

AHDB – SPot Farm East - PCN 2018



Globodera rostochiensis

PCN UK Survey 2016

- 48% land infested
- almost 90% *G.pallida*

Industry Cost Estimates

- £25.9m/year (BPC 2009)

Nematicide Cost

Where applied largest single crop protection cost, on average >double 'late blight' protection!

Total >£15m per season

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SPot Farm PCN History 2016-2018

➤ **Spot East East 2016 – Resistance and Tolerance trial 12 varieties**

➤ **Spot Farm West 2017**

1. New Nematicide Demonstration – ‘Velum Prime’
2. Resistance and tolerance trial – AHDB PCN calculator
3. Trap Cropping Demonstration



➤ **SPot Farm West 2018 – Nematicide depth of incorporation trial**

➤ **SPot Farm East 2018**

1. Resistance and Tolerance Trial
2. New Nematicide Demonstration – ‘Velum Prime’
3. Trap Cropping Demonstration



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Trap Crop Demonstration

A trap crop targets reducing the levels of PCN population by stimulating a hatch of PCN juveniles from eggs without providing a site to allow feeding and multiplication, hatched juveniles then die.

4 non replicated blocks

1. *Solanum sisymbriifolium* 'Sticky nightshade'
2. *Solanum melanocerasum* 'Huckleberry'
3. 'Azo'
4. No Crop

3 x Replicated PCN tests from 0.5m circles within plots

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Trap Crop Demonstration - *Solanum sisymbriifolium*

2nd October



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Trap Crop Demonstration - *Solanum sisymbriifolium*

21st December



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Trap Crop Demonstration - *Solanum melanocerasum*

2nd October



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Trap Crop Demonstration - *Solanum melanocerasum*

21st December



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Trap Crop Demonstration – 'Azo'

2nd October



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Trap Crop Demonstration – 'Azo'

21st December



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Trap Crop Demonstration – *no crop?*

2nd October



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Trap Crop Demonstration

Pf:P*i* Ratio – Results

TBC

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Trap Crop Demonstration

Conclusions

- *Growth initially slow, high weed competition*
- *Pf:Pi Ratio TBC*

Further Research Required

- *Continual assessment of performance - reduction in PCN population in different soil types*
- *Herbicide screen – to allow improved canopy development with less competition*
- *Option to assess performance over winter – 'Azo'*

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New Nematicide Demonstration

Comparison of new a.i. *fluopyram* – ‘Velum Prime’ to current standards.

- 1st new nematicide for a number of years
- no harvest interval (latest application at planting)
- low dose rate 625ml/ha
- In furrow approval (PCN)– at present – water rate 100l/ha

Field demonstration of 2 replicates 5 Treatments – Variety Maris Peer

1. Untreated
2. Vydate 10G 55kg/ha overall incorporated
3. Velum Prime 625ml/ha In furrow
4. Nemathorin 10G 30 kg/ha overall incorporated
5. Nemathorin 10G 15kg/ha + Velum Prime 625 ml/ha In furrow

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New Nematicide Demonstration



101	Untreated
Pre eggs/g	1
102	Vydate 10G 55kg/ha
Pre eggs/g	0.5
103	Velum 625ml/ha
Pre eggs/g	0
104	Nemathorin 10G 30 kg/ha
Pre eggs/g	5
105	Nemathorin 10G 15 kg/ha + Velum P 625ml/ha
Pre eggs/g	0.5
	Spare Plot
	Spare Plot
108	Vydate 10G 55kg/ha
Pre eggs/g	35
109	Velum 625ml/ha
Pre eggs/g	16
110	Nemathorin 10G 30 kg/ha
Pre eggs/g	51
111	Nemathorin 10G 15 kg/ha + Velum P 625ml/ha
Pre eggs/g	24
112	Untreated
Pre eggs/g	16

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New Nematicide Demonstration

Pre PCN

16-51

Eggs/g



← Vydate 10G 55 kg/ha

← Volum Prime 625ml/ha

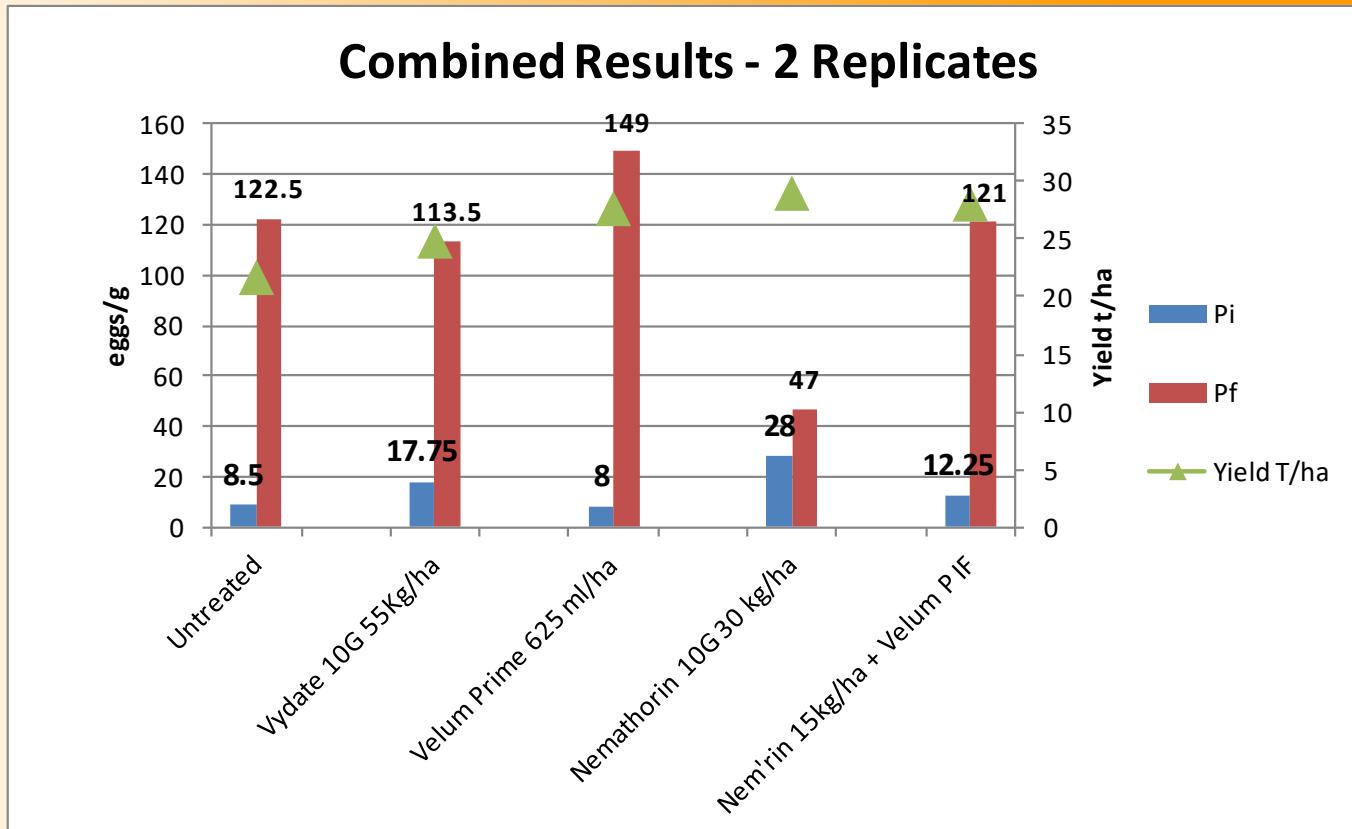
← Nemathorin 10G 30 kg/ha

← Nemathorin 10G 15 kg/ha + Volum Prime 625 ml/ha

← Untreated

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New Nematicide Demonstration

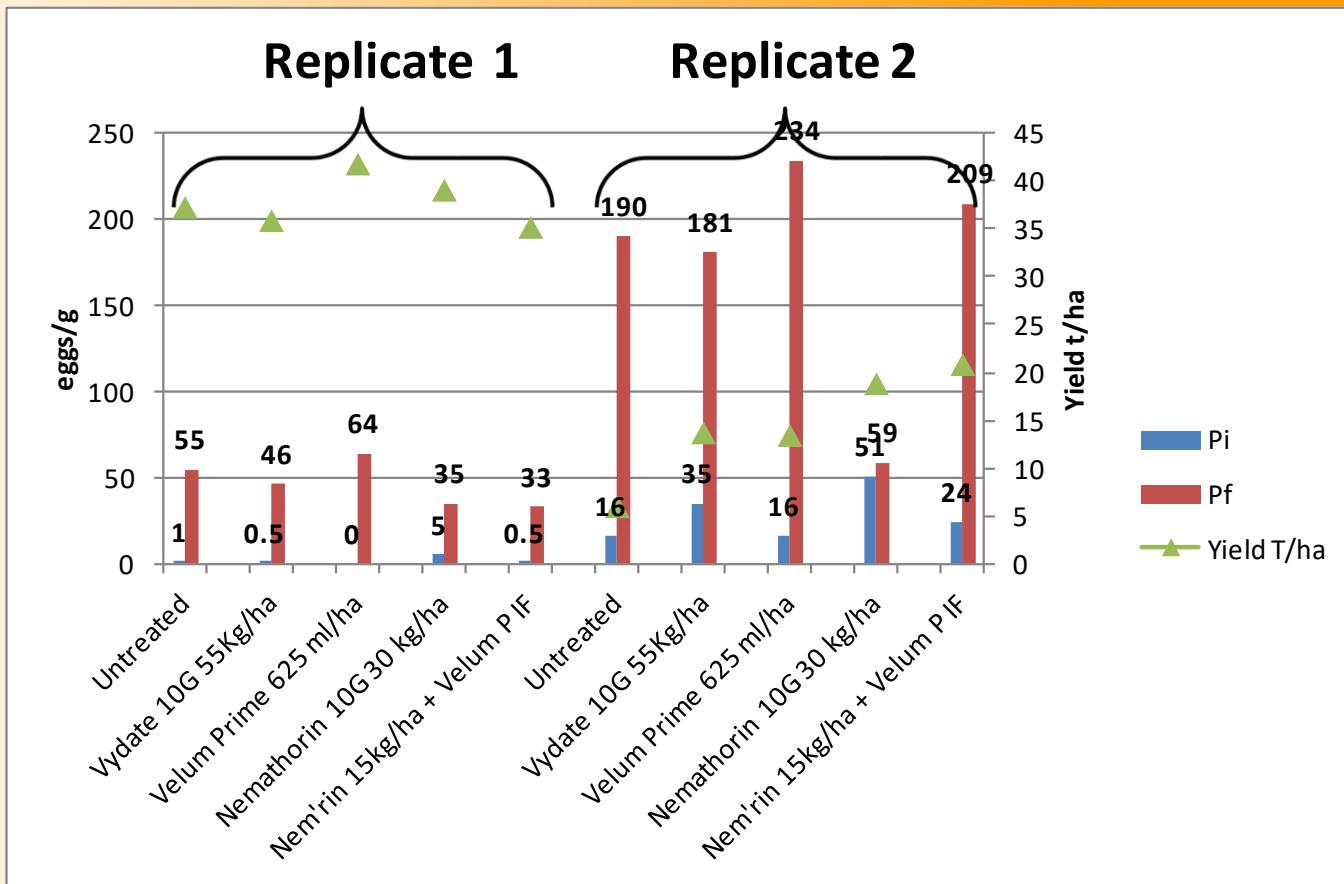


Treatment	Yield T/ha
Untreated	21.7
Vydate 10G 55Kg/ha	24.8
Volum Prime 625 ml/ha	27.7
Nemathorin 10G 30 kg/ha	29.0
Volum Prime 625 ml/ha	27.7
Nem'r'in 15kg/ha + Volum P IF	28.1

Caution only 2 replicates!

