Precision Agriculture

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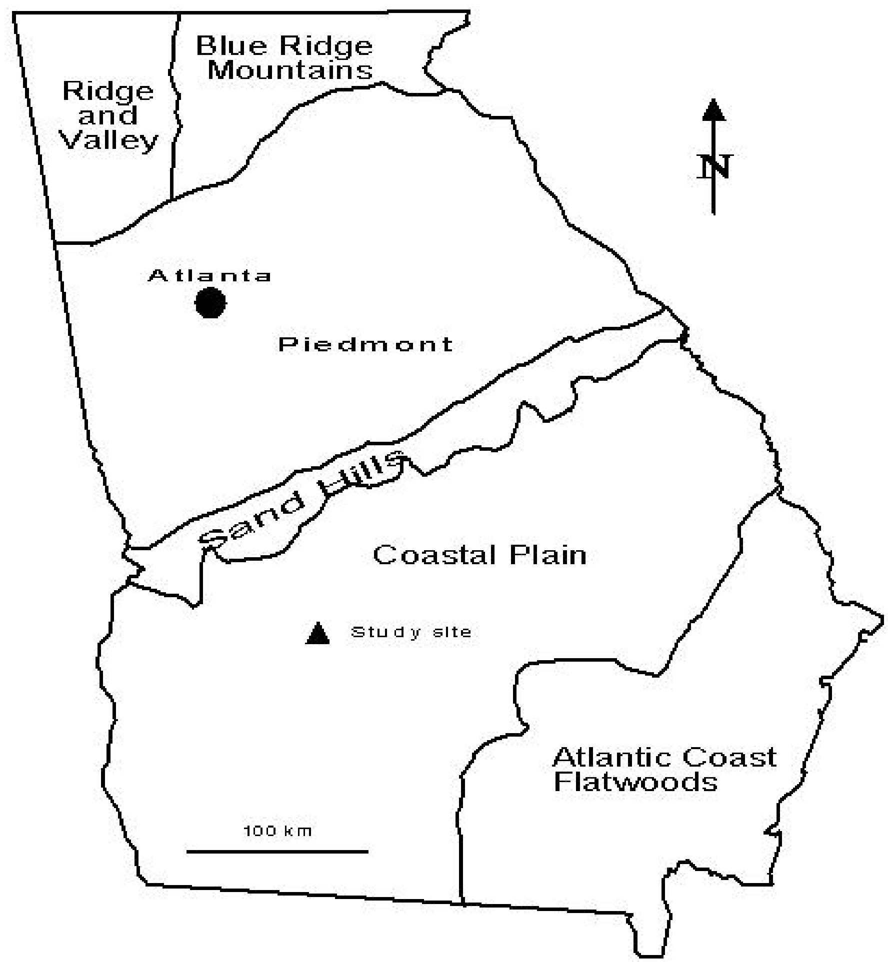
The Crisp County Project

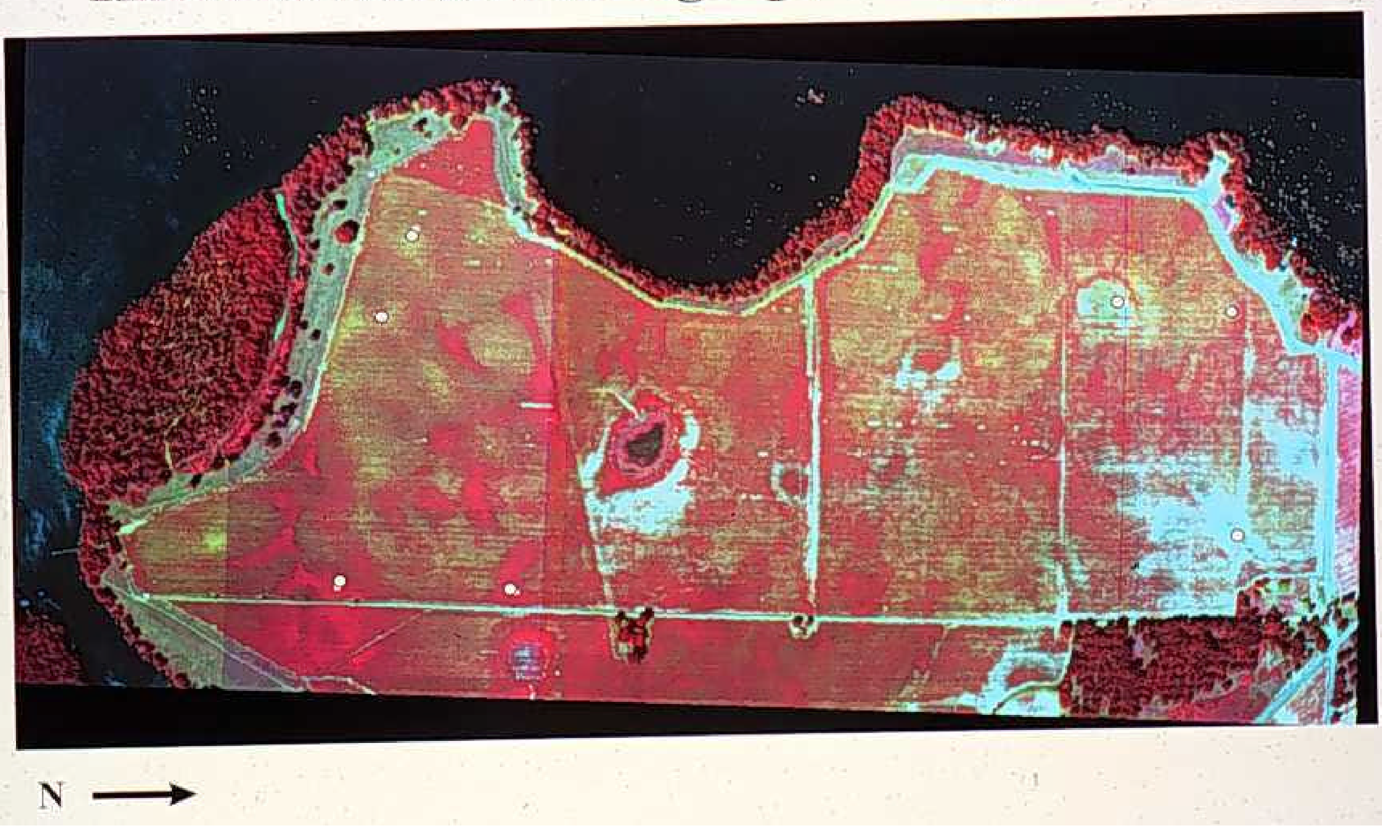
- Emphasis on fertilization, liming, and water quality
- Mapping of surface soil properties, since they influence productivity
  - Soil organic carbon
  - Soil clay
- Modeling of important processes that affect pH and liming and N cycling

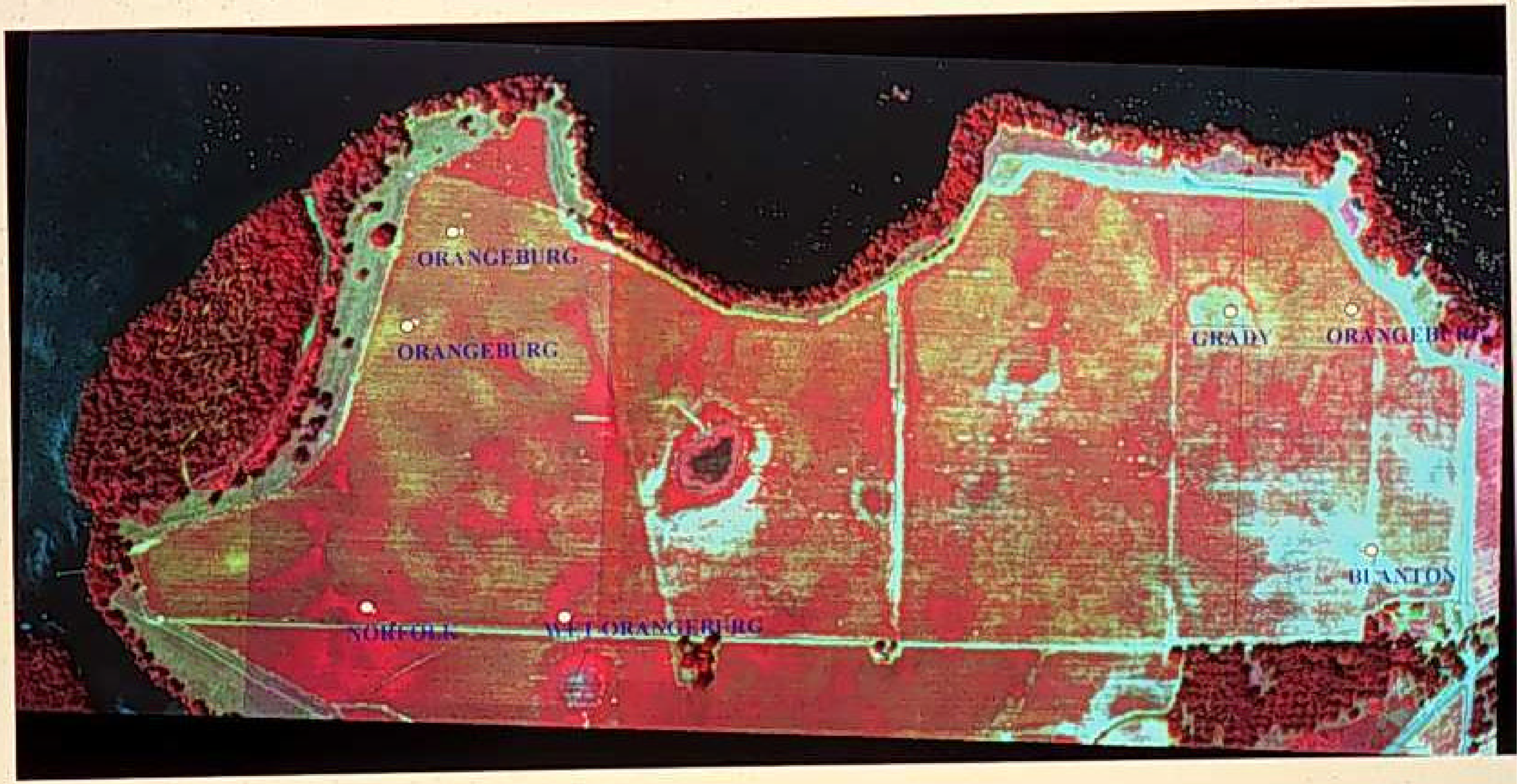
Financial support and collaborators

- USEPA section 319 funds through Ga EPD and Georgia Soil and Water Conservation Commission
- NASA Space Grant funds
- Georgia Plant Food Educational Society
- Potash and Phosphate Institute
- Numerous faculty


