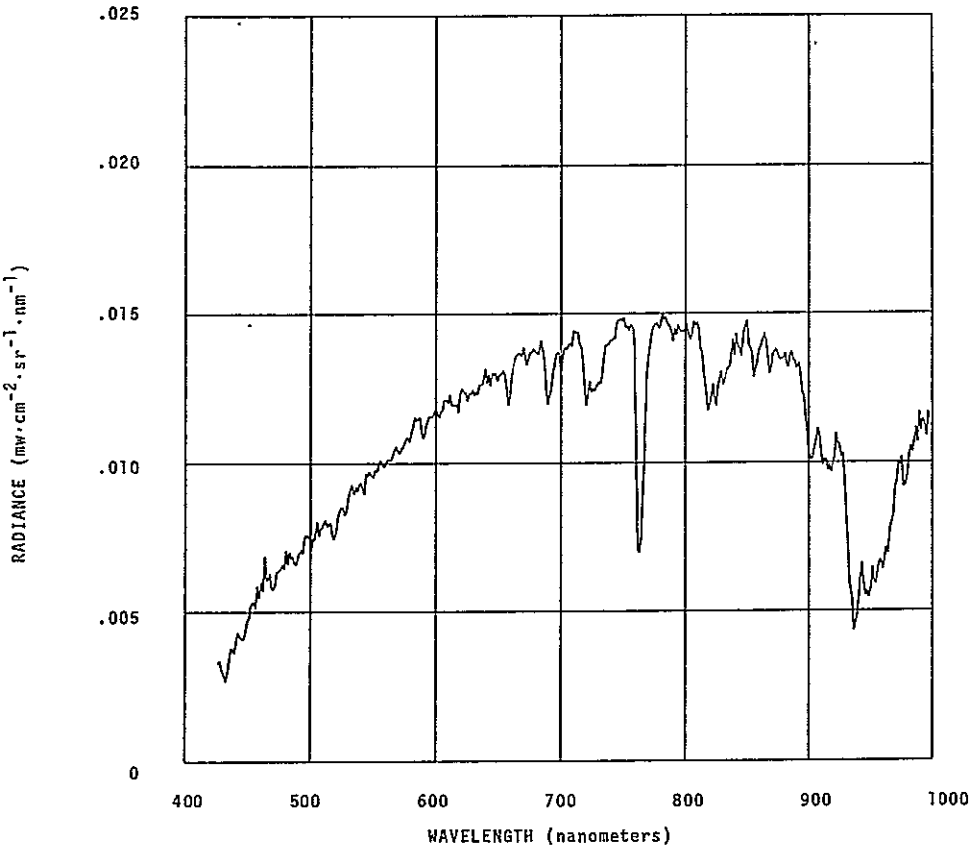
FIELD DESCRIPTION

20 inches high, 80% leaf cover, moderately thick uniform canopy. Crop ripe, very yellow (harvested 5/17/75). Soil dry. Imperial, light brown silty clay (7.5YR 6/4).

PHOTO INTERPRETATION

inhomogeneous tone; coarse texture; nonuniform differential densities ranging from high to medium; total cover; entire field is ripe; furrows run perpendicular to FL.

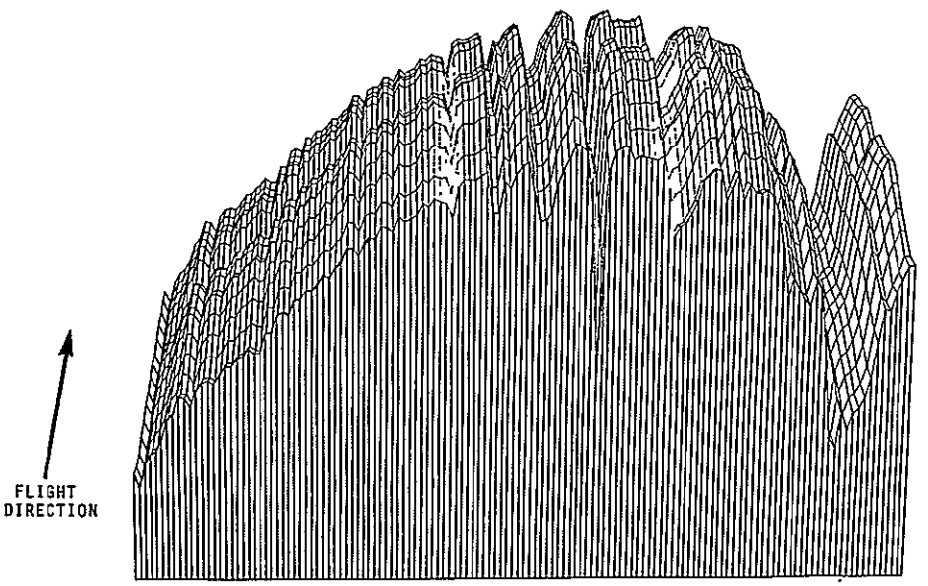
1564



10:10 AM 5/15/75

SUN ELEV = 66°

1553-1567



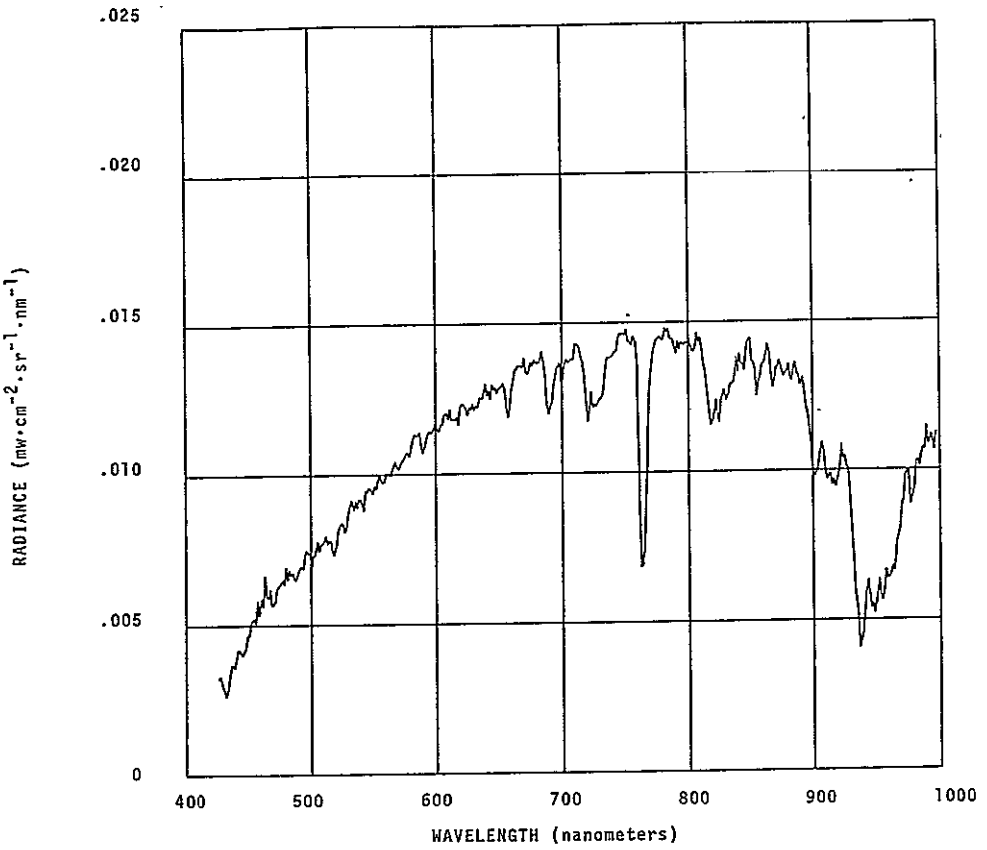
RIPE BARLEY

FIELD DESCRIPTION

24 to 36 inches high, 80% leaf cover, moderately thick uniform canopy. Crop ripe, very yellow (harvested 5/17/75). Soil dry. Imperial, light brown silty clay (7.5YR 6/4).

PHOTO INTERPRETATION

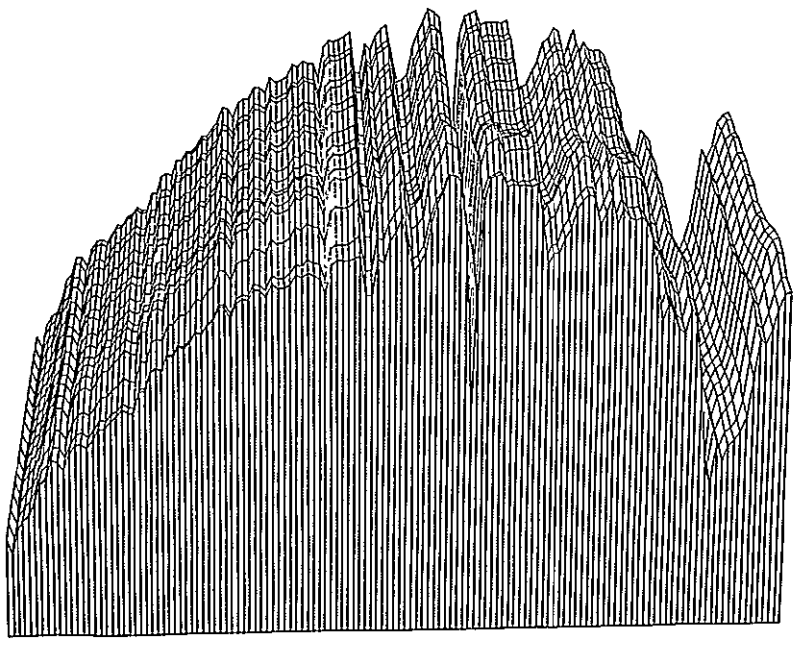
inhomogeneous tone; nonuniform coarse texture; nonuniform differential densities ranging from high to medium; total cover; entire field is ripe; furrows run perpendicular to FL.



1578

10:10 AM 5/15/75

SUN ELEV = 66°



1568-1584

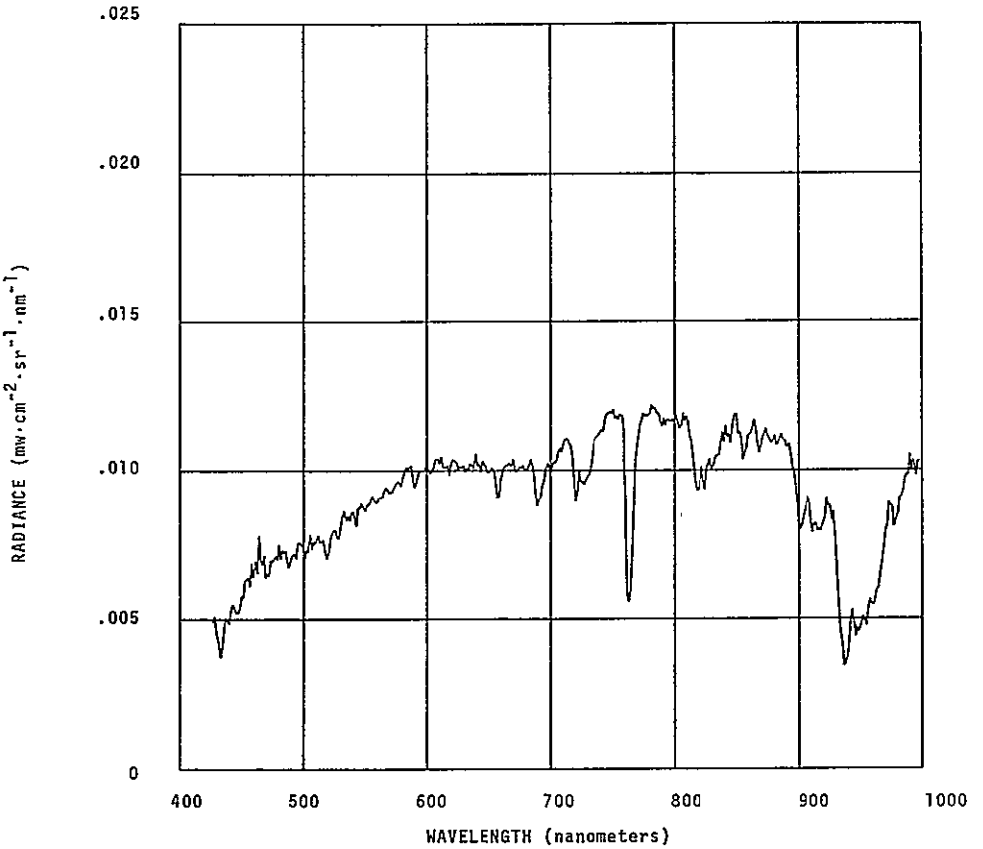
HARVESTED CARROTS

FIELD DESCRIPTION

harvested, 10% refuse on surface, 6 to 8 inch clods of soil. Rough surface. Soil dry. Imperial, light brown silty clay (7.5YR 6/4).

PHOTO INTERPRETATION

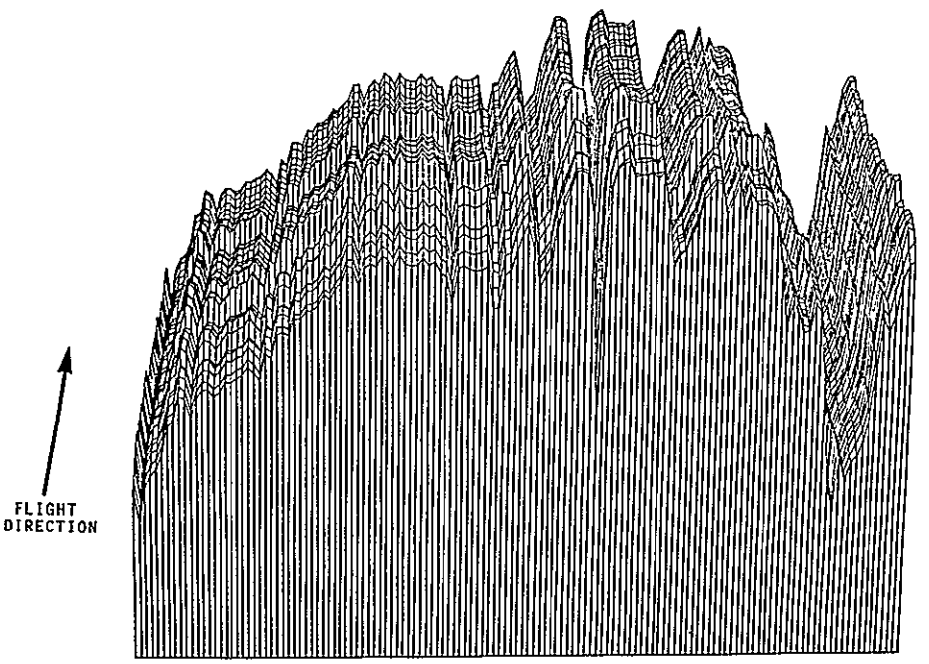
inhomogeneous tone; coarse texture; low density; little cover; furrows run parallel with FL.



1615

10:34 AM 5/16/75

SUN ELEV = 70°



1585-1639

EMERGENT COTTON

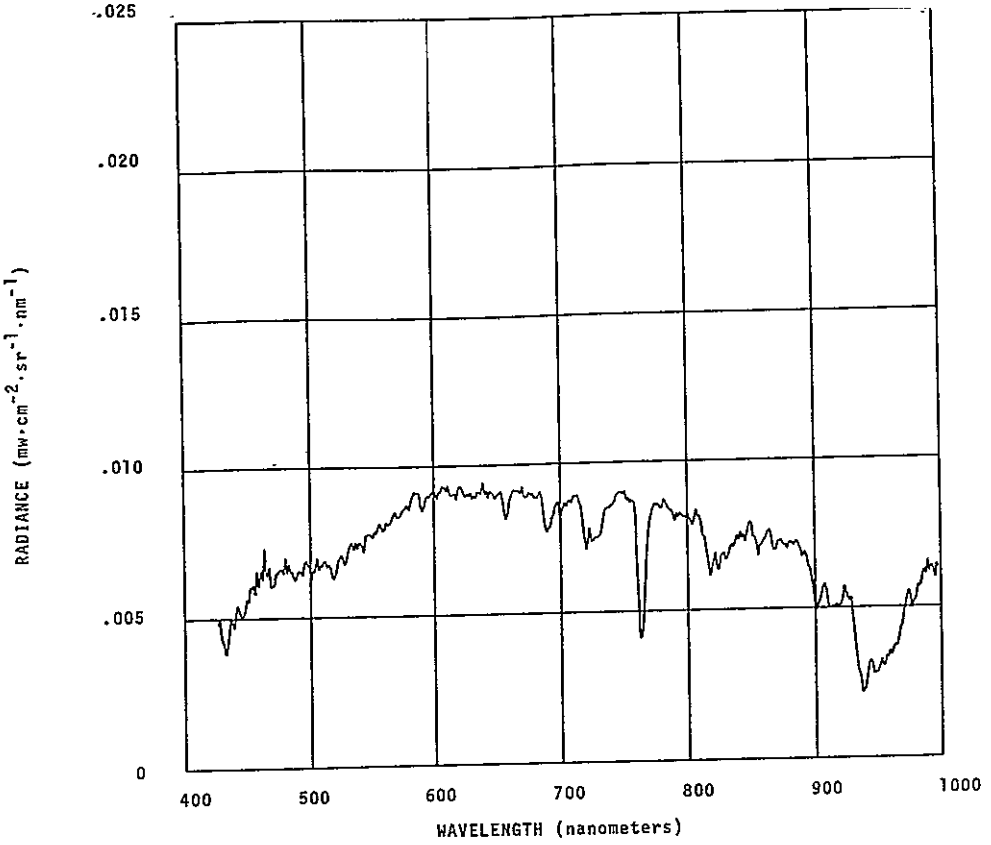
FIELD DESCRIPTION

1 to 3 inch shoots, 1 to 2% leaf cover, thin uniform canopy. Furrows 8 inches deep spaced 3 feet apart. 1 to 6 inch clods of soil. Moderately rough surface. Soil dry. Imperial, light brown silty clay (7.5YR 6/4).

PHOTO INTERPRETATION

homogeneous tone; fine texture; low density; little cover; furrows run parallel with FL.

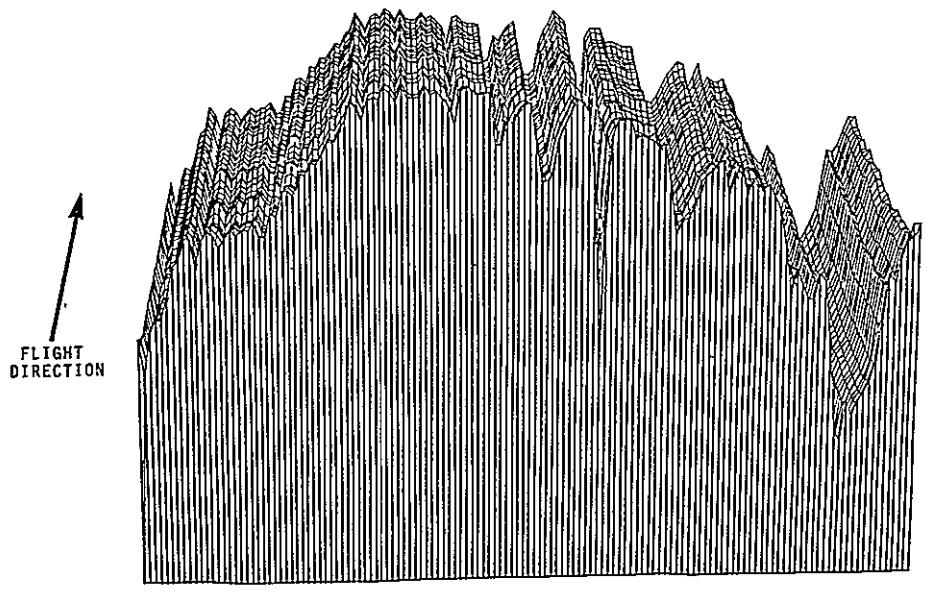
1658



10:15 AM 5/16/75

SUN ELEV = 67°

1640-1673



EMERGENT COTTON

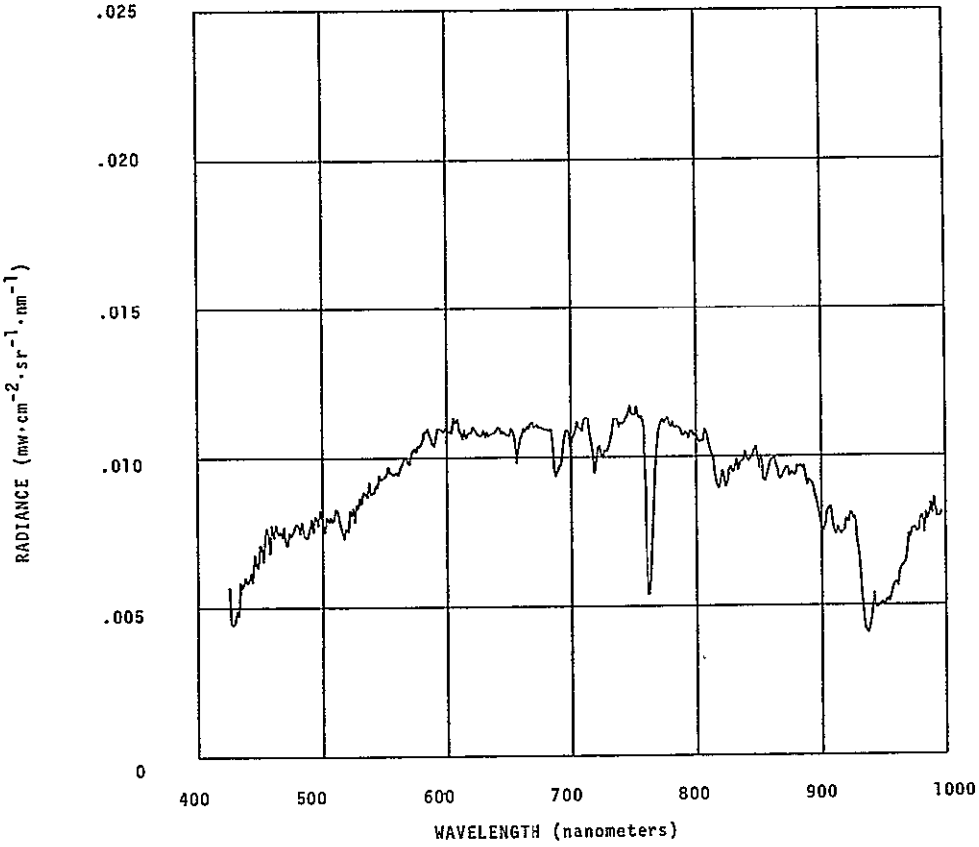
FIELD DESCRIPTION

2 to 5 inches, 2 to 5% leaf cover, very thin uniform canopy. Furrows 8 inches deep spaced 2 feet apart. 1 to 6 inch clods of soil. Moderately smooth surface. Soil dry. Imperial, light brown silty clay (7.5YR 6/4).

PHOTO INTERPRETATION

homogeneous tone; fine texture; bare soil.

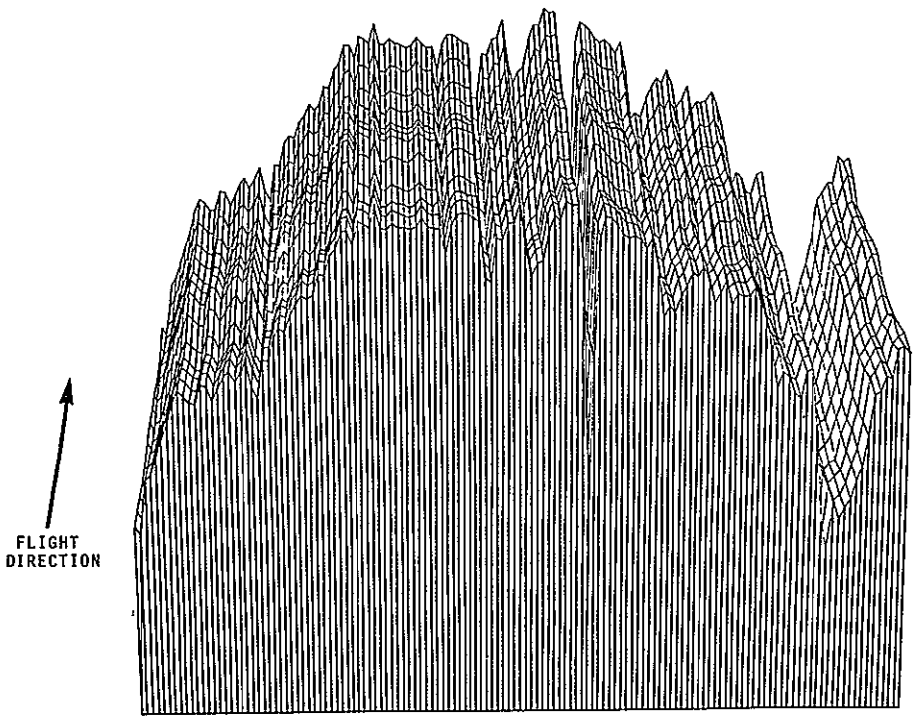
1684



11:15 AM 5/20/75

SUN ELEV = 76°

1674-1686



EMERGENT COTTON

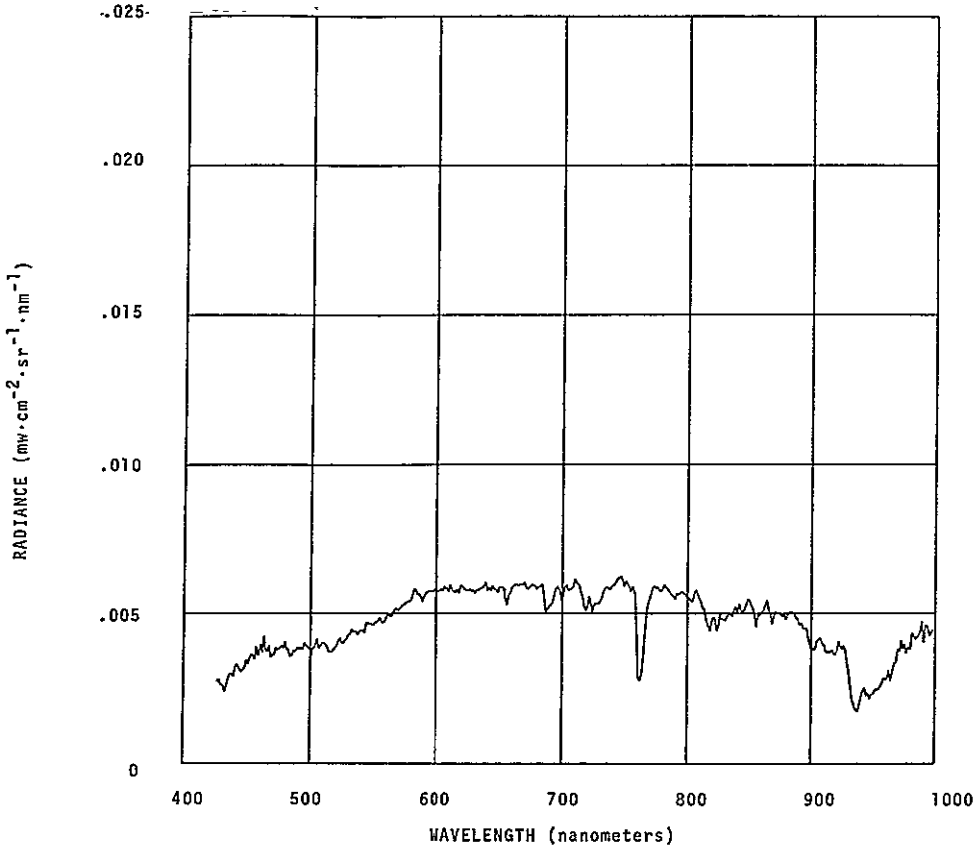
FIELD DESCRIPTION

3 inch shoots, 1 to 2% leaf cover, thin uniform canopy. Crop planted in rows 3 feet apart. Bare soil between rows has clods to 3 inches. Moderately rough surface. Soil moist on furrow ridges, muddy in troughs. Imperial, silty clay.

PHOTO INTERPRETATION

homogeneous tone; fine texture; low density; little cover; furrows run parallel with FL.

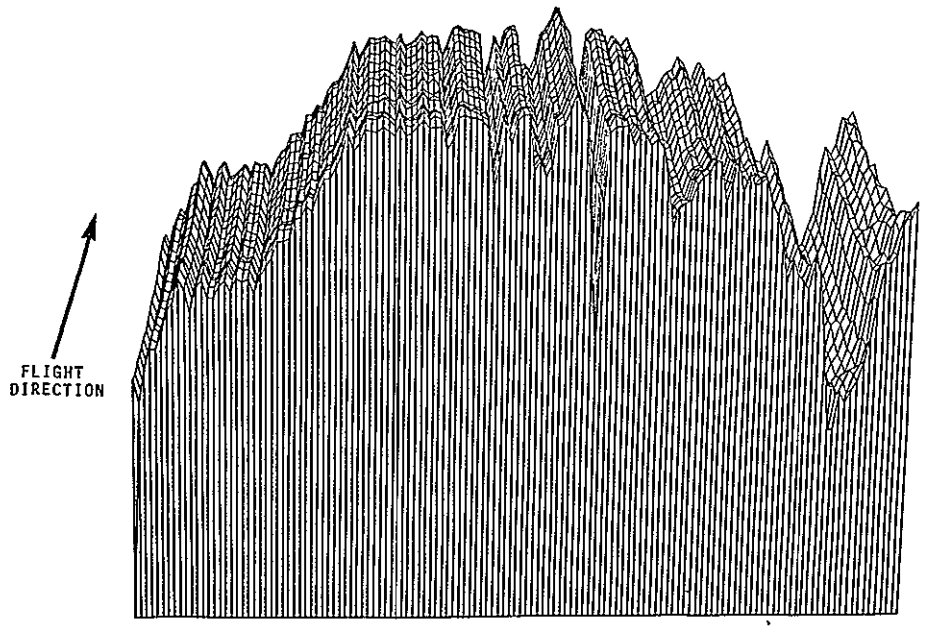
1693



9:28 AM 5/15/75

SUN ELEV = 58°

1687-1703



EMERGENT COTTON

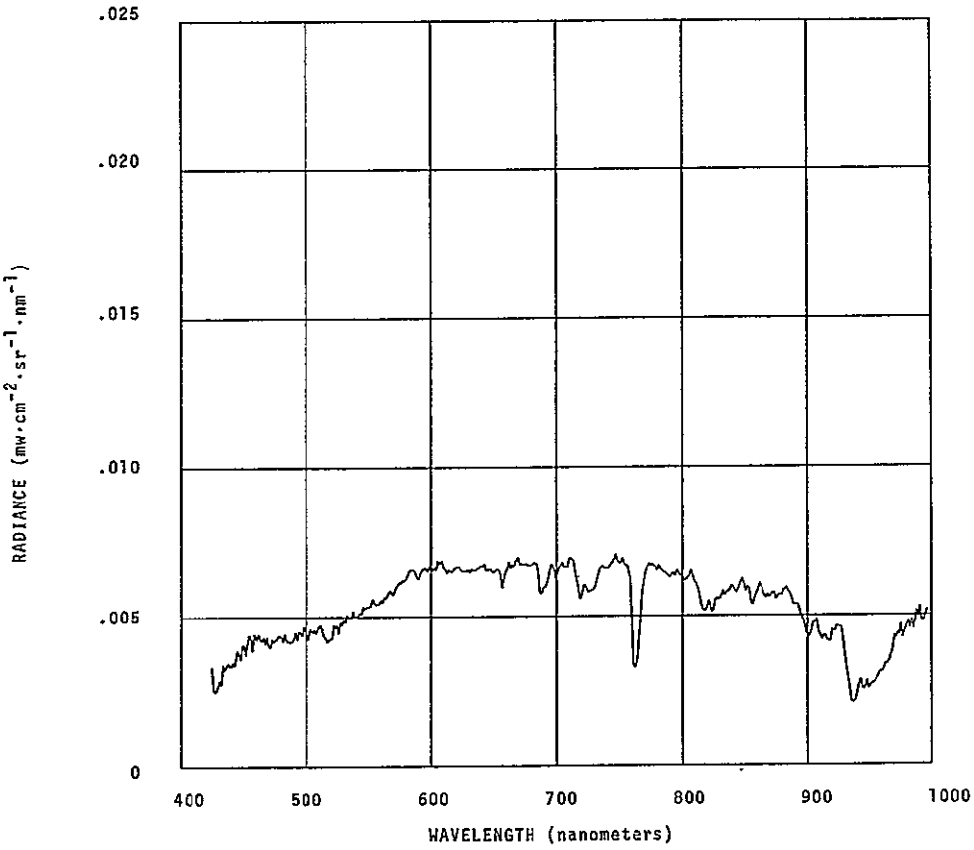
FIELD DESCRIPTION

3 inch shoots, 1 to 2% leaf cover, thin uniform canopy. Crop planted in rows 3 feet apart. Bare soil between rows has clods to 3 inches. Moderately rough surface. Soil moist on furrow ridges, muddy in troughs. Imperial, silty clay.

PHOTO INTERPRETATION

homogeneous tone; medium texture; bare soil; furrows run parallel with FL.

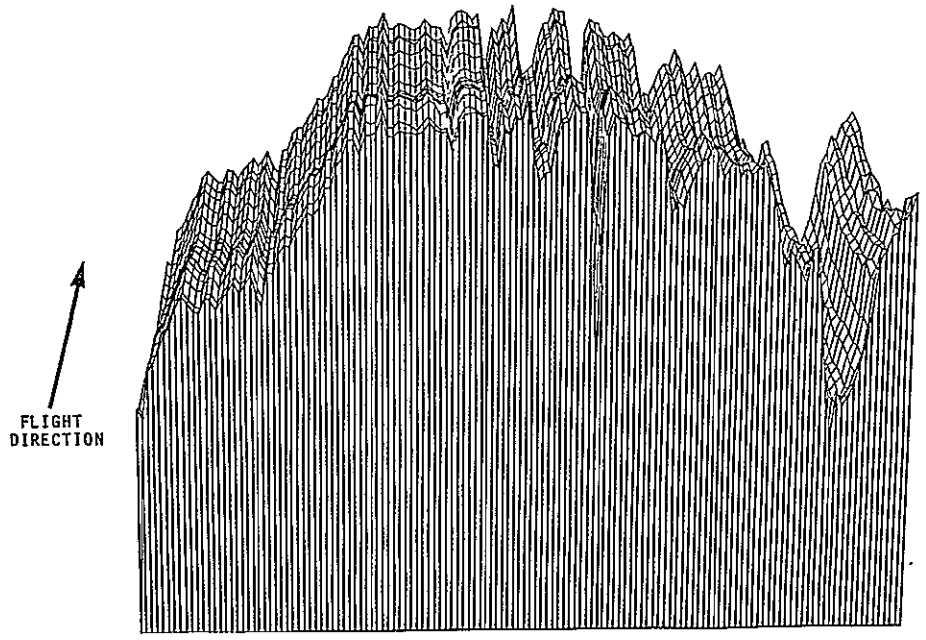
1710



10:42 AM 5/15/75

SUN ELEV = 71°

1704-1719



EMERGENT COTTON

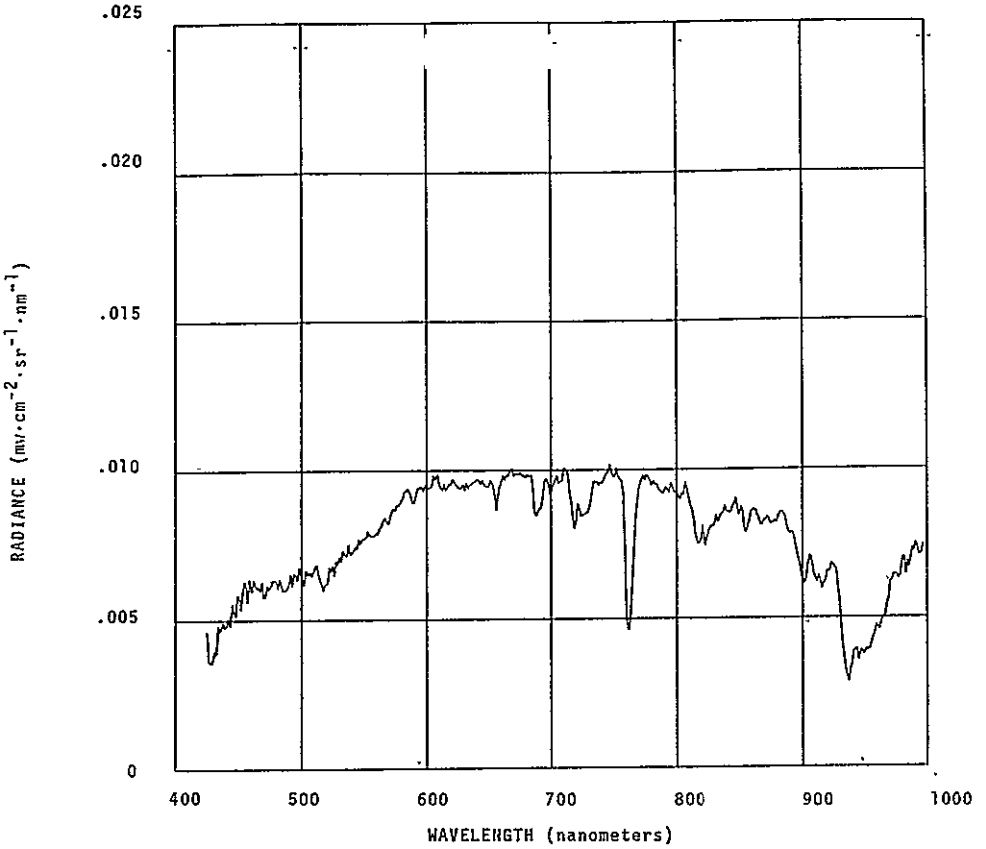
FIELD DESCRIPTION

3 inch shoots, 1 to 2% leaf cover, thin uniform canopy. Crop planted in rows 3 feet apart. Bare soil between rows has clods to 3 inches. Moderately rough surface. Soil dry. Imperial, light brown silty clay (7.5YR 6/4).

PHOTO INTERPRETATION

homogeneous tone; medium texture; bare soil; furrows run parallel with FL.

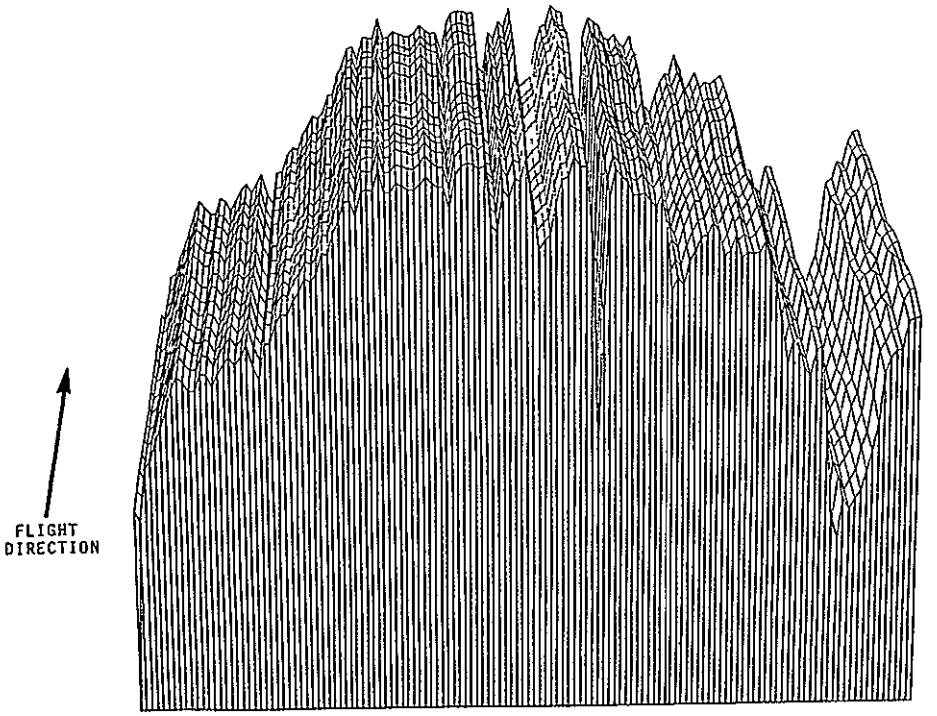
1724



10:42 AM 5/15/75

SUN ELEV = 71°

1720-1732



MATURE COTTON

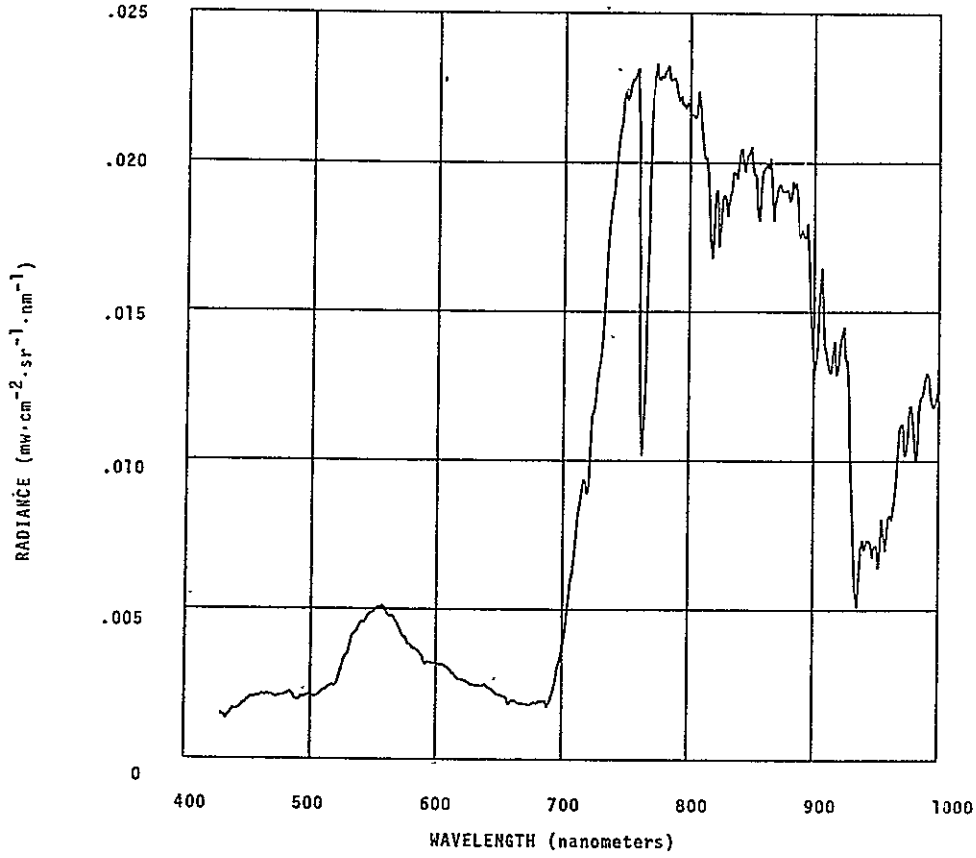
F I E L D D E S C R I P T I O N

3 to 4 feet high, 100% leaf cover, thick uniform canopy (no buds or flowers). Soil dry. Imperial, light brown silty clay (7.5YR 6/4).

P H O T O I N T E R P R E T A T I O N

homogeneous tone except furrows are detectable; coarse texture; high density; total cover; furrows run parallel with FL.

1739



10:32 AM 9/23/75

SUN ELEV = 54°

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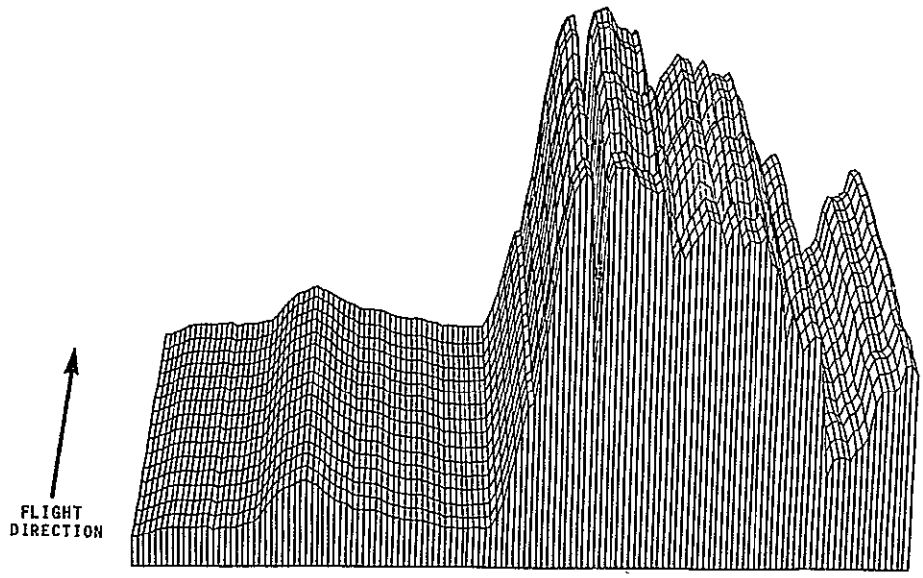
OF POOR QUALITY

1733-1748



MATURE COTTON

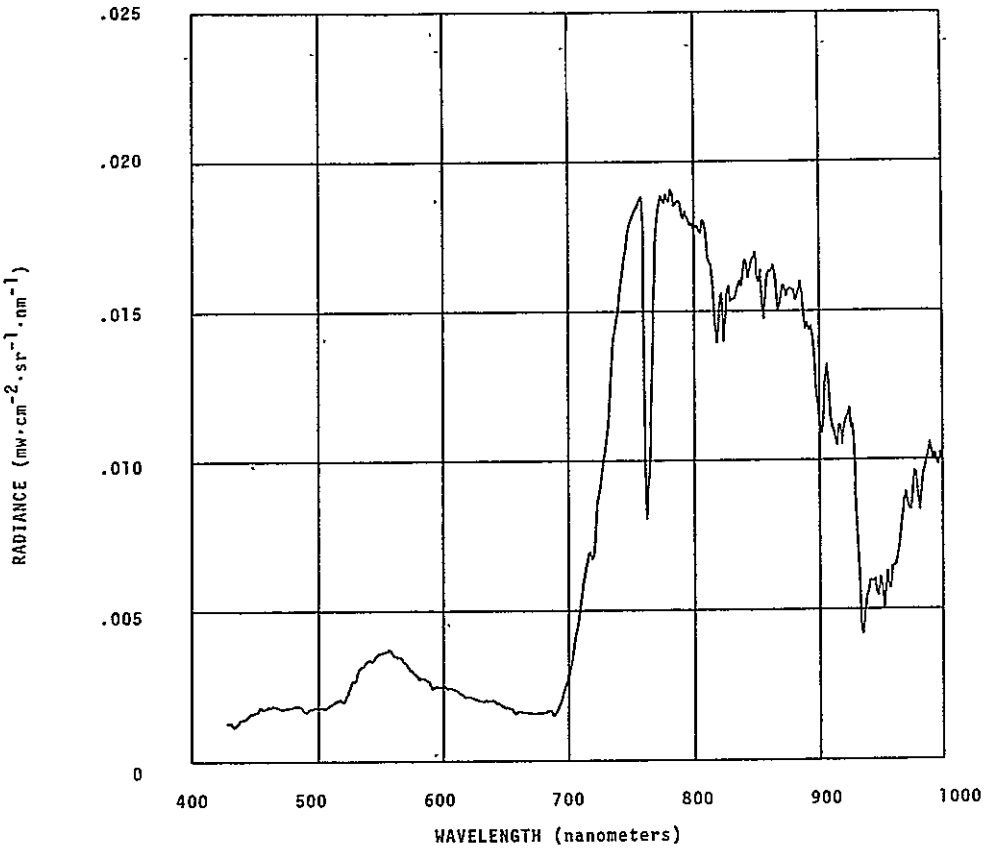
F I E L D D E S C R I P T I O N

54 inches high, 100% leaf cover, thick uniform canopy. Blossoms and closed cotton balls on plants. Soil dry. Imperial, light brown silty clay (7.5YR 6/4).

P H O T O I N T E R P R E T A T I O N

homogeneous tone; medium texture; high density; total cover; furrows run parallel with FL.

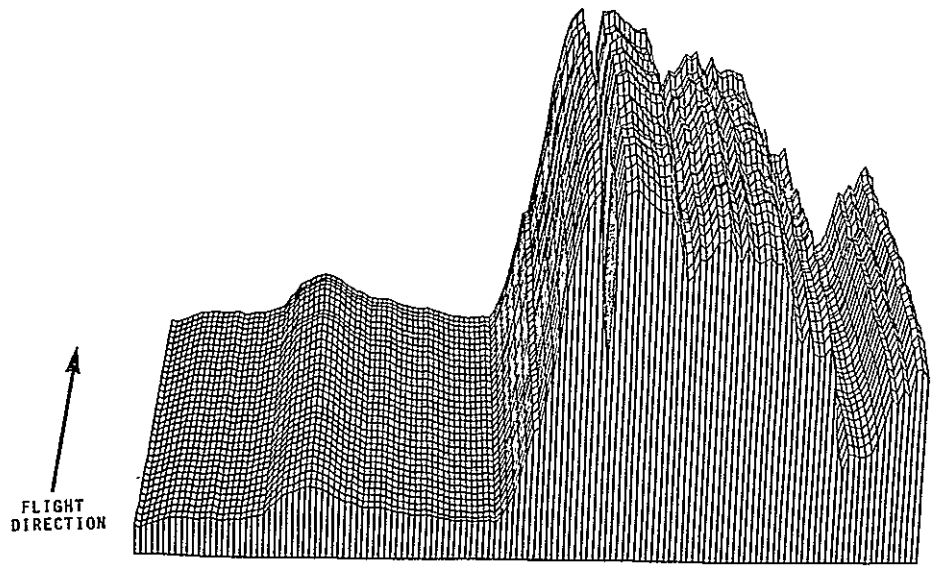
1752



11:19 AM 9/23/75

SUN ELEV = 57°

1749-1782



RIPENING COTTON

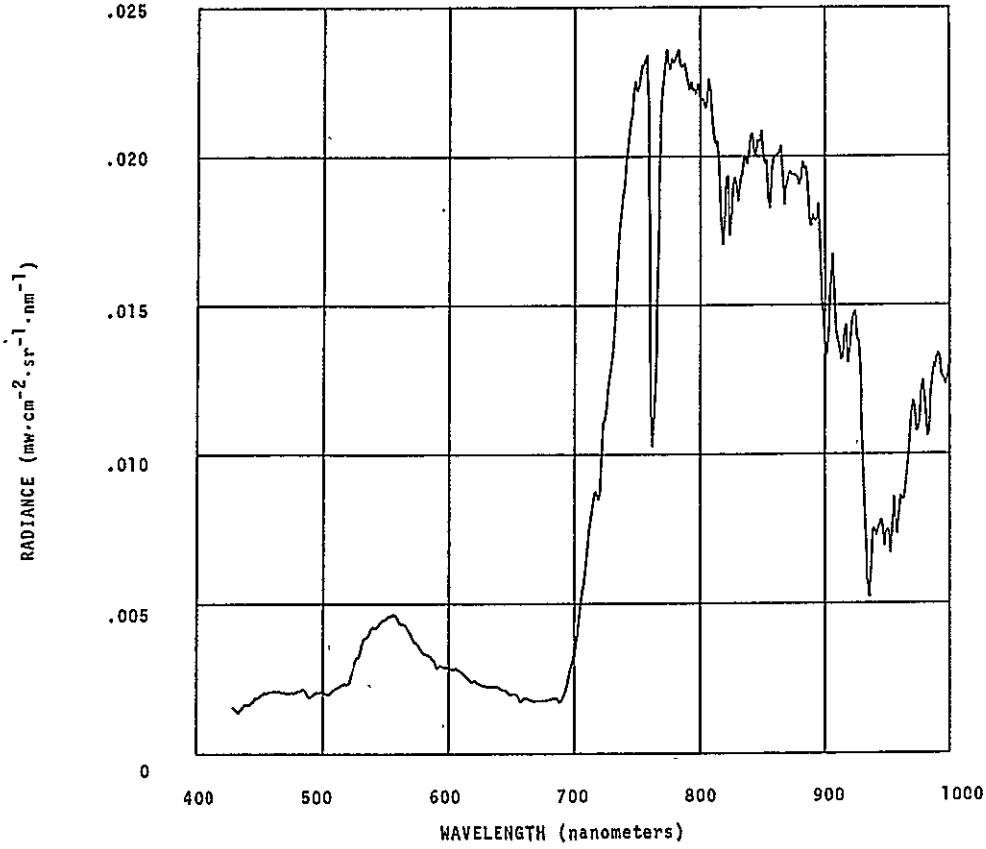
FIELD DESCRIPTION

40 inches high, 100% leaf cover, thick uniform canopy. Flowered buds and some opened cotton balls (buds and balls less than 1% of leaf area). Soil moist. Imperial, silty clay.

PHOTO INTERPRETATION

homogeneous tone; coarse texture; high density; total cover; furrows run parallel with FL.

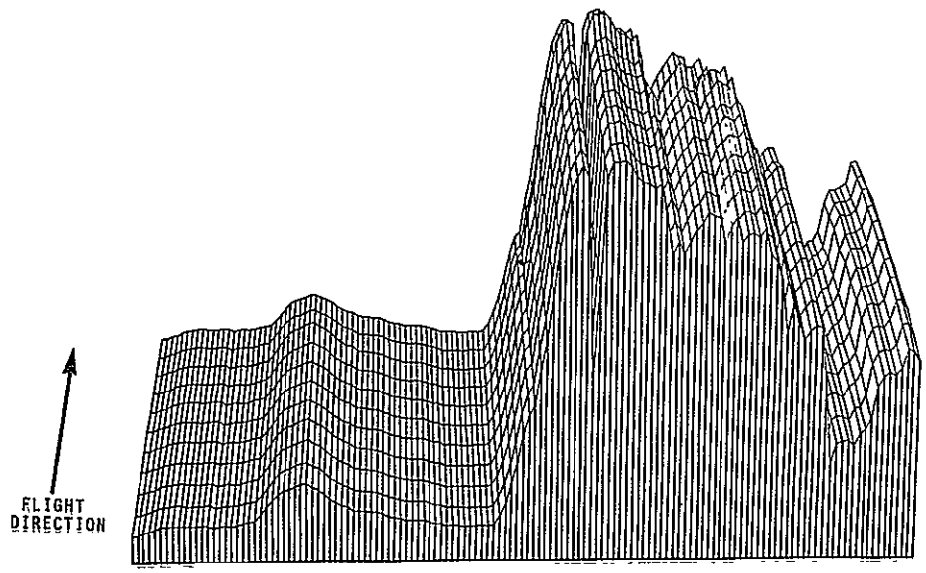
1787



10:26 AM 9/23/75

SUN ELEV = 54°

1783-1793



RIPENING COTTON

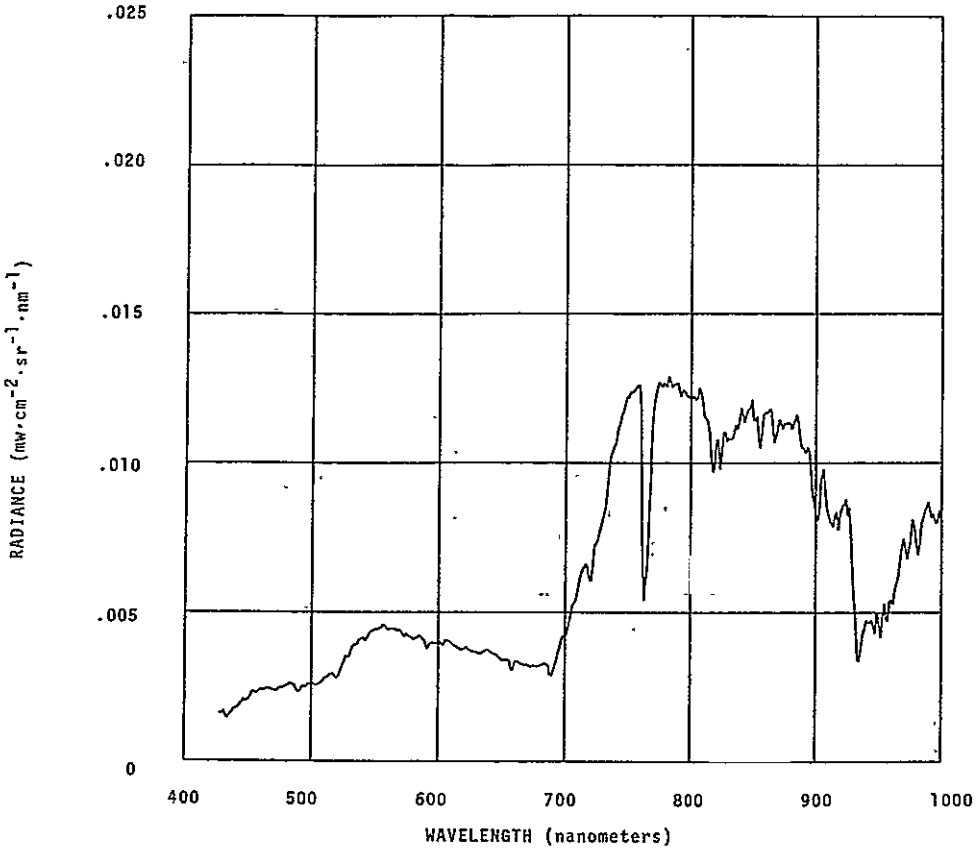
FIELD DESCRIPTION

42 inches high, 100% leaf cover, uniform canopy. Cotton balls on plants, some balls open (≈1% of leaf area is white balls). Soil very wet. Imperial, silty clay.

