The effects of late blight (Phytophthora infestans) on taewa Māori

N. Roskruge[1] and J. Anderson[2]
[1]Institute of Natural Resources, Private Bag 11-222, Massey University, Palmerston North 4442, New Zealand
[2] The New Zealand Institute for Plant & Food Research Limited, Pukekohe Research Centre, 49 Cronin Road, RD1, Pukekohe, New Zealand

Abstract

Taewa Māori or Māori potatoes have been maintained by Māori in private gardens for at least the last 200 years and there is some assumption this may have nurtured a natural tolerance to some pests and diseases. Some observers consider that the purposeful annual selection of seed stock for taewa by non-commercial producers over many generations may have unwittingly yielded desirable traits such as a better tolerance to key diseases including late blight (*Phytophthora infestans*). Four cultivars of taewa Māori, *Huakaroro, Karupārera, Tūtaekurī* and *Moemoe* were submitted to the national late blight trials at Crop & Food Research Ltd (now Plant & Food Research Ltd), Pukekohe for the 2008 and 2010 seasons. The four cultivars were scored for the level of late blight incidence over a six week period. Based on the mean scores achieved these varieties all indicated a level of natural resistance to *P. infestans* over and above the level of resistance seen in some other popular varieties of potato in New Zealand. They were more susceptible to the disease however than two prominent commercial varieties *Rua* and *Moonlight,* both recognised as having high resistance to the disease. There was no notable difference between the four varieties themselves for their resistance to the disease and this aspect agrees with earlier laboratory based trials that investigated the individual traits of these taewa varieties in response to late blight.

Additional keywords: potato, disease severity, blight resistance

Introduction

Taewa Māori or Māori potatoes (*Solanum tuberosum* ssp. *andigena*) have been grown in New Zealand for at least 200 years. Primarily they have been maintained year-by-year by Māori communities in home or marae (communal) gardens. During the early colonisation period (1830-1860) Māori were providers of these potatoes to new and fast developing towns such as Nelson and Auckland (Roskruge, 2007), however the land wars of the 1860s saw the demise of any commercial production of this crop by Māori. In the last ten years there has been a renaissance in the niche market opportunities of crops such as taewa Māori and the consumer is now much more aware of them, making their availability as both seed for home gardeners and produce for restaurants, farmers-markets and supermarkets more desirable. The primary difference between taewa and the modern potato is captured in their subspecies nomenclature and lies in their

physical characteristics such as having many eyes on the tuber, usually quite deep compared to modern varieties, a mix of skin and flesh colours and generally being smaller in size and less productive. Taewa Māori are classified as *S. tuberosum* ssp. *andigena.* Modern potato cultivars (*S. tuberosum* ssp. *tuberosum*) have been bred for their specific qualities around size, shape, cooking and processing qualities and suitability for production.

As taewa have been maintained in private gardens for the last 200 years, there is some assumption by contemporary horticulturists that this may have nurtured a natural tolerance to some pests and diseases introduced to New Zealand in the last 160 years that now affect potato crops. One major disease worth noting is late blight (*Phytophthora infestans*) which has been occasionally noted as seriously affecting taewa Māori crop (Late blight is translated in Te Reo Māori as *'Kōaro ki muri'.* Earlier English translations use the term *'Te Paraiti'*). Some observers consider that the purposeful annual selection of seed stock for taewa by non-commercial producers for so many generations may have unwittingly yielded desirable traits such as a better tolerance to key diseases including late blight. There has been no research thus far to investigate this hypothesis and so an initial trial has been undertaken to evaluate the rate of late blight infection on taewa when compared to modern potato cultivars.

Late blight is the most important economic and potentially severe disease of potatoes which has the capacity to cause heavy yield losses of up to 100% (Stevenson *et al.,* 2001). Oyarzun *et al.* (2001) note that the *andigena* sub-species of potatoes are generally late producing cultivars, hardy but highly susceptible to this disease; this is compounded by the many cultural management options applied to crops by traditional communities across South America and the new 'races' of the disease now arising. Further there is the potential for these races to display more aggressive infection processes or fungicide resistance. Huarte (2003) identified that there are many scores of 'native potatoes' which have good late blight resistance however the science community is still studying the interaction between these genotypes and the environment around late blight and so their resistance traits are not yet fully understood.

