Research Project Report

Independent Variety Trials 2012

Ref: R447

Reporting Period: April 2012 - March 2013

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Report No. 2013/7

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SUMMARY FOR GROWERS

1.1. Project Aims

In order to comply with both national and European Community legislation for the marketing of seed potatoes, all potato varieties must be placed on the official National List (NL) of a Member State. When this is achieved, a variety is automatically entered on to the Common Catalogue which is, in effect, an EC National List. Part of the NL testing involves assessing a new variety for Value for Cultivation and Use. In the UK, this testing is largely concentrated on assessing varietal performance for susceptibility to diseases, pests and some tuber quality characteristics considered to be of most importance in UK potato production. After a review of the Independent Variety Trials (IVT) programme, industry, through the British Potato Council (now Potato Council), it was concluded that additional tests for some other diseases were also desirable in order to provide growers with the fullest information on the performance of new varieties before large scale production occurred. In addition, industry also concluded that potato varieties on the Common Catalogue which were being developed for GB production should also to be tested to provide independent data on these varieties for GB growers. It was also decided that IVT tests would be conducted over 2 years and not 3 years as previously, and that industry alone would be responsible for conducting field growing trials to assess varietal performance with respect to yield and usage quality.

The integration of the IVT test programme with that of UK National List Value for Cultivation and Use test programme was achieved in 2005 by the consortium of SASA, SRUC, Biomathematics & Statistics Scotland (BioSS) and the James Hutton Institute (JHI) which was awarded a 3 year contract to conduct the IVT programme. The tests conducted for IVT purposes were to determine varietal susceptibility to foliage late blight in the field, black dot, black scurf, silver scurf and skin spot. This contract was extended for a further 3 years starting 2008 and again for a further 3 years starting in 2011. An additional test to determine susceptibility to potato mop top virus (spraing) was included in the programme from 2011. Work to develop a test to evaluate varietal susceptibility to *Dickeya 'solani*' is also being carried out. As the test is still in development results for the test are not available at this time.

1.2. Work Undertaken and Findings

In 2012, tests were conducted on 7 varieties undergoing their 2nd year of UK NL testing, 9 varieties which had completed UK NL tests and 12 Common Catalogue varieties (Table 2). SASA conducted a test to determine susceptibility to foliage late blight at a site near Ayr which is operated in conjunction with JHI. A pot test for black dot and a field trial for mop top (spraing) were conducted by SRUC and pot tests for silver scurf and skin spot by SASA. An assay for assessing varietal resistance to *Rhizoctonia* stem canker was investigated at SRUC using all varieties normally assessed for black scurf resistance. The Common Catalogue varieties were also tested by SASA for susceptibility to tuber late blight, common scab, powdery scab, blackleg (*Pectobacterium atrosepticum*), dry rot (*Fusarium sulphureum* and *F. solani* var. *coeruleum*), potato cyst nematodes (pathotypes of *Globodera rostochiensis* and *G. pallida*), external damage (splitting) and internal damage (bruising). All tests were completed satisfactorily.

Susceptibility/resistance was rated on a 1-9 scale. Tables 1a and b summarise the results for varieties being tested in 2012. Table 1a presents the final ratings for varieties completing the test programme. For varieties in the 1st year of the IVT programme, Table 1b presents provisional ratings shown in italic font for one year's test results and final ratings from NL tests in bold.

TABLE 1A. SUMMARY OF FINAL VARIETAL RATINGS (1=LOW, 9=HIGH) FOR RESISTANCE TO DISEASES, PESTS AND DEFECTS FOR VARIETIES COMPLETING THE IVT PROGRAMME BASED ON OVER YEARS ANALYSIS OF IVT 2005-2012 AND NL FROM 1981 EXCEPT FOR LATE BLIGHT FOR WHICH ANALYSIS COVERED ONLY PERIOD OF TESTING WITH A 13_A2 GENOTYPE. RESULTS IN INDIVIDUAL TEST TABLES ARE BASED ON 2 YEARS ONLY AND MAY VARY FROM DATA IN THIS TABLE.

	Shelford	Violetta	Red Emmalie	Mistay	Nitza	Zohar	Zahov	Safiyah	Bremner	Ambassador	Electra	Emma	Taurus	VR808
Maturity	EM	EM	EM	EM	EM	EM	M	2E	EM	1E	EM	2E	EM	EM
Foliage late blight (field)	**4**	**5**	**4**	**5**	**4**	**4**	**4**	**3**	**5**	**4**	**5**	**3**	**4**	**2**
Black dot	**5**	**8**	**7**	**4**	**4**	**3**	**6**	**2**	**6**	**3**	**6**	**3**	**8**	**3**
Black scurf *														
Silver scurf	**8**	**5**	**5**	**4**	**7**	**6**	**8**	**6**	**7**	**6**	**6**	**6**	**7**	**4**
Skin spot	**6**	**9**	**9**	**4**	**7**	**7**	**2**	**7**	**6**	**7**	**8**	**3**	**8**	**7**
Mop top	**8**	**9**	**9**	**9**	**8**	**9**	**9**	**9**	**9**	**9**	**3**	**9**	**5**	**9**
Foliage late blight (lab) ^	**4**	**2**	**1**	**4**	**3**	**4**	**3**	**2**	**6**	**-**	**-**	**-**	**-**	**-**
Tuber late blight	**2**	**3**	**3**	**5**	**1**	**3**	**2**	**1**	**4**	**2**	**2**	**3**	**3**	**1**
Blackleg- *Pectobacterium atrosepticum*	**7**	**5**	**8**	**4**	**8**	**6**	**3**	**8**	**6**	**2**	**4**	**1**	**4**	**5**
Powdery scab	**5**	**4**	**4**	**7**	**4**	**5**	**6**	**3**	**5**	**6**	**3**	**2**	**7**	**1**
Common scab	**3**	**4**	**7**	**3**	**5**	**3**	**5**	**6**	**6**	**3**	**8**	**3**	**5**	**4**
Dry rot – *Fusarium coeruleum*	**5**	**5**	**8**	**7**	**4**	**7**	**9**	**6**	**8**	**9**	**3**	**5**	**7**	**9**
Dry rot – *Fusarium sulphureum*	**1**	**7**	**8**	**1**	**4**	**5**	**1**	**9**	**2**	**8**	**3**	**1**	**1**	**7**
PCN Ro-1	**2**	**2**	**2**	**5**	**8**	**2**	**7**	**7**	**3**	**3**	**7**	**4**	**8**	**7**
PCN Pa 2/3	**2**	**3**	**3**	**5**	**3**	**1**	**3**	**2**	**3**	**6**	**2**	**2**	**3**	**2**
External damage (splitting)	**5**	**6**	**4**	**2**	**2**	**1**	**7**	**2**	**6**	**3**	**6**	**5**	**5**	**5**
Internal damage (bruising)	**4**	**6**	**4**	**4**	**4**	**3**	**5**	**5**	**5**	**5**	**8**	**4**	**4**	**4**

* = the black scurf test has been discontinued and a test for *Rhizoctonia* stem canker is currently in development, therefore no result is available for publication in this report.

^ = The laboratory test for foliage late blight is only conducted as part of the NL programme, results have been included for information only

TABLE 1B. SUMMARY OF RATINGS (1=LOW, 9=HIGH) FOR RESISTANCE TO DISEASES, PESTS AND DEFECTS FOR POTATO VARIETIES COMPLETING ONE YEAR OF THE IVT PROGRAMME (PROVISIONAL RATINGS ARE SHOWN IN ITALICS, FINAL RATINGS ARE IN BOLD). SCORES ARE BASED ON OVER-YEARS ANALYSIS OF IVT 2005-2012 AND NL FROM 1981 EXCEPT FOR LATE BLIGHT FOR WHICH ANALYSIS COVERED ONLY PERIOD OF TESTING WITH A 13_A2 GENOTYPE. RESULTS IN INDIVIDUAL TEST TABLES MAY VARY FROM DATA IN THIS TABLE.

	Bute	G03TT007006	03.Z.6.A5	02.Z.216 A6	00C133-020	02C053-016	03C114-006	Arizona	Compass	Infinity	Jelly	Panther	Royal	Setanta
Maturity	EM	EM	LM	2E	EM	EM	EM	EM	M	EM	M	2E	EM	M
Foliage late blight (field)	*4*	*3*	*9*	*4*	*7*	*4*	*2*	*3*	*3*	*4*	*5*	*3*	*5*	*5*
Black dot	*8*	*7*	*6*	*4*	*7*	*7*	*6*	*1*	*2*	*7*	*7*	*7*	*3*	*4*
Black scurf *														
Silver scurf	*5*	*8*	*4*	*8*	*7*	*5*	*6*	*4*	*7*	*5*	*6*	*6*	*7*	*4*
Skin spot	*7*	*3*	*6*	*7*	*6*	*8*	*3*	*5*	*1*	*4*	*6*	*6*	*6*	*5*
mop top	*8*	*9*	*8*	*1*	*7*	*9*	*9*	*5*	*9*	*6*	*9*	*9*	*7*	*9*
Foliage late blight (lab) ^	**4**	**2**	**6**	**3**	**5**	**3**	**4**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Tuber late blight	**3**	**1**	**2**	**6**	**3**	**3**	**1**	*1*	*2*	*2*	*1*	*1*	*2*	*3*
Blackleg- *Pectobacterium atrosepticum*	**6**	**3**	**5**	**5**	**3**	**5**	**6**	*5*	*2*	*7*	*4*	*1*	*7*	*7*
Powdery scab	**7**	**5**	**7**	**7**	**8**	**7**	**5**	*3*	*1*	*6*	*5*	*2*	*7*	*6*
Common scab	**4**	**6**	**6**	**7**	**5**	**7**	**7**	*4*	*4*	*5*	*6*	*3*	*5*	*2*
Dry rot – *Fusarium coeruleum*	**8**	**1**	**5**	**5**	**4**	**5**	**4**	*4*	*6*	*9*	*8*	*9*	*5*	*9*
Dry rot – *Fusarium sulphureum*	**8**	**1**	**7**	**1**	**7**	**7**	**6**	*1*	*1*	*6*	*1*	*1*	*1*	*3*
PCN Ro-1	**8**	**8**	**7**	**3**	**7**	**3**	**7**	*7*	*8*	**2**	*9*	**3**	*9*	**1**
PCN Pa 2/3	**3**	**3**	**2**	**3**	**3**	**3**	**2**	**3**	**3**	**2**	**3**	*7*	*4*	**2**
External damage (splitting)	**6**	**4**	**7**	**3**	**7**	**6**	**2**	*5*	*6*	*6*	*6*	*5*	*7*	*6*
Internal damage (bruising)	**6**	**5**	**7**	**7**	**5**	**5**	**7**	*5*	*6*	*5*	NT	*5*	*6*	*8*

* = the black scurf test has been discontinued and a test for *Rhizoctonia* stem canker is currently in development, therefore no result is available for publication in this report

^ = The laboratory test for foliage late blight is only conducted as part of the NL programme, results have been included for information only

NT = not tested

1.3. Conclusions

In summary, the main findings (Resistant = 7 or more; Susceptible = 3 or less) for the test varieties, with final ratings in bold were as follows:

Shelford

Resistant to: **silver scurf, mop top (spraing)** and **blackleg**

Susceptible to: **tuber late blight, common scab, dry rot – *F. sulphureum,* PCN Ro1** and **PCN Pa 2/3 and 1**

Violetta

Resistant to: **black dot, skin spot, mop top (spraing)** and **dry rot – *F. sulphureum***

Susceptible to: **tuber late blight, PCN Ro1** and **PCN Pa 2/3 and 1**

Red Emmalie

Resistant to: **black dot, skin spot, mop top (spraing), blackleg, common scab** and **dry rot – *F. coeruleum*** and ***F. sulphureum*,**

Susceptible to: **tuber late blight, PCN Ro1** and **PCN Pa 2/3 and 1**

Mistay

Resistant to: **mop top (spraing), powdery scab** and **dry rot – *F. coeruleum***

Susceptible to: **common scab, dry rot – *F. sulphureum*** and **external damage**

Nitza

Resistant to: **silver scurf, skin spot, mop top (spraing), blackleg** and **PCN Ro1**

Susceptible to: **tuber late blight, PCN Pa 2/3 and 1** and **external damage**

Zohar

Resistant to: **skin spot, mop top (spraing)** and **dry rot – *F. coeruleum***

Susceptible to: **black dot, tuber late blight, common scab, PCN Ro1, PCN Pa 2/3 and 1, external damage** and **internal damage**

Zahov

Resistant to: **silver scurf, mop top (spraing), dry rot – *F. coeruleum,* PCN Ro1** and **external damage**

Susceptible to*:* **skin spot, tuber late blight, blackleg, dry rot – *F. sulphureum*** and **PCN Pa 2/3 and 1**

Safiyah

Resistant to: **skin spot, mop top (spraing), blackleg, dry rot – *F. sulphureum*** and **PCN Ro1**

Susceptible to: **foliage late blight, black dot, tuber late blight, powdery scab, PCN Pa 2/3 and 1** and **external damage**

Bremner

Resistant to: **silver scurf, mop top (spraing)** and **dry rot – *F. coeruleum***

Susceptible to: **dry rot – *F. sulphureum,* PCN Ro1** and **PCN Pa 2/3 and 1**

Ambassador

Resistant to: **skin spot, mop top (spraing)** and **dry rot – *F. coeruleum*** and ***F. sulphureum***

Susceptible to: **black dot, tuber late blight, blackleg**, **PCN Ro1** and **external damage**

Electra

Resistant to: **skin spot, PCN Ro1** and **internal damage**

Susceptible to: **mop top (spraing), tuber late blight, powdery scab, dry rot – *F. coeruleum*** and ***F. sulphureum*****,** and **PCN Pa 2/3 and 1**

Emma

Resistant to: **mop top (spraing)**

Susceptible to: **foliage late blight, black dot, skin spot, tuber late blight, blackleg, powdery scab, common scab, dry rot –*F. sulphureum,*** and **PCN Pa 2/3 and 1**

Taurus

Resistant to: **black dot, silver scurf, skin spot, powdery scab, dry rot** – ***F. coeruleum*** and **PCN Ro1**

Susceptible to: **tuber late blight*,* dry rot –*F. sulphureum,*** and **PCN Pa 2/3 and 1**

VR808

Resistant to: **skin spot, mop top (spraing) and dry rot – *F. coeruleum*** and ***F. sulphureum***

Susceptible to: **foliage late blight, black dot, tuber late blight, powdery scab** and **PCN Pa 2/3 and 1**

Bute

Resistant to: black dot, *skin spot, mop top (spraing),* **powdery scab, dry rot – *F. coeruleum*** and ***F. sulphureum*** and **PCN Ro1**

