Exploring tools to monitor in-season crop nitrogen status

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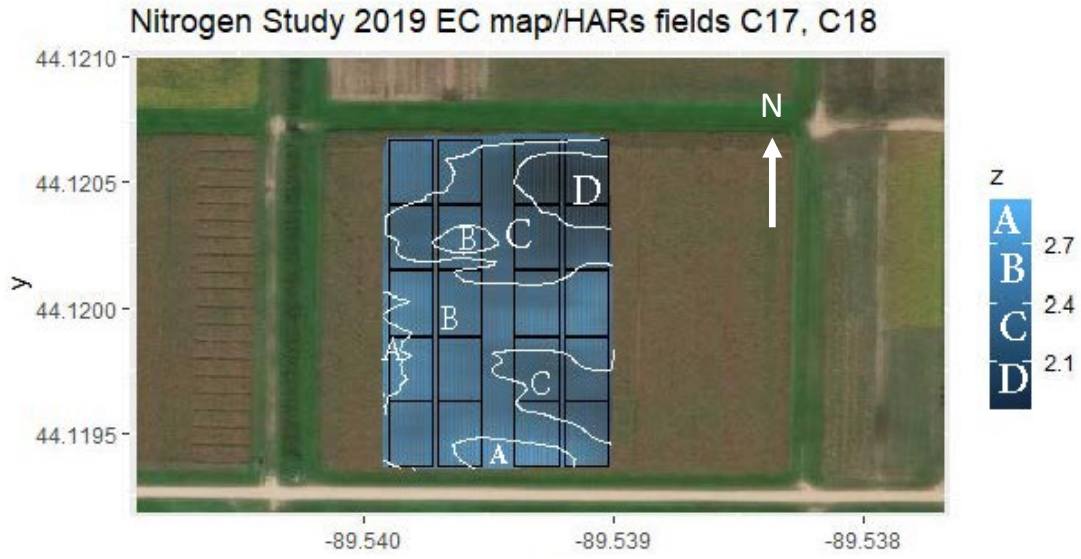
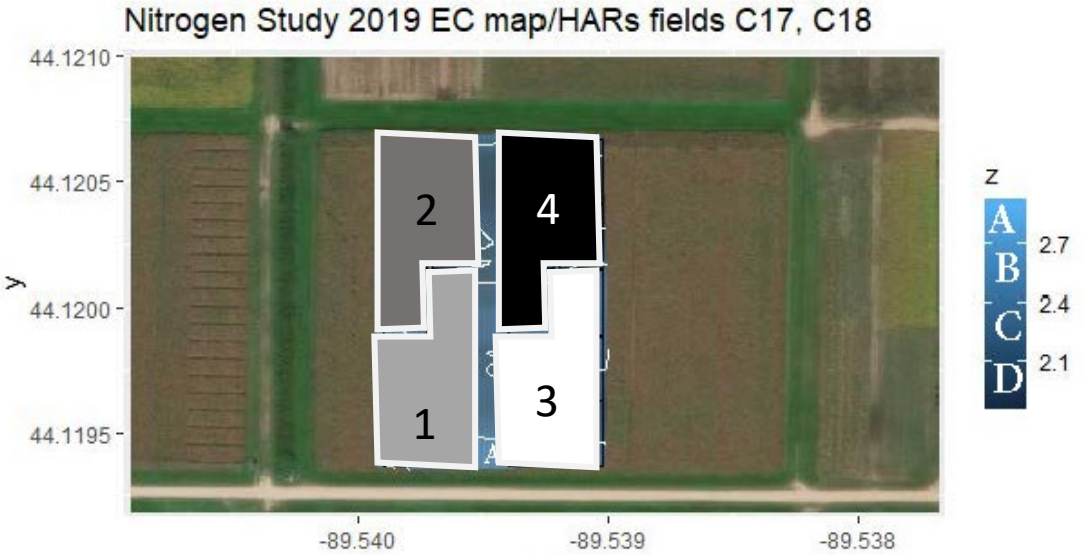
Nitrogen management on sandy soils is difficult
Plainfield series: Mixed, mesic Typic Udipsamments

- Low nutrient holding capacity
  - Low clay content
  - Low organic matter
  - High mineralization rate
- Low water holding capacity
  - Minimal soil structure
  - low fine pore space
  - Potentially hydrophobic
- High infiltration
  - High leaching potential of mobile nutrient
  - Heavy rainfalls tend to infiltrate rather than create surface runoff
- Research
  - General nitrogen management findings can be applied to most crops
  - Nutrient application timing relative to potential rainfall is critical

Research overview

- Tissue samples for nitrogen status
- Developing nitrogen recs for Hodag + W9433-1rus


Nitrogen Study 2019 EC map/HARs fields C17, C18
44.1210
44.1205
44.1200
44.1195
y
-89.540
-89.539
-89.538
N
A
B
C
D
z
2.7
2.4
2.1


Nitrogen Study 2019 EC map/HARs fields C17, C18
44.1210
44.1205
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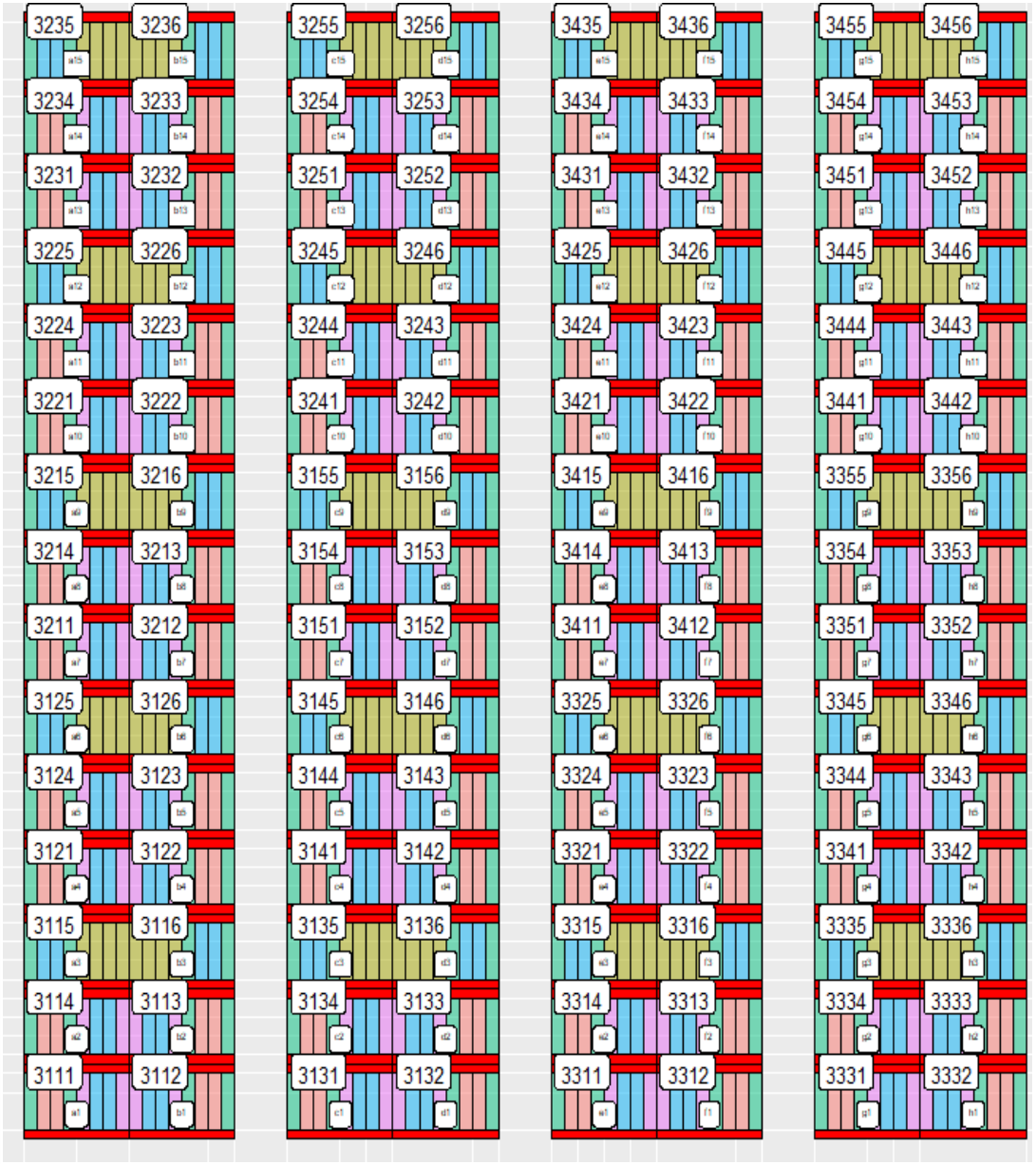
44.1195
y
-89.540
-89.539
-89.538
1
2
3
4
z
2.7
2.4
2.1


Continuous rows in 2019 *no gaps*

Tissue collection

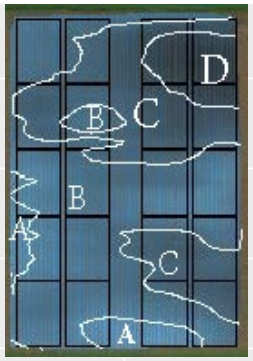
- Different rows for:
  - Harvest
  - Whole Vines
  - Leaves and petioles
- Petiole and Leaves collected
  - Petioles separated from leaflets.
  - Nitrogen from petioles and leaves combined by plot to get leaf content



Nitrogen Application (pounds/acre)

	Plant	Hill	Tuber Int	Early Bulking	Mid Bulking	Total
	7-May	25-May	5-Jun	10-Jul	25-Jul	--
Control	40	0	0	0	0	40
Rate 1	40	70	70	0	0	180
Rate 2	40	70	130	0	0	240
Rate 3	40	70	130	60	0	300
Rate 4	40	70	130	60	60	360

