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A potato collecting expedition in the province of Jujuy, Argentina and disease indexing of virus and fungus pathogens in Andean cultivars

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Abstract

A potato collecting expedition was carried out in the province of Jujuy, Argentina in March 24 to April 15, 2001. The objective was to collect local cultivars of potatoes and wild potato species, covering high mountain valleys not previously collected or areas where germplasm was not available. A total of 247 accessions was collected, 188 cultivated accessions of *S. tuberosum* subsp. *andigenum*, four of *Solanum tuberosum* subsp. *tuberosum*, two of *S. curtilobum* and 53 accessions of wild species. The wild species collected were *S. acaule* subsp. *acaule*, *S. chacoense*, *S. infundibuliforme*, *S. megistacrolobum* subsp. *megistacrolobum*, *S. microdontum*, *S. gourlayi*, *S.* × *viirsooi* and *S. oplocense*. Herbarium voucher specimens were obtained when possible. For the collection of cultivated potatoes, tubers were gathered from farmer's fields and in a few cases from stores or markets. Seed samples were generally obtained for the wild species. Detailed collection site data were recorded at every site. After breaking dormancy, the accessions of the cultivated species were screened for the presence of Potato virus Y (PVY), Potato virus X (PVX), Potato leafroll virus (PLRV), Potato virus S (PVS), Potato virus M (PVM), Potato virus V (PVV), Andean potato latent virus (APLV), Andean potato mottle virus (APMoV), Potato rough dwarf virus (PRDV), Potato spindle tuber viroid (PSTVd) and *Spongospora subterranea* f. sp. *subterranea*. PSTVd, APLV and PRDV were not detected, but different levels of infection are reported for the other pathogens assayed.

Introduction

The tuber-bearing species included in section *Petota* Dumort. contain cultivated and wild species distributed from the southwestern Unites States to central Chile (Hawkes 1990; Spooner and Hijmans 2001). In Argentina, the tuber-bearing species are widely distributed from sea level in the province of Buenos Aires up to 4300 m in the northwestern Andes of Jujuy and from 22° lat. S in the north down to 40°50′ lat. S in the province of Neuquén. According to the phytogeographical areas defined by Cabrera and Willink (1980) the wild species in Argentina are found in the South American Neotropical Region, in the Monte, Pampeana, Prepuneña, Puneña, Chaqueña, Paranense, Espinal, Yungas and Subantartic Woodland provinces.

Wild tuber-bearing species has been reported from the province of Jujuy (Hawkes and Hjerting 1969, 1983; Okada 1979; Cabrera 1983; Okada and Clausen 1982, 1985). At INTA's germplasm collection there is a variable number of accessions collected in the province of Jujuy; the species found are *Solanum acaule* subsp. *acaule* Bitter, *S.*

acaule subsp. *aemulans* (Bitter and Wittm.) Hawkes and Hjert., *S. infundibuliforme* Philippi, *S. megistacrolobum* Bitter, *S.* × *indunii* Okada and Clausen, *S.* × *viirsooi* Okada and Clausen, *S. gourlayi* Hawkes, *S. chacoense* Bitter, *S. vidaurrei*Cárdenas, *S. spegazzinii* Bitter, *S. tarijense* Hawkes, *S. vernei* Bitter and Wittm, *S. okadae* Hawkes and Hjert. and *S. oplocense* Hawkes.

The cultivated short-day adapted species *S.tuberosum* subsp. *andigenum* Juz. and Bukasov is widely distributed in the Andes from Venezuela, through Colombia, Ecuador, Peru, Bolivia and Northwest Argentina (Hawkes 1990). In Argentina, cultivars of this species are grown in the provinces of Jujuy, Salta and Catamarca (Viirsoo 1954a, b; Hawkes and Hjerting 1969; Okada 1979; Clausen 1989). These landraces are grown mainly in the high mountain valleys and quebradas of the Puna and Prepuna phytogeographical areas.

Although Hawkes and Hjerting (1969) reported the presence of other cultivated species such as *S. juzepczukii* Bukasov ($2n = 3x = 36$), *S. chaucha* Juz. and Bukasov ($2n = 3x = 36$) and *S. curtilobum* Juz. and Bukasov ($2n = 5x = 60$) in Argentina, no living collections of these species are held at the Argentinean Genebank. Collecting of both wild and cultivated potatoes has been carried out in a comprehensive way along the whole country (Okada 1976, 1979; Okada and Clausen 1984; Clausen 1989; Spooner and Clausen 1993). As a result of these efforts, wild species as well as local cultivars of *S. tuberosum* subsp. *andigenum*, from the province of Salta, and to a less extent from the province of Jujuy are held at the Genebank of the Instituto Nacional de Tecnología Agropecuaria (INTA), Estación Experimental Agropecuaria Balcarce (Active Genebank) and by the Base Genebank, located at the Instituto de Recursos Biológicos, INTA, Castelar.