PHOTO INTERPRETATION

homogeneous tone; medium texture; high density; total cover; furrows run parallel with FL.

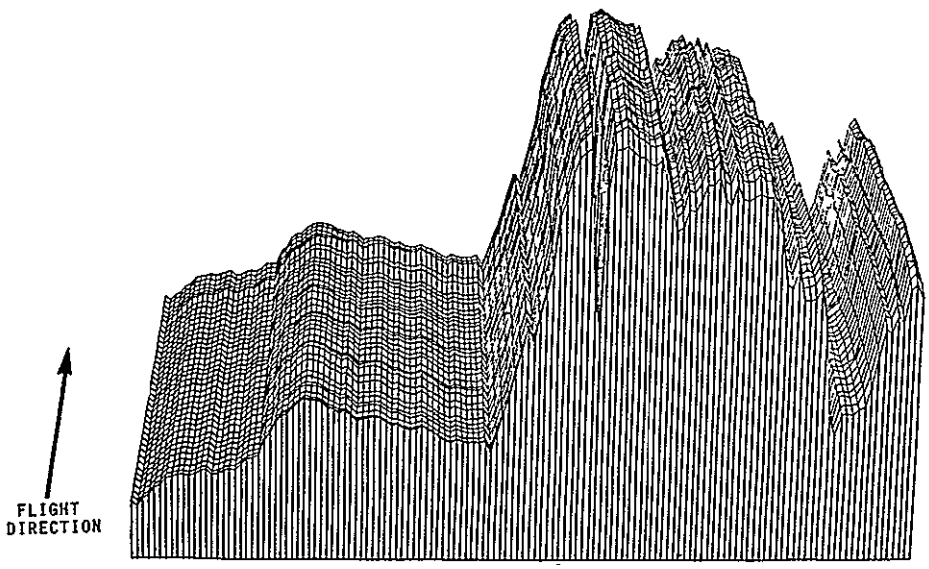
1816



11:19 AM 9/23/75

SUN ELEV = 57°

1794-1832



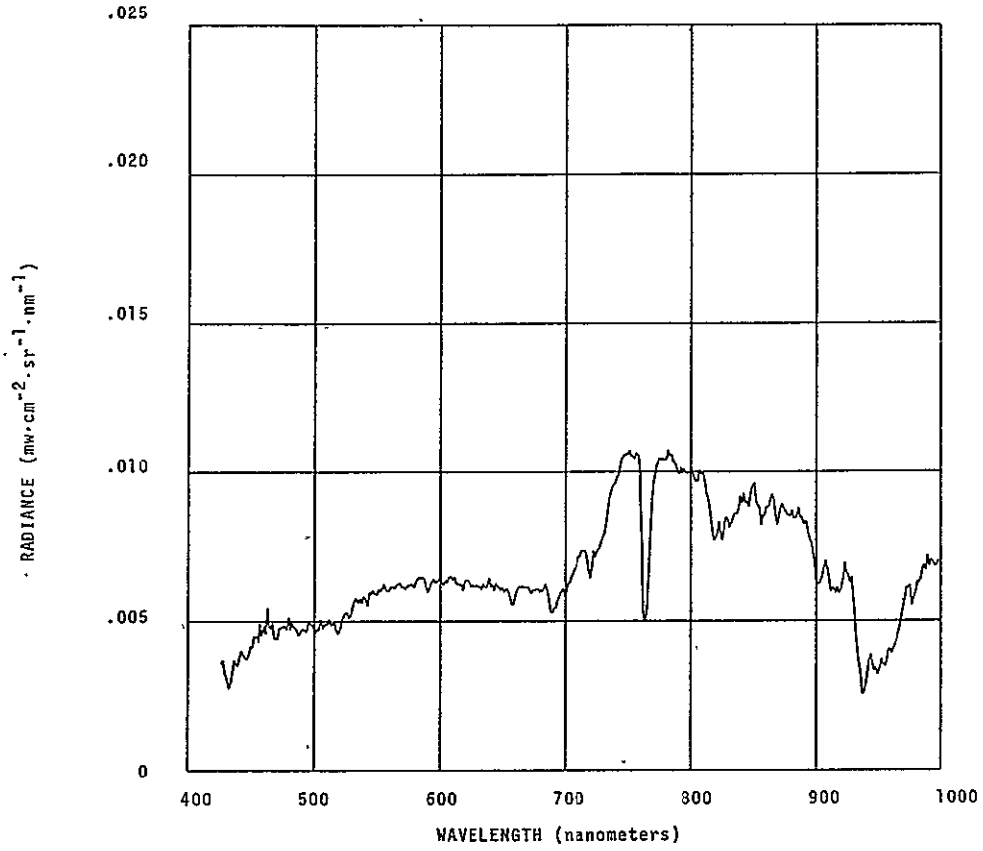
MELONS

FIELD DESCRIPTION

1 to 2 inches high, 10 to 15% leaf cover, thin uniform canopy. Furrows 10 inches deep spaced 3 feet apart. Soil wet in furrows in parts of the field, dry over most areas. Imperial, silty clay.

PHOTO INTERPRETATION

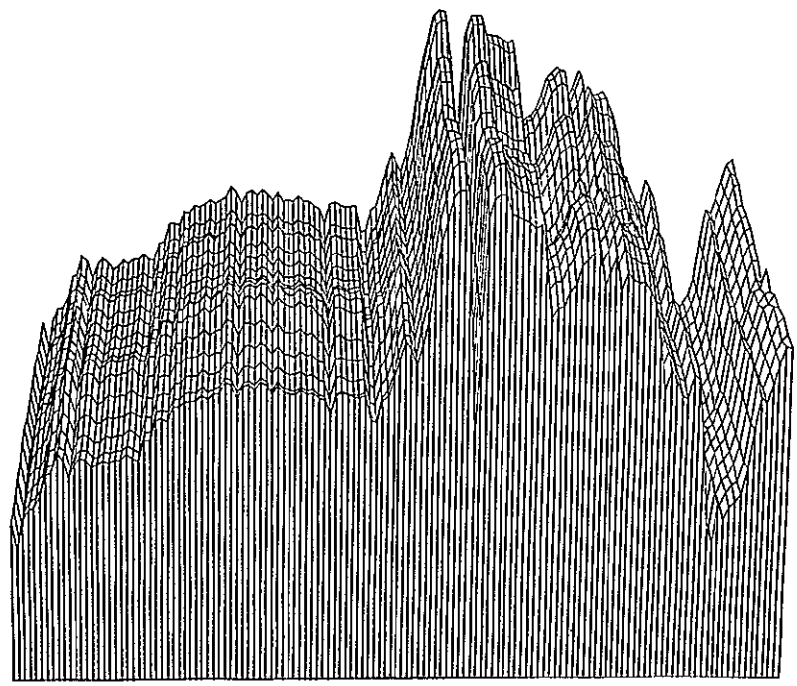
inhomogeneous tone; coarse texture; low density; 1/3 cover and field is divided by a line of bare soil perpendicular to FL; furrows run parallel with FL.



1844

10:27 AM 5/16/75

SUN ELEV = 69°



1833-1848

FLIGHT DIRECTION

MELONS

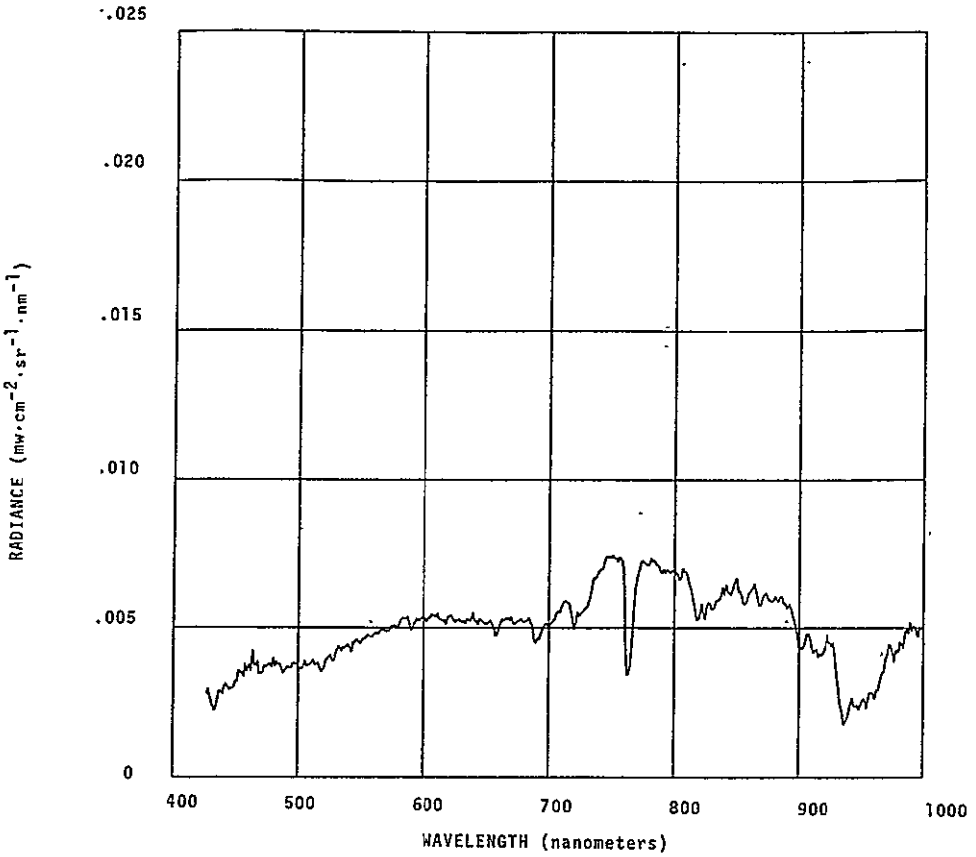
FIELD DESCRIPTION

2 to 3 inches high, 5% leaf cover, thin uniform canopy. Soil furrowed 8 inches deep spaced 3 feet apart. Moist in furrows. Imperial, silty clay.

PHOTO INTERPRETATION

inhomogeneous tone; fine texture; low density, very slight cover; furrows run parallel with FL; differential soil moisture pattern.

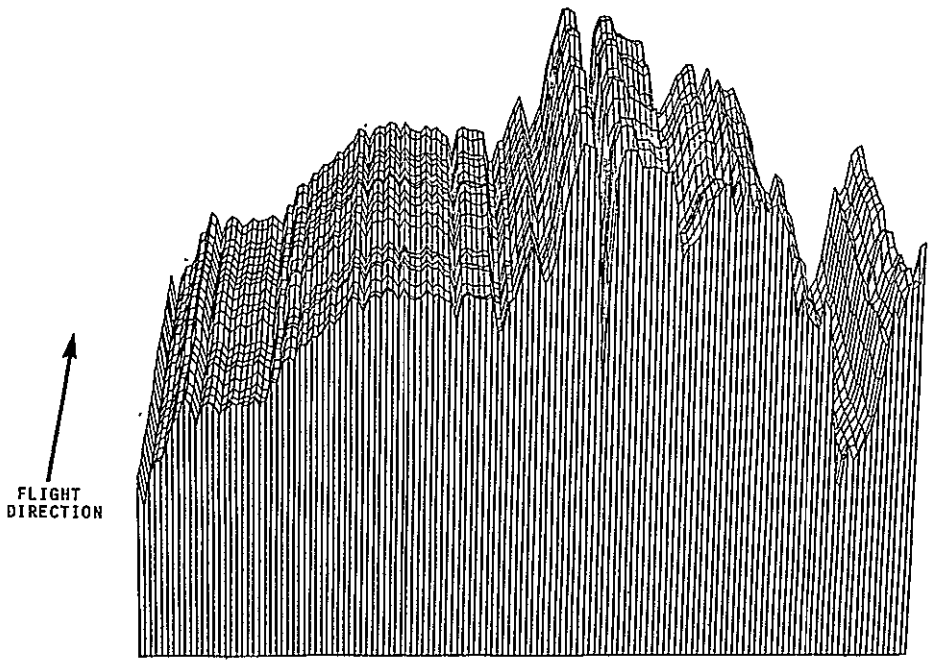
1869



10:27 AM 5/16/75

SUN ELEV = 69°

1849-1870



MELONS

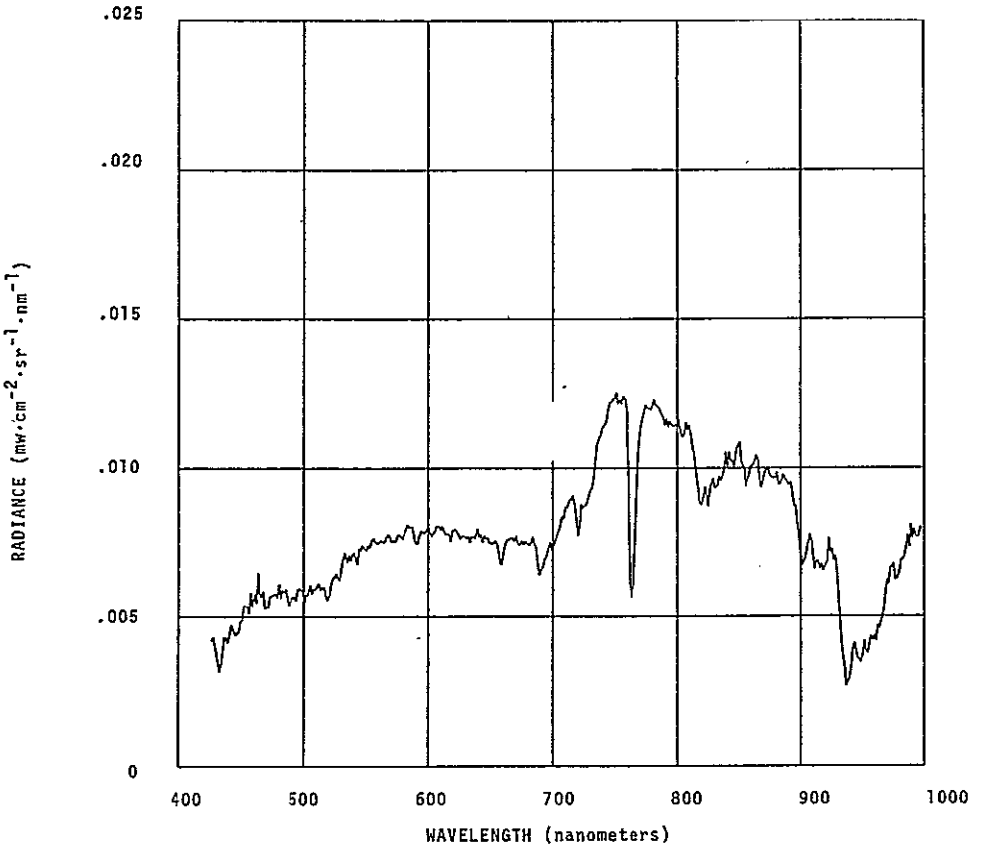
FIELD DESCRIPTION

3 to 4 inches high, 20% leaf cover, thin uniform canopy. Furrows 8 inches deep spaced 3 feet apart.

PHOTO INTERPRETATION

inhomogeneous tone; coarse texture; low density; 1/3 cover; furrows run parallel with FL.

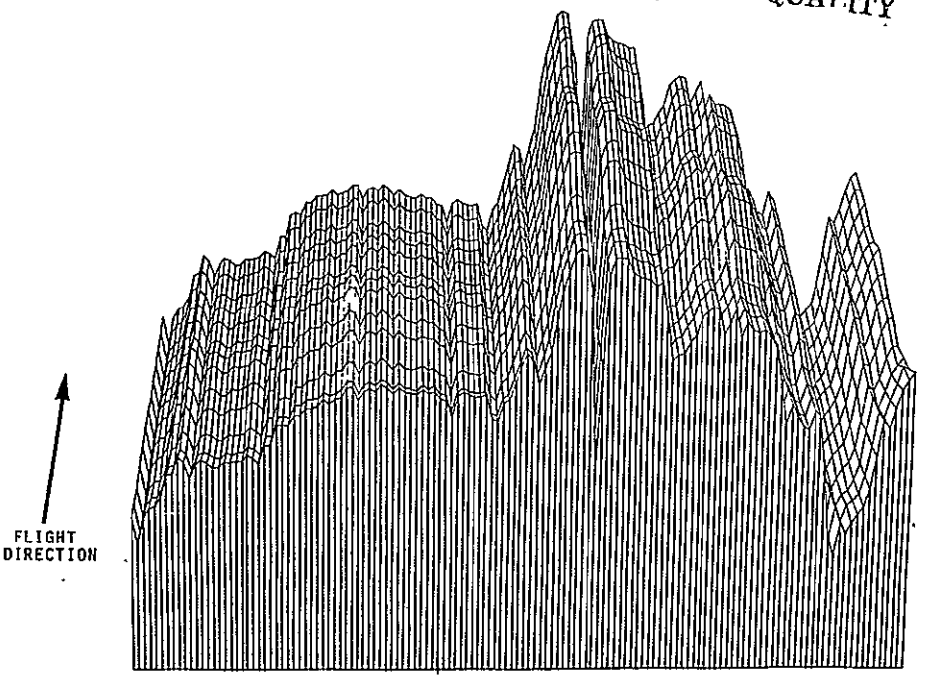
1875



10:47 AM 5/16/75

SUN ELEV = 72°

1871-1883



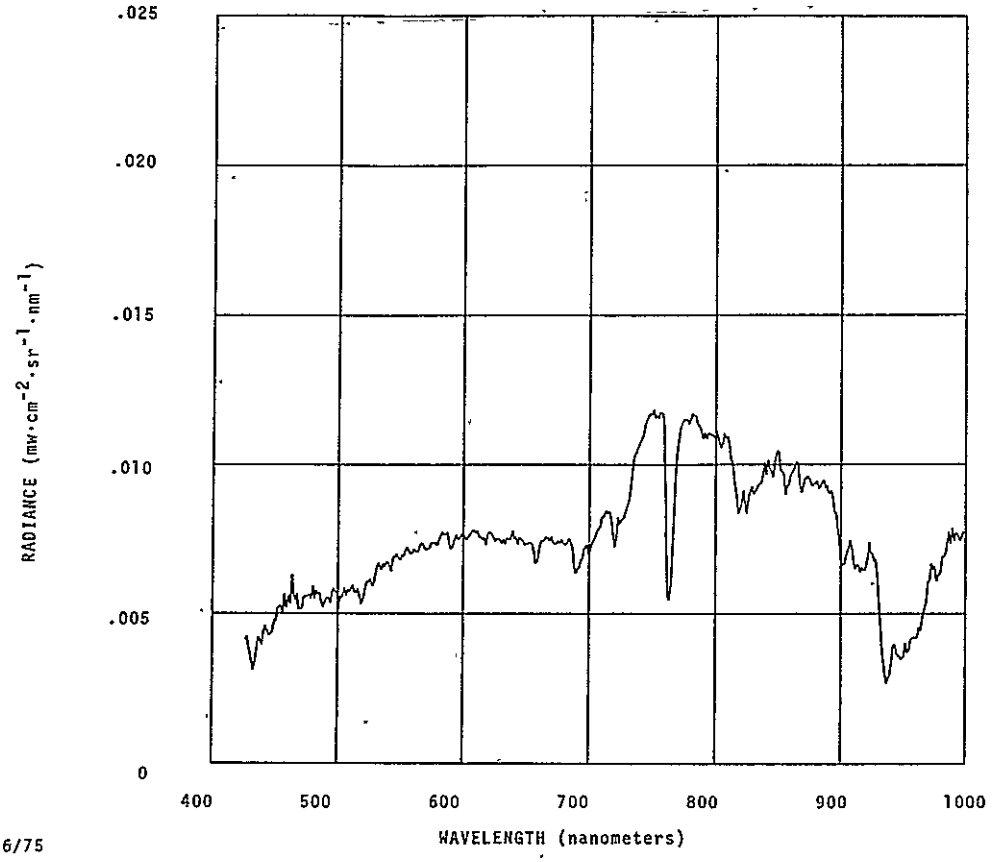
MELONS

FIELD DESCRIPTION

3 to 4 inches high, 20% leaf cover, thin uniform canopy.. Furrows 8 inches deep spaced 3 feet apart.

PHOTO INTERPRETATION

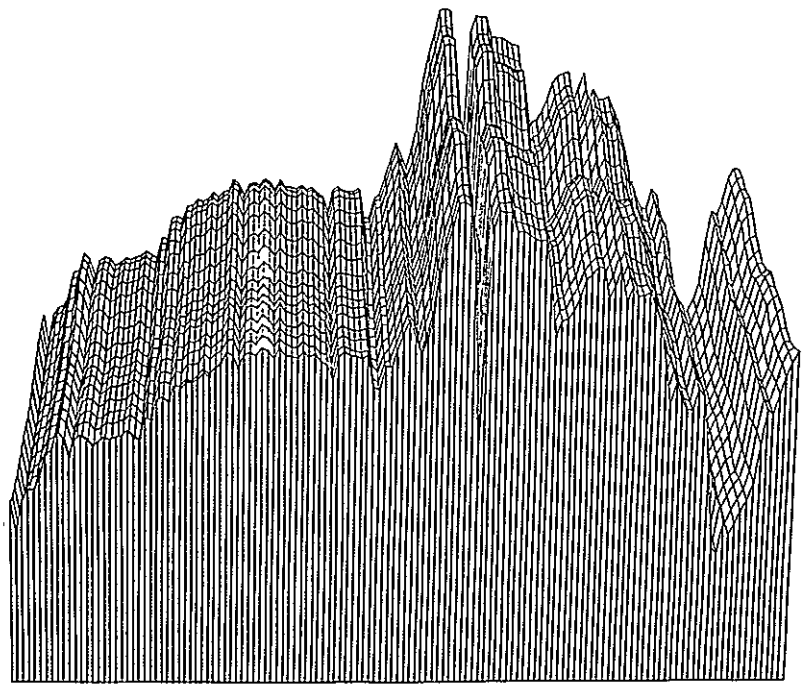
inhomogeneous tone; coarse texture; low density; 1/3 cover; furrows run parallel with FL.



1895

10:47 AM 5/16/75

SUN ELEV = 72°



1884-1900

MELONS

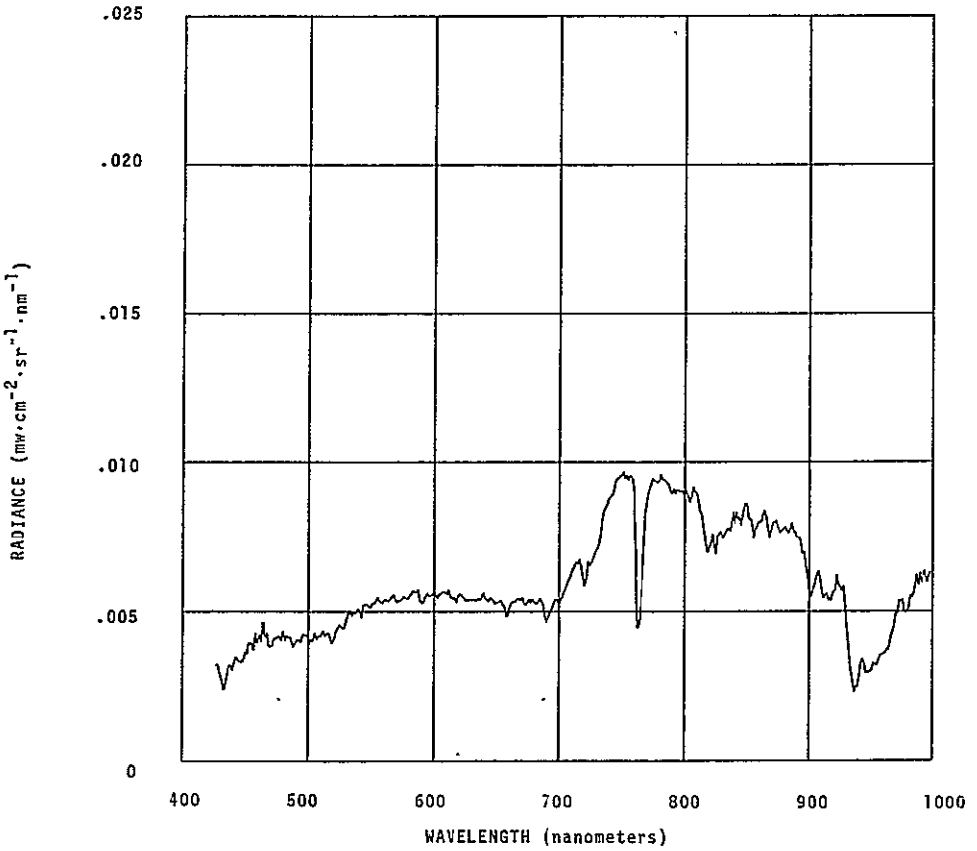
FIELD DESCRIPTION

3 to 4 inches high, 30 to 50% leaf cover, thin variable canopy. Furrows 12 inches deep spaced 3 feet apart. Soil wet, standing water. Imperial, silty clay.

PHOTO INTERPRETATION

inhomogeneous tone; coarse texture in areas of higher growth, medium in areas where the crop is lower to the ground; low density; nonuniform cover; furrows run parallel with FL.

1912



10:47 AM 5/16/75

SUN ELEV = 72°

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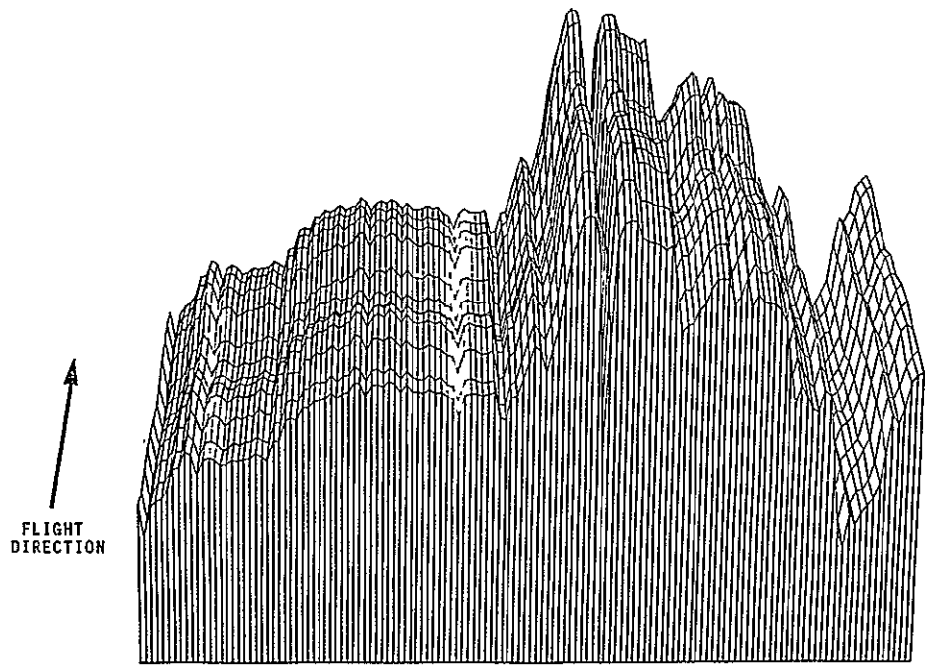
1901-1912



MELONS

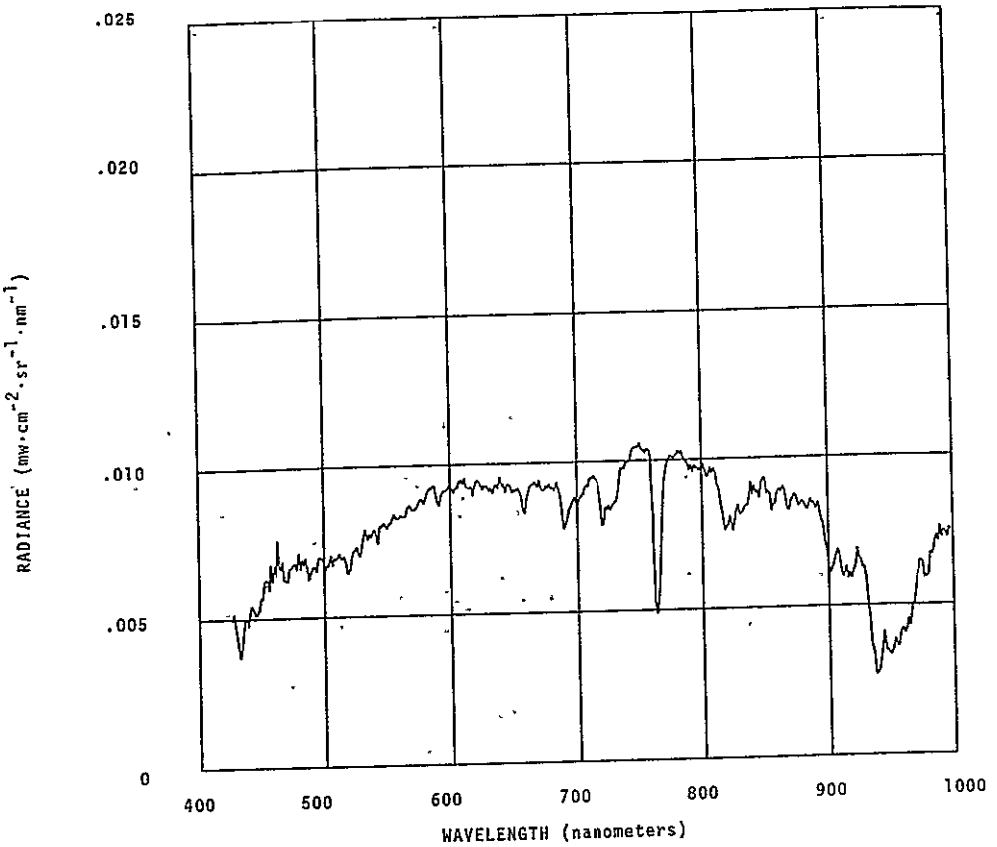
FIELD DESCRIPTION

3 to 4 inches high, 30 to 50% leaf cover, thin variable canopy. Furrows 12 inches deep spaced 3 feet apart. Soil dry. Imperial, light brown silty clay (7.5YR 6/4).

PHOTO INTERPRETATION

inhomogeneous tone; coarse texture; low density; 1/3 cover; furrows run parallel with FL; crop cover is in a diagonal pattern, probably because of subsurface drainage pipes producing diagonal striations of sparse cover.

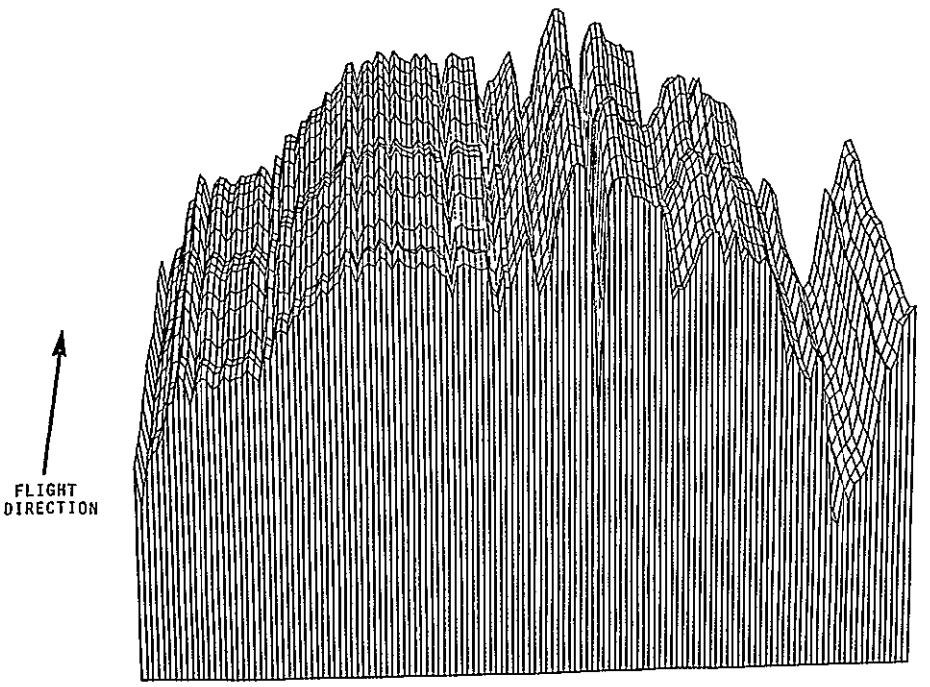
1920



10:55 AM 5/16/75

SUN ELEV = 73°

1913-1927



EMERGENT SORGHUM

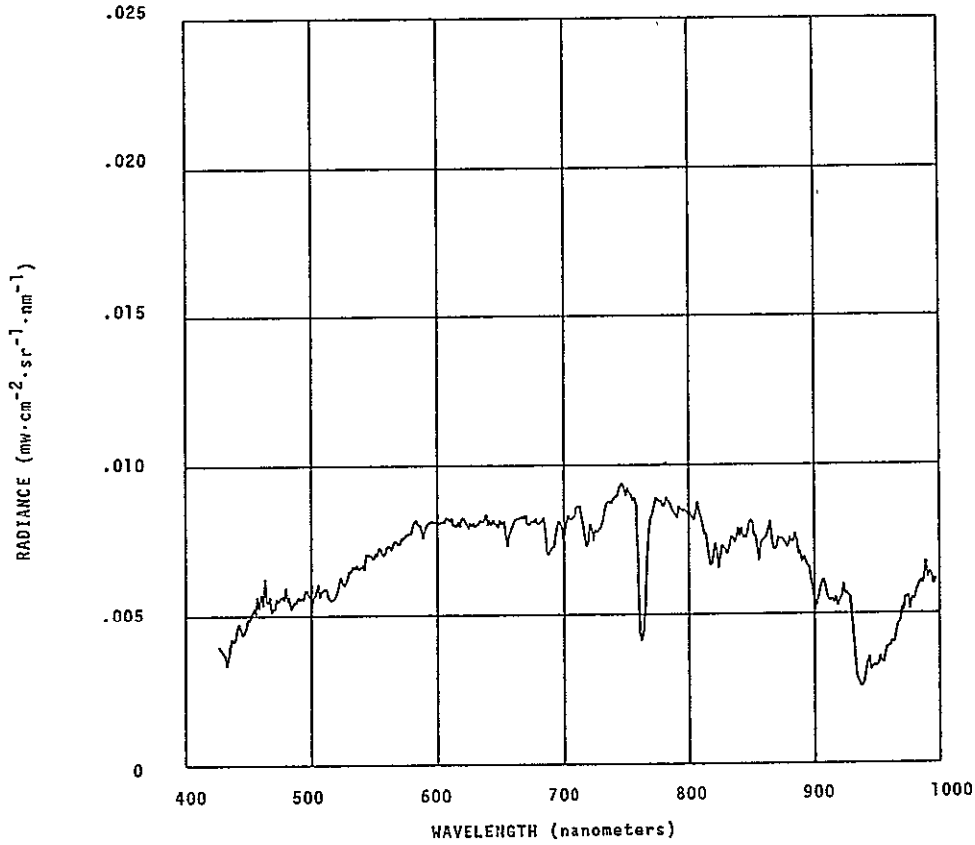
FIELD DESCRIPTION

2 to 8 inches high, 2% leaf cover, thin uniform canopy. 1 inch clods of soil. Smooth surface. Soil dry. Imperial, light brown silty clay (7.5YR 6/4).

PHOTO INTERPRETATION

inhomogeneous tone; coarse texture; low density little cover (differential growth); furrows run parallel with FL.

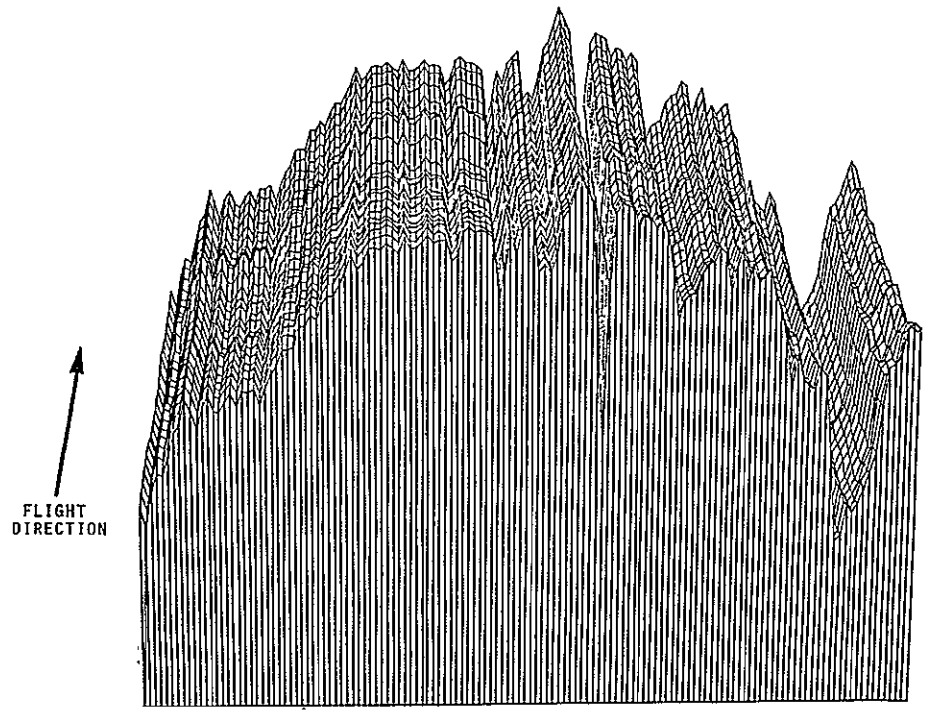
1948



9:28 AM 5/15/75

SUN ELEV = 58°

1928-1952



EMERGENT SORGHUM

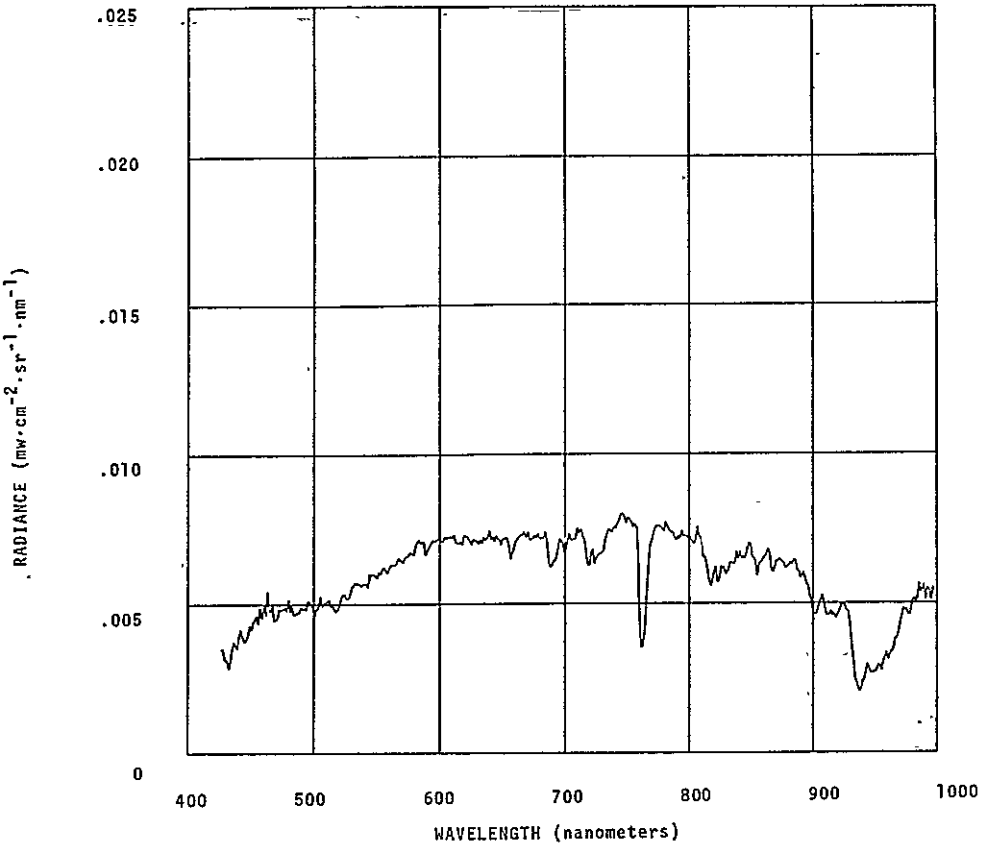
FIELD DESCRIPTION

2 to 8 inches high, 2% leaf cover, thin uniform canopy, 1 inch clods of soil. Smooth surface. Soil dry. Imperial, light brown silty clay (7.5YR 6/4).

PHOTO INTERPRETATION

inhomogeneous tone, striated perpendicular to FL; fine texture; low density; no cover; furrows run parallel with FL.

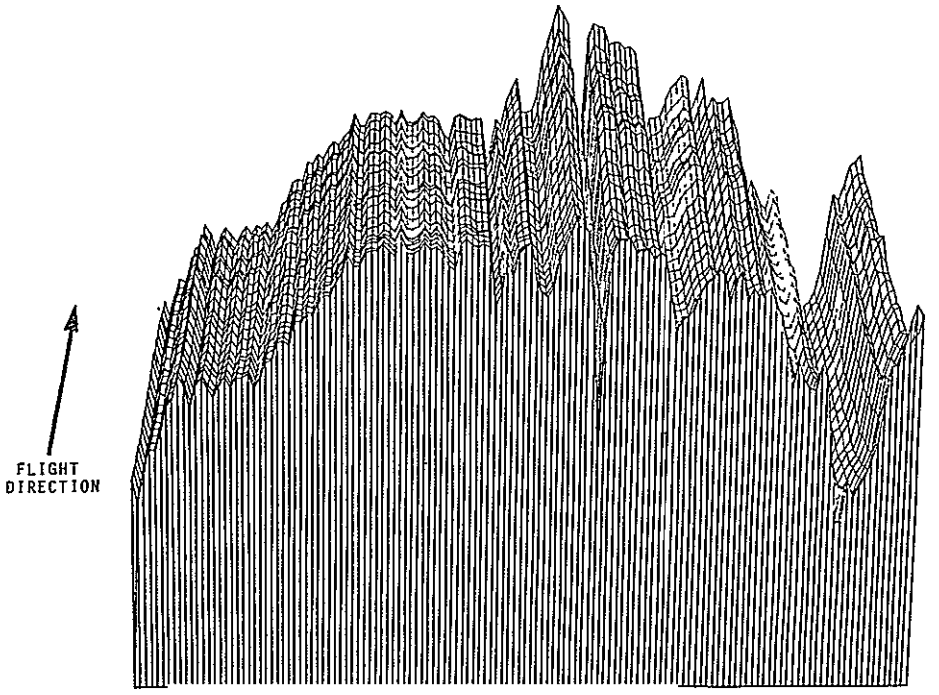
1964



9:37 AM 5/15/75

SUN ELEV = 59°

1953-1975



EMERGENT SORGHUM

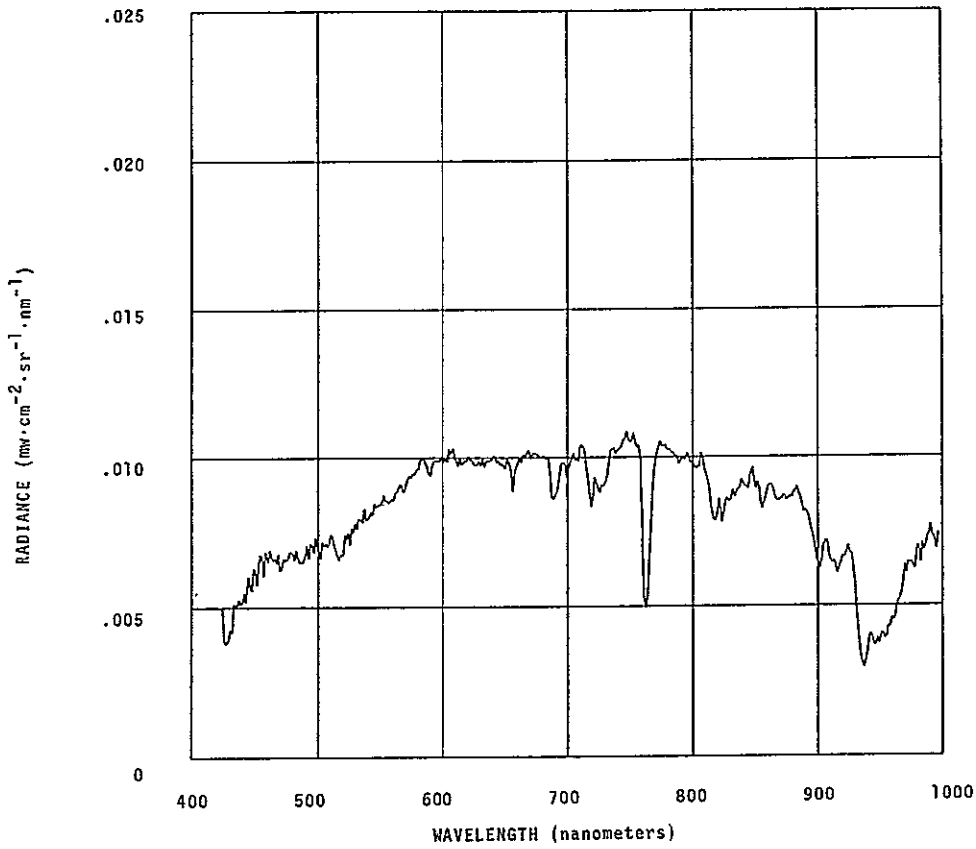
FIELD DESCRIPTION

2 to 8 inches high, 2% leaf cover, thin uniform canopy. 1 inch clods of soil. Smooth surface. Soil dry. Imperial, light brown silty clay (7.5YR 6/4).

PHOTO INTERPRETATION

inhomogeneous tone; coarse texture; low density; little cover; differential growth; furrows run parallel with FL.

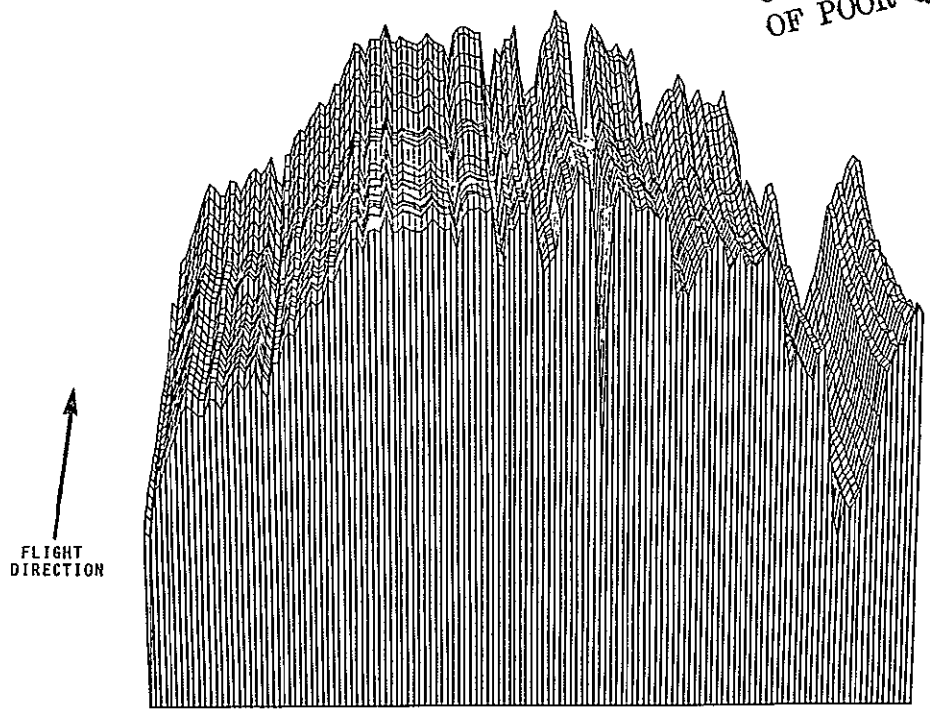
1997



10:42 AM 5/15/75

SUN ELEV = 71°

1976-2001



EMERGENT SORGHUM

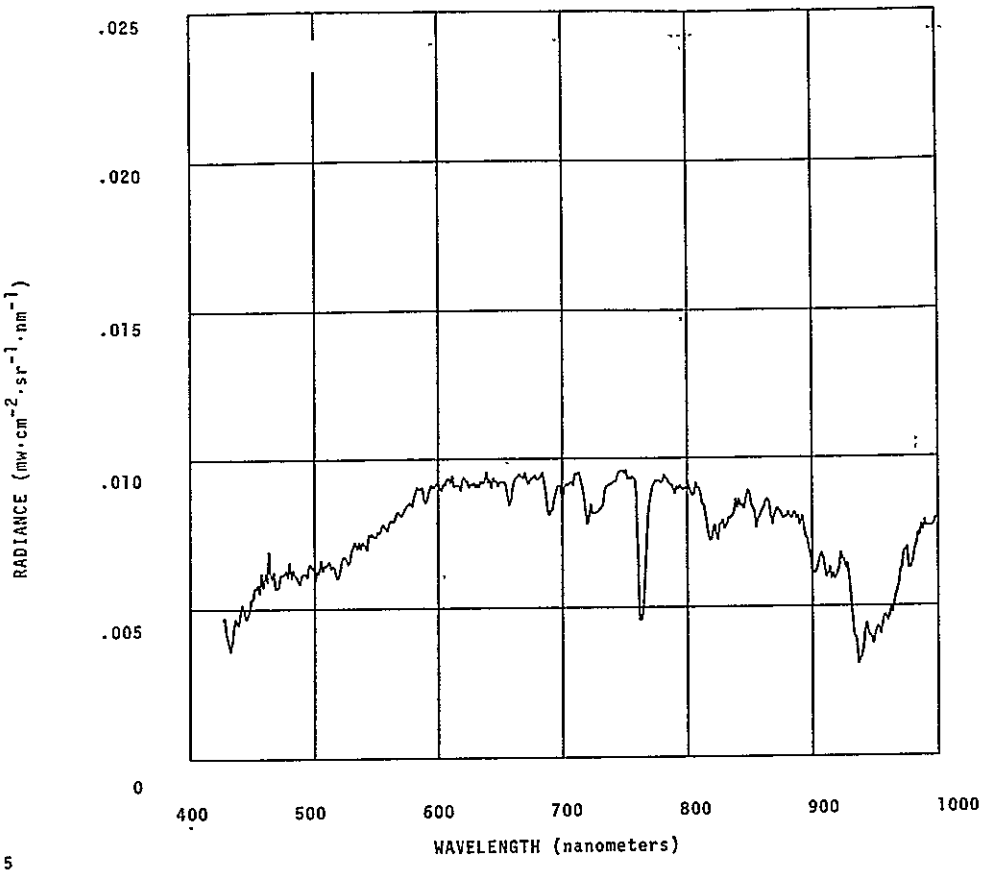
FIELD DESCRIPTION

8 to 12 inches high, 5 to 10% leaf cover, thin uniform canopy. 1 to 3 inch clods of soil. Moderately rough surface. Soil dry. Imperial, light brown silty clay (7.5YR 6/4).

PHOTO INTERPRETATION

inhomogeneous tone; coarse texture; low density; little cover; eastern 520 feet have slightly more dense cover; furrows run perpendicular to FL.

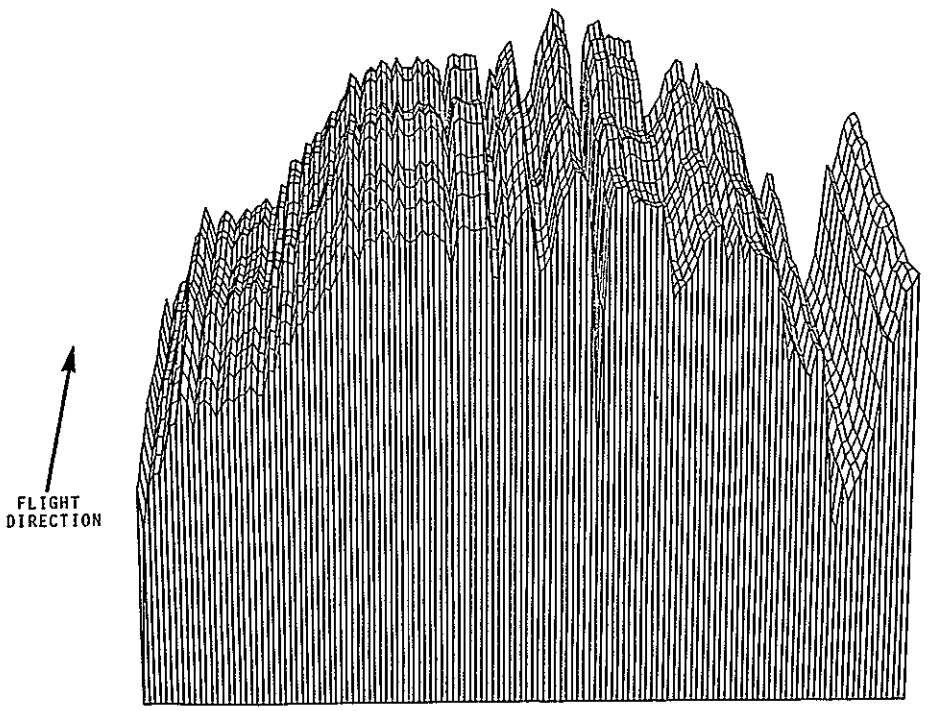
2004



9:58 AM 5/15/75

SUN ELEV = 63°

2002-2016



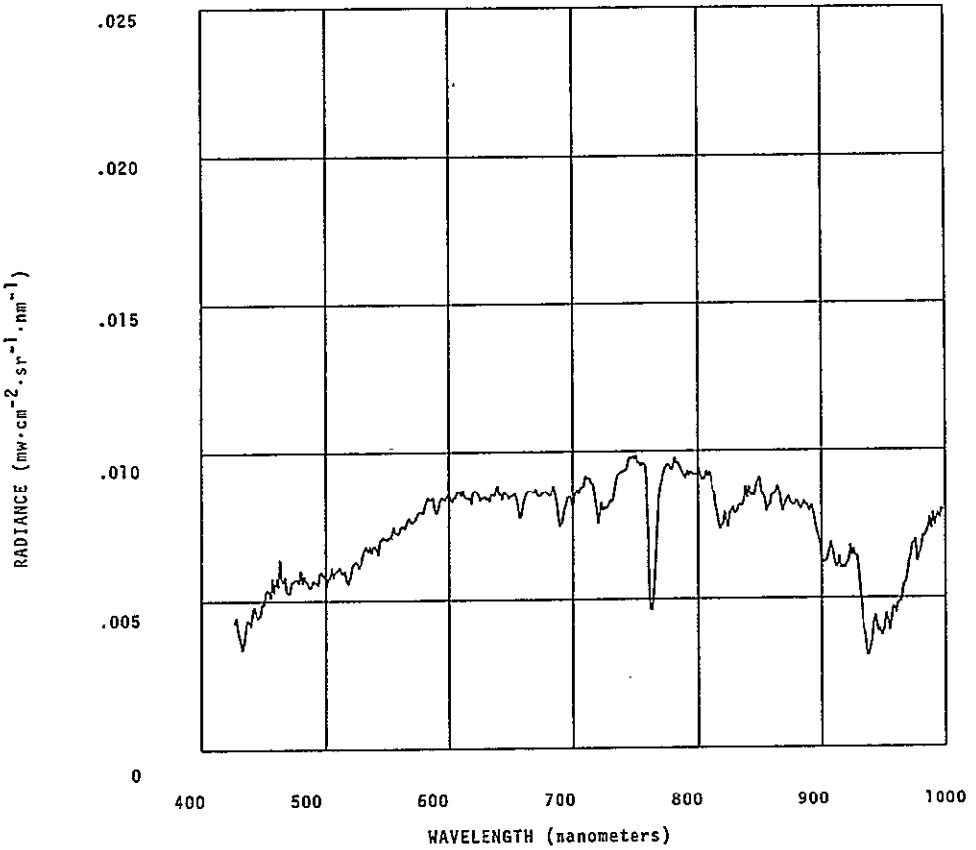
EMERGENT SORGHUM

FIELD DESCRIPTION

10 to 12 inches high, 30 to 40% leaf cover, thin uniform canopy. 1 to 2 inch clods of soil. Moderately rough surface. Soil dry. Imperial, light brown silty clay (7.5YR 6/4).

