

## Project report for SSCR-Potatoes

### **Project title:**

Assessing the effect of changes in the *Phytophthora infestans* population on resistance of commercial varieties and breeding material to foliar late blight.

### **Applicant(s):**

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### **Background to the project (200 words max).**

The ongoing surveillance of *P. infestans* populations causing late blight in GB potato crops (2008-2019), funded through the AHDB 'Fight against Blight' campaign has identified shifts in dominant genotypes (strains).

From 2006-10 the 13\_A2 genotype was dominant and was found to be largely metalaxyl resistant and able to overcome sources of host resistance that were previously robust. As a result of SSCR funding received in 2008 and in conjunction with data from other researchers, the late blight resistance ratings of many varieties in the AHDB database were revised (Lees *et al.* 2012).

13\_A2 has since declined as a proportion of the population (78.4% in 2008 to 8.8% in 2019 and 0.7% in 2020). Genotype 6\_A1, an aggressive strain, has been dominant since 2011 (35.8% in 2019). A recent notable change has been the arrival of two new genotypes from Europe; 37\_A2 (Fluazinam insensitive) in 2016, and 36\_A2 in 2017. The proportion of 36\_A2 increased rapidly (26.7% of the population in 2019), with reports from agronomists of rapid and difficult to control epidemics. Fungicide sensitivity work is currently funded by the AHDB and has not shown a shift in sensitivity to active ingredients from seven FRAC groups tested.

These findings raise the question of whether foliage blight resistance ratings (1-9 scale of increasing resistance) are still accurate in the presence of the current pathogen population. This has potential implications for control strategies, particularly IPM strategies which include both varietal host resistance and fungicidal control and control of late blight in organic crops. It is timely to assess parental breeding material and other sources of host resistance using the contemporary population to inform potato breeding activities.

### **Aims and objectives (100 words max).**

1. To assess resistance to foliar potato late blight in commercial potato varieties using the dominant and emerging genotypes present in the UK *P. infestans* population.
2. To determine foliar late blight resistance to current *P. infestans* genotypes in parental breeding material and other genetic resources as appropriate.

**Research results** (Please include figures, images, diagrams etc as appendices

– 1 page):

Glasshouse foliage blight trials were carried out to assess a range of potato varieties for resistance to late blight caused by *P. infestans* genotypes 36\_A2 (emerging), 6\_A1 (dominant), and 13\_A2 (previously tested). Thirty-two clones in total were tested (Figure 1). These comprised 14 of the most popular commercial varieties by planted area in 2019, 10 varieties with increasing planted area (2014-2019) and 8 breeding clones and varieties. Two isolates of each *P. infestans* genotype obtained from the 2019 outbreak were used for the resistance tests and were also characterised for race structure (ability to overcome known R genes) (Figure 2).

Whole plant glasshouse tests were carried out following well-established standard protocols. The 32 varieties were screened using a randomised block design with varieties and isolates randomised. Two replicates of each variety were tested per isolate, and King Edward was used as a susceptible control. Plants were assessed eight days after inoculation (Figure 3), each plant was scored for percentage disease and given a score between 1-9, where 1 = collapsed and 9 = no disease. More than 80% disease severity (this represents a resistance rating of 2), was consistently shown on the control plants for all *P. infestans* genotypes (Figure 4), indicating successful inoculation conditions.

Analysis of the disease scores showed variation across the varieties and different *P. infestans* genotypes (Figures 5 and 6). Forty percent of the varieties tested showed no significant difference in the disease score resulting from inoculation by each of the three genotypes. If the difference between the mean scores is greater than the 5% LSD (1.3) then it is considered statistically significant in this test. Average disease resistance ratings for 36\_A2 were significantly higher (i.e. caused less disease) than those for 13\_A2 and 6\_A1 on six of the varieties tested (Estima, Marfona, Royal, Sagitta, Taurus, Jazzy). Similarly, 36\_A2 did not produce any disease ratings lower than the other genotypes on the breeding material tested (Figure 7), indicating that resistance was not compromised.

