



BIOLOGICAL NITROGEN AVAILABILITY TRIALS: 2021 AND 2022 RESULTS

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PEIDAL

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Agriculture and Land

What is the Biological Nitrogen Availability Test?



- A measurement of the N mineralization potential of the soil, predicted over 130 days (the growing season)
- Has been specifically calibrated for use on PEI by the Dalhousie AC Atlantic Soil Health Lab
- Available at the PEI Analytical Lab within the Soil Health package

Soil Health Test Report


13-Jan-2020

PEI Analytical Laboratories
PEI Department of Agriculture and Land
23 Innovation Way
PO Box 2000, Charlottetown, PE C1A 7N8
Fax: (902)-368-6299
Telephone: (902)-620-3300



Example Report John Doe Farms
1234 Farm Lane
Farmington, PE

Client No: 1909110001
Accession No: SH20011301
Samples Reported: 13-Jan-2020
Samples Received: 13-Jan-2020

Soil Health #: SH20011301-1	Soil #: S200113001-1	Sample ID: Field A	
Tillage Depth: 7 - 9 inch	Cropping System: Root Crops	Amendments Applied (manure, etc): <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No	
Yield: Average			
Soil Texture			
Sand (%) 54.1			
Silt (%) 30.9			
Clay (%) 15.0	Soil Texture Class: Sandy Loam		
Test	Results	Score (out of 100)	Rating
Organic Matter	2.9 %	53	M
Active Carbon	495 µg/g	46	L+
Soil Respiration	0.50 mg/g	40	L+
Aggregate Stability	20.0 %	22	L
Biological Nitrogen Availability	20.0 mg/kg	36	L+
pH	6.0		
Phosphorous Index (P/AI)	10.19 %		
C:N Ratio	11.20		
Total Nitrogen	0.15 %		
Dates of analysis available upon request. ND - C:N ratio could not be accurately calculated due to Total Nitrogen or Total Carbon being below detection limit			
Copies To:		Approved By:  SHDC	
Methods: SHL_1M Active Carbon SHL_2M Soil Respiration SHL_3M Biological Nitrogen Availability		SHL_5M Texture SHL_4M Wet Aggregate Stability SFL_22M - pH* SFL_23M - Organic Matter* SFL_24M - Nutrients*	
* Accredited and NAPT Certified Method			

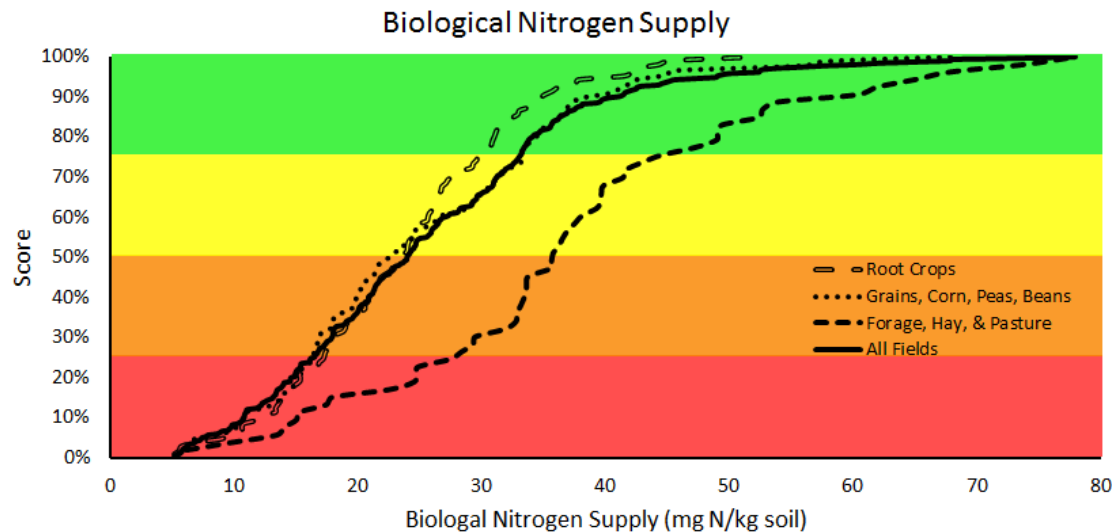
BNA value and Total N value can be plugged into a calculation to give an estimated amount of soil derived plant available N for the crop throughout the growing season

When will the N be available?

What about plant uptake efficiency?

How is it influenced by weather, etc?

Scoring Function BNA Ranges for Root Crops on PEI



Rating	BNA Value	Total N	130 day Mineralization (kg N/ha)
Low	<17.3	<0.18	<93
Low+	17.3-23.3	0.18-0.22	94-119
Medium	23.4-29.7	0.22-0.24	120-140
High	>29.7	>0.24	>140

2021-2022 BNA Trials

- Trials were developed to help identify BNA value estimates in practice for potato crops
- Trials occurred over 2021 and 2022 on potato fields across PEI
- Trial partners: PEIDAL, Genesis Crop Systems Inc., Dalhousie AC (David Burton)

Trial Setup

- 2021 Trials

- 5 fields (3 non-irrigated, 2 irrigated)
- Treatments:
 - GSP
 - GSP +25%
 - GSP-25%

-2022 Trials

- 7 fields (1 irrigated, 6 non-irrigated)
- Treatments:
 - GSP
 - GSP -25%
 - BNA (+15 or -30 lbs N vs. GSP)
 - 100 lb N rate



Trial Setup

2021

Cultivars Used	N Range by Treatment (lb/ac)
Clearwater Russet	150-250
Mountain Gem	140-243
Russet Burbank	140-243

2022

Cultivars Used	N Range by Treatment (lb/ac)
Caribou	100-160
Targhee	100-190
Russet Burbank	100-210
FL2137	100-169