Susceptible to: **tuber late blight** and **PCN Pa 2/3 and 1**

G03TT007006

Resistant to: *black dot, silver scurf, mop top (spraing)* and **PCN Ro1**

Susceptible to: *foliage late blight, skin spot,* **tuber late blight, blackleg**, **dry rot – *F. coeruleum*** and ***F. sulphureum*** and **PCN Pa 2/3 and 1**

03.Z.6.A5

Resistant to: *foliage late blight, mop top (spraing),* **powdery scab, dry rot – *F. sulphureum*, PCN Ro1,** and **external** and **internal damage**

Susceptible to: *tuber late blight* and **PCN Pa 2/3 and 1**

02.Z.216 A6

Resistant to: *silver scurf, skin spot,* **powdery scab, common scab** and **internal damage**

Susceptible to*: mop top (spraing),* **dry rot – *F. sulphureum*, PCN Ro1, PCN Pa 2/3 and 1,** and **external damage**

00C133-020

Resistant to: *foliage late blight, black dot, silver scurf, mop top (spraing),* **powdery scab, dry rot – F. sulphureum**, **PCN Ro1** and **external damage**

Susceptible to: **tuber late blight, blackleg** and **PCN Pa 2/3 and 1**

02C053-016

Resistant to: *black dot, skin spot, mop top (spraing),* **powdery scab, common scab** and **dry rot – *F. sulphureum***

Susceptible to: **tuber late blight, PCN Ro1** and **PCN Pa 2/3 and 1**

03C114-006

Resistant to: *mop top (spraing),* **common scab, PCN Ro1** and **internal damage**

Susceptible to: *foliage late blight, skin spot,* **tuber late blight, PCN Pa 2/3 and 1** and **external damage**

Arizona

Resistant to: **PCN Ro1**

Susceptible to: *foliage late blight, black dot, tuber late blight, powdery scab, dry rot – F. sulphureum* and **PCN Pa 2/3 and 1**

Compass

Resistant to: *silver scurf, mop top (spraing)* and **PCN Ro1**

Susceptible to: *foliage late blight, black dot, skin spot, tuber late blight, blackleg, powdery scab*, ***dry rot – F. sulphureum*** and **PCN Pa 2/3 and 1**

Infinity

Resistant to: *black dot, blackleg* and *dry rot – F. coeruleum*

Susceptible to: *tuber late blight,* **PCN Ro1** and **PCN Pa 2/3 and 1**

Jelly

Resistant to: *black dot, mop top (spraing), dry rot – F. coeruleum* and **PCN Ro1**

Susceptible to: *tuber late blight, dry rot – F. sulphureum* and **PCN Pa 2/3 and 1**

Panther

Resistant to: *black dot, mop top (spraing), dry rot – F. coeruleum* and **PCN Pa 2/3 and 1**

Susceptible to: *foliage late blight, tuber late blight, blackleg, powdery scab, common scab, dry rot – F. sulphureum* and **PCN Ro1**

Royal

Resistant to: *silver scurf, mop top (spraing), blackleg, powdery scab,* **PCN Ro1** and *external damage*

Susceptible to: *black dot, tuber late blight* and *dry rot – F. sulphureum*

Setanta

Resistant to: mop top (spraing), blackleg, dry rot – F. coeruleum and *internal damage*

Susceptible to: *tuber late blight, common scab, dry rot – F. sulphureum,* **PCN Ro1** and **PCN Pa 2/3 and 1,**

2. EXPERIMENTAL REPORT

2.1. Introduction

A review of the UK National List programme was concluded in 2004 and the various varietal characteristics were prioritised according to national importance and to industry. In consultation with industry stakeholders, it was also agreed that closer co-operation with IVT funded by PCL would be advantageous in minimising duplication of testing and in ensuring that the decision making process for the official listing of new varieties could utilise all available, good quality independent data such as that generated in IVT tests.

For National List purposes, the diseases and pests prioritised as being of national importance were foliage late blight, tuber late blight, blackleg (*Pectobacterium atrosepticum* syn. *Erwinia carotovora* var. *atroseptica*) and potato cyst nematode (*Globodera rostochiensis* pathotype Ro1). The characters agreed as being of less significance nationally but important to industry were powdery scab, common scab, dry rot - *Fusarium solani* var. *coeruleum*, dry rot - *F.sulphureum*, potato virus Y^{o}*,

potato leaf roll virus*, potato cyst nematode (*Globodera pallida* pathotypes Pa2/3 and Pa1), external damage (splitting) and internal damage (bruising). In addition, unreplicated assessments of tuber yield, and external and internal tuber defects were to be made in order to comply with the requirements of the EU Directive 72/180/EEC and 02/8/EC. The consultation also agreed that varieties entered for IVT testing could be incorporated into NL tests.

In 2005, a 3 year contract to conduct a revised IVT programme was awarded to a consortium of SASA, SRUC, BioSS and JHI. The tests to be conducted for IVT purposes were foliage late blight in the field (SASA), black scurf (SRUC), black dot (SRUC), silver scurf (SASA) and skin spot (SASA). From 2011, an additional test was included in the programme this was potato mop top virus (spraing) (SRUC). In 2012, the black scurf test was discontinued due to a high level of variability in the test data, resulting in inconsistent resistance ratings for this pathogen. In 2012 an evaluation of a possible *Rhizoctonia* stem canker test was carried out. In addition, SASA would test Common Catalogue varieties entered for IVT for all NL characters, except potato viruses (Y^o, Y^N, A and leafroll). Tests were to be conducted over 2 years instead of 3 years. The contract was extended for a further 3 years to cover the growing seasons 2008-2010, and renewed again for a further 3 year period covering the growing seasons 2011-2013. This report summarises the testing conducted over the 2012-2013 season.

* It was agreed to extend the NL programme from 2009 onwards to test for two additional potato viruses, these were virus A and virus YN.

2.2. Materials and Methods

2.2.1. Standard Varieties

The standard varieties used in 2011 were reviewed and retained in 2012. The varieties used in each test are listed below with, in brackets, their foliage maturity and the susceptibility rating as published in NIAB Pocket Guide to Varieties of Potatoes, 2006:

Foliage late blight:	Home Guard [1E, 2], Bintje [M, 2], Russet Burbank [M, 3], Valor [M, 6], Cara [M, 6], Sarpo Mira [M, 7]
Black dot:	Lady Christl [1E, 2], Pentland Squire [M,3], Fianna [M,5], Cara [M,6], Saxon [2E,7]
Silver scurf:	Lady Christl [1E, 2], Pentland Squire [M, 3], Romano [2E, 4], Fianna [M, 5], Saxon [2E, 5], Cara [M, 7]
Skin spot:	Pentland Squire [M, 2], King Edward [M, 3], Sante [M, 3], Saxon [2E, 6], Romano [2E, 7], Fianna [M, 8]
Potato mop top: virus (spraing)	Cara [M, 3], Nicola [M, 4], Valor [M, 6], Saturna [M, 7], Maris Piper [M, 5]
Rhizoctonia:	Sante [M], Duke of York [1E], Saxon [2E], King Edward [M], Cara [M], Lady Christl [1E] As this was an evaluation of a potentially new assay no rating are available but the varieties used previously as standard for the black scurf test were retained with the exception of Blue

Danube. The variety Harmony is considered susceptible to *Rhizoctonia* stem canker and was used as a standard for evaluating the optimum time for assessment of stem canker.

2.2.2. Varieties in Trial

The varieties are listed in Tables 2A &B. In line with the policy established by Potato Council, for the varieties submitted for UK National List Trials, only those varieties entering the 2nd year of testing or those that had completed NL testing were considered for entry to the IVT programme. In addition, 6 new Common Catalogue varieties were identified for inclusion in the test programme. As a plant health precaution to prevent the introduction of non-indigenous bacterial pathogens, all seed potatoes from non-Scottish sources were tested for brown rot (*Ralstonia solanacearum*, ring rot (*Clavibacter michiganensis* subsp. *sepodonicus*) and *Dickeya* spp. bacteria.

TABLE 2A. VARIETIES IN IVT IN 2012 (NATIONAL LIST ROUTE)

Stage of test 2012

AFP	Variety	Breeder/Agent	Maturity	NL	IVT
4/712	Shelford	PepsiCo Intnl Ltd	E. Maincrop	Completed	2
4/770	Violetta	Karsten Ellenberg	E. Maincrop	Completed	2
4/771	Red Emmalie	Karsten Ellenberg	E. Maincrop	Completed	2
4/772	Mistay	JHI/MRS Ltd	E. Maincrop	Completed	2
4/774	Nitza	Jacques Onona Intl Ltd	E. Maincrop	Completed	2
4/775	Zohar	Jacques Onona Intl Ltd	E. Maincrop	Completed	2
4/776	Zahov	Jacques Onona Intl Ltd	Maincrop	Completed	2
4/779	Safiyah	Higgins Agriculture Ltd	2nd Early	Completed	2
4/780	Bremner	Higgins Agriculture Ltd	E. Maincrop	Completed	2
4/782	Bute	Zella Doig	E. Maincrop	2	1
4/783	G03TT007006	Germicopa SAS/Branston	E. Maincrop	2	1
4/784	03.Z.6.A5	JHI/MRS Ltd (Geenvale)	L. Maincrop	2	1
4/785	02.Z.216 A6	JHI/MRS Ltd (Geenvale)	2nd Early	2	1
4/786	00C133-020	Cygnet PB Ltd	E. Maincrop	2	1
4/787	02C053-016	Cygnet PB Ltd	E. Maincrop	2	1
4/788	03C114-006	Cygnet PB Ltd	E. Maincrop	2	1

TABLE 2B. VARIETIES IN IVT IN 2012 (COMMON CATALOGUE ROUTE)

stage of test 2012

AFP	Variety	Breeder/Agent	Maturity	NL	IVT
	Ambassador	Agrico Research/Agrico UK	1st Early	2	2
	Electra	IPM Ltd	E. Maincrop	2	2
	Emma	IPM Ltd	2nd Early	2	2
	Taurus	HZPC	E. Maincrop	2	2
	VR808	Van-rijn - KWS B.V.	E. Maincrop	2	2
	Arizona	Agrico	E. Maincrop	1	1
	Compass	HZPC	Maincrop	1	1
	Jelly	Europlant/Karmark (Greenvale)	Maincrop	1	1
	Infinity	IPM Ltd	E. Maincrop	1	1
	Panther	HZPC	2nd Early	1	1
	Royal	McCain	E. Maincrop	1	1
	Setanta	IPM Ltd	Maincrop	1	1

2.2.3. IVT Test Methods

The test methods used were those agreed and set out in the standard protocols prepared for the 2012 programme. Details of this year's tests are provided below:

2.2.3.1. Foliage late blight in the field, 2012

The test tubers were planted in plots of 2 tubers at Dalrymple, by Ayr. The 1st early and 2nd early/maincrop experiments were planted on 29 May. The layout was a randomised block design with 4 replications, each of 2 tubers. Plants of King Edward, in small pots, infected by a complex isolate (1.2.3.4.5.6.7.10.11) of *P. infestans* were laid out along the adjacent rows of King Edward on 16 July. On 24, 27, 30 July, 2, 6 August, the % foliage affected by late blight was assessed using the diagrammatic key of Cruickshank *et al.* (1982). The % Area Under the Disease Progress Curve (AUDPC) was calculated according to the formulae of Fry (1978), after applying the angular transformation to the percentage values on each date.

2.2.3.2. Skin spot, 2012

Test tubers were dipped for 0.5 min in a suspension of spores and mycelia (Carnegie & Cameron, 1983) and planted in pots containing a 1:1 mix of Bulrush compost and John Innes No 2 compost on 11 May. Pots were placed outdoors in peat beds and watered by drip irrigation into each pot. The layout was randomised block with 6 replications. As plants had senesced by mid August there was no requirement to apply diquat dibromide (Reglone) to kill the haulms. The tubers were harvested into separate plastic boxes on 23-24 October and then stored at 5-8^{0}C until the last week in March. The % surface area affected by skin spot was recorded in 5 categories and a surface infection index calculated (Boyd, 1957).

2.2.3.3. Silver scurf, 2012

Petri dishes containing 2% malt extract agar were inoculated using three isolates of silver scurf which were grown for a minimum of 14 days, then macerated in sterile

distilled water. The suspension was added to Bulrush compost at a rate of 1L of suspension per 42L of soil and mixed in a small cement mixer. The test tubers were planted in pots containing the infested soil and placed in a polytunnel on 1 June and watered by drip irrigation into each pot. The layout was a randomised block design with 6 replications. Haulms were allowed to senesce naturally. Tubers were harvested on 17 October into separate plastic boxes and washed so visible symptoms could be observed, the tubers were then stored at 12-15^{o}C and high humidity until silver scurf lesions had developed sufficiently on the susceptible standard varieties. In the last week of February, the % surface area affected by silver scurf on each tuber was assessed using 6 categories. A mean silver scurf index was calculated for each plot by multiplying the number of tubers in each category by the mid-point value and dividing the sum of these values by the total number of tubers assessed.

2.2.3.4. Black dot, 2012

Three isolates of *Colletotrichum coccodes* were cultured in Petri dishes on PDA agar. When the colonies had reached the edge of the dishes, the cultures were macerated using a liquidiser. The suspension was added to Bulrush compost at the rate of 1 Petri dish of *C. coccodes* per 8 kg compost in a cement mixer and mixed for 10 minutes. Test tubers were planted on 9 May in 25 cm diameter pots filled with amended compost which were set in individual watering saucers and then placed in a polytunnel in a randomised block design with 6 replications. Pots were watered every 2 days so that the compost was kept damp but not over-watered. Haulms were allowed to senesce naturally. Tubers were harvested on 16 October, after symptoms of black dot had been seen on the daughter tubers of the susceptible reference varieties. The tubers were placed into paper bags and kept overnight in a cold store. The % surface area affected by black dot was then assessed on the 26 November 2012.

2.2.3.5. **Rhizoctonia** *stem canker, 2012*

Three isolates of *Rhizoctonia solani* AG-3 were grown in Petri dishes on PDA agar. When the colonies had reached the edge of the agar plate, the cultures were macerated in a liquidiser and added to compost in a cement mixer at a rate of 1 dish per 8 kg of Bulrush compost. On 10 May, a single seed tuber of each variety was planted in a 25 cm diameter pot which was placed in an individual watering saucer. Six replicate pots of each of 36 varieties were laid out in a shade house (polytunnel with mesh sides) as a randomised block experiment. Plants were grown and maintained as in Section 2.2.3.4. The first three replicates were assessed four weeks post-emergence (27 June 2012) while the remaining three replicates were assessed eight weeks post-emergence (25 July 2012). For one of the 36 varieties (Harmony) there were a further nine pots – three assessed at week 2 (13 June 2012), three at week 10 (8 August 2012) and three at week 12 (22 August 2012). The layout of pots in the shade house was such that the three replicates assessed after four weeks were grouped together in the shade house. Similarly, the three replicates assessed after eight weeks were grouped together. Additionally a further nine pots of Harmony were housed separately in the shade house with three pots destructively sampled at 2, 10 and 12 weeks, respectively. For any one of these three assessment times the three pots were adjacent to each other in the shade house. Thus assessment date was confounded with spatial location in all cases. The numbers of stolons and pruned (i.e. infected) stolons in each pot were recorded in all cases. Additionally, stolon and stem canker severity on a 0-4 scale was recorded. The corresponding range of severity percentages for each category of the scoring scale is shown in the table below.