Blue Ridge
Mountains
Ridge
and
Valley
N
Atlanta
Piedmont
Sand Hills
Coastal Plain
Study site
Atlantic Coast
Flatwoods
100 km

Inferred Aerial Photograph on Sept. 5, 1997





N →

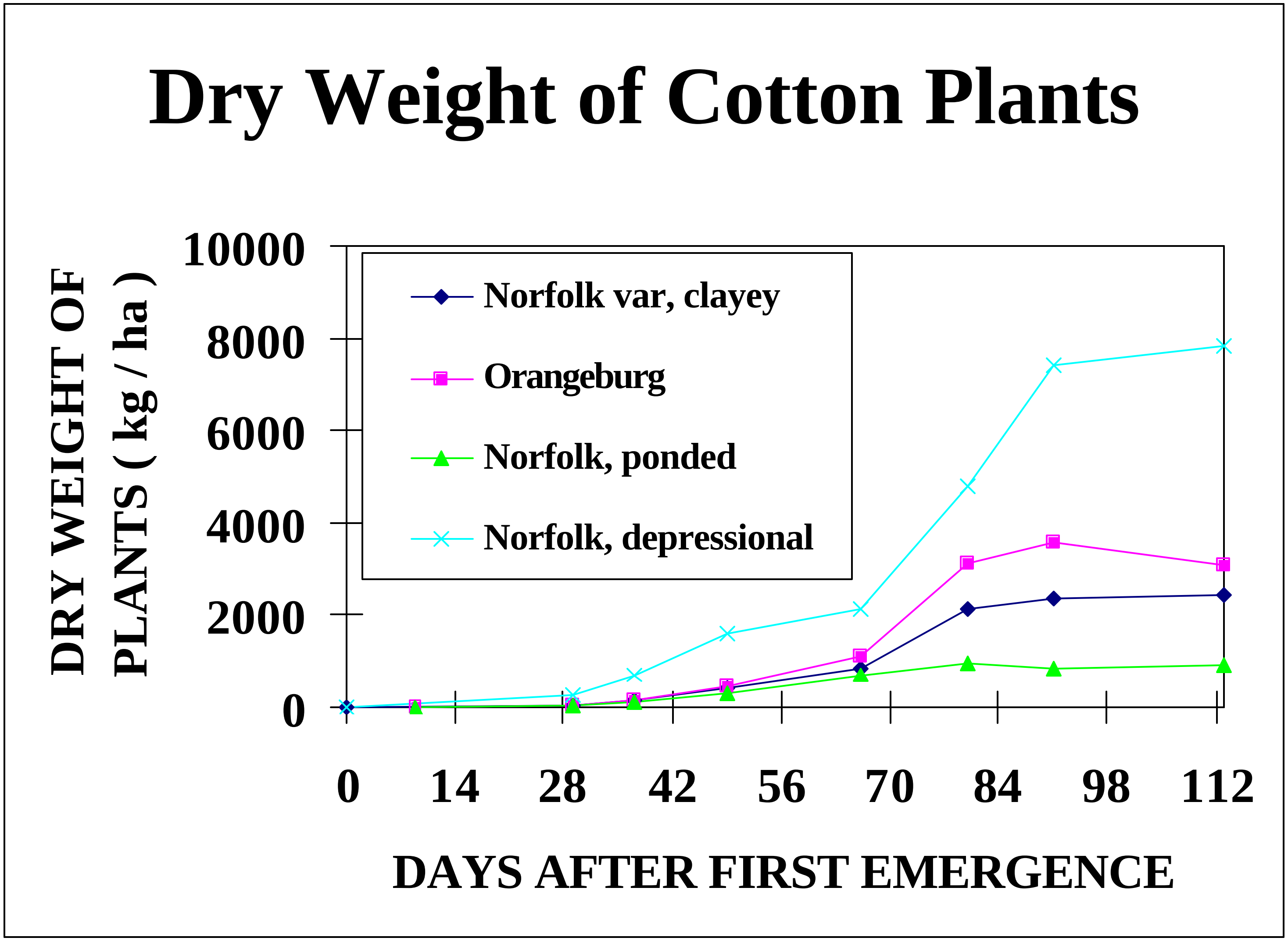


Figure 4. Total above ground dry matter of cotton in four widely different soil areas of the production field.

Table 2. Cotton lint yields for six widely different locations in the Crisp County production field.

Area	Yield (Kg/ha)
Norfolk var, clayey	225
Orangeburg NW	400
Orangeburg SW	329
Orangeburg S	388
Norfolk, ponded	211
Norfolk, depressional	828
Orangeburg, depressional	695

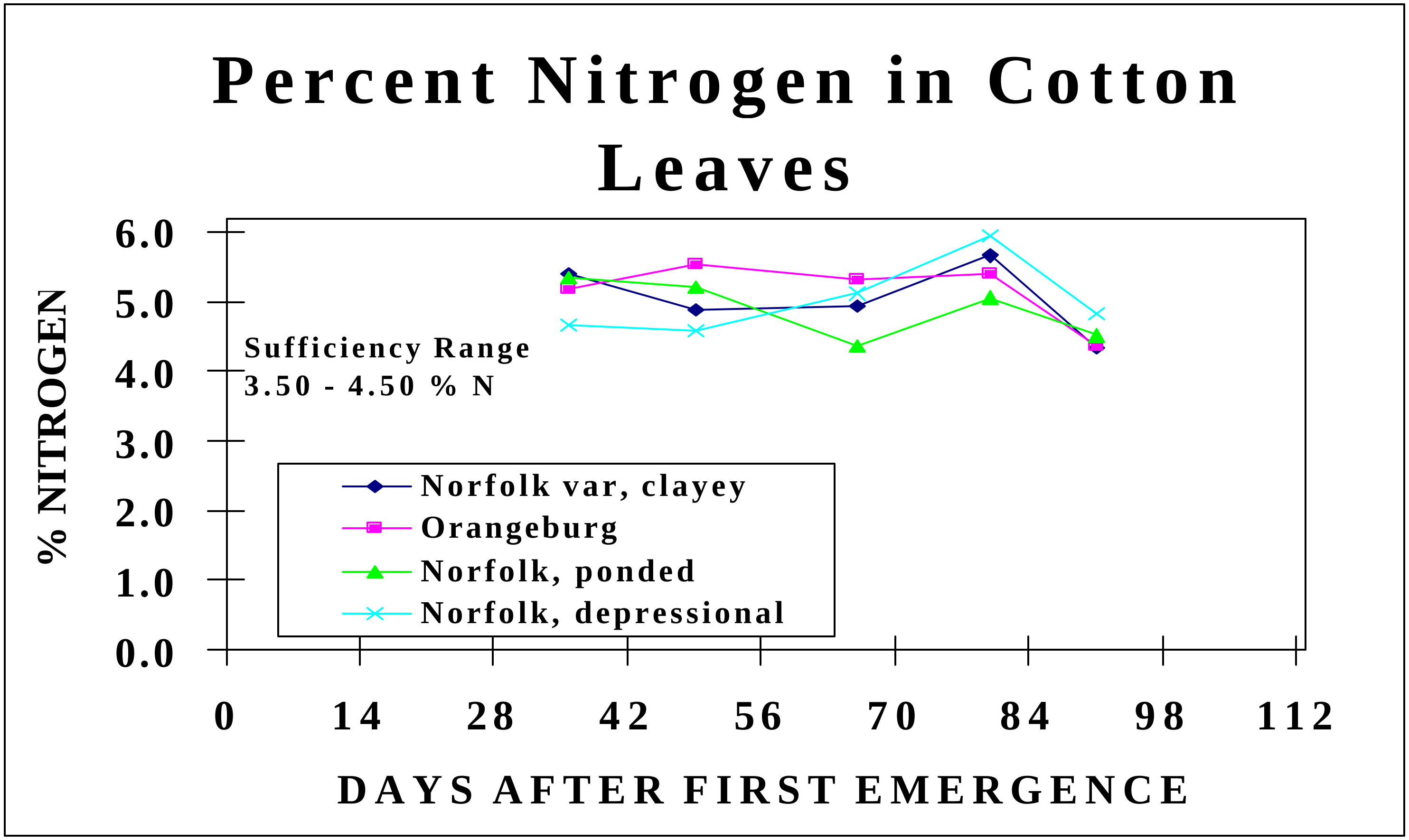


Figure 2. Concentration of total N in the most recent fully expanded leaves from cotton in four widely different soil areas of the production field.