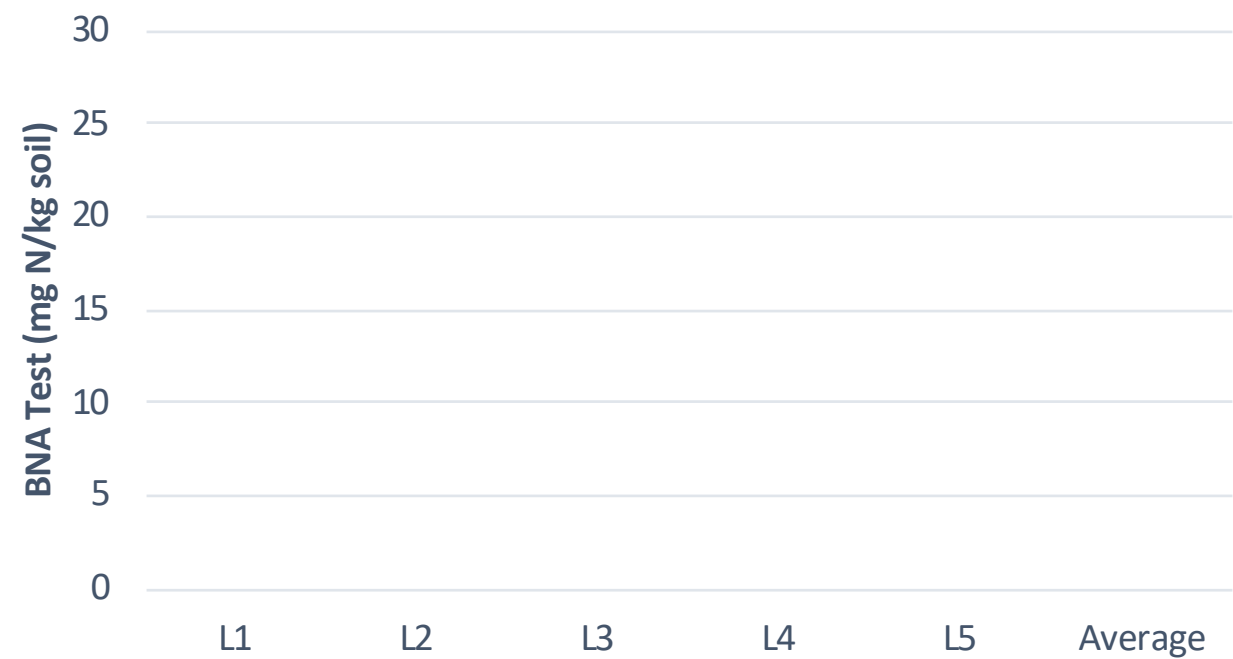
All N applied at planting was DAP or MAP + CAN.



Pre-plant and Top Dress N sources were always Urea.

BNA Trials 2021

BNA Test



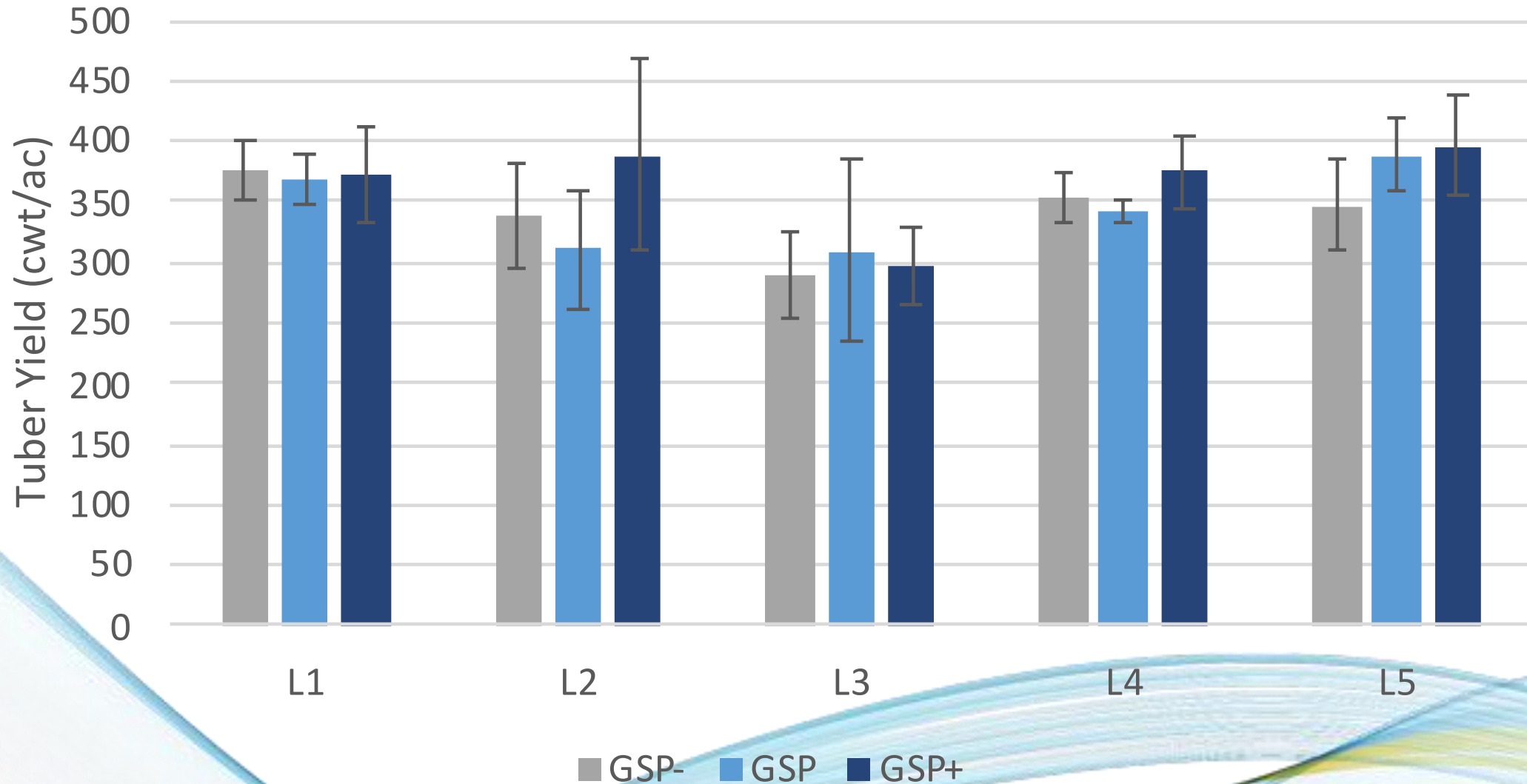
130-day N mineralization



- Predicted soil derived plant available N throughout season estimated to be min. 60-65 lb N/ac for all trial fields