Scoring scale for stem and stolon canker severity:

Score	% severity	Mid-point
0	0	0
1	1 – 10	5
2	10 – 25	17.5
3	26 – 50	37.5
4	> 50	75

2.2.3.6. PMTV, 2012

A plot in the Woodlands field at SAC Aberdeen previously contaminated with powdery scab / PMTV in 2009 was planted on the 24 May 2012 with varieties grown in single tuber randomised blocks with 6 replicates. The plots were irrigated during the season. After harvest on the 26 September the tubers were placed in a cool store (c.18^{o}C) for 3 weeks before placed in a cold store at 4^{o}C. Tubers were assessed for visual symptoms of PMTV spraing after cutting on 13 November 2011. All tubers from each of the 6 replicates were assessed individually. The results were expressed as the average percentage of the tubers showing symptoms.

2.2.3.7. Dickeya 'solani'

A test investigating susceptibility to *D. 'solani'* is currently in development. In 2012, 11 varieties were selected for the test based on previous work conducted on *D. 'solani'*; these were: Bintje, Cara, Charlotte, Desiree, Estima, Maris Piper, Mondial, Mozart, Nicola, Saturna and Spunta. Prior to planting, seed tubers of each variety were stab inoculated at the stolon end to a depth of *c.* 2 cm with the eye of a darning needle containing *c.* 0.01-0.02 ml of a bacterial suspension of a mixture of isolates at 10^3 cells ml^{-1} , 10^5 cells ml^{-1} or 10^7 cells ml^{-1}. Tubers were planted on 16th May in 7.5L pots containing Bullrush compost in a polytunnel. Each plot consisted of 4 pots *c.* 5cm apart and laid out in a randomised block design with 3 replications. This gave a total trial size of 396 pots. Plants were watered by drip irrigation to maintain constantly wet conditions; the plants were allowed to senesce naturally. The polytunnel was kept warm in June and July to encourage disease development. The plants were examined weekly for symptoms of blackleg and affected plants recorded using a 1-5 scale (see below). Pots were harvested on 8-9th November. The tubers from each replicate (harvested individually from pots) were rolled over a hand riddle (25 mm) for 30 sec and then stored in autoclave bags lined with damp paper for 48 hours at *c.* 28^{o}C. The number of tubers affected by bacterial rotting was recorded. Further assessments were made up to a period of 2 weeks.

Foliar assessment scale:

1 Healthy
2 necrotic/chorotic
3 basal stem rot
4 blackleg/on its way out
5 dead

Top wilts were noted during assessments, but not used in the statistical analysis

2.2.4. NL Tests

These were conducted on Common Catalogue varieties in accordance with the document "United Kingdom National List Trials: Trials Procedures for the Official Examination of value for Cultivation and Use (VCU) – Potato 2012". The methods are summarised below:

Tuber late blight: the rose-end of field-grown tubers is sprayed with the 13_A2 isolate of *P. infestans*. The number of tubers affected by late blight is counted after 10-14 days incubation.

Common Scab: test tubers are planted in pots in artificially infested compost kept dry during tuber initiation. Severity of common scab is assessed on daughter tubers.

Powdery scab: test tubers are planted in compost infected with scab peelings and kept wet during tuber initiation. Severity of powdery scab is assessed on daughter tubers.

Blackleg: test tubers are inoculated at the heel end with *Pectobacterium atrosepticum* and planted in an irrigated field trial. Incidence of blackleg is assessed 3 times during the growing season.

Dry rot (separate test for *Fusarium solani* var. *coeruleum* and *F. sulphureum*): test tubers are wounded and inoculated with a suspension of spores and incubated at 12-15^{o}C. The degree of internal rotting is assessed.

Potato Cyst Nematode (*Globodera* spp.): tubers are planted in pots in compost infected with a standard concentration of PCN eggs. Cyst multiplication on roots is assessed.

Damage, external (splitting) and internal (bruising): a standard force is applied to the heel end of field grown tubers. Tubers for the splitting test are stored at 4-6^{o}C and the incidence of splitting at the point of impact is recorded. Tubers for the bruising test are stored at 9-11^{o}C and the depth of damage at point of impact measured.

2.2.5. Statistical analysis

Most of the data was recorded as percentages and was angularly transformed before conducting an individual trial analysis of variance. For PCN and skin spot log transformations were used. Over-year trial means were calculated using REML from transformed trial means; for IVT the test years from 2005 (the year when the consortium took over the trialling) were used, giving eight years for this report, and for NL tests, all years from 1981 were used where data was available. Late blight data is from 2008 when testing with the new isolate was introduced. This data was used to calculate the provisional and final ratings presented in Tables 1a and 1b. However, in the individual test reports, ratings presented are based on the analysis for 2 years only and have been presented to one decimal point to provide greater clarity. All ratings of 1-9 were derived by linear transformation (or according to a multiplication index for PCN) using varieties with known consistent susceptible and resistant reactions as fixed reference points.

2.2.5.1. **Rhizoctonia *stem canker test development***

In order to analyse the data it has been necessary to assume for the main trial (which compares the 36 varieties at two assessment dates) that assignment of assessment date to the six replicate blocks of varieties was done at random rather than the first assessment to the first three blocks and the second assessment to the final three blocks. Similarly, it has been necessary to assume when analysing all the data on Harmony across the five assessment dates that assessment date was randomly assigned to the fifteen pots. Clearly, this was not the case. As such, the analyses presented are not strictly valid. In practice, although assessment date is completely confounded with spatial location, the conclusions are unlikely to be seriously misleading provided there are no grounds for expecting a spatial effect within the shade house on any of the response variables. This may be more plausible within the small sub-experiment for Harmony covering assessments on weeks 2, 10 and 12 than when comparing assessments between weeks 4 and 8.

Stem and stolon canker severity were recorded on an ordinal scale. Single unit increments in the scoring scale do not correspond to equal increments in increasing severity. In other words, an increase in the score from 1 to 2 does not correspond to the same increase in severity as an increase in the score from 2 to 3. Consequently, it would be inappropriate to analyse the scores *per se* by parametric analysis of variance. Instead, scores have been converted to percentage severity by assigning to the pot the mid-point value of the respective score. An angular transformation has then been applied to the pot percentages prior to statistical analysis to more closely satisfy the assumption of variance homogeneity. Formal comparisons should be made on the transformed scale and consequently SEDs, LSDs and P values are only presented for the analysis of the transformed data. However, for reference only, the means calculated on untransformed values are also shown.

Ideally, incidence data represented by the number of pruned stolons out of the total number of stolons should be analysed by fitting either a generalised linear model or generalized linear mixed model, both with a binomial error structure and the logit link function. This approach reflects the binomial nature of the response variable and also takes into account that there are more stolons in some pots than others, which impacts on precision. Such an approach using a generalized linear model was possible for a comparison of the five assessment dates for Harmony.

Unfortunately such a model could not be fitted successfully to the combined data from both weeks 4 and 8. Consequently, the varieties X weeks interaction was tested by firstly applying the empirical logit transformation to the numbers of stolons and pruned stolons, and then using analysis of variance, as done previously for transformed canker and stolon severity percentages. Some caution should be exercised in interpreting the results from the latter combined analysis as no allowance is made for the varying precision in comparisons due to varying numbers of stolons although it does take into account the expected relationship between precision and the mean.

The empirical logit is very similar to applying a logit transformation to the proportion of pruned stolons but differs slightly in order to able to deal with cases where either all or none of the stolons were pruned for an individual pot.

For generalized linear models a dispersion parameter is estimated from the data, reflecting the fact that variation was greater than might be expected in a binomially distributed variable. It indicates clumping of infection. This approach was applied

separately to data from week 4. A report on the statistical analysis of the data is provided in Appendix I.

2.3. Results

Ring rot, brown rot and *Dickeya* bacteria were not found in tested seed potatoes.

2.3.1. IVT Tests

2.3.1.1. Foliage late blight (field)

Late blight was recorded on some varieties at a low severity on 24 and 27 July. However, late blight on susceptible varieties progressed well after this and the foliage of all but the more resistant varieties was dead by 6 August. The AUDPC values for the varieties in 2012 were higher than those in 2011 which could have been a result of the wet season. Foliage of the differentials R1, R2, R3, R4, R5, R6, R7, R10 and R11 was killed by late blight. No growing lesions developed on plants of R8 or R9 differentials. This confirmed the results of detached leaflet tests that the virulence of isolate was 1.2.3.4.5.6.7.10.11.

Violetta, Mistay, Bremner and Electra had some level of resistance scoring 5.1, 4.8, 4.7 and 4.7 respectively. The remaining varieties were relatively susceptible, with VR808 (2.6), Emma (3.1) and Safiyah (3.2) being the most susceptible varieties on test, with scores similar to the two susceptible reference varieties Bintje (3.0) and Russet Burbank (3.4). There was one 1st early candidate variety Ambassador, which was susceptible with a score (2.9) lower than the susceptible reference variety Home Guard (4.1).

03.Z.6.A5 (8.3) was the most resistant 1st year candidate variety in 2012, with a score ranking higher than the Sarpo Mira (8.0) standard. 00C133-020 had moderate resistance scoring 6.8. The most susceptible varieties were 03C114-006 (2.4) and Panther (3.1).

TABLE 3A MEAN % (ANGULAR TRANSFORMATION) AREA UNDER DISEASE PROGRESS IN FOLIAGE LATE BLIGHT FIELD TEST IN 2011 AND 2012 (1ST EARLY VARIETIES)

	Test Year		
Variety	**2011**	**2012**	**1-9 rating**
HOME GUARD	29.6	38.8	4.1
AMBASSADOR	38.7	45.9	2.9
LSD (P0.05)	5.0	13.3	**1.4**

TABLE 3B MEAN % (ANGULAR TRANSFORMATION) AREA UNDER DISEASE PROGRESS IN FOLIAGE LATE BLIGHT FIELD TEST IN 2011 AND 2012 (2ND EARLY/MAINCROP VARIETIES)

	Test Year		
Variety	**2011**	**2012**	**1-9 rating**
BINTJE	38.4	44.8	**3.0**
CARA	20.6	23.6	**5.8**
RUSSET BURBANK	32.7	45.7	**3.4**
SARPO MIRA	3.0	10.6	**8.0**
VALOR	14.6	22.3	**6.3**
SHELFORD	27.4	39.3	**4.2**
VIOLETTA	23.5	31.1	**5.1**
RED EMMALIE	28.2	40.3	**4.1**
MISTAY	26.0	32.8	**4.8**
NITZA	29.5	37.5	**4.2**
ZOHAR	29.1	33.6	**4.5**
ZAHOV	29.6	41.1	**3.9**
SAFIYAH	34.5	46.6	**3.2**
BREMNER	22.6	37.6	**4.7**
ELECTRA	26.6	33.5	**4.7**
EMMA	36.1	46.1	**3.1**
TAURUS	29.1	34.0	**4.4**
VR808	40.5	48.5	**2.6**
BUTE	-	35.2	*4.4*
G03TT007006	-	43.4	*3.2*
03.Z.6.A5	-	8.5	*8.3*
02.Z.216.A6	-	37.7	*4.0*
00C133-020	-	18.9	*6.8*
02C053-016	-	40.3	*3.7*
03C114-006	-	49.2	*2.4*
ARIZONA	-	41.7	*3.5*
COMPASS	-	41.1	*3.5*
INFINITY	-	39.0	*3.8*
JELLY	-	32.2	*4.8*
PANTHER	-	43.9	*3.1*
ROYAL	-	33.6	*4.6*
SETANTA	-	30.5	*5.1*
LSD (P0.05)	5.1	5.6	**0.7**

2.3.1.2. Rhizoctonia stem canker

2012 saw the first year of this test as a possible replacement for the black scurf test. A report produced by BioSS regarding the statistical analysis of the data is provided in Appendix I.

2.3.1.3. Black dot

Some varieties had more disease in 2012 than 2011 (Table 4) such as Red Emmalie, Ambassador and VR808; however other varieties had less such as Cara, Violetta and Taurus. Violetta and Red Emmalie were the most resistant scoring 7.3 and 7.1 respectively. The most susceptible variety was Safiyah (2.4) which had similar levels of disease in the two years of trials.

Bute was the most resistant of the varieties undergoing the first year of testing. The majority of the other first year varieties showed some resistance to black dot. Arizona. Compass and Royal were the least resistant scoring 1.0, 1.2 and 2.8 respectively.

TABLE 4. MEAN % (ANGULAR TRANSFORMATION) SURFACE AREA AFFECTED BY BLACK DOT

	Test Year		
Variety	**2011**	**2012**	**1-9 rating**
CARA	15.6	5.6	**7.5**
FIANNA	18.5	20.7	**6.0**
LADY CHRISTL	28.3	29.5	**4.5**
P SQUIRE	41.8	34.3	**3.0**
SAXON	19.1	*	**5.8**
SHELFORD	21.7	32.6	**4.8**
VIOLETTA	18.2	4.9	**7.3**
RED EMMALIE	3.8	22.0	**7.1**
MISTAY	22.6	34.7	**4.5**
NITZA	28.4	27.6	**4.6**
ZOHAR	35.4	31.4	**3.8**
ZAHOV	26.7	18.1	**5.5**
SAFIYAH	40.9	42.6	**2.4**
BREMNER	15.8	22.0	**6.1**
AMBASSADOR	27.6	48.4	**3.0**
ELECTRA	21.7	20.0	**5.8**
EMMA	27.3	49.4	**2.9**
TAURUS	18.3	0.0	**7.7**
VR808	23.7	44.5	**3.6**
BUTE	-	11.3	*8.1*
G03TT007006	-	16.7	*6.9*
03.Z.6.A5	-	19.0	*6.4*
02.Z.216.A6	-	32.3	*3.4*
00C133-020	-	16.2	*7.0*
02C053-016	-	14.2	*7.4*
03C114-006	-	18.7	*6.4*
ARIZONA	-	54.3	*1.0*
COMPASS	-	42.3	*1.2*
INFINITY	-	15.7	*7.1*
JELLY	-	14.3	*7.4*
PANTHER	-	17.3	*6.7*
ROYAL	-	35.3	*2.8*
SETANTA	-	31.9	*3.5*
LSD (P0.05)	12.3	22.0	**3.7**

* Saxon was not included in 2012 due to a mix of seed

2.3.1.4. Silver scurf

Overall, candidate varieties showed some level of resistance with most scoring 5.0 of higher. The least resistant were Violetta (4.5), Mistay (4.2) and VR808 (4.2). Among the first year candidates, 02.Z.216.A6 and G03TT007006 had moderate resistance scoring 6.3 and 6.0 respectively. The most susceptible were Compass, Setanta and 03.Z.6.A5 scoring 3.1, 3.1 and 3.4, respectively.

