



A field trial investigating the resistance and tolerance characteristics of eleven potato varieties to *Globodera pallida* in Scotland.

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May 2023



Drone image of Barnyards trial site

* Scottishpotatoes.org is a partnership between SRUC and James Hutton Institute.



Introduction

Delivering a sustainable potato industry for Scotland through management of Potato cyst nematode (PCN) is a project managed by the Plant Health Centre with Scottish Government funding. In 2022 a field trial was established which aimed to provide information on the integrated control of *Globodera pallida* (Project Work package 7) and to provide a knowledge exchange platform branded as 'PCN Action Scotland' (Project Work package 8). An open day was conducted (16th August 2022) which was attended by over one hundred growers, agronomists, and potato breeders. At this event attendees also engaged with other work package leaders and outputs. The results of this trial were presented at a project conference (James Hutton Institute, 17th January 2023). This report brings together all the data and analysis from this trial.

Field trial

A field trial was planted at Barnyards Farm (Grid reference 488 575) on 02/05/2022 - a location with a moderate to high PCN population. The trial consisted of twelve potato varieties (11 varieties are reported here as information relating to the 12th variety was confidential to the breeder). Replicates of each variety were planted and treated with either Nemathorin 10G (30 kg/ha, a.i. Fosthiazate) or left untreated. All inputs into the trial were applied by the host grower and followed standard practice for ware crops in the region. The trial was flailed on 01/09/2022 and treated with Spotlight plus (1.0 l/ha) on 06/09/2022 before harvest on 24/09/2022.

Varieties

Details of the varieties including breeder, parentage, maturity, and the seed spacing used in this trial are given in Table 1. The variety characteristics, including resistance to both forms of PCN, which have been taken from multiple sources including the AHDB potatoes potato variety database and information held by breeders themselves is given in Table 2.

Cara, Innovator, Maris Peer, and Elland were included as examples of susceptibility to *G. pallida* as tolerant; resistant and intolerant, susceptible, and intolerant; resistant and tolerant varieties, respectively.

Table 1: Trial varieties, breeder, parentage, maturity, and seed tube spacing used.

Variety	Breeder	Parentage	Maturity	Seed spacing
Cara	IPM	Ulster Glade x A25/19	Late maincrop	30 cm
Maris Peer	PBI Cambridge	120/13 x Ulster Knight	Second early	31 cm
Elland	Cygnet	Golden Millenium x Innovator	Early maincrop	38 cm
Innovator	HZPC	Shepody x RZ-84-2580	Second early	41 cm
Eurostar	Stet	Victoria x Innovator	Main crop	50 cm
Buster	IPM	Innovator x ET5838/8	Late Maincrop	31 cm
Amanda	Solana	Epoka x SV66 123	Medium early	33 cm
Karelia	Europlant (Greenvale)	III 61659230 x Wentow 58 7 49	Medium early	35 cm
Cinderella	Cygnet	Crisps4all x 12601 AB1	Early	50 cm
Lanorma	Branston	Bydand x Caesar	Early maincrop	32 cm
Tyson	Stet	Sylvana x Cyrano	Maincrop	25 cm

Table 2: Pest and disease resistance of varieties (Data from range of sources)

Variety	Disease/Pest resistance (scale 1 [highly susceptible]- 9 [fully resistant])				
	<i>G. rostochiensis</i>	<i>G. pallida</i>	Powdery scab	Blackleg	Common scab
Cara	R	2	3	6	7
Maris Peer	2	2	6	4	5
Elland	3	9	4	6	6
Innovator	2	8	7	5	6
Eurostar	9	9	4	4	5
Buster	9	9	4	6	7
Amanda	R	8	7	6	7
Karelia	8	8		High	High - Very High
Cinderella	R	6	7	-	(6)
Lanorma	9	5	4	4	7
Tyson	1	4	Slightly susceptible	-	6

- No data available

Assessments

Assessments were made before planting, during emergence and ground cover development, at harvest, and post-harvest.

Initial PCN population (Pi) at planting: Soil (500g) was sampled from each individual plot before planting. These were assessed by the SRUC crop clinic to determine the number of cysts and eggs present and expressed as number of viable cysts and eggs per gram of soil.

Crop emergence: The emergence of each plot was assessed on 30/05/22, 07/06/2022, and 15/06/2022 and expressed as the number of plants per 6m of drill.

Potato foliage groundcover: The ground cover in each plot was assessed visually on 07/06/2022, 15/06/2022, 22/06/2022, 30/06/2022, 08/07/2022, and 25/07/2022 and expressed as a percentage.

Number of plants and stems: After haulm destruction a count was taken of the number of plants and stems present in 3m drill lengths of each plot. The results were expressed as number of plants and stems per 3m length.

Dry matter and specific gravity: This was assessed by hygrometer for tuber samples from each plot and results were expressed as a percentage dry matter and relative density.

Post harvest PCN population (Pf): Soil (500g) was sampled from each individual plot after harvest. These samples were assessed by SRUC crop clinic to determine the number of cysts and eggs present and expressed as number of viable cysts and eggs per gram of soil.

Tuber yield and number: The central two drills of each plot were harvested. The harvested tubers were graded into different size fractions (<25mm, 25-30mm, 30-35mm, 35-40mm, 40-45mm, 45-50mm, 50-55mm, 55-60mm, 60-65mm, 65-70mm, 70-75mm, 75-80mm, 80-85mm, and >85mm) using a 'smartgrader' with the yield and tuber number in each size fraction determined. Results were expressed as tonnes/ha and tubers per ha. Total yield and tuber number was determined.

Internal defects (Rots, Spraing, Hollow heart and Internal rust spot): fifty tuber samples were sliced to record the frequency of internal defects by Scottish Agronomy. Results are expressed as percentage of tubers with internal disease present.

Tuber skin finish and surface disease: Samples of fifty tubers were retained in an ambient store and assessed in early December 2022. The tubers were washed and assessed for the presence of common scab (*Streptomyces scabies* spp.), powdery scab (*Spongospora subterranea*), black scurf (*Rhizoctonia solani*), Silver scurf (*Helminthosporium solani*) and black dot (*Colletotrichum coccodes*). Results are expressed as the percentage of tubers with infection (% incidence) and the average severity scores (scale of 0-3).

PCN Action Scotland open day, Barnyards - 16th August 2022



Results

Crop emergence and ground cover

Table 3: Crop emergence and ground cover at a range of dates during early and mid-growing season

Emergence and Ground Cover by Variety																		
Treatment	Emergence						Ground Cover											
	30/05/2022		07/06/2022		15/06/2022		07/06/2022		15/06/2022		22/06/2022		30/06/2022		08/07/2022		25/07/2022	
	N ^o /6m		N ^o /6m		N ^o /6m		%		%		%		%		%		%	
Cara	5.1	cd	17.6	b	17.5	bc	10.0	b	20.6	a	33.8	a	68.1	a	93.8	a	100.0	a
Maris Peer	7.8	ab	17.6	b	17.9	b	6.9	c	13.3	bc	21.3	cde	36.3	d	66.9	d	98.8	a
Elland	1.1	fg	12.1	d	13.9	g	3.0	de	7.1	ef	12.3	fg	23.1	e	41.3	e	81.9	bc
Innovator	5.3	cd	12.6	d	13.0	h	6.9	c	13.8	bc	20.9	de	45.6	c	68.8	cd	85.0	b
Eurostar	0.4	g	10.6	e	11.0	i	4.0	d	8.3	de	14.9	f	33.8	d	67.5	cd	100.0	a
Buster	0.3	g	10.0	e	17.0	d	1.5	e	5.0	f	9.8	g	21.9	e	39.4	e	76.9	c
Amanda	9.3	a	17.0	b	17.1	cd	8.1	bc	14.9	b	24.4	bc	50.6	bc	83.1	b	99.4	a
Karelia	3.5	de	15.0	c	15.0	f	6.3	c	11.0	cd	19.4	e	36.9	d	66.3	d	94.4	a
Cinderella	6.5	bc	9.5	e	9.5	j	13.1	a	15.5	b	25.6	b	48.8	c	75.0	c	97.5	a
Lanorma	0.1	g	14.4	c	15.0	f	4.0	d	14.6	b	26.3	b	62.5	a	91.3	a	100.0	a
Tyson	2.0	efg	20.9	a	21.0	a	7.5	c	14.1	b	23.1	bcd	55.6	b	88.1	ab	100.0	a
LSD P=.05	2.11		1.25		0.48		1.91		3.03		3.50		5.63		7.90		6.47	
Standard Deviation	2.11		1.26		0.48		1.91		3.04		3.51		5.65		7.92		6.48	
CV	57.30		8.79		3.16		30.52		25.06		17.16		12.99		11.19		6.88	
Emergence and Ground Cover by Treatment																		
Treatment	Emergence						Ground Cover											
	30/05/2022		07/06/2022		15/06/2022		07/06/2022		15/06/2022		22/06/2022		30/06/2022		08/07/2022		25/07/2022	
	N ^o /6m		N ^o /6m		N ^o /6m		%		%		%		%		%		%	
Untreated	2.9	b	13.9	b	15.4	a	5.3	b	11.6	a	18.3	b	39.9	b	63.2	b	90.5	b
30kg/ha Nemathorin	4.5	a	14.7	a	15.2	a	7.2	a	12.6	a	22.6	a	47.1	a	78.2	a	98.0	a
LSD P=.05	0.86		0.51		0.20		0.78		1.24		1.43		2.30		3.22		2.64	
Standard Deviation	2.11		1.26		0.48		1.91		3.04		3.51		5.65		7.92		6.48	
CV	57.30		8.79		3.16		30.52		25.06		17.16		12.99		11.19		6.88	
Emergence and Ground Cover by Variety and Treatment																		
Treatment	Emergence						Ground Cover											
	30/05/2022		07/06/2022		15/06/2022		07/06/2022		15/06/2022		22/06/2022		30/06/2022		08/07/2022		25/07/2022	
	N ^o /6m		N ^o /6m		N ^o /6m		%		%		%		%		%		%	
Cara Untreated	2.3	f-i	17.8	b	17.5	cde	8.8	cde	20.0	ab	31.3	b	65.0	ab	88.8	ab	100.0	a
Cara Treated	8.0	abc	17.5	b	17.5	cde	11.3	abc	21.3	a	36.3	a	71.3	a	98.8	a	100.0	a
Maris Peer Untreated	7.8	abc	17.3	bc	17.8	cd	6.3	efg	13.5	cd	18.8	efg	32.5	ijk	57.5	fgh	97.5	ab
Maris Peer Treated	7.8	abc	18.0	b	18.0	c	7.5	def	13.0	cde	23.8	d	40.0	f-i	76.3	cd	100.0	a
Elland Untreated	0.5	hi	11.5	fg	14.0	h	2.5	hi	6.3	gh	11.0	jk	20.0	l	33.8	j	72.5	c
Elland Treated	1.8	ghi	12.8	ef	13.8	h	3.5	hi	8.0	fgh	13.5	hij	26.3	kl	48.8	hi	91.3	ab
Innovator Untreated	4.5	d-g	13.0	ef	13.0	i	5.0	fgh	14.0	cd	16.8	fgh	41.3	fgh	61.3	fg	73.8	c
Innovator Treated	6.0	b-e	12.3	fg	13.0	i	8.8	cde	13.5	cd	25.0	cd	50.0	cde	76.3	cd	96.3	ab
Eurostar Untreated	0.0	i	10.5	gh	11.0	j	3.5	hi	8.5	fgh	13.5	hij	31.3	jk	62.5	efg	100.0	a
Eurostar Treated	0.8	hi	10.8	gh	11.0	j	4.5	gh	8.0	fgh	16.3	ghi	36.3	g-j	72.5	de	100.0	a
Buster Untreated	0.0	i	8.0	i	17.0	e	1.5	i	4.5	h	8.5	k	21.3	l	35.0	j	65.0	c
Buster Treated	0.5	hi	12.0	fg	17.0	e	1.5	i	5.5	gh	11.0	jk	22.5	l	43.8	ij	88.8	b
Amanda Untreated	10.0	a	17.0	bc	17.3	de	7.5	def	14.8	cd	23.8	d	45.0	def	77.5	cd	98.8	a
Amanda Treated	8.5	ab	17.0	bc	17.0	e	8.8	cde	15.0	cd	25.0	cd	56.3	c	88.8	ab	100.0	a
Karelia Untreated	1.5	hi	15.0	d	15.0	g	5.0	fgh	11.0	def	17.5	fgh	31.3	jk	56.3	fgh	88.8	b
Karelia Treated	5.5	cde	15.0	d	15.0	g	7.5	def	11.0	def	21.3	def	42.5	efg	76.3	cd	100.0	a
Cinderella Untreated	6.0	b-e	9.5	hi	9.5	k	12.5	ab	14.8	cd	22.5	de	45.0	def	63.8	ef	95.0	ab
Cinderella Treated	7.0	bcd	9.5	hi	9.5	k	13.8	a	16.3	bc	28.8	bc	52.5	cd	86.3	bc	100.0	a
Lanorma Untreated	0.3	i	14.3	de	15.0	g	3.5	hi	13.0	cde	23.8	d	57.5	bc	85.0	bc	100.0	a
Lanorma Treated	0.0	i	14.5	de	15.0	g	4.5	gh	16.3	bc	28.8	bc	67.5	a	97.5	a	100.0	a
Tyson Untreated	0.8	hi	20.5	a	22.3	a	5.0	fgh	13.5	cd	21.3	def	55.0	c	85.0	bc	100.0	a
Tyson Treated	3.3	e-h	21.3	a	19.8	b	10.0	bcd	14.8	cd	25.0	cd	56.3	c	91.3	ab	100.0	a
LSD P=.05	2.98		1.77		0.68		2.70		4.29		4.95		7.97		11.17		9.14	
Standard Deviation	2.11		1.26		0.48		1.91		3.04		3.51		5.65		7.92		6.48	
CV	57.30		8.79		3.16		30.52		25.06		17.16		12.99		11.19		6.88	

