Miscanthus: biofuels, invaders or both?

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36 Billion Gallons of Alternative Fuel...
2007 Energy Independence and Security Act
What makes a good biomass crop?

- C4 photosynthesis
- Long canopy duration
- High water use efficiency
- Recycles nutrients to roots
- Low input
- Clean burning
- Sterile – non-invasive
- Winter standing
- Easily removed
- No known pests/diseases
- Easily managed


Fig 1: Translocation increases nutrient use efficiency in perennial grasses.
What Are “The Canes”?
- multiple interbreeding genera and species
Examples include:

- Saccharum spp.
- Erianthus spp.
- Miscanthus spp.
M. × giganteus: Naturally Occurring Hybrid

 Miscanthus sinensis
 Diploid
 2n=2x=38

 Miscanthus sacchariflorus
 Tetraploid
 2n=4x=76

 Miscanthus × giganteus
 Triploid
 2n=3x=57

Sterile
Distribution of three Asian Miscanthus species

Original *M. x giganteus* hybrid collected in 1935 in Yokohama, Japan, cultivated in Denmark, then distributed throughout Europe and U.S. as an ornamental plant. Slide courtesy of Tom Voigt, UIUC.
Giant Miscanthus
(*Miscanthus × giganteus*)

A higher yielding alternative to switchgrass in some areas, especially the Midwest

- High Yielding (6-15 t/acre)
- Sterile clone
- Must be planted from rhizomes
- New to US: 10’s to 100’s of acres
- Widely planted in Europe: thousands of acres
- Used for heat and power with coal
From Heaton et al. (2010) Advances in Botanical Research, 56, 76-137.
Green Leaf Area Index and Duration


Species: p<0.0001
DOY: p<0.0001
Species*DOY: p<0.0001
M. × giganteus stems?

![Graph showing mean emergence percentage by soil temperature]

Miscanthus, a closer look
M. × giganteus floret
M. × giganteus: Naturally Occurring Hybrid

**Miscanthus sinensis**
- Diploid
- $2n=2x=38$

+ **Miscanthus sacchariflorus**
- Tetraploid
- $2n=4x=76$

= **Miscanthus × giganteus**
- Triploid
- $2n=3x=57$

STERILE
**M. sinensis vs. M. sacchariflorus**

**M. sinensis**
- bunch grass
- hairs = spikelet
- awns on florets
- firmer flowers in many colors
- many foliage colors
- August-October flowering

**M. sacchariflorus**
- aggressive rhizomes
- hairs = 2x spikelet
- no awns
- white soft flowers
- only green foliage
- August-early September flowering

http://miscanthus.cfans.umn.edu/identification.html
M. Sinensis - Japan


http://www.ask.com/wiki/Miscanthus_sinensis
M. Sinensis – Chinese Silvergrass

http://www.bonap.org/BONAPmaps2010/Miscanthus.html

Distribution of three Asian Miscanthus species

Original *M. x giganteus* hybrid collected in 1935 in Yokohama, Japan, cultivated in Denmark, then distributed throughout Europe and U.S. as an ornamental plant. Slide courtesy of Tom Voigt, UIUC.
M. sacchariflorus – Amur silvergrass

http://www.bonap.org/BONAPmaps2010/Miscanthus.html

M. sacchariflorus
Eastern Iowa, 2012. Photo credit: Virgil Schmitt
Right place, right time?

M. × giganteus

M. sacchariflorus

M. sinensis
Current work: assessing Miscanthus (and switchgrass) invasive potential

**Goal:** understand how likely new varieties are to flower, reproduce, establish and compete compared to existing varieties and native ecotypes

Model pollen flow and population dynamics

- 2 locations: Iowa, Ohio
- Range of germplasm: locally collected ecotypes, publically available cultivars, advanced breeding lines
- 3 experiments along ontogenic gradient: seed survival, seedling competition, mature plant fitness
Seed Survival

How long do switchgrass seeds last in the seed bank?

- Place clean, live, counted seed (tetrazolium test) in mesh bags
- Bury, dig up annually (3 years)
- Count seedlings that germinate
Seed Addition

How do seeds germinate and compete with competition?

- Sow at different densities
- 2 levels of competition provided by natural weed populations
- Seed production, biomass of switchgrass measured annually
Clonal Competition

Once established, how competitive are individual clones?

- Clonal seedlings planted with ‘high’ or ‘low’ competitor plants (high = *bromus tectorum*; low = *Schizachyrium scoparium*)
- Flowering time, seed set, morphology, biomass monitored
- Combined with other experiments’ results for systems modeling
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Speed Breeding in Action?

Switchgrass
Variety = EGX 1101
Senesced date = January

Winnsboro, LA
Dec. 5, 2007
32.5 N lat.
Wink Alison

Switchgrass
Variety = Sunburst
Senesced date = September