TABLE 5. MEAN % (ANGULAR TRANSFORMATION) SURFACE ARE AFFECTED BY SILVER SCURF

	Test Year		
Variety	**2011**	**2012**	**1-9 rating**
CARA	22.6	15.4	**7.0**
FIANNA	27.7	31.8	**5.2**
LADY CHRISTL	51.0	46.4	**2.0**
PENTLAND SQUIRE	42.7	27.7	**4.3**
ROMANO	16.3	25.1	**6.7**
SAXON	33.7	*	**4.3**
SHELFORD	19.9	20.0	**6.8**
VIOLETTA	26.6	40.9	**4.5**
RED EMMALIE	22.0	40.4	**5.0**
MISTAY	37.9	33.4	**4.2**
NITZA	23.3	28.0	**5.9**
ZOHAR	22.0	34.9	**5.4**
ZAHOV	23.3	18.3	**6.7**
SAFIYAH	28.3	25.1	**5.7**
BREMNER	22.8	24.5	**6.2**
AMBASSADOR	28.8	28.2	**5.4**
ELECTRA	27.5	32.8	**5.1**
EMMA	29.6	27.6	**5.4**
TAURUS	24.4	26.2	**5.9**
VR808	24.7	47.0	**4.2**
BUTE	-	33.6	*4.1*
G03TT007006	-	21.9	*6.0*
03.Z.6.A5	-	37.8	*3.4*
02.Z.216.A6	-	19.5	*6.3*
00C133-020	-	25.4	*5.4*
02C053-016	-	32.3	*4.3*
03C114-006	-	31.1	*4.5*
ARIZONA	-	39.9	*3.1*
COMPASS	-	27.1	*5.1*
INFINITY	-	35.9	*3.7*
JELLY	-	29.7	*4.7*
PANTHER	-	28.7	*4.9*
ROYAL	-	24.6	*5.5*
SETANTA	-	39.7	*3.1*
LSD (P0.05)	9.0	10.6	**2.9**

* Saxon was not included in 2012 due to a mix of seed

2.3.1.5. Skin spot

The severity of skin spot symptoms was greater in 2012 than 2011. Red Emmalie (8.1), Violetta (8.0), Taurus (7.3), Electra (7.2) and VR808 (7.1) were the most resistant candidate varieties, all scoring higher than resistant reference varieties. Zahov and Emma were the most susceptible scoring 2.6 and 3.1, respectively.

Of the 1st year candidate varieties, the majority had moderate resistance. 02C053-016 was the most resistant scoring 7.4; Compass was the most susceptible scoring 1.1.

TABLE 6. MEAN % (LOG TRANSFORMATION [LOG (SKIN SPOT% + 0.1) WHERE LOG IS LOG TO BASE 10]) SURFACE AREA AFFECTED BY SKIN SPOT.

	Test Year		
Variety	**2011**	**2012**	**1-9 rating**
FIANNA	-0.4	-0.8	**6.7**
KING EDWARD	0.8	0.1	**2.8**
PENTLAND SQUIRE	1.0	0.4	**2.0**
ROMANO	-0.5	-0.9	**7.0**
SANTE	0.8	0.8	**1.6**
SAXON	-0.4	*	**6.9**
SHELFORD	0.1	-0.6	**5.4**
VIOLETTA	-0.9	-1.0	**8.0**
RED EMMALIE	-1.0	-1.0	**8.1**
MISTAY	0.6	-0.3	**4.0**
NITZA	-0.3	-0.9	**6.7**
ZOHAR	-0.1	-0.9	**6.4**
ZAHOV	0.8	0.2	**2.6**
SAFIYAH	-0.3	-0.8	**6.6**
BREMNER	-0.1	-0.7	**6.0**
AMBASSADOR	-0.4	-0.8	**6.6**
ELECTRA	-0.4	-1.0	**7.2**
EMMA	0.3	0.4	**3.1**
TAURUS	-0.5	-1.0	**7.3**
VR808	-0.7	-0.7	**7.1**
BUTE	-	-0.8	*6.4*
G03TT007006	-	0.0	*3.3*
03.Z.6.A5	-	-0.6	*6.0*
02.Z.216.A6	-	-0.7	*6.1*
00C133-020	-	-0.6	*5.8*
02C053-016	-	-1.0	*7.4*
03C114-006	-	0.2	*2.9*
ARIZONA	-	-0.3	*4.5*
COMPASS	-	0.6	*1.1*
INFINITY	-	-0.2	*4.3*
JELLY	-	-0.7	*6.0*
PANTHER	-	-0.6	*5.8*
ROYAL	-	-0.7	*6.1*
SETANTA	-	-0.4	*4.9*
LSD (P0.05)	0.6	0.6	**2.0**

* Saxon was not included in 2012 due to a mix of seed

2.3.1.6. Potato mop top virus (spraing)

The majority of candidates had resistance, with 12 of the 14 scoring 7.6 or higher (Table 7). Of the remaining varieties, Taurus scored 4.7 and Electra was susceptible scoring 2.7.

Eleven of the 14 1st year candidates were resistance scoring 9.0. Two had moderate resistance; these were Infinity (6.6) and Arizona (5.5). One candidate was susceptible scoring 1.0 this was 02.Z.216.A6.

TABLE 7. MEAN % (ANGULAR TRANSFORMATION) OF TUBERS SHOWING SYMPTOMS OF POTATO MOP TOP VIRUS (SPRAING).

	Test Year		
Variety	**2011**	**2012**	**1-9 rating**
CARA	14.1	23.7	**7.0**
NICOLA	27.7	23.0	**5.4**
VALOR	19.8	38.5	**4.4**
SATURNA	33.3	28.2	**4.0**
MARIS PIPER	0.0	4.0	**9.0**
SHELFORD	19.2	13.6	**7.6**
VIOLETTA	0.0	0.0	**9.0**
RED EMMALIE	0.0	0.0	**9.0**
MISTAY	0.0	0.0	**9.0**
NITZA	11.3	18.6	**8.0**
ZOHAR	8.5	14.3	**8.9**
ZAHOV	0.0	0.0	**9.0**
SAFIYAH	3.5	0.0	**9.0**
BREMNER	6.6	18.7	**8.6**
AMBASSADOR	20.4	0.0	**9.0**
ELECTRA	35.7	36.0	**2.7**
EMMA	4.0	5.9	**9.0**
TAURUS	35.0	20.8	**4.7**
VR808	0.0	6.3	**9.0**
BUTE	-	15.2	*9.0*
G03TT007006	-	9.4	*9.0*
03.Z.6.A5	-	16.2	*9.0*
02.Z.216.A6	-	46.0	*1.0*
00C133-020	-	19.2	*9.0*
02C053-016	-	3.5	*9.0*
03C114-006	-	4.5	*9.0*
ARIZONA	-	26.0	*5.5*
COMPASS	-	0.0	*9.0*
INFINITY	-	24.3	*6.6*
JELLY	-	0.0	*9.0*
PANTHER	-	11.0	*9.0*
ROYAL	-	20.3	*9.0*
SETANTA	-	11.4	*9.0*
LSD (P0.05)	16.4	15.6	**3.4**

2.3.1.1. Dickeya 'solani'

A trial was conducted in 2012 with an aim of developing a test for *D. solani* for inclusion in the future IVT programme. A report produced by BioSS regarding the statistical analysis of the data is included in the appendix of this document.

2.3.2. NL Tests

2.3.2.1. Tuber late blight

Overall there was a greater incidence of disease in 2012 than 2011. Of the candidate varieties entered for testing, all were relatively susceptible with scores between 1.3 and 3.6

Most first year varieties were relatively susceptible; Setanta was the least susceptible scoring 3.2

TABLE 8A MEAN % (ANGULAR TRANSFORMATION) TUBERS AFFECTED BY LATE BLIGHT (1ST EARLY VARIETIES)

	Test Year		
Variety	**2011**	**2012**	**1-9 rating**
HOME GUARD	81.0	82.4	**2.0**
AMBASSADOR	78.9	86.9	**1.8**
LSD (P0.05)	13.7	21.7	

TABLE 8B MEAN % (ANGULAR TRANSFORMATION) TUBERS AFFECTED BY LATE BLIGHT (2ND EARLY/MAINCROP VARIETIES)

	Test Year		
Variety	**2011**	**2012**	**1-9 rating**
BINTJE	72.4	84.9	**2.0**
CARA	34.9	62.3	**6.0**
SARPO MIRA	62.2	59.9	**4.3**
VALOR	46.8	44.1	**6.4**
ELECTRA	76.6	82.4	**1.9**
EMMA	65.0	78.8	**2.9**
TAURUS	60.7	72.9	**3.6**
VR808	77.8	90.0	**1.3**
ARIZONA	-	90.0	*1.1*
COMPASS	-	86.9	*1.6*
INFINITY	-	86.9	*1.6*
JELLY	-	90.0	*1.1*
PANTHER	-	90.0	*1.1*
ROYAL	-	86.8	*1.7*
SETANTA	-	78.4	*3.2*
LSD (P0.05)	15.3	14.7	**1.7**

*2.3.2.2. Blackleg (***Pectobacterium atrosepticum***)*

The incidence of blackleg was variable for some varieties between the two years of testing. For example, Ambassador, Emma and VR808 had fewer blackleg symptoms recorded in 2012 than in 2011, whereas Electra and Taurus had less blackleg recorded in 2011. VR808 had the highest score of 4.8; Emma and Ambassador were the most susceptible scoring 1.0 and 1.6 respectively.

Of the 1st year varieties entered, Setanta, Infinity and Royal had resistance scoring 7.3, 7.0 and 7.0 respectively. Panther (1.2) and Compass (2.4) were the most susceptible.

TABLE 9. MEAN % (ANGULAR TRANSFORMATION) PLANTS AFFECTED BY BLACKLEG (*PECTOBACTERIUM ATROSEPTICUM*)

Variety	Test Year 2011	2012	1-9 rating
AILSA	0.0	15.0	**8.0**
CONCURRENT	52.4	64.9	**3.0**
CULTRA	36.9	32.3	**5.8**
ESTIMA	36.5	53.3	**3.5**
MORENE	48.6	54.9	**4.2**
AMBASSADOR	66.5	55.4	**1.6**
ELECTRA	32.9	56.4	**3.7**
EMMA	79.4	61.9	**1.0**
TAURUS	26.9	58.4	**4.0**
VR808	47.5	24.7	**4.8**
ARIZONA	-	38.1	*5.7*
COMPASS	-	65.0	*2.4*
INFINITY	-	27.9	*7.0*
JELLY	-	46.0	*4.7*
PANTHER	-	75.0	*1.2*
ROYAL	-	27.7	*7.0*
SETANTA	-	25.1	*7.3*
LSD (P0.05)	15.1	13.1	**3.3***/4.1*

2.3.2.3. Common Scab

Of the varieties completing testing, Electra was the most resistant with a score of 7.2. Ambassador (2.8) and Emma (3.3) were the most susceptible varieties.

Of the varieties in their 1st year of testing, Jelly had moderate resistance with a score of 5.9. Setanta was the most susceptible variety on test (2.1).

TABLE 10. MEAN % (ANGULAR TRANSFORMATION) SURFACE AREA AFFECTED BY COMMON SCAB

Variety	Test Year 2011	2012	1-9 rating
DESIREE	51.3	54.4	**3.1**
ESTIMA	42.4	39.1	**5.4**
HOME GUARD	45.2	43.7	**4.4**
MARIS BARD	54.4	52.8	**3.7**
MARIS PEER	52.9	56.5	**4.0**
MARIS PIPER	59.1	54.5	**2.0**
PENTLAND CROWN	33.5	28.7	**7.0**
AMBASSADOR	47.9	58.0	**2.8**
ELECTRA	44.4	23.3	**7.2**
EMMA	44.8	56.9	**3.3**
TAURUS	53.6	37.6	**4.5**
VR808	43.3	48.8	**4.4**
ARIZONA	-	45.9	*3.2*
COMPASS	-	44.5	*3.6*
INFINITY	-	41.5	*4.3*
JELLY	-	35.6	*5.9*

PANTHER	-	47.0	*2.9*
ROYAL	-	39.1	*5.0*
SETANTA	-	50.2	*2.1*
LSD (P0.05)	8.6	11.0	**2.9**/*5.3*

2.3.2.4. Powdery Scab

Overall there was a similar incidence of powdery scab in the test years. Estima continued to be clearly more susceptible than any of the other reference varieties. Taurus was the most resistant variety scoring 7.5. VR808 (1.0) and Emma (1.8) were the most susceptible.

Of the first year candidate varieties Royal and Setanta were the most resistant scoring 6.9 and 6.5, respectively. The most susceptible varieties were Compass (2.5) and Panther (2.8).

TABLE 11. MEAN % (ANGULAR TRANSFORMATION) SURFACE AREA AFFECTED BY POWDERY SCAB

	Test Year		
Variety	**2011**	**2012**	**1-9 rating**
ACCENT	22.7	21.4	**6.1**
CARA	18.3	20.3	**6.5**
ESTIMA	33.5	47.3	**3.0**
PENTLAND CROWN	14.6	16.9	**7.1**
SANTE	12.0	8.8	**8.0**
AMBASSADOR	25.6	23.7	**5.6**
ELECTRA	43.3	37.5	**3.0**
EMMA	49.4	45.7	**1.8**
TAURUS	13.8	12.8	**7.5**
VR808	51.6	56.0	**1.0**
ARIZONA	-	40.4	*3.9*
COMPASS	-	51.5	*2.5*
INFINITY	-	20.9	*6.4*
JELLY	-	24.6	*6.0*
PANTHER	-	49.2	*2.8*
ROYAL	-	17.4	*6.9*
SETANTA	-	20.3	*6.5*
LSD (P0.05)	7.6	8.1	**1.4**

*2.3.2.5. Dry rot (*Fusarium *spp.)*

2.3.2.5.1. F. solani var. *coeruleum*

There was generally more disease recorded in 2011 than 2012. VR808 (7.7), Ambassador (7.7) and Taurus (6.8) were the most resistant candidate varieties. The remaining test varieties were Emma and Electra scoring 4.7 and 3.6, respectively.

Three 1st year varieties had high resistance, these were Setanta (8.0), Infinity (7.9) and Panther (7.8). The susceptible varieties were Arizona and Royal scoring 2.6 and 3.4 respectively.

