MIGLIORAMENTO GENETICO E BIOTECNOLOGIE APPLICATE ALLA PATATA: RECENTI PROGRESSI E SFIDE FUTURE

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Università degli Studi di Napoli Federico II

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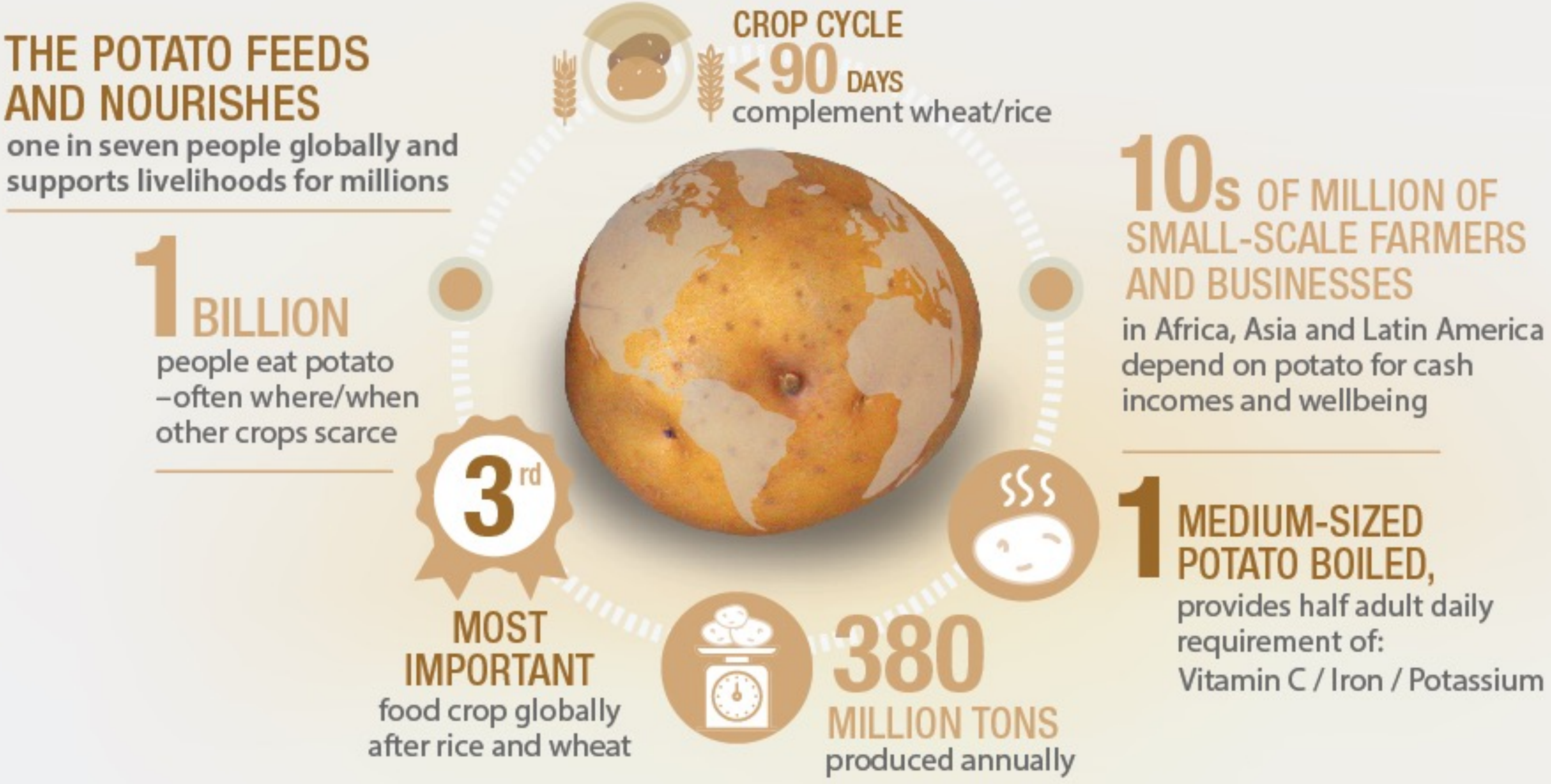
ROMA, 13 DICEMBRE 2024



https://cipotato.org/research/potato-agri-food-systems-program/

POTATO BREEDING OBJECTIVES

YIELD	Tuber number, size, bulking rate, drought resistance, storability
CONFORMITY	Tuber shape, regularity and uniformity
GROWTH DEFECTS	Gemmation, hollow heart, growth cracks
QUALITY	Browning, blackening, sloughing, texture, dry matter and sugars content, dormancy
MECHANICAL DAMAGE	Shatter cracks, scuffing, bruising
EYE APPEAL	Skin and flesh colour
RESISTANCE	Late blight, Viruses (PVX, PVY, PLRV), Cyst nematodes, Common Scab, Wart, Skinspot, Powdery Scab, Soft and Dry Rot

POTATOES

Thanks to plant breeding over the past 15 years, farmers in the EU have grown an extra **10 million tons of potatoes every year.**

That's more than the annual potato output of the whole of Poland, and means the EU can export potatoes instead of importing them.

Research source: http://bit.do/plantetp-HFFAResearch
More info: www.plantetp.org

OUTLINE

- Conventional Breeding
- Analitical Breeding
- Genomics & Biotechnology
- FUTURE

OUTLINE

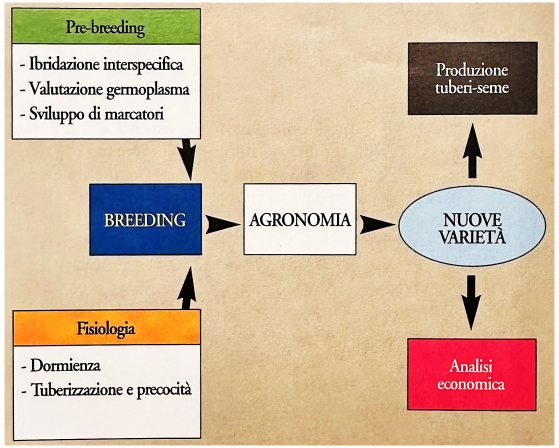
Conventional Breeding

Analitical Breeding

Genomics & Biotechnology

FUTURE

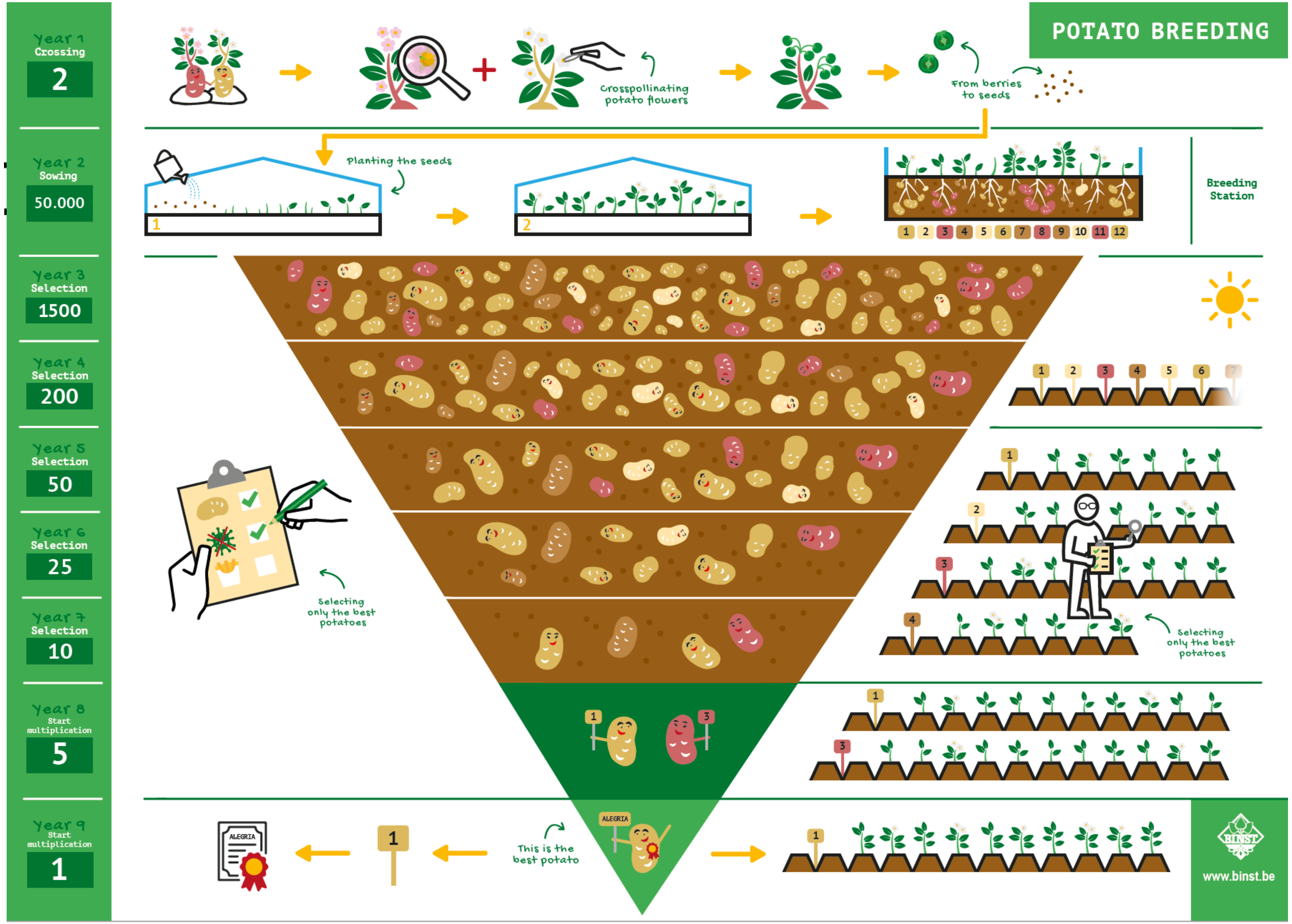
THE NATIONAL POTATO BREEDING PROJECT



MINISTERO DELLE POLITICHE AGRICOLE ALIMENTARI E FORESTALI

- Università Federico II, Portici
- Università Aldo Moro, Bari
- CNR-IGV, Portici
- CNR-ISAFOM, Catania
- CNR-IPP, Bari
- ISCI, Bologna e Salerno
- ISSDP, Firenze
- ENEA, Roma
- ISPAVE, Roma
- Cisa Mario Neri, Imola
- CRPV, Cesena
- Italpatate
- UNAPA

THE NATIONAL POTATO BREEDING PROJECT



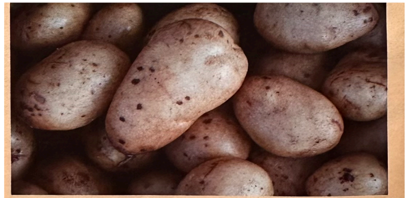
THE VARIETIES RELEASED

PUKARA

Sigla del clone:	-
Costitutore:	ITALPATATE - INIA (Cile)
Incrocio:	Cleopatra x Yagana
Aree di coltivazione:	tutte le zone italiane, interessate alle produzioni di patata a buccia rossa
Epoca di coltivazione:	semine primaverili
Utilizzo:	consumo fresco, frigostoccaggio
Ciclo di maturazione:	medio-tardivo
Forma del tubero:	tonda-ovale
Colore della buccia:	rosso chiaro
Colore della polpa:	giallo
Sostanza secca:	17-18%
Tipologia culinaria:	B
Resistenze e/o tolleranze:	PLRV

ELMAS

Sigla del clone:	ISCI 67
Costitutore:	Istituto Sperimentale per le Colture Industriali, Bologna
Incrocio:	Liseta x (Concorde x Wn 106-81)
Aree di coltivazione:	Sicilia, Puglia, Sardegna
Epoca di coltivazione:	extrastagionale (primaticcia e bisestile)
Utilizzo:	novella, consumo fresco
Ciclo di maturazione:	precoce
Forma del tubero:	allungata-ovale
Colore della buccia:	giallo chiaro (elevata lavabilità)
Colore della polpa:	giallo
Sostanza secca:	17-18%
Tipologia culinaria:	BA



SILA

Sigla del clone:	CS 8617
Costitutore:	Dipartimento di Scienze del Suolo, della Pianta e dell'Ambiente, Università degli Studi di Napoli "Federico II", Portici (NA) – ARSAA Calabria
Incrocio:	DTO 14 x W 879
Aree di coltivazione:	Sicilia, Puglia, Sardegna, Campania
Epoca di coltivazione:	normale (semine primaverili)
Utilizzo:	consumo fresco, frigostoccaggio, industria (cubettato, prefritti)
Ciclo di maturazione:	medio
Forma del tubero:	tonda-ovale
Colore della buccia:	giallo
Colore della polpa:	giallo intenso
Sostanza secca media:	21-22%
Tipologia culinaria:	BC
Resistenze e/o tolleranze:	resistente a nematodi cisticoli (*Globodera rostochiensis* patotipo RO2) e galligeni (*Meloidogyne javanica*)

IGEA

Sigla del clone:	ISCI B 26
Costitutore:	Istituto Sperimentale per le Colture Industriali, Bologna
Incrocio:	Turbo x (Wn 233-69 x Monalisa)
Aree di coltivazione:	tutte le zone italiane, interessate alle produzioni di patata biologica
Epoca di coltivazione:	semine anticipate in Sicilia (novembre), altrove semine primaverili
Utilizzo:	consumo fresco e frigostoccaggio
Ciclo di maturazione:	medio-tardivo
Forma del tubero:	ovale
Colore della buccia:	giallo chiaro (buona lavabilità)
Colore della polpa:	giallo chiaro
Sostanza secca:	18-19%
Tipologia culinaria:	B
Resistenze e/o tolleranze:	altamente tollerante alla peronospora

SIBARI

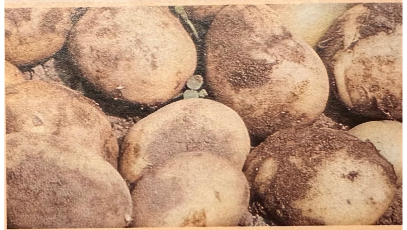
Sigla del clone:	CS 8621
Costitutore:	Dipartimento di Scienze del Suolo, della Pianta e dell'Ambiente, Università degli Studi di Napoli "Federico II", Portici (NA) – ARSSA Calabria
Incrocio:	Vivax x Rosalie
Aree di coltivazione:	tutte le aree italiane
Epoca di coltivazione:	normale (semine primaverili)
Utilizzo:	consumo fresco, frigostoccaggio, industria (cubettato, prefritti)
Ciclo di maturazione:	medio
Forma del tubero:	ovale-allungata
Colore della buccia:	giallo
Colore della polpa:	giallo intenso
Sostanza secca media:	21-22%
Tipologia culinaria:	BC
Resistenze e/o tolleranze:	resistente a nematodi cisticoli (*Globodera rostochiensis* patotipo RO2)

RUBINO

Sigla del clone:	ISCI 4052
Costitutore:	Istituto Sperimentale per le Colture Industriali, Bologna
Incrocio:	(Agata x Jaerla) x (Cilena x Wn 106-81)
Aree di coltivazione:	Sicilia, Puglia, Sardegna, Campania
Epoca di coltivazione:	extrastagionale (primaticcia e bisestile)
Utilizzo:	novella, consumo fresco, esportazione (polpa soda)
Ciclo di maturazione:	medio-precoce
Forma del tubero:	tondo-ovale
Colore della buccia:	giallo chiaro (buona lavabilità)
Colore della polpa:	giallo
Sostanza secca:	17-18%
Tipologia culinaria:	AB