PHOTO INTERPRETATION

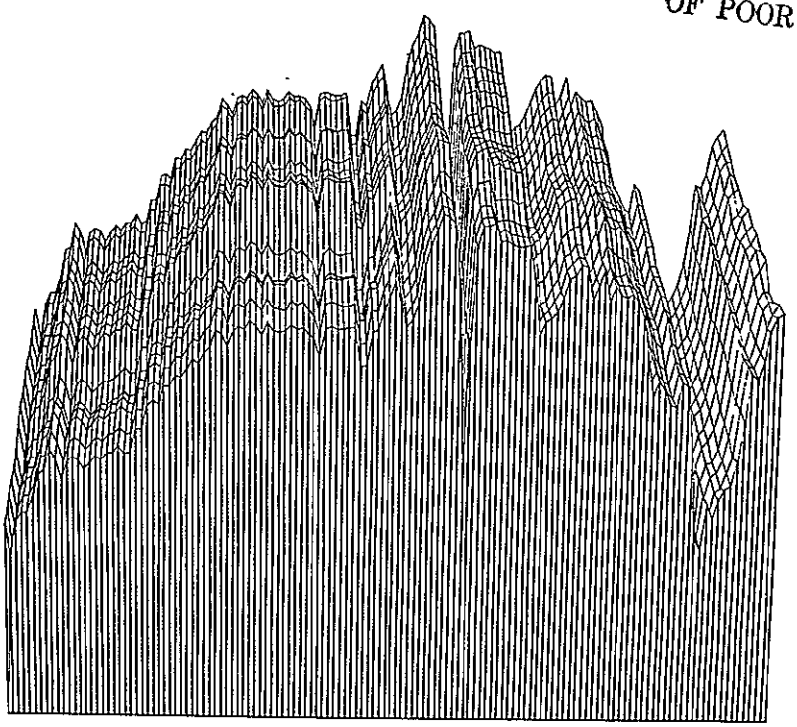
Inhomogeneous tone; coarse texture; low density; little cover; nonuniform differential growth, furrows run perpendicular to FL.



2026

9:58 AM 5/15/75

SUN ELEV = 63°



2017-2031

FLIGHT DIRECTION

HEADED SORGHUM

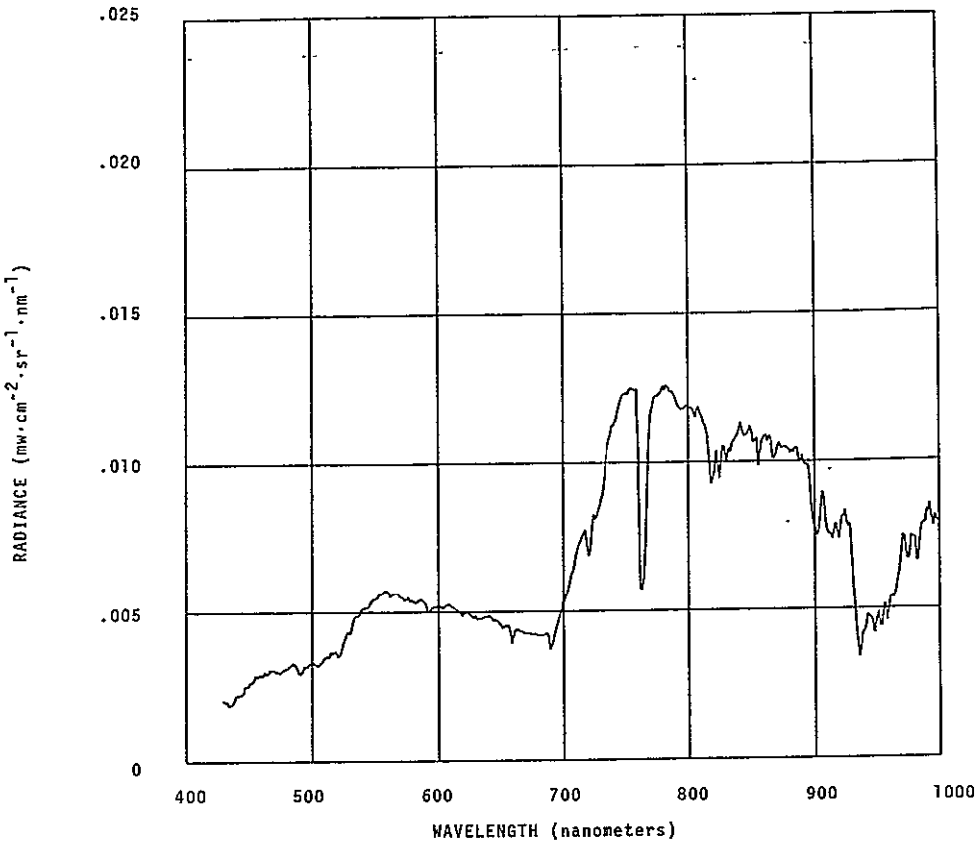
FIELD DESCRIPTION

2 to 4 feet high, 90% leaf cover, uniform canopy. Light green heads, green to yellow leaves. Soil dry. Imperial, light brown silty clay (7.5YR 6/4).

PHOTO INTERPRETATION

homogeneous tone; medium texture; medium density; near total cover; furrows run perpendicular to FL.

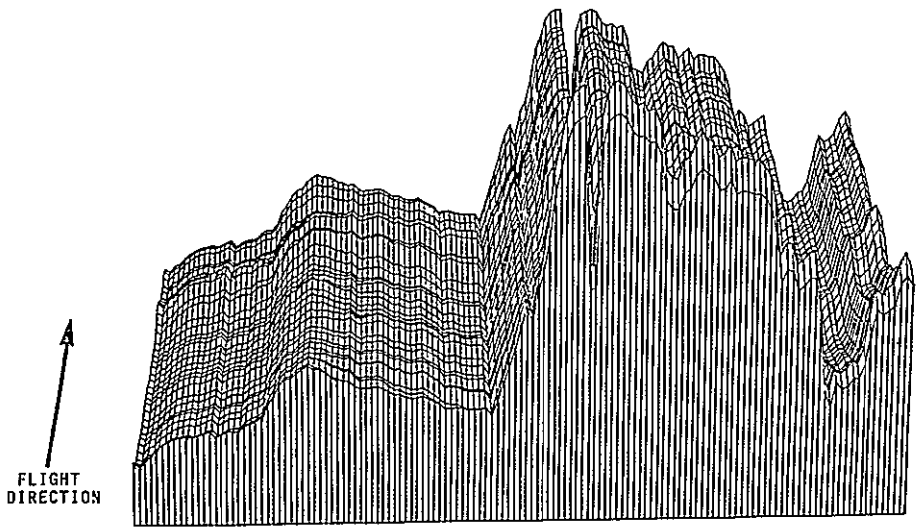
2059



11:03 AM 9/23/75

SUN ELEV = 56°

2032-2065



HEADED SORGHUM

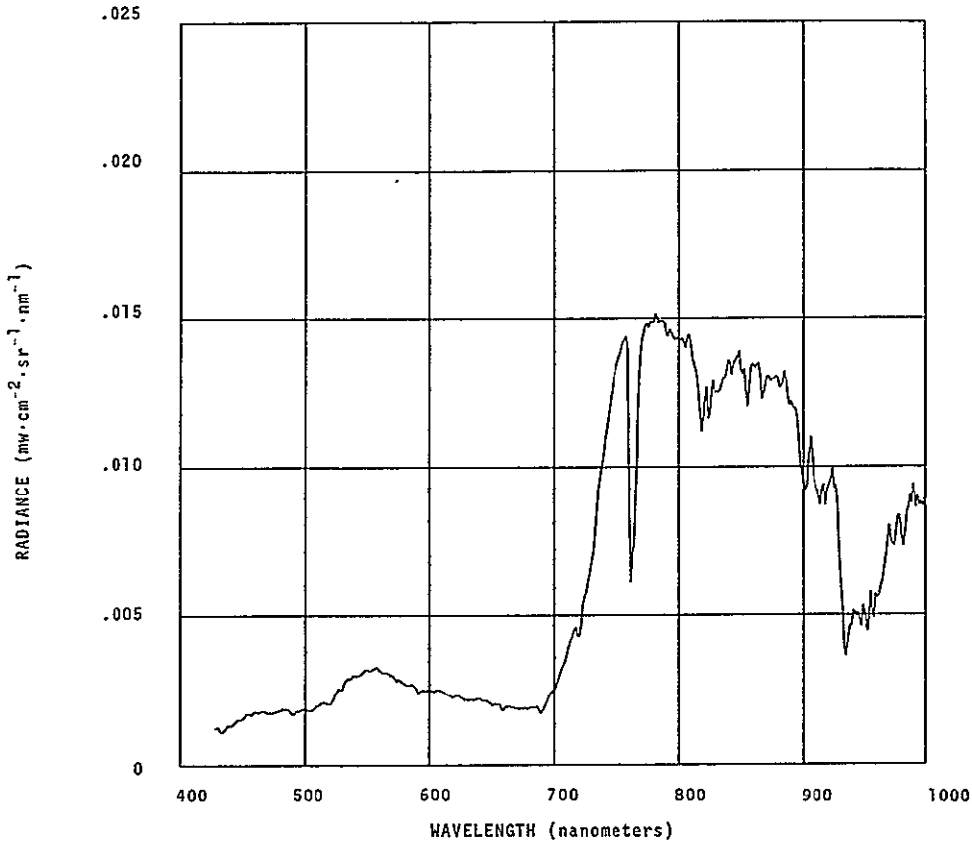
FIELD DESCRIPTION

40 inches high, 100% leaf cover, thick uniform canopy. Heads and leaves green. Soil wet. Imperial, silty clay.

PHOTO INTERPRETATION

homogeneous tone except furrows are slightly detectable; coarse texture; high density; total cover; furrows run parallel with FL.

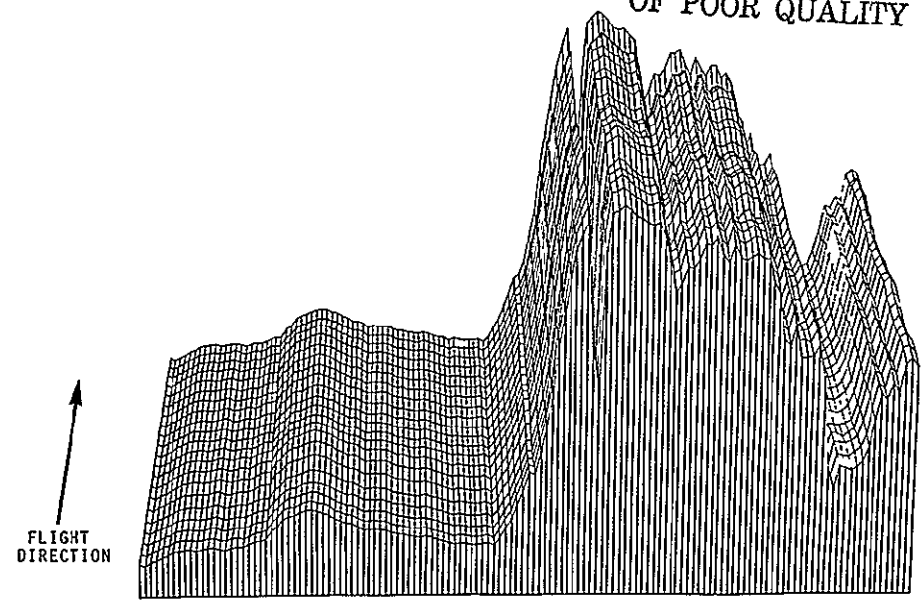
2076



11:19 AM 9/23/75

SUN ELEV = 57°

2066-2086



EMERGENT SUGAR BEETS

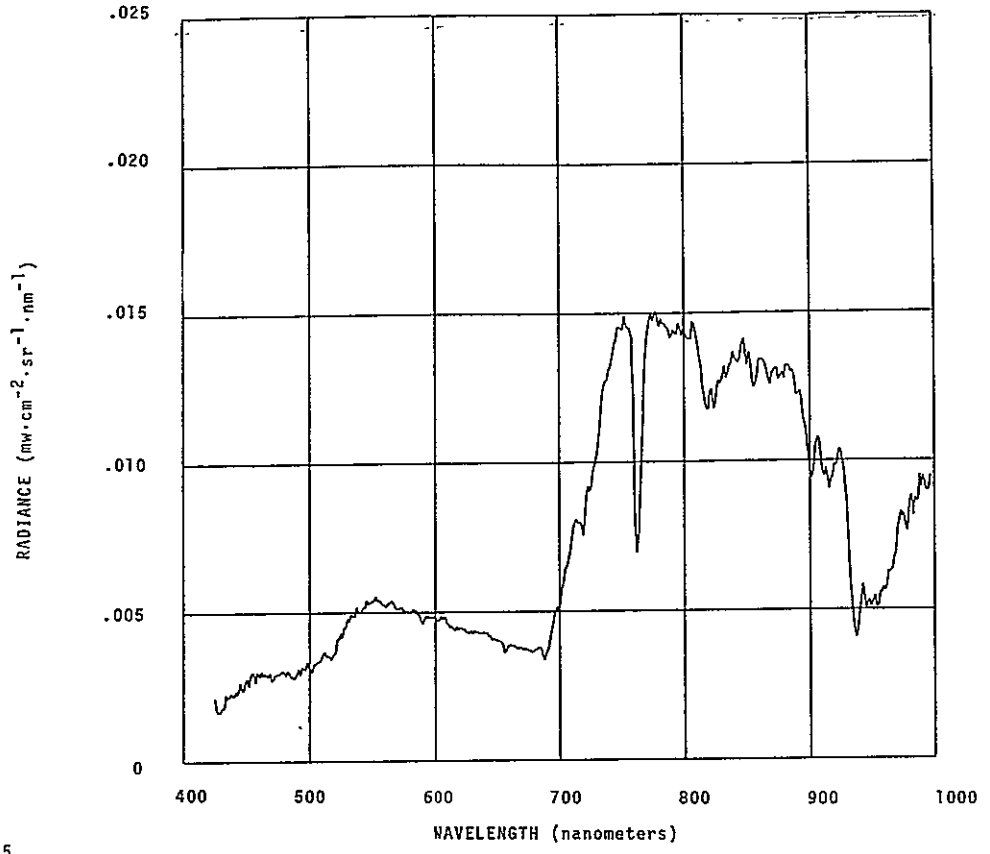
FIELD DESCRIPTION

6 to 12 inches high, 90 to 95% leaf cover (5% weeds, 3 feet high), moderately thick uniform canopy. Soil dry. Imperial, light brown silty clay (7.5YR 6/4).

PHOTO INTERPRETATION

homogeneous tone; medium texture; medium density; near total cover; furrows run perpendicular to FL.

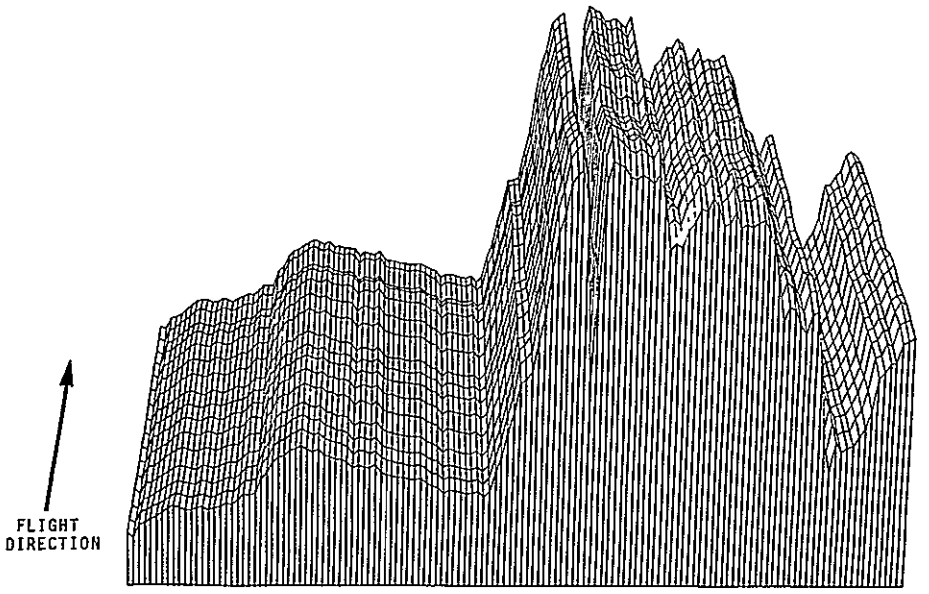
2092



10:30 AM 5/15/75

SUN ELEV = 69°

2087-2102



THINNED SUGAR BEETS

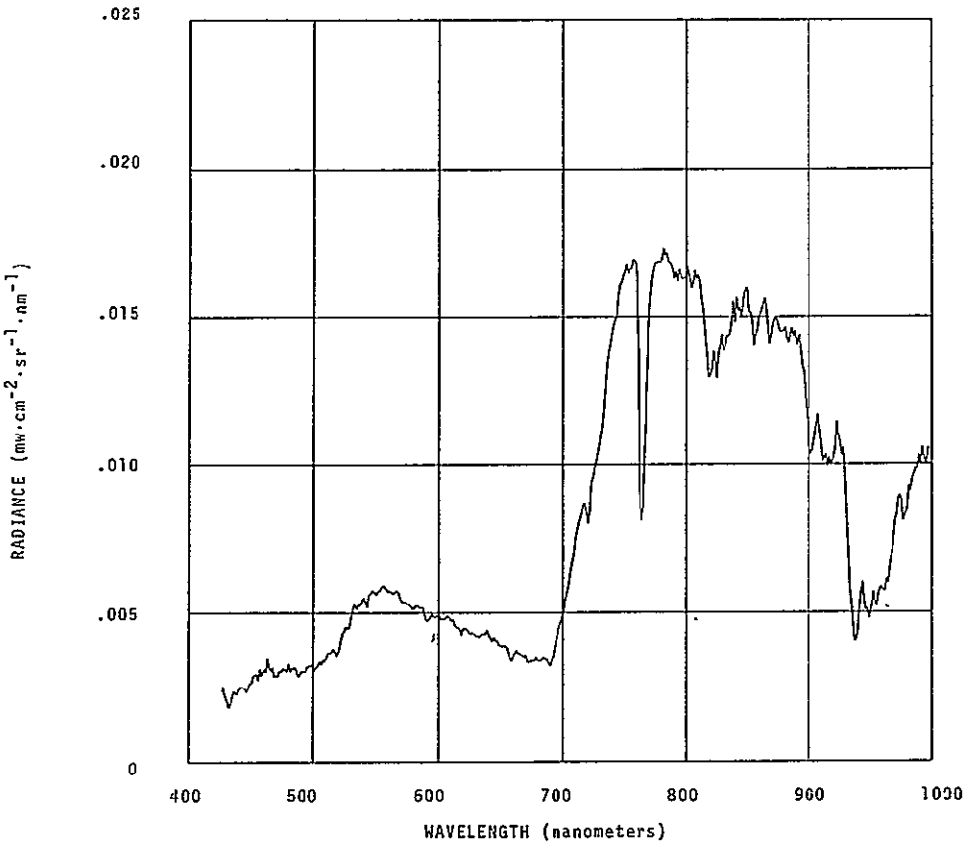
FIELD DESCRIPTION

12 to 16 inches high (5 foot high crowns on plants), 80 to 100% leaf cover (5% crowns, 5% weeds), thick patchy canopy. Soil moist to dry. Imperial, silty clay.

PHOTO INTERPRETATION

homogeneous tone; medium texture; medium density; near total cover.

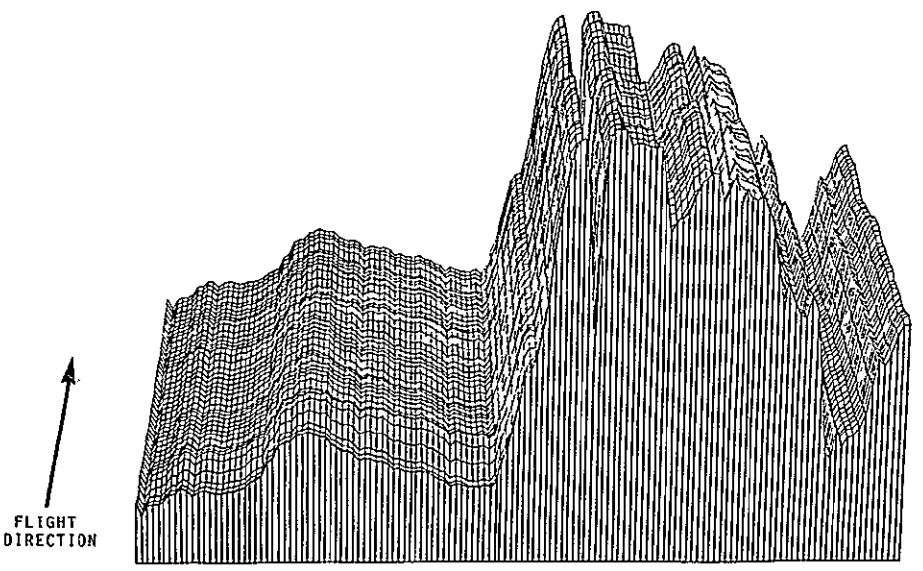
2107



10:55 AM 5/16/75

SUN ELEV = 73°

2103-2147



THINNED SUGAR BEETS

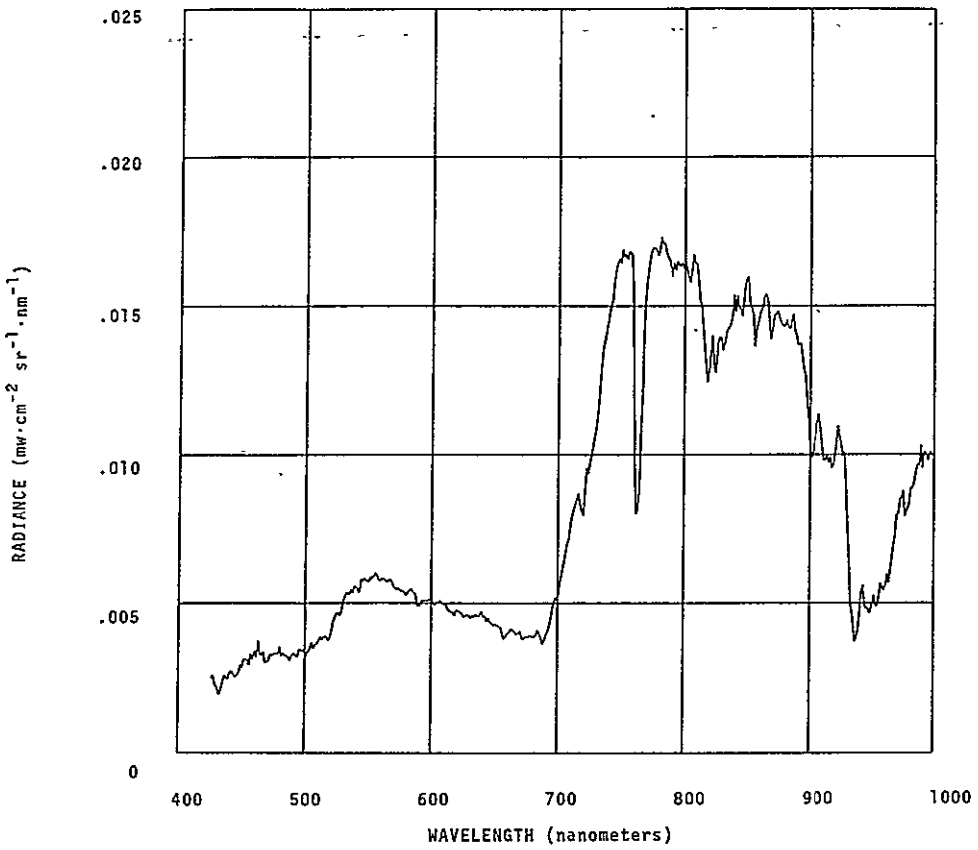
FIELD DESCRIPTION

14 to 18 inches high, 80% leaf cover, moderately thick patchy canopy. Crop ready for harvest. Soil dry. Imperial, light brown silty clay (7.5YR 6/4).

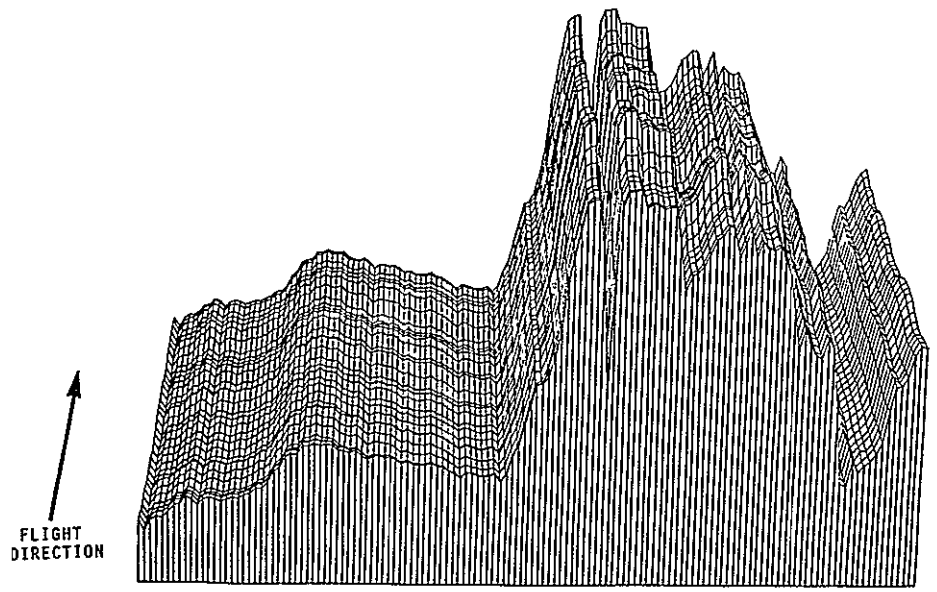
PHOTO INTERPRETATION

inhomogeneous tone; coarse texture; medium density; 2/3 cover; nonuniform differential ripening; furrows run parallel with FL.

2169



2148-2179



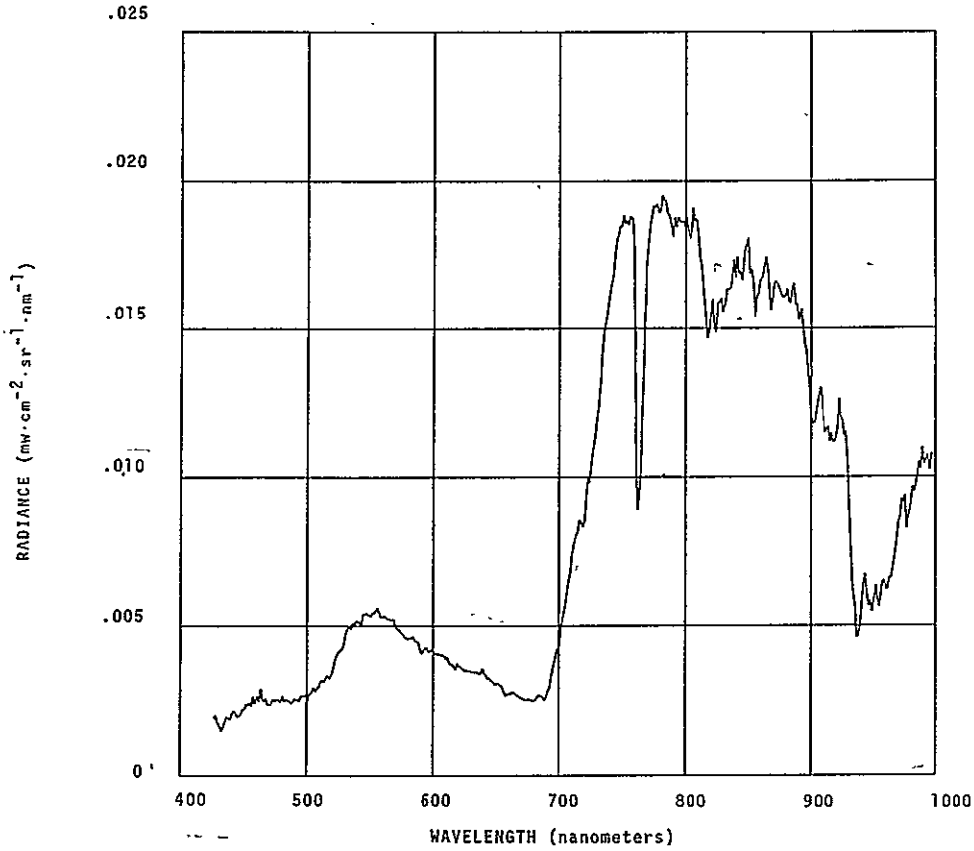
THINNED SUGAR BEETS

FIELD DESCRIPTION

12 to 24 inches high (4 foot high crowns on plants), 95 to 100% leaf cover (1% crowns, 2% weeds), thick uniform canopy. Soil dry. Imperial, light brown silty clay (7.5YR 6/4).

PHOTO INTERPRETATION

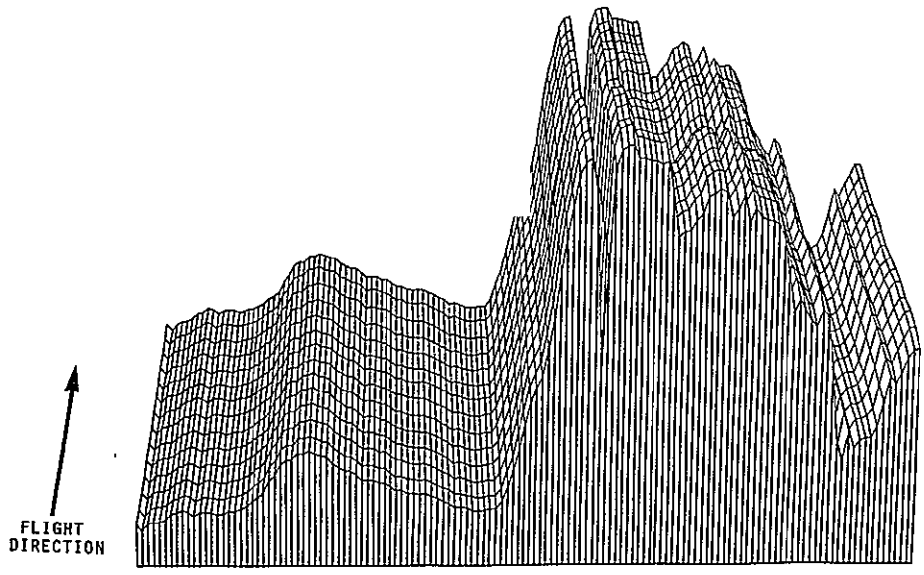
homogeneous tone; medium texture; medium density; total cover.



2189

10:10 AM 5/15/75.

SUN ELEV = 66°



2180-2193

THINNED SUGAR BEETS

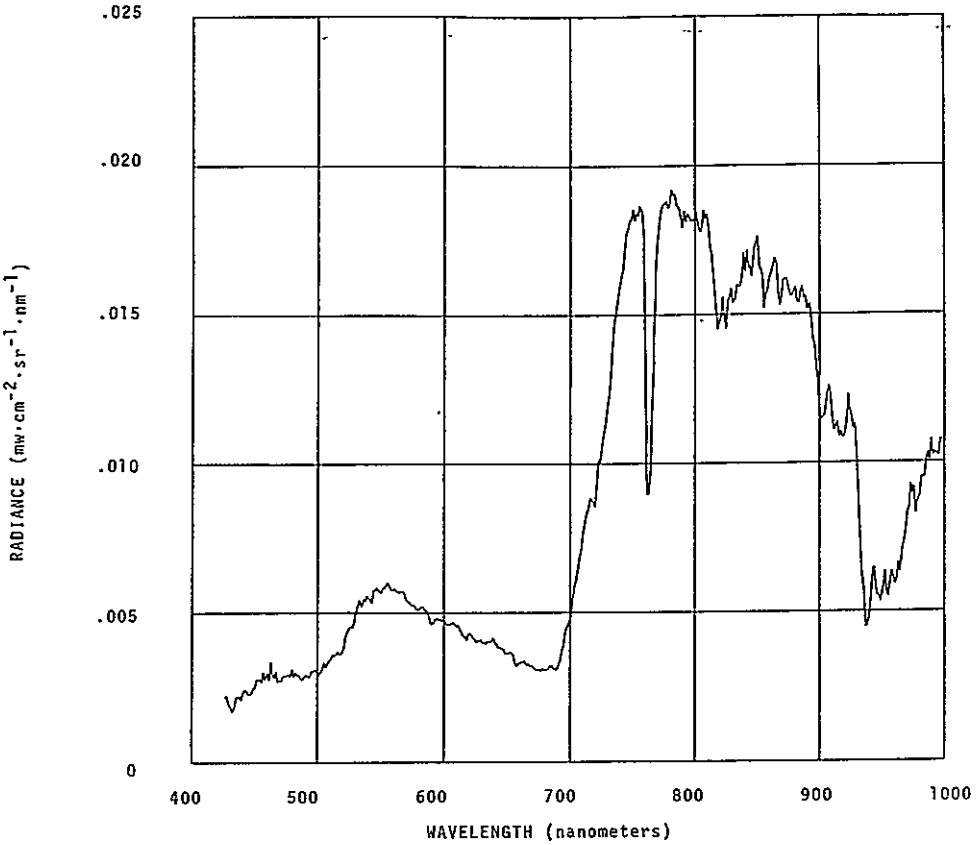
FIELD DESCRIPTION

12 to 24 inches high (4 foot high crowns on plants), 95% to 100% leaf cover (1% crowns, 2% weeds), thick uniform canopy. Soil wet. Imperial, silty clay.

PHOTO INTERPRETATION

homogeneous tone; medium texture; medium density; total cover.

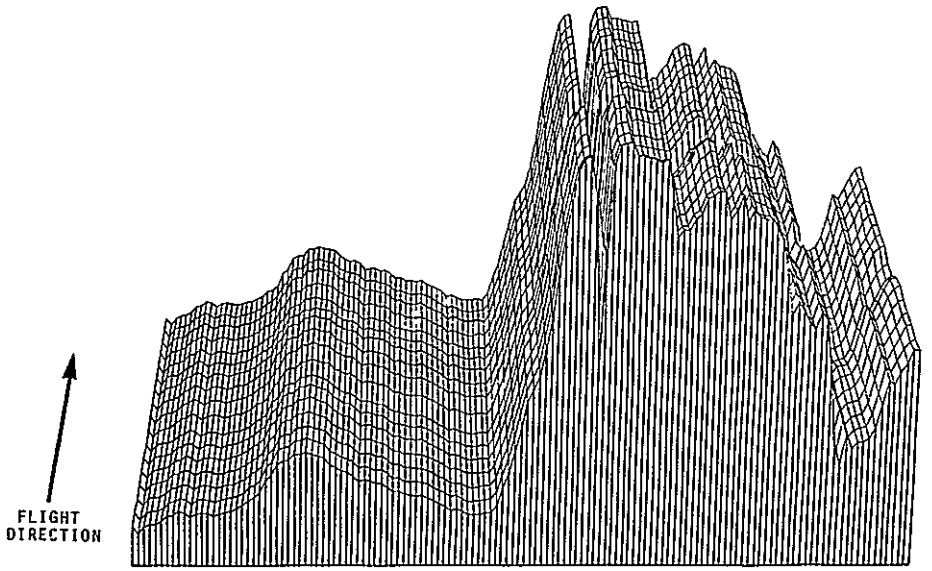
2207



10·10 AM 5/15/75

SUN ELEV = 66°

2194-2210



THINNED SUGAR BEETS

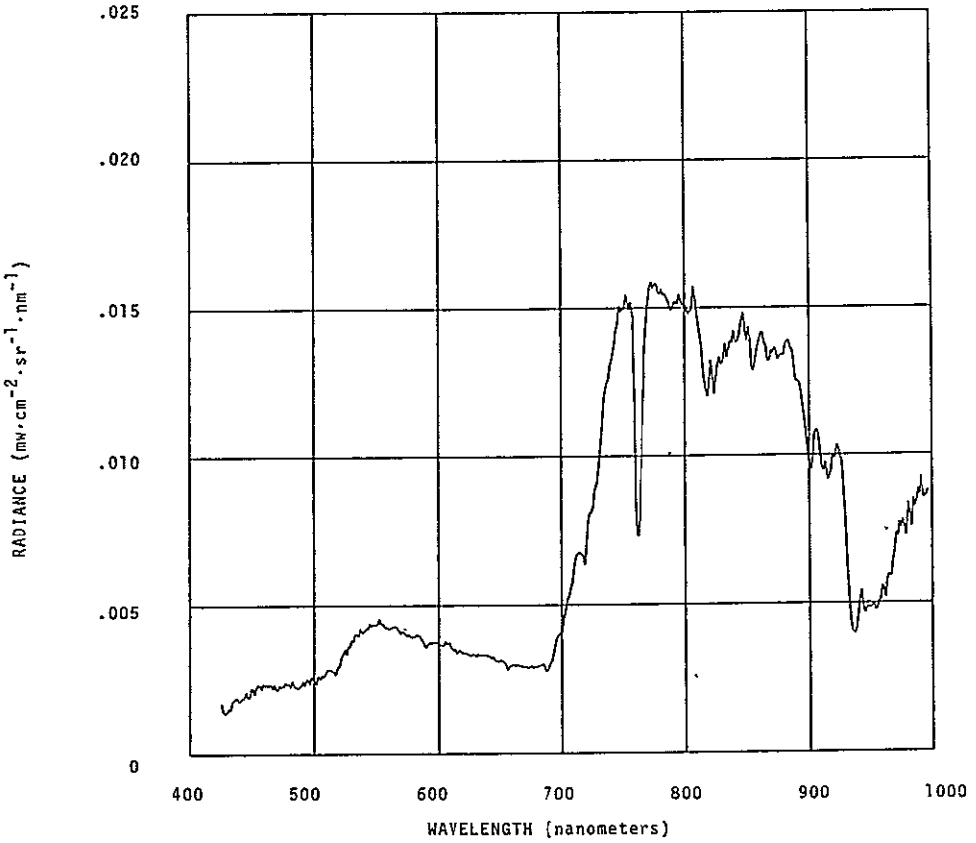
FIELD DESCRIPTION

12 to 36 inches high (4 foot high crowns on plants), 100% leaf cover (30% weeds), thick uniform canopy. Soil dry. Imperial, light brown silty clay (7.5YR 6/4).

PHOTO INTERPRETATION

inhomogeneous tone; coarse texture; medium density; near total cover; furrows run perpendicular to FL.

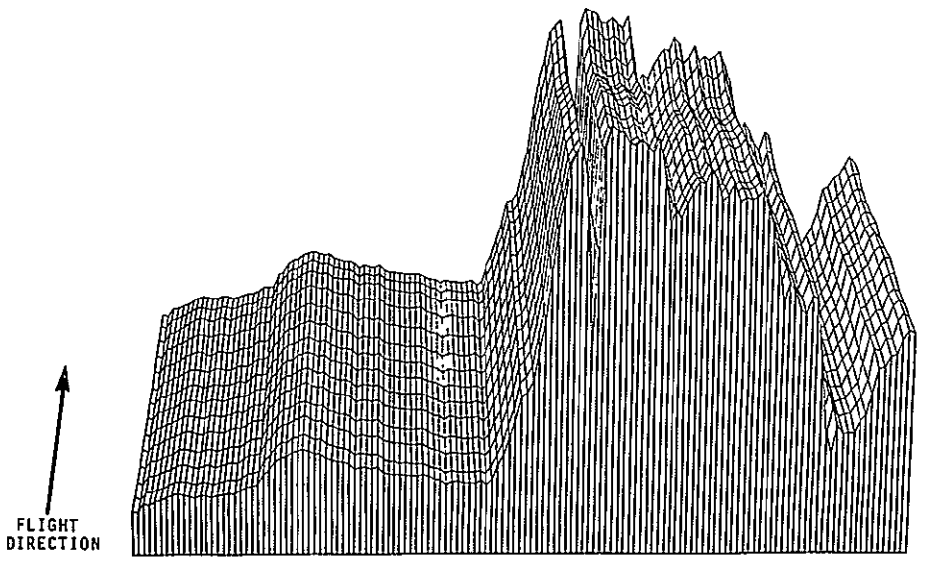
2217



10:04 AM 5/15/75

SUN ELEV = 65°

2211-2224



MATURE SUGAR BEETS

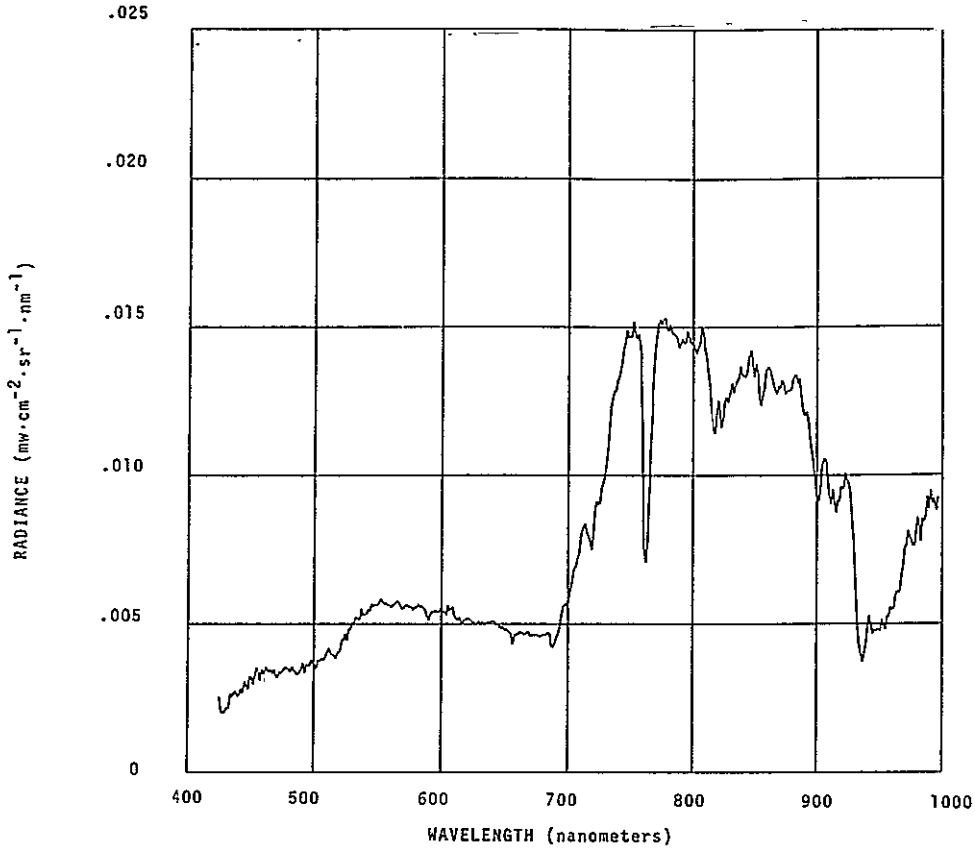
FIELD DESCRIPTION

24 to 30 inches high, 100% leaf cover (1% weeds), thick uniform canopy. Soil dry. Imperial, light brown silty clay (7.5YR 6/4).

PHOTO INTERPRETATION

Inhomogeneous tone, striated parallel with FL; coarse texture; medium density, near total cover; furrows run parallel with FL.

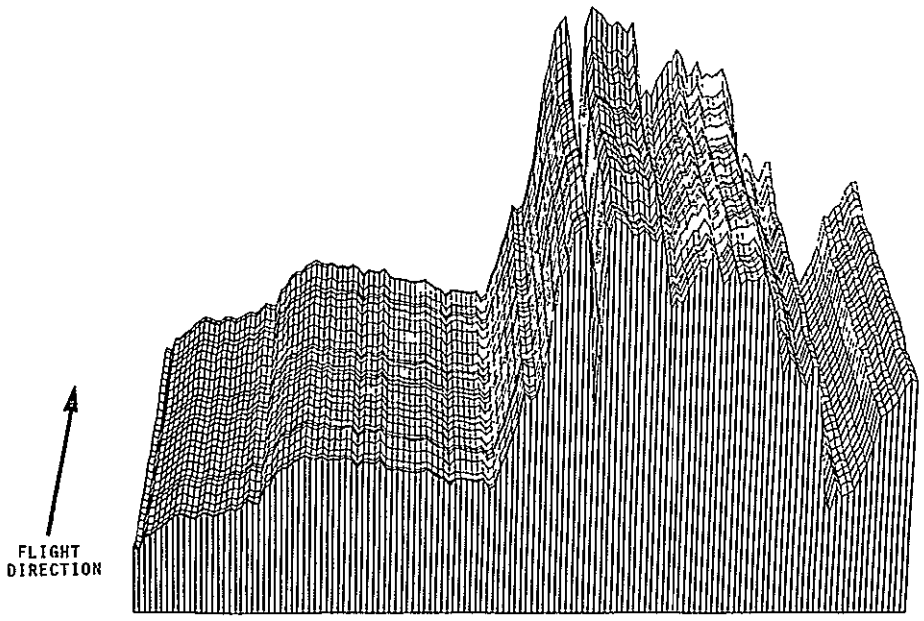
2227



10:17 AM 5/15/75

SUN ELEV = 67°

2225-2255



HARVESTED SUGAR BEETS

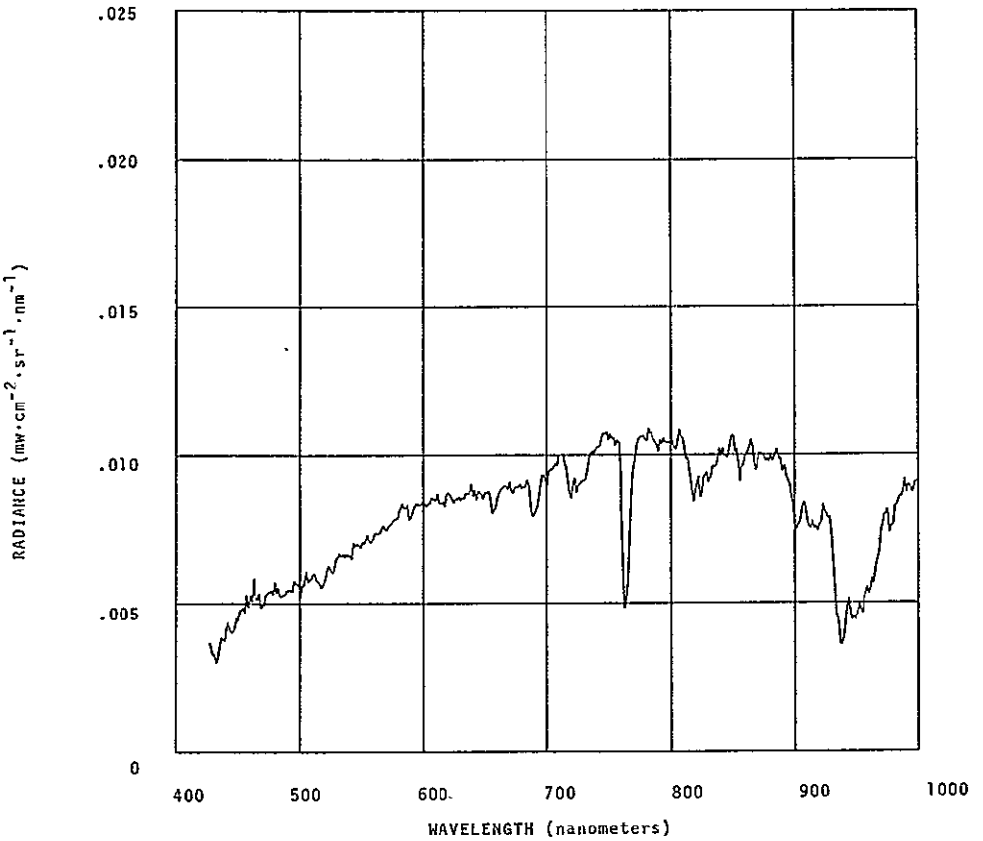
FIELD DESCRIPTION

harvested, 40% refuse lying on surface. 1 to 6 inch clods of soil. Rough surface. Soil dry. Imperial, light brown silty clay (7.5YR 6/4).

PHOTO INTERPRETATION

inhomogeneous tone, striated parallel with FL; medium texture; bare soil; furrows running parallel with FL.

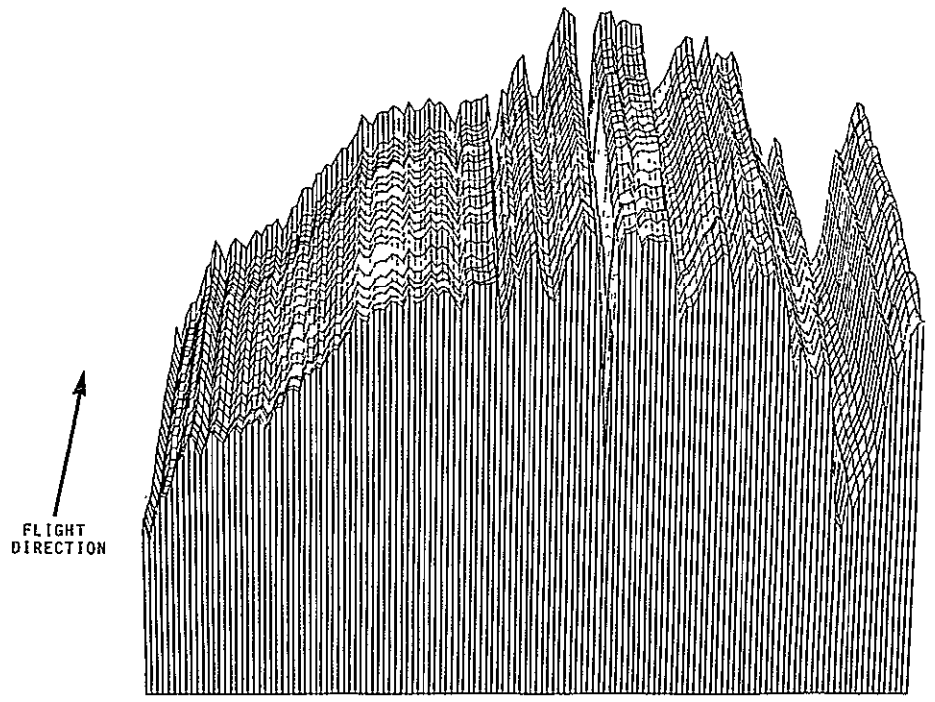
2277



9:43 AM 5/15/75

SUN ELEV = 61°

2256-2281



HARVESTED SUGAR BEETS

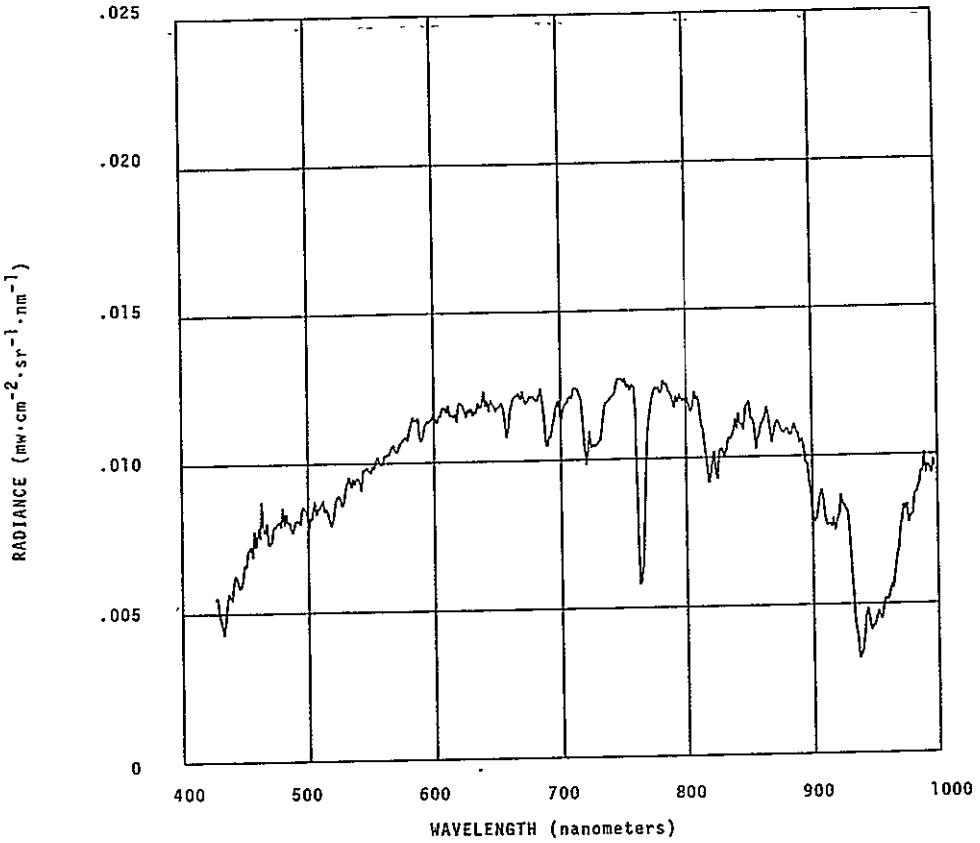
FIELD DESCRIPTION

harvested, 40 to 50% refuse lying on surface.
6 inch clods of soil. Surface rough. Soil dry.
Imperial, light brown silty clay (7.5YR 6/4).

PHOTO INTERPRETATION

homogeneous tone; medium texutre; bare soil;
furrows run parallel with FL.