2019 Nitrogen Study Stems per Plant



A 2.7
B 2.4
C 2.1
D

Stems per plant

7
6
5
4
3
2

Silverton W9433 Snowden Hodag

Variety

ecZone
a
b
c
d

seedType
cut
whole

2019 Nitrogen Study Plants per 25 feet

Stems per plant

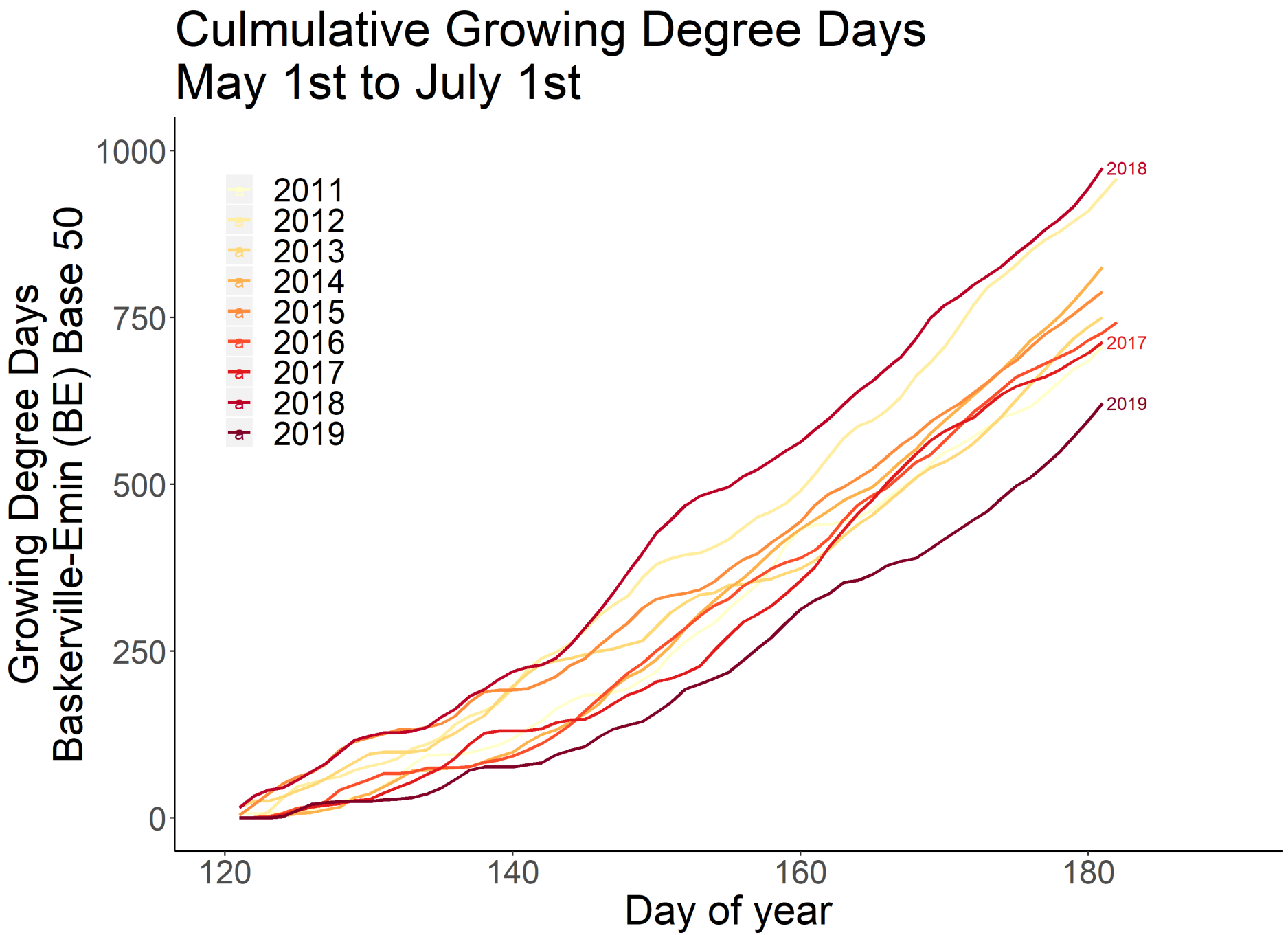
26
25
24
23
22
21

Silverton W9433 Snowden Hodag

Variety

ecZone
a
b
c
d

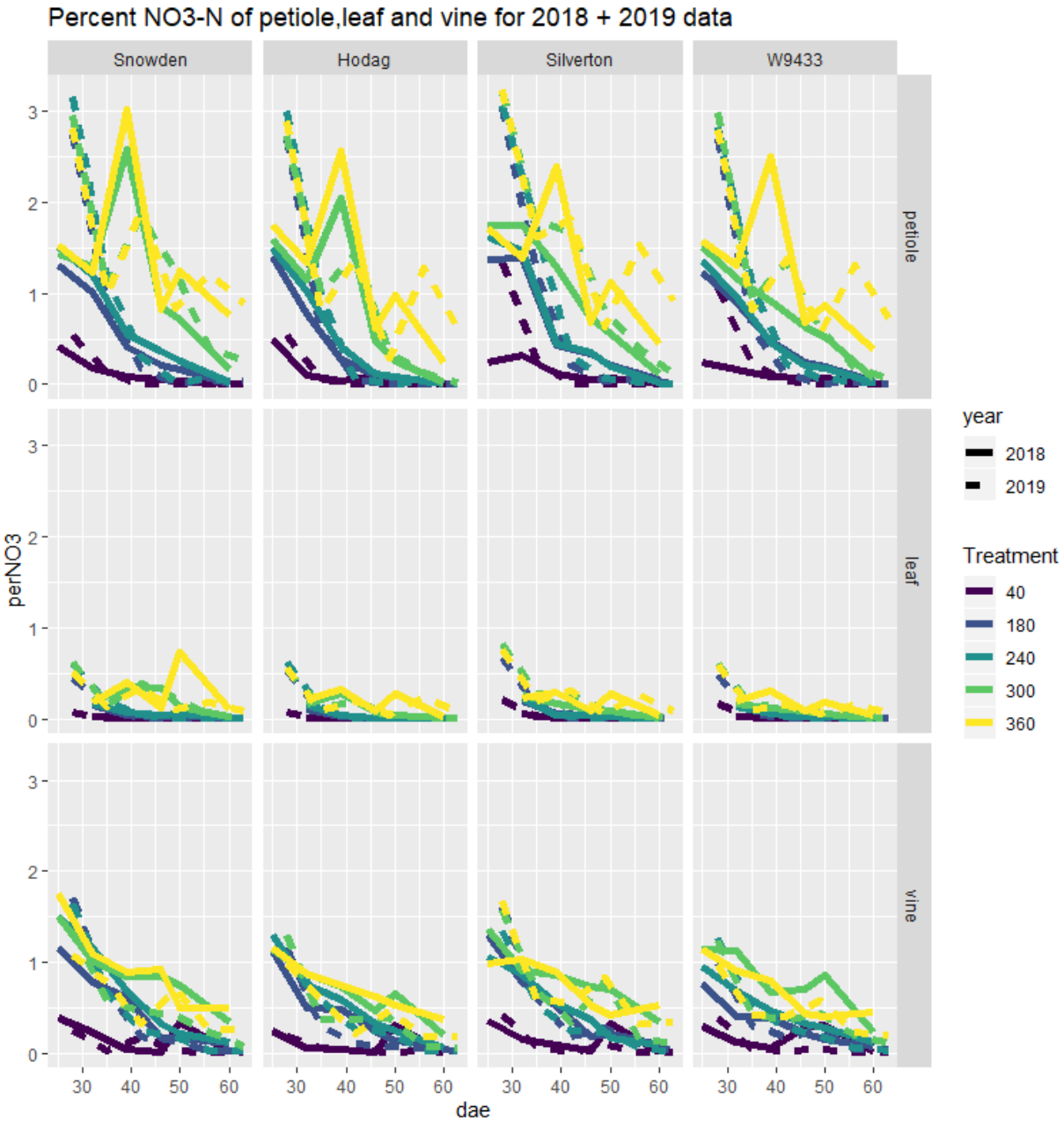
seedType
cut
whole

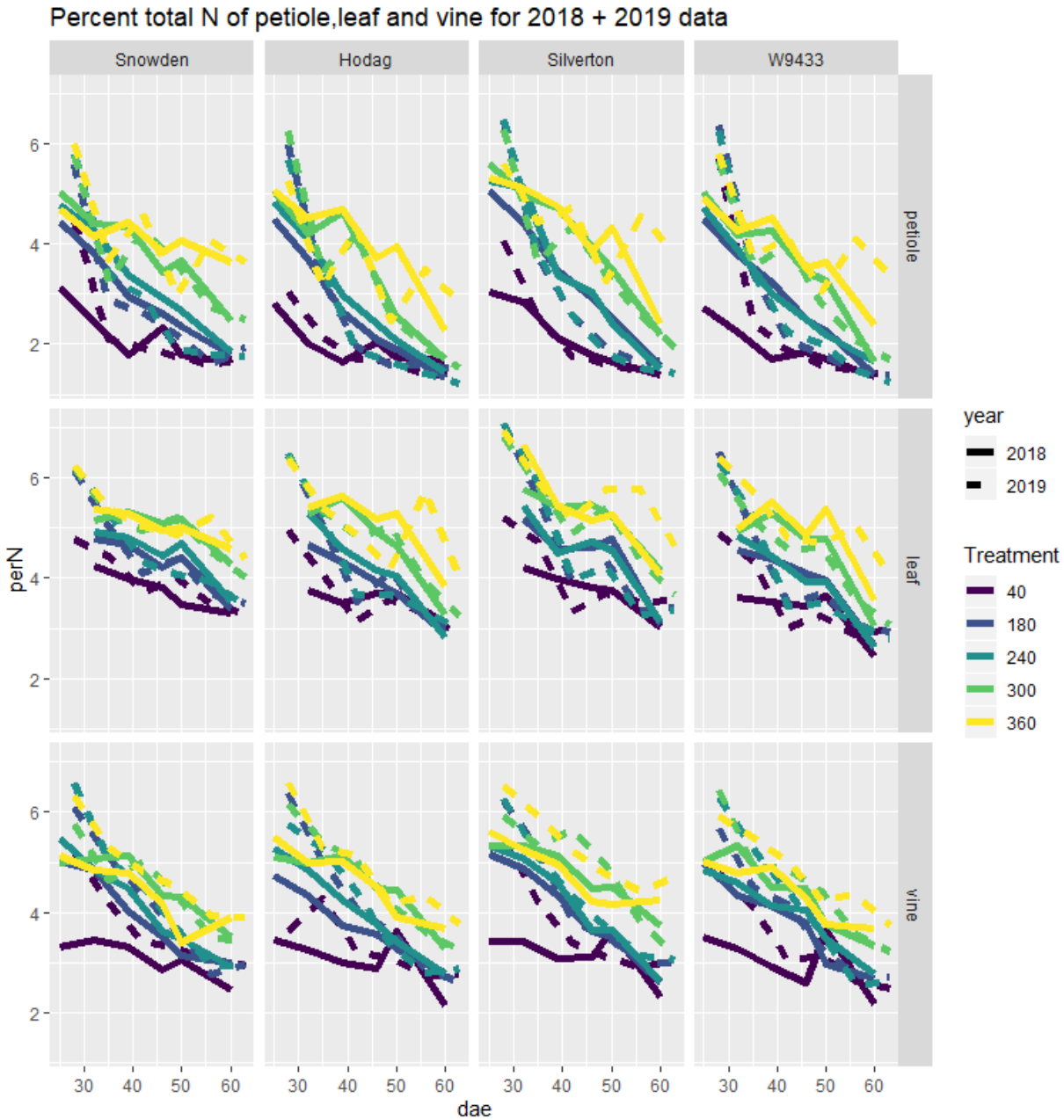

Culmulative Growing Degree Days
May 1st to July 1st
Growing Degree Days
Baskerville-Emin (BE) Base 50
1000
750
500
250
0
2011
2012
2013
2014
2015
2016
2017
2018
2019
2018
2017
2019
120
140
160
180
Day of year

