Maize: Phenotypic Response to Variable Depth Water Input

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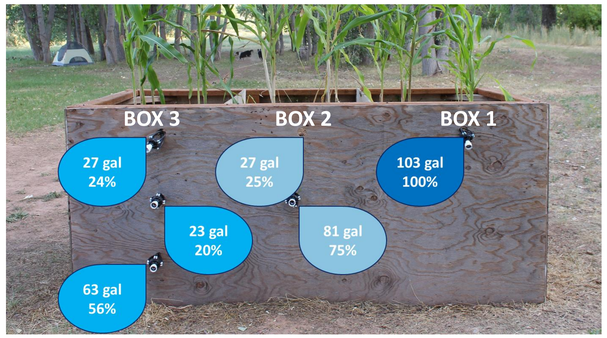
Introduction

Evidence of maize (*Zea mays*) farming during the Fremont occupation of Range Creek Canyon, UT has been well-documented. Over 100 storage structures, numerous maize cobs, starch recovered from ground stone, and pollen and carbon isotope evidence from soil cores all suggest a subsistence strategy that included maize cultivation. Farming experiments in Range Creek suggest dry-farming would not have been a sustainable option for the Fremont. With access to a permanent water source, irrigation farming would have been the most effective method of delivering controlled amounts of water to crops, allowing for improved yields.

Ongoing experiments explore the efficacy of timing and amount of water necessary to produce the highest crop yields despite the costs associated with irrigation. Pivotal to understanding this cost/benefit trade-off is documenting root depth of dry-adapted maize varieties under different irrigation regimes.

1. How deep are the roots of heirloom maize varieties?

2. Can maize roots adapt to varying watering regimes in a single season?



(amount of water provided and time spent watering at each input depth)

Methods

To observe variability in root growth, an experiment was conducted to document the roots of Pima 60-Day Maize. By watering three separate bins at different depths, the phenotypic response in root length as a function of the depth at which the water is provided was measured.

- Construct planter box with 3 separate boxes (48”x32”x36” of dirt), separated by painted ½” cdx plywood walls.

- Drip-irrigation hoses with 8 drip tubes were each placed at different depths in the soil: Box 1 = surface only. Box 2 = surface and 12” depth. Box 3 = surface, 12”, and 24” depth.

- Water input measured by recording amount of time to fill a container of known volume using drip hoses. Time was then used as determinant for water amount distributed through the irrigation tubes.

Results

The maize was planted on June 17 and harvested on September 14. The side panel of the box was removed to access the soil profile. The remaining moisture from watering at each terminal level was measured (overlay image below), following the expected area relative to water input. Using a hose to expose the roots revealed a large root mass in the area of terminal water input in each box (image to the right).

- Root depths were over 3 ft in all three boxes.

- Greater root densities were observed at respective irrigation depths.

- Box 1 produced the smallest plants by height and by stalk diameter.

- Box 2 produced the least number of cobs and the largest plants.

Number of Cobs

	Box 1	Box 2	Box 3
Plant 1	0	0	0
Plant 2	1	0	1
Plant 3	1	1	1
Plant 4	2	1	1
Plant 5	0	0	1
Plant 6	1	0	1
Total	5	2	5
Avg	0.83	0.33	0.83

Plant Height (cm)

	Box 1	Box 2	Box 3
Plant 1	117	164	148
Plant 2	160	167	161
Plant 3	145	181	139
Plant 4	126	143	149
Plant 5	69	147	139
Plant 6	120	154	131
Avg	123	159	145

Stalk Diameter (cm)

	Box 1	Box 2	Box 3
Plant 1	1.3	1.4	1.2
Plant 2	1.5	1.5	1.3
Plant 3	1.2	1.8	1.3
Plant 4	1.1	1.2	1.2
Plant 5	0.8	1	1.2
Plant 6	1	1.3	1
Avg	1.15	1.37	1.20

Area of Soil Moisture After Watering at Terminal Input

BOX 1 **BOX 2** **BOX 3**

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Discussion

The Pima 60-Day maize roots grown in Range Creek Canyon are capable of adapting to different and variable water depths in soil, suggesting a phenotypic response in a single growing season. Each box also showed the roots capable of growing more than 3 ft, suggesting knowledge of root depth not necessarily affecting irrigation schedule. Plant size and productivity results suggest the box watered from the surface produced smaller plants. Cob production was variable.

Next Steps:

- Line bottom of box with weed fabric to prevent other plant roots from entering the box.

BOX 1

- Provide different amounts of water in each box, all from the surface.

BOX 2

- Repeat experiment with Tohono O’odham 60-Day maize variety.

BOX 3

References: Boomgarden, S.A. 2015. Experimental maize farming in Range Creek Canyon, Utah. Doctoral dissertation, The University of Utah, Salt Lake City, UT.