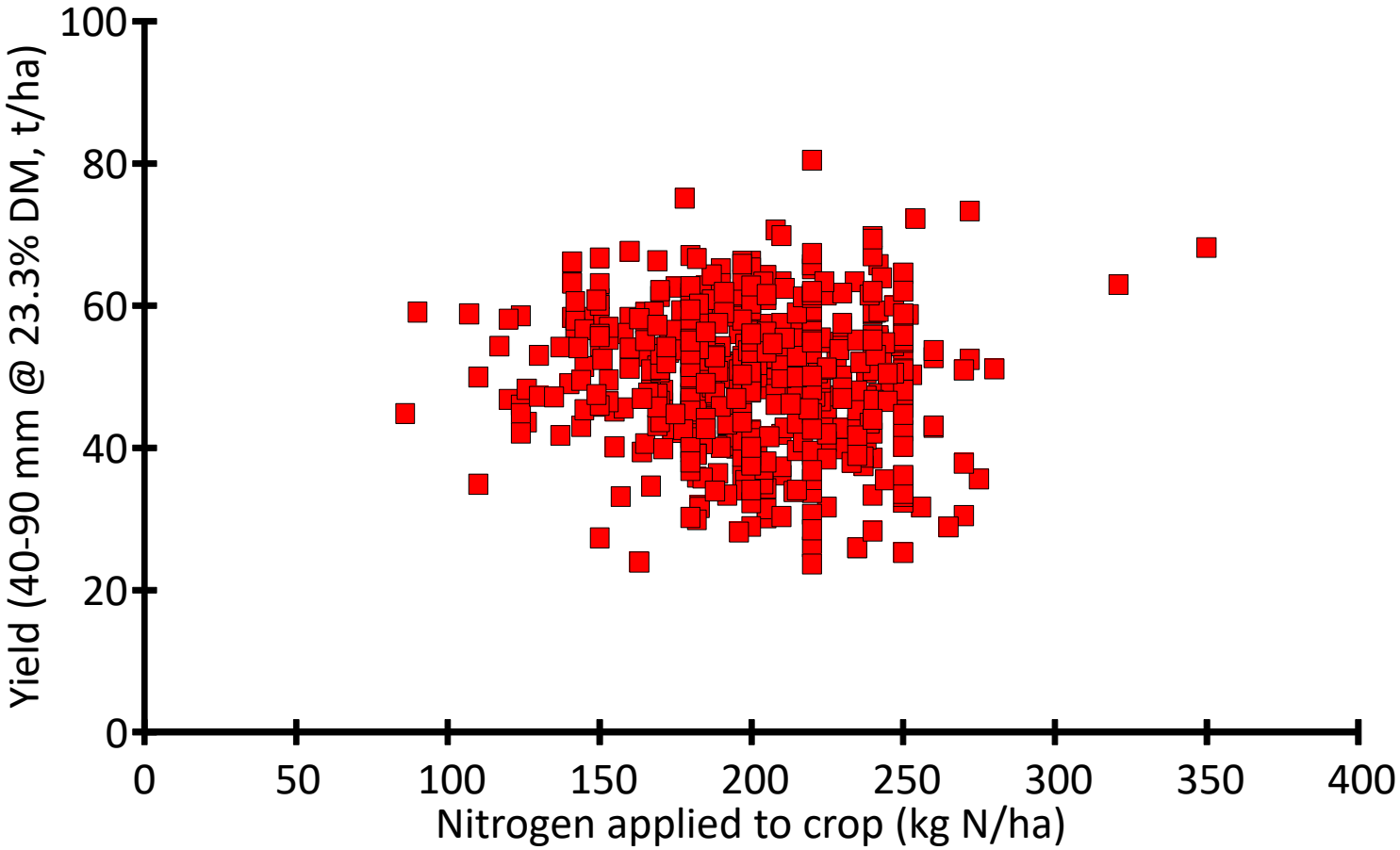
SPot North 2018 Results

Mark Stalham & Marc Allison

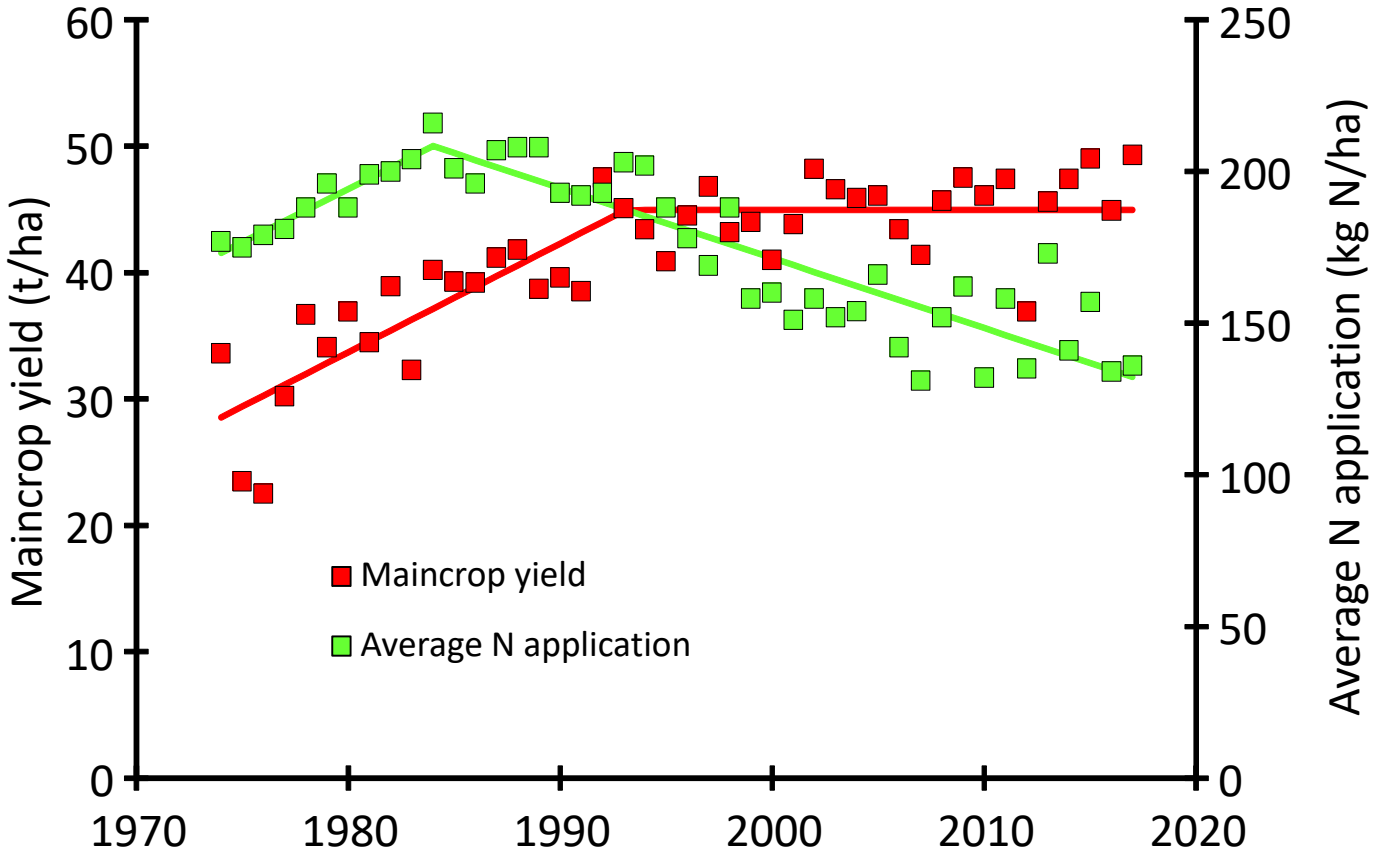
Nitrogen at SPot Farms

Hypothesis: does N application drive yield?

Data from 556 processing crops 2010-2016
Mean ware yield at 23.3 % DM = 50.0 t/ha
Mean N application rate = 201 kg N/ha



Survey data suggest otherwise



British Survey of Fertilizer Practice & AHDB

Summary of SPot N trials (2016-2018)

SPot site	Year	Variety	N treatments	Summary of N effects on yield	Yields >40 mm (t/ha)	Tuber DM (%)
East	2016	R Burbank	Split N, All N in seedbed (both 260)	**No effect**	68.2, 68.3	22.0, 22.1
	2017	Brooke	Split N, All N in seedbed, Placed N (all 220), 160, 180, 220, 160+30	**No effect of rate or timing. Placed lower**	61.0, 61.1, 55.7, 61.2, 59.2, 61.0, 62.3	24.5, 24.8, 25.0, 24.3, 24.3, 24.7, 24.3
	2018	Estima	180, 210, 240, 270	**No effect**	54.8, 56.9, 56.6, 55.1	18.9, 18.8, 18.4, 18.5
North	2018	M Piper	120, 150, 180, 150+30	**No effect**	49.7, 48.1, 49.3, 50.7	23.6, 23.4, 23.2, 23.4
South West	2017	Electra	90, 120, 150	**No effect**	58.7, 61.7, 61.3	17.1, 16.3, 16.4
	2018	Electra	0, 30, 60, 90, 120	**No effect**	72.0, 61.2, 72.4, 73.4, 72.3	16.4, 15.7, 15.6, 15.8, 15.4
Scotland	2017	M Piper	177, 147, Liquid, Injection	**Injection lower**	54.3, 51.2, 54.5, 49.8	19.2, 19.4, 18.5, 18.4
	2018	M Piper	176, 147, 120, Placed	**TBA**	TBA	TBA