The issue of late blight affecting taewa crops is not new. Harris (2006) wrote of a minor late blight epidemic in New Zealand during the 1905-1906 season(s) which affected both the European and Māori potato crops. Māori referred to this disease as *Te Paraiti*, a transliteration of the term 'blight'. Late blight has been evident in New Zealand for almost as long as the modern potatoes have been grown here, certainly from the mid-nineteenth century onwards. It is a disease that is climatically driven and is favoured by mild humid conditions across all regions of New Zealand. In New Zealand epidemics can potentially occur at any stage of the crop growth cycle.

There is some expectation that taewa or Māori potatoes may have a level of natural resistance to this disease due to natural selection over the past 200 years. This is the first time taewa have been included in the national late blight trials at Crop & Food Research Ltd (now Plant & Food Research Ltd), Pukekohe. Earlier work had looked at the susceptibility of some taewa varieties to late blight in a controlled laboratory environment (Long and Roskruge, 2005). Results of this earlier experiment indicated no significant difference in the rate of

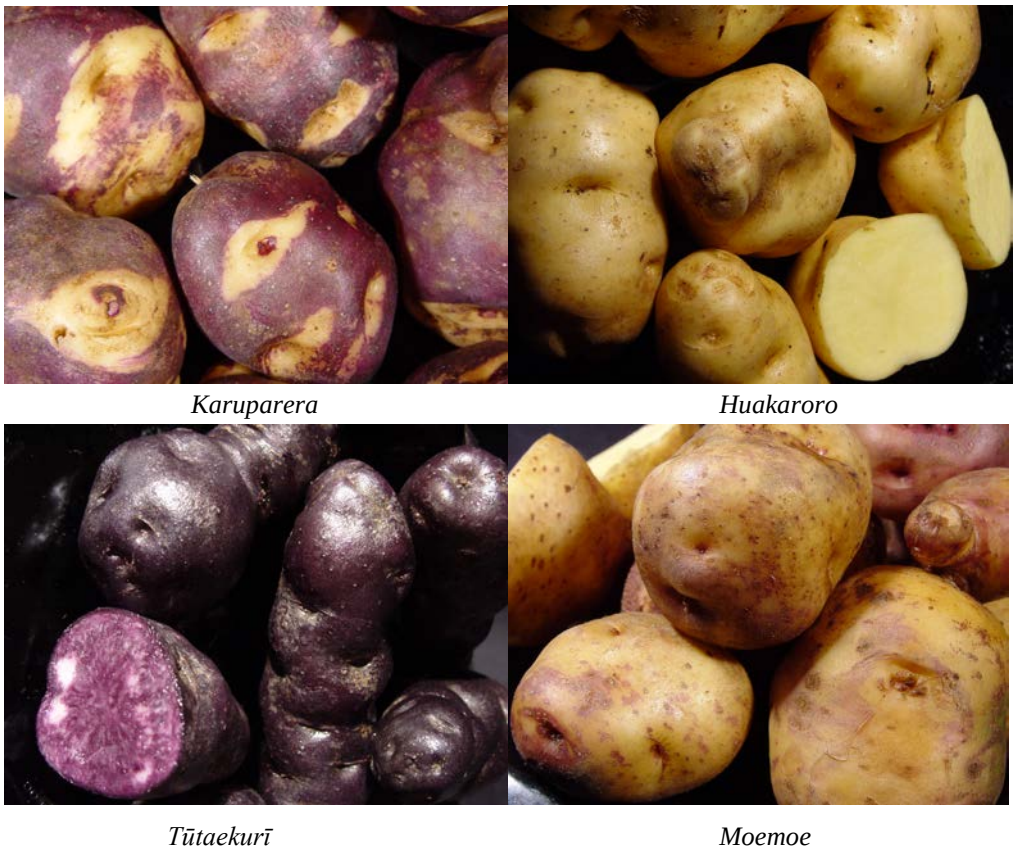
resistance to the disease under those conditions between four taewa varieties and the modern cultivar *Rua*.

Materials and Methods

Four cultivars of taewa Māori (*S. tuberosum* ssp. *andigena*) were submitted to the national late blight trials undertaken by the then Crop & Food Research Ltd (now Plant & Food Research Ltd), Pukekohe for the 2008 and 2010 seasons. They were *Huakaroro*, a yellow skin/yellow flesh variety; *Karupārera*, purple skin/white flesh; *Tūtaekurī*, purple/blue skin and flesh colour; and *Moemoe*, multi coloured skin with creamy patterned flesh (Plate 1).

The Pukekohe trials are a biennial field screening trial for resistance to late blight and have been carried out for over twenty years. Trials are laid out as Latinised row and column design in a single rectangular array of plots, indexed by rows and columns. In each trial, disease severity based on the percentage of affected foliage is repeatedly assessed on a 1-9 ordinal scale from the first sign of infection and at subsequent occasions. The soil type for all trials at the Pukekohe Research Station is a Patumahoe clay loam. The overall results from the full trial were analysed using standard ANOVA statistical processes.

