AMARANTH PRODUCTION PRACTICES IN THE U.S.

Rob Myers, Ph.D.
University of Missouri
USDA-SARE
Presentation outline

- Work on amaranth production in Missouri
- Challenges with growing amaranth
- Opportunities based on amaranth traits
- Funding opportunities through USDA-SARE
Work With Amaranth in Missouri

- Basic production management studies
- Cropping systems research
- Plant characterization
- On-farm trials
- Market development
- Development of improved varieties
Basic Production Management

- Fertilizer rates
- Seeding rates
- Planting dates
- Row widths
Nitrogen Fertilization

• Conducted for two years in two locations
• Rates of 0, 45, 90, 130, and 180 kg N/ha, broadcast preplant as ammonium nitrate
• Lines D136-1, K266, and Plainsman
• Results indicated that only 45 to 90 kg N/ha was required to reach maximum yield across varieties, but varieties differed in responsiveness. Lodging and height also increased in response to nitrogen fertilizer.
Seeding Rates

• Three year study
• Rates of 0.28, 0.55, 1.1, 2.2, and 4.4 kg/ha, all in 76 cm (30 inch) rows
• Lines D136-1, K266, and K343 (Plainsman)
• Grain yield was not different for any of the seeding rates, due to the crop trait of self-thinning and compensating in per plant yield
Planting Date

• Three year study

• Three or four planting dates each year, with about 10-14 days separating each planting

• Lines D136-1, K266, and K343 (Plainsman)

• Mid-May to mid-June plantings in central Missouri were not different in yield, but planting in early July reduced yield 10 to 60%, depending on variety and year of test
Planting date study
Row Widths

- Started in 1992, 1 location, 2 years
- Row spacings of 19 cm (7.5 in.), 38 cm (15 in.), and 76 cm (30 in.) inches
- Narrow row spacing provided good early season weed control, but excessive self competition limited plant development, speeded maturity, and reduced yield
Row width study
Cropping Systems Research

- Long term rotations
- Intercropping
- Cover cropping
- Double cropping
Amaranth (on left below) in crop rotation study
Intercropping

- Conducted in 2 locations for 2 years
- Centered around pearl millet and cowpea intercrop system, but included amaranth:
  - amaranth vs. pearl millet as intercrops with cowpea
  - amaranth and cowpea in alternating rows, 2 row strips, 6 row strips, and sole cropped
  - amaranth and cowpea mixed plots at 0, 45, and 90 kg N/ha
- Amaranth can be intercropped with cowpea
Amaranth intercropped with cowpeas
Cover Crop Study

- Evaluated the effect of spring cover crops on development and yield of amaranth
  - crimson clover, hairy vetch, cereal rye, and Austrian winter pea
- Split plot treatments evaluated effect of supplemental nitrogen fertilizer in combination with the cover crops
Amaranth following rye cover (on left)
Crimson clover works well as cover crop before amaranth in Missouri
Amaranth as a double crop after wheat or canola
Plant Characterization Studies on Amaranth

- Germination response to light and temperature
- Seedling vigor
- Physiological maturity indicator
“Translucent” (less developed) amaranth seeds

“Opaque” (more mature) amaranth seeds
Challenges in Growing Amaranth

- Stand establishment
- Insects
- Disease
- Weeds
- Lodging
- Shattering seed
- Determining maturity
Poor stand establishment
Tarnished plant bug *Lygus lineolaris*
Amaranth seed damage from *Lygus*
Amaranth inflorescence damaged by Lygus
Blister beetle feeding on amaranth leaves
Webworm feeding on amaranth leaves
Stem breakage from wind
Plants lodging when roots give way in wet soils
There is genetic variability for lodging resistance, allowing for variety improvements.
Seeds falling to the ground (shattering)
Amaranth after frost in Missouri
Amaranth is amazingly diverse!
Germplasm Development

- Amaranth breeding
  - Started with National Plant Germplasm material
  - Crosses in greenhouse winter 2005-2006
  - F1’s selected by phenotypes in field summer 2006
  - F2’s advanced in greenhouse winter 2006-2007
  - Advanced selected grain heads in 2007-2009
  - In 2010 tested select lines and advancing over 70
  - Since 2011 have been scaling up seed of two lines and continuing to evaluate them for possible release

- Selection criteria
  - Lodging resistance and harvestability
  - Yield potential and vigor
  - Nutritional characteristics
# Amaranth Nutrition Data

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<td>Protein (%)</td>
<td>11.7</td>
<td>9.4</td>
<td>11.3</td>
<td>15.6</td>
<td>16.2</td>
<td>15.5</td>
<td>16.2</td>
<td>15.3</td>
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<tr>
<td>Fat (%)</td>
<td>1.8</td>
<td>4.7</td>
<td>3.3</td>
<td>6.2</td>
<td>6.4</td>
<td>6.8</td>
<td>6.4</td>
<td>7.3</td>
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<tr>
<td>Fiber, total dietary (%)</td>
<td>12.5</td>
<td>N/A</td>
<td>N/A</td>
<td>3.2</td>
<td>2.9</td>
<td>2.9</td>
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<td>3.3</td>
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<tr>
<td>Iron (ppm)</td>
<td>4.3</td>
<td>2.7</td>
<td>3.0</td>
<td>8.4</td>
<td>7.0</td>
<td>8.8</td>
<td>11.8</td>
<td>9.3</td>
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<tr>
<td>Zinc (ppm)</td>
<td>3.1</td>
<td>2.2</td>
<td>N/A</td>
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<td>3.4</td>
<td>4.5</td>
<td>3.5</td>
<td>4.4</td>
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<tr>
<td>Vitamin A (IU)</td>
<td>negligible</td>
<td>469</td>
<td>205</td>
<td>5700</td>
<td>7400</td>
<td>8700</td>
<td>9700</td>
<td>8200</td>
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<tr>
<td>Squalene (mg/100 g)</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>363</td>
<td>396</td>
<td>470</td>
<td>407</td>
<td>483</td>
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</table>

Wheat, corn and sorghum data from published USDA nutrition sources
Amaranth data from University of Missouri Chemical Services Lab
August 21st, 2011
September 10, 2011
Barriers and Constraints

- Further breeding is needed to improve yield, reduce lodging, reduce seed shatter, and improve ease of harvesting
- Small seed size makes handling difficult
- Insect pests can be a significant problem
- More utilization research is needed
- Markets remain relatively small and undeveloped
- General lack of familiarity with amaranth in the public and private sector
Opportunities

- Amaranth is widely adapted, tolerant of dry conditions, and diverse germplasm is available for use in breeding.
- Amaranth has relatively good yield for a high protein grain crop.
- Amaranth can be grown with conventional grain crop equipment.
- The colorful appearance of the crop and its colorful history continue to generate interest.
- Amaranth has a variety of potential uses.
What is SARE?

SARE is the USDA Sustainable Agriculture Research and Education grants program, aimed at supporting sustainable innovations for the whole of American agriculture.
SARE Grant Types

- Since 1988, SARE has invested in 4,000 projects nationwide
- SARE in the North Central Region offers grants for:
  - Research & Education
  - Professional Development
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- Nutrient management
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...and much more