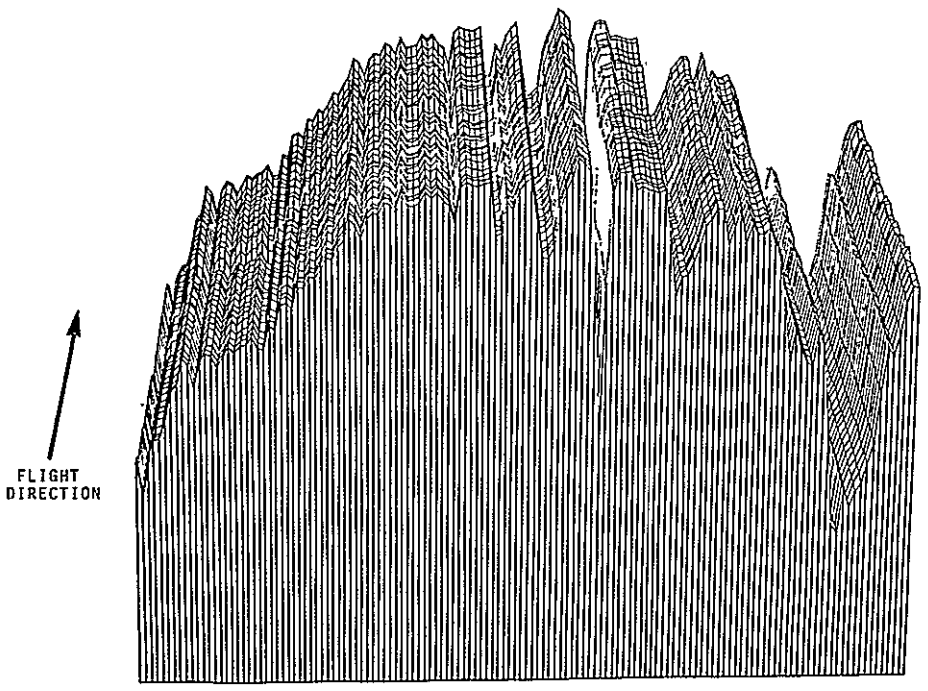
2303



10:15 AM 5/16/75

SUN ELEV. = 67°

2282-2315



HARVESTED SUGAR BEETS

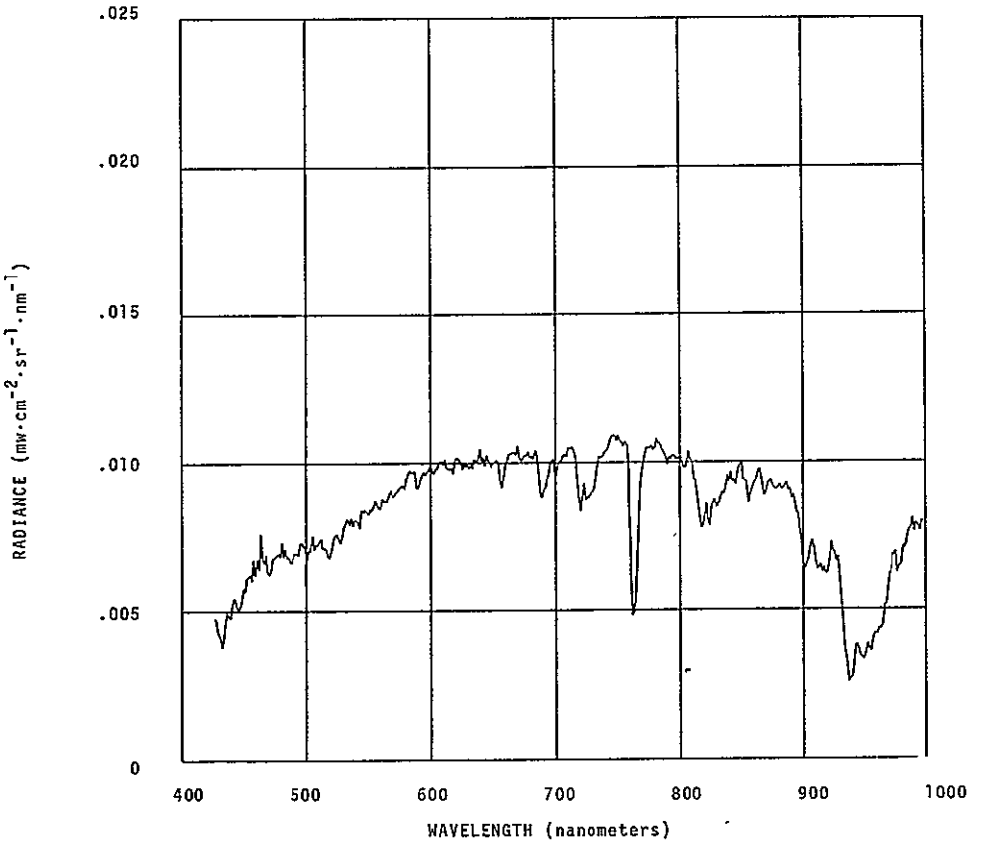
FIELD DESCRIPTION

harvested, 40 to 50% refuse lying on surface.
6 inch clods of soil. Rough surface. Soil dry.
Imperial, light brown silty clay (7.5YR 6/4).

PHOTO INTERPRETATION

homogeneous tone; medium texture; bare soil;
furrows run parallel with FL.

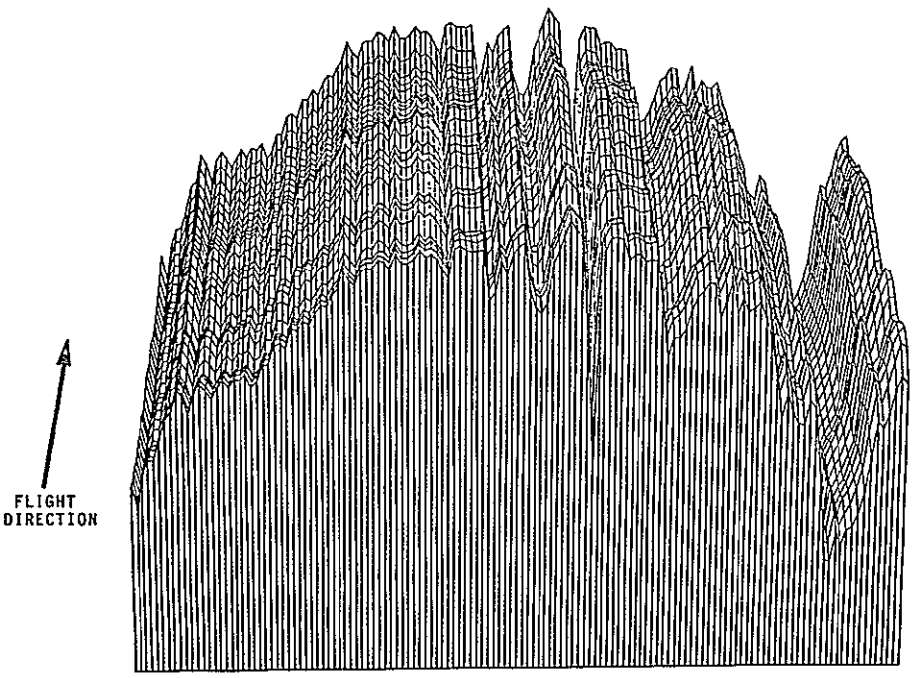
2329



9:54 AM 5/16/75

SUN ELEV = 63°

2316-2344



HARVESTED SUGAR BEETS

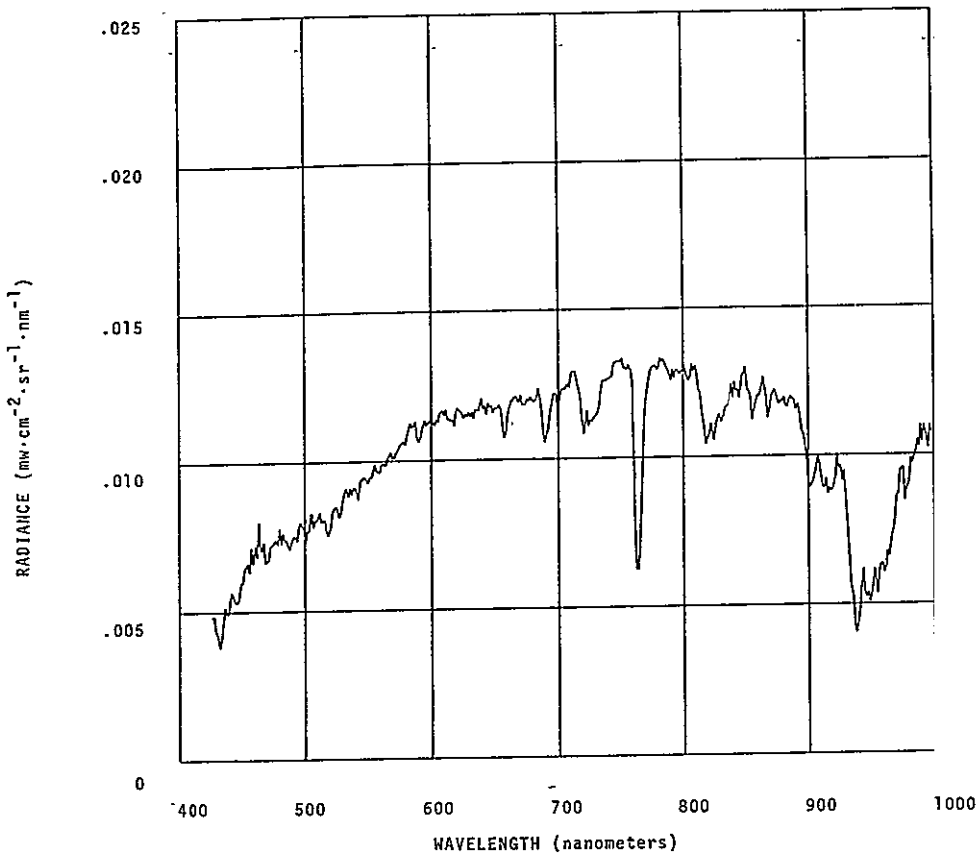
FIELD DESCRIPTION

harvested, 40 to 50% refuse lying on surface. 50 to 60% bare soil. 6 inch clods of soil. Rough surface. Soil dry. Imperial, light brown silty clay (7.5YR 6/4).

PHOTO INTERPRETATION

inhomogeneous tone; medium texture; bare soil; three dark rows running perpendicular to FL may be due to soil moisture; furrows run perpendicular to FL.

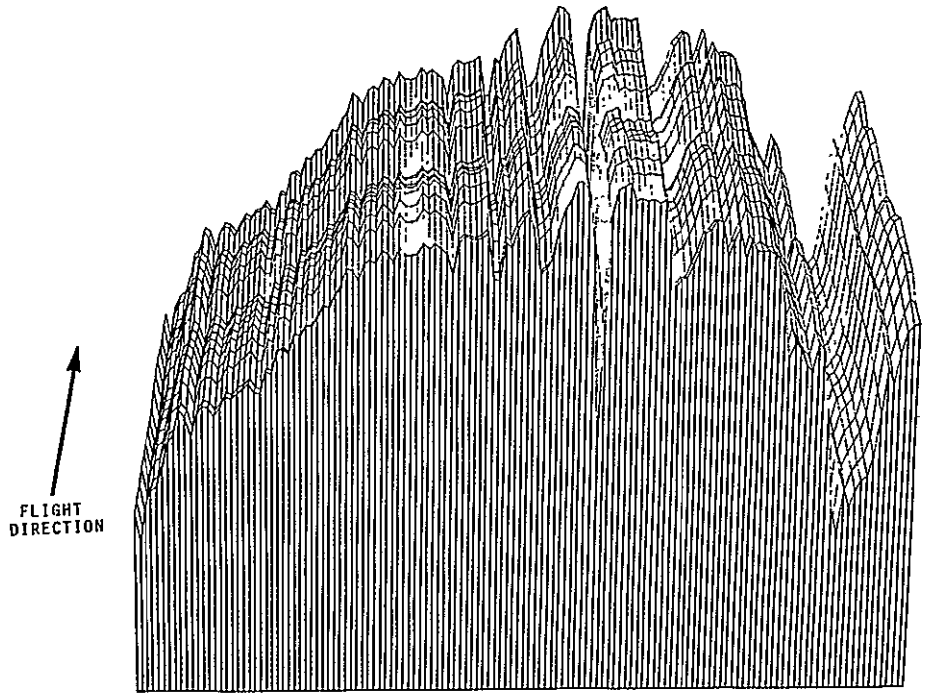
2350



10:24 AM 5/15/75

SUN ELEV = 68°

2345-2360



HARVESTED SUGAR BEETS

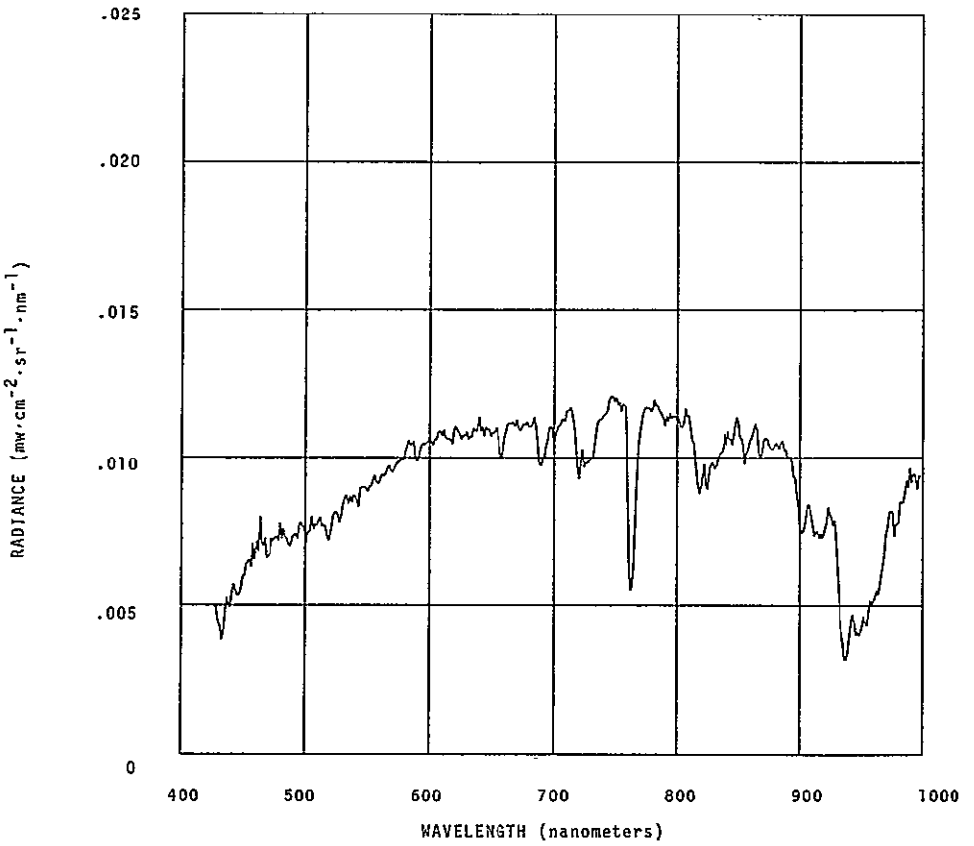
FIELD DESCRIPTION

harvested, 50% refuse lying on surface. 6 inch clods of soil. Surface rough. Soil dry. Imperial, light brown silty clay (7.5YR 6/4)

PHOTO INTERPRETATION

inhomogeneous tone striated parallel with FL, coarse texture; bare soil; furrows run parallel with FL

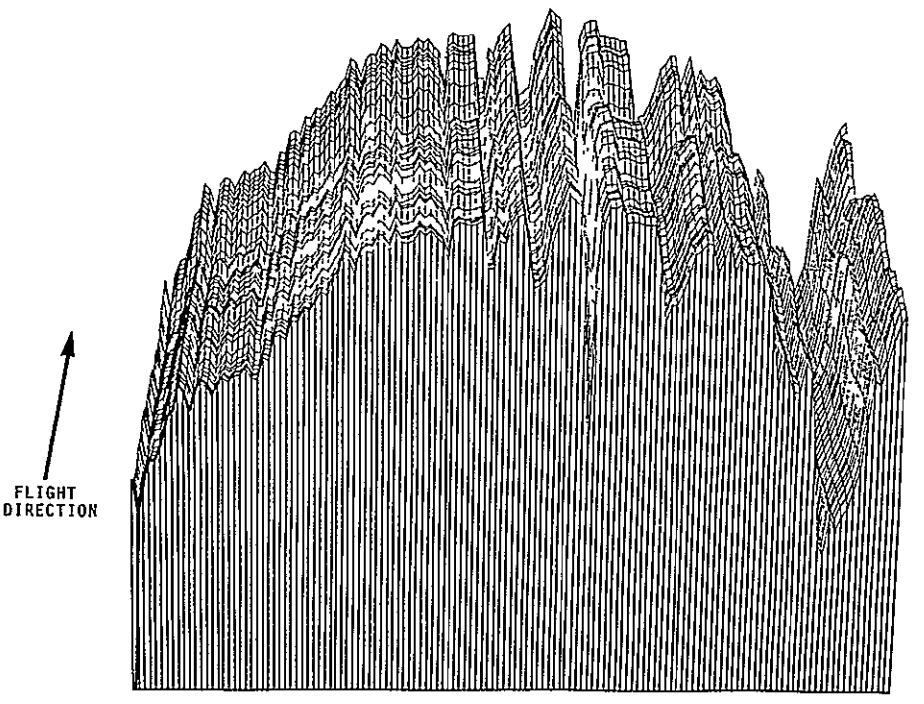
2368



10:15 AM 5/16/75

SUN ELEV = 67°

2361-2406



HARVESTED SUGAR BEETS

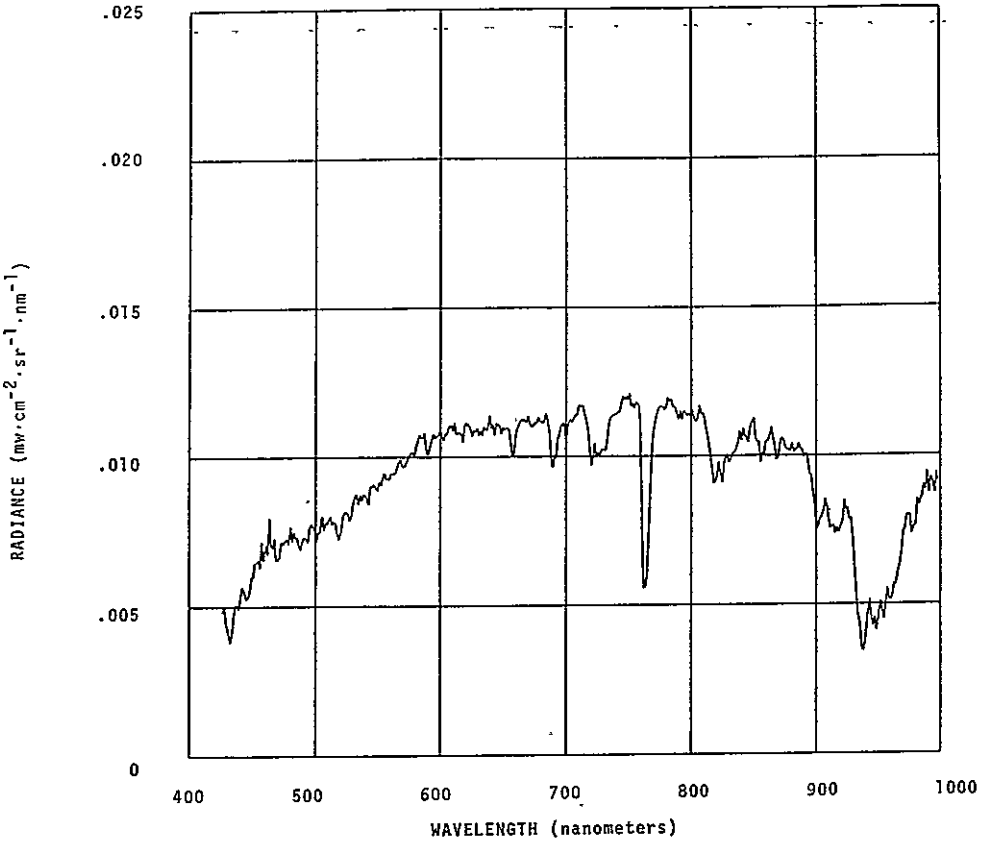
FIELD DESCRIPTION

harvested, 50% bare soil, 50% dead refuse 6 to 8 inch clods of soil Rough surface. Cattle grazing. Soil dry. Imperial, light brown silty clay (7.5YR 6/4).

PHOTO INTERPRETATION

homogeneous tone but furrows are detectable and run perpendicular to FL; fine texture; bare soil; two very dark striations appear to be due to higher moisture content.

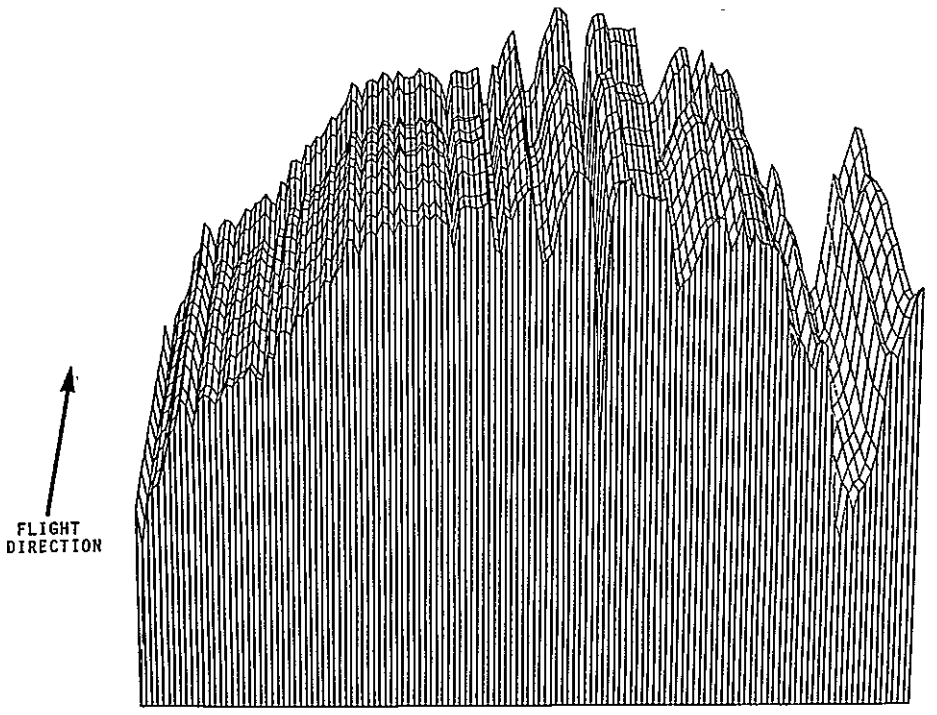
2411



10:10 AM 5/15/75

SUN ELEV = 66°

2407-2418



HARVESTED SUGAR BEETS

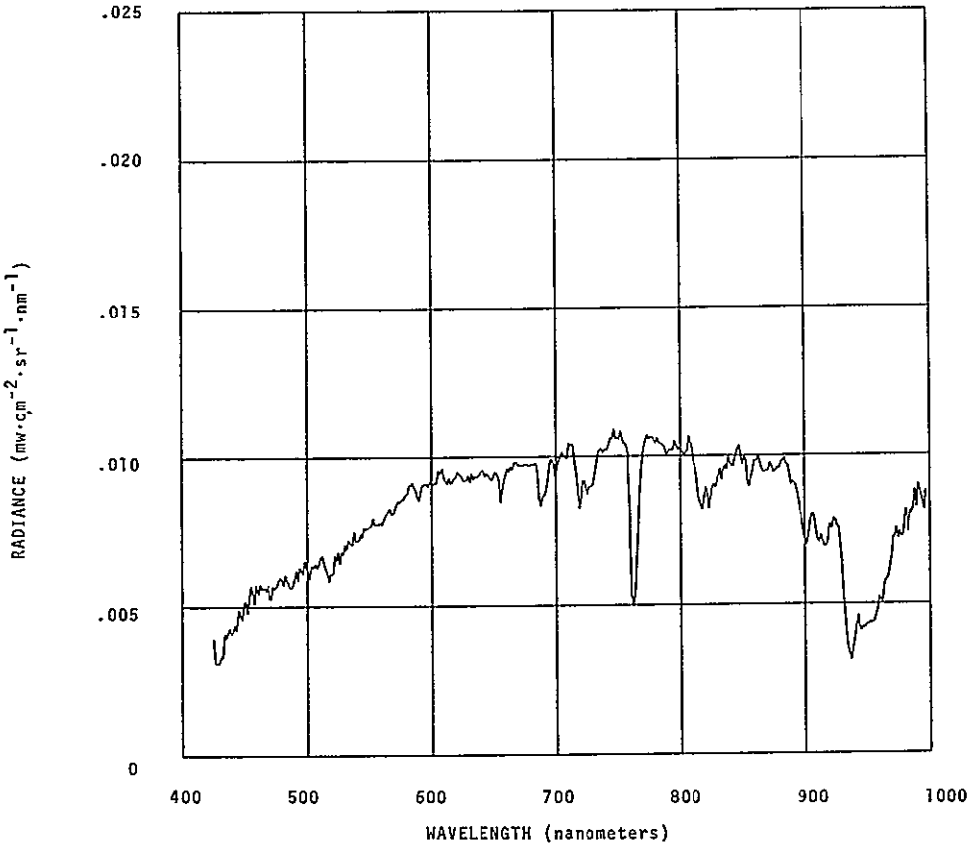
FIELD DESCRIPTION

harvested, 50% bare soil, 50% dead refuse. 6 to 8 inch clods of soil. Rough surface. Cattle grazing. Soil dry. Imperial, light brown silty clay (7.5YR 6/4).

PHOTO INTERPRETATION

inhomogeneous tone, striated perpendicular to FL; medium texture, bare soil; furrows run perpendicular to FL.

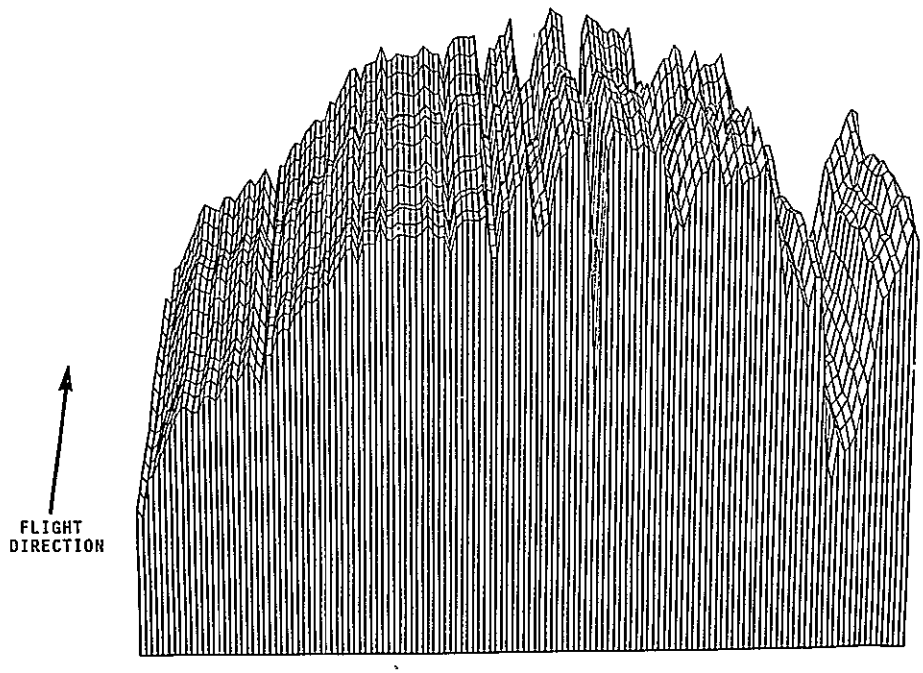
2425



10:04 AM 5/15/75

SUN ELEV = 65°

2419-2432



BOOTED WHEAT

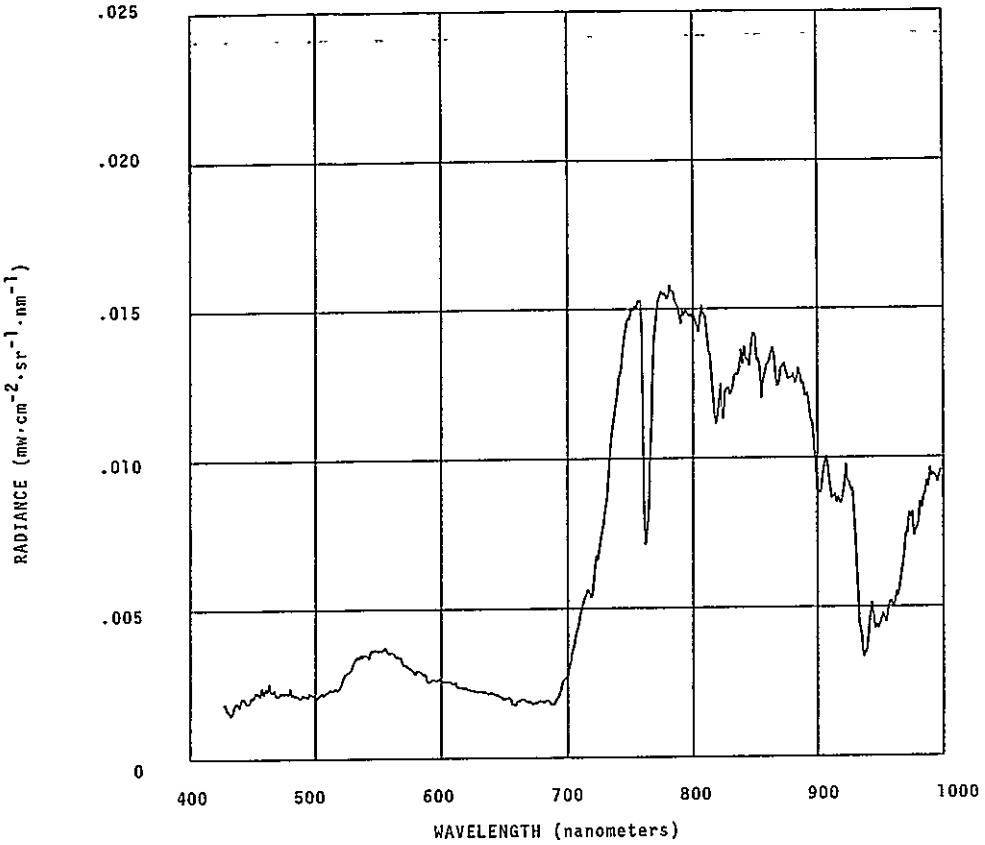
FIELD DESCRIPTION

12 inches high, 70 to 80% leaf cover, moderately thick uniform canopy. No heads. Soil dry. Imperial, light brown silty clay (7.5YR 6/4).

PHOTO INTERPRETATION

homogeneous tone except furrows are detectable; fine texture; high density; total cover; furrows run parallel with FL.

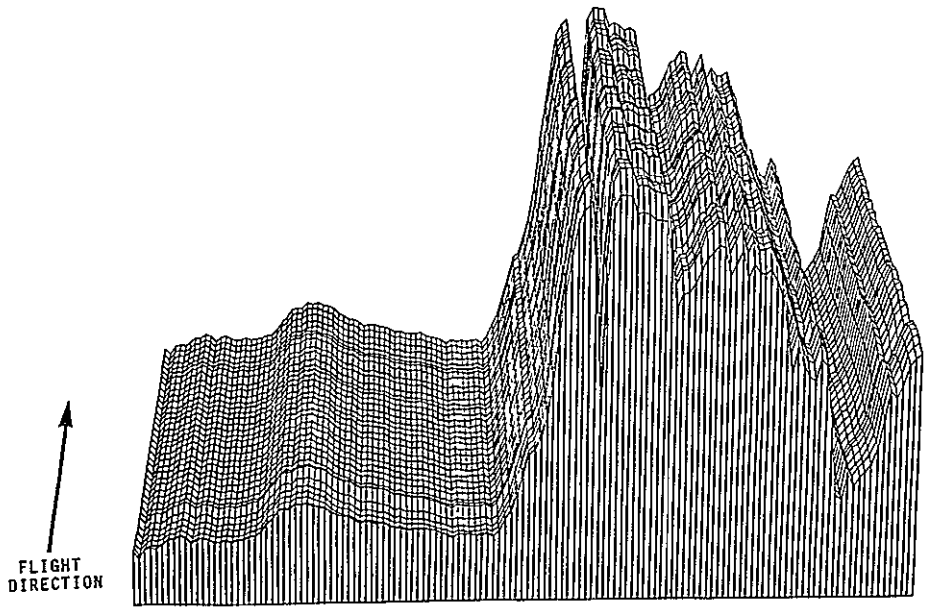
2451



10:03 AM 5/16/75

SUN ELEV = 65°

2433-2468



BOOTED WHEAT

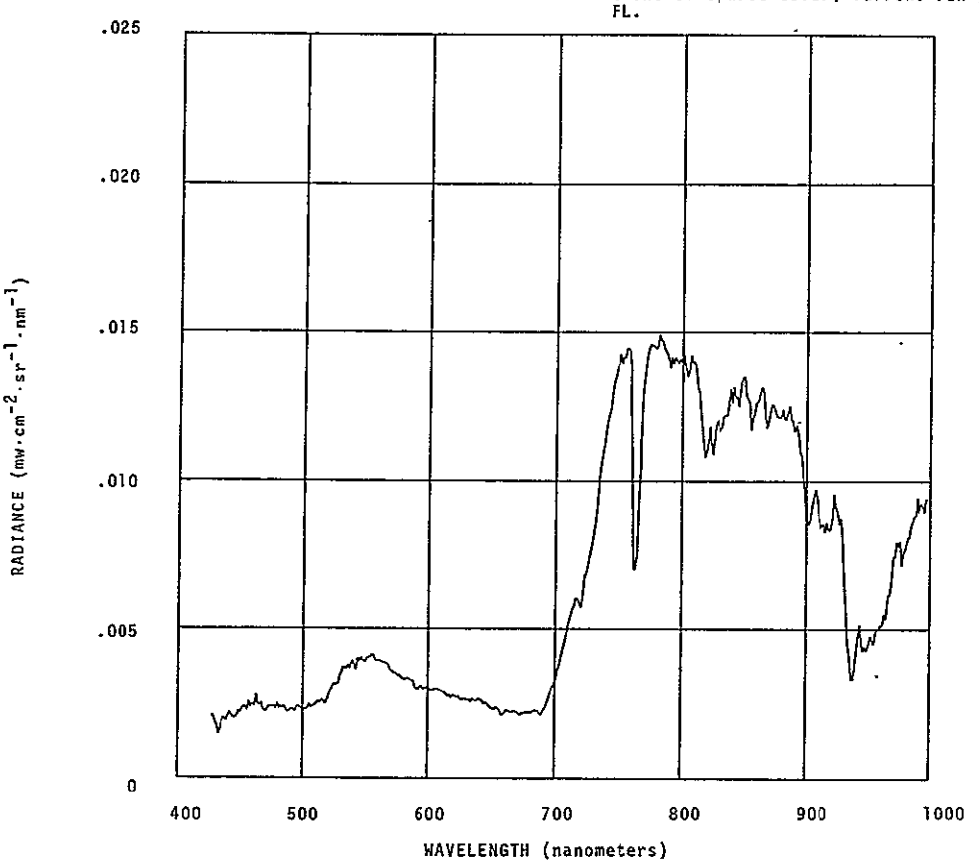
FIELD DESCRIPTION

12 to 14 inches high, 80 to 100% leaf cover, moderately thick patchy canopy. Heads not emerged, crop green. Soil wet. Imperial, silty clay.

PHOTO INTERPRETATION

inhomogeneous tone; texture is differential ranging from medium to coarse; density is differential ranging from medium to low; crop cover is in a diagonal pattern, probably caused by subsurface drainage pipes producing striations of sparse cover; furrows run parallel with FL.

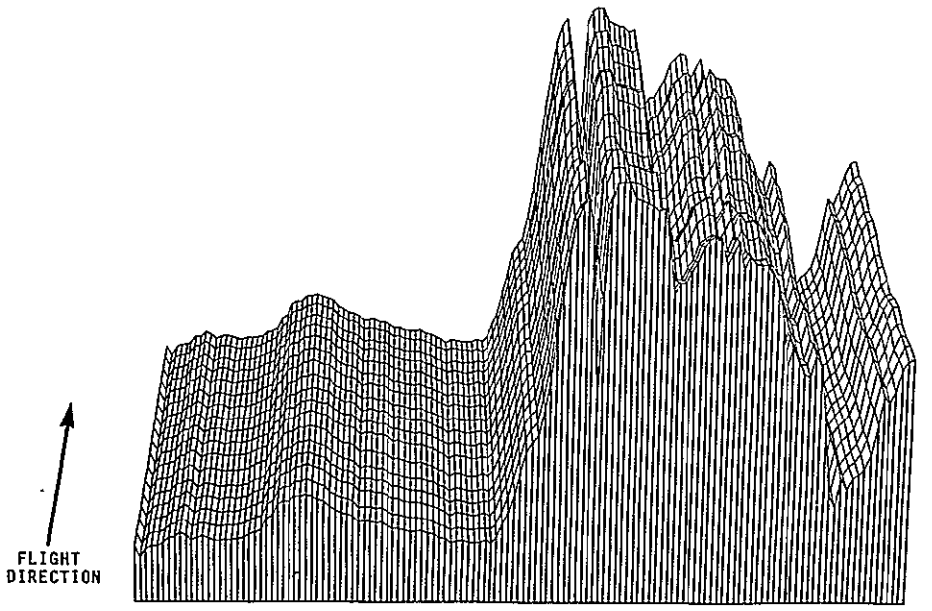
2470



10:34 AM 5/16/75

SUN ELEV = 70°

2469-2485



BOOTED WHEAT

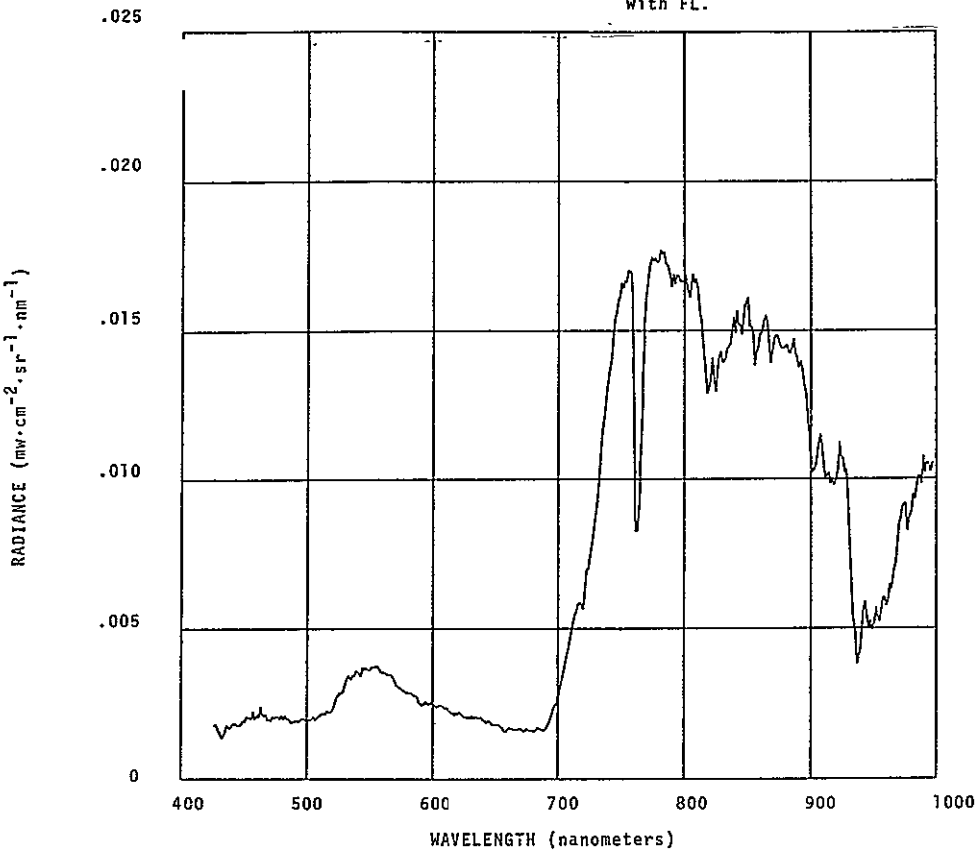
FIELD DESCRIPTION

12 to 14 inches high, 80 to 100% leaf cover, moderately thick patchy canopy. Heads not emerged, crop green. Soil wet. Imperial, silty clay.

PHOTO INTERPRETATION

Inhomogeneous tone; texture is differential ranging from medium to coarse; density is differential ranging from medium to low; crop cover is in a diagonal pattern, probalby caused by subsurface drainage pipes producing striations of sparse cover; furrows run parallel with FL.

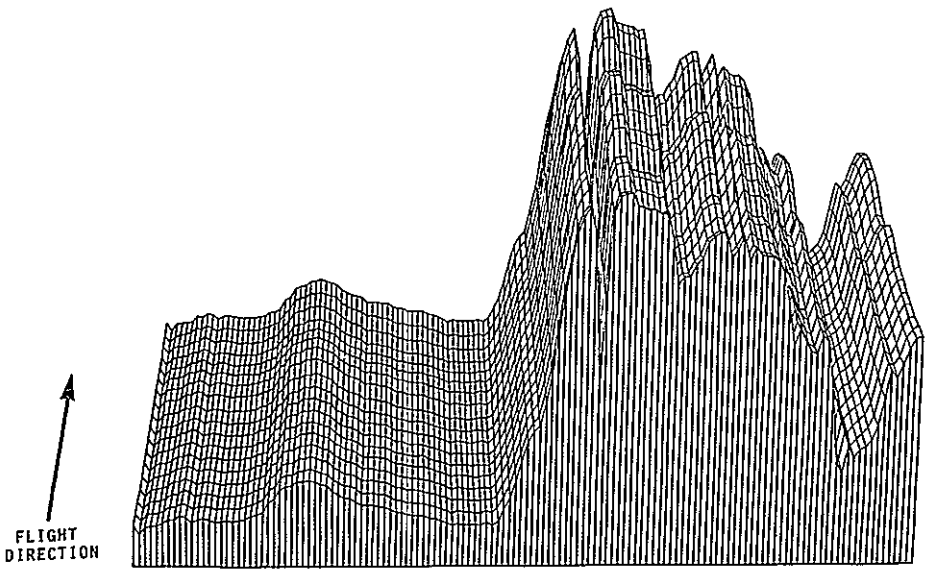
2492



10-34 AM 5/16/75

SUN ELEV = 70°

2486-2503



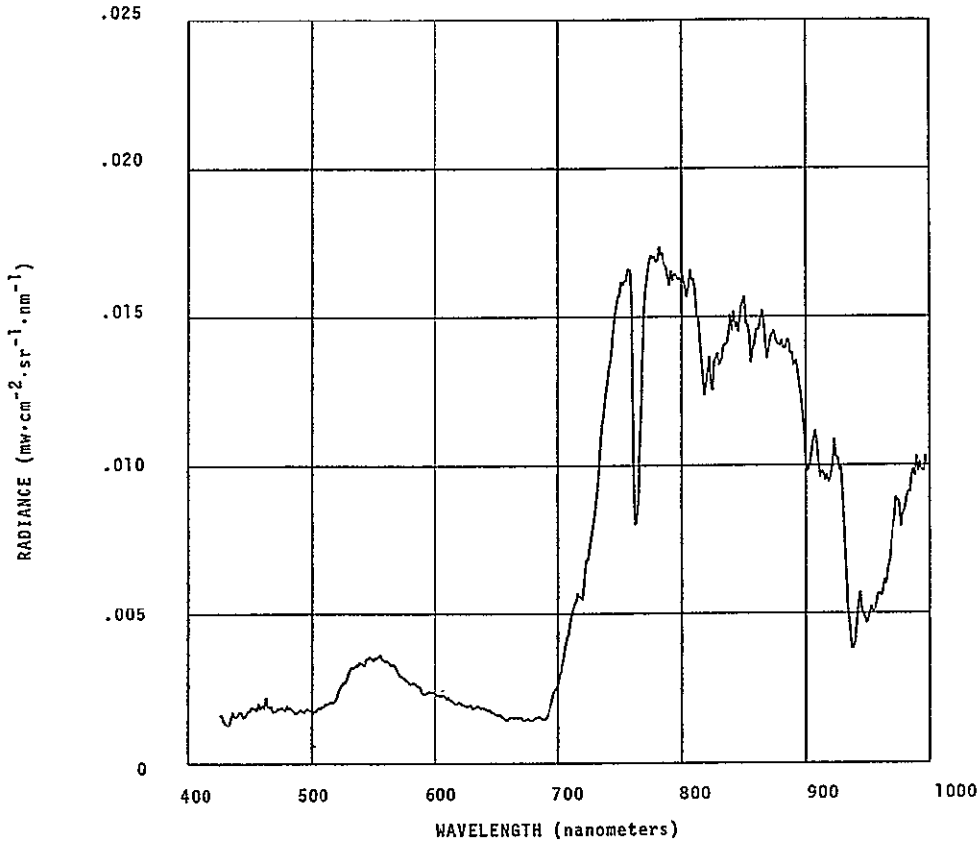
BOOTED WHEAT

FIELD DESCRIPTION

24 inches high, 100% leaf cover, thick uniform canopy. Heads not emerged, crop green. Soil wet. Imperial, silty clay.

PHOTO INTERPRETATION

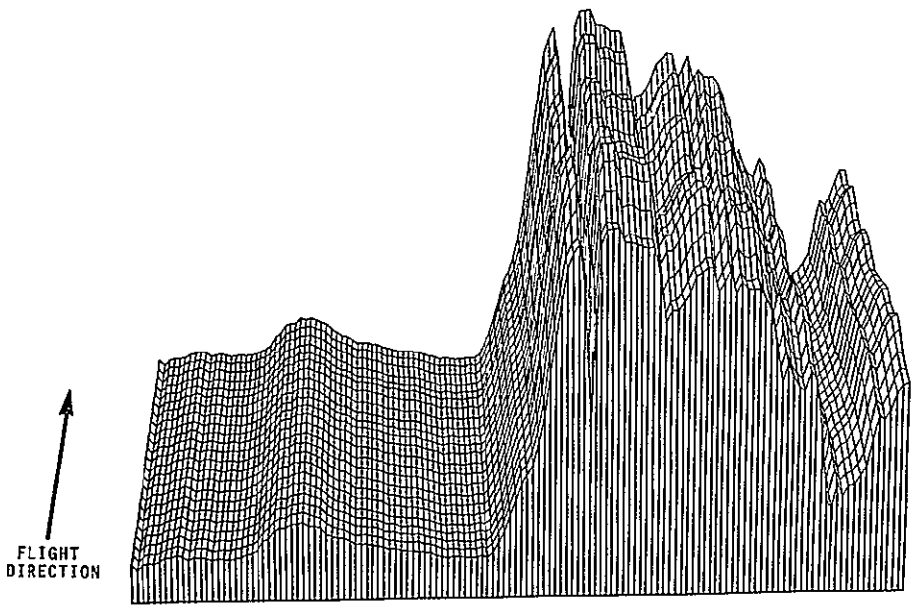
homogeneous with a slight detection of furrows; fine texture; high density; total cover; furrows run parallel with FL.



2525

10:20 AM 5/16/75

SUN ELEV = 68°



2504-2526

HEADED WHEAT

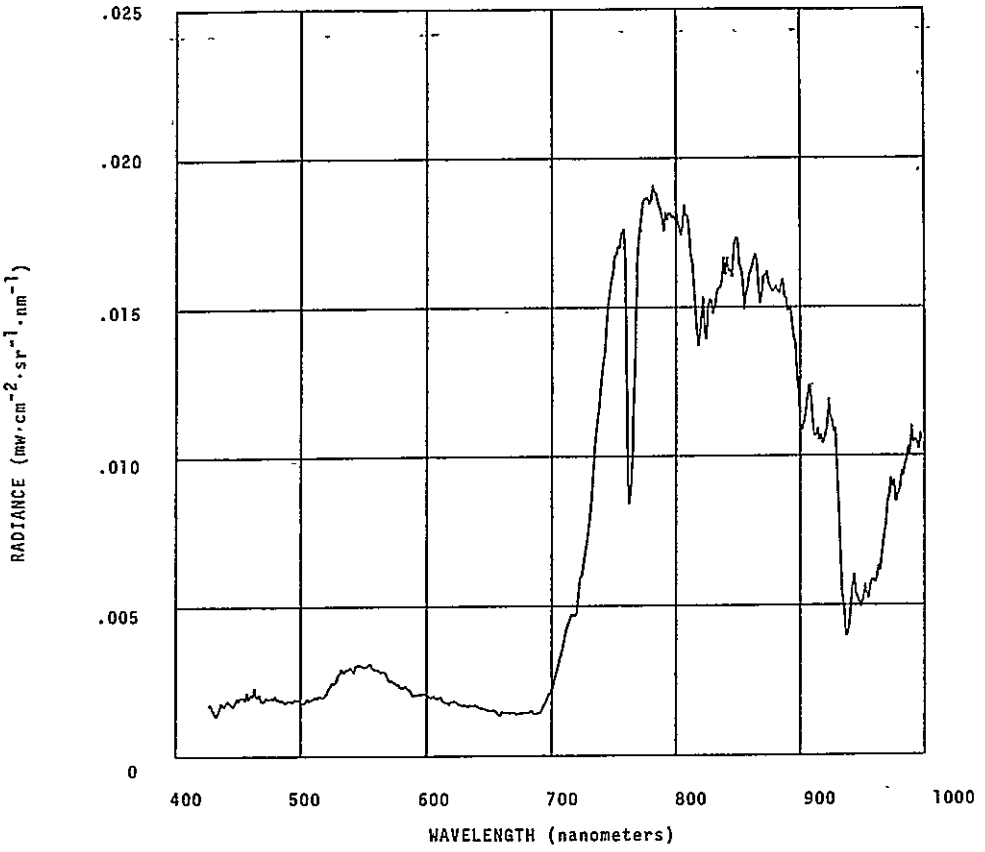
FIELD DESCRIPTION

24 inches high, 100% leaf cover, thick uniform canopy. Heads 90% emerged and deep green. Soil dry. Imperial, light brown silty clay (7.5YR 6/4).

PHOTO INTERPRETATION

homogeneous tone; no texture; high density; total cover.

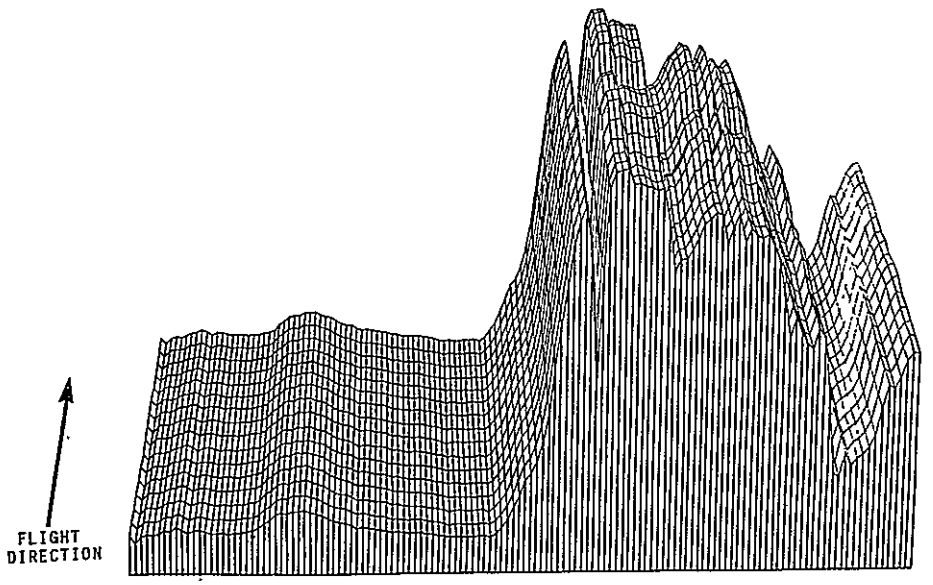
2531



10:08 AM 5/16/75

SUN ELEV = 66°

2527-2542



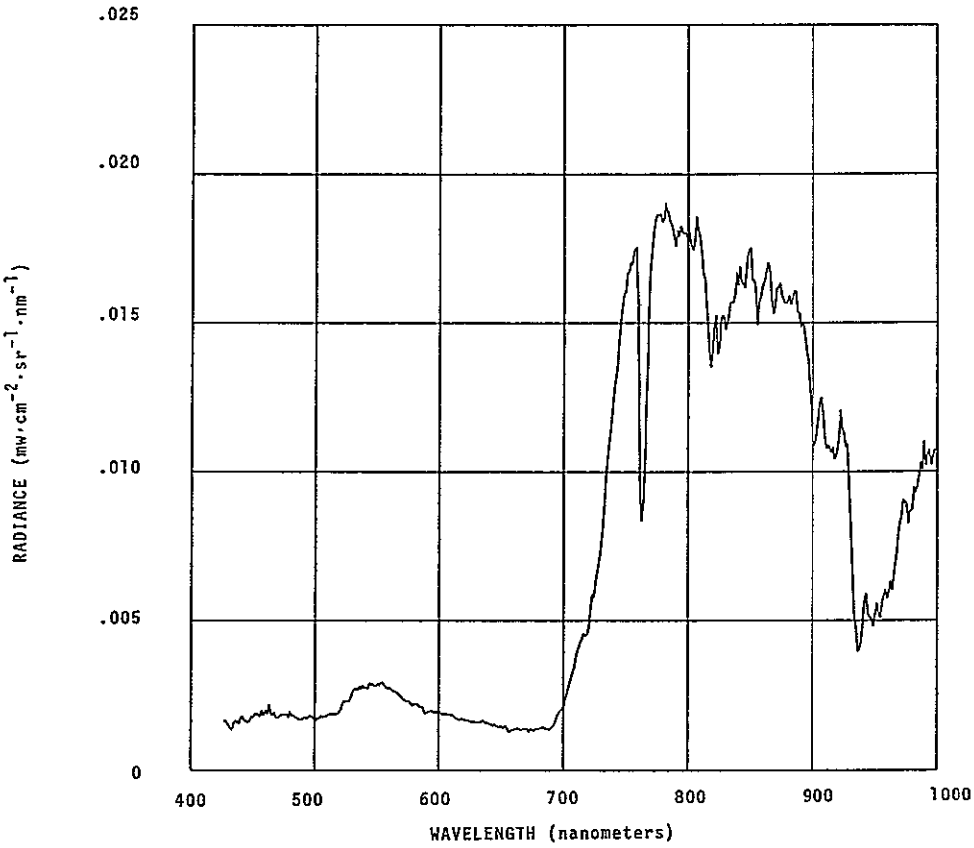
HEADED WHEAT

FIELD DESCRIPTION

24 inches high, 100% leaf cover, thick uniform canopy. Heads 90% emerged and deep green. Soil dry. Imperial, light brown silty clay (7.5YR 6/4).

PHOTO INTERPRETATION

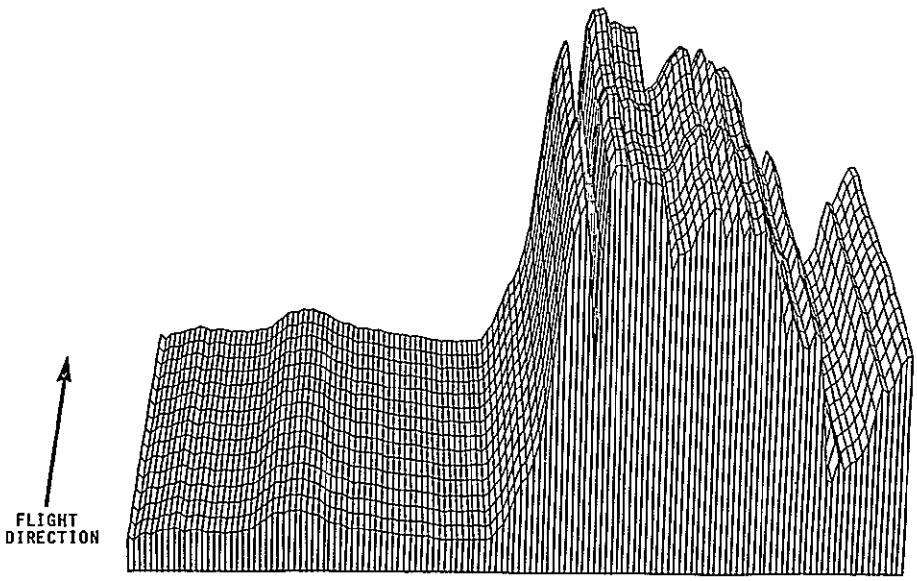
homogeneous tone except furrows are slightly detectable; no texture; total cover; furrows run parallel with FL.



2546

10:03 AM 5/16/75

SUN ELEV = 65°



2543-2557

HEADED WHEAT

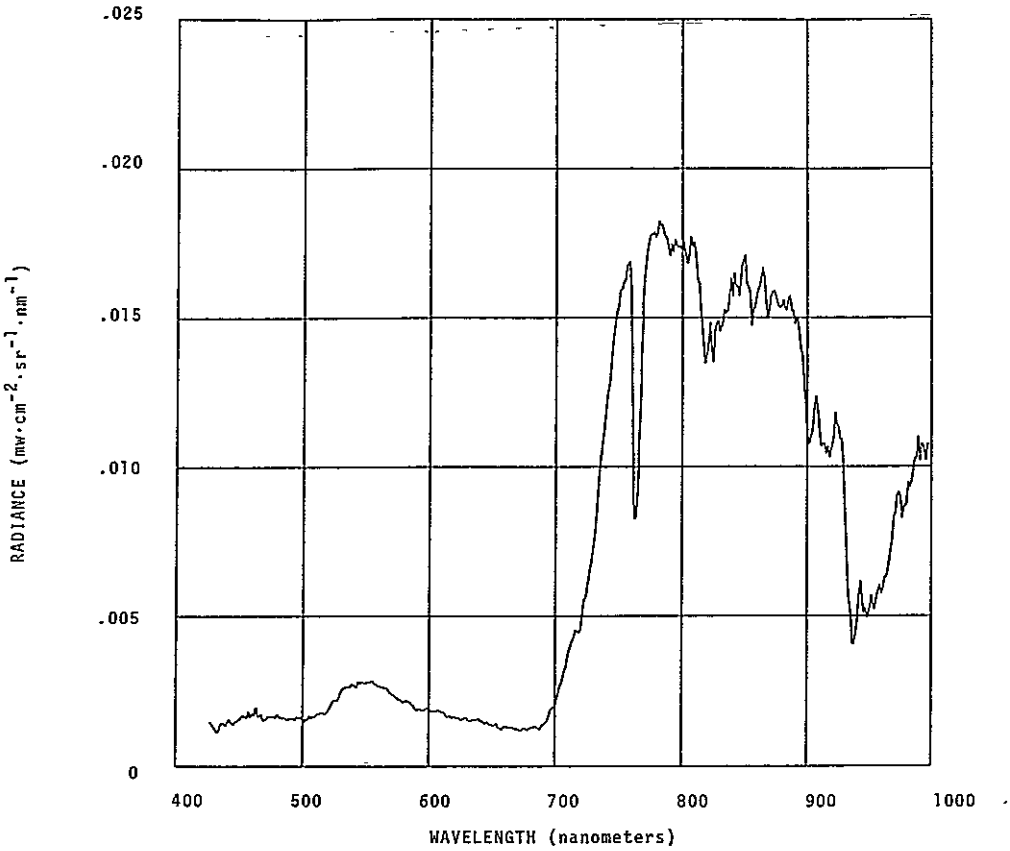
FIELD DESCRIPTION

30 to 36 inches high, 100% leaf cover, thick uniform canopy. Heads fully emerged and green. Soil moist to dry. Imperial, silty clay.