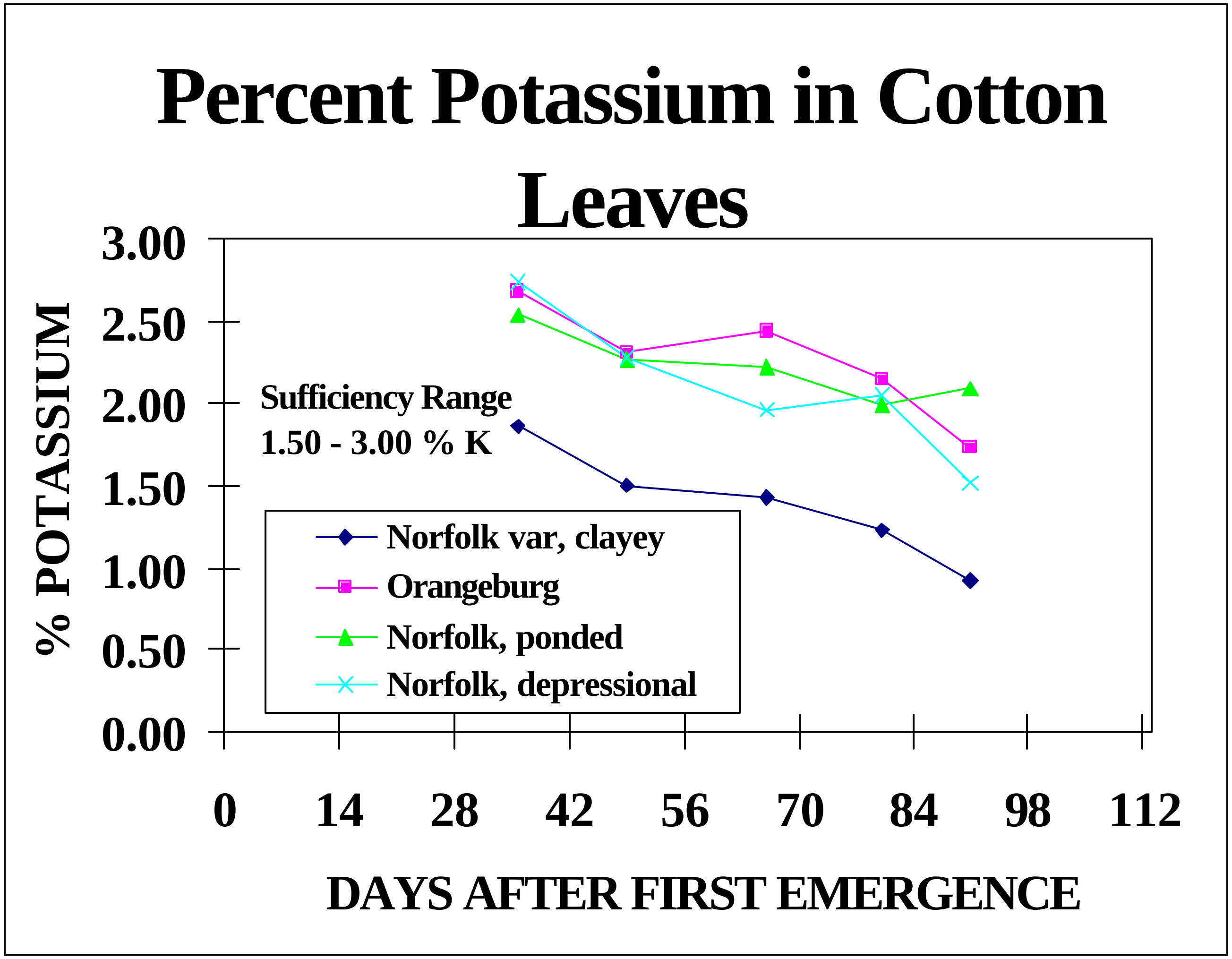


Figure 3. Concentration of total K in the most recent fully expanded leaves from cotton in four widely different soil areas of the production field.

Why the large variation in crop growth and yield?

Yield variation

- Not due to fertility variation
