Research Project Report

Independent Variety Trials 2016

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1. SUMMARY

1.1. Introduction

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 onto 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 (VCU). 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 Potato Council (now AHDB Potatoes), 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 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.

A review of the UK National List programme was concluded in 2004 and the various varietal characteristics were prioritised according to national importance. In consultation with industry stakeholders, it was also agreed that closer co-operation with IVT funded by AHDB Potatoes 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 leafroll 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.

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

The integration of the IVT test programme with that of the UK National List VCU test programme was achieved in 2005 by the consortium of Scottish Agricultural Science Agency (now Science and Advice for Scottish Agriculture (SASA)), SAC Commercial Ltd (SAC), Biomathematics & Statistics Scotland (BioSS) and Scottish Crop Research Institute (SCRI) (now 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. A 1 year extension was given for 2014 to complete trialling of varieties that commenced IVT in 2013**.** An additional test to determine susceptibility to Potato Mop Top Virus (spraing) was included in the programme from 2011. 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. As part of the programme, SASA have evaluated Common Catalogue varieties entered for IVT for all NL characters, except potato viruses (Y^o, Y^N, A and leafroll) and a laboratory test for foliar late blight.

A new 4 year contract was awarded to the consortium with the new programme commencing April 2015 with the IVT specific tests of field foliage blight^, silver scurf and skin spot which are conducted at SASA and black dot and Potato Mop Top Virus (spraing) which are conducted at SAC. This report summarises all the testing conducted over the 2015-2016 season.

^ The NL test for foliage blight changed from a laboratory test to a field test after the contract was awarded. Some candidates have scores for both the laboratory and the field test. Therefore this report lists field foliage blight as an IVT specific test. It will be listed as an NL test in future reports.

1.2. Work Undertaken and Key Findings

In 2016, tests were conducted on 9 varieties which had completed UK NL tests, 6 varieties undergoing their 2nd year of UK NL testing, and 15 Common Catalogue varieties (Table 1).

SASA conducted a test to determine susceptibility to foliage late blight at a site near Ayr which is operated in conjunction with JHI. Pot tests for silver scurf and skin spot were also conducted by SASA. A pot test for black dot and a field trial for Potato Mop Top Virus (spraing) were conducted by SAC. 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 2a and 2b present the ratings for varieties completing the test programme and scores are shown in bold font. Table 3 summarises the results for varieties tested in 2016. These scores are provisional and shown in italic font.

Table 1a. Varieties in IVT in 2016

UK National List

				stage of test 2016	
AFP	**Variety**	**Breeder/Agent**	**Maturity**	**NL**	**IVT**
4/802	Sorrento	MRS/Greenvale	M	completed	2
4/809	05.Z.39 A 35	MRS/Taypack	M	completed	2
4/816	Cammeo	Caithness Pot Holding BV/Caithness Pot Exports Ltd	EM	completed	2
4/817	Raleigh	Caithness Varieties Ltd	2E	completed	2
4/818	04C126-005	Cygnet PB Ltd	EM	completed	2
4/819	Reiver	JHI/MRS Ltd	EM	completed	2
4/820	Mayan Rose (06.Z.266 A 4)	JHI/MRS Ltd/Greenvale	M	completed	2
4/821	Scapa (06.Z.266 A 15)	JHI/MRS Ltd/Greenvale	M	completed	2
4/824	06.6860.2	Cullen Allen Ltd	EM	completed	2
4/830	FL2339	PepsiCo Intl Ltd	M	2	1
4/831	07.Z.104 A1	Higgins Agriculture Ltd	M	2	1
4/832	07.Z.120 A11	Higgins Agriculture Ltd	M	2	1
4/833	07.Z.129 A3	Higgins Agriculture Ltd	M	2	1
4/834	05C040-006	Cygnet PB Ltd	M	2	1
4/835	88.P.43 VAR	JHI/MRS Ltd/Greenvale	M	2	1

Table 1b. Varieties in IVT in 2016

Common Catalogue

				stage of test 2016	
AFP	**Variety**	**Breeder/Agent**	**Maturity**	**NL**	**IVT**
n/a	Captain	Germicopa UK	M	2	2
n/a	Constance	Agrico	M	2	2
n/a	Emily	Cullen and Allen Ltd	EM	2	2
n/a	Fandango	IPM Potato Group	EM	2	2
n/a	Georgina	Branston Ltd	M	2	2
n/a	Heraclea	HZPC	EM	2	2
n/a	Imagine	IPM Potato Group	EM	2	2
n/a	Performer	Agrico	M	2	2
n/a	Camel	KWS	M	1	1
n/a	Carolus	Agrico	M	1	1
n/a	Eurostar	KWS	M	1	1
n/a	Innovator	HZPC	EM/M	1	1
n/a	Kelly	Germicopa SAS/Germicopa UK	M	1	1
n/a	Lady Valora	Meijer	M	1	1
n/a	Sagitta	HZPC	EM	1	1

Table 2a. Summary of varietal ratings (1=low, 9=high) for resistance to diseases, pests and defects for varieties completing the IVT programme. Scores are based on over-years analysis of IVT 2005-2016 and NL from 1981 except for late blight* and PCN**.

* late blight: analysis covered only the period of testing with a 13_A2 genotype.

** PCN Ro1 and Pa2/3 are tested in year 1 and if resistance is found the test is repeated in year 2. Scores in the table are presented using a 1-9 scale as determined by the EU PCN Directive (2007/33/EC).
Results in individual test tables (tables 4-17) are based on the 2 test years and scores may vary slightly from data in this table which is based on an over years analysis.

	Sorrento	05.Z.39 A 35	Cammeo	Raleigh	04C126-005	Reiver	Mayan Rose (06.Z.266 A 4)	Scapa (06.Z.266 A 15)	06.6860.2
Maturity	M	EM	EM	2E	EM	EM	M	M	EM
Foliage late blight (field)	**7**	**3**	**5**	**4**	**5**	**5**	**6**	**6**	**5**
Black dot	**7**	**4**	**4**	**8**	**5**	**6**	**6**	**6**	**5**
Silver scurf	**7**	**6**	**5**	**7**	**5**	**5**	**5**	**4**	**5**
Skin spot	**4**	**9**	**6**	**3**	**4**	**8**	**7**	**5**	**5**
Potato Mop Top Virus (spraing)	**8**	**3**	**5**	**3**	**7**	**9**	**6**	**8**	**8**
Foliage late blight (lab) ^	**7**	**3**	**5**	**4**	**4**	**3**	**1**	**2**	**4**
Tuber late blight	**6**	**5**	**4**	**3**	**2**	**4**	**1**	**6**	**5**
Blackleg- *Pectobacterium atrosepticum*	**6**	**7**	**5**	**3**	**9**	**6**	**5**	**6**	**4**
Powdery scab	**8**	**5**	**1**	**7**	**6**	**7**	**7**	**7**	**6**
Common scab	**7**	**3**	**5**	**8**	**4**	**4**	**9**	**9**	**4**
Dry rot – *Fusarium coeruleum*	**2**	**8**	**5**	**6**	**7**	**7**	**7**	**7**	**7**
Dry rot – *Fusarium sulphureum*	**6**	**1**	**1**	**1**	**2**	**1**	**8**	**1**	**5**
PCN Ro-1	**1**	**9**	**2**	**8**	**2**	**9**	**2**	**2**	**1**
PCN Pa 2/3	**2**	**5**	**2**	**2**	**1**	**3**	**2**	**2**	**2**
External damage (splitting)	**6**	**7**	**2**	**3**	**7**	**6**	**6**	**7**	**6**
Internal damage (bruising)	**4**	**5**	**6**	**3**	**4**	**5**	**7**	**5**	**4**

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

Table 2b. Summary of varietal ratings (1=low, 9=high) for resistance to diseases, pests and defects for varieties completing the IVT programme. Scores are based on over-years analysis of IVT 2005-2016 and NL from 1981 except for late blight* and PCN**.