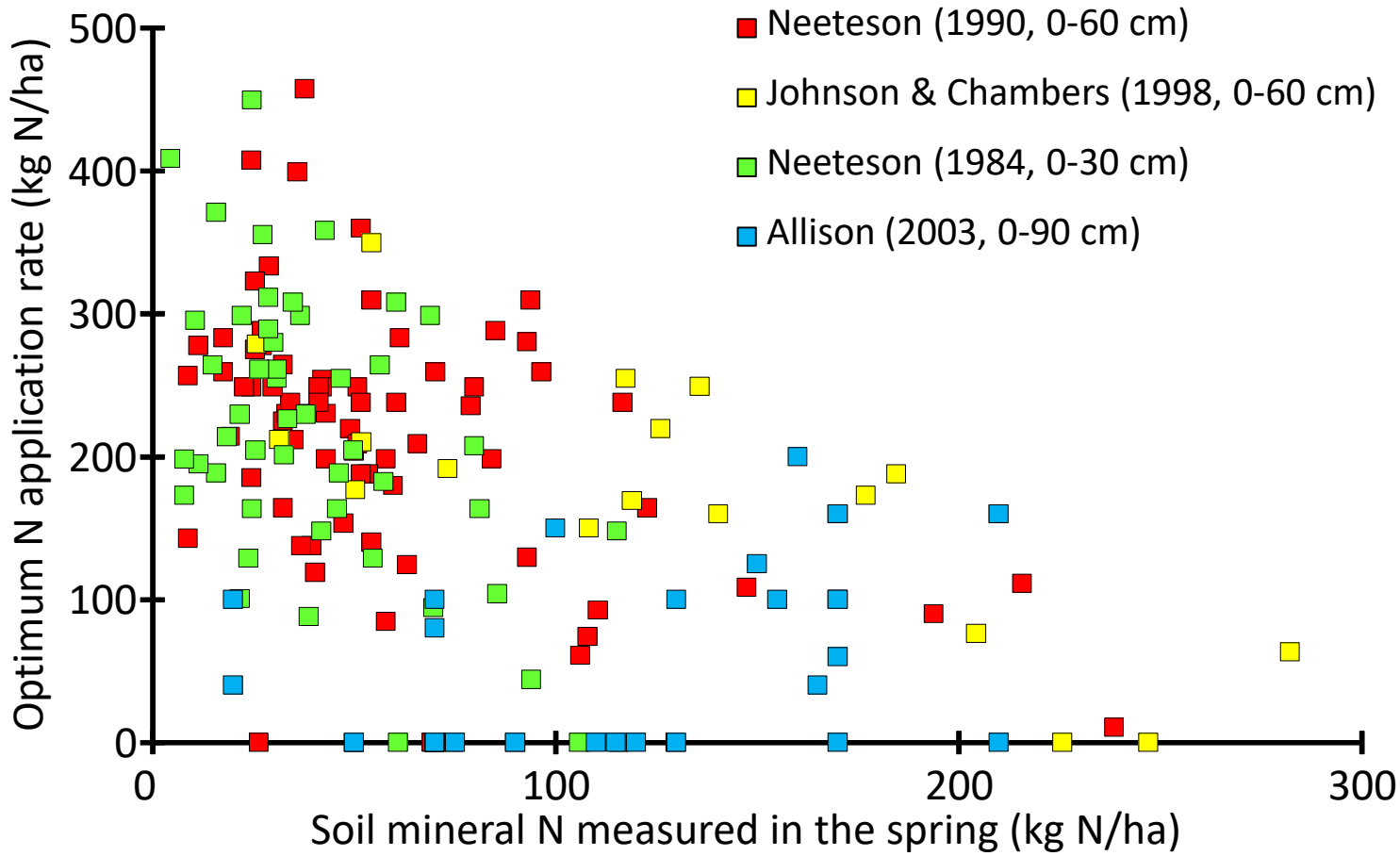
Setting the N rates for SPot North 2018

Step	Process	Factors	Outcome
1	Calculate soil nitrogen supply (SNS)	Cereal stubble, shallow, sandy loam soil in a low rainfall area	SNS Index = 1 (soil will supply 60-80 kg N/ha)
2	Identify determinacy group	Maris Piper	Variety group = 3 (indeterminate, long haulm longevity)
3	Calculate season length	24 May (emergence) to end August (defoliation)	Season length = 100 days
4	Calculate initial N requirement of crop		133 kg N/ha
5	Calculate supply from organic manures	Nothing applied to previous crop	But soil OM is 2.7 %
6	**Fertilizer required**		**130 kg N/ha**

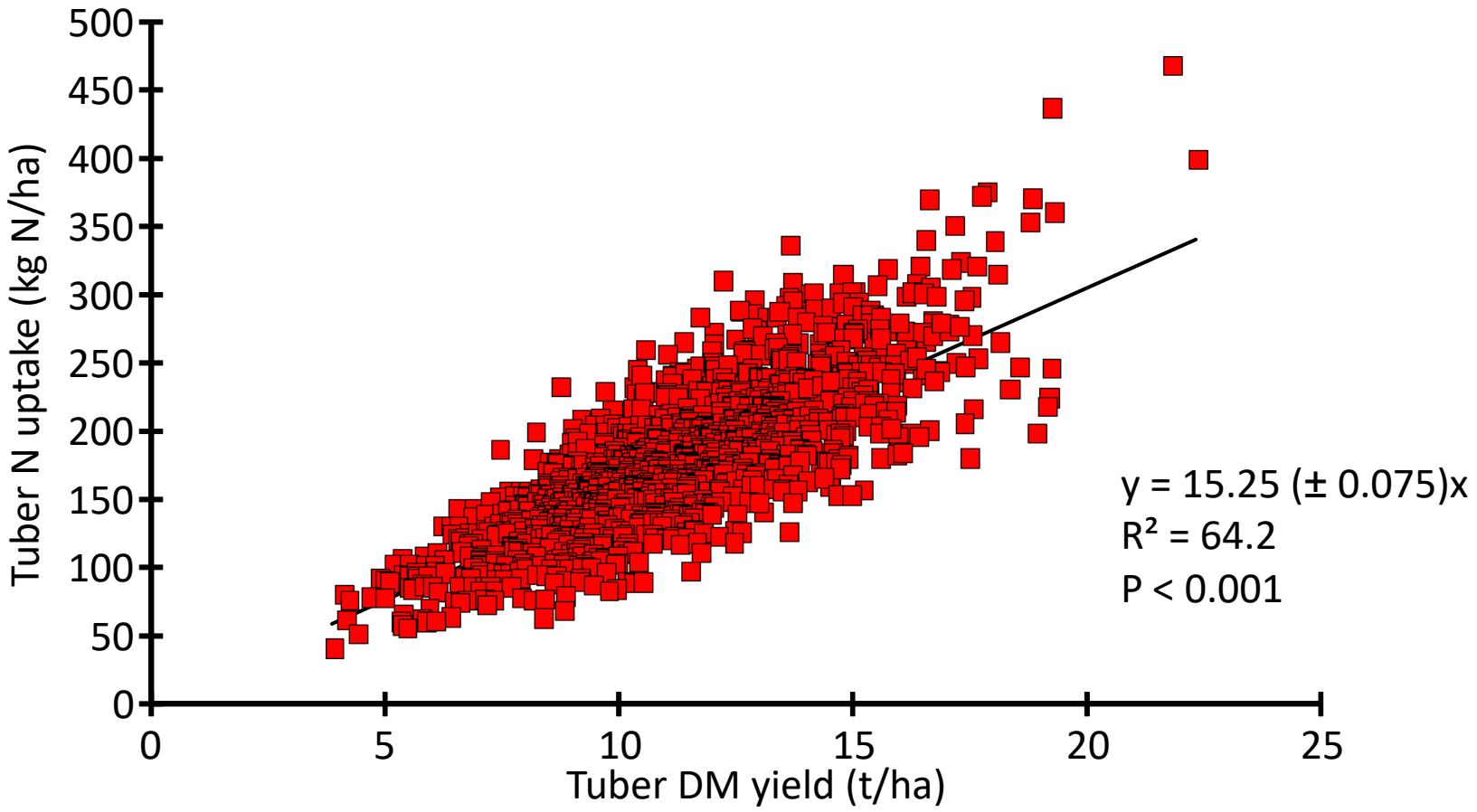
Spot N 2018 Hypotheses

1. The optimum N for Maris Piper on the site would be < 150 kg/ha not the commercial rate of 180 kg/ha
2. Top-dressing does not increase yield compared with all N in seedbed
3. Reducing N increases the risk of black dot infection
4. Reducing N increases the risk of bruising

Can we use soil tests to guide N fertilizer recommendations?