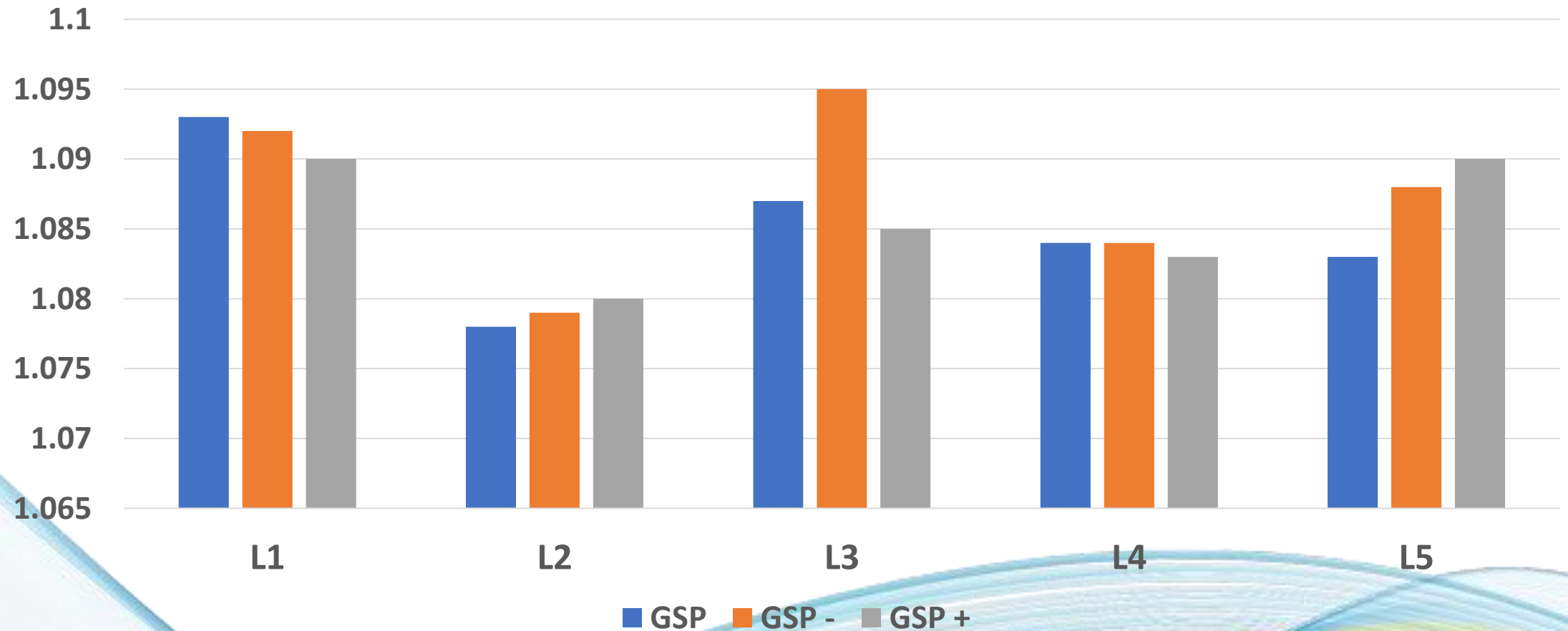
BNA Trials 2021

Marketable Yield



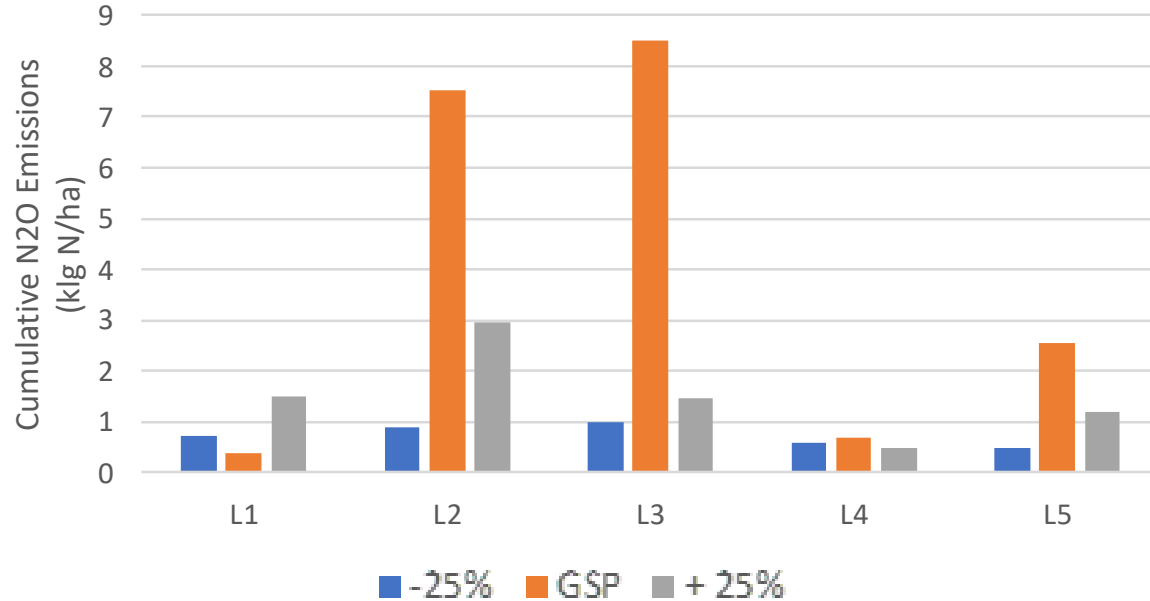
Slides adapted from D. Burton (2023)