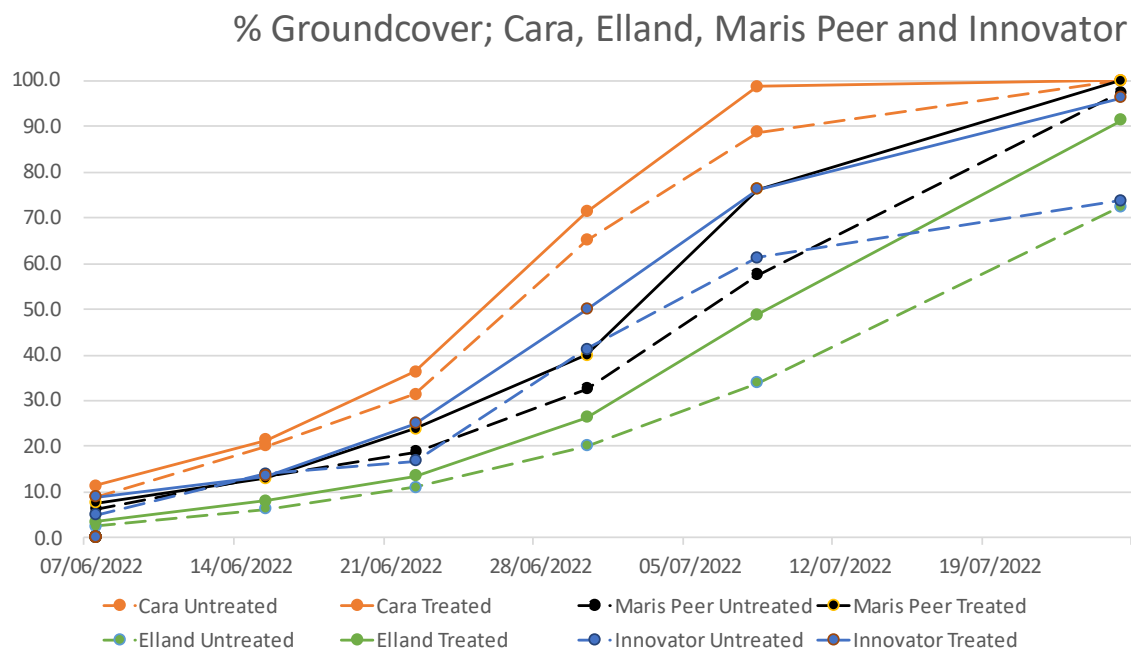


Figure 1 - Sequential assessment of percentage ground cover for four contrasting varieties

Significant differences in the emergence of different varieties were observed, as might be expected. Overall, Nemathorin treatment resulted in a significantly increased overall emergence when compared to untreated reps. Although the effect was small, there were no significant differences observed between the emergence of individual varieties in response to Nemathorin treatment (Table 3). The early growth of potatoes is mostly reliant upon reserves present within the mother tuber and at this early growth stage is generally unaffected by the presence of PCN.

Later observations of ground cover development were found to vary between varieties and in response to the application of Nemathorin (Figure 1). In each case (where a significant effect was observed) the application of Nemathorin improved development of ground cover. The only variety where there was not a significant positive effect of Nemathorin application at any of the assessments was Eurostar.

Number of plants, stems, rots, Dry matter, and specific gravity

The number of plants in each plot was a factor of the initial planting rate with the number of stems in each 3 m of drill length being dependent upon the planting density and the characteristics of the variety (Table 4). Significant differences were noted between varieties and in developing variety-specific agronomy recommendations these differences should be considered. There was no significant effect of Nemathorin application on the number of plants or in stem numbers.

Table 4: Number of plants and stems at the end of the season, dry matter, and specific gravity.

Number of plants, stems, rots, dry matter (%) and density by vareity												
Treatment	Plants		Stems		Rots		Rots		DM		Density	
	24/09/2022		24/09/2022		24/09/2022		14/10/2022		28/10/2022		28/10/2022	
	/3m		/3m		/3m		/3m		%		1.065-1.110	
Cara	9.8	b	53.8	a	0.0	c	0.0	b	17.1	e	1.066	e
Maris Peer	9.6	bc	37.1	c	0.0	c	0.0	b	19.0	c	1.076	bc
Elland	7.5	ef	22.6	fg	2.4	a	0.4	b	17.0	e	1.066	e
Innovator	7.3	f	33.9	cd	0.0	c	0.0	b	18.0	d	1.071	d
Eurostar	5.9	g	19.4	g	0.8	bc	1.3	ab	17.0	e	1.066	e
Buster	9.0	cd	23.8	fg	0.0	c	0.3	b	17.0	e	1.065	e
Amanda	9.0	cd	46.4	b	0.0	c	0.0	b	19.3	b	1.077	b
Karelia	8.1	e	31.3	de	0.0	c	0.0	b	17.0	e	1.065	e
Cinderella	6.5	g	54.0	a	1.6	ab	2.3	a	21.6	a	1.088	a
Lanorma	8.1	e	44.3	b	0.6	bc	0.4	b	17.0	e	1.065	e
Tyson	10.9	a	26.1	ef	1.3	abc	0.1	b	18.0	d	1.071	d
LSD P=.05		0.68		5.62		1.26		1.53		0.33		0.002
Standard Deviation		0.68		5.63		1.27		1.54		0.33		0.002
CV		8.10		16.14		221.02		398.85		1.84		0.169
Number of plants, stems, rots, dry matter (%) and density by treatment												
Treatment	Plants		Stems		Rots		Rots		DM		Density	
	24/09/2022		24/09/2022		24/09/2022		14/10/2022		28/10/2022		28/10/2022	
	/3m		/3m		/3m		/3m		%		1.065-1.110	
Untreated	8.5	a	35.4	a	0.5	a	0.3	a	18.2	a	1.071	a
30kg/ha Nemathorin	8.3	a	34.4	a	0.6	a	0.5	a	18.0	b	1.070	b
LSD P=.05		0.28		2.29		0.52		0.63		0.14		0.001
Standard Deviation		0.68		5.63		1.27		1.54		0.33		0.002
CV		8.10		16.14		221.02		398.85		1.84		0.169
Number of plants, stems, rots, dry matter (%) and density by vareity and treatment												
Treatment	Plants		Stems		Rots		Rots		DM		Density	
	24/09/2022		24/09/2022		24/09/2022		14/10/2022		28/10/2022		28/10/2022	
	/3m		/3m		/3m		/3m		%		1.065-1.110	
Cara Untreated	9.8	b	57.8	a	0.0	d	0.0	b	17.3	g	1.066	h
Cara Treated	9.8	b	49.8	bc	0.0	d	0.0	b	17.0	g	1.066	h
Maris Peer Untreated	9.5	bc	36.8	efg	0.0	d	0.0	b	19.2	cd	1.077	cd
Maris Peer Treated	9.8	b	37.5	def	0.0	d	0.0	b	18.8	de	1.075	def
Elland Untreated	7.8	fgh	24.0	kl	2.0	abc	0.3	b	17.0	g	1.066	h
Elland Treated	7.3	gh	21.3	l	2.8	ab	0.5	b	17.0	g	1.066	h
Innovator Untreated	7.5	fgh	34.0	fgh	0.0	d	0.0	b	18.0	f	1.071	g
Innovator Treated	7.0	h	33.8	f-i	0.0	d	0.0	b	18.0	f	1.071	g
Eurostar Untreated	6.0	i	20.3	l	1.0	bcd	1.8	ab	17.1	g	1.066	h
Eurostar Treated	5.8	i	18.5	l	0.5	cd	0.8	b	17.0	g	1.066	h
Buster Untreated	9.0	bcd	23.5	kl	0.0	d	0.0	b	17.0	g	1.065	h
Buster Treated	9.0	bcd	24.0	kl	0.0	d	0.5	b	17.0	g	1.065	h
Amanda Untreated	9.3	bc	48.0	bc	0.0	d	0.0	b	19.5	c	1.078	c
Amanda Treated	8.8	cde	44.8	cd	0.0	d	0.0	b	19.2	cd	1.076	cde
Karelia Untreated	8.0	efg	29.3	g-k	0.0	d	0.0	b	17.0	g	1.065	h
Karelia Treated	8.3	def	33.3	f-j	0.0	d	0.0	b	17.0	g	1.065	h
Cinderella Untreated	7.0	h	54.0	ab	0.0	d	1.3	ab	22.0	a	1.090	a
Cinderella Treated	6.0	i	54.0	ab	3.3	a	3.3	a	21.3	b	1.086	b
Lanorma Untreated	8.3	def	45.5	c	1.3	bcd	0.5	b	17.0	g	1.065	h
Lanorma Treated	8.0	efg	43.0	cde	0.0	d	0.3	b	17.0	g	1.065	h
Tyson Untreated	10.8	a	26.0	i-l	1.8	a-d	0.0	b	18.1	f	1.072	fg
Tyson Treated	11.0	a	26.3	h-l	0.8	cd	0.3	b	17.9	f	1.070	g
LSD P=.05		0.96		7.94		1.79		2.17		0.47		0.003
Standard Deviation		0.68		5.63		1.27		1.54		0.33		0.002
CV		8.10		16.14		221.02		398.85		1.84		0.169

A small number of rots were present at harvest. There was no overall significant effect of Nemathorin on the development of rots. However, for Cinderella alone, Nemathorin application resulted in a significantly increased number of rots (from 0 to 3.3%) at the initial assessment (24/09/2022). This small difference is not considered to be of importance.

