N Fertilization Following a Drought, and What Does the Clay Chemistry Map Mean for Me?

Best of the Best in Wheat Research & Marketing 2018

Dickinson, Williston, and Minot, ND

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Drought-

Low crop removal (maybe)

Residual soil nitrate really important

If a crop was baled for forage last year, substantial N was probably removed.

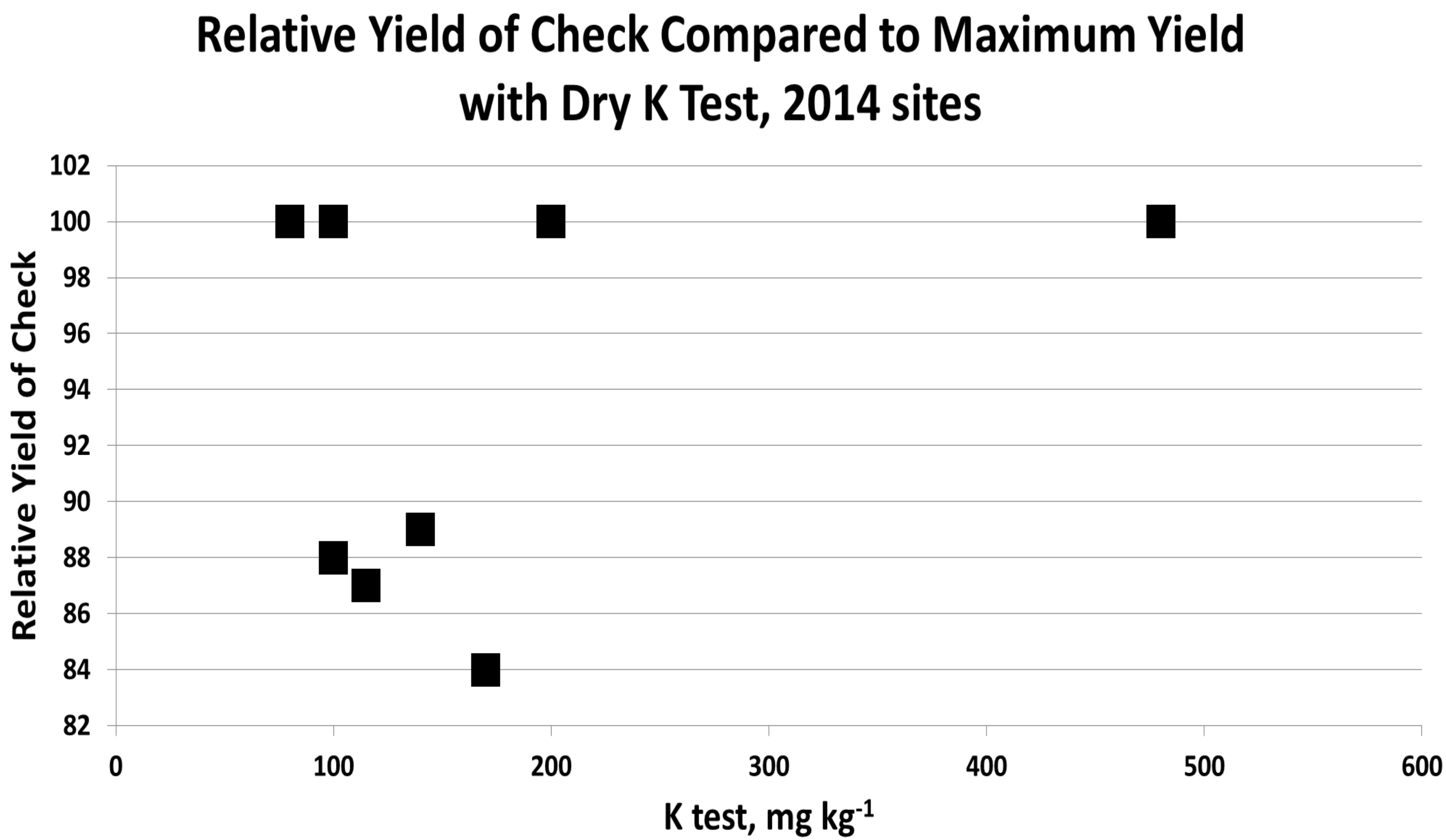
A ‘checkbook balance’ method for N doesn’t work.

Soil testing is still the best way to direct nutrient application.