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New Nematicide Demonstration



Caution only 2 replicates!

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New Nematicide Demonstration

Conclusions

- all nematicides improved yields compared to the untreated
- trend towards Nemathorin 10G restricting multiplication
- ***Caution only 2 replicates!!***



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Tolerance and Resistance Trial



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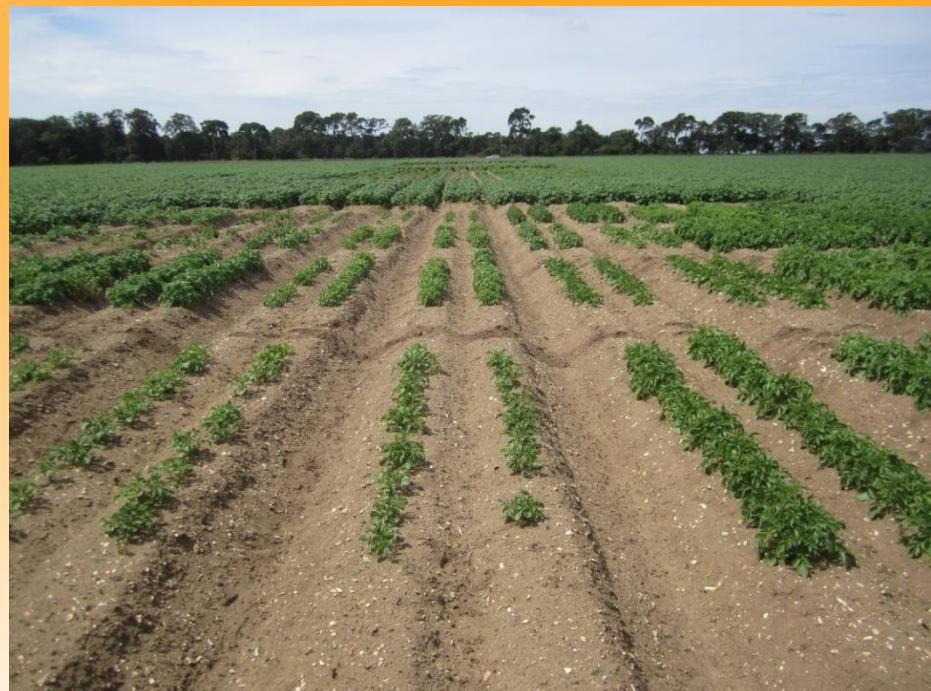
Tolerance and Resistance Trial

Trial Objective

VCS (UK) Ltd was commissioned to undertake a replicated trial (4 replicates) comparing the performance of 12 varieties within a mixed *Globodera pallida* & *Globodera rostochensis* infected site on a sand soil type with and without nematicide treatment.

Objectives

- Investigate the resistance levels of the varieties to *Globodera pallida* and *Globodera rostochensis*
- Investigate the tolerance of the new varieties
- Compare the performance of individual varieties with and without nematicide treatment



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Tolerance and Resistance Trial

Resistance – the ability of a variety to affect the multiplication of PCN

- Full resistance - no multiplication of PCN from eggs which hatch (some may remain dormant)
- Partial resistance – some multiplication from eggs which hatch

Tolerance – the ability of a variety to produce reasonable yield when grown in the presence of PCN

- Generally tolerant varieties produce larger root systems and are more vigorous in their growth habit

Tolerance Interactions

- Nematode Population
- Soil Type
- Nematicide application

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Tolerance and Resistance Trial

Trial/Field Details - Claybreck

- Planting Date 18th May
- Desiccation Date 28th September
- Harvest date 17th October
- Soil type – Loamy Sand
- Irrigation as per field applications
- Fertiliser application as per field

	Soil Index	Fertiliser Application	Notes
N		230	Split - pre plant/pre em/TI
P	3	50	
K	2-	360	
Mg	2	40	

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Tolerance and Resistance Trial

Trial Details

- Block design – 12 varieties within selected blocks (according to PCN population) of 4 nematicide treated and 4 non nematicide treated blocks also in a random order within block
- Block PCN levels
 - Block 1: 0-3 eggs/g
 - Block 2: 3-17 eggs/g
 - Block 3: 20-42 eggs/g
 - Block 4: 42-115 eggs/g
- Plot size 20.13m² – 4 rows
- PCN sampling 30 Cores Pre planting and Post harvest using a hand corer to a depth of 15-20cm.
- PCN Assessments eggs/g and cysts – Richard Austin Agriculture Ltd
- Nematicide application 30 kg/ha Nemathorin 10G (fosthiazate 10%) - pepperpot method applied to destoned beds prior to incorporation with a Bye Engineering front mounted bed tiller
- Plots hand planted at a standard spacing of 30 cm
- All treatments except nematicide as the field crop including irrigation

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Tolerance and Resistance Trial

Trial Design

Initial Population

2 Beds	2 Beds	2 Beds	2 Beds	2 Beds	2 Beds
1	1	19	49	53	55
0.5	2	16	22	42	33
0.5	12	20	35	17	31
4	6	15	12	32	60
Irrigation Wheeling					
4	6	8	63	56	48
2	16	38	115	42	110
3	27	19	89	92	78
8	2	16	54	106	20
4	6	22	75	61	38
2	3	14	15	35	33
2	1	15	29	73	22
0	2	8	63	79	38
Irrigation Wheeling					
1	0	1	29	34	46
3	2	7	31	47	28
0.5	0.5	10	45	37	29
0.5	0.5	0.5	14	52	11

Block Initial Populations

- BL1 **0-3** eggs/g
- BL2 **3-17** eggs/g
- BL3 **20-42** eggs/g
- BL4 **42-115** eggs/g

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Trial Design Blocks

2 Beds	2 Beds	2 Beds	2 Beds	2 Beds	2 Beds
1	1	19	49	53	55
0.5	2	16	22	42	33
0.5	12	20	35	17	31
4	6	15	12	32	60
Irrigation Wheeling					
4	6	8	63	56	48
2	16	38	115	42	110
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Irrigation Wheeling					
1	0	1	29	34	46
3	2	7	31	47	28
0.5	0.5	10	45	37	29
0.5	0.5	0.5	14	52	36

Block Initial Populations

- BL1 0-3 eggs/g
- BL2 3-17 eggs/g
- BL3 20-42 eggs/g
- BL4 42-115 eggs/g

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Tolerance and Resistance Trial

Trial Design
Speciation pre
Planting

Richard Austin Agriculture
PCR speciation

| 2 Beds |
|--------|--------|--------|--------|--------|--------|
| 1 | 1 | 19 | 49 | 53 | 55 |
| | | | | | |
| 0.5 | 2 | 16 | 22 | 42 | 33 |
| | | | | | |
| 0.5 | 12 | 20 | 35 | 17 | 31 |
| | | | | | |
| 4 | 6 | 15 | 12 | 32 | 60 |

Irrigation Wheeling

4	6	8	63	56	48
2	16	38	115	42	110

3	27	19	89	92	78
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4	6	22	75	61	38
2	3	14	15	35	33

2	1	15	29	73	22
0	2	8	63	79	38

Irrigation Wheeling

1	0	1	29	34	46
3	2	7	31	47	28

0.5	0.5	10	45	37	29

Block Speciation

- Area 5  35% Pa
- Remainder *G.rostochensis*

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Tolerance and Resistance Trial

Variety	G.Pallida Resistance	G.rostochensis resistance	Market Segment
M.Peer	2	2	
Cara	2	9	
Innovator	8	2	
Eurostar	8	8	
Alcander	Res	Res	Crisping
Elland	9	3	Processing/Pre-pack
Iodea	Res	Res	Salad
Lanorma	5	9	Pre-pack
Marvel	8	5	Bag/Processing
Monte Carlo	9*	9*	Pre-pack
Royal	3	9	Processing
Stet clone	Res	Res	Pre-pack

Source: IVT Testing, Breeders data

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Tolerance and Resistance Trial

Ground cover 17th July - Innovator



Innovator 1 egg/g Treated



Innovator 37 eggs/g Treated

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Tolerance and Resistance Trial

Ground cover 17th July - Innovator



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Tolerance and Resistance Trial

Ground cover

2nd August



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Tolerance and Resistance Trial

Ground cover

2nd August



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Tolerance and Resistance Trial

Ground cover



Stet clone

Eurostar

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Tolerance and Resistance Trial

Ground cover



Alcander

Maris Peer

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Tolerance and Resistance Trial