Plant Nitrogen Status

- Tissue samples for nitrogen status
  - Petioles
  - Whole Leaf
  - Whole Vine
- Nitrogen types
  - No3-N
  - Total N

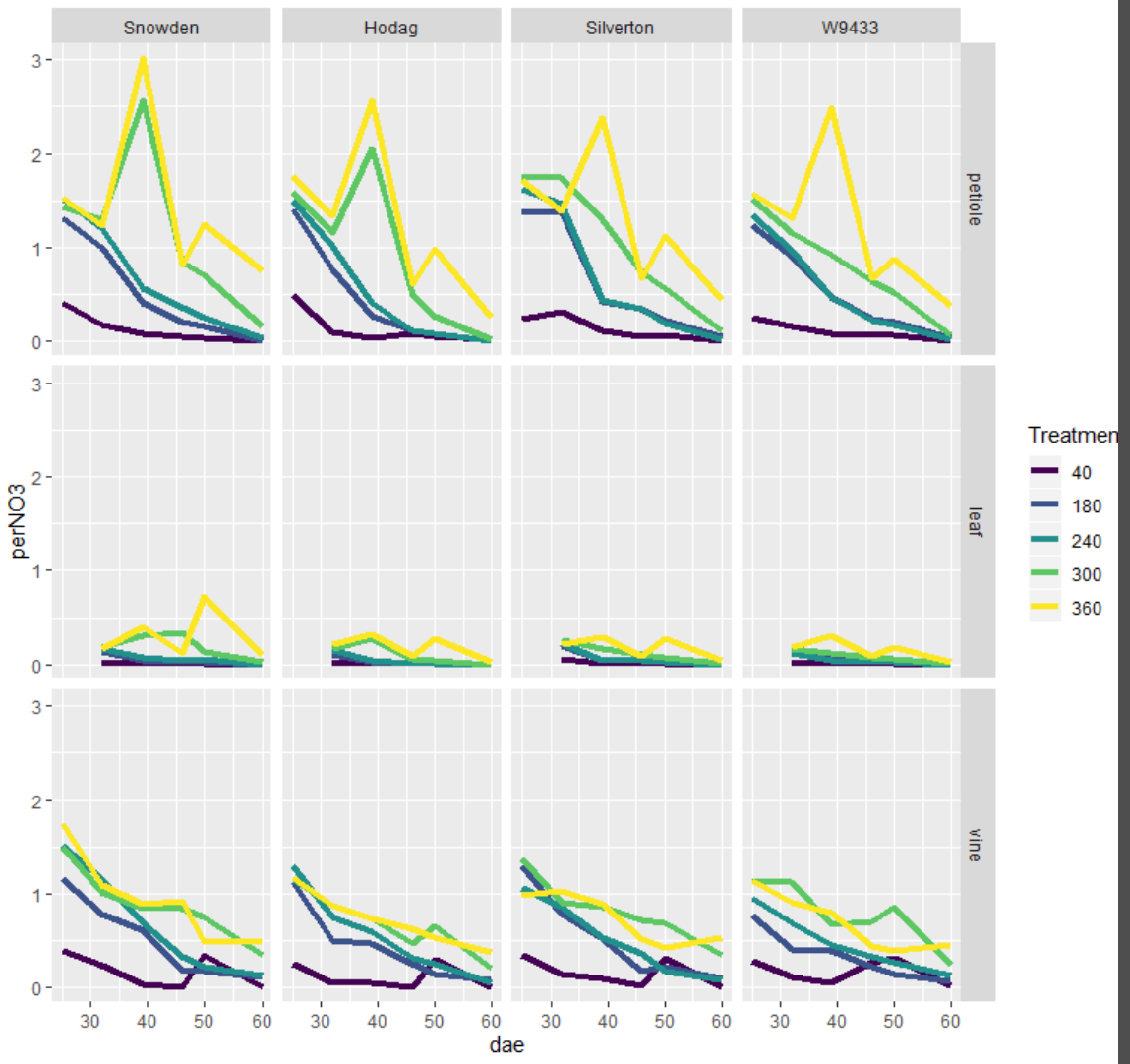
Tissue sampling



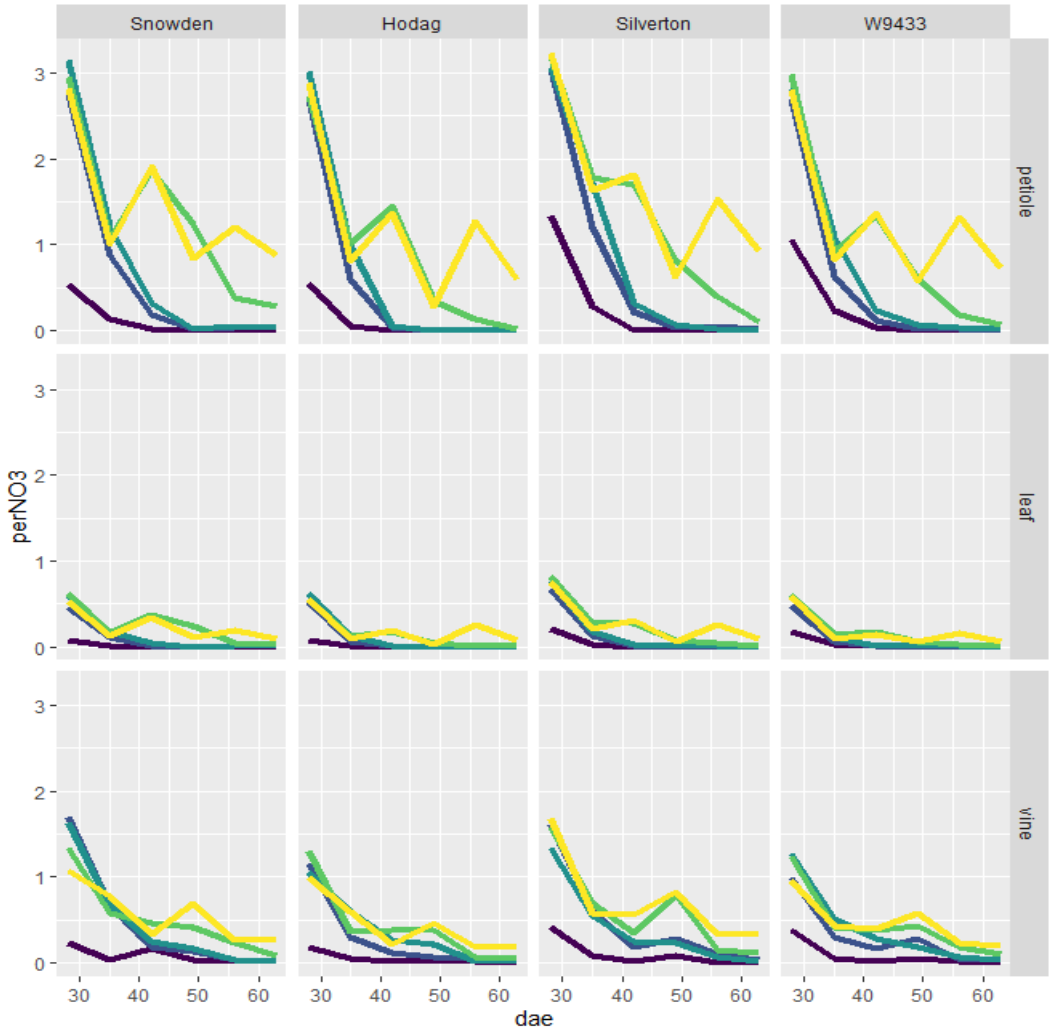


