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INTEGRATING PHYSIOLOGICAL, MORPHOLOGICAL AND ANATOMICAL TRAITS TO UNDERSTAND THE DIFFERENTIAL SUCROSE YIELD IN SUGARCANE GENOTYPES

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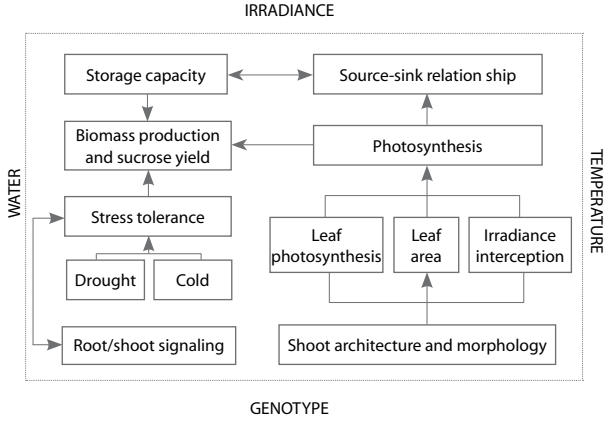
Our purpose is to understand some aspects of sucrose yield by addressing physiological, morphological and anatomical traits. This strategy will increase the subjacent knowledge about sucrose yield and let us to a more complex scenario about this important agricultural theme. In fact, improvement in the understanding of ecophysiological aspects related to phytomass production and sucrose yield of sugarcane is an essential condition to the development of the Brazilian sugar-ethanol sector. However, little is known about the relationship between plant traits and sucrose yield in the Brazilian sugarcane genotypes, an important issue for sugarcane breeding programs and modeling.

The following questions are relevant for the Brazilian agriculture, mainly considering that sugarcane breeding programs have periodically launched many productive cultivars: why do sugarcane genotypes accumulate differential sucrose amount in stalks? Is it a physiological and/or morphological and/or anatomical matter? Is it related to the source, sink or source-sink characteristics? Is the high sucrose yield related to differential sensitivity of sugarcane genotypes to stressful conditions found during the winter season? Is the differential sensitivity found in a specific phenological stage or in entire crop cycle? About those questions, an integrated approach for studying sugarcane plants is essential to study plant growth and sucrose accumulation. This challenge will be addressed in sugarcane genotypes with differential sucrose yield and canopy architecture growing under field and controlled (greenhouse and growth chamber) conditions. Several physiological, morphological and anatomical traits related to photosynthesis and sugar metabolism will be evaluated, with this project being the first step towards an integrative and interdisciplinary approach to understand the ecophysiology of Brazilian sugarcane genotypes. A team of experts from several well-recognized Brazilian institutions is prepared to deal with biomass production and sugar yield under a holistic point of view.



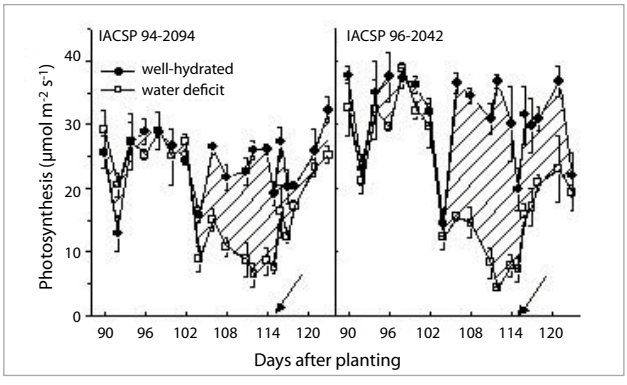


Figure 1 (results). Time-course of leaf photosynthesis as affected by soil drought. Arrow indicates re-watering

