

Disease Note: First Records of Potato Late Blight Caused by *Phytophthora infestans* in Bolivia

Mario Coca Morante*

Laboratorio de Fitopatología, Departamento de Fitotecnia y Producción Vegetal, Universidad Mayor de San Simón, Cochabamba, Bolivia

Abstract

Late blight, caused by the oomycete *Phytophthora infestans*, is one of the most destructive of all potato diseases. In the Bolivian Andes, it is common, but this does not seem to have always been the case. The aim of the present work was to review the historic literature to produce a record of the disease in Bolivia. No mention of late blight appears in any 19th century document. Indeed, the earliest mention of the disease is from 1943. Late blight would therefore seem to be a relatively new disease in Bolivia.

Keywords: Late blight; Wild potatoes; Cultivated potatoes

Introduction

Late blight, caused by the oomycete *Phytophthora infestans* Mont. de Bary, is historically one of the most destructive of all potato (*Solanum tuberosum* L.) diseases. In the Bolivian Andes, it causes important potato losses at altitudes of 2000-3500 m, between which the climatic conditions are suitable for its development. The traditional potato-growing area of the Department of Cochabamba is commonly affected (Figure 1). If control measures are not taken (mainly the use of fungicides), losses can be severe. In recent times it has shown the re-emergence of this disease by finding new more aggressive populations, for example, resistant to fungicides fenilalamides as Ridomil (Metalaxyl-Mefenoxam) [1,2]. The Andean countries, including Bolivia, have significant value in studies related to the biology and epidemiology of *P. infestans* and its implications at local, regional and global levels for the management of late blight of potato (*S. tuberosum* L.) and tomato (*Solanum sculentum* L.). During part of the nineteenth and twentieth centuries, expeditions and botanical collections of cultivated and wild potato species for different regions of the Andean area of Bolivia, with the purpose of taxonomic studies and other scientific interest were made. The question remains, however, as to when late blight first appeared in Bolivia. Though it is certainly a serious pathogen in the country today, it is unclear when it first arrived. The present work reviews the historical literature to provide a record of potato late blight in Bolivia.

Materials and Methods

During the 19th and 20th centuries, many botanical expeditions to the Andes were undertaken, and collections made of wild and cultivated potatoes from different parts of Bolivia. An exhaustive review was made of the scientific literature from this period to the present, and any mention of potato blight recorded.

Results

The historical literature was found to contain little information on potato late blight in Bolivia.

1800-1900

No 19th century record of potato late blight was found. The oldest information on potato collection from this period records the botanical expeditions of Alcides D'Orbigny [3]. Among the forms collected was a wild potato from near the town of Chuquisaca, which was later described by Michel F Dunal as *S. boliviense* Dunal. Later, between 1855 and 1861, Gilbert Mandon collected wild potato specimens in the area of Valle de Sorata (Province of Larecaja in the Department of La Paz);

these were eventually described as *S. candolleianum* Berthault (by Pierre Berthault in 1911), *S. circaeifolium* Bitter (by George Bitter in 1912), and *S. Boliviense* ssp. *virgultorum* (by Bitter in 1913, later revised as *S. virgultorum* (Bitter) Cárdenas and Hawkes). None of these collectors, however, mention late blight. A little later, in 1883, Luis Felipe Guzmán published information on his collection of wild potatoes in a booklet entitled *Vida campesina* (produced in Cochabamba in commemoration of the centenary of the birth of Simón Bolívar) [4]. However, he makes no mention of late blight either [2]. Finally, in 1891, Miguel Bang, who spent several years in Bolivia at the end of the 19th century, collected a wild potato species near Cochabamba that was later classified as *S. brevicaule* Bitter (described by Bitter) [5]. But just like those before him, Bang makes no mention of late blight.