* late blight: analysis covered only the period of testing with a 13_A2 genotype.

** PCN Ro1 and Pa2/3 are tested in year 1 and if resistance is found the test is repeated in year 2. Scores in the table are presented using a 1-9 scale as determined by the EU PCN Directive (2007/33/EC).

Results in individual test tables (tables 4-17) are based on the 2 test years and scores may vary slightly from data in this table which is based on an over years analysis.

	Captain	Constance	Emily	Fandango	Georgina	Heraclea	Imagine	Performer
Maturity	M	M	EM	EM	M	EM	EM	M
Foliage late blight (field)	**3**	**5**	**5**	**4**	**4**	**4**	**4**	**3**
Black dot	**4**	**4**	**4**	**6**	**5**	**7**	**7**	**7**
Silver scurf	**7**	**8**	**6**	**8**	**7**	**7**	**8**	**5**
Skin spot	**9**	**4**	**7**	**6**	**4**	**7**	**6**	**5**
Potato Mop Top Virus (spraing)	**8**	**7**	**8**	**8**	**8**	**6**	**6**	**6**
Tuber late blight	**2**	**1**	**2**	**3**	**2**	**3**	**2**	**2**
Blackleg- *Pectobacterium atrosepticum*	**2**	**6**	**7**	**4**	**4**	**4**	**5**	**1**
Powdery scab	**6**	**3**	**6**	**5**	**4**	**5**	**5**	**5**
Common scab	**4**	**8**	**6**	**5**	**6**	**4**	**4**	**7**
Dry rot – *Fusarium coeruleum*	**6**	**5**	**1**	**6**	**5**	**7**	**5**	**7**
Dry rot – *Fusarium sulphureum*	**1**	**1**	**1**	**1**	**3**	**1**	**5**	**3**
PCN Ro-1	**8**	**3**	**8**	**8**	**8**	**5**	**8**	**4**
PCN Pa 2/3	**2**	***3^***	**2**	**2**	**2**	**3**	***3^***	**8**
External damage (splitting)	**3**	**2**	**7**	**5**	**4**	**7**	**8**	**5**
Internal damage (bruising)	**5**	**5**	**5**	**5**	**6**	**6**	**6**	**5**

^A review of the *G. pallida* test was conducted in 2017 which resulted in a recommended change to the relative susceptibility score that determines if a candidate should receive a second year of testing. Two candidates that were in 2nd year trials in 2016 are affected by this change and as a result will receive a second year of testing in 2018. The score listed in this report is provisional and based on one year of testing only.

Table 3. Summary of provisional ratings (1=low, 9=high) for resistance to diseases, pests and defects for varieties completing one year of the IVT programme. Scores are based on over-years analysis of IVT 2005-2016 and NL from 1981 except for late blight* and PCN**.

* late blight: analysis covered only the period of testing with a 13_A2 genotype.

** PCN Ro1 and Pa2/3 are tested in year 1 and if resistance is found the test is repeated in year 2. Scores in the table are presented using a 1-9 scale as determined by the EU PCN Directive (2007/33/EC).

Results in individual test tables (Tables 4-17) are based on 1 year only and scores may vary slightly from data in this table which is based on an over years' analysis.

	FL 2339	07.Z.104 A1	07.Z.120 A11	07.Z.129 A3	05C040-006	88.P.43 VAR	Camel	Carolus	Eurostar	Innovator	Kelly	Lady Valora	Sagitta
Maturity	M	M	M	M	M	M	M	M	M	EM/M	M	M	EM
Foliage late blight (field)	*4*	*5*	*4*	*4*	*4*	*5*	*3*	*8*	*4*	*4*	*7*	*5*	*4*
Black dot	*4*	*7*	*5*	*5*	*7*	*6*	*4*	*5*	*6*	*8*	*7*	*5*	*2*
Silver scurf	*6*	*7*	*6*	*7*	*9*	*5*	*8*	*8*	*9*	*6*	*8*	*8*	*7*
Skin spot	*2*	*4*	*5*	*4*	*6*	*6*	*8*	*8*	*9*	*5*	*6*	*8*	*4*
Potato Mop Top Virus (spraing)	*9*	*9*	*7*	*7*	*8*	*8*	*7*	*8*	*8*	*8*	*8*	*8*	*9*
Tuber late blight	*3*	*1*	*4*	*4*	*6*	*6*	*2*	*8*	*4*	*1*	*2*	*3*	*2*
Blackleg-*Pectobacterium atrosepticum*	*6*	*8*	*6*	*4*	*7*	*5*	*2*	*6*	*3*	*6*	*6*	*4*	*6*
Powdery scab	*4*	*6*	*3*	*6*	*4*	*8*	*2*	*4*	*2*	*7*	*1*	*5*	*2*
Common scab	*5*	*4*	*6*	*7*	*3*	*9*	*4*	*6*	*5*	*4*	*4*	*6*	*6*
Dry rot – *Fusarium coeruleum*	*2*	*6*	*6*	*6*	*8*	*6*	*6*	*7*	*8*	*8*	*8*	*5*	*7*
Dry rot – *Fusarium sulphureum*	*1*	*7*	*2*	*4*	*1*	*1*	*1*	*9*	*1*	*1*	*1*	*9*	*9*
PCN Ro-1	*9*	*6*	*3*	*2*	*9*	*4*	*8*	*1*	*8*	*2*	*9*	*8*	*9*
PCN Pa 2/3	*2*	*2*	*9*	*5*	*2*	*4*	*8*	*1*	*8*	*8*	*1*	*2*	*2*
External damage (splitting)	*8*	*8*	*8*	*8*	*8*	*8*	*6*	*6*	*8*	*5*	*8*	*8*	*8*
Internal damage (bruising)	*2*	*7*	*8*	*3*	*6*	*2*	*5*	*5*	*5*	*6*	*1*	*6*	*5*

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 as appropriate) were as follows:

* For PCN Pa 2/3 and 1, a score of 4 or more has significant valuable resistance; a score or 3 or less is regarded as susceptible.

Sorrento
Resistant to: **foliage late blight, black dot, silver scurf, Potato Mop Top Virus (spraing), powdery scab** and **common scab**
Susceptible to: **dry rot – *F. coeruleum,* PCN Ro1** and **PCN Pa 2/3 and 1**

05.Z.39 A 35
Resistant to**: skin spot, blackleg, dry rot – *F. coeruleum*, PCN Ro1, PCN Pa 2/3 and 1** and **external damage**
Susceptible to*:* **foliage late blight, Potato Mop Top Virus (spraing), common scab and dry rot – *F. sulphureum***

Cammeo
Susceptible to: **powdery scab**, **dry rot – *F. sulphureum,* PCN Ro1, PCN Pa 2/3 and 1** and **external damage**

Raleigh
Resistant to: **black dot, silver scurf, powdery scab, common scab** and **PCN Ro1**
Susceptible to: **skin spot, Potato Mop Top Virus (spraing), tuber late blight, blackleg**, **dry rot – *F. sulphureum***, **PCN Pa 2/3 and 1, external damage** and **internal damage**

04C126-005
Resistant to: **Potato Mop Top Virus (spraing), blackleg, dry rot – *F. coeruleum*** and **external damage**
Susceptible to: **tuber late blight, dry rot – *F. sulphureum***, **PCN Ro1** and **PCN Pa 2/3 and 1**

