First complete full genetic map of miscanthus - promising energy crop

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Researchers in Wales and the United States have collaborated to complete the first high-resolution, comprehensive genetic map of a promising energy crop called miscanthus (*Miscanthus sinensis*). The results – published in the current edition of the peer-reviewed, online journal *PLoS One* – provide a significant breakthrough towards advancing the production of bioenergy.

The breakthrough results from the long-term collaboration between energy crop company Ceres, Inc., based in Thousand Oaks, California, USA, and the Institute of Biological, Environmental and Rural Sciences (IBERS) at Aberystwyth University in Wales. The IBERS team created the collection of genetically related plants and Ceres then sequenced and analyzed the DNA. In other crops, this type of comprehensive genetic mapping has significantly shortened product development timelines.

As published in the journal article, Ceres researchers mapped all 19 chromosomes of miscanthus, a towering cane-like grass that can be used as a feedstock for advanced biofuels, bio-products and biopower. The multi-year project involved generation and analysis of more than 400 million DNA sequences creating a blueprint of the genetic alphabet of the plant.

Among the massive volumes of data, researchers found 20,000 genetic differences, called markers, that allow geneticists to differentiate individual plants based on small variations in their DNA. More than 3,500 of these markers were used to create the genetic map, and are

valuable for crop improvement purposes. In contrast, previously announced mapping projects discovered only about 600 markers and did not fully characterize the structure of all the miscanthus chromosomes, a necessary step in establishing a high-tech plant breeding program.

Ceres Chief Scientific Officer Richard Flavell, PhD, FRS, CBE says that the rapid improvements in breeding made possible by this mapping project are needed for miscanthus to be more widely used as an energy crop. While it has been grown on a small scale across Europe for two decades, primarily for electricity generation, large-scale commercial production is not economically viable at this time due to high production costs and few commercially available miscanthus cultivars.

"By defining the genetic diversity in our germplasm collections with the new DNA markers, we can more rapidly introduce important crop traits into our new, seed-propagated miscanthus products," said Flavell. He explained that unlike the most popular current miscanthus that is vegetatively propagated, Ceres' seeded types are expected to require significantly less time, effort and money to be bred for different environments and to be established by growers. Ceres is currently evaluating its improved seeded miscanthus varieties in multiple locations.

Iain Donnison, PhD, head of the bioenergy team at IBERS, notes that, in addition to its use in developing new products, the mapping project has provided greater insight into how the miscanthus genome compares to other well-understood crop plants. Previously, most miscanthus research had been focused on field trials, and little was known about its genetics.

"The joint miscanthus development programme with Ceres has provided new insight into the evolution of the species as well as the similarities and differences in populations across different countries and environments," said Donnison. "This rich library of information took

decades to produce in other crops, but with modern biology and genomics technology Ceres and IBERS have put together what I believe is one of the world's most comprehensive marker-based breeding programs in miscanthus."

The collaborative research received funding as part of the Biotechnology and Biological Sciences Research Council Sustainable Bioenergy Centre (BSBEC). This innovative academic-industry research partnership underpins development in the important and emerging bioenergy sector. Both Ceres and IBERS are contributing members of BSBEC.

Professor Douglas Kell, Chief Executive of the Biotechnology and Biological Sciences Research Council, noted: "This partnership between academia and industry makes a significant contribution towards achieving sustainable feed-stocks for renewable energy and other bio derived products. A genetic map paves the way toward breeding improvements to increase the amount of sunlight captured, the amount of carbon that can be assimilated over a growing season and the partitioning of the carbon in harvested biomass. This research is an important step towards improving yields for bio feed-stocks without increasing inputs."

"The collaboration between IBERS and Ceres is a great example of how industry and academia can work together to increase the commercial potential of the UK's research resources, both at home and internationally," said Kell.

More information: The full journal article can be found at dx.plos.org/10.1371/journal.pone.0033821

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