The dry matter (and related assessment of specific gravity) was, as expected, found to vary significantly between varieties. For five varieties (Cara, Elland, Eurostar, Buster, and Lanorma) the dry matter was under 18%. This low dry matter may result in poor taste and texture characteristics of some varieties for fresh market use. However, in this trial, the somewhat high Nitrogen rate applied (210 kg/ha) uniformly across all varieties and treatments is likely to have had a detrimental effect on dry matter development and the development of variety-specific agronomy protocols should address this issue. In contrast, a high dry matter relative to other varieties for Cinderella (21.6%) might be considered too high for general pre-pack use.

A small, but significant difference in the dry matter in response to Nemathorin application (+ 0.2%) was observed.

Internal defects (Spraing, Hollow Heart, and Internal rust spot)

Spraing was observed only in the variety Cara (Table 5). Application of Nemathorin resulted in a significant reduction in the incidence of Spraing (5.0% to 2.5%).

Hollow heart and internal rust spot were both observed at trace levels only with no significant difference between varieties or in response to Nemathorin treatment.

Initial PCN population (Pi) and PCN population after harvest (Pf)

The initial population was determined for each plot and *G. pallida* was the only species detected. Variation across the site result in some significant differences between the initial population for the varieties (Table 6). The lowest Pi was recorded for the Cara (20.4 eggs/gram) and the highest for Maris Peer (43.5 eggs/gram) (Figure 2). There was however no significant difference recorded between the treated and untreated plots of any individual variety. Variation across small areas within a field trial is inevitable but this trial would appear to be more uniform than others.

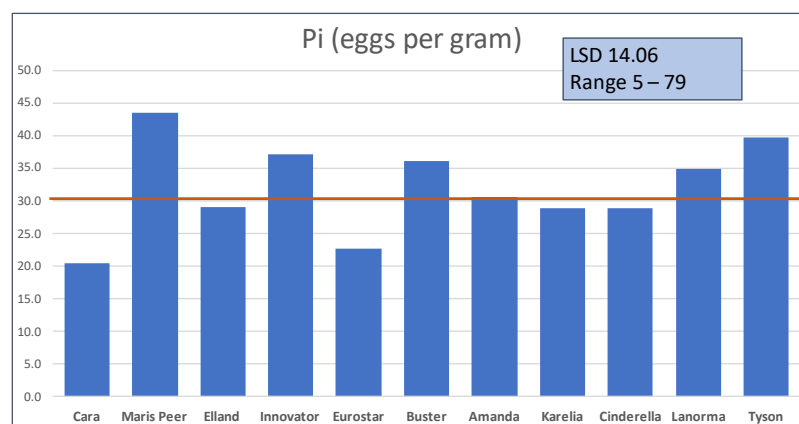


Figure 2: Average PCN population (eggs per gram) at planting for each variety (mean of treated and untreated). Orange bar – Average number of eggs per gram across varieties.

Table 5: Incidence of Spraing, Hollow heart, and Internal rust spot (IRS)

Spraing, hollow heart and Internal rust spot by Variety							
Treatment	Spraing		Hollow Heart		IRS		
	01/11/2022		01/11/2022		01/11/2022		
	%		%		%		
Cara	3.8	a	0.0	a	0.5	a	
Maris Peer	0.0	b	0.0	a	0.0	a	
Elland	0.0	b	0.3	a	0.8	a	
Innovator	0.0	b	0.0	a	0.3	a	
Eurostar	0.0	b	0.0	a	0.8	a	
Buster	0.0	b	0.3	a	0.0	a	
Amanda	0.0	b	0.0	a	0.0	a	
Karelia	0.0	b	0.0	a	0.0	a	
Cinderella	0.0	b	0.0	a	0.0	a	
Lanorma	0.0	b	0.0	a	0.5	a	
Tyson	0.0	b	0.5	a	0.3	a	
LSD P=.05		1.38		0.54		0.84	
Standard Deviation		1.39		0.54		0.84	
CV		444.07		515.23		337.08	
Spraing, hollow heart and Internal rust spot by Treatment							
Treatment	Spraing		Hollow Heart		IRS		
	01/11/2022		01/11/2022		01/11/2022		
	%		%		%		
Untreated	0.2	a	0.1	a	0.2	a	
30kg/ha Nemathorin	0.4	a	0.1	a	0.3	a	
LSD P=.05		0.57		0.22		0.34	
Standard Deviation		1.39		0.54		0.84	
CV		444.07		515.23		337.08	
Spraing, hollow heart and Internal rust spot by Variety and Treatment							
Treatment	Spraing		Hollow Heart		IRS		
	01/11/2022		01/11/2022		01/11/2022		
	%		%		%		
Cara Untreated	2.5	b	0.0	b	0.0	b	
Cara Treated	5.0	a	0.0	b	1.0	ab	
Maris Peer Untreated	0.0	c	0.0	b	0.0	b	
Maris Peer Treated	0.0	c	0.0	b	0.0	b	
Elland Untreated	0.0	c	0.0	b	0.0	b	
Elland Treated	0.0	c	0.5	ab	1.5	a	
Innovator Untreated	0.0	c	0.0	b	0.5	ab	
Innovator Treated	0.0	c	0.0	b	0.0	b	
Eurostar Untreated	0.0	c	0.0	b	0.5	ab	
Eurostar Treated	0.0	c	0.0	b	1.0	ab	
Buster Untreated	0.0	c	0.0	b	0.0	b	
Buster Treated	0.0	c	0.5	ab	0.0	b	
Amanda Untreated	0.0	c	0.0	b	0.0	b	
Amanda Treated	0.0	c	0.0	b	0.0	b	
Karelia Untreated	0.0	c	0.0	b	0.0	b	
Karelia Treated	0.0	c	0.0	b	0.0	b	
Cinderella Untreated	0.0	c	0.0	b	0.0	b	
Cinderella Treated	0.0	c	0.0	b	0.0	b	
Lanorma Untreated	0.0	c	0.0	b	0.5	ab	
Lanorma Treated	0.0	c	0.0	b	0.5	ab	
Tyson Untreated	0.0	c	1.0	a	0.5	ab	
Tyson Treated	0.0	c	0.0	b	0.0	b	
LSD P=.05		1.96		0.76		1.19	
Standard Deviation		1.39		0.54		0.84	
CV		444.07		515.23		337.08	

Table 6: Analysis of Initial PCN population (Pi) (15/05/22022) and after harvest (Pf) (27/09/2022) expressed as eggs per gram of soil and number of viable cysts.

Soil Analysis by Variety										
Treatment	Eggs/Larvae per g soil					Viable Cysts per 200 g soil				
	15/05/2022		27/09/2022		27/09/2022	15/05/2022		27/09/2022		
	Pi		Pf		Pf/Pi	Pi	Pf	Pf/Pi		
Cara	20.4	d	499.8	a	24.50	150.5	ab	1270.9	a	8.44
Maris Peer	43.5	a	309.0	b	7.10	199.6	ab	998.3	b	5.00
Elland	29.0	bcd	1.4	c	0.05	164.6	ab	20.9	de	0.13
Innovator	37.1	ab	2.9	c	0.08	194.1	ab	21.0	de	0.11
Eurostar	22.6	cd	11.9	c	0.53	143.3	b	53.5	de	0.37
Buster	36.1	abc	0.9	c	0.02	175.0	ab	7.6	e	0.04
Amanda	30.5	a-d	4.1	c	0.13	153.6	ab	34.8	de	0.23
Karelia	28.8	bcd	5.8	c	0.20	171.5	ab	30.1	de	0.18
Cinderella	28.9	bcd	68.0	c	2.35	157.5	ab	201.8	d	1.28
Lanorma	34.9	abc	290.9	b	8.34	192.9	ab	760.6	c	3.94
Tyson	39.6	ab	368.5	b	9.31	214.0	a	1004.8	b	4.70
LSD P=.05			14.06		83.38			66.58		190.78
Standard Deviation			14.09		83.59			66.75		191.27
CV			44.71		63.54			38.44		51.52
Soil Analysis by Treatment										
Treatment	Eggs/Larvae per g soil					Viable Cysts per 200 g soil				
	15/05/2022		27/09/2022		27/09/2022	15/05/2022		27/09/2022		
	Pi		Pf		Pf/Pi	Pi	Pf	Pf/Pi		
Untreated	32.1	a	141.4	a	4.40	189.0	a	400.5	a	2.12
30kg/ha Nemathorin	30.9	a	121.7	a	3.94	158.4	b	342.1	a	2.16
LSD P=.05			5.74		34.04			27.18		77.89
Standard Deviation			14.09		83.59			66.75		191.27
CV			44.71		63.54			38.44		51.52
Soil Analysis by Variety and Treatment										
Treatment	Eggs/Larvae per g soil					Viable Cysts per 200 g soil				
	15/05/2022		27/09/2022		27/09/2022	15/05/2022		27/09/2022		
	Pi		Pf		Pf/Pi	Pi	Pf	Pf/Pi		
Cara Untreated	21.3	def	527.8	a	24.78	133.3	bc	1322.8	a	9.92
Cara Treated	19.5	ef	471.8	ab	24.19	167.8	abc	1219.0	ab	7.26
Maris Peer Untreated	45.5	a	361.8	bcd	7.95	224.3	ab	1153.8	ab	5.14
Maris Peer Treated	41.5	abc	256.3	d	6.18	175.0	abc	842.8	cd	4.82
Elland Untreated	31.5	a-f	1.8	e	0.06	189.0	abc	27.8	e	0.15
Elland Treated	26.5	a-f	1.0	e	0.04	140.3	bc	14.0	e	0.10
Innovator Untreated	32.0	a-f	5.3	e	0.17	197.5	ab	29.8	e	0.15
Innovator Treated	42.3	ab	0.5	e	0.01	190.8	abc	12.3	e	0.06
Eurostar Untreated	27.0	a-f	16.8	e	0.62	185.5	abc	66.5	e	0.36
Eurostar Treated	18.3	f	7.0	e	0.38	101.0	c	40.5	e	0.40
Buster Untreated	34.5	a-f	1.8	e	0.05	167.5	abc	10.3	e	0.06
Buster Treated	37.8	a-f	0.0	e	0.00	182.5	abc	5.0	e	0.03
Amanda Untreated	27.0	a-f	5.5	e	0.20	155.3	bc	25.0	e	0.16
Amanda Treated	34.0	a-f	2.8	e	0.08	152.0	bc	44.5	e	0.29
Karelia Untreated	35.8	a-f	7.3	e	0.20	207.8	ab	35.8	e	0.17
Karelia Treated	21.8	c-f	4.3	e	0.20	135.3	bc	24.5	e	0.18
Cinderella Untreated	25.5	b-f	86.8	e	3.40	158.8	abc	242.5	e	1.53
Cinderella Treated	32.3	a-f	49.3	e	1.53	156.3	abc	161.0	e	1.03
Lanorma Untreated	39.0	a-e	321.8	cd	8.25	204.5	ab	842.8	cd	4.12
Lanorma Treated	30.8	a-f	260.0	d	8.44	181.3	abc	678.5	d	3.74
Tyson Untreated	39.3	a-e	344.0	cd	8.75	249.5	a	987.8	bc	3.96
Tyson Treated	40.0	a-d	393.0	bc	9.83	178.5	abc	1021.8	bc	5.72
LSD P=.05			19.88		117.92			94.16		269.81
Standard Deviation			14.09		83.59			66.75		191.27
CV			44.71		63.54			38.44		51.52

The population detected after growing (post-harvest sample) can be analysed as a standalone dataset or interpreted as a ratio between the initial population and the population after harvest (the Pi/Pf ratio) (Table 6).

