



Project Report

Assessment of varietal tolerance to potato cyst nematode (PCN) damage

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1. Summary of results

Tolerance is the ability of a variety to yield in spite of pest attack. Tolerance to the two potato cyst nematode (PCN) species (*Globodera pallida* and *Globodera rostochiensis*) has not been evaluated for many of the widely grown GB varieties. The work described in this report was commissioned by the British Potato Council, DuPont (UK) Ltd. and Greenvale AP to provide some of the missing information on PCN tolerance. Potato varieties were grown in an untreated area and in an adjacent nematicide treated area. Yield from the treated and untreated areas was compared to provide a relative ranking of PCN tolerance for the varieties. The results allow the varieties to be positioned according to potential yield loss and initial PCN infestation level and will be incorporated into the BPC PCN management model.

The work was carried out at two sites in 2005 and at two sites in 2006. The 2 sites in 2005 were at Holbeach, Lincolnshire (fine sandy silt loam) and Trunch, Norfolk (sandy loam). Holbeach was infested with a *G. pallida* population of 20-22 eggs/g soil and was un-irrigated. Trunch was infested with a *G. pallida* population of 16-19 eggs/g soil and was irrigated.

At Trunch, Maris Peer, Marfona, Sante and Lady Rosetta showed the largest yield increases due to nematicide use, indicating that these varieties have low tolerance to *G. pallida*. The same four varieties also showed the least tolerance in the Holbeach trial, despite different irrigation regimes and soil types between the two sites. The good correlation between two different sites provided confidence in this field-based method of comparing varietal tolerance to PCN. Cara, Maris Piper and Vales Everest exhibited a higher level of tolerance to PCN than the other varieties, at both Trunch and Holbeach. Sovereign and Desiree were also amongst the most tolerant varieties at Trunch.

The partially resistant varieties, Vales Everest and Sante, greatly limited multiplication of PCN at both sites, as shown by the ratio of the final and initial PCN populations (Pf:Pi ratio). Lady Rosetta also consistently provided low Pf:Pi ratios despite a lack of documented evidence that this variety has any partial resistance to *G. pallida*. The PCN population dynamics at Trunch contrast to the results obtained from the un-irrigated site at Holbeach. Untreated Pf:Pi ratios were generally higher at Holbeach compared with Trunch. In addition, nematicide treatments appeared far more efficacious at Trunch when compared to the Holbeach results.

The 2 sites in 2006 were at Spalding, Lincolnshire (fine sandy silt loam) and Cawston, Norfolk (sandy loam). Spalding was infested with a *G. rostochiensis* population of 17-19 eggs/g soil and was un-irrigated. Cawston was infested with a *G. pallida* population of 11-14 eggs/g soil and was irrigated. At Cawston, Saturna, Lady Claire, Vivaldi, Emerald and Maris Peer, showed the largest yield increases due to nematicide use, indicating that these varieties have low tolerance to *G. pallida*.

At Spalding, Maris Peer, Emerald, Vivaldi and Hermes showed the largest yield increases due to nematicide use. Maris Peer proved to be a good marker variety for intolerance to PCN effects on yield, being amongst the least tolerant varieties at all sites in both years. Other varieties showing consistently low levels of tolerance to PCN included Emerald, Vivaldi, Marfona, Sante and Lady Rosetta. The two crisping varieties Lady Claire and Saturna appeared intolerant on an irrigated sandy loam site but more tolerant on un-irrigated silt. In practice, these varieties will be grown on irrigated sandy loams and should therefore be considered as intolerant. Most of the varieties categorised here as intolerant are indeterminate early or second early varieties.

In 2006, Cara, Maris Piper and Vales Everest featured as the most tolerant varieties at both sites. Another variety which showed good tolerance to PCN was Markies (only included in 2006). Sovereign appeared relatively tolerant but was less consistent across sites than the varieties named above. The inclusion of Cara as a marker variety for high levels of tolerance was justified by the results obtained over 2005-6. The varieties classed as tolerant by this work are predominantly indeterminate maincrop varieties.

In 2006, all the *G.rostochiensis* resistant varieties resulted in a decline of PCN levels (Pf:Pi less than 1) at Spalding. The extent of PCN decline appeared similar across all resistant varieties. The *G.pallida* site at Cawston produced results very similar to those obtained at Trunch in 2005, where Vales Everest + Vydate resulted in multiplication rates less than 1.0. In contrast, growing Cara and Markies resulted in high PCN multiplication, even where Vydate was used. Untreated multiplication rates with these two varieties were typically 3X-4X greater than for all other varieties trialled. With these varieties PCN effects in the growing crop may go undetected due to tolerance but a very high level of *G. pallida* is likely to remain after lifting. The results here suggest that growing Vales Everest in a similar situation would result in good control of PCN multiplication without sacrificing yield. This combination of PCN tolerance and partial resistance to *G.pallida* provides a unique opportunity for sustainable potato production on *G.pallida* infested land. Hitherto, varieties were either; intolerant and resistant (e.g. Sante), or tolerant and susceptible (e.g. Cara, Markies).

2. Experimental section

2.1 Introduction

It is known that some potato varieties can yield better than other varieties in PCN infested soil. This tolerance to PCN has not been evaluated for many of the widely grown GB varieties. In contrast, information on resistance to PCN, based on cyst multiplication data, is more widely available. Varietal tolerance and resistance to PCN are often misunderstood by the potato industry. Resistant varieties may be very intolerant of PCN and highly tolerant varieties often show almost no resistance to PCN. Varietal tolerance information would be of great practical benefit to growers in PCN infested areas, allowing varieties to be positioned according to potential yield loss and initial PCN infestation level.

Similar work to that reported here, was carried-out in association with BPC, Greenvale AP and DuPont (Agricultural Products) Ltd. during 2005. This work showed some consistent varietal trends to PCN tolerance across two different soil types. The work in 2006 attempts to add confidence to these emerging varietal trends and increase the scope of the work by looking at some newer varieties likely to make an impact on the market in the near future.

Normally PCN resistance and tolerance traits are assessed by pot growing methods. These can be expensive and difficult to relate to the outside, field-grown crop. In the current work, a second season looking at a field-based method, which relies on finding an area of exceptionally uniform PCN infestation, was used. The varieties were grown in an untreated area and in an adjacent, nematicide treated area. Untreated versus treated yields were compared to assess tolerance. Initial PCN levels were compared with post-cropping levels to assess the impact of variety on PCN population dynamics (PCN resistance). Absolute tolerance data is not obtained using this method because the yield from PCN-free soil is not available. Instead, yield is compared from nematicide treated and untreated plots to provide a relative ranking of the PCN tolerance for a range of varieties. The varieties Cara and Maris Peer were included to validate the trial, and as benchmark varieties for high and low tolerance respectively.

The aim of the work was to provide further data on variety tolerance for inclusion in the BPC PCN management model. The model, developed at SCRI with financial support from BPC, has proved a useful tool for growers and agronomists, however, it currently contains information on tolerance for only a limited number of varieties. The current work was carried out to provide additional tolerance data across two important, potato-growing soil types.

2.2 Methods

Information and results for the trials carried out in 2005 are provided in Annex 2.

2.2.1 Trial sites 2006

The trials were carried out at two sites: Spalding, Lincolnshire (fine sandy silt loam) and Cawston, Norfolk (sandy loam). Fields with the required PCN infestation levels were selected on the basis of normal commercial PCN sampling at one hectare sampling units. Suitable areas within fields were re-sampled on a 20 metre square grid to confirm required PCN level and uniformity of the infestation. Twelve varieties were planted at both sites.

TABLE 1. TREATMENT LIST

	Treatment	Rate / ha	Timing
1	Hermes		
1a	Hermes + Vydate	55kg/ha	Pre-planting
2	Lady Claire		
2a	Lady Claire + Vydate	55kg/ha	Pre-planting
3	Saturna		
3a	Saturna + Vydate	55kg/ha	Pre-planting
4	Maris peer		
4a	Maris peer + Vydate	55kg/ha	Pre-planting
5	Cara		
5a	Cara + Vydate	55kg/ha	Pre-planting
6	Sovereign		
6a	Sovereign + Vydate	55kg/ha	Pre-planting
7	Maris piper		
7a	Maris piper + Vydate	55kg/ha	Pre-planting
8	Emerald		
8a	Emerald + Vydate	55kg/ha	Pre-planting
9	Melody		
9a	Melody + Vydate	55kg/ha	Pre-planting
10	Markies		
10a	Markies + Vydate	55kg/ha	Pre-planting
11	Vivaldi		
11a	Vivaldi + Vydate	55kg/ha	Pre-planting
12	Vales Everest		
12a	Vales Everest + Vydate	55kg/ha	Pre-planting

Further details of the trials are provided in Annex 1

Soil and climatic data were collected at nematicide application. Composite soil samples were taken from each treatment block for assessment of initial PCN level (Pi) and species composition. Each soil sample comprised sixty soil cores taken with a 1cm diameter auger from 0-20cm depth.

2.2.2 Potato yield and grade

Each three metre variety plot was harvested and graded by hand. The following tuber size grades were recorded:

- <45mm
- >45mm
- Total yield

2.2.3 Potato Cyst Nematode (PCN) populations

Post harvest

Forty soil cores (0-20cms) were taken from each plot at lifting, using a 1cm diameter auger. The soil samples were analysed for final PCN level (Pf) at GrowScience Ltd.(Holbeach). Analysis was carried out on transformed values (e+1/g soil).