DAYTONA

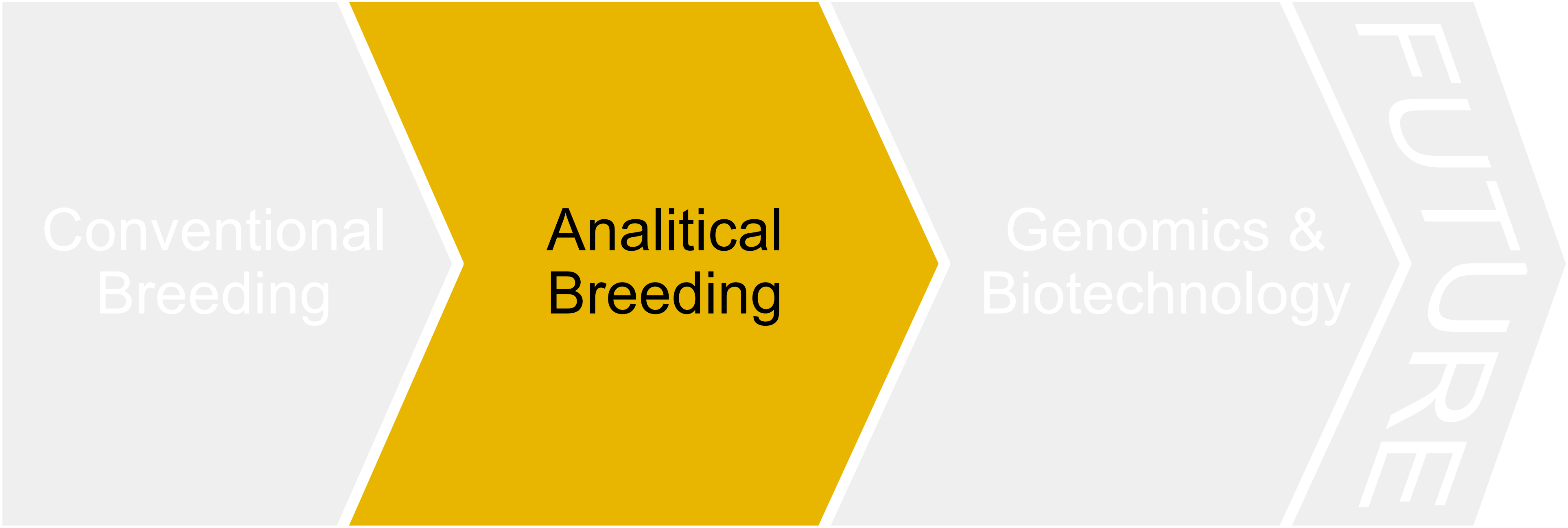
Sigla del clone:	MN290
Costitutore:	Cisa Mario Neri, Imola (BO)
Incrocio:	Spunta x Colmo
Aree di coltivazione:	Nord e Centro Italia
Epoca di coltivazione:	normale (ciclo primaverile-estiva)
Utilizzo:	patata comune
Ciclo di maturazione:	da medio a medio-tardivo
Forma del tubero:	tonda-ovale
Colore della buccia:	giallo chiaro (discreta lavabilità)
Colore della polpa:	bianco
Sostanza secca:	23%
Tipologia culinaria:	C



ZAGARA

Sigla del clone:	MN 326
Costitutore:	Cisa Mario Neri, Imola (BO)
Incrocio:	Timate x MN 1290 E
Aree di coltivazione:	Sud Italia
Epoca di coltivazione:	semine in agosto
Utilizzo:	novella
Ciclo di maturazione:	precoce
Forma del tubero:	ovale
Colore della buccia:	giallo brillante (ottima lavabilità)
Colore della polpa:	giallo
Sostanza secca:	17%
Tipologia culinaria:	AB

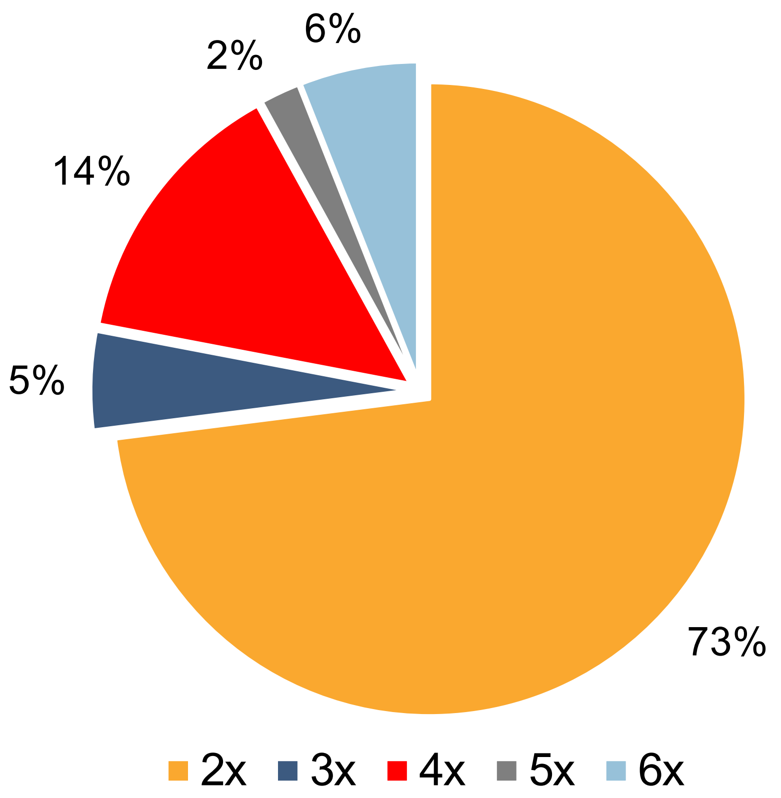
OUTLINE


Conventional Breeding
Analitical Breeding
Genomics & Biotechnology
FUTURE

GERMPLASM RESOURCES

- **104 potato species**
  - 100 “wild”
  - 4 cultivated
- **Wide geographic range**
- **Most are 2n=2x=24**
- **Cultivated potato = 4x**
- **Hybridization**
  - Haploids
  - Chromosome doubling
  - 2n gametes
  - Somatic hybridization

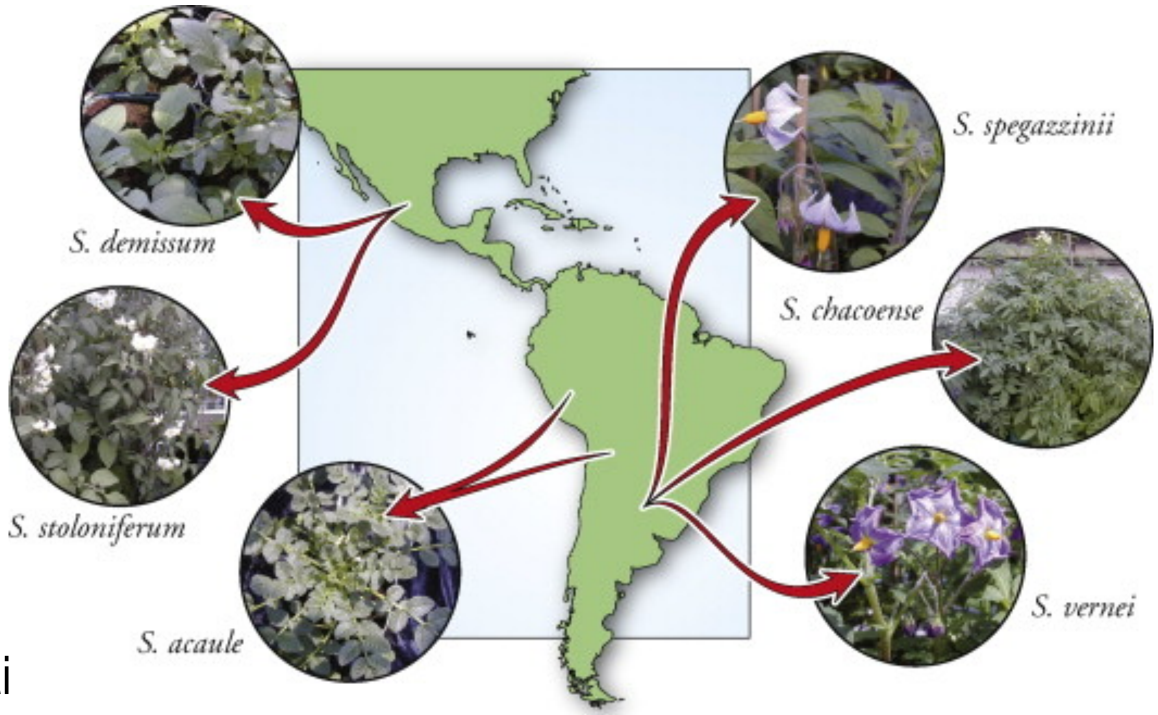
Potato wild species ploidy



Jansky & Spooner 2018

SPECIES UTILIZATION IN BREEDING

- *S. demissum*: LB, PLRV
- *S. acaule*: Viruses, nematode, frost
- *S. chacoense*: Viruses, insects
- *S. spegazzinii*: Nematodes
- *S. stoloniferum*: PVY and PVA
- *S. vernei*: nematodes, high starch



- **Additional 9 species**: in a few varieti
- **Primitive cultivated**: adg, stn, phu 9

Carputo & Aversano 2018

POTATO GENETIC RESOURCES

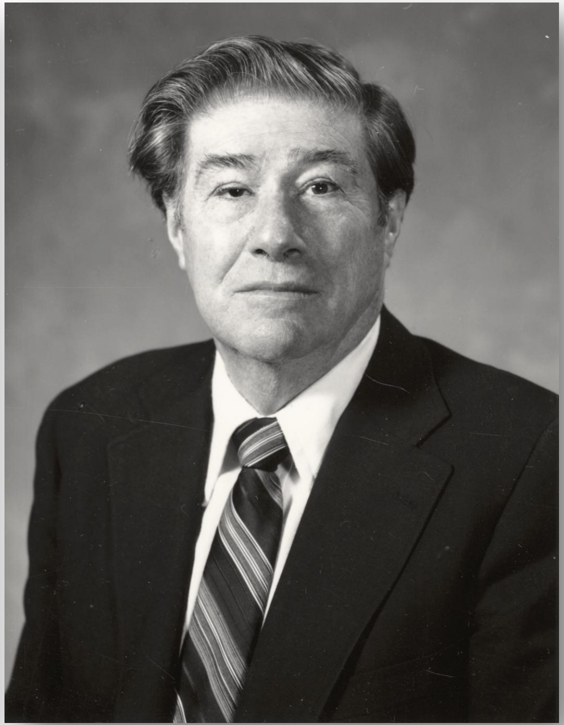
Table 1. Results (mean ± standard error) from screening tests for resistance to *Ralstonia solanacearum*, PVY^{NTN}, low temperatures in non-acclimated (NACC) and acclimated (ACC) conditions of the 21 genotypes belonging to the 12 *Solanum* species[a]

Genotype code (accession)	Species	*R. solanacearum* (WD)	PVY^{NTN} (OD_{405})	NACC (°C)	ACC (°C)
Acl1B (PI210029)	*S. acaule*	4.0 ± 0	0.140 ± 0.060	3.6	NA
Acl1C (PI210029)	*S. acaule*	4.0 ± 0	0.252 ± 0.103	4.0	4.3
Blb1C (PI275190)	*S. bulbocastanum*	3.6 ± 1.1	0.016 ± 0.00	2.3	3.0
Blb2C (PI275188)	*S. bulbocastanum*	0.0 ± 0	0.531 ± 0.086	2.0	2.5
PT29 (PI243510)	*S. bulbocastanum*	0.1 ± 0.3	0.116 ± 0.216	1.7	NA
Can1B (PI365321)	*S. canasense*	4.0 ± 0	0.123 ± 0.152	2.0	2.4
Cph2A (PI347759)	*S. cardiophyllum*	4.0 ± 0	0.153 ± 0.122	1.8	2.2
Cph1C (PI283062)	*S. cardiophyllum*	3.7 ± 0.5	0.014 ± 0.003	1.6	3.0
Chc1A (PI133124)	*S. chacoense*	1.1 ± 1.8	0.022 ± 0.009	1.9	3.3
Chc1B (275141)	*S. chacoense*	3.6 ± 1.1	0.144 ± 0.093	2.1	3.4
Cmm1T (PI243503)	*S. commersonii*	0.0	0.125 ± 0.063	6.4	8.9
Cmm6-6 (PI590886)	*S. commersonii*	4.0 ± 0	0.305 ± 0.136	2.8	6.7
Etb3 (PI558054)	*S. etuberosum*	2.0 ± 0	0.016 ± 0.00	3.0	5.0
Fen1B (PI275165)	*S. fendleri*	4.0 ± 0	0.571 ± 0.123	1.8	2.4
Fen2B (PI458417)	*S. fendleri*	4.0 ± 0	0.365 ± 0.173	1.7	3.3
Mlt1A (8MLT-M1)	*S. multidissectum*	4.0 ± 0	0.234 ± 0.088	2.7	4.4
IVP35 (PI584995)	*S. phureja*	0.0	0.013 ± 0.001	2.6	3.2
IVP101 (PI484993)	*S. phureja*	NA	0.053 ± 0.030	1.9	2.7
Sto1A (PI275248)	*S. stoloniferum*	4.0 ± 0	0.152 ± 0.124	2.2	2.4
Sto1C (PI275248)	*S. stoloniferum*	4.0 ± 0	0.150 ± 0.052	1.8	3.4
Tar2B (PI414148)	*S. tarijense*	4.0 ± 0	0.142 ± 0.065	1.1	2.2
Blondy	*S. tuberosum*	4.0 ± 0	0.193 ± 0.073	2.3	3.1

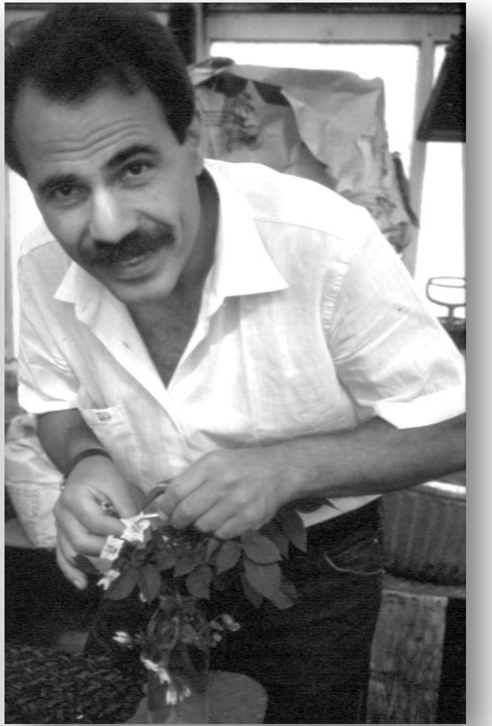
Carputo et al., 2013

THE INTROGRESSION BREEDING

Prof. Luigi Monti and Prof. Luigi Frusciante, 1980, Portici

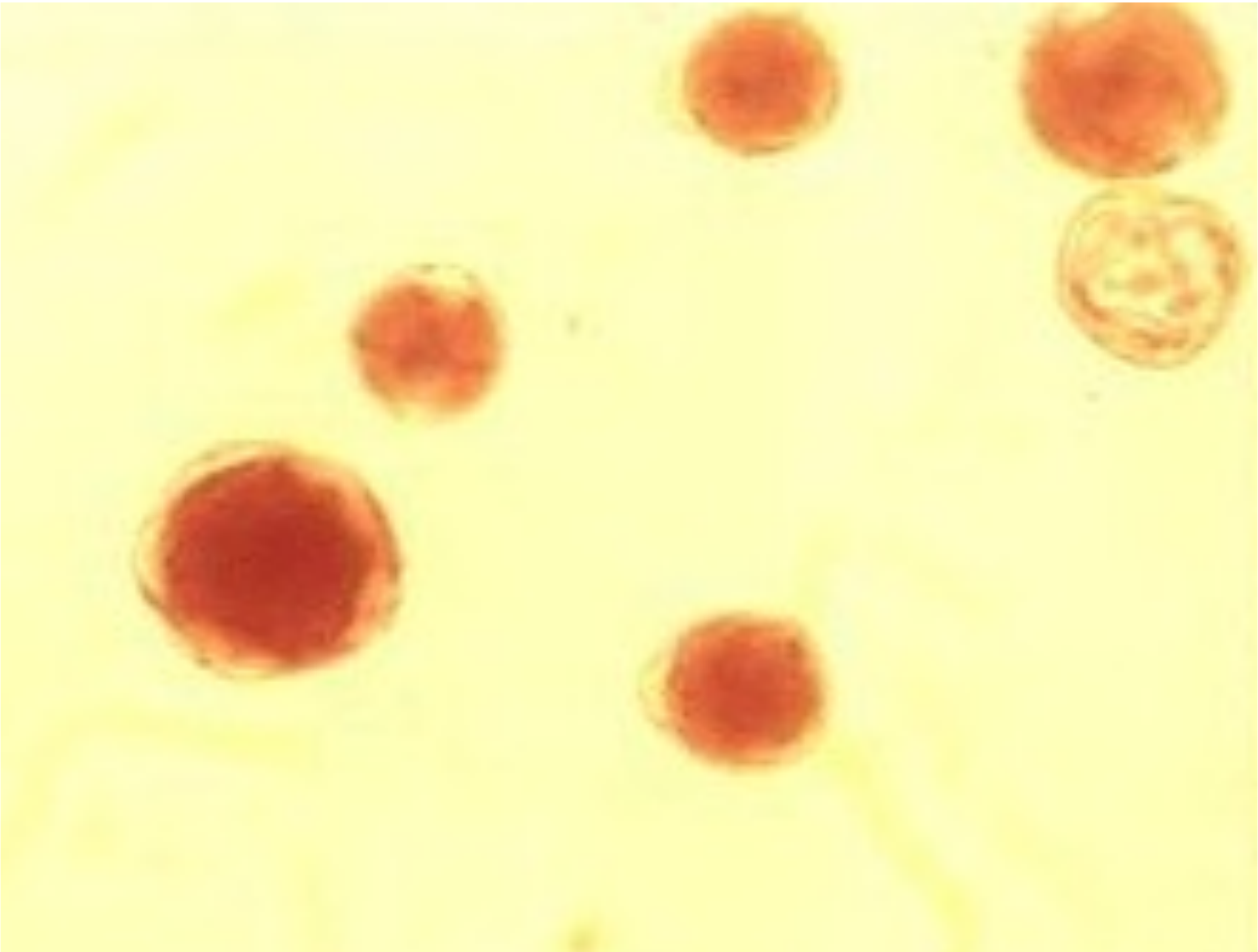


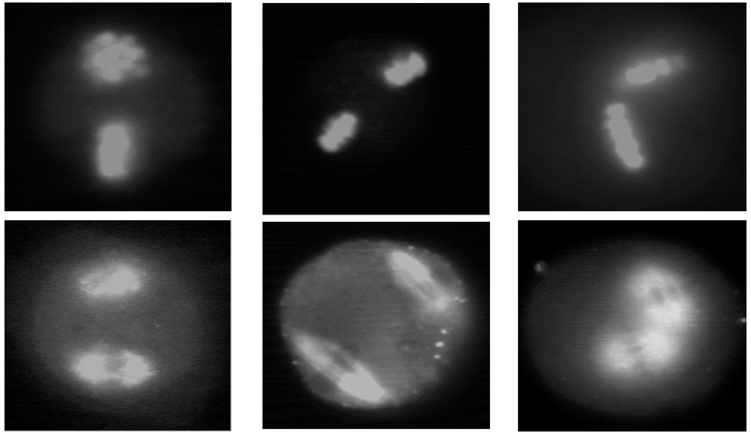
Emeritus Campbell-Bascom
Professor Stanley J. Peloquin
(1921 – 2008)

