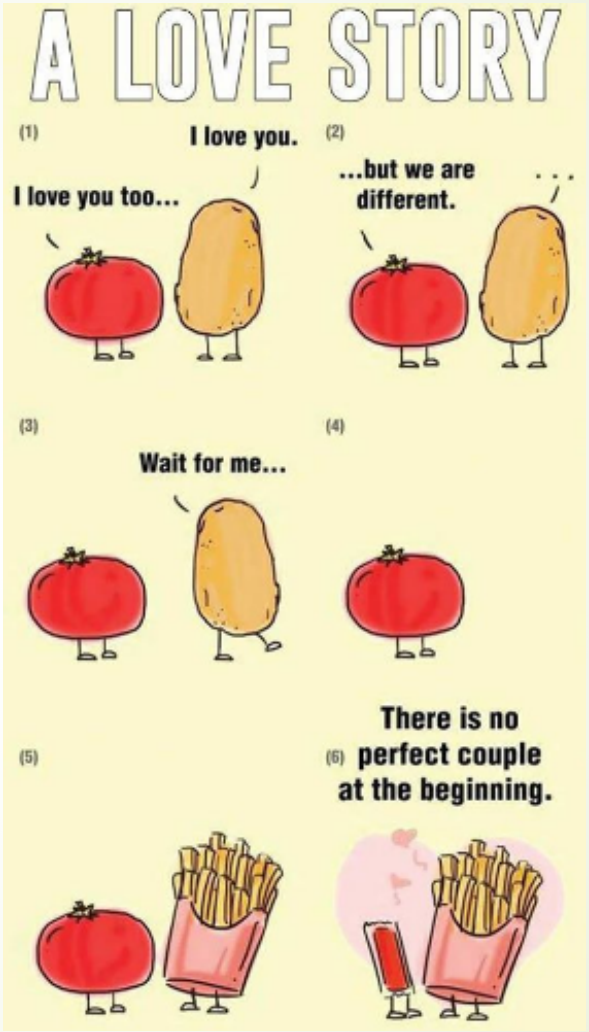
Tomato and Potato ?



https://www.pinterest.de/pin/518969557035407087

What is the **genetic relationship** between cultivated **Potato** and **Tomato**?

Isabell Naumann

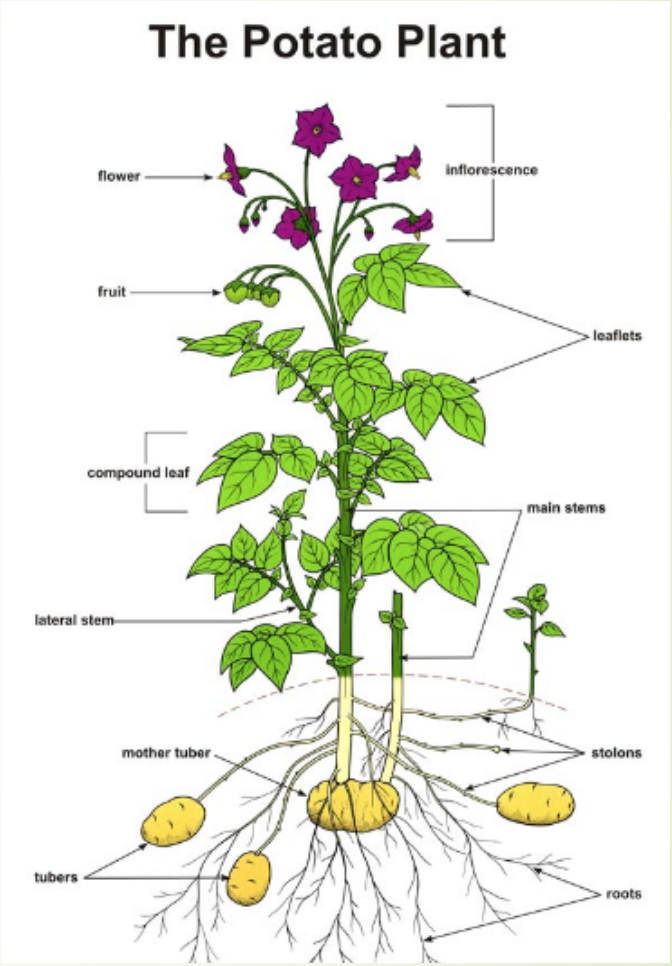
Food & Genes, 09.12.19

Introduction

- Solanaceae / nightshade family
- >3000 species
  - Tomato (Solanum lypersicum), potato (Solanum tuberosum)
- Economically third most important
  - number one in terms of vegetable crops
- Great adaptability to diverse climate conditions

