SIIB
CRC Sugar Industry Innovation through Biotechnology

project profile

nitrogen efficient varieties: sustainable and profitable

Vigorous growing sugarcane varieties that require less nitrogen fertiliser could drastically reduce costs to our environment and sugarcane growers. The Cooperative Research Centre for Sugar Industry Innovation through Biotechnology (CRC SIIB) project "Improving the nitrogen use efficiency of sugarcane" has been addressing this topic as a path towards more sustainable and profitable sugarcane production.

Screening over 200 different sugarcane genotypes using the latest biotechnological tools, CRC SIIB researchers have investigated how efficiently different varieties use nitrogen, and how such knowledge could help design more efficient production systems.

Background

It is difficult to estimate how much nitrogen fertiliser is needed by any given crop, so to ensure productivity, many sugarcane growers err on the side of caution and apply nitrogen for maximum results. Ultimately, crops use a small amount of the applied nitrogen. In many cases, more than 50% of applied nitrogen fertilizer is not used by the crop, making sugarcane cropping systems open to nitrogen loss.

This characteristic contributes to environmental imbalances which can cause degradation of natural ecosystems and emission of potent greenhouse gases. Excess nitrogen also isn't that great for crops, too much can cause poor juice quality, delayed ripening and lodging.

In the future, when more nitrogen efficient varieties are available, growers could apply less fertiliser and still be assured of high yields. If this is the case, based on an average farm, a 25% improvement of nitrogen use efficiency could result in annual savings of $16 million.

This project examined whether natural genetic variation between varieties exists for nitrogen use efficiency. The potential of molecular breeding tools to help breed nitrogen efficient varieties has also been investigated.

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"...results from this work reveal that the greatest improvements in nitrogen efficiency may come from combining improved varieties with better nitrogen management at the farm level."

The research team started by screening 200 sugarcane genotypes. In a world first for sugarcane, biotechnology and physiology research were combined to determine how these plants differ in their nitrogen use efficiency and which soil nitrogen forms are preferentially used by the plants.

Progress

The CRC research team found that considerable natural variation in nitrogen use efficiency exists between sugarcane genotypes. This variation allows nitrogen efficient plants to produce twice as much biomass (ie they grow larger) with the same amount of nitrogen than inefficient plants.

They also discovered that sugarcane has preferences for particular nitrogen forms. The most commonly used nitrogen fertiliser in the Australian cane industry is urea which is converted in the soil to ammonium and nitrate.

Nitrate and ammonium are easily lost from the soil as vapour; nitrate in particular is easily lost from the cropping system because it also leaches from the soil.

The CRC study showed that sugarcane does not take up much nitrate when plants are well supplied with nitrogen, leaving the crop vulnerable to inefficient use of the fertilizer and nitrate leaching. This backs the CRC's theory of more precise nitrogen application to achieve optimum results and minimal impact on the environment.

This research also highlighted the ability of sugarcane to use organic forms of nitrogen, such as amino acids, which are the initial product when organic matter decays. In new cropping systems where a considerable amount of nitrogen is supplied by that which is naturally contained in the trash blanket, the ability to use organic forms of nitrogen is beneficial because the crop uses the nutrient before it is converted to ammonium and nitrate.

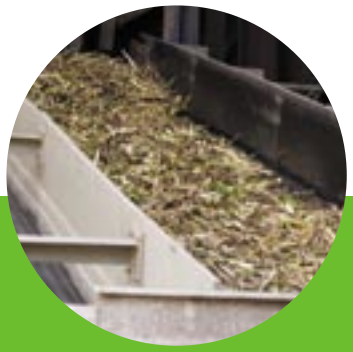
In addition to these outcomes, the CRC's nitrogen research has shown that metabolic engineering could be used to develop plants able to take up extra nitrogen from the soil when soil nitrogen supply is high and absorb the nitrogen more efficiently. While it is still early days in terms of this research, progress is looking very promising.

Overall, results from this work reveal that the greatest improvements in nitrogen efficiency may come from combining improved varieties with better nitrogen management at the farm level. Ultimately, we need to work towards providing growers with the best possible varieties and ensure they have the best information as to how to get the soil nitrogen equation right.

Looking ahead

This CRC SIIB project will help to refine our understanding of the sugarcane plant's preference for certain N forms and how this knowledge can be used for better crop management.

Importantly, the sugarcane nitrogen life cycle: from soil to plant to soil, will be characterised in more detail so this knowledge can be used to develop new screening tools (to refine our knowledge and application of nitrogen) and more nitrogen efficient varieties.



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