The cultivated potatoes have received different taxonomic treatments. They have been classified as species under the International Code of Botanical Nomenclature (ICBN) (Hawkes 1990; Ochoa 1990) and as cultivar groups under the International Code of Cultivated Plants (ICNCP) (Dodds 1962; Huamán and Spooner 2002). Although both classifications are still used, it is likely that Huamán and Spooner's proposal to place all the landraces as cultivar-groups of *S. tuberosum*, may provide a classification of convenience based on user-defined needs. Until we finish the identification and characterisation of this collection we will maintain the species treatment.

The potato cultivars grown in the Andean valleys of Argentina have been reported to be heavily infected by virus. Virus symptoms have been observed in the fields of the Andean farmers and they report low yield in many varieties probably as the result of increasing levels of virus infection as well as other pests in the cultivars planted. On the other hand, Andean virus free cultivars are introduced from Bolivia, replacing the local native varieties.

The main causes contributing to the loss of potato diversity in Northwest Argentina are the changes in agricultural practices, which result in some cases by the replacement of the potato by other crops, pests and diseases of the potato crop and a very low possibility of the use of pesticides. Another cause is the migration of the inhabitants of the Puna and Prepuna towards urban centres in search of a better way of living and a very low possibility to obtain clean potato seed of their local cultivars.

Many viruses have a worldwide distribution (Hooker 1981) while others are restricted to Andean regions. Although many of these pathogens will not usually kill the crop, their presence can result in reduced yields. Assessment of virus infection, cleaning virus infected clones and providing the local farmers with clean potato seed may result in the maintenance of the biodiversity of these agricultural systems.

According to Salazar (1995), the eradication of viruses in plant populations could eliminate a non-specific protection against diseases and eliminate the effect some viruses have on the maintenance of the biodiversity. An example in potatoes is the resistance against infection by late blight in virus-infected plants (Fernández de Cubillos and Thurston 1975). Not all the viruses cause important losses in crop production and their presence could present an advantage. However, more information is needed concerning the variability of the viruses and their use in controlling other diseases.

Powdery scab of potatoes is caused by the infection of tubers by the fungus *Spongospora subterranea* (Wallr.) Lagerh. f. sp. *subterranea* Tomlinson.

This is a disease distributed worldwide and which reduces the quality and yield of the potato (Harrison et al. 1997). In Argentina, it has been reported from the northwestern provinces (Escande, pers. commun; Lucero 1998). This fungus has been identified as the vector of a soilborne virus, the Mop-top furovirus (PMTV) (Jones and Harrison 1969). The long-lived resting spores can persist in the soil and retain the infectious virus for at least a year.

There is an urgent need to collect and preserve these local potato varieties, as a reduction in the number of varieties has already taken place. The objectives of this work are to collect cultivated and wild potato species in areas not previously collected and assess the level of virus and *Spongospora* infection of the cultivated clones collected. The goals established for the coming years are to make available to the farmers clean potato seed of the most important local cultivars.

Materials and methods

Locality data

The collection of the varieties of *S. tuberosum* subsp. *andigenum* were planned according to existing gaps in the germplasm collection from the province of Jujuy, held in the Argentinean Gene Bank. Information concerning potato growing was gathered from areas reported as traditional for the cultivation of Andean potato varieties as well as from marginal sites. The Instituto de Biología de Altura and the Facultad de Ciencias Agrarias of the University of Jujuy and two non-governmental organisations (OCLADE and CARITAS) provided additional information from these areas. For the collection of the wild species, references were gathered from the main Argentinean herbaria, previous collecting reports, literature records (Hawkes and Hjerting 1969; Hawkes 1990; Correll 1962; Okada 1974) and regional floras as well as our database at INTA. For the mapping of localities the topographic map 1 : 250 000 scale from the Instituto Geográfico Militar in Argentina, departmental maps utilised for the registration of properties from the Departments of Cochinoca, Rinconada, Susques and Santa Catalina, as well as available road maps were utilised.

Germplasm collection

The sampling sites of the cultivated potatoes were the farmers' fields where all the varieties under cultivation were sampled; usually 5 or 6 potatoes of each different variety or morphotype were collected. In each valley, 3–4 different farmer's fields were collected and in the search for the wild species, a range of altitudes and sites were explored. The sites were generally reached by truck, walking or occasionally on horse back. For the collection of wild species, true seeds were preferred, although when these were not available, tubers were collected. Longitude and latitude data were obtained by a global positioning system (GPS) and altitude data with an altimeter. Herbarium specimens were made for each germplasm collection.