2.3 Results 2006

2.3.1 PCN populations

In 2006, both sites contained a single-species PCN population. The Spalding site was infested with a population of *G. rostochiensis* and the Cawston site infested with *G. pallida*. The initial PCN levels showed an even infestation over the trial area at both Spalding and Cawston, allowing comparison between nematicide treated plots and untreated plots. The high numbers of cysts present in all samples, indicated a long-standing PCN infestation at both sites.

TABLE 2. PCN LEVELS IN THE TRIAL AREA (PI) AT SPALDING (SAMPLED 12.04.2006)

Sample area	Total cysts/100g soil	eggs/g soil
Block 1	42	17
Block 2	59	19
Block 3	43	17

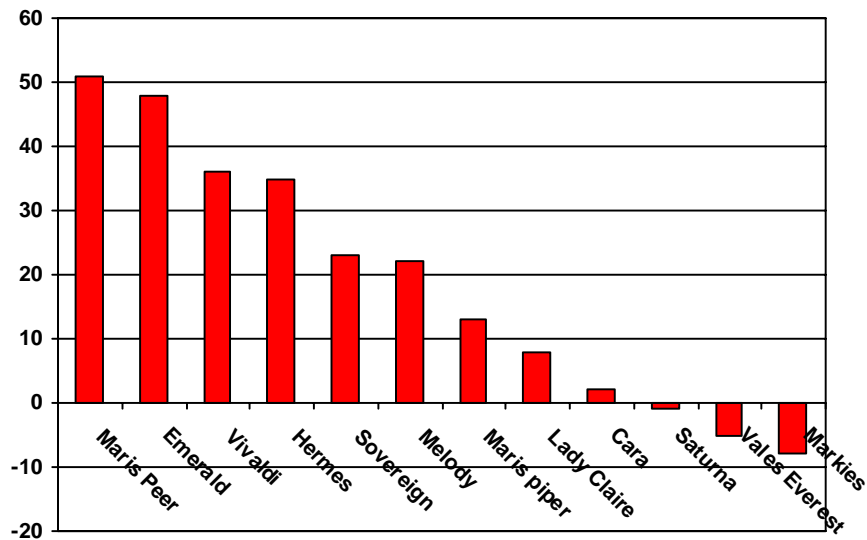
TABLE 3. PCN LEVELS IN THE TRIAL AREA (PI) AT CAWSTON (SAMPLED 01.04.2006)

Sample area	Total cysts/100g soil	eggs/g soil
Block 1	19	13
Block 2	21	14
Block 3	17	11

2.3.2 Potato yield and grade, Spalding.

Nematicide application resulted in a yield increase in all but three varieties, many of these yield increases were significant (Table 4; $P=0.05$). However the size of yield increase varied greatly with variety, indicating a range of PCN tolerance levels within the varieties tested. Maris Peer, Emerald, Vivaldi and Hermes showed the largest yield increases due to nematicide use, indicating that these varieties have low tolerance to PCN. Conversely, Cara, Vales Everest, Saturna and Markies exhibited a higher level of tolerance to PCN (Fig. 1). The relative performance of the benchmark varieties Maris Peer and Cara indicated the validity of the trial.

FIGURE 1. EFFECT OF NEMATICIDE ON % INCREASE IN TOTAL YIELD (SPALDING; RANKED DATA).



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TABLE 4. EFFECT OF NEMATICIDE ON YIELD AND GRADE OF POTATOES (SPALDING; T/HA).

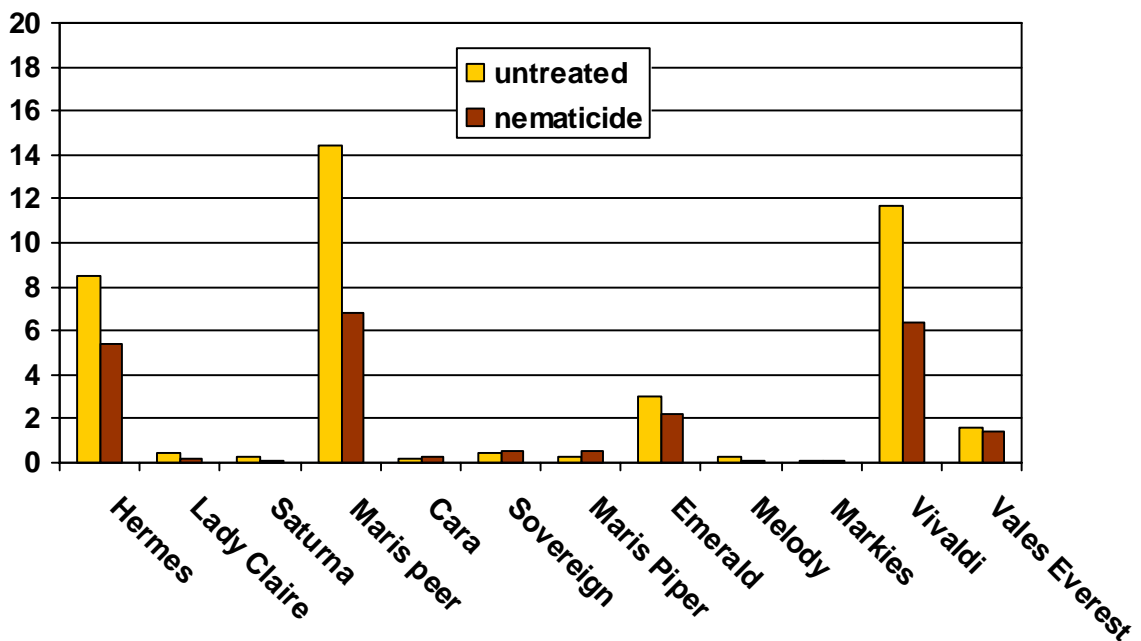
Crop Name	Potato tuber	Potato tuber	Potato tuber
Part Rated	21/Sep/2006	21/Sep/2006	21/Sep/2006
Rating Date	<45mm	+45mm	Total Yield
Rating Data Type	t/ha	t/ha	t/ha
Rating Unit			
Trt Treatment			
No. Name	4	5	6
1 Hermes	4.7 e-h	37.7 fgh	42.4 g-k
2 Hermes + Vydate	2.4 gh	54.7 cde	57.1 def
3 Lady Claire	7.3 c-f	27.8 hi	35.1 jkl
4 Lady Claire + Vydate	8.6 b-e	29.2 ghi	37.8 ijk
5 Saturna	13.2 ab	37.4 fgh	50.7 e-h
6 Saturna + Vydate	16.4 a	33.5 gh	49.9 e-i
7 Maris Peer	11.9 abc	18.8 ijk	30.7 kl
8 Maris Peer + Vydate	9.0 b-e	36.0 gh	45.0 f-j
9 Cara	3.2 fgh	71.4 a	74.6 ab
10 Cara + Vydate	8.9 b-e	67.2 ab	76.1 a
11 Sovereign	1.6 h	39.6 fg	41.2 h-k
12 Sovereign + Vydate	1.9 h	48.6 ef	50.5 e-h
13 Maris Piper	4.9 e-h	59.0 b-e	63.9 a-d
14 Maris Piper + Vydate	6.8 d-g	65.4 abc	72.2 abc
15 Emerald	12.0 ab	12.9 k	24.9 l
16 Emerald + Vydate	10.4 bcd	26.5 hij	36.9 jkl
17 Melody	2.4 gh	52.2 de	54.7 d-g
18 Melody + Vydate	2.4 gh	64.3 abc	66.7 a-d
19 Markies	1.6 h	60.4 a-d	62.0 b-e
20 Markies + Vydate	2.2 gh	54.9 cde	57.1 def
21 Vivaldi	15.2 a	15.7 jk	30.9 kl
22 Vivaldi + Vydate	12.9 ab	29.0 ghi	41.9 h-k
23 Vales Everest	1.6 h	61.8 a-d	63.4 a-d
24 Vales Everest + Vydate	2.4 gh	57.6 b-e	60.0 cde
LSD (P=0.05)	4.63	11.78	12.67
Standard Deviation	2.81	7.14	7.68
CV	41.07	16.14	15.04
Replicate F	0.582	2.058	2.192
Replicate Prob(F)	0.5626	0.1393	0.1233
Treatment F	9.018	18.346	10.838
Treatment Prob(F)	0.0001	0.0001	0.0001

Means followed by same letter do not significantly differ (P=0.05, LSD)

2.3.3 PCN population dynamics, Spalding.

The use of a nematicide reduced the PCN population increase (Pf:Pi) for all varieties not resistant to *G. rostochiensis*. All of these reductions are significant (Table 5; P=0.05). Variety greatly influenced the PCN population increase both in the presence and absence of a nematicide. Even where a nematicide was used, Pf:Pi values of 5 were exceeded by most *G. rostochiensis* susceptible varieties. Cropping all *G. rostochiensis* resistant varieties resulted in a sharp decline in PCN numbers. Differences between the resistant varieties, in their ability to cause PCN decline, were not observed in this trial. The varieties Maris peer, Vivaldi and Hermes resulted in the greatest PCN population increase, both with and without a nematicide treatment. Emerald resulted in significantly (P=0.05) less PCN multiplication than the related variety Maris Peer (Fig. 2).

FIGURE 2. EFFECT OF VARIETY AND NEMATICIDE ON PCN POPULATION DYNAMICS (Pf:Pi).



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TABLE 5. THE EFFECT OF VARIETY AND NEMATICIDE ON PCN POPULATION DYNAMICS (SPALDING; Pf:Pi).