In this test the variety Innovator produced an unusual result, scoring a rating of between 8-9 for all three *P. infestans* genotypes. With an official foliage blight resistance rating of 3 this was unexpected. Looking back at previous data, in field trials inoculated with 13\_A2 scores for Innovator have varied from 7 to 2 (6 in 2019, 2.7 in 2020). However, in previous glasshouse experiments with 6\_A1, 37\_A2, and 36\_A2 Innovator also scored a rating of 9. We would therefore draw no conclusions for this variety in the current test as it appears so inconsistent but will repeat the tests in 2021.

The results also highlighted differences in disease due to the presence of known R genes in some varieties. Maris Peer (Figure 8) and Pentland Dell (Figure 9) are both known to possess *Rpi-R2* or *Rpi-R2-like* genes and this accounted for the difference between 13\_A2, which is able to overcome the R2 gene (Figure 2) and 36\_A2 and 6\_A1 which are unable to do so.

Figure 10 and Figure 11 show how the disease scores for each variety/genotype combination in this test compare to current resistance ratings. The more resistant varieties performed well, consistently showing low levels of disease. There is more variation in the varieties with official ratings of 4-5, which is not entirely unexpected, and where the scores in this test are lower than the official rating it is generally for all three genotypes or just 13\_A2. In 2012, official late blight resistance ratings were reduced for some varieties originally scoring 5 or higher, as a result of extensive testing with 13\_A2 in response to the increase of this genotype in the population. Ratings were changed by rounding up or down to nearest whole number and only for those varieties showing a change greater than the maximum 5% LSD of 1.9 in that study. Applying the same criteria as above to the results from this project identifies seven varieties for which the ratings show a difference of more than the 5% LSD (1.3) from the current foliage blight resistance rating (Figure 12 and 13) but there is less data.

**Outcomes** (- Comment on the proposed outcomes and describe who has been helped by this work and how - 200 words max):

1. From these results there does not appear to be evidence that current resistance ratings for contemporary varieties or breeding material are specifically affected by *P. infestans* genotype 36\_A2. These are results from a limited number of isolates tested in one year and further testing and field trials would be required to confirm this.

There is an indication that some individual varieties may be more susceptible to 36\_A2, such as Markies which is also the variety with the second largest grown area in 2019. This could be part of the explanation as to why 36\_A2 is increasing in the population even though it does not have as wide a virulence profile in overcoming known R genes as other genotypes such as 13\_A2. Again, these results should be treated with caution until repeated as variation can occur between years. 36\_A2 is thought to be more aggressive than other isolates but this would not account for a difference between varieties.

2. These results also indicate that there is still susceptibility to genotype 13\_A2 in the widely grown varieties.

Host resistance is underutilised in IPM strategies, which highlights the importance of having up to date information on individual varietal resistance tested using the contemporary pathogen population. It is also important to know, where possible, which R genes are present in varieties and breeding material as this can be matched with knowledge of the pathogen to understand which resistance sources will be most effective.

**Next steps** (e.g. Information on further funding etc – 100 words max):

Repeated glasshouse tests and field trials would be required to build a robust picture of how the current late blight population may affect resistance ratings, particularly for those where differences have been noted in this preliminary test.

For 36\_A2 specifically, it will be useful to look at the variety resistance data together with aggressiveness data and fungicide test results. This would give a more comprehensive view of the reasons behind the increase of 36\_A2 in the population compared to other genotypes which are fungicide insensitive or able to overcome a wider range of host resistance genes. AHDB is currently funding such fungicide testing.

