Discovery of wheat's clustered chemical defenses creates new avenues for research

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A research collaboration has helped to explain the chemical defenses that protect wheat plants against disease—opening potential new avenues of study in this globally cultivated crop.

Researchers at the John Innes Centre leveraged recent advances in mapping of bread wheat's complex genome to make the discovery.

The Osbourn and Uauy groups collaborated to generate data that led to the discovery of several sets of genes in wheat that are switched on when the plant is attacked by disease-causing microbes.

These genes are found in six biosynthetic gene clusters in the wheat genome. Gene clusters that produce defense molecules have also previously been found in other cereal crops such as oat and rice.

To find out what chemicals are produced by these clusters the researchers isolated genes of interest and introduced them into the plant Nicotiana benthamiana, a close relative of tobacco. This transient expression technique enabled rapid analysis of the biochemical pathways encoded by the clusters.

The researchers found that the clusters encoded a versatile set of molecules including triterpenes, diterpenes and flavonoids, including a previously unknown molecule which was named ellarinacin.

The group are continuing their work on deciphering other molecules produced by the gene clusters and understanding how they contribute to protection of wheat against pests and disease.

Wheat is one of the most important cereal crops and supplies one fifth of the calories consumed by humans worldwide. Despite its agricultural importance, little is known about the chemicals wheat produces in response to pest and pathogen attacks.

Knowing genetic pathways produce certain useful chemicals means that these gene combinations could be bred into wheat varieties to make them more resistant to diseases at a time when climate change is making this more of a problem.

The study which appears in the journal *PNAS* also found that Brachypodium distachyon, a wild grass relative of wheat contained a pathogen-induced variation of the Ellarinacin cluster, which produces a structurally similar compound, brachynacin.

The paper highlights the start of a significant new direction for wheat research explains Dr Polturak.

"Our genomics-driven approach has allowed us to identify compounds that are produced in wheat only under certain conditions—in this case pathogen attack. Finding these molecules by the 'classical' approach of chemical analysis of wheat extracts would be challenging."

Professor Anne Osbourn, a Group Leader at the John Innes Centre and an author of the paper says that "from knowing little about wheat defense compounds, we have now discovered six previously unknown pathways for biosynthesis of defense compounds in wheat, including entirely new chemicals that haven't been reported before. Our work continues, to investigate what these molecules are doing in wheat, how they contribute to defense against pathogens, and how the whole network of pathogen-induced gene clusters is regulated."

More information: Guy Polturak et al, Pathogen-induced biosynthetic pathways encode defense-related molecules in bread wheat, *Proceedings of the National Academy of Sciences* (2022). DOI: 10.1073/pnas.2123299119

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