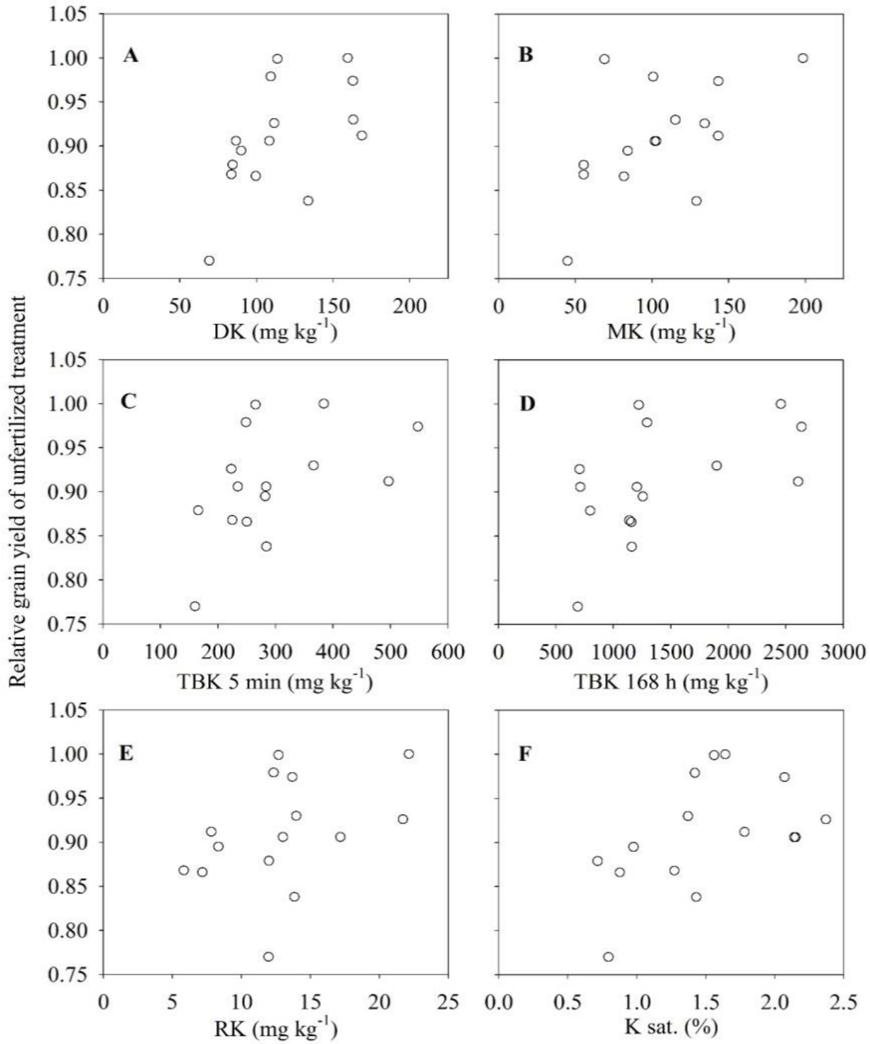
K study started 2014 season

Response to decline in K soil test levels in SE North Dakota as a result of rotation change from wheat/barley/sugar beet, which do not result in high K removal to corn and soybean which removes much K.

Common K soil tests in SE ND are 100-200 ppm.


Relative Yield of Check Compared to Maximum Yield
with Dry K Test, 2014 sites
Relative Yield of Check
102
100
98
96
94
92
90
88
86
84
82
0
100
200
300
400
500
600
K test, mg kg-1

Potassium recs in North Dakota now linked to soil clay chemistry



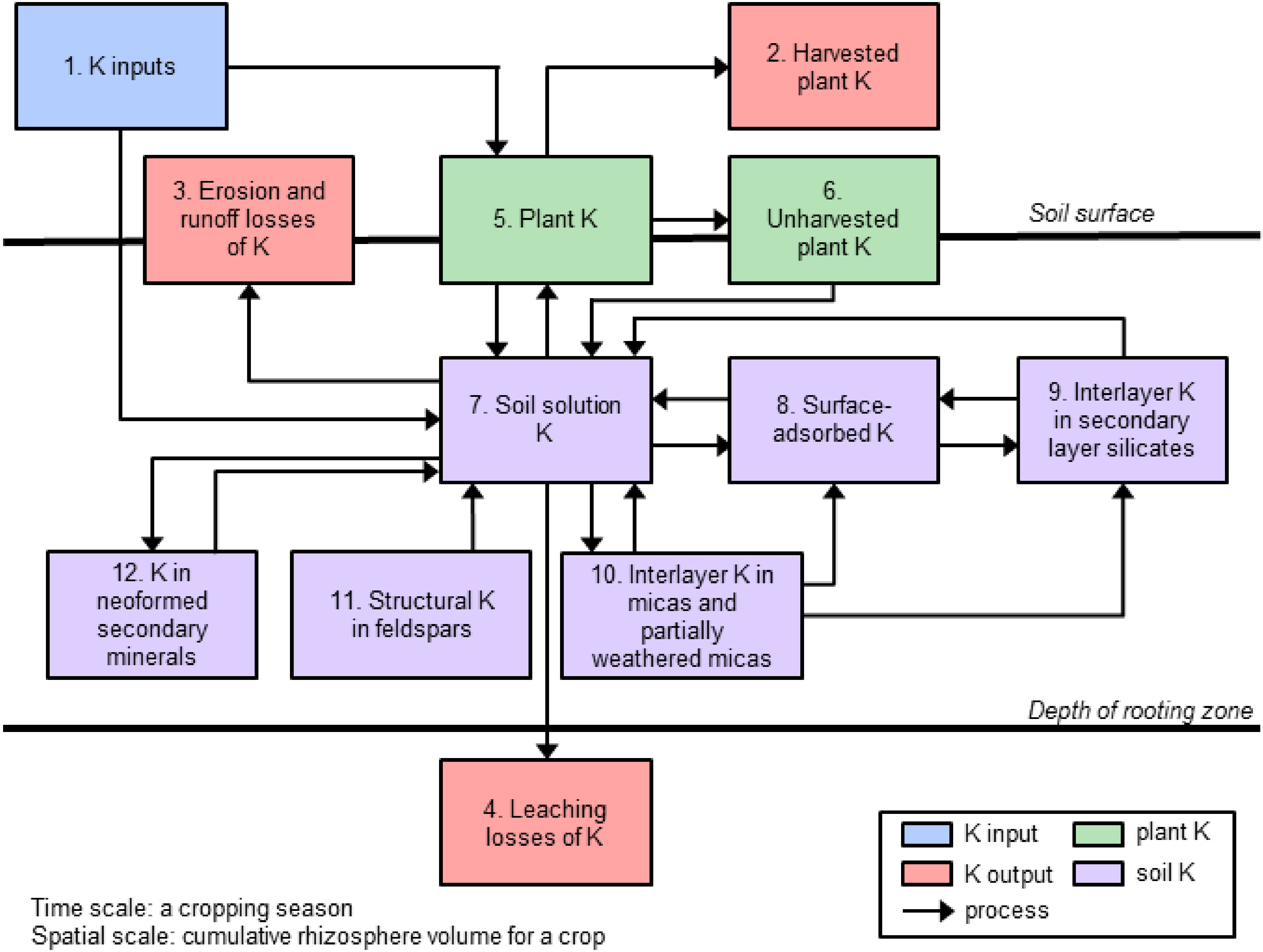
Site, Year	K test, ppm	Expected Yield Increase	Actual Yield Increase
Buffalo, 2014	100	Y	N†
Walcott E, 2014	100	Y	Y
Wyndmere, 2014	100	Y	N
Milnor, 2014	100	Y	N
Gardner, 2014	115	Y	Y
Fairmount, 2014	140	Y	N
Walcott W, 2014	80	Y	N
Arthur, 2014	170	N	Y
Valley City, 2014	485	N	N
Page, 2014	200	N	N
Absaraka, 2015	113	Y	N
Arthur, 2015	125	Y	Y
Barney, 2015	170	N	N
Casino, 2015	120	Y	Y
Dwight, 2015	110	Y	N
Fairmount1, 2015	188	N	Y
Fairmount2, 2015	118	N	Y
Leonard N, 2015	380	N	N
Leonard S, 2015	190	N	N
Milnor, 2015	118	Y	Y
Prosper, 2015	205	N	N
Valley City, 2015	200	N	N
Walcott, 2015	109	Y	Y
Absaraka, 2016	160	N	Y
Valley City, 2016	226	N	Y
Gardner, 2016	60	Y	Y
Lisbon, 2016	78	Y	Y
Mooreton, 2016	70	Y	N
Colfax, 2016	54	Y	Y

