CHOOSING THE RIGHT VARIETAL TRAITS FOR ORGANIC GRAINS

2019 Organic Grain Winter Conference
Mac Ehrhardt, Albert Lea Seed

What We'll Cover Today

Selecting Seed for Organic Systems
• Practical things to think about
• General breeding & selection
Breeding/Testing Methods & Changes
Species-by-Species Selection Considerations

Please Ask Questions!

Selecting Seed for Organic Systems

Practical Considerations
• Does it make sense to grow this in your area?
  • Cotton in WI?
  • Winter Barley in WI?
  • Hard Red Spring Wheat in WI?
• Spring field peas on heavy, wet, poorly drained soils?
• Has there been enough breeding work done to make this species a viable choice? (Lupin beans)
Practical Considerations, continued

Who is your intended customer? (And what do they want?)

- Specific variety?
  - Food-grade
  - Specialty marketing? (heirloom)
  - Malting barley
- Specific characteristics?
  - Milling quality (make sure you know)
  - Test weight (corn, wheat, oats)
  - Protein (wheat, hay)
- Things they hate? Deal killers?
  - GMO (corn & beans) (what level?)
  - Ergot (rye)
  - Light test weight (oats)

Major Crops (corn, soy, alfalfa, wheat, oats, barley)

- Majority of breeding by large companies or Universities with little/no interest in organic
- Large-scale breeding programs do all breeding, screening, & evaluation in conventional randomized, replicated systems
Randomized, Replicated Testing Goals

- Reduce variability
- Identify & characterize genetics
  - Yield
  - Moisture
  - Stalk & Root Lodging
  - Test Weight
  - Disease Susceptibility
  - Other Characteristics

The Result of Randomized, Replicated Testing

Identifies the best hybrids & varieties for performance in randomized, replicated plots under high fertilization and pesticide management.

Does that sound like organic farming?

How Organic Seed Companies Select from Conventional Data

Proxy characteristics from conventional data
- **Corn**: Emergence, Height & Canopy, Ear Flex
- **Soybeans**: Height, Canopy width
- **Wheat**: T.W. & protein, disease resistance

Customer feedback (takes years)
- “...worked great”
- “Poor emergence”
- “Short, poor weed shading”

Organic Breeding Under Organic Conditions

Not much on-organic-farm breeding work has been done (for major grain crops)

...but this is starting to change.

- Some Universities (such as U. WI Madison, ISU, and others) have begun to breed for organic systems
- Programs & Grants for breeding under organic systems
  - USDA-OREI
  - U of IL $2 Million Grant in 2018 for Org. Corn Research
  - $17 Million in latest farm bill (Org. Research)
  - OFRF
Evaluation/Testing under Organic Conditions

• Mostly on commercial/released hybrids & varieties
• Universities (such as U. WI, U. MN, VT, and others)
• Some other public-facing organizations (e.g. Organic Valley)
• Evaluating & Screening hybrids/varieties for organic production:
  • A.L. Seed/Viking Organic Product Screening Trials

<table>
<thead>
<tr>
<th>Location</th>
<th>Variety</th>
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<td>55.34</td>
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</table>

Viking Organic Research Trials, 2018

• 4 rows, harvest middle 2
• Replicated 4 times at each location
• Data from 1 location here
• 3 other locations (lost one, weeds)
### Considerations for Variety Selection by Species: Corn

#### National Organic Program Rule

The use of GMOs is prohibited in organic production and handling. The NOP regulations prohibit the use of GMOs as “excluded methods” under 7 CFR § 205.105, “Allowed and prohibited substances, methods, and ingredients in organic production and handling.”

#### Considerations for Variety Selection by Species: Corn, continued

- **NOP Standard** is a process-based standard.
- There has never been a “threshold” or “tolerance level” for A.P. GMO in the NOP Organic Rule.

