Effects of Topographic Position and Fertilizer Rate on Early Growth of Hybrid Aspen Alleycropped with Winter Triticale

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Overview

- Purpose of study
- Experimental design
- Results
- Discussion

Purpose of Study

- Component of larger project comparing biomass productivity of annual and perennial cropping systems
  - Continuous corn
  - Corn/soybean rotation
  - Switchgrass
  - Sorghum/winter triticale double-crop
  - **Hybrid aspen/winter triticale alleycrop**
- Why winter triticale?
  - Provide early income for landowner
  - Growth cycle (mid-September to late-June) minimizes competition with the trees (peak growth July to August)
  - Weed control
- Why hybrid aspen?
  - Fast grower
  - Well-suited for marginal ag land

Study site near Ames, IA (est. 2009).

Triticale between aspen rows (July 2010).

Purpose (cont.)

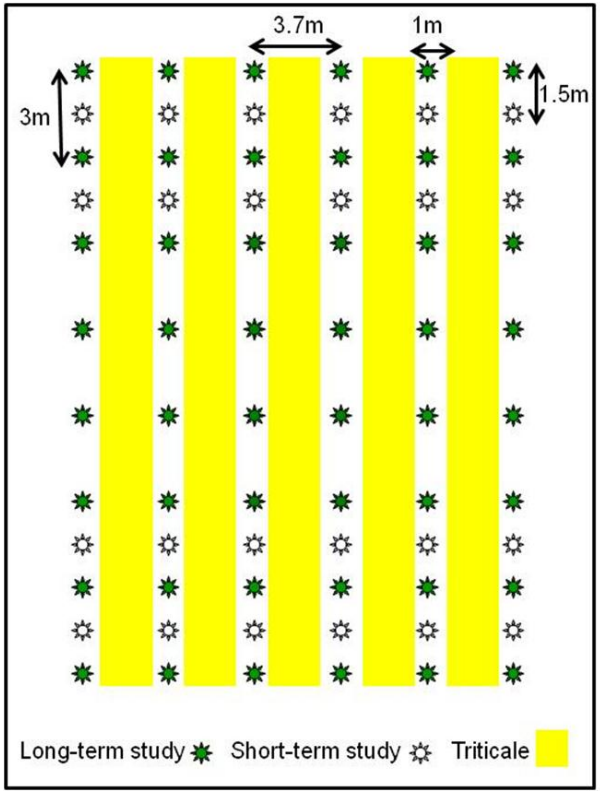
- Five topographic positions
  - Summit
  - Shoulder slope
  - Back slope
  - Toe slope
  - Floodplain
- Four fertilizer rates (20-10-5 NPK tablets placed in planting hole)
  - 0 g $tree^{-1}$
  - 10 g $tree^{-1}$ (= 3.5 kg N ha^{-1})
  - 20 g $tree^{-1}$ (= 7.0 kg N ha^{-1})
  - 40 g $tree^{-1}$ (= 14 kg N ha^{-1})
- Evaluated early tree growth (age 1-3)
  - Total aboveground dry biomass (branch + stem)
  - Allocation to branches (branch ÷ total)

Aerial view of study site. (photo T. Schultz)

Ground view of back slope position. (photo T. Ontl)

Experimental Design

- Planting timeline and layout
  - Triticale planted in fall ’08, strips 1 m wide killed with glyphosate in spring ’09
  - Hybrid aspen ‘Crandon’ (*Populus alba* L. × *P. grandidenta* Michx.) planted into strip-killed rows in late spring ’09
  - Long-term study trees planted at 3.0 × 3.7 m
  - Short-term study trees planted at 1.5 × 3.7 m; randomly assigned fertilizer rate and harvest age of 1-3 years
- Split-plot design
  - Main plot: 5 topographic positions × 3 reps = 15 plots
  - Split plot: 4 fertilizer rates × 3 ages × 2 trees = 24 trees plot^{-1} (= 360 trees total)



Plot layout as viewed from above.