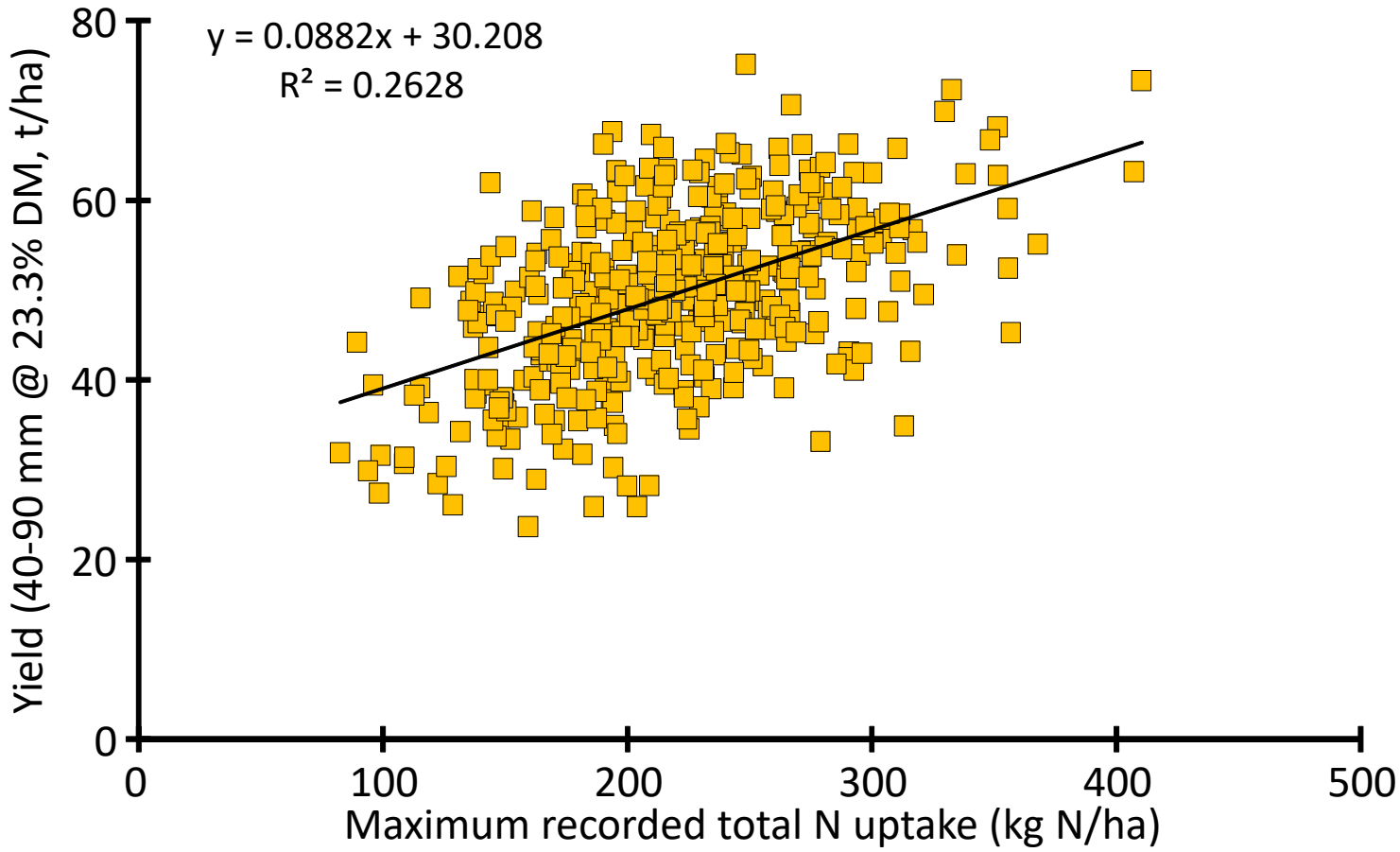


Relationship between tuber N uptake and tuber dry matter yield



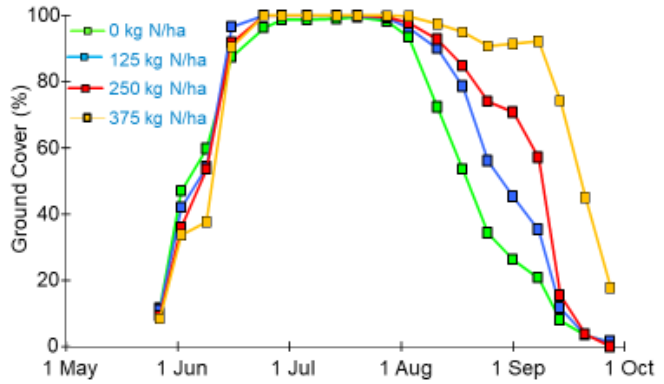
Big N uptake = big yield?

Data from 402 processing crops 2010-2016 where N uptake was measured
Mean ware yield at 23.3 % DM = 49.6 t/ha
Mean total N uptake = 220 kg N/ha



Effect of N on yield formatio Russet Burbank, CUF 2008

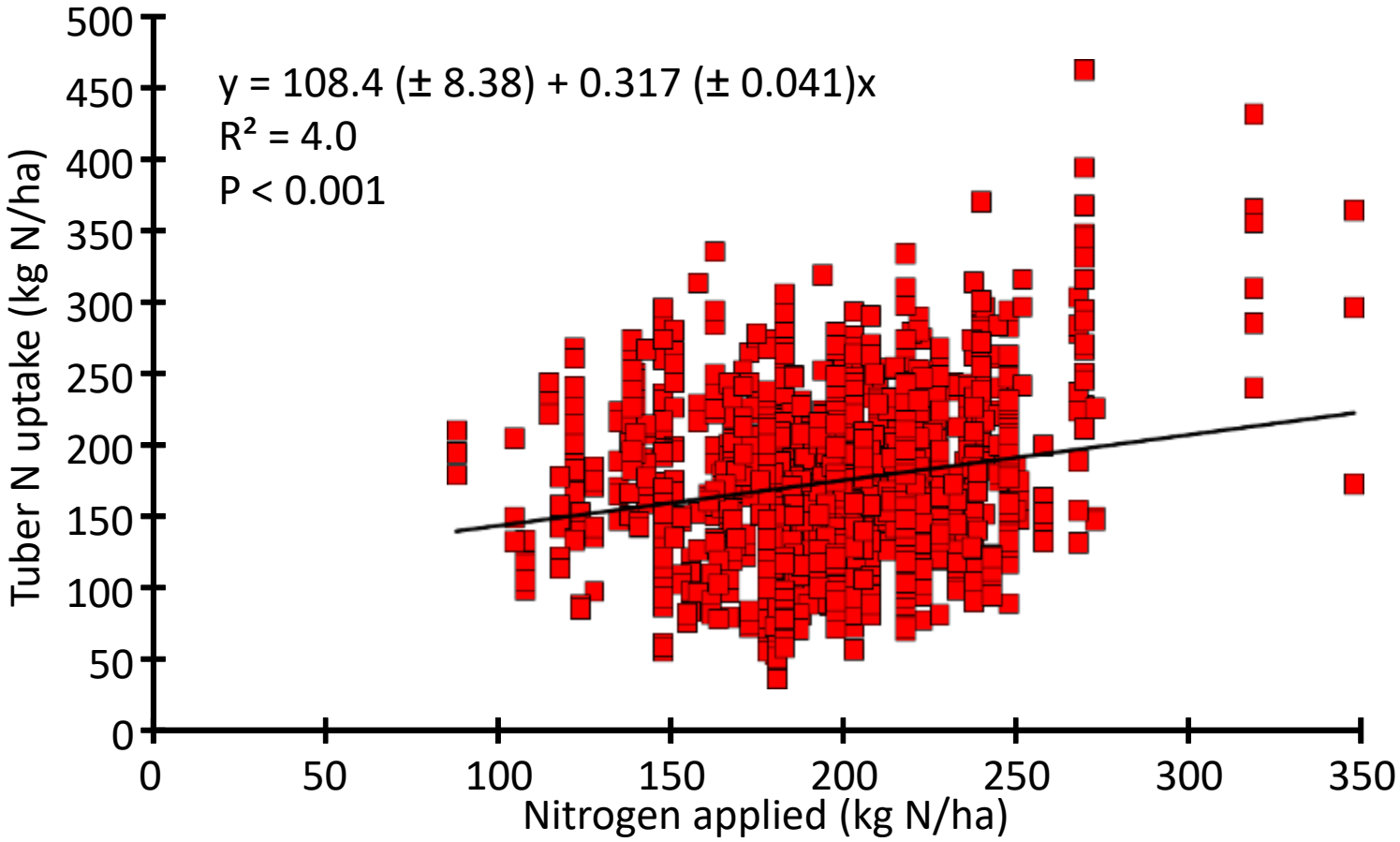
Effect of N application on ground cover development



Harvested 29 September

Nitrogen applied (kg N/ha)	Total N uptake (kg N/ha)	Integrated GC (% days)	Radiation absorbed (TJ/ha)	Total DM (t/ha)	Harvest index (%)	Total FW yield (t/ha)
0	142	7843	12.8	14.2	93	56.7
125	197	8622	13.8	16.6	87	64.7
250	225	9071	14.2	17.5	87	69.1
375	308	10262	15.3	18.9	87	77.8
S.E.	25.1	318.2	0.38	1.28	2.5	3.78

Relationship between N uptake by tubers and fertilizer N application

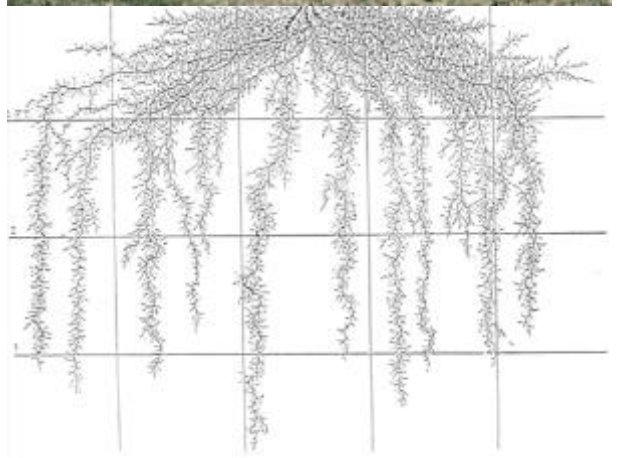


What factors affect the amount of N taken up by the crop?