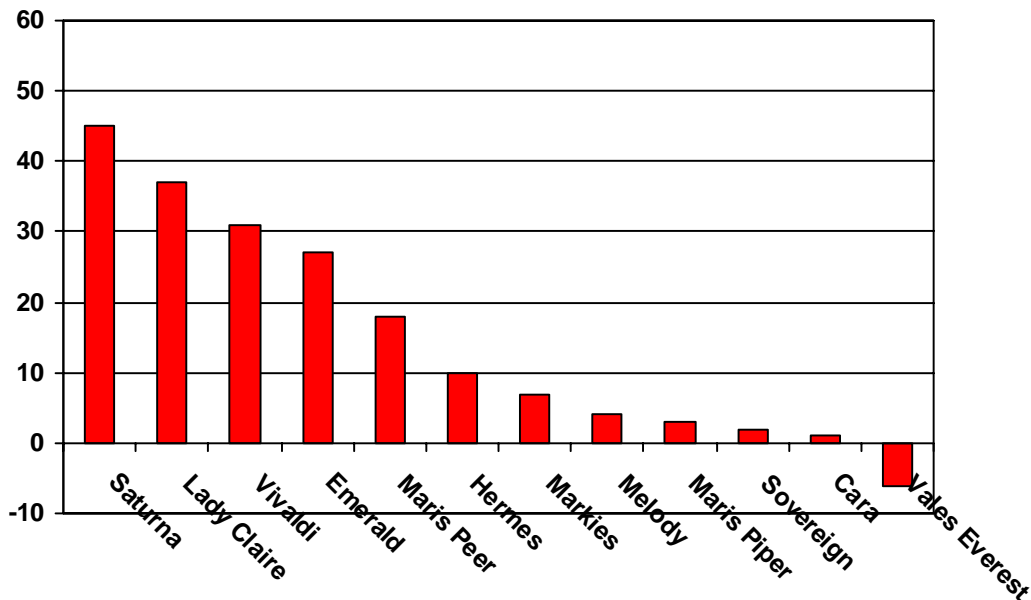
Crop Name Rating Date Rating Data Type	Potato 21/Sep/2006 Pf:Pi
Trt Treatment No Name .	7
1 Hermes	8.5 b
2 Hermes + Vydate	5.4 cd
3 Lady Claire	0.4 ef
4 Lady Claire + Vydate	0.2 ef
5 Saturna	0.3 ef
6 Saturna + Vydate	0.1 f
7 Maris Peer	14.4 a
8 Maris Peer + Vydate	6.8 bc
9 Cara	0.2 ef
10 Cara + Vydate	0.3 ef
11 Sovereign	0.4 ef
12 Sovereign + Vydate	0.5 ef
13 Maris Piper	0.3 ef
14 Maris Piper + Vydate	0.5 ef
15 Emerald	3.0 de
16 Emerald + Vydate	2.2 ef
17 Melody	0.3 ef
18 Melody + Vydate	0.1 f
19 Markies	0.1 ef
20 Markies + Vydate	0.1 ef
21 Vivaldi	11.7 a
22 Vivaldi + Vydate	6.4 bc
23 Vales Everest	1.6 ef
24 Vales Everest + Vydate	1.4 ef
LSD (P=.05)	2.88
Standard Deviation	1.74
CV	64.36
Replicate F	1.103
Replicate Prob(F)	0.3405
Treatment F	16.079
Treatment Prob(F)	0.0001

Means followed by same letter do not significantly differ (P=.05, LSD)

2.3.4 Potato yield and grade, Cawston.

Nematicide application resulted in a yield increase in all varieties except Vales Everest, many of these yield increases were significant (Table 6; $P=0.05$). However the size of yield increase varied greatly with variety, indicating a range of PCN tolerance levels within the varieties tested. Saturna, Lady Claire, Vivaldi, Emerald and Maris Peer, showed the largest yield increases due to nematicide use, indicating that these varieties have low tolerance to PCN. Conversely, Cara, Markies, Sovereign, Melody, Maris Piper and Vales Everest exhibited a higher level of tolerance to PCN (Fig. 3).

FIGURE 3. EFFECT OF NEMATICIDE ON % INCREASE IN TOTAL YIELD (CAWSTON; RANKED DATA).



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TABLE 6. EFFECT OF NEMATICIDE ON YIELD AND GRADE OF POTATOES (CAWSTON; T/HA).

Crop Name	Potato tuber	Potato tuber	Potato tuber
Part Rated	3/Oct/2006	3/Oct/2006	3/Oct/2006
Rating Date	<45mm	+45mm	Total Yield
Rating Data Type	t/ha	t/ha	t/ha
Rating Unit			
Trt Treatment			
No. Name	4	5	6
1 Hermes	3.3 ij	49.6 gh	52.9 ghi
2 Hermes + Vydate	1.8 j	56.4 fg	58.2 f-i
3 Lady Claire	12.9 de	11.4 k	24.3 k
4 Lady Claire + Vydate	13.4 de	20.0 jk	33.4 jk
5 Saturna	19.0 abc	24.3 jk	43.3 ij
6 Saturna + Vydate	15.8 cd	47.1 gh	62.9 efg
7 Maris Peer	18.5 abc	17.7 jk	36.2 jk
8 Maris Peer + Vydate	16.5 bcd	26.2 ij	42.8 ij
9 Cara	7.3 f-i	110.3 ab	117.6 a
10 Cara + Vydate	6.1 g-j	112.8 a	118.8 a
11 Sovereign	5.0 hij	76.9 e	81.9 cd
12 Sovereign + Vydate	2.1 j	81.3 de	83.3 cd
13 Maris Piper	9.5 efg	60.3 fg	69.7 def
14 Maris Piper + Vydate	10.4 ef	61.4 fg	71.8 def
15 Emerald	14.9 cd	20.2 jk	35.1 jk
16 Emerald + Vydate	20.3 ab	24.2 jk	44.5 hij
17 Melody	3.0 ij	67.1 ef	70.1 def
18 Melody + Vydate	4.3 ij	68.6 ef	72.9 def
19 Markies	9.1 e-h	61.0 fg	70.1 def
20 Markies + Vydate	5.3 g-j	69.9 ef	75.2 de
21 Vivaldi	21.6 a	23.9 jk	45.6 hij
22 Vivaldi + Vydate	20.3 ab	39.4 hi	59.7 fgh
23 Vales Everest	2.1 j	97.8 bc	99.9 b
24 Vales Everest + Vydate	2.2 j	91.7 cd	93.9 bc
LSD (P=.05)	4.27	14.76	15.47
Standard Deviation	2.59	8.94	9.38
CV	25.37	16.26	14.39
Replicate F	0.611	0.924	0.619
Replicate Prob(F)	0.5470	0.4043	0.5430
Treatment F	20.863	34.499	22.247
Treatment Prob(F)	0.0001	0.0001	0.0001

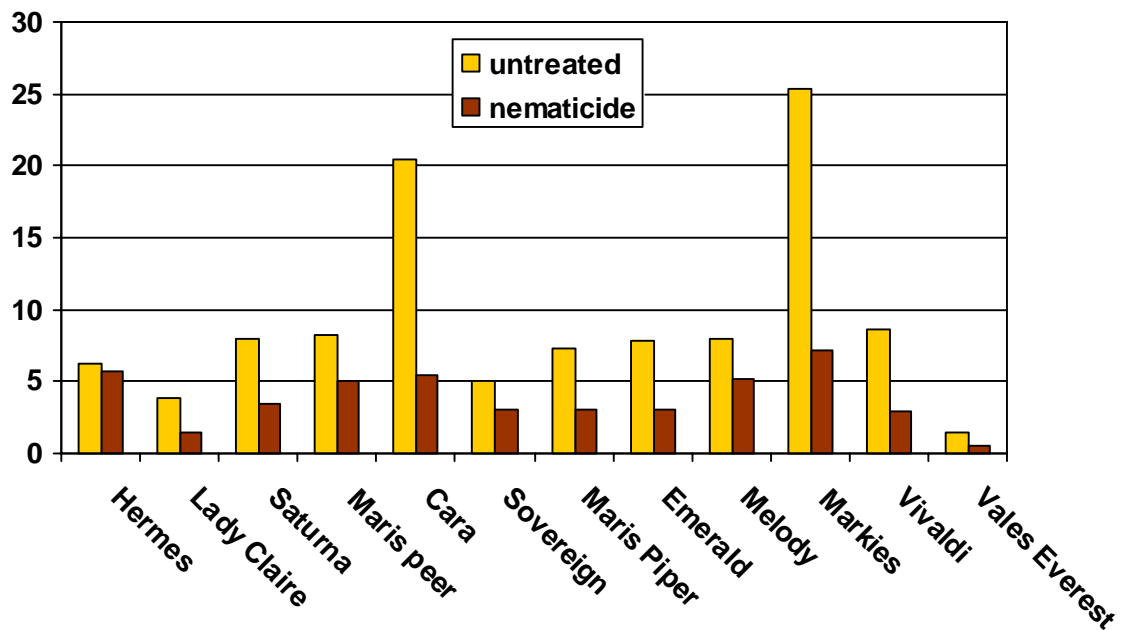
Means followed by same letter do not significantly differ (P=.05, LSD)

2.3.5 PCN population dynamics, Cawston.

Use of a nematicide reduced PCN multiplication (Pf:Pi) for all varieties tested. Several of the reductions were significant (Table 7; P=0.05). Only the Vales Everest + Vydate combination resulted in a reduction in PCN level (Pf:Pi of less than 1). Variety greatly influenced the PCN multiplication, both in the presence and absence of a nematicide (Fig. 4). Growing the varieties Cara and Markies, resulted in large PCN population increases compared with all other varieties in the trial. In contrast to the Spalding site, Emerald resulted in similar PCN multiplication to the related variety Maris Peer. However the comparison is between different PCN species at each site.