Ground cover



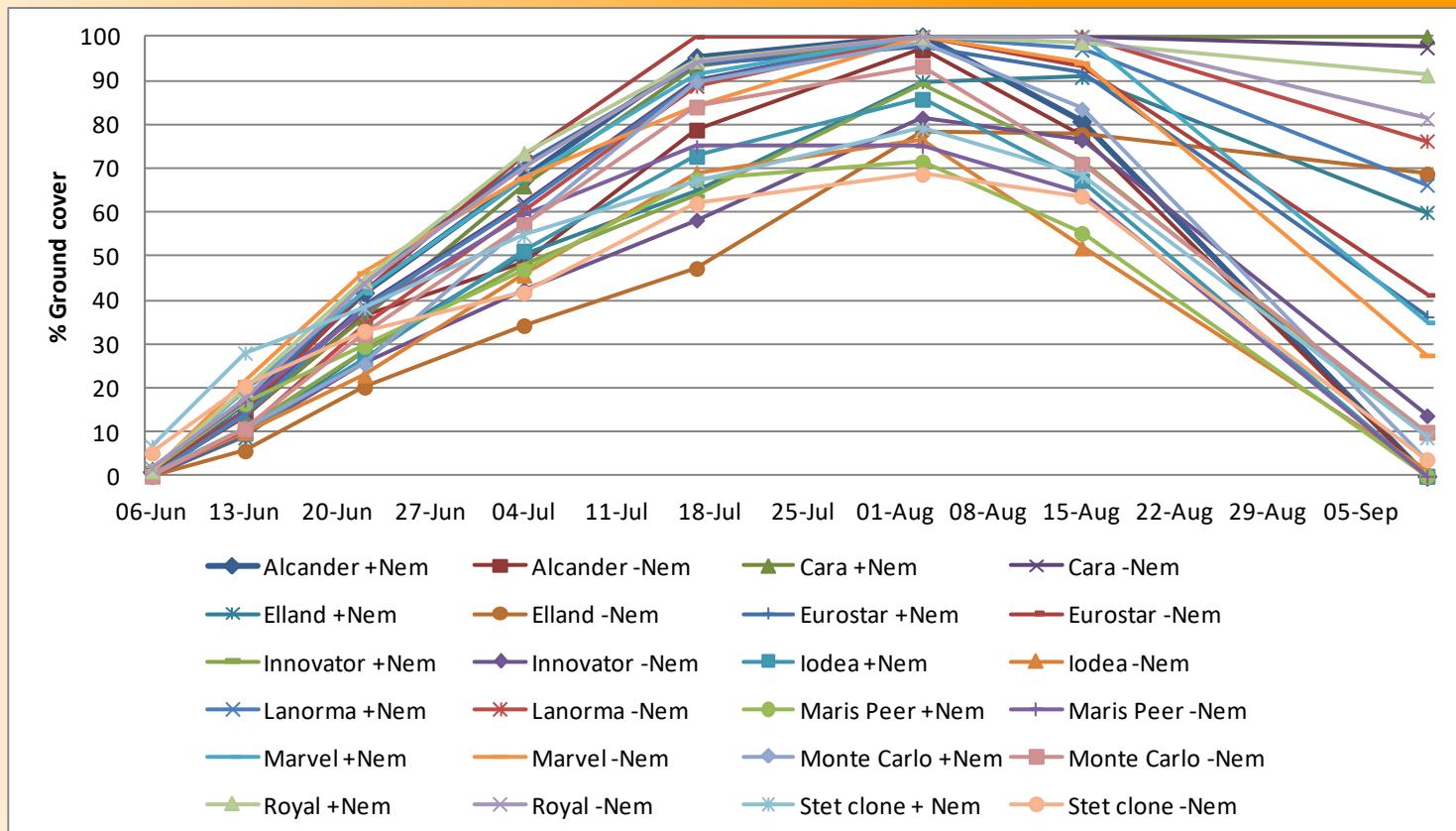
Elland

Royal

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Tolerance and Resistance Trial

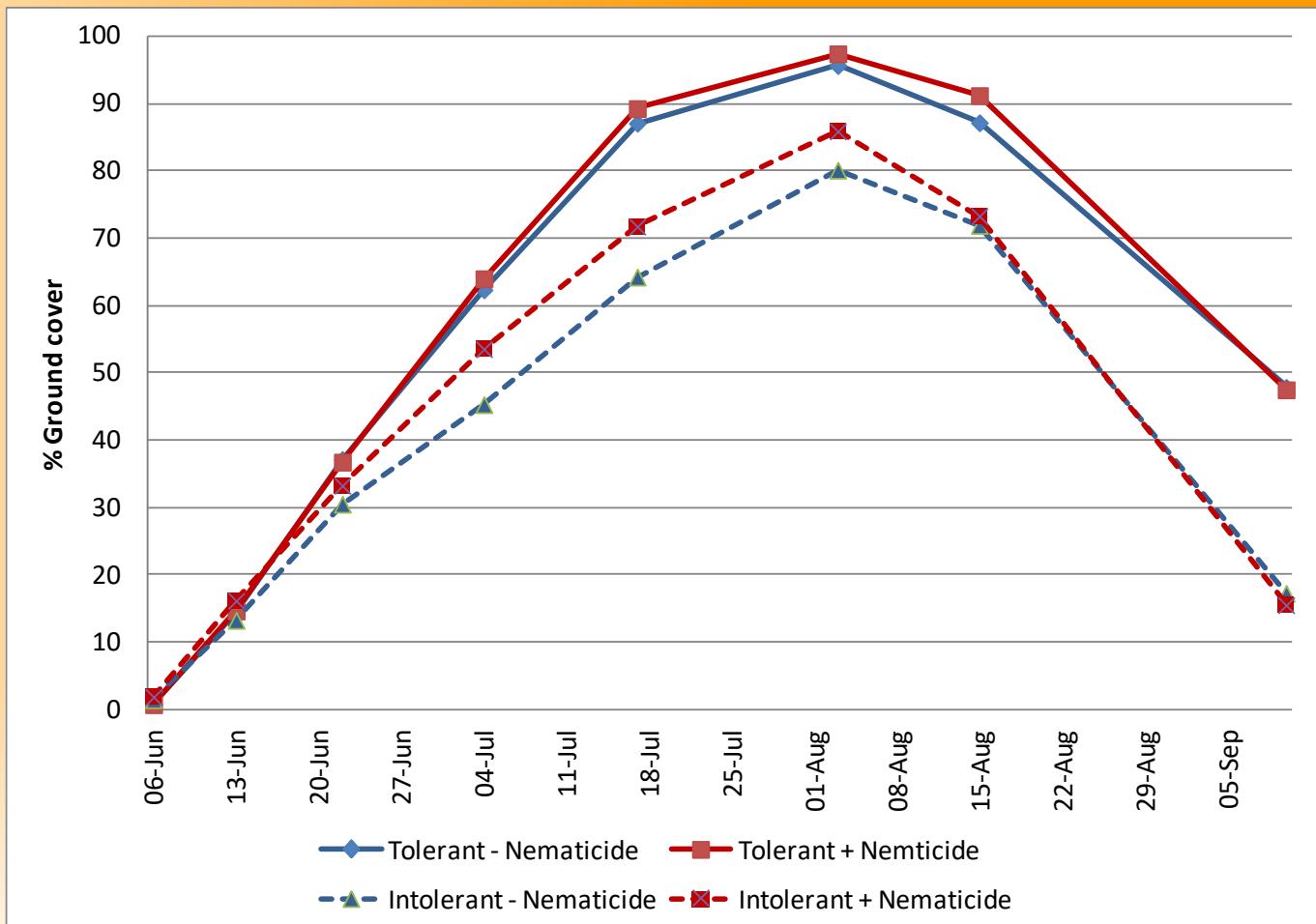
Ground cover (all varieties and treatments)



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Tolerance and Resistance Trial

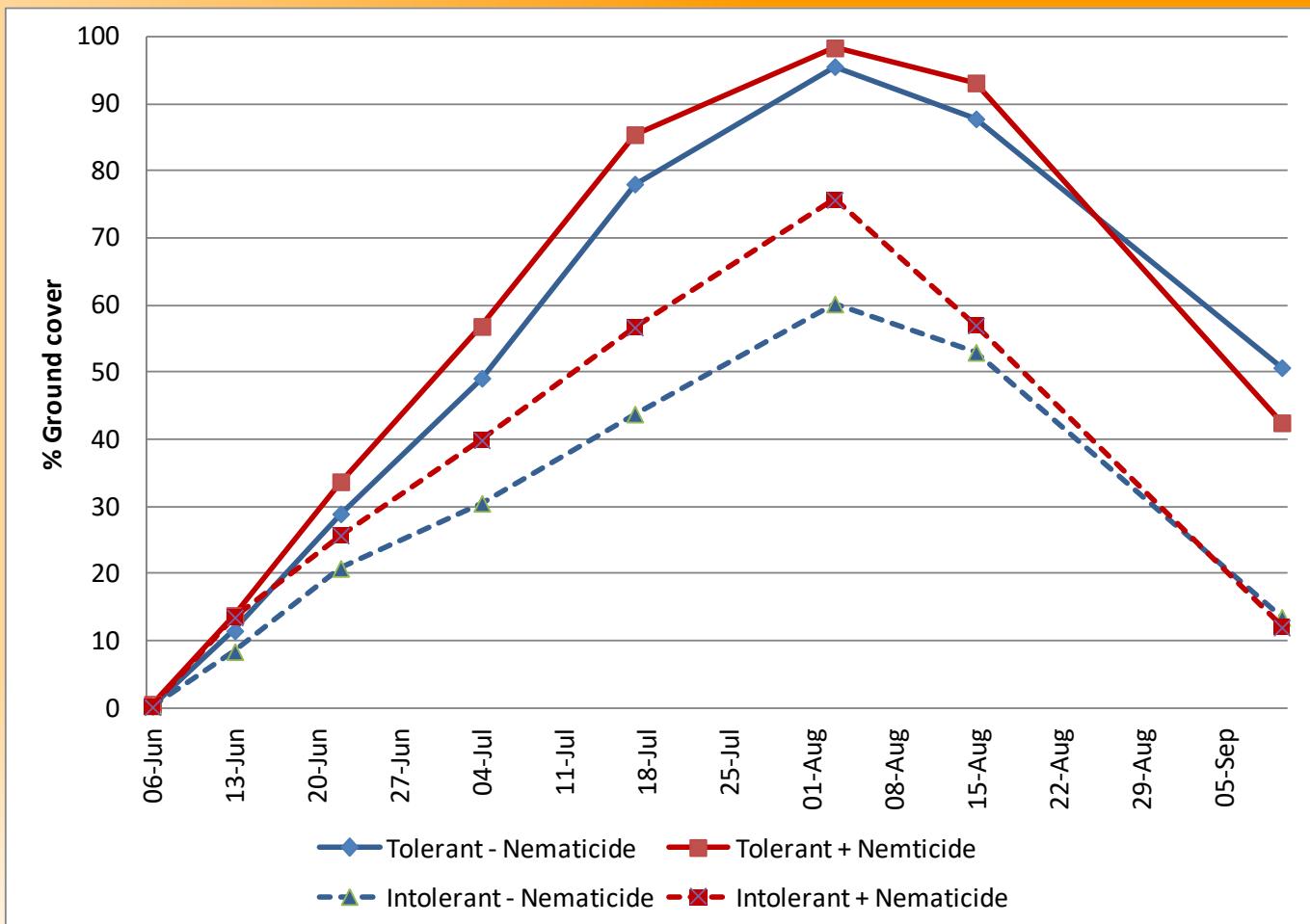
Ground cover
(all reps)



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Tolerance and Resistance Trial