1900 to the present

Wild potatoes: In the 20th century, a number of expeditions were made to the Bolivian Andes, during which wild potatoes were collected [3,6]. Karl Fiebrig and Otto Buchtien toured the area in 1903-1904, as did Juzepczuk in mid-August of 1927, Martin Cárdenas and other Bolivian researchers from 1935 onwards, Balls, Gourlay and Hawkes in 1939, Carlos Ochoa and other Bolivian researchers from 1955, Hans Ross, Rimpau and Diers in 1959, Correl, Kenneth S Dodds, Graham Paxman and Heinz H Brucher in 1960, Donald Ugent in 1962, Ochoa, Hawkes, Cribb, Hjerting and Huaman between 1971 and 1981, and Hawkes, Astley, Hjerting, Hondelman, van Harten and van Soest, Huaman and Landeo (of the International Potato Centre), Israel Avilés, Carlos Alarcón, Arturo Moreira and Gerardo Caero in the same period, Spooner, van den Berg, Willman Garcia and Maria Luis Ugarte in 1993 and 1994, and Coca Morante, Ticona, Castillo Plata and Tolin Tordoya between 2001 and 2003 [3,6-9]. Only two references exist, however, to infection of wild potatoes by *P. infestans*. In March 1955, Cardenas [10], recorded a possible sighting during an expedition to collect wild specimens in the Province de Valle Grande (Department of

*Corresponding author: Mario Coca Morante, Facultad de Ciencias Agrícolas y Pecuarias, Mario Coca Morante, Laboratorio de Fitopatología, Departamento de Fitotecnia y Producción Vegetal, Universidad Mayor de San Simón, Cochabamba, Bolivia, Tel: 59144762383; Fax: 59144762385; E-mail: agr.mcm10@gmail.com

Received August 16, 2016; Accepted August 29, 2016; Published August 31, 2016

Citation: Morante MC (2016) Disease Note: First Records of Potato Late Blight Caused by *Phytophthora infestans* in Bolivia. J Plant Pathol Microbiol 7: 374. doi: 10.4172/2157-7471.1000374

Copyright: © 2016 Morante MC. This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.



Figure 1: Map of the Department of Cochabamba, location of the first records of *P. infestans* in Bolivia (white arrows), and main potato production areas (red circles).

Santa Cruz). The observation was made in a damp forest in the region known as “Siberia” (Figure 1). Cardenas [10], writes: “... we discovered another white-flowered wild potato that showed lesions reminiscent of *Phytophthora infestans* infection.” This potato was later classified as *S. cevallos-tovarasii* [7], but was later understood by Ochoa [3] to be a synonym of *S. microdontum* Bitter. In the other instance, Coca Morante et al. [8] recorded late blight caused by *P. infestans* affecting the wild species *S. achacachense* Card. and *S. circaiefolium* Bitter in the area of Sorata-La Paz area (Figure 2).

Cultivated potatoes: Many different varieties of potatoes are cultivated in Bolivia, yet in his work “Clasificación de la papa de Bolivia” (Classification of the Potato in Bolivia), the first to examine the diversity of potatoes cultivated in this country, Cevallos-Tovar makes no mention of late blight [11]. In March 1954, Bell and Alandia [12] indicated that “in a data-collecting expedition to gather information on late blight attack in the extensive cultivated area around Lake Titicaca, no such attack was recorded. Similarly, in 1954, mentioned by Bell and Alandia [13] researchers at the Estación Experimental del Altiplano del Servicio Agrícola Interamericano (High Plains Research Station of the Interamerican Agriculture Service), reported “there are no known instances of late blight attack in these areas [around Lake Titicaca], perhaps because the temperature is too low for infections to be successful. But, in 2004, is mentioned by first time the presence of late blight symptoms in northern Altiplano Experimental Station [14]. (Figures 2A and 2B).

Earlier, however, in 1943, Cardenas [15] had published what would appear to be the first official report of *P. infestans* infection in Bolivia. Writing in the journal *Revista de Agricultura* he noted: “at the