The PCN population dynamics reported here for susceptible varieties at Cawston are similar to the results obtained from the un-irrigated site at Spalding.

FIGURE 4. EFFECT OF VARIETY AND NEMATICIDE ON PCN POPULATION DYNAMICS (Pf:Pi).



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TABLE 7. THE EFFECT OF VARIETY AND NEMATICIDE ON PCN POPULATION DYNAMICS (CAWSTON PF:Pi).

Pest Name	<i>Globodera pallida</i>
Crop Name	Potato
Crop Variety	Various
Rating Date	3/Oct/2006
Rating Data Type	Pf:Pi
Trt Treatment	
No. Name	7
1 Hermes	6.3 c-f
2 Hermes + Vydate	5.7 c-f
3 Lady Claire	3.9 e-h
4 Lady Claire + Vydate	1.5 h
5 Saturna	8.0 cd
6 Saturna + Vydate	3.4 fgh
7 Maris Peer	8.2 cd
8 Maris Peer + Vydate	5.0 def
9 Cara	20.5 b
10 Cara + Vydate	5.4 c-f
11 Sovereign	5.0 d-g
12 Sovereign + Vydate	3.0 fgh
13 Maris Piper	7.3 cde
14 Maris Piper + Vydate	3.1 fgh
15 Emerald	7.8 cd
16 Emerald + Vydate	3.0 fgh
17 Melody	7.9 cd
18 Melody + Vydate	5.2 c-f
19 Markies	25.4 a
20 Markies + Vydate	7.2 cde
21 Vivaldi	8.6 c
22 Vivaldi + Vydate	2.9 fgh
23 Vales Everest	1.5 gh
24 Vales Everest + Vydate	0.5 h
LSD (P=.05)	3.50
Standard Deviation	2.12
CV	32.52
Replicate F	14.123
Replicate Prob(F)	0.0001
Treatment F	21.036
Treatment Prob(F)	0.0001

3. Discussion and conclusions

Tolerance

At Cawston in 2006, Saturna, Lady Claire, Vivaldi, Emerald and Maris Peer showed the largest yield increases due to nematicide use, indicating that these varieties have low tolerance to PCN. Three of these varieties also showed the least tolerance in the Spalding trial, despite different PCN species, irrigation regime and soil type between the two sites.

The good correlation between two different sites provides confidence in this field-based method of comparing varietal tolerance to PCN. However, the two crisping varieties Saturna and Lady Claire performed very differently between the two sites. These varieties appeared tolerant at Spalding but very intolerant at Cawston. The same inconsistency between sites was observed with Saturna in 2005 when the same species of PCN (*G. pallida*) occurred at both sites.

Cara, Maris Piper, Markies and Vales Everest exhibited a higher level of tolerance to PCN at both Cawston and Spalding. Sovereign and Melody were also amongst the most tolerant varieties at Cawston.

PCN populations

At both sites in 2006, the partially resistant variety Vales Everest, greatly limited the multiplication of PCN. At Cawston, growing Vales Everest + Vydate resulted in a decrease in PCN (*G.pallida*) population. Growing *G.rostochiensis* resistant varieties (Lady Claire, Saturna, Cara, Sovereign, Maris piper, Melody, Markies and Vales Everest) at Spalding resulted in greatly reduced PCN multiplication. The PCN population dynamics reported for Cawston are similar to the results obtained from the un-irrigated site at Spalding (when comparing susceptible varieties).

Annex 1. Details of trials carried out in 2006.

Spalding

Co-operator:	Lincolnshire Field Products Ltd. Spalding, Lincs
Site:	Holbeach Spalding Lincs.
Grid reference:	TF 288264
Soil type:	fine sandy silt loam
Previous crop (2005):	Brussels sprout
Crop & Cultivar:	Potato – 12 varieties were planted at 20cm spacing. Tightly graded seed (35-45mm) of a similar physiological age was planted.
Planting Date:	14.04.2006
Field Preparation:	Mouldboard plough (winter) Power harrow Rotovator (to incorporate nematicide) Plant
Plot Maintenance	Late blight, weed and insect control consistent with good local practise. Crop not irrigated.
Previous treatments:	Nil
Plot size:	1 row X 3m
Design:	RCB – first block not randomised. Three replicates.

Application Details

Nematicide granules were broadcast evenly over the ploughed soil surface using a Kerb granule shaker. Granules were then immediately incorporated into the top 15cm soil using a Basalier rotatiller prior to planting.

Date:	12.04.2006
Crop Stage:	pre-planting – two days prior to hand planting varieties.
Crop Cover:	n/a
Leaf Moisture:	n/a
Soil Moisture (Surface):	moist
Soil Moisture (Sub-surface):	moist
Soil Condition:	loose
Soil Tilth:	fine - small clods
Weather at application:	
Air temperature (Deg. C):	10
Soil temperature (Deg. C):	9
Wind (kph):	10
Cloud cover (%):	100

Treatment List

	Treatment	Rate / ha	Timing
1	Hermes		
1a	Hermes + Vydate	55kg/ha	Pre-planting
2	Lady Claire		
2a	Lady Claire + Vydate	55kg/ha	Pre-planting
3	Saturna		
3a	Saturna + Vydate	55kg/ha	Pre-planting
4	Maris peer		
4a	Maris peer + Vydate	55kg/ha	Pre-planting
5	Cara		
5a	Cara + Vydate	55kg/ha	Pre-planting
6	Sovereign		
6a	Sovereign + Vydate	55kg/ha	Pre-planting
7	Maris piper		
7a	Maris piper + Vydate	55kg/ha	Pre-planting
8	Emerald		
8a	Emerald + Vydate	55kg/ha	Pre-planting
9	Melody		
9a	Melody + Vydate	55kg/ha	Pre-planting
10	Markies		
10a	Markies + Vydate	55kg/ha	Pre-planting
11	Vivaldi		
11a	Vivaldi + Vydate	55kg/ha	Pre-planting
12	Vales Everest		
12a	Vales Everest + Vydate	55kg/ha	Pre-planting

Product List

Product	Active Ingredient	g/l or kg	Formulation	Batch Number
Vydate	oxamyl	10% w/w	GR	APR04CE051

Cawston

Co-operator:	Clifford Pye Ltd. Cawston, Norfolk
Site:	Cawston Norfolk
Grid reference:	TG 135254
Soil type:	sandy loam
Previous crop (2005):	Winter barley
Crop & Cultivar:	Potato – 14 varieties were planted at 20cm spacing. Tightly graded seed (35-45mm) of a similar physiological age was planted.
Planting Date:	07.04.2006
Field Preparation:	Mouldboard plough (winter) Nematicide applied overall – Horstine Farmery TMA4 Bed form De-stone Plant
Plot Maintenance	Late blight, weed and insect control consistent with good local practise. Irrigated crop.
Previous treatments:	Nil
Plot size:	1 row X 3m
Design:	RCB – first block not randomised. Three replicates.

Application Details

Nematicide granules were broadcast evenly over the ploughed soil surface using a Horstine Microband TMA4 applicator.

Date:	01.04.2006
Crop Stage:	pre-planting – six days prior to hand planting varieties.
Crop Cover:	n/a
Leaf Moisture:	n/a
Soil Moisture (Surface):	moist
Soil Moisture (Sub-surface):	moist
Soil Condition:	loose
Soil Tilth:	fine
Weather at application:	
Air temperature (Deg. C):	13
Soil temperature (Deg. C):	9
Wind (kph):	15
Cloud cover (%):	70

Treatment List

	Treatment	Rate / ha	Timing
1	Hermes		
1a	Hermes + Vydate	55kg/ha	Pre-planting
2	Lady Claire		
2a	Lady Claire + Vydate	55kg/ha	Pre-planting
3	Saturna		
3a	Saturna + Vydate	55kg/ha	Pre-planting
4	Maris peer		
4a	Maris peer + Vydate	55kg/ha	Pre-planting
5	Cara		
5a	Cara + Vydate	55kg/ha	Pre-planting
6	Sovereign		
6a	Sovereign + Vydate	55kg/ha	Pre-planting
7	Maris piper		
7a	Maris piper + Vydate	55kg/ha	Pre-planting
8	Emerald		
8a	Emerald + Vydate	55kg/ha	Pre-planting
9	Melody		
9a	Melody + Vydate	55kg/ha	Pre-planting
10	Markies		
10a	Markies + Vydate	55kg/ha	Pre-planting
11	Vivaldi		
11a	Vivaldi + Vydate	55kg/ha	Pre-planting
12	Vales Everest		
12a	Vales Everest + Vydate	55kg/ha	Pre-planting

Product list

Product	Active Ingredient	g/l or kg	Formulation	Batch Number
Vydate	oxamyl	10% w/w	GR	APR04CE051

Annex 2. Details of trials carried out in 2005

Trials and results from 2 sites in 2005

The trials were carried out at two sites: Holbeach, Lincolnshire (fine sandy silt loam) and Trunch, Norfolk (sandy loam). Fields with the required PCN infestation levels were selected on the basis of normal commercial PCN sampling at one hectare sampling units. Suitable areas within fields were re-sampled on a 20 metre square grid to confirm required PCN level and uniformity of the infestation. Fourteen varieties were planted at both sites.