Introduction - Potato

- Angiosperms -> Eudicots -> Asterics -> Solanales -> Solanaceae -> Solanum -> **Solanum tuberosum**
- Tetraploid with 48 Chromosomes
- Native to america,
  - domesticated 7000-10000 years ago
- Genome size: 840 Mb



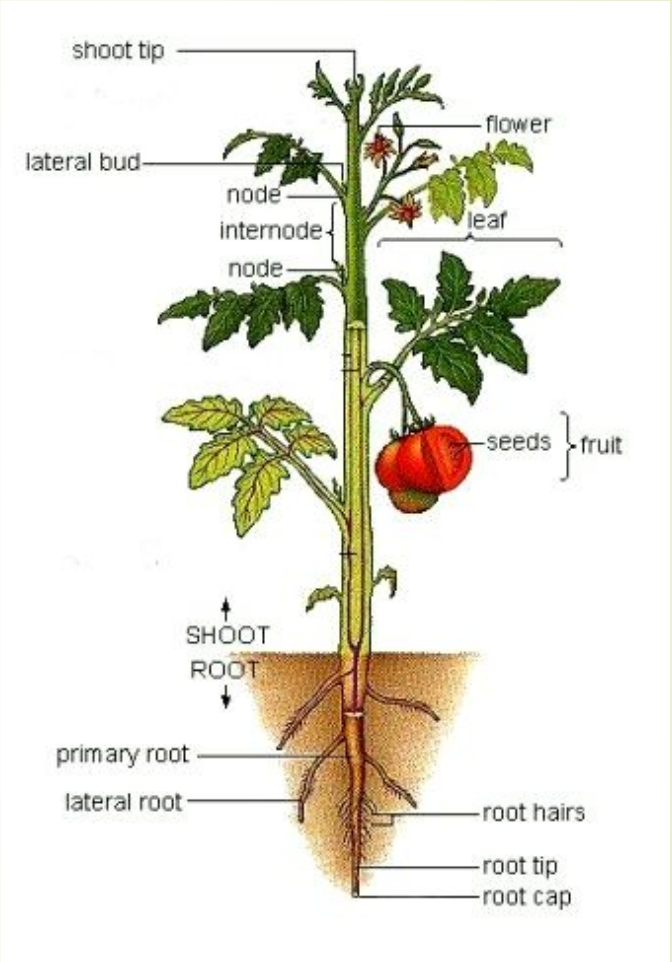
https://cipotato.org/crops/potato/how-potato-grows/

Introduction - Potato

- 1500 -> Europe via the Canary Islands
- Non-inbred
- heterozygous
- What do we eat?

Introduction - Tomato

- Angiosperms -> Eudicots -> Asterics -> Solanales -> Solanaceae -> Solanum -> **Solanum lypersicum**
- Diploid with 24 Chromosomes
- Native to South and Central America
- Genome size 950 Mb



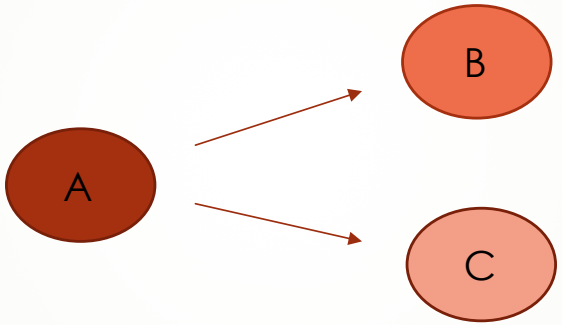
https://www.pinterest.de/pin/215469163399485079/

Introduction - Tomato

- 1521 -> Europe, after the Spanish conquest in Mexico
- Plant model
- 67 million years ago -> Polyploidization in ancestor

Definitions

- Pfam = database of protein families
- Homology



  - ortholog, paralog

Definitions

- Synteny = physical co-localization of genetic loci on the same chromosome within species
- BAC - FISH

Similarities & Differences: Potato – Tomato

- Is the potato and tomato genome sharing various genomic features?

