Optimizing Grass Biomass Yield and Quality for Combustion

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In general, the federal government continues to ignore the potential for grass bioheat, while interest in the Northeast USA fluctuates with oil prices. The Northeast imports most of its energy and is therefore heavily reliant on these greatly fluctuating outside energy sources. Grass biomass for residential and light industrial heating has the potential to be a local closed-loop energy system, with the grass produced, densified and marketed locally. The energy content in pelleted grass is similar to premium wood pellets, and the efficiency of the system is very high. It is well-known that harvest management has a major impact on grass yield and composition. Warm-season grasses are most efficient if harvested once a year, while cool-season grasses have optimum yield with two harvests per season. Grass biomass for combustion should be relatively low in total ash content (primarily silica), but more importantly relatively low in nitrogen (N), potassium (K), chlorine (Cl) and sulfur (S) content. The basic factors influencing N, K, Cl, and silica uptake by grasses include plant species, soil type, plant water uptake, N, K and Cl fertilizer use, organic fertilizer application, and harvest management. The impact of organic matter application (manure or compost) on tradeoffs between grass biomass production, composition, and soil test N, P and K dynamics needs to be investigated.

Thirty-six species blocks were established [12 blocks each of switchgrass (*Cave-in-Rock*), reed canarygrass (*Rival*) and tall fescue (*KY-31*)], each 6 m x 18 m. Of these 36 blocks, 18 were on a sandy soil and 18 were located on a clay soil, on the Cornell research farm at Willsboro, NY. The six treatments applied to each block were: 1) Check treatment with no additional manure or fertilizer. 2) Dairy manure, 36.3 MT ha^{-1} wet-basis, early spring application. 3) Composted dairy manure, similar rate of dry matter as with dairy manure. 4) 168 kg ha^{-1} of N fertilizer for cool-season grasses, split-applied. 84 kg ha^{-1} for switchgrass, no P or K fertilizer. 5) Recommended rate of K as KCl (112 kg ha^{-1} of 0-0-60) (same N rate as #4). 6) 112 kg ha^{-1} of 0-0-60 plus P at 56 kg ha^{-1} of 0-46-0. (same N rate as #4). Treatments were applied from 2009 to 2011.

Switchgrass produced the highest yields in all three years, with 5.4 tons/acre on the sand site under fertilized conditions, and 6.0 tons/acre on the clay site in 2011. In 2011, tall fescue yielded higher than reed canarygrass on the sandy soil, but lower than reed canarygrass on the clay soil. Differences among commercial fertilizer treatments were not observed until 2011. The NPK treatment on cool-season grasses was higher yielding than either the N or NP treatments. Commercial fertilizer treatments had no significant impact on switchgrass yields. Cool-season grasses with manure application produced similar yields to the NPK commercial fertilizer treatment. For all 3 years, compost-treated cool-season grasses yielded much less than other treatments, averaging 50% lower yields than manure treatment. There was no difference in yield, however, between compost and manure for switchgrass. Forage elemental concentration response to treatments was very consistent over the three years of treatment applications. Adding K and Cl using either KCl, manure or compost, significantly increased forage K and Cl content, with very high Cl uptake using manure. Ash content followed the patterns of K and Cl uptake, with higher ash in manure and compost treatments. Switchgrass was lower in ash and elemental concentrations than the cool-season grasses, making it a more acceptable for combustion.