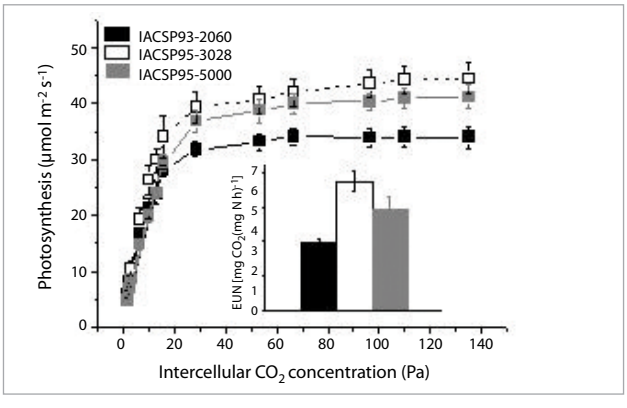


Figure 2 (results). Leaf photosynthetic response to increasing CO_2 concentration and nitrogen use efficiency in sugarcane varieties

SUMMARY OF RESULTS TO DATE AND PERSPECTIVES

We noticed significant variation on photosynthetic performance among sugarcane genotypes subjected to water deficit. Under such condition, differences on biomass production and sucrose content were also found when comparing plant genotypes. As compared to IACSP96-2042, the genotype IACSP94-2094 has anticipated stomatal closure in response to water deficit, maintaining higher leaf water potential when such stressful condition happened at the initial development phase. This phenological phase was the most susceptible to the deleterious effects of water shortage, regarding plant biomass of sugarcane genotypes. Besides a rapid stomatal response to soil drying, IAC94-2094 also exhibited higher stomatal conductance during water withholding period. As a consequence, higher leaf CO_2 assimilation and less reduction in plant biomass production were found in IACSP94-2094. Accumulation of leaf soluble carbohydrates – not sucrose – was also related to the tolerance of IAC94-2094 under constraining condition. Under water deficit, stalk mass was reduced about 11% and 49% in IACSP94-2094 and IACSP96-2042, respectively. An important issue regards the previous classification of such sugarcane genotypes in relation to drought response, in which both were considered tolerant according to plant yield under constraining environments. Our data confirmed such assumption for IACSP94-2094 and revealed that IACSP96-2042 is a productive genotype and has not drought tolerance from the physiological point of view. The higher sucrose yield and biomass production of IACSP96-2042 is probably related to its high photosynthetic activity when there is soil water availability. Regarding the canopy photosynthesis, we have found some interesting data. Significant differences in photosynthetic capacity were noticed among genotypes IACSP93-2060, IACSP95-3028 and IACSP95-5000, which are caused by mesophyll limitations. Although variations in potential photosynthesis have been found, environmental conditions restricted sugarcane photosynthesis, with genotypes showing similar values of diurnal CO_2 uptake at the superior canopy layer. On the other hand, the inferior canopy layer had an important role on photosynthesis of sugarcane plants, which is regulated by irradiance availability. High irradiance at the inferior canopy layer of IACSP95-3028 caused increased photosynthesis and improved plant vegetative development, given by increases in tillering, leaf area and accumulation of leaf and stalk phytomass. After 170 days of plant harvest, the sugarcane variety IACSP95-3028 with higher canopy biomass production also exhibited higher photosynthetic capacity at the superior canopy layer and higher diurnal CO_2 uptake at the inferior canopy layer when compared to IACSP93-2060 and IACSP95-5000. Another important result regards the nitrogen use efficiency, with the genotype IACSP95-3028 presenting the highest efficiency as compared to IACSP93-2060 and IACSP95-5000.

MAIN PUBLICATIONS

Marchiori PER. 2010. Variation in canopy photosynthesis of sugarcane varieties. Master thesis in Tropical and Subtropical Agriculture. Agronomic Institute, Campinas/SP, Brazil. 56p. [In Portuguese]

Machado RS, Ribeiro RV, Marchiori PER, Machado DFSP, Machado EC, Landell MGA. 2009. Biometric and physiological responses to water deficit in sugarcane at different phenological stages. *Pesq. Agropec. Bras.* **44**:1575-1582. [In Portuguese]

Machado RS. 2009. Physiological responses of sugarcane genotypes to water deficit imposed during the initial development phase. Master thesis in Tropical and Subtropical Agriculture. Agronomic Institute, Campinas/SP, Brazil. 64p. [In Portuguese]

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