TABLE 12. MEAN % (ANGULAR TRANSFORMATION) INTERNAL AREA AFFECTED BY *FUSARIUM COERULEUM*

	Test Year		
Variety	**2011**	**2012**	**1-9 rating**
CATRIONA	56.4	64.0	**1.0**
ESTIMA	42.3	27.7	**4.0**
NADINE	24.8	20.8	**5.7**
PENTLAND SQUIRE	55.0	29.4	**3.0**
SANTE	7.3	4.1	**8.0**
AMBASSADOR	7.1	9.7	**7.6**
ELECTRA	35.3	40.2	**3.6**
EMMA	44.4	15.4	**4.7**
TAURUS	16.9	12.3	**6.8**
VR808	6.1	9.7	**7.7**
ARIZONA	-	31.5	*2.6*
COMPASS	-	21.8	*4.5*
INFINITY	-	4.5	*7.9*
JELLY	-	12.8	*6.3*
PANTHER	-	5.1	*7.8*
ROYAL	-	27.3	*3.4*
SETANTA	-	4.1	*8.0*
LSD (P0.05)	8.6	9.7	**2.6**

2.3.2.5.2. F. sulphureum

Overall there was more disease recorded in 2012 than 2011. Ambassador and VR808 were the most resistant scoring 7.1 and 6.8, respectively. All other 2nd year varieties were susceptible; these were Emma (1.0), Taurus (1.0) and Electra (1.2).

Of the first year varieties, all were susceptible scoring 1.0 with the exception of Infinity which scored 2.7

TABLE 13. MEAN % (ANGULAR TRANSFORMATION) INTERNAL AREA AFFECTED BY *FUSARIUM SULPHUREUM*

	Test Year		
Variety	**2011**	**2012**	**1-9 rating**
ATLANTIC	42.9	43.1	**1.0**
MARIS PIPER	36.2	25.7	**3.0**
NADINE	32.9	27.8	**3.2**
SANTE	13.6	12.0	**8.0**
SAXON	15.3	27.7	**5.6**
AMBASSADOR	8.3	24.1	**7.1**
ELECTRA	32.7	41.9	**1.2**
EMMA	54.6	69.3	**1.0**
TAURUS	25.1	61.7	**1.0**
VR808	14.5	20.1	**6.8**
ARIZONA	-	57.7	*1.0*
COMPASS	-	60.4	*1.0*
INFINITY	-	26.4	*2.7*
JELLY	-	67.7	*1.0*
PANTHER	-	66.5	*1.0*
ROYAL	-	55.1	*1.0*
SETANTA	-	37.9	*1.0*
LSD (P0.05)	9.1	11.2	**6.2**

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2.3.2.6. External damage (splitting)

The incidence of splitting varied between 2011 and 2012, with large differences between some reference and candidate varieties; but this trend was not seen for all varieties as Russet Burbank as Red Craig's Royal had similar amounts of splitting in both years. The 1st early variety Ambassador was susceptible scoring 2.5. The 2nd early/maincrop varieties scored between 4.3 and 5.8.

Of the first year candidate varieties, Royal was the most resistant scoring 6.3. Panther and Arizona were the least resistant varieties on test scoring 3.9 and 4.2 respectively.

TABLE 14A. MEAN % (ANGULAR TRANSFORMATION) TUBERS AFFECTED BY SPLITTING AFTER APPLYING STANDARD FORCE (1ST EARLY VARIETIES)

	Test Year		
Variety	**2011**	**2012**	**1-9 rating**
ULSTER SCEPTRE	44.9	42.9	**3.0**
HOME GUARD	0.0	40.0	**5.3**
AMBASSADOR	17.6	81.1	**2.5**
LSD (P0.05)			

TABLE 14B. MEAN % (ANGULAR TRANSFORMATION) TUBERS AFFECTED BY SPLITTING AFTER APPLYING STANDARD FORCE (2ND EARLY/MAINCROP VARIETIES)

	Test Year		
Variety	**2011**	**2012**	**1-9 rating**
RED CRAIGS ROYAL	50.0	45.6	**2.6**
RUSSET BURBANK	42.3	38.2	**3.4**
RECORD	16.0	8.3	**6.0**
MARIS PIPER	9.8	54.8	**4.1**
MARIS PEER	6.1	37.5	**5.1**
ELECTRA	19.2	10.2	**5.8**
EMMA	31.4	20.5	**4.7**
TAURUS	13.5	40.0	**4.6**
VR808	36.0	25.0	**4.3**
ARIZONA		28.1	*4.2*
COMPASS		18.3	*5.1*
INFINITY		16.7	*5.3*
JELLY		16.7	*5.3*
PANTHER		32.1	*3.9*
ROYAL		4.9	*6.3*
SETANTA		21.3	*4.8*
LSD (P0.05)			**4.3**

2.3.2.7. Internal damage (bruising)

Electra was the most resistant scoring 7.4. The other 2nd early/maincrop varieties scored between 4.0 and 4.7. The 1st early variety, Ambassador, had moderate resistance scoring 5.4.

For the first year varieties, most varieties had some level of resistance. Setanta (7.9) was the most resistant variety, obtaining a score higher than the resistant reference varieties. Jelly was not included in the test due to a shortage of tubers from the harvested trial plot.

TABLE 15A. MEAN DEPTH (MM) OF BRUISE AT POINT OF IMPACT OF STANDARD FORCE (1ST EARLY VARIETIES)

	Test Year		
Variety	**2011**	**2012**	**1-9 rating**
ULSTER SCEPTRE	5.4	2.5	**4.9**
HOME GUARD	2.0	2.1	**6.5**
AMBASSADOR	2.5	4.1	**5.4**
LSD (P0.05)			

TABLE 15B. MEAN DEPTH (MM) OF BRUISE AT POINT OF IMPACT OF STANDARD FORCE (2ND EARLY/MAINCROP VARIETIES)

Variety	Test Year 2011	2012	1-9 rating
RED CRAIGS ROYAL	3.1	6.1	**4.3**
RUSSET BURBANK	5.4	4.7	**4.0**
RECORD	4.5	5.3	**4.1**
MARIS PIPER	2.4	2.8	**6.0**
MARIS PEER	2.8	4.4	**5.2**
ELECTRA	1.2	0.7	**7.4**
EMMA	5.6	4.5	**4.0**
TAURUS	3.9	4.6	**4.7**
VR808	5.8	3.7	**4.3**
ARIZONA	-	4.1	*4.6*
COMPASS	-	2.8	*5.9*
INFINITY	-	3.5	*5.3*
JELLY	-	*	*
PANTHER	-	3.4	*5.4*
ROYAL	-	2.9	*5.9*
SETANTA	-	1.0	*7.9*
LSD (P0.05)			**1.7**

* Jelly was not included in the trial due to insufficient tubers

2.3.2.8. Potato Cyst Nematode

Resistance to PCN (*G. rostochiensis* Ro1) is normally conferred by the major gene H1 and results in no, or minimal, multiplication of cysts on the potato. Varieties expressing this type of resistance to Ro1 were Electra, Taurus and VR808. Of the first year candidates, Arizona, Compass Jelly and Royal had resistance.

The first year candidate, Panther had resistance to *G. pallida.* This is not the full resistance occurring with H1 gene for Ro1 which limits cyst multiplication to no more than the original population

TABLE 16. MULTIPLICATION OF CYSTS OF 3 PATHOTYPES OF POTATO CYST NEMATODE (*GLOBODERA ROSTOCHIENSIS*) PATHOTYPE 1, *G. PALLIDA* PATHOTYPES 2/3) ON TEST VARIETIES, EXPRESSED AS 1-9 RATING.

VARIETY	Ro1	Pa 2/3	Pa1
DESIREE	**2 (S)** †	**2 (S)**	**2 (S)**
ESTIMA	**2 (S)**	*	*
MARIS PIPER	**7 (R)**	**3 (S)**	**2 (S)**
12380	**7 (R)**	**7 (R)**	**6**
VANTAGE	**5**	**6**	**6**
MORAG	**4**	**4**	**3 (S)**
VALES EVEREST	*	**6**	**8 (R)**
INNOVATOR	*****	**8 (R)**	**8 (R)**
AMBASSADOR	**3 (S)**	**7 (R)**	*
ELECTRA	**7 (R)**	**2 (S)**	*
EMMA	**4**	**2 (S)**	*
TAURUS	**8 (R)**	**3 (S)**	*
VR808	**7 (R)**	**2 (S)**	*
ARIZONA	*7 (R)*	*3 (S)*	*
COMPASS	*8 (R)*	*3 (S)*	*
INFINITY	*2 (S)*	*2 (S)*	*
JELLY	*9 (R)*	*3 (S)*	*
PANTHER	*3 (S)*	*7 (R)*	*
ROYAL	*9 (R)*	*4*	*
SETANTA	*1 (S)*	*2 (S)*	*

† R denotes full resistance and S denotes full susceptibility

2.4. Discussion and Conclusions

The full range of disease tests was completed on time with reasonable disease development in all tests. In some tests e.g. foliage and tuber late blight, and skin spot, disease severity was greater in 2012 than in 2011, whereas the incidence of dry rot – *F. coeruleum* was generally less in 2012 than 2011. As in previous years, some differences in the relative reactions of varieties were found between test years. For example, Red Emmalie and Ambassador were more susceptible to black dot in 2012 than 2011; and Violetta, Red Emmalie and VR808 were more susceptible to silver scurf in 2012 than 2011. Such yearly variation appears to be an inherent part of this type of testing and may be a consequence of differing disease pressures and environmental conditions in the test year. Conditions in a polytunnel will, for example, be affected by outside temperature, amount of sunshine and humidity and this could impact on disease pressure. The amount of disease pressure to which a variety is exposed can affect its reaction as reported by Hilton *et al.* (2000) for silver scurf. The potential for variability in a variety's reaction needs to be recognised when considering ratings, particularly those based on one test in one year.

At the start of 2012 it was decided to discontinue the *Rhizoctonia* black scurf test as the results were inconsistent from year to year. It was agreed that an assay to assess possible resistance/ tolerance for stem canker and related symptoms i.e. pruned stolons as caused by *Rhizoctonia solani* would be investigated. The investigation consisted of a screen of all 36 varieties and additionally a test with a known susceptible variety (Harmony) to determine the ideal time point expressed as weeks after planting for assessment of stem canker. There was evidence (P=0.003) of a difference in stem canker severity for variety Harmony between the five assessment

dates. Stem canker was significantly higher (P<0.05) at week 2 than any other assessment date. It was also significantly higher (P<0.05) at weeks 10 and 12 than at week 4. In the main trial involving 36 varieties there was very strong statistical evidence of varietal discrimination in stem canker severity at week 4 but no statistical evidence of discrimination at week 8. This would strongly indicate stem canker severity should be compared at week 4 in preference to week 8. In the main trial involving 36 varieties there was statistical evidence of varietal discrimination in stolon canker severity when combining data from both weeks 4 and 8. There was no statistical evidence of better varietal discrimination at either week 4 or week 8. In the main trial involving 36 varieties there was statistical evidence (P=0.011) of varietal discrimination in the proportion of pruned stolons based on assessment in week 4 but no such evidence in week 8.

Development of a test for susceptibility to *Dickeya 'solani* 'was continued in 2012. Plants were observed for symptoms of blackleg on a weekly basis. Harvested tubers were rolled over a hand riddle and stored in a humid environment at a high temperature; tubers affected by bacterial rotting were then recorded. The plant assessments showed much clearer differences between varieties and inoculum levels than the tubers. Based on the plant scores, the 10^5 concentration didn't discriminate varieties as well as the other two concentrations.

2011 saw the introduction of a test for potato mop top virus (spraing). In this test the number of tubers with spraing symptoms is recorded. This report contains the results of the two year test and the majority of varieties had resistance. As noted in the R447 IVT report 2011, there were two coloured flesh varieties in the test (Violetta and Red Emmalie), it should be noted that the assessment of coloured flesh varieties is limited as spraing can be difficult to observe in these circumstances.

As reported in the R447 IVT report 2011, Sarpo Mira was the most resistant variety in the field foliage blight tests, but showed susceptibility to tuber blight in the test years of 2010 and 2011. The variety performed similarly in the 2012 blight trials. Such differences in reaction between foliage and tuber have been recorded in previous testing and confirm the necessity to ensure that more than one resistant variety is included in the test programme.

In the National List and IVT testing programmes, the resistance of a candidate variety to a range of diseases is evaluated in a series of standardised tests which each include a set of standard reference varieties whose reactions are known. For each disease, the resistance rating of a candidate variety is determined by comparing the amount of disease developing on the candidate variety with that on the standard varieties over at least two years of testing. The process of calculating variety scores is subject to regular review. As part of a review of NL decision making, statistical advice was that over-year means should be calculated from data for as many years as possible rather than two test years. This proposal has been adopted for NL analysis using data since 1981 and has been applied to IVT data for the last eight years. This has meant that small changes in some of the historic ratings ascribed to a variety have occurred, sometimes exacerbated by the process of rounding up or down to a whole number. For example, a variety scoring 3.7 for a character is recorded as 4, the same as a variety scoring 4.4. Small shifts in the calculations may move these values up or down. **Users of this data should bear in mind that the final rating of a variety should be treated as a broad guide as to how a variety might perform in practice rather being an absolute value.** Disease resistance ratings are recorded on a 1 to 9

scale where 1 is highly susceptible and 9 very resistant. Thus the higher the value, the more resistant a variety is to a disease. Typically, varieties with a score of 1, 2 or 3 would be considered highly susceptible, those with a score 4 or 5 considered susceptible, those with a score 6 or 7 moderately resistant and those with scores 8 or 9 highly resistant. A high resistance score should not be taken as indicating that a disease will be absent but that there is less risk of the disease developing on these varieties. With most other diseases and faults, all varieties can be affected to a greater or lesser extent. In consequence, the need for other control measures such as fungicide application should be evaluated, based on other factors such as the level of inoculum likely to be present and whether environmental conditions favour the pathogen.

The British Potato Variety Database was launched on the web in July, 2007 and formally presented to industry at the Potatoes in Practice event in August, 2007. This is now the mechanism for publication of both NL and IVT data and brings this data together with breeder's information formerly presented in publications such as "Scotland - The Natural Home of Potatoes". This database allows SASA to publish variety information immediately from various trials as soon as it is finalised. To date, the database has been accessed 165,196 times up to July 2013.