- Apparently due to variation in the availability of water
  - Correlated with organic C and clay contents of surface soil
  - Correlated with landscape position

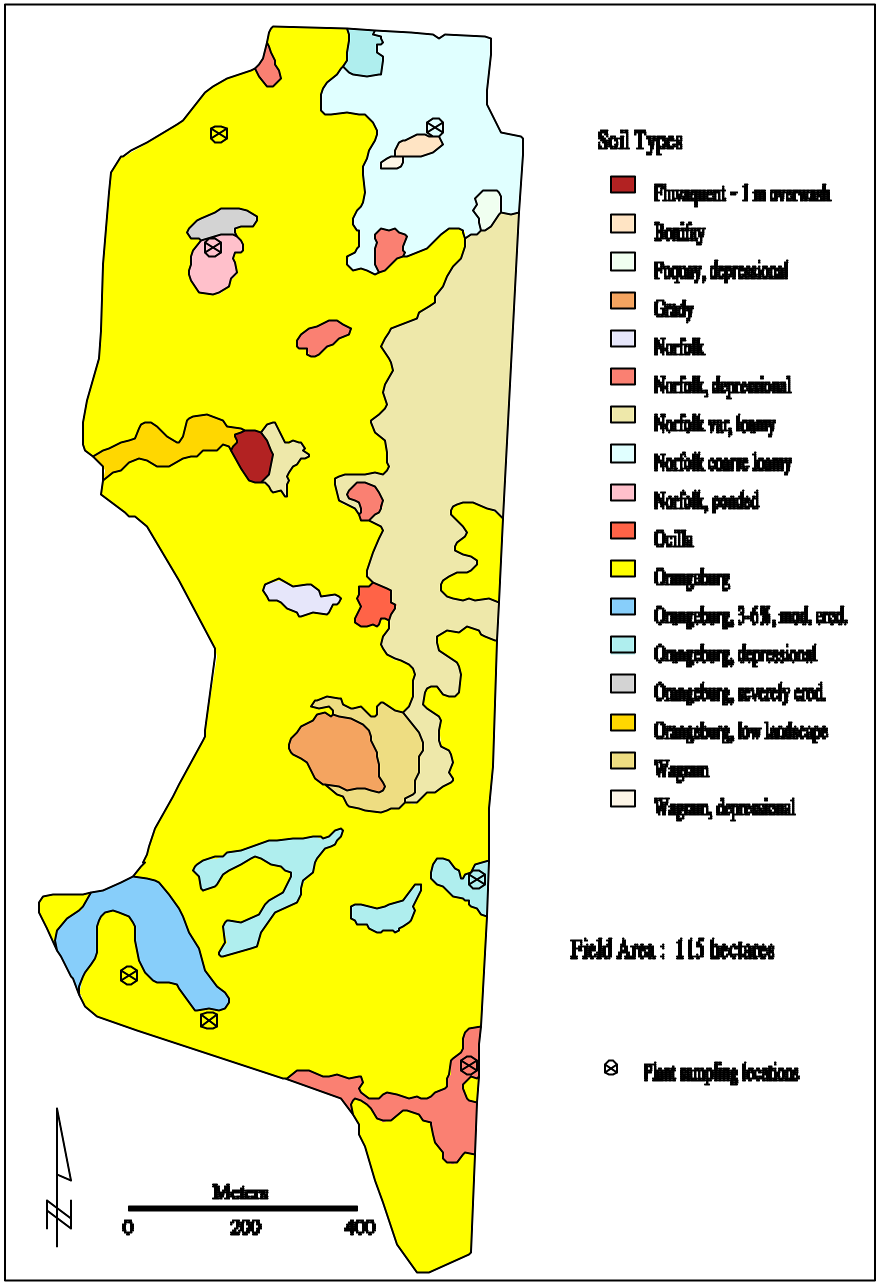
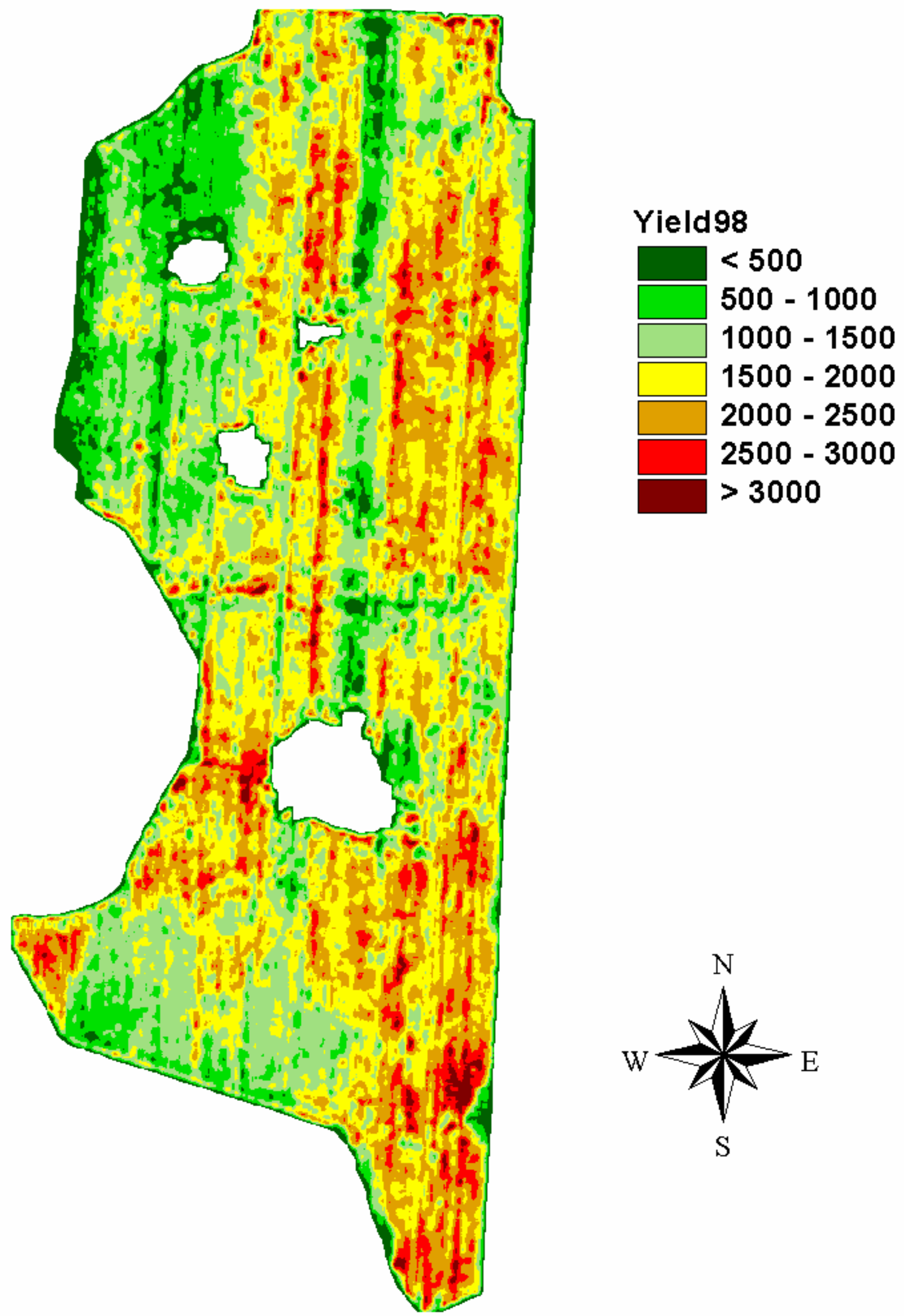
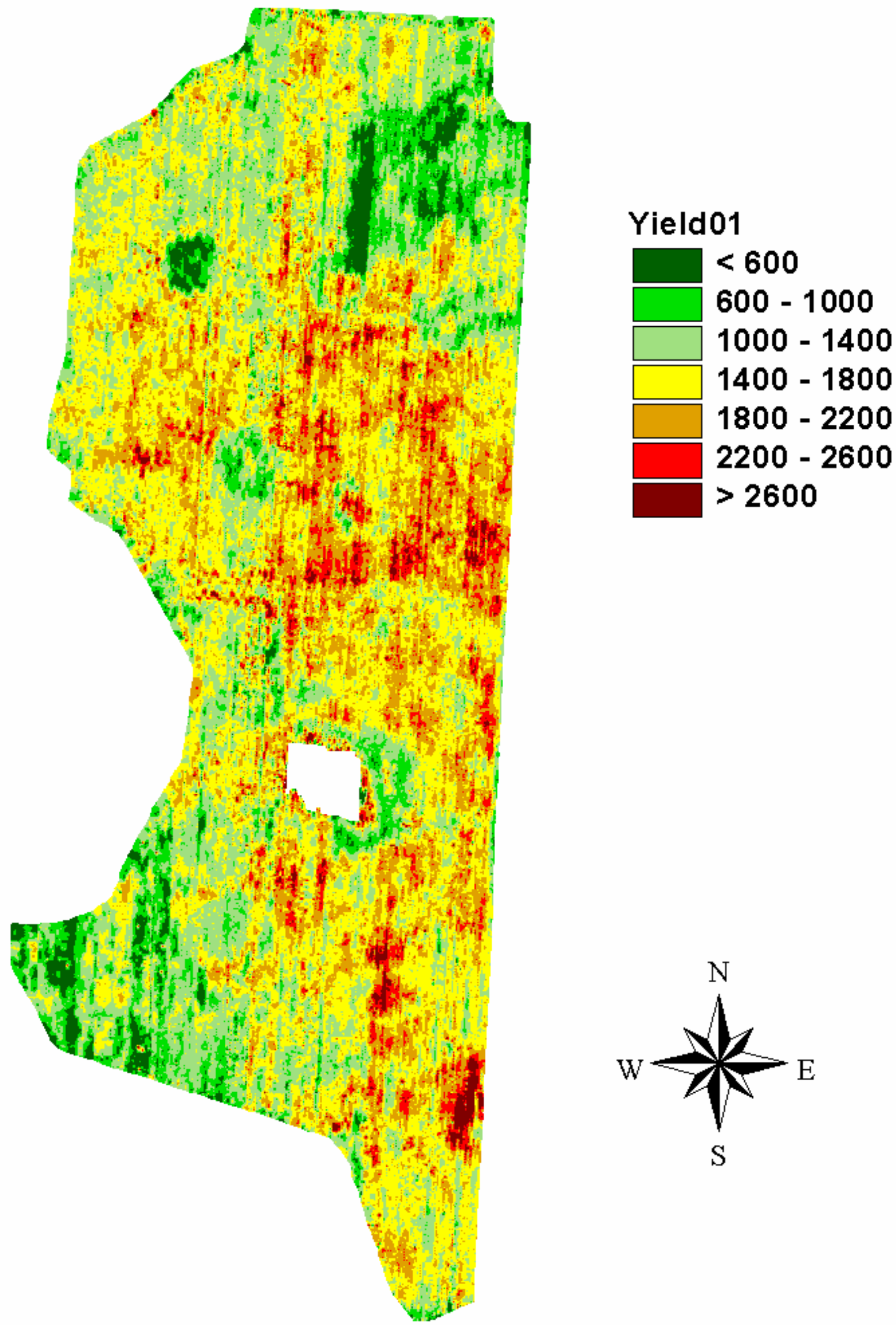


