



Breeding Multiple Virus Resistant Potatoes in Peru

Humberto A. Mendoza

Perú

Introduction

Virus diseases cause drastic reduction on yield and tuber quality around the world being Leafroll (PLRV), Y (PVY) and X (PVX) the most common and damaging.

Potato asexual propagation permits a rapid disease spread in time and space as infected seed tubers carry viruses from a season to the next and insect vectors and men from field to field causing the well known “CROP DEGENERATION” that gradually reduces yield.

In the developed world virus damage is avoided using certified seed that permits high yields even planting susceptible cultivars.

In most developing countries where certified seed is expensive or scarce VIRUS RESISTANCE is the ONLY EFFECTIVE CONTROL.

Most damaging potato viruses



PVX



PVY



PLRV

Genetics of Virus Resistance

PVX and PVY Immunities

Control of Immunities to PVX and PVY are by single *loci* each with two alleles showing complete dominance.

For PVX, the X allele = Immunity and the recessive x = susceptibility.

For PVY, the Y allele = Immunity and the recessive y = susceptibility.

In the autotetraploid potato, five genotypes are possible at each *locus*

| | | |
|----------------------------------|---|---------------|
| Quadruplex - XXXX or YYYY | } | = Immune |
| Triplex - XXXx or YYYYy | | |
| Duplex - XXxx or YYyy | | |
| Simplex - Xxxx or Yyyy | | |
| Nulliplex - xxxx or yyyy | | = Susceptible |

From a practical point of view, it does not make any difference if we have a *quadruplex, triplex, duplex or simplex* genotype as all of them are immune to the virus.

Progenitor's genotype is very important for breeding.

Rate of transmission of immunity as a function of the genotype of the resistant progenitor.

| Susceptible progenitor | Immune progenitor | Percent immune clones in the progeny of each type of cross |
|----------------------------------|-----------------------------------|---|
| xxxxyyyyy (nulliplex) | XxxxYyyy (simplex) | 25.0% |
| xxxxyyyyy (nulliplex) | XXxxYYyy (duplex) | 69.0% |
| xxxxyyyyy (nulliplex) | XXXxYYYYy (triplex) | 96.4% |
| xxxxyyyyy (nulliplex) | XXXXYYYYY (quadruplex) | 100.0% |

Triples and Quadruples progenitors, called Multiplex have a great value in potato breeding.

Resistance to PLRV

Inheritance of resistance to PLRV is complex and not as well known as that of PVX and PVY.

Several mechanisms are described as resistances to infection, multiplication, translocation, insect vectors, etc.

The more utilized resistance to infection appears polygenically inherited. Earlier estimates of heritability were low ($h^2 = 0.29$) making it difficult to breed.

As detection methods improved, a sizable additive gene action reflected by a higher heritability, $h^2 = 0.69$ was reported which would increase selection response (Salas, 2007)

Breeding Objective
(Within the main)

**Assembly of new genetic material for variety
Selection in the developing world**

Breeding Strategy

(Mendoza *et al*, 1989)

1. Immunity to PVX and PVY was independently obtained from *S. tuberosum* L. ssp. *andigena* and from *neo tuberosum* (long day adapted *andigena*). Then, the first step was to improve the agronomic value of this material increasing gene frequencies for adaptation to heat, yield *per se* and immunity to both PVX and PVY.
2. Resistance to PLRV was obtained from cultivars and breeding lines from Europe and USA already adapted to long days, some adaptation to heat and good agronomic and tuber quality traits.
3. Once the improvement of the PVX and PVY joint immunity group was achieved, then crossing with the PLRV resistant group should take place and start the joint selection for PLRV resistance combined with PVX + PVY immunity.

