2023 ARBC

Online Qualifier Paper Round

Paper Round Answer Key

Article 1:

https://www.science.org/doi/10.1126/science.aat9077

1. What is the purpose of photorespiration? (1pt)

2. In figure 1A, this paper schematically represents the alternative pathways (APs) that they introduced into the plants. What happens to the hydrogen peroxide produced from the conversion of glycolyate→glyoxylate in the native pathway? How is this different in AP2? (2pts)

    a. Would you expect adding the gene for Catalase (with an appropriate promoter) into the vector construct for AP3 to increase or decrease overall photosynthetic efficiency? Why? (2pts)

3. What technique was used to produce the image in figure 1c? (1pt)

    a. Aside from the introduced proteins, why was Actin content also assessed in the blot? Why was PGL35 also measured? (1pt)

    b. This blot analyzes samples from three distinct parts of the plant cell. In which sample would you expect to find the highest content of Photosystem II? What about Cytochrome b6f? What about Rubisco? (2pts)

    c. Which of the introduced proteins for AP3 seems to be found in the lumen rather than the thylakoid membrane? (1pt)

4. What was the authors' purpose of analyzing the ratio of Fv'/Fm'? (1pt)

Related Article:
https://journals.plos.org/plosbiology/article/file?id=10.1371/journal.pbio.2006352&type=printable
https://www.farmprogress.com/biotechnology/nitrogen-fixing-corn-farming-s-holy-grail-when

1. What types of macromolecules are nitrogen likely to be incorporated into? (1pt)

2. In what soil conditions might plants favor ammonium vs nitrate as a nitrogen source, and why might this be? (1pt)

3. Referencing figure 4 in the image below, by what factor is the amount of oxygen reduced? Why might this be beneficial for the bacteria and the plant? (1pt)

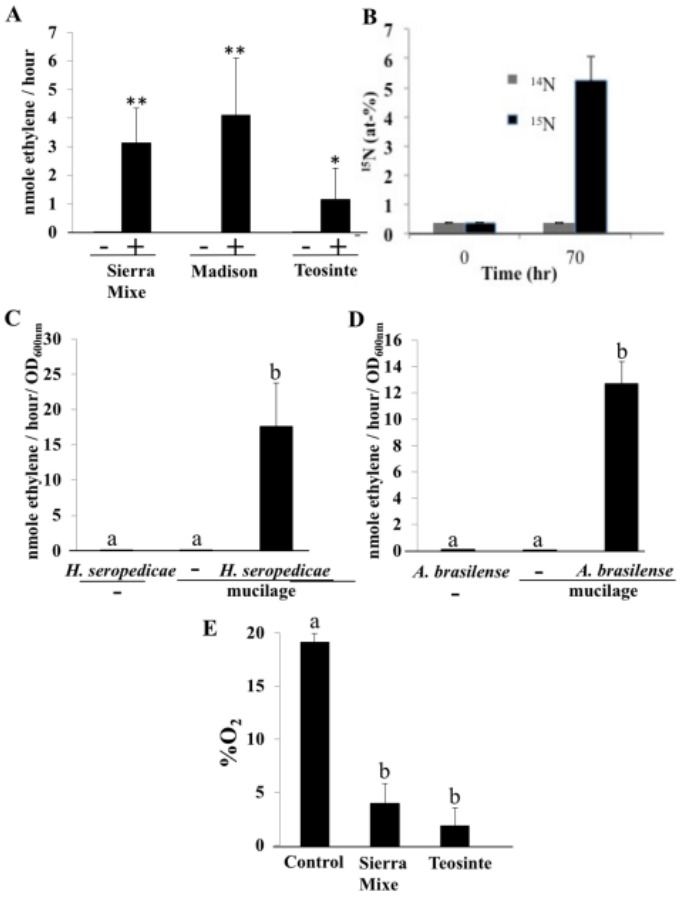

Fig 4. Nitrogenase and N_2 fixation activity in mucilage produced by Sierra Mixe maize. (A) Mucilage of various Sierra Mixe maize lines collected in Sierra Mixe or field-grown plants in Madison, USA, and of teosinte display strong acetylene reduction activity. (-, no acetylene; +, 10% acetylene). Asterisks indicate significant differences ($^{*}P < 0.05$; $^{**}P < 0.01$, Mann-Whitney test). (B) Nitrogen fixation in Sierra Mixe maize mucilage by $^{15}N_2$ assimilation. Mucilage collected from Sierra Mixe maize grown in Sierra Mixe was incubated in gas-tight vials filled with $^{15}N_2$ or $^{14}N_2$ gas for 70 hours at 37 ˚C. ^{15}N (atom % excess) was determined by IRMS. (C and D) *H. seropedicae* and *A. brasilense* display acetylene reduction activity when added to nonfixing mucilage, whereas the same mucilage supplemented with sterile medium (-) or the same bacteria without mucilage (-) do not. (E) Oxygen concentration at 8 mm inside of the mucilage. Means and standard errors are shown. Different letters indicate statistically supported groups (Kruskal-Wallis test). (Data at DOI: 10.6084/m9.figshare.6534545). IRMS, isotope-ratio mass spectrometry.

4. Often, fertilizers are added directly to the soil of the plant, and it is uptaken by the roots. However, excess fertilizer often has negative effects on the environment and the plant. Explain why scientists are interested in pursuing plants that culture nitrogen-fixing bacteria:

5. Why are many scientists and experts skeptical about the potential of this corn strain to improve agriculture? What are the other viable alternatives?

Synthesis questions:

1. Both of these modifications/adaptations are attempts to combat the inhibitory effect of what substance/factor on overall productivity?

2. Hypothetically, would you expect introducing the synthetic APs mentioned in the first article into the corn strain discovered in the second article to increase crop productivity similar to the results found with tobacco? Why or why not?

    a. In reality, what scientific barriers would probably make it difficult for scientists to introduce APs into this new strain of corn if they wanted to?