Comparative genome analysis of *Solanum lycopersicum* and *Solanum tuberosum*

Rohit Lall[1], George Thomas[1], Satendra Singh[2], Archana Singh[3] & Gulshan Wadhwa[4]*

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Received October 05, 2013; Accepted October 30, 2013; Published November 11, 2013

Similarities & Differences: Potato – Tomato

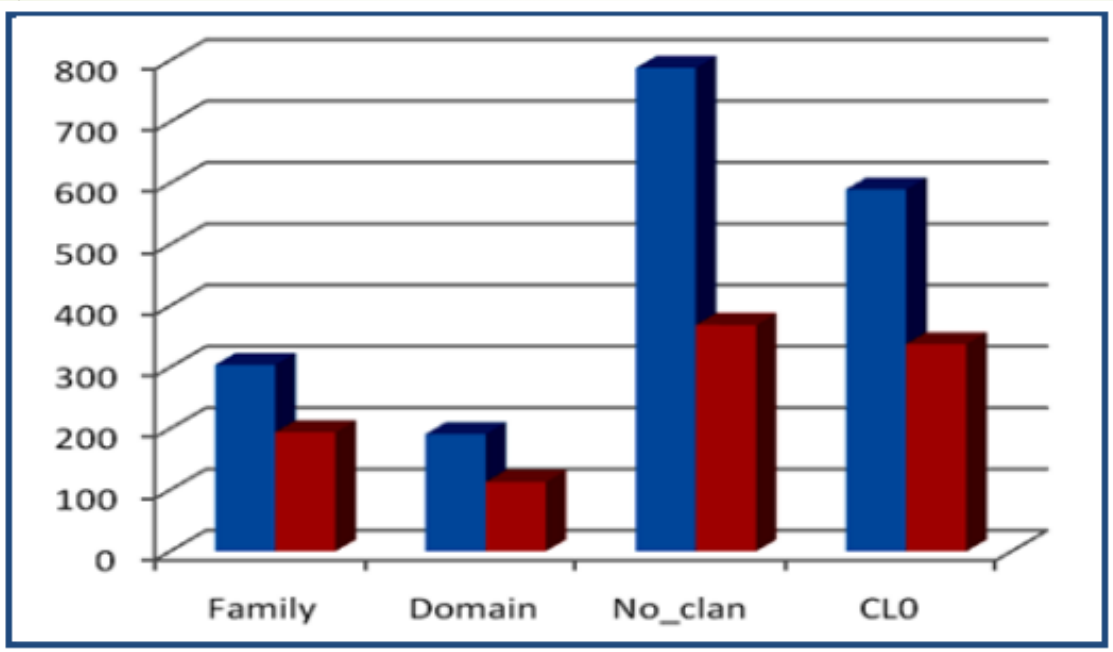


Figure 1: Pfam comparison of *S. lycopersicum* and *S. tuberosum* protein sequences.

Blue = S.lycopersicum
Red = S.tuberosum

Lall, R., Thomas, G., Singh, S., Singh, A., & Wadhwa, G. (2013). Comparative genome analysis of Solanum lycopersicum and Solanum tuberosum. *Bioinformation*, 9(18), 923.

