Name_____

DATA Nugget

Can biochar improve crop yields?

Featured scientist: Erika Foster from Colorado State University

Research Background:

If you walk through the lush Amazon rainforest, the huge trees may be the first thing you see. But, did you know there are wonderful things to explore on the forest floor? In special places of the Amazon, there exist incredible dark soils called “Terra Preta”. These soils are rich in nutrients that help plants grow. The main source of nutrients and dark color is from charcoal added by humans. Hundreds of years ago the indigenous people added their cooking waste, including ash from fire pits, into the ground to help their food crops grow. Today, scientists and farmers are trying out this same ancient method. When this charcoal is added to soil to help plants grow, we call it **biochar**.

Biochar is a pretty unique material. It is created by a special process that is similar to burning materials in a fire place, but without oxygen. Biochar can be made from many different materials. Most biochar has lots of tiny spaces, or pores, that cause it to act like a hard sponge when it is in the soil. Due to these pores, the biochar can hold more water than the soil can by itself. Along with that extra water, it also can hold nutrients. Biochar has been shown to increase crop yield in tropical places like the Amazon.

Farmers in western Colorado wanted to know what would happen if they added biochar to fields near them. Their farms experience a very different climate that is cooler and drier than the Amazon. In these drier environments, farmers are concerned about the amount of water in the soil, especially during droughts. Farmers had so many questions about how biochar works in soils that scientists at Colorado State University decided to help. One scientist, Erika, was curious if biochar could really help farms in dry Colorado. Erika thought that biochar could increase crop yield by providing pores that would hold more water in the soil that crop plants can use to grow.

A soil scientist, Matt, adding biochar to the field in a treatment plot.

Name_____

To test the effects of biochar in dry agricultural environments, Erika set up an experiment at the Colorado State University Agricultural Research and Development Center. She set up plots with three different soil conditions: biochar added, manure added, and a control. She chose to include a manure treatment because it is what farmers in Colorado were currently adding to their soil when they farmed. For each treatment she had 4 replicate plots, for a total of 12 plots. She added biochar or manure to a field at the same rate (30 Megagrams/ ha or 13 tons/acre). She didn't add anything to control plots. Erika then planted corn seeds into all 12 plots.

Erika also wanted to know if the effects of biochar would be different when water was limited compared to when it was plentiful. She set up another experimental treatment with two different irrigation levels: full irrigation and limited irrigation. The full irrigation plots were watered whenever the plants needed it. The limited irrigation plots were not watered for the whole month of July, giving crops a drought period during the growing season. Erika predicted that the plots with biochar would have more water in the soil. She also thought that corn yields would be higher with biochar than in the manure and control plots. She predicted these patterns would be true under both the full and limited irrigation treatments. However, she thought that the biochar would be most beneficial when crops were given less water in the limited irrigation treatments.

To measure the water in the soil, Erika took soil samples three times: a few weeks after planting (June), the middle of the growing season (July), and just before corn harvest (September). She weighed out 10 g of moist soil, then dried the samples for 24 hours in an oven and weighed them again. By putting the soil in the oven, the water evaporates out and leaves just the dry soil. Sarah divided the weight of the water lost by the weight of the dry soil to calculate the **percent soil moisture**. At the end of the season she measured **crop yield** as the dry weight of the corn cobs in bushes per acre (bu/acre).

Scientific Questions: Is there evidence that biochar increases soil moisture and crop yield? Does the effect depend on whether there were drought conditions?

What is the hypothesis? Find the hypothesis in the Research Background and underline it. A hypothesis is a proposed explanation for an observation, which can then be tested with experimentation or other types of studies.

Field technician Alex helps to weigh the corn plant total biomass, with the remaining corn stalks in a pile behind.

Name_____

Scientific Data:

Use the data below to answer the scientific questions:

	Full Irrigation			
Soil Treatment	**% Soil Moisture**	**SD**	**Crop Yield (bu/acre)**	**SD**
Biochar	14.8	0.6	167.8	6.0
Control	13.7	0.6	153.9	7.8
Manure	15.4	1.3	165.1	4.0

	Limited Irrigation			
Soil Treatment	**% Soil Moisture**	**SD**	**Crop Yield (bu/acre)**	**SD**
Biochar	15.5	1.8	137.0	3.5
Control	14.4	2.0	134.9	9.0
Manure	18.0	2.6	139.4	5.2

**Standard deviation (SD) tells us about the amount of variation in the data. A large SD means there is a lot of variation around the mean, while a small SD means the data points all fall very close to the mean.*

What data will you graph to answer the questions?