NO3-N vs Total N

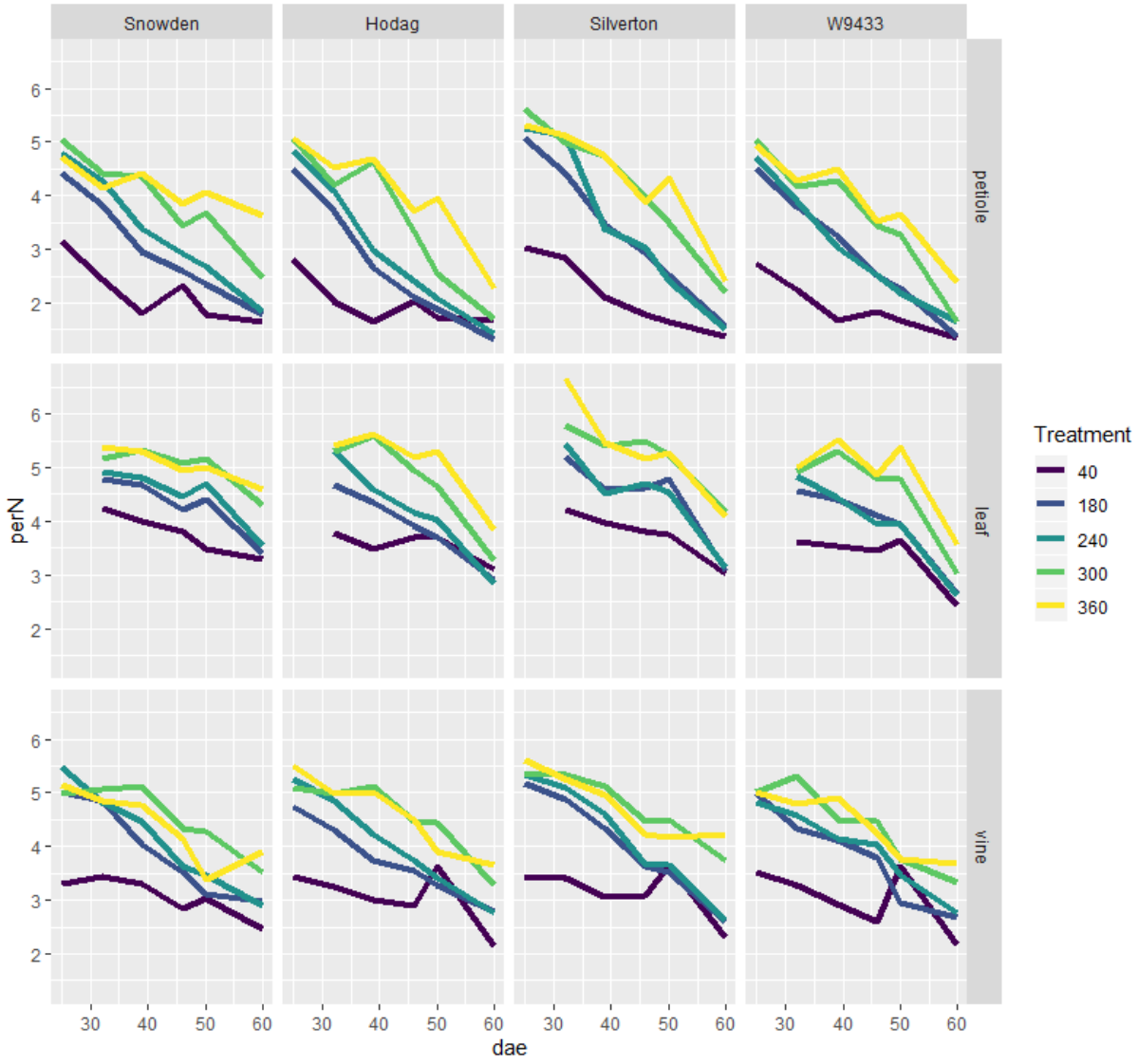
2018 no3-N



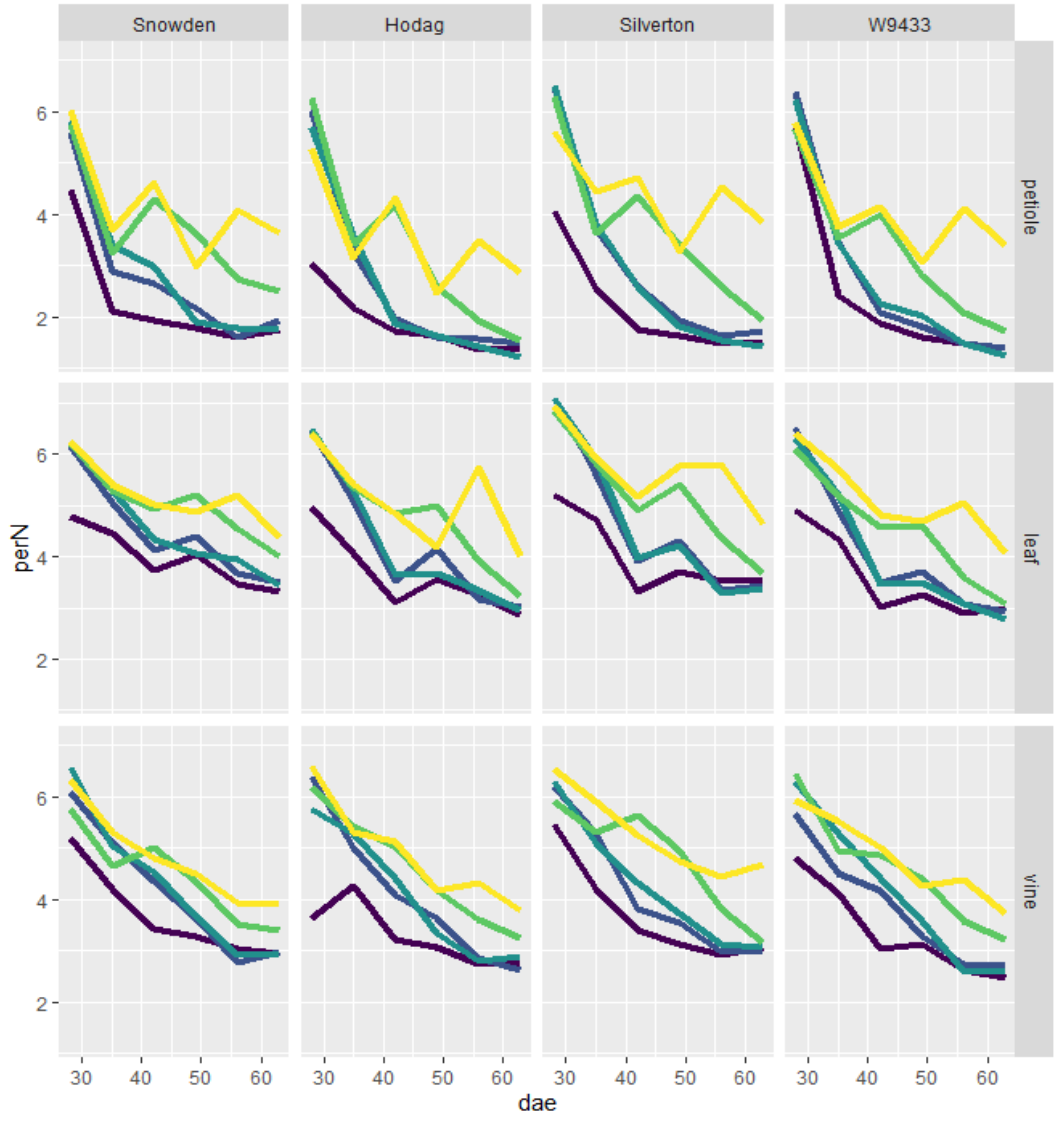
2019 no3-N



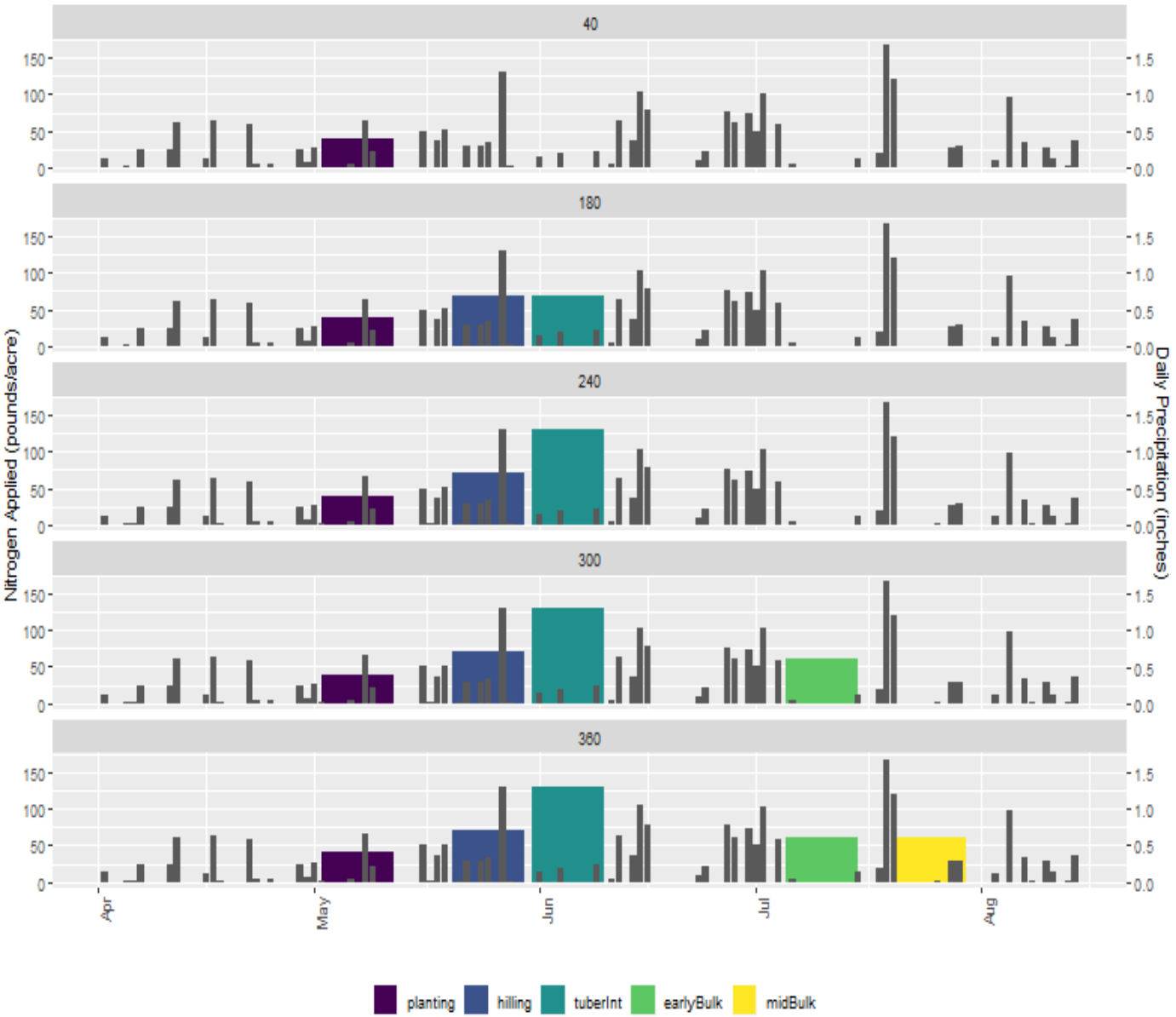
2018 total N

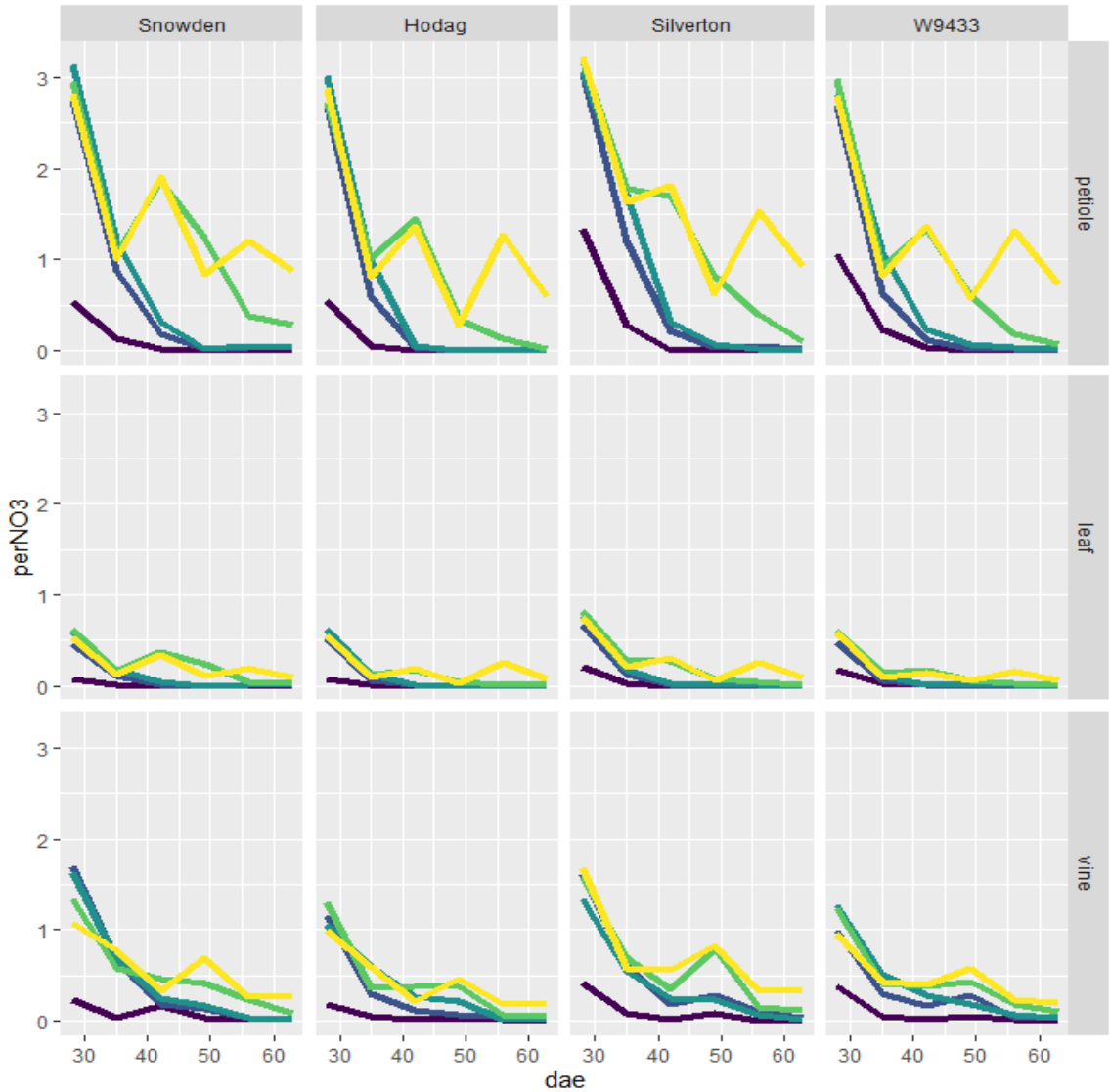