Reiver
Resistant to: **skin spot, Potato Mop Top Virus (spraing), powdery scab, dry rot – *F. coeruleum*** and **PCN Ro1**
Susceptible to: **dry rot – *F. sulphureum*** and **PCN Pa 2/3 and 1**

Mayan Rose (06.Z.266 A 4)
Resistant to: **skin spot, powdery scab, common scab, dry rots – *F. coeruleum*** and ***F. sulphureum*** and **internal damage**
Susceptible to: **tuber late blight***,* **PCN Ro1** and **PCN Pa 2/3 and 1**

Scapa (06.Z.266 A 15)
Resistant to: **Potato Mop Top Virus (spraing), powdery scab, common scab, dry rot – *F. coeruleum*** and **external damage**
Susceptible to: **dry rot – *F. sulphureum*,** **PCN Ro1** and **PCN Pa 2/3 and 1**

06.6860.2
Resistant to: **Potato Mop Top Virus (spraing)** and **dry rot – *F. coeruleum***
Susceptible to: **PCN Ro1** and **PCN Pa 2/3 and 1**

Captain
Resistant to: **silver scurf, skin spot, Potato Mop Top Virus (spraing),** and **PCN Ro1**
Susceptible to: **foliage late blight, tuber late blight, blackleg, dry rot – *F. sulphureum*, PCN Pa 2/3 and 1** and **external damage**

Constance
Resistant to: **silver scurf, Potato Mop Top Virus (spraing**) and **common scab**
Susceptible to: **tuber late blight, powdery scab, dry rot – *F. sulphureum*, PCN Ro1,** *PCN Pa 2/3 and 1* and **external damage**
A review of the G. pallida *test was conducted in 2017 which resulted in a recommended change to the relative susceptibility score that determines if a candidate should receive a second year of testing. Constance is one of two varieties that were in 2nd year trials in 2016 and are affected by this change. As a result it will receive a second year of testing in 2018. The score listed in this report is provisional and based on one year of testing only.*

Emily
Resistant to: **skin spot, Potato Mop Top Virus (spraing), blackleg, PCN Ro1** *and* **external damage**
Susceptible to: **tuber late blight, dry rots – *F. coeruleum*** and ***F. sulphureum*** and **PCN Pa 2/3 and 1**

Fandango
Resistant to: **silver scurf, Potato Mop Top Virus (spraing)** and **PCN Ro1**
Susceptible to: **tuber late blight, dry rot – *F. sulphureum*** and **PCN Pa 2/3 and 1**

Georgina
Resistant to: **silver scurf, Potato Mop Top Virus (spraing)** and **PCN Ro1**
Susceptible to: **tuber late blight**, **dry rot – *F. sulphureum*** and **PCN Pa 2/3 and 1**

Heraclea
Resistant to: **black dot, silver scurf, skin spot, dry rot – *F. coeruleum*,** and **external damage**
Susceptible to: **tuber late blight**, **dry rot – *F. sulphureum*** and **PCN Pa 2/3 and 1**

Imagine
Resistant to: **black dot, silver scurf, PCN Ro1** and **external damage**
Susceptible to: **tuber late blight** and *PCN Pa 2/3 and 1*
A review of the G. pallida *test was conducted in 2017 which resulted in a recommended change to the relative susceptibility score that determines if a candidate should receive a second year of testing. Imagine is one of two varieties that were in 2nd year trials in 2016 and are affected by this change. As a result it will receive a second year of testing in 2018. The score listed in this report is provisional and based on one year of testing only*

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

FL 2339
Resistant to*: Potato Mop Top Virus (spraing), PCN Ro1* and *external damage*
Susceptible to: *skin spot, tuber late blight, dry rots – F. coeruleum and F. sulphureum, PCN Pa 2/3 and 1* and *internal damage*

07.Z.104 A1
Resistant to: *black dot, silver scurf, Potato Mop Top Virus (spraing*), *blackleg, dry rot - F. sulphureum, external damage* and *internal damage*
Susceptible to: *tuber late blight* and *PCN Pa 2/3 and 1*

07.Z.120 A11
Resistant to: *Potato Mop Top Virus (spraing), PCN Pa 2/3 and 1, external damage* and *internal damage*
Susceptible to: *powdery scab, dry rot – F. sulphureum* and *PCN Ro1*

07.Z.129 A3
Resistant to: *silver scurf, Potato Mop Top Virus (spraing), common scab, PCN Pa 2/3* and *1* and *external damage*
Susceptible to: *PCN Ro1* and *internal damage*

05C040-006
Resistant to: *black dot, silver scurf, Potato Mop Top Virus (spraing), blackleg, dry rot – F. coeruleum, PCN Ro1,* and *external damage*
Susceptible to: *common scab, dry rot – F. sulphureum* and *PCN Pa 2/3 and 1*

88.P.43 VAR
Resistant to: *Potato Mop Top Virus (spraing), powdery scab, common scab, PCN pa 2/3 and 1* and *external damage*
Susceptible to: *dry rot – F. sulphureum* and *internal damage*

Camel
Resistant to: *silver scurf, skin spot, Potato Mop Top Virus (spraing), PCN Ro1 and Pa 2/3 and 1*
Susceptible to: *foliage late blight, tuber late blight, blackleg, powdery scab* and *dry rot - F. sulphureum*

Carolus
Resistant to: *foliage late blight*, *silver scurf, skin spot*, *Potato Mop Top Virus (spraing), tuber late blight,* and *dry rots – F. coeruleum* and *F. sulphureum*
Susceptible to: *PCN Ro 1* and *Pa 2/3 and 1*

Eurostar
Resistant to: *silver scurf, skin spot, Potato Mop Top Virus (spraing), dry rot - F. coeruleum, PCN Ro 1* and *Pa 2/3 and 1* and *external damage*
Susceptible to: *blackleg, powdery scab* and *dry rot - F. sulphureum*

Innovator
Resistant to: *black dot, Potato Mop Top Virus (spraing), powdery scab, dry rot – F. coeruleum* and *PCN Pa 2/3 and 1*
Susceptible to: *tuber late blight, dry rot - F. sulphureum, and PCN Ro1*

Kelly
Resistant to: *foliage late blight, black dot, silver scurf, Potato Mop Top Virus (spraing), dry rot – F. coeruelum, PCN Ro 1* and *external damage*
Susceptible to: *tuber late blight, powdery scab, dry rot – F. sulphureum, PCN Pa 2/3 and 1*, and *internal damage*

Lady Valora
Resistant to: *silver scurf, skin spot, Potato Mop Top Virus (spraing), dry rot - F. sulphureum, PCN Ro 1* and *external damage*
Susceptible to: *tuber late blight* and *PCN Pa 2/3 and 1*,

Sagitta
Resistant to: *silver scurf, Potato Mop Top Virus (spraing), dry rots – F. coeruleum* and *F. sulphureu, PCN Ro1* and *external damage*
Susceptible to: *black dot, tuber late blight, powdery scab*, and *PCN pa 2/3 and 1*

3. MATERIALS AND METHODS

3.1. Standard Varieties

The standard varieties used in 2015 were reviewed and retained in 2016 with the exception of those for the Potato Mop Top Virus (spraing) test. These were updated after a change in the resistant and susceptible anchor varieties used in the over-years analysis. The varieties used in each test are listed below with, in brackets, their foliage maturity and the susceptibility rating. Foliage late blight ratings are taken from work conducted by Lees *et al*. (2012), the other test ratings are as published in NIAB TAG Network Potatoes 2015 book:

Foliage late blight:	Home Guard [1E, 4], Bintje [M, 3], Russet Burbank [M, 3], Valor [M, 6], Cara [M, 6], Sarpo Mira [M, 8]
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, 4], Nicola [M, 4], Valor [M, 3], Saturna [M, 3], Maris Piper [M, 8], Zahov [EM, 8]

3.2. Varieties in Trial

15 varieties were tested through the UK National List route and 15 varieties were tested through the Common Catalogue route. The varieties tested are listed in Tables 1a and 1b.