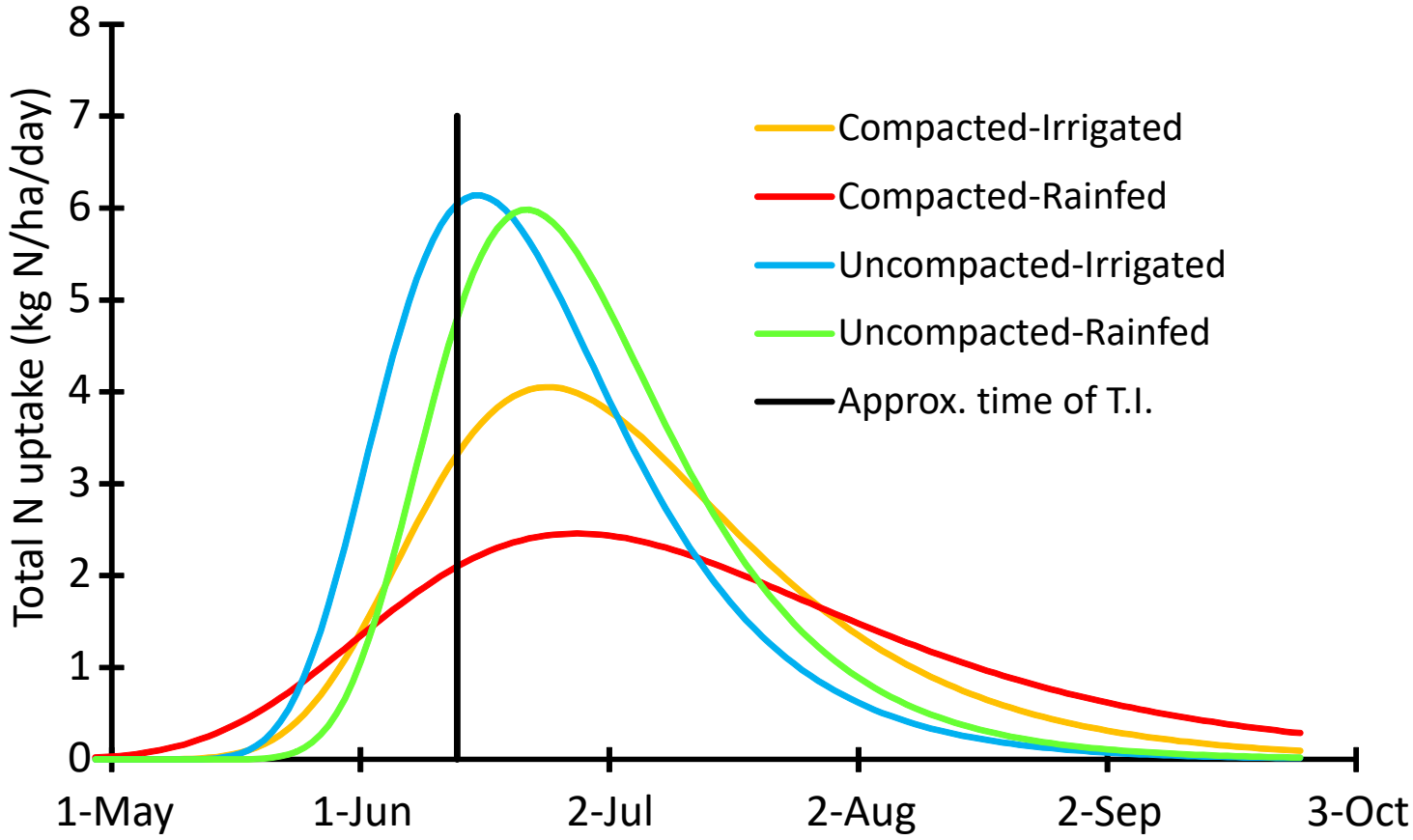
N application → (4 %) → N uptake → Tuber Yield

96 %

- PCN
- Water (deficient/excess)
- Soil Nitrogen Supply
- Soil compaction
- Environment (radiation/temperature)
- Pathology
- ?

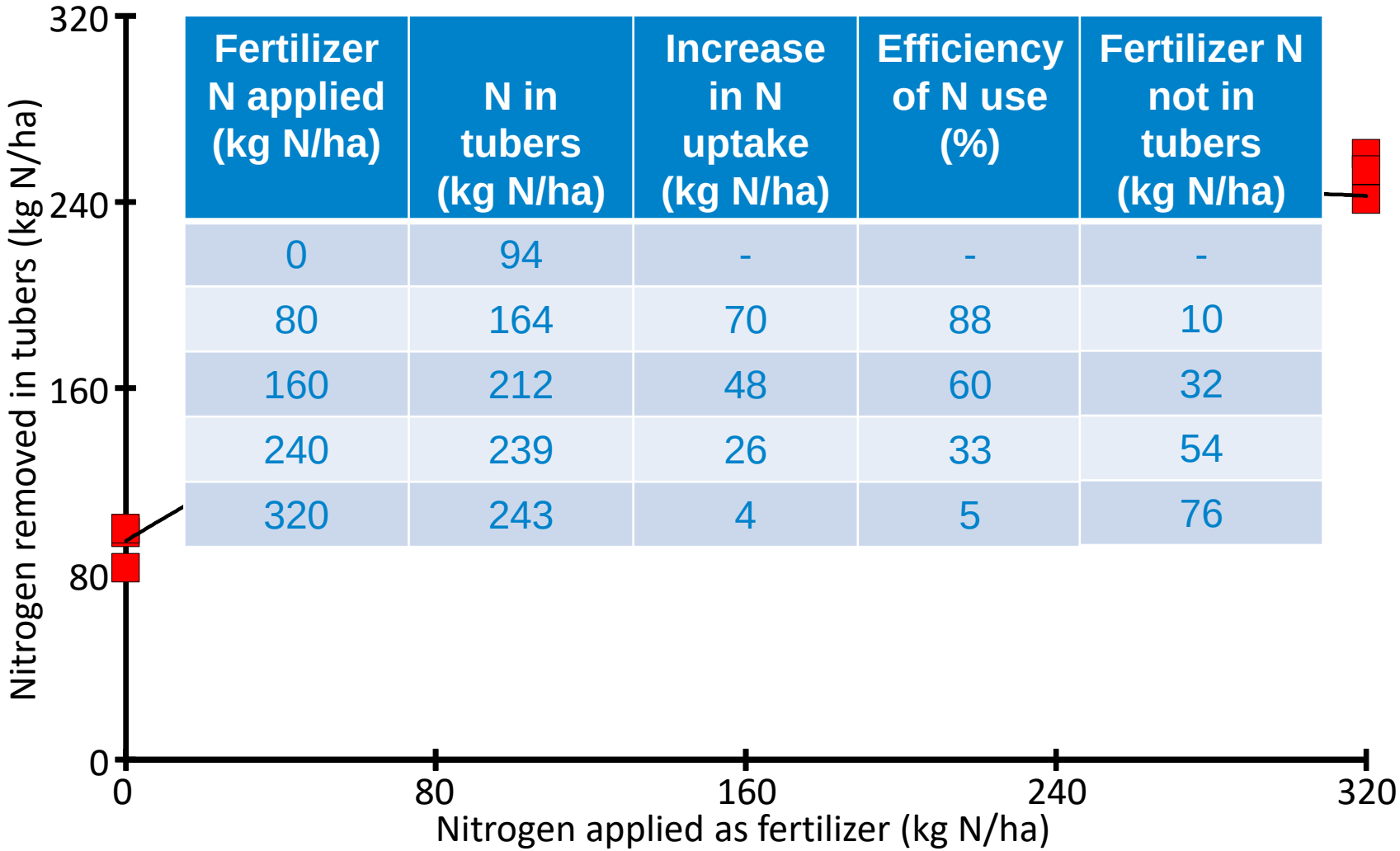


Effect of compaction and irrigation on nitrogen uptake. Maris Piper CUF 2006



What do we mean by N use efficiency?

Fertilizer N applied (kg N/ha)	N in tubers (kg N/ha)	Increase in N uptake (kg N/ha)	Efficiency of N use (%)	Fertilizer N not in tubers (kg N/ha)
0	94	-	-	-
80	164	70	88	10
160	212	48	60	32
240	239	26	33	54
320	243	4	5	76



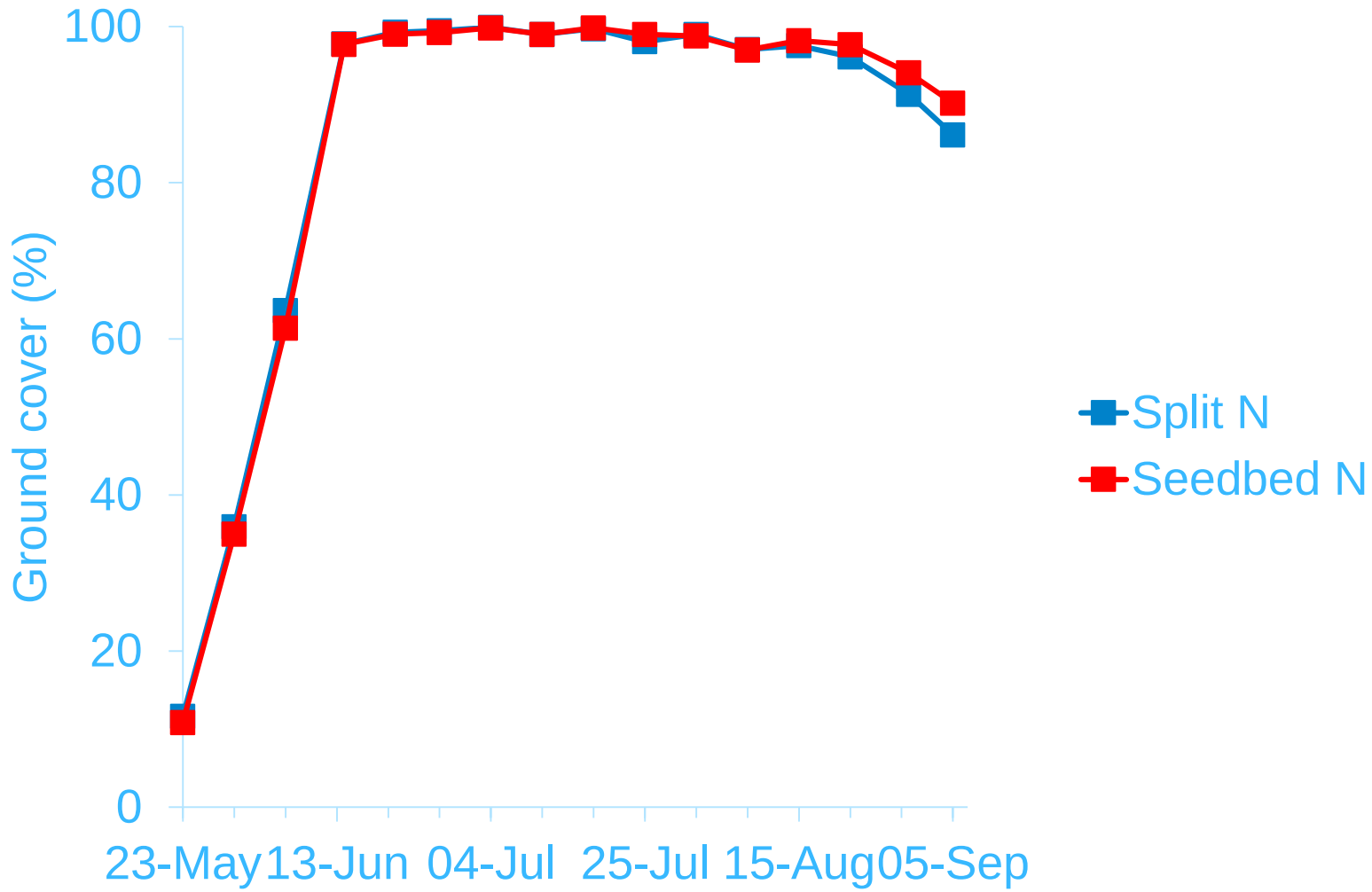
Effect of irrigation, N application and variety on tuber yield. CUF Reference Crop 2006-2017