The 14 varieties which completed IVT in 2012 were Shelford, Violetta, Red Emmalie, Mistay, Nitza, Zohar, Zahov, Safiyah, Bremner, Ambassador, Electra, Emma, Taurus and VR808. In summary, the key findings for these varieties are as follows:

Shelford

Resistant to: **silver scurf, mop top (spraing)** and **blackleg**

Susceptible to: **tuber late blight, common scab, dry rot – *F. sulphureum,* PCN Ro1** and **PCN Pa 2/3 and 1**

Violetta

Resistant to: **black dot, skin spot, mop top (spraing)** and **dry rot – *F. sulphureum***

Susceptible to: **tuber late blight, PCN Ro1** and **PCN Pa 2/3 and 1**

Red Emmalie

Resistant to: **black dot, skin spot, mop top (spraing), blackleg, common scab** and **dry rot – *F. coeruleum*** and ***F. sulphureum*,**

Susceptible to: **tuber late blight, PCN Ro1** and **PCN Pa 2/3 and 1**

Mistay

Resistant to: **mop top (spraing), powdery scab** and **dry rot – *F. coeruleum***

Susceptible to: **common scab, dry rot – *F. sulphureum*** and **external damage**

Nitza

Resistant to: **silver scurf, skin spot, mop top (spraing), blackleg** and **PCN Ro1**

Susceptible to: **tuber late blight, PCN Pa 2/3 and 1** and **external damage**

Zohar

Resistant to: **skin spot, mop top (spraing)** and **dry rot – *F. coeruleum***

Susceptible to: **black dot, tuber late blight, common scab, PCN Ro1, PCN Pa 2/3 and 1, external damage** and **internal damage**

Zahov

Resistant to: **silver scurf, mop top (spraing), dry rot – *F. coeruleum,* PCN Ro1** and **external damage**

Susceptible to*:* **skin spot, tuber late blight, blackleg, dry rot – *F. sulphureum*** and **PCN Pa 2/3 and 1**

Safiyah

Resistant to: **skin spot, mop top (spraing), blackleg, dry rot – *F. sulphureum*** and **PCN Ro1**

Susceptible to: **foliage late blight, black dot, tuber late blight, powdery scab, PCN Pa 2/3 and 1** and **external damage**

Bremner

Resistant to: **silver scurf, mop top (spraing)** and **dry rot – *F. coeruleum***

Susceptible to: **dry rot – *F. sulphureum,* PCN Ro1** and **PCN Pa 2/3 and 1**

Ambassador

Resistant to: **skin spot, mop top (spraing)** and **dry rot – *F. coeruleum*** and ***F. sulphureum***

Susceptible to: **black dot, tuber late blight, blackleg**, **PCN Ro1** and **external damage**

Electra

Resistant to: **skin spot, PCN Ro1** and **internal damage**

Susceptible to: **mop top (spraing), tuber late blight, powdery scab, dry rot – *F. coeruleum*** and ***F. sulphureum*****,** and **PCN Pa 2/3 and 1**

Emma

Resistant to: **mop top (spraing)**

Susceptible to: **foliage late blight, black dot, skin spot, tuber late blight, blackleg, powdery scab, common scab, dry rot –*F. sulphureum*,** and **PCN Pa 2/3 and 1**

Taurus

Resistant to: **black dot, silver scurf, skin spot, powdery scab, dry rot** – ***F. coeruleum*** and **PCN Ro1**

Susceptible to: **tuber late blight**, **dry rot –*F. sulphureum*,** and **PCN Pa 2/3 and 1**

VR808

Resistant to: **skin spot, mop top (spraing) and dry rot – *F. coeruleum*** and ***F. sulphureum***

Susceptible to: **foliage late blight, black dot, tuber late blight, powdery scab** and **PCN Pa 2/3 and 1**

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United Kingdom National List Trials: Trials Procedures for the Official Examination of Value for Cultivation and Use (VCU) – Potato 2012

4. APPENDICES

4.1. Appendix I: Statistical Analysis of 2012 *Rhizoctonia* Data

Introduction

In order to provide comprehensive independent disease resistance ratings for potato varieties for the potato industry, SASA and SRUC carry out a series of independent variety trials (IVT) on behalf of the Potato Council. This report summaries the statistical analysis of a rhizoctonia (black scurf) trial which had two objectives. Firstly,

there was a need to compare varieties for rhizoctonia susceptibility. Secondly, there was a need to assess whether there is an optimum time after emergence for assessment.

Data collected

Six replicate pots of each of 36 varieties were laid out as a randomised block experiment. The first three replicates were assessed four weeks post-emergence while the remaining three replicates were assessed eight weeks post-emergence. For one of the 36 varieties (Harmony) there were a further nine pots – three assessed at week 2, three at week 10 and three at week 12. The layout of pots in the glasshouse was such that the three replicates assessed after four weeks were grouped together in the glasshouse. Similarly, the three replicates assessed after eight weeks were grouped together. Harmony was one of these 36 varieties. Additionally a further nine pots of Harmony were housed separately in the glasshouse with three pots destructively sampled at 2, 10 and 12 weeks respectively. For any one of these three assessment times the three pots were adjacent to each other in the glasshouse. Thus assessment date was confounded with spatial location in all cases. The numbers of stolons and pruned (i.e infected) stolons in each pot were recorded in all cases. Additionally, stolon and stem canker severity on a 0-4 scale was recorded. The corresponding range of severity percentages for each category of the scoring scale is shown in the table below.

TABLE 1: SCORING SCALE FOR STEM AND STOLON CANKER SEVERITY

Score	% severity	Mid-point
0	0	0
1	1 – 10	5
2	10 – 25	17.5
3	26 – 50	37.5
4	> 50	75

Statistical methods

In order to analyse the data it has been necessary to assume for the main trial (which compares the 36 varieties at two assessment dates) that assignment of assessment date to the six replicate blocks of varieties was done at random rather than the first assessment to the first three blocks and the second assessment to the final three blocks. Similarly, it has been necessary to assume when analysing all the data on Harmony across the five assessment dates that assessment date was randomly assigned to the fifteen pots. Clearly, this was not the case. As such, the analyses presented are not strictly valid. In practice, although assessment date is completely confounded with spatial location, the conclusions are unlikely to be seriously misleading provided there are no grounds for expecting a spatial effect within the glasshouse on any of the response variables. This may be more plausible within the small sub-experiment for Harmony covering assessments on weeks 2, 10 and 12 than when comparing assessments between weeks 4 and 8.

Stem and stolon canker severity were recorded on an ordinal scale. Single unit increments in the scoring scale do not correspond to equal increments in increasing severity. In other words, an increase in the score from 1 to 2 does not correspond to the same increase in severity as an increase in the score from 2 to 3. Consequently, it would be inappropriate to analyse the scores per se by parametric analysis of variance. Instead, scores have been converted to percentage severity by assigning to the pot the mid-point value of the respective score. An angular transformation has

then been applied to the pot percentages prior to statistical analysis to more closely satisfy the assumption of variance homogeneity. Formal comparisons should be made on the transformed scale and consequently SEDs, LSDs and P values are only presented for the analysis of the transformed data. However, for reference only, the means calculated on untranformed values are also shown.

Ideally, incidence data represented by the number of pruned stolons out of the total number of stolons should be analysed by fitting either a generalised linear model or generalized linear mixed model, both with a binomial error structure and the logit link function. This approach reflects the binomial nature of the response variable and also takes into account that there are more stolons in some pots than others, which impacts on precision. Such an approach using a generalized linear model was possible for a comparison of the five assessment dates for Harmony.

Unfortunately such a model could not be fitted successfully to the combined data from both weeks 4 and 8. Consequently, the varieties X weeks interaction was tested by firstly applying the empirical logit transformation to the numbers of stolons and pruned stolons, and then using analysis of variance, as done previously for transformed canker and stolon severity percentages. Some caution should be exercised in interpreting the results from the latter combined analysis as no allowance is made for the varying precision in comparisons due to varying numbers of stolons although it does take into account the expected relationship between precision and the mean.

The empirical logit is very similar to applying a logit transformation to the proportion of pruned stolons but differs slightly in order to able to deal with cases where either all or none of the stolons were pruned for an individual pot.

For generalized linear models a dispersion parameter is estimated from the data, reflecting the fact that variation was greater than might be expected in a binomially distributed variable. It indicates clumping of infection. This approach was applied separately to data from week 4.

Harmony at weeks 2, 4, 8, 10 and 12

The results from the statistical analysis of stem and stolon cankers in the variety Harmony are shown in Table 2. There was evidence (P=0.003) of a difference in stem canker between assessment dates. Stem canker was significantly higher (P<0.05) at week 2 than any other assessment date. It was also significantly higher (P<0.05) at weeks 10 and 12 than at week 4.
Where the mean differences in pairwise comparisons are close to the LSD, conclusions should be made with caution. This is due to both the confounding between spatial location and assessment date, and also the fact that LSDs are not increased to account for multiple comparison testing (and hence increased risk of spurious statistical significance). The dip in stem canker severity at week 4 is perhaps surprising and should be viewed with caution.

There was no statistical evidence of a difference in stolon canker severity between assessment dates. However, the lack of statistical evidence of a difference does not mean there was evidence of no difference. Indeed, the statistical power to detect a difference was low.

TABLE 2: STEM AND STOLON CANKER PERCENTAGE SEVERITY IN HARMONY OVER TIME

	Untransformed	Angular transf	Untransformed	Angular transf
	Stem canker	Stem canker	Stolon canker	Stolon canker
Week 2	62.5	52.6	13.3	20.8
Week 4	1.7	4.3	1.7	4.3
Week 8	7.5	12.6	3.3	8.6
Week 10	26.7	29.5	14.2	16.9
Week 12	24.2	29.1	24.2	29.1
SED		9.21		8.81
LSD (5%)		20.51		19.64
P value		0.003		0.111

The proportions of pruned stolons at the different assessment times for Harmony are shown in Table 3a, with the associated SEDs and LSDs from analysis on the transformed scale (logit scale) are shown in Tables 3b and 3c respectively. There was only very weak statistical evidence (P=0.087) for differences in the proportion of stolons pruned between assessment dates. It is perhaps worth noting that the SEDs and LSDs are smallest for comparisons involving the later assessment dates which simply reflects the presence of more stolons at these time points. The presence of greater variation than expected from binomial data (i.e. clustering) was evident from an estimated dispersion parameter of 2.11. The weak evidence arose from the far higher observed proportion of pruned stolons at week 2 than at later dates.

TABLE 3A: PROPORTIONS OF PRUNED STOLONS IN HARMONY OVER TIME

	Proportion (original scale)	Proportion (logit scale)
Week 2	0.727	0.981
Week 4	0.057	-2.803
Week 8	0.205	-1.355
Week 10	0.349	-0.623
Week 12	0.270	-0.995

TABLE 3B: SEDS FOR PAIRWISE COMPARISONS OF PROPORTIONS OF PRUNED STOLONS ON THE TRANSFORMED SCALE

Week 4	1.445			
Week 8	1.140	1.205		
Week 10	1.056	1.125	0.693	
Week 12	1.067	1.135	0.709	0.564
	Week 2	Week 4	Week 8	Week 10

TABLE 3C: LSDS (5%) FOR PAIRWISE COMPARISONS OF PROPORTIONS OF PRUNED STOLONS ON THE TRANSFORMED SCALE

Week 2					
Week 4	3.219				
Week 8	2.540	2.684			
Week 10	2.353	2.508	1.543		
Week 12	2.377	2.530	1.579	1.256	
	Week 2	Week 4	Week 8	Week 10	Week 12

All varieties at weeks 4 and 8

Results for stem canker on the angular transformed (Table 4a) and the untransformed percentage scale (Table 4b) are shown below. There was evidence of an interaction between variety and assessment date (P=0.021). This can be viewed in one of two ways. These are that the difference between assessment dates varies from variety to variety or alternatively that the difference between varieties depends on the assessment date. For example, severity was worse for Zahov at the first assessment while the converse was the case for Cara.

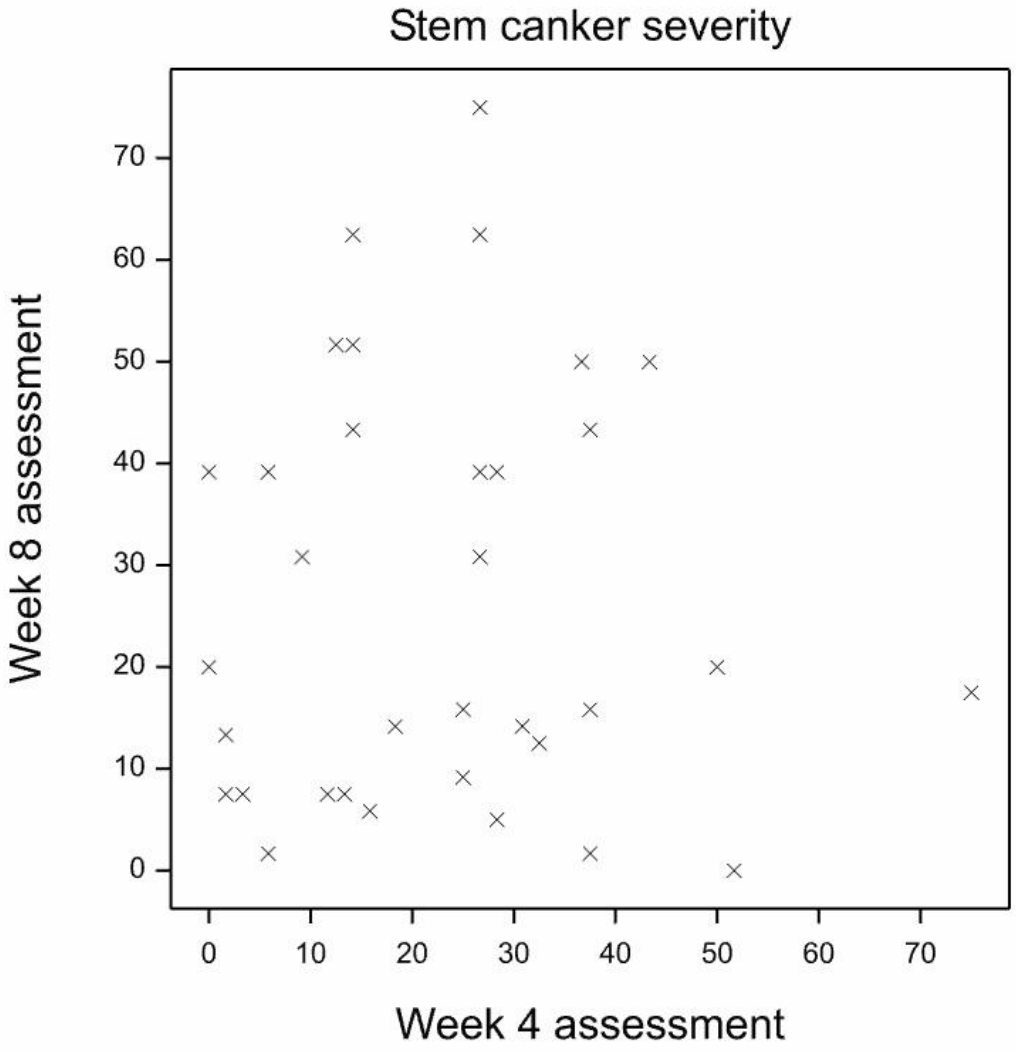
TABLE 4A: STEM CANKER SEVERITY ON THE ANGULAR TRANSFORMED SCALE

Variety		Week 4	Week 8
00C133-020		24.3	60.0
02.Z.216 A6		21.2	8.2
02C053-016		20.8	12.6
03.N.8A81		4.3	20.8
03.Z.6.A5		8.6	12.6
03C114-006		16.9	33.4
96HG773B1 (Bremner)		24.3	33.4
Ambassador		32.6	21.2
Arizona		24.3	36.9
BEE 96 482 (Safiyah)		16.9	44.3
Bute (166HVN05)		16.9	40.8
Cara		24.3	52.6
Compass		32.6	40.8
Duke of York		28.6	12.9
Electra		28.6	36.9
Emma		20.0	16.9
G03TT007006		44.3	0.0
Harmony		4.3	12.6
Infinity		8.2	4.3
Jelly		32.6	4.3
King Edward		36.5	45.2
Lady Christl		40.8	40.0
Nitza		0.0	25.1
Panther		16.9	44.3
Red Emmalie		25.2	21.2
Royal		32.6	12.6
Sante		28.2	16.9
Saxon		12.6	44.3
Setanta		16.5	12.6
Shelford		16.9	52.6
Taurus		0.0	36.9
Violetta		20.8	16.9
VR808		8.2	36.9
Zahov		60.0	24.7
Zohar		40.0	25.1
SED = 16.13			
LSD (5%) = 31.88			