## Appendix

Clone	List	Current Foliage Blight Rating
Estima	Top 15 by area in 2019	4
Innovator	Top 15 by area in 2019	3
Lady Rosetta	Top 15 by area in 2019	4
Marfona	Top 15 by area in 2019	4
Maris Peer	Top 15 by area in 2019	4
Maris Piper	Top 15 by area in 2019	4
Markies	Top 15 by area in 2019	5 <sup>1</sup>
Melody	Top 15 by area in 2019	4
Nectar	Top 15 by area in 2019	4
Pentland Dell	Top 15 by area in 2019	4 <sup>1</sup>
Rooster	Top 15 by area in 2019	4
Royal	Top 15 by area in 2019	5
Sagitta	Top 15 by area in 2019	3
Taurus	Top 15 by area in 2019	4
Brooke	Increasing Area	5
Challenger	Increasing Area	4
Carolus	Increasing Area	9
Daisy	Increasing Area	4
Eurostar	Increasing Area	6 <sup>2</sup>
Gemson	Increasing Area	4
Jazzy	Increasing Area	4
Jelly	Increasing Area	5
Lanorma	Increasing Area	4
VR 808	Increasing Area	2
Alouette	Breeding material	9 <sup>2</sup>
Athlete	Breeding material	9 <sup>2</sup>
Kelly	Breeding material	8
Vitabella	Breeding material	n/a
Breeding Clone 1	Breeding material	n/a
Breeding Clone 2	Breeding material	n/a
Breeding Clone 3	Breeding material	n/a
Breeding Clone 4	Breeding material	n/a

Figure 1: Varieties and breeding clones tested. Current foliage blight resistance ratings obtained from AHDB Potato Variety Database. <sup>1</sup>Foliage blight ratings reduced in 2012 as a response to 13\_A2 testing. <sup>2</sup> Has not undergone Independent Variety Trials testing procedures. The variety Cultra was also in the top 15 by planted area but seed could not be sourced for this trial.

Isolate	Genotype	Race profile
2019_W4722B	13_A2	CR,1,2,3,4,5,6,7,10,11
2019_W8814B	13_A2	CR,1,2,3,4,6,7,10,11
2019_W3641A	36_A2	CR,1,3,4,5,6,7,8,10,11
2019_W4524C	36_A2	CR,1,3,4,5,6,7,10,11
2019_W3856C	6_A1	CR,1,3,4,7,10,11
2019_W4268A	6_A1	CR,1,3,4,7,8,10,11

Figure 2: Differential race profiles of isolates tested Indicates which known R genes each isolate can overcome. CR = Craig’s Royal (no known R genes – universal susceptible).



Figure 3: Plants showing disease symptoms 8 days post inoculation.

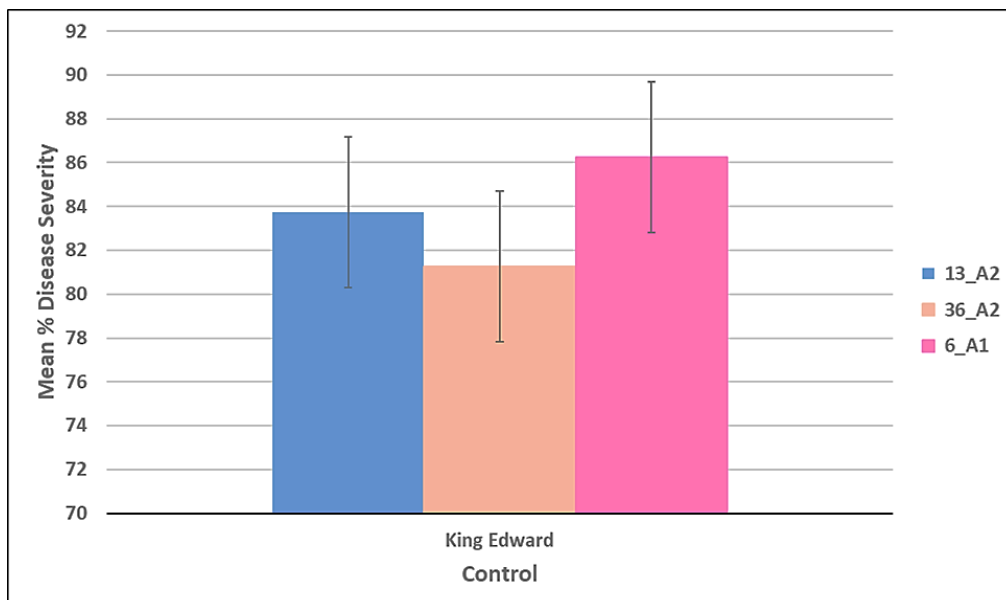


Figure 4: Comparison of late blight disease severity on King Edward susceptible controls across genotypes showing no significant difference.

