A recipe for the perfect salsa tomato

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The Ohio State University
Format:
• Intro to the crop
• Basic botany/mating system
• Important traits
• Organization of program
• Breeding schemes
  • influenced by the number of seeds per cross, mating system, generation time...
• Selection strategy
Tomato is in the family *Solanaceae*

The flowers are bisexual, radially symmetric, and consist of 5 parts (sepals, petals, anthers). The calyx is united, at least at the base. The corolla is also united but its shape varies.

Includes:
- Tomato
- Potato
- Eggplant(s)
- Pepper(s)
- Tobacco
- Tomatillo
- Ground Cherry
- Petunia
- and more!

Important features
Self pollinated
Large numbers of seed per cross or self

Market Niches
Processing
Whole-Peel, Paste
Fresh-market
Round, Roma, Cherry
Greenhouse
Round, beefsteak, cluster, cherry
Rootstock
Growth habit of different market classes
Market Niches have led to genetic differentiation.

(A) S. pimpinellifolium, Cherry, LR, Vintage, FM, Processing

(B) Vintage, FM, Processing
Plants vary in mating system from completely outcrossing to completely inbreeding (selfing)

Cultivated tomatoes are self-pollinating.

Pollen shedding often occurs before flowers open.

Self-pollinating leads to homozygosis. Inbred lines breed true.
Controlled Crosses:

Emasculation
Pollination
Tagging
Pollen collection

Emasculation

Pollination

Tagging
http://www.youtube.com/user/TomatoLab
Treat seed to minimize spread of seed-borne pathogens (viruses and bacteria).

Acid (HCl), Bleach, TSP, heat...
Seed saving:
http://www.youtube.com/watch?v=gg8FDRa-rBQ

Large-Scale
Important features
Self pollinated
Large numbers of seed per cross or self

Market Niches
Processing
Whole-Peel, Paste
Fresh-market
Round, Roma, Cherry
Greenhouse
Round, beefsteak, cluster, cherry
Rootstock
Traits – Quality and Disease Resistance

Quality for whole-peel and diced product

Bacterial Canker (*Clavibacter michiganensis*)
Bacterial Spot (*Xanthomonas* species)
Sources of traits....

http://tgrc.ucdavis.edu/
http://www.ars-grin.gov/npgs/
Anatomy of OSU’s Tomato Breeding Program

Hybrid test-crosses

New Variation (unadapted lines)

New Variation (wild species)

Germplasm

Replicated trials

New Variety

Early Generation Adapted
Anatomy of OSU’s tomato breeding program
Mechanics of tomato breeding

Making crosses:
http://www.youtube.com/watch?v=acVHJBKlUIE

Seed saving:
http://www.youtube.com/watch?v=gg8FDRa-rBQ

Related video content:
http://www.youtube.com/user/TomatoLab?feature=watch
Backcross Breeding

Diagram:
- OH 981205 (PTO)
- OH 88119
- PETO 882 (PTO)
  - OH 88119
Purpose of pedigree selection:

Combine many traits from two parents
In the long-term, pedigree selection = recurrent selection

OH 88119 – used as a parent in commercial hybrids, early with concentrated fruit set, susceptible to bacterial spot.

OH 9242 – used as a parent in commercial hybrids, excellent color, susceptible to bacterial spot.

Hawaii 7998 – resistant to bacterial spot, indeterminate plant with small fruit and poor yield.

PI 114490 – wild cherry tomato with resistance to bacterial spot

Peto 882 – processing type with resistance to bacterial speck.

Goal:
early concentrated set, excellent color, resistant to bacterial spot, resistant to bacterial speck
Resistant Selection OH87663 compared to OH88119
Plant breeders often strive to increase the efficiency of selection

- gain under selection $\Delta G = k^* \sigma_p^* h^2$
- ability to measure “$G$” and increase $h^2$
- time
- resources
Layout of field evaluations:

Follows an experimental design in order to separate the components that contribute to variation:
- Between years (weather)
- Within a field (soil conditions, drainage)
- Between fields
- Between a planting dates
- Genetics

National Resource Conservation Service soil survey maps
http://websoilsurvey.nrcs.usda.gov/app/
Replication and Randomization

Randomized Complete Block and Augmented Designs (increasingly used to allow for larger populations with same resources)

Use planting date to create more environments on a single farm
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Field Book

Field book contains variables for experimental design (e.g. pedigree information, location, year, row, column, and quadrant in field)
Tomato Analyzer – To measure Shape and Color
(Darrigues et al., JASHS, 2008, 133, 579-586)


Plot #  Plot File Name  Fruit No.  1  2  3  4  5  6  7  8  9
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3801  2003 Toolbar_L_int-c.jpg  8  8.22 48.20 138.78 75.31 50.12 88.86 39.30 21.46 28.74

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L*
y = 0.9589x + 1.3866
R² = 0.983
P < 0.0001

-60 -40 -20 0 20 40 60 80 100

Tomato Analyzer values

a*
y = 1.1612x - 8.2186
R² = 0.9794
P < 0.0001

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Tomato Analyzer values
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Year + PLOT = unique identifier
Tied to variety name “GENOTYPE” and pedigree information
Year + LOC + Block are experimental design parameters (which may be expanded in augmented designs)

Data

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Phenotype Data
Distributions
ANOVA
Partitioning Variation (heritability)
BLUPs

Genotype Data
Marker Matrix

Kinship matrix
Structure
Q Matrix (PCA)

population mean, variance, BLUP, determine selection intensity (K)
Estimate Breeding Value (Random effect)
Selection: What to keep and what to throw away

Replication at F3

• Goal: keep best individuals from the best families. (combine family-based selection and single seed descent).

• Data turn-over becomes important.

• Scaled rating of fruit size, fruit number, fruit color (internal), thickness of locule wall, firmness, vine health; analyze and go back to best families.
Selection: What to keep and what to throw away

Begin hybrid test-crosses at F4

Collect objective data for yield, fruit size, fruit color, BRIX, pH, titratable acids, firmness.

Scaled data for vine health/resistance

Subjective data for flavor
Marker-assisted selection

Extraction of DNA

Selection based on genotype
Backcross Breeding – accelerated by marker assisted background genome selection

- **F1**: 50%
- **BC1**: 75%
- **BC2**: 87.5%
- **BC3**: 93.75%
DNA-based marker resources permit selection for recurrent parent genotype in order to speed back-crossing (can achieve the equivalent of BC4 at BC2)

Breeding and selection predominantly

- Backcross (including inbred-backcross and advanced-backcross)
- Pedigree
- Recurrent Selection
• Intro to the crop

• Basic botany/mating system

• Important traits

• Organization of program

• Breeding schemes
  • influenced by the number of seeds per cross, mating system, generation time...

• Selection strategy
• 2 cups coarsely diced thick-walled “roma” tomatoes (substitute can of diced tomato)
• ¼ cup chopped fresh cilantro
• 4-6 cloves fresh chopped garlic
• ½ cup chopped onion
• Jalapeno, finely chopped (alt, coat a Padron in olive oil, roast, and chop finely)
• ½ teaspoon salt
• Juice of 1 lime
Thanks for joining us today.

Join us for the rest of the webinar series:
http://www.extension.org/plant_breeding_genomics

http://www.extension.org/pages/60426/webinar-registration-and-archive

Help us improve the series by taking part in the survey!