The vegetative collections of cultivated clones were brought to the EEA Balcarce and transplanted in a greenhouse, after previous treatment with rindite and giberellic acid to break dormancy. After sprouting, each clone was planted and assayed for: Potato virus Y (PVY), Potato virus X (PVX), Potato leafroll virus (PLRV), Potato virus S (PVS), Potato virus M (PVM), Potato virus V (PVV), Andean potato latent virus (APLV), Andean potato mottle virus (APMoV) and Potato rough dwarf virus (PRDV) using DAS-ELISA with polyclonal or monoclonal antibodies (Clark and Adams 1977). Potato spindle tuber viroid (PSTVd) was assayed using NASH (CIP 1993). PRDV polyclonal antibodies (IFFIVE, Argentina) and the poly- and monoclonal antibodies employed for the other viruses (BIOREBA AG, Switzerland) were used according to the manufacturer's instructions. For the detection of *Spongospora subterranea* all the tubers collected were visually inspected for symptoms of the fungus. Identification was checked using DAS-ELISA with a sensitive monoclonal antibody (BIOREBA AG, Switzerland).

Results and discussion

Previous collections of potatoes in Northwest Argentina have concentrated on both wild and cultivated species. The 1989 expedition to the areas of Iruya, Santa Victoria (province of Salta) and Valle Grande (province of Jujuy) included the traditional potato-growing areas of Northwest

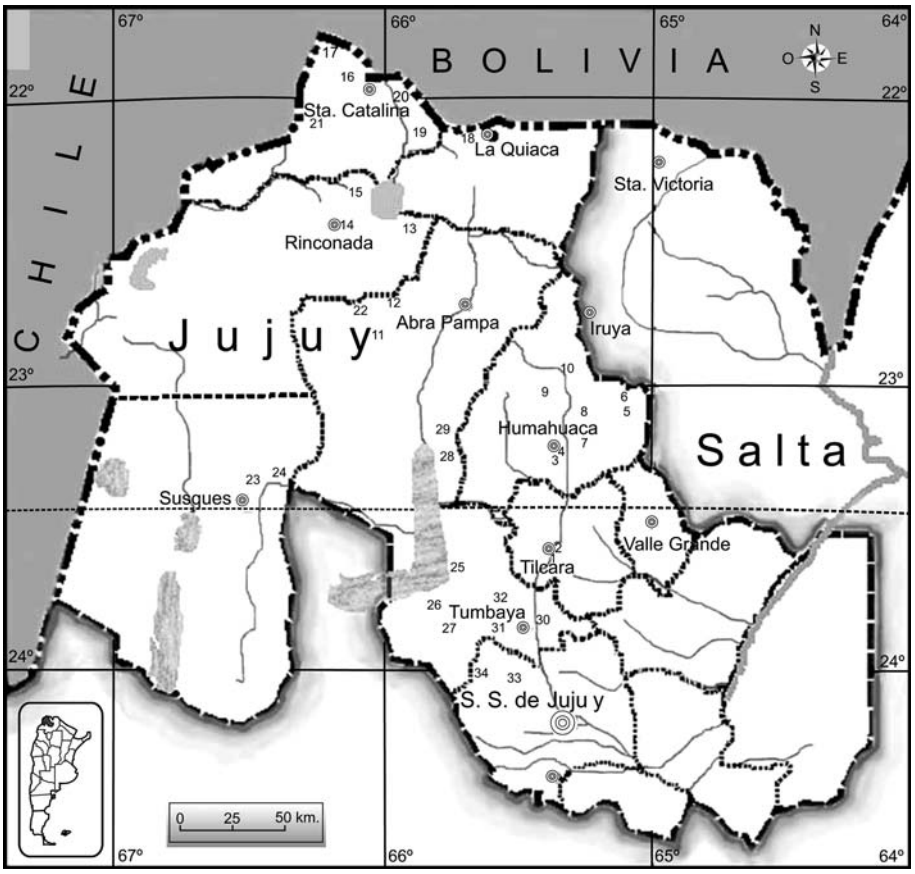

Figure 1. Departments collected in the province of Jujuy, Argentina and generalised collecting areas corresponding to Table 1.

Argentina. The departments explored during this expedition, included areas from which no living collections were held in the genebank. The cultivars, species and number of accessions collected are listed in Table 1 with the numbered main collecting sites, mapped on Figure 1. A summary of the species collected is listed on Table 2.

Wild species

The wild species collected were identified as *S. acaule*, *S. chacoense*, *S. infundibuliforme*, *S. megistacrolobum*, *S. microdontum*, *S. gourlayi*, *S.* × *viirsooi* and *S. oplocense* (Table 1). All these species were collected in the Prepuna and Puna phytogeographical provinces.