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. Tests were also conducted for Potato spindle tuber viroid. Tests on all candidates were negative.

3.3. IVT Test Methods

The test methods used were those agreed and set out in the standard protocols prepared for the 2016 programme. Details of the tests are provided below:

Foliage late blight in the field, 2016

The test tubers were planted in plots of 2 tubers at Dalrymple, by Ayr on 24 May, 2016. 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 21 July, 2016. On 27 July, 2016, and 2, 5, 9, 12 August, 2016 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.

Skin spot, 2016

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 20 May, 2016. Pots were placed outdoors in peat beds and watered by drip irrigation into each pot. The layout was a randomised block with 6 replications. The haulm senesced naturally so there was no need to apply diquat dibromide. The tubers were harvested into separate plastic boxes on 19 October 2016 and then stored at 5-8^{0}C until the last week in March, 2017. The % surface area affected by skin spot was recorded in 5 categories and a surface infection index calculated (Boyd, 1957).

Silver scurf, 2016

Petri dishes containing 2% malt extract agar were inoculated using two isolates of silver scurf which were grown for a minimum of 14 days, then macerated in 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 on 11 May, 2016 and placed in a polytunnel; watering was 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 28 October, 2016 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 mid-February, 2017, 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.

Black dot, 2016

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 26 May, 2016 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 20 October, 2016 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 8 November, 2016.

Potato Mop Top Virus (spraing), 2016

A plot in the Woodlands field at SAC Aberdeen previously contaminated with powdery scab / PMTV in 2009 was planted on the 6 June, 2016 with varieties grown in triple tuber

randomised blocks with 6 replicates. The plots were not irrigated during the season as it was sufficiently wet.

After harvest on the 7 November, 2016 the tubers were placed in a cool store (c.18^{o}C) for 3 weeks before being placed in a cold store at 4^{o}C. Tubers were assessed for visual symptoms of PMTV spraing after cutting on 16 January, 2017. All tubers from each of the 6 replicates were assessed individually. The results were expressed as the average percentage of the tubers showing symptoms.

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 2016". 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 12-15 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 2 or 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^{0}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.

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 12 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 ratings presented in Tables 2a, 2b and 3. However, in the individual test reports, ratings presented are based on the analysis for the test years 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.

4. RESULTS

4.1. IVT Tests

For each IVT test there is a summary of varieties in the 2 year of trials, focusing on their performance over both years. There is also a summary for varieties completing 1st year of trials in 2016, highlighting the performance of particular varieties. The 1-9 ratings listed for the varieties in the relevant test table are presented in bold font for varieties completing 2 years of trials; those scores in italic font are provisional scores after 1 year of testing. The names of the reference varieties are highlighted in bold font for each test.

4.1.1. Foliage late blight (field) (Table 4)

The trial was planted in late May, 2016. The first assessment was conducted 6 days after the infector plants were placed in the trial. The disease spread quickly after the first assessment with five assessments conducted in total.

Summary of 2015/2016 trial

Overall there were similar levels of disease recorded in both years with the reference varieties performing as expected. Sorrento was the most resistant candidate with a score of 6.9. The most susceptible candidates were Captain, Performer and 05.Z.39 A 5 scoring 3.1, 3.2 and 3.3 respectively.

2016 trial

Carolus showed a very high level of resistance (9.0) scoring higher than the resistant reference variety Sarpo Mira (8.0). Kelly also demonstrated resistance scoring 7.5. The most susceptible candidates were Camel and FL 2339 scoring 3.4 and 3.5 ,respectively.

Table 4. Mean % (angular transformation) Area under Disease Progress in foliage late blight field test in 2015 and 2016 (2nd early/maincrop varieties)

	Test Year		
Variety	**2015**	**2016**	**1-9 rating**
BINTJE	46.7	44.2	**3.0**
CARA	25.7	28.1	**5.9**
RUSSET BURBANK	43.9	34.7	**4.0**
SARPO MIRA	11.8	16.1	**8.0**
VALOR	28.6	29.1	**5.6**
SORRENTO	21.0	20.9	**6.9**
05.Z.39 A 35	43.6	43.9	**3.3**
CAMMEO	35.0	33.7	**4.8**
RALEIGH	44.8	38.2	**3.6**
04C126-005	31.2	31.7	**5.2**
REIVER	28.4	31.9	**5.4**
MAYAN ROSE	20.2	27.3	**6.4**
SCAPA	21.0	26.7	**6.4**
06.6860.2	33.6	33.5	**4.9**
CAPTAIN	45.1	44.2	**3.1**
CONSTANCE	38.6	31.2	**4.7**
EMILY	35.5	36.7	**4.5**
FANDANGO	42.7	34.9	**4.1**
GEORGINA	42.4	37.8	**3.9**
HERACLEA	44.1	38.0	**3.7**
IMAGINE	43.5	34.9	**4.0**
PERFORMER	48.1	40.5	**3.2**
FL 2339		41.2	*3.5*
07.Z.104 A1		29.9	*5.5*
07.Z.120 A11		38.6	*4.0*
07.Z.129 A3		38.2	*4.1*
05C040-006		36.8	*4.3*
88.P.43 VAR		28.6	*5.8*
CAMEL		42.1	*3.4*
CAROLUS		10.3	*9.0*
EUROSTAR		37.3	*4.2*
INNOVATOR		37.9	*4.1*
KELLY		18.9	*7.5*
LADY VALORA		34.8	*4.7*
SAGITTA		39.0	*3.9*
LSD (P=0.05)	5.5	5.5	**1.0**

4.1.2. Black dot (Table 5)

Single test tubers were planted in May, 2016 in 25 cm diameter pots filled with amended compost. The pots were set in individual watering saucers in a polytunnel in a randomised block design with 6 replications. Pots were watered regularly so that the compost was kept damp but not over-watered. Haulms were allowed to senesce naturally and tubers harvested in October, 2016

Summary of 2015/2016 trial

There were variations in performance of some candidates and reference varieties between years. There were generally higher levels of black dot recorded in 2016. Emily was the one candidate that performed similarly in both years. None of the candidates were very susceptible with the poorest performing candidates Constance and Emily both scoring 4.4. The most resistant candidate in trial was Raleigh with a score of 7.8.

2016 trial

Innovator was the most resistant candidate scoring 8.3, with Sagitta the most susceptible candidate with a score of 3.5.