An Historical Perspective on the Chemistry and Mineralogy of Soil Potassium

Symposium - Soil Potassium Tests and Their Relationship to Plant Availability and Native Mineralogy

DELAWARE ENVIRONMENTAL INSTITUTE
UNIVERSITY OF DELAWARE

Donald L. Sparks
S. Hallock du Pont Chair
Director, Delaware Environmental Institute


1. K inputs
2. Harvested plant K
3. Erosion and runoff losses of K
5. Plant K
6. Unharvested plant K
Soil surface
7. Soil solution K
8. Surface-adsorbed K
9. Interlayer K in secondary layer silicates
12. K in neoformed secondary minerals
11. Structural K in feldspars
10. Interlayer K in micas and partially weathered micas
Depth of rooting zone
4. Leaching losses of K
K input
plant K
K output
soil K
process
Time scale: a cropping season
Spatial scale: cumulative rhizosphere volume for a crop

By the ‘text book’…

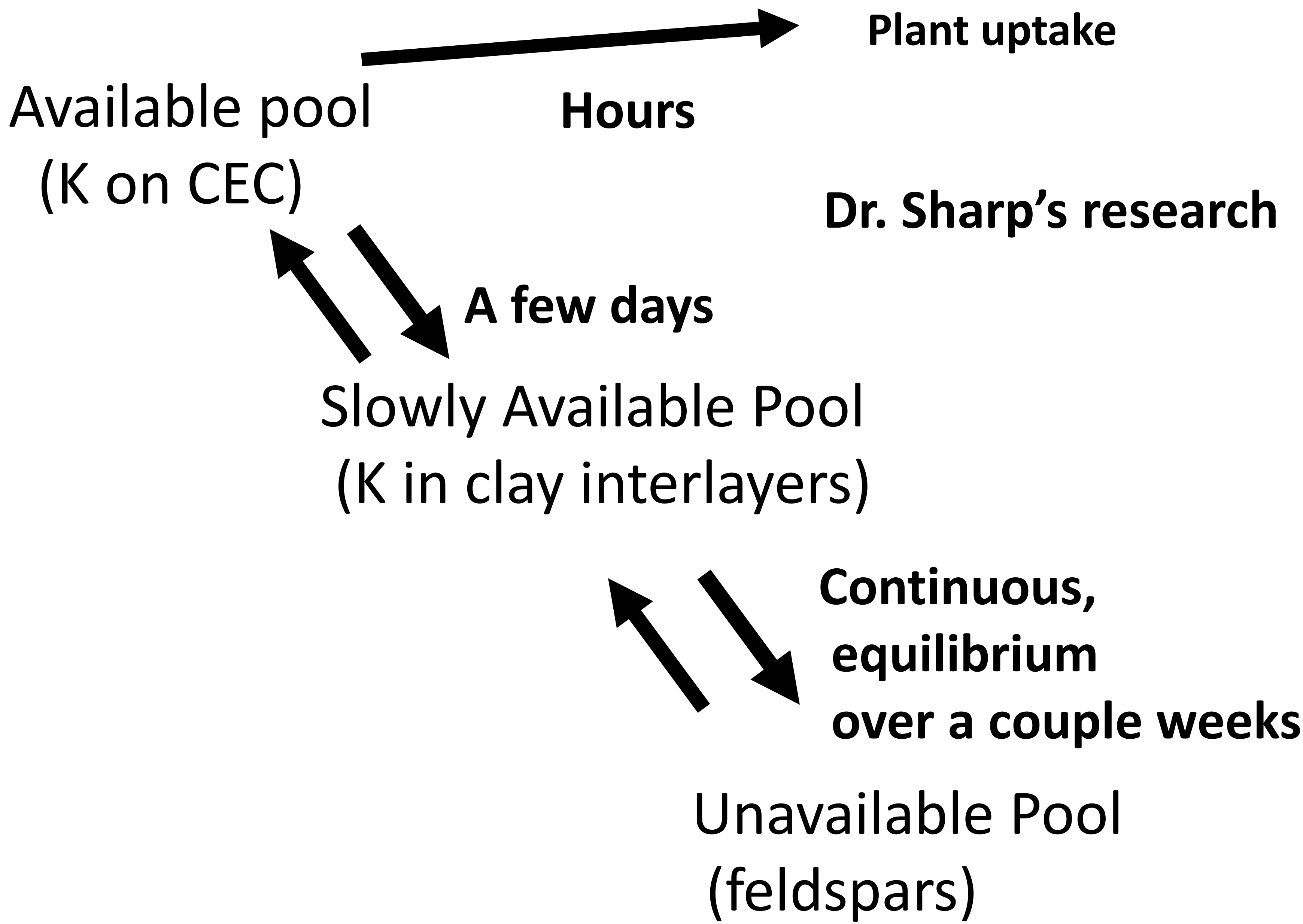
Available pool
(K on CEC)

Weeks to months

Slowly Available Pool
(K in clay interlayers)

Years

Unavailable Pool
(feldspars)


Plant uptake
Available pool
(K on CEC)
Hours
Dr. Sharp's research
A few days
Slowly Available Pool
(K in clay interlayers)
Continuous,
equilibrium
over a couple weeks
Unavailable Pool
(feldspars)