Plate 1: The four varieties of taewa Māori submitted to trials



Sixteen seeds of each variety; all sourced from the virus-free seed stock through Massey University, were planted in the trial. In the 2008 trial 98 varieties of potato were

planted in the paddock and scored simultaneously. The trial was planted on 1 November 2007 and scoring for late blight undertaken fortnightly beginning on 11 January 2008 then 25 January 2008 and 11 February 2008. The 2010 trial involved 95 potato varieties in total. The trial was planted on 19 September 2009 and scoring undertaken fortnightly beginning on 15 December 2009 through to 14 January 2010. The crop was allowed to grow unabated during the period of the trials so the spread of the disease could occur naturally and then be evaluated. Weather conditions play an important role in the manifestation and spread of late blight and impact naturally on the rate of disease spread onto this crop however, as all varieties were subject to the same weather and disease exposure in the paddock the scores are representative of the environment across all varieties. Both seasons were conducive to late blight conditions although the 2008 season was delayed considerably due to wet ground conditions.

The scoring is based on a subjective assessment across all trials where zero (0) is 100% defoliation due to late blight infestation and nine (9) represents no late blight at all (Table 1).

As all varieties are planted in the same trial it is assumed they are all exposed to the same level of the pathogen which is allowed to occur naturally. A total score was then calculated for the three assessments; therefore a score of 0-1 indicating the variety succumbed to maximum late blight infestation and a score of 27 indicating no late blight effect whatsoever.

Table 1: Assessment criteria for late blight trials

Score	Disease symptoms visible
9	No visible symptoms
8	< 10% necrotic tissue
7	11 – 25% necrotic tissue
6	26 – 40% necrotic tissue
5	41 – 60% necrotic tissue
4	61 – 70% necrotic tissue
3	71 – 80% necrotic tissue
2	81 – 90% necrotic tissue
1	> 90% necrotic tissue
0	Dead

For the purposes of the trial the variety *Ilam Hardy* which is considered to have a moderate level of resistance to *P. infestans* was used as the benchmark variety against which the natural resistance was assessed.

Results

The results are summarised in Table 2 where averages of total scores for a number of cultivars of potatoes well known in the New Zealand market are given alongside those for the taewa varieties. The rating value is against the score aligned to the *Ilam Hardy* variety.

The $LSD_{0.05}$ value of 2.6 (Table 2) indicates all the taewa varieties were marginally less affected by the disease than the benchmark cultivar and that there is little difference between taewa cultivars. In addition, they fall slightly outside the CV when compared to the threshold value applied to *Ilam Hardy;* indicative of them as marginally less affected by the disease but providing no conclusive evidence of late blight resistance.

Table 2: Late blight trial results 2008-2010

Name	Accumulated blight resistance score	Relative rating
Rua	23.4	137.6
Moonlight	21.1	124.1
Huakaroro	**20.7**	**121.8**
Tūtaekurī	**19.8**	**116.5**
Desiree	19.4	114.1
Karupārera	**19.2**	**112.9**
Moemoe*	**18.9**	**111.2**
Nadine	17.2	101.2
Ilam Hardy	17.0	100.0
Agria	16.9	99.4
Russet Burbank	12.7	74.7

$LSD_{0.05}$ = 2.6; $LSD_{0.01}$ = 3.4; Coefficient of Variation (CV) = 8.9%
*Moemoe included in 2008 trial only.

Discussion

In general, all four taewa varieties were marginally less affected by the late blight than the benchmark variety *Ilam Hardy* and scored similar results with *Karupārera* and *Moemoe* appearing to be slightly more susceptible than the other two but at no statistically significant level. All four cultivars scored closely to the popular variety *Desiree* but not as well as *Rua* and *Moonlight* (Figure 1). This would indicate from initial studies that they have some natural resistance to the disease but not generally any higher than many common varieties produced commercially. It is worth noting however, as the cultivars of Māori potato have not been bred for any resistant behaviour hence they may have some inherent levels of 'natural resistance' developed over time.

