Practices for Selecting & Breeding Regionally-Adapted Vegetable Seeds

By Erica Kempter

Nature & Nature Seeds
Where did our vegetable seeds come from?
Adaptation

Definition: The changes in structure and physiology of an organism to become more suited to an environment.
Seed Biodiversity

10,000 years created a world full of incredible food biodiversity.
What Are Regionally-Adapted Seeds?

- Definition: Seeds that are genetically adapted to growing especially well in the climate of a particular place or region.
- They are Open-pollinated seed varieties (O.P.)
- Open-pollinated seeds can evolve and adapt to the place in which they are grown; hybrids by nature cannot
By nature, seeds from this system are not regionally-adapted
Where do I find regionally-adapted seeds?

- Likely you won’t find them by opening up any old seed catalog
- Where does seed from seed catalogs come from?
- Lack of transparency makes it challenging to find seeds that are regionally-adapted
How to find Regionally-Adapted Seeds
Existing Variety Trials

- SKC - Seed to Kitchen Collaborative, UW Madison
  - Variety trials in the Midwest
  - [https://seedtokitchen.horticulture.wisc.edu/trial-results.html](https://seedtokitchen.horticulture.wisc.edu/trial-results.html)

- NOVIC (Northern Organic Vegetable Improvement Collaborative)
  - Variety trials - some trials done in the Midwest, New York
  - [https://varietytrials.eorganic.info/taxonomy/term/70](https://varietytrials.eorganic.info/taxonomy/term/70)

- Seed Linked
  - [https://www.seedlinked.com/](https://www.seedlinked.com/)

- Organic Seed Alliance
How to find Regionally-Adapted Seeds
Public Plant Breeders

- UW Madison
  - Irwin Goldman: beets, carrots, onions
  - Bill Tracy - sweet corn
  - Julie Dawson - tomatoes
- Cornell, NY
  - Michael Mazourek: squash, peppers, cucumbers,
How to find Regionally-Adapted Seeds
Public Plant Breeders
Farmer/Breeders

- Podolls - Prairie Road Organic Seeds
  - Beets, beans, melons, onions, corn, squash, tomato, watermelon
- Frank Morton - Wild Garden Seeds, Oregon
- Adaptive Seeds - Oregon
- Evenstar Farm - Maryland
- Alan Kapular - Peace Seeds, Oregon
How to find Regionally-Adapted Seeds
Tap into Existing Seed Biodiversity

- Seed Savers Exchange
- Open Source Seed Initiative
- Small, farm-based seed companies
  - Sandhill Preservation, Prairie Road Organic Seeds, Meadowlark Hearth Seeds, Ann Arbor Seed Company
  - Nature & Nurture Seeds
- Seed libraries & seed swaps
- USDA GRIN
How to find Regionally-Adapted Seeds
Do your own Variety Trials

- Lettuce - What to evaluate for?
  - Vigor, heat and bolt resistance, flavor
  - Eating quality, pest/disease resistance, days to maturity, storage, hardiness/frost resistance, nutrition
Grow and Save your Own Seeds to adapt them to your farm!
Adaptation to Soil Conditions
Adaptation to Climate
Regionally-Adapted Seeds
Grand Rapids Lettuce
How are seeds made?
Cross Pollination

Pollen is transferred from one plant to another plant.
So the parents are two separate plants.
Self Pollination

- Pollen is transferred from the anther (male) to the stigma (female) of the same plant. This can either happen within the same flower or some plants have separate male and female flowers on the same plant.
- So the mom and the dad are the same plant.
Self-Pollinated Crops “selfers”

- Have closed flower structure that limits bee’s access to flower
- Do not suffer from “inbreeding depression” - loss of vigor due to inbreeding
- Tomatoes, Beans, Peas, Lettuce
Self Pollinated Crops “promiscuous selfers”

- Peppers, Eggplant
- Can self pollinate or cross pollinate
- Do not suffer from “inbreeding depression” - loss of vigor due to inbreeding
“Out-Crossers” - Crops that tend to Cross Pollinate
Example: Squash

Delicata pollen (male) + Delicata stigma (female) => Delicata Squash Seeds
“Out-Crossers” - Crops that tend to Cross Pollinate
Example: Squash

- Zucchini Pollen (male) + Delicata stigma (female) = crossed Squash Seeds
How to Prevent/Minimize Cross Pollination?

