



The Effect of Fungicides on Local *Phytophthora infestans* Populations

Phytophthora infestans



- Net worth of potato sector up to €250m
- Fungicides costs
~€500/ha and ~9000ha pa grown

(Teagasc, 2017 and CSO, 2016)

Phytophthora infestans in Ireland

- 1983 – 2007, blight epidemic each year except for 4 years
- Pre-2008, spray intervals ~ 10 days and ~10 sprays/crop
- In 2004; 364,106kg fungicide a.i. on Irish potato crop (DAFM)



- Post-2008, shift in dynamics of blight strains
- Spray intervals <7 days and ≥ 15 sprays/crop

Impact of blight epidemic on unsprayed potato varieties?

The 2009 Wipe-Out



10/07/09



27/07/09

Control Strategy



1. Application of Fungicides

- Expensive
- Not always effective

2. Resistant varieties

- Not always suitable for market
- Resistance break down

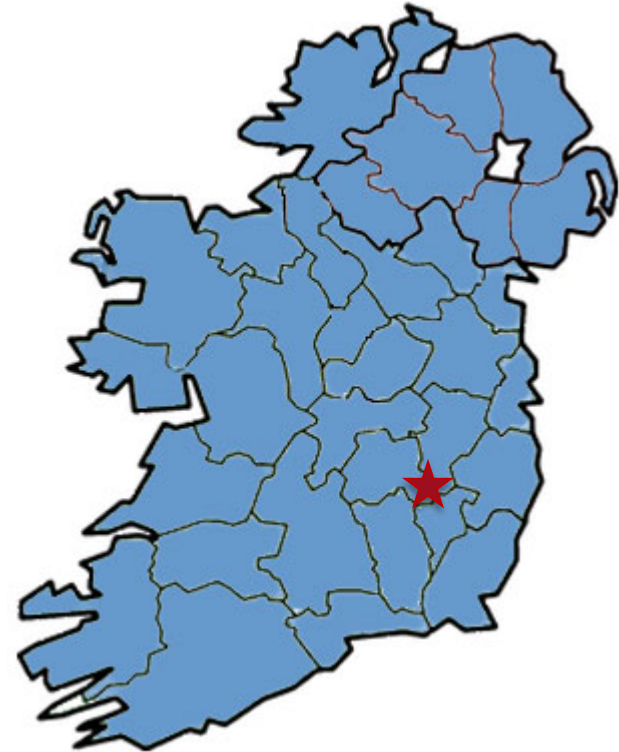
Constant pathogen evolution

→ Important to monitor blight population and its response to fungicide application

Fungicide Trial Oak Park Carlow 2014-2016

The Trial

- Blight susceptible variety 'King Edward'
- Sown late April
- Complete Randomised Block Design
- 3.3m x 9m
- Fungicides
 - 10 Fungicide Treatments
 - Untreated Control
- Fungicide Application
 - Same fungicide applied all season
 - 2014 → 7day intervals
 - 2015 and 2016 → 10-14 day intervals