Figure 5. Map of soils for the production field based on an order 1 soil survey.

1998 infrared image


Yield98
< 500
500 - 1000
1000 - 1500
1500 - 2000
2000 - 2500
2500 - 3000
> 3000
N
W
E
S



Yield01
< 600
600 - 1000
1000 - 1400
1400 - 1800
1800 - 2200
2200 - 2600
> 2600
N
W
E
S

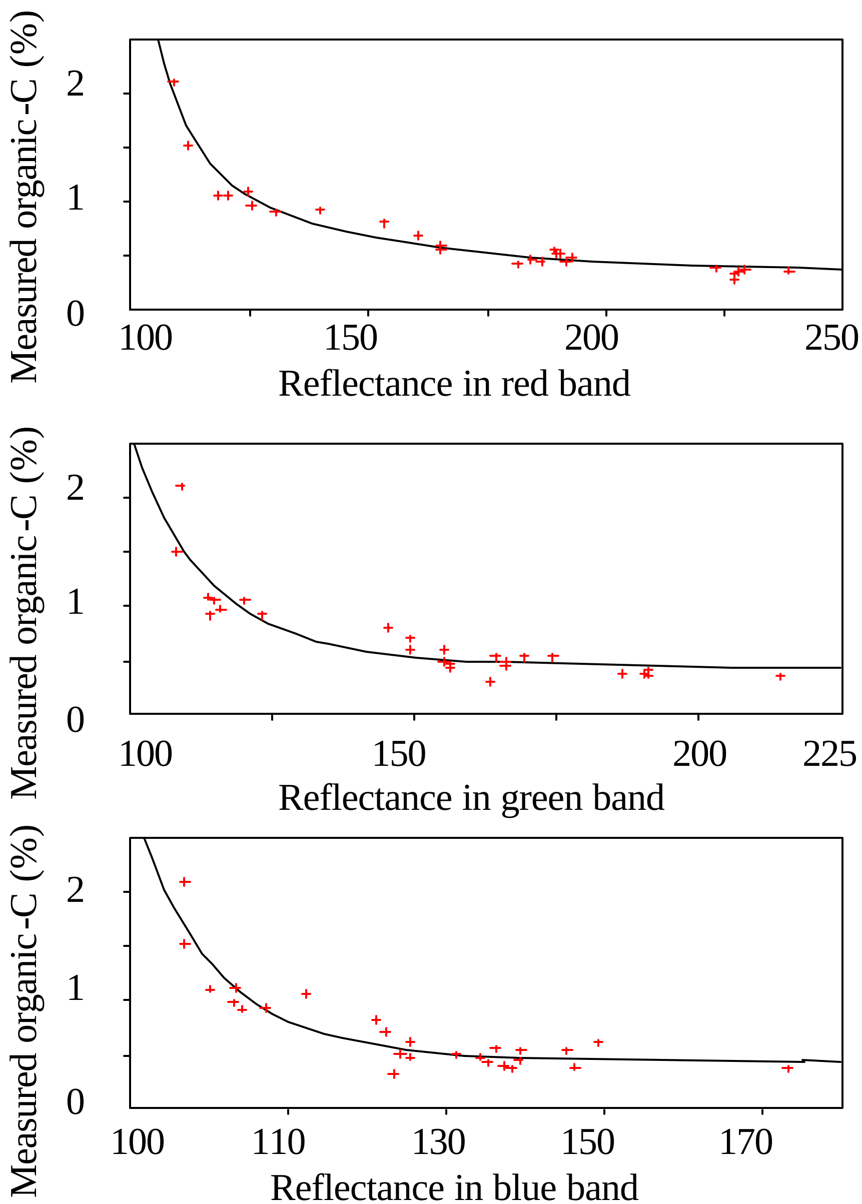
Mapping soil organic C

Why map soil organic C

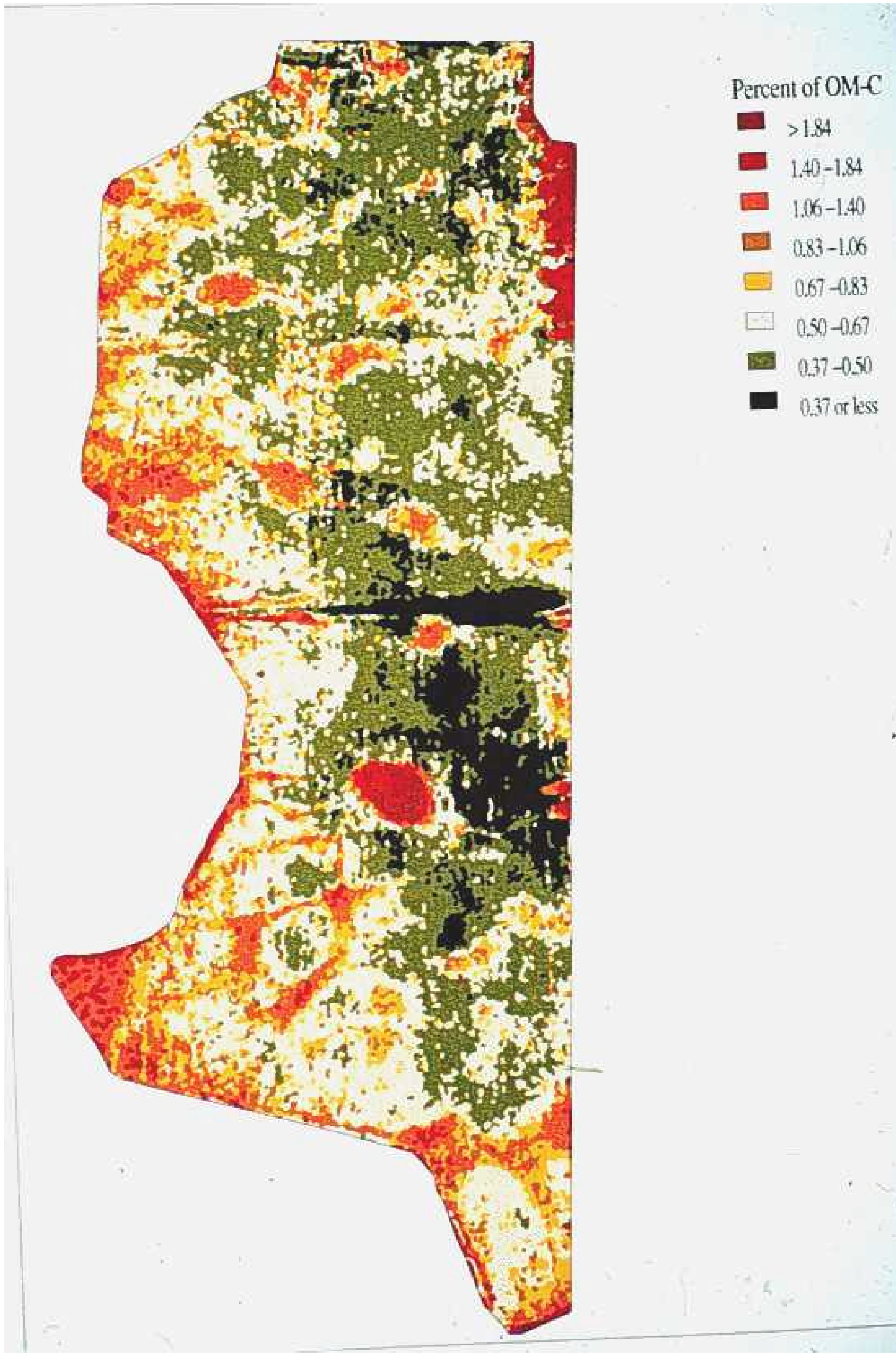
- It may potentially provide insights into estimating the spatial variability of N mineralization.
- It may be useful for variable rate herbicide decisions.
- It can be used as one component for mapping soil pH buffering capacity.