S. acaule is a tetraploid rosette-forming species, distributed from Ecuador to Argentina. Two subspecies are known from Argentina, subsp. *acaule* and subsp. *aemulans* (Hawkes 1990) but the accessions collected were identified as subsp. *acaule*. This subspecies is found in humid habitats of the Puna, between 2800 and 4400 m, along streams and in some cases as a weed in potato fields or in disturbed grazed areas. *Solanum acaule* was in a few cases found growing in the vicinity of *S. megistacrolobum*, *S. infundibuliforme* and *S.* × *viirsooi*. This latter species is a natural triploid hybrid of *S. acaule* × *S. infundibuliforme* as shown by Okada and Clausen (1985) and was identified in two sites (Table 1).

S. infundibuliforme is a slender diploid species with small leaves, with the base strongly decurrent on to the stem. It is found in Bolivia and Argentina. According to Hawkes and Hjerting (1989) and Ochoa (1990), the type locality for this species is located in Chile, but this site is now included in Bolivia. However, collecting in Chile would prob-

Table 1. Potato taxa, number of accessions collected, localities and map locations of generalised collection sites.

Species/Cultivars, number of accessions	Department/locality	Map locality	Material collected*
adg**: 'Collareja' (2), 'Rosada'	Tilcara/Maimará; Juella	1	T
adg: 'Ojos colorados'(2), 'Colorada' (2), 'Cuarentona' (2), 'Chacarera' (2), 'Collareja' (2), 'Moradita'; *S. gourlayi*	Tilcara/Alfarcito; Casa Colorada	2	S–T–H
adg: 'Tuni', 'Collareja'	Humahuaca/Uquía; Pucará	3	T
S. infundibuliforme, *S. megistacrolobum*, *S. acaule*	Humahuaca/Humahuaca	4	S–T–H
adg: 'Tuni' (2), 'Overa' (3), 'Chorcoyeña' (4), 'Papa oca' (3), 'Runa' (2); 'Huareña', 'Ojos colorados' (2), 'Azul overa' (2), cur***: 'Luqui'; *S. megistacrolobum* (2), *S. acaule* (2), *S. viirsooi*, *S. infundibuliforme*	Humahuaca/Aparzo; Palca de Aparzo; Varas; Molloj	5	S–T–H
cur: 'Luqui'; adg: 'Blanca', 'Churqueña', 'Colorana'; *S. acaule*	Humahuaca/Cholcán	6	S–T–H
adg: 'Chacarera', 'Runa', 'Ojos colorados', 'Collareja' (2)	Humahuaca/Ocumazo	7	T
adg: 'Chacarera', 'Runa' (2), 'Azul o sayama', 'Tuni', 'Tuni blanca', 'Collareja' (3), 'Colorada' (2), 'Collareja redonda' (2)	Humahuaca/Coctaca; Hornaditas	8	T
S. infundibuliforme (2)	Humahuaca/Quebrada de la Soledad	9	S
S. infundibuliforme, *S. acaule* (2), *S. viirsooi*, *S. megistacrolobum*	Humahuaca/Esquinas Blancas	10	S–T–H
adg: 'Rosada' (2), 'Tuni blanca', 'Tuni'; *S. acaule*, *S. infundibuliforme*	Cochinoca/Tambillos; Casabindo	11	S–T–H
adg: 'Chacarera'	Cochinoca/Cochinoca	12	T
S. acaule, *S. megistacrolobum*	Cochinoca/Chipaite	13	S–H
adg: 'Rosada' (2), 'Ojosa', 'Runa'; *S. infundibuliforme*, *S. megistacrolobum* (2), *S. acaule* (3)	Rinconada/Rinconada; El Cóndor	14	S–T–H
S. infundibuliforme, *S. acaule*, *S. megistacrolobum*	Rinconada/Lagunillas	15	S–H
adg****; *S. infundibuliforme*	Santa Catalina/Santa Catalina	16	S–T–H
adg****; *S. acaule* (2), *S. oplocense* (2), *S. megistacrolobum*, *S. infundibuliforme*	Santa Catalina/El Angosto	17	S–T–H
adg: 'Waich' a', 'Sani '; *S. infundibuliforme*, *S. acaule*, *S. megistacrolobum*	Yavi/La Quiaca; Cuesta de Tosquero	18	S–T–H
tbr*****; *S. infundibuliforme*	Santa Catalina/Cieneguillas	19	S–T–H
adg: 'Collareja' (3), 'Malgacha', 'Imilla', 'Rosada', ' Ojosa' (2) 'Sani', 'Runa', 'Condorilla', 'Yuruma', 'Chacarera'; tbr (2)	Santa Catalina/Casira	20	T
adg: 'Moradita', 'Condorilla', 'Blanca redonda', 'Blanca'; *S. acaule* (2); *S. infundibuliforme* (2)	Santa Catalina/Cabrería; Oratorio	21	S–T–H
adg: 'Collareja redonda' (6), 'Collareja larga', 'Colorada', 'Rosada' (3), 'Moradita', 'Cuarentona'; *S. acaule*	Cochinoca/Agua Caliente, Doncella, Rachaite	22	S–T–H
adg: 'Rosada', 'Malgacha' (2), 'Runa', 'Blanca'; *S. acaule*	Susques/Lapao	23	S–T–H
adg: 'Cuarentona', 'Yaguana'	Susques/Agua Chica	24	T
adg: 'Rosada'	Tumbaya/Tres Morros	25	T
adg: 'Blanca' (4), 'Rosada', 'Cuarentona' (4), 'Collareja' (3), 'Asta de cabra', 'Tuni', 'Overa', 'Runa'; tbr	Tumbaya/El Moreno	26	T
adg: 'Blanca' (3), 'Cuella', 'Tuni', 'Colorada', 'Overa', 'Cuarentona redonda' (2), 'Rosada', 'Asta de cabra'; *S. acaule*	Tumbaya/El Angosto, San José del Chañi	27	S–T–H
adg: 'Collareja Redonda' (2), 'Chacarera'	Cochinoca/Quebraleña	28	T
adg: 'Collareja', 'Moradita'	Cochinoca/Agua de Castilla	29	T
adg: 'Tuni', 'Chacarera' (2), 'Runa'	Tumbaya/Tumbaya	30	T
adg: 'Collareja' (2), 'Churqueña negra', 'Runa' (2), 'Blanca' (4), 'Ojos colorados', 'Tuni blanca' (2), 'Tuni morada' (2), 'Chacarera' (4), 'Tonca'; *S. gourlayi*, *S. infundibuliforme*	Tumbaya/Patacal, Cieneguillas, Estancia Grande	31	T–S
adg: 'Ojos colorados', 'Collareja', 'Chacarera', 'Tuni'	Tumbaya/Cárcel	32	T