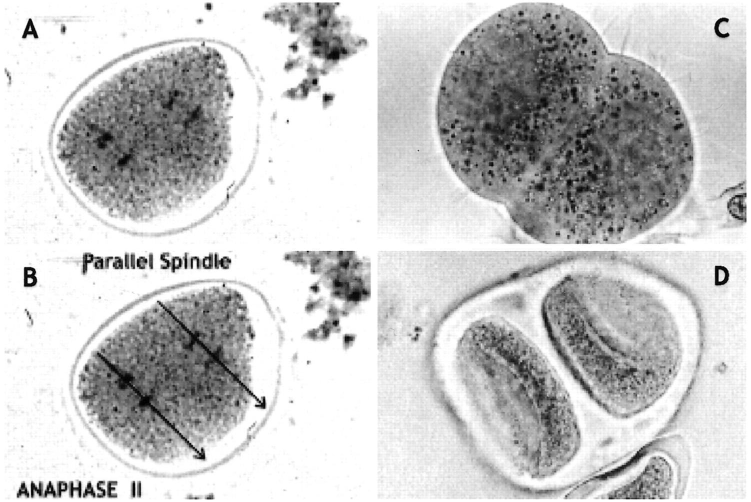


Prof. Luigi Frusciante,
12 January, 1984
Madison, WI (USA)

2n GAMETES







Conicella et al., 2003

2n GAMETES

The Role of 2*n* Gametes and Endosperm Balance Number in the Origin and Evolution of Polyploids in the Tuber-Bearing Solanums

Domenico Carputo,*,[1] Luigi Frusciante[†] and Stanley J. Peloquin[‡]

**Department of Soil, Plant, and Environmental Sciences, Faculty of Biotechnological Sciences, University of Naples "Federico II," 80055 Portici, Italy, [†]Department of Soil, Plant, and Environmental Sciences, Faculty of Agricultural Sciences, University of Naples "Federico II," 80055 Portici, Italy and [‡]Department of Horticulture, University of Wisconsin, Madison, Wisconsin 53706-1590*

1997)

Short Communication

DISCREPANCY BETWEEN SPINDLE ANOMALIES AND 2N POLLEN PRODUCTION IN *SOLANUM* INTERSPECIFIC HYBRIDS

Amalia Barone[1*], Domenico Carputo[2], Giuliana La Rotonda[2], and Luigi Frusciante[2]

Abstract

Theor Appl Genet (2000) 101:805–813

D. Carputo · A. Barone · L. Frusciante

2n gametes in the potato: essential ingredients for breeding and germplasm transfer

2n Gametes in *Solanum Tuberosum* Dihaploids*

Flora Alfano[1], Maria Cammareri[1], Angela Errico[2], Luigi Frusciante[2], and Clara Conicella[1]

[1]CNR-IMOF, Research Institute for Vegetable and Ornamental Plant Breeding, Via ... 055 Portici, Italy.
[2]Department of Agronomy and Plant Genetics, University of N... Portici, Italy. Tel. (081) 776164... 55

*Contribution no. 84 from CNR-IMOF, Resear... ding.

α-Tubulin and F-actin distribution during microsporogenesis in a 2*n* pollen producer of *Solanum*

G. Genualdo, A. Errico, A. Tiezzi, and C. Conicella

Perspectives

Anecdotal, Historical and Critical Commentaries on Genetics

Edited by James F. Crow and William F. Dove

Meiotic Mutants in Potato: Valuable Variants

Stanley J. Peloquin,* Leonardo S. Boiteux[†] and Domenico Carputo[‡]

**Department of Horticulture, Plant Sciences, University of Wisconsin, Madison, Wisconsin 53706-1590, [†]Centro Nacional de Pesquisa de Hortaliças (CNPH)/Empresa Brasileira de Pesquisa Agropecuária (EMBRAPA), C.P. 218, 70359-970 Brasília-DF, Brazil and [‡]Department of Agronomy and Plant Genetics, University of Naples, 80055 Portici, Italy*

Cytological evidences of SDR-FDR mixture in the formatio of 2n eggs in a potato diploid clone

C. Conicella[1], A. Barone[2], A. Del Giudice[2], L. Frusciante[2,*] and L. M. Monti[2]

[1] Center of Vegetable Breeding, CNR, Portici, Italy
[2] Dept. of Agronomy Science and Plant Genetics, Univ. of Naples, Portici, Italy

Received April 6, 1990; Accepted April 23, 1990
Communicated by F. Salamini

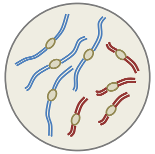
Theor Appl Genet (1995) 91:98–104

A. Barone · C. Gebhardt · L. Frusciante

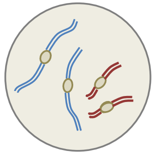
Heterozygosity in 2n gametes of potato evaluated by RFLP markers

BREEDING AT DIPLOID LEVEL

haploidization



4x - S. tuberosum



2x - S. tuberosum x Wild species - 2x

↓

Hybrid - 2x x S. tuberosum - 4x

▶ *2n gametes*

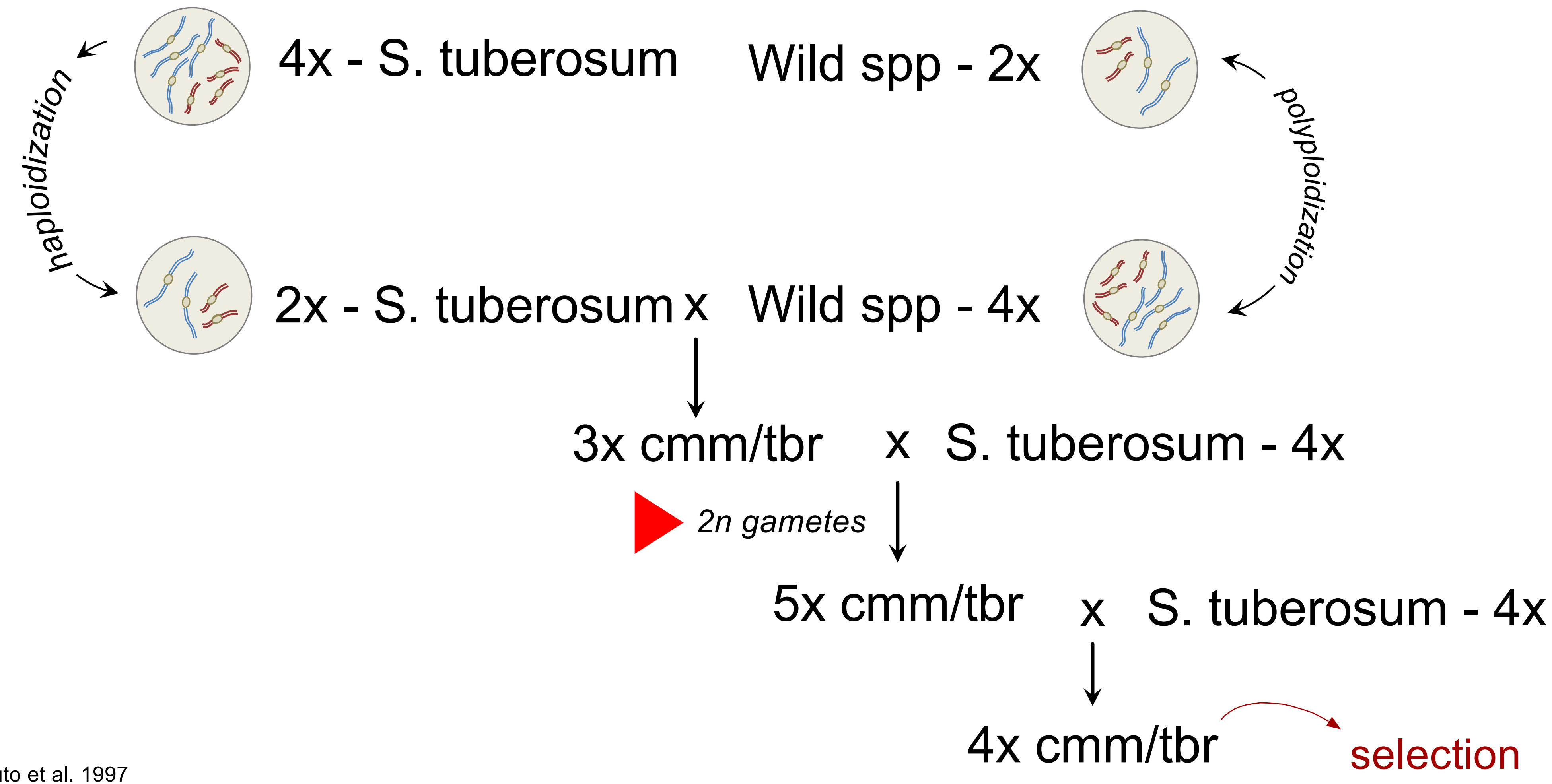
↓

New clones 4x

→ selection

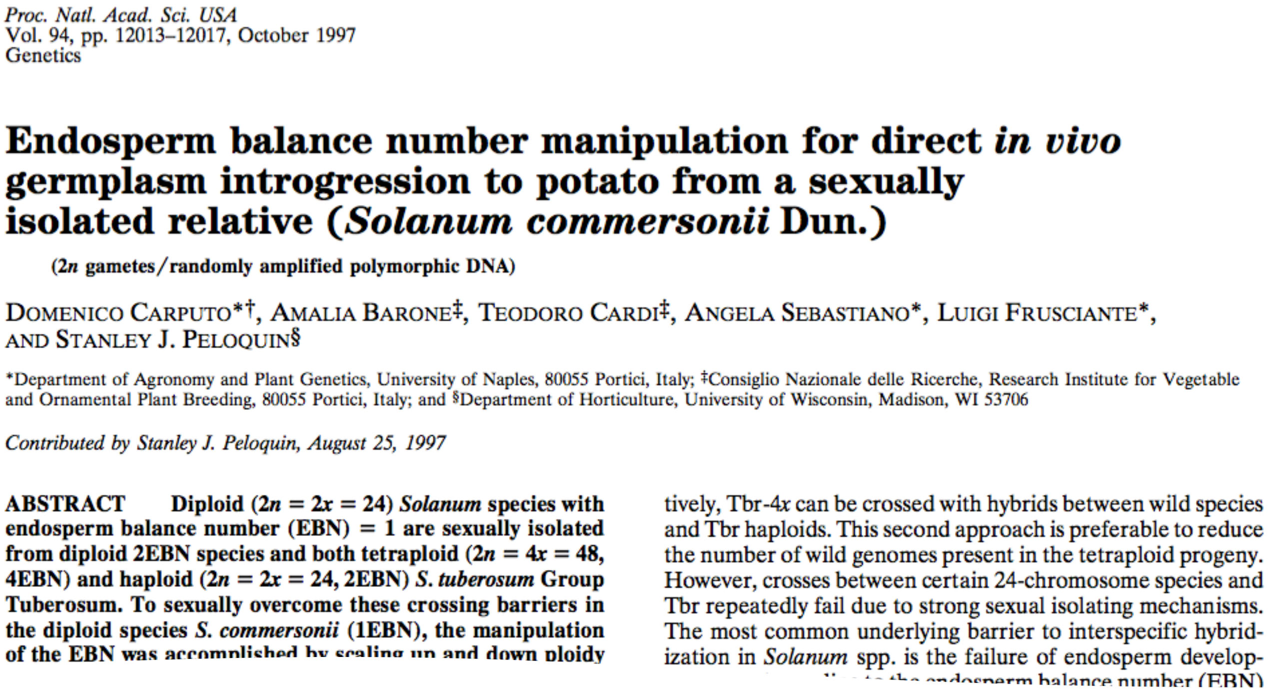
Carputo et al. 2003

BREEDING VIA PLOIDY MANIPULATION



Carputo et al. 1997

BREEDING AT POLYPLOID LEVEL



Proc. Natl. Acad. Sci. USA
Vol. 94, pp. 12013–12017, October 1997
Genetics

Endosperm balance number manipulation for direct *in vivo* germplasm introgression to potato from a sexually isolated relative (*Solanum commersonii* Dun.)