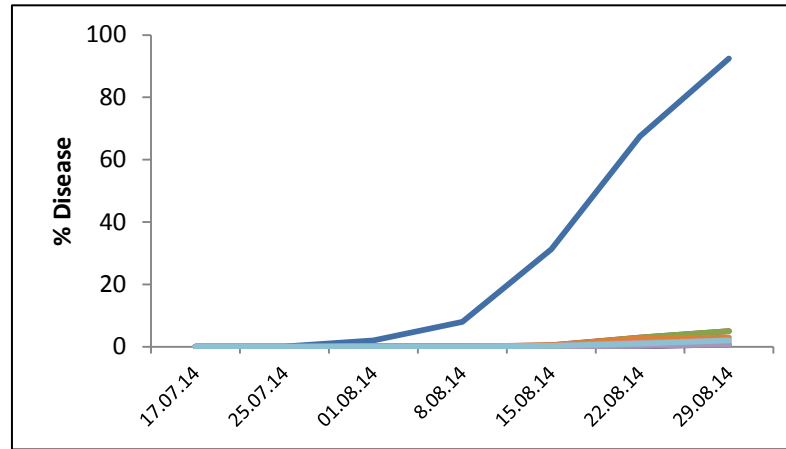
Fungicide Treatments 2014-2016

Treatment	Product*	Company	Active Ingredient a.i.
1	Untreated		
2	Dithane DF	Dow AgroSciences	750 g/kg Mancozeb
3	Proxanil	Arysta	400 g/L Propamocarb hydrochloride and 50 g/L Cymoxanil
4	Shirlan	Syngenta	500 g/l Fluazinam
5	Revus	Syngenta	250 g/l (23.4% w/w) Mandipropamid
6	Ranman Top	Belchim Crop Protection	160 g/l Cyazofamid
7	Infinito	Bayer Crop Science Limited	62.5 g/L (5.53 % w/w) Fluopicolide + 625 g/L (55.3%w/w) Propamocarb hydrochloride
8	Ridomil Gold	Syngenta	64% w/w Mancozeb and 4% w/w Metalaxyl-M
9	Valbon	Certis	17.5 g/kg (1.75% w/w) Bentiavalicarb-isopropyl and 700 g/kg (70% w/w) Mancozeb
10	Diablo	Arigan	80 g/kg Ametoctradin and 480 g/kg Mancozeb
11	Curzate M	DuPont	Mancozeb and Cymoxanil 72.5%WG

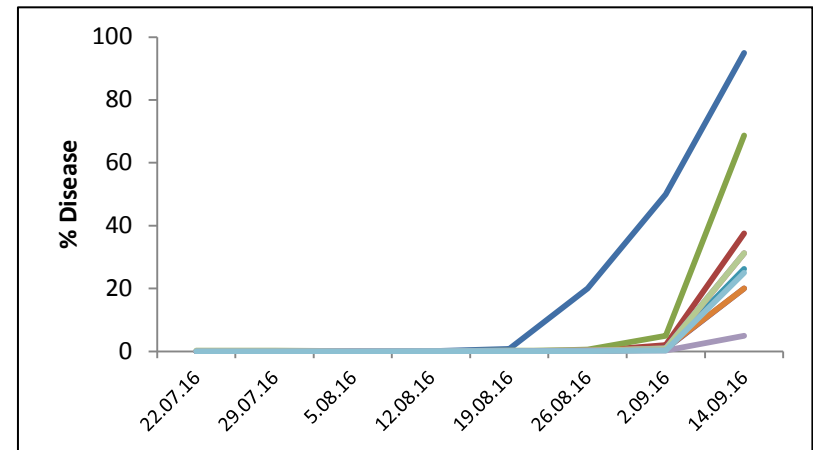
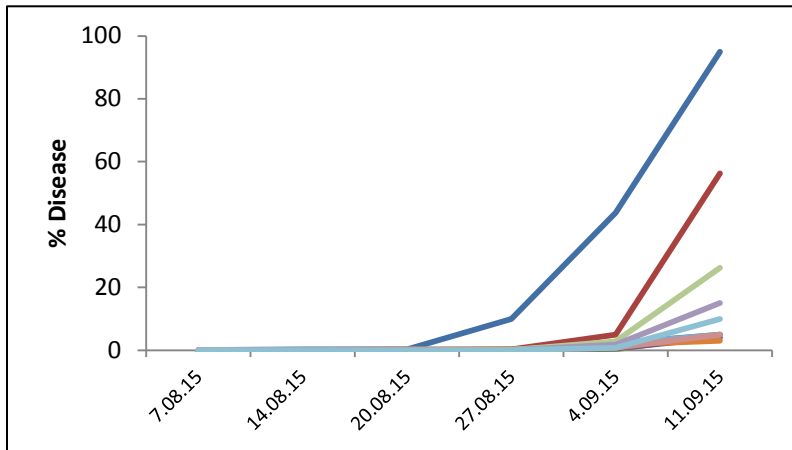
*All commercially available fungicides

Disease Data 2014-2016

- Untreated
- Dithane DF
- Proxanil
- Shirlan
- Revus
- Ranman Top
- Infinito
- Ridomil Gold
- Valbon
- Diabolo