Table 1. Continued.

Species/Cultivars, number of accessions	Department/locality	Map locality	Material collected*
adg: 'Colorada', 'Overa' (2), 'Chaqueña' (2), 'Cuarentona', 'Cuarentona morada' (4), 'Cuarentona rosada', 'Blanca', 'Ojos colorados', 'Cuella', 'Chacarera', 'Rosada'; *S. microdontum*, *S. chacoense*	General Belgrano/Quebrada del río León, Papachacra	33	S–T–H
adg: 'Cuarentona', 'Cuella' 'Chacarera', 'Collareja redonda', 'Colorada boliviana', 'Rosada' (2), 'Imilla'	General Belgrano/Cuevas	34	T

* Seeds (S); Tubers (T); Herbarium (H); adg**: *S. tuberosum* subsp. *andigenum*; cur***: *S. curtilobum*; adg****: cultivar not identified; tbr*****: *S. tuberosum* subsp. *tuberosum*.

Table 2. Summary of species collected.

Species	Number of accessions
S. tuberosum subsp. *andigenum*	188
S. tuberosum subsp. *tuberosum*	4
S. curtilobum	2
S. acaule subsp. *acaule*	20
S. chacoense	1
S. gourlayi	2
S. infundibuliforme	15
S. megistacrolobum subsp. *megistacrolobum*	10
S. microdontum	1
S. oplocense	2
S. × *viirsooi*	2

ably indicate its presence there also. In Argentina its distribution is restricted to the provinces of Jujuy and Salta, between 2300 and 4300 m, on very dry hillsides of the Puna and Prepuna. Frequently it grows in the vicinity of *S. gourlayi*.

S. megistacrolobum is a diploid species with a rosette habit found from southern Peru to Northwest Argentina. It grows in humid habitats of the Puna and Prepuna generally between 2700 and 4300 m in the provinces of Jujuy and Salta, in sandy or stony places frequently close to streams or in the proximity of cattle enclosures. In Jujuy and Salta grow *S. megistacrolobum* and *S. toralapanum*, according to Hawkes and Hjerting (1989) or *S. megistacrolobum* subsp. *toralapanum* (Ochoa 1990; Giannattasio and Spooner 1994). The accessions collected were identified as subsp. *megistacrolobum*.