BNA Trials 2021- Tuber Specific Gravity

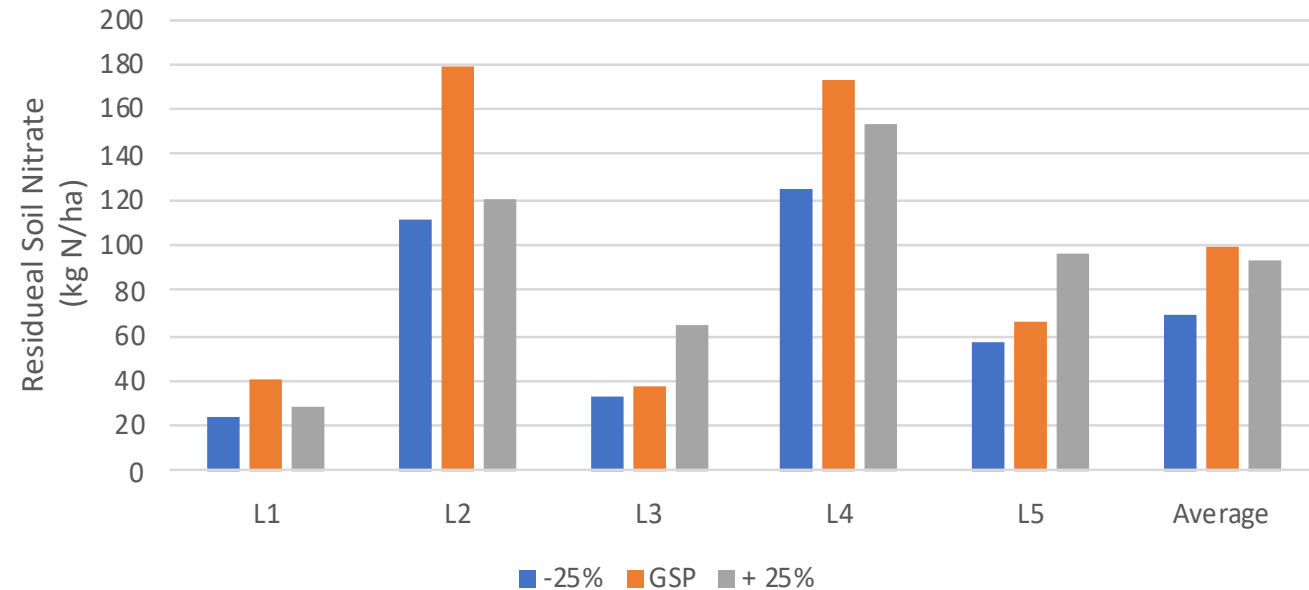


BNA Trials 2021

Nitrous Oxide Emissions



Residual Soil Nitrate

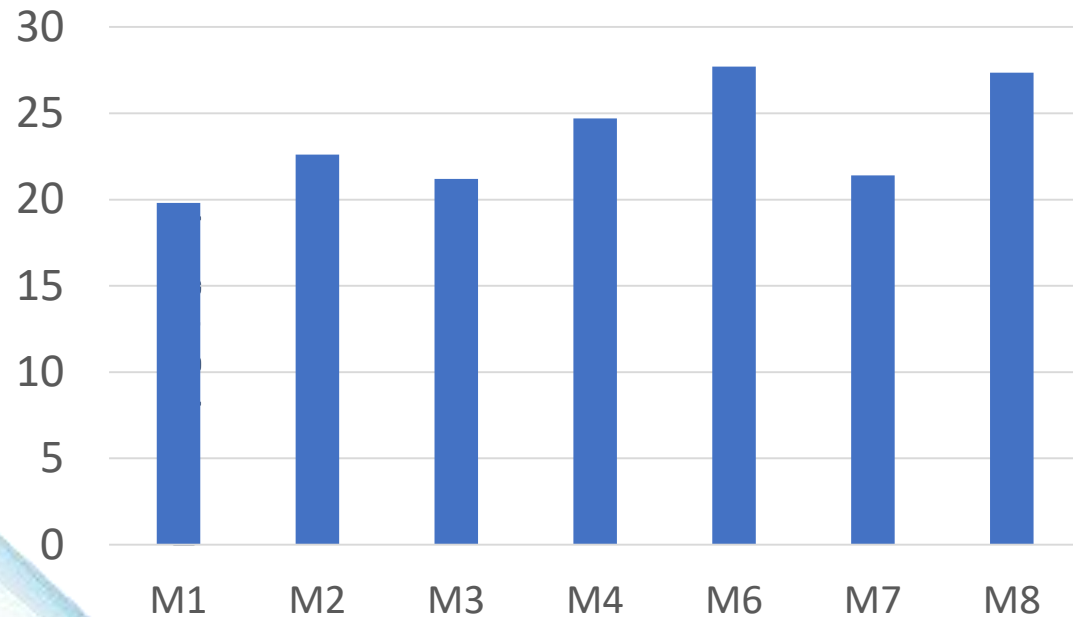


N₂O emissions uncharacteristically high for GSP for L2 and L3. When the GSP practice is excluded, the treatment GSP-25% resulted in reduced N₂O emissions in four of the five sites examined relative to the GSP + 25%, and was unchanged on the remaining site (L4), despite there being no reduction in yield.

Residual soil nitrate (post-harvest) was always lowest within GSP-25%.

