Project number: 5373
Funding source: Teagasc
Date: September 2012
Project dates: Jan 2005 – Sep 2008

Strategies for the control of Potato late blight caused by *Phytophthora infestans* (Mont.) de Bary

Key external stakeholders:
Potato growers. Retail trade and potato consumers

Practical implications for stakeholders:
Potato late blight is the most destructive disease of potato worldwide. This project examined the physiological characteristics of late blight genotypes in the 2007 population. These characteristics included mating type, resistance to the fungicide metalaxyl and also the ability of late blight isolates to overcome known resistance genes (Blacks differential indicators R1-11) present in cultivated potato. This information ensures that fungicides are used appropriately and informs potato breeders about the durability of resistance genes to blight for use in potato breeding strategies. The ability to increase the interval between fungicide applications was also examined which would represent a significant saving to growers if feasible.

Main results:
Physiological race characterisation showed very little change from a previous survey conducted in 1996. Of 11 known resistance genes (Blacks differential set) virulence was found to all genes. The most common race in Ireland is 1, 3, 4, 7, 10, 11, while races pathogenic on R2, R6, R8 and R9 were very rare. Only one isolate was found which could overcome the R9 indicator. No A2 mating type isolates were found during this survey period. Metalaxyl resistance was confirmed to be extremely low validating the continued use of this fungicide up to 2007. Trials undertaken comparing the efficacy of applying blight fungicides at seven or ten day intervals showed reducing the spray interval delayed the onset of disease, reduced the level of foliage blight at the end of the season but only had a slight positive effect on tuber yield.

Opportunity / Benefit:
Confirmation that certain R genes still confer useable resistance to late blight and may be used in potato breeding for resistance breeding strategies. Confirmation that the A2 mating type remains absent from the population up to 2007 reduces the possibility of emergence of fitter strains by sexual recombination. Additionally the project shows the potential to decrease the number of fungicide applications when weather permits.

Collaborating Institutions:
None

Contact Denis Griffin Email: Denis.griffin@teagasc.ie.

Teagasc project team: Mr Leslie Dowley (PI)
Dr. Denis Griffin
External collaborators: N/A

1. Project background:

Potato late blight, caused by the oomycete fungus Phytophthora infestans (Mont.) de Bary, is the most destructive disease affecting the potato worldwide. Annual losses in Ireland have been estimated at €10.2 m. Disease control requires regular application of fungicides at high rates and short intervals throughout the growing season. P. infestans is a fungus which is constantly changing. There is evidence that the fungus is becoming much more complex in terms of physiological race specialisation while resistance to the phenylamide fungicide metalaxyl was confirmed in 1981. The existence of a second (A2) mating-type was confirmed in 1989. This could lead to increased virulence and aggressiveness through sexual hybridisation. Regular monitoring of the population for physiological race specialisation, fungicide resistance and mating-type is required so that the most appropriate control measures can be put in place.

Current disease control relies almost exclusively on the routine application of a wide range of different fungicides. Metalaxyl has been a mainstay of control programmes in the past and because of its systemicity and known resistance risk has been used primarily early in the season to protect rapidly growing crops and reduce selection for resistant strains. However with a rapidly changing population, the efficacy of this fungicide in controlling P. infestans needs to be continually assessed so that most effective products can be chosen.
Conventional potato crops rely on up to 15 fungicide applications in a season. Given work constraints and weather conditions many growers spray their crops on a weekly basis to ensure good protection from late blight. The frequency of spraying has increased over time. Experiments were conducted to examine the efficacy of two different protectant fungicide products Dithane and Shirlan (mancozeb and fluazinam respectively) applied at seven and ten day intervals on disease control.

2. Questions addressed by the project:

Determining phenotypic variation in the Irish population of *Phytophthora infestans* in relation to phenylamide resistance, physiological race specialisation and mating-type during the project period 2005-2007 and assess the impact of the findings on disease control.

Examine if an increase in spray interval from seven to 10 days is feasible examining two commonly used protectant fungicides.

3. The experimental studies:

Samples of late blight from infected commercial potato crops around the country were sent by Teagasc potato advisers and Department of Agriculture potato inspectors during 2007 to Teagasc Oak Park for characterization. Blight was isolated into pure culture and subjected to mating type determination by pairing the isolates with known A1 and A2 mating types and examining the cultures for oospore production. Isolates generally only produce oospores with opposite mating types. Spore suspensions of the bulk samples of late blight infected foliage from the fields were inoculated onto leaf discs of potato floating on three different concentrations of metalaxyl (0, 5 And 100 ppm). Resistant isolate were able to grow on all levels while sensitive strains could only grow on the 0 concentration. Isolates were also inoculated onto detached leaflets of potato varieties known to contain individual resistance genes to late blight (Blacks differential indicators containing genes R1-11). The race or virulence spectrum (ability to overcome resistance genes) was recorded for each isolate tested.