Breeding Methodology

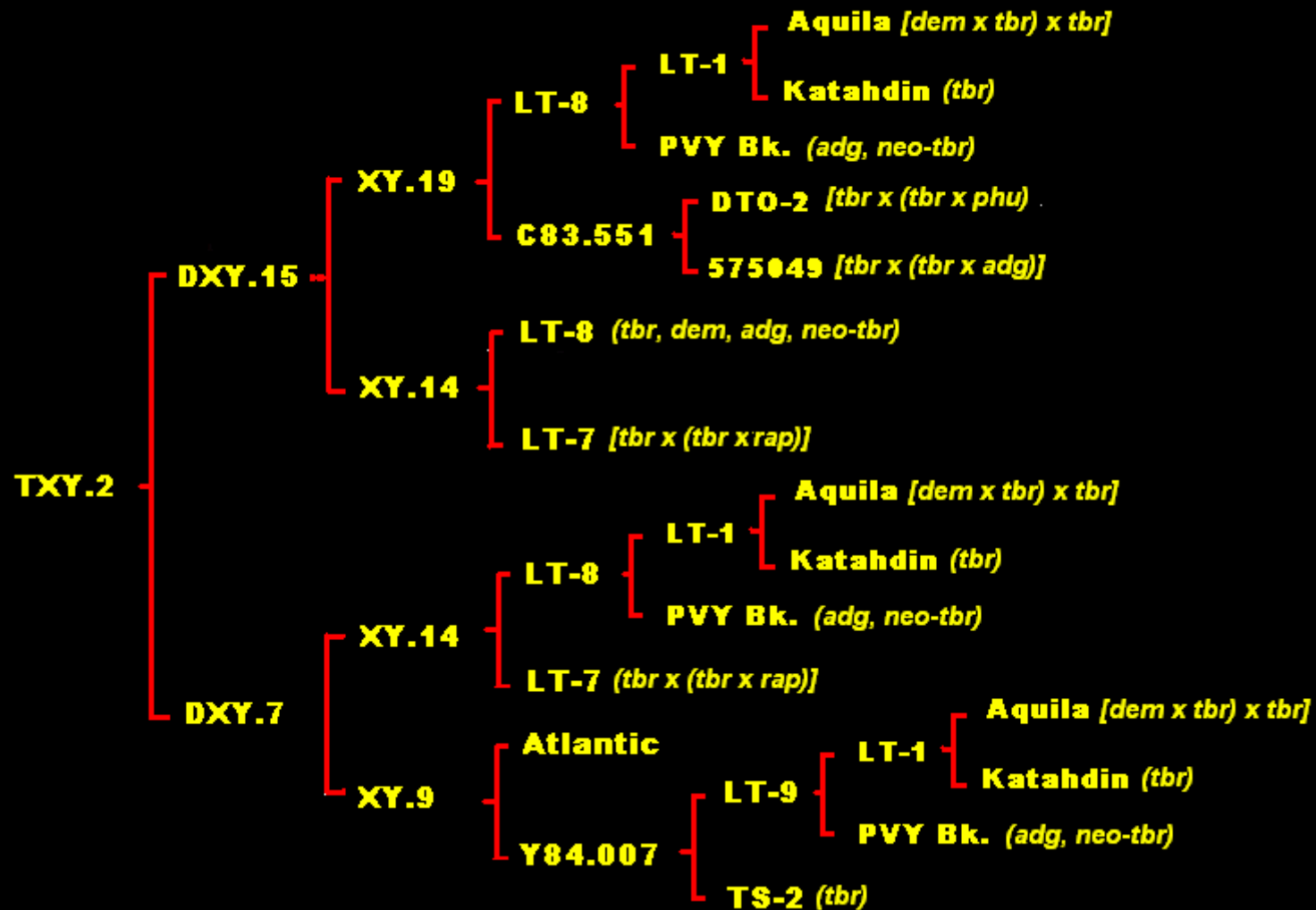
(Mendoza *et al*, 1989)

