INTRODUCTION

Perennial crops like energy cane (Saccharum spp.) and elephant grass (also called napier grass) (Pennisetum purpureum (L.) Schum.) which produces cellulose bio-ethanol are prioritized as renewable source of energy.

These can be grown in marginal lands with minimum inputs. How these crops may affect on soil organic carbon (SOC) pools (soil C fraction concentrations) and soil total nitrogen (STN) in response to nitrogen(N) fertilization and winter cover crop like Clover (Trifolium incarnatum) is poorly known.

Results from past study of other perennial lignocellulosic grasses are also not consistent. Jung & Lal (2011), and Gauder et al. (2016) has claimed SOC increased under N- fertilization in case of Miscanthus, however no significant effect on SOC was found by Ferchaud et al. (2016) and Higashi et al. (2014).

SOC and STN increased due to leguminous cover crops (hairy vetch) and to non leguminous crop (rye) in lignocellulosic grasses (Sainju et al., 2015).

PURPOSE OF THE STUDY

Analyze the SOC and STN in energy cane and elephant grass crop field grown in marginal land with:
- three nitrogen fertilizers treatment (0,100 and 200 Kg N/ha)
- two cover crop treatments (control vs winter clover)

MATERIALS AND METHODS

PLANTING AND FERTILIZATION

Two perennial grasses energy cane and elephant grass were planted in 2011 and harvested every fall (November). Clover (Trifolium incarnatum), a leguminous crop, was planted as cover crop.

The experiment was designed in randomly complete block design.

There were total 8 treatments including control, cover+0 Kg N/ha, cover+100 Kg N/ha and cover+200 Kg N/ha for each crop.

T1 = Energy cane control , T2 = Energy cane + cover + 0 Kg N/ha , T3 = Energy cane cover + 100 Kg N/ha, T4 = Energy cane cover + 200 Kg N/ha, T5 = Elephant grass control, T6 = Elephant grass + cover + 0 Kg N/ha, T7 = Elephant grass cover + 100 Kg N/ha, T8 = Elephant grass cover + 200 Kg N/ha

SOIL SAMPLING AND ANALYSIS

Soil samples were collected using a probe (3.5 cm inside diameter) randomly within the plot after biomass harvesting in the fall.

Each core was separated into 0-5, 5-15, 15-30, 30-60, and 60-90 cm depth intervals, composed within a depth, air-dried, and ground to 2 mm. Samples were analyzed for soil total C and STN concentrations with a high-induction furnace C and N analyzer (Elementar, Mt Laurel, New Jersey) after grinding a subsample to 0.5 mm.

Since pH in the soil samples were less than 7.0, soil total C was considered as SOC (Nelson and Sommers 1996).

Data for baseline study was analyzed for all soil depths, whereas, data after harvest of crop for years 2011-2014 were analyzed for two depths 0-15 cm and 15-30 cm using statistical software R (ver. 3.0, RFSRC, Vienna, Austria)

RESULTS

Soil  carbon and  nitrogen from perennial energy crop systems in 15-30 cm soil depth (Table 1).

Fig 3: Average SOC at different depths and treatments over the years

Fig 4: Average STN at different depths and treatments over the years

Fig 5: SOC levels compared for different years at two soil depths

Fig 6: STN levels compared for different years at two soil depths

DISCUSSION

Soil C and N fraction concentration from baseline samples decreased with soil depth (Table 1). Mostly biomass residue and microbial activities might have higher level at top soil contributing for higher soil C and N fraction.

The SOC and STN when compared between two crop showed elephant grass field had significantly higher than energy cane (Fig 3 & 4 - 1st arrow from top).

There was no significant difference between SOC and STN in both crops with and without N fertilizers (Fig 3 & 4 - 2nd arrow from top).

Crop with winter cover was significantly higher in SOC and STN levels except for STN in energy cane, which was not significantly different (Fig 3 & 4 – 3rd arrow from top).

Irrespective of crops elephant grass with cover and 100 Kg of N sequesetred more SOC and STN in soil (Fig 3 & 4 – significance with upper case).

Both SOC and STN were found to be significantly higher in top soil (0-15 cm) compared to sub-soil (15-30 cm) (Fig 5 & 6).

Different treatments when compared among the year showed significantly higher SOC level in second and third year (2012 & 2013), which then decreased in year 2014 and was not significantly different compared to establishment year (2011) (Fig 7).

STN was significantly higher in year 2012, 2013 and 2014 compared to establishment year (2011) (Fig 8).

Low SOC level in year 2014 could be due to low rainfall during active vegetative growth stage of the crop (August-September precipitation). The attainable SOC decreases with low rainfall (Hoy et al., 2013).

The SOC and STN were found to have an affect on biomass yield of the crop. The biomass yield increased till year 2013 and then decreased in year 2014, which later increased in 2015, for which soil analysis is ongoing (Fig 9). The pattern of increment in SOC/STN and yield was similar, indicating direct positive relationship between them.

CONCLUSIONS

Soil C and N fraction concentrations were higher in top layer of soil and that remained higher for all the years.

The application of nitrogen fertilizer did not have significant impact on SOC and STN which implies strongly that energy cane and elephant crops can be grown in limited input cropping system.

The winter cover crop had significant impact on SOC and STN and can be recommended in lieu of external fertilizer application.

REFERENCES


ACKNOWLEDGEMENT

The study was supported by financial support from Agriculture and Food Research Initiative, National Institute of Food and Agriculture (NIFA), US Department of Agriculture (USDA-NIFA-AR003042; GE0X-2010-03868).

ACKNOWLEDGEMENT

The study was supported by financial support from Agriculture and Food Research Initiative, National Institute of Food and Agriculture (NIFA), US Department of Agriculture (USDA-NIFA-AR003042; GE0X-2010-03868).