	Estima				Cara			
	Rain-fed		Irrigated		Rain-fed		Irrigated	
	kg N/ha	t/ha	kg N/ha	t/ha	kg N/ha	t/ha	kg N/ha	t/ha
Mean	**146**	**43.6**	**193**	**65.4**	**87**	**58.0**	**87**	**70.1**
	± 27.6	**± 4.77**	**± 19.5**	**± 3.42**	**± 21.8**	**± 3.53**	**± 22.5**	**± 4.74**

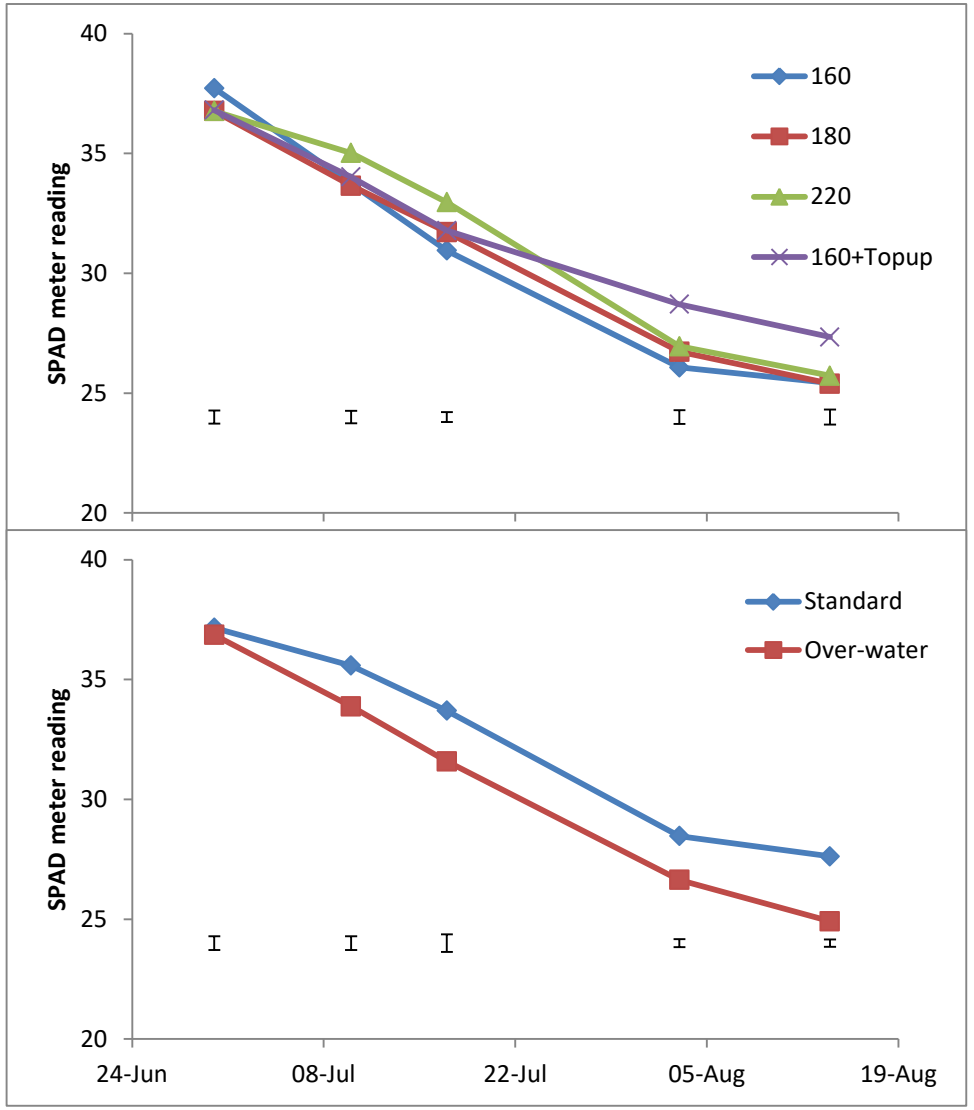
Irrigation increased optimum N application rate by 47 kg N/ha in Estima and 0 kg N/ha in Cara

Data from Firman

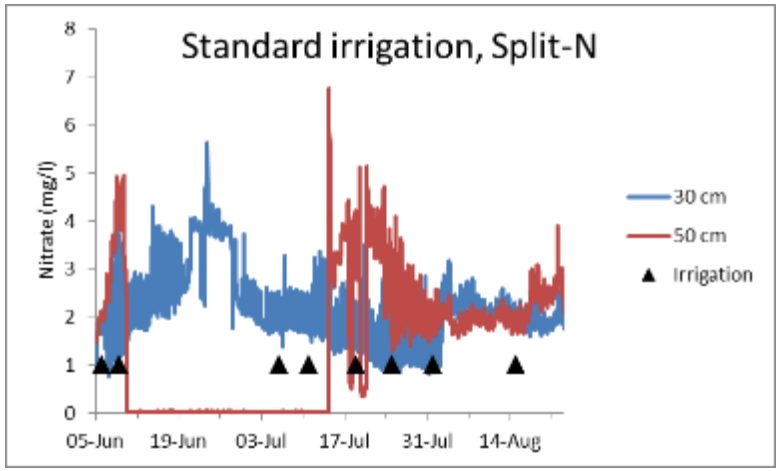
SPot Farm East 2016
Split N vs Seedbed N comparison

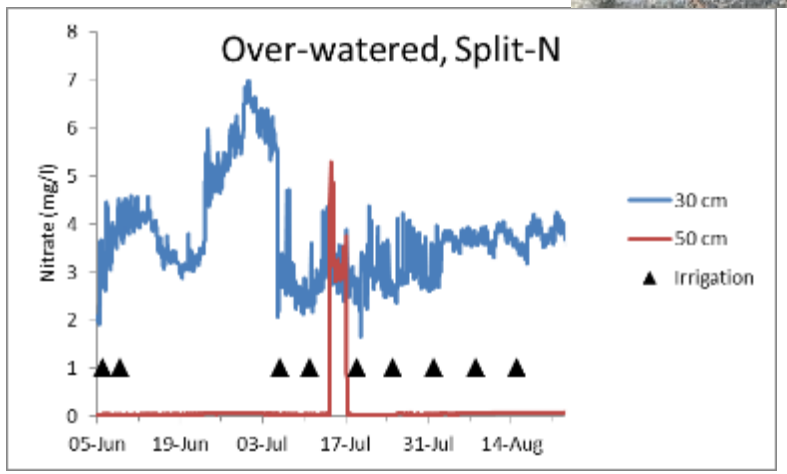


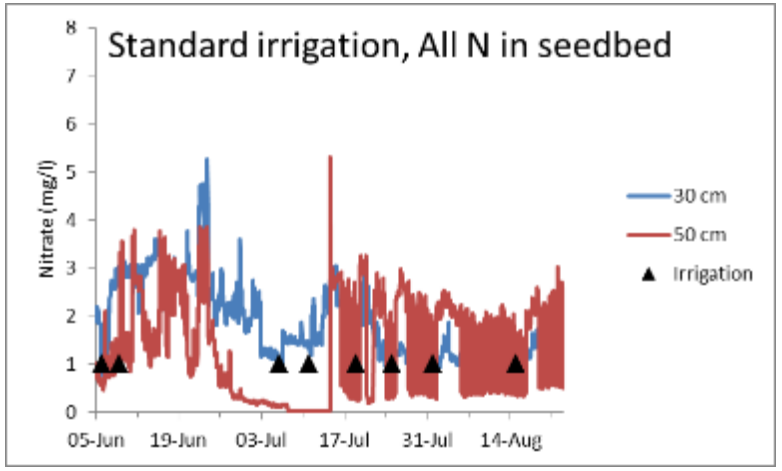
SPAD Meter: measuring leaf chlorophyll content for predictions of N deficiency