Similarities & Differences: Potato – Tomato

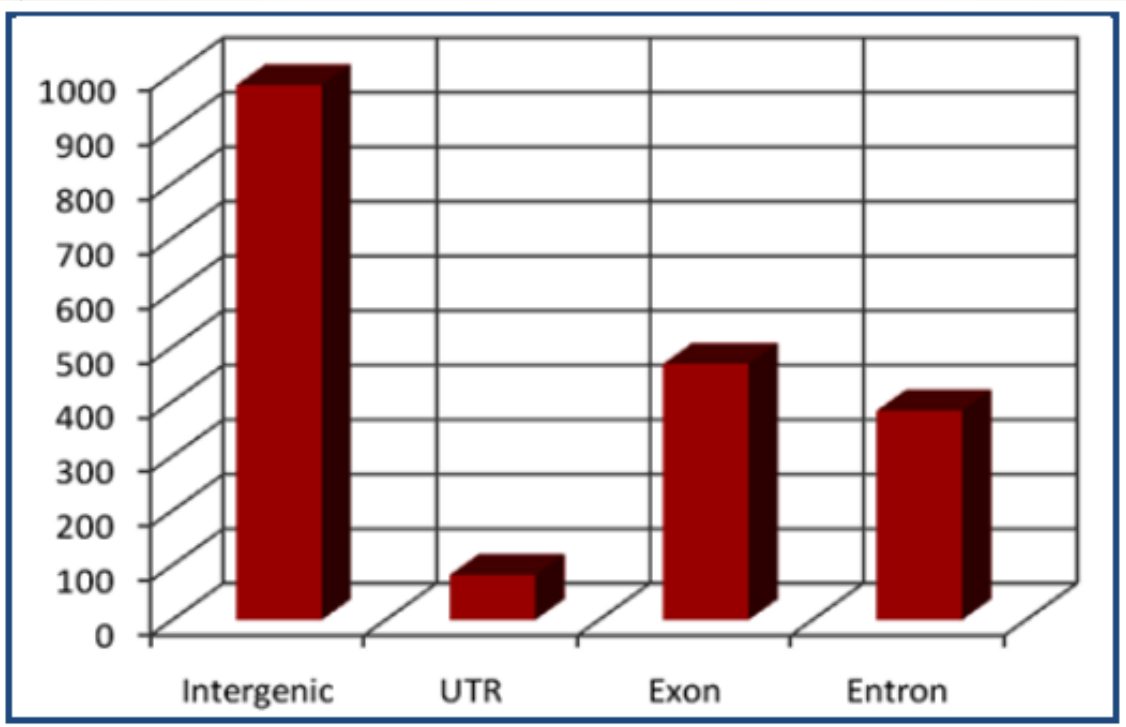


Figure 2: Genomic region comparison of Tomato and Potato.

Lall, R., Thomas, G., Singh, S., Singh, A., & Wadhwa, G. (2013). Comparative genome analysis of Solanum lycopersicum and Solanum tuberosum. *Bioinformation*, 9(18), 923.

Similarities & Differences: Potato – Tomato

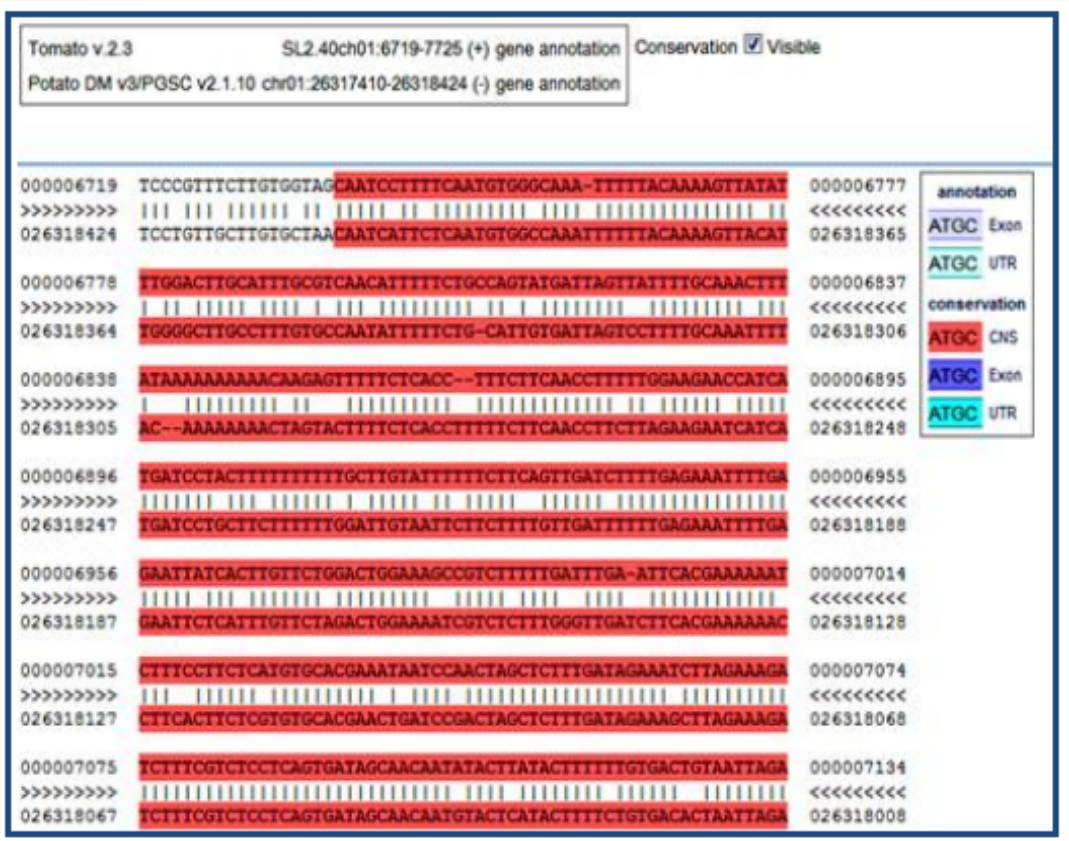


Figure 3: Conserved region present in two genomes.