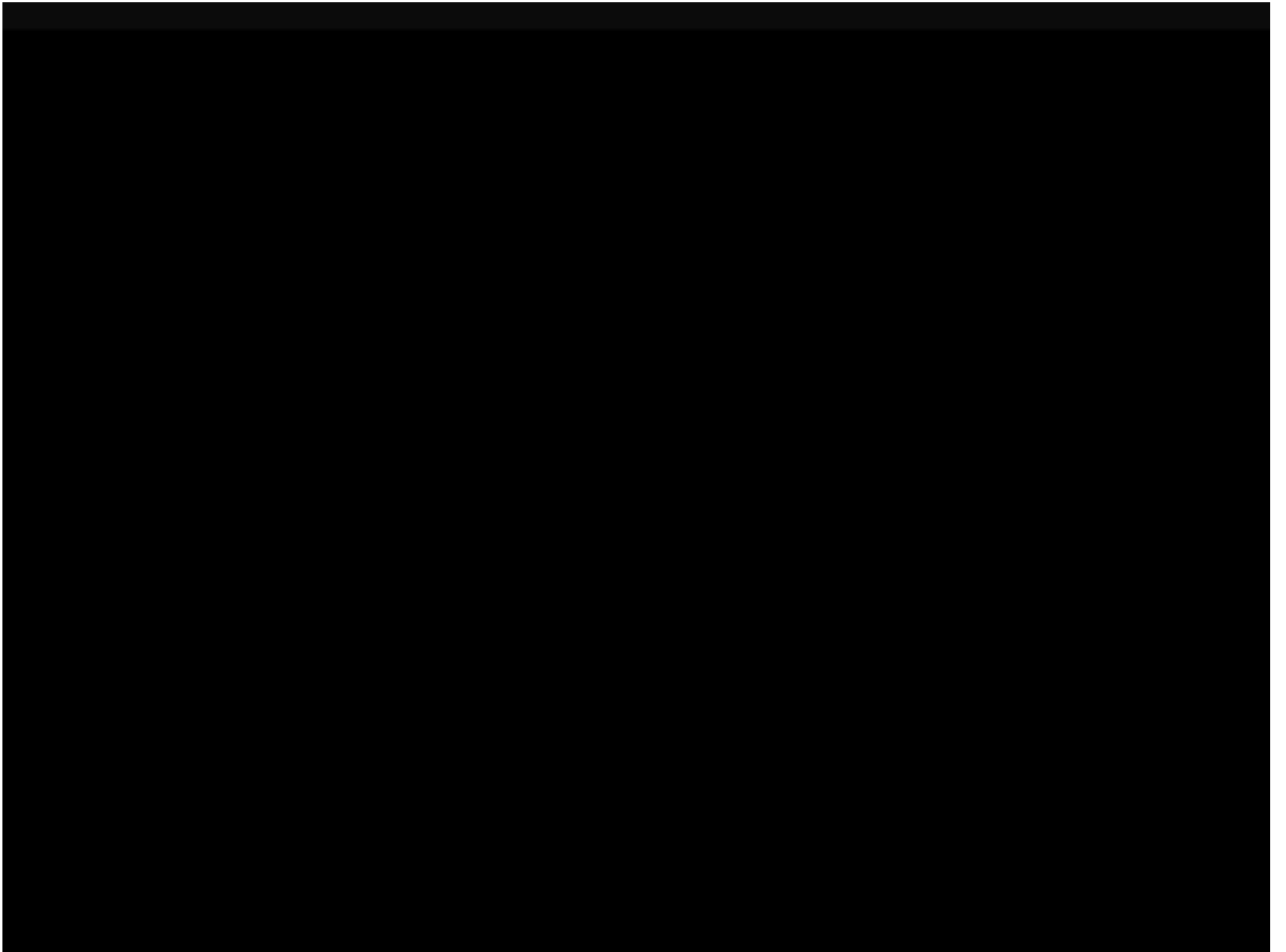
1. (Xxxxyyyy) x (xxxxYyyy) \Rightarrow *adg* & *neo tbr* – Single virus immunity
Identify *simplex* XxxxYyyy \Rightarrow Select for yield and tuber quality
2. XxxxYyyy x Heat tolerant xxxxyyyy (*tbr*, *neo tbr*)
Identify *simplex* XxxxYyyy \Rightarrow Select for heat tolerance, yield & tuber quality and progeny tests to identify progenitors (XY series)
3. Intercross *simplex* XxxxYyyy selected progenitors
Identify *duplex* XXxxYYyy \Rightarrow Select for heat tolerance, yield & tuber quality and progeny tests to identify progenitors (DXY series)
4. Intercross duplex XXxxYYyy selected progenitors
Identify *triplex* XXXxYYYYy \Rightarrow Select for heat tolerance, yield & tuber quality and progeny test to identify progenitors (TXY series)
5. Along the way, cross selected heat tolerant X+Y immune x PLRV resistant clones to combine the three resistances.

**BREEDING STRATEGY and
METHODOLOGY**

OUTCOMES

Pedigree of the *Triplex* (XXXxYYYy) Progenitor TXY.2





Selection of a large number of PVX and PVY immune progenitors with a high general combining ability for several commercial traits for use in breeding

XY (XxxxYyyy) – Simplex series

DXY (XXxxYYyy) – Duplex series

TTY (XXXxYYYY) – Triplex series

Identification and breeding of several PLRV resistant progenitors

Serrana and Pentland Crown (Brandolini *et al*, 1992),

LR93.156, [(G7445 x YY.1) x Y84.004],

LR93.160 (Mariella x XY.13),

C93.154 and C93.156 [(Monalisa x YY.5) x Y84.004)] (Salas, 2007)