Table A2.1 - Treatment List

	Treatment	Rate / ha	Timing
1	Hermes		
1a	Hermes + Vydate	55kg/ha	Pre-planting
2	Lady Rosetta		
2a	Lady Rosetta + Vydate	55kg/ha	Pre-planting
3	Saturna		
3a	Saturna + Vydate	55kg/ha	Pre-planting
4	Maris peer		
4a	Maris peer + Vydate	55kg/ha	Pre-planting
5	Cara		
5a	Cara + Vydate	55kg/ha	Pre-planting
6	Sovereign		
6a	Sovereign + Vydate	55kg/ha	Pre-planting
7	Maris piper		
7a	Maris piper + Vydate	55kg/ha	Pre-planting
8	Estima		
8a	Estima + Vydate	55kg/ha	Pre-planting
9	Sante		
9a	Sante + Vydate	55kg/ha	Pre-planting
10	Desiree		
10a	Desiree + Vydate	55kg/ha	Pre-planting
11	Marfona		
11a	Marfona + Vydate	55kg/ha	Pre-planting
12	Pentland Dell		
12a	Pentland Dell + Vydate	55kg/ha	Pre-planting
13	Everest		
13a	Everest + Vydate	55kg/ha	Pre-planting
14	King Edward		
14a	King Edward + Vydate	55kg/ha	Pre-planting

Soil and climatic data was collected at nematicide application. Composite soil samples were taken from each treatment block for assessment of initial PCN level (Pi) and species

composition. Each soil sample comprised sixty soil cores taken with a 1cm diameter auger from 0-20cm depth.

Crop vigour

Assessment of haulm volume was carried out to assess the vigour of plants at 53 and 71 days after planting at Holbeach and 51 and 66 days after planting at Trunch. Crop vigour/haulm volume was assessed as % crop ground cover.

Potato yield and grade

Each three metre variety plot was harvested and graded by hand. The following tuber size grades were recorded:

<45mm
>45mm
Total yield

Potato Cyst Nematode (PCN) – post harvest.

Forty soil cores (0-20cms) were taken from each plot at lifting, using a 1cm diameter auger. The soil samples were analysed for PCN level (e+l/g soil) at GrowScience (Holbeach).

Results

PCN populations

Both sites contained a single species PCN population of *Globodera pallida*. The initial PCN levels showed an even infestation over the trial area at both Holbeach and Trunch, allowing comparison between nematicide treated plots and untreated plots. The high numbers of cysts present in all samples, indicate a long-standing PCN infestation at both sites.

Table A2.2 - PCN levels in the trial area (Pi) at Holbeach (sampled 18.04.2005)

Sample area	Total cysts/100g soil	eggs/g soil
Block 1	37	20
Block 2	43	22
Block 3	37	21

Table A2.3 - PCN levels in the trial area (Pi) at Trunch (sampled 18.04.2005)

Sample area	Total cysts/100g soil	eggs/g soil
Block 1	28	19
Block 2	21	17
Block 3	31	16

Crop vigour (haulm volume / % ground cover), Holbeach.

An indirect method of assessing varietal tolerance is to compare the vigour of a variety grown with and without a nematicide. Small differences in vigour between the nematicide treated and untreated plots would indicate good tolerance to PCN damage. Conversely, large differences in crop vigour indicate lower levels of tolerance to PCN.

Use of nematicide increased crop vigour in all varieties, many of these vigour increases were significant ($P=0.05$). Maris Peer, Sante, Marfona and Lady Rosetta showed the greatest vigour increases due to nematicide application, indicating that these varieties may be among the least tolerant to PCN (Figs. A2.1-2; Table A2.4).

Figure A2.1 – Effect of nematicide on crop vigour increase (% ground cover) at Holbeach 53 days after planting

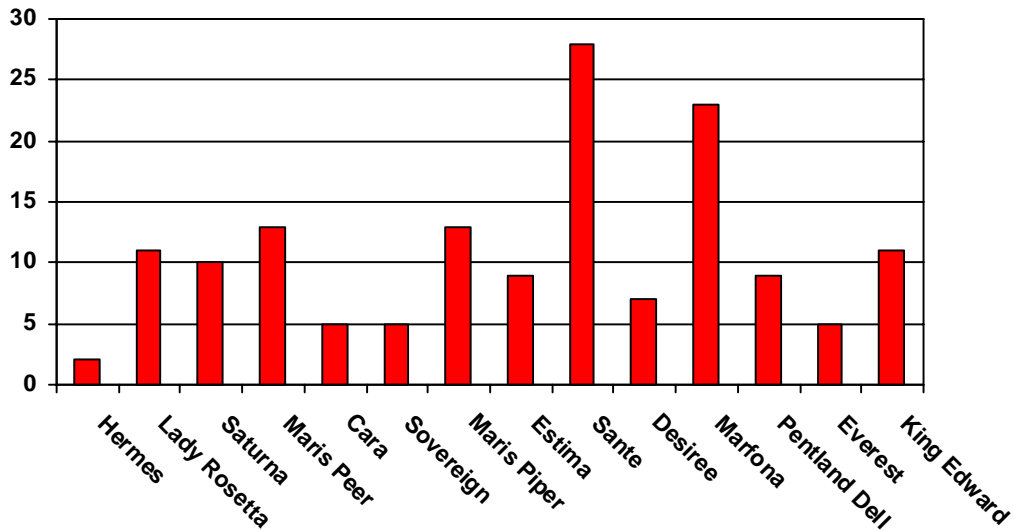


Figure A2.2 – Effect of nematicide on crop vigour increase (% ground cover) at Holbeach 71 days after planting

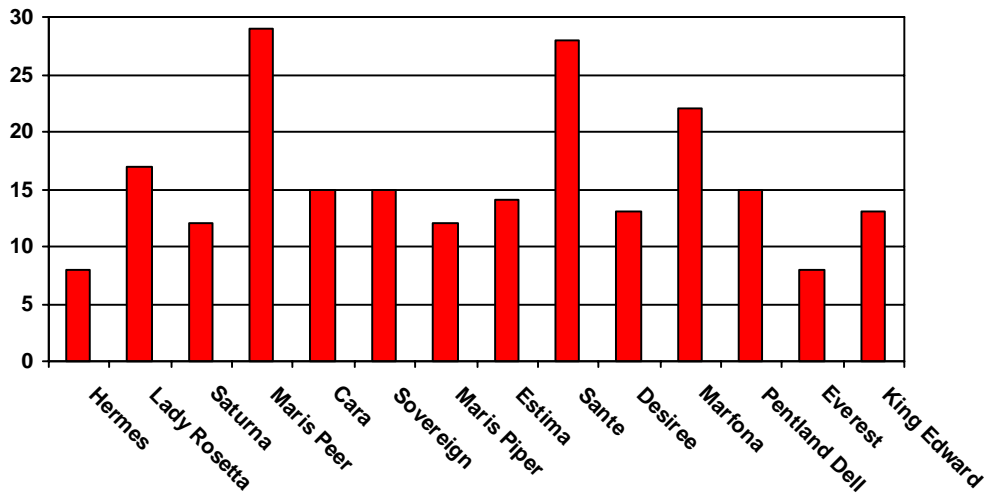


Table A2.4 – Crop vigour (% ground cover) assessed at Holbeach 53 and 71 days after planting.

Part Rated		Haulm	Haulm
Rating Date		9/Jun/2005	27/Jun/2005
Rating Data Type		Crop vigour	Crop vigour
Rating Unit		% ground	% ground
Trt No.	Treatment Name	Rate Unit	
		6	7
1	Hermes	13 jk	45 g-k
2	Hermes + Vydate	15 ijk	53 d-h
3	Lady Rosetta	22 hij	38 jk
4	Lady Rosetta + Vydate	33 c-f	55 d-g
5	Saturna	32 d-g	60 b-e
6	Saturna + Vydate	42 bc	72 a
7	Maris Peer	20 h-k	38 jk
8	Maris Peer + Vydate	33 c-f	67 abc
9	Cara	32 d-g	53 d-h
10	Cara + Vydate	37 cd	68 abc
11	Sovereign	15 ijk	40 ijk
12	Sovereign + Vydate	20 h-k	55 d-g
13	Maris Piper	35 cde	55 d-g
14	Maris Piper + Vydate	48 b	67 abc
15	Estima	23 ghi	48 f-j
16	Estima + Vydate	32 d-g	62 a-d
17	Sante	37 cd	42 ijk
18	Sante + Vydate	65 a	70 ab
19	Desiree	25 fgh	45 g-k
20	Desiree + Vydate	32 d-g	58 c-f
21	Marfona	27 e-h	38 jk
22	Marfona + Vydate	50 b	60 b-e
23	Pentland Dell	18 h-k	43 h-k
24	Pentland Dell + Vydate	27 e-h	58 c-f
25	Everest	13 jk	45 g-k
26	Everest + Vydate	18 h-k	53 d-h
27	King Edward	12 k	37 k
28	King Edward + Vydate	23 ghi	50 e-i
LSD (P=.05)		9.4	11.4
Standard Deviation		5.8	7.0
CV		20.19	13.29
Replicate F		1.410	5.405
Replicate Prob(F)		0.2531	0.0073
Treatment F		14.085	6.814
Treatment Prob(F)		0.0001	0.0001

Means followed by same letter do not significantly differ (P=.05, LSD)

Potato yield and grade, Holbeach.

Nematicide application resulted in a yield increase in all varieties, many of these yield increases were significant ($P=0.05$). However the size of yield increase varied greatly with variety, indicating a range of PCN tolerance levels within the varieties tested.

Maris peer, Marfona, Sante and Lady Rosetta showed the largest yield increases due to nematicide use, indicating that these varieties have low tolerance to PCN. Conversely, Cara, Saturna, Maris Piper and Everest exhibited a higher level of tolerance to PCN (Figs. A2.3-4; Table 5).