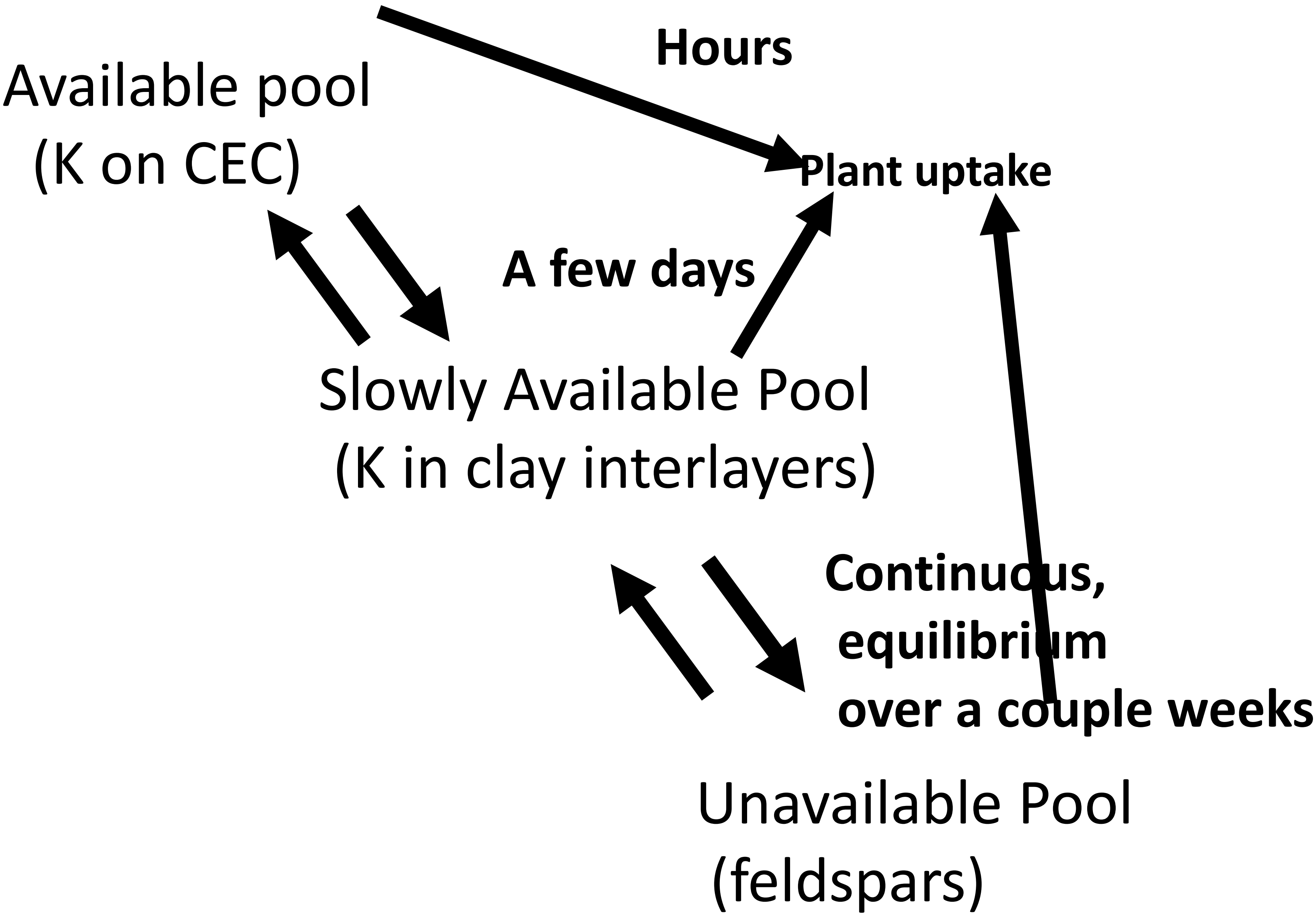

Available pool
(K on CEC)
Hours
Plant uptake
A few days
Slowly Available Pool
(K in clay interlayers)
Continuous,
equilibrium
over a couple weeks
Unavailable Pool
(feldspars)

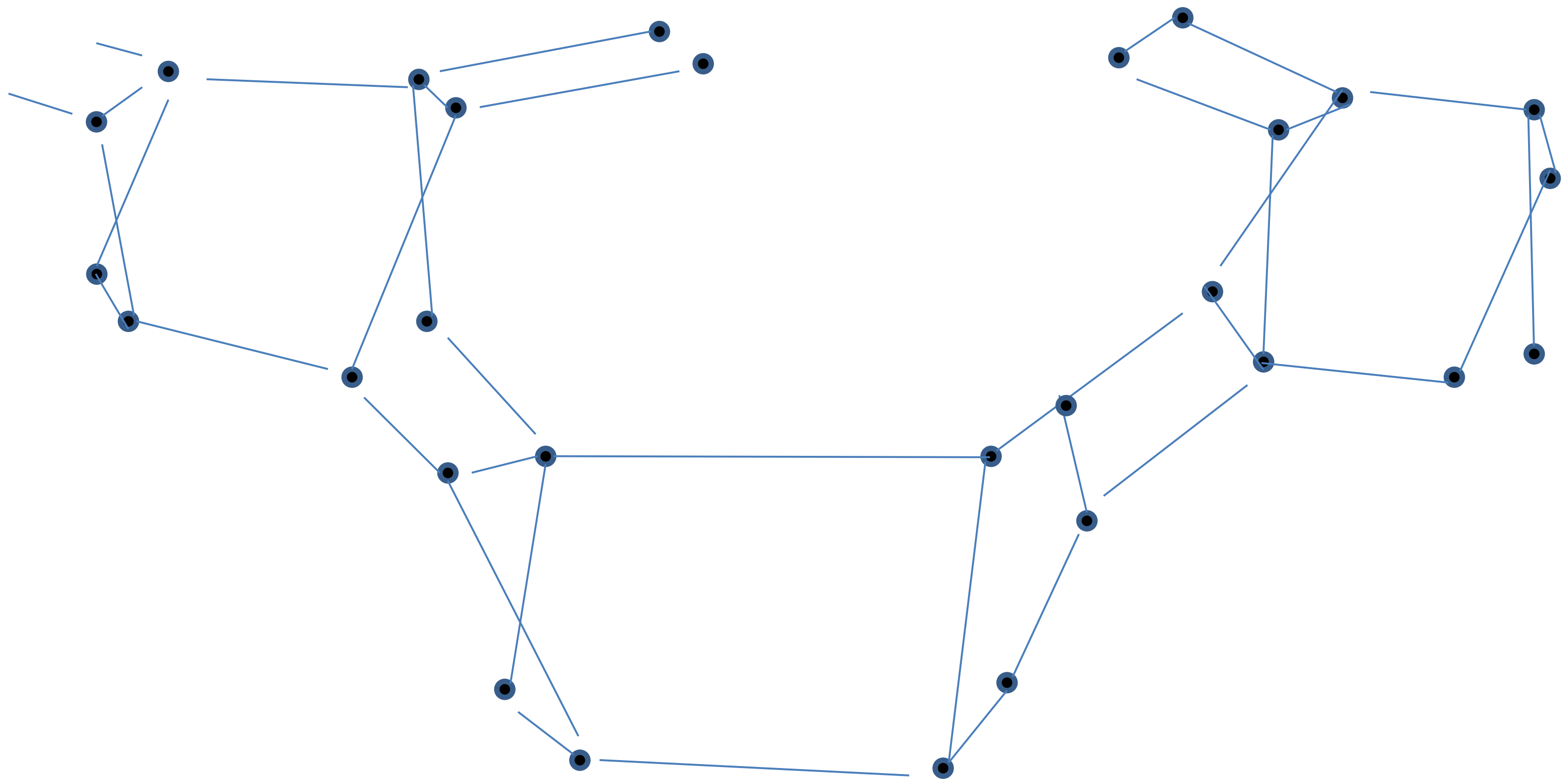
Table 1. Effect of K applications on corn grain yields at four sites over three growing seasons. Yield was not significantly ($p \leq 0.05$) affected by treatment for any year-site combination.

