IMPROVING PHOTOSYNTHESIS

Photosynthesis is essential to life on Earth. It uses sunlight, carbon dioxide from the atmosphere, and water to synthesize sugars, lipids, amino acids, and other cell building blocks needed for plant growth. Researchers at land-grant universities across the nation are working to better understand photosynthesis and how it is affected by environmental, molecular, and genetic constraints so that they can improve efficiency and increase plant productivity, which is necessary to meet rising food, fuel, and fiber needs. With their diverse expertise, project members are tackling this global issue with practical solutions for specific crops, regions, and production systems.

RESEARCH IMPACTS

Researchers developed new tools and techniques to reveal, analyze, and target various components of photosynthesis. This helps guide plant engineering efforts. Other insights enable scientists to modify plants without introducing foreign genes, relieving consumer concerns about genetically engineered crops.

Researchers discovered ways to manipulate photosynthesis so that plants produce more usable biomass and more oil. This will help meet rising demand for food, fiber, and biofuels even as available suitable farmland decreases.

Researchers identified genetic mechanisms that increase resistance to salt, heat, and water stress. Manipulating these could reduce crop loss and costs and help maintain plant yields under climate change.

Researchers found ways to modify the capture and release of CO_2 during photosynthesis in order to regulate global warming.

Quantifying different factors that affect photosynthesis has helped farmers make cost-effective crop management decisions.

MULTISTATE RESEARCH HIGHLIGHTS

- **University of Florida** scientists provided over 22,000 seed stocks to nearly 1,500 researchers worldwide for use in their studies.
- Researchers in **Washington, Nebraska, and Illinois** investigated how photosynthesis responds to environmental cues and stress.
- Scientists determined when to apply agrochemicals without disrupting photosynthesis.
- **University of Illinois** studies showed that planting corn in narrower rows allows for greater solar energy use, resulting in higher grain yields.
- **Kansas State University** and **Mississippi State University** researchers improved understanding of heat stress and tolerance in wheat, sorghum, and other crops. **University of Missouri** insights could reveal ways to improve soybean heat tolerance.
- A special type of photosynthesis – crassulacean acid metabolism, or CAM – takes up CO_2 at night, which allows more efficient water use. **University of Nevada** scientists are figuring out how to bioengineer CAM into "normal" plants.
- "C4" plants concentrate CO_2 and waste less energy than normal plants. **Washington State University** scientists are identifying ways to transfer C4 traits into other crops.
- Algae concentrate CO_2 during photosynthesis to compensate for low and variable levels in the water. **Louisiana State University and University of Illinois** are seeing if this mechanism can be transferred to crop plants to improve yields.
- **University of Nebraska** studies of the enzyme that helps bind carbon during photosynthesis could help scientists engineer plants with increased carbon fixation, which increases the rate of photosynthesis and plant growth.
- Researchers at **Michigan State University** are looking at the glucose-6-phosphate shunt to find ways to reduce the amount of CO_2 wasted during photosynthesis.
- A **Virginia Tech University** scientist has shown that overexpression of the SnRK1 gene can increase biomass production.
- **University of Florida** scientists found ways to influence the movement of the compounds produced by photosynthesis to increase seed size and kernel number.
- In a **University of California** study, decreasing the size of the light-harvesting "antenna" in tobacco leaves increased photosynthetic production, resulting in a 25% yield increase.
- **Michigan State University** studies on fatty acids production during photosynthesis will guide the engineering of vegetable oil food crops and biofuel crops.
- **University of Nevada** researchers used new techniques that do not require genetic engineering to isolate algae strains that are suitable for use in biofuels.

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