Lall, R., Thomas, G., Singh, S., Singh, A., & Wadhwa, G. (2013). Comparative genome analysis of Solanum lycopersicum and Solanum tuberosum. *Bioinformation*, 9(18), 923.

Similarities & Differences: Potato – Tomato

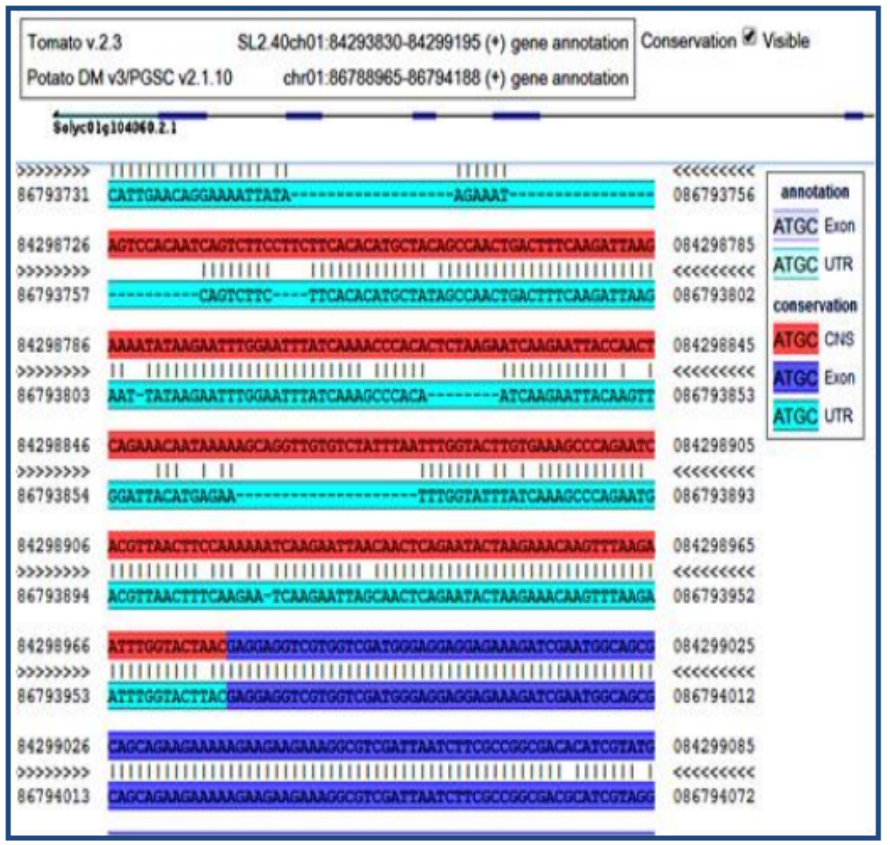


Figure 4: Genomic regions with conserved, UTR and exons.

Lall, R., Thomas, G., Singh, S., Singh, A., & Wadhwa, G. (2013). Comparative genome analysis of Solanum lycopersicum and Solanum tuberosum. *Bioinformation*, 9(18), 923.

Similarities & Differences: Potato – Tomato

Is there a synteny in euchromatin regions of tomato, potato and pepper?