Annual K Application†	Soil: Rumford	Kenansville	Matapeake	Sassafras
kg K ha^{-1}	yield, Mg ha^{-1}			
		1982		
0	13.1	12.4	12.1	13.1
94	13.4	12.3	11.3	12.9
94S	14.0	12.3	11.7	13.0
282	13.5	11.4	11.1	13.1
282S	13.8	11.4	11.2	12.2
SEM‡	0.3	0.5	0.4	0.4
		1983		
0	8.9	–	12.7	9.2
94	9.4	–	12.5	9.1
94S	8.5	–	12.1	7.6
282	11.5	–	11.8	6.9
282S	11.5	–	12.2	6.9
SEM	0.9	–	0.4	1.2
		1984		
0	9.8	–	8.7	–
94	10.1	–	9.2	–
94S	10.3	–	9.8	–
282	10.0	–	9.4	–
282S	10.5	–	9.3	–
SEM	0.2	–	0.4	–

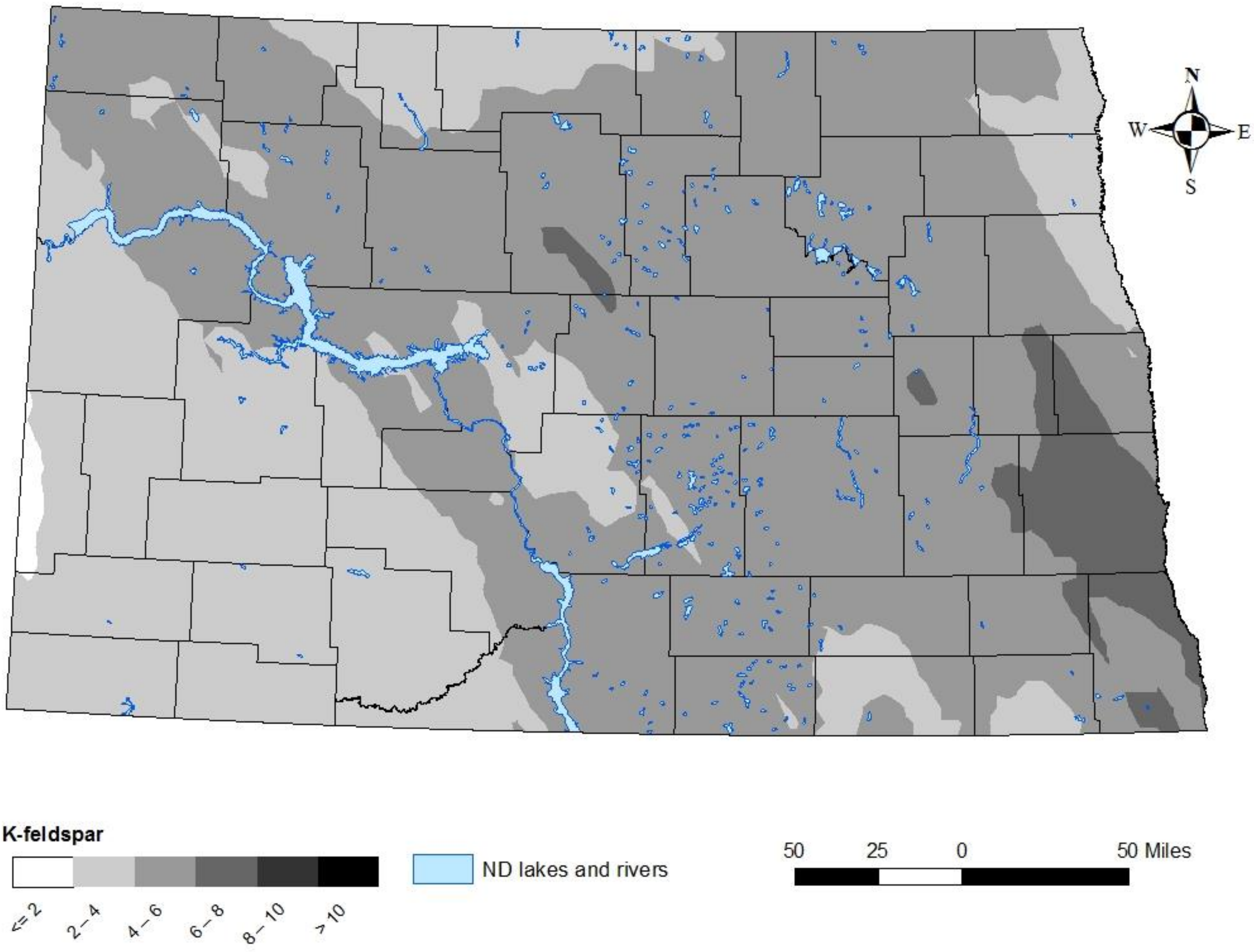
† S indicates K was applied in three equal portions to give the total rate indicated.
‡ Standard error of the mean.

From Parker et.al., SSSAJ 1989b

Potassium feldspar-



3-D framework of SiO_4 and Al_2O_3 tetrahedrals isomorphous substitution of Al for Si ~ ¼ of the time results in significant negative (-) charge. Potassium within the open spaces helps balance charge.



