1 Switchgrass Data

All data used in the present analysis, along with site, citation, and treatment information, are available in the BETY database. Each data point is identified by a unique trait_id: id is the primary key in the traits table, and trait_id is the foregin key in auxillary tables (Appendix B).

Present study data

Vcmax and SLA

V_{cmax} and SLA measurements were made on four year old switchgrass (*P. virgatum*) stands were grown in an agricultural study site in Savoy, IL (40^{o}10'20"N, 88^{o}11'40"W, 228 m above sea level). Gas exchanges were measured on leaves with a portable infrared gas analyzer (LI-COR 6400LCF; Li-COR, Lincoln, NE). During measurements, leaves were exposed to a CO_2 concentration of 370 μmol mol^{-1}, temperature at 25^{o}C, vapor pressure deficit (VPD) at the leaf surface 1.5 kPa and airflow through the chamber 250 μmol s^{-1}. For the CO_2 response (A-Ci) curves, leaves were acclimated for 30-60 minutes before adjusting the CO_2 concentrations. Thereafter, CO_2 concentration was decreased in 5 steps (400, 300, 200, 100 and 50 ppm CO_2) and then increased in 3 steps (400, 600 and 800 Îijmol mol-1 CO_2). A-Ci curves were fitted to a coupled photosynthesis-stomatal conductance model (Collatz et al., 1992). The rate saturated region of the A-Ci curves were used to estimate maximum Rubisco activity (Vcmax) (Miguez et al., 2009). SLA was computed as the ratio of leaf area to mass. Ten 0.5 cm^2 leaf punches from 4 different plants were taken and oven-dried at 65 ^{o}C for two weeks and then weighed.

Stomatal Slope data

Stomatal slope was estimated using measurements of four leaves from each of five field-grown energy crop species during the 2010 growing season. The five species included two C4 grasses: Miscanthus (*Miscanthus x giganteus*) and Switchgrass (*P virgatum*) planted in 2008 and three deciduous tree species: Red Maple (*Acer rubrum*), Eastern Cottonwood (*Populus deltoides*, and Sherburne Willow *Salix x Sherburne*) planted in 2010 as 2 year old saplings. All plants were grown at the Energy Biosciences Institute Energy Farm (40^{o}10'N, 88^{o}03"W).
Photosynthesis (A), stomatal conductance (gs), intercellular [CO_2] (ci), and humidity deficit at the leaf surface (Ds) were obtained via open gas exchange systems with 2 cm^2 leaf chambers housing infrared gas analyzers to measure fluxes of both CO_2 and water (LI-6400; LI-COR Inc., Lincoln, NE, USA). Data were collected following a simplified version of the protocol described by Leakey et al. (2006) in which photosynthetic photon flux density was maintained at 1500 μmol m^{-2} s^{-1}, leaf temperature was 25 ± 3^oC and the vapor pressure deficit from leaf to air was < 2 kPa while [CO_2] entering the chamber was varied stepwise (400, 250, 350, 450, 650, 850, 1200, 1500 ppm). A minimum of 20 minutes was allowed for A and gs to completely stabilize before data were collected at each [CO_2]. For each individual leaf, linear least squares regression was used to estimate the stomatal slope based on the Ball et al. (1987) model of stomatal conductance (not used in present study but provided as data in appendix), and then separately for the Leuning (1995) model of stomatal conductance. A common value of $\Gamma = 40\mu$P Pa^{-1}, and $D_0 = 1500$ Pa was used in accordance with Leuning (1995).

	Mean	n	SE	BETY trait_id
Leuning slope parameter				
	4.35	1	0.51	40909
	3.93	1	0.13	40910
	3.74	1	0.21	40911
	4.37	1	0.33	40912
SLA (gC/m^2)				
	34.5	2	12.2	2592
	28.4	2	4.7	2593
	32.1	2	3.6	2597
	30.5	2	5.7	2598
Vcmax				
	18.1	2	6.2	2638
	16.3	2	2.9	2639
	8.9	2	4.8	2640
	8.8	2	6.97	2641
	20.8	2	7.5	2642
	14.4	2	5.8	2643
	16.9	2	8.4	2644
	6.2	2	2.1	2645