7 day interval



10-14 day interval

Workflow

1. Lesion Sampling

- Plots were sampled mid-September; 16 lesions per plot
- 2014; Live samples were collected and isolated.
- 2015 and 2016; Lesions were collected on Whatmann FTA cards



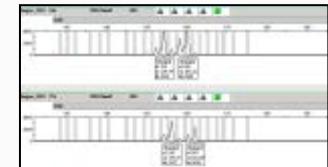
2. DNA Extraction and Multiplex PCR

- 2014: Sigma GenElute™ Plant Genomic DNA Miniprep Kit
- 2015 and 2016: Whatmann FTA card DNA Extraction Protocol
- Amplification of the Euroblight standardised twelve microsatellite markers were used for genotypic characterisation (Li et al., 2013; Lees et al., 2006; Knapova and Gisi, 2002)

3. Analysis

- Analysis of SSR Profiles for genotypic characterisation

Genotype	PI02	PI04	PI63	PI70	D13	PI48	G11	SSR2	SSR4	SSR6	SSR8	SSR11
6_A1	258 266 268	166 170	273 279	192 195		213 217 160 160		173 175	284 292 296	244 244	260 266	341 355
13_A2	266 268	166 170	273 279	192 192	136 142	205 213 154 160 164		173 173	284 288 294	244 244	260 266	341 341
8_A1_1	262 268	166 170	273 279	192 192	118 122 136	205 217	162 162	173 175	288 294	242 244	260 266	331 341
8_A1_2	268 268	166 170	273 279	192 192	118 136	205 217	166 166	173 175	284 288 294	242 244	260 266	331 341
5_A1	268 268	166 170	273 279	192 195	136 136	205 217	156 162	175 175	295 295	244 244	260 266	331 355