Pf values for the highly resistant varieties (Elland, Innovator, Eurostar, Buster, Amanda, and Karelia) did not differ significantly from one another and ranged from 0.9 to 11.9 eggs per gram. This can be compared with a Pi of 31.5 eggs per gram (Figure 3). The partially resistant variety Cinderella (resistance score of 6) can also be included, statistically, in this group. However, the Pf was 68 eggs per gram representing an apparent increase from the Pi value.

Maris Peer, Lanorma, and Tyson (resistance scores of 2, 5, and 4 respectively) can be grouped together and all had significantly higher Pf values than the former group of resistant varieties with Pf values ranging from 290 – 309 eggs per gram. The Pf value for Cara, a highly susceptible and tolerant variety, was significantly higher than all other varieties in this trial at 500 eggs per gram.

There was no significant effect of Nemathorin on the Pf values either overall or for different individual varieties (with the single exception of Maris Peer).

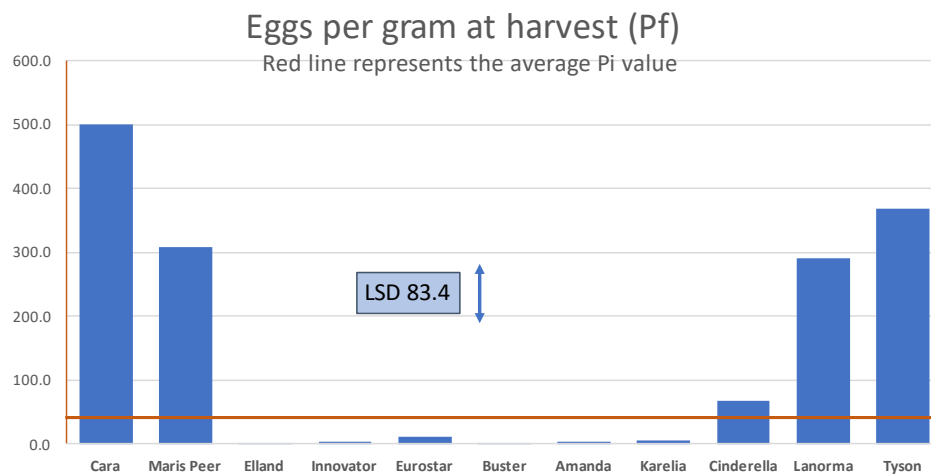


Figure 3: Pf (eggs per gram) values for all varieties (average of treated and untreated plots). Orange bar – average number of eggs per gram of soil. LSD – least significant difference.

Yield and tuber numbers

Tables 7a and 7b give the total yield (tonnes per ha) and yield in 5mm size fractions. The total yield data is summarised in Figure 4. The variety maturity characteristics differ, and this has affected the yield potential. For example, Cara, a late maincrop variety, yielded only 37.4 t/ha (treated). However earlier varieties (e.g., Maris Peer (Second early) and Lanorma (early Maincrop)) produced greater (treated) yields (53.4 t/ha and 67.1 t/ha respectively). With a longer growing season and appropriate fertiliser applications the yield of later maturing varieties could have been expected to increase.

The main interest in these results lies in the differences between the yield of untreated and treated plots as this provides a measure of the tolerance to PCN (Figure 4).

Table 7a: Total yield (in tonnes per ha) and yield in size fractions between 25mm and 55mm

Yield by Variety																
Treatment	Yield Total T/Ha		Yield <25mm T/Ha		Yield 25-30mm T/Ha		Yield 30-35mm T/Ha		Yield 35-40mm T/Ha		Yield 40-45mm T/Ha		Yield 45-50mm T/Ha		Yield 50-55mm T/Ha	
Cara	36.99	f	0.09	abc	0.17	bc	0.68	b	1.39	bc	2.82	b	4.25	c	6.02	b
Maris Peer	46.20	de	0.11	a	0.46	a	1.14	a	2.17	a	4.02	a	7.15	a	8.13	a
Elland	52.11	bc	0.06	cde	0.15	bc	0.35	cde	0.77	def	1.32	def	2.50	d	3.21	cd
Innovator	50.23	cd	0.02	ef	0.10	bcd	0.17	def	0.35	fg	0.59	fg	1.03	ef	2.50	de
Eurostar	43.55	e	0.01	f	0.06	cd	0.09	ef	0.19	g	0.60	efg	1.08	ef	2.44	de
Buster	52.72	bc	0.01	f	0.06	cd	0.16	def	0.38	fg	0.62	efg	1.20	ef	1.41	e
Amanda	56.36	b	0.07	a-d	0.20	b	0.52	bc	1.20	bcd	2.67	bc	5.81	b	8.64	a
Karelia	63.04	a	0.01	f	0.03	d	0.07	f	0.16	g	0.28	g	0.82	f	2.51	de
Cinderella	44.45	e	0.06	b-e	0.18	bc	0.53	bc	1.69	ab	3.12	b	6.47	ab	9.35	a
Lanorma	65.31	a	0.06	b-e	0.20	b	0.40	bcd	0.60	efg	1.47	d	2.21	de	3.50	cd
Tyson	54.00	bc	0.10	ab	0.19	b	0.49	bc	1.13	cde	1.86	cd	3.08	cd	6.15	b
LSD P=.05	5.27		0.04		0.12		0.28		0.55		0.83		1.24		1.35	
Standard Deviation	5.28		0.04		0.12		0.28		0.55		0.83		1.24		1.36	
CV	10.21		82.30		74.21		69.97		61.46		47.89		39.08		28.15	
Yield by Treatment																
Treatment	Yield Total T/Ha		Yield <25mm T/Ha		Yield 25-30mm T/Ha		Yield 30-35mm T/Ha		Yield 35-40mm T/Ha		Yield 40-45mm T/Ha		Yield 45-50mm T/Ha		Yield 50-55mm T/Ha	
Untreated	47.87	b	0.07	a	0.17	a	0.47	a	0.96	a	2.02	a	3.49	a	4.71	a
30kg/ha Nemathorin	55.55	a	0.04	b	0.16	a	0.34	b	0.82	a	1.44	b	2.86	b	4.94	a
LSD P=.05	2.15		0.02		0.05		0.12		0.22		0.34		0.51		0.55	
Standard Deviation	5.28		0.04		0.12		0.28		0.55		0.83		1.24		1.36	
CV	10.21		82.30		74.21		69.97		61.46		47.89		39.08		28.15	
Yield by Variety and Treatment																
Treatment	Yield Total T/Ha		Yield <25mm T/Ha		Yield 25-30mm T/Ha		Yield 30-35mm T/Ha		Yield 35-40mm T/Ha		Yield 40-45mm T/Ha		Yield 45-50mm T/Ha		Yield 50-55mm T/Ha	
Cara Untreated	36.56	k	0.11	ab	0.18	b-g	0.69	b	1.45	bc	3.23	bc	4.88	cde	6.66	cde
Cara Treated	37.43	k	0.06	b-f	0.15	b-g	0.67	b	1.33	b-e	2.40	cde	3.63	efg	5.39	efg
Maris Peer Untreated	38.98	jk	0.17	a	0.70	a	1.79	a	2.95	a	4.84	a	8.29	a	8.12	a-d
Maris Peer Treated	53.42	e-h	0.05	c-f	0.22	bcd	0.50	b-e	1.39	bcd	3.21	bc	6.01	bc	8.15	abc
Elland Untreated	50.08	ghi	0.06	b-e	0.12	b-g	0.31	b-f	0.73	c-g	1.27	e-k	2.69	f-i	2.70	h-l
Elland Treated	54.14	e-h	0.06	b-f	0.18	b-g	0.40	b-f	0.80	c-g	1.37	e-j	2.32	f-j	3.72	g-j
Innovator Untreated	47.52	hi	0.03	def	0.05	d-g	0.10	ef	0.22	g	0.57	ijk	0.99	ij	1.50	kl
Innovator Treated	52.93	e-i	0.02	def	0.16	b-g	0.25	c-f	0.48	fg	0.61	ijk	1.08	ij	3.51	g-j
Eurostar Untreated	38.35	k	0.00	f	0.08	c-g	0.11	def	0.23	g	0.77	h-k	1.17	hij	2.56	h-l
Eurostar Treated	48.75	ghi	0.01	ef	0.05	d-g	0.07	f	0.14	g	0.44	jk	0.99	ij	2.31	h-l
Buster Untreated	45.94	ij	0.03	def	0.09	b-g	0.19	c-f	0.45	fg	0.69	h-k	1.71	hij	1.92	jkl
Buster Treated	59.50	b-e	0.00	f	0.03	fg	0.14	def	0.30	g	0.55	ijk	0.69	j	0.89	l
Amanda Untreated	50.16	ghi	0.06	b-f	0.14	b-g	0.70	b	1.18	b-f	2.91	bcd	5.50	cd	8.07	bcd
Amanda Treated	62.57	a-d	0.08	bcd	0.26	b	0.35	b-f	1.22	b-f	2.43	cde	6.11	bc	9.22	ab
Karelia Untreated	60.05	a-e	0.01	ef	0.04	efg	0.06	f	0.21	g	0.41	jk	1.04	ij	2.94	h-k
Karelia Treated	66.04	ab	0.02	def	0.01	g	0.08	f	0.11	g	0.15	k	0.61	j	2.08	i-l
Cinderella Untreated	38.02	k	0.09	bc	0.13	b-g	0.51	bcd	1.69	b	3.91	ab	7.34	ab	8.67	ab
Cinderella Treated	50.89	f-i	0.04	c-f	0.23	bc	0.55	bc	1.69	b	2.33	c-f	5.61	bcd	10.02	a
Lanorma Untreated	63.56	abc	0.06	b-f	0.22	bcd	0.32	b-f	0.63	d-g	1.78	d-h	2.15	g-j	3.46	hij
Lanorma Treated	67.06	a	0.06	b-e	0.19	b-f	0.49	b-e	0.56	efg	1.16	g-k	2.26	f-j	3.53	g-j
Tyson Untreated	49.92	ghi	0.15	a	0.21	b-e	0.69	b	1.17	b-f	2.25	c-g	4.01	def	6.08	ef
Tyson Treated	58.07	c-f	0.06	b-f	0.18	b-g	0.30	b-f	1.10	b-f	1.48	e-j	2.15	g-j	6.23	de
LSD P=.05	7.45		0.06		0.17		0.40		0.77		1.17		1.75		1.92	
Standard Deviation	5.28		0.04		0.12		0.28		0.55		0.83		1.24		1.36	
CV	10.21		82.30		74.21		69.97		61.46		47.89		39.08		28.15	