N
W
E
S
K-feldspar
<= 2
2 – 4
4 – 6
6 – 8
8 – 10
> 10
ND lakes and rivers
50
25
0
50 Miles

Clays measured in survey-

Smectite- (includes montmorillonite/beidelite)
(Crisp leaf-lettuce sandwich w/o mayo)

Illite- 2-1 limited expanding clay
(peanut butter sandwich)

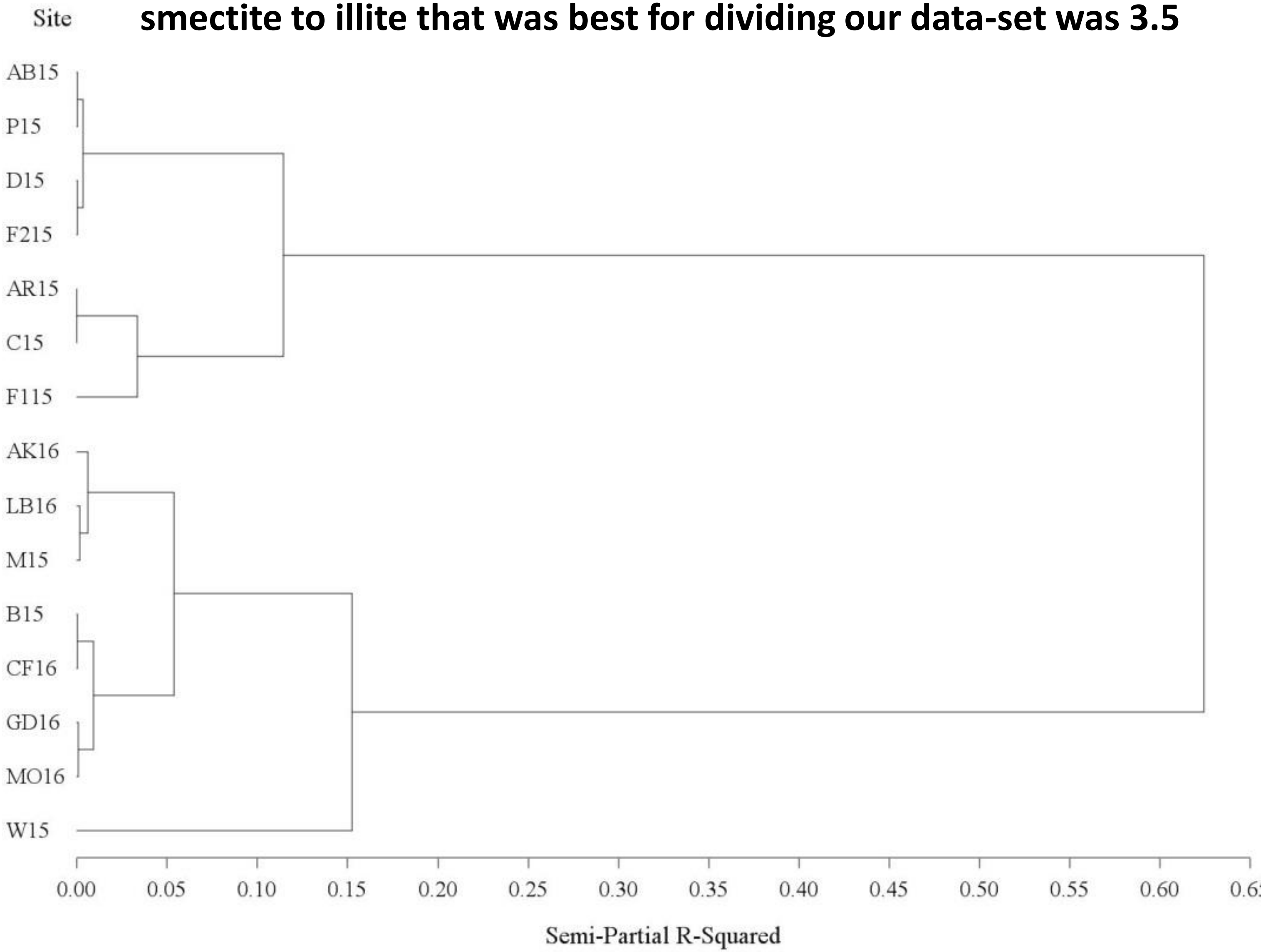
Kaolinite (1-1 non-expanding clays)

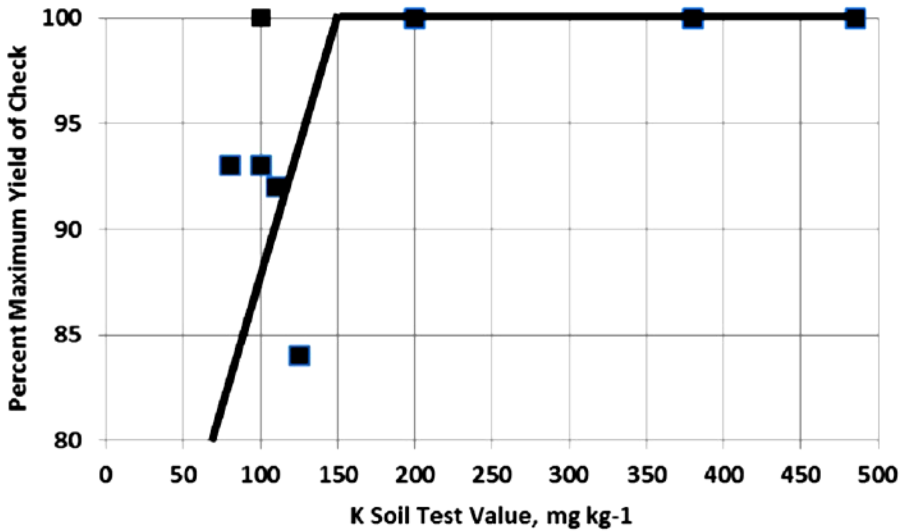
Chlorite (3-1 non-expanding clays)

Smectites ‘fix’, or temporarily retain K when soil is dry

Illites do not ‘fix’ K when dry

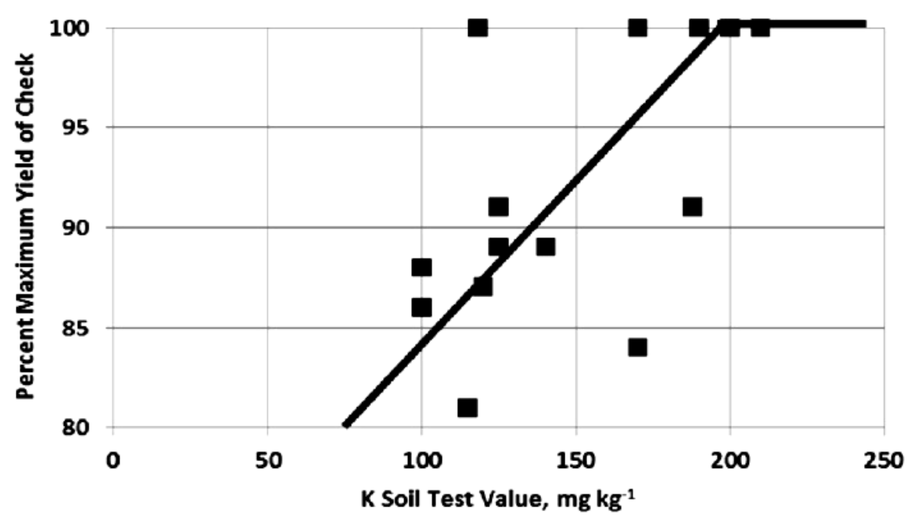
Used statistics to cluster the sites into two groups. The ratio of smectite to illite that was best for dividing our data-set was 3.5

