Sugarcane Leaf Spectra and Photosynthesis Responses to Millmud Application on a Sand Soil

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Abstract

Leaf spectra, SPAD, and photosynthetic rate (Pn) of one erianthus and seven sugarcane genotypes were determined on a sand soil with and without millmud added at the rate of 1,500 m^3 ha^{-1} prior to planting. Millmud treatment was the main plot and genotype was the subplot. These physiological traits were measured at the top visible dewlap leaves during growing seasons of the 1st- and 2nd-ratoon crops. Millmud reduced leaf reflectance at 560 and 720 nm. Leaf spectra of sugarcane differed from that of erianthus. Millmud significantly increased leaf SPAD (16%) and Pn (63%) for the 1st ratoon, but not for the 2nd ratoon. Genotypic differences in leaf SPAD and Pn were detected. Compared to other genotypes, The leaf SPAD and Pn of CP 01-2390 and erianthus responded less to the added millmud. CP 01-2390 was the most sand adapted genotype. These results indicate that there is promise for selecting high yielding genotypes for sand soils in Florida by making early stage selections based on leaf physiological measurements.

Introduction

Studies have suggested that the addition of millmud, a by-product from the sugarcane milling process, can significantly improve sugarcane yields on sand soils in Florida. Little is known about physiological responses of sugarcane genotypes to millmud addition. Better understanding of sugarcane genotype variation in physiological and yield traits on sand soils with and without millmud application may improve cultivar selection and productivity on sand soils.

Objective

Determine sugarcane genotypic responses to millmud application on a sand soil in leaf spectral reflectance, chlorophyll level (SPAD readings), and photosynthesis.

Plate 1. A part of the experimental field.

Materials and Methods

Treatment:

- Soil treatment (main plots)
  1. Sand soil without millmud
  2. Sand soil with millmud (1,500 m^3 ha^{-1})

- Genotype (subplot)
  1. CL 90-4725
  2. CP 01-1372
  3. CP 01-2390
  4. CP 03-1912
  5. CP 78-1628
  6. CPCL 01-0877
  7. TCP 02-4587
  8. Erianthus

Measurements:

From May through August of each year

- Leaf hyperspectral reflectance
- Leaf chlorophyll content (SPAD readings)
- Leaf photosynthetic rate (Pn)

Data are means across measurement dates.

When plants were mature

- Sucrose content (Commercial recoverable sucrose, g kg^{-1} cane)
- Cane yield (Mg cane ha^{-1})
- Sucrose yield (Mg ha^{-1})

Results

1. Leaf reflectance response to millmud

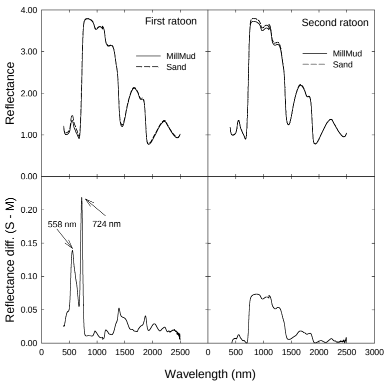

Fig. 1. Leaf reflectance as affected by millmud application.

2. Genotype variation in leaf reflectance

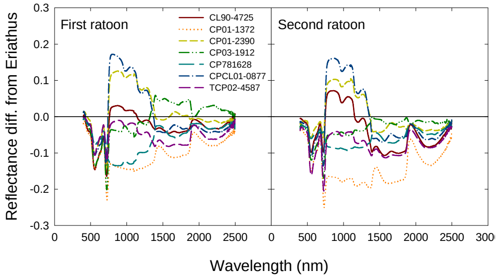

Fig. 2. Leaf reflectance differences of seven sugarcane genotypes from erianthus in the 1st- and 2nd-ratoon crops.

3. Leaf relative chlorophyll levels (SPAD readings)

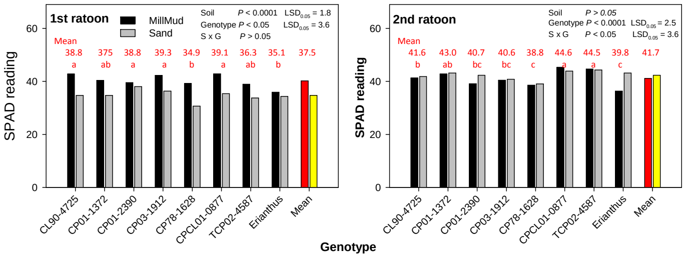

Fig. 3. Leaf SPAD readings of one erianthus and seven sugarcane genotypes on a sand soil with and without added millmud in the 1st- and 2nd-ratoon crops.

4. Leaf net photosynthetic rate (Pn)

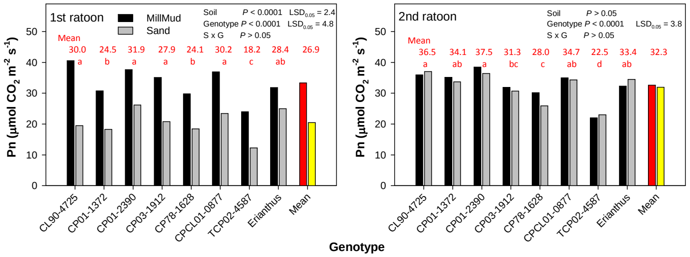

Fig. 4. Leaf photosynthetic rate (Pn) of one erianthus and seven sugarcane genotypes on a sand soil with and without added millmud in the 1st- and 2nd-ratoon crops.

Summary and Conclusions

- Millmud application reduced leaf reflectance at 560 and 720 nm. Millmud significantly increased leaf SPAD readings and Pn for the first-ratoon crop but not for the second-ratoon crop.
- Sugarcane genotypes showed considerable differences in leaf spectra compared to erianthus. Leaf SPAD and Pn responses of CP 01-2390 and erianthus to added millmud were much less than those of other genotypes. CP 01-2390 was genotype most adapted to the sand soil.
- Selection genotypes based on leaf physiological characters in early stage can identify genotypes with high yield potential on sand soils in Florida.