Called “Isolation” or “Isolation Distance”

- controlling the pollen source by isolating plants by species
- Techniques
  - Isolation distance - separate each variety by a certain distance (in feet or miles)
  - Caging/row cover to prevent insects
  - Covering flowers and hand pollinating
- Isolation Technique is Determined by mode of pollination
  - Insect pollinated
  - Wind pollinated
"Out-Crossers" - Crops that tend to Cross Pollinate
(will cross with other varieties within the same species)

<table>
<thead>
<tr>
<th>Insect Pollinated - Isolate by ½ mile</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brassicas</td>
</tr>
<tr>
<td>Radish</td>
</tr>
<tr>
<td>Brassica oleracea (cabbage, kale, cauliflower, etc) - will cross with other Brassica oleracea)</td>
</tr>
<tr>
<td>Brassica rapa (turnips, chinese cabbage, mizuna etc)</td>
</tr>
<tr>
<td>Arugula</td>
</tr>
<tr>
<td>Onions</td>
</tr>
<tr>
<td>Carrots</td>
</tr>
<tr>
<td>Cucurbits (cucumber, squash, melons)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Wind Pollinated - Isolate by</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chenopods - 1 mile</td>
</tr>
<tr>
<td>Spinach</td>
</tr>
<tr>
<td>Beets and Chard</td>
</tr>
<tr>
<td>Corn - 1-2 miles</td>
</tr>
</tbody>
</table>
Isolation Distance
Self-Pollinated Crops

“Selfers”
Isolation distance: 10-50ft
- Lettuce
- Beans (not lima, runner, or fava), peas, soybeans
- Tomatoes

“Promiscious Selfers”
Isolation distance: 300ft or cover plants/flowers with row cover fabric
- Peppers
- Eggplant
Climate Considerations
Rain & Humidity

Dry-seeded crops:
- crops whose seeds need to be harvest when the seeds are dry
  - can be challenging to grow in our climate
  - Lettuce, brassicas, beans, peas, arugula, dill, cilantro, carrots, onions, roots, corn

Wet-seeded crops:
- crops whose seeds are harvested when encapsulated in a wet fruit
  - Tomato, pepper, eggplant, cucurbits, ground cherry, tomatillo
  - These are the easiest to grow in our climate
Climate Considerations
Temperature
for more info see “Seed to Seed” book

Warm Weather Seed Crops
- crops whose seeds prefer to develop when temps are warm (70-85F)
  - Tomato, pepper, eggplant, corn
  - Melons, watermelon
  - Eggplant & Basil - need a long hot summer

Cool Weather Seed Crops:
- crops whose seeds prefer to develop when temps are cool (60-75F)
  - Lettuce, brassicas, peas, arugula, mustard, beets/chard,
  - spinach & broccoli/ cauliflower - can be challenging to grow seeds in hot humid summers
Annual vs Biennial Seed Crops

- Annual - make seed in one growing season
- Biennial - dig up plants in fall and store in cold storage; re-plant in spring (example beets)
Seed Growing Guidelines

- Use Open-Pollinated varieties
- Save seeds only from the strongest, healthiest plants
- Rogueing - remove bad plants (low vigor, early bolting, etc)
- Prevent/minimize cross pollination through isolation
- Consider minimum population size (how many plants do you need to grow to maintain enough genetic diversity in the seed crop in order to prevent inbreeding depression (ie loss of vigor) in future generations
  - “Selfers” - grow a minimum of 5-10 plants
  - “Out-Crossers”
    - Most “out-crosser” crops: 20-50 plants
    - Cucurbits: 5-10 plants
    - Corn: 50-100 plants
Seed Growing

- Different than vegetable production:
  - Spacing - much more space required
  - Time - much more time required
    - Seed crops use “real estate” much longer than veg crops
Best Seed Crops for the Midwest

Field Grown
- Tomatoes
- Peppers
  - Isolate varieties by covering with row cover fabric
- Cucumber
- Squash (choose early varieties)
- Amaranth, sunflowers
- Beans
- Peas

Need a Hoophouse
- Radish
- Spinach
- Arugula
- Mustard greens
Seed Growing & Harvesting:
Our crop planning revolves around seeds
Growing Peppers for Seed
Cleaning Pepper seeds
Growing Tomatoes for Seed
Decanting Tomato Seeds
Cucumbers
Squash
Growing Lettuce for Seed
Growing Lettuce for Seed
Amaranth
Siberian kale (B. napus)
Dry Cleaning Seeds
Plant Breeding: goal: high yielding, marketable, great tasting tomatoes
Disease Resistance
Flavor
Breeding Cold Hardy Greens
Breeding Cold Hardy Greens