S. gourlayi was collected at several sites, between 2845 and 3360 m, growing among Bromeliaceae and columnar cacti, on dry hillsides. This species has been described for Bolivia and Argentina and both diploid and tetraploid populations have been reported for the province of Jujuy (Clausen and Okada 1987). This species has received different taxonomic treatments according to Correll (1962), Ugent (1966), Hawkes (1990), Ochoa (1990), Van den Berg (1996, 1998) and Miller and Spooner (1999) re-examined all the species included in the *S. brevicaule* complex which includes *S. gourlayi* and *S. oplocense* and stated that of the 30 species included in the complex, only two species are well defined; one of which is *S. oplocense*. Spooner and Hijmans (2001), in the latest revision of the tuber bearing *Solanum* species, accept the treatment of *S. gourlayi* as synonym of *S. leptophyes* Bitter (Ochoa 1990), but citing this species only from Bolivia. We have an important number of accessions identified as *S. gourlayi* from Argentina according to Hawkes (1990) but it is likely that we may change our identification of all these accessions.

S. oplocense is a species known from Bolivia and Argentina and the existence of hexaploid cytotypes in Argentina was reported by Okada (1979). All the populations gathered up to now in the province of Jujuy are hexaploid while tetraploid and diploid cytotypes have been reported from Bolivia (Ochoa 1990). In Jujuy, this species is found between 3250 and 3800 m and the accessions collected were found growing under the shade of spiny bushes or in fences close to cultivated fields.

S. microdontum is a diploid species found in Bolivia and Argentina; in the latter country it has been found in the provinces of La Rioja, Catamarca, Tucumán, Salta and Jujuy. It is a species common in *Alnus acuminata* Kuntz

woods. In this expedition, we found this species in the department of General Belgrano, at the edge of the Yunga province.

S. chacoense is a widely distributed diploid species occurring from sea level in the province of Buenos Aires up to 3700 m in northwest Argentina and is reported for Brazil, Bolivia, Uruguay and Paraguay. Only one accession was collected by us in Jujuy in the department of General Belgrano.

S. gourlayi, *S. megistacrolobum*, *S. infundibuliforme* and *S. acaule* were collected in several places as weeds in potato fields and *S. oplocense* was found in a fence surrounding a potato field. Hybridisation between wild and domesticated potatoes is a phenomenon that has been documented in centres of crop diversity (Astely and Hawkes 1979; Johns and Keen 1986) and we suspect that the traditional farming practices carried out in Northwest Argentina may result in hybridisation between wild potato species and native cultivars. Wild potatoes as weeds in potato fields are a common phenomenon in Jujuy province, but these species are also found in fields left for fallow, and this may provide an appropriate environment for hybridisation.

Cultivated species

New accessions of local cultivars from Jujuy indicated that the growing of landraces of cultivated potatoes has disappeared from some areas. For example Cochinoca was a traditional potato growing area, but the young people are migrating to other valleys, such as the Quebrada of Humahuaca, replacing the potato by other crops, such as leafy vegetables, onion, garlic and flowers, for the markets of San Salvador de Jujuy and elsewhere.

Almost all the varieties collected belong to *S. tuberosum* subsp. *andigenum* (Table 1), but in the area of Aparzo, a site located Northwest of the locality of Humahuaca towards the border with the province of Salta, two accessions of 'Luqui' were collected. The chromosome counts confirmed that both accessions were pentaploid with 60 chromosomes. According to Ochoa (1990) in Bolivia both *S. juzepczukii* (triploid) and *S. curtilobum* (pentaploid) include cultivars named 'Luqui'. In Argentina, Viirsoo (1954a, b) evaluated this cultivar in Tucumán, but with no report of chromosome number and the provenance of this clone was La Quiaca, close to the Bolivian border. Hawkes and Hjerting (1969) reported a triploid species cultivated in Catamarca but collected elsewhere and considered it to be *S. juzepczukii*. These authors also reported the presence of *S. curtilobum* from La Quiaca, department of Yavi, but they speculated about an introduction from Bolivia. We collected two pentaploid accessions of *S. curtilobum* in a valley east of Humahuaca town in the area of Aparzo, one in a place called Molloj and the other in Chorcán. We have not finished the chromosome counts of the entire collection, and we may detect yet other ploidy levels. This is the first time we maintain living collections of *S.curtilobum* from this area.