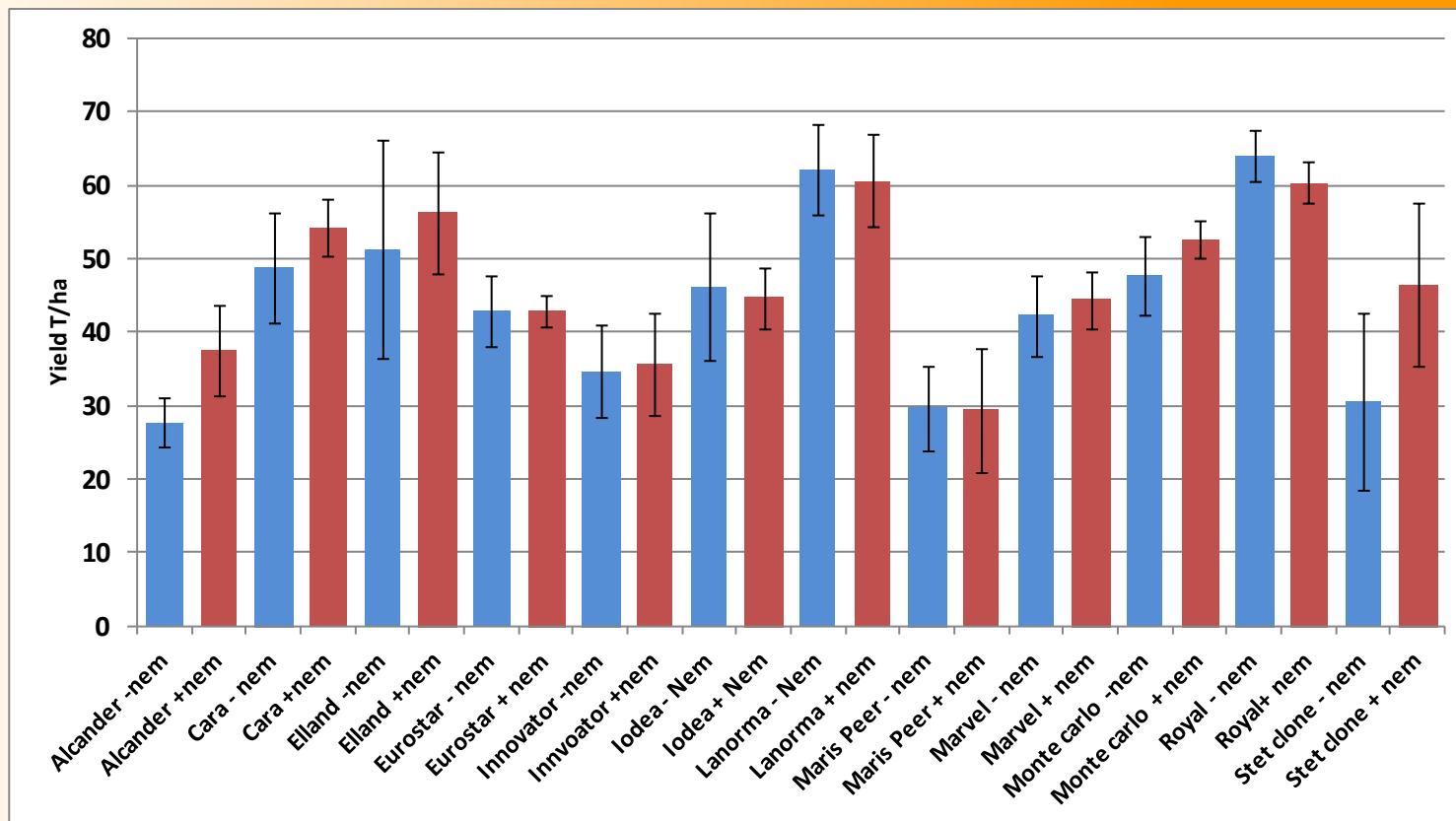
Ground cover
(high initial
Eggs/g >20
Population
Rep 3 & 4)



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Tolerance and Resistance Trial

Average Gross Yield T/ha (all replicates)

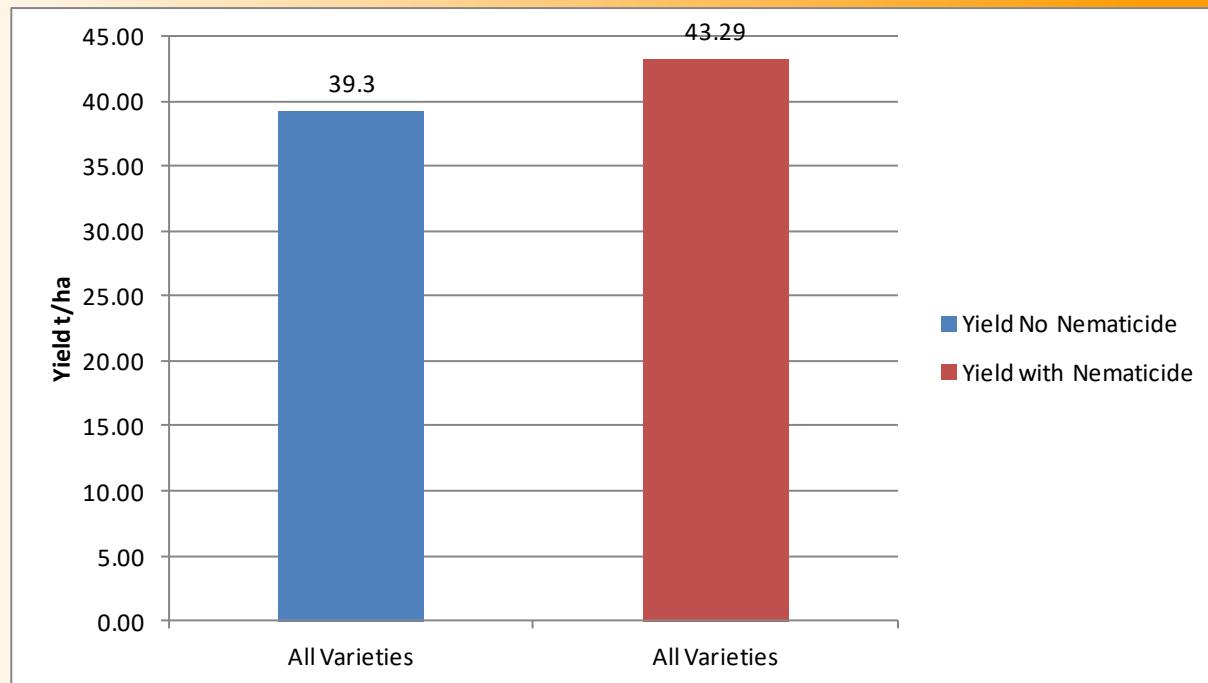


Note variation in response to initial eggs/g

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Tolerance and Resistance Trial

Average Gross Yield T/ha

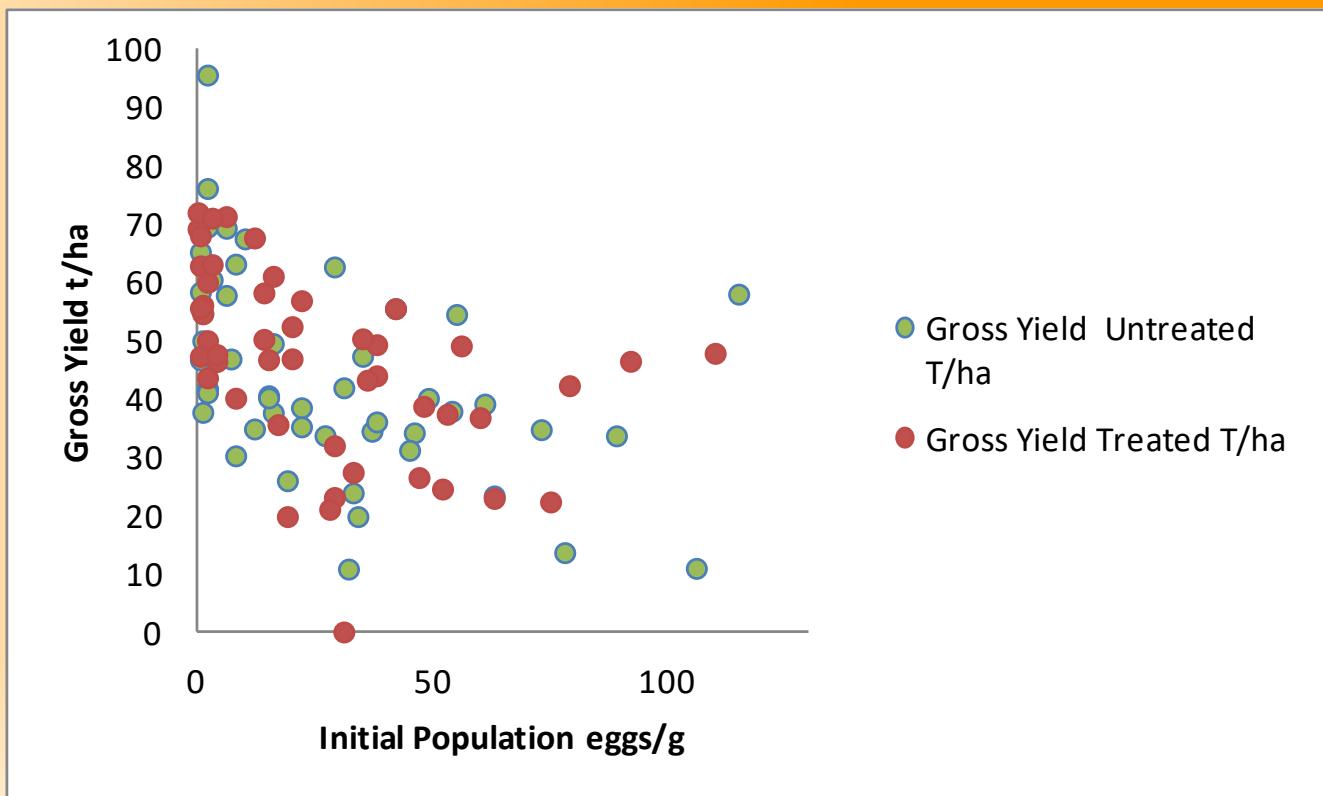


Average Yield increase of 10.2% following application of nematicide (block 2-4)

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Tolerance and Resistance Trial