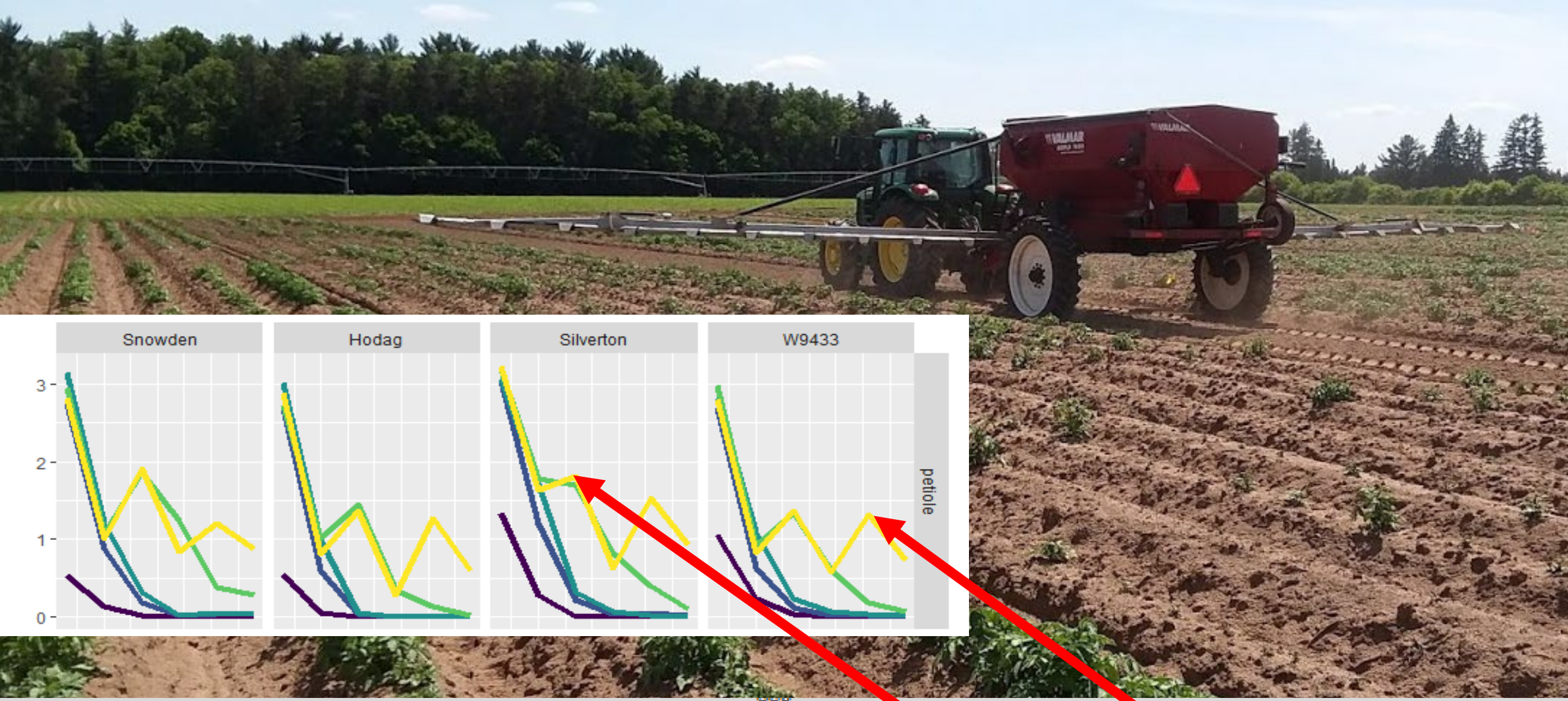
2019 total N

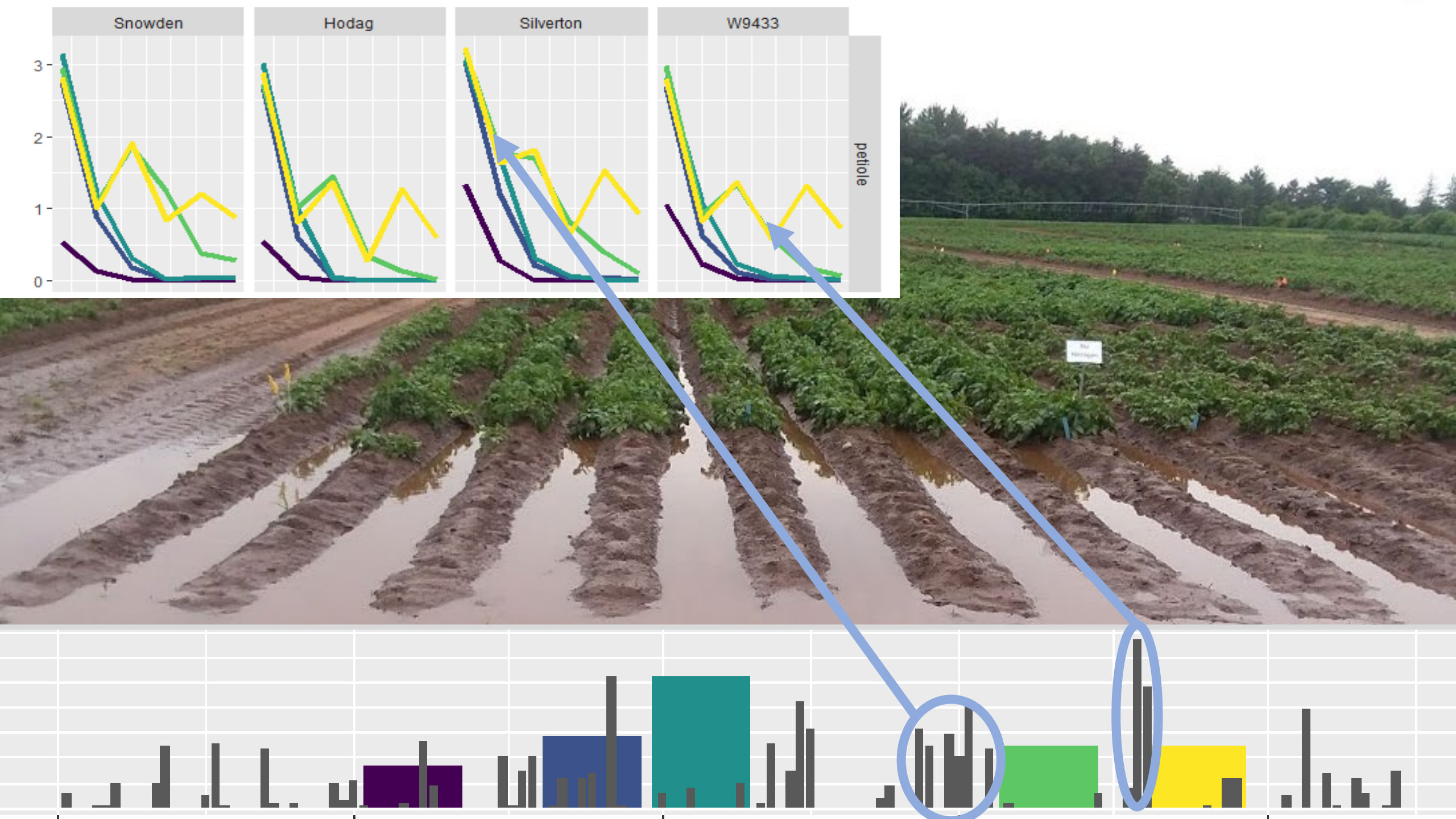


2019 no3-N


40
180
240
300
360
Nitrogen Applied (pounds/acre)
Daily Precipitation (inches)
Apr
May
Jun
Jul
Aug
planting
hilling
tuberInt
earlyBulk
midBulk