(2*n* gametes/randomly amplified polymorphic DNA)

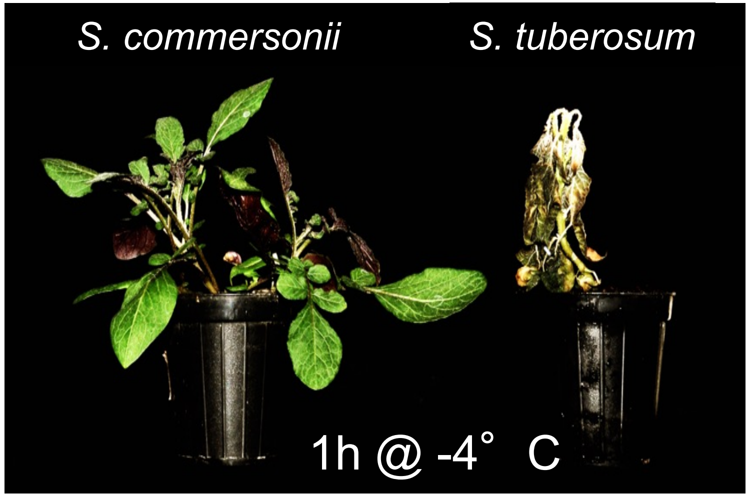
DOMENICO CARPUTO*†, AMALIA BARONE‡, TEODORO CARDI‡, ANGELA SEBASTIANO*, LUIGI FRUSCIANTE*, AND STANLEY J. PELOQUIN§

*Department of Agronomy and Plant Genetics, University of Naples, 80055 Portici, Italy; ‡Consiglio Nazionale delle Ricerche, Research Institute for Vegetable and Ornamental Plant Breeding, 80055 Portici, Italy; and §Department of Horticulture, University of Wisconsin, Madison, WI 53706

Contributed by Stanley J. Peloquin, August 25, 1997

ABSTRACT **Diploid (2*n* = 2*x* = 24) *Solanum* species with endosperm balance number (EBN) = 1 are sexually isolated from diploid 2EBN species and both tetraploid (2*n* = 4*x* = 48, 4EBN) and haploid (2*n* = 2*x* = 24, 2EBN) *S. tuberosum* Group Tuberosum. To sexually overcome these crossing barriers in the diploid species *S. commersonii* (1EBN), the manipulation of the EBN was accomplished by scaling up and down ploidy**

tively, Tbr-4*x* can be crossed with hybrids between wild species and Tbr haploids. This second approach is preferable to reduce the number of wild genomes present in the tetraploid progeny. However, crosses between certain 24-chromosome species and Tbr repeatedly fail due to strong sexual isolating mechanisms. The most common underlying barrier to interspecific hybridization in *Solanum* spp. is the failure of endosperm develop-



Species	NAC (°C)*	AC (-°C)**
S. commersonii	- 6.4	- 10.2
S. tuberosum	- 2.3	- 3.1

** NAC: non-acclimated*
***AC: acclimated*

Plant Breeding 119, 127—130 (2000)

ISSN 0179-9541

Tolerance to low temperatures and tuber soft rot in hybrids between *Solanum commersonii* and *Solanum tuberosum* obtained through manipulation of ploid endosperm balance number (EBN)

D. Carputo[1], T. Cardi[2], J. P. Palta[3], P. Sirianni[1], S. Vega[3] and L. Frusciante[1]

Euphytica
DOI 10.1007/s10681-014-1338-3

Genotype-specific changes associated to early synthesis of autotetraploids in wild potato species

Riccardo Aversano · Maria-Teresa Scarano · Giovanna Aronne · Immacolata Caruso · Vincenzo D'Amelia · Veronica De Micco · Carlo Fasano · Pasquale Termolino · Domenico Carputo

Secondary Metabolite Profile in Induced Tetraploids of Wild *Solanum commersonii* Dun.

by Immacolata Caruso[a])[1]), Laura Lepore[b])[1]), Nunziatina De Tommasi[b]), Fabrizio Dal Piaz[b]), Luigi Frusciante[a]), Riccardo Aversano[a]), Raffaele Garramone[a]), and Domenico Carputo*[a])

[a]) Department of Soil, Plant, Environmental, and Animal Production Sciences (DISSPAPA), University of Naples Federico II, Via Università 100, I-80055 Portici (Na) (phone: +39-081-2539225; fax: +39-081-2539481; e-mail: carputo@unina.it)
[b]) Department of Pharmaceutical Sciences, University of Salerno, Via Ponte don Melillo, I-84084 Fisciano (SA)

Amer J of Potato Res (2002) 79:345-352

Tuber Quality and Soft Rot Resistance of Hybrids between *Solanum tuberosum* and the Incongruent Wild Relative *S. commersonii*

menico Carputo[1*], Luigi Frusciante[1], Luigi Monti[2], Mario Parisi[1], and Amalia Barone[1]

Euphytica
DOI 10.1007/s10681-008-9673-x

Breeding potential of *Solanum tuberosum–S. commersonii* pentaploid hybrids: fertility studies and tuber evaluation

I. Caruso · L. Castaldi · G. Caruso · L. Frusciante · D. Carputo

JOURNAL OF AGRICULTURAL AND FOOD CHEMISTRY
J. Agric. Food Chem. **2002**, *50*, 1553–1561 **1553**

Glycoalkaloid Content and Chemical Composition of Potatoes Improved with Nonconventional Breeding Approaches

Fabrizio Esposito,† Vincenzo Fogliano,† Teodoro Cardi,‡ Domenico Carputo,§ and Edgardo Filippone*,§

Am. J. Pot Res (2009) 86:196–202
DOI 10.1007/s12230-009-9072-4

Resistance to *Ralstonia solanacearum* of Sexual Hy Between *Solanum commersonii* and *S. tuberosum*

Domenico Carputo · Riccardo Aversano · Amalia Barone · Antonio Di Matteo · Massimo Iorizzo · Loredana Sigillo · Astolfo Zoina · Luigi Frusciante

Theor Appl Genet (200
DOI 10.1007/s00122-003-1356-3

D. Carputo · A. Terra · A. Barone · F. Esposito · V. Fogliano · L. Monti · L. Frusciante

Glycoalkaloids and acclimation capacity of hybrids between *Solanum tuberosum* and the incongruent hardy species *Solanum commersonii*

THE SOMATIC FUSION

Solanum commersonii (+) *S. tuberosum* haploids

Theor Appl Genet (1993) 87:193–200

TAG THEORETICAL AND APPLIED GENETICS

Production of somatic hybrids between frost-tolerant *Solanum commersonii* and *S. tuberosum*: characterization of hybrid plants

T. Cardi [1]*, F. D'Ambrosio [2], D. Consoli [1], K. J. Puite [3], K. S. Ramulu [3]

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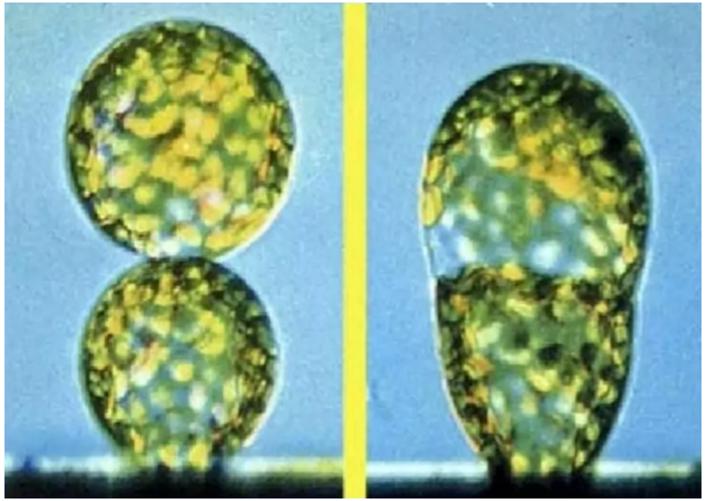

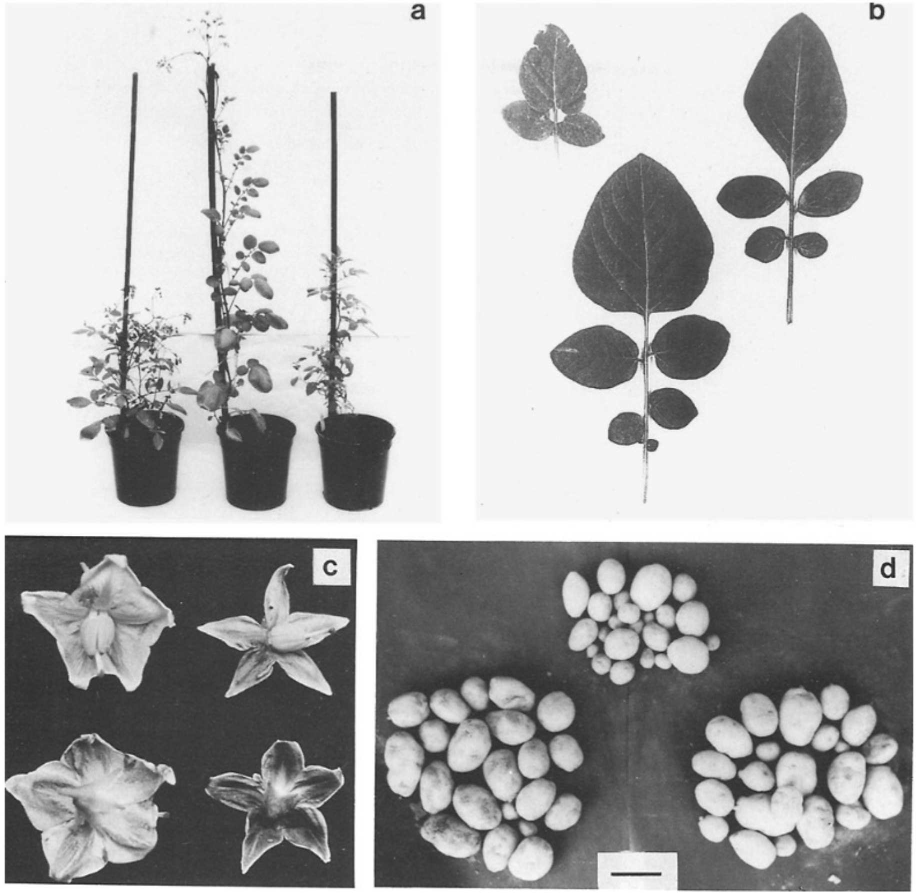

THE SOMATIC FUSION

1993) 753

PRODUCTION OF SOMATIC HYBRIDS BETWEEN FROST TOLERANT *SOLANUM COMMERSONII* AND *S. TUBEROSUM*: PROTOPLAST FUSION, REGENERATION AND ISOZYME ANALYSIS[1]

T. Cardi[2,*], K. J. Puite[3], K. S. Ramulu[3], F. D'Ambrosio[4], and L. Frusciante[4]

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Nuclear and cytoplasmic genome composition of *Solanum bulbocastanum* (+) *S. tuberosum* somatic hybrids

Marina Iovene, Salvatore Savarese, Teodoro Cardi, Luigi Frusciante, Nunzia Scotti, Philipp W. Simon, and Domenico Carputo

Abstract: Somatic hybrids between the wild incongruent species ...

Theor Appl Genet (1999) 99:819–828 © Springer-Verlag 1999

T. Cardi · T. Bastia · L. Monti · E.D. Earle

Organelle DNA and male fertility variation in *Solanum* spp. and interspecific somatic hybrids

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Fertility of somatic hybrids *Solanum commersonii* (2x, 1EBN) (+) *S. tuberosum* haploid (2x, 2EBN) in intra- and inter-EBN crosses[1]

D. Carputo, P. Garreffa, M. Mazzei, L. Monti, and T. Cardi

Abstract: *Solanum commersonii* (+) *S. tuberosum* hybrids with different endosperm balance numbers (EBN) and ploidy were used in various crossing schemes with 4EBN *S. tuberosum* cultivars and a 3EBN somatic hybrid to test their behavior in intra- and inter-EBN crosses and to derive a BC_1 population for potato breeding. The somatic hybrids included 12 tetraploids ($2n$ = 48, 3EBN), 18 hypotetraploids ($2n$ = 43–47, 3EBN), 2 hexaploids ($2n$ = 72, 4 or 5EBN),

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Theor Appl Genet (2002) 104:539–546 © Springer-Verlag 2002

A. Barone · J. Li · A. Sebastiano · T. Cardi · L. Frusciante

Evidence for tetrasomic inheritance in a tetraploid *Solanum commersonii* (+) *S. tuberosum* somatic hybrid through the use of molecular markers

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BIOLOGIA PLANTARUM 56 (1): 1-8, 2012

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Curr Genet (2004) 45: 378–382
DOI 10.1007/s00294-004-0496-6

RESEARCH ARTICLE

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The *rpl5–rps14* mitochondrial region: a hot spot for DNA rearrangements in *Solanum* spp. somatic hybrids

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Key words: cluster analysis, potato, principal component analysis, *Solanum commersonii*, *Solanum tuberosum*, somatic hybrids

OUTLINE

Conventional Breeding

Analitical Breeding

Genomics & Biotechnology

FUTURE

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The Plant Journal (2005) 44, 208–222

The *Rpi-blb2* gene from *Solanum bulbocastanum* is an *Mi-1* gene homolog conferring broad-spectrum late blight resistance in potato

Edwin A.G. van der Vossen[1,*], Jack Gros[2], Anne Sikkema[2], Marielle Muskens[2], Doret Wouters[1], Petra Wolters[1,†], Andy Pereira[2] and Sjefke Allefs[2]

[1] Plant Research International BV, PO Box 16, 6700 AA Wageningen, The Netherlands, and
[2] Agrico Research, PO Box 40, 8300 AA Emmeloord, The Netherlands

…eor Appl Genet (2001) 102:1265–1272

T. Bastia · N. Scotti · T. Cardi

Organelle DNA analysis of *Solanum* and *Brassica* somatic hybrids by PCR with 'universal primers'

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Substitutes for genome differentiation in tuber-bearing *Sola…* interspecific pollen-pistil incompatibility, nuclear-cytoplasmi… male sterility, and endosperm

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D. Carputo[1]*, D. Alioto[2], R. Aversa… C. Villano[1] and L. Frusciante[1]

[1] Department of Soil Plant, Environmental, a… Naples Federico II, Via Università 100, 800… Arboriculture, Botany and Plant Pathology, U… 100, 80055, Portici, Italy

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Theor Appl Genet (2003) 108:87–94
DOI 10.1007/s00122-003-1406-x

ORIGINAL PAPER

N. Scotti · L. Monti · T. Cardi

Organelle DNA variation in parental *Solanum* spp. genotypes and nuclear-cytoplasmic interactions in *Solanum tuberosum* (+) *S. commersonii* somatic hybrid-backcross progeny

Received: 16 February 2003 / Accepted: 12 May 2003 / Published online: 3 September 2003


Research Article
Genome Microscale Heterogeneity among Wild Potatoes Revealed by Diversity Arrays Technology Marker Sequences
Alessandra Traini,1 Massimo Iorizzo,2 Harpartap Mann,3 James M. Bradeen,3 Domenico Carputo,1 Luigi Frusciante,1 and Maria Luisa Chiusano1
1 Department of Agricultural Sciences, University of Naples Federico II, Via Università 100, 80055 Portici, Naples, Italy
Theor Appl Genet (1995) 91:98–104
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A. Barone · C. Gebhardt · L. Frusciante
Heterozygosity in 2n gametes of potato evaluated by RFLP markers
Food Chemistry 239 (2018) 789–796
Contents lists available at ScienceDirect
Food Chemistry
journal homepage: www.elsevier.com/locate/foodchem
Microstructure and tuber properties of potato varieties
genetic profiles
Contents lists available at ScienceDirect
Gene
journal homepage: www.elsevier.com/locate/gene
Research paper
Distinct gene networks drive differential response to abrupt or gradual water de cit in potato
Alfredo Ambrosone, Giorgia Batelli, Hamed Bostan, Nunzio D'Agostino, Maria Luisa Chiusano
Gaetano Perrotta, Antonietta Leone, Stefania Grillo, Antonello Costa
The Plant Journal (2002) 30(3), 361–371
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Localization by restriction fragment len
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to the potato cyst nematode Globodera rostoc
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Junqi Song, James M. Bradeen, S. Kristine Naess, John A. Raasch, Susan M. Wielgus, Geraldine T. Haberlach, Jia Liu, Hanhui Kuang, Sandra Austin-Phillips, C. Robin Buell, John P. Helgeson, and Jiming Jiang
A. Barone · A. Sebastiano · D. Carputo
L. Frusciante
Riccardo Aversano · Salvatore Savarese
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Contents lists available at SciVerse ScienceDirect
Journal of Geochemical Exploration
journal homepage: www.elsevier.com/locate/jgeoexp
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Research Article

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Gene

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Mole...ar marker-assisted ... of *Solanum comme...* ...ated *S. tuberosum* gene pool