TABLE 4B: STEM CANKER SEVERITY ON THE ORIGINAL (UNTRANSFORMED) PERCENTAGE SCALE

Variety		Week 4	Week 8
00C133-020		26.7	75.0
02.Z.216 A6		15.8	5.8
02C053-016		13.3	7.5
03.N.8A81		1.7	13.3
03.Z.6.A5		3.3	7.5
03C114-006		9.2	30.8
96HG773B1 (Bremner)		26.7	30.8
Ambassador		37.5	15.8
Arizona		26.7	39.2
BEE 96 482 (Safiyah)		14.2	51.7
Bute (166HVN05)		14.2	43.3
Cara		26.7	62.5
Compass		37.5	43.3
Duke of York		28.3	5.0
Electra		28.3	39.2
Emma		25.0	9.2
G03TT007006		51.7	0.0
Harmony		1.7	7.5
Infinity		5.8	1.7
Jelly		37.5	1.7
King Edward		36.7	50.0
Lady Christl		43.3	50.0
Nitza		0.0	20.0
Panther		14.2	51.7
Red Emmalie		25.0	15.8
Royal		32.5	12.5
Sante		30.8	14.2
Saxon		12.5	51.7
Setanta		11.7	7.5
Shelford		14.2	62.5
Taurus		0.0	39.2
Violetta		18.3	14.2
VR808		5.8	39.2
Zahov		75.0	17.5
Zohar		50.0	20.0

The correlation between variety means for stem canker severity percentages at the two assessment dates was -0.03.



The interaction between assessment date and varieties may be of interest in itself. It indicates that varietal discrimination comparisons differed depending on assessment date. In order to compare the relative varietal discrimination at the two assessment dates, the magnitude of the variety variance ratios from separate analyses of variance of angular transformed data from the two assessment dates have been compared. The respective variance ratios for weeks 4 and 8 for stem canker severity were 2.57 ($P<0.001$) and 1.05 ($P=0.418$) respectively. This indicates very strong statistical evidence of varietal discrimination at week 4 but no statistical evidence of discrimination at week 8. This would strongly indicate stem canker severity should be compared at week 4 in preference to week 8.

Results for stolon canker severity on the angular transformed (Table 5a) and original scale (Table 5b) are shown below. There was evidence of a difference between varieties ($P=0.039$) and also between assessment dates ($P=0.038$) with means of 10.15 and 14.33 (SED=1.371, LSD (5%) =3.807) on the angular transformed scale. However, there was no statistical evidence of an interaction between variety and assessment date ($P=0.379$) although statistical power to detect any such effect was low. In the absence of statistical evidence of an interaction interest should focus on the main effects of variety and of assessment date when comparing varieties.

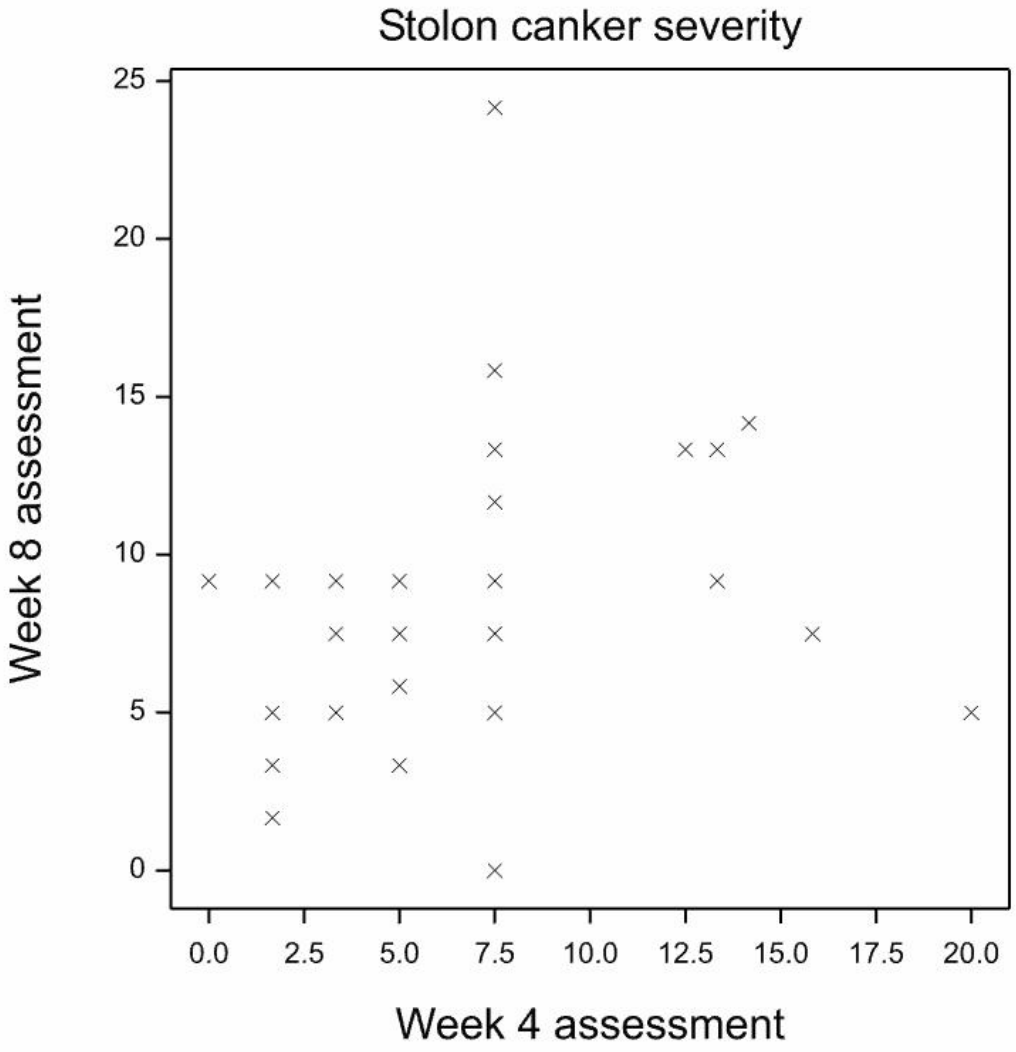
TABLE 5A: STOLON CANKER SEVERITY ON THE ANGULAR TRANSFORMED SCALE

Variety		Week 4	Week 8	Average
00C133-020		4.31	16.86	10.58
02.Z.216 A6		12.92	8.61	10.77
02C053-016		8.61	16.86	12.74
03.N.8A81		0.00	16.86	8.43
03.Z.6.A5		4.31	4.31	4.31
03C114-006		12.92	16.86	14.89
96HG773B1 (Bremner)		12.92	16.86	14.89
Ambassador		12.55	20.79	16.67
Arizona		0.00	16.86	8.43
BEE 96 482 (Safiyah)		12.55	12.55	12.55
Bute (166HVN05)		12.55	16.49	14.52
Cara		12.59	20.79	16.69
Compass		12.55	16.86	14.70
Duke of York		12.55	12.92	12.74
Electra		21.20	12.55	16.88
Emma		4.31	8.61	6.46
G03TT007006		12.55	0.00	6.28
Harmony		4.31	8.61	6.46
Infinity		4.31	4.31	4.31
Jelly		12.92	12.55	12.74
King Edward		20.79	20.79	20.79
Lady Christl		20.79	16.86	18.83
Nitza		0.00	16.86	8.43
Panther		12.55	29.07	20.81
Red Emmalie		4.31	12.92	8.61
Royal		12.92	8.24	10.58
Sante		8.61	12.55	10.58
Saxon		12.55	21.20	16.88
Setanta		4.31	8.61	6.46
Shelford		12.55	20.79	16.67
Taurus		4.31	12.92	8.61
Violetta		8.61	12.92	10.77
VR808		0.00	16.86	8.43
Zahov		25.14	12.92	19.03
Zohar		16.89	16.89	16.89
SED (marg means)				7.509
LSD (5%)				14.846

TABLE 5B: STOLON CANKER SEVERITY ON THE ORIGINAL (UNTRANSFORMED) SCALE

Variety		Week 4	Week 8	Average
00C133-020		1.67	9.17	5.42
02.Z.216 A6		5.00	3.33	4.17
02C053-016		3.33	9.17	6.25
03.N.8A81		0.00	9.17	4.58
03.Z.6.A5		1.67	1.67	1.67
03C114-006		5.00	9.17	7.08
96HG773B1 (Bremner)		5.00	9.17	7.08
Ambassador		7.50	13.33	10.42
Arizona		0.00	9.17	4.58
BEE 96 482 (Safiyah)		7.50	7.50	7.50
Bute (166HVN05)		7.50	11.67	9.58
Cara		12.50	13.33	12.92
Compass		7.50	9.17	8.33
Duke of York		7.50	5.00	6.25
Electra		15.83	7.50	11.67
Emma		1.67	3.33	2.50
G03TT007006		7.50	0.00	3.75
Harmony		1.67	3.33	2.50
Infinity		1.67	1.67	1.67
Jelly		5.00	7.50	6.25
King Edward		13.33	13.33	13.33
Lady Christl		13.33	9.17	11.25
Nitza		0.00	9.17	4.58
Panther		7.50	24.17	15.83
Red Emmalie		1.67	5.00	3.33
Royal		5.00	5.83	5.42
Sante		3.33	7.50	5.42
Saxon		7.50	15.83	11.67
Setanta		1.67	3.33	2.50
Shelford		7.50	13.33	10.42
Taurus		1.67	5.00	3.33
Violetta		3.33	5.00	4.17
VR808		0.00	9.17	4.58
Zahov		20.00	5.00	12.50
Zohar		14.17	14.17	14.17

The correlation between variety means for stolon canker severity at the two assessment dates was 0.305. When viewing the plot below the reader should bear in mind that some points represent more than one variety as their values coincided with other varieties.



For the above stolon canker severity data already collected the statistically most powerful comparison of varieties is obtained by combining data from both assessment dates (i.e. utilising all the data). However, if it is necessary to select a single assessment date on the basis of whichever provides the greater varietal discrimination, then this should be done by comparing the magnitude of the variety variance ratios from separate analyses of variance of angular transformed data from the two assessment dates.

The respective variance ratios for weeks 4 and 8 for stolon canker severity were 1.34 (P=0.154) and 1.29 (P=0.184) respectively. This indicates that neither assessment has clear superiority over the other. Neither showed statistical evidence of varietal discrimination in their own right but this is a reflection of the halving of replication when only considering a single assessment date.

<u>All varieties at weeks 4 and 8 – Proportions of pruned stolons</u>

For the reasons stated in the statistical methods section, the proportions of pruned stolons have been compared by analysis of variance following empirical logit transformation.

There was a statistically significant interaction (P=0.028) between varieties and assessment date. Means on the empirical logit scale are shown in Table 6 as formal statistical comparisons should be made on the transformed scale. The interaction indicates that the relative susceptibility of varieties to each other varies between the two assessment dates.

TABLE 6: EMPIRICAL LOGITS OF STOLONS INFECTED WITH BLACK SCURF

Variety		Week 4	Week 8
00C133-020		-0.33	-0.75
02.Z.216 A6		-0.58	-1.67
02C053-016		-0.26	-1.43
03.N.8A81		-3.33	-0.76
03.Z.6.A5		-2.92	-1.59
03C114-006		-2.70	-1.22
96HG773B1 (Bremner)		-0.74	-1.17
Ambassador		-1.01	0.08
Arizona		-3.27	-0.66
BEE 96 482 (Safiyah)		-1.26	-1.19
Bute (166HVN05)		-0.50	-0.42
Cara		-1.95	-0.66
Compass		-1.17	-0.57
Duke of York		-0.10	-0.55
Electra		-0.73	-0.25
Emma		-3.06	-1.50
G03TT007006		-1.22	-2.34
Harmony		-2.59	-1.57
Infinity		-1.40	-3.20
Jelly		-0.08	-2.51
King Edward		-0.54	-0.63
Lady Christl		0.90	-1.03
Nitza		-3.30	-0.68
Panther		-0.73	-0.06
Red Emmalie		0.69	-1.82
Royal		0.27	-2.53
Sante		-1.15	-1.34
Saxon		-2.58	-0.64
Setanta		-1.52	-2.32
Shelford		-1.70	-0.54
Taurus		-3.17	-1.54
Violetta		-1.60	-0.66
VR808		-3.10	-0.58
Zahov		2.04	-1.10
Zohar		-1.50	-1.13
SED = 1.259			
LSD (5%) = 2.490			

Ordinarily, a separate analysis would not be performed for data from assessments in each of weeks 4 and 8. However, this has been done here for two reasons. Firstly, there is a need to compare the varietal discrimination between the two assessment dates. Secondly, it is possible in this particular case to carry out an analysis which takes into account the varying numbers of stolons from pot to pot (and hence varying precision) when weeks are analysed separately.

All varieties at week 4 – proportions of infected stolons

It was impossible to fit a generalized linear mixed model to the stolon data at week 4 as there were varieties with no infected stolons. Instead, a generalized linear model had to be fitted instead. There was statistical evidence (P=0.011, $F_{34,67}$=1.92) of a difference between varieties in the proportion of infected stolons.