Table 7b: Yield (tonnes per ha) in marketable fraction (45-65mm and 65-85mm) and in size fractions from 55mm to >85mm

Yield by Variety																		
Treatment	Yield 55-60mm T/Ha		Yield 60-65mm T/Ha		Yield 65-70mm T/Ha		Yield 70-75mm T/Ha		Yield 75-80mm T/Ha		Yield 80-85mm T/Ha		Yield >85mm T/Ha		Yield 45-65mm T/Ha		Yield >65mm T/Ha	
Cara	6.70	de	5.98	ef	4.99	ef	3.18	e	0.59	g	0.16	d	0	d	22.95	def	8.91	de
Maris Peer	9.00	bc	6.77	def	4.59	ef	2.37	e	0.29	g	0.00	d	0	d	31.05	bc	7.25	de
Elland	6.21	de	7.84	cde	11.20	abc	7.40	d	6.24	de	2.88	bc	1.981	bc	19.75	fg	29.71	b
Innovator	4.81	ef	8.61	bcd	10.22	bcd	7.92	d	8.33	bcd	2.30	bcd	3.268	ab	16.95	g	32.04	b
Eurostar	3.79	f	4.47	f	8.20	cd	8.73	cd	7.50	cd	4.56	ab	1.83	bcd	11.79	h	30.82	b
Buster	3.75	f	5.03	f	9.13	cd	12.19	ab	8.93	abc	5.77	a	4.08	a	11.39	h	40.10	a
Amanda	12.22	a	11.82	a	7.31	de	3.85	e	1.55	fg	0.51	d	0.00	d	38.49	a	13.22	d
Karelia	5.70	def	10.40	abc	13.95	a	14.30	a	10.39	ab	3.19	bc	1.24	cd	19.43	fg	43.07	a
Cinderella	10.43	ab	6.92	def	3.83	f	1.72	e	0.15	g	0.00	d	0.00	d	33.18	b	5.70	e
Lanorma	6.14	de	9.16	bcd	13.30	ab	11.33	bc	11.27	a	3.40	bc	2.28	abc	21.00	efg	41.58	a
Tyson	8.93	bc	9.00	bcd	8.86	cd	7.30	d	3.73	ef	1.93	cd	1.24	cd	27.16	cd	23.05	c
LSD P=.05		2.08		2.62		3.19		2.73		2.68		2.35		1.90		4.24		6.43
Standard Deviation		2.09		2.63		3.19		2.74		2.69		2.36		1.90		4.25		6.45
CV		29.50		32.51		35.48		36.73		51.61		107.70		131.73		18.36		25.47
Yield by Treatment																		
Treatment	Yield 55-60mm T/Ha		Yield 60-65mm T/Ha		Yield 65-70mm T/Ha		Yield 70-75mm T/Ha		Yield 75-80mm T/Ha		Yield 80-85mm T/Ha		Yield >85mm T/Ha		Yield 45-65mm T/Ha		Yield >65mm T/Ha	
Untreated	6.74	a	7.60	a	7.38	b	6.76	b	4.89	a	1.56	b	1.034	b	22.54	a	21.63	b
30kg/ha Nemathorin	7.42	a	8.55	a	10.63	a	8.16	a	5.52	a	2.82	a	1.855	a	23.77	a	28.99	a
LSD P=.05		0.85		1.07		1.30		1.12		1.09		0.96		0.77		1.73		2.62
Standard Deviation		2.09		2.63		3.19		2.74		2.69		2.36		1.90		4.25		6.45
CV		29.50		32.51		35.48		36.73		51.61		107.70		131.73		18.36		25.47
Yield by Variety and Treatment																		
Treatment	Yield 55-60mm T/Ha		Yield 60-65mm T/Ha		Yield 65-70mm T/Ha		Yield 70-75mm T/Ha		Yield 75-80mm T/Ha		Yield 80-85mm T/Ha		Yield >85mm T/Ha		Yield 45-65mm T/Ha		Yield >65mm T/Ha	
Cara Untreated	6.52	e-i	5.64	d-g	4.32	h-k	2.60	klm	0.29	jk	0.00	g	0	e	23.68	d-g	7.22	klm
Cara Treated	6.88	e-h	6.33	c-g	5.66	g-j	3.75	i-m	0.88	ijk	0.32	fg	0	e	22.22	d-g	10.60	jkl
Maris Peer Untreated	6.91	e-h	3.43	g	1.79	jk	0.00	m	0.00	k	0.00	g	0	e	26.74	cde	1.79	lm
Maris Peer Treated	11.09	bc	10.11	ab	7.40	e-i	4.73	h-l	0.58	jk	0.00	g	0	e	35.36	ab	12.71	ijk
Elland Untreated	5.04	g-k	5.75	d-g	9.95	b-g	8.24	d-h	7.79	b-e	2.62	b-g	2.82	bcd	16.17	h-l	31.42	def
Elland Treated	7.38	d-g	9.93	abc	12.46	a-d	6.57	f-j	4.70	e-h	3.13	b-g	1.14	b-e	23.33	d-g	28.01	fg
Innovator Untreated	3.59	ijk	8.54	b-f	8.43	d-h	9.98	b-g	8.12	b-e	1.96	d-g	3.48	b	14.61	i-m	31.97	def
Innovator Treated	6.04	f-k	8.67	b-e	12.01	a-d	5.86	h-k	8.55	a-d	2.64	b-g	3.06	bcd	19.30	f-j	32.12	def
Eurostar Untreated	4.20	h-k	4.90	fg	7.07	e-i	7.35	e-i	5.98	d-g	3.46	b-f	0.47	de	12.84	klm	24.32	fgh
Eurostar Treated	3.39	jk	4.05	g	9.32	c-g	10.12	b-f	9.03	a-d	5.66	ab	3.19	bc	10.74	lm	37.32	cde
Buster Untreated	4.27	h-k	5.44	d-g	8.90	d-g	10.77	b-e	6.35	c-f	3.66	b-e	1.47	b-e	13.34	j-m	31.15	def
Buster Treated	3.23	k	4.63	g	9.36	c-g	13.61	ab	11.51	ab	7.89	a	6.69	a	9.43	m	49.06	a
Amanda Untreated	14.24	a	10.82	ab	3.18	ijk	1.46	lm	1.91	h-k	0.00	g	0	e	38.63	a	6.55	klm
Amanda Treated	10.21	bcd	12.82	a	11.44	a-e	6.24	g-k	1.20	h-k	1.01	efg	0	e	38.35	a	19.89	ghi
Karelia Untreated	5.03	g-k	12.00	ab	14.18	ab	12.32	bc	9.78	abc	1.67	d-g	0.39	de	21.00	e-h	38.34	cd
Karelia Treated	6.37	f-i	8.81	bcd	13.73	abc	16.28	a	11.01	ab	4.71	a-d	2.095	b-e	17.86	g-k	47.81	ab
Cinderella Untreated	9.42	b-e	4.98	efg	1.07	k	0.22	m	0.00	k	0.00	g	0.00	e	30.40	bc	1.29	m
Cinderella Treated	11.45	ab	8.87	bcd	6.59	f-i	3.22	j-m	0.30	jk	0.00	g	0.00	e	35.95	ab	10.12	j-m
Lanorma Untreated	6.30	f-j	9.90	abc	13.66	abc	11.68	bcd	10.32	ab	1.50	d-g	1.59	b-e	21.82	d-h	38.74	bcd
Lanorma Treated	5.97	f-k	8.43	b-f	12.93	a-d	10.99	b-e	12.22	a	5.30	abc	2.98	bcd	20.19	f-i	44.41	abc
Tyson Untreated	8.47	c-f	8.47	b-f	5.54	g-k	6.63	f-j	3.65	f-k	1.88	d-g	0.75	cde	27.02	cd	18.45	hij
Tyson Treated	9.39	b-e	9.53	abc	12.18	a-d	7.96	d-h	3.81	f-j	1.97	c-g	1.73	b-e	27.30	cd	27.65	fg
LSD P=.05		2.95		3.70		4.51		3.86		3.79		3.33		2.68		6.00		9.09
Standard Deviation		2.09		2.63		3.19		2.74		2.69		2.36		1.90		4.25		6.45
CV		29.50		32.51		35.48		36.73		51.61		107.70		131.73		18.36		25.47

Table 8a: Total tuber numbers (per ha) and number in size fractions between 25mm and 55mm

