The use of digestate as fertilizer: effect on cocksfoot productivity and total energy input

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Introduction

The financial viability of bioenergy production is mostly influenced by the productivity and quality of the biomass (Lehtomäki *et al.* 2011; Šiaudinis *et. al.* 2012. Biogas which is an important form of bioenergy, is composed of methane and carbon dioxide produced from the anaerobic digestion of organic raw materials. To maximize the economic value of the anaerobic digestion process, both biogas and digestate should be efficiently utilized.

The energy input for grass grown specifically for biogas production ranges from 4.1 to 24.5 GJ/ha (Kryževičienė *et al.* 2005; Navickas *et al.* 2006; Navickas *et al.* 2011) depending on the fertilizer rate. In this case and because of nutrient content in digestate, it may also be used as an organic fertilizer to increase the productivity of crops with a reduced need for mineral fertilizers.

The objective of the current study was to investigate the effect of digestate, derived from pig manure and organic residues, on the productivity of cocksfoot (*Dactylis glomerata* L.).

Materials and methods

The field and laboratory experiments were carried out in Central Lithuania (55°24'N) during the 2009/10 and 2010/11 growing seasons on an *Apicalcari - Endohypogleyic Cambisol*, light loam soil. The experiment included the following treatments: no fertilization, fertilization with mineral nitrogen (N_{180} and N_{360}), and fertilization with digestate (N_{90}, N_{180}, N_{270}, N_{360} and N_{450}). Swards were harvested at approximately 2 month intervals during the growing season (October to April). Herbage was cut at a height of 5 cm with a mower when herbage mass reached 3-4 t/ha. After cutting there was a residual biomass of ~1 t/ha. Four cuts of swards were taken in 2009 and three cuts in 2010. All harvested material was removed from the experimental area. Further details of methods are presented by Tilvikiene *et al.* (2010).

Results and Discussion

Over the 2 years of measurement, cocksfoot biomass production showed significant response to N applications of up to 180 kg N/ha as mineral fertilizer, and 270 kg N/ha as digestate (Fig. 1). These responses to N were similar to Lemežienė *et al.* (1998) who reported that the annual biomass yield of cocksfoot increased from 9.3 to 16 t/ha/yr with N applications up to 150 kg N/ha/yr. The biomass yield of swards fertilized with digestate N_{360} was significant higher than of cocksfoot fertilized with the same rate of nitrogen presented in mineral fertilizers. During anaerobic digestion (Wilkie 2005; Voca *et al.* 2005) most of the organic material is mineralized making the nutrients more readily available to cocksfoot.

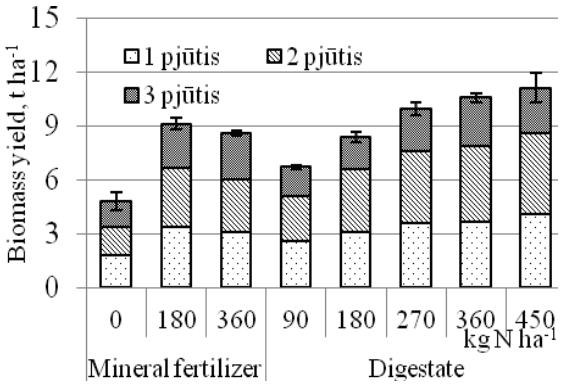

Figure 1. Biomass yield of cocksfoot, averaged over the two years.

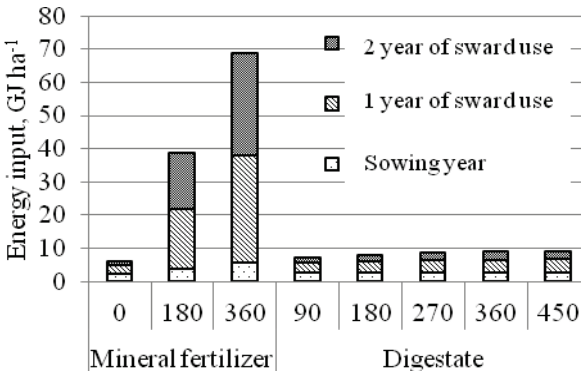

Figure 2. Energy input for growing and transportation cocksfoot biomass.

Energy inputs were much higher for swards fertilized with mineral fertilizer than those fertilized with digestate (Fig. 2). The results indicate that where it is available, digestate is a more energy-efficient form of fertilizer than mineral fertilizer.

Conclusions

The results of the fertilization of cocksfoot applied as either mineral fertilizer or digestate suggest that nitrogen rates higher than 180 kg affect the higher biomass yield of swards fertilized with digestate compared to those fertilized with mineral nitrogen. The use of digestate as fertilizer reduces energy input for grass growing, but more research is needed to evaluate the environmental of digestate as fertilizer. Just as importantly, the carbon to nitrogen ratio in the biomass of cocksfoot fertilized with digestate was better suited for biogas production compared to that in the biomass of cocksfoot fertilized with mineral fertilizers (Tilvikiene *et al.* 2010).

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References

Kryževičienė A, Žaltauskas A, Jasinskas A (2005) Daugiamečių žolių auginimas ir naudojimas biokurui. *Žemės ūkio mokslai* **1**, 40-49.

Lehtomaki A, Viinikainen TA, Rintala JA (2011) Screening boreal energy crops and crop residues for methane biofuel production. *Biomass and Bioenergy* **32**, 541-50.

Lemežienė N, Kanapeckas J, Butkute B (2009) Biodujų gamybai tinkamiausios paprastosios šunažolės (*Dactylis glomerata* L.) veislės, selekcinės linijos ir ekotipai. *Zemdirbyste–Agriculture* **96**, 36-46.

Navickas K, Venslauskas K, Župerka V, Nekrošius A, Kulikauskas T, Butkutė B (2011) Organinės apkrovos įtaka žolinių augalų biomasės anaerobinio perdirbimo energetiniams rodikliams. *Žemės ūkio inžinerija*. *Mokslo darbai* **43**, 5-15.

Šiaudinis G, Šlepetienė A, Jasinskas A, Karčauskienė D (2012) The evaluation of biomass and energy productivity of common mugwort (*Artemisia vulgaris* L.) and cup plant (*Silphium perfoliatum* L.) in *Albeluvisol*. *Zemdirbyste-Agriculture* **99**, 357-362.

Tilvikienė V, Kadžiulienė Ž, Dabkevičius Z (2010) Effect of digestate application on cocksfoot biomass production and Quality. T*reatment and use of organic residues in agriculture: Challenges and Opportunities towards sustainable management: proceedings of the 14th Ramiran International Conference,* 1-4.

Voća N, Krička T, Ćosić T, Rupić V, Jukić Ž, Kalambura S (2005) Digested residue as a fertilizer after the mesophilic process of anaerobic digestion. *Plant, Soil and Environment* **51**, 262-266.