PHOTO INTERPRETATION

homogeneous tone, no texture; high density; total cover.

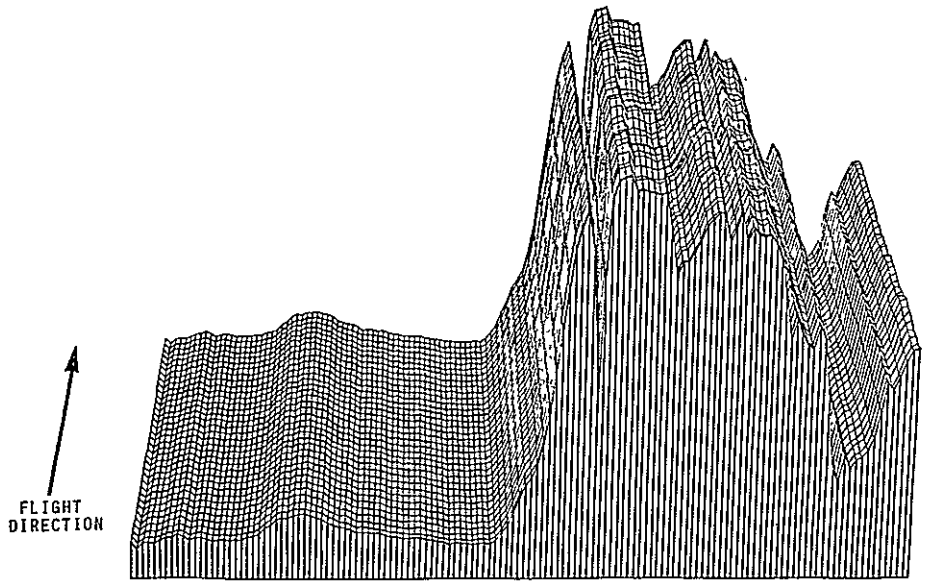
2573



10:15 AM 5/16/75

SUN ELEV = 67°

2558-2592



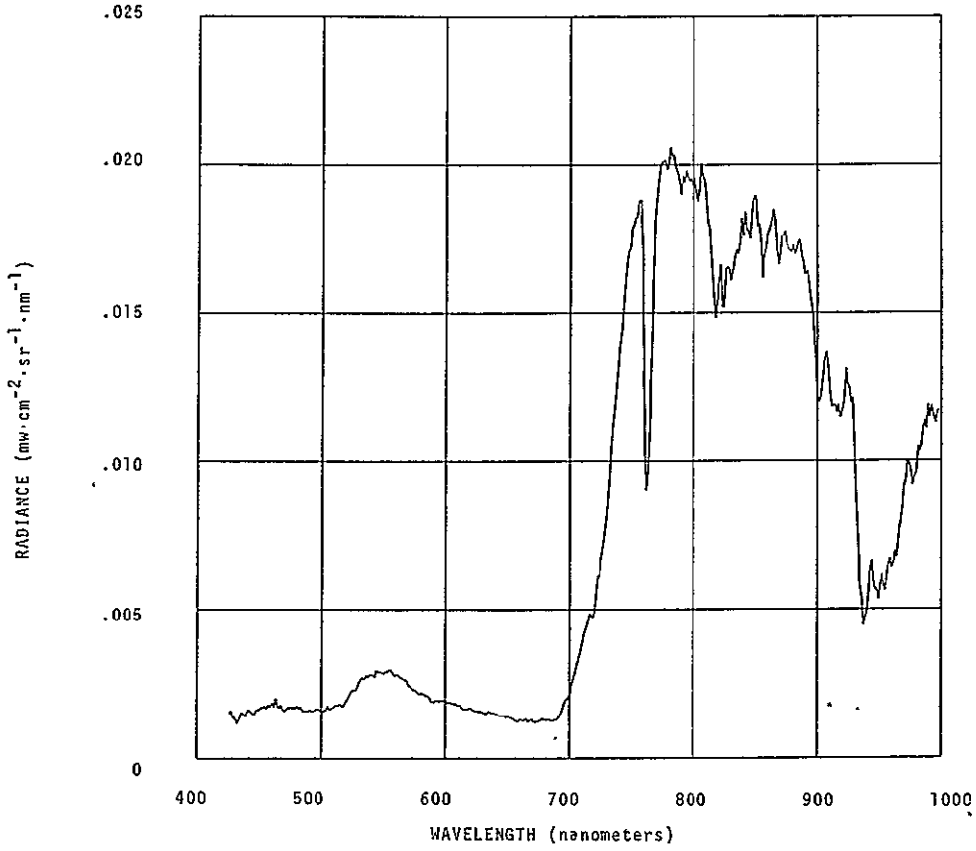
HEADED WHEAT

FIELD DESCRIPTION

36 inches high, 100% leaf cover, thick uniform canopy. Heads fully emerged and deep green. Soil wet Imperial, silty clay.

PHOTO INTERPRETATION

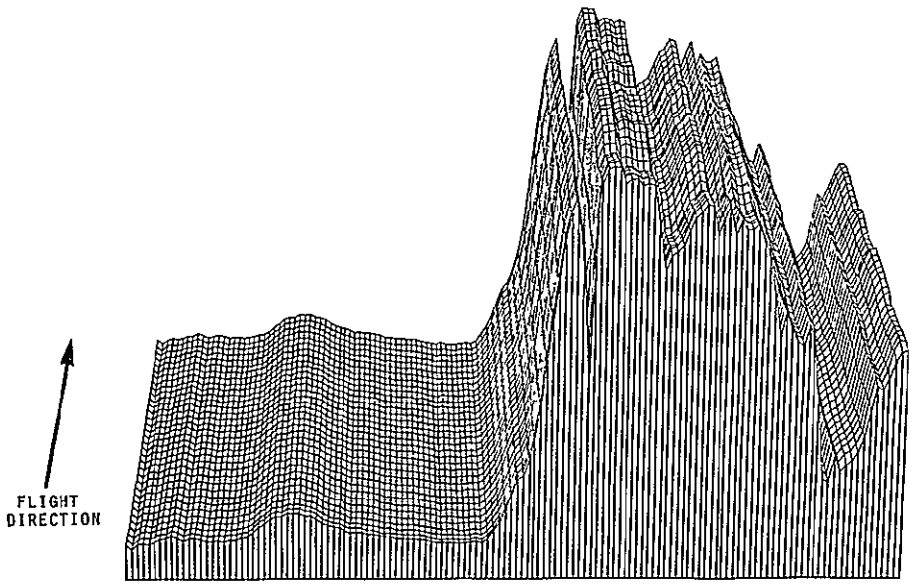
homogeneous tone; no texture; high density; total cover; uniformly unripe.



2623

10:03 AM 5/16/75

SUN ELEV = 65°



2593-2626

HEADED WHEAT

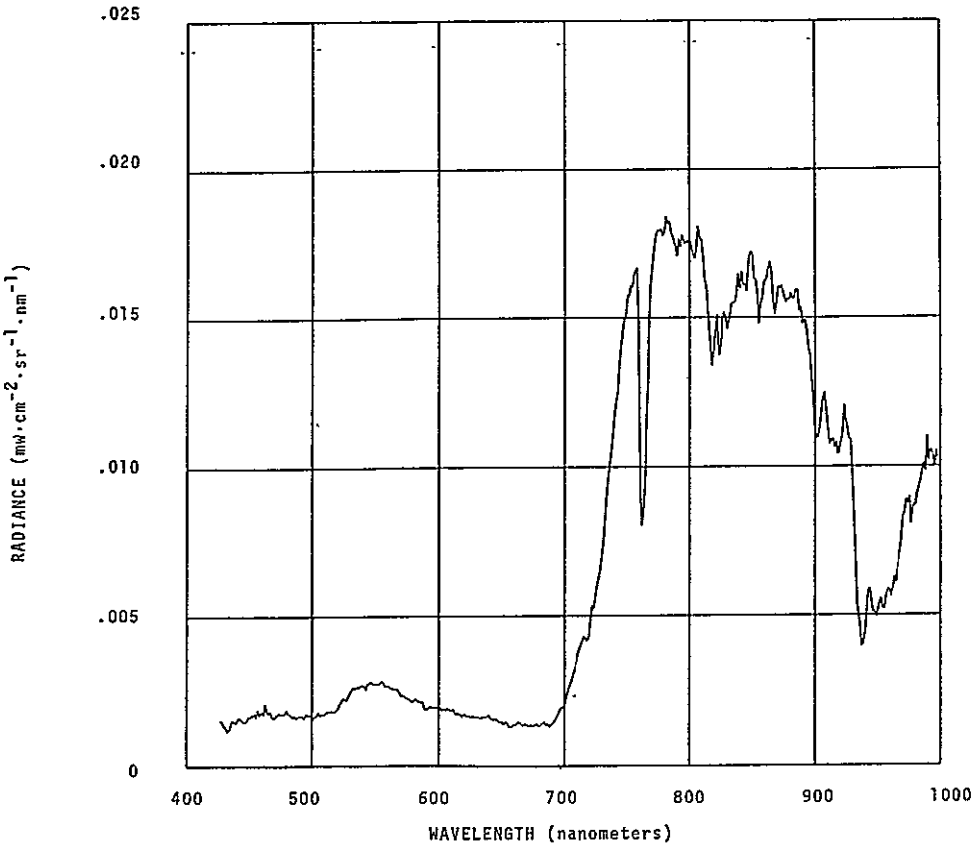
FIELD DESCRIPTION

36 to 40 inches high, 100% leaf cover (3 to 4% weeds), thick uniform canopy. Heads fully emerged and deep green. Soil wet. Imperial, silty clay.

PHOTO INTERPRETATION

homogeneous tone; no texture; high density; total cover.

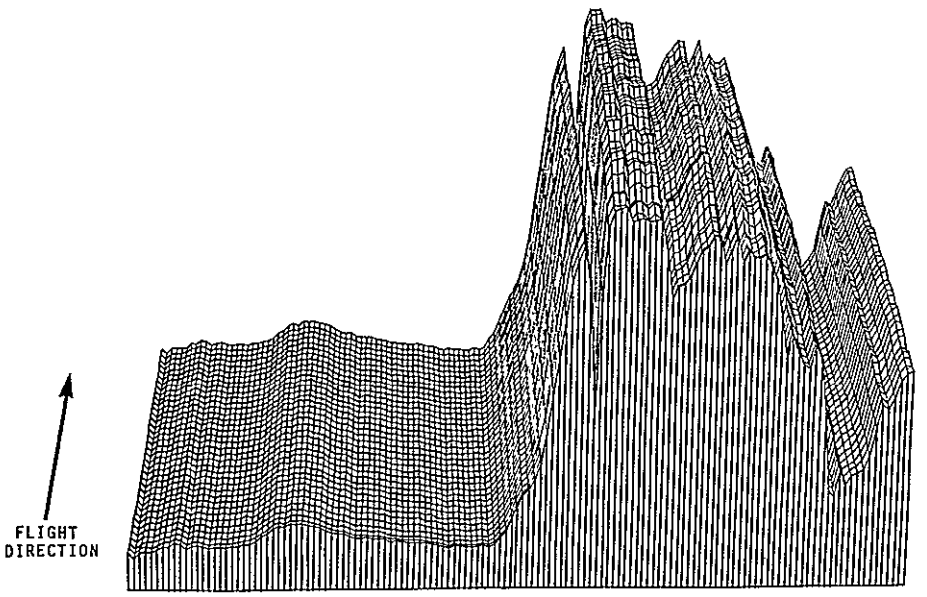
2639



10:08 AM 5/16/75

SUN ELEV = 66°

2627-2663



HEADED WHEAT

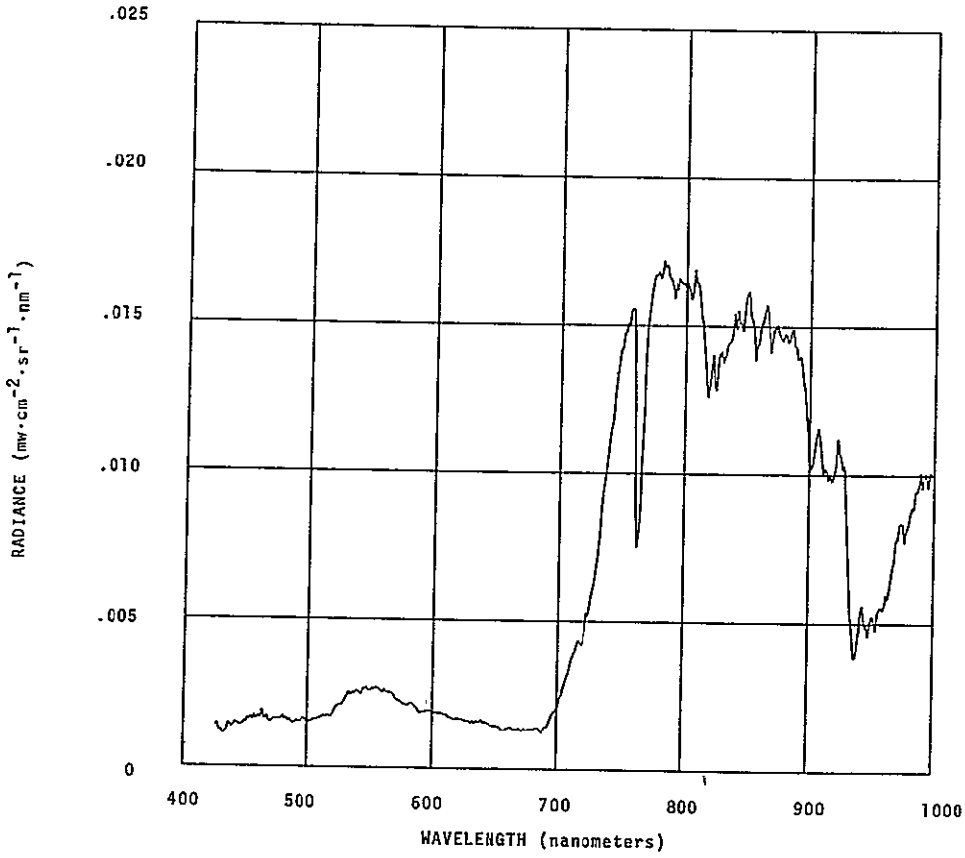
FIELD DESCRIPTION

36 to 40 inches high, 100% leaf cover, thick uniform canopy. Heads fully emerged and green. Soil dry. Imperial, light brown silty clay (7.5YR 6/4).

PHOTO INTERPRETATION

homogeneous tone; no texture; high density; total cover.

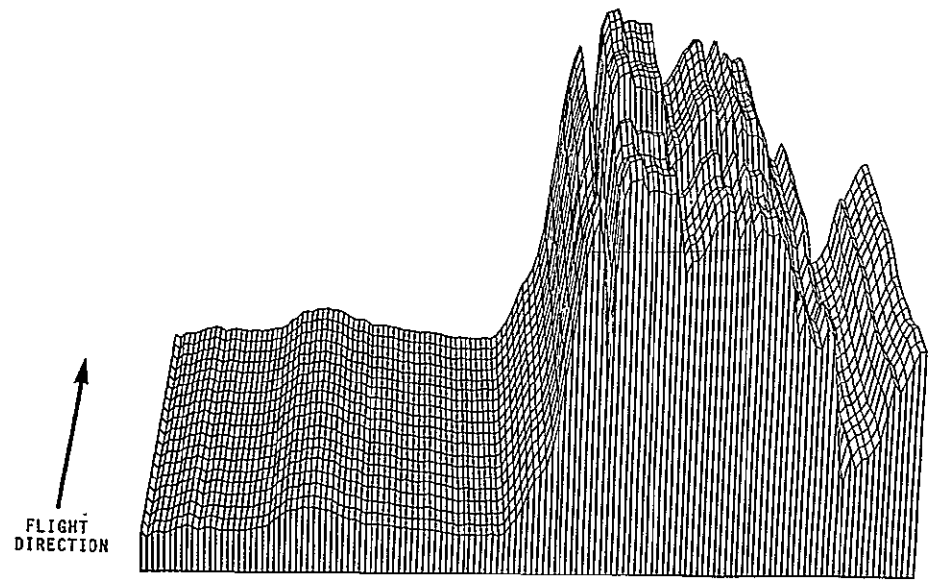
2678



10:20 AM 5/16/75

SUN ELEV = 68°

2664-2678



HEADED WHEAT

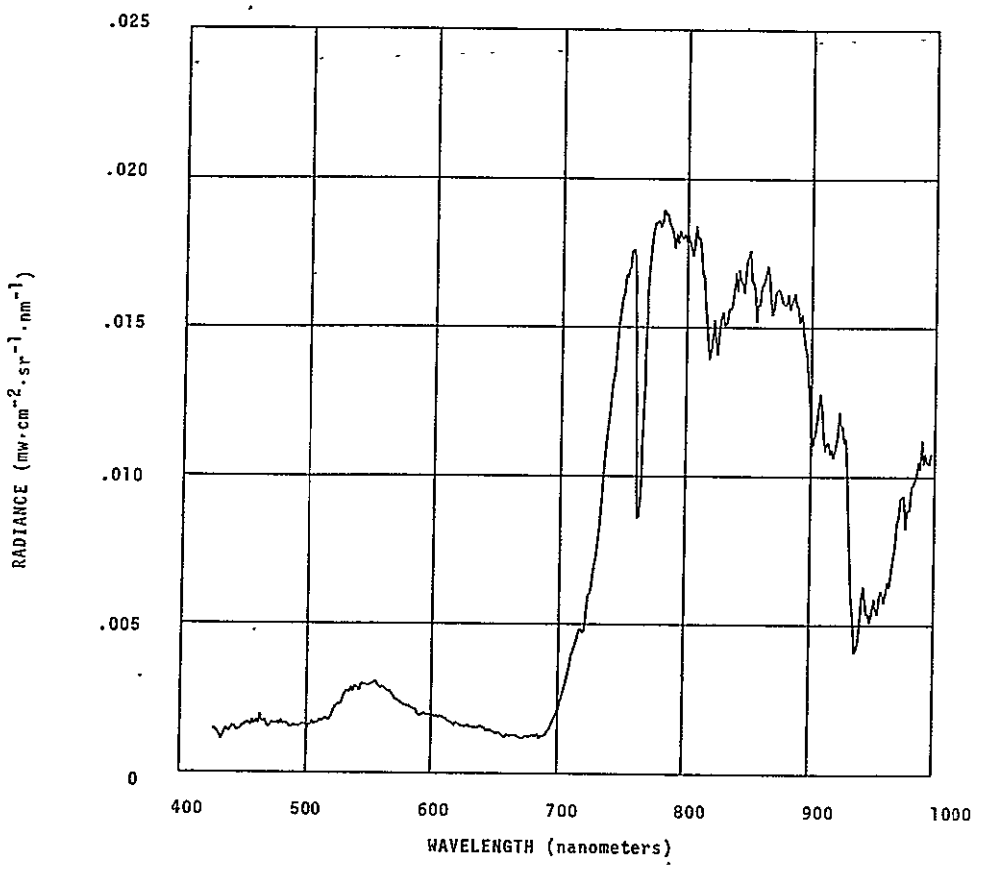
FIELD DESCRIPTION

36 to 40 inches high, 100% leaf cover, thick uniform canopy. Heads fully emerged and deep green. Soil dry. Imperial, light brown silty clay (7.5YR 6/4).

PHOTO INTERPRETATION

homogeneous tone; no texture; high density; total cover. *

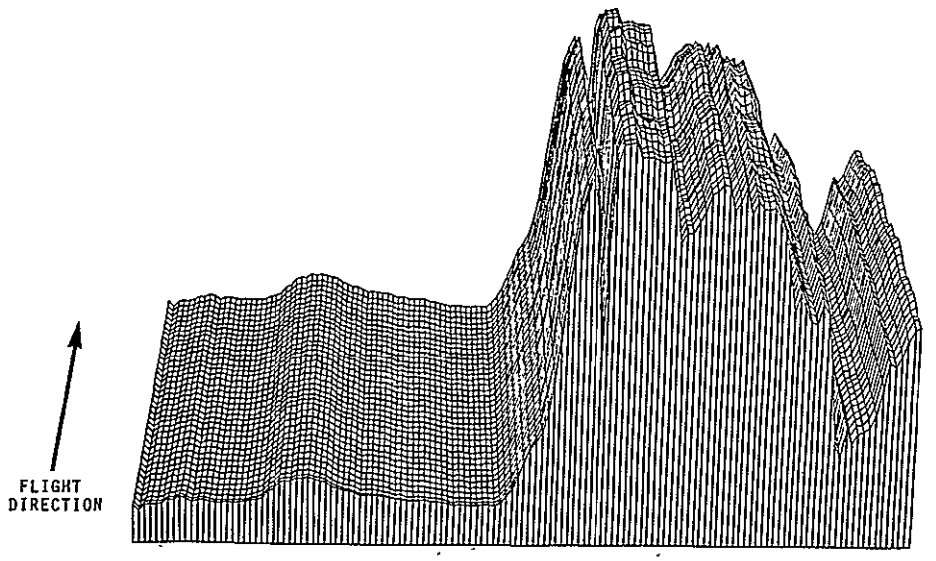
2699



10:15 AM 5/16/75

SUN ELEV = 67°

2679-2717



HEADED WHEAT

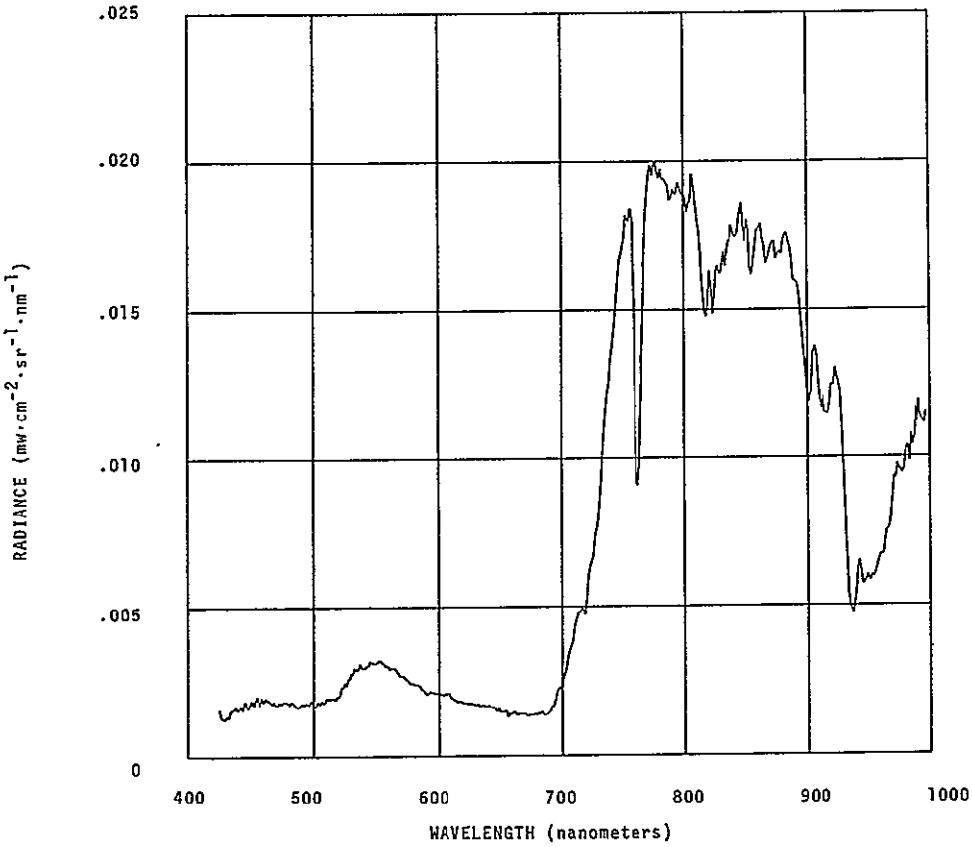
FIELD DESCRIPTION

36 to 40 inches high, 100% leaf cover, thick uniform canopy. Heads fully emerged and deep green. Soil dry. Imperial, light brown silty clay (7.5YR 6/4).

PHOTO INTERPRETATION

homogeneous tone; no texture; high density; total cover.

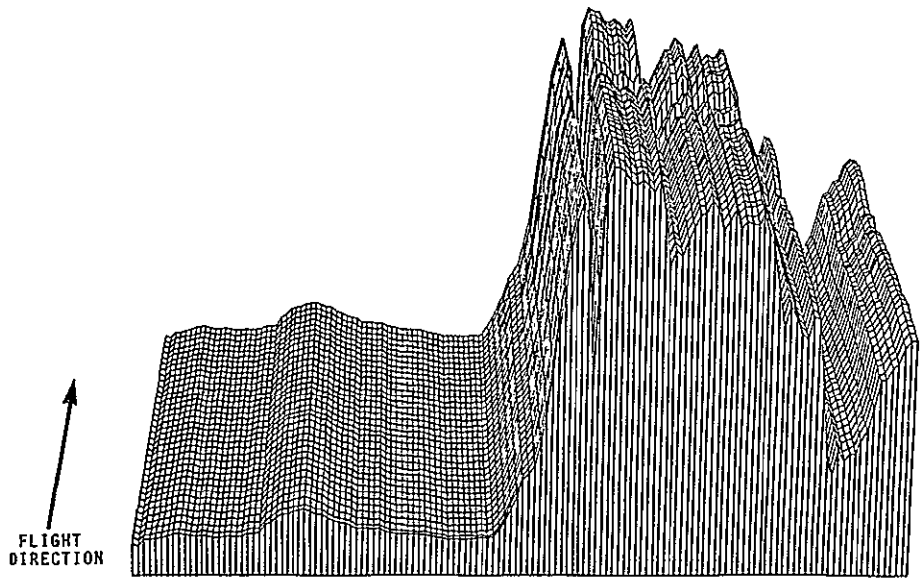
2737



11:03 AM 5/16/75

SUN ELEV = 74°

2718-2753



HEADED WHEAT

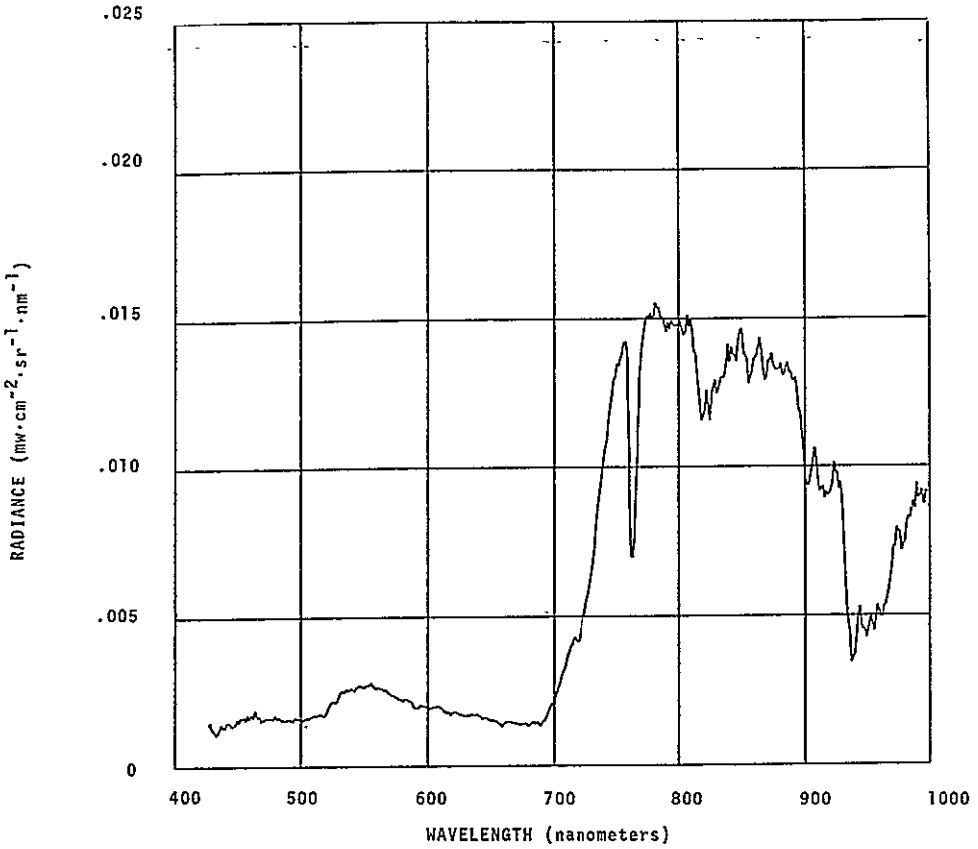
F I E L D D E S C R I P T I O N

36 to 40 inches high, 100% leaf cover, thick uniform canopy. Heads fully emerged and green. Soil wet. Imperial, silty clay.

P H O T O I N T E R P R E T A T I O N

homogeneous tone; no texture; high density; total cover.

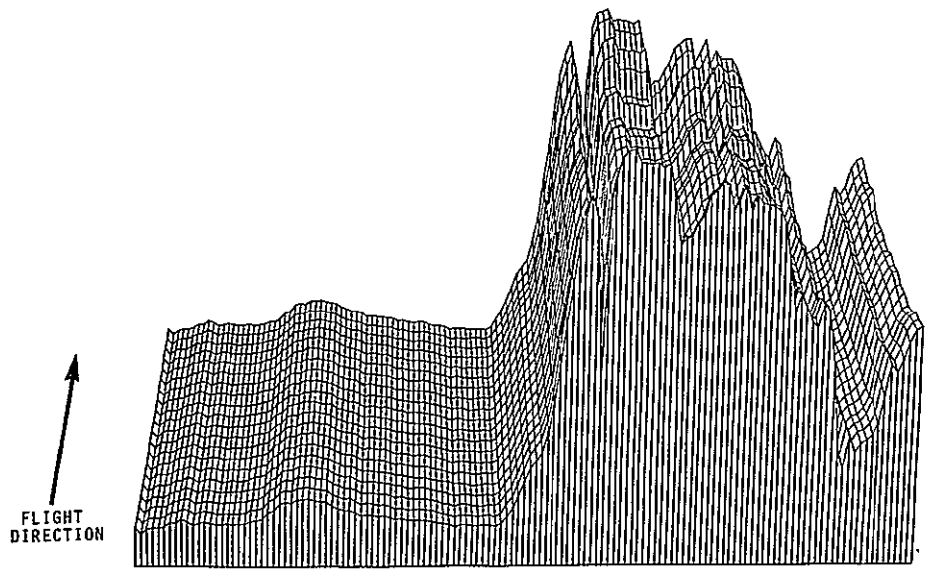
2760



10:27 AM 5/16/75

SUN ELEV = 69°

2754-2773



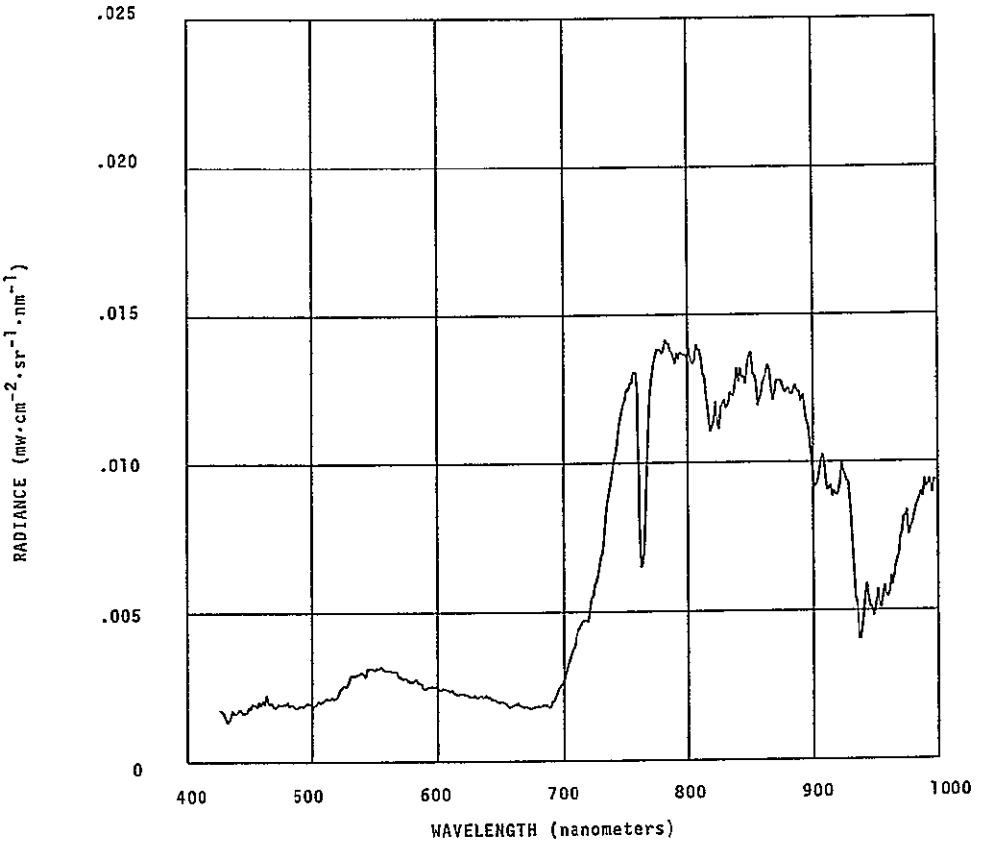
HEADED WHEAT

FIELD DESCRIPTION

40 inches high, 100% leaf cover, thick uniform canopy. Heads fully emerged and green, stalks green. Soil very wet (muddy). Imperial, silty clay.

PHOTO INTERPRETATION

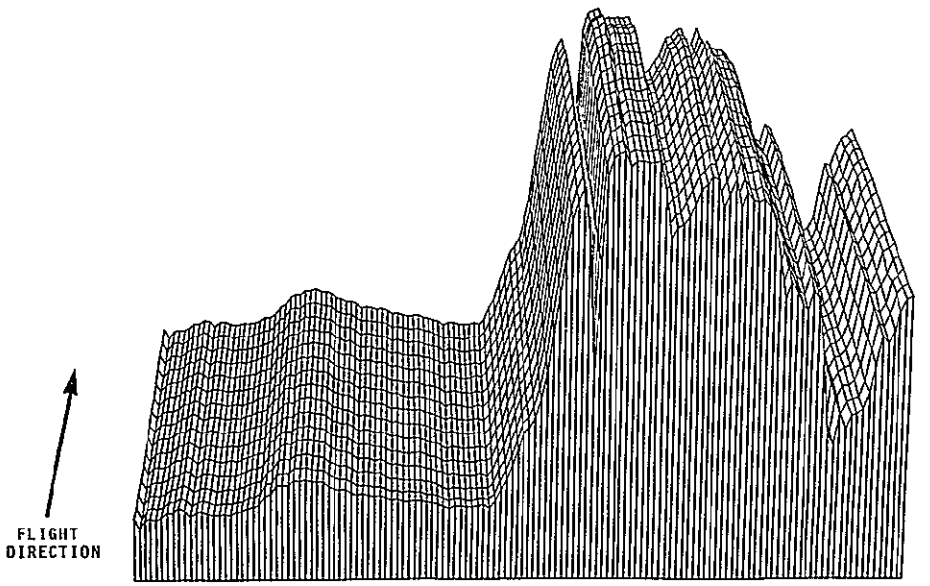
homogeneous tone except furrows are slightly detectable; texture is absent or fine; high density; total cover; furrows run parallel to FL.



2780

9:58 AM 5/15/75

SUN ELEV = 63°



2774-2788

RIPENING WHEAT

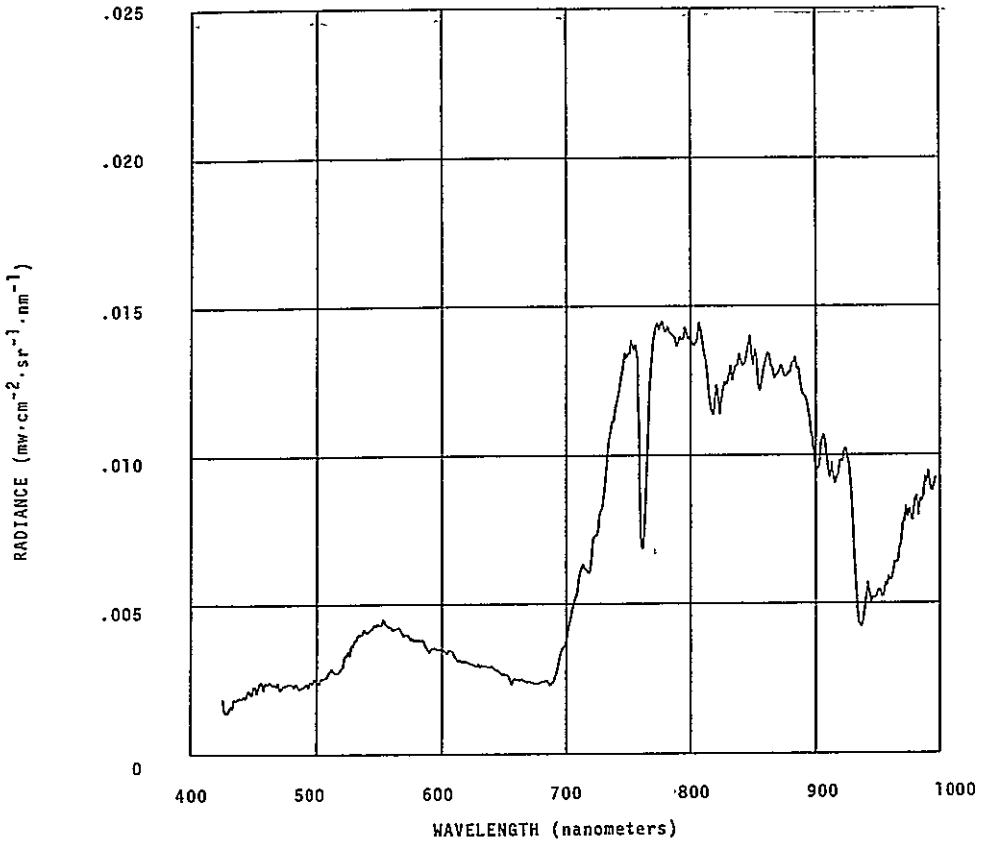
FIELD DESCRIPTION

26 to 30 inches high, 100% leaf cover, thick uniform canopy. Heads fully emerged and turning green-yellow. Soil dry. Imperial, light brown silty clay (7.5YR 6/4).

PHOTO INTERPRETATION

inhomogeneous tone; texture is absent or fine; high density; total cover; nonuniform differential ripening; furrows run perpendicular to FL.

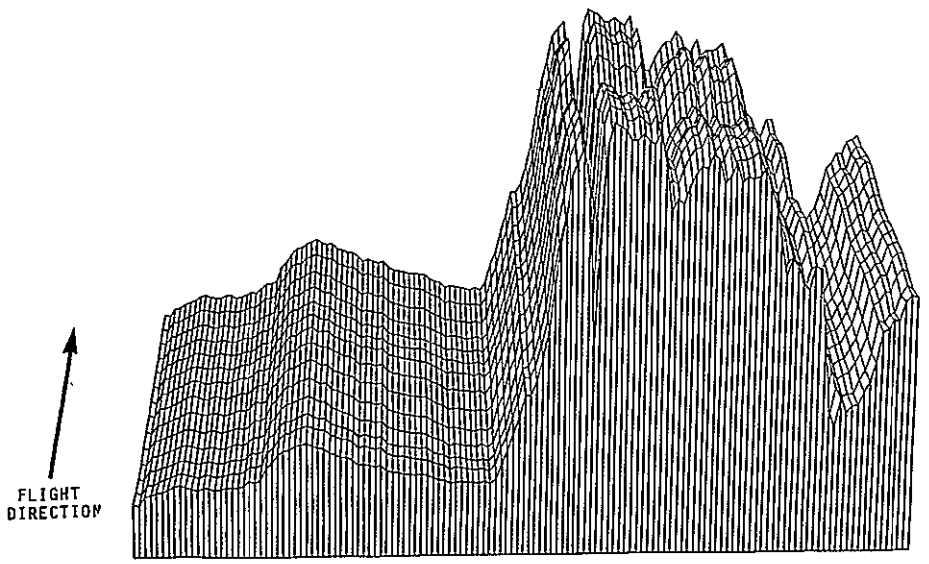
2794



10:42 AM 5/15/75

SUN ELEV = 71°

2789-2802



RIPENING WHEAT

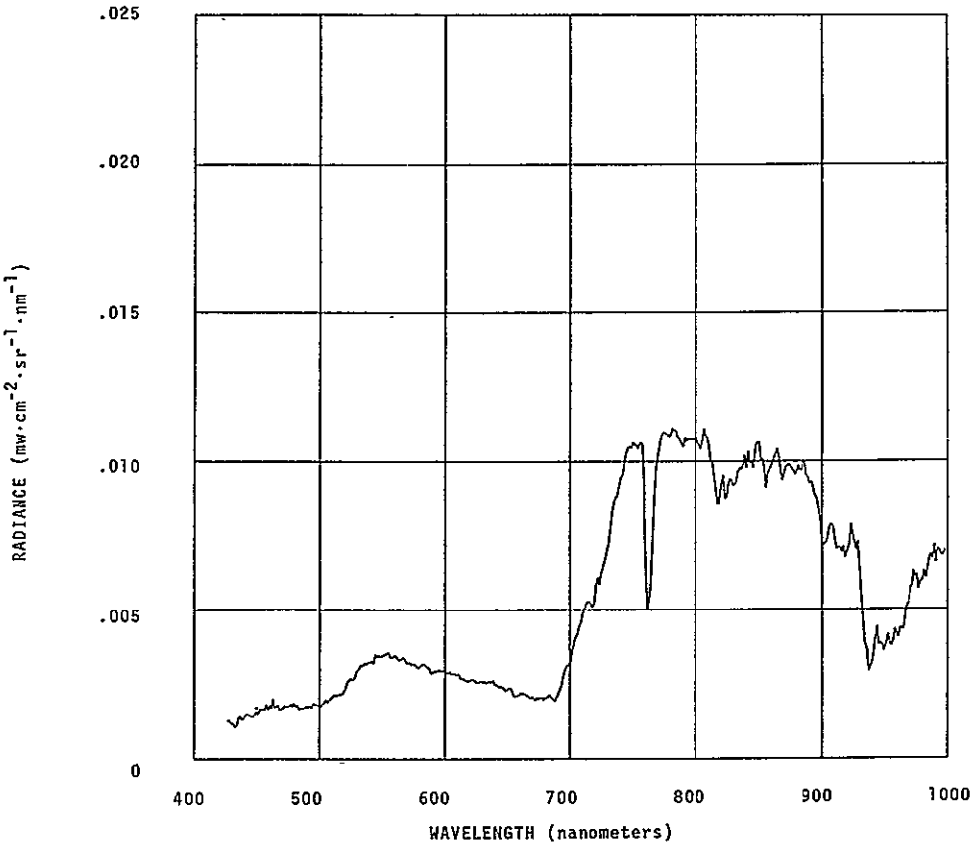
FIELD DESCRIPTION

26 to 30 inches high, 90 to 100% leaf cover, moderately thick uniform canopy. Heads fully emerged and turning yellow-green. Soil dry. Imperial, light brown silty clay (7.5YR 6/4).

PHOTO INTERPRETATION

inhomogeneous tone; texture is absent or fine; high density; total cover; nonuniform differential ripening; furrows run perpendicular to FL.

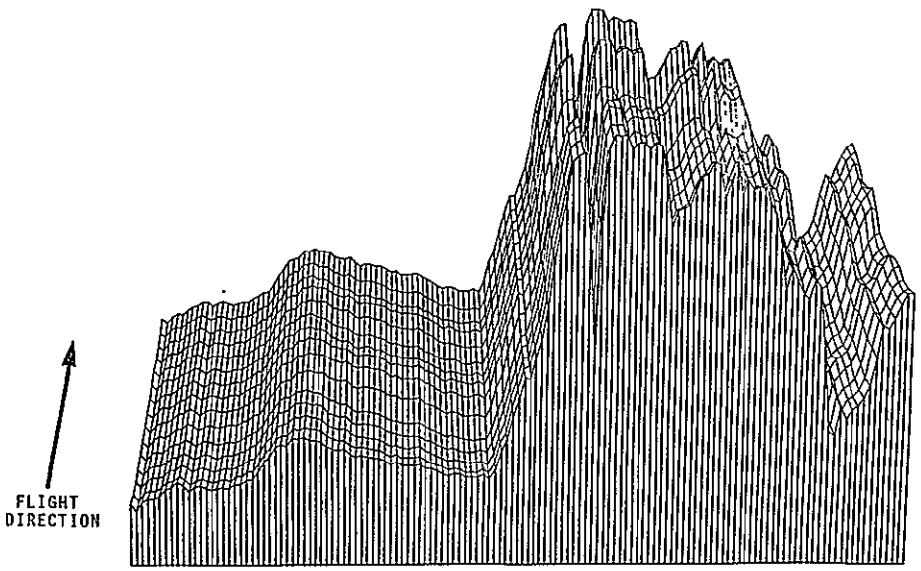
2816



9:37 AM 5/15/75

SUN ELEV = 59°

2803-2817



RIPENING WHEAT

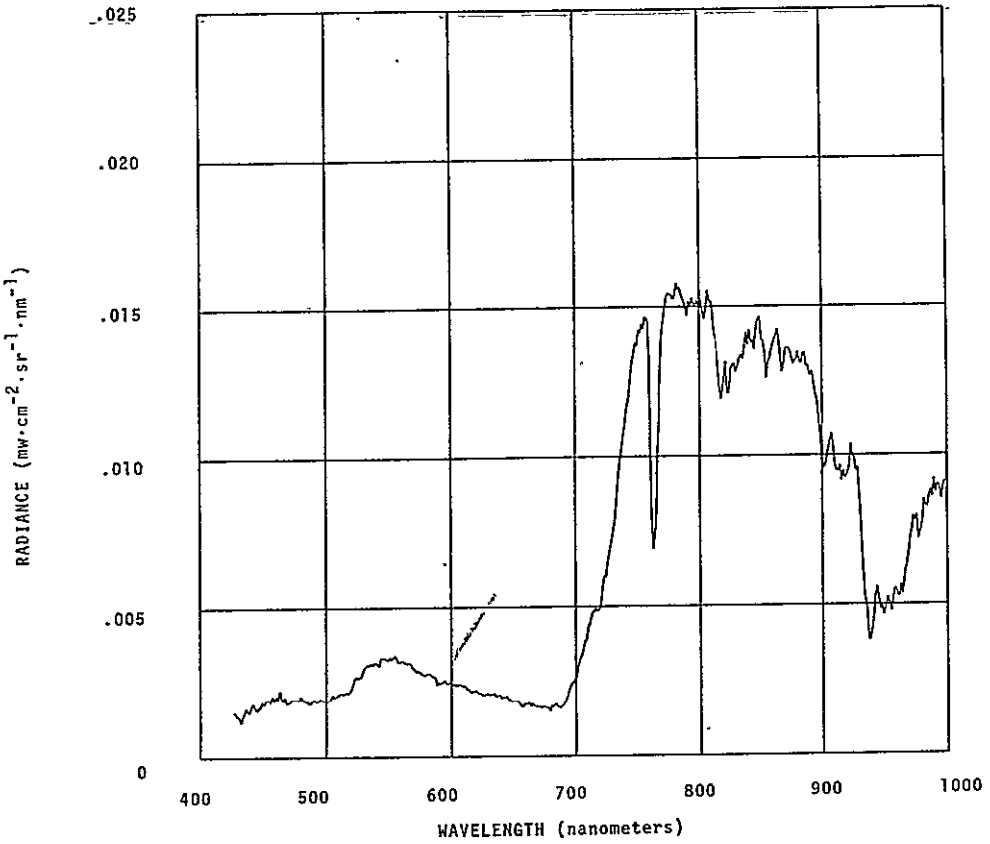
FIELD DESCRIPTION

28 to 30 inches high, 100% leaf cover (1 to 2% weeds), thick uniform canopy. Heads fully emerged and green, stalks green on top yellowing on bottom 1/3 of stalk. Soil dry. Imperial, light brown silty clay (7.5YR 6/4).

PHOTO INTERPRETATION

homogeneous tone; fine texture; high density; total cover; furrows run parallel with FL.

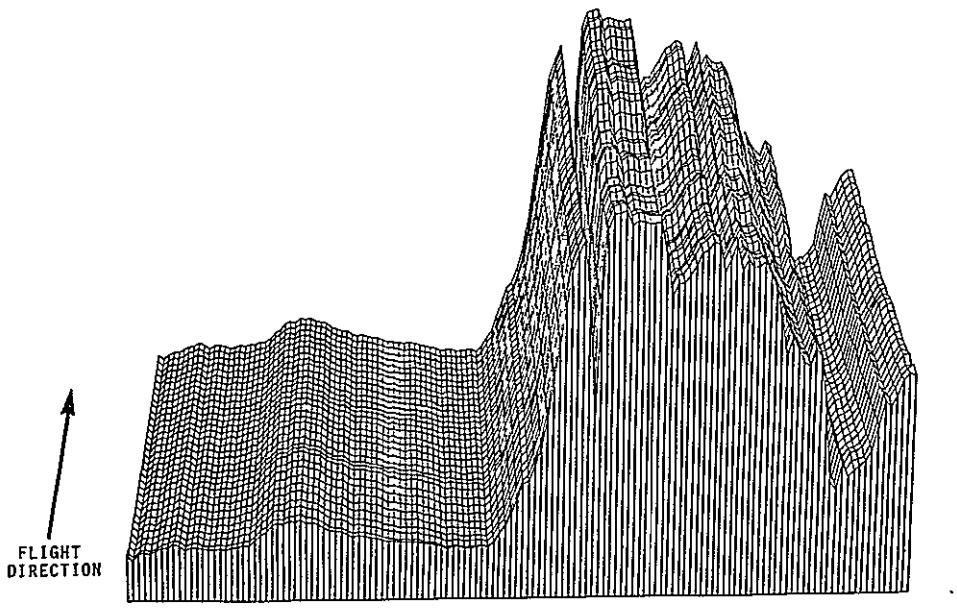
2837



9:43 AM 5/15/75

SUN ELEV = 61°

2818-2850



RIPENING WHEAT

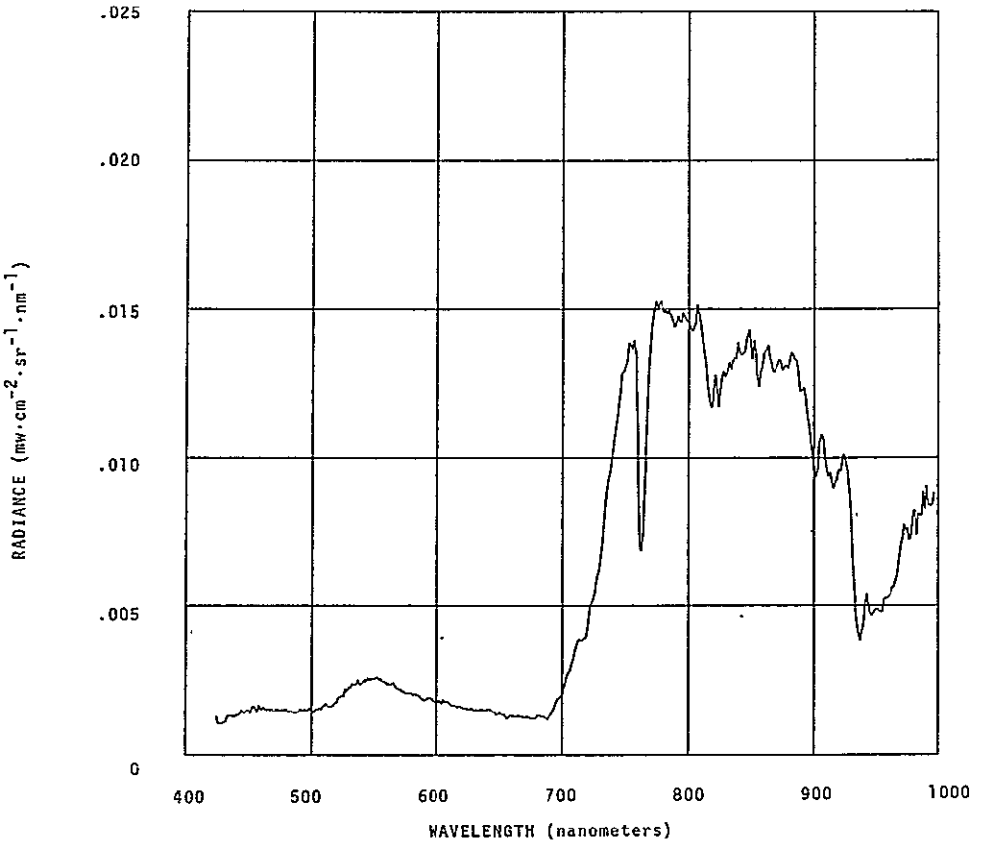
FIELD DESCRIPTION

28 to 30 inches high, 100% leaf cover (1 to 2% weeds), thick uniform canopy. Heads fully emerged and green, stalks green on top yellowing on bottom 1/3 of stalk. Soil dry. Imperial, light brown silty clay (7.5YR 6/4).

PHOTO INTERPRETATION

homogeneous tone with the exception of a grid of thin spots in what seems to be an irrigation pattern; texture is absent or fine; high density; near total cover; furrows run parallel with FL.