Table 5. Mean % (angular transformation) surface area affected by black dot

	Test Year		
Variety	**2015**	**2016**	**1-9 rating**
CARA	23.3	61.9	**5.9**
FIANNA	30.3	64.6	**5.3**
LADY CHRISTL	41.0	55.8	**5.2**
P SQUIRE	55.6	77.8	**3.0**
SAXON	31.4	52.7	**6.0**
SORRENTO	26.8	46.9	**6.6**
05.Z.39 A 35	52.5	57.0	**4.5**
CAMMEO	43.0	64.6	**4.6**
RALEIGH	18.2	36.2	**7.8**
04C126-005	45.3	54.6	**5.0**
REIVER	33.4	45.9	**6.3**
MAYAN ROSE	35.6	51.2	**5.8**
SCAPA	36.5	40.7	**6.4**
06.6860.2	43.7	54.5	**5.1**
CAPTAIN	33.5	69.2	**4.9**
CONSTANCE	48.0	62.7	**4.4**
EMILY	53.9	55.9	**4.4**
FANDANGO	25.5	56.5	**6.1**
GEORGINA	46.6	53.2	**5.0**
HERACLEA	38.5	32.1	**6.8**
IMAGINE	25.0	46.5	**6.8**
PERFORMER	25.9	48.4	**6.6**
FL 2339		64.0	*4.7*
07.Z.104 A1		39.8	*7.6*
07.Z.120 A11		59.0	*5.3*
07.Z.129 A3		59.3	*5.2*
05C040-006		43.8	*7.1*
88.P.43 VAR		46.9	*6.7*
CAMEL		62.2	*4.9*
CAROLUS		53.2	*5.9*
EUROSTAR		50.4	*6.3*
INNOVATOR		33.4	*8.3*

KELLY		43.6	*7.1*
LADY VALORA		56.4	*5.6*
SAGITTA		73.8	*3.5*
LSD (P=0.05)	19.5	21.0	**2.1**

4.1.3. Silver scurf (Table 6)

The trial was inoculated and planted in May, 2016 and the plants grew well in the polytunnel. At harvest there were some visible silver scurf symptoms on the susceptible reference variety Lady Christl. Tubers were incubated in a humid controlled environment room until the assessment in mid-February, 2017.

Summary of 2015/2016 trial

Overall there was more silver scurf recorded in 2016 than 2015 with Lady Christl remaining the most susceptible in the test. Eight varieties showed resistance to silver scurf scoring between 6.6 and 7.6. No candidates were susceptible.

2016 trial

No candidates were susceptible. The most resistant candidates were Eurostar (8.3) and 05C040-006 (8.2).

Table 6. Mean % (angular transformation) surface are affected by silver scurf

	Test Year		
Variety	**2015**	**2016**	**1-9 rating**
CARA	10.4	21.3	**7.0**
FIANNA	15.2	26.3	**6.2**
LADY CHRISTL	40.8	52.3	**2.0**
PENTLAND SQUIRE	24.5	30.0	**5.1**
ROMANO	23.7	25.7	**5.6**
SAXON	18.7	37.4	**5.0**
SORRENTO	13.7	20.4	**6.8**
05.Z.39 A 35	21.4	28.2	**5.5**
CAMMEO	24.8	27.3	**5.3**
RALEIGH	10.3	20.0	**7.1**
04C126-005	16.3	35.0	**5.4**
REIVER	18.4	33.1	**5.4**
MAYAN ROSE	22.3	35.1	**4.9**
SCAPA	25.7	35.2	**4.6**
06.6860.2	23.7	34.9	**4.8**
CAPTAIN	8.8	28.0	**6.6**
CONSTANCE	9.4	14.6	**7.6**
EMILY	13.9	27.2	**6.2**
FANDANGO	8.8	18.2	**7.4**
GEORGINA	11.1	19.1	**7.1**
HERACLEA	10.1	21.9	**7.0**
IMAGINE	9.6	15.5	**7.5**
PERFORMER	22.6	37.2	**4.7**
FL 2339		29.7	*5.7*
07.Z.104 A1		24.4	*6.5*
07.Z.120 A11		28.7	*5.8*
07.Z.129 A3		24.6	*6.5*

05C040-006		13.9	*8.2*
88.P.43 VAR		31.0	*5.4*
CAMEL		16.6	*7.8*
CAROLUS		17.9	*7.6*
EUROSTAR		13.4	*8.3*
INNOVATOR		27.6	*6.0*
KELLY		19.3	*7.3*
LADY VALORA		16.6	*7.8*
SAGITTA		23.0	*6.7*
LSD (P=0.05)	4.3	5.6	**1.1**

4.1.4. Skin spot (Table 7)

The trial was inoculated and planted in May, 2016. The plants grew well in the peat beds and tubers were harvested in October, 2016. To allow development of the skin spot in storage, tubers were kept in a controlled environment room until the assessment at the end of March, 2017.

Summary of 2015/2016 trial

Overall there was less skin spot recorded in 2016 than 2015. Three candidates (05.Z. 39 A5, Reiver and Captain) scored the same as the resistant reference variety Fianna (9.0). The least resistant candidate was Raleigh scoring 3.5.

2016 trials

Seven candidates demonstrated high resistance to black dot scoring between 7.6 and 9.0. Four of these candidates (Camel, Carolus, Eurostar and Lady Valora) all scored 9.0.

Table 7. Mean % (log transformation [log (skin spot% + 0.1) where log is log to base 10]) surface area affected by skin spot.

	Test Year		
Variety	**2015**	**2016**	**1-9 rating**
FIANNA	-0.5	-0.6	**9.0**
KING EDWARD	0.7	0.8	**2.3**
PENTLAND SQUIRE	0.8	0.9	**2.0**
ROMANO	-0.2	-0.1	**7.0**
SANTE	0.9	0.8	**1.9**
SAXON	0.2	-0.2	**6.5**
SORRENTO	0.7	0.2	**4.1**
05.Z.39 A 35	-0.8	-0.8	**9.0**
CAMMEO	0.3	-0.3	**6.5**
RALEIGH	0.8	0.3	**3.5**
04C126-005	0.5	0.3	**4.2**
REIVER	-0.4	-0.8	**9.0**
MAYAN ROSE	-0.3	-0.1	**7.4**
SCAPA	0.2	0.1	**5.6**
06.6860.2	0.5	-0.3	**5.9**
CAPTAIN	-0.6	-0.7	**9.0**
CONSTANCE	0.6	0.1	**4.7**
EMILY	-0.1	-0.3	**7.4**
FANDANGO	0.2	-0.3	**6.5**
GEORGINA	0.6	0.2	**4.3**

HERACLEA	0.0	-0.8	**8.5**
IMAGINE	-0.0	-0.1	**6.6**
PERFORMER	0.4	-0.0	**5.4**
FL 2339		0.6	*3.3*
07.Z.104 A1		0.1	*5.8*
07.Z.120 A11		0.0	*6.4*
07.Z.129 A3		0.2	*5.5*
05C040-006		-0.2	*7.8*
88.P.43 VAR		-0.2	*7.6*
CAMEL		-0.7	*9.0*
CAROLUS		-0.7	*9.0*
EUROSTAR		-0.9	*9.0*
INNOVATOR		0.1	*6.0*
KELLY		-0.3	*8.1*
LADY VALORA		-0.7	*9.0*
SAGITTA		0.1	*5.9*
LSD (P=0.05)	0.4	0.4	**2.3**

4.1.5. Potato Mop Top Virus (spraing) (Table 8)

A plot contaminated with powdery scab / PMTV in 2009 was planted at the beginning of June, 2016 with varieties grown in triple tuber randomised blocks with 6 replicates. The plots were not irrigated during the season as it was sufficiently wet at critical times. After harvest in November, the tubers were placed in a cool store for 3 weeks before being placed in a cold store. Tubers were assessed for visual symptoms of PMTV spraing in January, 2017.

Summary of 2015/2016 trial

Four candidates, Reiver, Fandango, 06.6860.2 and Sorrento showed high level of resistance scoring 8.5 or higher. Two candidates in trial, 05.Z 39 A5 and Raleigh were the most susceptible, both scoring 2.8.

2016 trial

All candidates demonstrated a high level of resistance scoring between 8.0 and 9.0

Table 8. Mean % (angular transformation) of tubers showing symptoms of Potato Mop Top Virus (spraing).