Figure A2.3 – Effect of nematicide on % increase in total yield (Holbeach; ranked data).

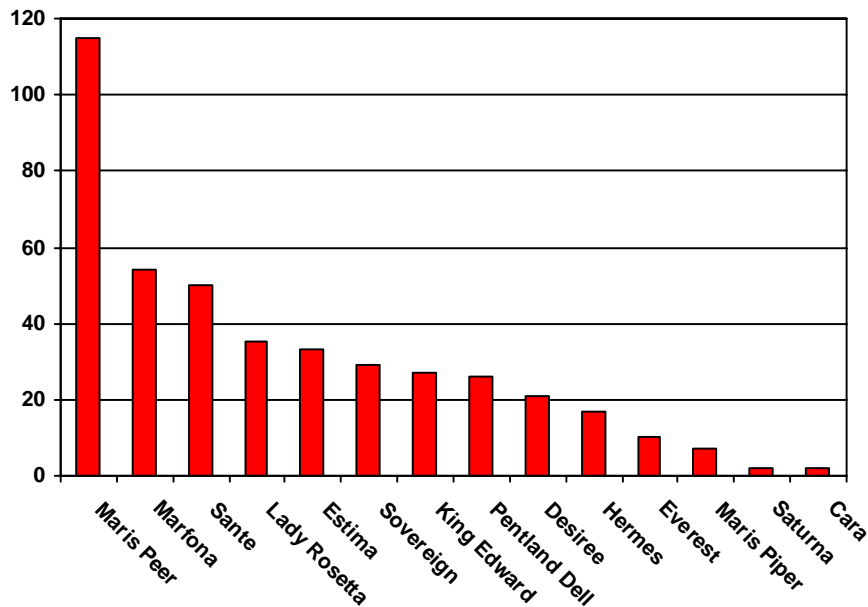


Table A2.5 – Effect of nematicide on yield and grade of potatoes (Holbeach; t/ha).

Pest Name			<i>Globodera pallida</i>	<i>Globodera pallida</i>	<i>Globodera pallida</i>
Crop Code			SOLTU	SOLTU	SOLTU
BBCH Scale			BPOT	BPOT	BPOT
Crop Name			Potato	Potato	Potato
Crop Variety			various	various	various
Part Rated			<45mm	+45mm	
Rating Date			21/Sep/2005	21/Sep/2005	
Rating Data Type			<45mm	+45mm	Total Yield
Rating Unit			t/ha	t/ha	t/ha
Trt No.	Treatment Name	Rate Unit	3	4	5
1	Hermes		1.9 k	47.4 e-h	49.4 def
2	Hermes + Vydate		2.9 jk	55.1 c-f	58.0 c-f
3	Lady Rosetta		5.1 ij	42.4 fgh	47.5 efg
4	Lady Rosetta + Vydate		3.6 jk	60.6 b-e	64.2 bcd
5	Saturna		14.7 b	39.0 fgh	53.7 def
6	Saturna + Vydate		14.0 bc	40.8 fgh	54.8 def
7	Maris Peer		18.5 a	7.5 j	26.0 h
8	Maris Peer + Vydate		18.8 a	37.0 ghi	55.8 def
9	Cara		4.6 ij	75.4 ab	80.0 a
10	Cara + Vydate		5.1 ij	76.8 ab	81.9 a
11	Sovereign		2.9 jk	53.9 c-f	56.8 def
12	Sovereign + Vydate		3.2 jk	70.1 abc	73.3 abc
13	Maris Piper		8.1 fgh	67.7 a-d	75.9 ab
14	Maris Piper + Vydate		9.4 efg	72.0 ab	81.3 a
15	Estima		10.5 ef	33.4 hi	43.8 fg
16	Estima + Vydate		11.1 de	47.0 e-h	58.1 c-f
17	Sante		3.0 jk	52.6 d-g	55.7 def
18	Sante + Vydate		3.3 jk	80.4 a	83.6 a
19	Desiree		6.7 hi	38.9 fgh	45.6 fg
20	Desiree + Vydate		6.9 ghi	48.4 e-h	55.3 def
21	Marfona		11.4 cde	21.6 ij	33.1 gh
22	Marfona + Vydate		9.7 ef	41.2 fgh	50.9 def
23	Pentland Dell		10.5 ef	32.8 hi	43.3 fg
24	Pentland Dell + Vydate		10.1 ef	44.4 e-h	54.5 def
25	Everest		1.3 k	74.6 ab	76.0 ab
26	Everest + Vydate		1.6 k	82.1 a	83.7 a
27	King Edward		11.9 cde	37.0 ghi	48.9 def
28	King Edward + Vydate		13.1 bcd	49.1 e-h	62.2 b-e
LSD (P=.05)			2.61	16.54	15.55
Standard Deviation			1.60	10.13	9.52
CV			19.94	19.84	16.12
Replicate F			4.578	12.294	11.415
Replicate Prob(F)			0.0146	0.0001	0.0001
Treatment F			29.915	10.056	7.864
Treatment Prob(F)			0.0001	0.0001	0.0001

Means followed by same letter do not significantly differ (P=.05, LSD)

PCN population dynamics, Holbeach.

The use of a nematicide reduced the PCN population increase (Pf:Pi) for all varieties tested. Several of the reductions are significant (P=0.05). Variety greatly influenced the PCN population increase (Pf:Pi), both in the presence and absence of a nematicide. Even where a nematicide was used, Pf:Pi values of 10 were exceeded by most varieties.

Cara showed the highest rate of PCN multiplication, especially when grown without a nematicide. The more tolerant varieties generally resulted in the higher PCN multiplication rates. One notable exception to this trend was Everest which showed both tolerance and good levels of partial resistance to *G. pallida*. This combination of traits has not been available in other potato varieties (Fig. A2.4; Table A2.6).

Figure A2.4 – Effect of variety and nematicide on PCN population dynamics (Pf:Pi).

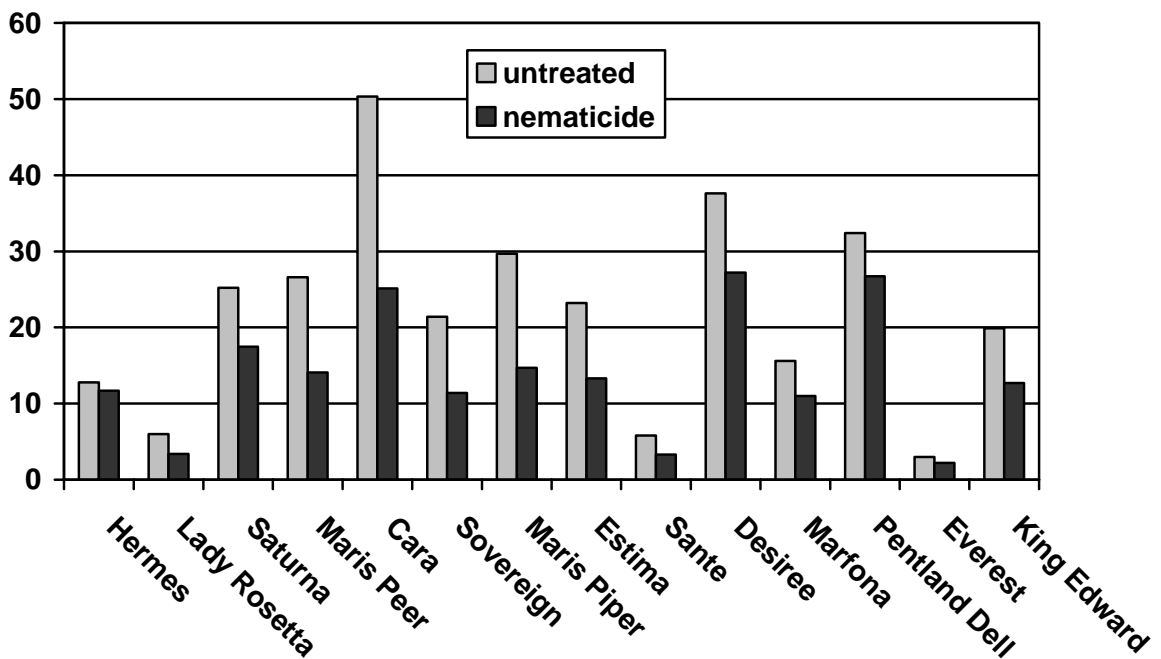


Table A2.6 – The effect of variety and nematicide on PCN population dynamics (Holbeach; Pf:Pi).

Part Rated			Pf/Pi ratio	
Trt No.	Treatment Name	Rate Unit	8	
1	Hermes		12.8	g-l
2	Hermes + Vydate		11.7	h-l
3	Lady Rosetta		6.0	i-l
4	Lady Rosetta + Vydate		3.4	jkl
5	Saturna		25.2	c-f
6	Saturna + Vydate		17.5	e-h
7	Maris Peer		26.6	cde
8	Maris Peer + Vydate		14.1	g-j
9	Cara		50.3	a
10	Cara + Vydate		25.1	c-f
11	Sovereign		21.4	d-h
12	Sovereign + Vydate		11.4	h-l
13	Maris Piper		29.7	bcd
14	Maris Piper + Vydate		14.7	f-i
15	Estima		23.2	c-g
16	Estima + Vydate		13.3	g-k
17	Sante		5.8	i-l
18	Sante + Vydate		3.3	jkl
19	Desiree		37.6	b
20	Desiree + Vydate		27.2	b-e
21	Marfona		15.6	f-i
22	Marfona + Vydate		11.0	h-l
23	Pentland Dell		32.4	bc
24	Pentland Dell + Vydate		26.7	b-e
25	Everest		3.0	kl
26	Everest + Vydate		2.2	l
27	King Edward		19.9	d-h
28	King Edward + Vydate		12.7	g-l
LSD (P=.05)			11.01	
Standard Deviation			6.74	
CV			37.49	
Replicate F			2.539	
Replicate Prob(F)			0.0884	
Treatment F			8.765	
Treatment Prob(F)			0.0001	

Means followed by same letter do not significantly differ (P=.05, LSD)

Crop vigour (haulm volume / % ground cover), Trunch.