...id DNA level ... species and hybrids

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Received: 16 February 2003 / Accepted: 12 May 2003 / Published online: 3 September 2003
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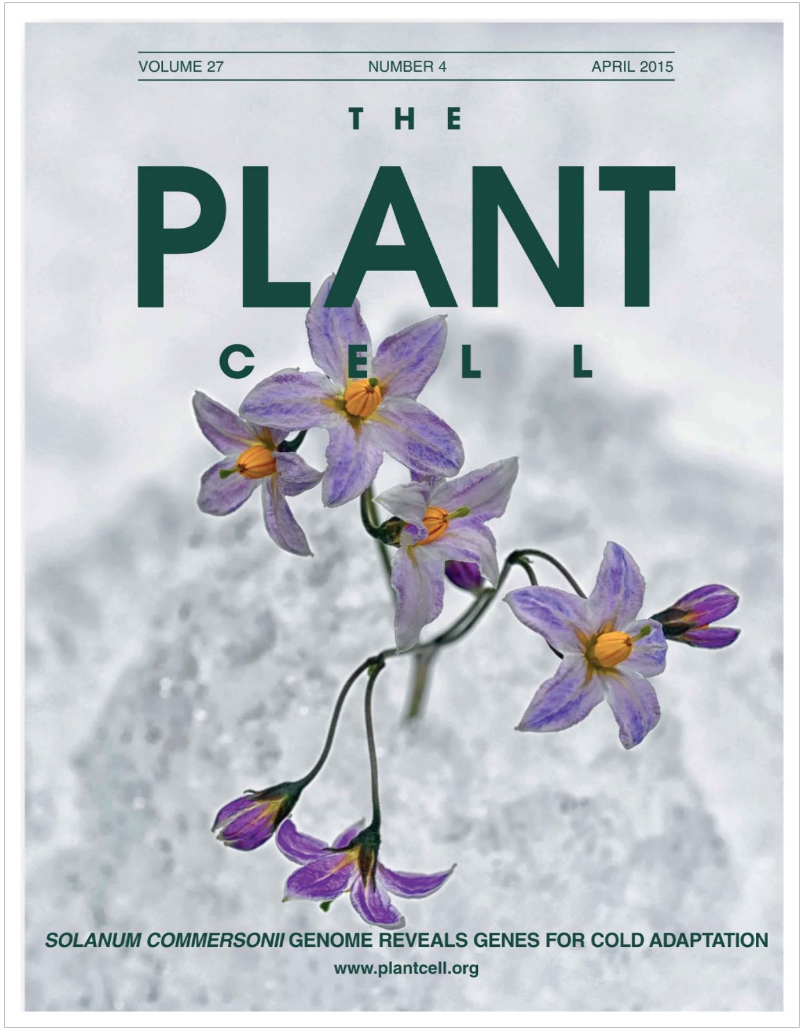
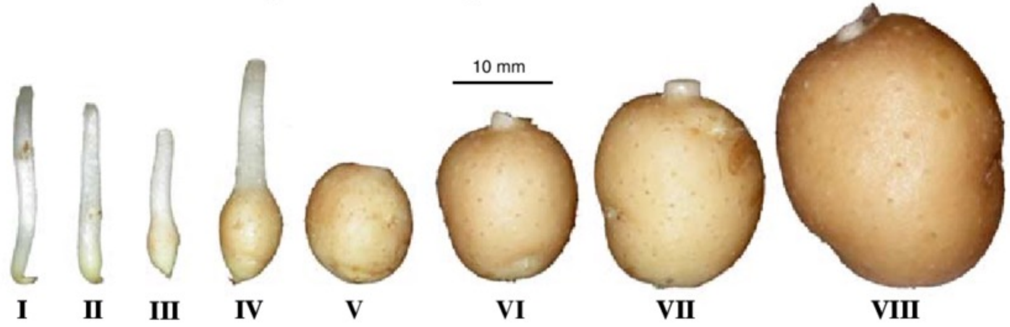
GENOMES REVEALED

The potato genome consortium 2011



Aversano et al. 2016

IDENTIFICATION OF GENES INVOLVED IN TUBERIZATION



Stage	Morphological and Weight Descriptions of Tuberization Stages
I	Hooked stolons with no swelling below the apical hook
II	Slight swelling below the apex begins to open apical hook
III	Further swelling in terminal 5 mm of stolon forces hook to open completely; developing tuber is less than twice the diameter of the stolon
IV	Longitudinal and radial expansion progress; developing tuber is approximately twice the diameter of the stolon.
V	0.6- to 1.5-g tuber
VI	1.5- to 2.5-g tuber
VII	2.5- to 5.0-g tuber
VIII	5- to 10-g tuber

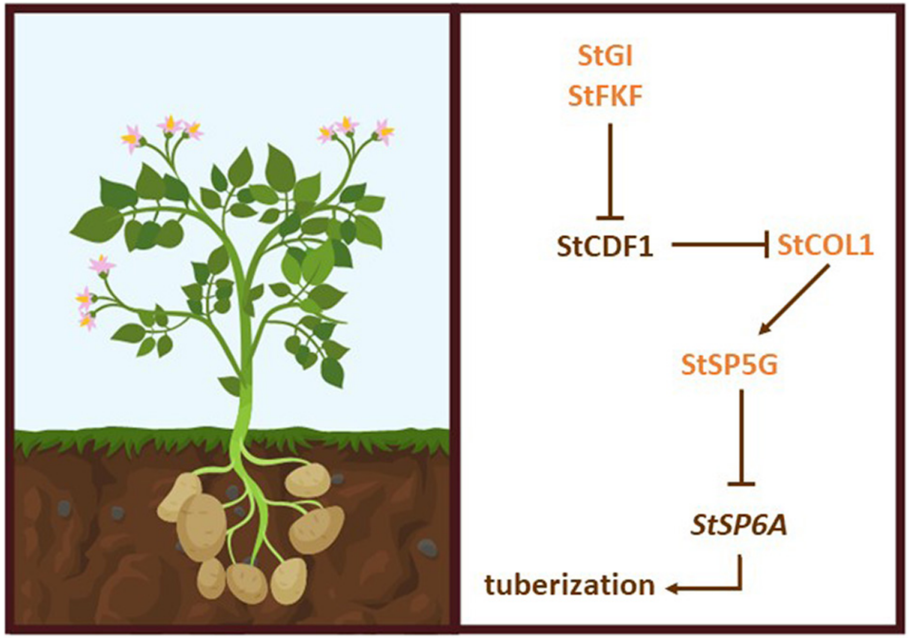
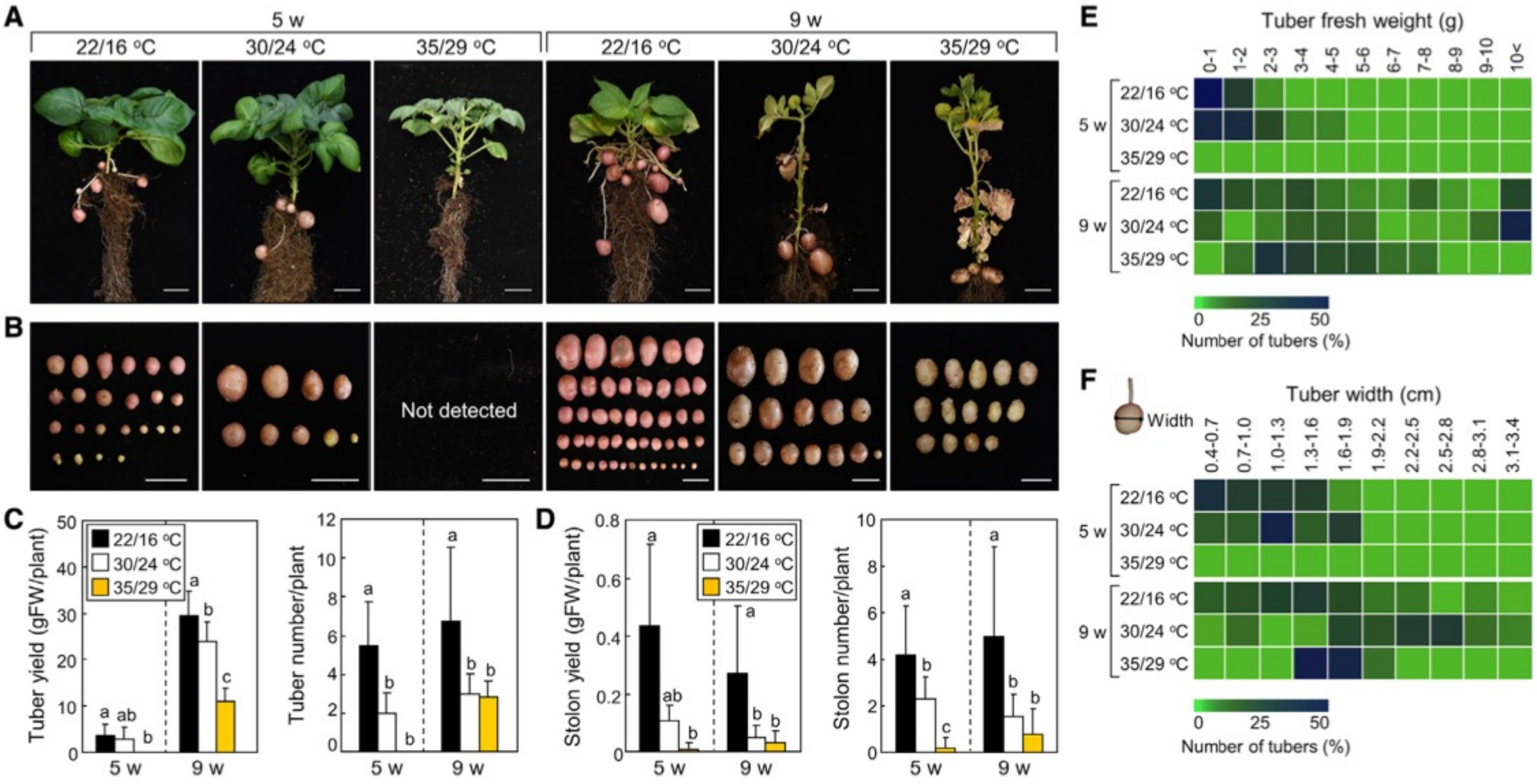


FIGURE 2 | Regulatory mechanism underlying tuber formation in potato. Right, components of the genetic pathway controlling tuberization. The tuberigen StSP6 is indirectly activated by StCDF1 and repressed by StCOL1 through StSP5G.

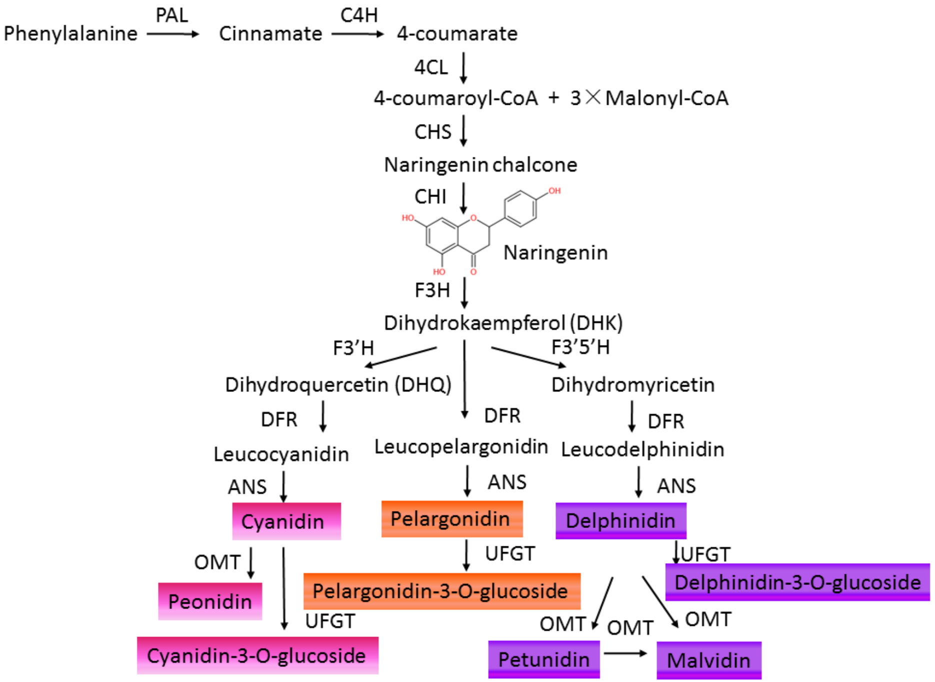
Osnato et al., 2022

POTATO TUBERIZATION IS SUPPRESED AT HIGH T.