	Test Year		
Variety	**2015**	**2016**	**1-9 rating**
CARA	30.4	32.8	**3.0**
NICOLA	11.2	7.3	**7.2**
VALOR	28.0	35.1	**3.0**
SATURNA	24.8	37.4	**3.1**
MARIS PIPER	0.0	4.4	**8.5**
ZAHOV	4.4	10.4	**7.5**
SORRENTO	4.4	0.0	**8.5**
05.Z.39 A 35	34.4	30.6	**2.8**
CAMMEO	26.8	11.1	**5.3**
RALEIGH	32.9	32.5	**2.8**

04C126-005	5.0	11.9	**7.3**
REIVER	0.0	0.0	**8.9**
MAYAN ROSE	17.6	10.0	**6.3**
SCAPA	-0.4	5.9	**8.4**
06.6860.2	0.0	3.1	**8.6**
CAPTAIN	8.7	2.9	**7.8**
CONSTANCE	10.6	11.9	**6.8**
EMILY	5.0	6.8	**7.8**
FANDANGO	-0.4	3.1	**8.7**
GEORGINA	-0.3	7.3	**8.2**
HERACLEA	9.4	15.8	**6.5**
IMAGINE	13.4	13.9	**6.3**
PERFORMER	23.9	3.1	**6.4**
FL 2339		0.0	*9.0*
07.Z.104 A1		0.0	*9.0*
07.Z.120 A11		7.3	*8.0*
07.Z.129 A3		6.3	*8.2*
05C040-006		2.9	*8.8*
88.P.43 VAR		6.0	*8.2*
CAMEL		7.3	*8.0*
CAROLUS		3.1	*8.7*
EUROSTAR		3.1	*8.7*
INNOVATOR		6.0	*8.2*
KELLY		2.8	*8.8*
LADY VALORA		4.2	*8.6*
SAGITTA		12.0	*9.0*
LSD (P=0.05)	15.6	11.4	**2.2**

4.1.6. Early blight (*Alternaria solani* and *A. alternata*)

An early blight test *(A. solani* and *A. alternata*) was proposed for the new IVT programme that commenced in 2015.

A. solani

Several isolates were obtained from JHI in 2016. These were trialled in the lab using different growth medium and exposing the agar plates to different time periods of fluorescent lights. On some occasions the required spore count was obtained however this was not consistently achieved by using the same media or exposure time to light. The lack of consistency in obtaining the required spore count resulted in no test being conducted in 2016.

A. alternata

Three UK isolates were obtained from Fera Plant Clinic. As with the *A. solani* isolates, these were tested on different growth media and exposing agar plates to fluorescent lights. There was a higher level of sporulation observed than with the *A. solani* isolates. When tested on detached leaflets of the reference varieties there was no infection, therefore no test was conducted on candidates in 2016.

Following the issues encountered in trialling isolates for this test it is recommended that the proposed early blight trials are not continued in the IVT programme.

4.2. NL Tests

For each NL test there is a summary of varieties entering the IVT programme through the Common Catalogue route. The first part of the summary is for varieties completing 2 years of trials, focusing on their performance over both years. The second part is for varieties completing 1st year of trials in 2016, highlighting the performance of particular varieties. The 1-9 ratings listed for the varieties in the relevant test table are presented in bold font for varieties completing 2 years of trials; those scores in italic font are provisional scores after 1 year of testing. The names of the reference varieties are highlighted in bold font for each test.

4.2.1. Tuber late blight (Table 9)

Summary of 2015/2016 trial

Overall there was more disease recorded in 2016. All of the candidates were susceptible scoring between 1.5 (Constance) and 3.1 (Heraclea).

2016 trial

The majority of candidates were susceptible. Only Carolus demonstrated some level of resistance scoring 6.9.

Table 9. Mean % (angular transformation) tubers affected by late blight (2nd early/maincrop varieties).

	Test Year		
Variety	**2015**	**2016**	**1-9 rating**
BINTJE	78.2	90.0	**2.0**
CARA	35.8	35.6	**6.0**
SARPO MIRA	78.8	75.5	**2.6**
VALOR	39.7	28.8	**6.1**
CAPTAIN	75.1	86.9	**2.3**
CONSTANCE	90.0	90.0	**1.5**
EMILY	80.5	84.4	**2.1**
FANDANGO	64.6	80.4	**3.0**
GEORGINA	75.2	87.0	**2.2**
HERACLEA	59.1	81.3	**3.1**
IMAGINE	80.2	90.0	**1.9**
PERFORMER	82.2	90.0	**1.8**
CAMEL		80.7	*2.7*
CAROLUS		23.4	*6.9*
EUROSTAR		65.5	*3.8*
INNOVATOR		90.0	*2.0*
KELLY		80.6	*2.7*
LADY VALORA		73.8	*3.2*
SAGITTA		86.8	*2.2*
LSD (P=0.05)	12.0	10.6	**1.4**

4.2.2. Blackleg (Table 10)

Reference varieties are tested at 2 sites each year as part of the NL programme. SASA and NIAB (the other UK NL test centre) both conduct a field trial. Common catalogue varieties are only tested at SASA. The 1-9 score for the reference varieties is from SASA and NIAB in 2015 and 2016. The 1-9 score for the candidate varieties are based on the 2015 and 2016 SASA trials only.

Summary of 2015/2016 trial

Emily was the most resistant candidate scoring 6.8. Performer was the most susceptible scoring 1.3 which was more susceptible than the reference variety Concurrent (3.0).

2016 trial

Innovator and Kelly were the most resistant varieties scoring 6.7. Camel was the most susceptible candidate scoring 2.7.

Table 10. Mean % (angular transformation) plants affected by blackleg (*Pectobacterium atrosepticum)*

	Test Year				
Variety	**2015 (SASA)**	**2015 (NIAB)**	**2016 (SASA)**	**2016 (NIAB)**	**1-9 rating^**
AILSA	21.9	12.7	15.0	13.6	**8.0**
CONCURRENT	48.9	82.5	67.5	46.9	**3.0**
CULTRA	13.6	21.1	38.0	19.2	**7.2**
ESTIMA	34.7	57.2	30.7	56.4	**4.8**
MORENE	67.0	67.0	50.0	34.0	**3.8**
CAPTAIN	63.9		63.2		**2.8**
CONSTANCE	29.0		36.7		**6.1**
EMILY	12.3		41.0		**6.8**
FANDANGO	49.5		48.9		**4.3**
GEORGINA	51.4		48.0		**4.3**
HERACLEA	65.9		37.1		**4.1**
IMAGINE	42.9		46.0		**4.8**
PERFORMER	72.5		81.1		**1.3**
CAMEL			67.0		*2.7*
CAROLUS			33.9		*6.5*
EUROSTAR			54.9		*4.1*
INNOVATOR			32.6		*6.7*
KELLY			32.5		*6.7*
LADY VALORA			52.4		*4.4*
SAGITTA			35.0		*6.4*
LSD (P=0.05)	14.4	13.6	13.3	14.3	**2.5**

^NL trial is conducted at 2 sites (SASA and NIAB); 1-9 rating for reference varieties uses data from 2 sites in 2015 and 2016, 1-9 rating for candidate varieties uses data from SASA only.

4.2.3. Common scab (Table 11)

Reference varieties are tested at 2 sites each year as part of the NL programme. SASA and NIAB (the other UK NL test centre) both conduct a trial. Common catalogue varieties are only tested at SASA. The 1-9 score for the reference varieties is from

SASA in 2015 and 2016 and NIAB in 2015. The 1-9 score for the candidate varieties are based on the 2015 and 2016 SASA trials only.