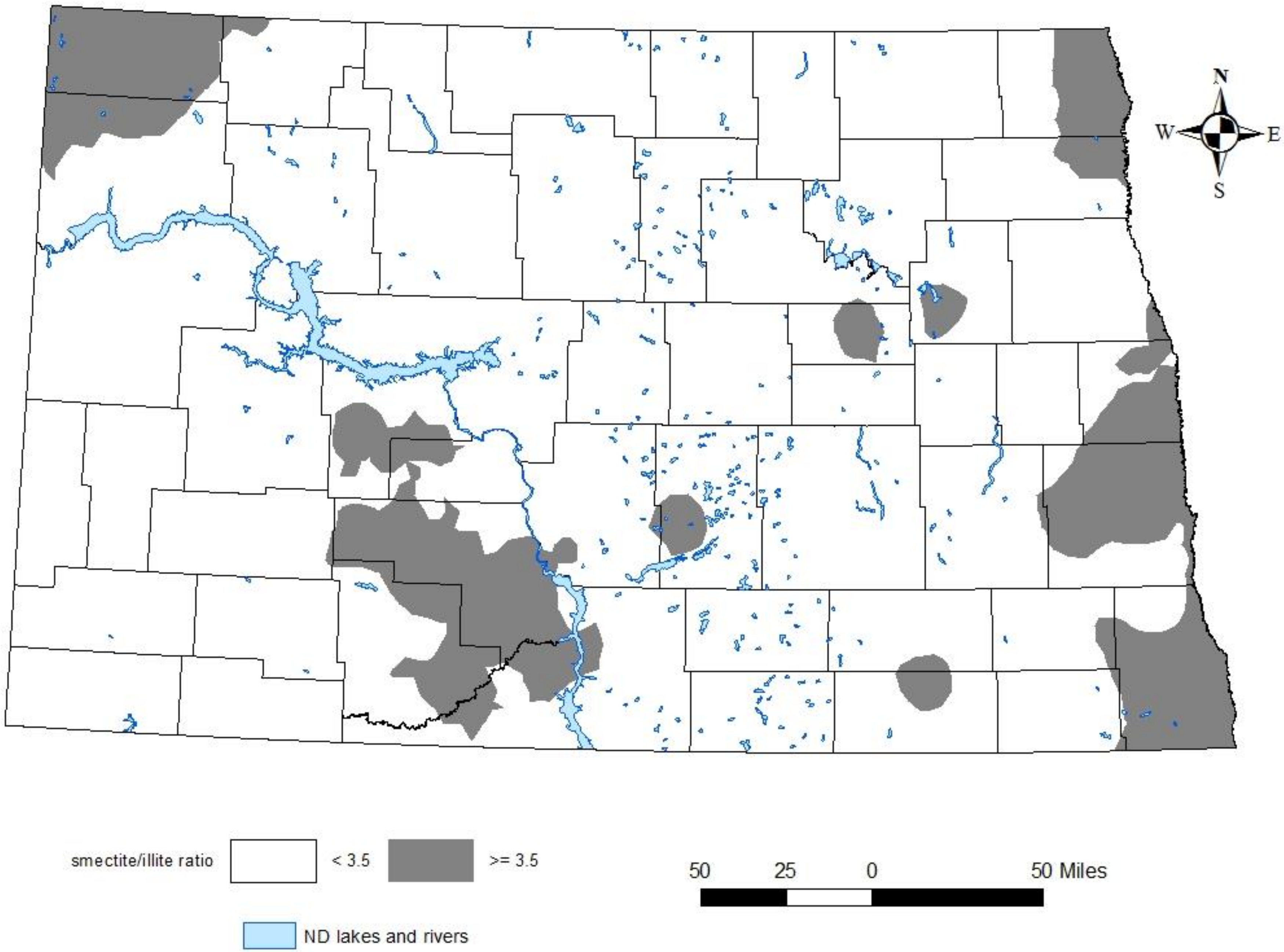




Smectite/illite ratio < 3.5

Smectite/illite ratio > 3.5




N
W
E
S
smectite/illite ratio
< 3.5
>= 3.5
50
25
0
50 Miles
ND lakes and rivers

New North Dakota critical K levels-

For corn, alfalfa-

Smectite/illite > 3.5 200 ppm

Smectite/illite < 3.5 150 ppm

For sugar beet-

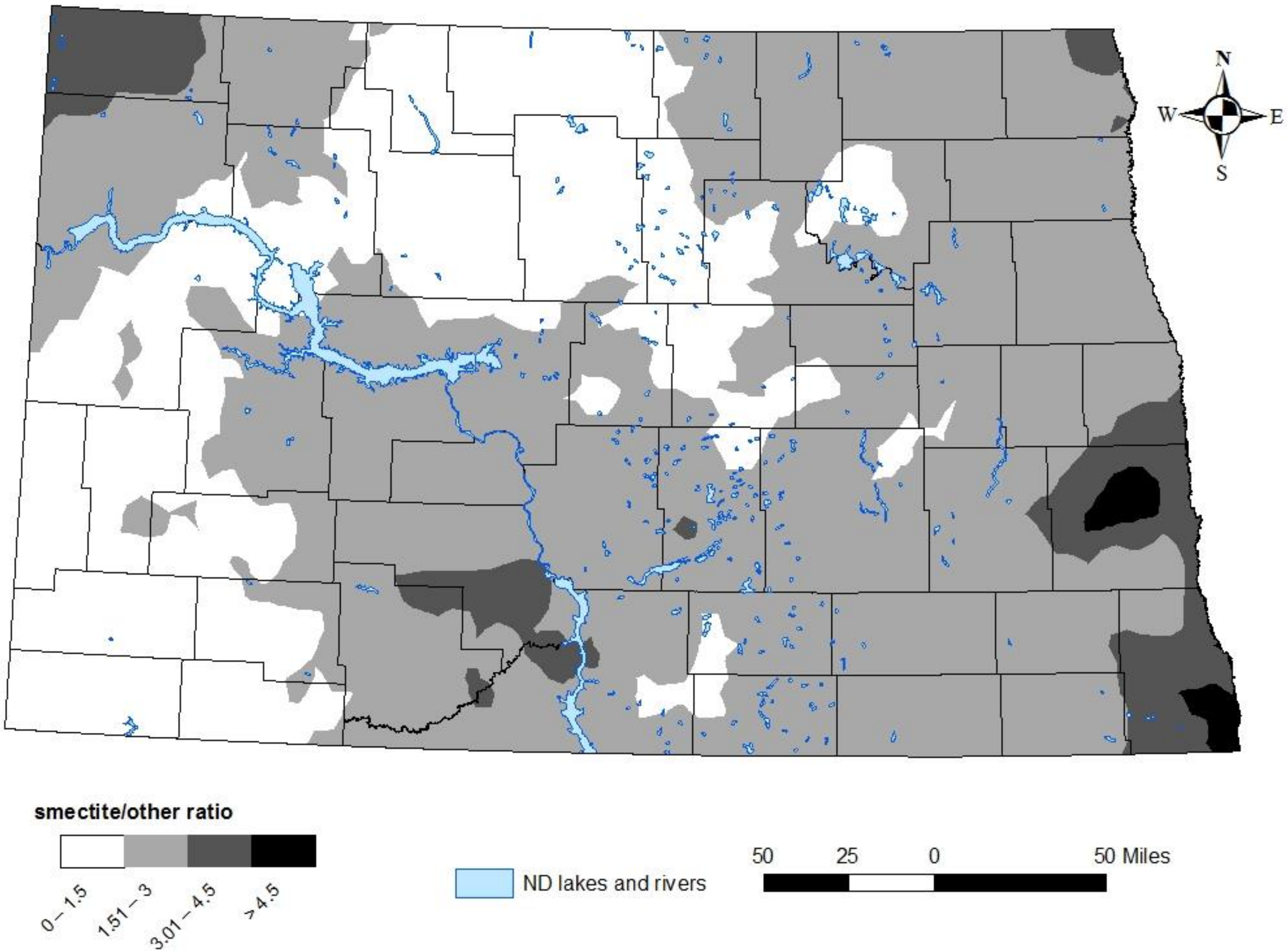