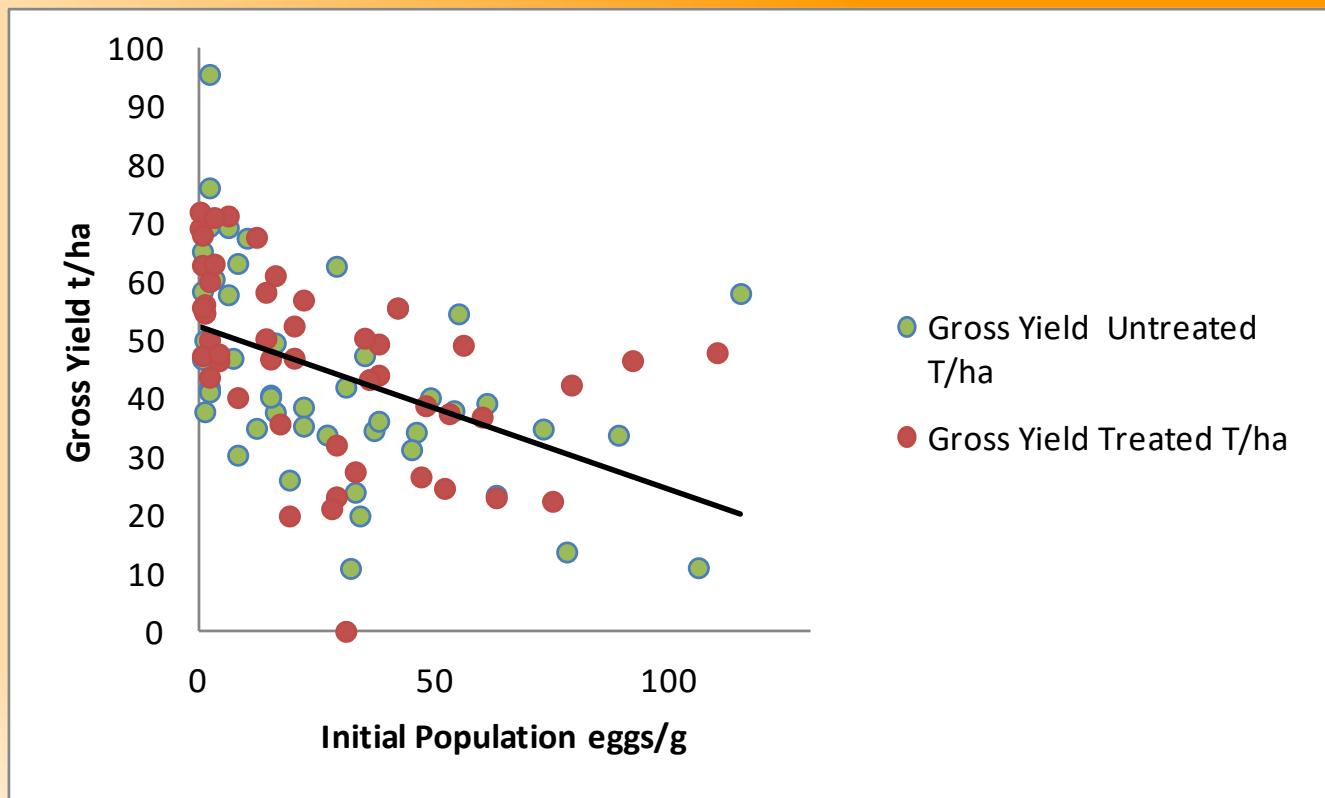
Gross Yield T/ha (all varieties)



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Tolerance and Resistance Trial

Gross Yield T/ha (all varieties)



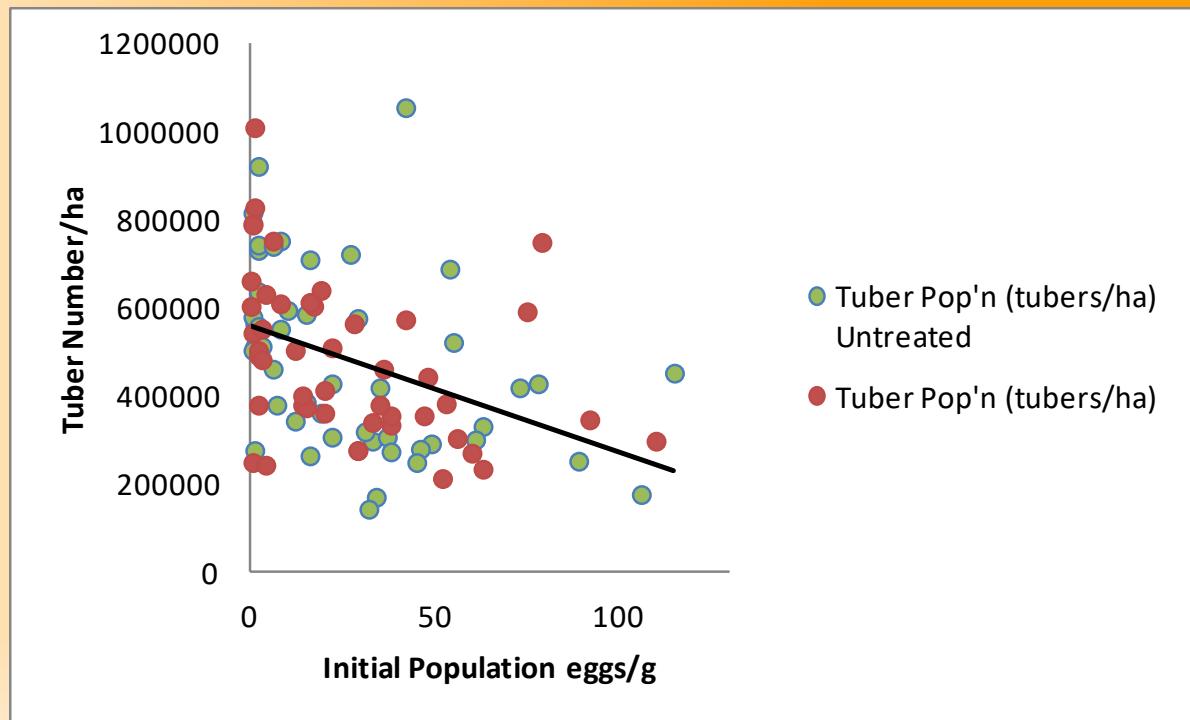
How do we use this to compare tolerance?

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Tolerance and Resistance Trial

Tuber Number per Ha

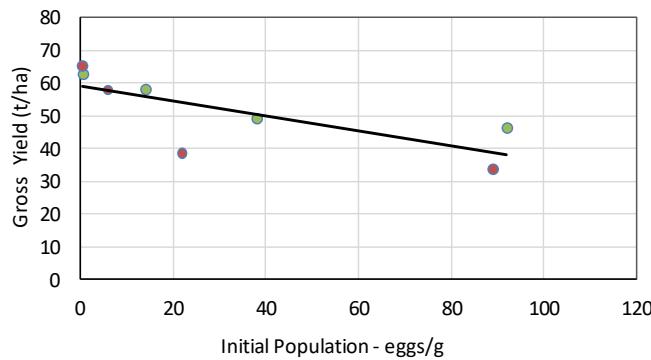
- Much of the decrease in yield is linked to reduced tuber number per ha



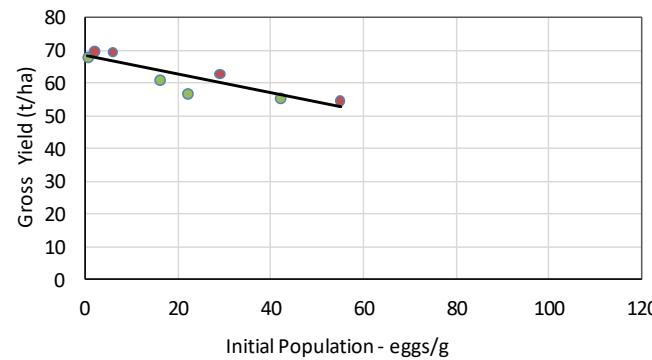
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Tolerance and Resistance Trial - tolerance assessment – rate of yield decrease with increase in population

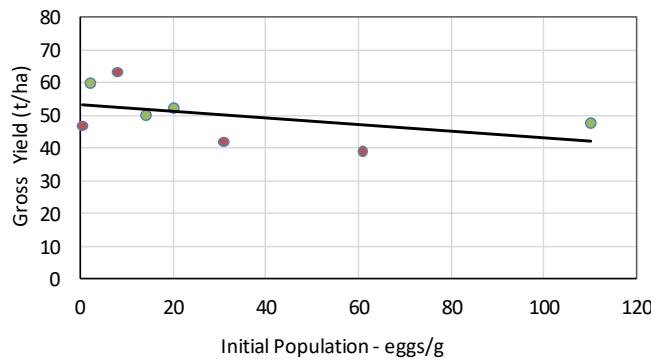
Cara



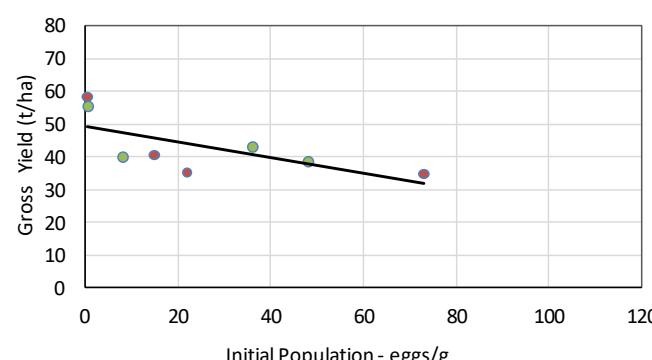
Royal



Monte Carlo



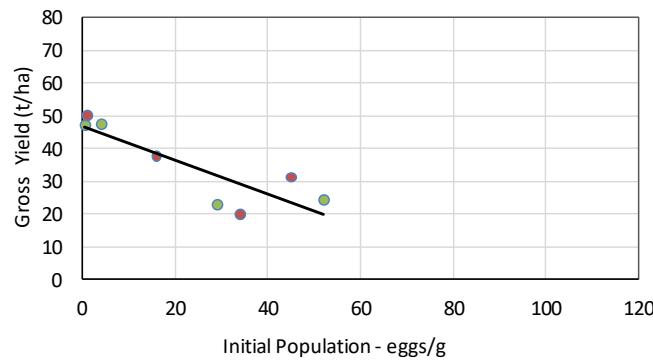
Marvel



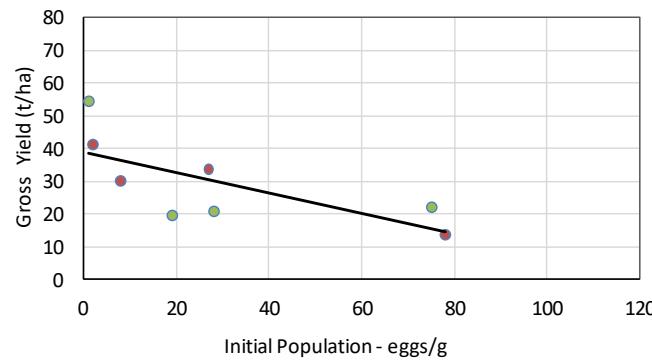
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Tolerance and Resistance Trial - tolerance assessment – rate of yield decrease with increase in population