Tuber number by Variety																	
Treatment		Number Total	Number <25mm		Number 25-30mm		Number 30-35mm		Number 35-40mm		Number 40-45mm		Number 45-50mm		Number 50-55mm		
		No/Ha	No/Ha		No/Ha		No/Ha		No/Ha		No/Ha		No/Ha		No/Ha		
Cara		381944	c	10648	abc	11574	bc	27778	b	37500	bc	52315	b	56481	c	60648	c
Maris Peer		542593	a	13426	a	31944	a	49074	a	58334	a	75463	a	95370	a	80555	b
Elland		289815	e	6019	c-f	8796	bcd	12963	cde	18982	de	20833	efg	28704	def	27778	def
Innovator		225000	f	2778	efg	6019	bcd	6019	de	8796	e	10648	fgh	12500	g	21296	efg
Eurostar		186574	f	463	g	3704	cd	3704	e	5093	e	9722	gh	12963	fg	20370	fg
Buster		229630	f	1389	fg	4167	cd	6482	de	9722	e	11111	fgh	15278	efg	13426	g
Amanda		485185	b	8333	bcd	12963	b	20833	bc	31482	cd	46759	bc	74537	b	81944	b
Karelia		307870	de	1852	fg	1852	d	2778	e	4167	e	5093	h	11111	g	24074	efg
Cinderella		495370	ab	8796	a-d	12500	b	22222	bc	47222	ab	60648	ab	91667	a	97685	a
Lanorma		389352	c	7407	cde	12963	b	16204	bcd	15278	e	26852	de	29630	de	34722	de
Tyson		446759	b	12500	ab	13889	b	20833	bc	32407	bcd	37037	cd	43982	cd	64815	c
LSD P=.05		50523		4857		8206		11755		14837		14909		16191		13917	
Standard Deviation		50651		4869		8227		11785		14874		14947		16232		13952	
CV		14		75		74		71		62		47		39		30	
Tuber number by Treatment																	
Treatment		Number Total	Number <25mm		Number 25-30mm		Number 30-35mm		Number 35-40mm		Number 40-45mm		Number 45-50mm		Number 50-55mm		
		No/Ha	No/Ha		No/Ha		No/Ha		No/Ha		No/Ha		No/Ha		No/Ha		
Untreated		357407	a	8025	a	11883	a	19753	a	25772	a	36960	a	46065	a	46065	a
30kg/ha Nemathorin		363349	a	4938	b	10494	a	13657	b	21991	a	26698	b	37963	b	48303	a
LSD P=.05		20626		1983		3350		4799		6057		6087		6610		5681	
Standard Deviation		50651		4869		8227		11785		14874		14947		16232		13952	
CV		14		75		74		71		62		47		39		30	
Tuber number by Variety and Treatment																	
Treatment		Number Total	Number <25mm		Number 25-30mm		Number 30-35mm		Number 35-40mm		Number 40-45mm		Number 45-50mm		Number 50-55mm		
		No/Ha	No/Ha		No/Ha		No/Ha		No/Ha		No/Ha		No/Ha		No/Ha		
Cara Untreated		399074	def	13889	abc	12037	b-f	29630	b	38889	bc	59259	bc	63889	cde	66667	cd
Cara Treated		364815	fg	7407	c-f	11111	b-f	25926	b-e	36111	bcd	45370	cde	49074	efg	54630	de
Maris Peer Untreated		581482	a	20371	a	49074	a	76852	a	77778	a	87963	a	109259	a	79629	bc
Maris Peer Treated		503704	bc	6481	d-g	14815	bc	21296	b-g	38889	bc	62963	bc	81481	bc	81482	bc
Elland Untreated		264815	h-k	6482	d-g	7408	b-f	11111	d-i	17593	d-g	19445	ghi	30556	ghi	23148	f-i
Elland Treated		314815	ghi	5556	efg	10185	b-f	14815	b-i	20370	c-g	22222	f-i	26852	ghi	32408	fgh
Innovator Untreated		192593	lm	2778	fg	2778	def	3704	hi	5556	g	10185	hi	11111	i	12963	hi
Innovator Treated		257408	i-l	2778	fg	9259	b-f	8333	f-i	12037	fg	11111	hi	13889	i	29630	fgh
Eurostar Untreated		184259	m	0	g	4630	c-f	4630	hi	6482	g	12037	hi	13889	i	21296	f-i
Eurostar Treated		188889	lm	926	fg	2778	def	2778	i	3704	g	7408	i	12037	i	19445	ghi
Buster Untreated		240741	j-m	2778	fg	6482	b-f	7408	f-i	12037	fg	12037	hi	22223	hi	18519	ghi
Buster Treated		218519	klm	0	g	1852	ef	5556	ghi	7407	g	10185	hi	8333	i	8333	i
Amanda Untreated		461111	bcd	6482	d-g	9259	b-f	26852	bcd	30556	b-f	50926	cd	71296	cde	75926	bc
Amanda Treated		509259	bc	10185	cde	16667	b	14815	b-i	32408	b-f	42593	c-f	77778	cd	87963	ab
Karelia Untreated		301852	g-j	926	fg	2778	def	2778	i	5556	g	7407	i	13889	i	26852	f-i
Karelia Treated		313889	ghi	2778	fg	926	f	2778	i	2778	g	2778	i	8334	i	21296	f-i
Cinderella Untreated		479630	bc	12963	bcd	9259	b-f	22223	b-f	48148	b	75926	ab	103704	ab	91667	ab
Cinderella Treated		511111	ab	4630	efg	15741	bc	22222	b-f	46296	b	45371	cde	79630	cd	103704	a
Lanorma Untreated		391667	def	7407	c-f	13889	bcd	12963	c-i	15741	d-g	33333	d-g	28704	ghi	34259	fg
Lanorma Treated		387037	ef	7408	c-f	12037	b-f	19445	b-h	14815	efg	20371	ghi	30556	ghi	35185	efg
Tyson Untreated		455556	b-e	18519	ab	14815	bc	28704	bc	33333	b-e	44445	cde	57408	def	63889	cd
Tyson Treated		437963	cde	6482	d-g	12963	b-e	12963	c-i	31482	b-f	29630	e-h	30556	ghi	65741	cd
LSD P=.05		71451		6868		11605		16625		20982		21085		22898		19681	
Standard Deviation		50651		4869		8227		11785		14874		14947		16232		13952	
CV		14		75		74		71		62		47		39		30	

Table 8b: Tuber number (per ha) in marketable fractions (45-65mm and 65-85mm) and in size fractions from 55mm to >85mm

Tuber number by Variety																		
Treatment	Number 55-60mm No/Ha		Number 60-65mm No/Ha		Number 65-70mm No/Ha		Number 70-75mm No/Ha		Number 75-80mm No/Ha		Number 80-85mm No/Ha		Number >85mm No/Ha		Number 45-65mm No/Ha		Number >65mm No/Ha	
Cara	50926	d	35648	def	24074	de	12037	e	1852	h	463	de	0	c	23	def	38426	de
Maris Peer	67593	c	39815	cde	21296	e	8796	e	926	h	0	e	0	c	31	bc	31019	e
Elland	39352	def	37963	de	43519	bc	23148	cd	15741	de	6019	bc	3241	b	20	fg	91667	c
Innovator	30556	ef	40278	cde	37963	bcd	37963	bcd	19908	cd	5093	b-e	4630	ab	17	g	90741	c
Eurostar	24074	f	22222	f	31481	cde	25926	c	18056	cde	8796	ab	3241	a	12	h	87500	c
Buster	25926	f	26389	ef	38889	bc	40278	b	23611	bc	12963	a	6944	a	11	h	122685	b
Amanda	88426	a	67130	a	32870	cde	13889	de	4630	gh	1389	cde	0	c	38	a	52778	d
Karelia	42593	de	60648	a	63426	a	52315	a	30093	ab	7870	ab	2315	bc	19	fg	156019	a
Cinderella	83796	ab	43982	bcd	19444	e	6945	e	463	h	0	e	0	c	33	b	26852	e
Lanorma	46759	d	53704	abc	60648	a	41667	b	35185	a	8333	ab	4630	ab	21	efg	150463	a
Tyson	72222	bc	56945	ab	44445	bc	29630	c	12500	ef	5556	bcd	2778	bc	27	cd	94908	c
LSD P=.05		15485	14823		14176		9657		6799		5271		3231		4		20996	
Standard Deviation		15524	14861		14212		9681		6816		5284		3240		4		21049	
CV		30	33		36		38		48		105		127		18		24	
Tuber number by Treatment																		
Treatment	Number 55-60mm No/Ha		Number 60-65mm No/Ha		Number 65-70mm No/Ha		Number 70-75mm No/Ha		Number 75-80mm No/Ha		Number 80-85mm No/Ha		Number >85mm No/Ha		Number 45-65mm No/Ha		Number >65mm No/Ha	
Untreated	49383	a	42207	b	31482	b	22917	b	13349	a	3549	b	1775	b	23	a	73071	b
30kg/ha Nemathorin	54321	a	48303	a	46528	a	28395	a	15278	a	6481	a	3318	a	24	a	100000	a
LSD P=.05		6322	6052		5787		3942		2776		2152		1319		2		8571	
Standard Deviation		15524	14861		14212		9681		6816		5284		3240		4		21049	
CV		30	33		36		38		48		105		127		18		24	
Tuber number by Variety and Treatment																		
Treatment	Number 55-60mm No/Ha		Number 60-65mm No/Ha		Number 65-70mm No/Ha		Number 70-75mm No/Ha		Number 75-80mm No/Ha		Number 80-85mm No/Ha		Number >85mm No/Ha		Number 45-65mm No/Ha		Number >65mm No/Ha	
Cara Untreated	50000	efg	33334	f-j	20371	g-j	10185	j-m	926	i	0	f	0	e	24	d-g	31481	ij
Cara Treated	51852	ef	37963	e-j	27778	f-i	13889	h-l	2778	hi	926	ef	0	e	22	d-g	45370	hi
Maris Peer Untreated	51852	ef	20370	j	8334	ij	0	m	0	i	0	f	0	e	27	cde	8334	j
Maris Peer Treated	83333	abc	59259	a-d	34259	d-h	17593	g-k	1852	i	0	f	0	e	35	ab	53704	ghi
Elland Untreated	31481	f-i	27778	hij	38889	c-g	25926	e-i	19445	de	5556	b-f	4630	bcd	16	h-l	94445	def
Elland Treated	47223	e-h	48148	b-h	48148	a-e	20371	f-j	12037	e-h	6482	b-f	1852	cde	23	d-g	88889	def
Innovator Untreated	22222	i	38889	d-j	30556	e-h	28704	d-g	18519	de	4630	c-f	4630	bcd	15	i-m	87037	def
Innovator Treated	38889	f-i	41667	c-i	45371	a-f	17593	g-k	21297	cde	5556	b-f	4630	bcd	19	f-j	94445	def
Eurostar Untreated	26852	hi	24074	ij	26852	f-i	22223	f-j	14815	ef	6482	b-f	926	de	13	klm	71296	fgh
Eurostar Treated	21296	i	20371	j	36111	d-g	29630	c-g	21297	cde	11111	a-d	5556	bc	11	lm	103704	de
Buster Untreated	29630	ghi	28704	hij	38889	c-g	36111	b-e	17593	e	8334	b-e	2778	b-e	13	j-m	103704	de
Buster Treated	22222	i	24074	ij	38889	c-g	44444	b	29630	abc	17593	a	11111	a	9	m	141667	bc
Amanda Untreated	102778	a	61111	abc	14815	hij	5556	klm	5556	f-i	0	f	0	e	39	a	25926	ij
Amanda Treated	74074	bcd	73148	a	50926	a-d	22222	f-j	3704	ghi	2778	ef	0	e	38	a	79630	efg
Karelia Untreated	37037	f-i	67593	ab	62037	a	43518	b	27778	bcd	3704	def	926	de	21	e-h	137963	bc
Karelia Treated	48148	e-h	53704	a-f	64815	a	61111	a	32407	ab	12037	abc	3704	b-e	18	g-k	174074	a
Cinderella Untreated	76852	bc	32408	g-j	5556	j	926	lm	0	i	0	f	0	e	30	bc	6482	j
Cinderella Treated	90741	ab	55556	a-e	33333	d-h	12963	i-m	926	i	0	f	0	e	36	ab	47222	hi
Lanorma Untreated	48148	e-h	57408	a-e	62037	a	42593	bc	31482	ab	3704	def	2778	b-e	22	d-h	142593	bc
Lanorma Treated	45370	fgh	50000	b-g	59260	ab	40741	bcd	38889	a	12963	ab	6481	b	20	f-i	158333	ab
Tyson Untreated	68519	cde	53704	a-f	27778	f-i	26852	e-h	12037	e-h	5556	b-f	1852	cde	27	cd	74074	e-h
Tyson Treated	75926	bc	60185	abc	61111	ab	32408	b-f	12963	efg	5556	b-f	3704	b-e	27	cd	115741	cd
LSD P=.05		21899	20963		20048		13657		9616		7454		4570		6		29693	
Standard Deviation		15524	14861		14212		9681		6816		5284		3240		4		21049	
CV		30	33		36		38		48		105		127		18		24	

Nemathorin application resulted in a significant increase in the total yield across all varieties of 7.63 t/ha (16%). Examination of the results for different size fractions indicates that this was due to an increase in the larger size fractions at the expense of smaller grades. However, there was no overall difference in the total number of tubers harvested (Tables 8a and 8b).