the plant journal

SEB Society for Experimental Biology

The Plant Journal (2012) **71**, 602–614 doi: 10.1111/j.1365-313X.2012.05012.x

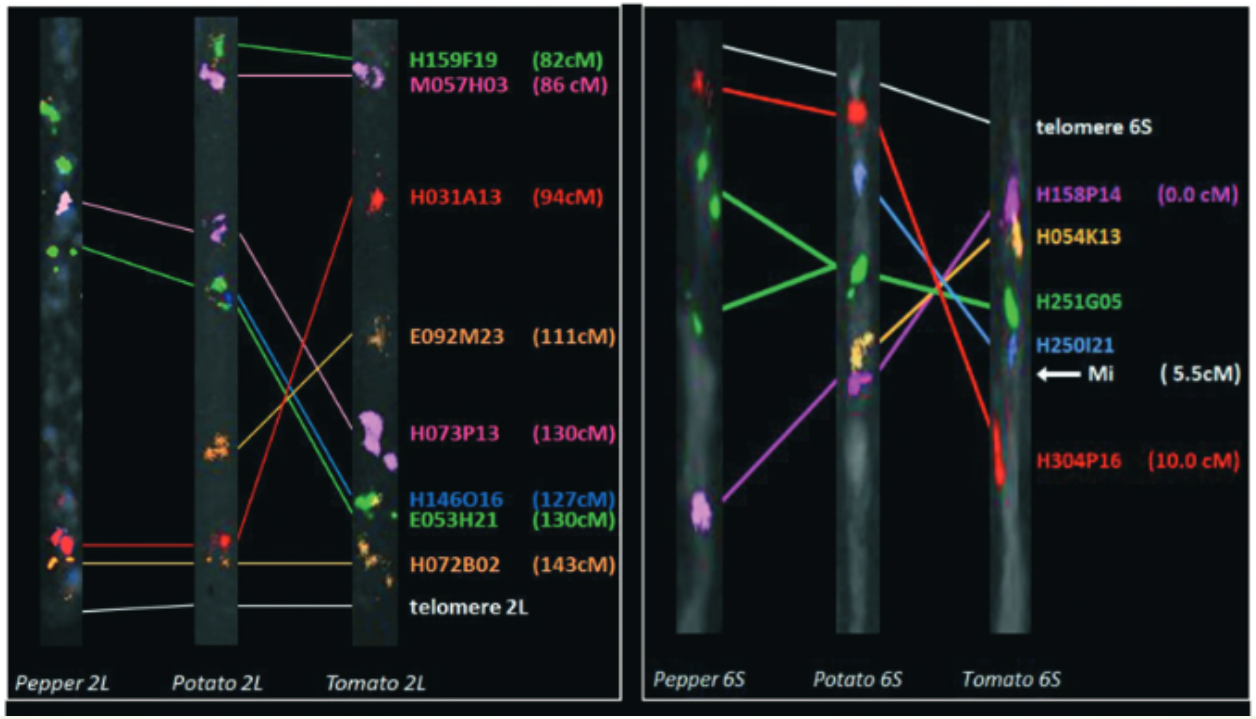
Structural homology in the Solanaceae: analysis of genomic regions in support of synteny studies in tomato, potato and pepper

Sander A. Peters[1,†,*], Joachim W. Bargsten[1,2,3,†], Dóra Szinay[4], José van de Belt[4], Richard G.F. Visser[2,5], Yuling Bai[2] and Hans de Jong[4]

Backround

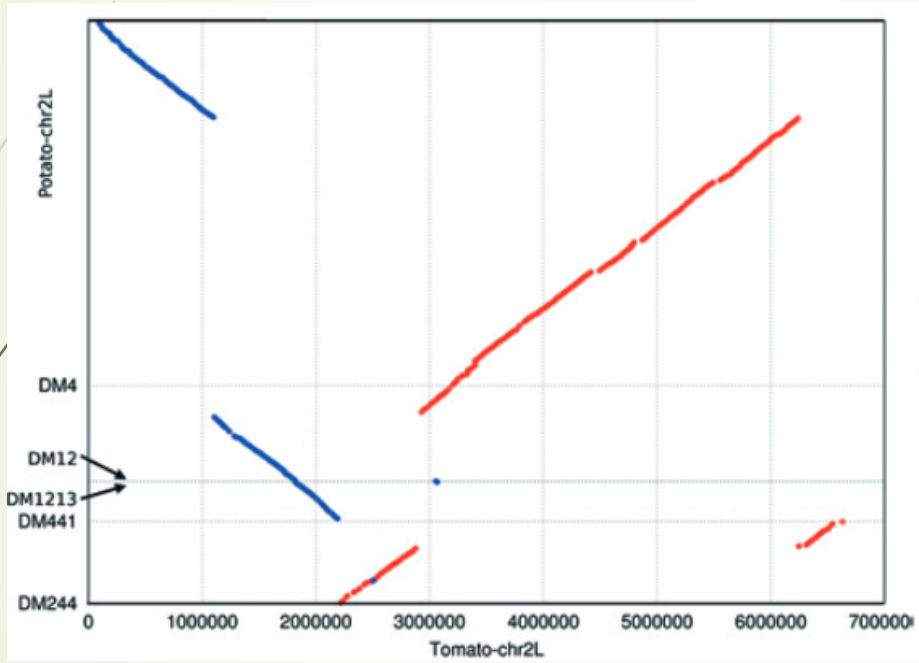
- Domestication -> narrowed genetic basis
  - Results: Loss of desirable traits
- Changing climate conditions -> increase demand of new varieties
- Introgressive hybridization
- analysing colineartiy & synteny