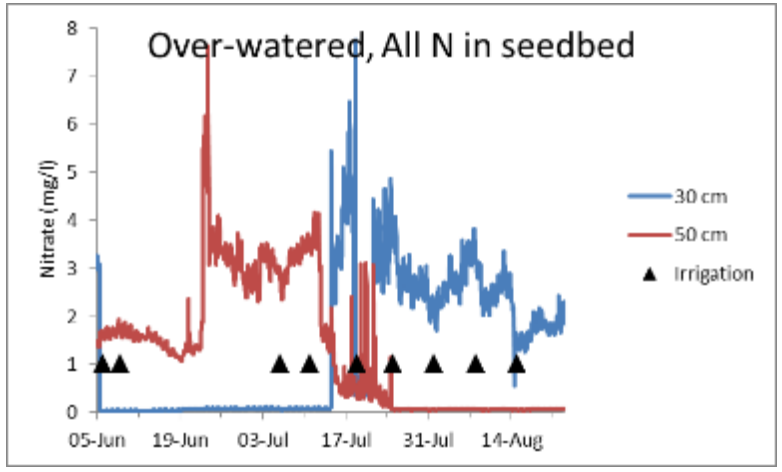


Are we leaching much N?
Soil NO_3 sensors (Tony Miller, JIC + Agrii)









SPot North N Experiment yield

N treatment	No. plants (000/ha)	No. stems (000/ha)	Total no. tubers (000/ha)	Total yield (t/ha)	Yield >45 mm (t/ha)	Tuber DM conc. (%)	Tuber DM yield (t/ha)
120	30.6	107	408	49.7	43.1	23.6	11.7
150	29.2	94	345	48.1	43.5	23.4	11.3
180	30.6	123	383	49.3	45.3	23.2	11.4
150+30	30.6	106	400	50.7	46.5	23.4	11.9
S.E. (12 D.F.)	2.11	11.8	34.4	1.74	1.56	0.27	0.47

SPot North N Black Dot

N treatment	Incidence (%)	Incidence (angular transformation)	Proportion <5 % SA (%)	Severity (% SA)
120	53.6	47.1	92.6	2.13
150	36.6	36.9	91.6	1.32
180	51.6	46.2	87.2	2.41
150+30	53.8	47.2	79.4	3.38
S.E. (12 D.F.)	6.99	4.16	4.90	0.954

SPot East Black dot
Main effects of N

Nitrogen	Incidence (%)	Proportion <5 % SA (%)	Severity (% SA)
180	56.4	74.8	4.97
210	55.4	74.8	6.12
240	50.2	77.0	5.65
270	57.5	73.9	5.60
S.E. (30 D.F.)	3.60	2.83	0.783

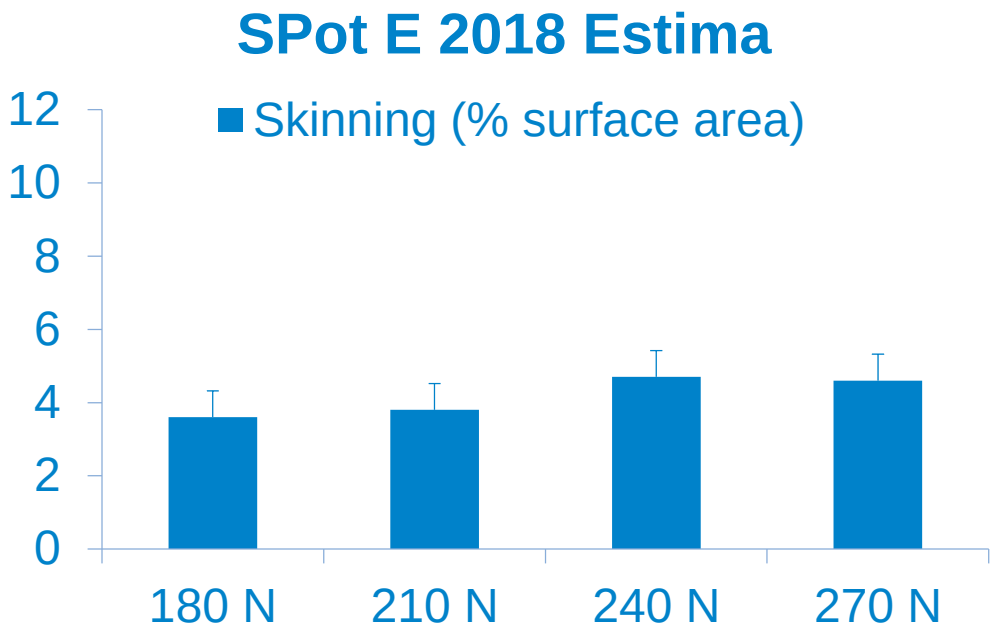
No effect of N rate or timing on black dot

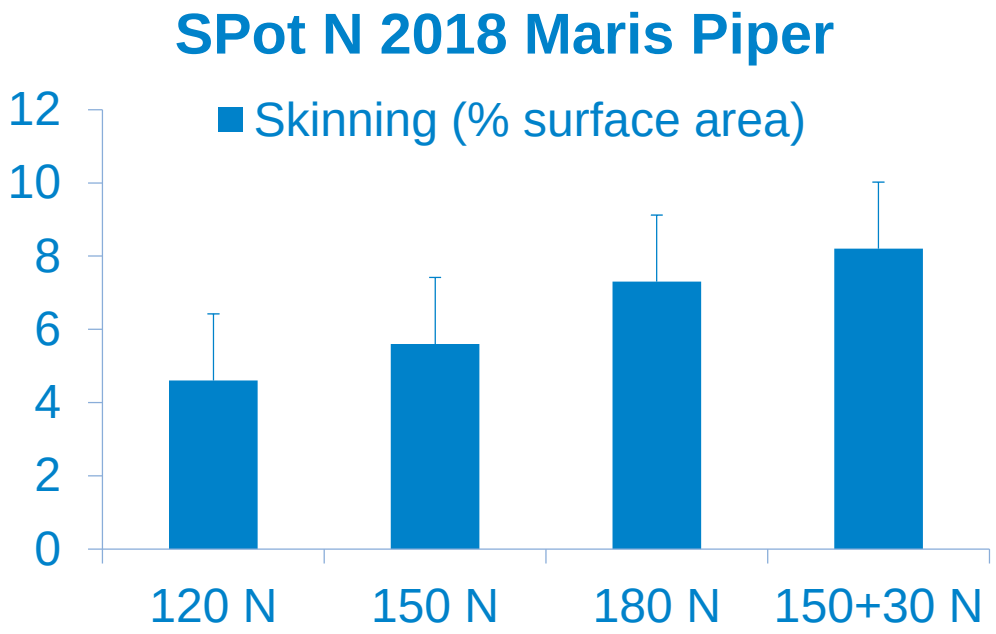
SPot Scotland Black dot Effects of N

Nitrogen	Incidence (%)	Proportion <5 % SA (%)	Severity (% SA)
N1 Standard 147 kg, top-dress 32 kg	48 (±8.4)	82 (±9.1)	3.7 (±2.09)
N2 Standard 147 kg, no top dress	52 (±18.8)	81 (±10.8)	3.4 (±2.09)
N3 Reduced 90 kg, no top-dress	50 (±10.0)	82 (±3.2)	3.9 (±1.28)
N4 Placed 147 kg, top-dress 32 kg	43 (±16.5)	85 (±10.4)	2.7 (±2.20)

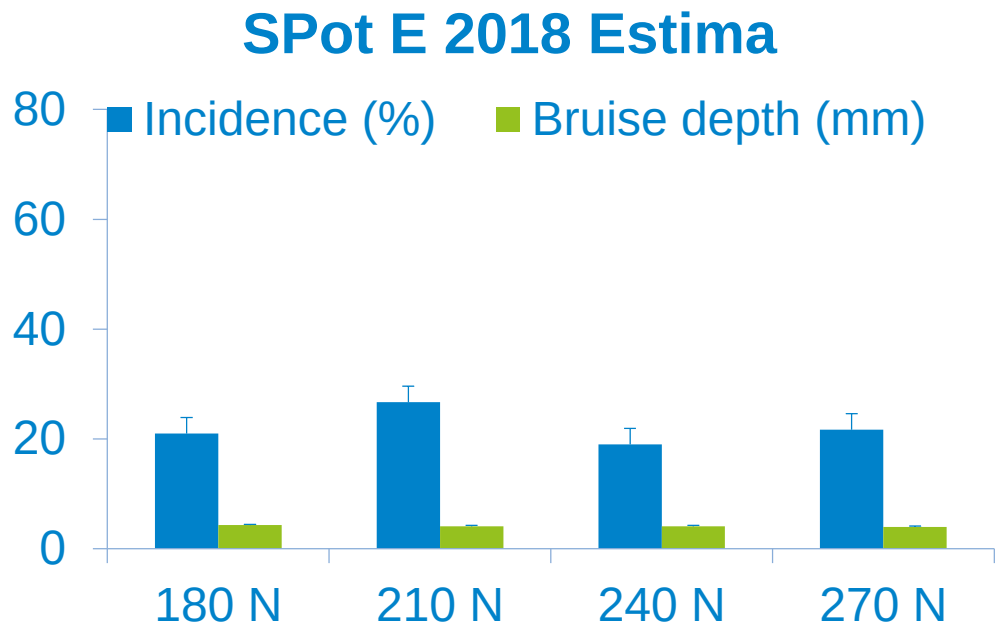
No effect of N rate, timing or position on black dot