A total of 43 probably different native varieties were collected (Table 1). According to Gomez (1946) cited by Albeck (1993) in the 1940s 75 varieties were found in the Quebrada of Humahuaca. Hawkes and Hjerting (1969) cite 25 varieties for the country although they stated that it was likely that this was not the total number of local varieties grown. As the search and description of these cultivars is pursued, it may be possible to establish the diversity still present on the farmer's fields. Since Okada's collections were carried out in the 1970s, it is likely that in some areas a decline of the number of varieties under cultivation has taken place. The maintenance of the local cultivars and the substitution of the potato crop by other alternatives are related to the altitude and proximity to urban centres. In the low valleys close to the main roads and towns, current production is mainly based upon introduced crops, fruits, vegetables and flowers, which are sold on markets of major towns in the province or in neighbouring provinces. Although potato diversity is declining in Jujuy, almost in all the communities visited potatoes were cultivated, but generally the number of different varieties held by each farmer was low. The most common cultivars found were 'Collareja', 'Chacarera', 'Colorada', 'Rosada', 'Runa', 'Blanca', 'Morada', but many farmers ask for the specific cultivars they used to grow but which have disappeared in their area, indicating that there is still a need for certain cultivars for specific uses. In some cases a few families within isolated communities still grow a specific cultivar as is the case of 'Luqui' and 'Chaqueña'.

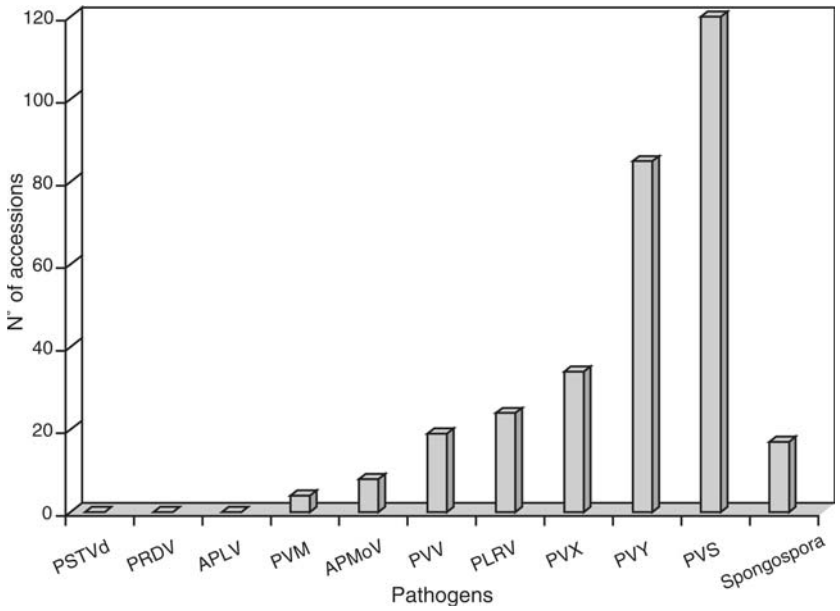

Figure 2. Levels of virus and powdery scab infection in the accessions assayed. PSTVd – Potato spindle tuber viroid; PRDV – Potato rough dwarf virus; APLV – Andean potato latent virus; PVM – Potato virus M; APMoV – Andean potato mottle virus; PVV – Potato virus V; PLRV – Potato leafroll virus; PVX – Potato virus X; PVY – Potato virus Y; PVS – Potato virus S; Spongospora – powdery scab.

There are several causes threatening potato cultivation in the area but cultural and economic causes are the relevant ones. As communications and road infrastructure improved in the second half of the 20th century, the emigration of people, from the valleys down to larger towns in search for a better way of living was common. By the end of the 20th century, the growth of unemployment in large towns and cities, the recognition of the right of indigenous people to own their land according to the last Constitutional Amendment in 1994 and the establishment of special agronomic projects around schools in some areas, are giving young people an opportunity to remain in the valleys. The growth of tourism in these areas in recent years will undoubtedly affect crop production in the area and may promote the local culture and the cultivation of local crops for traditional dishes. Our project is designed to provide local farmers with clean potato seed to contribute to the re-introduction of native potato cultivars and secure on farm conservation of the indigenous agro-biodiversity.

Figure 2 shows the frequency distribution of the clones with virus and powdery scab infection. Different levels of virus infection were detected in the clones collected. Potato rough dwarf virus (PRDV), Andean potato latent virus (APLV) and the Potato spindle tuber viroid (PSTVd) were not detected, but varying levels where observed for the other viruses. PSTVd up to now has not been detected in our wild and cultivated germplasm collection. PRDV has a limited geographical distribution and has been described for the area of Balcarce (Butzonitch et al. 1995) but as introduction of clones of commercial *S. tuberosum* subsp. *tuberosum* cultivars occur in the lower valleys of the Andean region, it was essayed in this germplasm collection.

Andean potato latent virus has been reported from Bolivia, Colombia, Ecuador and Peru (Jeffries 1998) and in spite of the movement of cultivated Andean germplasm through the Bolivian border into Argentina, this virus was absent in the clones essayed.