Use of nematicide increased crop vigour in most varieties, many of these vigour increases were significant (P=0.05). Sante, King Edward, Marfona and Maris Peer showed the greatest vigour increases due to nematicide application, indicating that these varieties may be among the least tolerant to PCN (Figs. A2.5-6; Table A2.7).

Figure A2.5 – Effect of nematicide on crop vigour increase (% ground cover), Trunch 51 and 66 days after planting

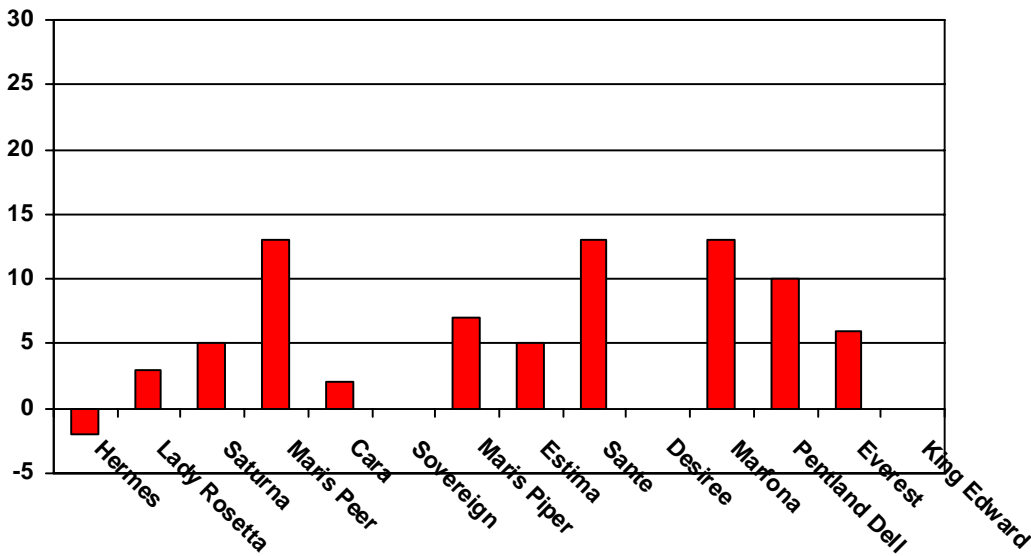


Figure A2.6 – Effect of nematicide on crop vigour increase (% ground cover), Trunch 51 and 66 days after planting

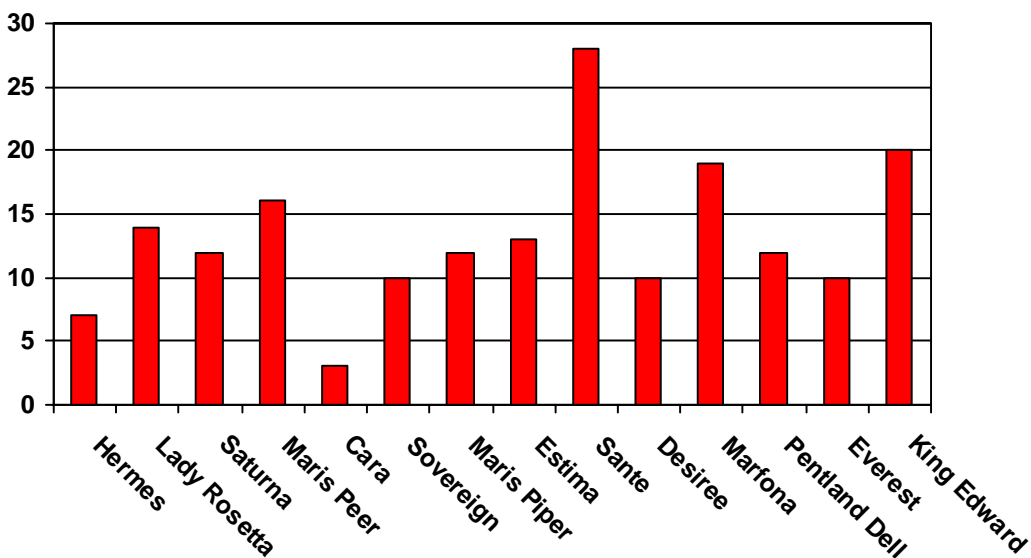


Table A2.7– Crop vigour (% ground cover) assessed at Trunch 51 and 66 days after planting

Rating Date			8/Jun/2005	23/Jun/2005
Rating Unit			% Ground cover	% Ground cover
Trt No.	Treatment Name	Rate Unit	6	7
1	Hermes		12 i	58 j-n
2	Hermes + Vydate		10 i	65 g-k
3	Lady Rosetta		22 fgh	48 op
4	Lady Rosetta + Vydate		25 d-g	62 h-m
5	Saturna		28 c-f	68 e-i
6	Saturna + Vydate		33 bcd	80 abc
7	Maris Peer		25 d-g	67 f-j
8	Maris Peer + Vydate		38 ab	83 ab
9	Cara		23 e-h	75 b-f
10	Cara + Vydate		25 d-g	78 a-d
11	Sovereign		11 i	53 mno
12	Sovereign + Vydate		11 i	63 h-l
13	Maris Piper		33 bcd	73 c-g
14	Maris Piper + Vydate		40 ab	85 a
15	Estima		18 ghi	55 l-o
16	Estima + Vydate		23 e-h	68 e-i
17	Sante		22 fgh	50 nop
18	Sante + Vydate		35 bc	78 a-d
19	Desiree		22 fgh	57 k-o
20	Desiree + Vydate		22 fgh	67 f-j
21	Marfona		32 b-e	58 j-n
22	Marfona + Vydate		45 a	77 a-e
23	Pentland Dell		15 hi	58 j-n
24	Pentland Dell + Vydate		25 d-g	70 d-h
25	Everest		12 i	60 i-m
26	Everest + Vydate		18 ghi	70 d-h
27	King Edward		12 i	43 p
28	King Edward + Vydate		12 i	63 h-l
LSD (P=.05)			8.8	9.9
Standard Deviation			5.4	6.1
CV			23.15	9.27
Replicate F			0.439	2.346
Replicate Prob(F)			0.6469	0.1054
Treatment F			9.853	9.465
Treatment Prob(F)			0.0001	0.0001

Potato yield and grade, Trunch.

Nematicide application resulted in a yield increase in all varieties, many of these yield increases were significant ($P=0.05$). However the size of yield increase varied greatly with variety, indicating a range of PCN tolerance levels within the varieties tested.

Maris Peer, Marfona, Sante and Lady Rosetta showed the largest yield increases due to nematicide use, indicating that these varieties have low tolerance to PCN. Conversely, Cara, Sovereign, Desiree, Maris Piper and Everest exhibited a higher level of tolerance to PCN (Figs.A2.8-9; Table A2.8).

Figure A2.8 – Effect of nematicide on % increase in total yield, Trunch

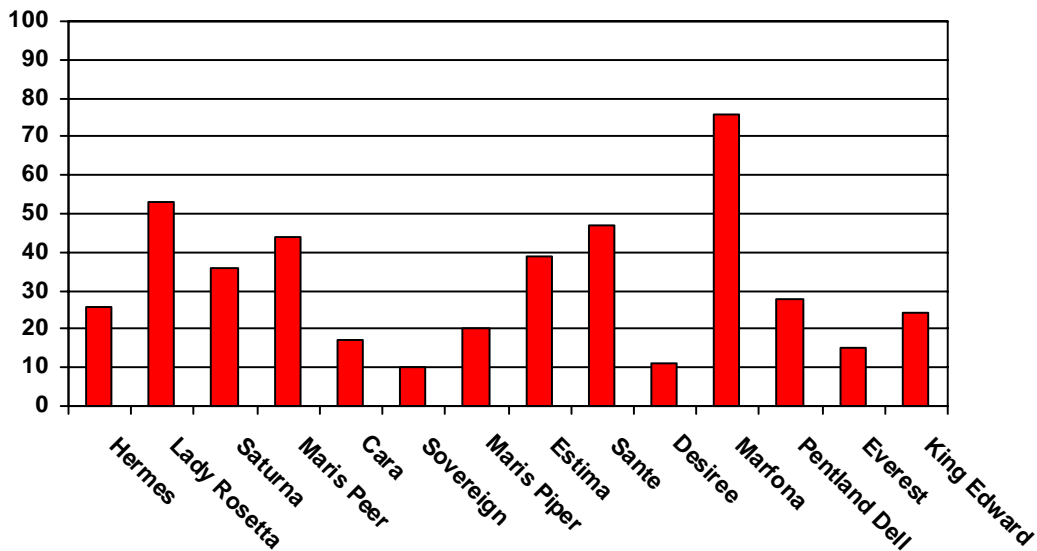


Figure A2.9 - Effect of nematicide on % increase in total yield (Trunch; ranked data).