To determine the effect of increasing spray intervals form seven to ten days, fungicide trials were undertaken. The foliage susceptible cultivar Rooster was used in trials conducted at Oak Park Research Centre, Carlow from 2002 to 2007. This variety is moderately susceptible to foliage blight and has a resistance rating of 5 on a scale of 1 to 9 (Dowley *et al*., 2008). The design for each trial was a randomized complete block with 5 treatments and 4 replications per treatment. The five treatments were an unsprayed control, 7 and 10-day programmes using the protectant fungicide mancozeb as well as 7 and 10-day programmes using the protectant fungicide fluazinam.

Contact Denis Griffin Email: Denis.griffin@teagasc.ie.

4. Main results:

Physiological Races
Eighty five isolates of P. infestans were tested for physiological race specialization. A total of 21 different physiological races were identified compared with 16 in 1986 and 4 in 1981. Two new virulence genes (8 and 9) were identified in Irish isolates of *P. infestans* for the first time in 2007. The most complex race contained all 11 virulence genes and the least complex contained 4 virulence genes. This is the first record of a race with all resistance breaking genes being confirmed in Ireland. The least complex races also contained two more virulence genes than in the previous year. This confirms that the physiological races of *P. infestans* in Ireland have become more complex.

Metalaxyl resistance
A total of 91 isolates were tested for resistance to the phenylamide fungicide metalaxyl, of which 13 isolates (14%) were resistant. However, of the 91 isolates tested, 14 came from outside the Republic of Ireland and of these 64% were resistant to metalaxyl. In the remaining 77 isolates from the Republic of Ireland, only 5% were shown to be resistant to metalaxyl. This confirms the continued downward trend in the % metalaxyl resistance in Irish isolates from recent years. Of the resistant isolate 50% contained a virulence gene for R2.

Mating type
During 2007 a total of 65 isolates were tested for mating type. All isolates were confirmed to be of the A1 mating type.

Effect of increasing the spray interval from seven to ten days.

Shirlan performed better than Dithane at both spray intervals resulting in less foliage and tuber blight at the end of the season. Shirlan at seven day intervals was the most effective treatment in the trials. The effect of increasing spray interval was consistent for both fungicides. Reducing the fungicide application window to seven days also gave better disease control by reducing the total level of foliage blight in the trials throughout the season and by delaying the onset of disease. The effect on total yield at the end of the season was small. However, given the vagaries of the Irish climate the risk of spraying at ten day intervals cannot be discounted. This data does suggest that when weather conditions are favourable spray intervals can be stretched to ten days.

5. Opportunity/Benefit:

The low frequency of the R genes R2, 6, 8 and 9 suggest these may be viable targets for potato breeders to incorporate in new varieties. The non detection of the A2 mating type and the low level of Metalaxyl resistance suggest the population has remained relatively stable and also this validated the continued use of Metalaxyl on potato crops up to 2007. The comparison of seven and ten day fungicide spray intervals shows superior control of blight by the seven day regime but small differences in total and marketable yield. This suggests that intervals may be extended however given the unpredictable nature of the Irish weather this should only be done during periods of dry weather when the crops has already received a number of fungicide applications.

6. Dissemination:

A late blight technical control manual was published as part of this project. The results were also disseminated at a major potato open day in Oak park on September 30th 2008.

Main publications:

Dowley, L.J., Grant J., and Griffin, D. 2008. Yield losses caused by late blight (*Phytophthora infestans (Mont.) de Bary*) in potato crops in Ireland. Irish Journal of Agricultural and Food Research 47: 69–78, 2008

Andrivon, D., Avendaño-Córcoles J., Cameron, A. M., Carnegie, S. F., Cooke, L.R., Corbière, R., Detourné, D., Dowley, L. J., Evans, D., Forisekova, K., Griffin, D. G., Hannukkala, A., Lees, A. K., Lebecka, R., Niepold, F., Polgar, Z., Shaw, D. S., Thompson, J., Trognitz, B., van Raaij, H. M. G. and Zimnoch-Guzowska, E. 2011 Stability and variability of virulence of *Phytophthora infestans* assessed in a ring test across European laboratories. Plant Pathology. 60: 556-565

Contact Denis Griffin Email: Denis.griffin@teagasc.ie.

Popular publications:

Potato Late Blight Control Technical Manual. 2008. L. J. Dowley, D. Griffin and M. Hennessy. ISBN 1-84170-505-5 Teagasc, Crops Research Centre Oak Park.

7. Compiled by: Denis Griffin

Contact Denis Griffin Email: Denis.griffin@teagasc.ie.