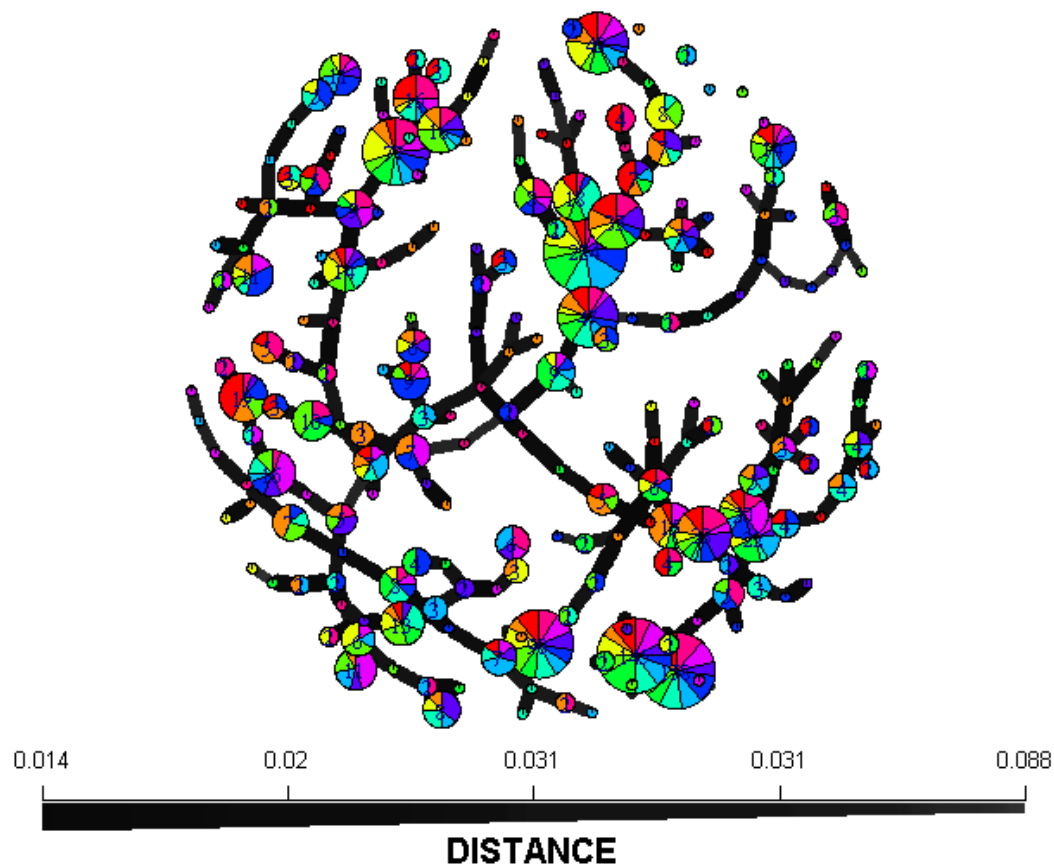


- Analysis using Poppr and STRUCTURE to determine population composition.

The Analysis.....