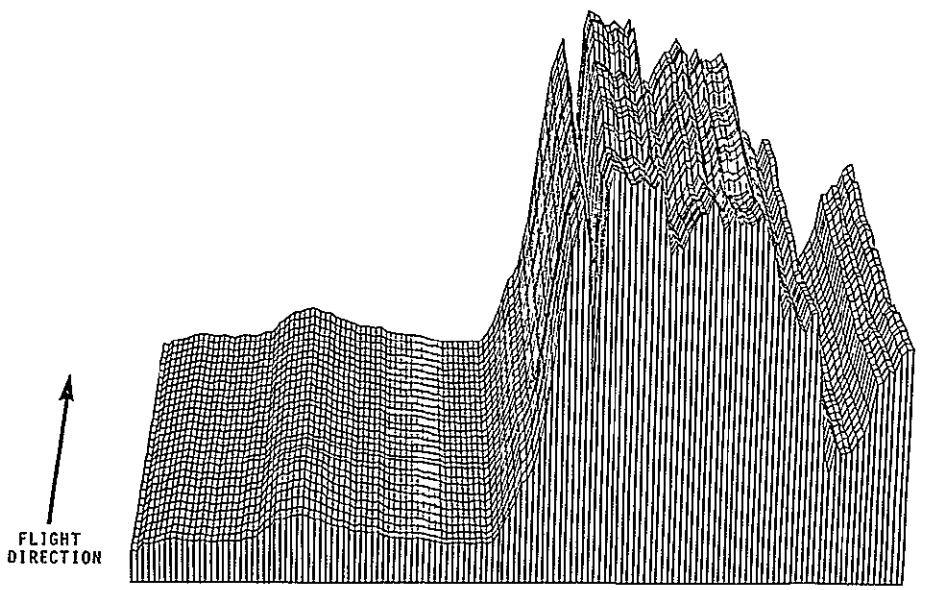
2866



9:51 AM 5/15/75

SUN ELEV = 62°

2851-2880



RIPENING WHEAT

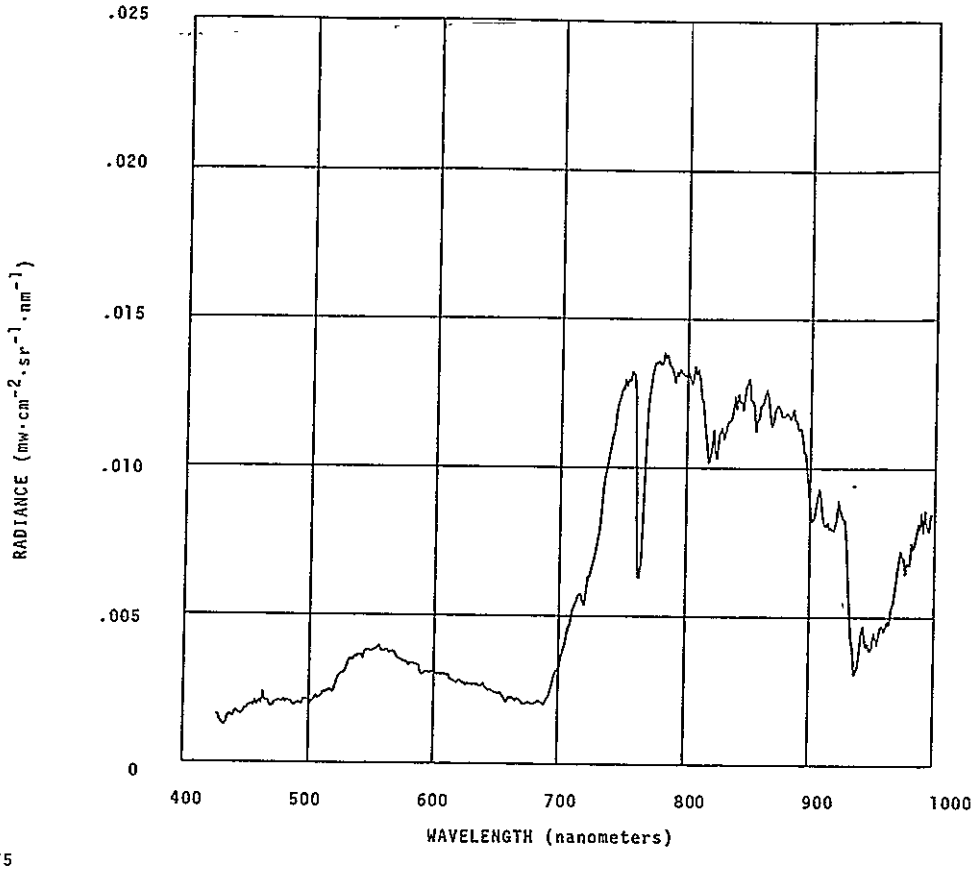
FIELD DESCRIPTION

30 inches high, 70 to 80% leaf cover, moderately thick uniform canopy. Heads fully emerged and turning yellow-green. Soil dry. Imperial, light brown silty clay (7.5YR 6/4).

PHOTO INTERPRETATION

inhomogeneous tone; fine texture; high density; total cover; differential ripening in a diagonal pattern probably caused by subsurface drainage pipes.

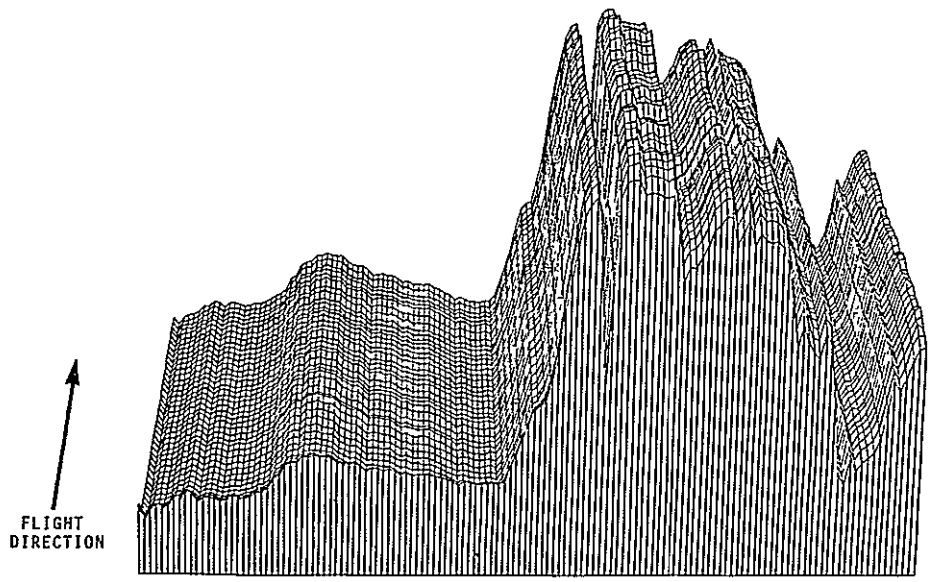
2902



10:15 AM 5/16/75

SUN ELEV = 67°

2881-2920



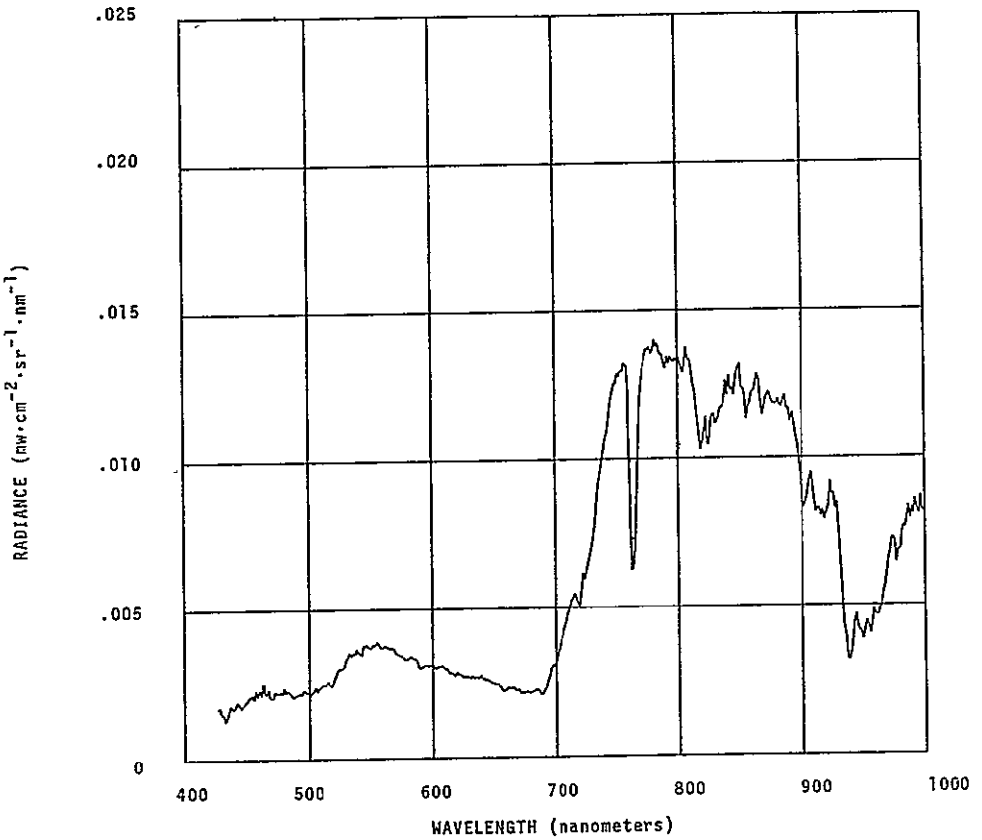
RIPENING WHEAT

FIELD DESCRIPTION

30 to 40 inches high, 100% leaf cover, thick uniform canopy (2 to 3% weeds). Heads fully emerged turning yellow-green, stalks green. Soil dry. Imperial, light brown silty clay (7.5YR 6/4).

PHOTO INTERPRETATION

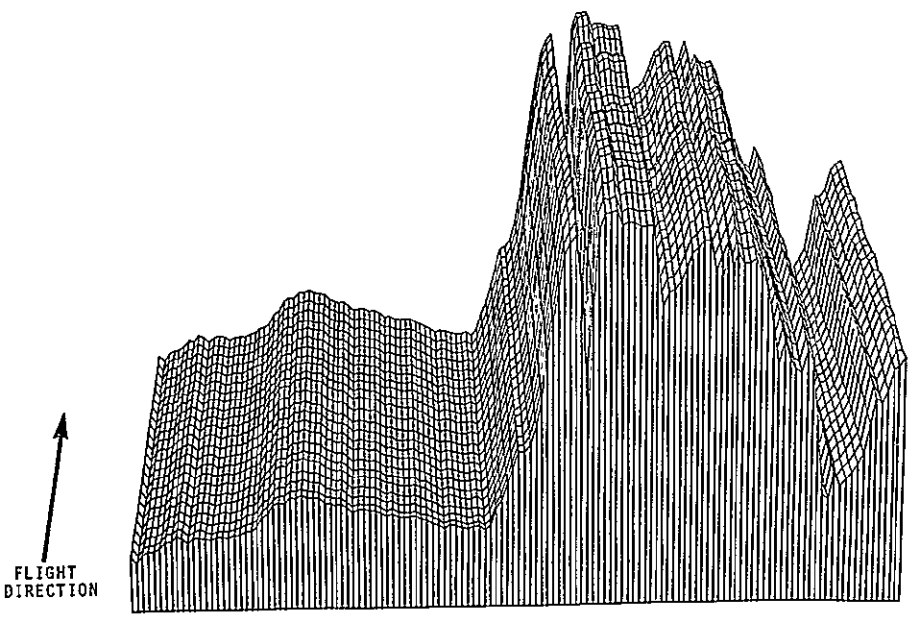
homogeneous tone; fine texture; high density; total cover.



2932

10:20 AM 5/16/75

SUN ELEV = 68°



2921-2943

RIPENING WHEAT

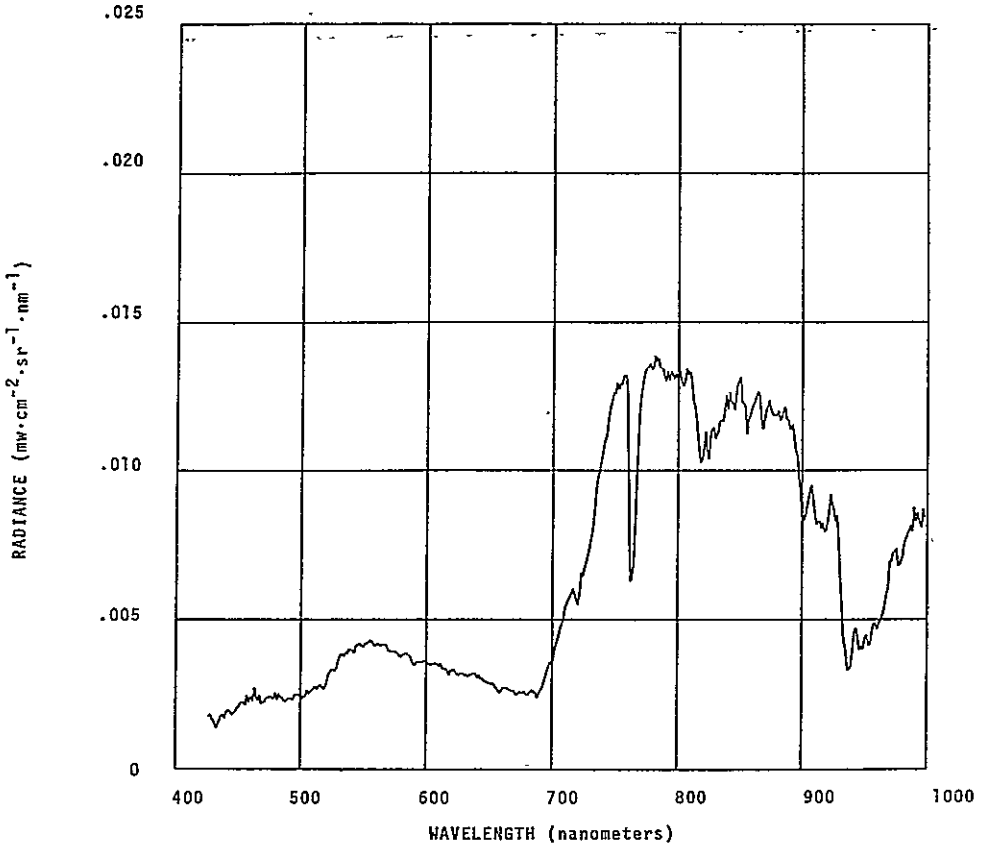
FIELD DESCRIPTION

30 to 40 inches high, 100% leaf cover, thick uniform canopy (2 to 3% weeds). Heads fully emerged turning yellow-green, stalks green. Soil dry. Imperial, light brown silty clay (7.5YR 6/4).

PHOTO INTERPRETATION

inhomogeneous tone; fine texture; high density; total cover; nonuniform differential ripening except the western 650 feet are uniformly more ripe.

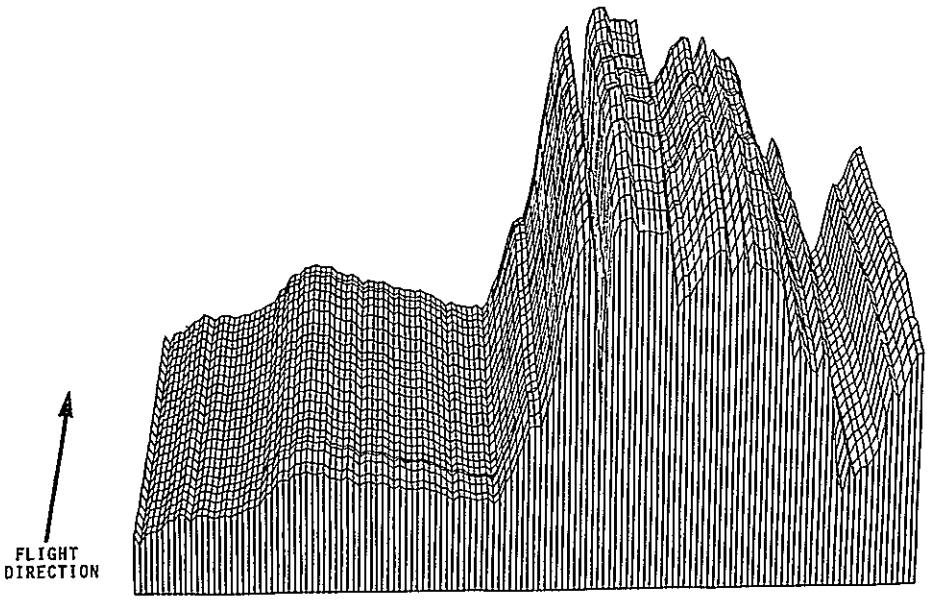
2960



10:27 AM 5/16/75

SUN ELEV = 69°

2944-2967



RIPENING WHEAT

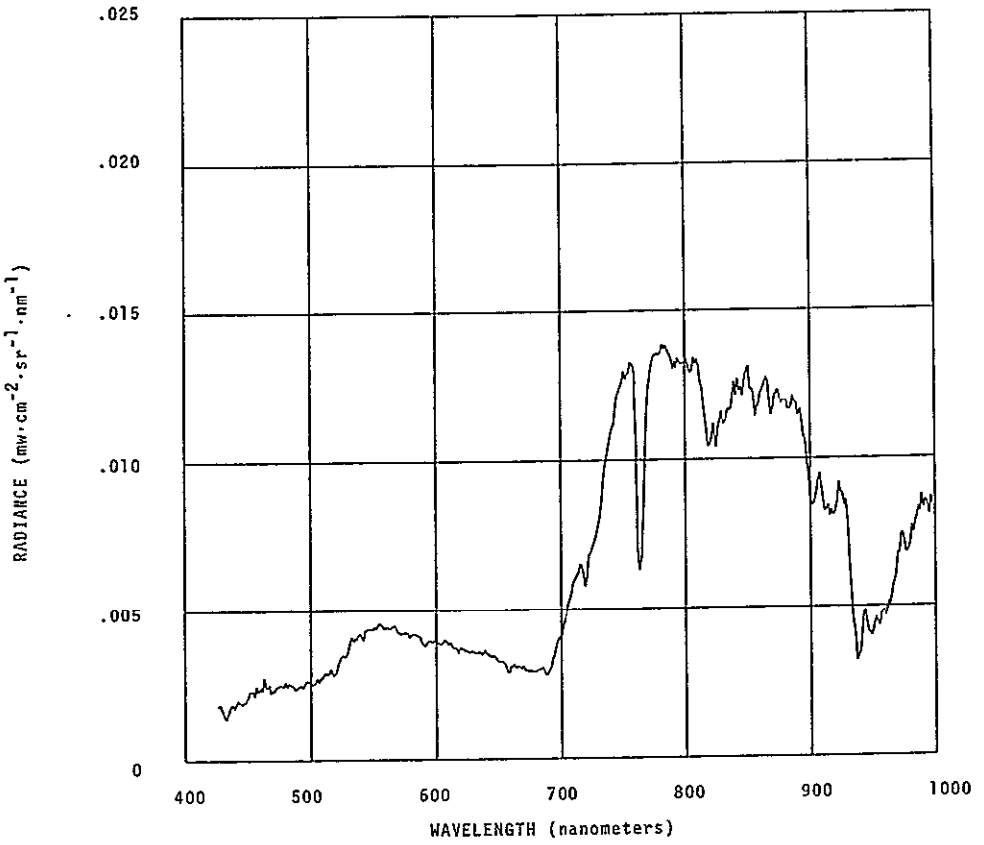
FIELD DESCRIPTION

36 inches high, 95 to 100% leaf cover, thick uniform canopy. Heads fully emerged, heads and stalks turning yellow-green. Soil dry. Imperial, light brown silty clay (7.5YR 6/4).

PHOTO INTERPRETATION

homogeneous tone; medium texture; differential densities ranging from medium to high in alternating rows; total cover; furrows run parallel with FL.

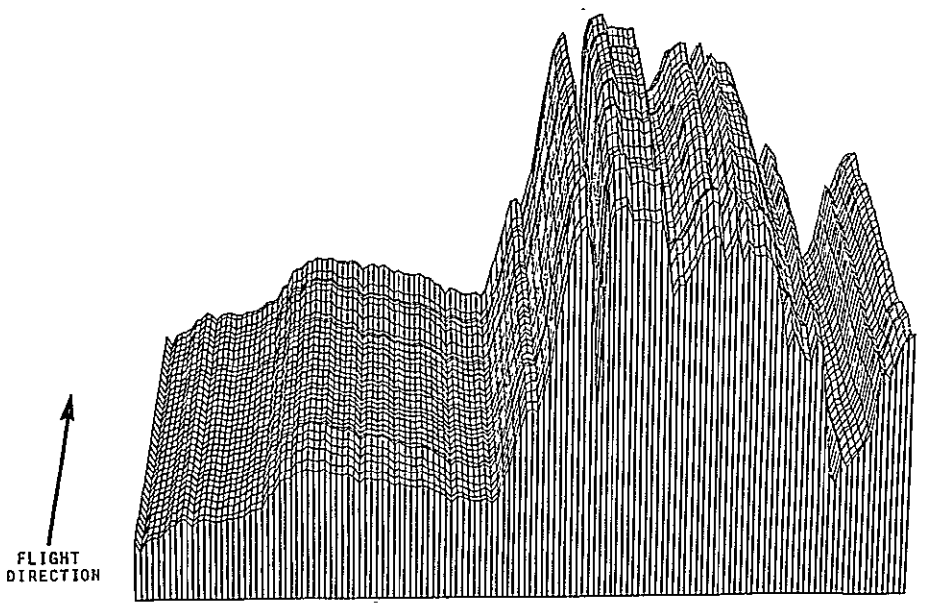
2980



10·47 AM 5/16/75

SUN ELEV = 72°

2968-3001



RIPENING WHEAT

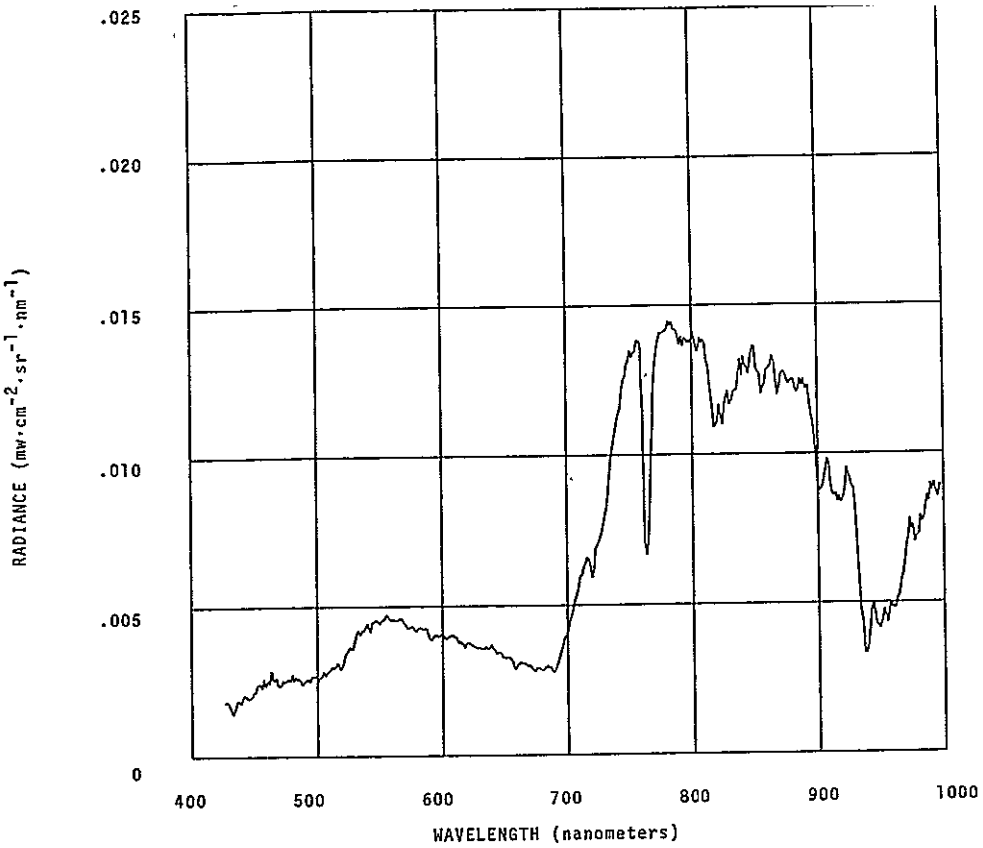
FIELD DESCRIPTION

36 inches high, 95 to 100% leaf cover, thick uniform canopy. Heads fully emerged, heads and stalks turning yellow-green. Soil dry. Imperial, light brown silty clay (7.5YR 6/4).

PHOTO INTERPRETATION

homogeneous tone; medium texture; slightly differential density ranging from medium to high in alternating rows; total cover; furrows run parallel with FL

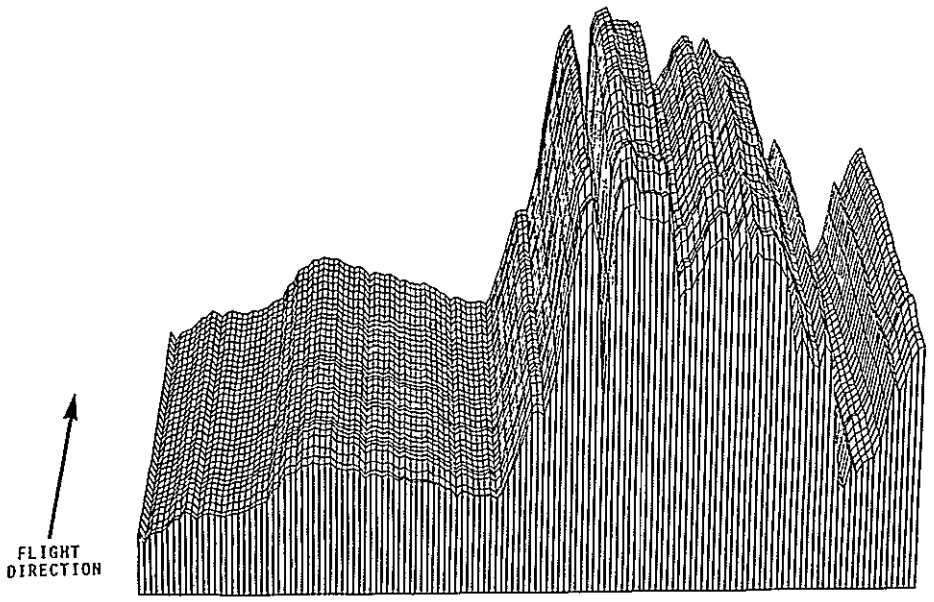
3018



10:55 AM 5/16/75

SUN ELEV = 73°

3002-3036



RIPENING WHEAT

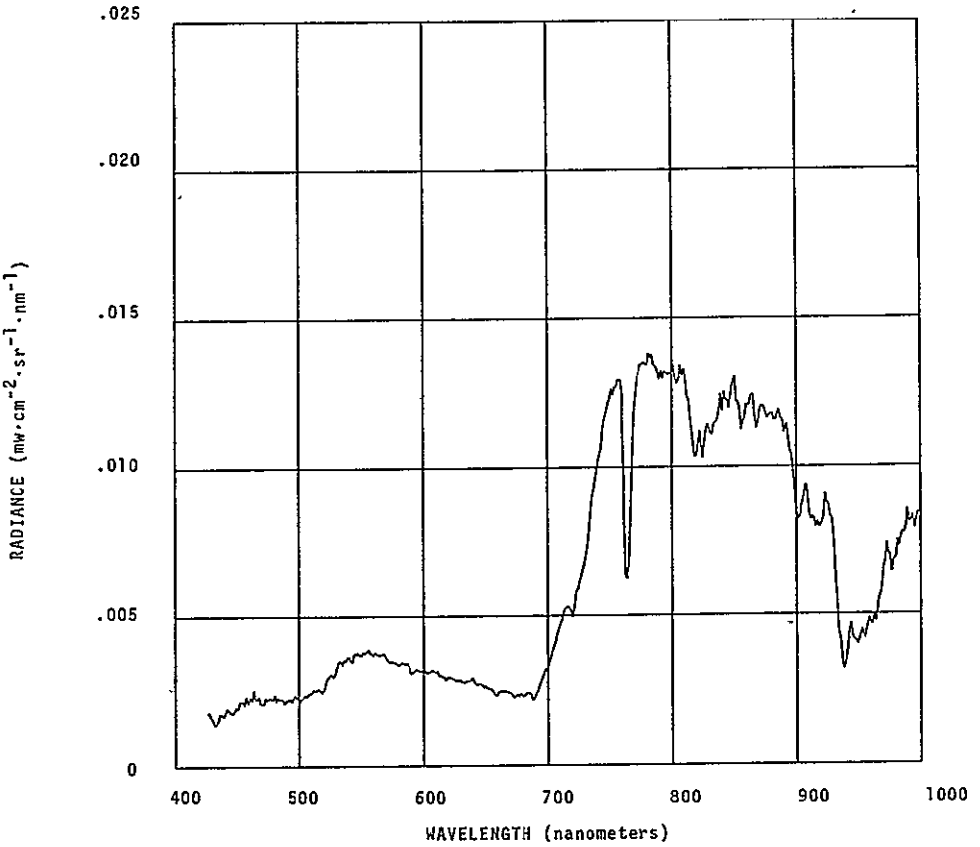
FIELD DESCRIPTION

36 inches high, 100% leaf cover, thick uniform canopy (2 to 5% weeds). Heads fully emerged and just beginning to turn green-yellow. Soil dry. Imperial, light brown silty clay (7.5YR 6/4).

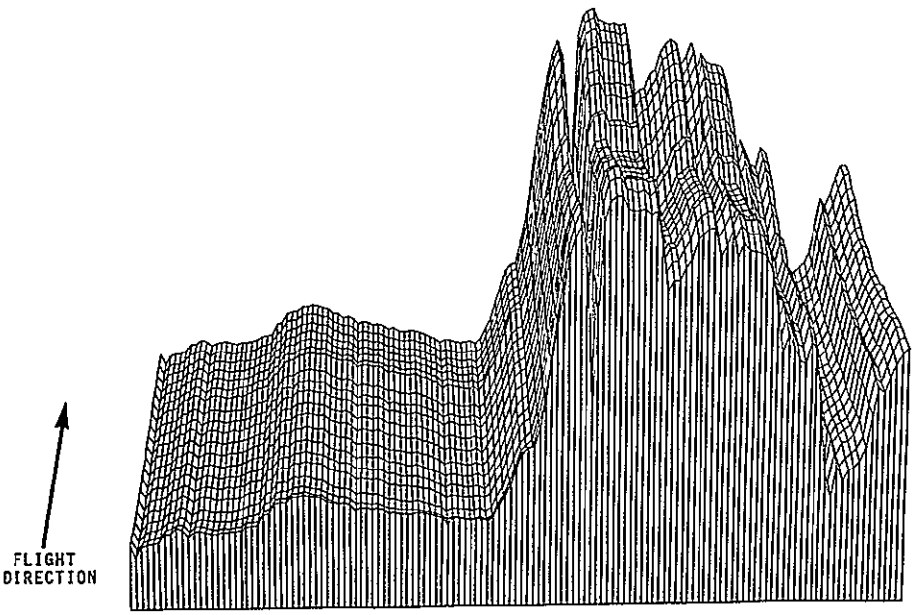
PHOTO INTERPRETATION

inhomogeneous tone; fine texture; high density; near total cover; slight nonuniform, differential ripening; furrows run parallel with FL.

3050



3037-3054



RIPENING WHEAT

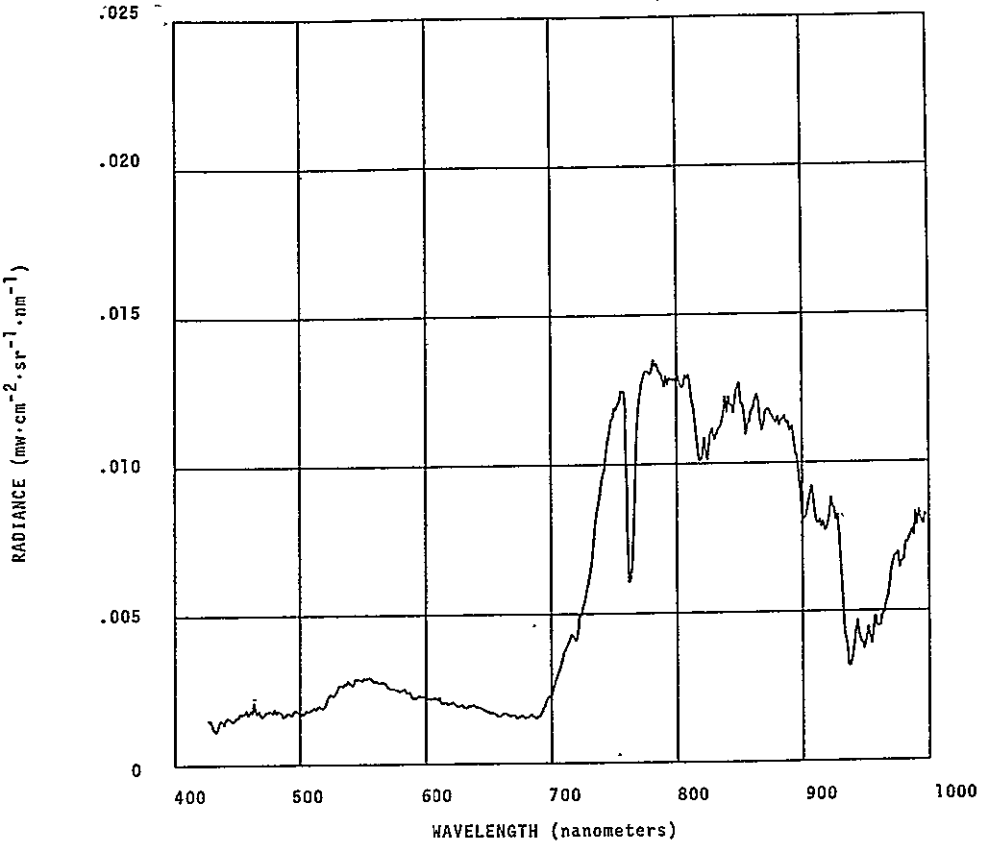
FIELD DESCRIPTION

36 to 40 inches high, 100% leaf cover, thick uniform canopy. Heads fully emerged and green. (Heads just beginning to yellow slightly.) Soil dry. Imperial, light brown silty clay (7.5YR 6/4).

PHOTO INTERPRETATION

homogeneous tone with the exception of a spot of bare soil (65 feet diameter) near the western boundary and a few small spots of bare soil in what seems to be an irrigation pattern; texture is either absent or fine and coarse around the bare soil area; high density with the exception of the bare soil area; near total cover; uniformly unripe; furrows run parallel with FL.

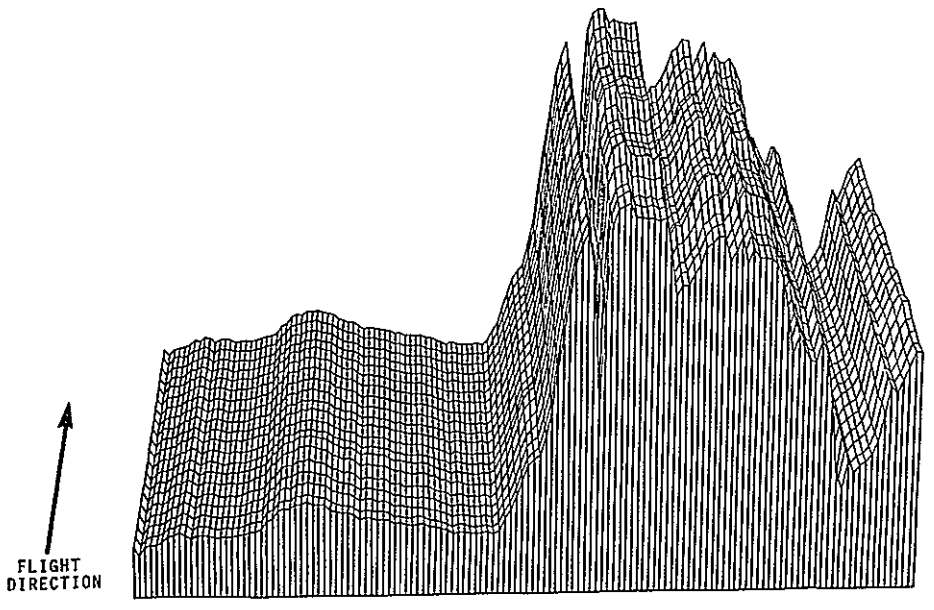
3070



10:27 AM 5/16/75

SUN ELEV = 69°

3055-3074



RIPENING WHEAT

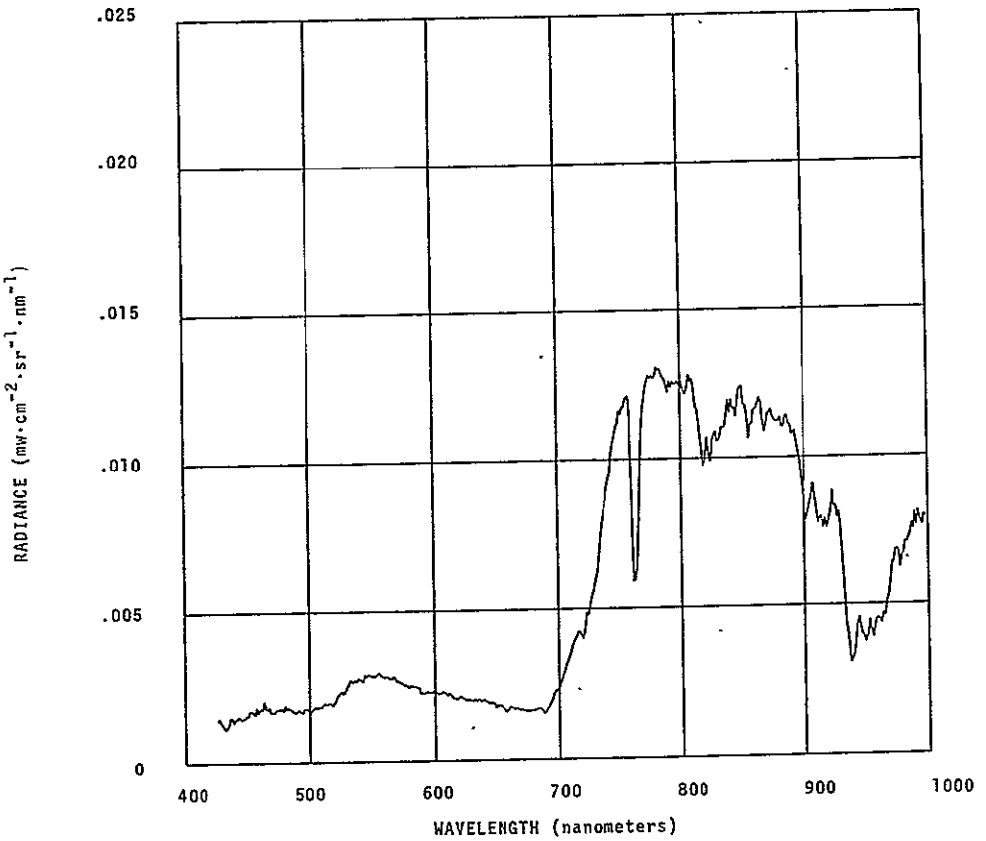
FIELD DESCRIPTION

36 to 40 inches high, 100% leaf cover, thick uniform canopy. Heads fully emerged and green. (Heads just beginning to yellow slightly.) Soil dry. Imperial, light brown silty clay (7.5YR 6/4).

PHOTO INTERPRETATION

homogeneous tone; texture is absent or fine, becoming medium at field edges; high density; uniformly unripe; furrows run parallel with FL.

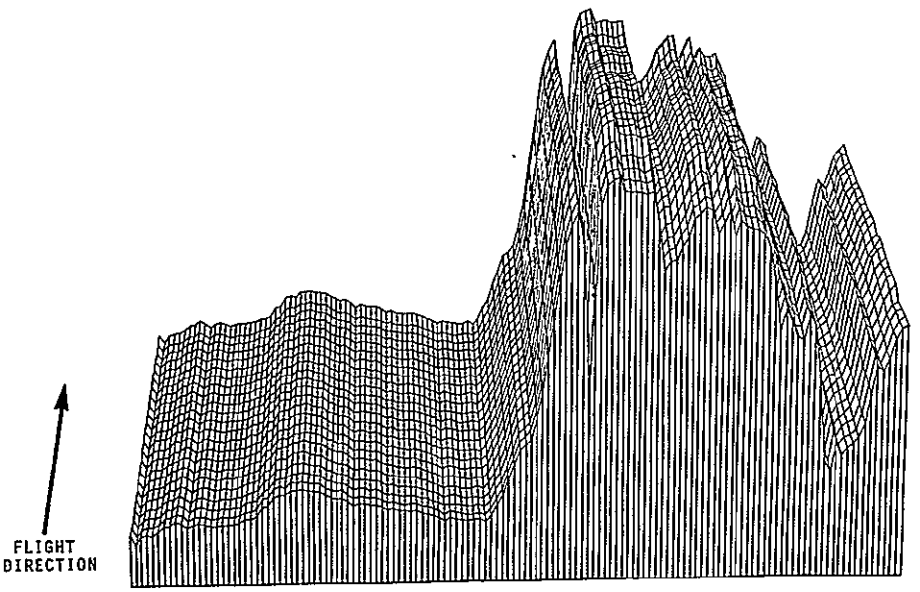
3088



10:27 AM 5/16/75

SUN ELEV = 69°

3075-3097



RIPENING WHEAT

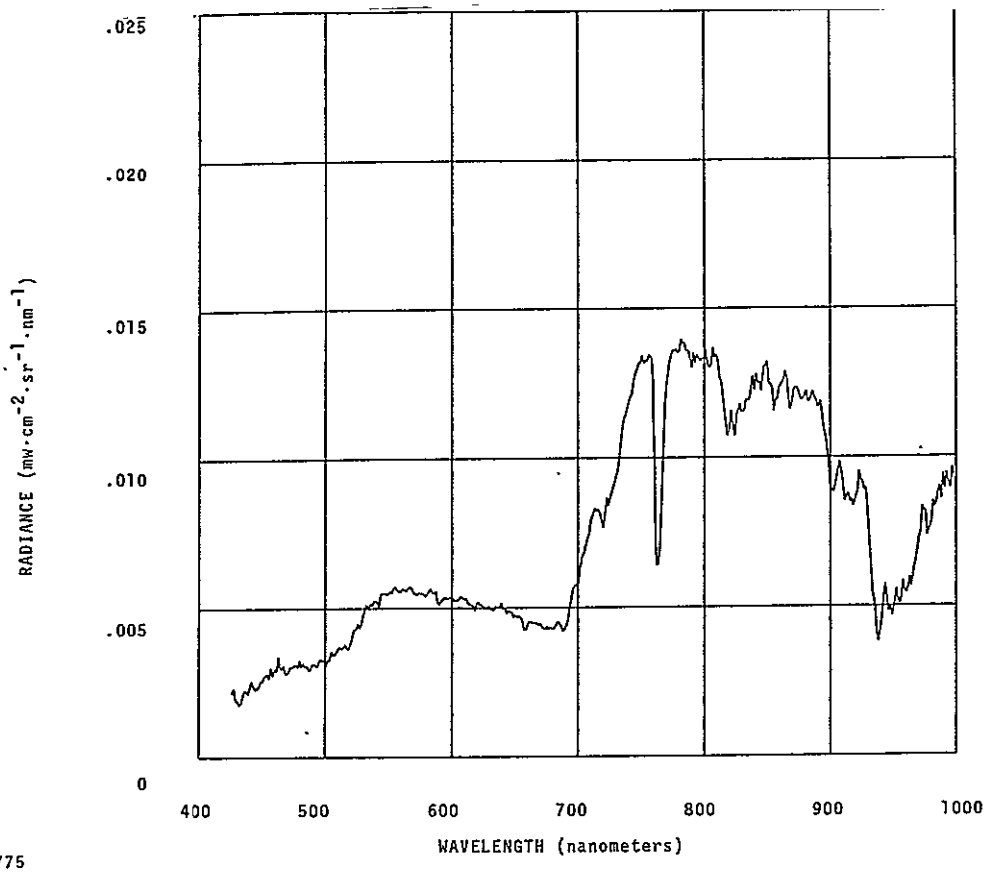
FIELD DESCRIPTION

36 to 40 inches high, 100% leaf cover, thick variable canopy (some areas of wheat lying over). Heads fully emerged and turning green-yellow, stalks green. Soil dry. Imperial, light brown silty clay (7.5YR 6/4).

PHOTO INTERPRETATION

inhomogeneous tone; medium texture; high density; near total cover; differential nonuniform ripening; furrows run perpendicular to FL.

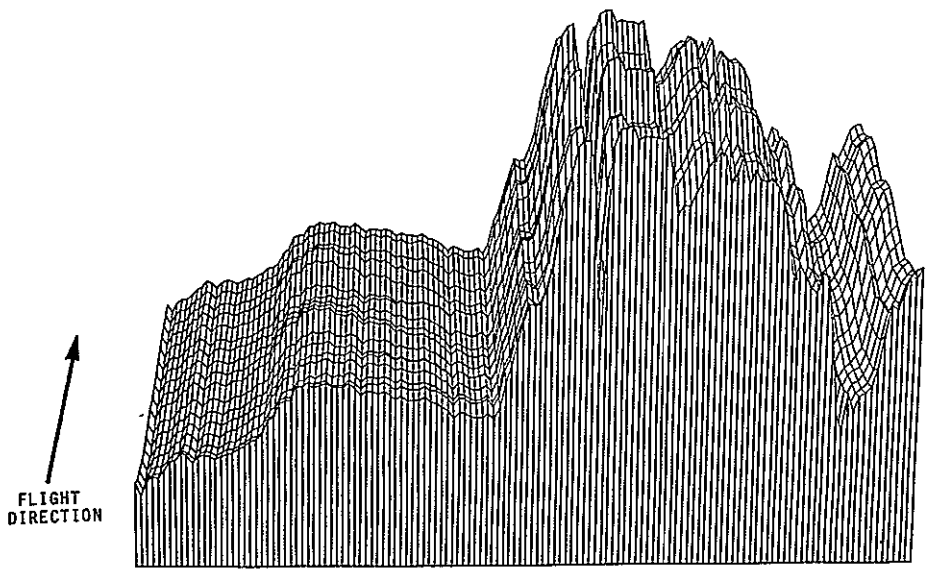
3103



9:58 AM 5/15/75

SUN ELEV = 63°

3098-3114



RIPENING WHEAT

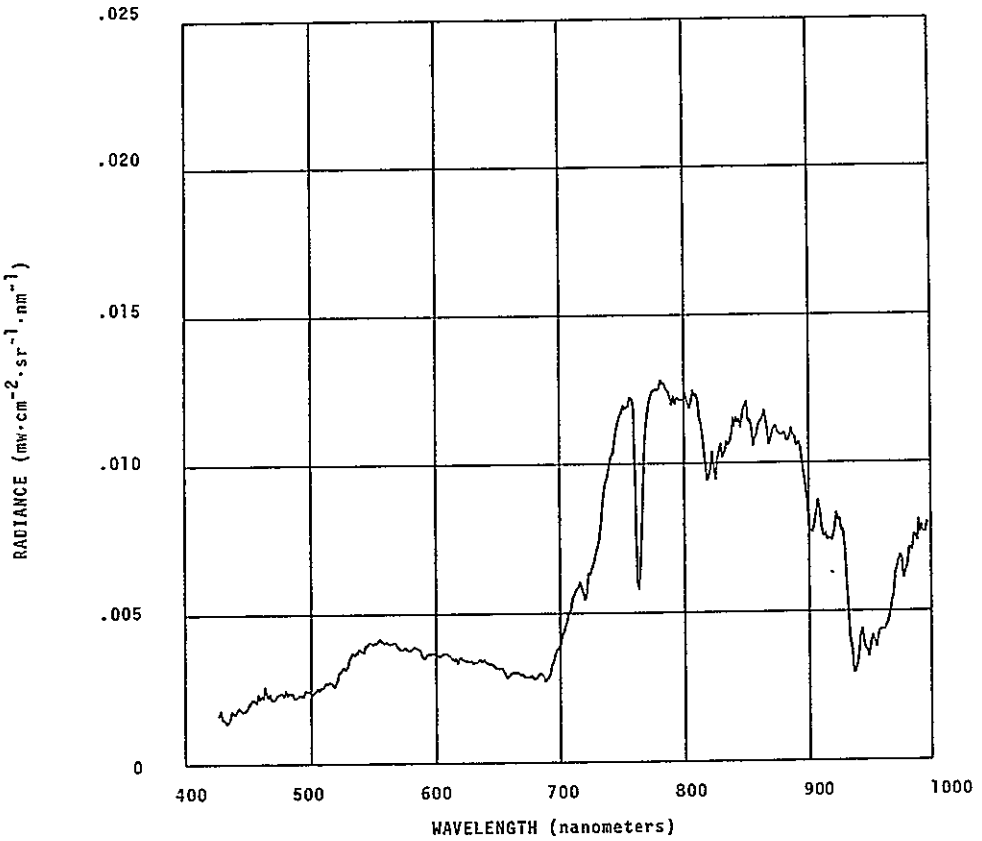
FIELD DESCRIPTION

36 to 40 inches high, 100% leaf cover, thick variable canopy (crop is lying over in some areas). Heads fully emerged and turning green-yellow, stalks green. Soil dry. Imperial, light brown silty clay (7.5YR 6/4).

PHOTO INTERPRETATION

inhomogeneous tone; fine texture; high density; total cover, differential nonuniform ripening.

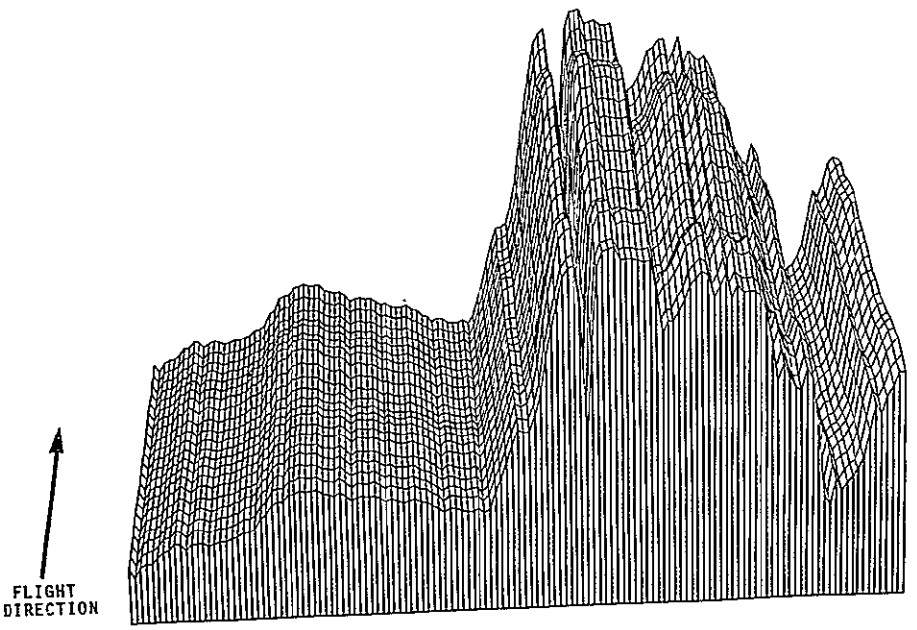
3125



10:20 AM 5/16/75

SUN ELEV = 68°

3115-3135



RIPENING WHEAT

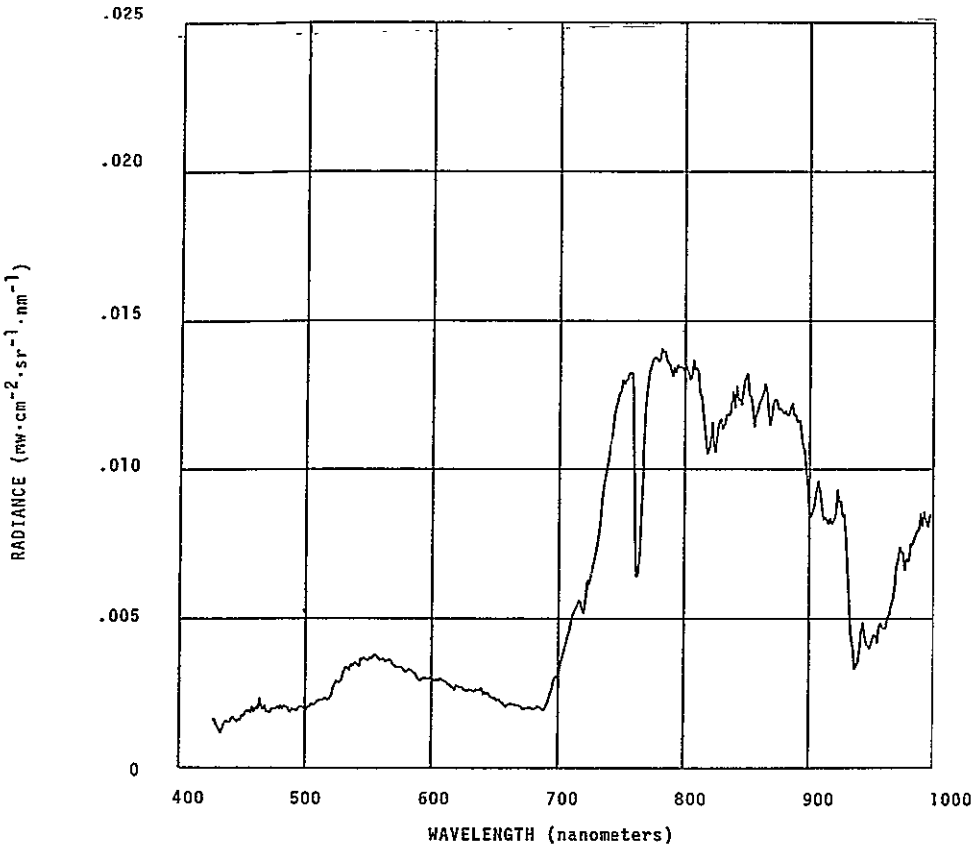
FIELD DESCRIPTION

36 to 40 inches high, 100% leaf cover, thick uniform canopy. Heads fully emerged and turning green-yellow. Soil moist to wet. Imperial, silty clay.

PHOTO INTERPRETATION

inhomogeneous tone; fine texture; high density; total cover; differential ripening in diagonal line pattern probably caused by subsurface drainage pipes.

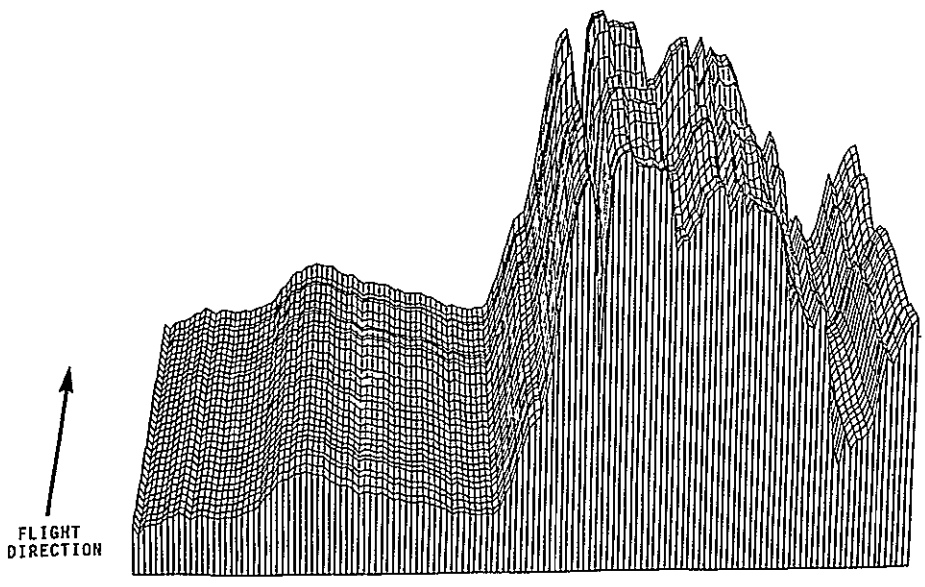
3166



10.27 AM 5/16/75

SUN ELEV = 69°

3136-3167



RIPENING WHEAT

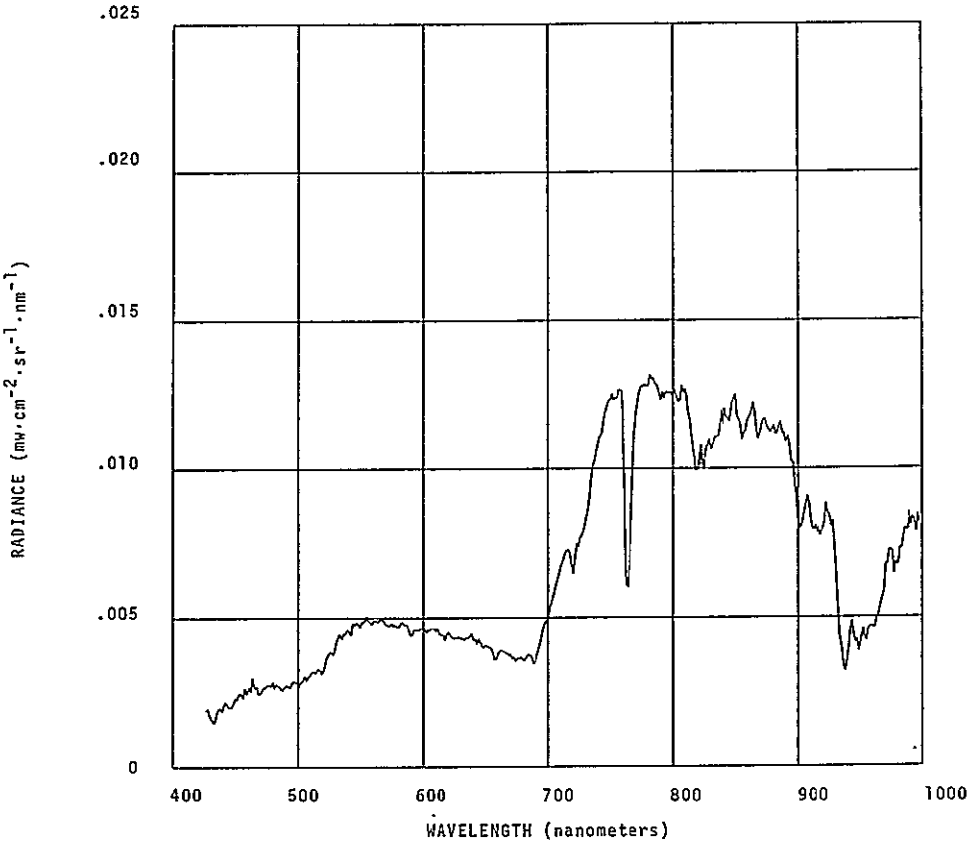
F I E L D D E S C R I P T I O N

36 to 40 inches high, 100% leaf cover, thick variable canopy (crop is lying over in some areas) Heads fully emerged and turning green-yellow, stalks green. Soil dry. Imperial, light brown silty clay (7.5YR 6/4).