Snowden
Hodag
Silverton
W9433
petiole
leaf
vine
petNO3
dae


Snowden
Hodag
Silverton
W9433
petiole
3
2
1
0


Snowden
Hodag
Silverton
W9433
petiole
3
2
1
0

Tissue Types for Nitrogen Status

Petiole is the most responsive tissue type to changes in plant available nitrogen

Petiole nitrate is the standard for research

Petiole collection is the smallest amount of biomass

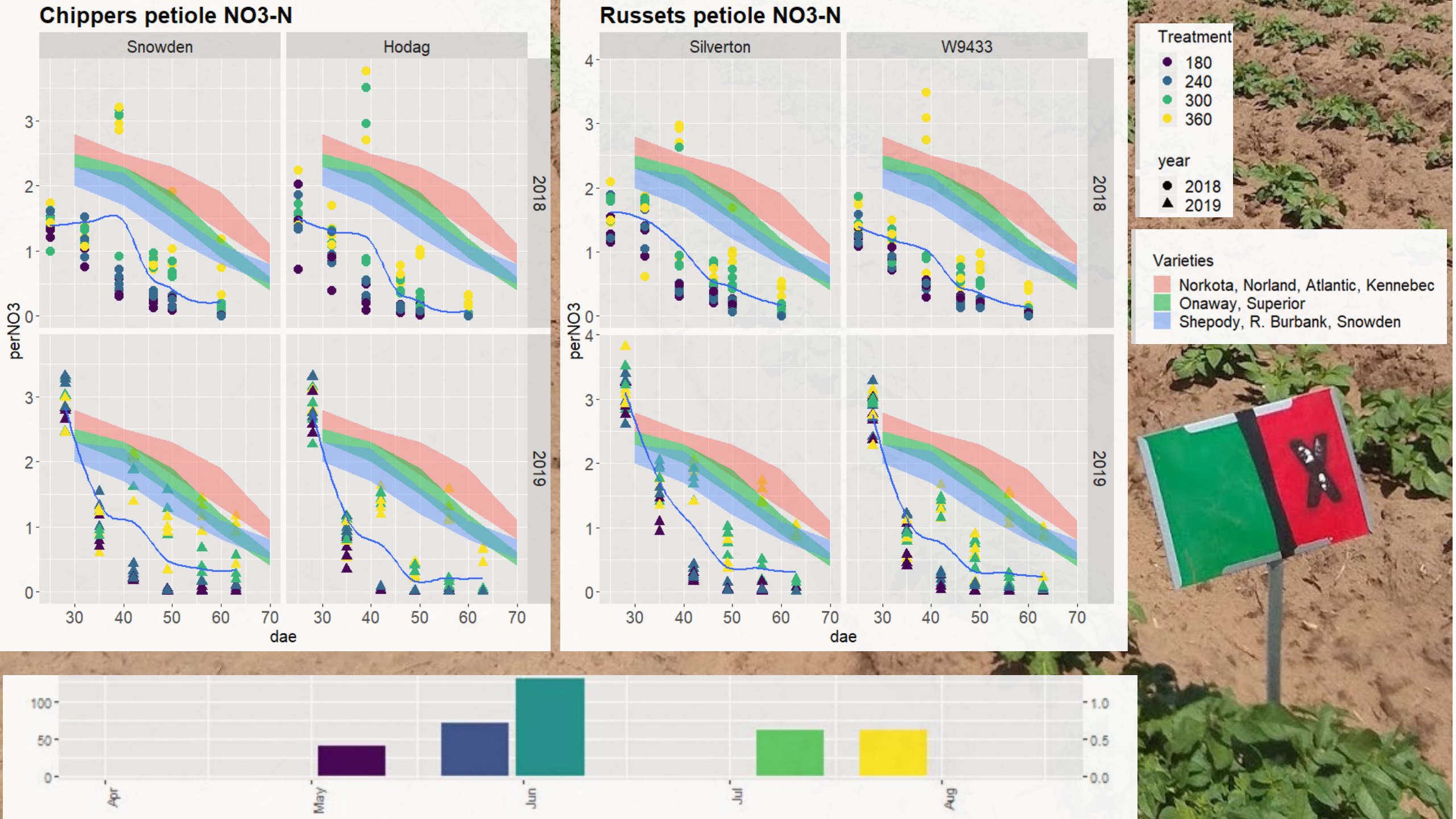
- Less to transport out of the field
- Can include more plants per sample

Whole vine sampling is much more work

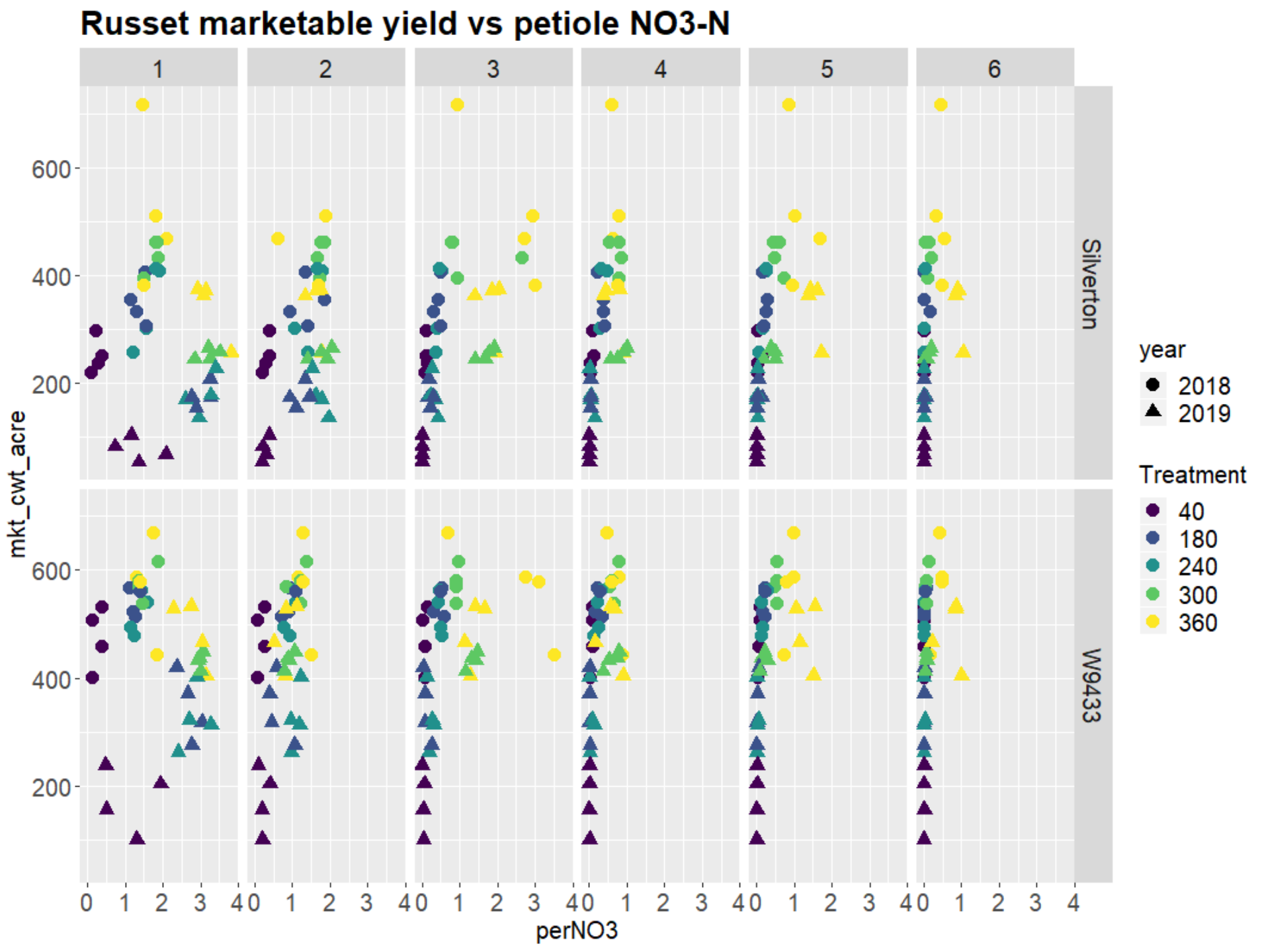
- Much larger sample mass – pounds per sample
- Harder to reduce sample size to get representative sample
- Harder to quickly dry sample for analysis

