Finding rice traits that tackle climate-change challenges

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Cultivated rice competing with weedy red rice (the taller plants among the rows) near Stuttgart, Arkansas. ARS scientists are examining weedy red rice for characteristics that could be used to adapt cultivated rice to climate change.

People around the world depend on food crops adapted to an array of temperature and precipitation regimes, but those conditions are in flux because of global climate change. So scientists want to identify plant

traits that could be used to develop food-crop cultivars that thrive despite—or perhaps because of—shifts in carbon dioxide (CO_2) levels, water availability, and air temperature.

As part of this effort, Agricultural Research Service plant physiologists Lewis Ziska, Martha Tomecek, and David Gealy conducted a study of several rice cultivars to determine whether changes of temperature and CO_2 levels affected seed yields. They also looked for visible traits that could signal whether a plant cultivar has the genetic potential for adapting successfully to elevated CO_2 levels.

For their study, the scientists included weedy red rice, which infests cultivated rice cropland. Despite the plant's downside, previous assessments indicated that weedy rice growing under elevated CO_2 levels had higher seed yields than cultivated rice growing under the same conditions.

The scientists used environmental growth chambers to study genetically diverse rice cultivars at current and future projections of atmospheric CO_2 and a range of day/night air temperatures. They observed that on average, all the rice cultivars put out more aboveground biomass at elevated CO_2 levels, although this response diminished as air temperatures rose.

For seed yield, only weedy rice and the rice cultivar Rondo responded to elevated CO_2 levels when grown at optimal day/night air temperatures of 84 °F and 70 °F. The researchers were also intrigued by an additional observation: Only weedy rice gained significant increases of aboveground biomass and seed yield under elevated CO_2 levels at the higher temperatures expected for rice-growing regions by the middle of the century.

In Beltsville, Maryland, plant physiologists Lewis Ziska and Martha Tomecek examine the response of different rice cultivars to changes in carbon dioxide and temperature. ARS scientists at Beltsville and Stuttgart, Arkansas, are working to select rice lines best adapted to the changing climate.

When Ziska and colleagues analyzed the study data for the weedy rice, they observed that seed-yield increases under elevated CO_2 resulted from an increase in panicle (seed head) and tiller production. Tillers are stalks put out by a growing rice plant, and as the plant matures, the seed heads—where rice grain is produced—develop at the end of the tillers.

Since rice tiller production is determined in part by a plant's genetic makeup, crop breeders might someday be able to use this weedy rice trait to develop commercial rice cultivars that can convert rising CO_2 levels into higher seed yields. To the researchers, these findings also suggest that the weedy, feral cousins of cultivated cereals could have other traits that would be useful in adapting to the environmental

challenges that may come with climate change.

"We know that atmospheric CO_2 and air temperatures will increase together," says Ziska. "Ideally, we can develop plants that respond well to elevated CO2 levels and incorporate traits that favor plant survival despite temperature changes."

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