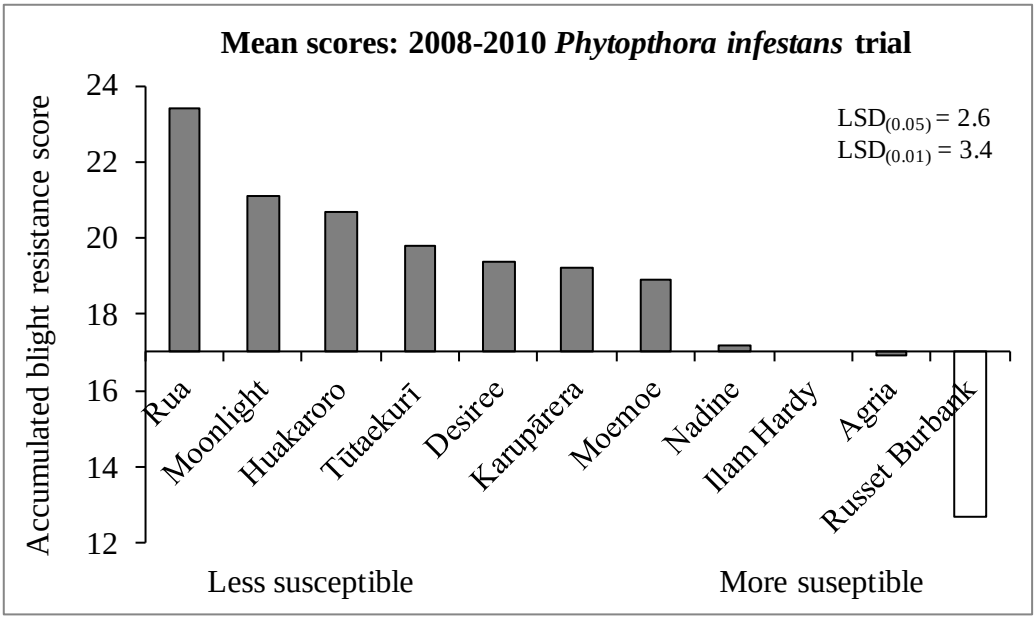


Figure 1: Accumulated blight resistance scores - taewa Māori cf. modern potato cultivars

The results were also consistent with the earlier laboratory experiment by Long and Roskruge (2005) which found no significant difference in disease resistance to *P. infestans* between the four taewa varieties included in this trial. In each case the rate of spread of the disease was consistent across varieties though the *Tūtaekurī* variety was found to be slightly later in succumbing to the disease, even later than *Rua* which was used as the comparative European potato variety.

Summary

Because taewa have been maintained privately for at least the last 200 years there is some assumption this may have nurtured a natural tolerance to some pests and diseases including late blight. Some observers consider the purposeful selection of seed stock for taewa annually by non-commercial producers for so many generations may have unwittingly yielded desirable traits such as a better tolerance to key diseases including late blight.

The scores for the rate of disease incidence on the four cultivars of taewa Māori all indicate a recognisable level of natural resistance to *P. infestans* over and above that seen in some other popular varieties of potato in New Zealand. They were more susceptible however to the disease than two prominent potato varieties; *Rua* and *Moonlight.*

These results represent only two years of trials and need to be interpreted as an initial observation around these varieties of taewa rather than a definitive outcome.This trial will need to be repeated over future seasons and some further work around the rate and severity of disease incidence is required to consolidate the results and allow their dissemination to growers of this crop.

References

Harris, G. 2006. Te Paraiti; the 1905-1906 potato blight epidemic in New Zealand and its effects on Māori communities, Te Whakatū Kōrero Working Papers, NZ Open Polytechnic, Wellington, New Zealand. 104 pp.

Huarte, M. 2003. Levels of resistance to Late Blight in Latin America. pp57-64. *In*: Proceedings of the International Workshop on Complementing Resistance to Late Blight (*Phytophthora infestans*) in the Andes,13-16 February, Cochabamba, Bolivia.

Long, P. and Roskruge, N. 2005. Tracking the natural resistance of three Māori (relict) potato varieties to late blight (*Phytophthora infestans*). Massey University Report. 7 pp.

Oyarzun, P.J., Taipe, J.A. and Forbes, G.A. 2001. *Phytophthora infestans* Characteristics and activity in Ecuador: country profile. pp. 15-26. *In*: Proceedings of the International Workshop on Complementing Resistance to Late Blight (*Phytophthora infestans*) in the Andes. 13-16 February, Cochabamba, Bolivia.

Roskruge, N. 2007. *Hokia ki te whenua*, PhD Thesis, Massey University, Palmerston North, New Zealand. 283 pp.

Stevenson, W.R., Loria, R., Franc, G.D. and Weingartner, D.P. (Eds). 2001. *Compendium of Potato Diseases*, American Phytopathological Society, Minnesota, United States of America. 106 pp.