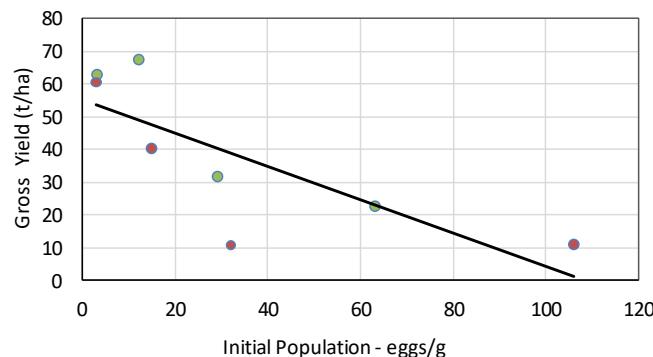
Innovator



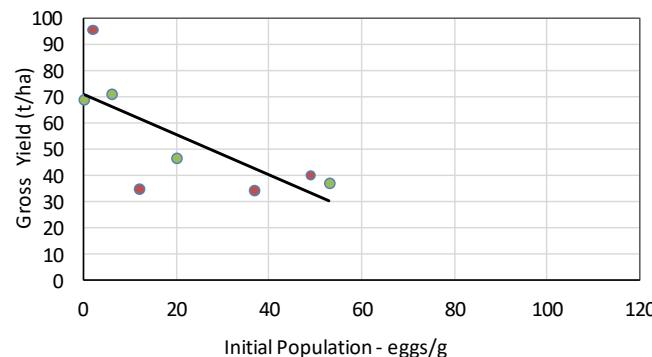
Maris Peer



Stet Clone



Elland

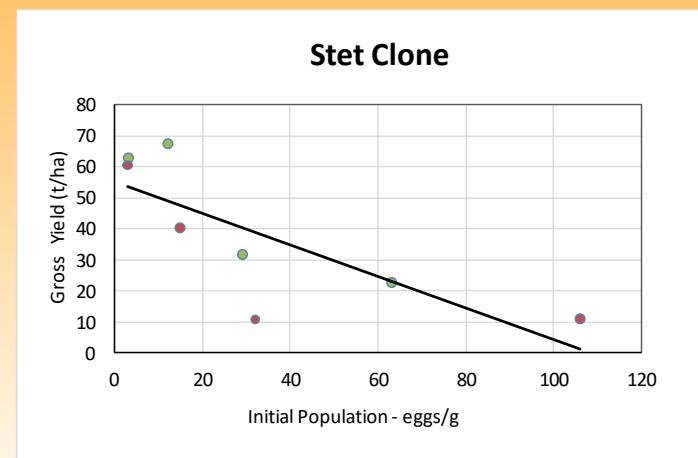
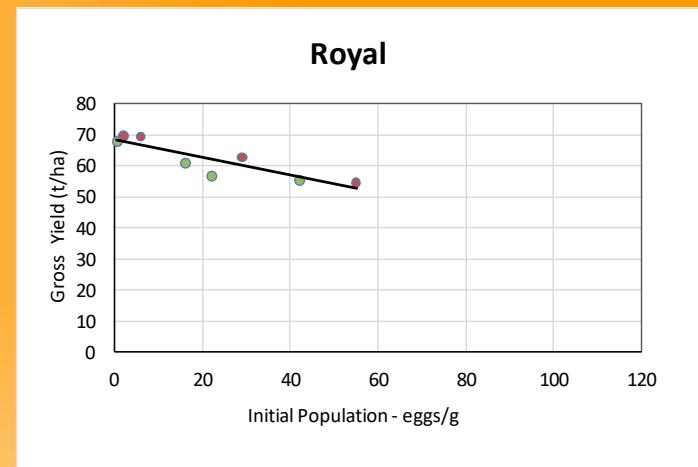


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Tolerance and Resistance Trial

Tolerance Ranking Method 1 – Rate of yield decrease with increase in population

	Ranking
Alcander	9
Cara	4
Elland	12
Eurostar	6
Innovator	11
Iodea	1**
Lanorma	3
Maris Peer	8
Marvel	5
Monte Carlo	2
Royal	7
Stet Clone	10



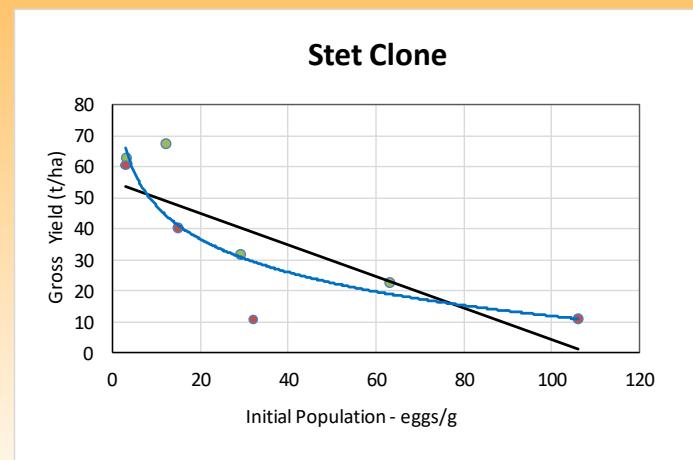
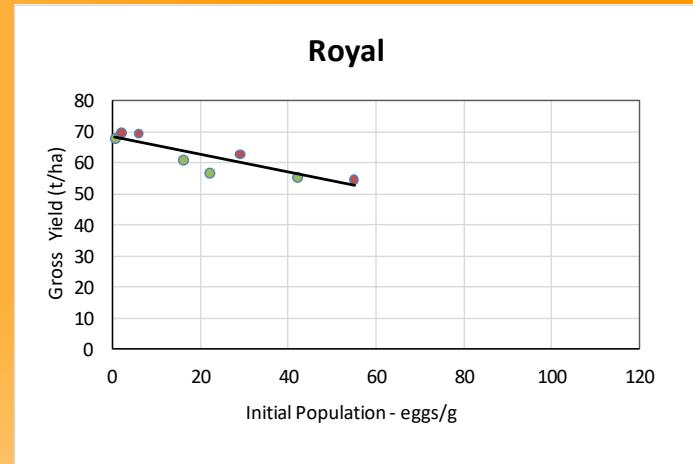
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Tolerance and Resistance Trial

Tolerance Ranking Method 1

	Ranking
Alcander	9
Cara	4
Elland	12
Eurostar	6
Innovator	11
Iodea	1**
Lanorma	3
Maris Peer	8
Marvel	5
Monte Carlo	2
Royal	7
Stet Clone	10

However for more intolerant varieties is a straight line a good fit? (large drop in yield at 10 eggs/g)



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Tolerance and Resistance Trial

Tolerance Ranking Method 2

Assessment of % decrease in yield Rep1/2 very low to low population compared to moderate/high population

	Yield T/ha (0-17 eggs/g Treated and Non treated)	Yield T/ha (20-115 eggs/g Treated and non Treated)	% yield low population to high population	Ranking
Alcander	40.07	25.30	63	8
Cara	61.07	42.02	69	7
Elland	67.80	39.74	59	10
Eurostar	48.02	37.79	79	4
Innovator	45.67	24.67	54	11
Iodea	45.78	45.26**	99	1**
Lanorma	71.72	51.23	71	6
Maris Peer	36.47	22.69	62	9
Marvel	48.70	38.01	78	5
Monte Carlo	55.08	45.36	82	3
Royal	67.02	57.44	86	2
Stet Clone	57.89	19.17	33	12

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Tolerance and Resistance Trial

Tolerance Ranking

2018 – either method provides a guide – do we need more than this??

2016

Tolerant	Moderately Tolerant	Moderately Intolerant	Highly Intolerant
Royal Performer Cara Lanorma	Eurostar Forza	M.piper M.peer Shepody Arsenal	Innovator Panther

2018

Tolerant	Moderately Tolerant	Moderately Intolerant	Highly Intolerant
Eurostar Iodea** Marvel Monte Carlo Royal	Cara Lanorma	M.peer Alcander	Elland Innovator Stet clone

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Tolerance and Resistance Trial

Tolerance Ranking 2016 & 2018 SPot East trials only

Tolerant	Moderately Tolerant	Moderately Intolerant	Highly Intolerant
Cara Eurostar Iodea** Marvel Monte Carlo Performer Royal	Forza Lanorma	← Alcander ← Arsenal Maris Peer → ← Maris Piper Shepody	Elland Innovator Panther Stet clone

No Resistance

Ro1 Resistance only

Partial Pa/Full ro1 resistance

Partial Pa/Partial Ro1 Resistance

Partial/Full Pa1 Resistance only

High Partial Pa/Full Ro1

Important to include resistance data with tolerance

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Tolerance and Resistance Trial

Pre Planting
Speciation

| 2 Beds |
|--------|--------|--------|--------|--------|--------|
| 1 | 1 | 19 | 49 | 53 | 55 |
| | | | | | |
| 0.5 | 2 | 16 | 22 | 42 | 33 |
| | | | | | |
| 0.5 | 12 | 20 | 35 | 17 | 31 |
| | | | | | |
| 4 | 6 | 15 | 12 | 32 | 60 |

Irrigation Wheeling

4	6	8	63	56	48
2	16	38	115	42	110
3	27	19	89	92	78
8	2	16	54	106	20
4	6	22	75	61	38
2	3	14	15	35	33
2	1	15	29	73	22
0	2	8	63	79	38

Irrigation Wheeling

1	0	1	29	34	46
3	2	7	31	47	28
0.5	0.5	10	45	37	29
0.5	0.5	0.5	14	52	36

Block Speciation

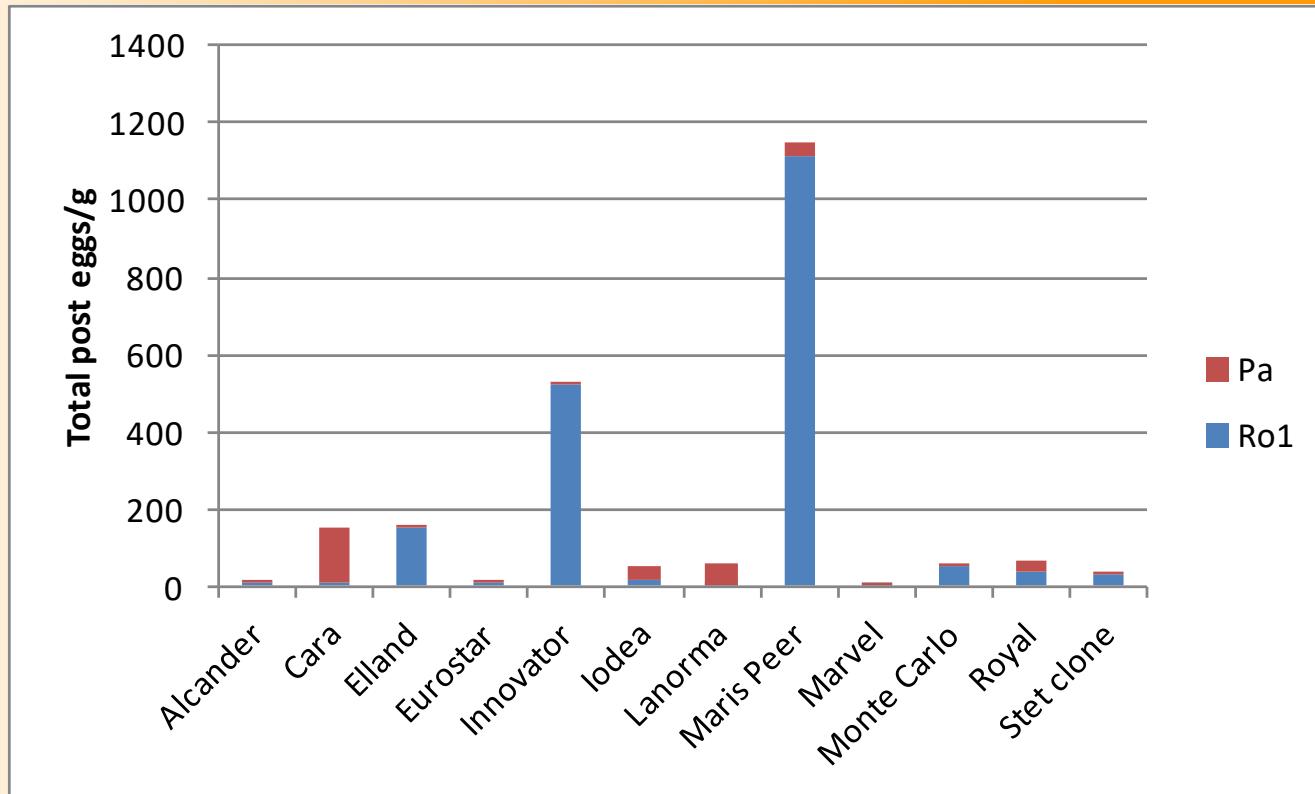
- Area 5  35% Pa
- Remainder *G.rostochensis*