Table 1

Previously published data

	Mean	n	SE	citation	BETY trait_id
SLA (gC/m^2)					
	38.8	2	1.0	Knapp (1985)	132
	40.6	2	2.2	Knapp (1985)	133
	40.8	8		Byrd and May II (2000)	281
	39.6	8		Byrd and May II (2000)	282
	49.5	8		Byrd and May II (2000)	283
	51.7	4		Byrd and May II (2000)	285
	53.3	4		Byrd and May II (2000)	286
	46.4	4		Byrd and May II (2000)	287
	54.2	4		Byrd and May II (2000)	288
	58.0	4		Byrd and May II (2000)	289
	52.8	4		Byrd and May II (2000)	290
	45.2	4		Trócsányi et al. (2009)	8478
	37.9	4		Trócsányi et al. (2009)	8482
	38.5	4		Trócsányi et al. (2009)	8487
fine root:leaf					
	0.59	4		Kiniry et al. (1999)	22092
	2.73	4		Kiniry et al. (1999)	22093
	0.43	4		Kiniry et al. (1999)	22094
	1.5	4		Kiniry et al. (1999)	22095
	1.81	2	0.27	Tjoelker et al. (2005)	25670
	0.74	2	0.30	Tjoelker et al. (2005)	25675

	Mean	n	SE	citation	BETY trait_id
leaf width (mm)					
	10.2	2	0.27	Knapp (1985)	136
	5.9	2	0.23	Knapp (1985)	137
	5.0	2	0.18	Redfearn et al. (1997)	332
	4.9	2	0.18	Redfearn et al. (1997)	333
	6.4	2	0.18	Redfearn et al. (1997)	334
	6.3	2	0.18	Redfearn et al. (1997)	335
	6.2	2	0.18	Redfearn et al. (1997)	336
	7.2	2	0.18	Redfearn et al. (1997)	337
	5.2	2	0.18	Redfearn et al. (1997)	338
	4.6	2	0.18	Redfearn et al. (1997)	339
	6.2	2	0.18	Redfearn et al. (1997)	340
	5.8	2	0.18	Redfearn et al. (1997)	341
	4.6	2	0.18	Redfearn et al. (1997)	342
	6.8	2	0.18	Redfearn et al. (1997)	343
	6.8	2	0.18	Redfearn et al. (1997)	344
	6.6	2	0.18	Redfearn et al. (1997)	345
	7.9	2	0.18	Redfearn et al. (1997)	346
	7.4	2	0.18	Redfearn et al. (1997)	347
	6.7	2	0.18	Redfearn et al. (1997)	348
	7.0	2	0.18	Redfearn et al. (1997)	349
	4.8	2	0.18	Redfearn et al. (1997)	386
	4.8	2	0.18	Redfearn et al. (1997)	387
	6.2	2	0.18	Redfearn et al. (1997)	388
	5.8	2	0.18	Redfearn et al. (1997)	389
	4.7	2	0.18	Redfearn et al. (1997)	390
	7.7	2	0.18	Redfearn et al. (1997)	391
	4.6	2	0.18	Redfearn et al. (1997)	392
	5.6	2	0.18	Redfearn et al. (1997)	393
	7.3	2	0.18	Redfearn et al. (1997)	394
	6.6	2	0.18	Redfearn et al. (1997)	395
	7.3	2	0.18	Redfearn et al. (1997)	396
	7.0	2	0.18	Redfearn et al. (1997)	397
	5.1	2	0.18	Redfearn et al. (1997)	398
	4.7	2	0.18	Redfearn et al. (1997)	399
	5.8	2	0.18	Redfearn et al. (1997)	400
	6.4	2	0.18	Redfearn et al. (1997)	401
	5.0	2	0.18	Redfearn et al. (1997)	402
	7.0	2	0.18	Redfearn et al. (1997)	403
	7.6	2	1.70	Oyarzabal et al. (2008)	453

Table 2

2 BETYdb

The Biofuel Ecophysiological Traits and Yields database (BETYdb, http://ebi-forecast.igb.uiuc.edu) structure (Figure 1).