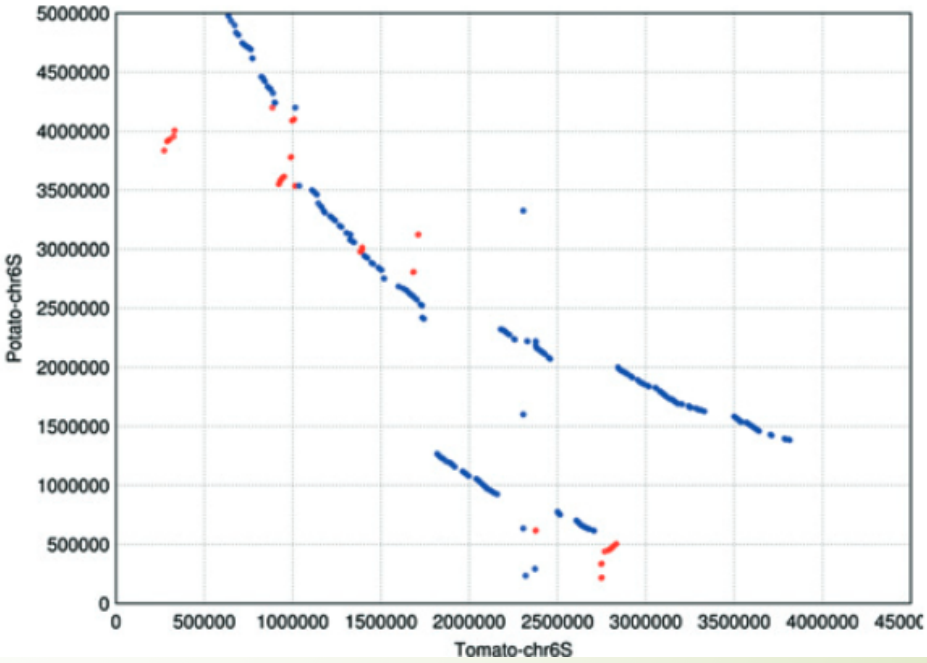
Results - Cytogenetic macrosynteny between tomato, potato and pepper



Peters, S. A., Bargsten, J. W., Szinay, D., van de Belt, J., Visser, R. G., Bai, Y., & de Jong, H. (2012). Structural homology in the Solanaceae: analysis of genomic regions in support of synteny studies in tomato, potato and pepper. *The Plant Journal*, *71*(4), 602-614.

Results -Comparative sequence alignment





Peters, S. A., Bargsten, J. W., Szinay, D., van de Belt, J., Visser, R. G., Bai, Y., & de Jong, H. (2012). Structural homology in the Solanaceae: analysis of genomic regions in support of synteny studies in tomato, potato and pepper. *The Plant Journal*, *71*(4), 602-614.

Summary

- **Is the potato and tomato genome sharing various genomic features?**
- proteins belong to different families, domains and clans
- Intergenic regions are conserved

- **Is there a synteny in euchromatin regions of tomato, potato and pepper?**
- Some structural rearrangements -> specific for tomato
  - Small changes > large-scale changes

Thank you for your attention!

Discussion – Questions?

- Is it possible to create a hybrid between tomato and potato?

Hybrid – Pomato / Tomtato / Tomoffel

- grafted plant
- Not occur in nature
- Makes food prduction more efficient



https://shop.mein-schoener-garten.de/tomtato-1-pflanze-tomaten-undkartoffeln-an-einer-pflanze-tomoffel/products/4817

Literature

- https://cipotato.org/crops/potato/how-potato-grows/, 03.12.19, 3pm
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- Wang, L., Xie, J., Hu, J., Lan, B., You, C., Li, F., ... & Wang, H. (2018). Comparative epigenomics reveals evolution of duplicated genes in potato and tomato. *The Plant Journal*, *93*(3), 460-471., 03.12.19, 5pm
- Peters, S. A., Bargsten, J. W., Szinay, D., van de Belt, J., Visser, R. G., Bai, Y., & de Jong, H. (2012). Structural homology in the Solanaceae: analysis of genomic regions in support of synteny studies in tomato, potato and pepper. *The Plant Journal*, *71*(4), 602-614. 03.12.19, 5pm
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- Gebhardt, C. (2016). The historical role of species from the Solanaceae plant family in genetic research. *Theoretical and Applied Genetics*, *129*(12), 2281-2294. 03.12.19, 5pm