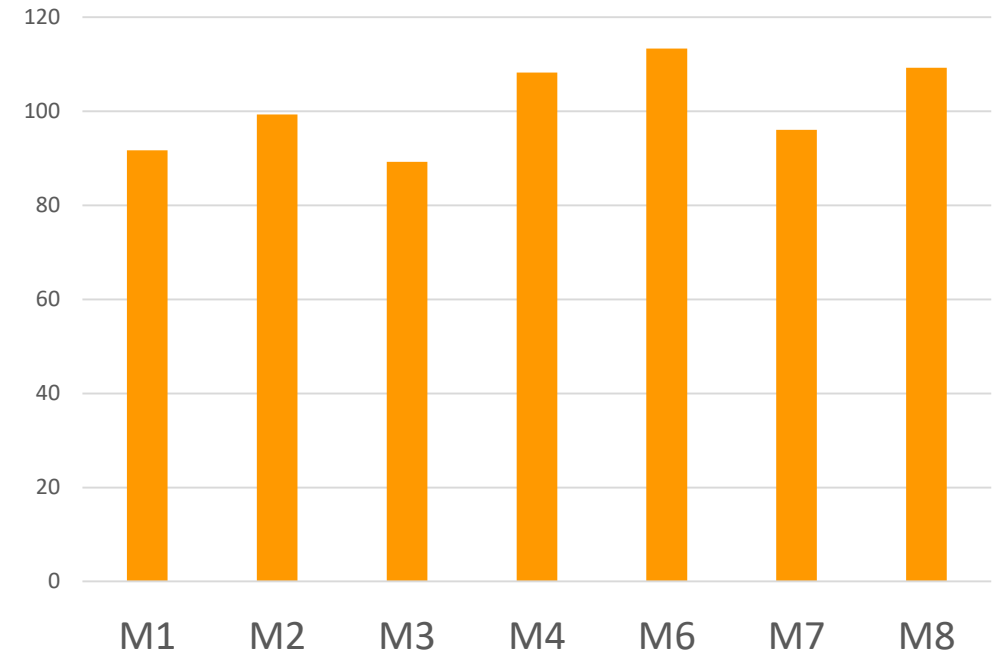
BNA Trials 2022

BNA



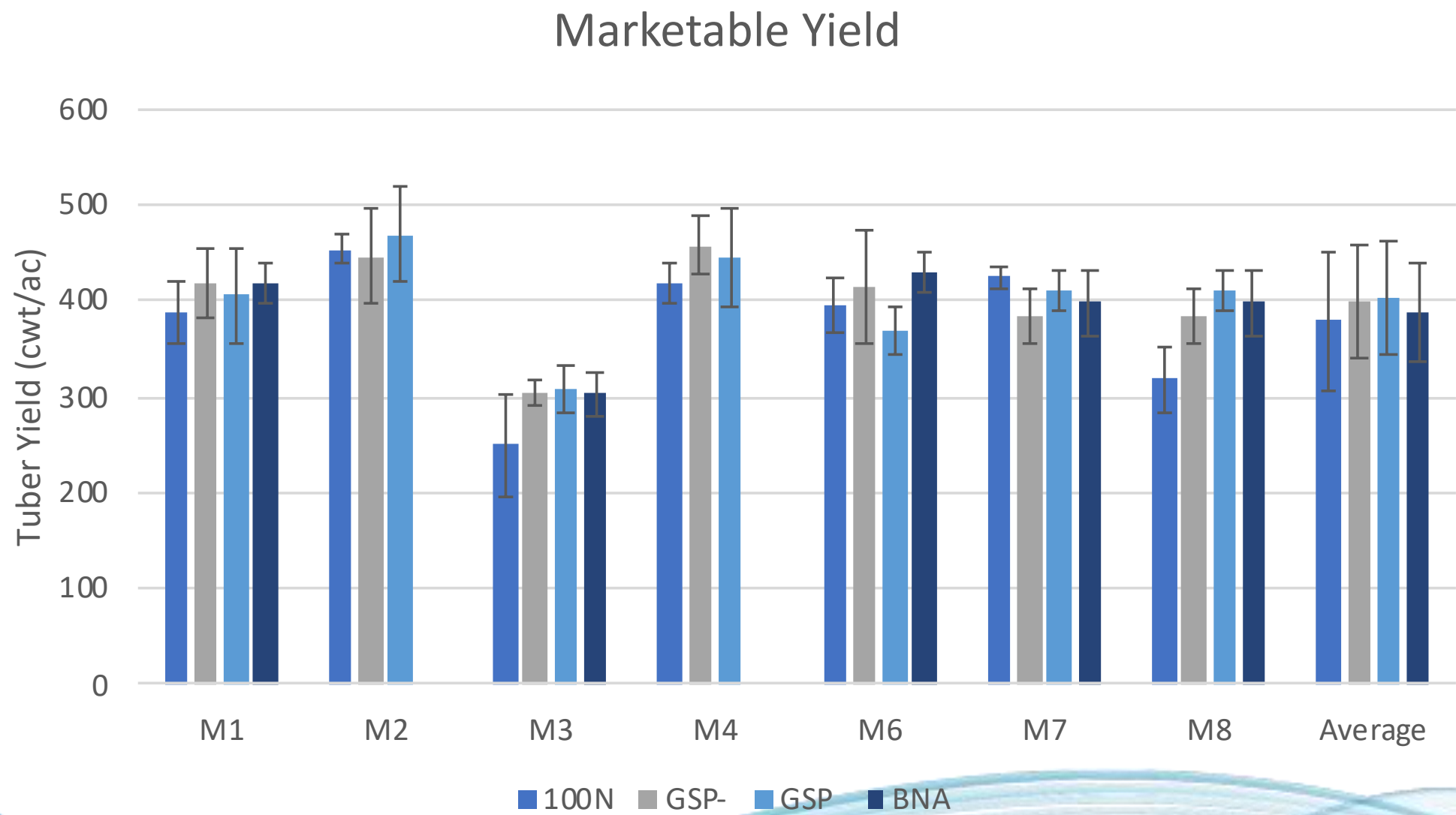
N Min. 130 days (kg N /ha)

130-day N mineralization
(kg N/ha)



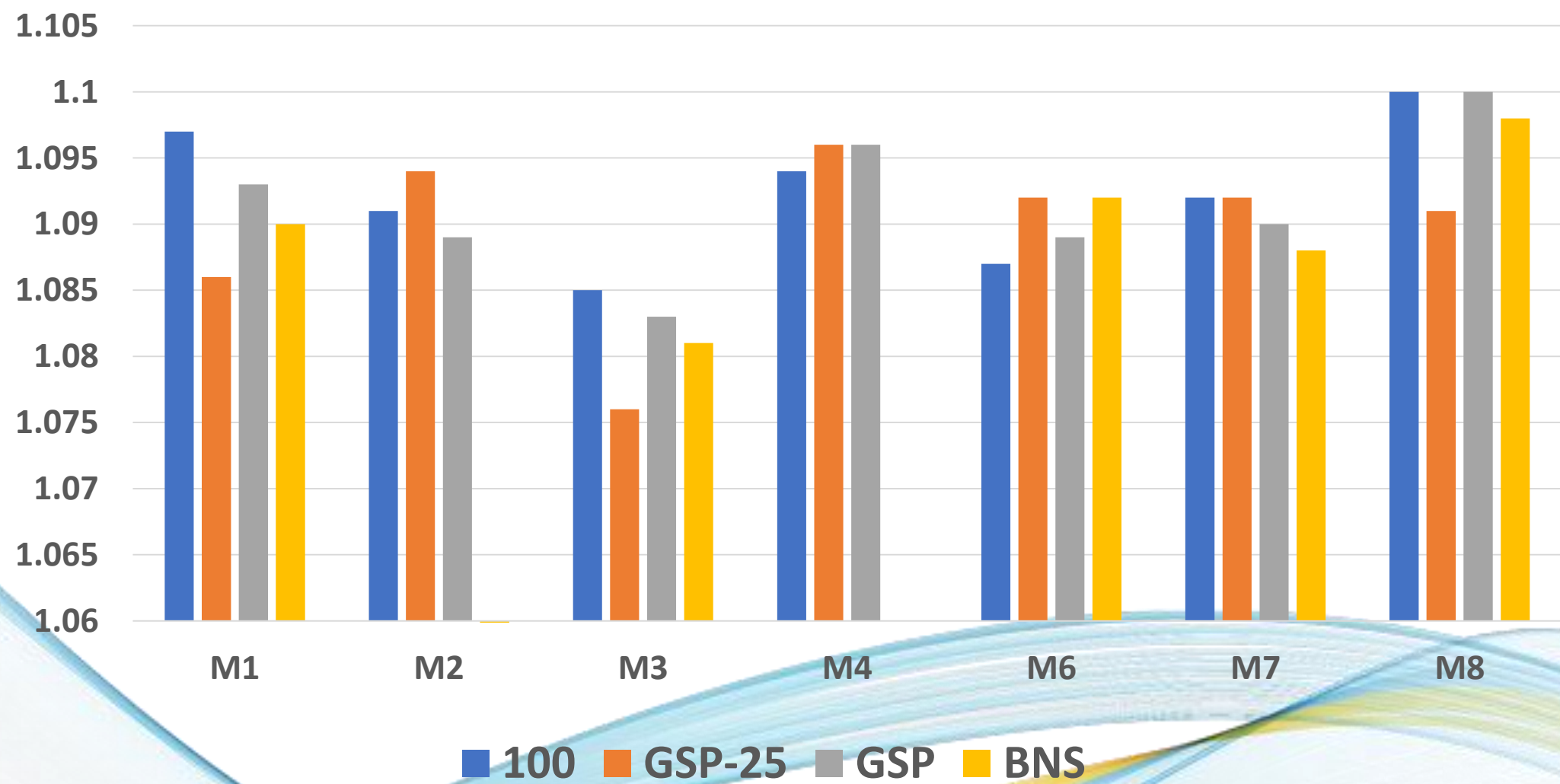
- Predicted soil derived plant available N throughout season estimated to be min. 75-80 lb N/ac for all trial fields