beginning of the present year, a rare epidemic affected the potato crop in Mizque (Figure 1). In but a few days it destroyed the plants of this important tubercle. The Beltsville Research Station of the Department of Agriculture in Washington D.C. confirmed the problem to be caused by *Phytophthora infestans* (Mont.) de Bary”. This identification is supported by the work of May and Ristaino [5], who detected haplotypes of *P. infestans* in herborized specimens from the same area deposited (in 1944, by Cárdenas) in the United States Department of Agriculture National Fungus Collection in Beltsville Maryland (BPI 1944). Indeed, in 1944 Cárdenas [16] reported (again in the *Revista de Agricultura*) the disease to have affected the area anew, as well as other areas of Bolivia and Peru (around Cuzco). Outbreaks then appear to have become more common. In 1949, a botanical collection expedition organised by the Comunidad de Choro (Ayopaya, Cochabamba) reported that “the El Choro Estate hardly produces some thousand ‘cargas’ [1 ‘carga’=approx. 100 kg] of potatoes, and is infested by *Phytophthora*, *Rhizoctonia*, *Spongospora* and viruses” [16] (Figure 1). Observations made in April 1960 further support an increasing presence of the disease. During an expedition to the Provinces of North and South Cinti (Department of Chuquisaca), Cardenas [10], noted the following concerning an estate in the Cupilina area: “... the local headman spoke of the state of abandonment in which that part of the Republic found itself, and he showed me some potatoes infected by *Phytophthora* ... the only clones cultivated in the area were an ordinary variety of *Solanum andigenum* known as Malkachu and a potato imported from Argentina, possibly Kathadin, both of which are sensitive to late blight” [10]. However, the disease did not spread rapidly everywhere. Though the presence of *P. infestans* around Lake Titicaca has been a matter of scientific debate for years, but it was not until 2004 that a few isolated



Figure 2: A: Potato seed production field at the Northern High Altiplano Belén Research Station, 2002-2003; B: Symptoms of late blight on the variety Waych'a (*S. tuberosum* subsp. *andigena*), at the aforementioned site; B. C: *S. achacachense* Cárdenas; D: *S. achacachense* affected by late blight at the base of the stems (red arrows).

cases of late blight were recorded by researchers from the Estación Experimental Belén del Altiplano Norte (Northern High Plains Belén Research Station) (Figures 2A and 2B).

Imported potato varieties: Imports of potatoes to Bolivia from Europe, and other American countries were made in order to improve yield. The first reports are from 1949, when several varieties of *Solanum tuberosum* L. were introduced to the Altiplano Experimental Station (Altiplano region of La Paz Department, 3818 masl) [17]. Between 1958 and 1960, the naturalist professor Martín Cárdenas, reported the introduction of varieties from Belgium, Colombia, Costa Rica, Ecuador, Spain, Mexico, Peru and USA [7]. In 1966 the use of the Dutch varieties Gineke, Mentor, Extase, Désirée, Pimpernel, Radosa, Alpha, Baraka, Realta, Spartan, Multa and Patrones, along with other 22 varieties from other European countries was reported at Altiplano Experimental Station [18]. In 1972-73 another introduction of Dutch varieties (Baraka, Gineke, Monalisa, Spunta, Radosa y Alpha) was registered, accounting to 30 tons of potato intended for cultivation in high land region of Cochabamba (Lope Mendoza, 3000-3200 masl). None of those reports mentioned the presence of *P. infestans*. Later on, in 1984, 200 tons of Dutch potatoes (Cardinal, Diamant, Monalisa, Gigant, Baraka and Alpha) introduced again for the high land region of Cochabamba, but with bacterial infections in the seeds [19]. Finally, between 1985 and 1990 several varieties Monalisa and Spunta (Argentina), ICA Purace, Diacol Capiro and ICA Tequendama (Colombia), Revolución (Peru) [12,19]. *P. infestans* was not reported in none of these last imports.

In conclusion potato late blight caused by *P. infestans* in Bolivia is little mentioned in the historic literature, the first record stemming from 1943 in cultivated potatoes. It would appear that before this time *P. infestans* was not an important pathogen of potato plants in this country, but gradually took hold among cultivated crops.

Acknowledgements

Thanks are owed to Gino Aguirre Villarroel (Dept. of Fitotecnia, Facultad de Ciencias Agrícolas y Pecuarias "Martín Cárdenas", Universidad de San Simón, Cochabamba, Marcelo Huarte (Head of Potato Research at the EEA INTA Balcarce and President of the Latin American Potato Association), José Ignacio Ruiz de Galarreta (Dept. of Plant Production and Protection, Arkaut Centre, NEIKER, Victoria, Spain), and Carmen de Blas (Editor of the Spanish Journal of Agricultural Research, INIA, Spain), for their valuable comments on the manuscript. The author is grateful to Adrian Burton and Alejandro Coca Salazar for language and editing assistance.