Summary of 2015/2016 trial

There was slightly less common scab overall in 2016 than 2015, although two candidates had slightly more common scab recorded in 2016, these were Fandango and Performer. Constance was the most resistant candidate with a score (7.4), which is slightly more resistant than the reference variety Pentland Crown (7.0). Imagine was the least resistant scoring 3.6.

2016 trial

No candidate demonstrated high resistance to common scab. Lady Valora had the highest score at 6.3, while Innovator was the most susceptible at 3.1.

Table 11. Mean % (angular transformation) surface area affected by common scab

Variety	Test Year 2015 (SASA)	2015 (NIAB)	2016 (SASA)	2016 (NIAB)	1-9 rating^
DESIREE	61.0	36.7	52.9	-	**2.3**
ESTIMA	50.0	31.3	43.1	-	**4.3**
HOME GUARD	55.3	34.7	56.0	-	**2.6**
MARIS BARD	52.7	24.1	52.6	-	**3.9**
MARIS PEER	49.4	27.7	49.7	-	**4.1**
MARIS PIPER	54.9	45.8	53.3	-	**2.0**
PENTLAND CROWN	36.0	24.6	29.6	-	**7.0**
CAPTAIN	49.9		46.2		**3.8**
CONSTANCE	35.8		35.6		**7.4**
EMILY	43.4		42.7		**5.2**
FANDANGO	41.3		48.5		**4.7**
GEORGINA	44.2		35.7		**6.1**
HERACLEA	50.3		45.1		**3.9**
IMAGINE	56.5		40.8		**3.6**
PERFORMER	34.3		41.6		**6.7**
CAMEL			46.6		*3.5*
CAROLUS			40.4		*5.7*
EUROSTAR			43.7		*4.6*
INNOVATOR			47.8		*3.1*
KELLY			46.4		*3.6*
LADY VALORA			38.6		*6.3*
SAGITTA			39.4		*6.0*
LSD (P=0.05)	8.6	7.4	6.0		**3.5**

^NL trial is conducted at 2 sites (SASA and NIAB); 1-9 rating for reference varieties uses data from 2 sites in 2015 and 1 site (SASA) in 2016 as the NIAB 2016 data was excluded due to a lack of discrimination. The 1-9 rating for candidate varieties uses data from SASA only.

4.2.4. Powdery scab (Table 12)

Summary of 2015/2016 trial

For the majority of candidates there was less powdery scab observed in 2016 compared to 2015. Constance however had more recorded in 2016 than 2015. None of the candidates were susceptible to powdery scab. The most resistant candidate was Emily with a score of 6.9.

2016 trial

Innovator was the most resistant candidate in 2016 scoring 7.4. Two candidates demonstrated susceptibility; these were Kelly (2.8) and Camel (3.3).

Table 12. Mean % (angular transformation) surface area affected by powdery scab

Variety	Test Year 2015	2016	1-9 rating
ACCENT	20.9	13.2	**6.8**
CARA	13.7	10.8	**7.5**
ESTIMA	42.1	43.9	**3.0**
PENTLAND CROWN	15.6	6.9	**7.7**
SANTE	10.2	8.1	**8.0**
CAPTAIN	19.7	20.2	**6.4**
CONSTANCE	30.3	45.0	**3.8**
EMILY	17.3	15.6	**6.9**
FANDANGO	22.0	23.9	**6.0**
GEORGINA	30.7	30.0	**4.9**
HERACLEA	26.4	20.0	**5.9**
IMAGINE	25.8	22.8	**5.8**
PERFORMER	35.5	14.3	**5.7**
CAMEL		41.6	*3.3*
CAROLUS		31.0	*4.8*
EUROSTAR		39.8	*3.6*
INNOVATOR		12.7	*7.4*
KELLY		45.2	*2.8*
LADY VALORA		22.7	*6.0*
SAGITTA		39.2	*3.7*
LSD (P=0.05)	4.9	5.5	**1.5**

4.2.5. Dry rot (*Fusarium* spp.)

F. solani var. *coeruleum* (Table 13)

Summary of 2015/2016 trial

The amount of disease was similar in both years for some of the candidates and reference varieties. For others like Constance and Georgina there was more disease recorded in 2016. Performer and Heraclea demonstrated high resistance scoring 8.3 and 7.8, respectively. Performer was slightly more resistant than the reference variety Sante (8.0). Emily was the only candidate that demonstrated susceptibility, scoring 1.0.

2016 trial

No candidates in the 2016 trial were susceptible with the scores ranging from 5.8 to 8.0.

Table 13. Mean % (angular transformation) internal area affected by *Fusarium coeruleum*

Variety	Test Year 2015	2016	1-9 rating
NADINE	13.8	15.1	**7.1**
CATRIONA	41.6	65.2	**2.0**
ESTIMA	8.8	8.0	**7.9**
PENTLAND SQUIRE	26.5	49.9	**4.0**
SANTE	10.6	4.1	**8.0**
CAPTAIN	21.8	15.0	**6.6**
CONSTANCE	15.7	41.5	**5.2**
EMILY	67.7	67.7	**1.0**
FANDANGO	23.3	17.4	**6.3**
GEORGINA	17.2	30.4	**5.9**
HERACLEA	11.3	6.9	**7.8**
IMAGINE	17.9	27.2	**6.0**
PERFORMER	5.4	4.1	**8.3**
CAMEL		22.3	*6.3*
CAROLUS		10.7	*7.4*
EUROSTAR		4.1	*8.0*
INNOVATOR		4.5	*8.0*
KELLY		5.8	*7.8*
LADY VALORA		27.9	*5.8*
SAGITTA		12.2	*7.2*
LSD (P=0.05)	8.7	8.2	**2.2**

Dry rot (*Fusarium* spp.)
F. sulphureum (Table 14)

Summary of 2015/2016 trial
The majority of candidates and reference varieties had similar levels of disease recorded in both years. None of the candidates demonstrated resistance. The least susceptible candidate was Imagine which scored 3.7. All other candidates were very susceptible and scored between 1.0 and 2.1.

2016 trial
Three candidates demonstrated resistance; these were Sagitta, Carolus and Lady Valora scoring 8.1, 7.4 and 7.2 respectively. The other four candidates were all very susceptible scoring 1.0.

Table 14. Mean % (angular transformation) internal area affected by *Fusarium sulphureum*

Variety	Test Year 2015	2016	1-9 rating
SANTE	9.8	9.4	**8.0**
ATLANTIC	30.7	33.2	**3.6**
MARIS PIPER	40.8	28.7	**3.0**
NADINE	31.1	28.4	**4.0**
SAXON	44.7	23.5	**3.1**
CAPTAIN	53.0	63.3	**1.0**
CONSTANCE	50.5	54.3	**1.0**
EMILY	60.4	63.6	**1.0**
FANDANGO	55.9	60.0	**1.0**
GEORGINA	36.9	49.9	**1.3**
HERACLEA	54.5	52.1	**1.0**
IMAGINE	29.3	33.3	**3.7**
PERFORMER	31.3	47.2	**2.1**
CAMEL		57.9	*1.0*
CAROLUS		11.9	*7.4*
EUROSTAR		63.3	*1.0*
INNOVATOR		53.8	*1.0*
KELLY		52.6	*1.0*
LADY VALORA		12.6	*7.2*
SAGITTA		9.1	*8.1*
LSD (P=0.05)	7.8	8.4	**3.1**

4.2.6. External damage (splitting) (Table 15)

Summary of 2015/2016 trial

Overall there was lower level of splitting recorded in 2016; this test can be influenced by environmental factors. There was a large difference in performance between years for reference variety Maris Peer. The results were rechecked in 2016 and the result confirmed. This was discussed with BioSS but the score was not excluded as Maris Peer is not used as an anchor variety for the analysis. None of the candidates demonstrated resistance. Two candidates Constance and Captain were susceptible scoring 2.3 and 3.3, respectively.