Results

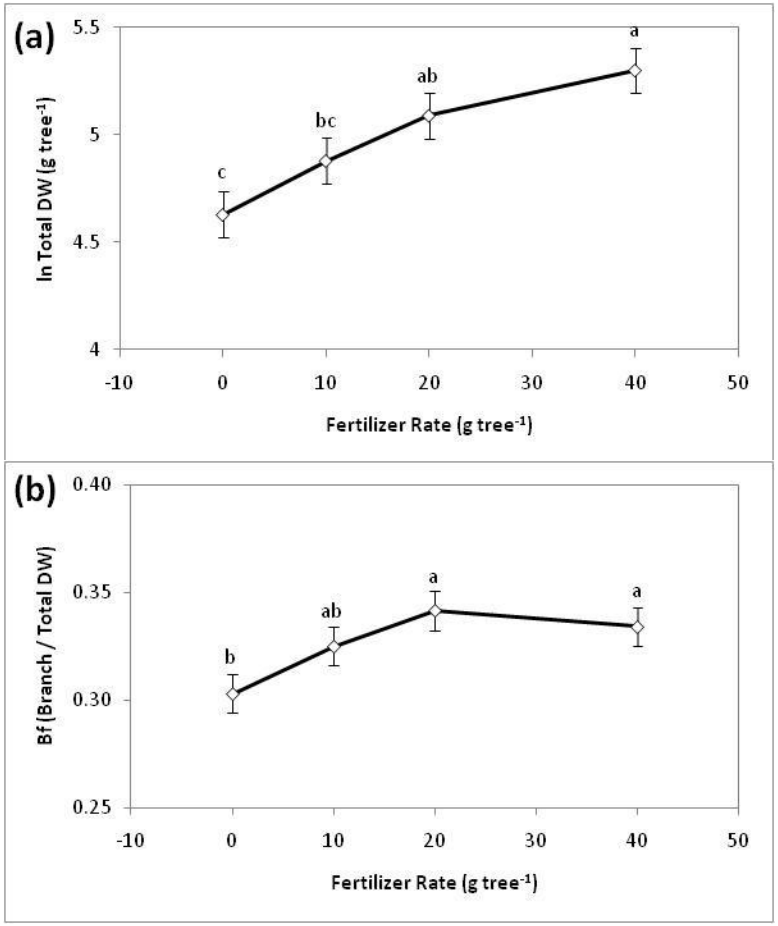
- Analysis of variance results for total aboveground dry biomass (DW) and fraction allocated to branches (B_f)

Effects	DW	B_f
Block	**0.0039**	0.1515
Position	0.7228	0.3389
Age	**<0.0001**	**<0.0001**
Fertilizer	**<0.0001**	**0.0111**
Age × Fertilizer	0.2508	0.7583
Position × Age	**0.0005**	0.1445
Position × Fertilizer	0.7283	0.9933
Position × Age × Fertilizer	0.6687	0.9477

Results (cont.)

- Fertilizer significantly increased total aboveground biomass (a) and branch fraction of total biomass (b)

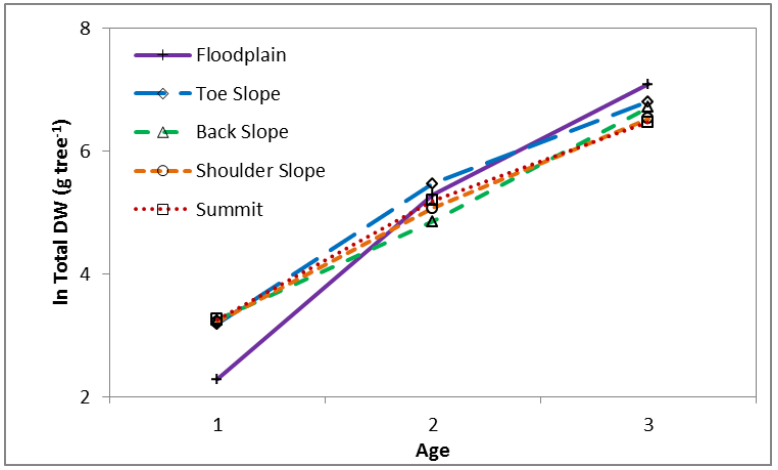
- Total aboveground biomass at end of study (age 3), by fertilizer rate:
  - 0 g tree^{-1} = 1.55 Mg ha^{-1}
  - 10 g tree^{-1} = 1.86 Mg ha^{-1}
  - 20 g tree^{-1} = 2.26 Mg ha^{-1}
  - 40 g tree^{-1} = 2.79 Mg ha^{-1}

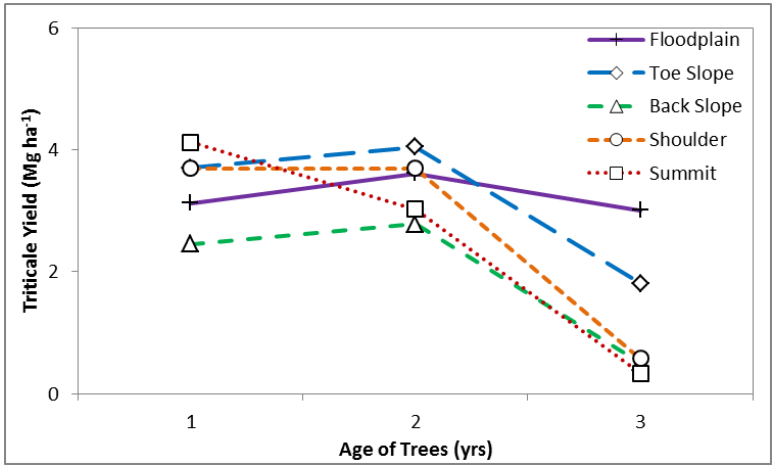


Effects of fertilizer rate on (a) total aboveground biomass and (b) branch fraction.