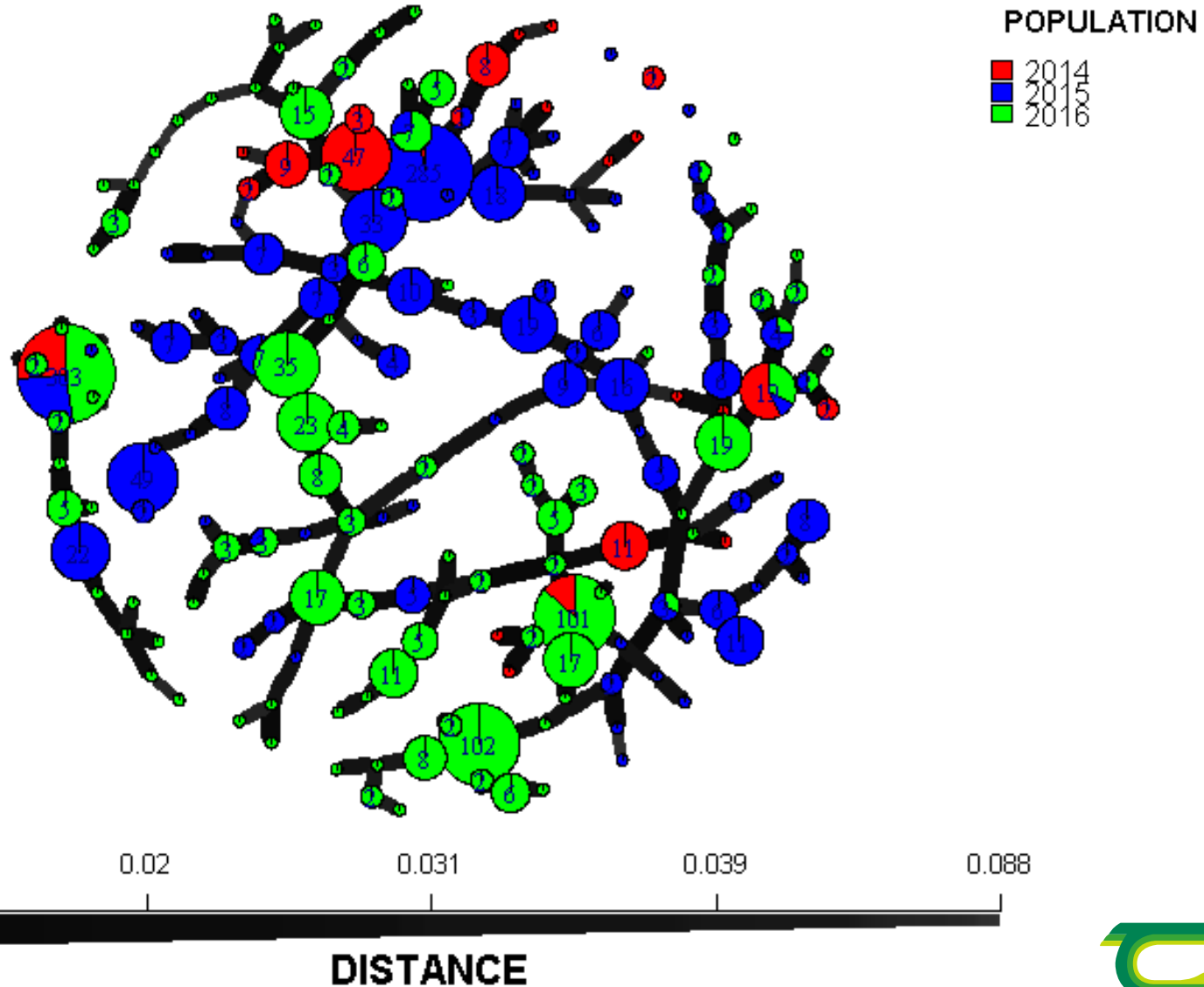
POPULATION

- Curzate M
- Diablo
- Dithane DF
- Infinito
- Proxanil
- Ranman Top
- Reyus
- Ridomil Gold
- Shirian
- Untreated
- Valbon

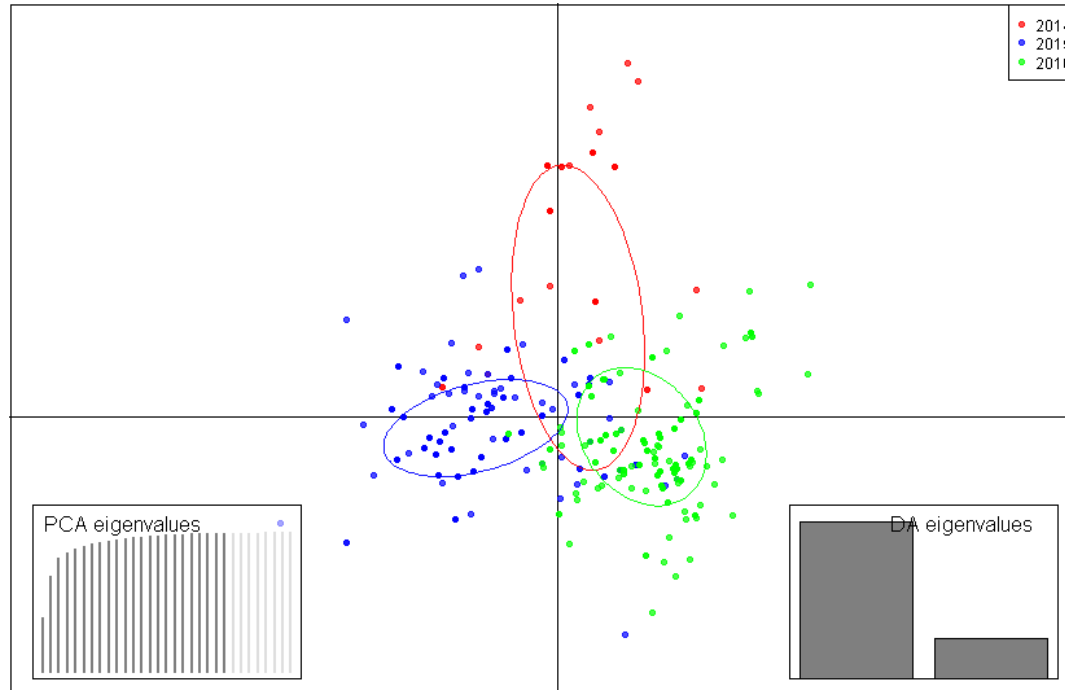


	2014	2015	2016
N=	209	704	640
MLG's	24	82	99

The Analysis.....