BNA Trials 2022

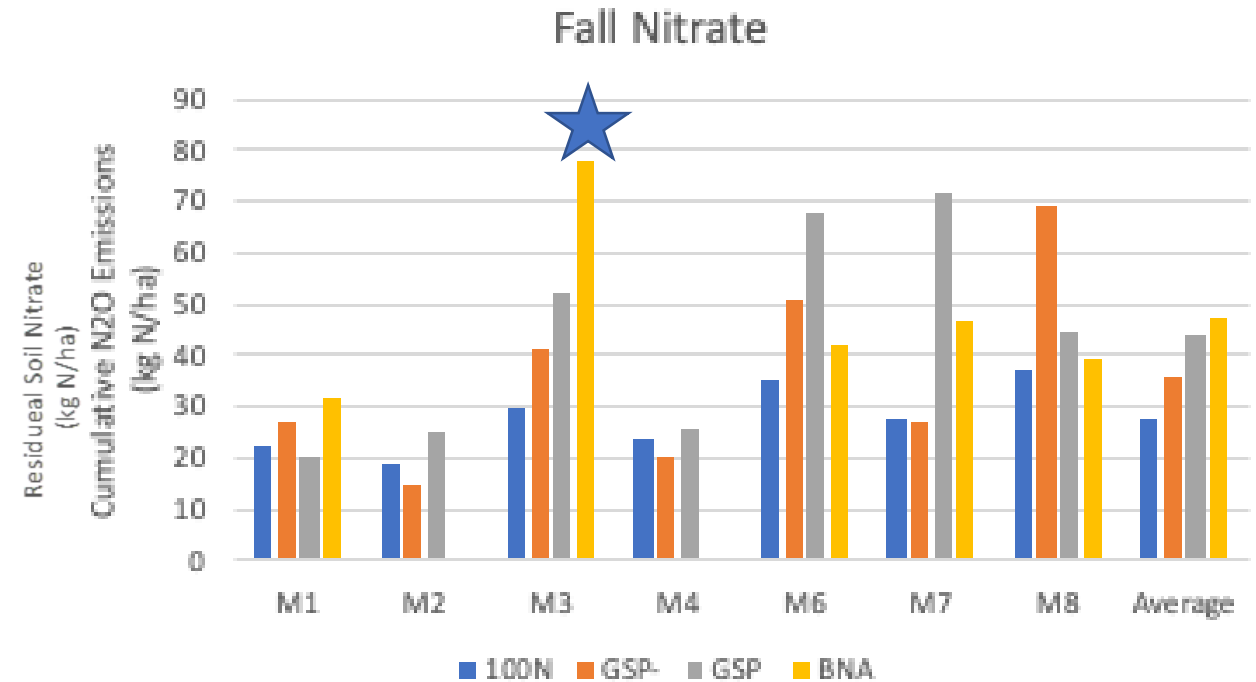
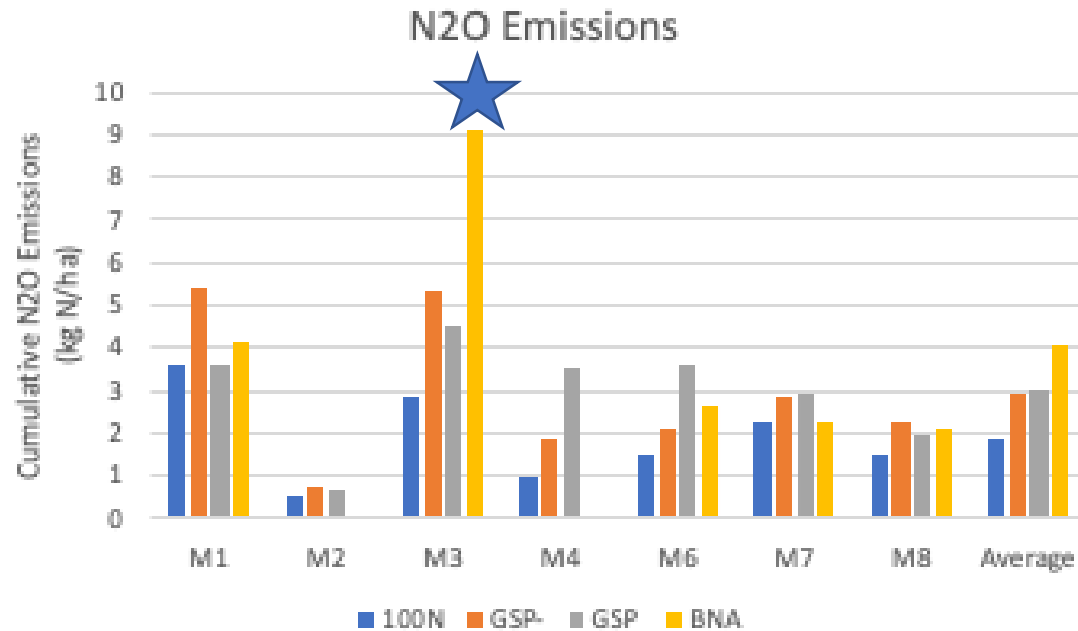


Still no significant yield response to N rate for 6 of 7 sites
For M8, GSP>BNA=100N>GSP -25% treatments- effect of alfalfa plowdown evident

BNA Trials 2022- Tuber Specific Gravity



2022 BNA Trials



Sig. difference within N₂O emissions between treatments that had pre-plant and planter N (M2, M6 and M7) vs. at planting with sidedress N.