We detected **Andean potato mottle virus** in 4.4% of the accessions. This virus has been found in Chile, Ecuador, Perú and Brazil (Jeffries 1998). In Jujuy province, it appeared in the departments of Humahuaca, Santa Catalina, Susques and Tumbaya, from germplasm cultivated on farms located between 3600 and 4000 m. This virus was found on the cultivars 'Luqui', 'Collareja', 'Azul', 'Ojosa' and 'Blanca redonda'.

Potato virus V has been reported for the highlands of Bolivia causing severe damage on native cultivars, and in Perú and Northern Europe (Jeffries 1998). It appeared in 10.5% of the entire cultivated collection and occurred in the departments of Tilcara, Humahuaca, Rinconada Tumbaya and General Belgrano, between 2300 and 4000 m. PVV was detected on the cultivars 'Collareja', 'Luqui', 'Colorada', 'Ojosa', 'Cuarentona' and 'Tuni'.

Potato virus M was found in a very low percentage (2.2%). This virus is economically important in Eastern Europe. According to Butzonitch et al. (1994), it has been identified in Argentina in cultivated fields of potatoes planted with potato seed introduced from Europe and Poland but it has failed to spread into commercial cultivars. In Jujuy it was only identified in a few clones, the majority belonging to a cultivar named 'Ojos Colorados' grown in the departments of Tumbaya, General Belgrano, Tilcara and Humahuaca, between 2490 and 3500 m.

Potato leafroll virus was detected in 13% of the collection and it was found in the departments of Susques, Sta. Catalina, Rinconada, Tilcara, Tumbaya and General Belgrano. This virus was found in important potato growing departments such as in Tumbaya and Gral. Belgrano but also in sites where potato cultivation has declined or at marginal sites such as Susques. The cultivars with positive results for this virus were 'Ojosa', 'Collareja redonda', 'Runa', 'Blanca', 'Rosada', 'Colorada', 'Churqueña negra', 'Cuarentona', 'Cuella' and 'Chacarera'. The aphid *Myzus persicae* is the most efficient PLRV transmission vector and it has been detected together with other aphids, in fields of 'Collareja' in the Department of Tilcara at 2300 m (Arce de Hamity et al. 2001).

Potato virus Y and **PVS** are both viruses with a worldwide distribution, where the transmission is generally by mechanical or aphid means in a non-persistent manner. High levels of both viruses were detected on the material assayed with values of 47% for PVY and 67% for PVS, and both were detected in all the departments sampled and on all the cultivars collected. Some serotypes of Potato virus X (PVX) have a worldwide distribution. In these cultivars, 19% of the clones gave positive results utilising polyclonal antibodies. This virus was found in all the areas explored on the cultivars 'Rosada', 'Tuni', 'Overa', 'Azul', 'Blanca', 'Luqui', 'Churqueña', 'Collareja', 'Sani', 'Moradita', 'Cuella', 'Colorada', 'Cuarentona' and 'Chacarera'.

A few clones gave negative results for all the viruses assayed: CCS 1172 ('Moradita') (Dept. Tilcara); CCS 1185 ('Tuni rosada') (Dept. Humahuaca); CCS 1271 (not identified), CCS 1288 and CCS 1295 ('Rosada' or 'Desiree'); CCS 1307 ('Moradita') (Dept. Santa Catalina); CCS 1371 ('Chacarera'), CCS 1247 ('Tuni blanca') and CCS 1251 ('Tuni rosada?') (Dept. Cochinoca); CCS 1255 ('Rosada' or 'Desiree') (Rinconada); CCS 1283 ('Waycha') and CCS 1284 ('Sani'), (Dept. Yavi); CCS 1366 ('Overa') (Dept. Tumbaya); CS 1419 ('Blanca') (Dept. General Belgrano).

The cultivars 'Waycha', 'Sani' and 'Desiree' are grown in Bolivia; CCS 1371 was obtained from a farmer in Tarija (Bolivia) and CCS 1271 is probably another Bolivian cultivar. We suspect that some of the clones called 'Rosada' are in fact cultivars of *S. tuberosum* subsp. *tuberosum* on the basis of plant and tuber appearance.

Small pustules on the tubers, considered to be powdery scab symptoms, were not coincident with the serological result in all the cases, as positive reactions to the fungus were observed on tubers with and without symptoms. Of a total of 180 clones, 17% gave positive results. The provenances of the infected tubers were widespread, and only tubers collected in the Department of Susques and Tilcara appeared without this pathogen. As the infection by this fungus is widespread, analysis of PMTV will be carried out on clones from this area in the future.

We are now initiating pathogen eradication to produce healthy clones for distribution to Andean farmers of the most important cultivars known for our country, previous micro-propagation and minituber production. These methods, will allow a rapid production of healthy seed for the farmers, stimulate the use of specific cultivars for special purposes and contribute to the maintenance of the diversity on the farms.

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