>3.5 150 ppm

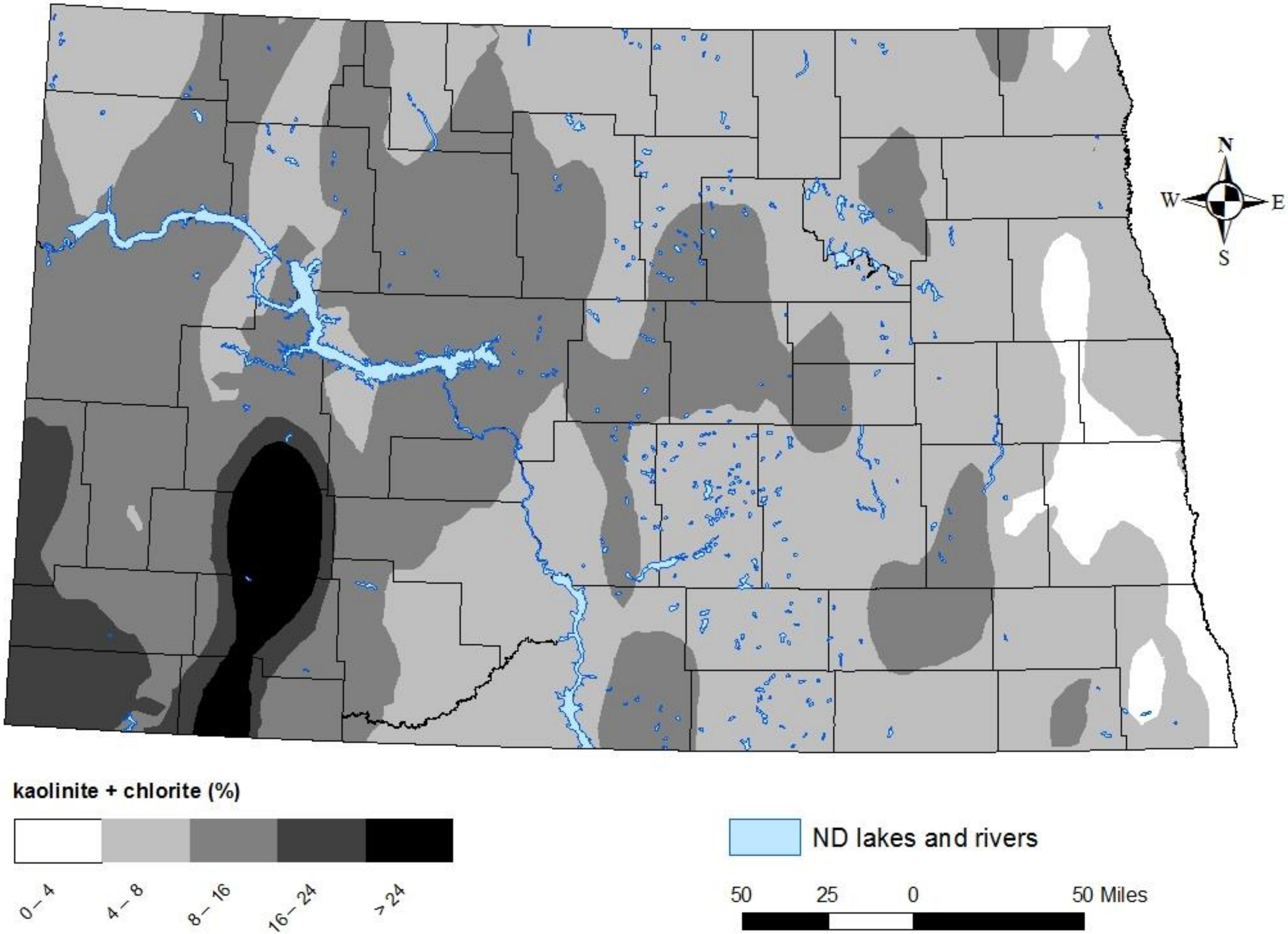
< 3.5 120 ppm

For spring wheat/durum/winter wheat

> 3.5 150 ppm

< 3.5 100 ppm


N
W
E
S
smectite/other ratio
0 – 1.5
1.51 – 3
3.01 – 4.5
>4.5
ND lakes and rivers
50
25
0
50 Miles


N
W
E
S
kaolinite + chlorite (%)
0 – 4
4 – 8
8 – 16
16 – 24
> 24
ND lakes and rivers
50
25
0
50 Miles