P H O T O I N T E R P R E T A T I O N

inhomogeneous tone; texture is differential, ranging from fine to medium; medium density; near total cover, differential ripening; furrows run parallel with FL.

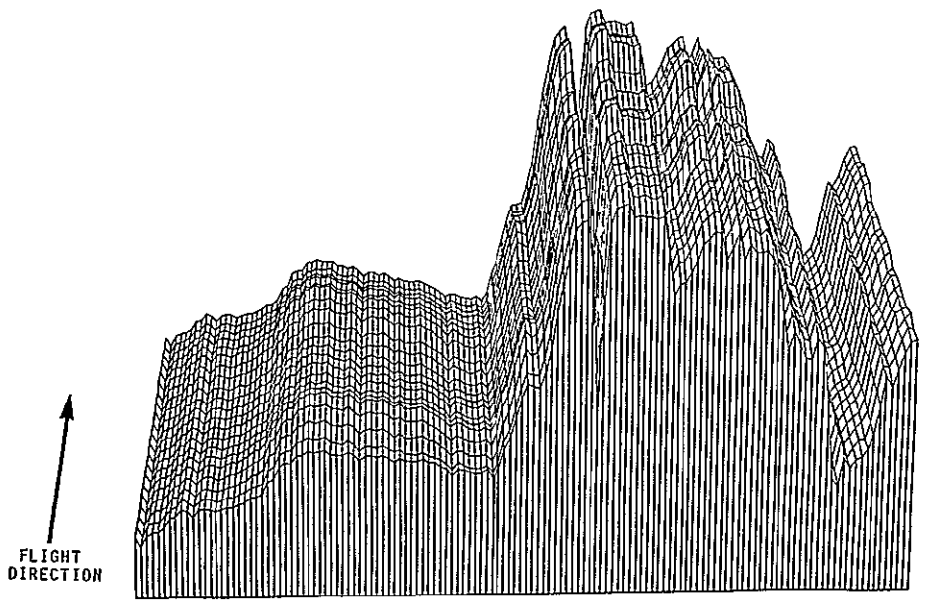
3174



10:27 AM 5/15/75

SUN ELEV = 69°

3168-3188



RIPENING WHEAT

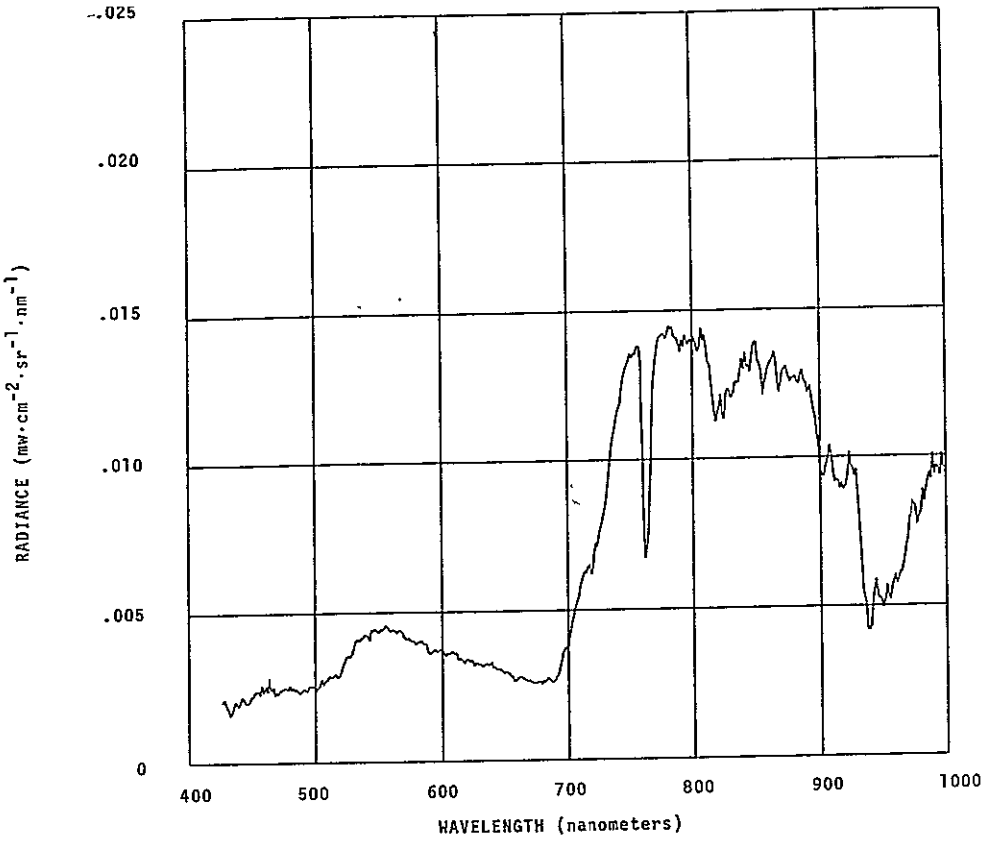
FIELD DESCRIPTION

36 to 40 inches high, 100% leaf cover, thick uniform canopy. Heads fully emerged and green-yellow, stalks green-yellow. Soil dry. Imperial, light brown silty clay (7.5YR 6/4).

PHOTO INTERPRETATION

homogeneous tone; fine texture; high density, however, slightly differential in rows; total cover; furrows run parallel with FL.

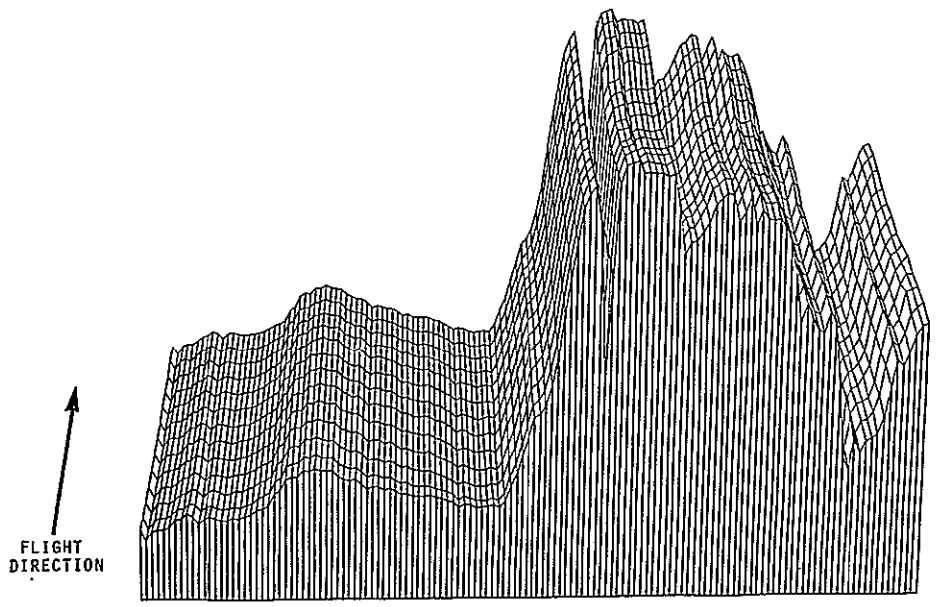
3192



9:58 AM 5/15/75

SUN ELEV = 63°

3189-3201



RIPENING WHEAT

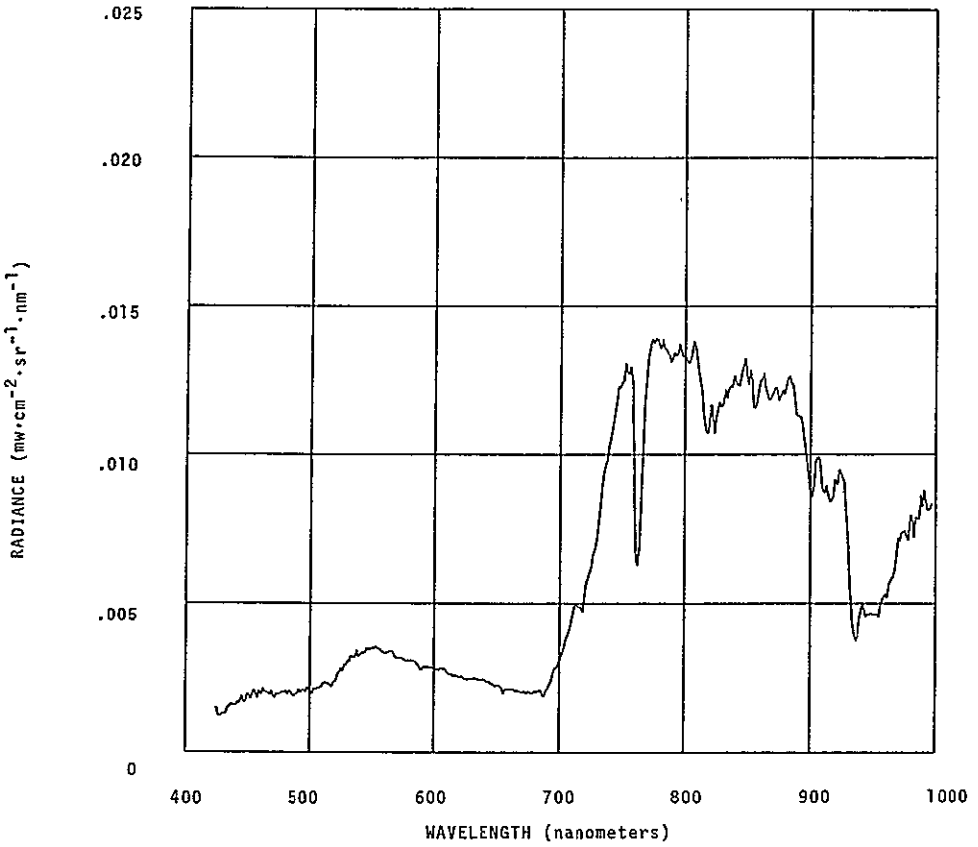
FIELD DESCRIPTION

36 to 40 inches high, 100% leaf cover, thick uniform canopy. Heads fully emerged and turning yellow-green, stalks yellow-green. Soil wet (standing water). Imperial, silty clay.

PHOTO INTERPRETATION

inhomogeneous tone; texture is absent or fine; high density; total cover; differential nonuniform ripening.

3226

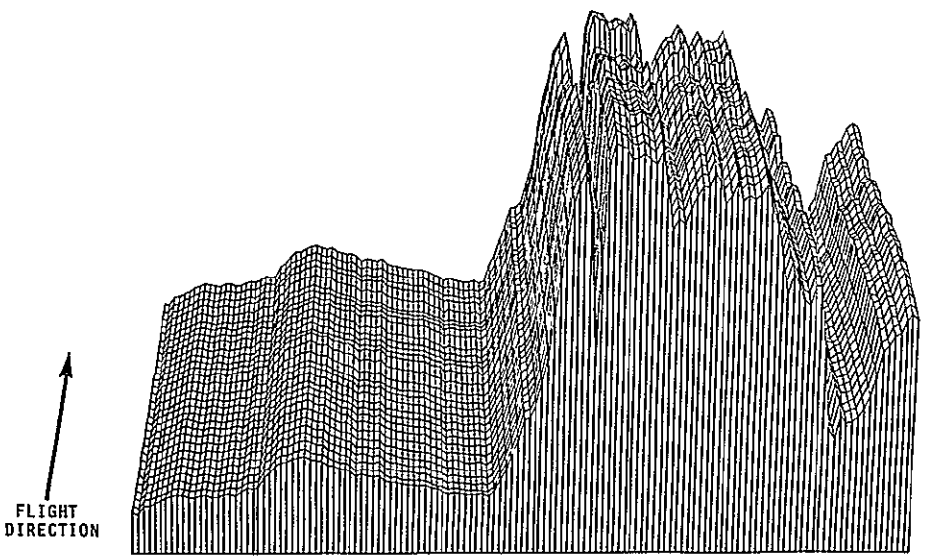


10:04 AM 5/15/75

SUN ELEV = 65°

ORIGINAL PAGE IS
OF POOR QUALITY

3202-3231



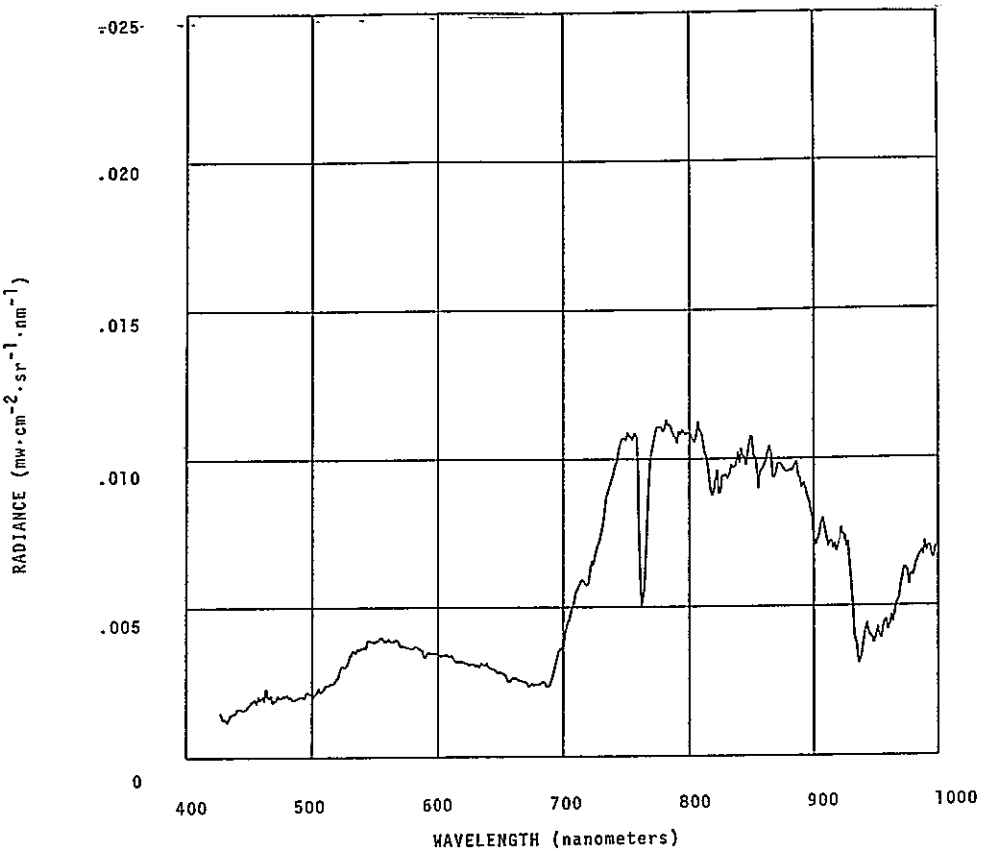
RIPENING WHEAT

F I E L D D E S C R I P T I O N

36 to 40 inches, 100% leaf cover, thick uniform canopy. Heads fully emerged and yellow to yellow-green, stalks green. Soil dry. Imperial, light brown silty clay (7.5YR 6/4).

P H O T O I N T E R P R E T A T I O N

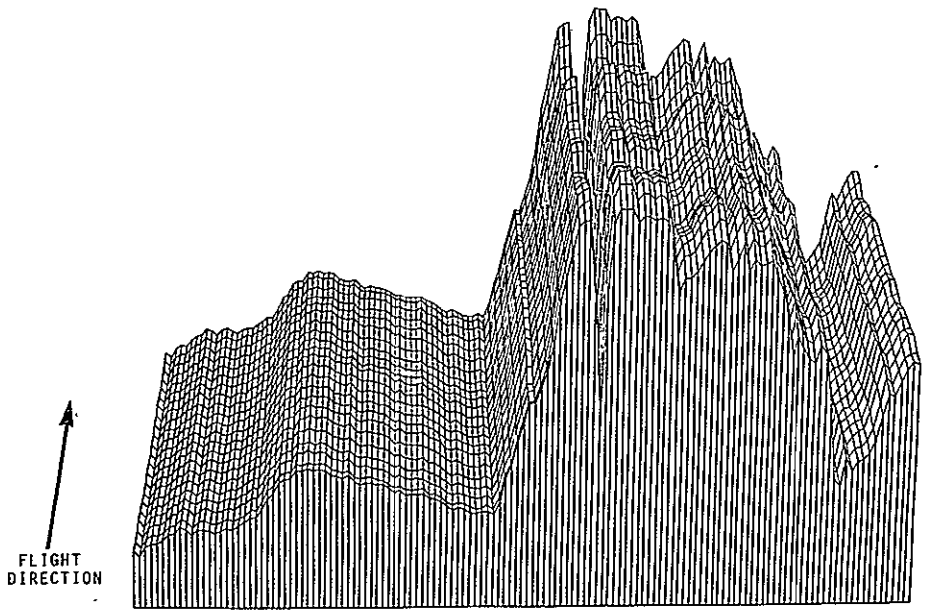
Inhomogeneous tone; fine texture and areas of lodged grain have no texture; high density; total cover; small scattered areas of lodged grain.



3240

9:37 AM 5/15/75

SUN ELEV = 59°



3232-3253

RIPENING WHEAT

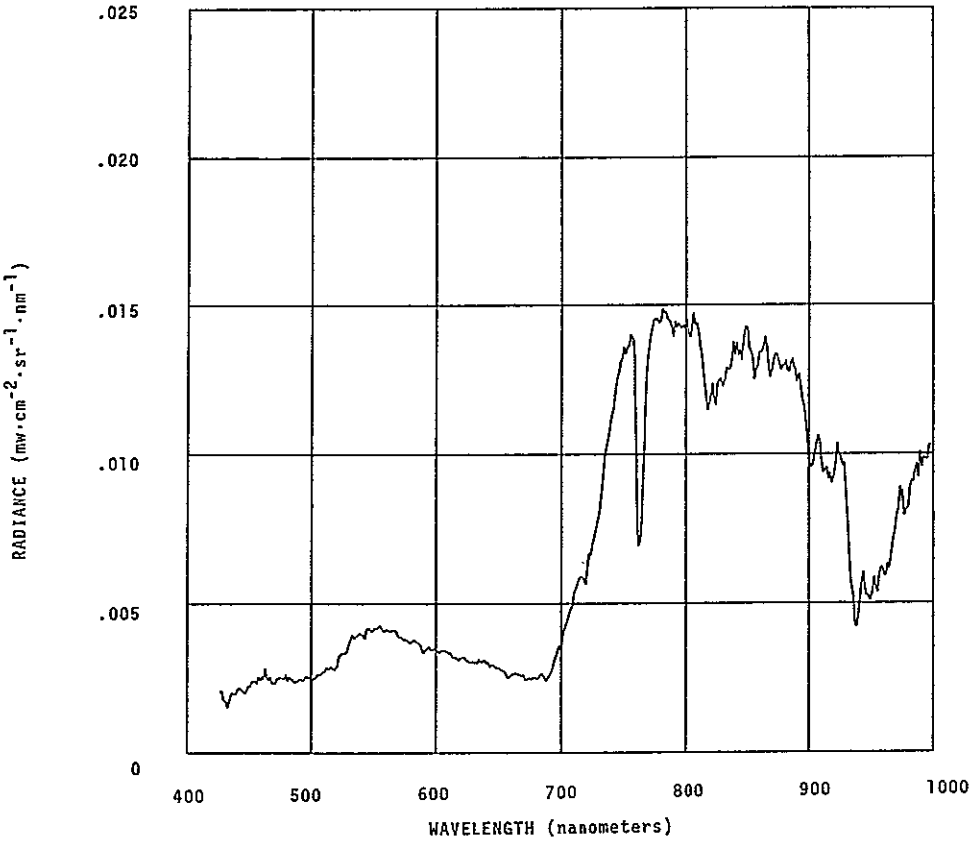
FIELD DESCRIPTION

40 inches high, 100% leaf cover, thick uniform canopy. Heads fully emerged with slight yellowing, stalks green. Soil very wet (muddy). Imperial, silty clay.

PHOTO INTERPRETATION

Inhomogeneous tone; texture is absent in lodged areas and fine in standing areas; high density; near total cover; large areas of lodged grain; furrows run parallel with FL.

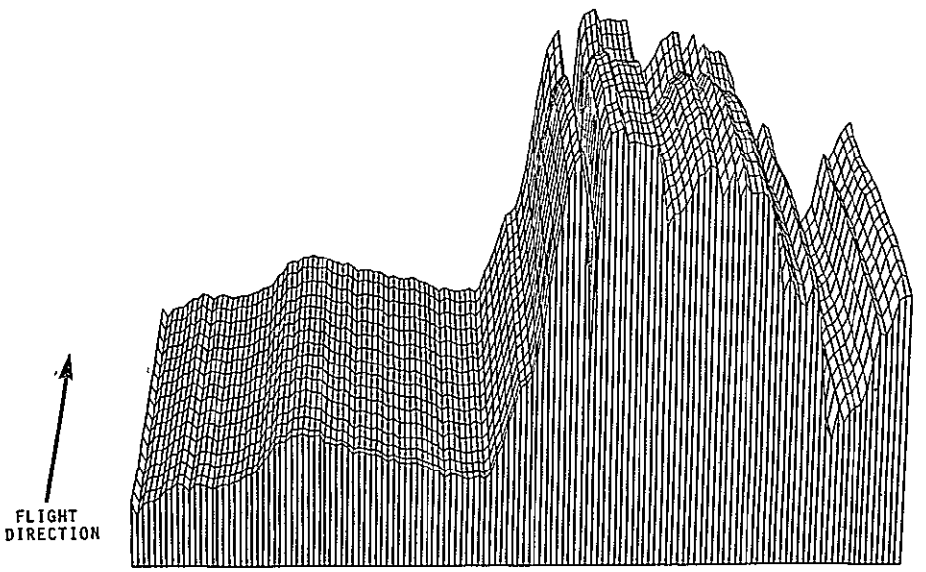
3263



9:58 AM 5/15/75

SUN ELEV = 63°

3254-3269



RIPENING WHEAT

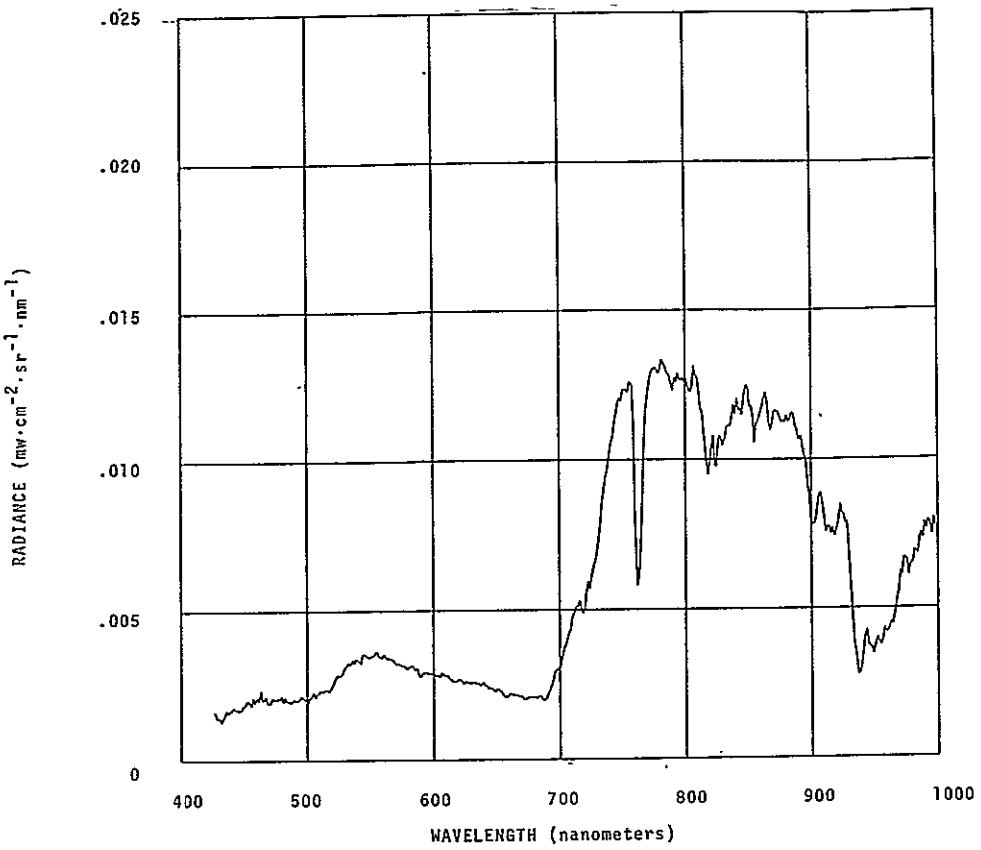
FIELD DESCRIPTION

40 to 48 inches high, 100% leaf cover, thick uniform canopy. Heads fully emerged and turning green-yellow. Soil dry. Imperial, light brown silty clay (7.5YR 6/4).

PHOTO INTERPRETATION

homogeneous tone; fine texture; high density; total cover; slight differential ripening; furrows run parallel with FL.

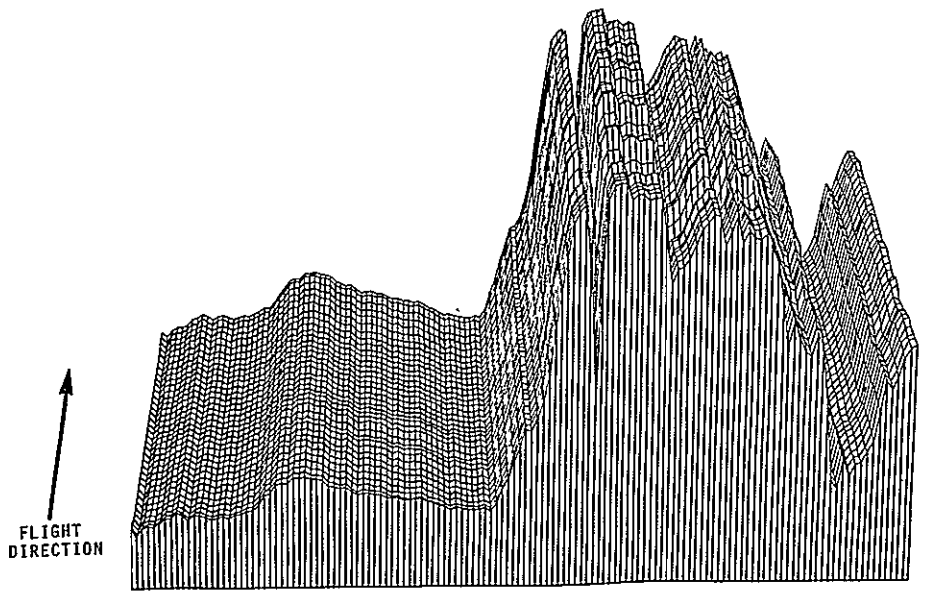
3280



9:54 AM 5/16/75

SUN ELEV = 63°

3270-3305



RIPENING WHEAT

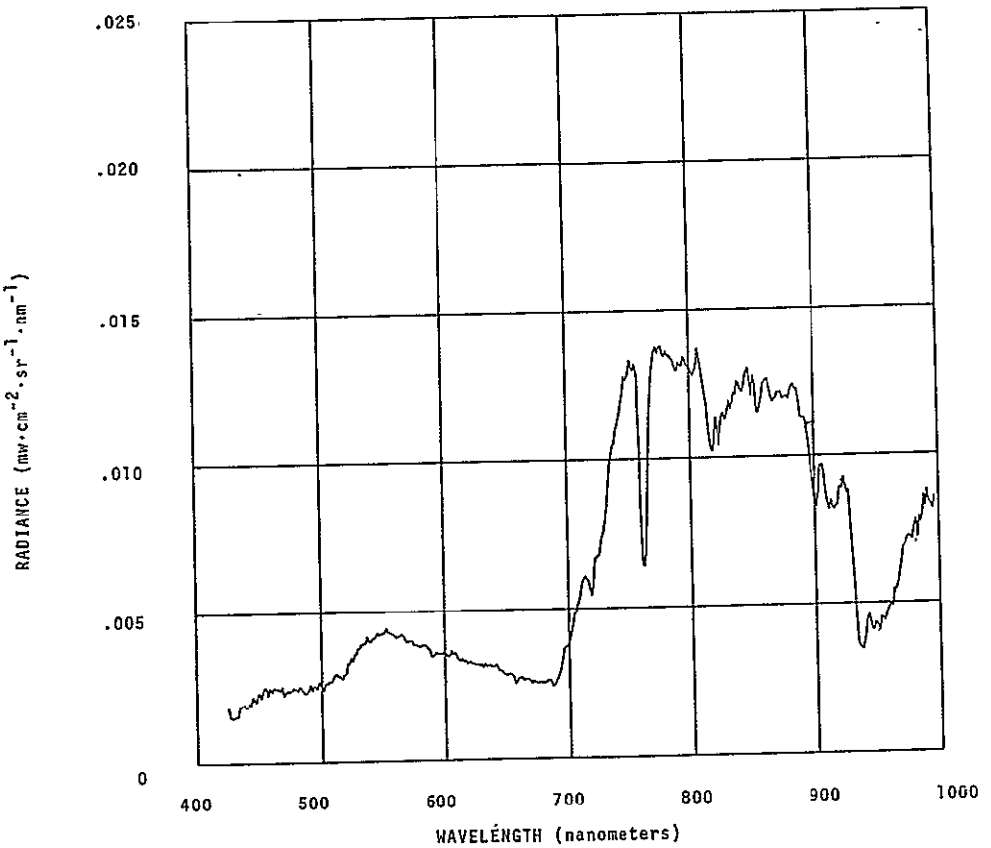
FIELD DESCRIPTION

40 to 48 inches high, 100% leaf cover, thick uniform canopy. Heads fully emerged and turning green-yellow. Soil dry. Imperial, light brown silty clay (7.5YR 6/4).

PHOTO INTERPRETATION

homogeneous tone; fine texture; high density; total cover; slight nonuniform differential ripening.

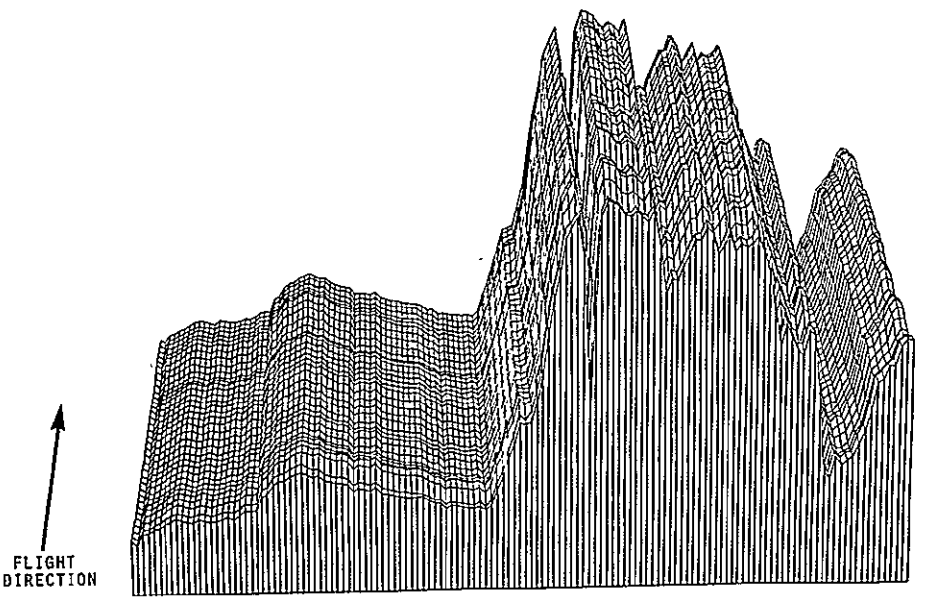
3320



11:03 AM 5/16/75

SUN ELEV = 74°

3306-3340



RIPE WHEAT

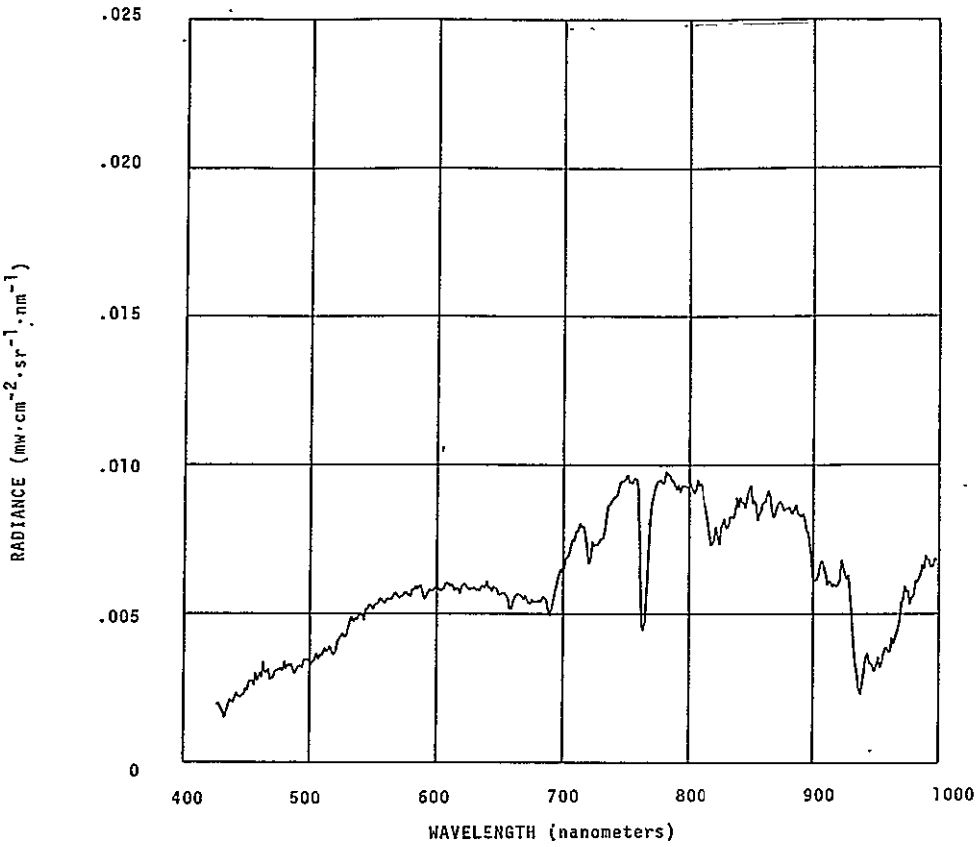
FIELD DESCRIPTION

30 inches high, 90 to 95% leaf cover, thick uniform canopy. Heads fully emerged, heads and stalks yellow. Soil wet. Imperial, silty clay

PHOTO INTERPRETATION

inhomogeneous tone; high density; total cover; field becomes uniformly more ripe westward and grain in furrows remains unripe; furrows run parallel with FL.

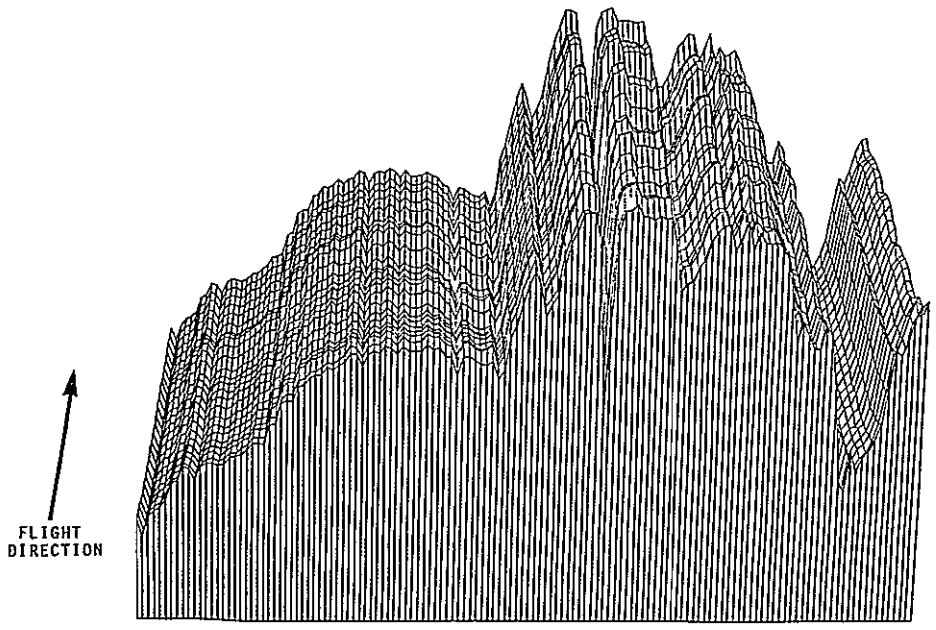
3351



10:47 AM 5/16/75

SUN ELEV = 72°

3341-3365



RIPE WHEAT

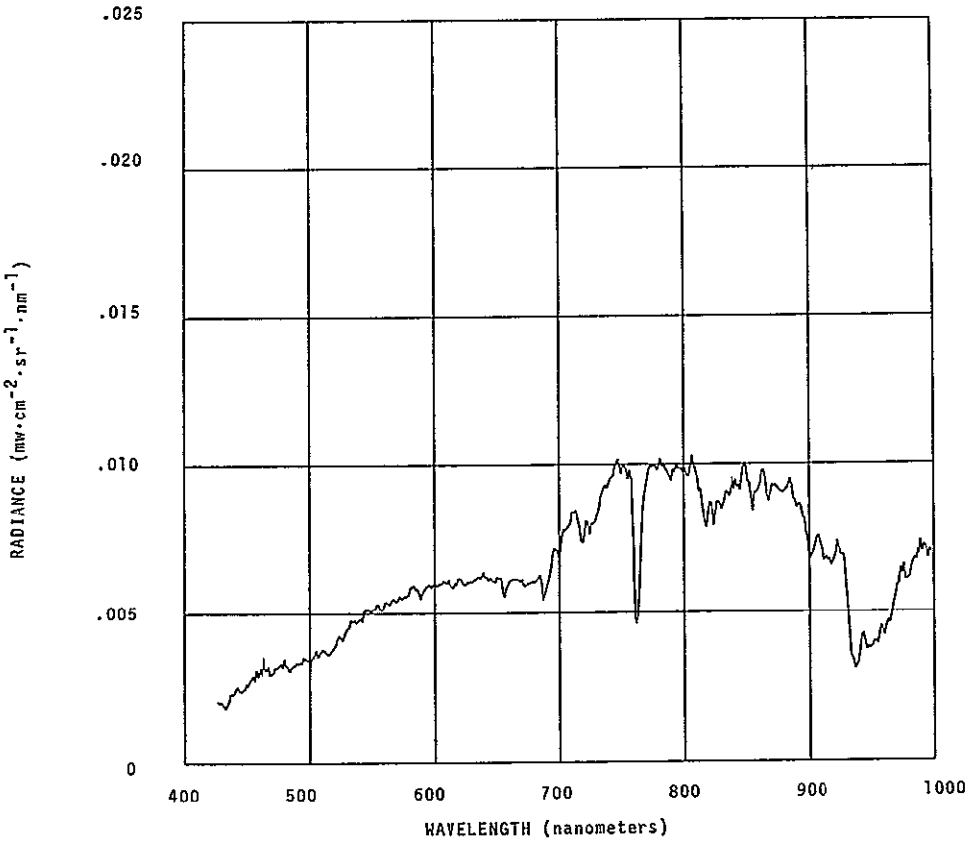
FIELD DESCRIPTION

30 inches high, 100% leaf cover, thick uniform canopy. Heads fully emerged and turning green-yellow. Soil very wet, some standing water. Imperial, silty clay.

PHOTO INTERPRETATION

inhomogeneous tone; fine texture; high density; near total cover, nonuniform differential ripening (high contrast); furrows run parallel with FL.

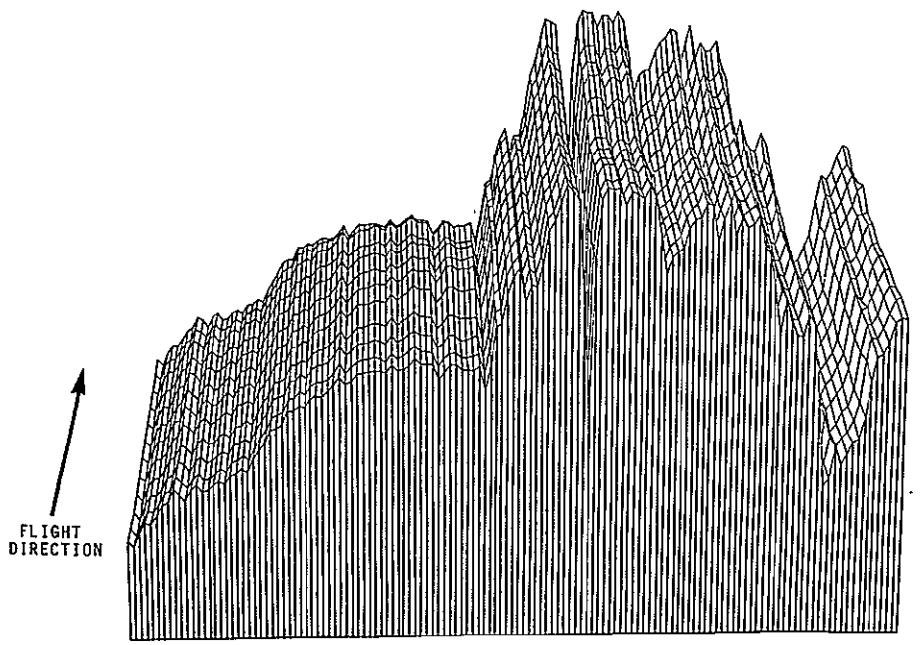
3368



9:28 AM 5/15/75

SUN ELEV = 58°

3366-3377



RIPE WHEAT

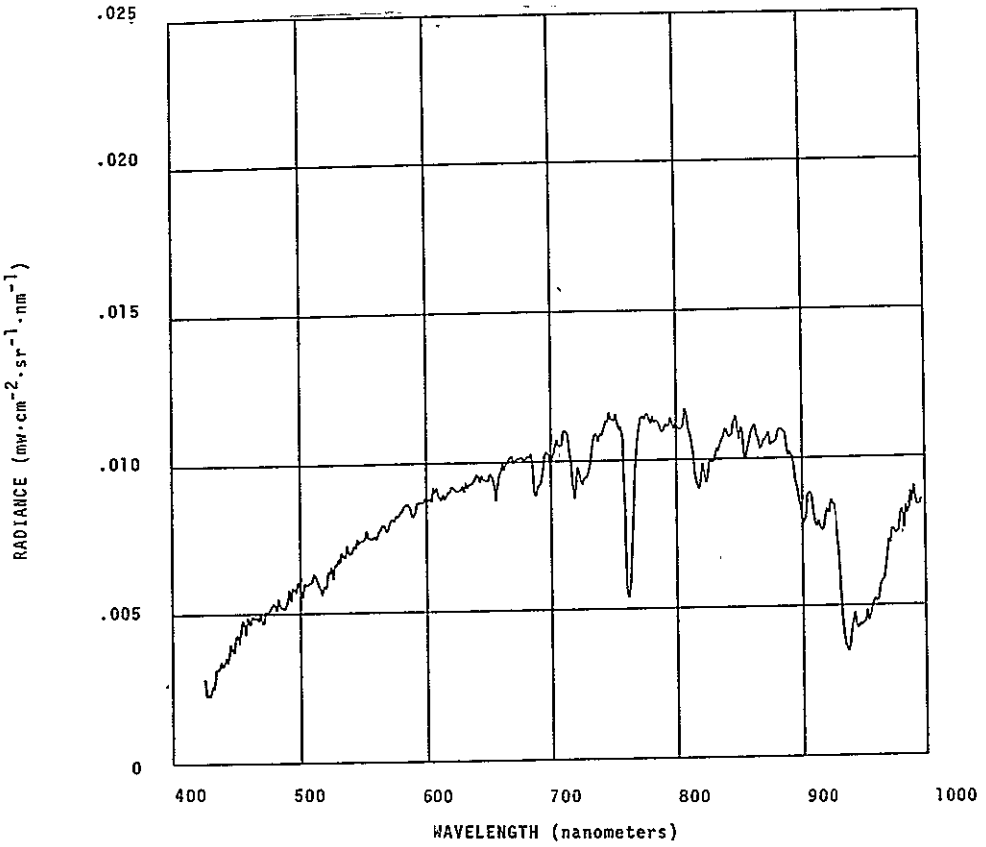
FIELD DESCRIPTION

36 to 40 inches, 90 to 100% leaf cover, thick uniform canopy. Crop very yellow and dry (ready for harvest). Soil dry. Imperial, light brown silty clay (7.5YR 6/4).

PHOTO INTERPRETATION

homogeneous tone; fine texture; high density; total cover; uniformly ripe; furrows run perpendicular to FL.

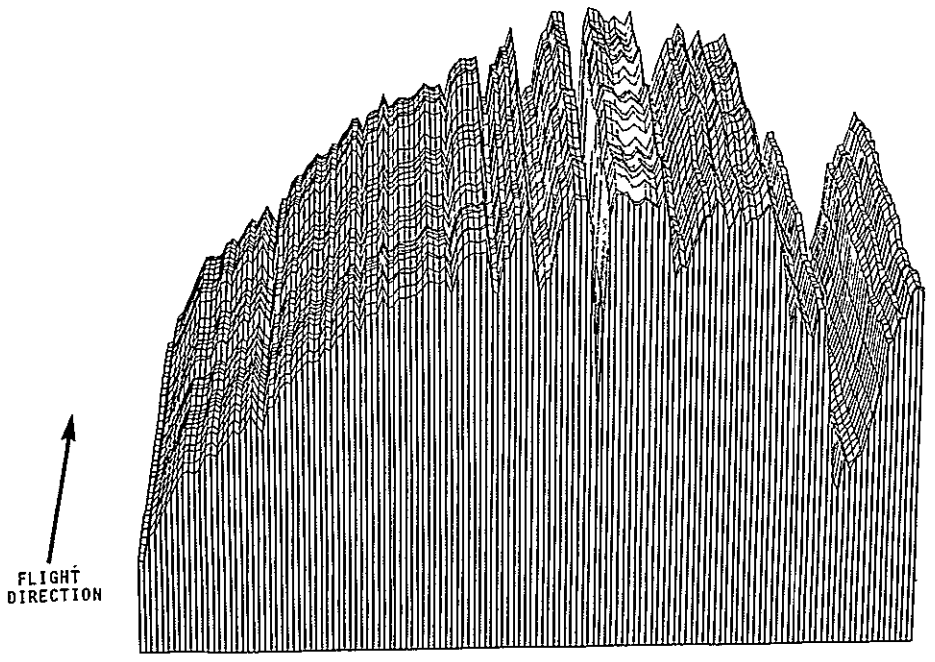
3383



10:33 AM 5/15/75

SUN ELEV = 70°

3378-3412



RIPE WHEAT

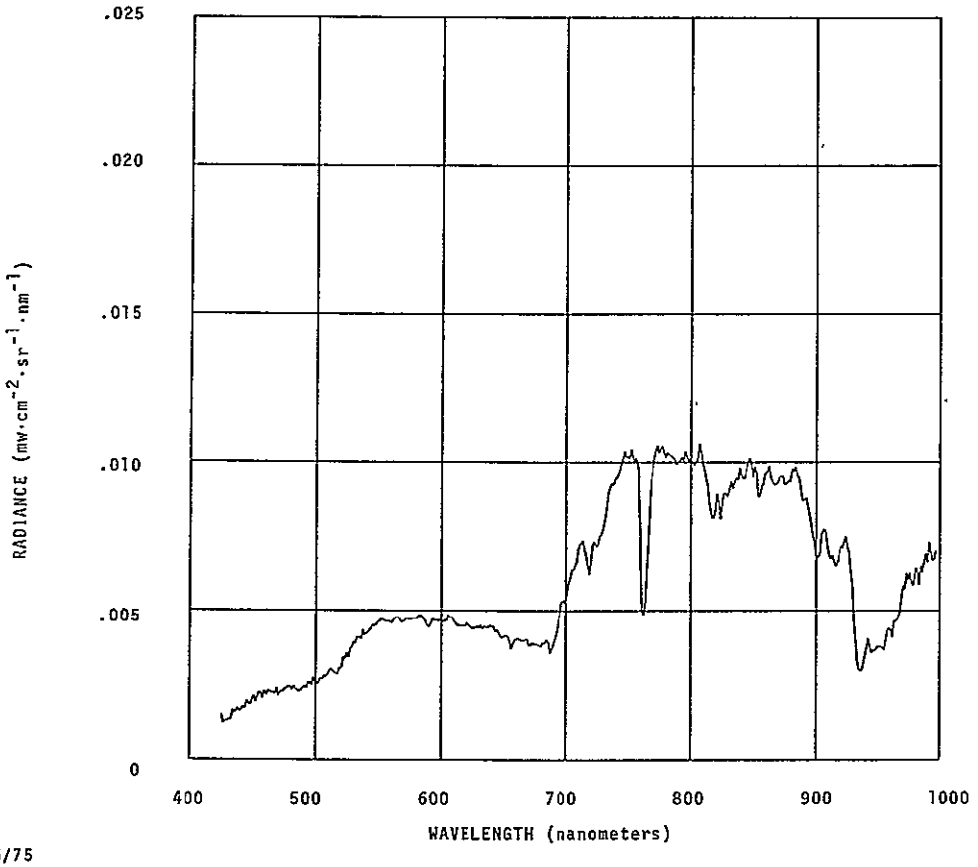
FIELD DESCRIPTION

36 to 40 inches high, 100% leaf cover, thick uniform canopy. Heads fully emerged and mostly yellow to yellow-green. Soil wet. Imperial, silty clay.

PHOTO INTERPRETATION

inhomogeneous tone; fine texture; high density, total cover; field is uniformly ripe except grain in furrows is unripe; furrows run perpendicular to FL.

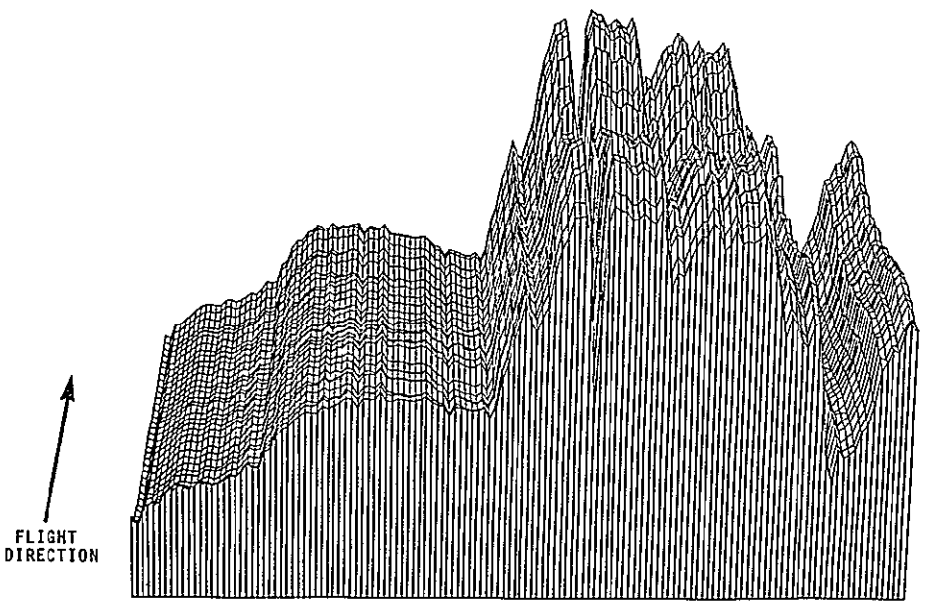
3444



10:04 AM 5/15/75

SUN ELEV = 65°

3413-3445



RIPE WHEAT

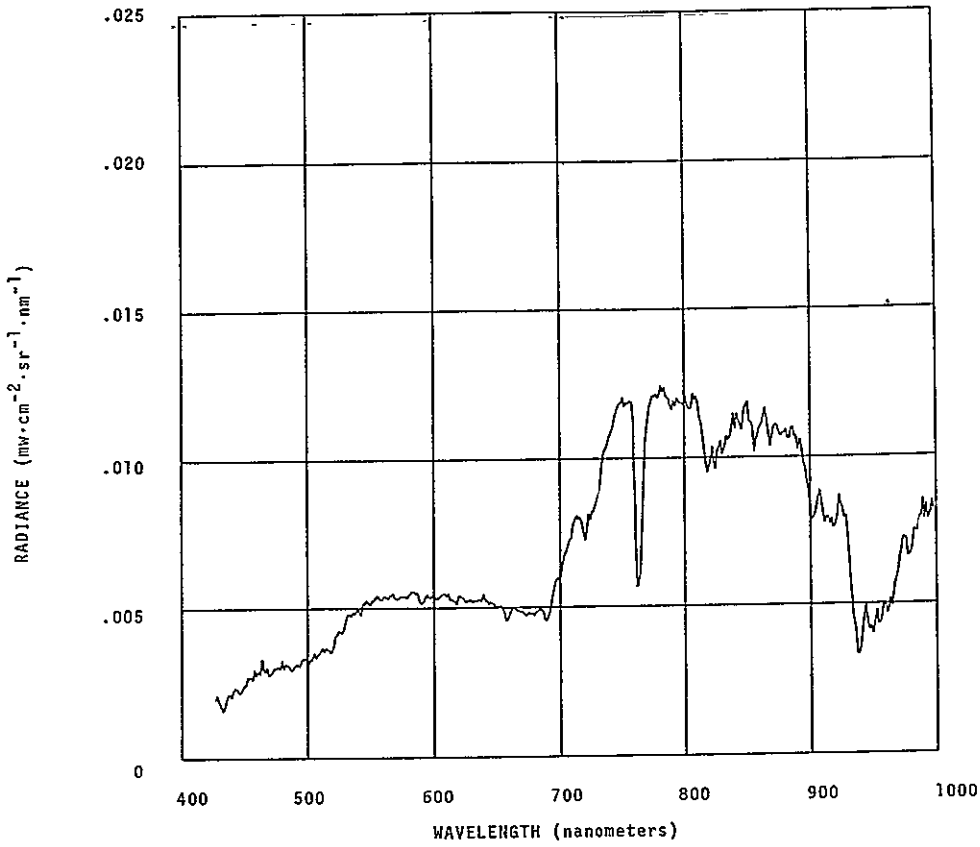
FIELD DESCRIPTION

40 to 45 inches high, 100% leaf cover (2% weeds), thick uniform canopy. Heads fully emerged and yellow, stalks green. Soil moist. Imperial, silty clay.

PHOTO INTERPRETATION

inhomogeneous tone; coarse texture, nonuniform differential density ranging from high to medium; near total cover with a few scattered sparse areas; nonuniform differential ripening; furrows run perpendicular to FL.