What does this mean about use of BNA test?

- In all fields tested (except 1), there were no statistically different yield differences (even 100 lb N/ac trial).
- We are getting significantly more N from the soil than we are accounting for, but these trials do not say definitively how much.
 - No lower limit of N reached

Other work on PEI suggests similar N contribution from soil

AAFC Harrington Plant bioassay trials from 2009-2018 (J. Nyiraneza et al.)

Avg. soil N contribution for 3 year potato rotations range from: 75 to 136 kg N/ha

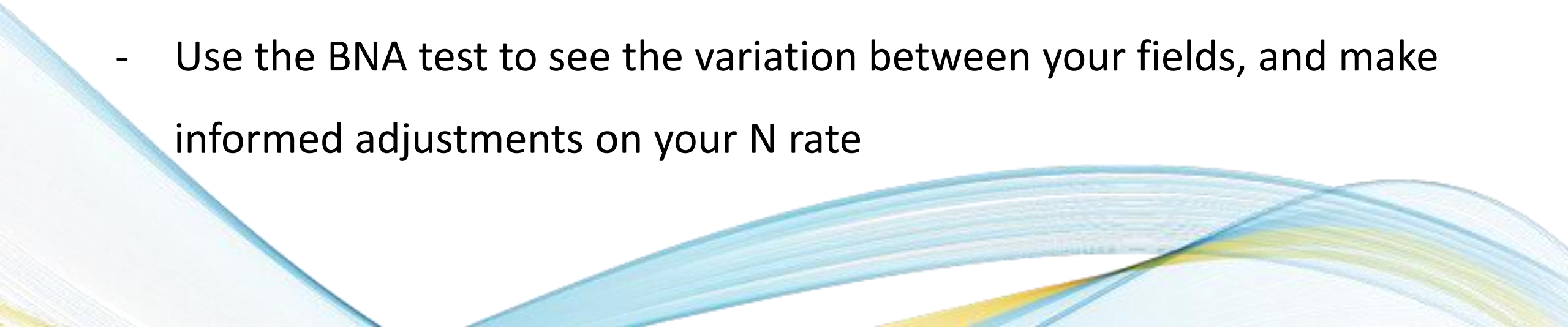
Factsheet available on the AIM website

Crop Sequence	Average soil N contribution to potato using a Plant Bioassay Approach ± Standard Deviation (kg N/ha)	
Three year potato rotation at two sites (2015-2018), soil pH = 6.1, 6.0; SOM = 3.0%, 2.7%		
Barley u/s Red Clover - Red Clover - Potato	83 ± 14	
Grain Corn - Sorghum Sudan Grass - Potato	75± 15	
Soybean - Brown Mustard (double cropping) - Potato	98 ± 26	
Three year potato rotation (2009-2011), soil pH = 5.8; SOM = 3.5%		
Barley - Barley - Potato	82± 28	
Barley u/s Timothy - Timothy - Potato	84± 5	
Barley u/s Red Clover - Red Clover (early fall plowing) - Potato	116 ± 17	
Barley u/s Red Clover - Red Clover (late fall plowing) - Potato	99 ± 29	
Barley u/s Red Clover - Red Clover (spring plowing) - Potato	127± 25	
Three year potato rotation at wo sites (2012-2015), soil pH = 5.3, 5.6; SOM = 3.4%, 3.3%		
Barley u/s Red Clover - Red Clover - Potato	123 ± 34	
Barley u/s Red Clover - Red Clover (mowed before fall plowing) - Potato	121± 41	
Barley u/s Red Clover - Red Clover (sprayed before fall plowing) - Potato	136 ± 29	
Barley u/s Red Clover - Red Clover (spring plowing) - Potato	124 ± 21	
Three year potato rotation (2014-2016), soil pH = 6.5; SOM = 3.1%		
Barley u/s Red Clover - Red Clover (fall plowing) - Potato	113± 32	
Barley u/s Red Clover Red Clover (spring plowing) - Potato	109± 27	
Two year potato rotation at two sites (2012-2014), soil pH = 5.9; SOM = 3.1%		
(sprayed and unsprayed before fall plowing)	No Spray	Spray
Negative Control (bare soil/weeds) - Potato	59 ± 13	57± 12
Red Clover - Potato	84 ± 20	56± 13
Rye - Potato	95 ± 33	68 ± 21
White Clover - Potato	96 ± 36	84 ± 36

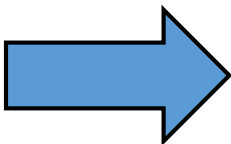
Takeaways

- The BNA test shows the amount of N from the soil could be substantial
- The BNA test has potential to be a useful tool when making N application recommendations
(IN ADDITION TO THE USE OF... other considerations such as yield potential, plowdown credits, crop removal, etc.)
- It does not appear that the BNA test will account for large legume plowdown credits (M3 2022 trials)
- **Future trials**- larger reduction in BNA estimates (find lower limit of N?)
- Trials are important to identify trends, under a variety of growing conditions.

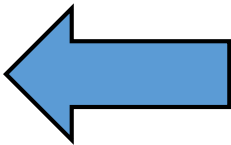
Takeaways

- There appears to be room to reduce N rates conservatively on your farm over time (groundtruth minor reductions on your own individual fields using split field comparisons)
 - Use the BNA test to see the variation between your fields, and make informed adjustments on your N rate
- 