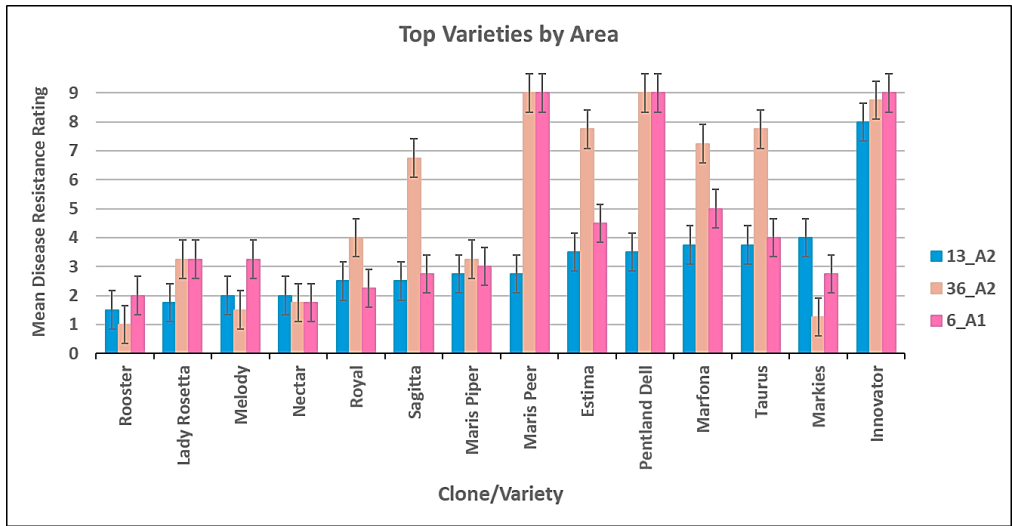


Figure 5: Mean disease resistance ratings 8 days after inoculation with each *P. infestans* genotype. Disease score 1 = collapsed and 9 = no disease. Error bars represent 5% LSD of 1.3.

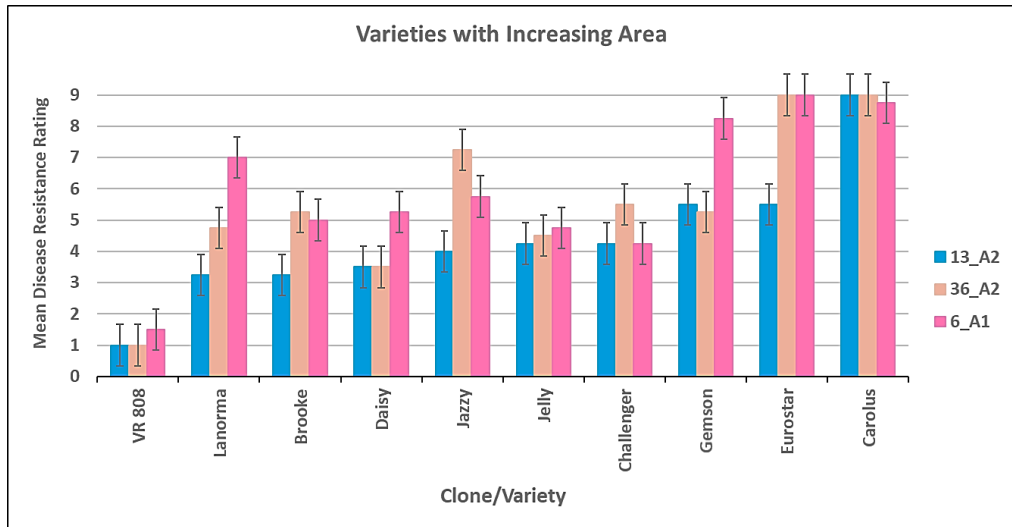


Figure 6: Mean disease resistance ratings 8 days after inoculation with each *P. infestans* genotype. Disease score 1 = collapsed and 9 = no disease. Error bars represent 5% LSD of 1.3.