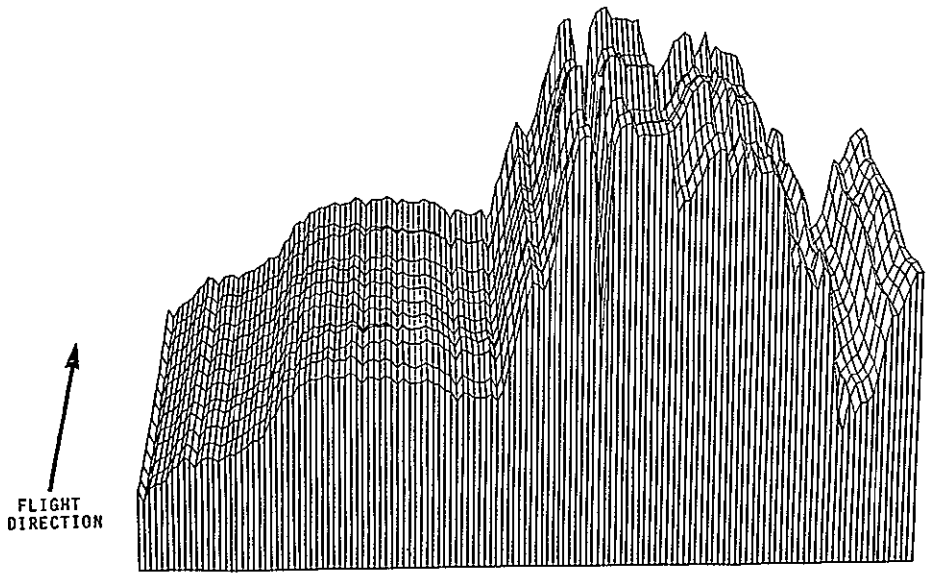
3450



10:10 AM 5/15/75

SUN ELEV = 66°

3446-3458



Appendix A. INSTRUMENTATION AND CALIBRATION

The aircraft instrument system used to collect high resolution spectra employs a Princeton Applied Research "Optical Multichannel Analyzer" (OMA) (Princeton Applied Research Corp., 1975), which drives a silicon vidicon detector coupled to a Jarrel-Ash .33 meter spectrometer, and a computer-compatible tape recorder (Figure A-1). Collecting optics image a ground target on the entrance slit of the Ebert design spectrometer. Radiation through the slit is collimated, dispersed by a grating, and refocused on the vidicon raster. The vidicon samples the spectrum on the detector in 500 wavelength intervals at the rate of 64 microseconds per channel and 32 milliseconds per frame. The detector output is amplified at the sensor, then sent to the A/D converter and digital processing. Digital data are stored in memory 1 where up to 10^4 scans can be summed. Spectral data in memory 1 are read out in real time on the display scope, and summed data are dumped into an interface built to automatically control the system. The interface recycles the OMA and sensor while dumping the summed data into a computer formatted eight track magnetic tape recorder. The interface monitors data going on tape for errors, and it triggers a 35 mm ground truth camera on every tenth spectrum going to tape. Table A-1 correlates

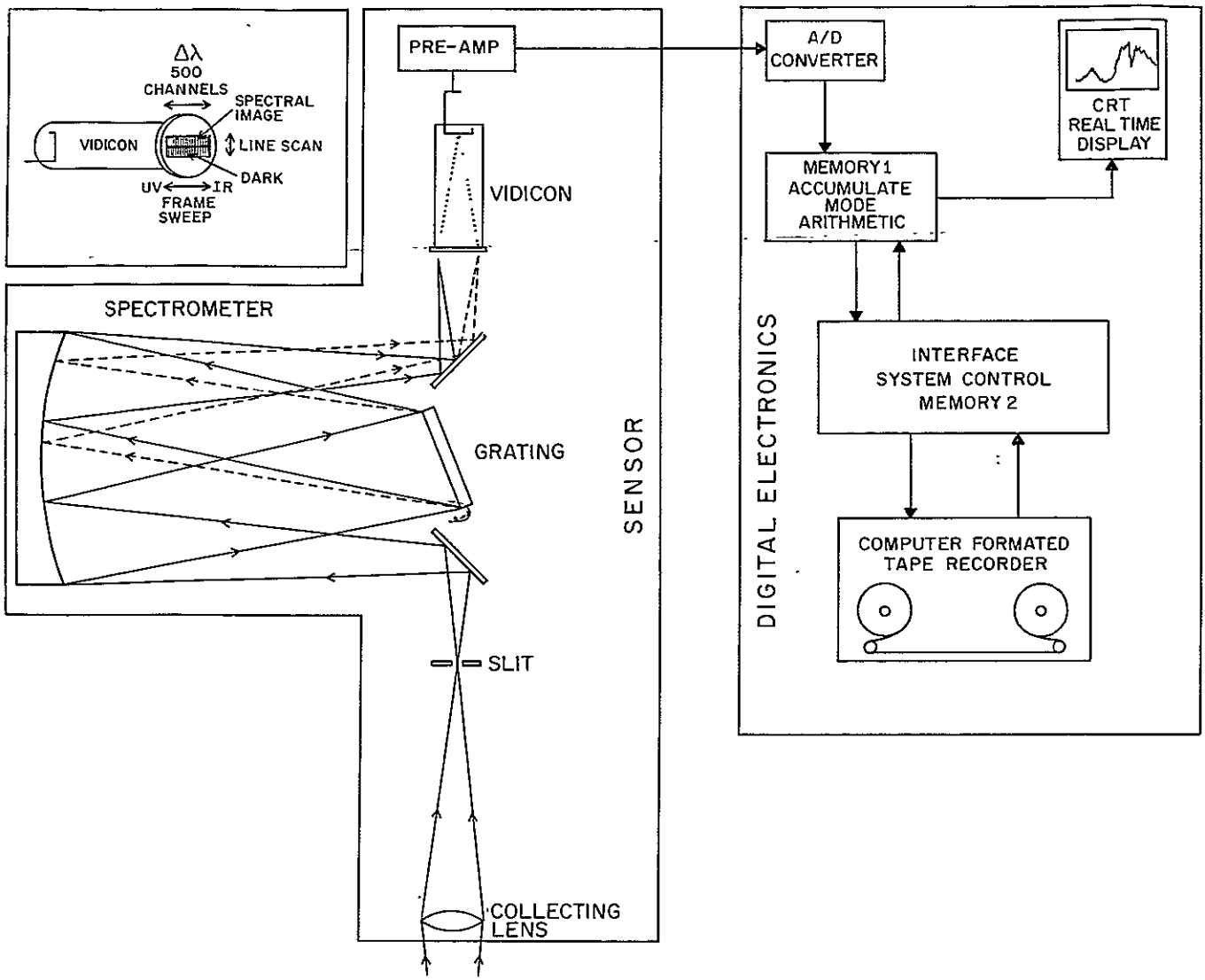


Figure A-1. Schematic diagram of the airborne instrument system. Radiation through the front optics is dispersed by the spectrometer and refocused on the vidicon. The vidicon raster format is shown in the inset diagram. Analog signals from the detectors are sent to the electronics package for processing and recording.

TABLE A-1. FLOW DIAGRAM OF THE AIRBORNE INSTRUMENT INTERNALLY PROGRAMMED OPERATION

Time Domain	Procedure	Data Material
64 microsec.	vertically scan one channel	one 13.96Å wide spectral channel
32 m sec.	sweep one vidicon frame of 500 channels	one spectrum to memory 1
320 m sec.	sum up 10 frames in memory 1	one averaged spectrum
3 x 32 m sec.	memory 1 data IBM formatted and recorded on tape	one averaged spectrum on tape
10 x 416 m sec.	camera triggered every 10th spectrum	one ground truth photograph

The operator gives the start signal at the beginning of a flight line and the sequence of events and timing are carried out with automatic recycling until the operator gives the stop signal.

the time domain procedure with the data format. The entire system functions continuously and automatically along an aircraft flight line.

The silicon target of the vidicon detector is a microscopic array of photodiodes spaced 8μ between centers and read out by an electron beam 20μ in diameter. A spectrum displayed on the vidicon raster is dispersed along the horizontal x-axis, or frame sweep dimension, of the detector (inset in Figure A-1). Each of 500 "monochromatic" channels in a frame is read out by a vertical line scan of 64 microseconds and output serially. The line scan is electronically chopped to remove dark current, which is read on the lower half of the raster where no signal is applied.

In the usual mode, photoelectric detectors, such as those used in LANDSAT, respond to radiant flux as a function $F(x,y,t)$ of the spatial coordinates on the detector surface and time

$$S(t) = \int \int_{\Sigma} F(x,y,t)\, dx\, dy \quad [\text{counts} \cdot t^{-1}] \qquad (1)$$

where $S(t)$ is the digitized detector signal at the time t of the readout integrated over the detector surface Σ. The photodiodes in a vidicon detector are storage devices responding to total energy incident between readouts. The

time relationships are lost, but the spatial relations can be preserved according to the scan mode used. The output signal of the OMA detector electronics can be written

$$S(x) = \int_0^T \int_{\Sigma_{y,\Delta x}} F(x,y,t)\, dt\, dy \ [\text{counts}\cdot\text{ch}^{-1}] \qquad (2)$$

where T is the readout interval. The line scan integrates the total energy incident between readouts, 32 msec., over the chromatic image of the spectrometer entrance slit focused on a 2.5 mm by 25μ detector element. Spectral information is preserved in 500 intervals in Δx along the frame sweep but spatial variables in each chromatic image are integrated over the line scan area $\Sigma y,\Delta x$. The vidicon system, functioning as a parallel input device, achieves considerable gain in sensitivity and simplicity of design over serial input devices using radiant flux detectors. Parallel optical input is the essential design element in the present application. It permits high spectral resolution measurements in 500 bands to be made in real time, and equally important, the simple design affords reliable operation from a light, inexpensive aircraft.

The instrument package consists of an electronics rack and the sensor, together weighing about 123 kilograms. It is flown in a light airplane at 610 meters above the terrain with the sensor looking vertically at the ground

along the flight path. The instantaneous field of view is 18 meters by 1.8 meters (Figure A-2). The shape is determined by the rectangular dimensions of the spectrometer entrance slit. The long axis of the field of view is fixed perpendicular to the flight direction. Ten spectra, or frame sweeps, are summed over .32 seconds corresponding to 18 meters of aircraft motion along the ground track. The sum of ten frame sweeps is recorded on tape and later averaged to obtain the spectral response integrated over an 18 meter square field of view. In the cycle of add ten frames - dump to tape - start new summation, three frames are skipped. Blocks of data on tape in 500 spectral bands correspond to consecutive 18 meters square integrated target areas along the flight path with about 5 meters of spacing between. Ground truth photographs taken every 10th dump to tape have about 60 percent overlap.

Instrument Calibration

Aircraft spectral measurements in 500 channels per spectrum are calibrated to convert recorded digital data from the instrument in counts per channel to apparent radiance per one nanometer interval. Calibration measurements are made in the laboratory before the instrument is installed on the aircraft for a series of survey flights and again after it returns. The absolute calibration relates aircraft measurements to a standard lamp. One calibration is applied to all measurements in a single flight line in

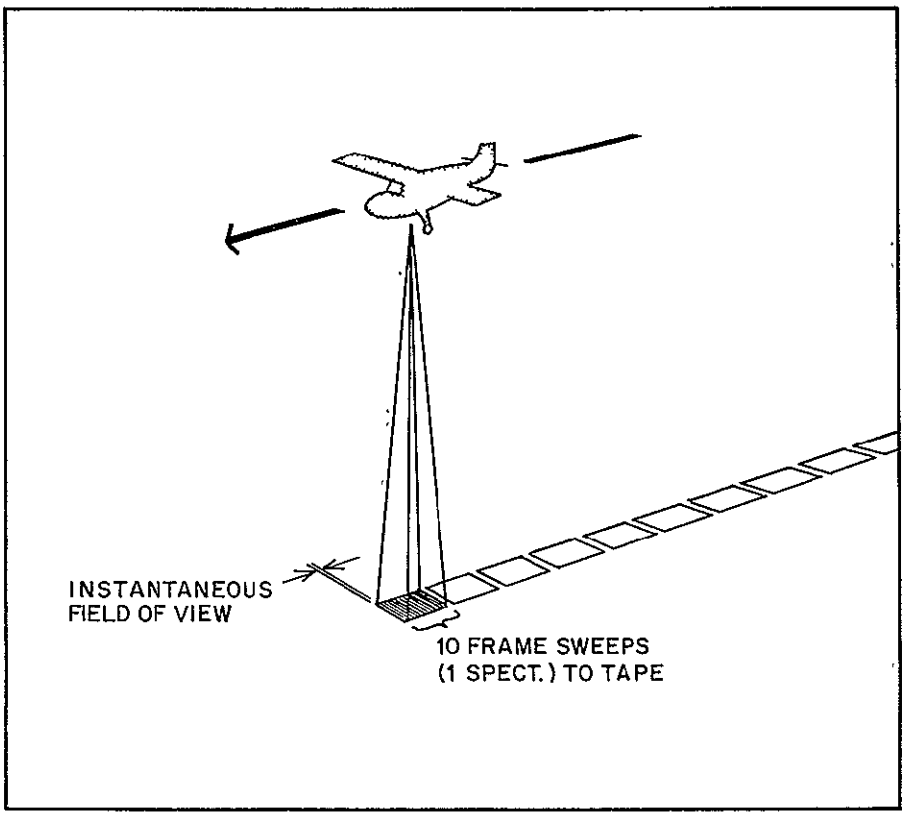


Figure A-2. Survey procedure. Spectral measurements are integrated over consecutive 18-meter-square areas along the ground track and recorded on tape. Flight lines are arranged to transect targets of interest.

order to preserve the separation of inherent inaccuracies of the absolute calibration from the precision of relative measurements along the flight line. Precision among spectral measurements in a flight line is affected by error in wavelength-channel correlation, caused by drift in grating position due to mechanical and temperature induced strain; drift in sensor electronics and detector sensitivity, mainly a function of temperature variation; and microphonics in the optical and vidicon systems. The drift due to temperature variations are small over a flight line of 2 to 3 minutes duration, and optical noise is controlled by careful design and construction. The precision over a flight line will be much better than the accuracy of absolute calibrations. The absolute calibrations will be affected by those factors affecting the precision only over much greater time periods and ranges in temperature. Absolute calibrations are also dependent on the accuracy and precision of the calibration source and laboratory conditions and procedures. The radiation standard used is an ISCO current regulated tungsten lamp (Instrumentation Specialties Company, Inc., n.d.) calibrated against a National Bureau of Standards lamp. Measurements made after the flight are compared with those taken at the same instrument settings before the flight. These are compared to determine drift in responsivity over the flight period. Calibration of the flight data is done in the after flight

calibration simulating instrument settings and temperatures at the time of the field measurements for each set of instrumentation circumstances.

The signal output of the instrument can be broken down, disregarding field effects, as a function of the mean spectral radiance of the target and the instrument factors. Radiant energy through the system is affected by the optical properties of each component in the collecting optics and in the dispersing device before it reaches the detector element. At the detector, the efficiency of the photon to electric signal conversion is a function of wavelength, position on the detector surface, and angle from the normal of incident radiation. The analog electronic signal produced at the detector is processed through several stages of amplification in which amplifier gains modify the signal before it is digitized. All of the instrument factors combined determine the radiance responsivity R_N of the total system at the time of the measurement. The amplified and digitized output signal S_I of the instrument can be written

$$S_I = \int_{\Delta\lambda} \bar{N}_\lambda(\lambda) R_N(\lambda) d\lambda \ [\text{counts}] \qquad (3)$$

for each channel of a spectral measurement.

The spectral response of each instrument component can

be assumed constant over the narrow wavelength $\Delta\lambda$ of an instrument channel. The output signal by channel can be written in simplified form with all instrument parameters included:

$$S_I = \overline{N}_\lambda \; T \; \tau_O \; \tau_F \; E_G \; R_D \; \Delta\lambda \; [\text{counts}]. \qquad (4)$$

The throughput T, as already discussed, includes the geometric factors that determine the field of view Ω' and the effective area A of the entrance aperture. Included in T is the f-stop, or aperture stop, setting of the collecting optics used during the field observation. The transmittance of the optical train τ_O includes all lenses, mirrors, and the detector window. Spectral transmission properties of all filters used for each observation are included in the term τ_F, and E_G is the spectral efficiency of the grating for non-polarized light. The detector response R_D is strongly dependent on wavelength, position on the light sensitive surface, and angle of incidence. To compensate for this as much as possible, the grating is set with a frequency standard to position the spectrum on the vidicon detector as it was in the field measurement.

An instrument transfer function can be defined for each specific optical configuration:

$$C_\lambda = [T \; \tau_O \; \tau_F \; E_G \; R_D \; \Delta\lambda]^{-1} \; [\text{counts} \cdot w^{-1} \cdot cm^2 \cdot sr \cdot ch.]. \qquad (5)$$

A set of instrument functions for each of the 500 channels is calculated for every combination of f-stop, filters, and grating position used in the field observations. The instrument function can be calculated from Equation (4):

$$C_\lambda = \bar{N}_{\lambda_L} \Big/ S_I \ [\text{counts} \cdot w^{-1} \cdot cm^2 \cdot sr \cdot ch.] \qquad (6)$$

where $\bar{N}_{\lambda_L}$ is the radiance of a white diffusing plate irradiated by the ISCO lamp of known radiant intensity. Field measurements are calibrated from

$$N'_\lambda = S_T \ C_\lambda \ [w \cdot cm^{-2} \cdot sr^{-1} \cdot ch.^{-1}] \qquad (7)$$

where N' is the apparent radiance of a target, S_T is the recorded signal for the target, and C_λ is the channel by channel transfer function for the specific instrument configuration. The spectral curves for the lamp measurement, the transfer functions, and the resultant calibrated lamp spectrum calculated from Equation (7) are shown in Figure A-3. The baseline (amplifier bias) is subtracted from the curves as it is in all the data.

Frequency calibration is accomplished using a krypton emission line spectral lamp (Figure A-4). The peaks of known wavelength can be located within 0.2 channels on the instrument display scope in real time. The channel width

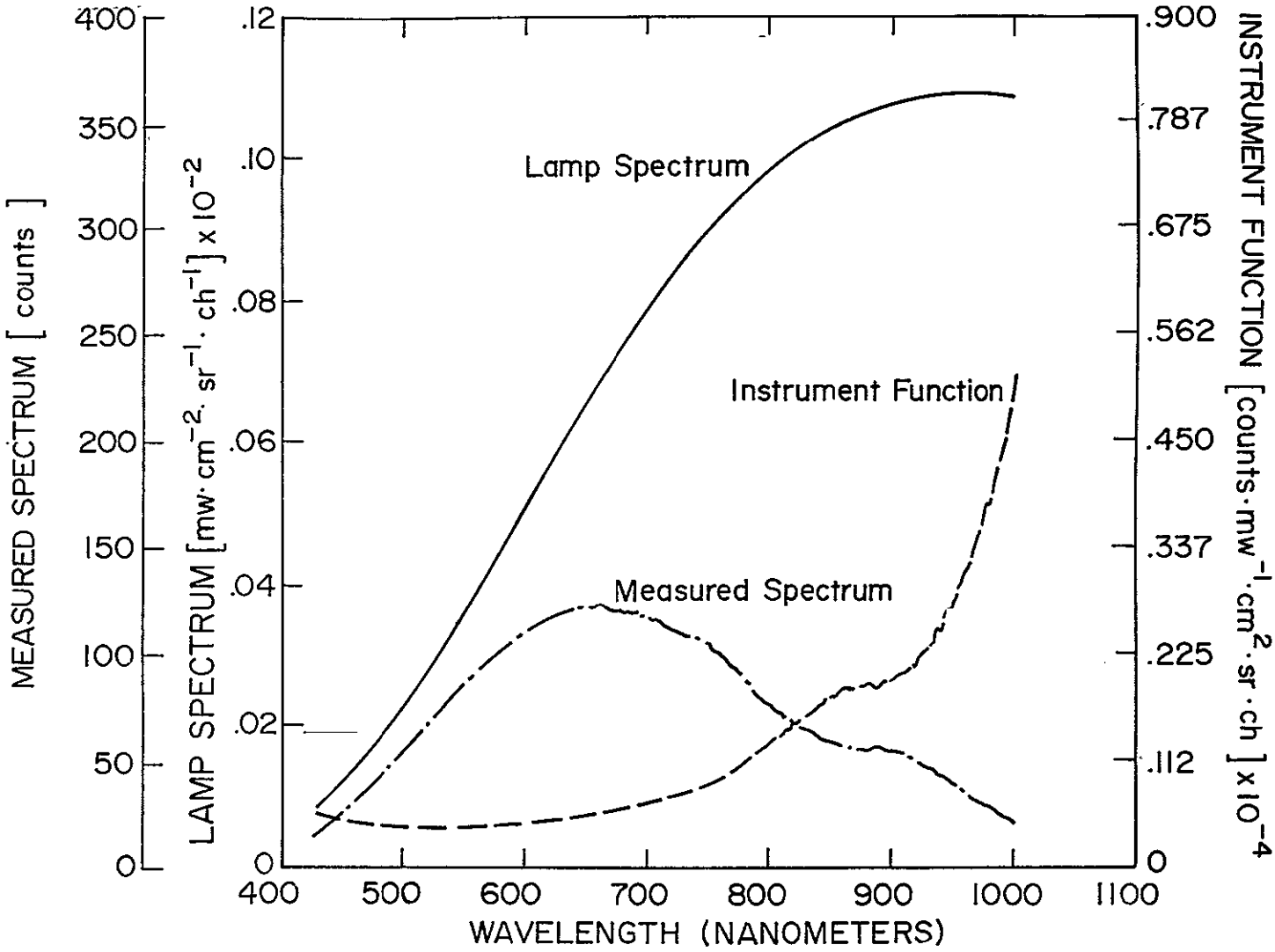


Figure A-3. True spectral curve of the ISCO calibration lamp (solid line) calculated as the product of the measured spectrum and the instrument function curve. The instrument function curve was determined from a similar measured spectrum of the calibration lamp.

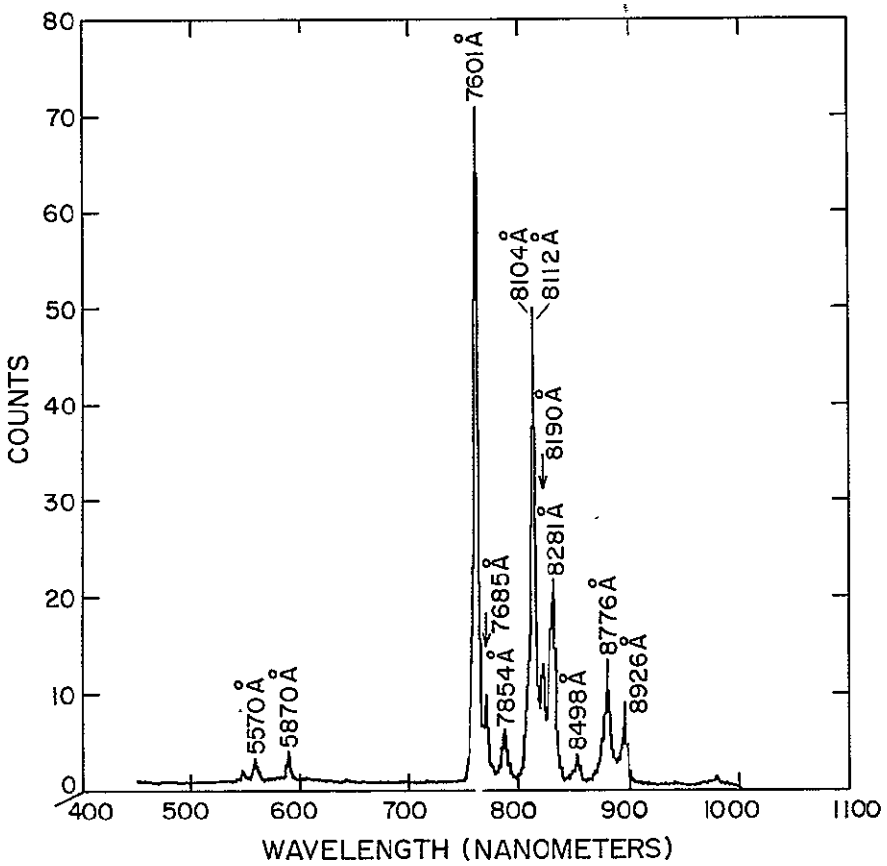


Figure A-4. Emission lines of a krypton gas lamp. Location and spacing of the lines of precisely-known frequencies are used in determining the instrument channel width and wavelength scale.

is calculated from the number of channels between the various peaks of known frequency. The channel width, $13.96\text{Å} \pm .025\text{Å}$ is determined by the grating dispersion and the spectrometer focal length. A 72 grooves per millimeter grating disperses the wavelength interval from 4000Å to 11000Å over 12.5 mm in the system spectrometer that has been modified to approximately .1 meter focal length. A split filter is placed in front of the detector to eliminate second order effects between 7000Å and 11000Å. The low dispersion grating gives a very even wavelength distribution across the detector. Error translated to the end channels due to uneven dispersion is 6.25Å, less than half a channel. Frequency alignment is made by positioning the 7601Å krypton peak on channel 250. Field calibration for grating setting is obtained from the position of the atmospheric oxygen absorption band centered at 7605Å. This absorption band is inherent in every field spectrum, allowing accurate monitoring of wavelength setting in the field data.

The field of view was mapped using a light source through a small aperture at 61 meters from the sensor. It is 15 milliradians in the long slit dimension and 1.5 milliradians in the slit width direction. The system linearity with change in intensity measures ± 1 percent using calibrated neutral density filters and the ISCO lamp. The detector and amplifier RMS noise, looking at a series of

recorded reference baselines (front lens covered), is ± 1 count in the accumulate ten scans mode. Most target measurement signals are between 100 and 700 counts per scan. The signal to noise ratio is greater than 100:1 in most cases. The maximum dynamic range is 750. The lag in response to signal change on the accumulate 10 scans mode was measured by repeatedly opening and closing the aperture while looking at a strong light source. The signal rises to within 12 percent of the maximum in the first recorded spectrum on opening the lens, and the signal drops to 17 percent of the last signal on closing off the front lens. The slow response time must be considered in planning flight lines and interpreting the data.

There is a maximum spectral standard deviation of 5.5 percent in calibration measurements made before and after the two aircraft flights to Nevada. The apparent drift in sensitivity can be traced mainly to temperature effects and frequency misalignment among measurements. The maximum standard deviation in sensitivity between the normal operating ranges of 15 ^{o}C to 27 ^{o}C is ± 3.5 percent in the blue spectral region (Figure A-5). There is a possible ± 1 channel absolute error in reproducing the grating settings as they were in the field. The oxygen absorption band is checked in every flight line, and the relative wavelength drift is always less than 1/2 channel. A drift of one channel can cause up to 2.5 percent standard deviation in the spectral

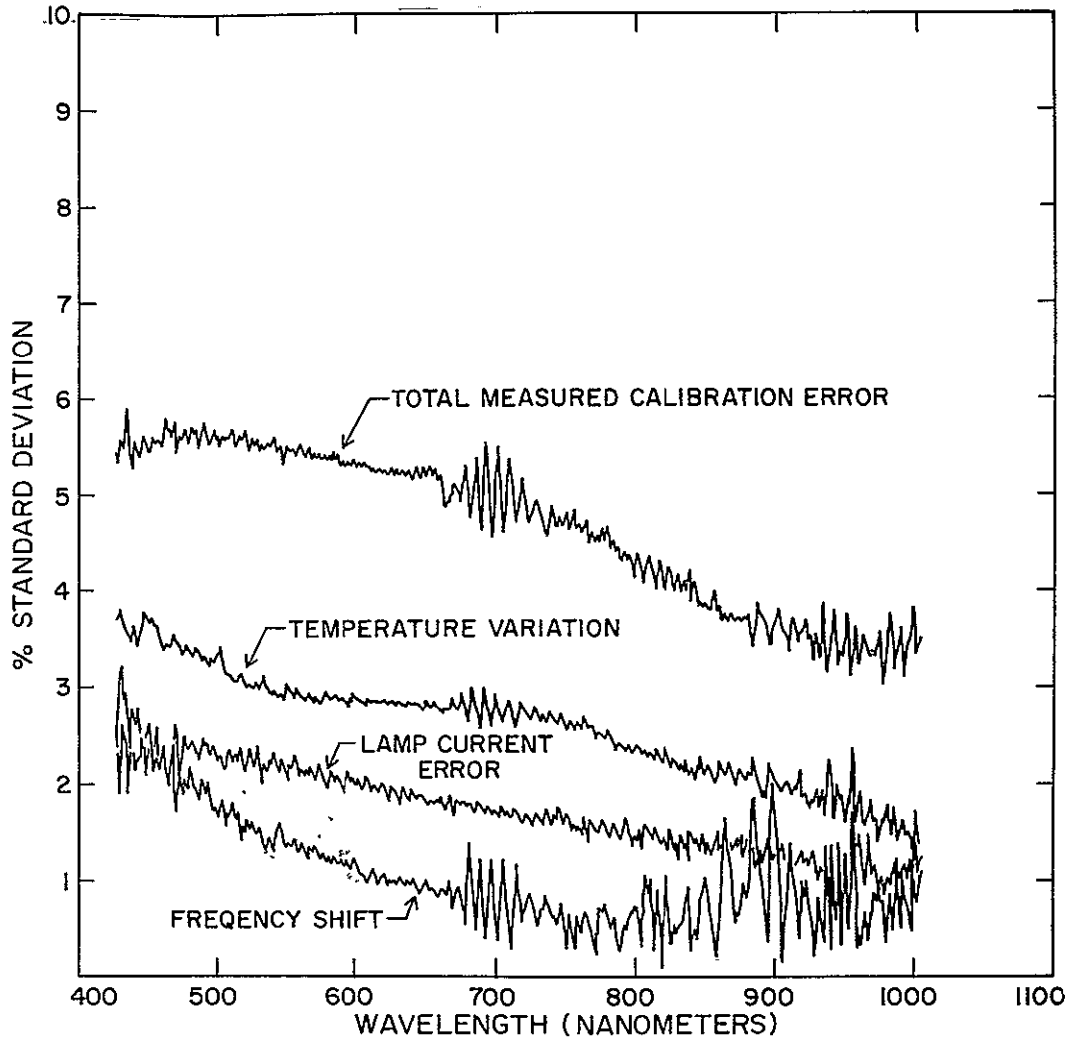


Figure A-5. Percent standard deviation as a function of wavelength among all before- and after-flight calibration lamp measurements. The three lower curves indicate measurement variation as temperature, frequency setting, and lamp current were varied under controlled laboratory conditions. The noise at 7000Å is the edge effect of the split filter for eliminating second-order overlap.

measurements. There is a possible error of the same amount due to lamp current adjustment error. The other sources of error, calibration lamp aging and electronics drift, have not been monitored.

The precision among all data collected will be on the order of the error discussed above. Drift in sensitivity over lamp measurements of 2 to 5 minutes, however, is less than $\pm$1 percent. This should also be the precision of the data within a flight line. Most of the error in the relative calibrations from one flight line to another over long time periods would be removed by on-board calibration. The accuracy, or absolute calibration has the added error of the calibrated light source. The manufacturer's estimate on that is $\pm$5 to 10 percent (Instrumentation Specialties Company, Inc.) relative to the NBS standard.

References

Collins, William. "Spectroradiometric Detection and Mapping of Areas Enriched in Ferric Iron Minerals Using Airborne and Orbiting Instruments." Ph.D. dissertation, Columbia University, 1976.

Instrumentation Specialties Company Inc. "Instrumentation Manual - Model 5RC Spectroradiometer Calibrator." Lincoln, Nebraska: Instrument Specialties Company Inc., n.d.

Princeton Applied Research Corp. "Optical Multichannel Analyzer (OMA), Operating and Service Manual." Princeton, NJ: Princeton Applied Research Corp., 1975.

Appendix B. SITE AND MISSION

Site

The data presented in this document were collected in Imperial County, California (33°N 115°W). This county, which encompasses nearly three million acres (1.5 million hectares), is bordered by Riverside County (north), the Colorado River (east), Mexico (south), and San Diego County (west).

The county can be described as comprised of two parts: the western two-thirds, dominated by a broad structural trough having a NNW-SSE axis; and the eastern one-third, where the broad, gently-sloping alluvial fans from the Chocolate Mountains meet the floodplain of the Colorado.

The trough in the western part of the county contains Colorado River sediments, and alluvium from the Chocolate Mountains and the California Coastal Range. The Salton Sea is in the center of the trough. Old Lake Cahuilla, now dry, is also in the center of the trough, and contains irrigated farmland which comprises the site locations.

Elevations in the Imperial County range from 71 meters below sea level to more than 1200 meters above sea level. Irrigation occurs only at elevations below 75 meters.

The climate of Imperial County is dry with hot summers and cool winters. Average rainfall is approximately 3 inches per year, of which about half falls in high intensity summer showers and about half in gentle winter rains.

Day temperatures rise above 100°F almost every day, May through October, dropping to the low 60's at night. Mean temperatures over a 50-year period at Imperial are 52.9 for January, 91.2 for July, 71.5 for the year.

Average annual humidity is about 30 percent and is often higher in July and August.

Highest evapotranspiration takes place during the period June through September. Consumptive use in this period is about one-third of an inch per day (USDA, 1967).

This study specifically focused on two sites of irrigated agricultural land in the Cahuilla dry lake, Imperial Valley, California. One site is located in the southern part of the county near the town of Calexico, while the other is located in the eastern-central portion of the county (Figure B-1). Together, they encompass approximately 3,840 acres or 1500 hectares of crop land. The crop types include both continuous-cover crops, such as alfalfa, wheat and barley, and row crops, such as sugar beets, melons, asparagus, carrots, sorghum and cotton. Crop distribution for the two sites is presented for each date of data collection in Figures B-2 and B-3.

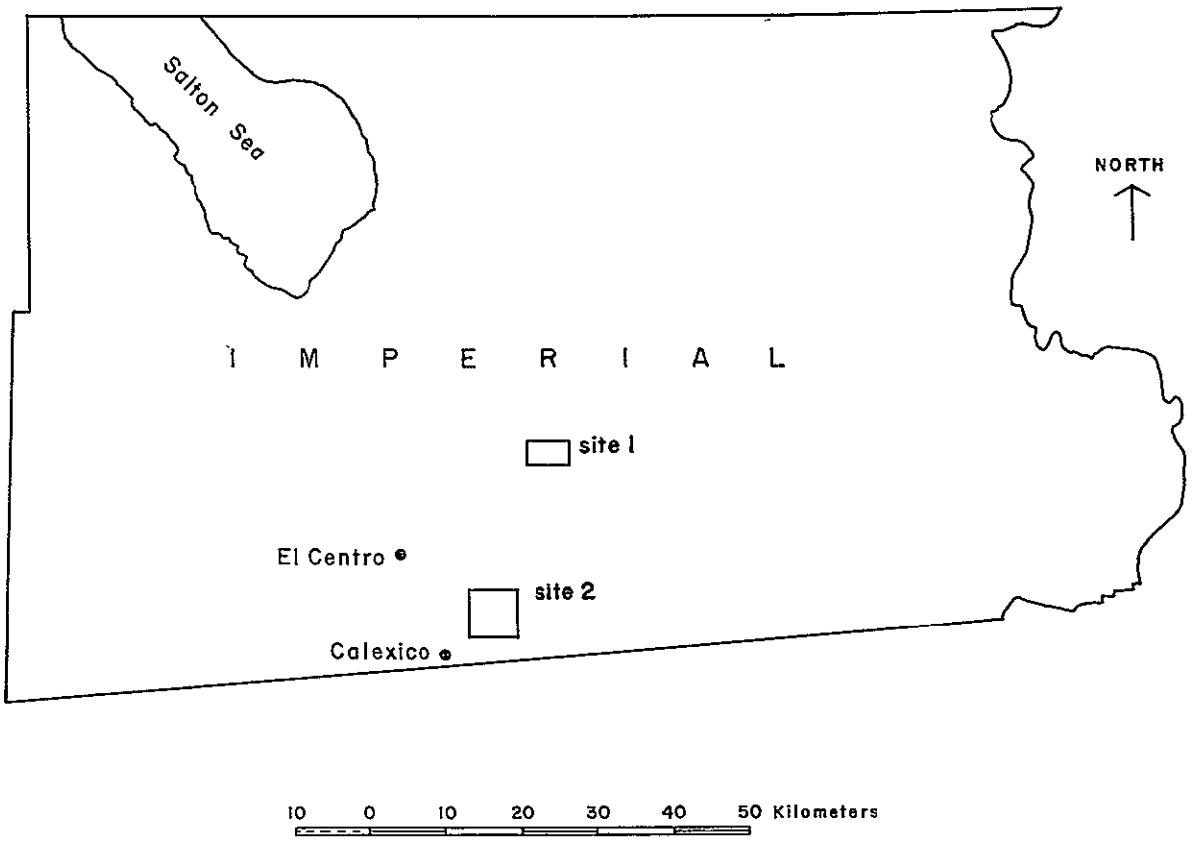


Figure B-1. Location of test sites, Imperial County, California.

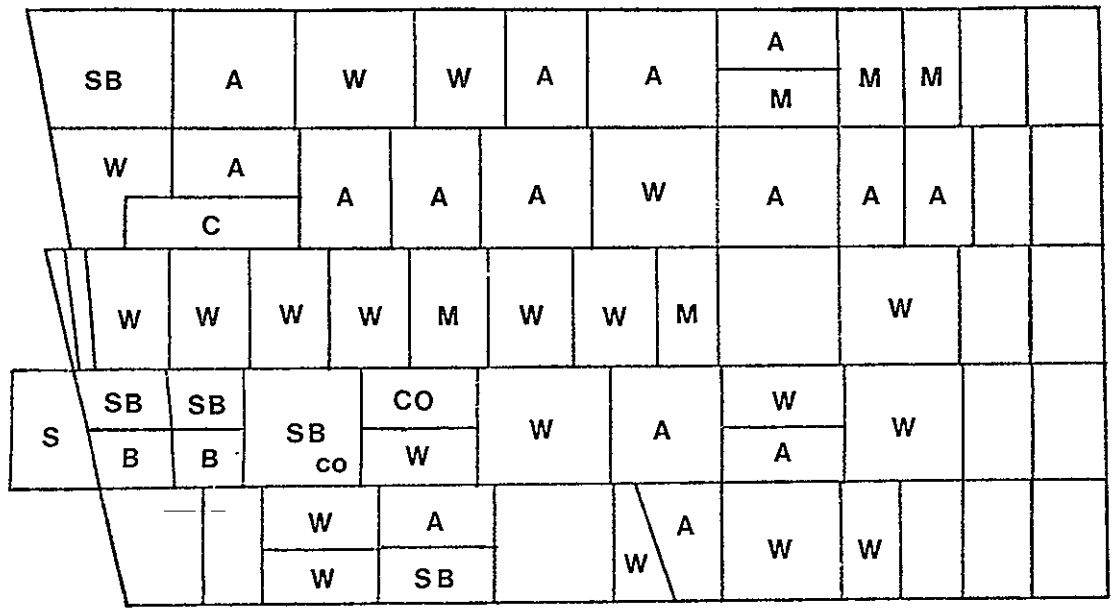


Figure B-2. Fields in site 1 for which spectra are included in the Atlas, labeled by crop type: A=alfalfa, B=bare soil, C=carrots, CO=cotton, M=melons, S=sorghum, SB=sugar beets, W=wheat. Lower case letters are used to denote September crop when it differs from May crop.

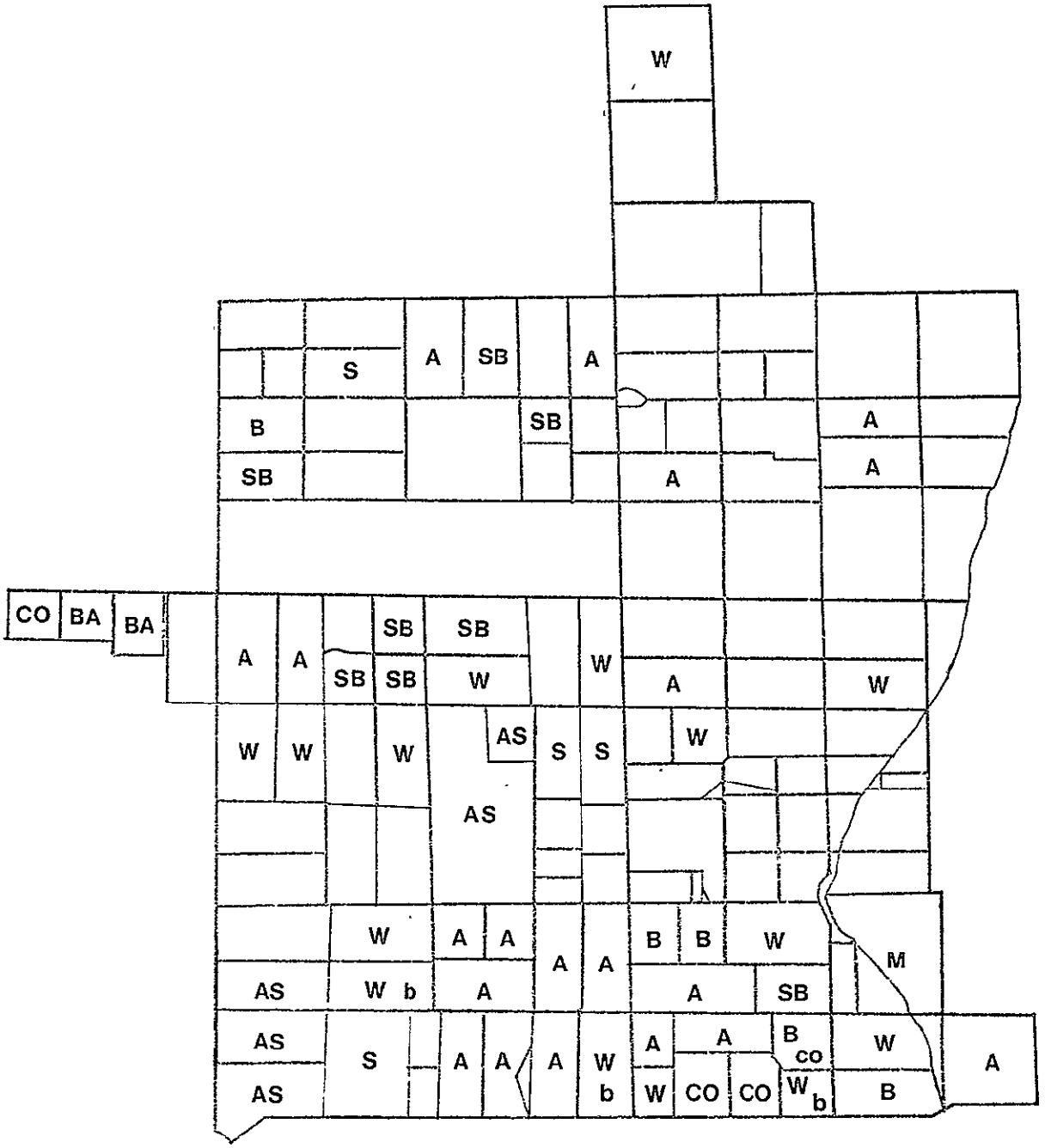


Figure B-3. Fields in site 2 for which spectra are included in the Atlas, labeled by crop type: A=alfalfa, AS=asparagus, B=bare soil, BA=barley, CO=cotton, M=melons, S=sorghum, SB=sugar beets, W=wheat. Lower case letters are used to denote September crop when it differs from May crop.

Mission

Spectroradiometer data and 35 mm color photography were simultaneously collected from a twin-engine Aero Commander at an altitude of 610 meters above local terrain. These flights were flown east-west, as shown in Figures B-4 and B-5. Site 1 was covered by ten flight lines approximately 5 miles (8km) in length. Site 2 was covered by eleven east-west flight lines, ten approximately 4 miles (6.5 km) long and one approximately 1 mile (1.6 km). Not all flight lines were flown on all missions, and some were flown twice on the same mission (Table B-1).

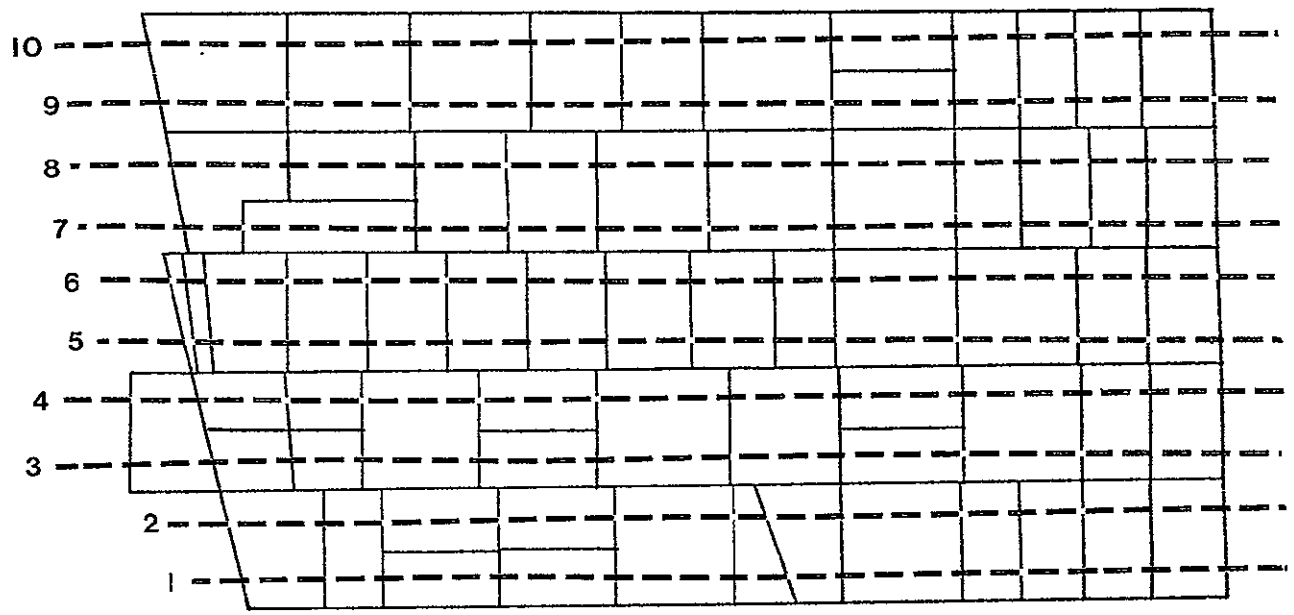


Figure B-4. Flight lines for site 1. Each flight line is approximately 5 miles (8 km) in length. Not all flight lines were flown on all missions, and some were flown twice on the same mission.

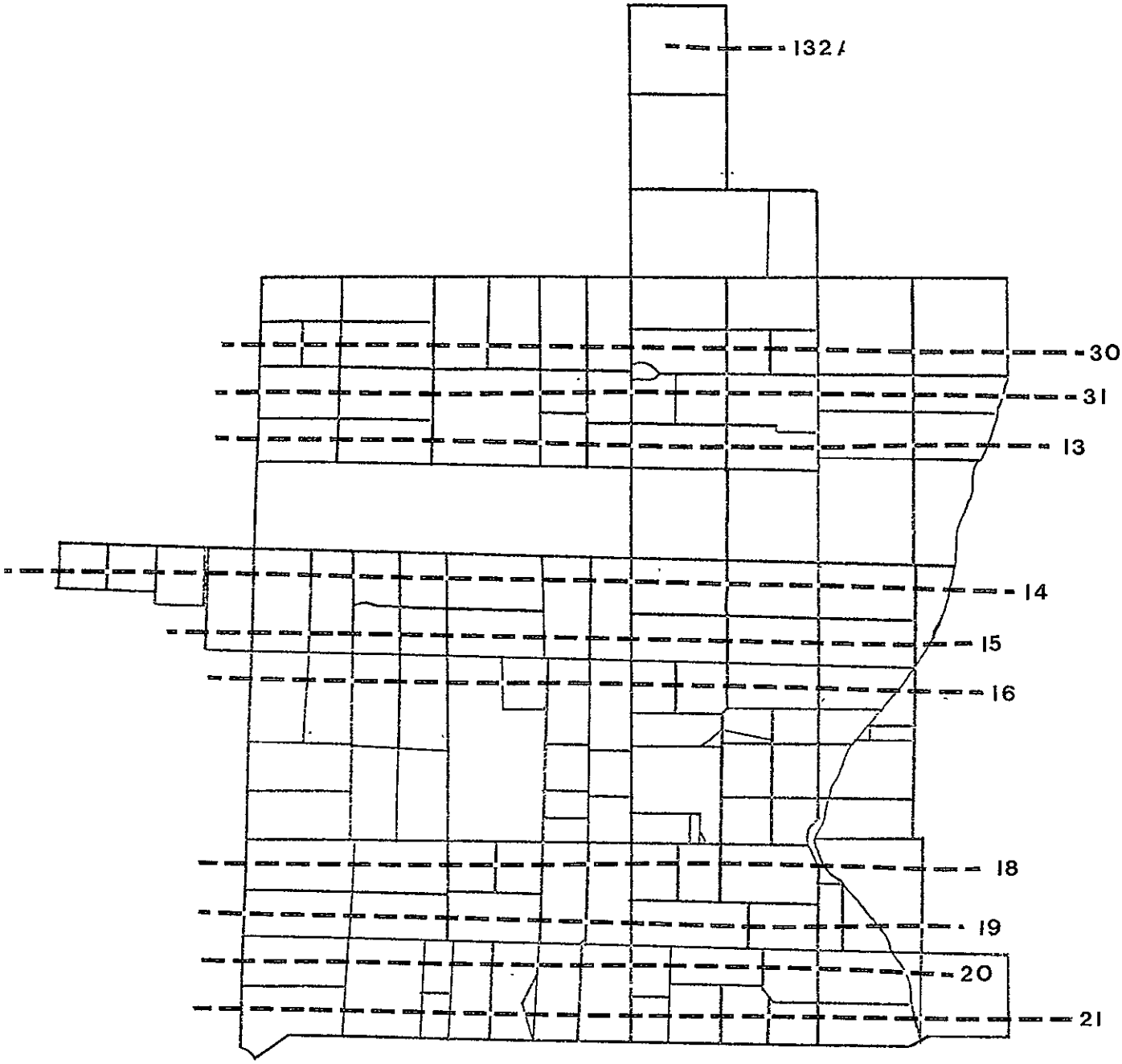


Figure B-5. Flight lines for site 2. Ten of the flight lines are approximately 4 miles (6.5 km) in length; the other one is approximately 1 mile (1.6 km) in length. Not all flight lines were flown on all missions, and some were flown twice on the same mission.

TABLE B-1. MISSIONS OVER IMPERIAL VALLEY TEST SITES, 1975

Site	Date	Time (Duration)	Flight Lines[a]
2	5/15/75	9:28 AM - 10:42 AM	13, 14, 15, 16, 18, 19, 21[b], 30, 31, 132A
1	5/16/75	9:54 AM - 11:03 AM	1, 2, 3[b], 4, 5, 6, 8, 10
1	5/20/75	10:55 AM - 11:10 AM	7, 9
2	5/20/75	11:15 AM - 11:25 AM	14
1	9/23/75	11:19 AM - 11:30 AM	3,4
2	9/23/75	10:26 AM - 10:37 AM	19, 20, 21
2	9/23/75	11:42 AM - 11:50 AM	21

[a]See Figures B-4 and B-5.

[b]Collected twice.

Appendix C. GROUND OBSERVATIONS

Ground truth was collected by GISS, Columbia and Dartmouth personnel on the same day as the overflights. Ground data were taken using standard windshield survey techniques accompanied by ground assessment in each field to determine irrigation state, crop, crop height and density, and overall field condition. These data were augmented by discussion with and participation of local USDA personnel as well as interested farmers who volunteered information and assistance. Also, Imperial Irrigation District provided extensive supporting data on crops, crop calendars and irrigation status.

In addition to these direct observations, baseline soil data have been extracted from the General Soil Map and Report, Imperial County, California (USDA, 1967). These data elements include soil type, soil texture, and soil color for the Ap horizon. Soil color is given in the Munsell notation when the soil is reported dry.

Reference

U.S. Department of Agriculture Soil Conservation Service. Report for General Soil Map, Imperial County, California. El Centro, California, 1967.

Appendix D. PHOTO INTERPRETATION SUPPORT

Photo interpretation of the 35 mm color aerial photography collected concurrently with the spectroradiometer data was performed for the purpose of supporting and clarifying the spectroradiometer data, and also to supplement the ground observations by uncovering broad and extensive patterns which were unrecognizable in ground field work.

An intensive interpretation was performed on individual fields using 35 mm (strip) color transparencies at a scale of 1:20,000. These strips were acquired simultaneously with the spectroradiometric data. The coverage of the fields encompassed 840 frames with approximately 60% overlap. Bausch and Lomb Zoom 240 optical equipment was utilized with varying magnifications, ranging from 4 to 7.5X, according to the image characteristic under examination. Each field was classified using the image characteristics, tone, texture, density, cover, crop status and furrow direction (see Table 2, Chapter 1).

When examining tone, fields were classified according to their homogeneity. If the tone was interrupted because of contrasts due to ripening, visibility of bare soil areas, soil moisture patterns, or any other crop condition, the field was graded inhomogeneous.

Texture results from differential height in the crop. For example, a coarse texture is present when growth is sporadic, harvesting is in progress, or when a crop, such as melons, is in an early growth phase and height difference between the clusters of plants and bare soil is large. Texture is absent or fine when the crop has smooth and uniform cover, or when the field contains bare soil. In those fields where texture was differential, the range was specified and exceptions were mentioned.

Both density and cover are descriptions of the amount of soil that is visible in the field, however, it is quite possible for a crop to have total cover but medium density, for example. To clarify the difference between terms, density is basically the number of plants per unit area and describes the thickness of the crop and how closely planted it is. Crop cover is more a description of the growth stage and vigor of the crop. If a crop is stressed, the cover can be spotty and discontinuous while a healthy (unstressed) crop will tend to have total or near total cover. Likewise, newly planted crops have very low cover while mature crops tend to have total cover.

The classification of furrow direction was very straightforward. The furrows either ran parallel or perpendicular to the flight line. However, the term "furrow" should be further defined since it is used loosely to refer not only to furrows but also to crop rows and irrigation control ridges in continuous-cover crops. In some fields, the crop density was so high that the furrows were not visible. In these cases, no mention was made of their direction.

Any unusual pattern or conditions fell under the crop status category. These included such things as ripening stages, and irrigation, growth, or soil moisture patterns. The location or size of these patterns was identified in terms of ground distance and proximity to field boundaries. Also, the possible reasons for unusual conditions were often mentioned.

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APPENDIX E. ADDITIONAL DATA PRODUCTS

The spectra used in compiling this Atlas are available on computer-compatible digital tape (CCT) for more detailed analysis. The digital tape includes coded information obtained from the ground observations and photo interpretation, in addition to the spectral radiances.

The CCT contains a total of 3458 records. Each record represents one spectral observation and is 844 bytes long (1 byte = 8 bits), consisting of a 24 byte ancillary data field followed by an 820 byte field containing the spectral radiances. The format of each record is shown in Table E-1.

Simultaneously acquired overlapping color aerial photographic coverage of areas where spectra were obtained is available at a scale of 1:20,000 on 35 mm positive transparencies at reproduction cost.

For further information on availability of data, contact Dr. Stephen G. Ungar, NASA, Institute for Space Studies, 2880 Broadway, New York, New York 10025.

TABLE E-1. BINARY RECORD FORMAT

Byte	Information
1-24	Ancillary data*
1-2	No. of first spectrum in set (16 bit integer)
3-4	No. of last spectrum in set (16 bit integer)
5-6	No. of spectrum representing set (16 bit integer)
7	Month
8	Day
9	Hour
10	Minutes
11	Sun elevation (degrees)
12	Crop code: 00=alfalfa; 01=asparagus; 02=bare soil; 03=barley; 04=carrots; 05=cotton; 06=melons; 07=sorghum;08=sugar beets; 09=wheat
13	Growth stage code: 00=emergent; 01=booted; 02=headed; 03=thinned; 04=maturing; 05=mature; 06=ripening; 07=ripe; 08=harvested
14	Height, lower limit (cm)
15	Height, upper limit (cm)
16	Percent crop cover
17	Soil moisture code: 00=wet ; 01=dry
18	Tone code: 00=homogeneous; 01=inhomogeneous
19	Texture code: 00=none or absent; 01=fine; 02=medium; 03=coarse; 04=differential
20	Density code: 00=bare soil; 01=low; 02=medium; 03=high; 04=differential
21	Cover code: 00=bare soil; 01=little; 02=one-third; 03=two-thirds; 04=near total; 05=total; 06=nonuniform
22	Furrow direction code: 00=parallel to flightline; 01=perpendicular to flightline
23-24	Fill bytes
25-844	Spectral radiances (2 bytes or 16 bits per channel)**

*This segment of each record is descriptive of the spectra-set to which the recorded spectrum belongs. When information is not available, the byte is set to integer value 255.

**Reflected energy is recorded for 410 channels in uniformly spaced integer levels from 0 to 10000 representing 0.0 to 0.025 $mw \cdot cm^{-2} \cdot sr^{-1} \cdot nm^{-1}$. The first channel is centered at 426.86 nanometers. Channel widths are 1.396 nm.