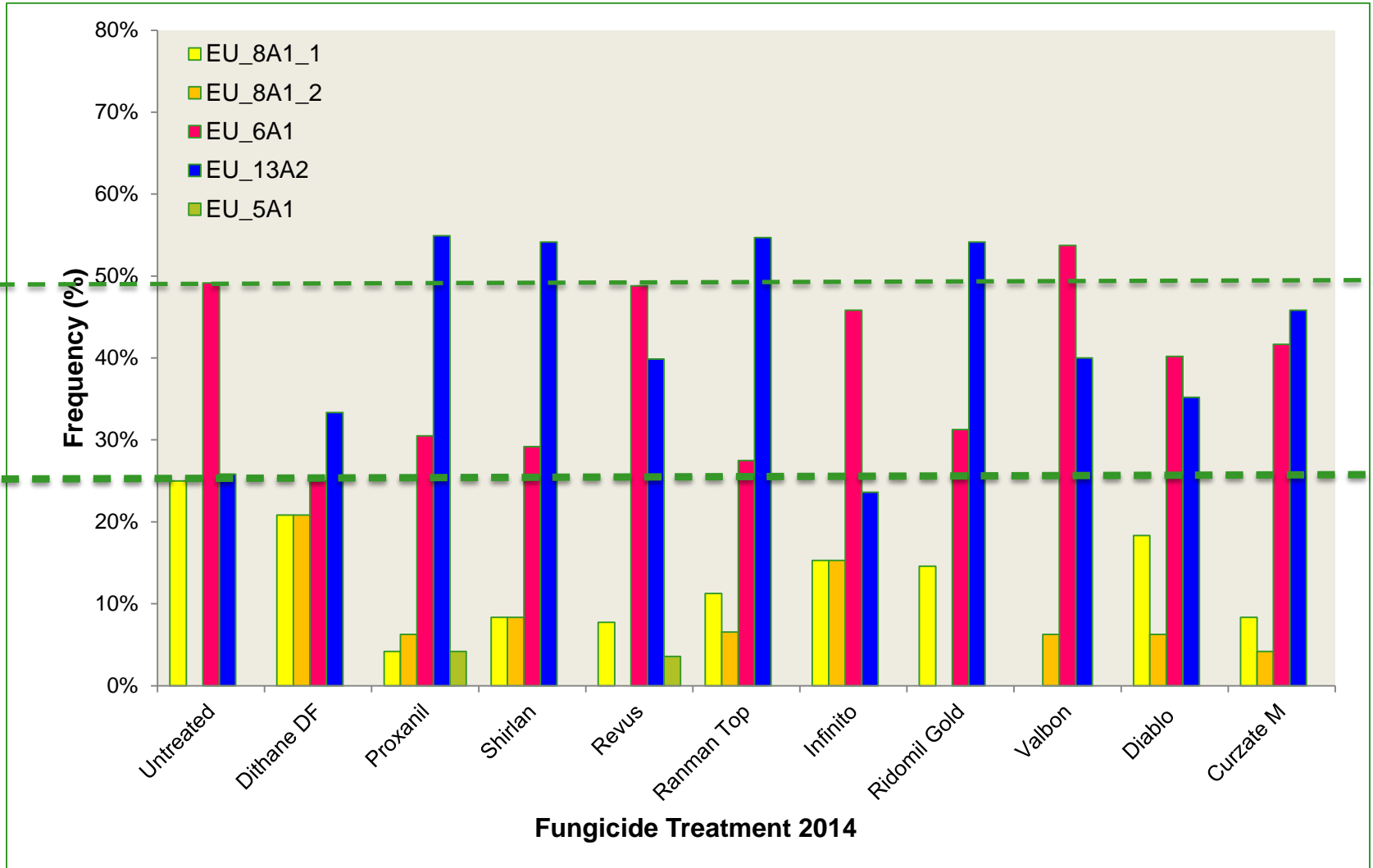


Discriminant Analysis of Principal Components (DAPC) plot using the 12-plex SSR loci from *Phytophthora infestans* samples 2014, 2015 and 2016