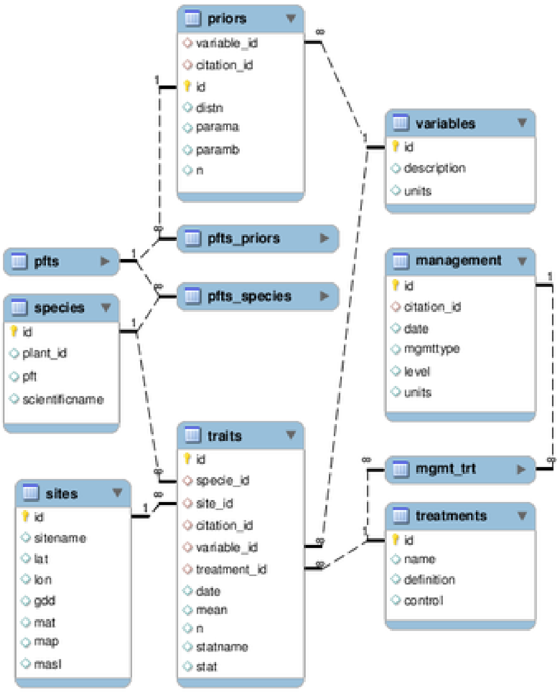

Figure 1

3 Transformations

Arrhenius correction

Parameters for enzyme kinetics ($V_{c_{max,T_m}}$ and root respiration rate) were scaled from the measurement temperature (T_o) to a standard temperature ($T_m = 298K (= 25^oC)$) using an Arrhenius correction:

$$V_{c_{max,T_m}} = \frac{V_{c_{max,T_0}}}{e^{3000*(1/(T_o)-1/(T_m))}}$$

Estimating SE from reported statistics

Often, differences between treatments are reported with P-values, least significant differences (LSD), and other statistics but provide no direct estimate of the variance. It is reasonable to always assume that the statistics were calculated using the assumption that the data are normally distributed.

1. given MSE and n

$$SE = \sqrt{MSE/n}$$

2. given P, n, and treatment means $\bar{X}_1$ and $\bar{X}_2$

$$SE = \frac{\bar{X}_1 - \bar{X}_2}{t_{(1-\frac{P}{2},2n-2)}\sqrt{2/n}}$$

3. given LSD, α, n, b where b is number of blocks [1], and $n = b$unless otherwise specified for a randomized complete block design (Rosenberg et al., 2004):

$$SE = \frac{LSD}{t_{(0.975,n)}\sqrt{2bn}}$$

4. given MSD (minimum significant difference) given n, α, df $= 2n - 2$ (Wang et al., 2000)

$$SE = \frac{MSD}{t_{(0.975,2n-2)}\sqrt{2}}$$

5. given a 95% Confidence Interval (measured from mean to upper or lower confidence limit), α, and n (Saville, 2003)

$$SE = \frac{CI}{t_{(\alpha/2,n)}}$$

6. given Tukey's HSD, n, where q is the 'studentized range statistic',

$$SE = \frac{HSD}{q_{(0.975,n)}}$$

7. To solve for MSE given F, df_{group}, and SS (required when a partial anova table is provided) The definition $F = MS_g/MS_e$, where g indicates the group, or treatment can be rearranged to solve for the MSE: $MS_e = MS_g/F$ Then if $MS_x = SS_x/df_x$,

we can substitute SS_g/df_g for MS_g in the definition of F: $F = \frac{SS_g/df_g}{MS_e}$ and then solve for MS_e: $MS_e = \frac{SS_g}{df_g \times F}$.

In the present study, all required transformations were done prior to entry in the database using these formulas. Subsequently, the PEcAn function `transformstats` has been developed to automate transformations of SD, MSE, LSD, 95%CI, HSD, and MSD to conservative estimates of SE.

Calculating precision from SE

Given variance ($\sigma^2 = \frac{1}{N}\sum(i_i - \mu)^2$), sd $\left(\sigma = \sqrt{\sigma^2} = \sqrt{\frac{1}{N}\sum(i_i - \mu)^2}\right)$, and se ($se = \frac{\sigma}{\sqrt{n}}$), calculate precision τ:

$$\sigma = se * \sqrt{n}$$
$$\sigma^2 = se^2 * n$$
$$\tau = \frac{1}{\sigma^2} = \frac{1}{se^2 * n}$$

4 Derivation of a Gamma prior on τ

$$\tau \sim G(\frac{n}{2}, \frac{\sum_{i=1}^{n}(\mu - x_i)^2}{2})$$

$$1/\tau_0 = \sigma^2 = \frac{\sum_{i=1}^{n}(\mu - x_i)^2}{n}$$

$$n/\tau_0 = n\sigma^2 = \sum_{i=1}^{n}(\mu - x_i)^2$$

$$\tau \sim IG(\frac{n}{2}, \frac{n}{2\tau})$$

References

Ball, J., I. Woodrow, and J. Berry, 1987. A model predicting stomatal conductance and its contribution to the control of photosynthesis under different environmental conditions. Pages 221—-224 *in* J. Biggins, editor. Progress in Photosynthesis Research. Martinus Nijhoff Publishers, Netherlands.