Nitrogen Balance Approach



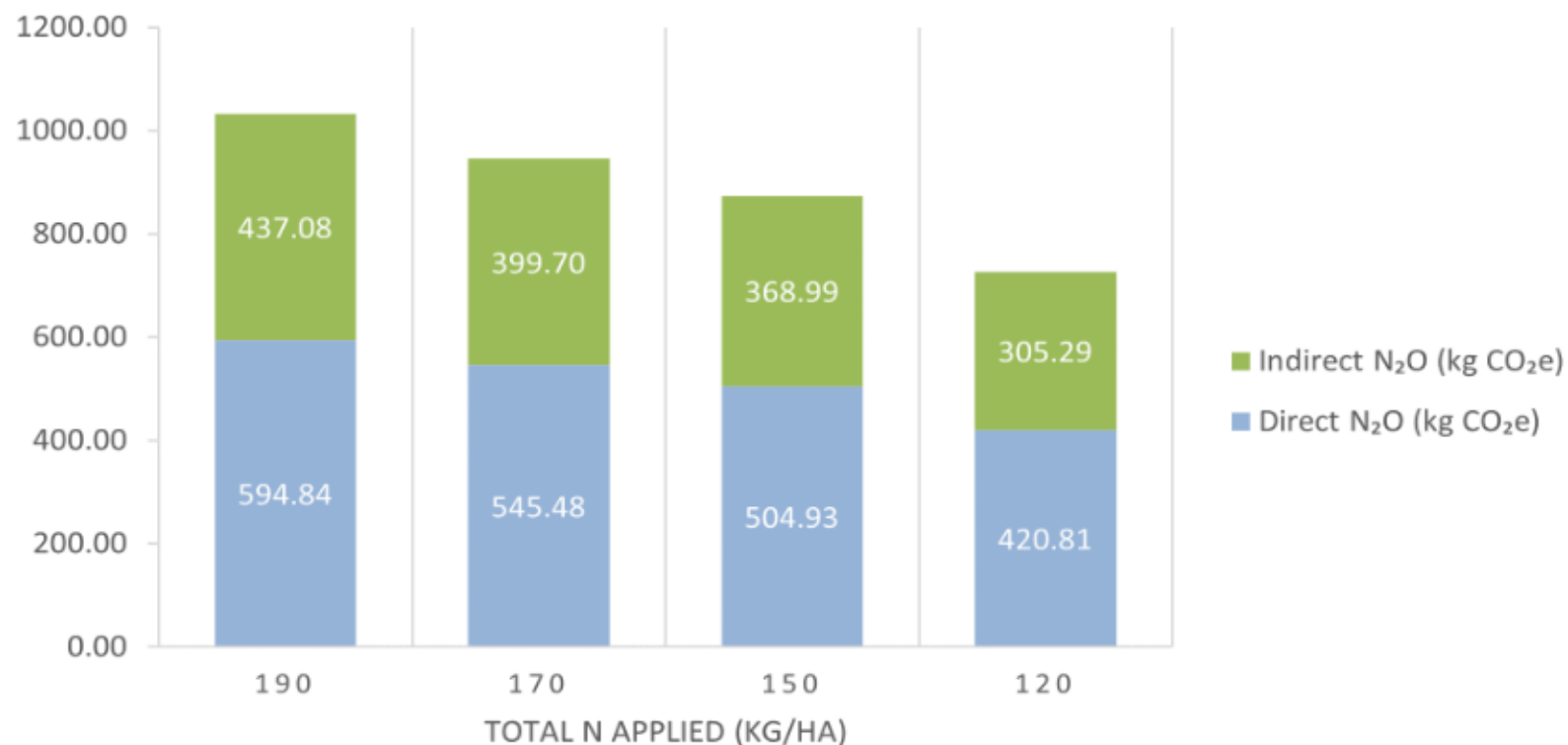
	Yield Goal (400 cwt/acre)
N Fertilizer (lb N/acre)	185
Crop N Removal (lb N/acre)	120
Residual N (lb N/acre)	65
N recovery in tubers (%)	65%



	Yield Goal (400 cwt/acre)
N Fertilizer (lb N/acre)	+ 185
Soil Nitrogen Supply (lb N/acre)	+ 90
Crop N Removal (lb N/acre)	- 120
Residue and Root N return (lb N/acre)	- 80
Residual N (lb N/acre)	75
N recovery in tubers (%)	43%

Small N rate changes make large impacts on GHG emissions

FIGURE 14 – Modeled N₂O Emissions Reductions at Various N Rates



Currently working on BNA N estimator tool

1													
2													
3		Sample ID	BNA Value	Total Nitrogen	Estimate ks	Nmin stable	Nmin labile	Nmin	Estimated N mineralization over 130 days	Estimated N Reduction to Fertility Recommendation (50%)	Estimated N Reduction to Fertility Recommendation (25%)	Estimated N Reduction to Fertility Recommendation (10%)	
4		UNITS	(mg N/kg soil)	(%)	-	(mg N/kg)	(mg N/kg)	(mg N/kg)	(lb N/ac)	(lb N/ac)	(lb N/ac)	(lb N/ac)	Definitions
5		EXAMPLE	17.7	0.1	0.18	23.17	17.70	40.87	71.72	36	18	7	BNA Value
6													Total Nitrogen
7													Estimate ks
8	1	2A	0	0	0.00	0.00	0.00	0.00	0.00	0	0	0	Nmin stable
9	2	Behind Home Farm	0	0	0.00	0.00	0.00	0.00	0.00	0	0	0	Nmin labile
10	3	Jenny's	0	0	0.00	0.00	0.00	0.00	0.00	0	0	0	Nmin
11	4	0	0	0	0.00	0.00	0.00	0.00	0.00	0	0	0	Estimated N mineralization over 130 days
12	5	0	0	0	0.00	0.00	0.00	0.00	0.00	0	0	0	Estimated N Reduction to Fertility Recommendation
13	6	0	0	0	0.00	0.00	0.00	0.00	0.00	0	0	0	
14	7	0	0	0	0.00	0.00	0.00	0.00	0.00	0	0	0	
15	8	0	0	0	0.00	0.00	0.00	0.00	0.00	0	0	0	
16	9	0	0	0	0.00	0.00	0.00	0.00	0.00	0	0	0	
17	10	0	0	0	0.00	0.00	0.00	0.00	0.00	0	0	0	
18													
19													
20													
21	1	Sample ID											
22		BNA Value (mg N/kg soil)											
23		Total Nitrogen (%)											
24													
25	2	Sample ID											
26		BNA Value (mg N/kg soil)											
27		Total Nitrogen (%)											
28													
29	3	Sample ID											
30		BNA Value (mg N/kg soil)											
31		Total Nitrogen (%)											
32													

INSTRUCTIONS

1. Put values from PEIAL Soil Health Test Report into sample calculation data columns to the left.
2. Once data is entered, the information will be automatically populated into the table above.
3. The BNA credit value that is estimated will be in the blue Column under "BNA Credit to n Fertility Recommendation"
4. Up to 10 fields can be added into the table at a time.

Thank you to Collaborators

- All participating farms:
 - Rollo Bay Holdings
 - MWM Farms
 - MacAulay Farms
 - Valley Grove Enterprises
 - Island Holdings
 - Ian Shaw Farms
- PEIDAL Support Staff- Danny Walker, Hardy Strom, Alex MacLeod, Eric Fortune, many others



**Genesis
Crop
Systems**

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