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Tolerance and Resistance Trial

Resistance

- Number of eggs sampled within 8 plots post harvest by species



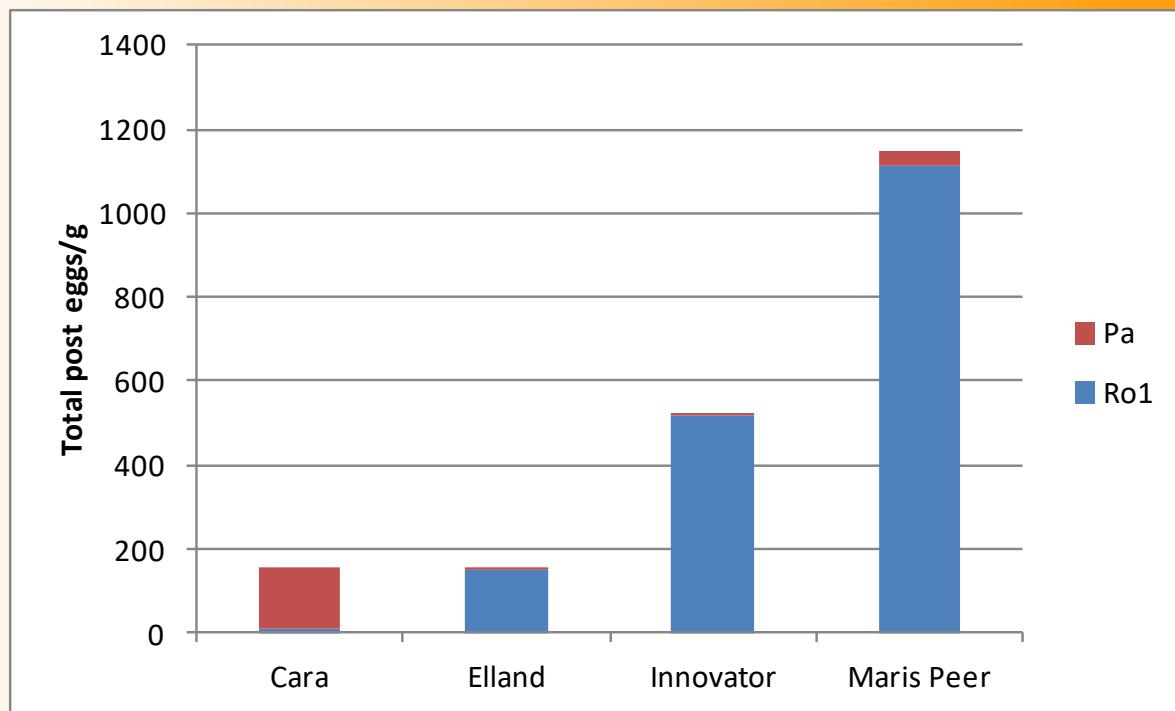
Large multiplication within non *G.rostochensis* resistant varieties

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Tolerance and Resistance Trial

Resistance

- Total Number of eggs/g over 8 plots post harvest – NON *G.rostochensis/G.pallida* resistant varieties



Pf:Pi Ratio Total

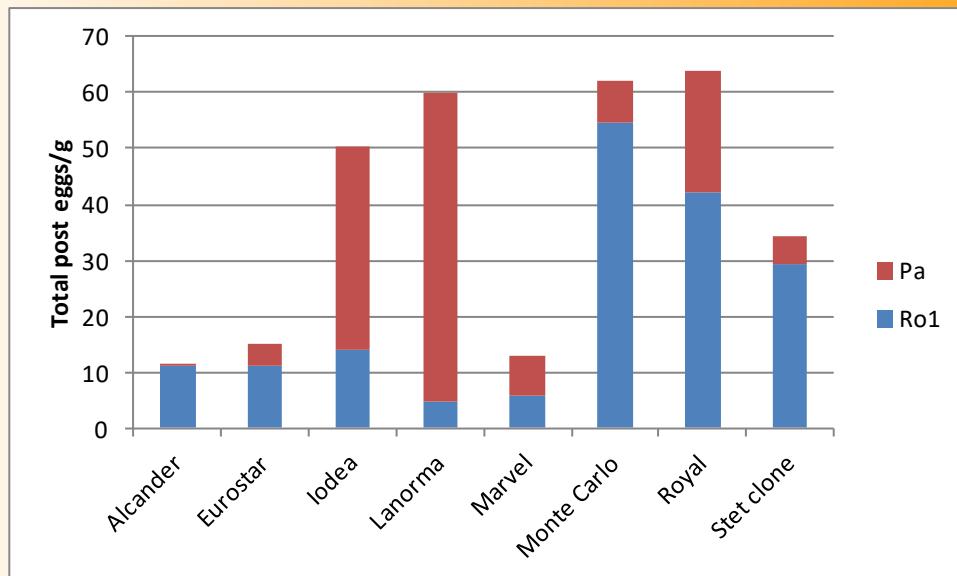
	Treated	Untreated
Elland	4.38	0.54
Innovator	2.73	3.00
Maris Peer	3.3	6.89

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Tolerance and Resistance Trial

Resistance

- Total Number of eggs/g over 8 plots post harvest of varieties with partial or full resistance to Ro1 and Pa



Pf:Pi Ratio Total

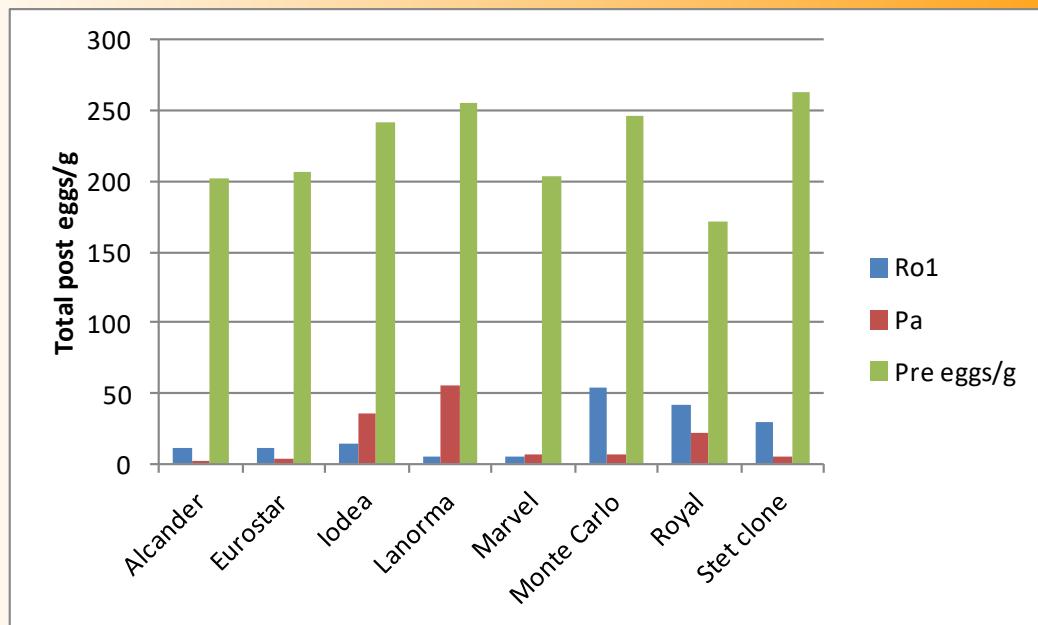
	Treated	Untreated
Alcander	0.03	0.08
Eurostar	0.04	0.11
Iodea	0.03	0.41
Lanorma	0.50	0.08
Marvel	0.05	0.08
Monte Carlo	0.10	0.47
Royal	0.17	0.54
Stet clone	0.18	0.10

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Tolerance and Resistance Trial

Resistance

- Total Number of eggs/g over 8 plots post harvest of varieties with partial or full resistance to Ro1 and Pa



