Participatory Variety Trials to Assess Response to Environment in Organic Vegetable Crops

Alexandra Lyon, University of Wisconsin

March 3, 2015

Welcome to the webinar!

• The webinar will start at the top of the hour.

• Find a handout of the slides and a fact sheet at http://www.extension.org/pages/71272

• To type in a question, use the question box on your control panel. We will read the questions aloud after the c. 45 minute presentation.

• The webinar is being recorded and you can find it in our archive in the coming week at http://www.extension.org/pages/25242
PARTICIPATORY VARIETY TRIALS
TO ASSESS RESPONSE TO
ENVIRONMENT IN ORGANIC
VEGETABLE CROPS

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Professor Erin Silva
University of Wisconsin-Madison
PRESENTATION OUTLINE

• NOVIC Project Overview
• Understanding response to environment
• Evaluating response to environment
• Conclusions and recommendations
FARMER USES FOR VARIETY TRIALS

• **Motivations:**
  - Look for needed traits
  - Replace unavailable varieties
  - Satisfy curiosity
  - Begin on-farm variety improvement

• **Challenges:**
  - Multi-site and multi-year trials
  - Replications
  - Data collection and analysis

RESEARCHER USES FOR VARIETY TRIALS

• **Motivations:**
  - Beginning and end of plant breeding process
  - Selection
  - Education/demonstration

• **Challenges:**
  - Research stations are not “target environment”
  - Lack of farming expertise
  - Guessing at what farmers want
WHAT IS NOVIC?

Participatory variety trials on organic farms

Funding through USDA OREI

Research partners & plant breeders:

- Oregon State University (Jim Myers)
- University of Wisconsin-Madison (Bill Tracy)
- Cornell University (Michael Mazourek)
- Organic Seed Alliance (John Navazio, Laurie McKenzie)
- Organic farmers in OR, WA, NY, WI, MN

Organic Variety Trials Reports

varietytrials.eorganic.info

MOTHER-BABY TRIAL DESIGN

Facilitates farmer participation/on-farm evaluation
Minimizes space and labor for farmers
Provides replicated data on research stations
Modified from Snapp et al. 2002

eOrganic Participatory On-Farm Research Webinar
<table>
<thead>
<tr>
<th>NOVIC I</th>
<th>NOVIC II</th>
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</thead>
<tbody>
<tr>
<td><strong>Growing seasons</strong></td>
<td><strong>2015-2017?</strong></td>
</tr>
<tr>
<td><strong>Crops</strong></td>
<td><strong>Crops</strong></td>
</tr>
<tr>
<td>• Sweet corn</td>
<td>• Sweet corn</td>
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<tr>
<td>• Squash butternut</td>
<td>• Squash: acorn &amp; delicata</td>
</tr>
<tr>
<td>• Broccoli</td>
<td>• Cabbage</td>
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<tr>
<td>• Snap peas</td>
<td>• Tomatoes</td>
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<tr>
<td>• Carrots</td>
<td>• Peppers</td>
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<tr>
<td>• Regional choice</td>
<td>• Regional choice</td>
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<tr>
<td><strong>Data collection</strong></td>
<td><strong>Data collection</strong></td>
</tr>
<tr>
<td>• Same on research station and farms</td>
<td>• Stations: Full dataset</td>
</tr>
<tr>
<td></td>
<td>• Farms: Focus on qualitative data and farmer ratings</td>
</tr>
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**IMPORTANCE OF RESPONSE TO ENVIRONMENT**

- Types of adaptation
- Adaptation and organic farms
- Implications for breeding
**RESPONSE TO ENVIRONMENT**

<table>
<thead>
<tr>
<th>Wide adaptation</th>
<th>Specific adaptation</th>
<th>Stability</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Variety does well over large areas</td>
<td>• Variety ranks among the highest yielders at some locations, but not others</td>
<td>• Yields vary relatively little around the average yield (Shukla 1972)</td>
</tr>
<tr>
<td>• High mean yields across environments</td>
<td>• (Abidin et al. 2005)</td>
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</table>

**SPECIFIC (LOCAL) ADAPTATION**

- On-farm/decentralized selection
  - Ceccarelli 2003 (barley)
- Dedicated organic breeding
  - Murphy 2007 (wheat)
  - Renaud 2014 (broccoli)
  - Drinkwater et al. 1995 (tomatoes)
- Addressing farm-to-farm variation
  - Wolfe et al., 2008
WIDE ADAPTATION

Benefits:
- High yielding across different environments
- More efficient use of plant breeding resources

Drawbacks:
- Best overall performer in all locations may not be the best in specific locations
- Fewer varieties grown, less biodiversity

Atlin et al. 2000

GENETICS X ENVIRONMENT INTERACTIONS

Large G x Location interaction (predictable) → specific adaptation

Large G x Year interaction (unpredictable) → wide adaptation

(Allard 1964)
INDIRECT SELECTION

Selection environment → Target environment

DIRECT SELECTION

Selection environment = Target environment
BREEDING FOR WIDE ADAPTATION

Selection environment

Selection environment

Selection environment

Target environments

Atlin et al. 2000

EVALUATING RESPONSE TO ENVIRONMENT
RESEARCH OBJECTIVES

• Determine response of varieties to diverse year x location environments; detect GxE interactions.
• Assess feasibility of simple graphic methods to analyze stability and performance.
• Make recommendations to improve participatory trialing.