#### New Approach?

Proposal would require transparency on A.P. of GMO in Hybrid Seed Corn only. (Both Organic & Unt. Conv.)
Cashton Farm Supply
- Org. Feed Corn: 5%
- Org. Feed Soy: 5%

Large Grain Aggregator X
- Org. Feed Corn: 2% (traceability emph.)
- Org. Food-grade Corn: “Neg. Strip Test”
- Org. Feed Soy: 2% (traceability emph.)
- Org. Food Soy: “Neg. Strip Test” (0.25% RR, 0.50% LL, 0.25% R2X)

SunOpta
- Org. Feed Corn: 1.5% – 5% (buyer-driven)
- Org. Food-grade Corn: 0.9%
- Org. Feed Soy: 1.5% – 5%
- Org. Food Soy: 0.1% – 0.9%

Scoular Grain
- Org. Feed Corn: 3% – 5% (buyer-driven)
- Org. Feed Soy: 0.9% – 5%

**What GMO levels are allowed by buyers of Organic Grain?**

<table>
<thead>
<tr>
<th>Category</th>
<th>Action Threshold</th>
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<tr>
<td>Seed and other propagation materials</td>
<td>0.55%</td>
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<tr>
<td>Inputs to human food, ingredients, supplements, personal care products, and other products that are either ingested or applied directly to skin, and pet food</td>
<td>0.0%</td>
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<tr>
<td>Livestock feed and supplements, including those used for animal-derived inputs to human food products</td>
<td>5%</td>
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<tr>
<td>Inputs to packaging, cleaning products, textiles and other products that are not ingested or applied directly to skin</td>
<td>1.5%</td>
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**What are Seed Companies doing about GMOs in seed?**

**REPORT OF SEED ANALYSIS**

SOS 1405 32nd Ave. Brookings, SD 57006

Date Received: 3/28/2017
Date Completed: 4/5/2017
Date of Report: 4/5/2017

To: Brian White
Fax: 

Sample Number: 83260
Account Number: 482 CL
Client ID: 20484-SUP / MR / 21913
OrderID: 
Customer Remarks: P-30G,GA21,MR162,MR604

Number of Seeds: 10000
Sample Remarks:

SGS Brookings is an accredited Laboratory (USML06) of the International Seed Testing Association (ISTA).
Limitation of Viking Pure & Ultra-Pure Seed Corn

- It can be cross-pollinated by neighboring fields
- It can be contaminated through co-mingling

What are Seed Companies Doing About GMOs in Organic Seed Corn?

PuraMaize is a natural gene blocking system that impedes fertilization from “foreign” pollen.

Limitations of PuraMaize

- Capital-intensive & time-consuming to develop
- Only 5 Pura-Maize hybrids have been released (so far)
- Grain & food companies have, so far, not been keen to pay a premium for grain produced from PuraMaize hybrids
Considerations for Variety Selection by Species: Corn

A. Maturity (map)
B. Emergence and Early Season Growth (Seed Coatings may help)
C. Height and leaf-angle (weed shading)
D. Ear Flex (population tolerance)
E. Yield and Yield Stability (Broad adaptability)
F. Root Strength
G. Stalk Strength
H. Drought tolerance
I. Wet ground tolerance
J. Health
K. Quality (Test Weight)

Hybrid Selection Criteria

Organic Corn Selection Criteria

Emergence/Vigor
- Very important as it needs to get out of the ground and canopy quality to shade the ground to prevent weed growth.

Adaptability
- Hybrids need to be able to perform on a wide range of environments.

Yield
- Hybrids (current & new) need to be able to compete with industry standards/checks. Looking for top-tier line yield performance.

Producibility
- Is it available? Need to be sure that the hybrid can be produced organically. Need untreated inbred seed with low GMO levels. Ideally, the female would be a modified or sister-line.

Agronomics
- This is a broad topic that can be broken down, it includes root structure and strength, stalk strength, standability, plant and ear height, etc.

Ear Flex
- Fits with agronomics, but even more important in organics as plant populations are typically less dense than in conventional farming.

Drydown
- Not as important to agronomics, but very important to many farmers. The faster corn can go from black-layer to 20%, the better for grain farmers. Later planting dates in organics express more need for faster drydown.

Disease Resistance
- Many early seedling diseases are not as harsh in organics with the later planting dates, but without fungicide possibilities, resistance to many stalk and leaf diseases is important.

Maturity
- Important to have a good spread of maturities to fit farmers’ needs. Also important to have “empty slots” in the lineup and not stack too many hybrids of the same maturity into the lineup on top of each other.