Nitrogen Recs for Hodag and W9433: in process

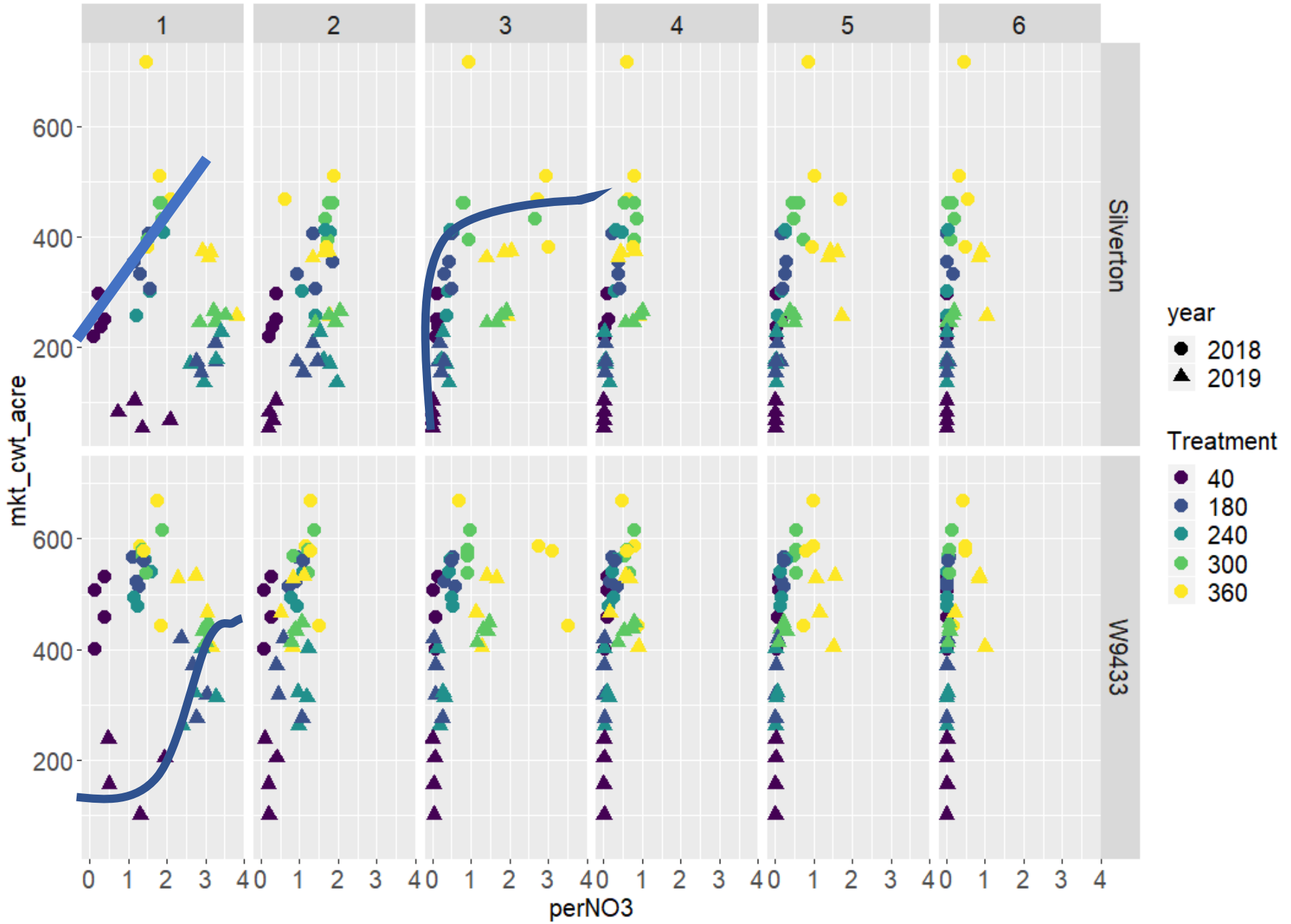
- Petiole no3-N of established varieties
  - Hodag vs Snowden
  - W9433 vs Silverton
- Petiole no3-N and marketable yield


Chippers petiole NO3-N
Snowden
Hodag
2018
2019
perNO3
dae
Russets petiole NO3-N
Silverton
W9433
Treatment
180
240
300
360
year
2018
2019
Varieties
Norkota, Norland, Atlantic, Kennebec
Onaway, Superior
Shepody, R. Burbank, Snowden
Apr
May
Jun
Jul
Aug

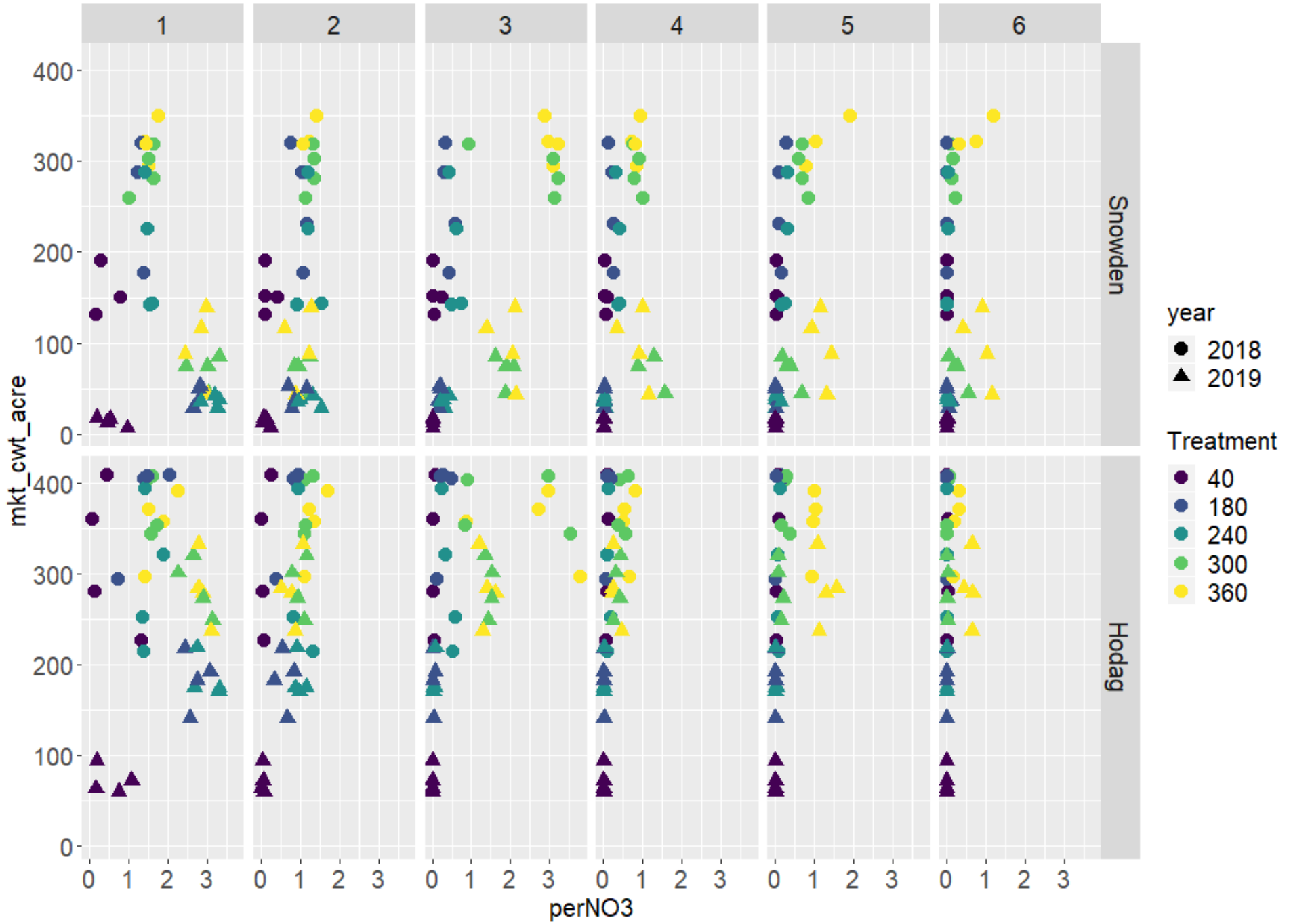
Petiole NO3-N and Yield


Russet marketable yield vs petiole NO3-N
1
2
3
4
5
6
Silverton
W9433
mkt_cwt_acre
600
400
200
perNO3
0 1 2 3 4
year
2018
2019
Treatment
40
180
240
300
360

Russet marketable yield vs petiole NO3-N



Chipper marketable yield vs petiole NO3-N



Petioles NO3-N as predictor of final yield

Petiole nitrate is the standard in UWEX recommendations

Petiole is very responsive to plant available nitrogen

Petiole usefulness is limited for informing application scheduling

- Takes too long between sample and results
- How does point compare to the whole field?
- Results are variable
  - Time of day
  - Time since heavy rain or application
  - N-source: UAN, AMS, Urea, polymer-coated urea

Petiole sap analysis

- faster – immediate results – but too much effort per sample
- Same issue with point versus field

Future tools

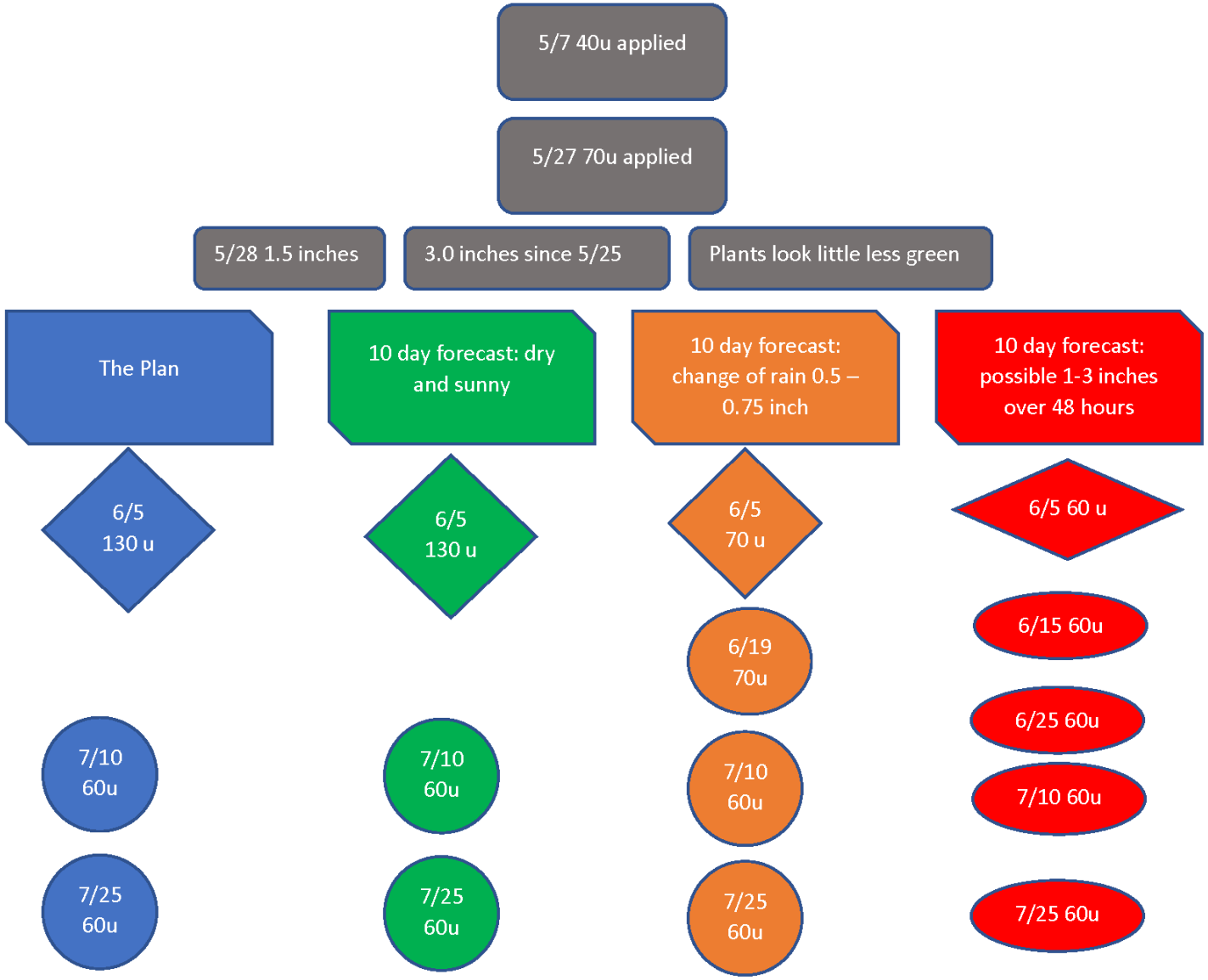
- Nutrient deficiency impact on yield/quality is fast
- Petiole results are slow
- Petioles have limited spatial component