Does the soil variability justify mapping soil organic C?

Fig. 2. The color slide image of the field. (The image was geo-referenced into the Universal Transverse Mercator coordinate system.)



Measured organic-C (%)
2
1
0
100
150
200
250
Reflectance in red band
Measured organic-C (%)
2
1
0
100
150
200
225
Reflectance in green band
Measured organic-C (%)
2
1
0
100
110
130
150
170
Reflectance in blue band


Percent of OM-C
> 1.84
1.40 – 1.84
1.06 – 1.40
0.83 – 1.06
0.67 – 0.83
0.50 – 0.67
0.37 – 0.50
0.37 or less

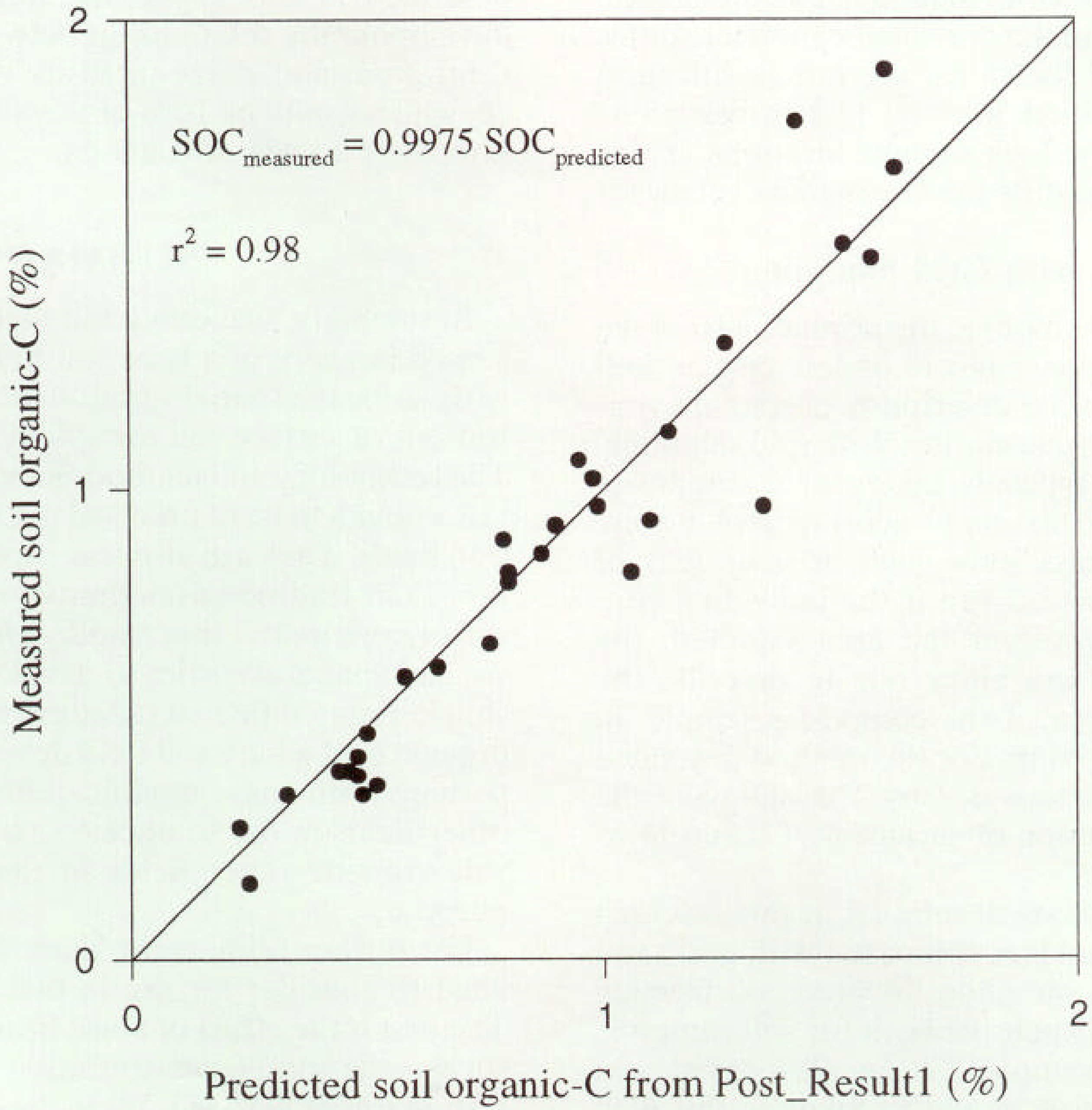
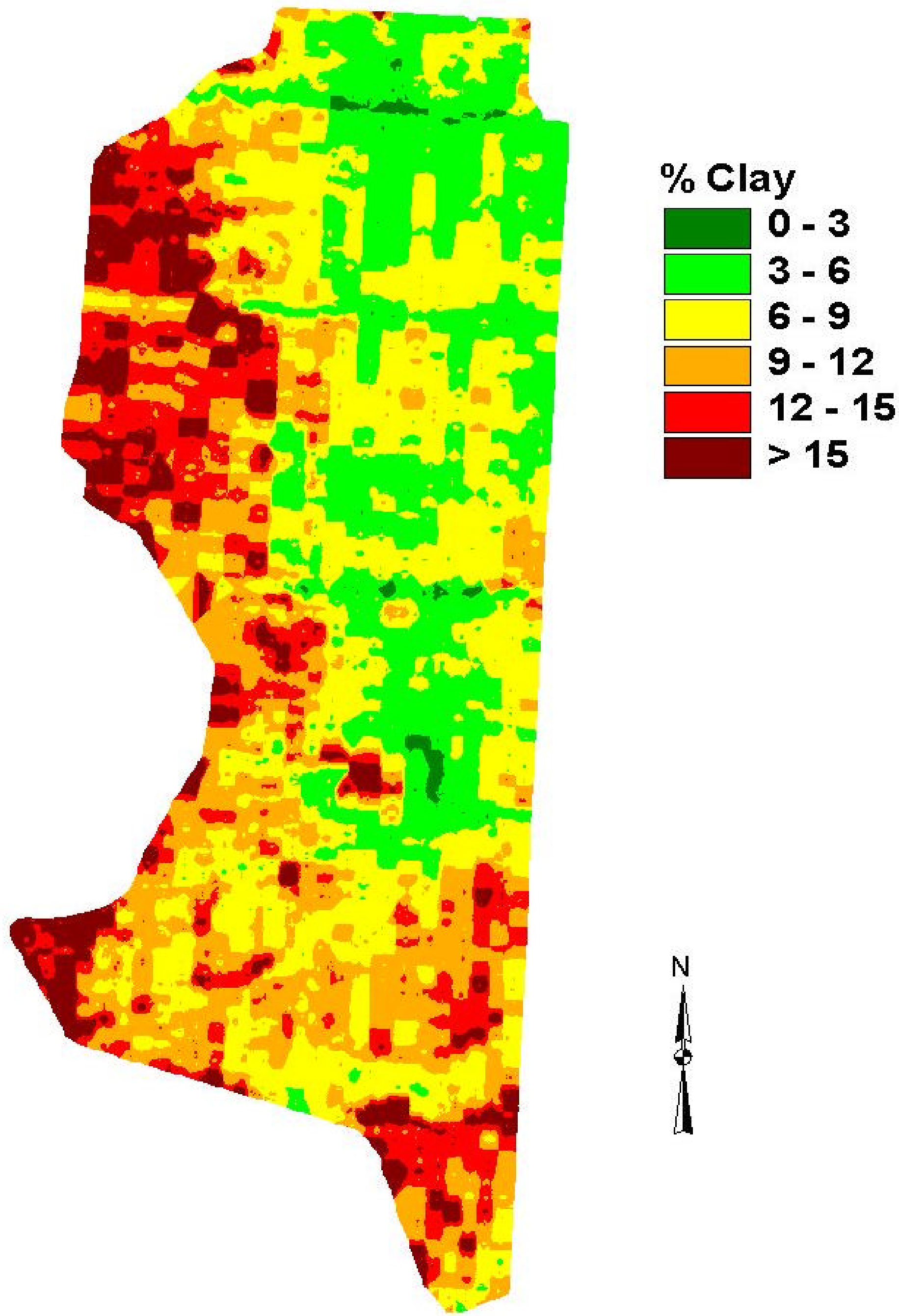
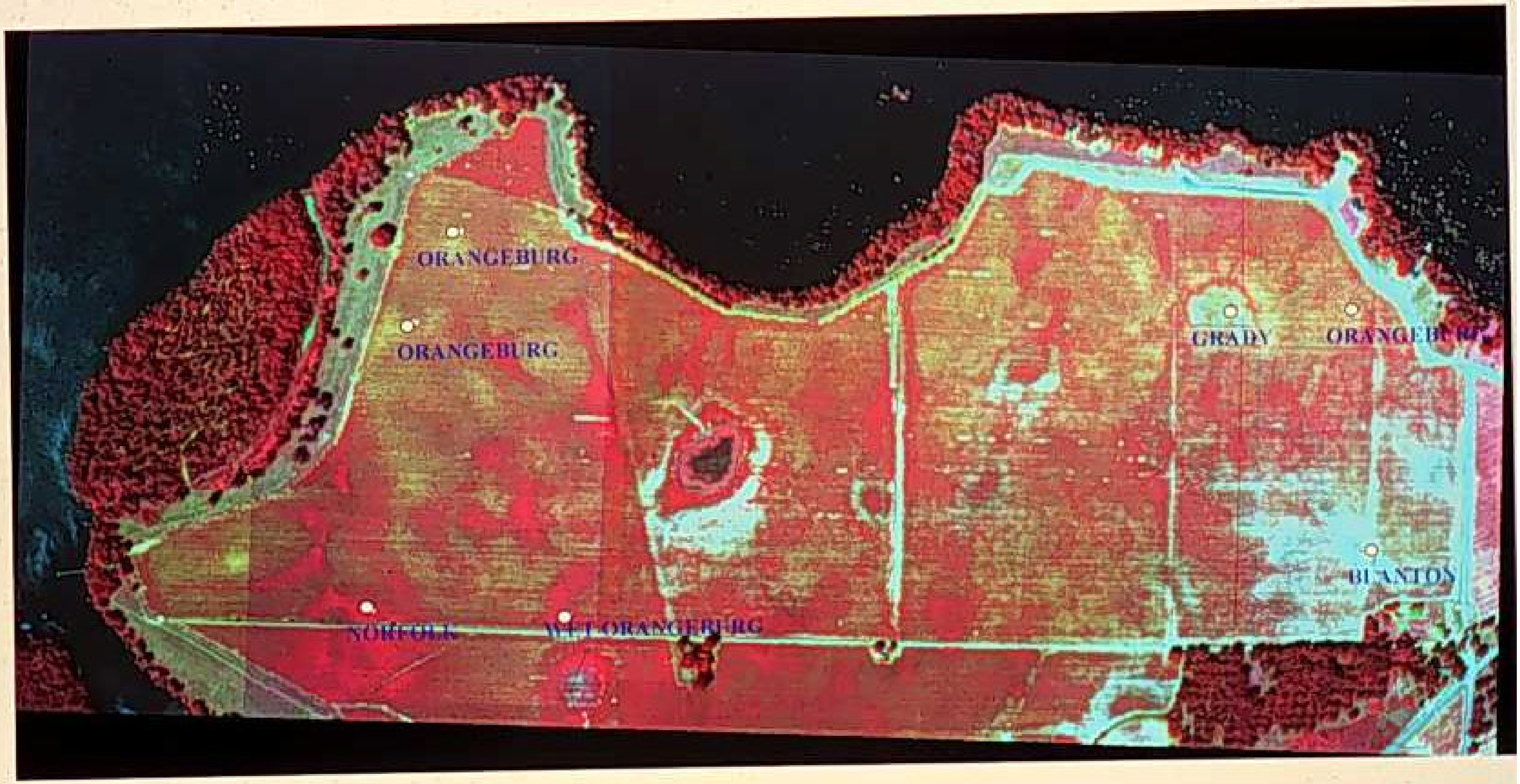