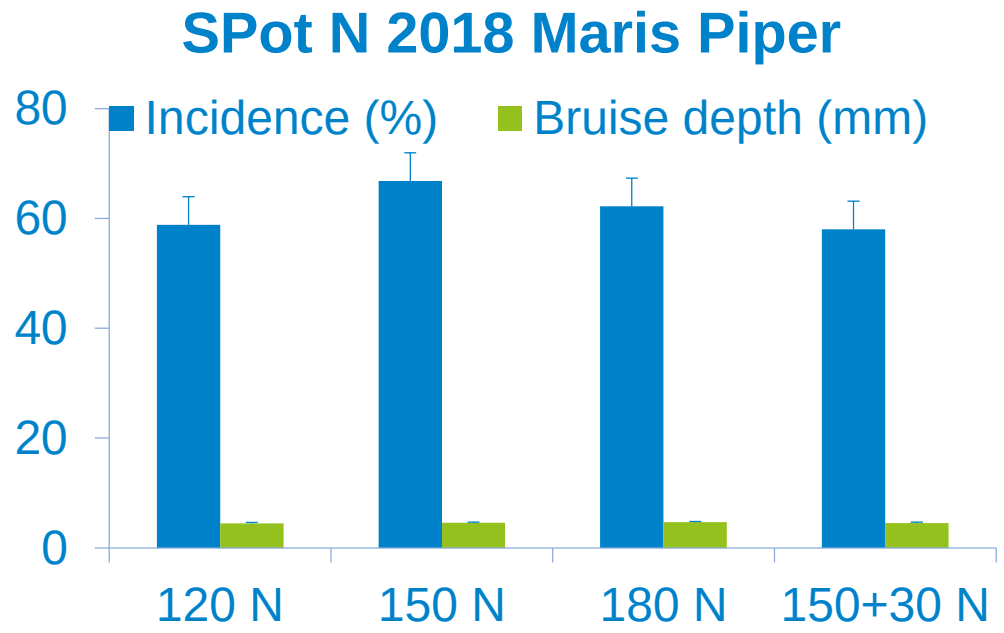
Increased N delays skinset?





No evidence that reduced N increases bruising





Isn't it about what is sold rather than yield digs? SPot Scotland 2017 Packout (Albert Bartlett)

	Trial	1	2	3	4
Treatment	Planting Top dress	Liquid Standard (177 N)	Standard Ridge inject (175 N)	**Standard No top dress (147 N)**	Standard Standard (176 N)
Crop harvested	No. boxes	23	24	**24**	22
Graded product	Tonnes	14.24	14.70	**15.88**	14.12
Packout	%	64.6	62.9	**67.6**	64.9
Yield packed	**t/ha**	**37.5**	**37.8**	**40.9**	36.1

Summary of SPot N trials (2016-2018)

SPot site	Year	Variety	N treatments	Summary of N effects on yield	Yields >40 mm (t/ha)	Tuber DM (%)
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	2017	Brooke	Split N, All N in seedbed, Placed N (all 220), 160, 180, 220, 160+30	**No effect of rate or timing. Placed lower**	61.0, 61.1, 55.7, 61.2, 59.2, 61.0, 62.3	24.5, 24.8, 25.0, 24.3, 24.3, 24.7, 24.3
	2018	Estima	180, 210, 240, 270	**No effect**	54.8, 56.9, 56.6, 55.1	18.9, 18.8, 18.4, 18.5
North	2018	M Piper	120, 150, 180, 150+30	**No effect**	49.7, 48.1, 49.3, 50.7	23.6, 23.4, 23.2, 23.4
South West	2017	Electra	90, 120, 150	**No effect**	58.7, 61.7, 61.3	17.1, 16.3, 16.4
	2018	Electra	0, 30, 60, 90, 120	**No effect**	72.0, 61.2, 72.4, 73.4, 72.3	16.4, 15.7, 15.6, 15.8, 15.4
Scotland	2017	M Piper	177, 147, Liquid, Injection	**Injection lower**	54.3, 51.2, 54.5, 49.8	19.2, 19.4, 18.5, 18.4
	2018	M Piper	176, 147, 120, Placed	**TBA**	TBA	TBA

Financial summary of SPot N trials to date

Commercial split N	All N in seedbed	Financial	Placed/injected	Financial
61.2 t/ha	+0.1 t/ha	+£20/ha	-4.9 t/ha	-£980/ha

Commercial rate	Optimal rate	N saving	Financial
57.2 t/ha	+0.8 t/ha	-53 kg/ha	+£197/ha

Summary

- Used RB209 to calculate N requirement for crop and site and mostly found 30-60 kg N/ha lower than commercial rate being used on surrounding crop
- Experiments and strip trials showed no evidence of loss of yield from these lower rates
- Placed or injected N tended to produce lower yields than broadcast
- No evidence that much N leached out of the rooting profile during the growth period on heavily irrigated sandy soils, but canopies were paler and shorter-lived where over-watering took place
- Decreased N did not result in increased bruising
- Decreased N resulted in better skinset

SPot North 2018 P, K, S Results

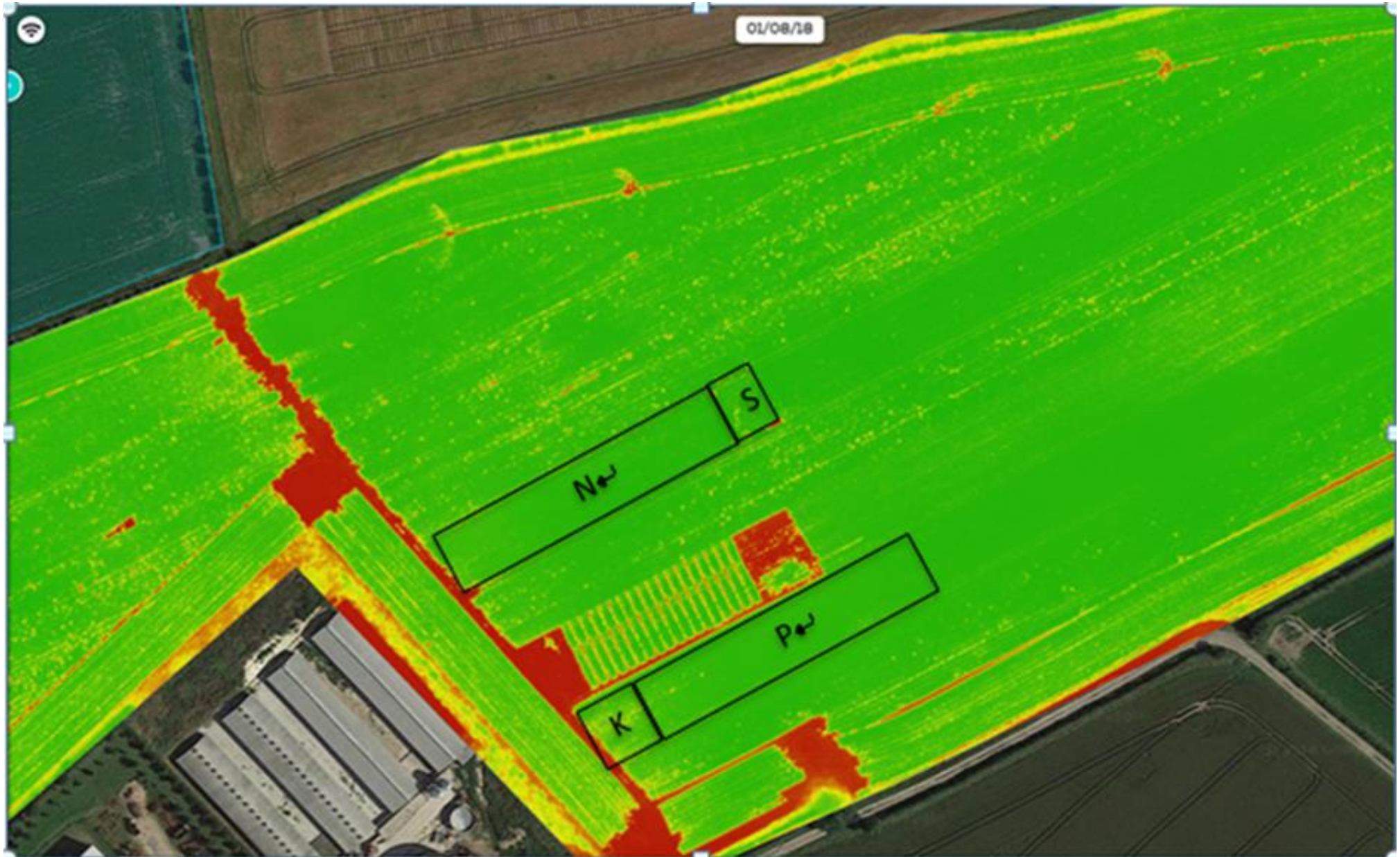
Site background

- Barn Field, Somerby Top Farm, Lincolnshire (53.5529° N, 0.3726° W)
- Sandy loam texture (78% S, 12% Z, 10% C) with high limestone content
- No PCN found in the trial area in November 2016
- Soil OM of 3.4 % (consequence of pig slurry from the site's pig unit?)
- pH 8.2
- P Index was 3- (30-31 mg/l)
- K Index 2+ (215-234 mg/l)
- Mg Index 2 (58-60 mg/l)
- SO_4 concentration very high (19.5 mg/l)

Site background

- Ploughed, ridged, destoned early May
- Planted 5 May
- Varieties
  - Maris Piper (N & S Experiments)
  - Royal (P & K Experiments)
- Emergence
  - Maris Piper 5 June
  - Royal 2 June
- Irrigation ??? mm

Any visible treatment effects on 1 August?