Additional considerations for seed companies: Corn, continued

• Availability of untreated inbred parent seed (male & female)
• Producibility in a seed field (often a guaranteed contract)
  • Parent seed vigor and height
  • Parent seed potential yield and pollen shed
• GMO content of parent seed
Considerations for Variety Selection by Species: Soybeans

What is my intended market?
- If food-grade, then grow what the buyer wants (if it fits your farm)
- If animal feed, then just grow the highest yielding, best adapted variety you can find

Considerations for Variety Selection by Species: Soybeans

- Geographical Adaptation
  - Maturity Zones in Soybeans (e.g. Group 1.5)
  - Photoperiod sensitive (map)
- Environmental Adaptation
  - East to West
- Disease pressure (White Mold, PRR, BSR, SDS, IDC)
- Insect Pressure (Cyst Nematode, Aphids)
  - Aphid-tolerant soybeans
  - Rag 1, Rag 2
  - Stacked (breeding effort in 2nd year)
- Wet soil Tolerance (PRR)
Considerations for Variety Selection by Species: Soybeans

- **Organic adaptability**
  - Same problems described previously for corn
    - Mostly conventional breeding & screening
    - Selection by proxy

- **Cultural adaptation**
  - Row width (Bushy)
  - Maturity & Planting date (Until June 15, plant full-season)
  - Are some varieties better for roller-crimper rye?

- **Practical adaptation**
  - What is available in organic seed?
  - Is there a much better conventional untreated option?

- A.P. of GMO?

What are Seed Companies doing about GMOs in organic soybean seed?
Starting with GMO-free soybean seedstock "seems achievable".
2/22/2019

Viking Organic Soybean Criteria

1. Plant Type
   Varieties with a more bushy plant type rather than narrow are more desirable. Need to be able to fill wide rows easily.

2. Plant Height
   More important in organic farming with the need to shade the row and help prevent weeds. Does come with standability risks.

3. Aphid Tolerance
   Very important in organic without the possibility of using foliar insecticides. But right now it’s either there, or it’s not.

4. Yield
   Varieties need to yield better or with current varieties. Also needs to compete well with Conventional, non-GMO varieties.

5. Broad Adaptation
   Need to be able to take each variety to a wide range of environments, east to west, and sometimes north to south.

6. Defense
   Soybean varieties need to be able to handle a wide range of stresses, i.e. Wet soils, drought, etc..

7. Disease Tolerance
   Related to defense, but specific to needs: In order: PRR, SWM, BSR, IDC, CN, SDS, Frog-eye.

8. Standability
   Good lodging scores are desirable.

9. Maturity
   Find maturities that fit the needs of customers, but not stacked on top of each other.

10. Food Grade
    Food grade markets are more prevalent in organic production. Soybeans with clear/yellow hila are more marketable, and higher protein can bring higher premiums. Work with end-users.

Considerations for Variety Selection by Species: Oats

Standard Oat Selection Criteria

1. Yield
2. Test Weight
3. Lodging Resistance/Height
4. Maturity
5. Disease Resistance
   - Crown Rust
   - BYDV
Considerations for Variety Selection by Species: Oats

Grain for a Miller? (check with them on preferred varieties)

Are you underseeding them with alfalfa?
If Yes, then most important factors are:
- Very Good lodging resistance
- Early Maturity
- Short
- Reins
- Antigo
- Deon
- Sumo
- Shelby 427 (?)
- Natty
- Reins
- Saddle
- Goliath
- Hayden
- Food Buyers Specifications---Oats

<table>
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<tr>
<th>Quality Standards</th>
<th>Foreign Material</th>
<th>Damage</th>
<th>Pest/Pesticide/Odors/FM restrictions</th>
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</thead>
<tbody>
<tr>
<td>Test Wt. 38 lb. (Min 36)</td>
<td>FM 2%</td>
<td>Frost</td>
<td>NO insect damaged kernels</td>
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<tr>
<td>Moisture 13.5% (10-14%)</td>
<td>wheat, barley, wild oat</td>
<td>Sprouted</td>
<td>NO preharvest glyphosate</td>
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<tr>
<td>Thins 12% (Max 20%)</td>
<td>Ergot 0.02 %</td>
<td>Green</td>
<td>NO detectable levels of pest.</td>
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<tr>
<td>Dehulled 8% (Max 12%)</td>
<td>Buckwheat</td>
<td>Vomitoxin 0.1 ppm</td>
<td>NO objectionable odors</td>
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Specifications for Grain Millers, Inc. Eden Prairie, MN