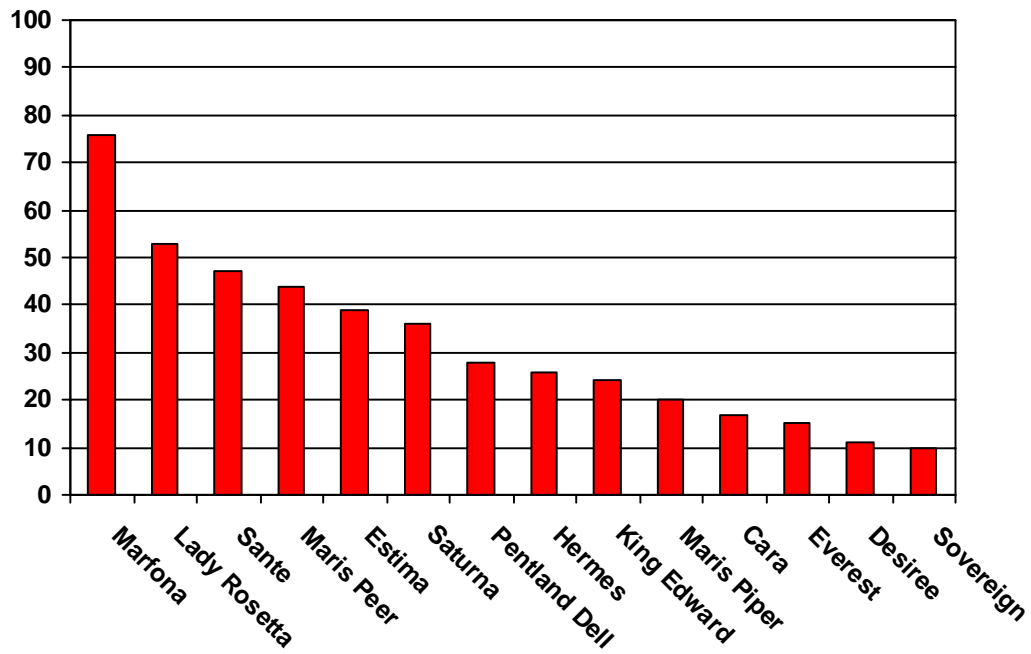


Table A2.8 – Effect of nematicide on yield and grade of potatoes (Trunch; t/ha).

Crop Name	Potato	Potato	Potato
Crop Variety	various	various	various
Rating Date	3/Oct/2005	3/Oct/2005	3/Oct/2005
Rating Data Type	<45mm	>45mm	Total yield
Rating Unit	t/ha	t/ha	t/ha
Trt No.	Treatment Name	Rate Unit	
1	Hermes	3.3 m	58.3 f-i
2	Hermes + Vydate	2.4 m	61.7 e-i
3	Lady Rosetta	7.7 hi	75.5 a-d
4	Lady Rosetta + Vydate	4.3 klm	32.0 kl
5	Saturna	14.8 bc	56.4 f-i
6	Saturna + Vydate	15.8 b	39.2 jkl
7	Maris Peer	20.6 a	57.8 f-i
8	Maris Peer + Vydate	15.7 b	73.5 cde
9	Cara	6.7 ijk	29.4 l
10	Cara + Vydate	3.7 lm	50.0 hij
11	Sovereign	3.7 lm	56.2 f-i
12	Sovereign + Vydate	3.1 m	71.9 cde
13	Maris Piper	8.6 ghi	62.8 c-g
14	Maris Piper + Vydate	9.8 fgh	77.7 abc
15	Estima	10.8 efg	67.8 c-f
16	Estima + Vydate	7.9 hi	75.2 a-e
17	Sante	3.8 lm	69.0 b-f
18	Sante + Vydate	6.1 i-l	77.5 cd
19	Desiree	11.8 def	83.5 ab
20	Desiree + Vydate	7.2 ij	43.6 i-l
21	Marfona	12.3 cde	54.3 f-j
22	Marfona + Vydate	7.1 ij	75.5 cde
23	Pentland Dell	15.4 b	67.7 c-f
24	Pentland Dell + Vydate	11.2 ef	71.4 cde
25	Everest	4.8 j-m	60.7 d-h
26	Everest + Vydate	4.0 lm	64.4 d-h
27	King Edward	15.2 b	88.3 a
28	King Edward + Vydate	14.1 bcd	36.1 jkl
	LSD (P=.05)	2.49	15.48
	Standard Deviation	1.52	9.48
	CV	16.95	16.41
	Replicate F	0.653	0.512
	Replicate Prob(F)	0.5243	0.6020
	Treatment F	32.202	9.414
	Treatment Prob(F)	0.0001	0.0001

Means followed by same letter do not significantly differ (P=.05, LSD)

PCN population dynamics, Trunch.

Use of a nematicide reduced the PCN population increase (Pf:Pi) for all varieties tested. Several of the reductions were significant (P=0.05). Several variety/nematicide combinations resulted in a reduction in PCN level (a Pf:Pi of <1). Variety greatly influenced the PCN population dynamics (Pf:Pi), both in the presence and absence of a nematicide (Fig. A2.10; Table A2.9).

At both sites, the partially resistant varieties Everest and Sante, greatly limited multiplication of PCN. Lady Rosetta also consistently provided low Pf:Pi ratios despite a lack of documented evidence that this variety has any partial resistance to *G. pallida*.

The PCN population dynamics reported here are in stark contrast to the results obtained from the un-irrigated site at Holbeach. Untreated Pf:Pi ratios were generally higher at Holbeach compared with Trunch. In addition, nematicide treatments appeared far more efficacious at Trunch when compared to the Holbeach results.

Figure A2.10 – Effect of variety and nematicide on PCN population dynamics (Pf:Pi).

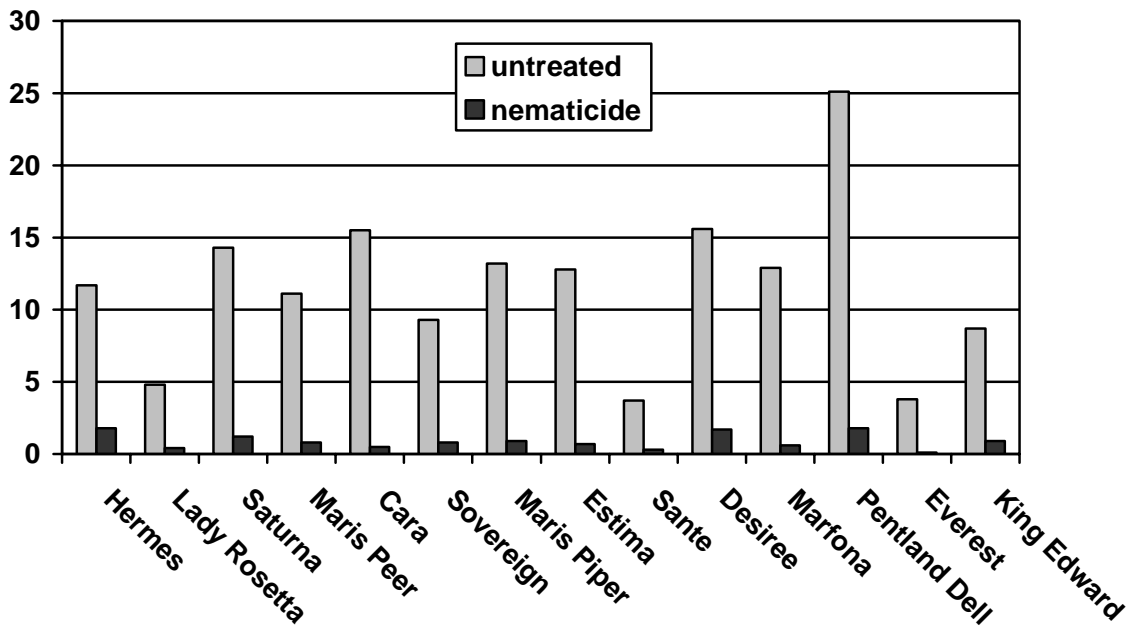


Table A2.9 – The effect of variety and nematicide on PCN population dynamics (Pf:Pi).

Rating Data Type		Pf:Pi
Trt No	Treatment Name Rate Unit	
.		8
1	Hermes	11.70 bc
2	Hermes + Vydate	1.83 ef
3	Lady Rosetta	4.80 de
4	Lady Rosetta + Vydate	0.40 ef
5	Saturna	14.27 b
6	Saturna + Vydate	1.17 ef
7	Maris Peer	11.13 bc
8	Maris Peer + Vydate	0.77 ef
9	Cara	15.47 b
10	Cara + Vydate	0.53 ef
11	Sovereign	9.30 cd
12	Sovereign + Vydate	0.80 ef
13	Maris Piper	13.17 bc
14	Maris Piper + Vydate	0.87 ef
15	Estima	12.83 bc
16	Estima + Vydate	0.70 ef
17	Sante	3.70 ef
18	Sante + Vydate	0.30 ef
19	Desiree	15.57 b
20	Desiree + Vydate	1.67 ef
21	Marfona	12.87 bc
22	Marfona + Vydate	0.60 ef
23	Pentland Dell	25.07 a
24	Pentland Dell + Vydate	1.80 ef
25	Everest	3.80 ef
26	Everest + Vydate	0.10 f
27	King Edward	8.73 cd
28	King Edward + Vydate	0.90 ef
LSD (P=.05)		4.581
Standard Deviation		2.805
CV		44.93
Replicate F		4.642
Replicate Prob(F)		0.0138
Treatment F		17.155
Treatment Prob(F)		0.0001

Means followed by same letter do not significantly differ (P=.05, LSD)