Independent variables: _____

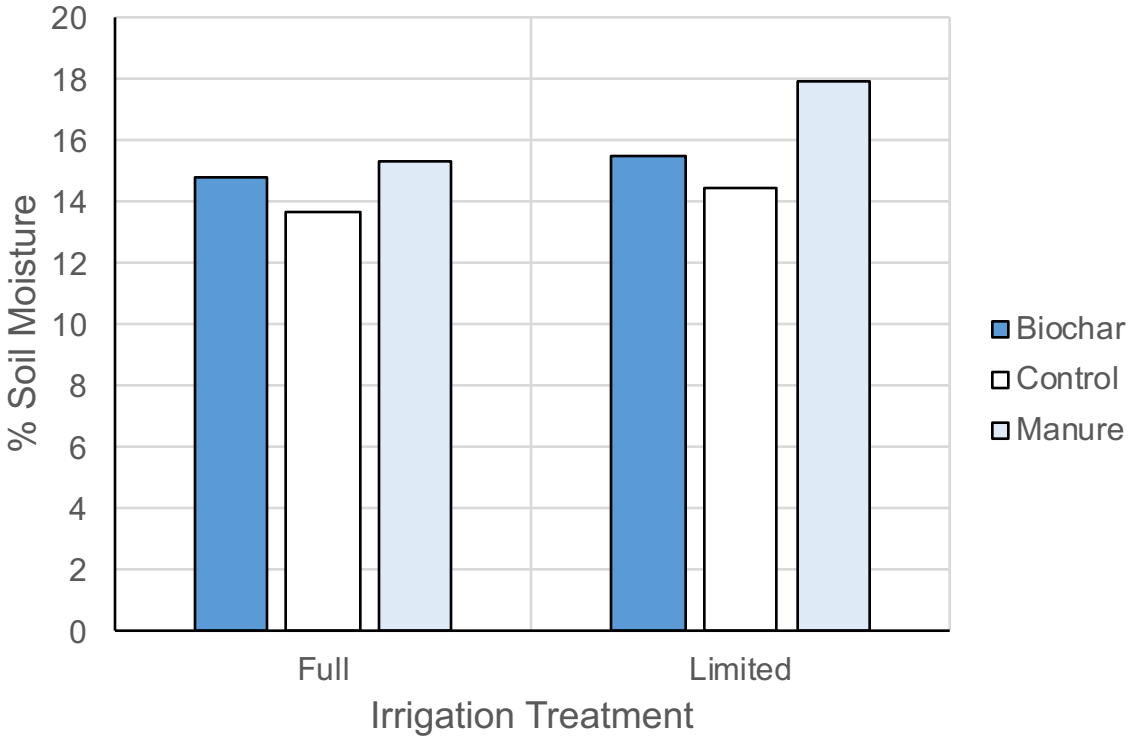
_____

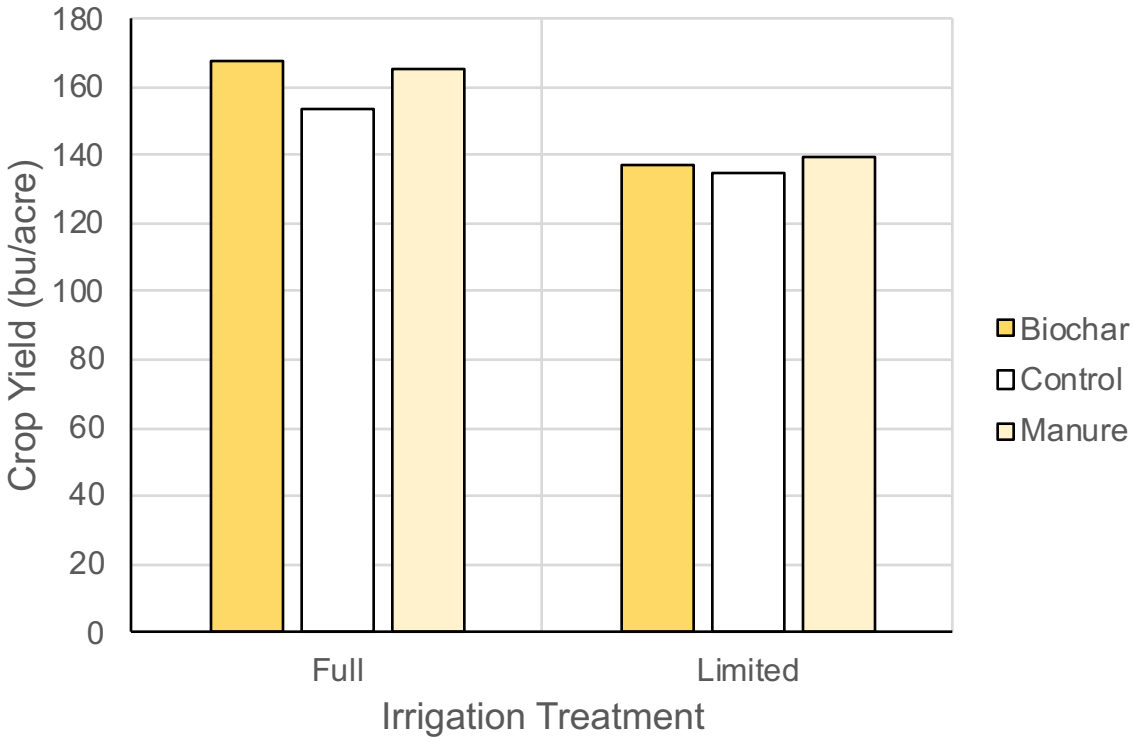
Dependent variables: _____

_____

Name_____

Below are graphs of the data: Identify any changes, trends, or differences you see in your graphs. Draw arrows pointing out what you see, and write one sentence describing what you see next to each arrow.





Name_____

Interpret the data:

Make a claim that answers each of the scientific questions.

What evidence was used to write your claim? Reference specific parts of the tables or graphs.

Explain your reasoning and why the evidence supports your claim. Connect the data back to what you learned about the potential benefits of adding biochar for farmers in dry environments.

Name_____

Did the data support Erika's hypothesis? Use evidence to explain why or why not. If you feel the data were inconclusive, explain why.

Your next steps as a scientist: Science is an ongoing process. What new question(s) should be investigated to build on Erika's research? What future data should be collected to answer your question(s)?