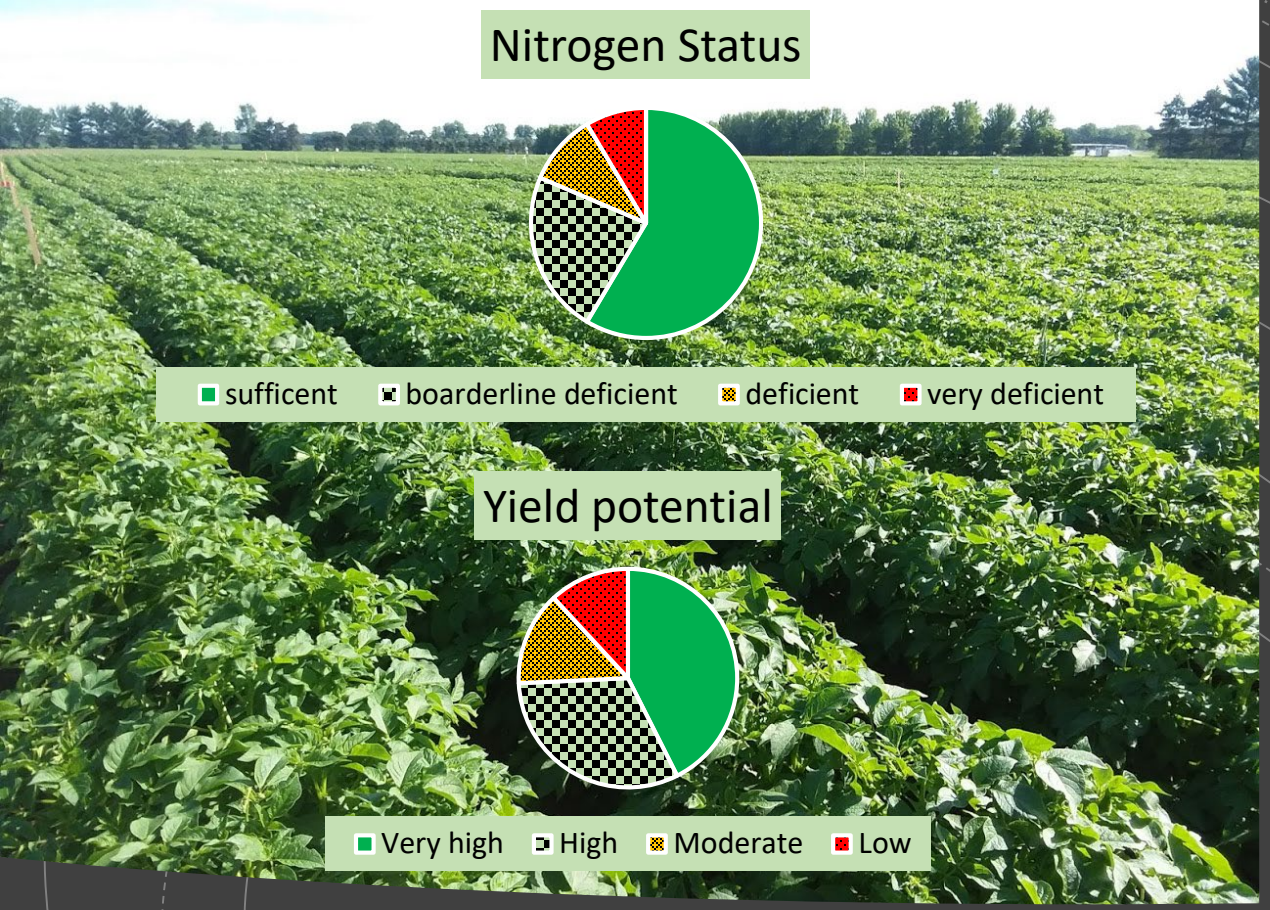
- Previous advances
  - Petiole dry analysis
  - Petiole sap analysis - in field results!
- Future advances
  - Forecast informed application recommendations
  - Fast maps

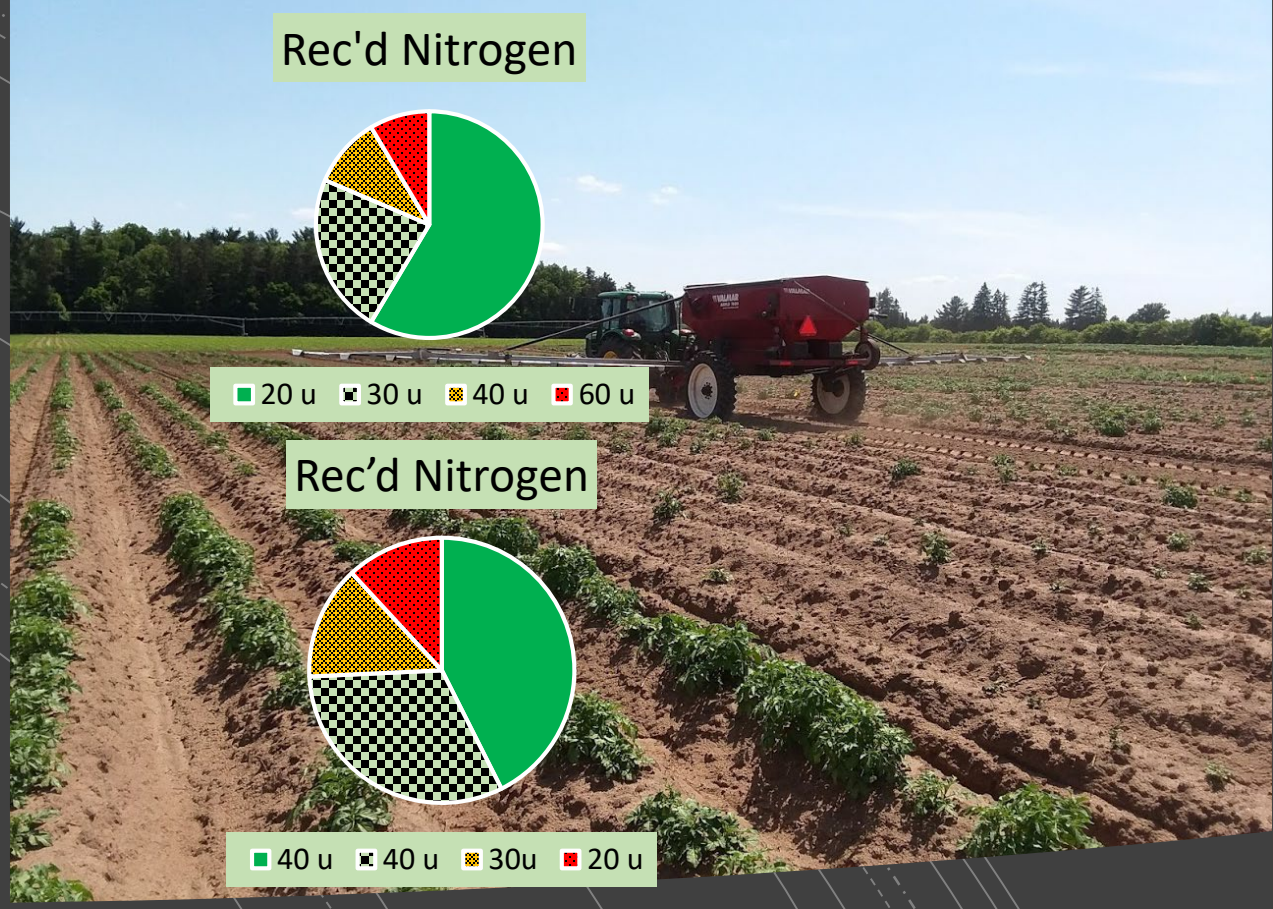
- Collaborations
  - Forecast informed applications
    - ???
  - Fast Maps
    - Infrared imaging
    - Hyperspectral imaging

Decision tree for 2019

- Limitations
  - Time
    - Only so many hours in a day
    - Pest program
    - Watering programs
  - Labor
  - Resources
    - Pumps
    - Poly tanks
  - Capital
    - Value of nitrogen source
    - Values of yield and quality







Fast maps

- Yes/no is application needed
- Record keeping for NMP
- May enable variable rate
  - Crop need
  - Soil type
  - Yield potential

Acknowledgements

- The Wisconsin Fertilizer Research Council - Soil Management, Soil Fertility & Plant Nutrition Research
- Wisconsin Potato Industry Board
- WPVGA
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