TABLE 8: PREDICTED VARIETY MEANS FROM LOGISTIC REGRESSION INFECTED STOLONS AT WEEK 4

	Transformed scale		Back-transformed
Variety	Prediction	s.e.	Prediction
00C133-020	0.288	1.643	0.5714
02.Z.216 A6	-1.190	0.928	0.2333
02C053-016	-0.336	0.890	0.4167
03.N.8A81	-4.094	2.169	0.0164
03.Z.6.A5	-3.714	2.177	0.0238
03C114-006	-2.862	1.106	0.0541
96HG773B1 (Bremner)	-0.799	0.863	0.3103
Ambassador	-0.827	0.689	0.3043
Arizona			0.0000
BEE 96 482 (Safiyah)	-1.186	0.741	0.2340
Bute (166HVN05)	-1.447	1.195	0.1905
Cara	-3.466	2.184	0.0303
Compass	-1.846	1.336	0.1364
Duke of York	-0.049	0.672	0.4878
Electra	-1.735	1.347	0.1500
Emma	-3.367	1.547	0.0333
G03TT007006	-0.981	0.841	0.2727
Harmony	-2.803	1.566	0.0571
Infinity	-1.386	0.909	0.2000
Jelly	-0.134	1.113	0.4667
King Edward	-0.619	1.008	0.3500
Lady Christl	1.041	1.021	0.7391
Nitza	-4.060	2.169	0.0169
Panther	-0.847	0.742	0.3000
Red Emmalie			0.9993
Royal	0.405	0.982	0.6000
Sante	-1.350	0.912	0.2059
Saxon	-2.428	0.916	0.0811
Setanta	-1.974	1.026	0.1220
Shelford	-1.407	0.693	0.1967
Taurus	-3.450	1.545	0.0308
Violetta	-2.833	1.565	0.0556
VR808			0.0000

Zahov	2.773	2.217	0.9412
Zohar	-1.504	1.189	0.1818

The SED range for comparisons between varieties with neither 0% nor 100% infected stolons was (0.99 – 3.20) on the logit scale.

All varieties at week 8 – proportions of infected stolons

Fitting a generalized linear mixed model there was no statistical evidence ($F_{34,58} = 0.76$ and P=0.809) of a difference in the proportion of pruned stolons between the varieties at week 8.

Variety	Logit scale means	Back-transformed means
00C133-020	-0.854	0.2986
02.Z.216 A6	-1.461	0.1882
02C053-016	-1.498	0.1828
03.N.8A81	-0.809	0.3081
03.Z.6.A5	-1.596	0.1686
03C114-006	-1.316	0.2115
96HG773B1 (Bremner)	-1.403	0.1974
Ambassador	0.046	0.5114
Arizona	-0.701	0.3316
BEE 96 482 (Safiyah)	-1.209	0.2298
Bute (166HVN05)	-0.492	0.3793
Cara	-0.701	0.3315
Compass	-0.712	0.3291
Duke of York	-0.602	0.3539
Electra	-0.508	0.3756
Emma	-1.809	0.1408
G03TT007006	-2.696	0.0632
Harmony	-1.501	0.1823
Infinity	-3.413	0.0319
Jelly	-2.554	0.0721
King Edward	-0.534	0.3696
Lady Christl	-1.106	0.2487
Nitza	-0.684	0.3355
Panther	-0.066	0.4835
Red Emmalie	-1.869	0.1336
Royal	-2.340	0.0879
Sante	-1.403	0.1973
Saxon	-0.682	0.3357
Setanta	-2.465	0.0784
Shelford	-0.593	0.3559
Taurus	-1.799	0.1420
Violetta	-0.738	0.3235
VR808	-0.651	0.3427
Zahov	-1.203	0.2309
Zohar	-1.225	0.2271
SED (min-max range)	0.745 – 1.385	
Average SED	0.839	

These results therefore indicate that for varietal discrimination on the basis of the proportions of pruned stolons, assessment should be made at week 4 in preference to week 8.

Conclusions

There was evidence (P=0.003) of a difference in stem canker severity for variety Harmony between the five assessment dates. Stem canker was significantly higher (P<0.05) at week 2 than any other assessment date. It was also significantly higher (P<0.05) at weeks 10 and 12 than at week 4.

In the main trial involving 36 varieties there was very strong statistical evidence of varietal discrimination in stem canker severity at week 4 but no statistical evidence of discrimination at week 8. This would strongly indicate stem canker severity should be compared at week 4 in preference to week 8.

There was no statistical evidence of a difference in stolon canker severity for variety Harmony between the five assessment dates. However, the lack of statistical evidence of a difference does not mean there was evidence of no difference. Indeed, the statistical power to detect a difference was low.

In the main trial involving 36 varieties there was statistical evidence of varietal discrimination in stolon canker severity when combining data from both weeks 4 and 8. There was no statistical evidence of better varietal discrimination at either week 4 or week 8. Analysis of each week in isolation showed no statistical evidence of varietal discrimination, reflecting the reduction in power from halving replication.

There was only very weak statistical evidence (P=0.087) for differences in the proportion of stolons pruned for the variety Harmony between the five assessment dates. Even this weak evidence only arose from the far higher observed proportion of pruned stolons at week 2 than at later dates.

In the main trial involving 36 varieties there was statistical evidence (P=0.011) of varietal discrimination in the proportion of pruned stolons based on assessment in week 4 but no such evidence in week 8.

4.2. Appendix II: Statistical Analysis of 2012 *Dickeya* experiment

Experimental Design and Data

- Randomised complete block design with three replicates
- Four pots per replicate
- Each pot was scored on an integer scale from 1 to 5 so that:

1 Healthy
2 necrotic/chlorotic
3 basal stem rot
4 on its way out/blackleg
5 Dead

- Seven weekly assessments between 19 June and 1 August.
- Also the health of the daughter tubers was assessed in two fractions (<25 mm and >25mm), noting the presence of rots.
- The treatments were set as a factorial, with 11 varieties x 3 levels of inoculum

Statistical method

Plant assessments

The response data was ordinal. It was noted that scores of 3 on the 1 to 5 scale were very scarce. Missing pots were treated as 5 (dead) since this seemed to be strongly related to the concentration of inoculum (0% missing pots for 10^3, 8% for 10^5 and 21% for 10^7). There are specific methods for this type of data. However these would be complex, especially given that the scores were at the pot within plot level and that the methods are typically dependent on strongish assumptions. Instead analysis of variance was applied to the mean scores for each plot. The residuals were reasonably behaved for all assessments after 3 July so no transformation was applied.

Tuber assessments

The proportion of diseased tubers in the two fractions was analysed using a logistic model for binomial data, allowing for overdispersion. The total number of tubers was analysed using a log-link model for Poisson data, allowing for overdispersion.

Results

Plant assessments

The analysis of variance results are summarised in Table 1, showing the variance ratios and p-values for the treatments.

TABLE 1: ANALYSIS OF VARIANCE RESULTS FOR PLANT SCORES

	19 June		26 June		3 July		9 July		17 July		25 July		1 August	
Effect	VR	p-val	VR	p- val	VR	p- val	VR	p- val	VR	p- val	VR	p- val	VR	p- val
Variety	5.3	<0.001	4.9	<0.001	6.0	<0.001	4.6	<0.001	3.7	<0.001	4.2	<0.001	5.7	<0.001
Inoculum	26.2	<0.001	23.1	<0.001	37.7	<0.001	31.3	<0.001	36.9	<0.001	30.3	<0.001	38.0	<0.001
Interaction	2.9	<0.001	1.3	0.219	1.5	0.124	1.4	0.156	1.7	0.064	1.7	0.053	2.1	0.014

This shows large differences between the concentrations of inoculum over the experiment (Figure 1). Initially all three differ in the order expected but later the higher two concentrations result in similar mean scores. There was also strong evidence that the varieties differed in their performance. Over the experiment evidence for an

interaction increased slightly. In Figure 2, the mean scores are showed for the last assessment date.

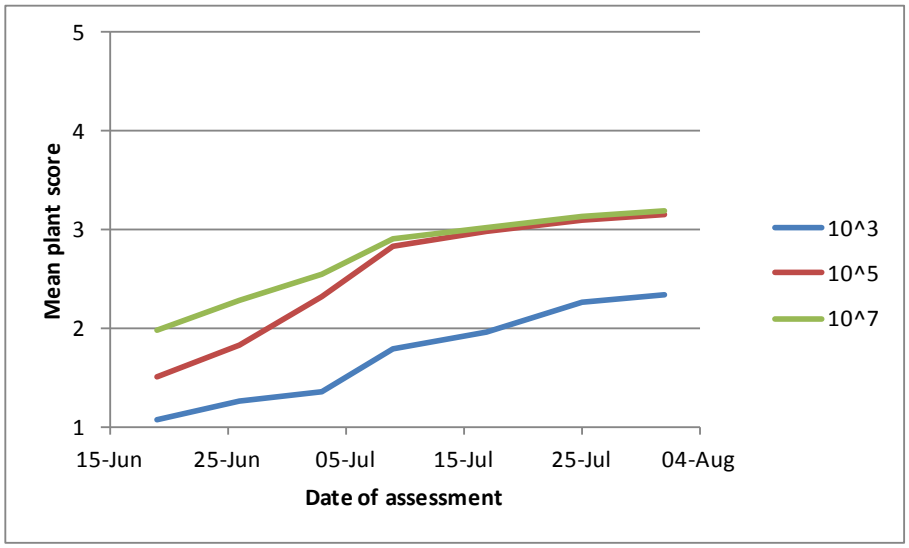


Figure 1: *Mean plant scores by inoculum concentration for each assessment*

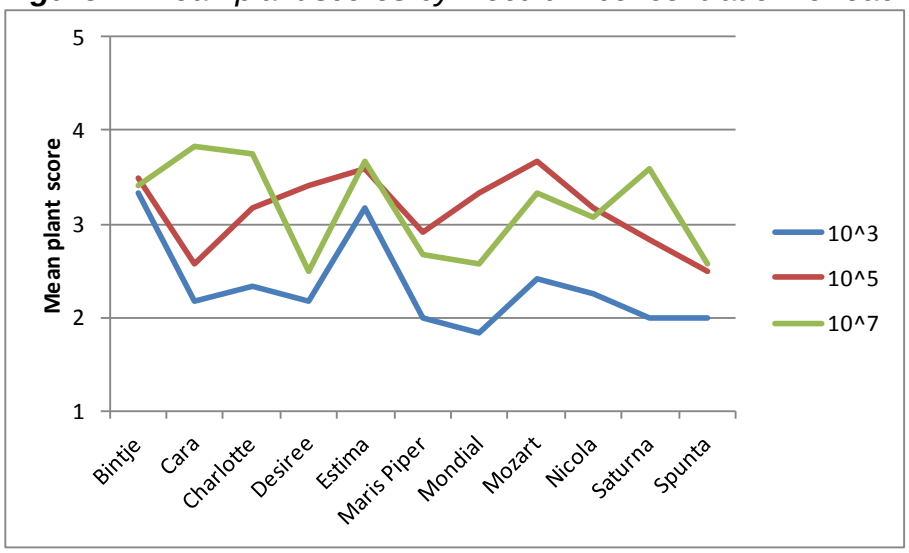


Figure 2: *Mean plant scores by inoculum concentration for each variety on 1 August (5% LSD= 0.73)*

The analyses of variance were run for each concentration separately. This was to understand how each enabled discrimination between varieties. Table 2 shows the variance ratios for the variety effect for each assessment date. The larger the value the greater the statistical differences between varieties. Those in bold correspond to p-values less than 0.05. This shows that the 10^5 concentration didn't discriminate varieties as well as the other two concentrations. Whilst the variance ratios increased over the assessments for the lowest concentration level, they decreased for the highest.

TABLE 2: ANALYSIS OF VARIANCE RESULTS FOR PLANT SCORES FOR EACH CONCENTRATION SEPARATELY – VARIANCE RATIOS FOR THE VARIETY EFFECT

	Concentration		
Assessment	10^3	10^5	10^7
19 June	**2.4**	2.3	**4.7**
26 June	1.7	1.4	**3.8**
03 July	**3.3**	2.0	**3.5**
09 July	**4.9**	0.9	**4.0**
17 July	**3.6**	1.4	**3.0**
25 July	**3.8**	1.7	**2.8**
1 August	**4.5**	**3.0**	**3.1**

Tuber assessments

The analysis of deviance results for the proportion of rotted tubers are summarised in Table 3, showing the deviance ratios and p-values for the treatments. There was no evidence for varietal or concentration effects on the proportions. The small p-value for the interaction with small tubers could be explained by an unusually high proportion of infected tubers for Maris Piper with the highest concentration.

TABLE 3: ANALYSIS OF DEVIANCE RESULTS FOR THE PROPORTION OF ROTTED TUBERS

	Small tubers		Large tubers	
Effect	DR	p- value	DR	p- value
Variety	0.8	0.606	1.6	0.114
Inoculum	0.0	0.995	0.6	0.574
Interaction	1.6	0.061	0.7	0.867

The analysis of deviance results for the numbers of tubers are summarised in Table 4, showing the deviance ratios and p-values for the treatments. There were strong varietal and concentration effects together with some evidence of an interaction. The mean numbers of tubers are shown in Figure 3.

TABLE 4: ANALYSIS OF DEVIANCE RESULTS FOR THE NUMBER OF TUBERS

	All sizes	
Effect	DR	p- value
Variety	7.11	<0.001
Inoculum	14.18	<0.001
Interaction	1.67	0.037

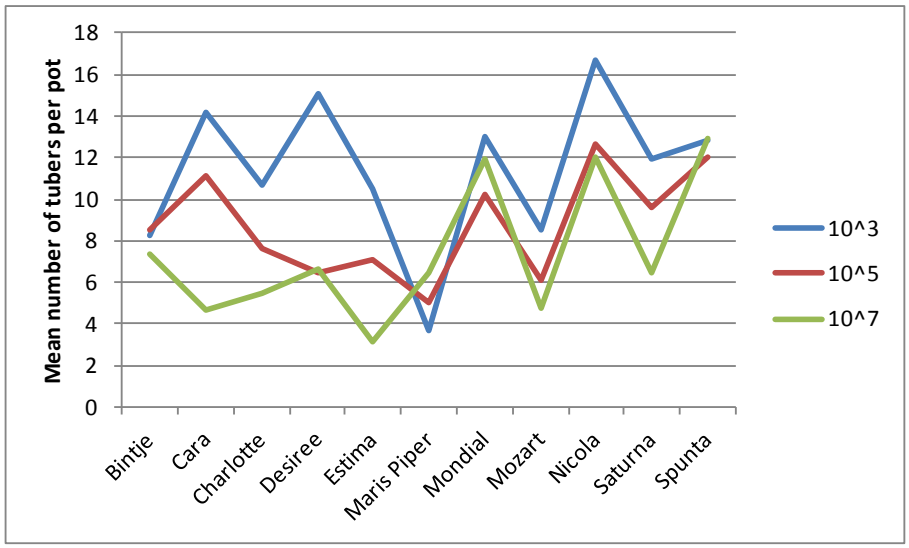


Figure 3: *Mean number of tubers per pot by inoculum concentration for each variety*

Conclusions

The plant assessments showed much clearer differences between varieties and inoculum levels than the tubers. Based on the plant scores, the 10^5 concentration didn't discriminate varieties as well as the other two concentrations. Whilst the varietal discrimination increased over the assessments for the lowest concentration level, it decreased for the highest.

It was noted that very few scores of 3 were assigned to pots. In addition, there was a high proportion of missing pots for the highest concentration; we presumed this was because the plants died under the higher disease pressure.