Fig. 8. The linear relationships between measured and predicted (Post_Result1) organic-C concentrations for the 31 locations.

Clay map developed from

Veris EC data


% Clay
0 - 3
3 - 6
6 - 9
9 - 12
12 - 15
> 15
N



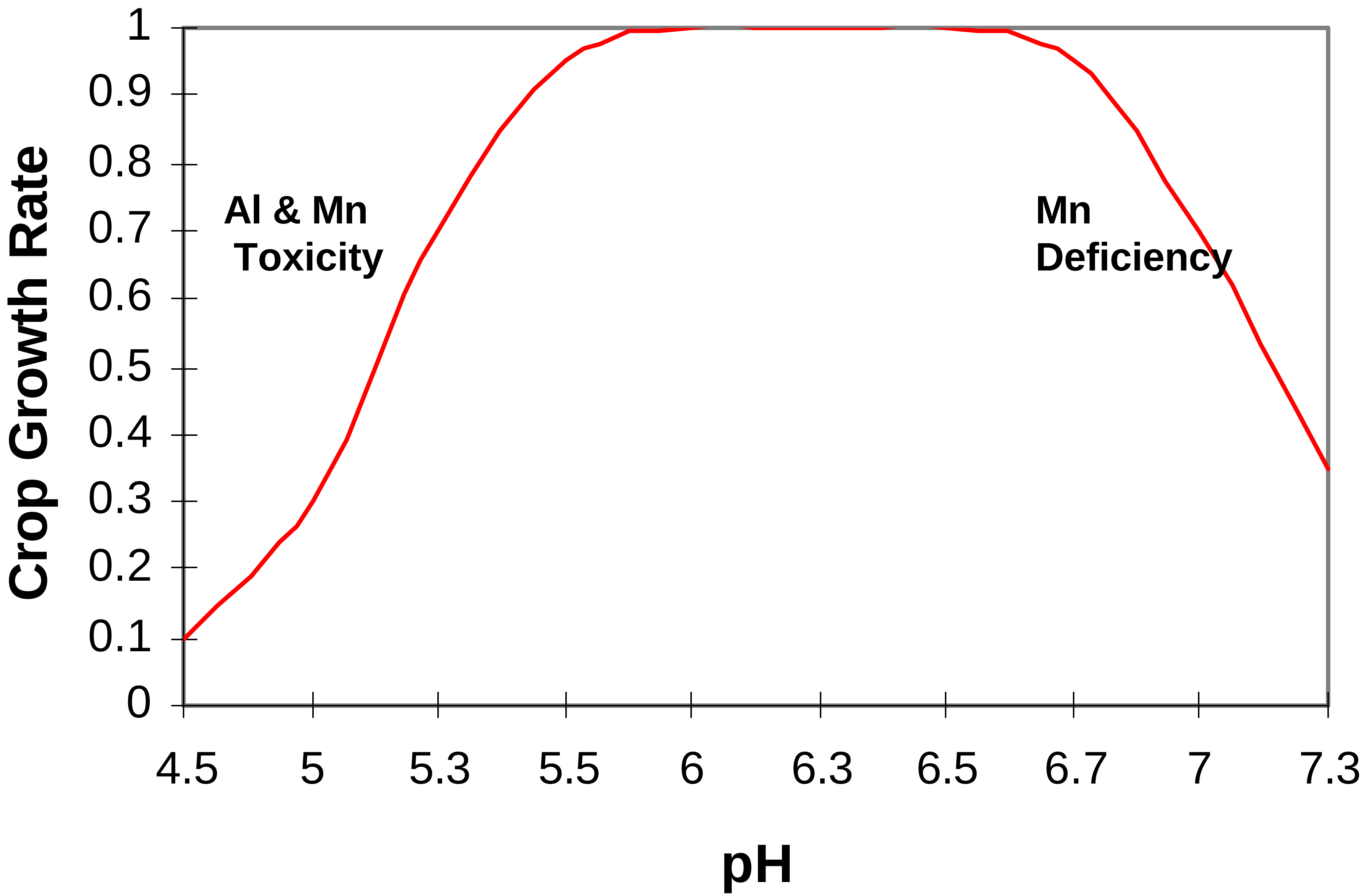
N

Soil pH with depth, Cabin Field

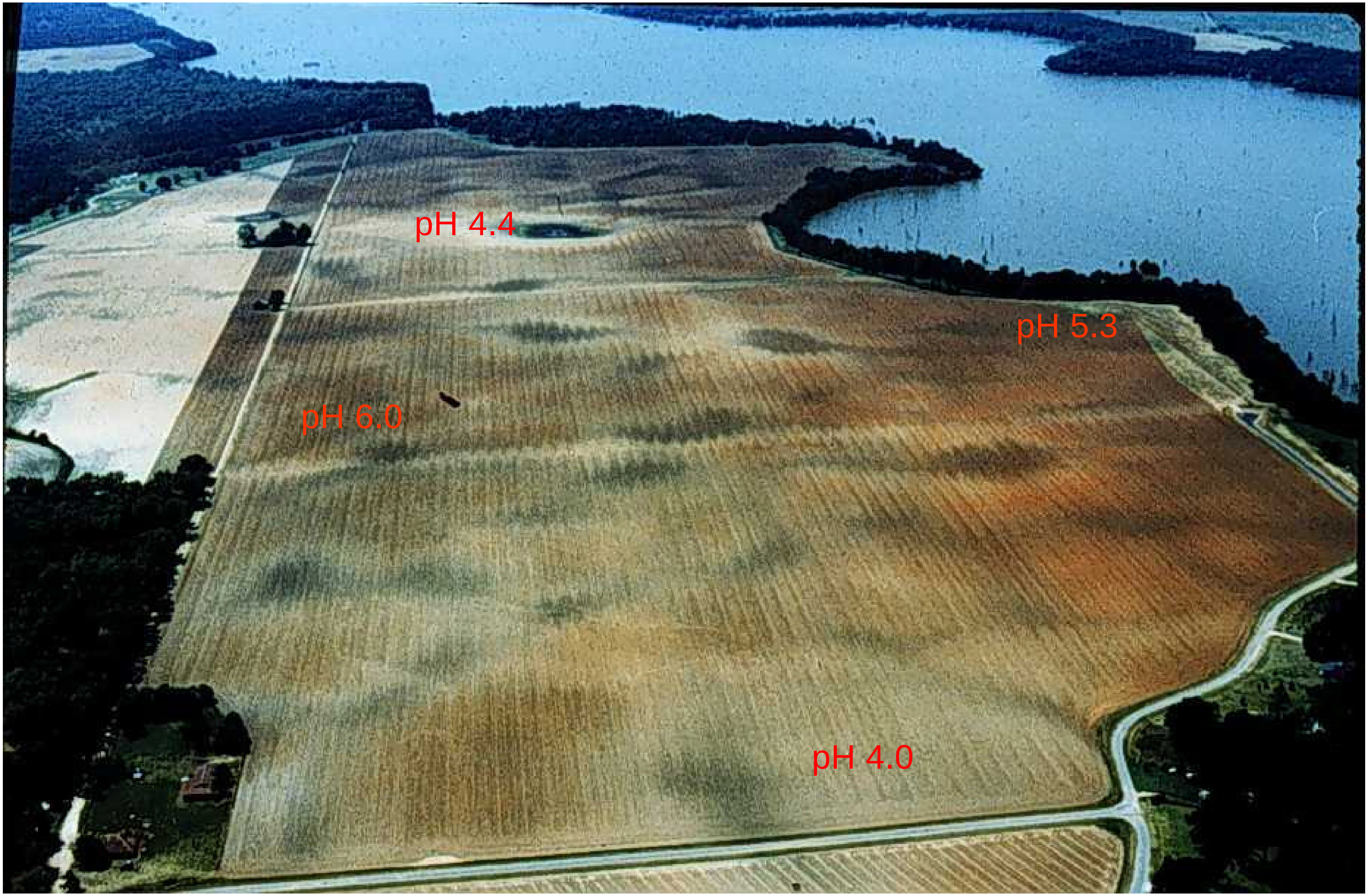
Depth (inch)	pH N	pH S
0-12	5.5	5.5
12-24	5.2	6.2
24-36	5.2	6.6
36-48	5.4	6.1
48-60	5.0	6.1

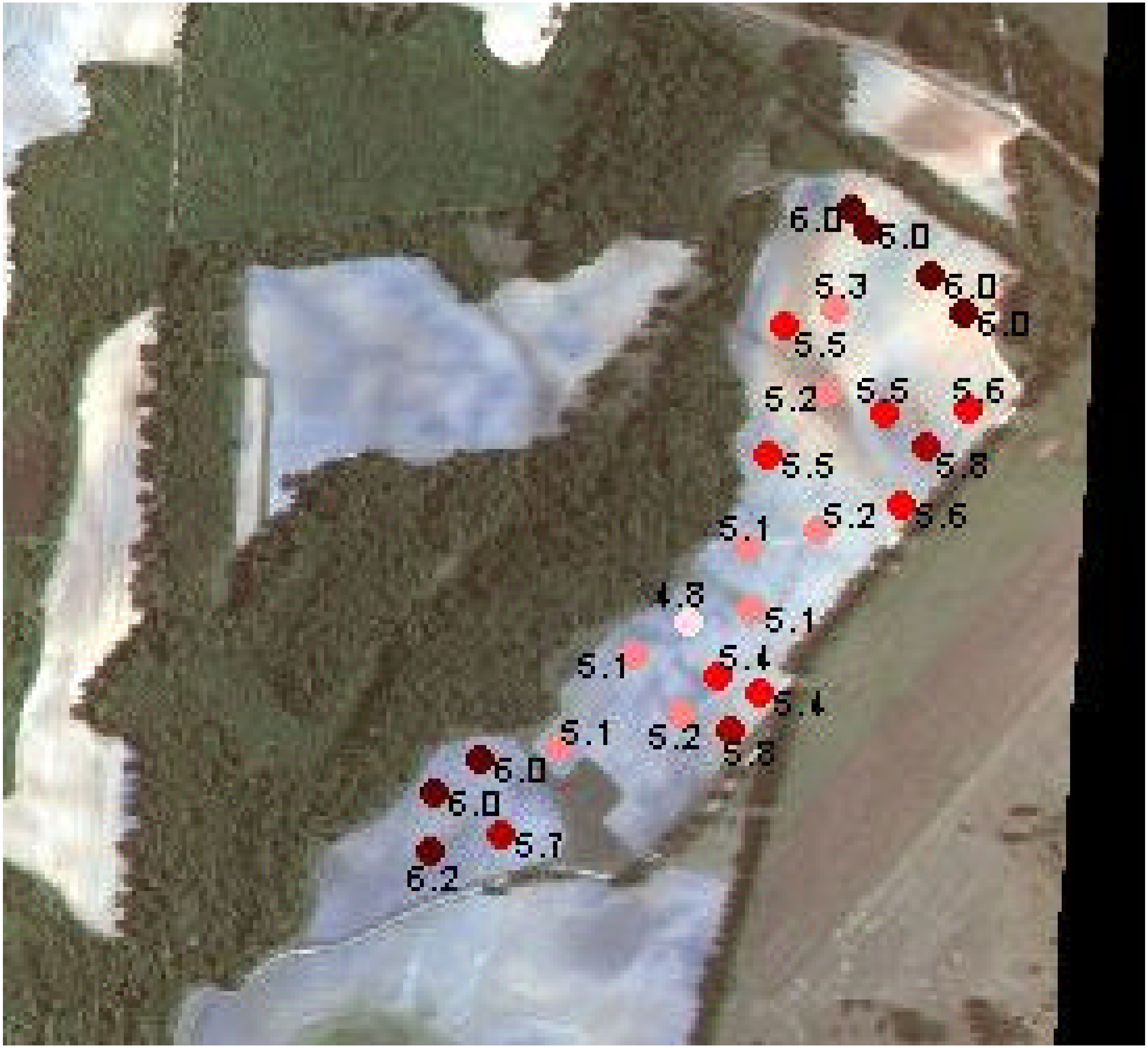
% H_2O remaining, Cabin Field

Date	S 12”	S 20”	S28”	N12”	N20”	N28”
6/12	85	90	92	100	99	100
6/22	70	72	72	64	93	95
7/1	48	2	0	0	62	69
7/8	25	0	0	0	1	37
7/18	78	11	0	93	93	87
7/29	55	0	0	37	84	84