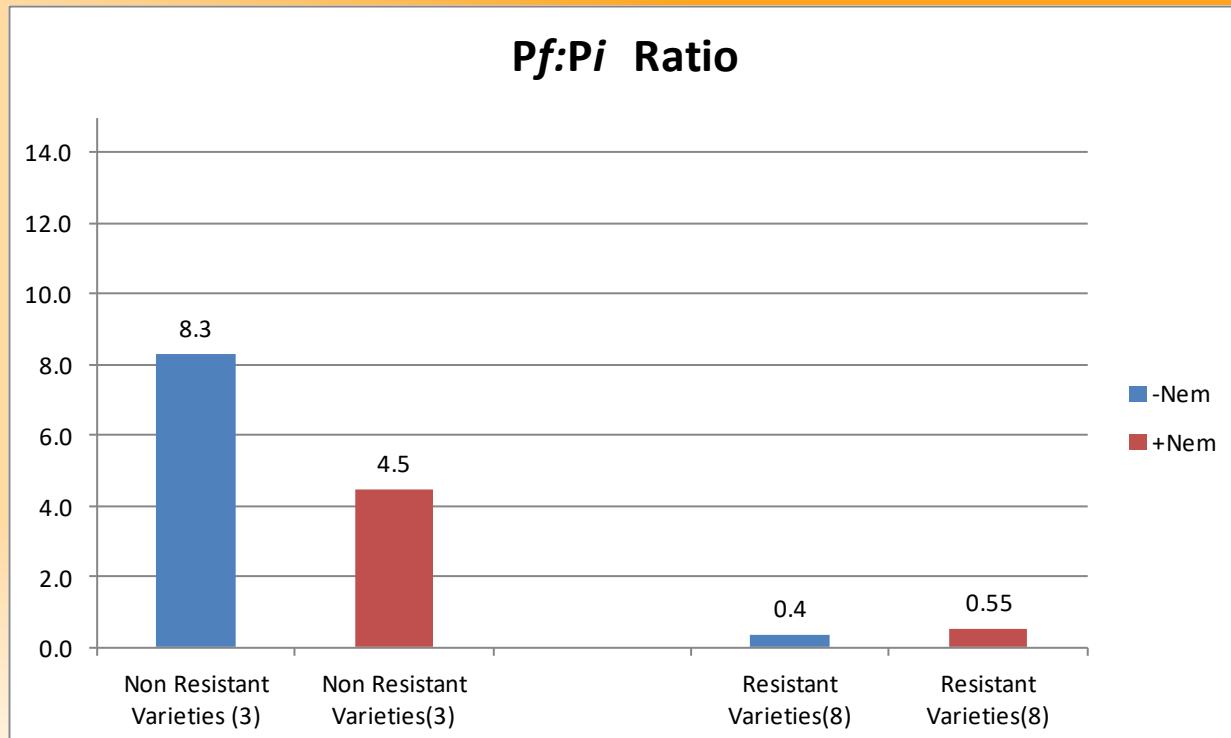
Pf:Pi Ratio Total

	Treated	Untreated
Alcander	0.03	0.08
Eurostar	0.04	0.11
Iodea	0.03	0.41
Lanorma	0.50	0.08
Marvel	0.05	0.08
Monte Carlo	0.10	0.47
Royal	0.17	0.54
Stet clone	0.18	0.10

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Variety Resistance (AHDB Spot Farm East 2016 – *G.pallida*)

- A varieties resistance characteristics generally have a greater effect on multiplication than nemticide application



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Tolerance and Resistance Trial

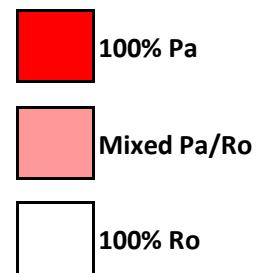
Speciation Pre

2 Beds	2 Beds	2 Beds	2 Beds	2 Beds	2 Beds
1	1	19	49	53	55
0.5	2	16	22	42	33
0.5	12	20	35	17	31
4	6	15	12	32	60
Irrigation Wheeling					
4	6	8	63	56	48
2	16	38	115	42	110
3	27	19	89	92	78
8	2	16	54	106	20
4	6	22	75	61	38
2	3	14	15	35	33
2	1	15	29	73	22
0	2	8	63	79	38
Irrigation Wheeling					
1	0	1	29	34	46
3	2	7	31	47	28
0.5	0.5	10	45	37	29
0.5	0.5	0.5	14	52	36

Speciation Post

2 Beds	2 Beds	2 Beds	2 Beds	2 Beds	2 Beds
0	0	49	0.5	249	40
0	0	94	4	0	2
1	6	9	0.5	0	0
0	125	7	29	5	0.5
Irrigation Wheeling					
7	7	278	10	0.5	0.5
0.5	13	0.5	5	5	3
46	239	4	10	0.5	189
7	3	5	0.5	9	87
23	2	0.5	97	21	7
0	0.5	8	0.5	3	0
36	0.5	0.5	83	0	0.5
3	86	0	2	4	1
Irrigation Wheeling					
4	0	1	3	140	1
1	13	3	16	2	260
3	5	9	50	11	1
1	5	3	3	118	4

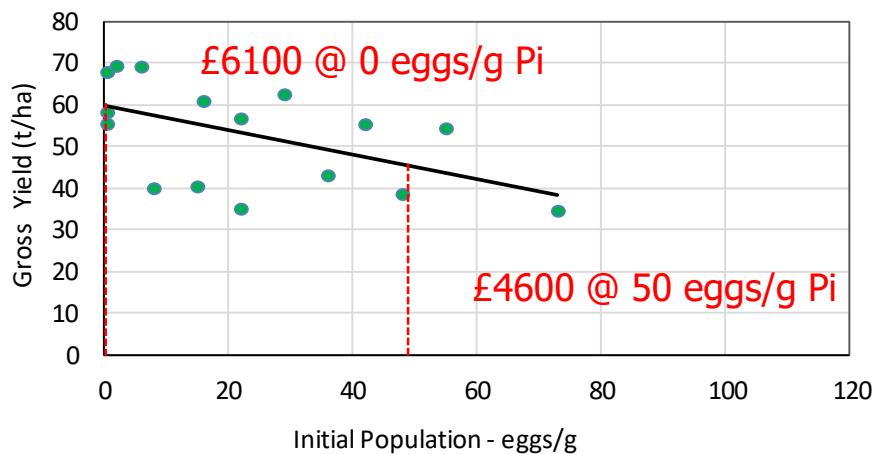
Key



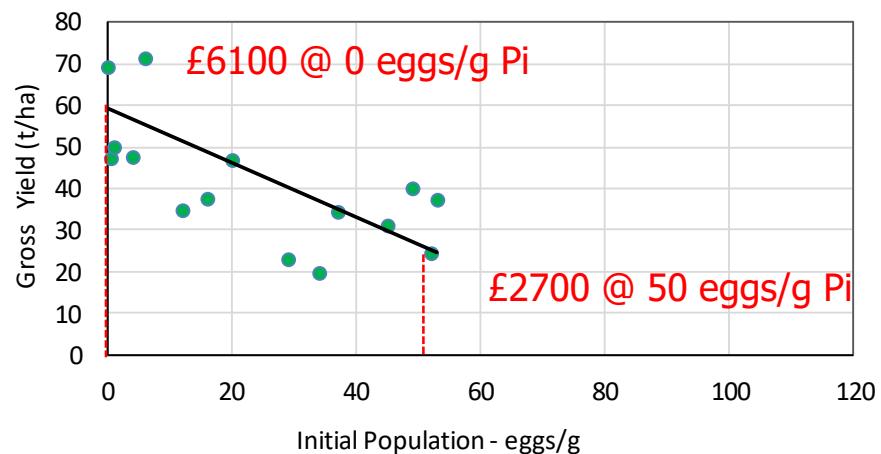
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Tolerance and Resistance Trial Financial implications PCN

Processing Tolerant



Processing Intolerant

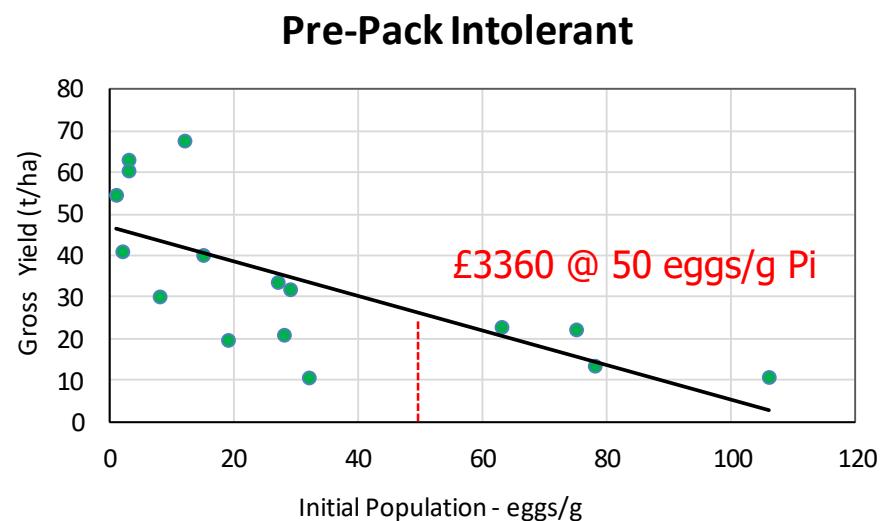
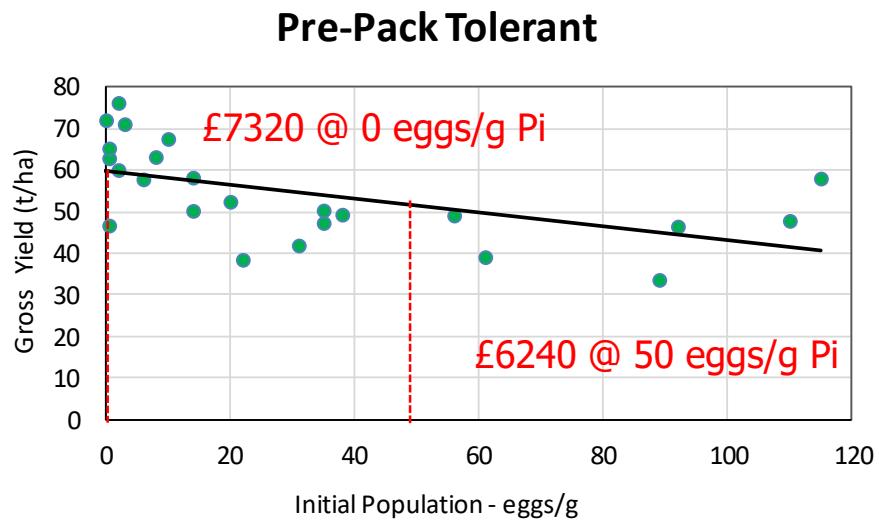


- Cost of Yield decrease
- Do not ignore MULTIPLICATION, Tolerance without resistance will significantly affect future yield

Note : income example estimating £100/T and utilising small data set from this trial

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Tolerance and Resistance Trial Financial implications PCN



- Cost of Yield decrease
- Do not ignore **MULTIPLICATION**, Tolerance without resistance will significantly affect future yield

Note : income example estimating £120/T and utilising small data set from this trial

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Tolerance and Resistance Trial

Conclusions

- Confirmation of partial *G.pallida* resistance to the population present on this site for newer varieties Alcander, Elland, Iodea, Lanorma, Marvel, Monte Carlo, Royal, Stet Clone
- Guidance of the tolerance of newer varieties in comparison to known standards
- Trial indicates the importance of speciation. – Risk of *G.rostochensis* increase with only Pa resistant varieties – Innovator/Elland.
- Indicates sensitivity of newer speciation tests - RAA

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Tolerance and Resistance Trial

Future Research

- Mitotype/Pathotype testing for *G.pallida* species for future resistance rotation planning
- Further investigation of decline rates linked to soil type/soil health/previous cropping
- Standardised testing for tolerance of new varieties – bulk box test variable but option to consider BBRO- Nottingham University live larvae injection maybe improve standardisation. Much reduced cost compared to field trials – part of IVT variety testing???

Thanks for assistance with the trial to Elveden Farms, AHDB and Richard Austin Agriculture for PCN testing/speciation