2016 trial

Lady Valora did not have any splitting recorded in 2016. Kelly, Eurostar and Sagitta all had low levels of splitting. Innovator was the least resistant scoring 4.5.

Table 15. Mean % (angular transformation) tubers affected by splitting after applying standard force (2nd early/maincrop varieties)

Variety	Test Year 2015	2016	1-9 rating
MARIS PEER	60.0	8.0	**4.8**
MARIS PIPER	38.0	44.0	**4.4**
RECORD	16.0	14.0	**6.0**
RED CRAIGS ROYAL	48.0	72.0	**3.2**
RUSSET BURBANK	88.0	46.0	**2.8**
CAPTAIN	58.0	58.0	**3.3**
CONSTANCE	84.0	66.7	**2.3**
EMILY	23.5	14.0	**5.8**
FANDANGO	28.0	32.0	**5.1**
GEORGINA	50.0	44.0	**4.0**
HERACLEA	30.0	16.0	**5.5**
IMAGINE	28.6	8.0	**5.8**
PERFORMER	28.0	42.0	**4.8**
CAMEL		24.0	*5.3*
CAROLUS		24.0	*5.3*
EUROSTAR		6.0	*6.5*
INNOVATOR		36.0	*4.5*
KELLY		2.0	*6.8*
LADY VALORA		0.0	*6.9*
SAGITTA		8.0	*6.4*
LSD (P=0.05)			**1.6**

4.2.7. Internal damage (bruising) (Table 16)

Summary of 2015/2016 trial

There was not a large variation in performance of the varieties with candidates scoring between 6.3 (Imagine) and 5.2 (Captain).

2016 trial

The majority of the candidates performed similarly, scoring between 5.2 and 6.3. Kelly was the exception with a susceptible score of 1.8.

Table 16. Mean depth (mm) of bruise at point of impact of standard force (2nd early/maincrop varieties)

Variety	Test Year 2015	2016	1-9 rating
MARIS PEER	5.9	5.9	**5.1**
MARIS PIPER	3.9	4.7	**6.0**
RECORD	5.8	4.8	**5.4**
RED CRAIGS ROYAL	5.0	7.1	**5.0**
RUSSET BURBANK	7.4	8.3	**4.0**
CAPTAIN	5.4	6.2	**5.2**
CONSTANCE	5.7	5.2	**5.4**
EMILY	5.2	5.6	**5.4**
FANDANGO	4.7	5.2	**5.6**
GEORGINA	3.7	4.9	**6.0**
HERACLEA	4.2	4.4	**6.0**

IMAGINE	3.2	4.4	**6.3**
PERFORMER	6.0	5.1	**5.3**
CAMEL		6.2	*5.2*
CAROLUS		5.9	*5.3*
EUROSTAR		5.2	*5.7*
INNOVATOR		4.2	*6.3*
KELLY		12.2	*1.8*
LADY VALORA		4.7	*6.0*
SAGITTA		5.0	*5.8*
LSD (P=0.05)			**0.9**

4.2.8. Potato Cyst Nematode (Table 17)

High level resistance to PCN (*G. rostochiensis* Ro1) is normally conferred by the major gene H1 and results in minimal multiplication of cysts on the potato. Varieties completing trials that expressed this type of resistance to Ro1 were Captain, Emily, Fandango, Georgina and Imagine. Candidates in first year trials that demonstrated this resistance were Camel, Eurostar, Kelly, Lady Valora and Sagitta.

The candidate Performer which has completed trials and the first year candidates Camel, Eurostar and Innovator showed high resistance to *G. pallida.*

Table 17. Multiplication of cysts of 3 pathotypes of potato cyst nematode (*Globodera rostochiensis* pathotype 1; *G. pallida* pathotypes 2/3 and 1) on test varieties, expressed as 1-9 rating as determined by the EU PCN Directive (2007/33/EC).

VARIETY	Ro1	Pa 2/3	Pa1
DESIREE	**2 (S)** †	**2 (S)**	**2 (S)**
ESTIMA	**2 (S)**	*	*
MARIS PIPER	**8**	**2 (S)**	**2 (S)**
12380	**8**	**6**	**6**
VANTAGE	**4**	**5**	**5**
MORAG	**4**	**3**	**3**
VALES EVEREST	*	**6**	**9**
INNOVATOR	*****	**8**	**9**
CAPTAIN	**8**	**2**	*
CONSTANCE	**3**	*3*^	*
EMILY	**8**	**2**	*
FANDANGO	**8**	**2**	*
GEORGINA	**8**	**2**	*
HERACLEA	**5**	**3**	**4**
IMAGINE	**8**	*3*^	*
PERFORMER	**4**	**8**	**9**
CAMEL	*8*	*8*	*
CAROLUS	*1*	*1*	*
EUROSTAR	*8*	*8*	*

INNOVATOR	*2*	*8*	*9*
KELLY	*9*	*1*	*
LADY VALORA	*8*	*2*	*
SAGITTA	*9*	*2*	*

† S denotes fully susceptible reference cultivars

* not tested

^ These varieties will receive a second year of testing for PCN Pa 2/3 in 2018 due to a recent change in the protocol. The provisional score is based on one year of testing in 2016.

5. DISCUSSION

The field foliage blight trial was planted in May after three consecutive years of planting in June due to poor weather in May. Once blight was observed in the plots it spread quickly with five assessments conducted in a 17 day period. In some tests e.g. black dot, silver scurf and tuber blight, disease severity was greater in 2016 than in 2015, whereas the incidence of skin spot and powdery scab was generally less in 2016 than 2015. Variations like this can be due to environmental conditions in the test year, therefore caution is required when considering ratings particularly for those with only one year of the test.

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. In the 6 years of testing the majority of varieties have demonstrated resistance. Following advice from BioSS it was agreed by the IVT partners to use the average of Maris Piper and Zahov as the anchor point for resistance. The average of Saturna and Valor was used for the susceptible anchor. This allows for a more accurate resistance score for the varieties**. It should be noted that this change to anchor points for the over years analysis will change some of the previously published scores and these will be updated on the AHDB Potatoes Variety Database.** A note will be added to the database when this change has been carried out.

In the NL 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 in this report, 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 the 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 12 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 3.6 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.** In this report the 1-9 scores presented in Tables 2a, 2b and 3 are from the over years analysis as recommended by the statisticians at BioSS. These scores for varieties completing trials are used for publication on the AHDB Potatoes Variety

Database. The 2 year tables (tables 4-17) show the performance over the test years and the 1-9 score here can vary slightly from those in Tables 2a, 2b and 3.

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.

17 varieties completed IVT in 2017. These were Sorrento, 05.Z.39 A 35, Cammeo, Raleigh, 04C126-005, Reiver, Mayan Rose (06.Z.266 A 4), Scapa (06.Z.266 A 15), 06.6860.2, Captain, Constance^, Emily, Fandango, Georgina, Heraclea, Imagine^ and Performer. An overview of strengths and weaknesses for these varieties is listed on pages 11 to 13 of this report. Scores for these varieties has been published on the AHDB Potatoes Variety Database. This database which was launched online in 2007 as the British Potato Variety Database has proved to be a useful tool for the publication of data from the NL and IVT programme. It allows the publication of data once results have been finalised which is usually by the end of July each year. The site is easy to use and has a search facility and the ability to compare two varieties on one screen.

^ As described elsewhere in the report, these varieties will receive a second year of testing for PCN Pa 2/3 in 2018 due to a recent change in the protocol. The provisional score is based on one year of testing.

6. REFERENCES

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