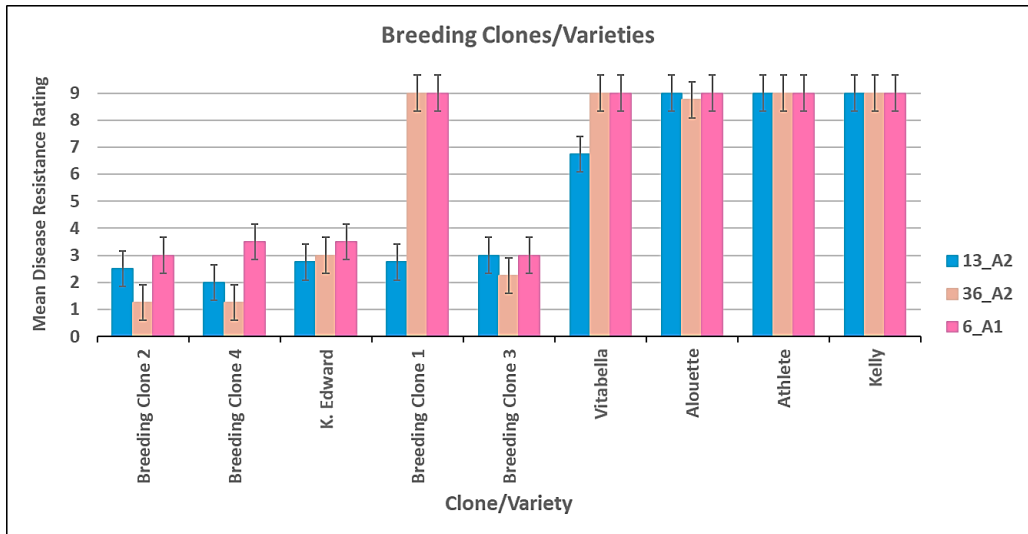


Figure 7: Mean disease rating (1-9 scale of increasing resistance) on breeding material 8 days after inoculation with each *P. infestans* genotype. Disease score 1 = collapsed and 9 = no disease. Error bars represent 5% LSD of 1.3.



Figure 8: Variety Maris Peer inoculated with *P. infestans* genotypes 13\_A2, 6\_A1, 36\_A2. With late blight symptoms only developed on the plant inoculated with 13\_A2.



Figure 9: Variety Pentland Dell inoculated with *P. infestans* genotypes 13\_A2, 36\_A2, 6\_A1. With symptoms only developed on the plant inoculated with 13\_A2.