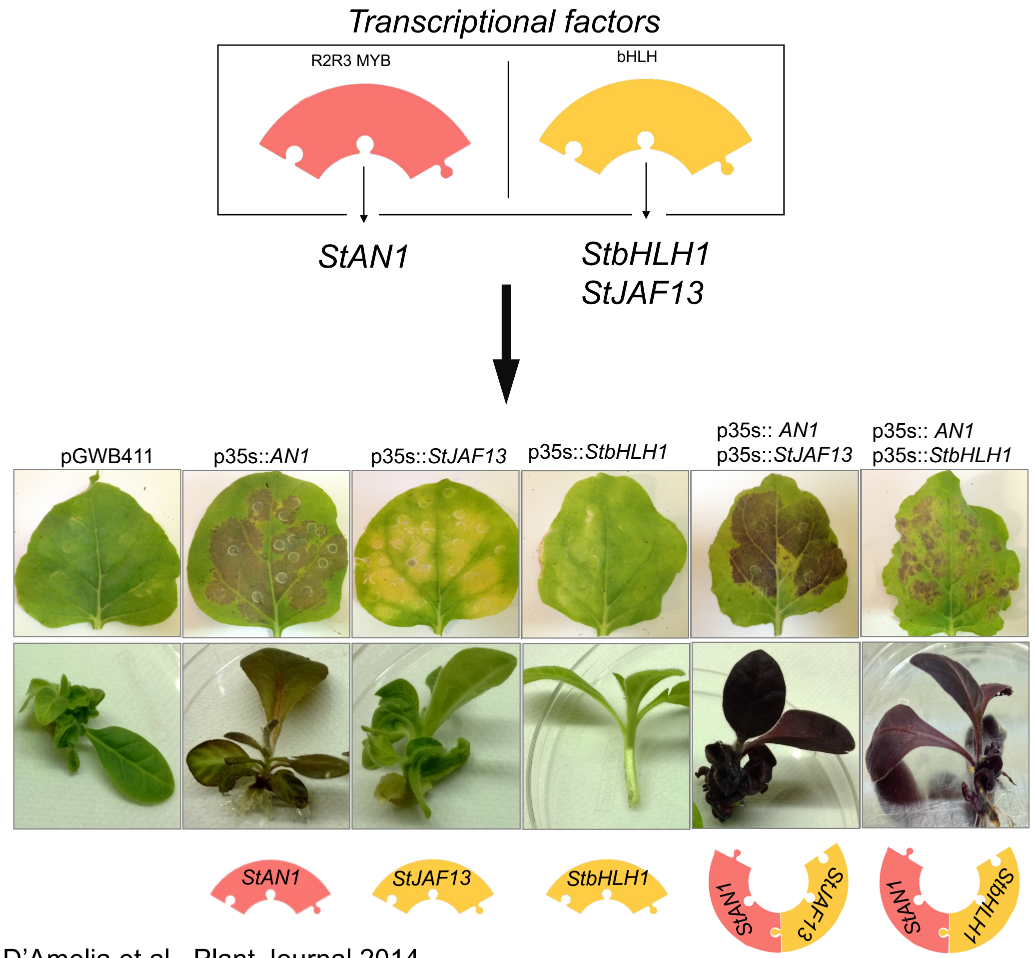
Park et al., 2022

POTATO: A RICH SOURCE OF ANTHOCYANIN MOLECULES



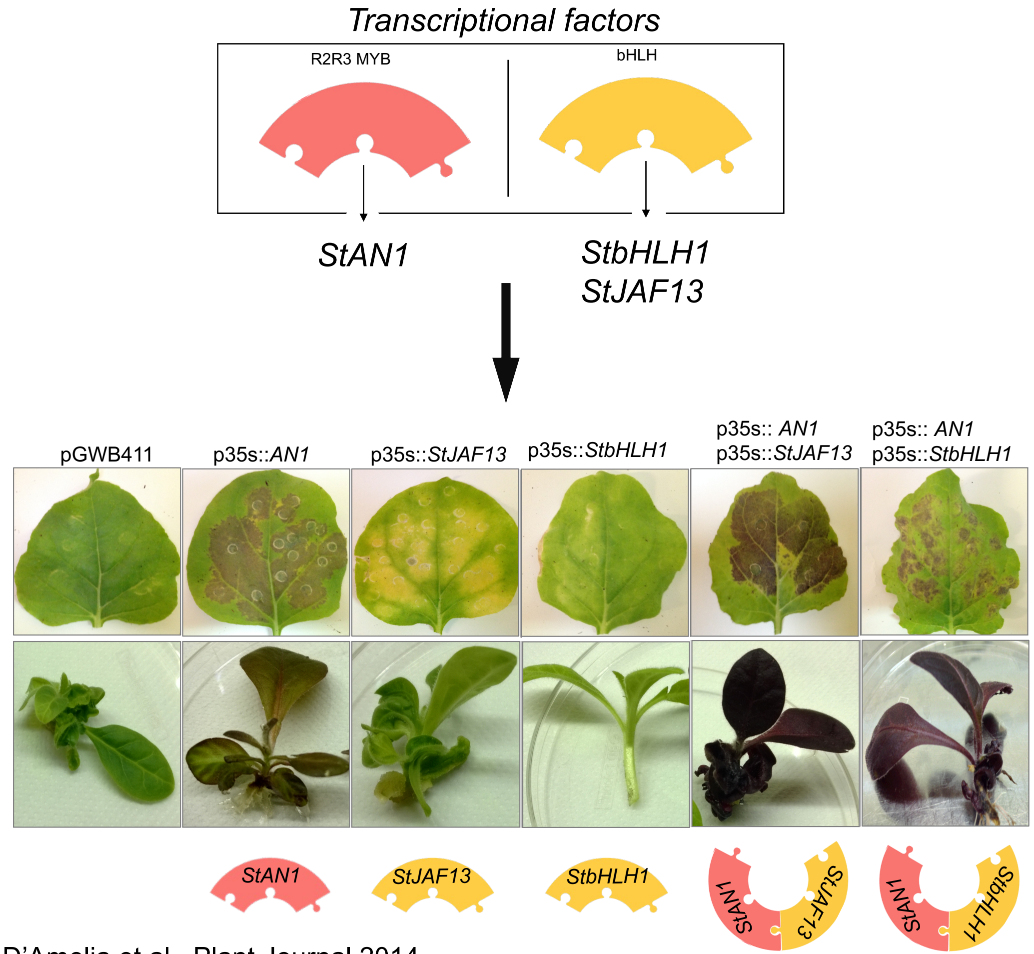
Pojer et al. 2013 PMID: 33412667

THE ANTOCHYANIN ACTIVATION COMPLEX GENES IN POTATO

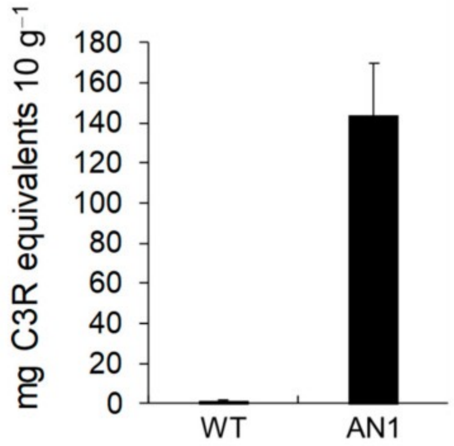


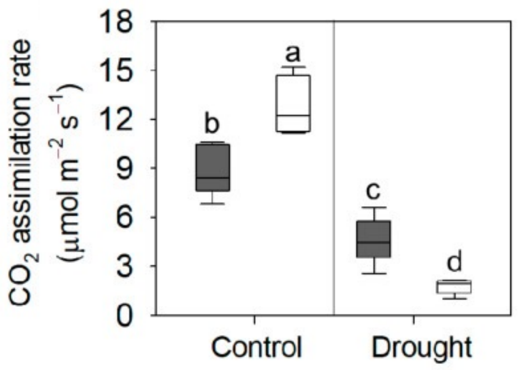
D'Amelia et al., Plant Journal 2014

THE ANTOCHYANIN ACTIVATION COMPLEX GENES IN POTATO



D'Amelia et al., Plant Journal 2014





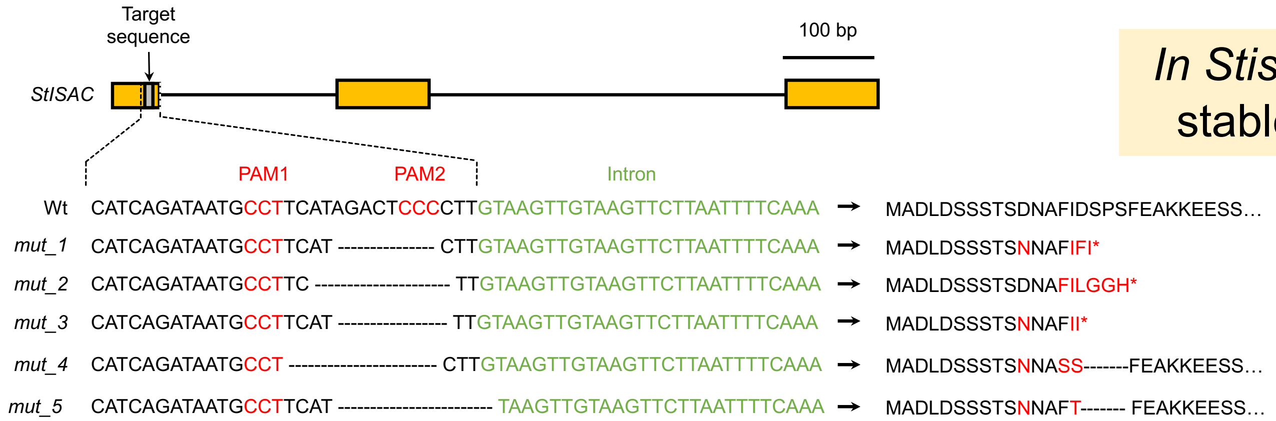
Cirillo et al. 2021 PMID: 33578910

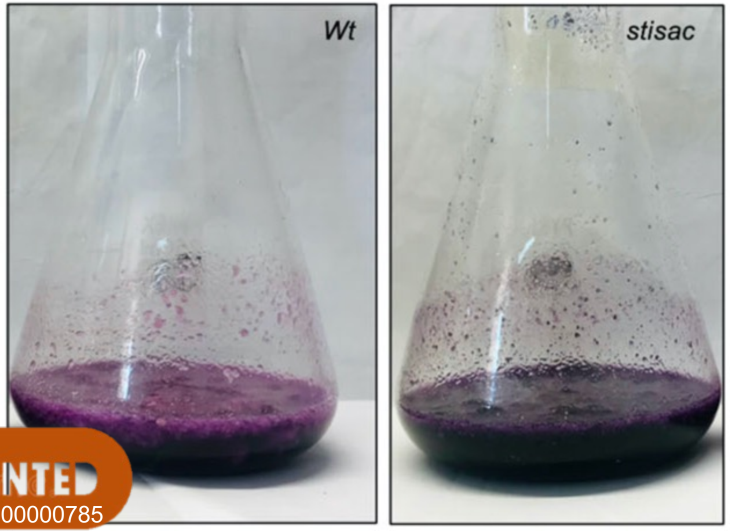
D'Amelia et al. 2016 Phytochemical Rev.

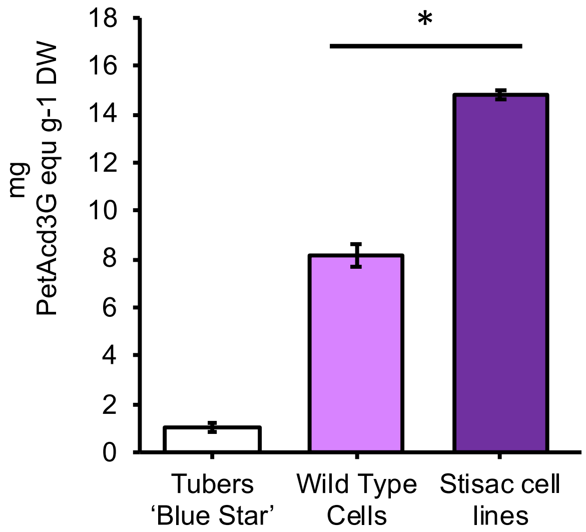
Anthocyanins reduce stress-related effects

BLUE CELLS STOP TO PRODUCE ANTHOCYANINS IN VITRO

In Stisac: doubled and stable anthocyanins







PATENTED
102021000000785

Metabolic Engineering of Potato Carotenoid Content

OPEN ACCESS Freely available online PLoS one

Metabolic Engineering of Potato Carotenoid Content through Tuber-Specific Overexpression of a Bacterial Mini-Pathway

Gianfranco Diretto[1,9], Salim Al-Babili[2,9], Raffaela Tavazza[1], Velia Papacchioli[1], Peter Beyer[2], Giovanni Giuliano[1*]

1 Ente per le Nuove Tecnologie, l'Energia e l'Ambiente (ENEA), Casaccia Research Center, Roma, Italy, 2 Faculty of Biology, Universität Freiburg, Freiburg, Germany

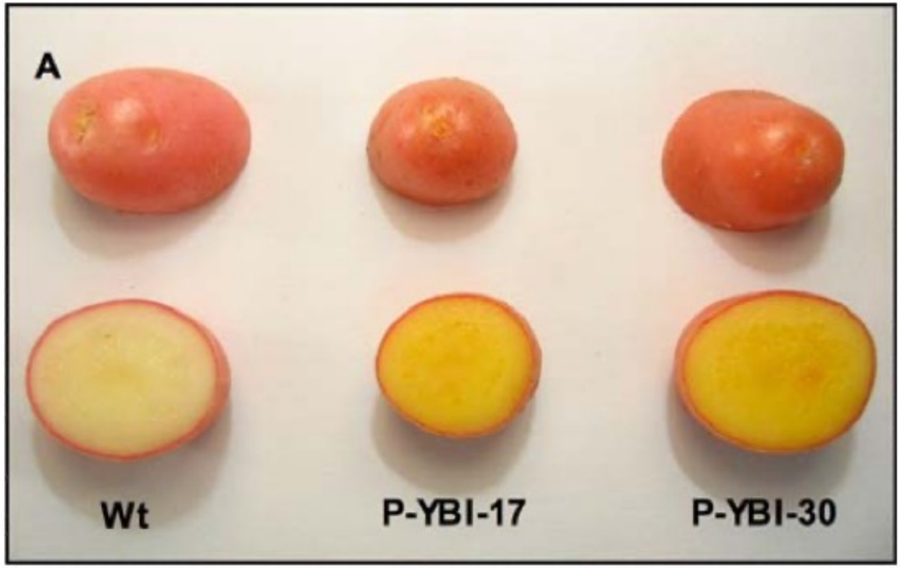
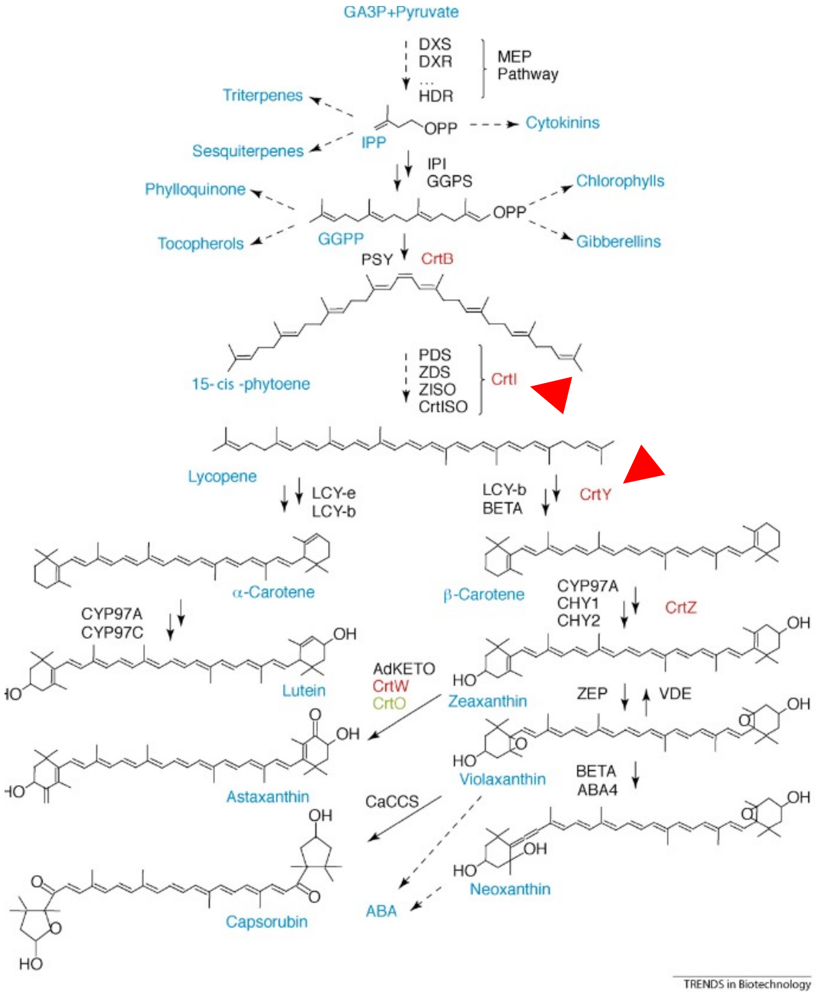


Figure 3. Tuber and leaf phenotypes of transgenic lines. A.Tuber phenotypes. B.Leaf phenotypes, viewed in transmitted light. The difference in size of the middle leaf is not representative.
doi:10.1371/journal.pone.0000350.g003



OUTLINE

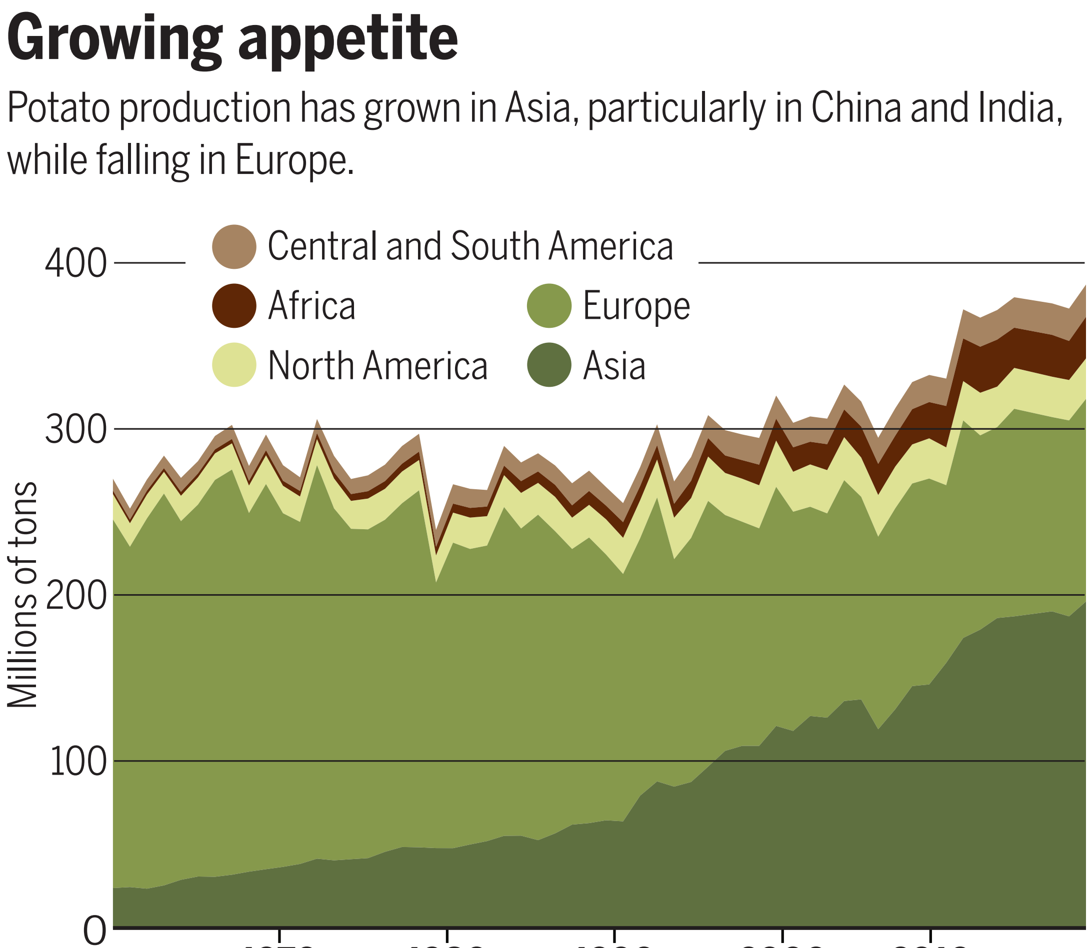
Conventional Breeding

Analitical Breeding

Genomics & Biotechnology

FUTURE

UPDATING A STAPLE FOOD



Stokstad, Science 2019

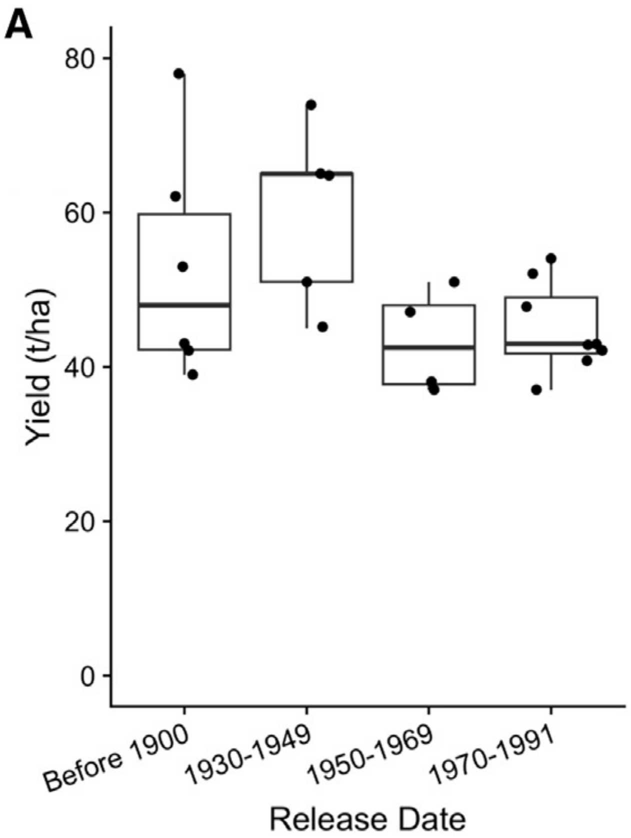


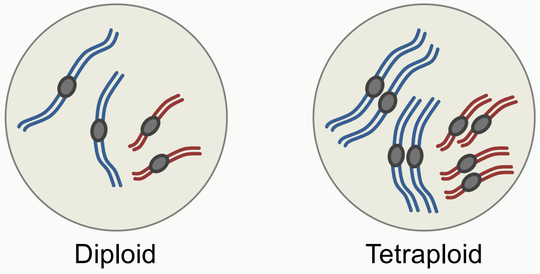
Figure 1. Tetraploid potato in the United States has made little to no genetic gain for yield due to the complexity of the genome

(A) Yield data (in tonnes/hectare) from 23 major US cultivars released between the late 19th and 20th centuries grown in a common field in 1990–1992 in the Montcalm Research Farm, Entrican, MI.[1] No significant increase in yield was observed through the ~100 years of breeding, with the highest yielding cultivar released before 1900.