K Background

1. Allison *et al.* (2001a) found that:
    a) Generally, K Index was a poor predictor of the probability of a yield response
    b) No more than 210 kg K_2O/ha be applied, even on soils with Index 1 or less
    c) When applied at the optimal rate for yield, the effects of K fertilizer on tuber DM concentration were non-significant
    d) Exceeding the optimal K application rate caused occasional reductions in tuber DM concentration, particularly if potassium chloride (KCl) was used

K Hypotheses

1. AHDB RB209 recommended K rate for site was 300 kg K_2O/ha to balance offtake by 50 t/ha crop
2. Different K products have different effects on tuber dry matter
3. Increased K reduces tuber DM

K Treatments

- **K products:**
  - None
  - Muriate of potash (KCl)
  - Sulphate of potash (K_2SO_4)
  - ICL PotashpluS
- **K rates:**
  - 0 kg K_2O/ha
  - 100 kg K_2O/ha
  - 200 kg K_2O/ha
  - 300 kg K_2O/ha
- **3 replicate blocks**

Yields (main effects of K source and K rate)

K source / rate	Yield >40 mm (t/ha)	Total yield (t/ha)	Tuber DM (%)	DM yield (t/ha)
KCl	35.1	37.2	24.9	9.3
K_2SO_4	34.5	37.0	25.1	9.3
PotashpluS	35.3	38.2	25.0	9.5
S.E. (22 D.F.)	1.46	1.39	0.15	0.37
0	34.6	36.8	25.2	9.3
100	35.2	38.0	25.1	9.6
200	35.6	37.9	24.7	9.4
300	34.4	37.1	25.0	9.3
S.E. (22 D.F.)	1.69	1.60	0.17	0.43

No effect of K source or rate on yield, and no directional effect on DM%

Fry colour (main effects of K source and K rate)

K source / rate	Fry colour (0 = USDA 0, 1= USDA 1)
KCl	0.029
K_2SO_4	0.038
PotashpluS	0.025
S.E. (22 D.F.)	0.0100
0	0.028
100	0.028
200	0.033
300	0.033
S.E. (22 D.F.)	0.0116

No effect of K source or rate on fry colour

P Background

1. Allison *et al.* (2001b) found that:
    a) Increases in the number of tubers in response to application of P fertilizer only occurred in soils with P Index 2 or lower and appeared to be associated with an increase in ground cover by the time of tuber initiation
    b) Applications of foliar P had no effect on number of tubers (or yield) and the authors discouraged this practice

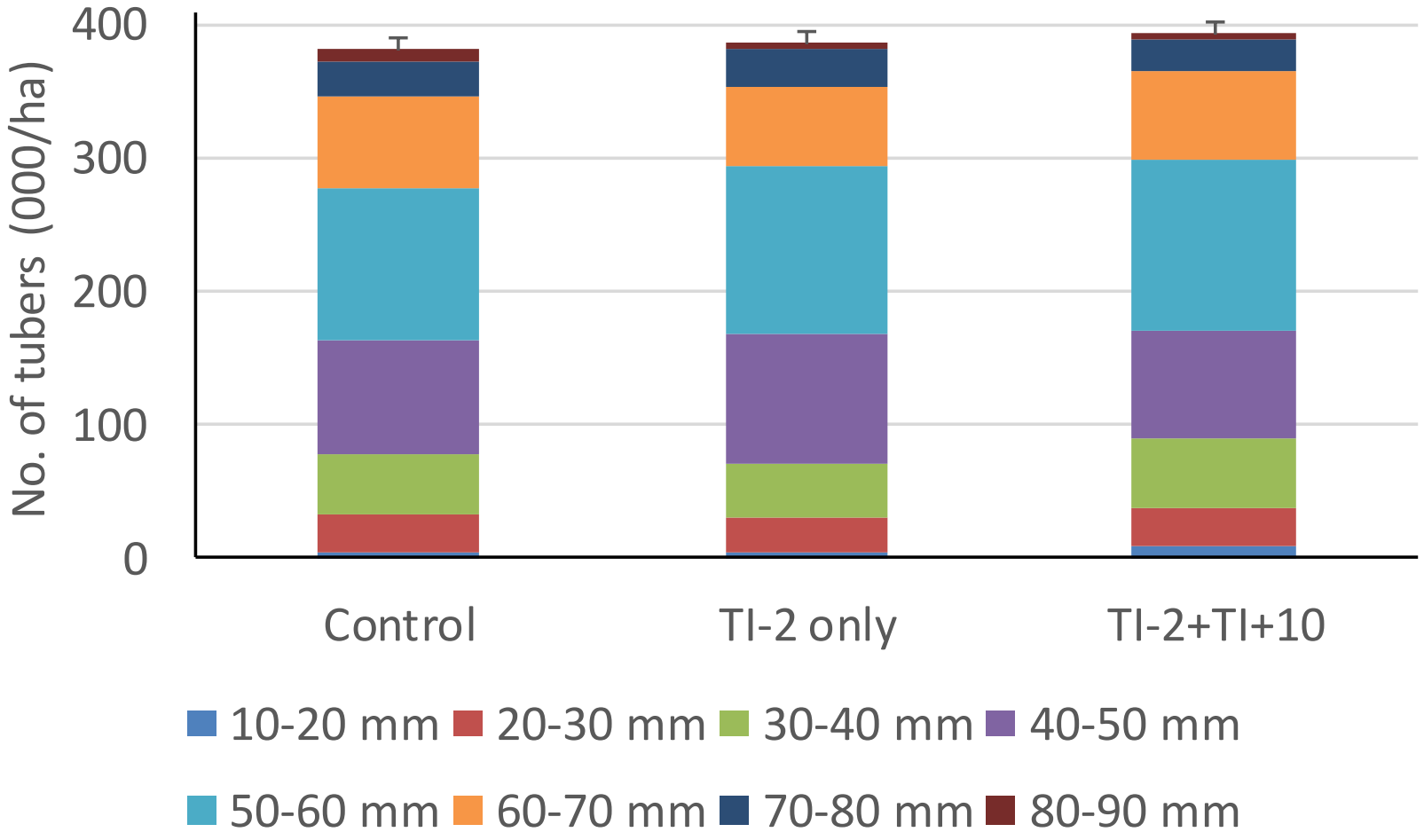
P Hypothesis

1. Foliar P can increase the number of tubers, even on high P Index soils

P Treatments

- No foliar P applied
- 10 l/ha MAGPHOS K applied as foliar spray in 200 l/ha 2 days prior to tuber initiation (15 June)
- 10 l/ha MAGPHOS K applied as foliar spray in 200 l/ha 2 days prior to tuber initiation (15 June) and second 10 l/ha 10 days after tuber initiation (27 June)
- 6 replicate blocks

Numbers of tubers



No effect of foliar P on number of tubers

Tuber yield

P treatment	Yield >40 mm (t/ha)	Total yield (t/ha)	Tuber DM (%)	DM yield (t/ha)
No foliar P	45.7	47.6	25.1	11.9
Foliar P at TI	45.1	46.8	24.8	11.6
Foliar P at TI and TI+10 days	44.3	46.3	25.0	11.6
S.E. (10 D.F.)	1.33	1.25	0.49	0.36

No effect of foliar P on yield

S Background

1. Previously, the supply of natural sources of S from the soil was regarded as sufficient for the potato crop
2. Significantly reduced S deposits from the atmosphere (due to a marked decline in industrial pollution), and continued use of fertiliser with low S content, S deficiency has gained increasing attention in many regions causing crops to become vulnerable to yield reductions
3. Spot North experiment is one of a series being conducted as part of a 3-year AHDB-funded project on S undertaken by NIAB CUF

S Hypotheses

1. Potato crops are responsive to S fertilizer
2. Product type influences S delivery
3. S can help control common scab

S Treatments

- No S
- 50 kg S/ha (125 kg SO_3) applied as ammonium sulphate at planting
- 50 kg S/ha applied as ICL Polysulphate at planting
- 50 kg S/ha applied as liquid sulphur at planting
- 6 replicate blocks

Petiole concentration of SO_4 (mg/l)

S treatment	mg/l
None	164
Ammonium sulphate†	173
ICL Polysulphate†	167
Liquid S†	177
S.E. (15 D.F.)	8.8

†125 kg SO_3/ha)

No effect of S application on plant uptake?

Numbers of tubers and yields

S treatment	Total no. tubers (000/ha)	Total yield (t/ha)	Tuber DM (%)
None	324	44.0	24.2
Ammonium sulphate†	340	42.3	24.1
ICL Polysulphate†	296	41.8	24.0
Liquid S†	396	48.1	24.2
S.E. (14 D.F.)	40.5	3.06	0.22

†125 kg SO_3/ha)

No effect of S on yield

Common scab and skin finish defects

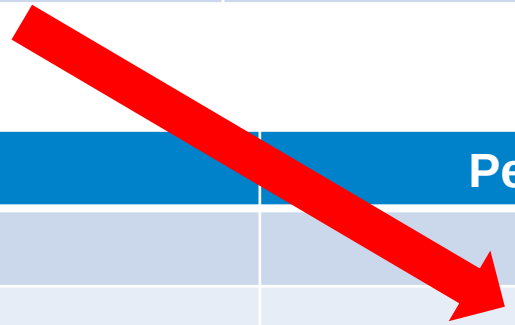
S treatment	Common scab (0=absent, 1=low, 2-medium, 3=high)	Proportion of tubers with skin finish defect (%)
None	1.67	68
Ammonium sulphate†	1.17	75
ICL Polysulphate†	1.67	83
Liquid S†	2.00	87
S.E. (15 D.F.)	0.214	9.6

†125 kg SO_3/ha)

No effect of S on skin quality?

Summary of AHDB S Project 2016-2018 (8 sites)

	Petiole SO_4 (mg S/l)	Yield (t/ha)	Tuber DM %
No S	117	62.7	22.0
With S	134	63.0	22.1
S.E.	5.4	1.50	0.09



Variety	Petiole SO_4 (mg S/l)
Innovator	123-160
VR808	68
Maris Piper	138-170
Royal	98
Russet Burbank	192

Summary

- Don’t do nutrition experiments on high Index soils!
- K Index 2+
  - No effect of K source or rate on yield, DM or fry quality
- P Index 3-
  - No effect of foliar P on number of tubers
- S soil concentration very high
  - No effect on yield or skin quality
- Optimal fertilizer for site
  - 120N, 0P, 0K, 0S

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