Sedafin, Pirola, Bzura and Mex-32 (Mendoza, 2008),

Virus resistant Peruvian Potato Varieties Released in the last 15 years



ÚNICA
PVY immune



BASADRE
PVX + PVY immune



PRIMAVERA
PVX + PVY immune



TACNA
Immune to PVX + PVY
Resistant to PLRV



REICHE
Immune to PVX + PVY



COSTANERA
Immune to PVX + PVY

Genetic Origin of the Virus Resistant Varieties Released in Peru

| Variety | Progenitors | |
|------------------|----------------------------------|------------------------------|
| | Female | Male |
| Costanera (LT-8) | LT-1 (Katahdin x Aquila) | (PVY + PVX Bulk) |
| Tacna | Serrana (Argentina) | XY.4 (LT-8 x TS-4) |
| Maria Bonita | 378015.18 | PVY Bulk |
| Basadre | Sedafin (Chile) | 388809.2 (Y84.007 x Y84.020) |
| Primavera | B-71-74-49.12 (Argentina) | 385280.1 (LT-8 x 575049) |
| Única | 387521.3 (AVRDC-1287.19 x 7XY.1) | Aphrodite (Netherlands) |
| Reiche | MEX-32 (Mexico) | XY.9 (Atlantic x Y84.007) |

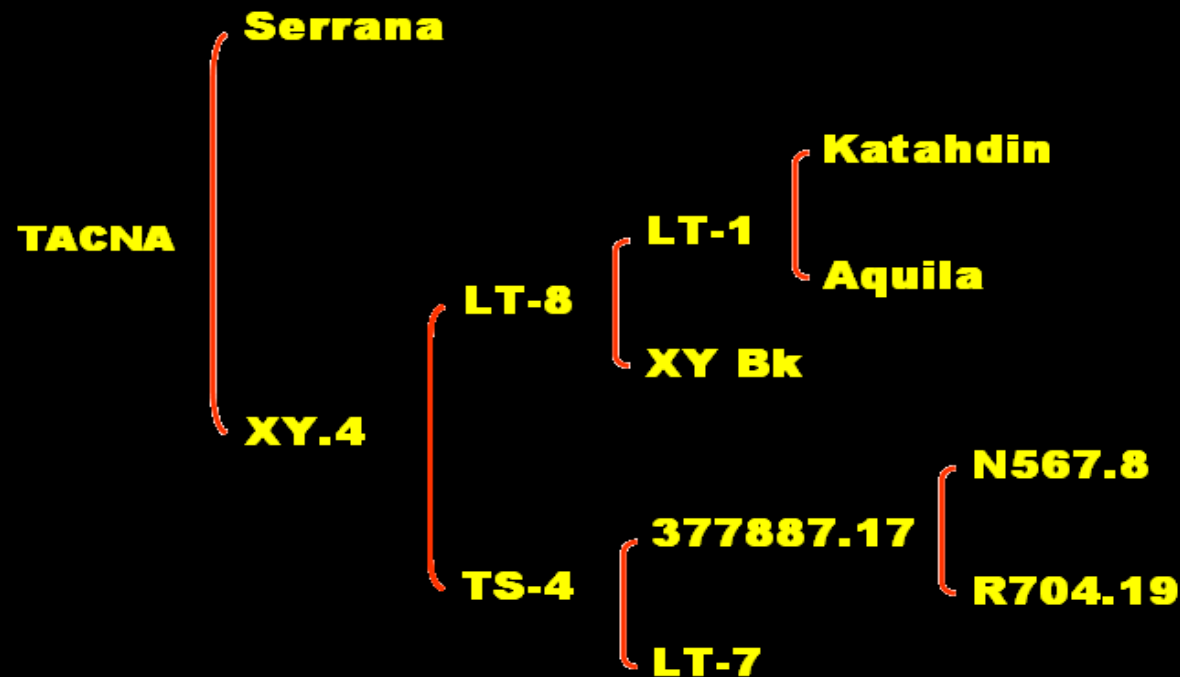


IPORÁ – INIA. Virus resistant variety released in Uruguay

COOPERATION-88

Breed in Peru and introduced to China. In 2007 was planted in 120,000 ha becoming the largest adopted CIP variety worldwide.

Selected at San Ramón and La Molina and later in Tacna, semi arid testing site in Peru. Early maturing (90-100 days), high yield, good processing quality. PVX and PVY immune and PLRV resistant. It has shown moderate tolerance to salinity and drought.



Thank you!!