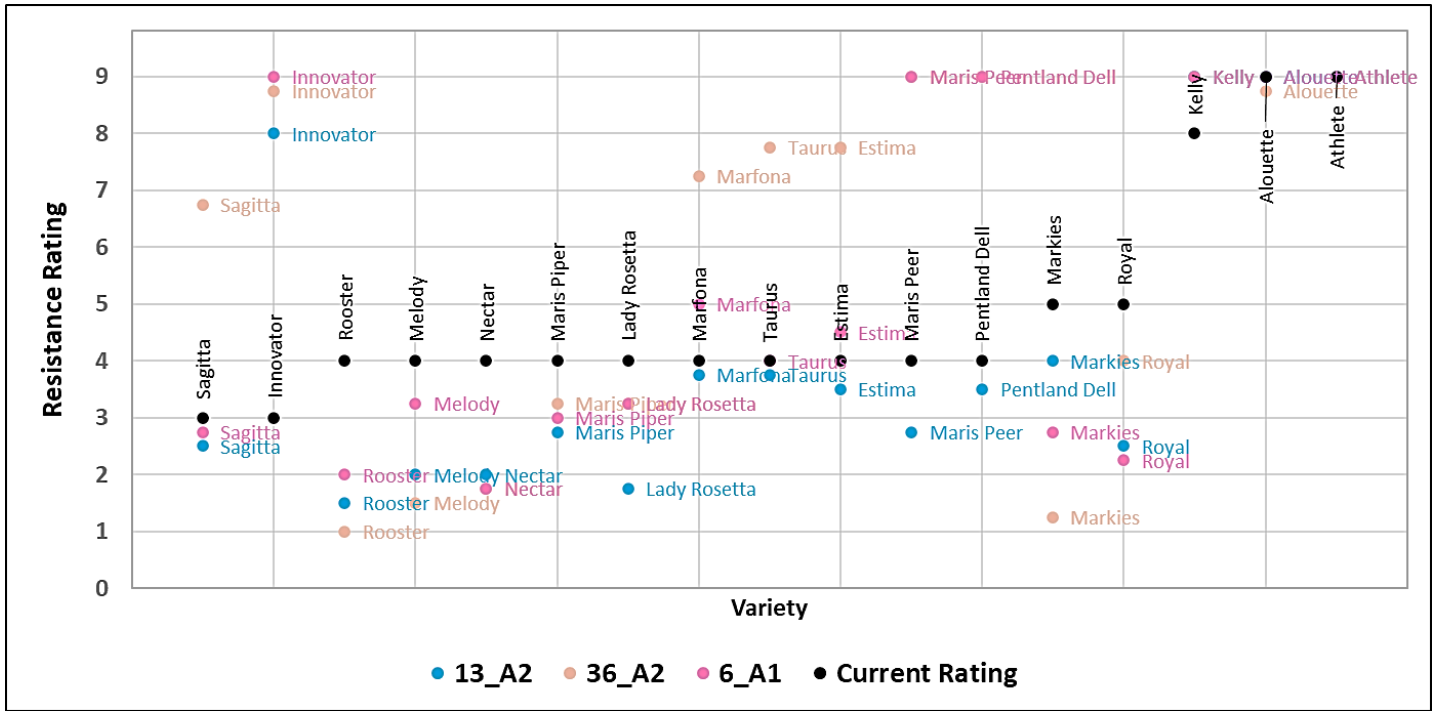


Figure 10: Official resistance ratings of fourteen of the most popular commercial varieties by planted area in 2019 including 3 varieties Alouette, Athlete, and Kelly used in breeding compared with results for each of the 3 genotypes tested. Alouette and Athlete have not undergone Independent Variety Trials testing procedures. Markies and Pentland Dell ratings previously decreased in 2012 based on 13\_A2 testing.