Results (cont.)

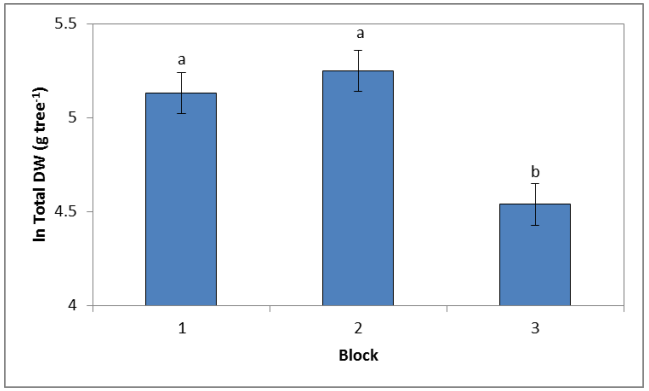
- Age × position interaction for total aboveground biomass
  - Floodplain < all others at age 1 (weed competition); not significantly different at ages 2 and 3
- Total aboveground biomass at age 3
  - Floodplain = 2.76 Mg ha^{-1}
  - Toe slope = 2.22 Mg ha^{-1}
  - Back slope = 1.78 Mg ha^{-1}
  - Shoulder = 1.45 Mg ha^{-1}
  - Summit = 1.46 Mg ha^{-1}
- Winter triticale yielded 2-4 Mg ha^{-1} each of the first 2 years, but only the floodplain and toe slope had this level of productivity in year 3





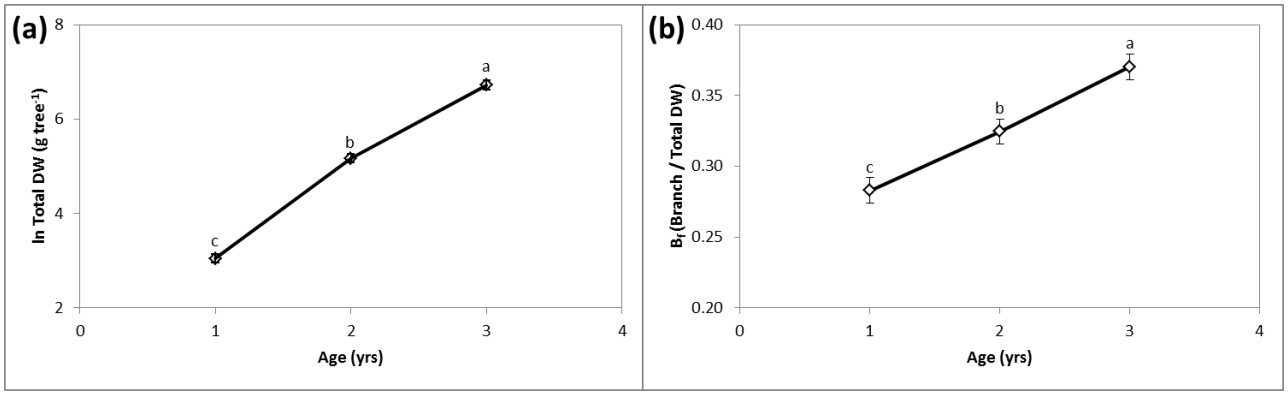
Results (cont.)

- Block effect for total aboveground biomass
  - Blocks 1 and 2 significantly higher than Block 3 (deer damage)



Block effect for total aboveground biomass.

- Total aboveground biomass & branch fraction both increased with age



Increasing (a) total aboveground biomass and (b) branch fraction, with age.

Discussion

- Significant fertilizer effects suggest long term (i.e. rotation length) studies on low rates of well-placed fertilizer are needed
  - Cost/benefit analysis
  - Higher branch fraction
- Effects of topographic position not statistically significant at age 3
  - Trend toward higher tree productivity at lower-lying positions (floodplain and toe slope)
- Winter triticale productive (2-4 Mg ha^{-1}) for first 2 years for all positions; only productive in year 3 at lower-lying positions
- Significantly lower tree productivity in block 3 and floodplain (age 1) demonstrate importance of controlling deer and weeds!
- Questions?

Acknowledgements

- Support and funding for this study were provided by:
  - ArborGen, Inc.
  - ISU College of Agriculture and Life Sciences
  - Leopold Center for Sustainable Agriculture
  - USDA Agriculture and Food Research Initiative
  - US Forest Service Institute for Applied Ecosystem Studies

- Triticale data provided by Theo Gunther (MS Agronomy)