Oat Variety Selection for 2019

Trials
1. Check more than one (they can conflict)
   - Data can be wrong (U. of MN test weights in 2016)
2. Oats change over years (especially due to Crown Rust)
3. Ask local suppliers what has been working
4. Ask your customer
   - Millers have recommended lists
   - Horse Oat buyers have preferences (white oats)
Considerations for Variety Selection by Species: Oats

Why planting date is important

- Heat stress at anthesis results in a greater potential yield loss than heat stress at tillering, jointing, or grain filling
- Reduced number of seeds fertilized and formed
- Late season heat stress due to delayed planting dates = shorter period of grain fill = lower test weight potential
Small Grains – Hybrid Winter Rye

- Hybrid winter rye: yields 2X to 3X our standard rye
- Hybrid winter rye: much lower ergot potential
- Everything oats do, hybrid winter rye does better:
  - Erosion control, nutrient scavenging, breaking up pest cycles, GHG capture, pesticide use reduction, reduced fertilizer use, water quality improvements
- Finite market for distilling/milling
- Huge potential market for animal feed
  - Swine rations in the E.U. include from 10-60% cereal rye
  - 2015 Germany, Poland, and Denmark fed over 180 million bushels of rye to swine
- KWS is funding 4-year swine-feeding study at U of IL

Small Grains – Hybrid Winter Rye

153 Bu./acre

Table 2. Relative grain yield of winter rye varieties in five Minnesota locations in single-year (2017) and multiple year comparisons (2015-2017).

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<thead>
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<th>Variety</th>
<th>Year</th>
<th>Location 1</th>
<th>Location 2</th>
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<th>Location 4</th>
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<td>Hybrid Rye</td>
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<td>81</td>
<td>78</td>
<td>73</td>
<td>70</td>
<td>77</td>
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<tr>
<td></td>
<td>2016</td>
<td>78</td>
<td>72</td>
<td>68</td>
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<td>80</td>
<td>82</td>
<td>75</td>
<td>73</td>
<td>78</td>
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Varietal Traits for Organic Grains: Barley

General Considerations

I. What is your end-use for barley?
   A. Forage
   B. Animal Feed
   C. Milling
   D. Malting

II. What are the requirements of your end-user?
   A. What is the probability of meeting their needs?
Varietal Traits for Organic Grains: Barley

Management Considerations:
- Avoid planting barley on fields with lots of corn trash. Corn trash carries the Fusarium fungus, which can cause FHB in barley.
- Avoid fields rotating from oats or wheat
- Well-drained soils are essential for producing good quality barley. Barley grows best in cool and dry conditions.

Optimum Planting Dates:
- As early as you can
- Recommended planting date: early April to very early May.

Food Buyers Specifications---Barley

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<tr>
<th>Quality Standards</th>
<th>Foreign Material</th>
<th>Damage</th>
<th>Pest/Pesticide/Odors restrictions</th>
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<tbody>
<tr>
<td>Test wt. 46 (44)</td>
<td>FM 1.5 (3%)</td>
<td>Frost</td>
<td>NO signs of insect infestation</td>
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<td>Moisture 13.5 (10-14%)</td>
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<td>Thins 4% (6%)</td>
<td>Blue barley 0% (1%)</td>
<td>Vomitoxin 0 (3 ppm)</td>
<td>NO pest. odors</td>
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<td>Plump 70%</td>
<td>Ergot 0% (0.04%)</td>
<td>Falling # 275 (min 250)</td>
<td>NO objectionable odors</td>
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Specifications for Grain Millers, Inc. Eden Prairie, MN

Varietal Traits for Organic Grains: Barley

General Considerations

I. 2-Row vs. 6-Row
- 2-Row had been preferred by malters
- 2-Row tends to have plumper kernals
- 6-Row used to yield more
- Check with your end-user