Byrd, G. T., and P. A. May II. 2000. Physiological Comparisons of Switchgrass Cultivars Differing in Transpiration Efficiency. Crop Sci. **40**:1271–1277. URL `http://www.ncbi.nlm.nih.gov/pubmed/21070419`.

Collatz, G., M. Ribas-Carbo, and J. Berry. 1992. Coupled Photosynthesis-Stomatal Conductance Model for Leaves of C4 Plants. Functional Plant Biology **19**:519—-538. URL `http://www.publish.csiro.au/paper/PP9920519`.

Kiniry, J., C. Tischler, and G. A. Van Esbroeck. 1999. Radiation use efficiency and leaf CO2 exchange for diverse C4 grasses. Biomass and Bioenergy **17**:95–112. URL `http://linkinghub.elsevier.com/retrieve/pii/S0961953499000367`.

Knapp, A. K. 1985. Effect of Fire and Drought on the Ecophysiology of Andropogon gerardii and Panicum virgatum in a Tallgrass Prairie. Ecology **66**:1309. URL `http://www.jstor.org/stable/1939184`.

Leakey, A. D. B., C. J. Bernacchi, D. R. Ort, and S. P. Long. 2006. Long-term growth of soybean at elevated [CO2] does not cause acclimation of stomatal conductance under fully open-air conditions. Plant, cell & environment **29**:1794–800. URL `http://www.ncbi.nlm.nih.gov/pubmed/16913868`.

Leuning, R. 1995. A critical appraisal of a combined stomatal-photosynthesis model for C3 plants. Plant, Cell and Environment **18**:339–355. URL `http://doi.wiley.com/10.1111/j.1365-3040.1995.tb00370.x`.

Miguez, F., X. Zhu, S. Humphries, G. Bollero, and S. Long. 2009. A semimechanistic model predicting the growth and production of the bioenergy crop Miscanthus ÃŮ giganteus: description, parameterization and validation. GCB Bioenergy **1**:282–296. URL `http://doi.wiley.com/10.1111/j.1757-1707.2009.01019.x`.

Oyarzabal, M., J. M. Paruelo, F. Pino, M. Oesterheld, and W. K. Lauenroth. 2008. Trait differences between grass species along a climatic gradient in South and North America. Journal of Vegetation Science **19**:183–192. URL `http://blackwell-synergy.com/doi/abs/10.3170/2007-8-18349`.

Redfearn, D., K. Moore, K. Vogel, S. Waller, R. Mitchell, and A. USDA. 1997. Canopy architecture and morphology of switchgrass populations differing in forage yield. Agronomy Journal **89**:262–269. URL `http://ddr.nal.usda.gov/handle/10113/27484`.

Rosenberg, M. S., K. A. Garrett, Z. Su, and R. L. Bowden. 2004. Meta-analysis in plant pathology: synthesizing research results. Phytopathology **94**:1013–7. URL `http://www.ncbi.nlm.nih.gov/pubmed/18943080`.

Saville, D. J. 2003. Basic statistics and the inconsistency of multiple comparison procedures. Canadian journal of experimental psychology **57**:167–75. URL http://www.ncbi.nlm.nih.gov/pubmed/14596475.

Tjoelker, M. G., J. M. Craine, D. Wedin, P. B. Reich, and D. Tilman. 2005. Linking leaf and root trait syndromes among 39 grassland and savannah species. The New phytologist **167**:493–508. URL http://onlinelibrary.wiley.com/doi/10.1111/j.1469-8137.2005.01428.x/full.

Trócsányi, Z. K., A. Fieldsend, and D. Wolf. 2009. Yield and canopy characteristics of switchgrass (Panicum virgatum L.) as influenced by cutting management. Biomass and Bioenergy **33**:442–448. URL http://linkinghub.elsevier.com/retrieve/pii/S0961953408002158.

Wang, Q., D. D. L. Denton, and R. Shukla. 2000. Applications and statistical properties of minimum significant difference-based criterion testing in a toxicity testing program. Environmental Toxicology and Chemistry **19**:113–117. URL http://www3.interscience.wiley.com/journal/122672445/abstract http://doi.wiley.com/10.1002/etc.5620190113.