METHODS - VARIABLE SELECTION

1. Identified crops with most complete quantitative data
   Looked for yield variables
2. Selected variables
   - Broccoli head diameter (cm)
   - Squash marketable weight per plant (kg)
   - Squash marketable number per plant
3. Selected environments and varieties
   - Environments = Year x Location
   - Found optimal varieties x environments to maximize data
SELECTED VARIETIES FOR ANALYSIS

<table>
<thead>
<tr>
<th>Broccoli</th>
<th>Squash</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solstice (OP)</td>
<td>Bugle (OP)</td>
</tr>
<tr>
<td>Common Ground Population (OP)</td>
<td>Early (F1)</td>
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<tr>
<td>OSU Composite (OP)</td>
<td>JWS 6823 (F1)</td>
</tr>
<tr>
<td>Windsor (F1)</td>
<td>Pilgrim (F1)</td>
</tr>
<tr>
<td>Arcadia (F1)</td>
<td>Metro (F1)</td>
</tr>
<tr>
<td>Gypsy (F1)</td>
<td>Waltham (OP)</td>
</tr>
<tr>
<td>Belstar (F1)</td>
<td>Tiana (F1)</td>
</tr>
</tbody>
</table>

METHODS - ADAPTABILITY ANALYSIS

A: Adaptation to good environments ($\beta > 1$)
B: Average performance ($\beta = 1$)
C: Adaptation to poor environments ($\beta < 1$)

Adapted from Hildebrand & Russell 1996
BROCCOLI: HEAD DIAMETER

SQUASH: MARKETABLE FRUIT PER PLANT
SQUASH: MARKETABLE WEIGHT PER PLANT

Average Marketable Weight per Plant (KG) of 7 Squash Varieties, by Environment

<table>
<thead>
<tr>
<th>Variety</th>
<th>W8-12</th>
<th>NY4-11</th>
<th>W11-13</th>
<th>W2-13</th>
</tr>
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<tbody>
<tr>
<td>Bugli</td>
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<td>Early</td>
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<td>JH-623</td>
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<td>Piplon</td>
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<td>Metro</td>
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<tr>
<td>Waltham</td>
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<tr>
<td>Tana</td>
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</table>

SQUASH: MARKETABLE WEIGHT PER PLANT

Marketable Weight per Plant (KG) of 7 Squash Varieties (Ave. Performance in 11 Environments)
CONCLUSIONS

Broccoli
• Gypsy shows wide adaptation while Belstar is better adapted to poor environments.

Squash
• Metro F1 and Tiana F1 were better adapted to good environments.
• Waltham OP was better adapted to poor environments in terms of fruit number, and showed wide adaptation in terms of weight.

Adaptability analysis
• Useful for visual interpretation of response to environment.
• Does not require the same sites for multiple years.
• Can be used to identify varieties with broad or specific adaptation.
RECOMMENDATIONS

For participatory trialing:
- Communicate importance of multi-year data
- Trialing network can ensure a minimum number of varieties x environments
- With multiple research teams, consistent records are key
- Strategic data collection

For further research:
- Adaptability analysis for other crops, traits, and varieties
- Direct measures of environmental variation to partition environments

WHAT KIND OF ADAPTATION?

A: Adaptation to good environments ($\beta > 1$)
B: Average performance ($\beta = 1$)
C: Adaptation to poor environments ($\beta < 1$)

Adapted from Hildebrand & Russell 1996
PRIORITIES FOR ORGANIC FARMERS

“TRIED-AND-TRUE”

“TRIED-AND-TRUE”

“You know, we can have a cold, wet spring like last year, or we can have a rather dry and hot-and-cold spring like we’re having this year—same thing with the summers. There are some varieties...that we’ve just honed in on. These are gonna be reliable for us regardless of what happens while they’re in the field.”
THANK YOU

• Farmer Participants
• USDA Organic Research & Education Initiative
• Ceres Trust
• Annie’s Homegrown
• Advisor: Erin Silva (UW-Madison)
• Committee members: Bill Tracy, Irwin Goldman (UW-Madison)
• Other NOVIC Collaborators: Jim Myers (OSU); Micaela Colley, Jared Zystro, Laurie McKenzie, Lane Selman (OSA); Michael Mazurek (Cornell), and many more!

REFERENCES


Contact me: onlyon@wisc.edu
More on NOVIC: eorganic.info/novic
Organic Variety Trials Reports: varietytrials.eorganic.info
Erin Silva’s Research Program: uworganic.wisc.edu

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• Have an organic farming question? Use the eXtension Ask an Expert service at https://ask.extension.org/groups/1668/ask
• We need your feedback! Please respond to an email survey about this webinar.
• Thank you for coming!