Agha et al., Cell Genomics 2023

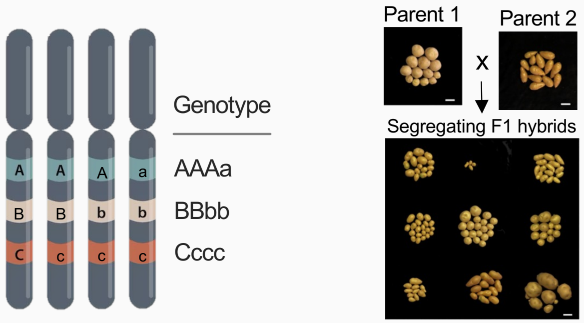
COMPLEX POTATO GENETICS

POLYPLOIDY



Cultivated potatoes are tetraploid, complicating genetic studies and breeding due to multiple sets of chromosomes, which obscure the inheritance of traits.

HETEROZYGOSITY



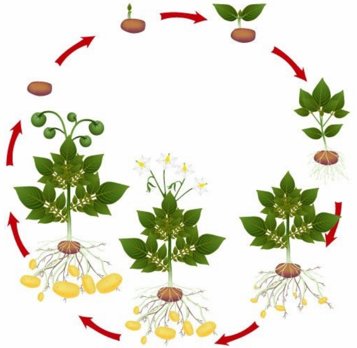
High levels of heterozygosity in potato make it difficult to achieve stable inbred lines necessary for hybrid breeding.

DELETERIOUS MUTATIONS

Genotype at locus	Other possible heterozygous genotypes at locus
AAAa*	Aa*a*a*, Aa*a*a*
BBb*b*	BBBb*, Bb*b*b*,
Cc*c*c*	CCc*c*, CCCc*

Many harmful mutations (*) are masked in heterozygous states but become problematic during inbreeding, reducing plant fitness and yield.

CLONAL PROPAGATION

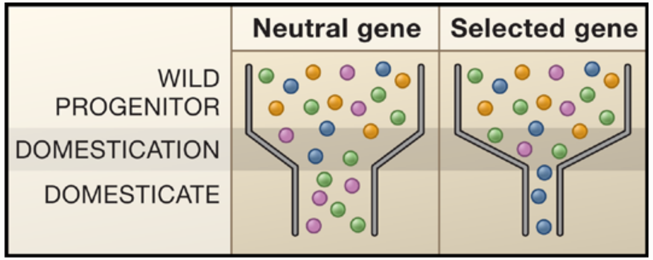


Potatoes are typically propagated clonally, which leads to the accumulation of deleterious mutations and limits genetic diversity.

BREEDING TIME

Developing improved varieties is slow due to the long generation time and the need for extensive testing to ensure desirable traits like disease resistance and yield stability.

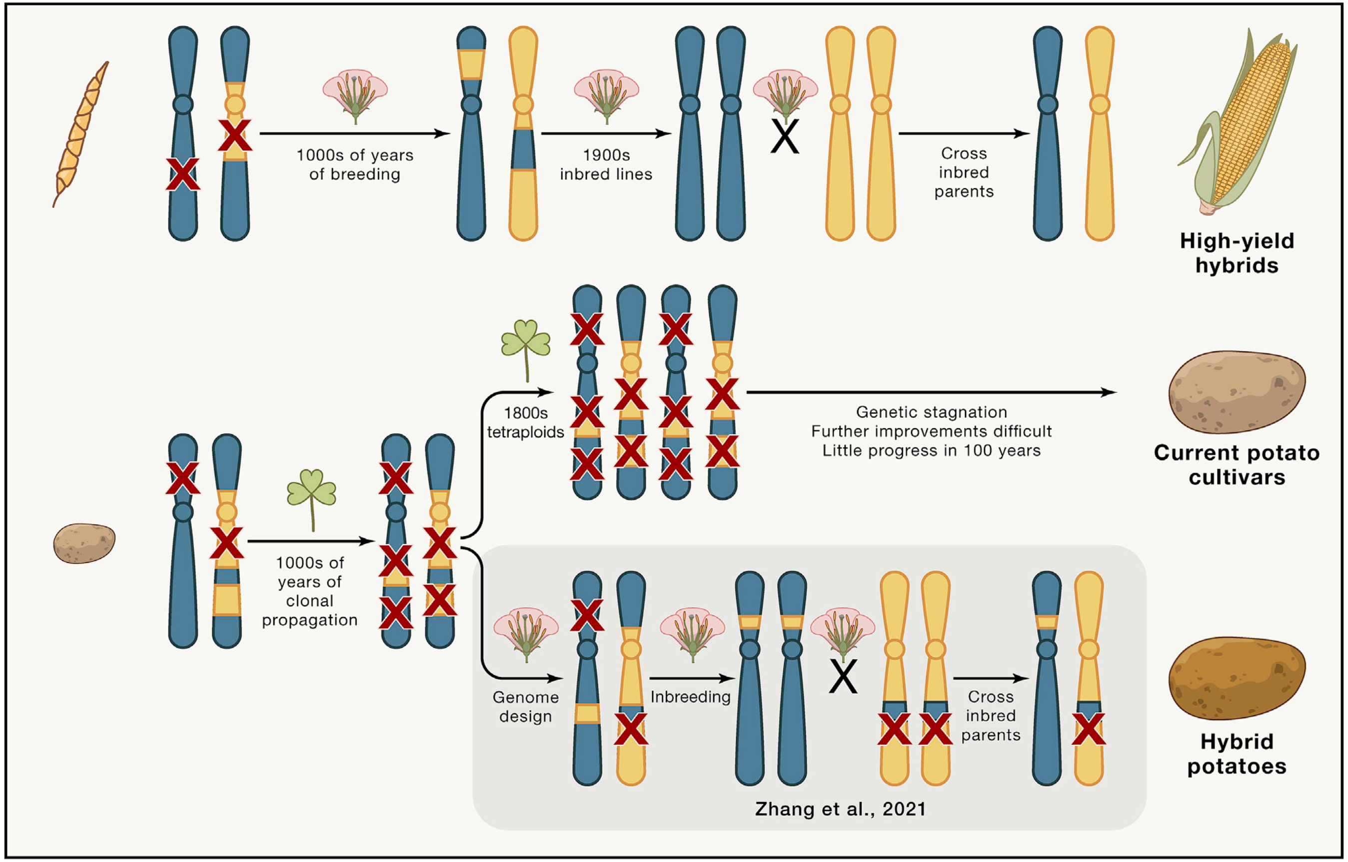
GENETIC BOTTLENECKS



Historical reliance on a narrow genetic base has reduced diversity, making crops more susceptible to diseases and environmental stresses.

UPDATING A STAPLE FOOD

Stokstad, Science 2019



Markel and Shil, Cell 2021

REINVENTION OF POTATO

Cell

CellPress

Article

Genome design of hybrid potato

Chunzhi Zhang,[1] Zhongmin Yang,[1] Dié Tang,[1] Yanhui Zhu,[1] Pei Wang,[1] Dawei Li,[1] Guangtao Zhu,[2] Xingyao Xiong,[1] Yi Shang,[2] Canhui Li,[2] and Sanwen Huang[1,3,*]

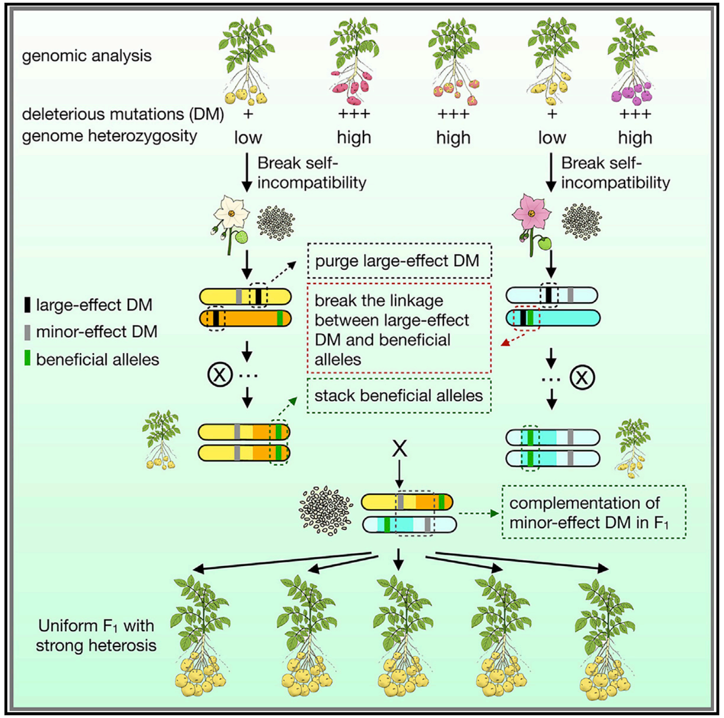
[1]Shenzhen Branch, Guangdong Laboratory of Lingnan Modern Agriculture, Genome Analysis Laboratory of the Ministry of Agriculture and Rural Affairs, Agricultural Genomics Institute at Shenzhen, Chinese Academy of Agricultural Sciences, Shenzhen, Guangdong 518120, China

[2]The AGISCAAS-YNNU Joint Academy of Potato Sciences, Yunnan Normal University, Kunming, Yunnan 650500, China

[3]Lead contact

*Correspondence: huangsanwen@caas.cn

https://doi.org/10.1016/j.cell.2021.06.006



Cell 184, 3873–3883, July 22, 2021

Cell

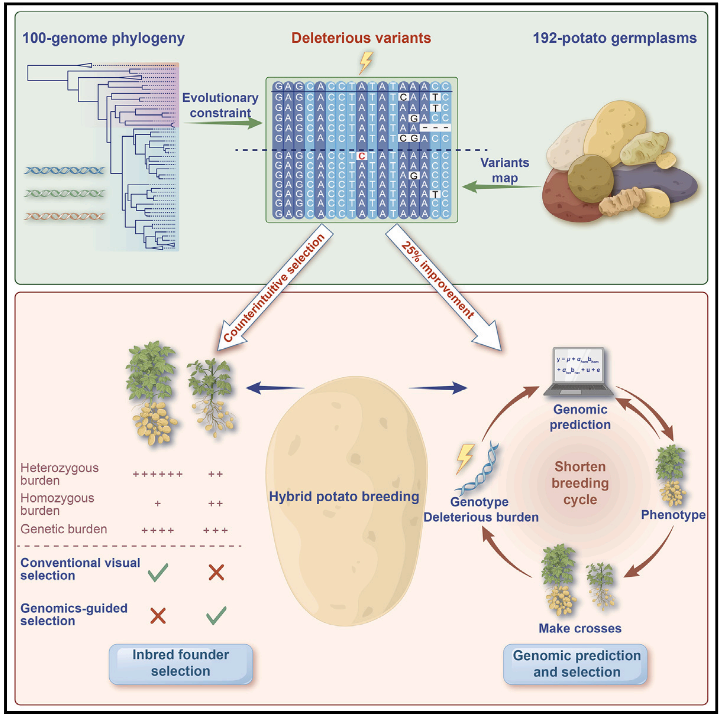
CellPress

Article

Phylogenomic discovery of deleterious mutations facilitates hybrid potato breeding

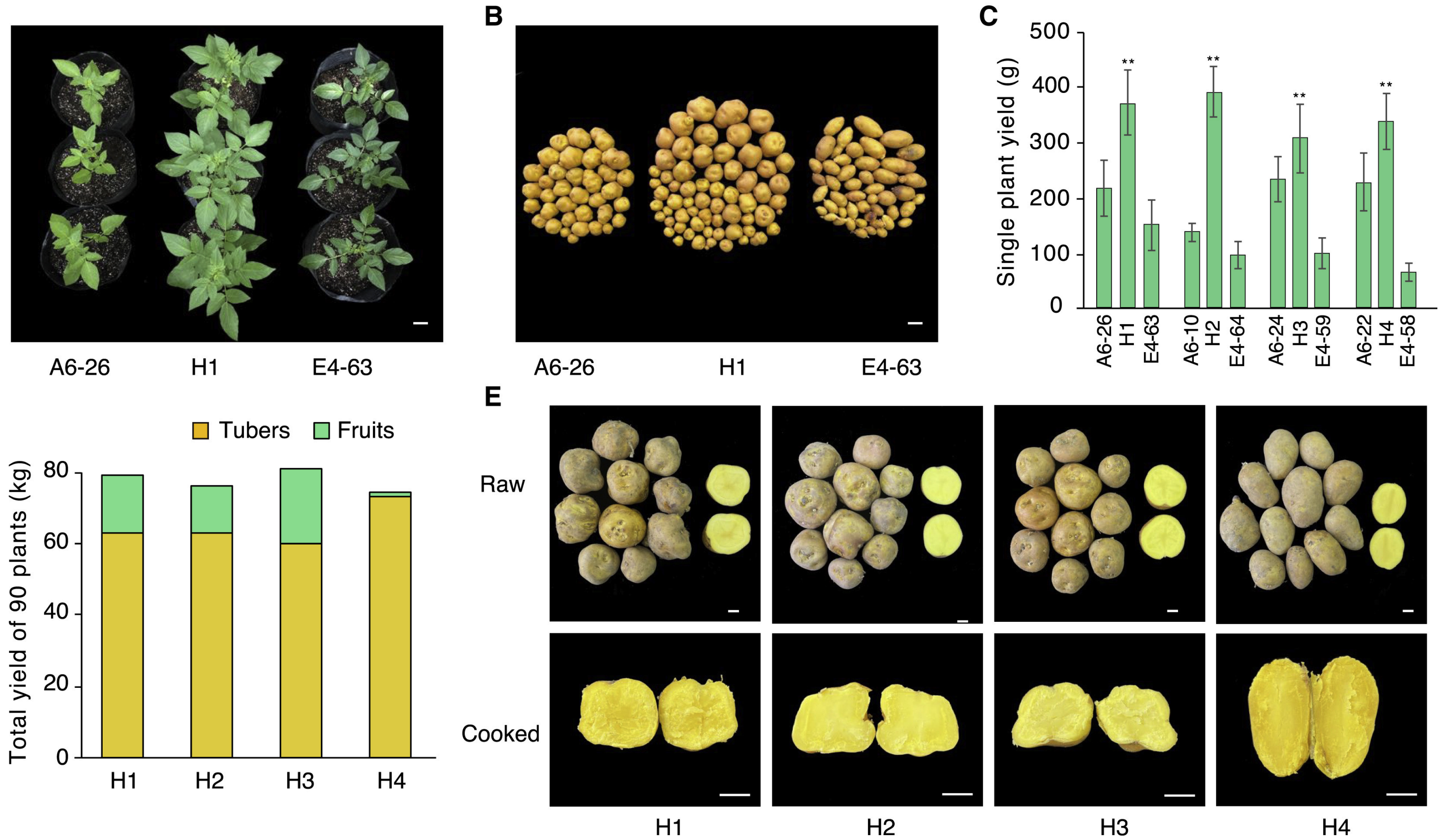
Yaoyao Wu,[1,2,16] Dawei Li,[1,3,16] Yong Hu,[1,4,16] Hongbo Li,[1,17] Guillaume P. Ramstein,[5,17] Shaoqun Zhou,[1] Xinyan Zhang,[1] Zhigui Bao,[1,6] Yu Zhang,[1,7] Baoxing Song,[8] Yao Zhou,[1,9,10] Yongfeng Zhou,[1] Edeline Gagnon,[11] Tiina Särkinen,[12] Sandra Knapp,[13] Chunzhi Zhang,[1] Thomas Städler,[14] Edward S. Buckler,[2,15] and Sanwen Huang[1,3,18,*]