The yield of all varieties was improved with Nemathorin application. However, the increase was significant only for Maris Peer, Eurostar, Buster, Amanda, and Cinderella. These varieties can, based on evidence from this trial, be considered as intolerant. Innovator was included in this trial as an example of a resistant and intolerant variety as this has been the experience in other trials and commercially. In this trial the increase in yield with Nemathorin treatment was 5.41 t/ha (11%) and not statistically significant. This might be attributed to the nitrogen application rate (210 kg/ha) which acted to compensate for the damage being caused by PCN.

Of the other varieties which are highly resistant (Elland and Karelia) the evidence from this trial suggest that they are more tolerant of PCN than other varieties. However, additional trials across a range of conditions are required before the tolerance of these varieties can be described with confidence.

Tuber numbers were assessed for all size fractions (Tables 8a and 8b). There was generally no effect of Nemathorin application on the number of tubers harvested. For the variety Maris Peer a significant decrease in the number of tubers was observed with Nemathorin treatment. No other variety interactions were observed.

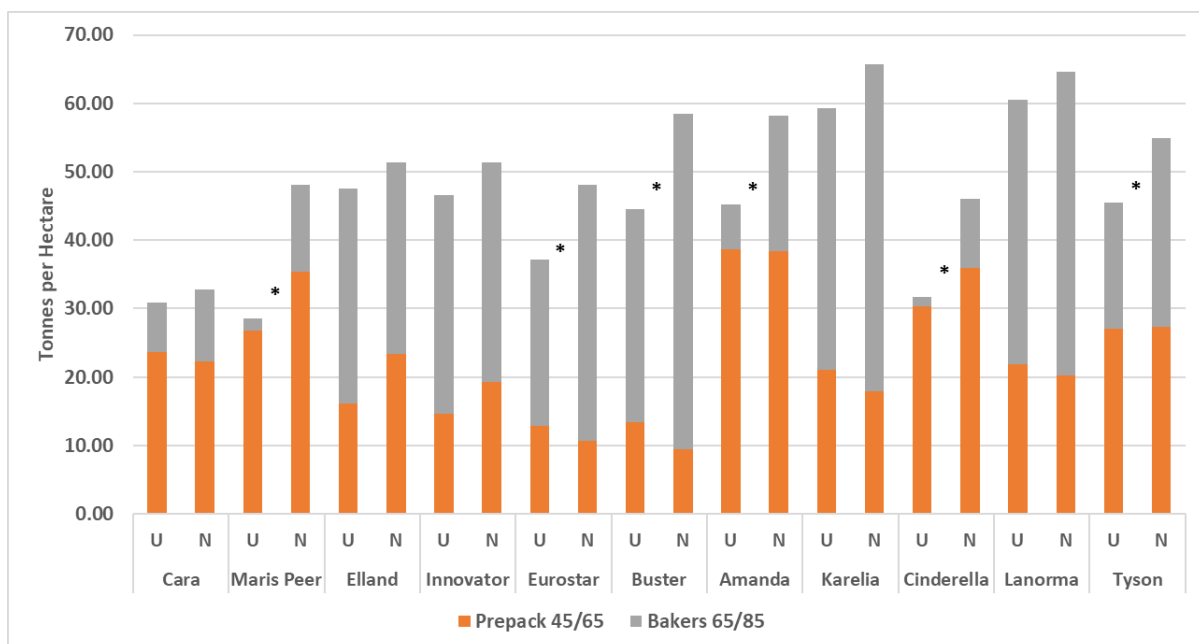


Figure 4: Total yield (tonnes per ha) of Nemathorin treated (N – right columns) and untreated varieties (U – left columns). Varieties with a significant difference in total yield indicated by an asterisk.

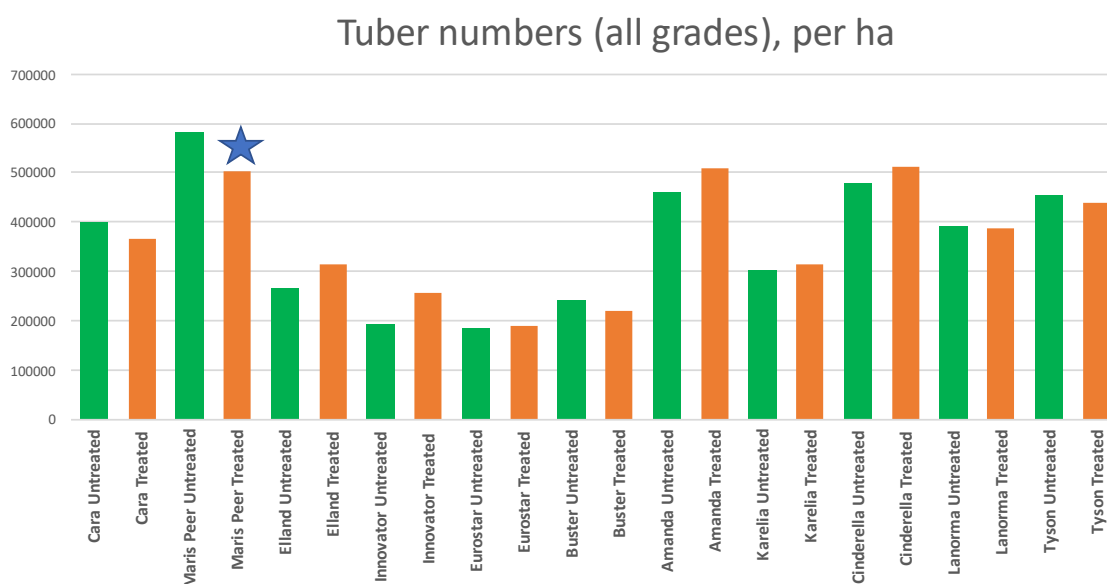


Figure 5: Total tuber numbers (per ha) for Nemathorin treated and untreated varieties. Within variety significant difference indicated

Tuber blemish diseases

Common scab (Table 9a): The incidence of common scab was low (between 1.5 and 10%) in all the varieties except for Cinderella which had a significantly increased incidence of common scab (41.5%). It should be noted that the site was irrigated. However, the regime was uniform across all varieties and the regime not optimised for every variety stage of development.

Silver scurf (Table 9a): Silver scurf incidence was high (average 75%) at the time of assessment. Significant differences were recorded between the treatments with the severity score for the varieties Innovator, Amanda, Karelia, and Tyson being significantly higher than the control variety, Cara.

Black scurf (Table 9a): Black scurf incidence was low. The disease was only recorded in the variety Innovator, with 97.5% of tubers with no incidence of the disease.

Powdery scab (Table 9b): Powdery scab incidence was low with less than 1% of tubers across the trial infected. However, a significantly higher incidence (23%) and severity of disease was recorded for the variety Buster. It should be noted that Buster emerged more slowly than other varieties and the period of susceptibility is likely to have been different from other varieties.

Black dot (Table 9b): The incidence and severity of Black dot was low. However, a significant increase in the amount of black dot on the variety Maris Peer was recorded (4% of tubers infected).

Table 9a: incidence and severity of Common scab (*Streptomyces* spp.), silver scurf (*Helminthosporium solani*) and black scurf (*Rhizoctonia solani*) on harvested tubers

Tuber disease assessment results												
Common Scab												
Treatment	Incidence		Severity		% of Tubers in Each Severity Category							
	%		0-3		0		1		2		3	
Cara	7.0	bc	0.075	bc	93.0	ab	6.5	bc	0.5	b	0	b
Maris Peer	4.5	c	0.060	bc	95.5	a	4.0	c	0.5	b	0	b
Elland	2.5	c	0.025	c	97.5	a	2.5	c	0	b	0	b
Innovator	1.5	c	0.015	c	98.5	a	1.5	c	0	b	0	b
Eurostar	10.0	bc	0.125	bc	90.0	ab	8.0	bc	1.5	b	0.5	b
Buster	3.5	c	0.035	bc	96.5	a	3.5	c	0	b	0	b
Amanda	6.0	bc	0.065	bc	94.0	ab	5.5	bc	0.5	b	0	b
Karelia	6.0	bc	0.060	bc	94.0	ab	6.0	bc	0	b	0	b
Cinderella	41.5	a	0.520	a	58.5	c	33.0	a	6.5	a	2.0	a
Lanorma	5.0	bc	0.050	bc	95.0	ab	5.0	bc	0	b	0	b
Tyson	3.0	c	0.030	c	97.0	a	3.0	c	0	b	0	b
LSD P=.05	9.07		0.12		9.07		7.54		2.75		1.02	
Standard Deviation	6.30		0.08		6.30		5.24		1.91		0.71	
CV	72.37		83.32		6.90		69.13		208.32		341.97	
Silver Scurf												
Treatment	Incidence		Severity		% of Tubers in Each Severity Category							
	%		0-3		0		1		2		3	
Cara	61.0	e	0.810	de	39.0	ab	43.0	abc	16.0	ef	2.0	cd
Maris Peer	65.0	cde	0.925	cde	35.0	ab	42.5	abc	16.5	ef	6.0	cd
Elland	55.0	e	0.700	e	45.0	a	46.0	abc	8.0	f	1.0	d
Innovator	84.0	a-d	1.260	bc	16.0	c-f	47.5	abc	31.0	bcd	5.5	cd
Eurostar	75.5	a-e	1.005	cde	24.5	b-e	52.5	abc	20.5	def	2.5	cd
Buster	63.5	de	0.750	e	26.5	bcd	48.5	abc	7.5	f	1.0	d
Amanda	92.5	ab	1.540	ab	7.5	ef	41.5	abc	41.0	ab	10.0	bc
Karelia	89.0	ab	1.575	ab	11.0	def	36.5	cd	36.5	bc	15.5	ab
Cinderella	66.5	cde	0.995	cde	33.5	abc	57.0	a	8.5	f	1.0	d
Lanorma	84.5	abc	1.185	bcd	15.5	c-f	55.0	ab	25.0	cde	4.5	cd
Tyson	94.5	a	1.885	a	5.5	f	22.0	d	50.5	a	22.0	a
LSD P=.05	20.62		0.42		18.15		17.93		13.42		8.26	
Standard Deviation	14.33		0.29		12.61		12.47		9.33		5.74	
CV	19.04		25.79		52.83		28.25		38.41		91.21	
Black Scurf												
Treatment	Incidence		Severity		% of Tubers in Each Severity Category							
	%		0-3		0		1		2		3	
Cara	0	b	0.000	b	100.0	a	0	b	0	a	0	a
Maris Peer	0	b	0.000	b	100.0	a	0	b	0	a	0	a
Elland	0	b	0.000	b	100.0	a	0	b	0	a	0	a
Innovator	2.5	a	0.025	a	97.5	b	2.5	a	0	a	0	a
Eurostar	0	b	0.000	b	100.0	a	0	b	0	a	0	a
Buster	0	b	0.000	b	100.0	a	0	b	0	a	0	a
Amanda	0	b	0.000	b	100.0	a	0	b	0	a	0	a
Karelia	0	b	0.000	b	100.0	a	0	b	0	a	0	a
Cinderella	0	b	0.000	b	100.0	a	0	b	0	a	0	a
Lanorma	0	b	0.000	b	100.0	a	0	b	0	a	0	a
Tyson	0	b	0.000	b	100.0	a	0	b	0	a	0	a
LSD P=.05	1.71		0.02		1.71		1.71		0.00		0.00	
Standard Deviation	1.19		0.01		1.19		1.19		0.00		0.00	
CV	408.08		408.08		1.19		408.08		0.00		0.00	