Literature

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- http://bioinformatics.psb.ugent.be/genomes/view/Solanum-lycopersicum#:~:targetText=The%20common%20tomato%20Solanum%20lycopersicum,a%20model%20reference%20for%20Solanaceae., 01.12.19 6pm
- https://en.wikipedia.org/wiki/Potato, https://en.wikipedia.org/wiki/tomato, 01.12.19 9pm
- https://en.wikipedia.org/wiki/Fluorescence_in_situ_hybridization, 01.12.19 10pm
- https://www.pinterest.de/pin/518969557035407087, 04.12.19, 11am
- https://en.wikipedia.org/wiki/Pomato, 04.12.19, 9pm

Results - Topology of tomato and potato 2L segments

Figure 2. Identity plots of *S. lycopersicum* and *S. tuberosum* group Phureja DM1-3 516 R44 segments of 2L, 6S, 10L and 11L. Sequences aligned in forward and reversed orientation are represented by red and blue lines, respectively. Tomato and potato chromosome labels are indicated on the *x* and *y* axes. Segment positions aligning to BAC H303G16, H150M12 and E043B08 are marked in the bottom right plot by arrows (a) to (c), respectively.

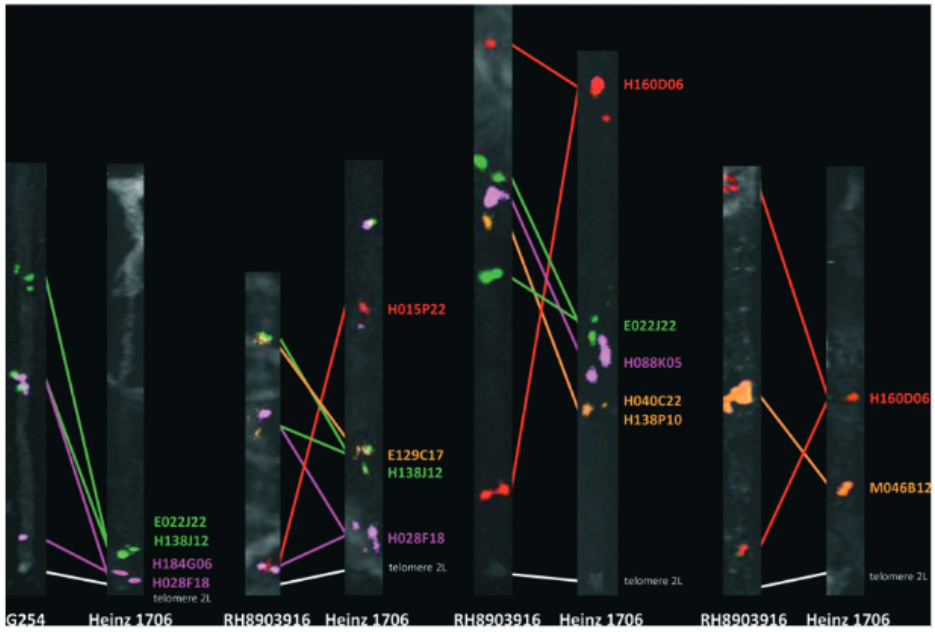


Figure 3. FISH analysis of colinearity breaks between tomato and potato 2L. Tomato BACs were hybridized on pachytene complements from tomato Heinz 1706 (lanes 2, 4, 6 and 8) and pachytenes from potato G254 (lane 1) and RH8903916 (lanes 3, 5 and 7). Corresponding cytogenetic mapping positions of *HindIII* (H), *EcoRI* (E) and *MboI* (M) tomato BACs on tomato and potato pachytenes are shown by coloured connecting lines. Telomere positions on the 2L are indicated by white connecting lines.

Results - Orthologs on tomato and potato 2L and linkage conservation

Figure 4. Comparative map for tomato and potato 2L. Chromosome 2 markers in tomato and potato scaffolds are indicated on the top and bottom bars with cM positions from the tomato EXPEN2000 and potato TXB1992 genetic maps. The order and relative positions of markers without a genetic position are derived from BLASTN hits to potato scaffolds. Aligned segments from potato DM scaffolds to tomato scaffold SL2.40sc03665 are represented by colored rectangles. Syntenic blocks are represented by colored polygons in the middle section, and correspond to the position and orientation of rearranged potato segments. The relative positions of tomato BACs flanking or spanning colinearity breaks are labeled with their identifier above each DM segment. The relative positions and order of the tomato BACs on the tomato and potato FISH map are indicated by corresponding colored dots. Some BACs spanning a colinearity break have one corresponding position on the tomato FISH map and two corresponding positions on the potato FISH map.