II. How to choose a barley?
A. For Millers/Malters, check with them
B. For feed: highest yield, best disease resistance
C. For forage: highest tonnage/quality
Varietal Traits for Organic Grains: Barley
Agronomic Considerations

I. Scab tolerance (FHB)
II. Yield
III. Lodging Resistance
IV. Recommended Varieties for grain
   1. ND Genesis, 2-row (Good FHB tolerance, high yields)
   2. Pinnacle, 2-row
   3. Conlon, 2-row (Best FHB tolerance, low yield)
   4. Quest, 6-row (Very good FHB tolerance, good yields)

Varietal Traits for Organic Grains: Wheat
Agronomic Considerations

Management Considerations:
- Avoid planting wheat on fields that were planted to corn the previous year. Corn trash harbors the Fusarium fungus which can cause Scab (FHB).

Optimum Planting Dates:
- HRS Wheat: Plant as soon as you can prepare a good seedbed (last week of March is fine). After April 21 in southern MN, you give up 1% of yield for each day of delay.
- Winter Wheat: Varies by latitude, but generally Sept. 10 – Oct. 10

Varietal Traits for Organic Grains: Wheat
General Considerations

I. What does your end-user want?
   A. Hard Red Spring
   B. Hard Red Winter
   C. Soft Red Winter

II. What are the requirements of your end-user?
   A. What is the probability of meeting their needs?
     ✓ Market available?
     ✓ Fit your climate? Soils? (agronomic fit)
     ✓ Work in your rotation?
Wheat---Classes

Hard          Soft

Durum---HRS---HRW---Hard White---SRW---Soft White

Wheat---Classes------Market Uses

• Durum----pasta, couscous, Mediterranean breads
• Hard Red Spring----artisan breads, croissants, bagels
• Hard Red Winter----yeast breads and other baked goods
• Hard White----white whole-wheat flour, flatbreads, Asian-style noodles
• Soft Red Winter----cookies, crackers, pastries, pretzels
• Soft White--------Asian-style bakery products, crackers
Starting a Cover Crop Seed Business: Intellectual Property

Types of I.P. on seed **germplasm** or **genetics**:

1. P.V.P. (Plant Variety Protection)
2. Patents
3. Licensed Varieties

**Plant Variety Protection Act**

- Varieties can be protected by Plant Variety Protection (PVP) certificates
  - Applied for by breeder or Univ. I.P. office
  - Twenty year protection on seed
  - Farmers can use seed on own holdings—but cannot sell PVP’d varieties (without Approval & Certification)
- PVP varieties must be sold only as variety names
- PVP Title V varieties must be sold as class of Certified Seed
- Examples:
  - Reins Oats, Deon Oats, Hayden Oats, Shelby 427 Oats
  - ND Dylan Winter Rye
  - Quest Barley, Pinnacle Barley, Rasmussen Barley
  - Shelly Spring Wheat, Expedition Winter Wheat
Patents

• **Plant Patent (Plant Protection Act 1930)**
  Very similar to a PVP BUT only for asexually propagated non-tuberous species (not usually seed)

• **Utility Patent (Most Seed Patents)**
  • 20 year protection
  • DUS (Distinctness, Uniformity and Stability) + innovative step + disclosure
  • Products, Processes (methods)
    • Maize variety per se first patented 1985
    • Patented herbicide resistant soybeans 1996
  • Requires license from owner for any use
  • No breeder exception in the US
  • Placed in public domain at expiration

• **Examples:**
  • Most Corn inbreds (and the resulting hybrids)
  • Soybean Seed (RR & Conv.)
  • Many Private Wheat Varieties
  • Some Privately-developed Barley, Triticale, & other grains

Licensed Seed

More and more seed grains are requiring a license to be signed before planting:

• Traited Corn, Soybeans, Cotton, Sugar Beets
• Conventional Soybeans (even I.S.U.)
• Winter Rye (both Hybrid rye & non-hybrid)
• Wheat
• Barley
• Cotton
“Subjects’ unwillingness to deduce the particular from the general was matched only by their willingness to infer the general from the particular.”

Daniel Kahneman quoting Nisbett and Borgida in his book *Thinking, Fast and Slow*