

Ramifications of sugarcane

Small RNA molecules control lateral stem growth in sugarcane

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Planting a sugarcane crop does not involve seeds. Instead, pieces of the plant's stalk, known as the culm, are used. Each fragment generates a new plant as its lateral buds develop. The genetics behind the architecture of sugarcane is being unveiled by a group of researchers led by agricultural engineer Fabio Nogueira from Universidade Estadual Paulista (Unesp) in the city of Botucatu, in partnership with bioinformaticist Renato Vicentini from the University of Campinas (Unicamp). In a study reported in the *Journal of Experimental Botany* in May 2013, the researchers showed that small RNA molecules (sRNA) control gene silencing and activation in these lateral buds, known as axillary buds.

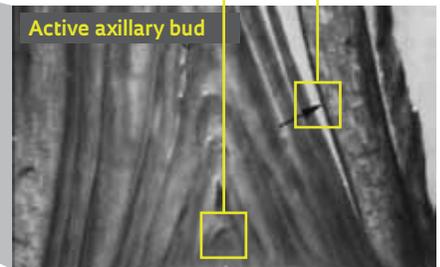
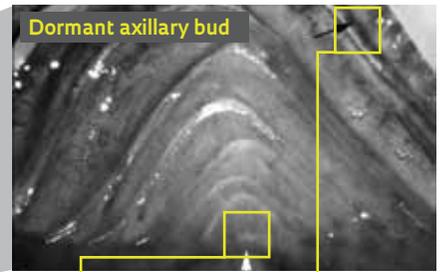
"Each segment of the culm has one or two dormant axillary buds," Nogueira explains. "When you cut the culm, the hormonal and metabolic balance changes, causing the buds to sprout and produce a new plant." The protagonists of this phenomenon are RNA molecules that serve as "on/off switches" for genes (see *Pesquisa FAPESP* Issue No. 133). One example is microRNA 159, abundantly present in dormant axillary buds, which also contain large amounts of the plant hormone abscisic acid. This microRNA blocks the plant's physiological

response to another hormone, gibberellic acid, which stimulates cell proliferation. When the plant is cut, a signal (as yet unidentified) reduces the amount of abscisic acid in the axillary buds, which in turn reduces the effects of microRNA 159 and activates the gibberellic acid signaling pathway.

The origin of many of these small RNAs that can influence hormonal signaling and responses to stressful situations — such as drought — may be mobile fragments of plant DNA known as transposable elements. Nogueira reached this conclusion when he compared the RNA sequences detected in his project with those in the database produced by the research group led by University of São Paulo (USP) biologist Marie-Anne Van Sluys (see *Pesquisa FAPESP* Issue No. 198). According to Nogueira, transposable elements associated with small RNAs increase diversity and control genome function. The association between the two genetic entities does not end there. "Some transposable elements are negatively regulated by small RNAs, which serve as buffers to prevent DNA modification," Nogueira notes. In the case of sugarcane, protecting DNA from change is important for maintaining the properties of commercial varieties developed to produce more sugar or to flourish in less rainy areas.

"I sought basic knowledge with my project, but this understanding is also essential for the propagation and productivity of sugarcane," Nogueira explains. The plant's architecture is central to determining the intended purpose of a given plantation. Sugarcane culms with few ramifications are better for producing sugar, whereas plants with more lateral buds and more leaves generate more biomass, the raw material used for the manufacture of second-generation ethanol. Knowing the genetic players involved in controlling these characteristics makes it possible to develop markers for plant selection and can contribute to the improvement of commercial varieties. The importance of this work was acknowledged by the 2012 edition of the Top Ethanol awards; second place in the academic works category was awarded to Fausto Ortiz-Morea for his master's thesis, which generated the paper recently published in the *Journal of Experimental Botany*. An additional publication by Nogueira's team, published in *BMC Plant Biology* in 2010, won second place at the same awards program in 2013.

Nogueira's work has yielded a catalogue of active small RNA molecules (microtranscriptome) from the axillary buds of sugarcane, and has made it available to



other researchers. In collaboration with a group from the Luiz de Queiroz School of Agriculture (Esalq/USP), Nogueira is testing some of these RNAs on plant models in order to observe their effects on metabolism.

The researcher celebrates being the first to examine the genetic regulation of sugarcane architecture, but he is actually the pioneer of a broader field. There are no studies on small RNA activity in the axillary buds of other plants because these structures are very small and difficult to isolate. With axillary buds that can be viewed with the naked eye, have measurable hormonal concentrations, and contain DNA and RNA that can be extracted, sugarcane has all the essential characteristics to become a model organism for plant architecture studies. ■

Project

Isolation and characterization of microRNAs and their target genes in sugarcane (no. 2007/58289-5); **Grant Mechanism** Young Investigators Awards Program; **Coordinator:** Fabio Tebaldi Silveira Nogueira (IB/Unesp); **Investment** R\$314,903.10 (FAPESP).

Scientific article

ORTIZ-MOREA, F.A. et al. Global analysis of the sugarcane microtranscriptome reveals a unique composition of small RNAs associated with axillary bud outgrowth. **Journal of Experimental Botany**. v. 64, n. 8, p. 2.307-20. May 2013.