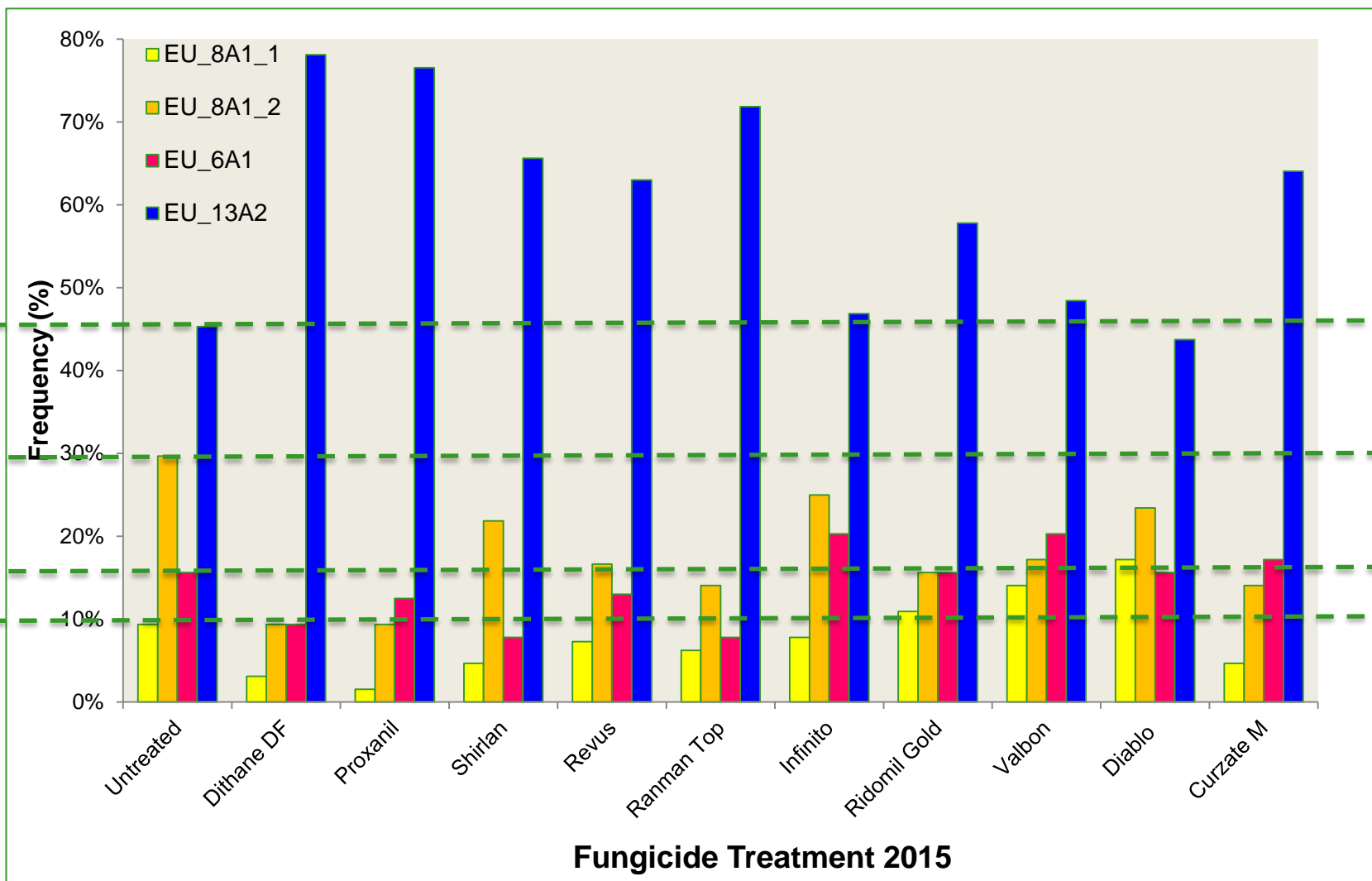


	EU_8A1_1	EU_8A1_2	EU_6A1	EU_13A2	EU_5A1
2014	12%	7%	39%	41%	1%
2015	14%	12%	14%	60%	0%
2016	42%	28%	26%	5%	0%

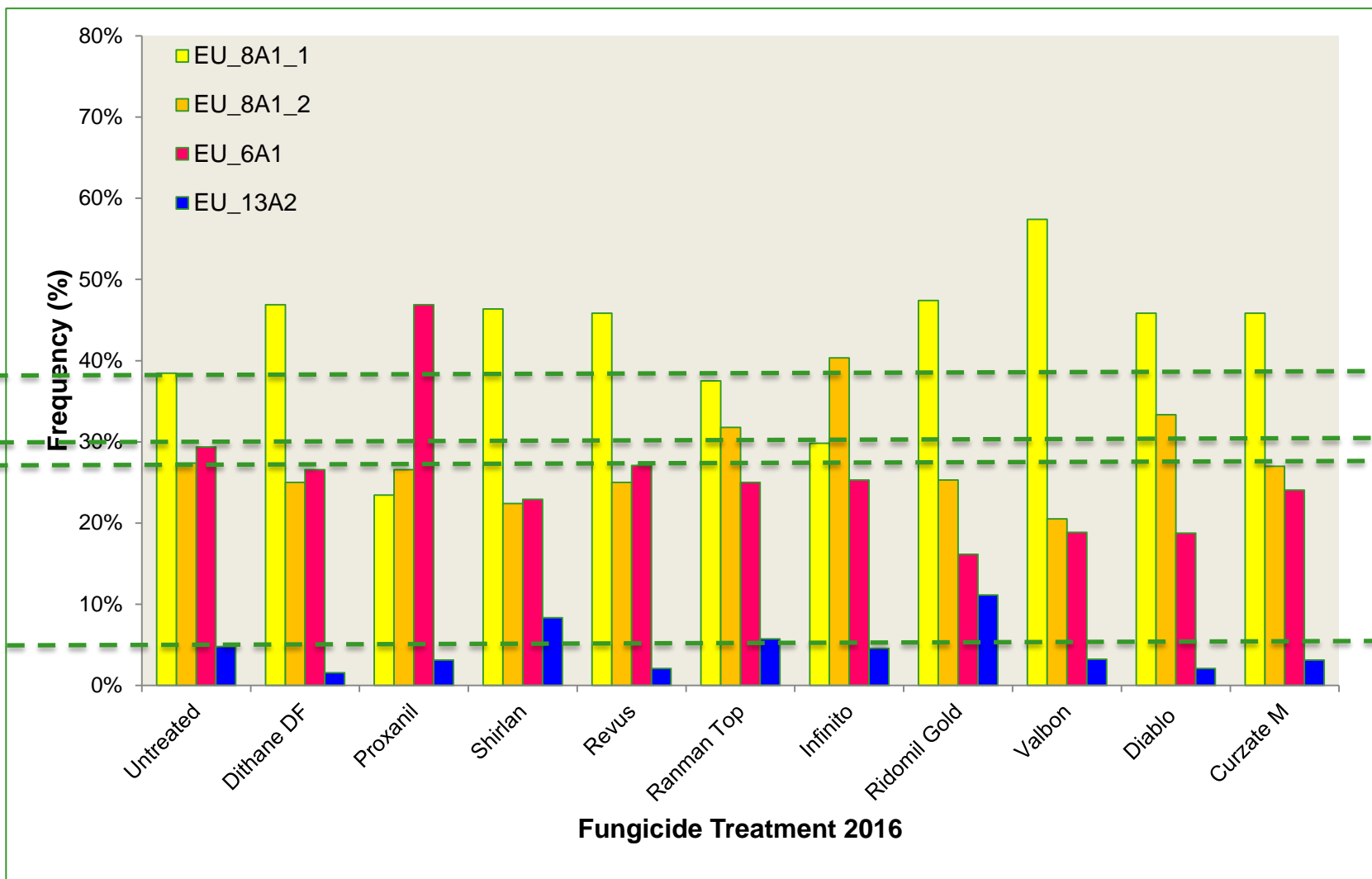
Frequency of 12 plex SSR loci from *Phytophthora infestans* samples in fungicide treated plot 2014



Frequency of 12 plex SSR loci from *Phytophthora infestans* samples in fungicide treated plot 2015



Frequency of 12 plex SSR loci from *Phytophthora infestans* samples in fungicide treated plot 2016



Conclusions

- Irish population remains clonal.
- The population structure was shown to be year dependant.
 - 2014: EU_6A1 and EU_13A2
 - 2015: EU_13A2
 - 2016: EU_8A1_1
- High frequency of 8_A1 which can be divided into 2-subgroups.
- The frequency of EU_8A1_1 and EU_8A1_2 in the population is increasing yearly.
- All treatments were affected by each genotype present within the trial site in 2015 and 2016.

Acknowledgments

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