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Producing biofuels with alternative fertilizers : a comparison of two promising species

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Introduction Globally , human systems need economically feasible , ecologically sound energy sources . Under rising energy costs associated with fossil fuels and concern over global climate change , countries are considering alternative energy sources , including renewable biomass development . Warm season perennial bunchgrasses are some of our best prospects for developing sustainable cropping systems for biomass and lignocellulosic energy production . These grasses are harvested on an annual or intra annual basis . Farmers cannot hope to continuously reap profits and production from a system without returning nutrients to the system to assure continued production . Unfortunately , most conventional nitrogen fertilizer is currently derived from fossil fuel driven Haber-Bosch process , which is deleterious to the Carbon balance and to the financial benefits gained from producing the grasses . However , bunchgrasses readily respond to manure-based fertilizers and show promise as filter strips in fields in which manure is applied . There is much interest in whether the North American native *Panicum virgatum* or the Asian native *Miscanthus × giganteus* is the most productive and sustainable potential biomass/lignocellulosic stock species . The comparative productivity of these two species is especially important as land managers decide which grass to plant for optimal economic and ecological return . We anticipate continued global interest in these species as the global community develops and expands the renewable energy sector .

Methods and materials We present a side-by side comparison of these species during the establishment year of a planned long-term study on a dairy operation in Comanche County , Central Texas . We used a completely randomized design , with five repetitions of two treatments (1 . dairy lagoon effluent application and 2 . no manure or irrigation) . We measured leaf area index (LAI) on biweekly intervals ($n=9$) between 13 June—27 August 2007 . We also sampled biomass data in July and August ($n=2$) .

Results and discussion Over the growing season , the average *Miscanthus* LAI (2 .0) under irrigated conditions was only 87% of the *Panicum* LAI (2 .3) . Under un-irrigated conditions *Miscanthus* LAI (1 .2) was only 63% of the *Panicum* LAI (1 .9) . Un-irrigated *Miscanthus* suffered a more severe decrease in LAI (42%) than did un-irrigated *Panicum* (20%) as compared to LAI values produced under irrigation . In June 2007 , under effluent treatment , *Miscanthus* produced 45% more biomass (408±117 g/m^2) than did *Panicum* (223±171 g/m^2) , while under non-irrigated conditions *Miscanthus* produced 15% less biomass (228 ±148 g/m^2) than *Panicum* (263±117 g/m^2) . By August 2007 , irrigated *Miscanthus* had lost its advantage , producing only 82% as much biomass as *Panicum* (901 ± 84 g/m^2 vs . 1094 ± 141 g/m^2) , while under un-irrigated conditions *Miscanthus* produced only 48% as much biomass (407±97 g/m^2) as *Panicum* (851±138 g/m^2) . Similar to LAI results , lack of irrigation had a far more deleterious effect on *Miscanthus* biomass (55% less) than on *Panicum* biomass (32% less) as compared to irrigated plants . These findings are in keeping with assessments of mature , un-irrigated , nutrient deprived , 5 year old stands at Temple , Texas . The *Panicum* and *Miscanthus* plots at Temple , Texas are established in a completely randomized design with four repetitions . In both 2006 and 2007 , *Miscanthus* produced 44% less biomass than *Panicum* (2907±612 g/m^2 vs . 5175± 1974 g/m^2) .

Conclusions Based on these observations in both first-year and mature stands in Central Texas , we conclude that *Miscanthus* is a promising biomass/lignocellulosic stock species under irrigated , high nutrient conditions , while *Panicum* will outperform *Miscanthus* under less favorable conditions and is more suitable in drier , more nutrient deficient areas .