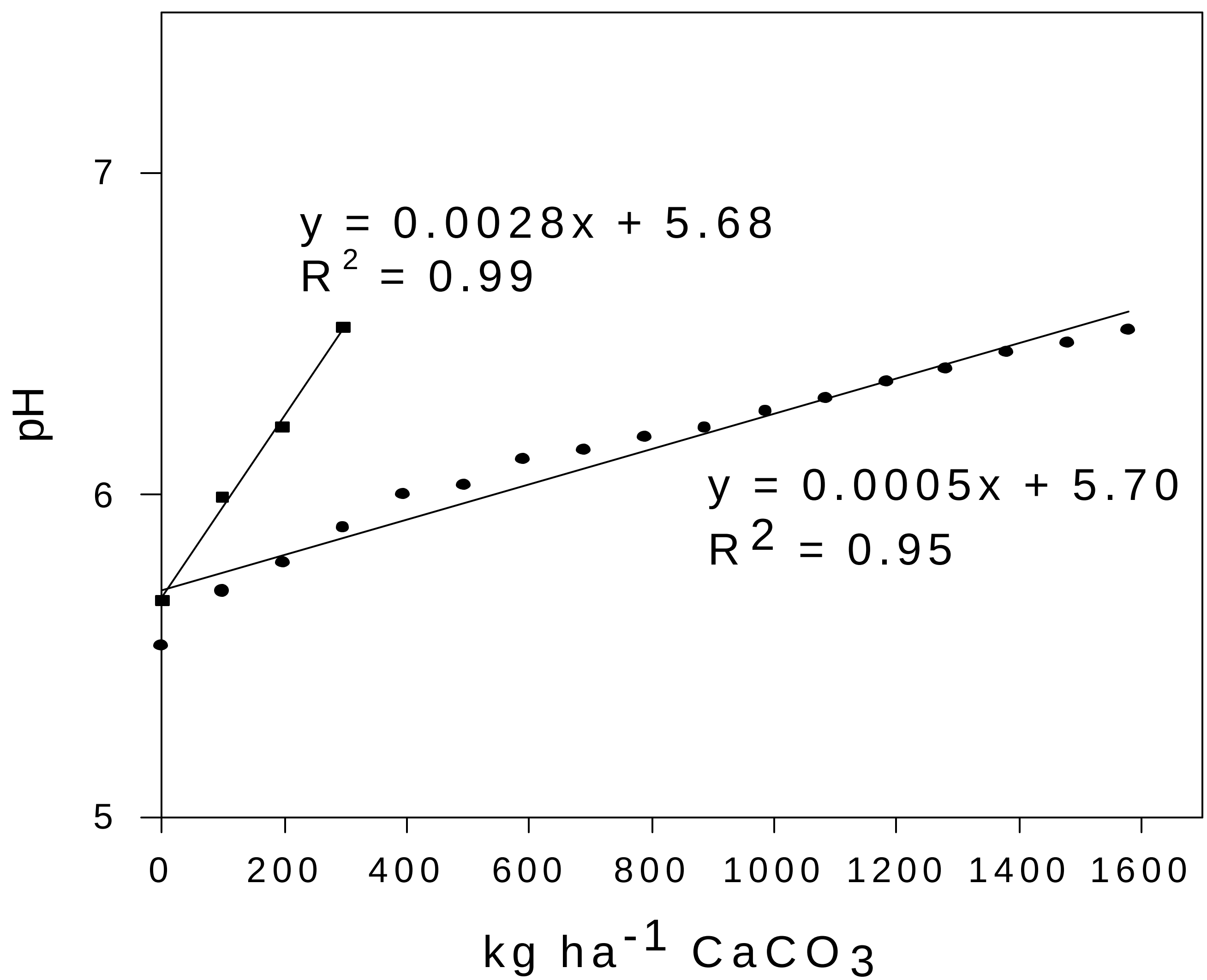


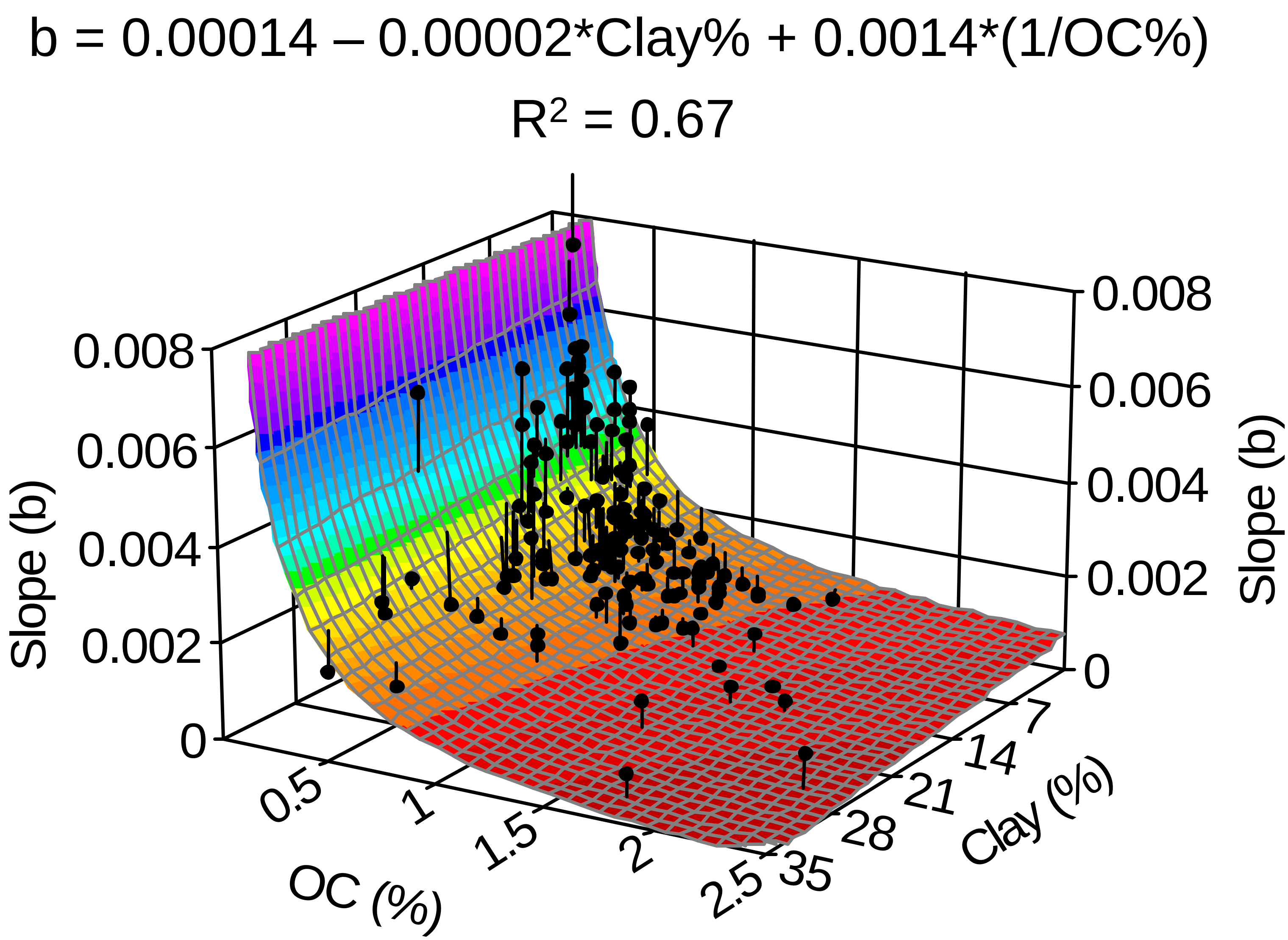
Crop Growth Rate
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Al & Mn
Toxicity
Mn
Deficiency
4.5
5
5.3
5.5
6
6.3
6.5
6.7
7
7.3
pH


pH 4.4
pH 5.3
pH 6.0
pH 4.0

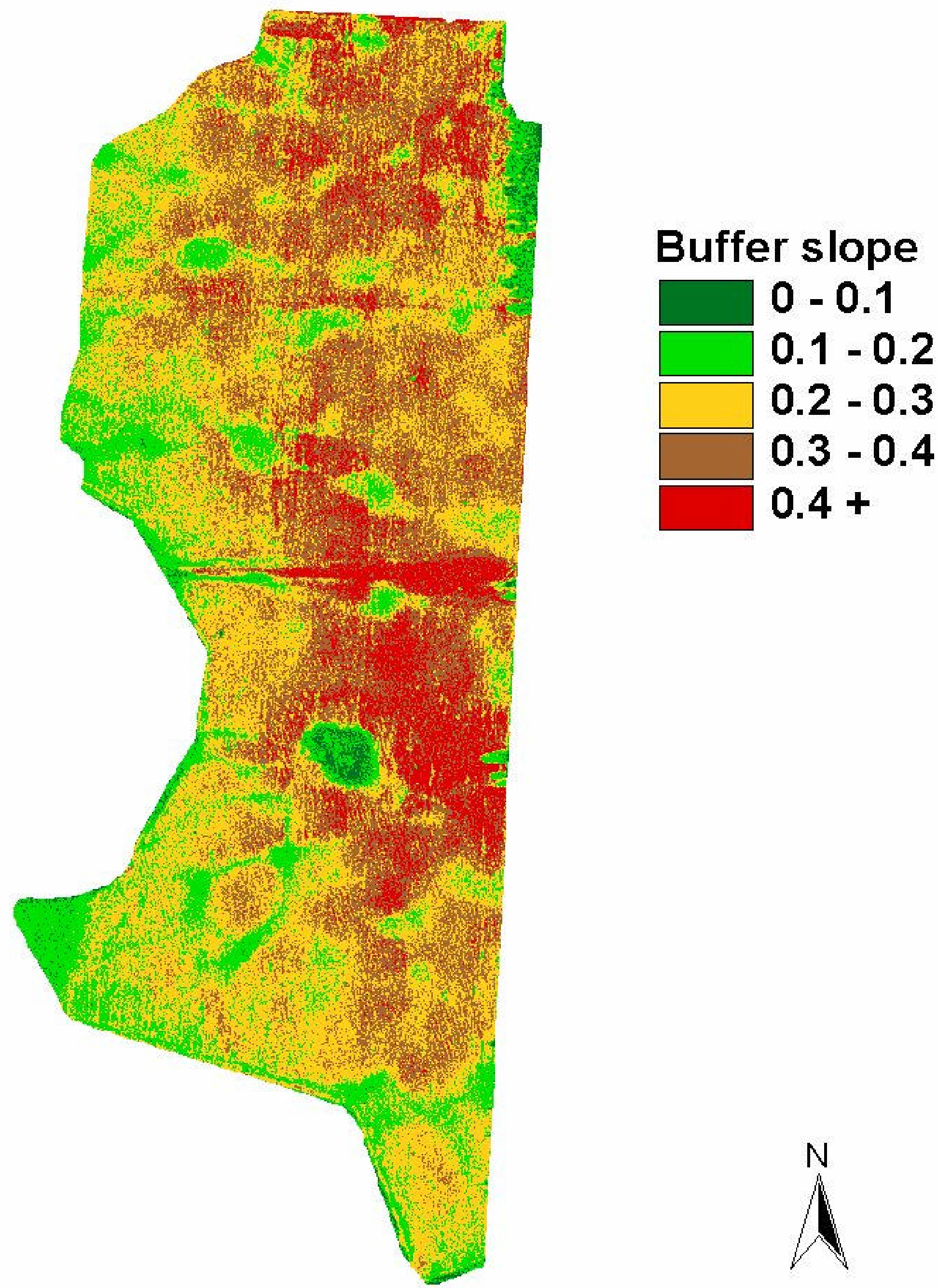

6.0
6.0
5.3
6.0
6.0
5.5
5.2
5.5
5.6
5.5
5.8
5.2
5.6
5.1
4.8
5.1
5.1
5.4
5.4
5.1
5.2
5.8
6.0
6.0
5.7
6.2

b (slope) Comparison





b = 0.00014 – 0.00002*Clay% + 0.0014*(1/OC%)
R2 = 0.67
Slope (b)
0.008
0.006
0.004
0.002
0
OC (%)
0.5
1
1.5
2
2.5
Clay (%)
7
14
21
28
35
Slope (b)
0.008
0.006
0.004
0.002
0


Buffer slope
0 - 0.1
0.1 - 0.2
0.2 - 0.3
0.3 - 0.4
0.4 +
N

Some thoughts

- Soil variability results in more variability of soil properties like pH when managed with modern farming practices.
- Subsoil pH needs further study.
  - How we manage N fertilization programs may influence the development of acid subsoils.
- Remote sensing can be a valuable tool to describe soil variability.

Some soil pH values from Crisp

depth	#1	#2	#3	#4	#5	#6	#7
0-15	5.8	5.8	6.2	5.7	5.3	6.10	5.6
15-30	5.6	6.0	6.0	5.2	5.2	5.9	5.5
30-60	4.9	6.10	5.5	4.8	5.0	5.3	5.2
60-90	5.0	5.7	5.0	5.0	4.8	5.2	4.8
90-120	4.9	5.3	5.0	5.0	4.5	4.9	4.4