Table 9b: Incidence and severity of Powdery scab (*Spongospora subterranea*) and Black dot (*Colletotrichum coccodes*). on harvested tubers

Tuber disease assessment Results												
Treatment	Powdery Scab											
	Incidence		Severity		% of Tubers in Each Severity Category							
	%		0-3		0		1		2		3	
Cara	1.0	b	0.100	b	99.0	a	1.0	b	0	b	0	a
Maris Peer	0.5	b	0.005	b	99.5	a	0.5	b	0	b	0	a
Elland	0.5	b	0.005	b	99.5	a	0.5	b	0	b	0	a
Innovator	0	b	0.000	b	100.0	a	0	b	0	b	0	a
Eurostar	1.5	b	0.015	b	98.5	a	1.5	b	0	b	0	a
Buster	23.0	a	0.255	a	77.0	b	20.5	a	2.5	a	0	a
Amanda	1.0	b	0.010	b	99.0	a	1.0	b	0	b	0	a
Karelia	0	b	0.000	b	100.0	a	0	b	0	b	0	a
Cinderella	0.5	b	0.005	b	99.5	a	0.5	b	0	b	0	a
Lanorma	2.0	b	0.020	b	98.0	a	2.0	b	0	b	0	a
Tyson	1.5	b	0.015	b	98.5	a	1.5	b	0	b	0	a
LSD P=.05	4.86		0.10		4.86		4.19		1.09			
Standard Deviation	3.38		0.07		3.38		2.91		0.76		0.00	
CV	121.03		181.01		3.48		114.62		303.51		0.00	
Treatment	Black Dot											
	Incidence		Severity		% of Tubers in Each Severity Category							
	%		0-3		0		1		2		3	
Cara	1.0	b	0.015	b	99.0	a	0.5	b	0.5	a	0	b
Maris Peer	4.0	a	0.050	a	96.0	a	3.0	b	0	a	0.5	a
Elland	1.0	b	0.010	b	99.0	a	1.0	b	0	a	0	b
Innovator	0	b	0.000	b	100.0	a	0	b	0	a	0	b
Eurostar	0	b	0.000	b	100.0	a	0	b	0	a	0	b
Buster	1.0	b	0.010	b	99.0	a	1.0	b	0	a	0	b
Amanda	0	b	0.000	b	100.0	a	0	b	0	a	0	b
Karelia	0	b	0.000	b	100.0	a	0	b	0	a	0	b
Cinderella	0	b	0.000	b	100.0	a	0	b	0	a	0	b
Lanorma	1.0	b	0.010	b	74.0	b	26.0	a	0	a	0	b
Tyson	1.5	ab	0.015	b	98.5	a	1.5	b	0	a	0	b
LSD P=.05	2.62		0.03		20.54		20.55		0.56		0.42	
Standard Deviation	1.82		0.02		14.28		14.28		0.39		0.29	
CV	208.10		231.61		14.71		511.65		467.10		692.82	

Discussion

The results of this trial provide further evidence of the large effect of varieties highly resistant to *G. pallida* can have on the pest population. The varieties Innovator, Elland, Eurostar, Buster, Amanda, and Karelia resulted in a Pi/Pf ratio of less than 1, thus the pest population was less after growing the crop than it was before. This effect is a powerful tool in the management of PCN populations. In contrast the production of highly, or partially resistant varieties (Cara, Maris Peer, Lanorma, and Tyson) resulting in large increases in the pest population at harvest (Pi/Pf ranging from 3.94 to 8.44).

It needs to be noted that of these varieties, Elland and Innovator have resistance only to *G. pallida* and not to *G. rostochiensis*. However, Eurostar, Buster, and Amanda can be considered resistant to both forms of PCN present in Scotland. The effect on a *G. rostochiensis* population was not assessed in this field trial as *G. rostochiensis* was not detectable at this site.

The initial population ($P_i = 31.5$ eggs per gram) can be considered moderate to high and in line with expectations. Nemathorin (Fosthiazate) treatment did not have an impact on the pest multiplication, and this was the case for all varieties. In situations such as this where P_i is relatively high, treatment with Nemathorin is unlikely to be effective in terms of population management. However, treatment with this product can protect the crop from the direct effects of feeding damage and a yield enhancement was observed. For resistant varieties, this difference in yield can provide an important measure of the tolerance of a variety to infection.

Maris Peer, Eurostar, Buster, Amanda, Cinderella, and Tyson all produced significantly higher yields when treated with Nemathorin than the untreated control plots. Thus, Eurostar, Buster, and Amanda while being fully resistant to *G. pallida*, were shown to be somewhat intolerant of infection. It is notable that for Cara, Elland, Karelia, and Lanorma the yield effect of Nemathorin treatments appeared to be positive, but small. Therefore, these results suggest that these varieties have a degree of tolerance to infection. In the case of Cara, included as a known susceptible and tolerant variety the result is in line with expectations.

Innovator, a widely grown variety, is known to show intolerance to PCN. However, in this trial there was a smaller effect than was expected. This may be due to a relatively high level of nitrogen fertiliser application (210kg/ka) which enabled the crop to develop better than expected under these conditions. In addition, tolerance assessment of varieties is known to produce variable results depending upon growing conditions, soil type, and pest pressure. Therefore, this set of results needs to be considered as the results of a single trial in a single year. Further work with a range of these varieties is planned for 2023.

The use of varieties with resistance to PCN, is central to the development of a sustainable production strategy for the potato crop in Scotland and the rest of the UK. Pressure to follow such a strategy will increase if further restrictions are made on the use of pesticides. However, the varieties must also be acceptable to the marketplace, and this also demonstrated that a selection of varieties, suited to the pre-packing sector, with resistance to *G. pallida*, is available to growers and supply chains in Scotland. The skin finish and other characteristics of the varieties in this trial were generally suited to this sector. Variety-specific agronomy protocols require refinement to ensure that the varieties are grown efficiently and maximise use of applied resources. Table 10 summarises the characteristics of the varieties in this trial.

Table 10: Summary of variety performance

Variety	Resistance to PCN		Comments (related to this trial)
	<i>G. pallida</i>	<i>G. rostochiensis</i>	
Cara	2	9	Fully susceptible and tolerant control variety. Low yield due to short season.
Maris Peer	2	2	Fully susceptible and tolerant control variety.
Elland	9	3	Early maincrop with full resistance to <i>G. pallida</i> . Relatively tolerant. Moderate yield. Suitable for prepacking.
Innovator	8	2	Second early with full resistance to <i>G. pallida</i> . Considered to be intolerant. Widely grown for French fry production. Skin finish is unsuitable for prepacking.
Eurostar	9	9	Maincrop with dual resistance. Shown to be intolerant in this trial. Moderate yield. Suitable for prepacking and general use.
Buster	9	9	Late Maincrop with dual resistance. Emergence delayed. Shown to be intolerant in this trial. High yield. Considered suitable for prepacking.
Amanda	8	R	Medium early with dual resistance. Shown to be intolerant in this trial. High yield. Considered suitable for prepacking.
Karelia	8	8	Medium early with dual resistance. Shown to be relatively tolerant in this trial. High yield. Considered suitable for prepacking.
Cinderella	6	R	Early with partial resistance to <i>G. pallida</i> . Shown to be relatively tolerant in this trial. Lower yield. Considered unsuitable for prepacking due high dry matter content.
Lanorma	5	9	Early maincrop with partial resistance to <i>G. pallida</i> and less suitable than fully resistant varieties in population management. Shown to be relatively tolerant in this trial. High yield. Suitable for prepacking.
Tyson	4	1	Maincrop with partial resistance to <i>G. pallida</i> and less suitable than fully resistant varieties in population management. Shown to be intolerant in this trial. Moderate yield. Suitable for prepacking.

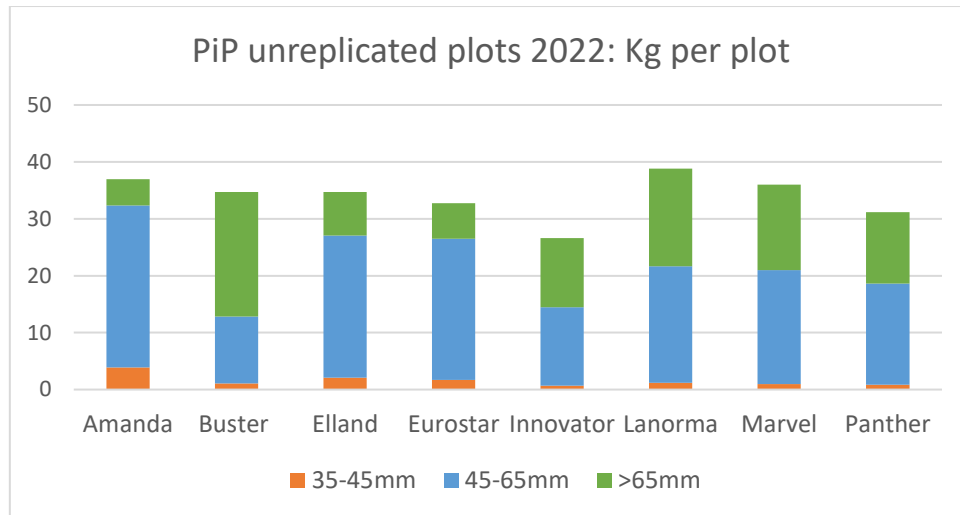
Acknowledgements

The trial site was provided by Mr Neill Smith, Barnyards Farm, Tannadice, Forfar, DD8 3QA with Scottish Agronomy field staff planting, harvesting, and management the field trial. SRUC crop clinic undertook the analysis of PCN soil samples. Miss Jane Brisbane, SRUC, managed the open day 2022.

Funding for this work from Scottish Government through the Plant health Centre is gratefully acknowledged.

Appendix: Potato in Practice demonstration 2022

Potatoes in Practice (11th August 2022) provided an opportunity to further engage with growers and supply chains on the production of *G. pallida* resistant varieties. A nonreplicated demonstration plot on a site with no recorded PCN was established for the purposes of demonstration. After the event, the plots were harvested and assessed. The results are presented below.



Variety	Disease incidence %				
	Common Scab	Powdery Scab	Black Scurf	Silver Scurf	Black Dot
Amanda	2.5	0	3	25	7
Buster	0.5	0.5	0	25	3
Elland	1.0	0.5	0	8	25
Eurostar	2.5	1.0	0	25	2.5
Innovator	0	0	0	0.5	25
Lanorma	1.5	2.5	0	25	2
Marvel	3.0	0	0	3	25
Panther	0	2.5	0	25	5

Pictures of selected washed samples from Potato in Practice