[1]State Key Laboratory of Tropical Crop Breeding, Shenzhen Branch, Guangdong Laboratory of Lingnan Modern Agriculture, Genome Analysis Laboratory of the Ministry of Agriculture and Rural Affairs, Agricultural Genomics Institute at Shenzhen, Chinese Academy of Agricultural Sciences, Shenzhen, Guangdong 518120, China



Cell 186, 2313–2328, May 25, 2023

FROM BREEDING TO GENOME DESIGN



Zhang et al., Cell 2021

GENE EDITING REVOLUTION

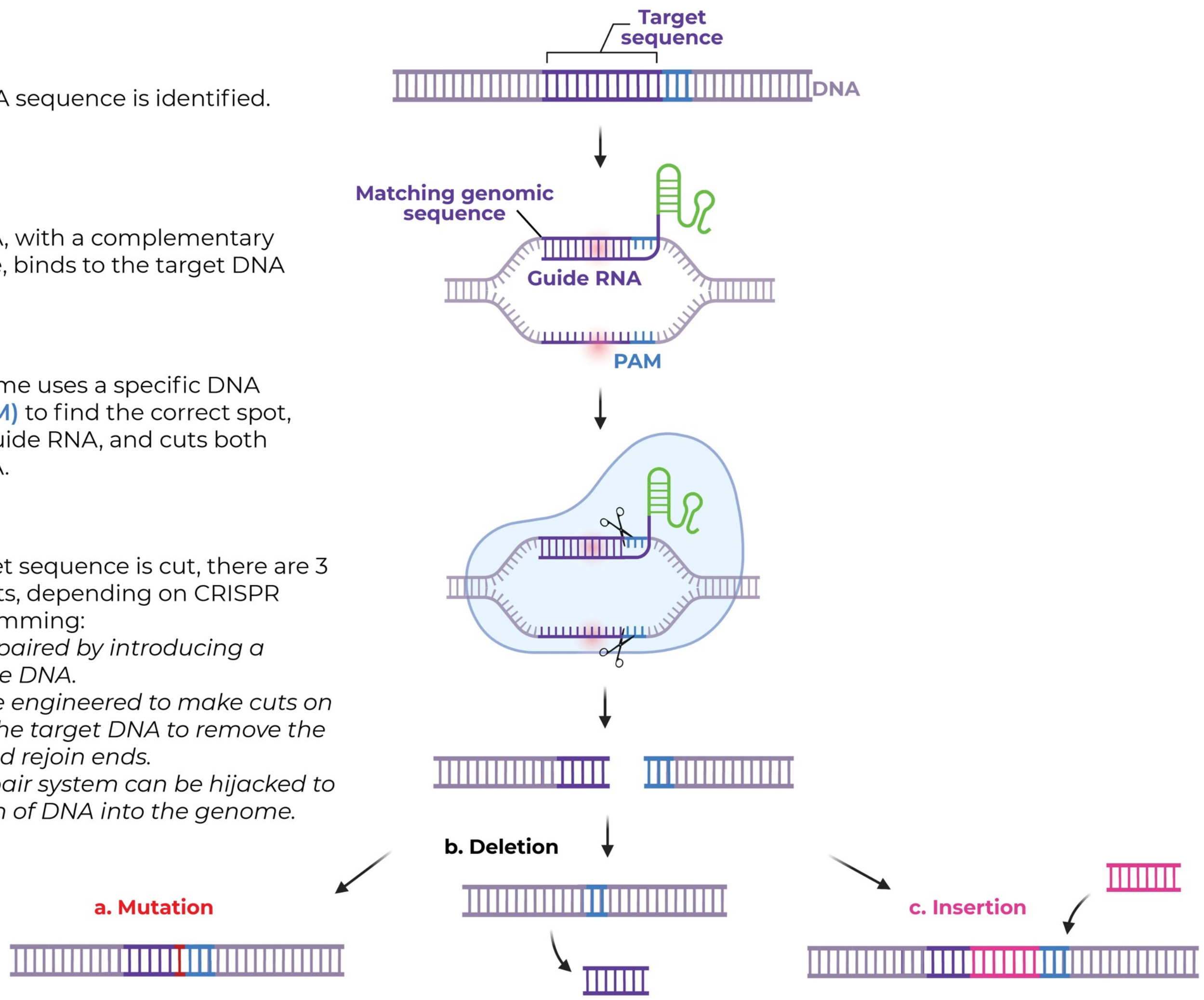
GENE EDITING REVOLUTION

1. The target DNA sequence is identified.

2. The guide RNA, with a complementary DNA sequence, binds to the target DNA sequence.

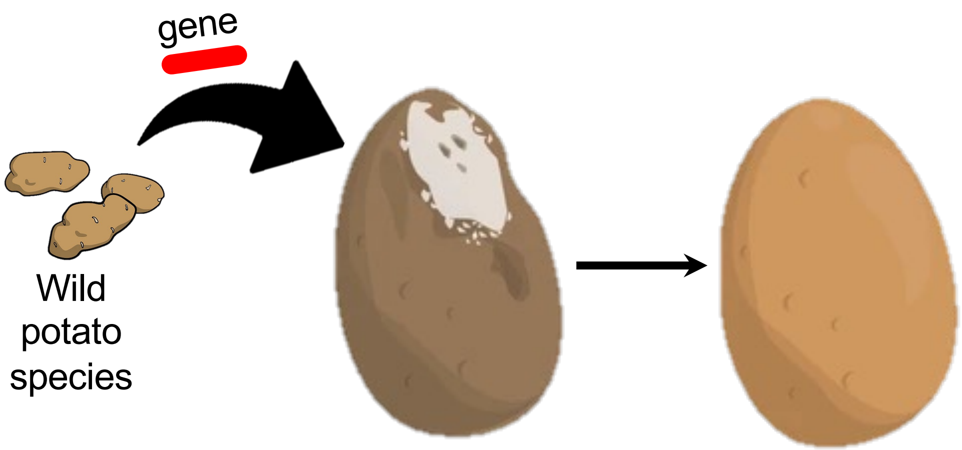
3. The Cas9 enzyme uses a specific DNA sequence (PAM) to find the correct spot, binds to the guide RNA, and cuts both strands of DNA.

4. Once the target sequence is cut, there are 3 potential results, depending on CRISPR system programming:
a. The cut is repaired by introducing a mutation in the DNA.
b. Enzymes are engineered to make cuts on either side of the target DNA to remove the target DNA and rejoin ends.
c. The DNA repair system can be hijacked to insert a section of DNA into the genome.



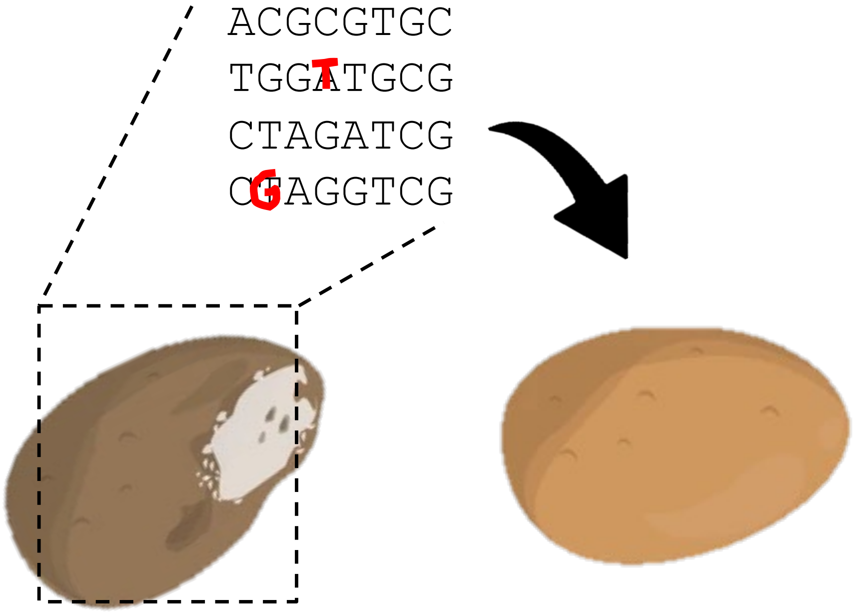
NBTs PRESERVE TRADITIONAL VARIETIES

Fast | Accurate | Identity remains unchanged



Insertion through genetic engineering of genes in their native form taken from the same species or from sexually compatible species.

CISGENESIS



Edit the DNA in a targeted manner at a specific position within the DNA. Mutations similar to those that would naturally occur spontaneously.

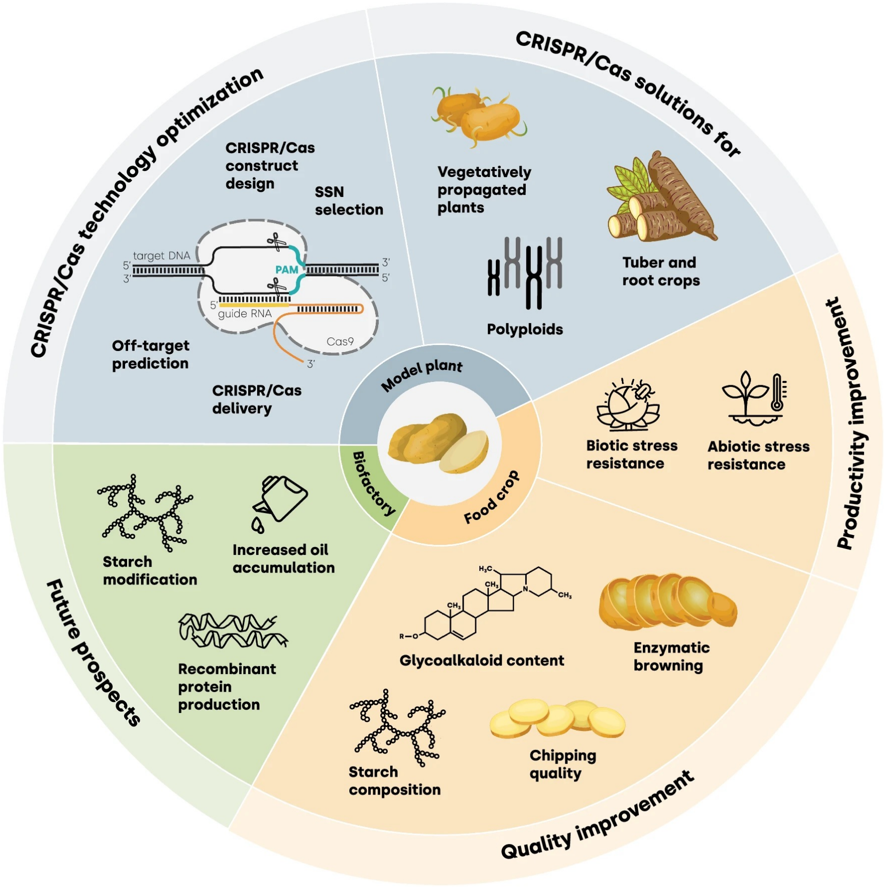
GENOME EDITING

POTATO IMPROVEMENT CRISPR/Cas GENOME EDITING

Applications of CRISPR/Cas system-mediated genome editing in potato

Trait	Editing Tool	Name of target genes	Type of edit
Genetic breeding	CRISPR/Cas9	Sp3 and Sp4	Gene knockout
	CRISPR/Cas9	S-Rnase	Gene knockout
	CRISPR/Cas9	StD6PK and StSIEL	Gene knockout
	CRISPR/Cas9	Sli	Gene knockout
Stress resistance	CRISPR/Cas9	StDND1, StCHL1, and StDMR6-1	Gene knockout
	CRISPR/Cas9	StFLORE	Promoter mutation
	CRISPR/Cas9	StCCoAOMT	Gene knockout
	CRISPR/Cas9	tMYB44	Gene knockout
	CRISPR/Cas13a	LshCas13a	Gene knockout
Improved quality	CRISPR/Cas9	tGBSS	Gene knockout
	CRISPR/Cas9	StGBSSI	Gene knockout
	A3A-CBE	StGBSSI	Base editing
	CRISPR/Cas9	StGBSSI	Gene knockout
	CRISPR/Cas9	StGBSSI	Gene knockout
	PmCDA1-CBE	StGBSSI	Base editing
	CRISPR/Cas9	StGBSSI	Gene knockout
	CRISPR/Cas9	SBE1 and SBE2	Gene knockout
	CRISPR/Cas9	SBE1 and SBE2	Gene knockout
	CRISPR/Cas9	AtCGS and StMGL	Gene knockout
	CRISPR/Cas9	St16DOX	Gene knockout
	CRISPR/Cas9	StSSR2	Gene knockout
	CRISPR/Cas9	StPPO2	Gene knockout
Improved yield	CRISPR/Cas9	StIT1	Gene knockout

Hou et al. Front. Genet. 2023



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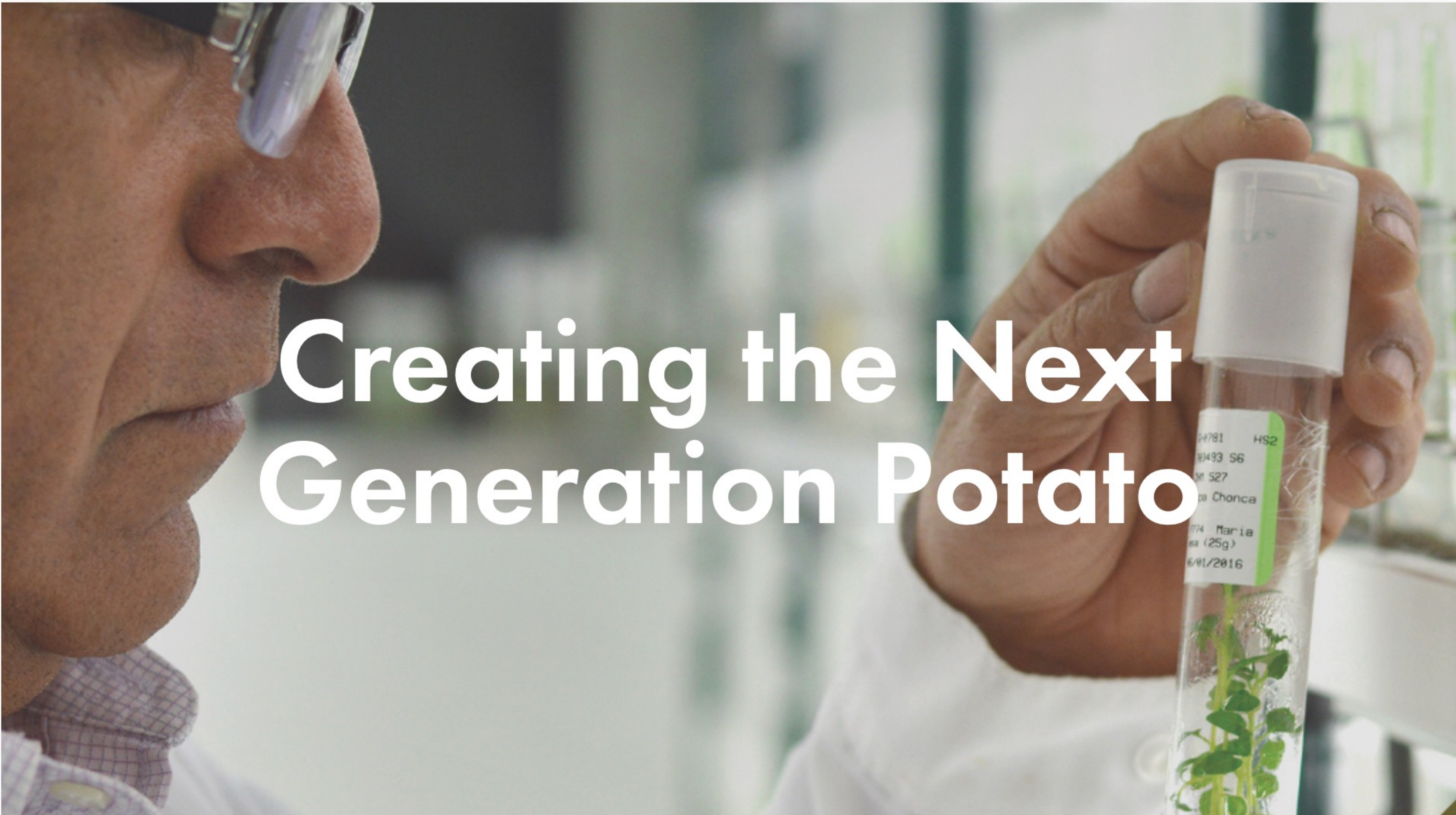
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