References

1. Fry EW, Goodwin SB (1997) Re-emergence of potato and tomato late blight in the United States. *Plant Disease* 81: 1349-1357.
2. Ristaino JB (2012) Worldwide Migrations, Host Shifts, and Reemergence of *Phytophthora infestans*, the Plant Destroyer. In: *Evolution of Virulence in Eukaryotic Microbes*, First Edition. Edited by L. David Sibley. Barbara J. Howlett, and Joseph Heitman. Wiley-Blackwell. Published by John Wiley & Sons, Inc pp: 192-207.
3. Ochoa C (1990) *The potatoes of South América: Bolivia*. Cambridge University Press. Cambridge. New York p: 512.
4. Urquidi A (1984) *University and Ecology (Disquisiciones, reminiscences and clarifications necessary)*. Poligraf graphics workshops. Cochabamba, Bolivia p: 252.

5. May KJ, Ristaino JB (2004) Identity of the mtDNA haplotype(s) of *Phytophthora infestans* in historical specimens from the Irish Potato Famine. Mycol Res 108: 1-9.
6. Spooner DM, van den Berg RG, García W, Ugarte ML (1994) Bolivia potato germplasm collecting expeditions 1993, 1994: Taxonomy and new germplasm resources. Euphytica 79: 137-148.
7. Cárdenas M (1963) Germplasm accumulated potatoes grown in Bolivia during the past six years. Folia Universitaria. Imprenta Universitaria. Cochabamba, Bolivia pp: 58-87.
8. Morante C, Ticona VH, Plata WC, Tordoya IT (2007) Distribution of wild potato species in the north of the Department of La Paz, Bolivia. Span J Agric Res 5: 326-332.
9. Hawkes JG, Hjerting JP (1989) The potatoes of Bolivia: their breeding and evolutionary relationships. Oxford University Press, Oxford.
10. Cárdenas M (1973) Memoirs of a Naturalist: Travels in Los Andes, La Plata, the United States and Europe. Editorial Don Bosco. La Paz, Bolivia p: 442.
11. Ballivian MV, Tovar CW (1941) Historical News and classification of potatoes in Bolivia, Agricultura 3: 1-17.
12. Asociación de Servicios Artesanales y Rurales (1983) Technical Report heights Carrasco project technical activities. Cochabamba, Bolivia p: 23.
13. Bell F, Alandia S (1955) Golden Nematode and other diseases of potato in Bolivia. Folia Universitaria. Imprenta Universitaria. Cochabamba, Bolivia pp: 42-44.
14. Estación Experimental Belén (2004) Technical report of seed potato production higher categories. Faculty of Agronomy, Universidad Mayor de San Andrés. La Paz, Bolivia p: 85.
15. Cárdenas M (1943) Origin of *Phytophthora infestans*. Journal of Agriculture No 1. School of Agronomy of the University of Cochabamba. Cochabamba, Bolivia p: 34.
16. Cárdenas M (1944) Plant Health: Some fungal diseases and entomological observed in Bolivia from 1942 to 1944. Journal of Agriculture of the School of Agronomy of the University of Cochabamba. Cochabamba, Bolivia pp: 39-46.
17. Servicio Agrícola Interamericano (SAI) (1950) Technical report. 1949/1950. Technical Report Experimental Station Altiplano. Servicio Agrícola Interamericano. La Paz, Bolivia.
18. Servicio Agrícola Interamericano (SAI) (1966) Technical report. 1965/1966. Technical Report Experimental Station Altiplano. Servicio Agrícola Interamericano. La Paz, Bolivia.
19. Acción Rural Agrícola Organizado (1985) Progress report production project plan seed potato seed supply emergency IBTA/ARADO. November 1984-June 1985. Cochabamba, Bolivia p: 12.