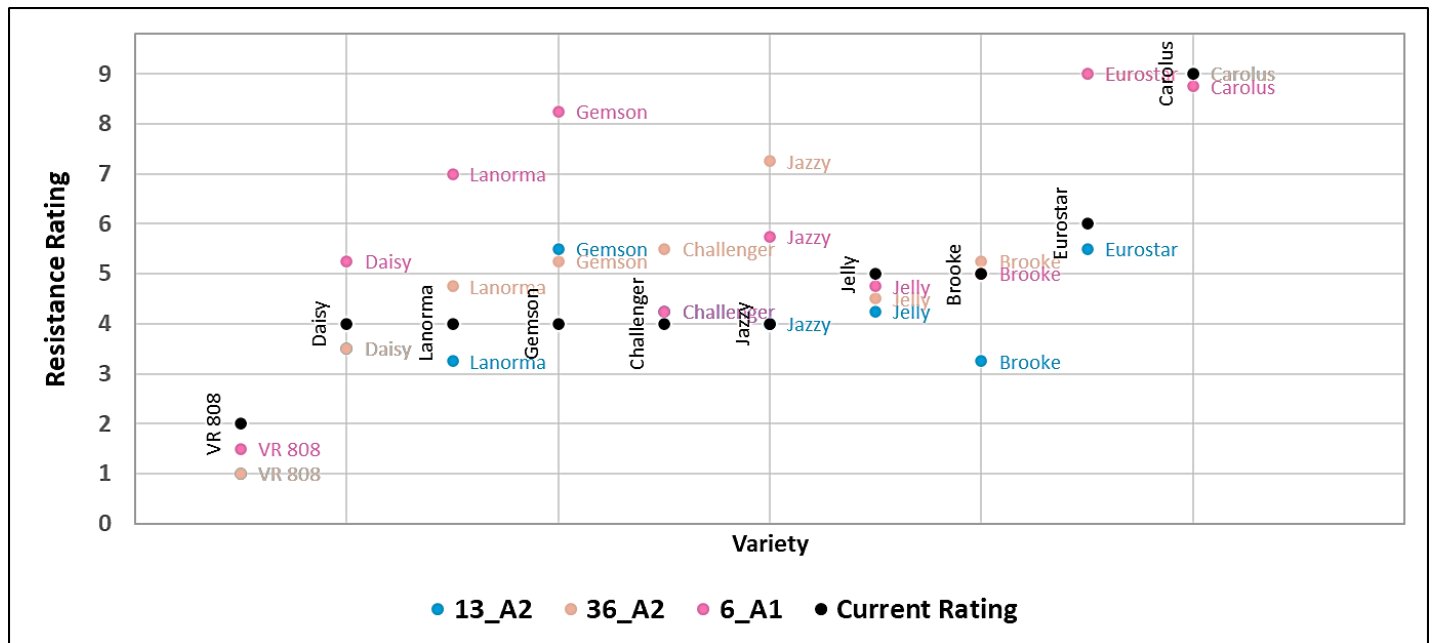


Figure 11: Official resistance ratings of 10 varieties with increasing planted area (2014-2019) compared with results for each of the 3 genotypes tested. Eurostar Has not undergone Independent Variety Trials testing procedures.



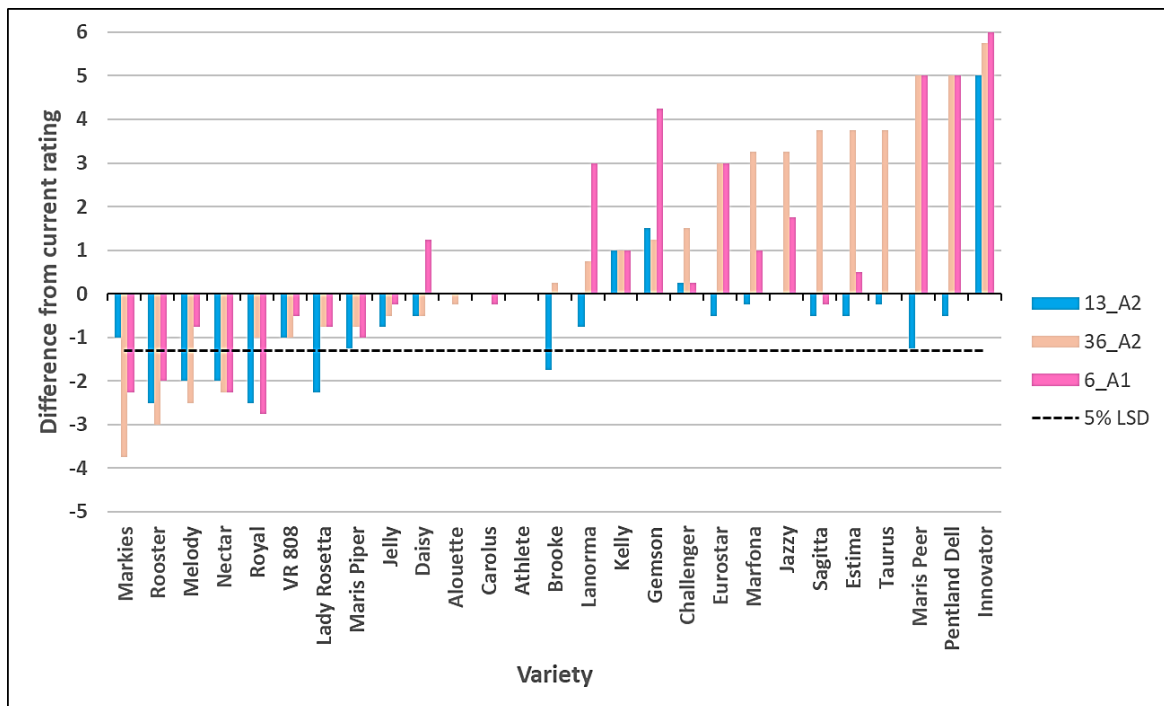


Figure 12: Difference in resistance ratings for each of the three genotypes when compared against current ratings. 0 is no difference from current rating. Dotted line represents the 5% LSD of 1.3.

Variety	Current Rating	13_A2	36_A2	6_A1
Brooke	5	3		
Lady Rosetta	4	2		
Markies	5		1	3
Melody	4	2	2	
Nectar	4	2	2	2
Rooster	4	2	1	2
Royal	5	3		2

Figure 13: Ratings of varieties for each genotype which showed a difference greater than the 5% LSD (1.3) from the current rating.