Biochars Effects on Water Consumption by Soybean on A Claypan Soil in Central Missouri

George Washington Carver Experimental Farm
Lincoln University in Missouri

M. R. Bayan, PhD, PhD. Soil Scientist and Geochemist

Hello Planet Earth! I am up…

Image source: http://9academy.com/dnevnik/wp-content/uploads/2015/11/Samo-nachaloto.jpg

Ouch…! Too hot, dry and inhospitable up here folks…

Source: http://www.agwatchnetwork.com/dry-weather-in-august-may-decrease-yield-of-missouri-crops/

Source: http://abcnews.go.com/blogs/headlines/2013/10/water-as-precious-as-gold-life-in-parched-western-kansas /

Yunnan Drought

Source: http://www.chinasmack.com/2010/pictures/yunnan-drought-fish-trapped-in-dried-lake-bed-photos.html

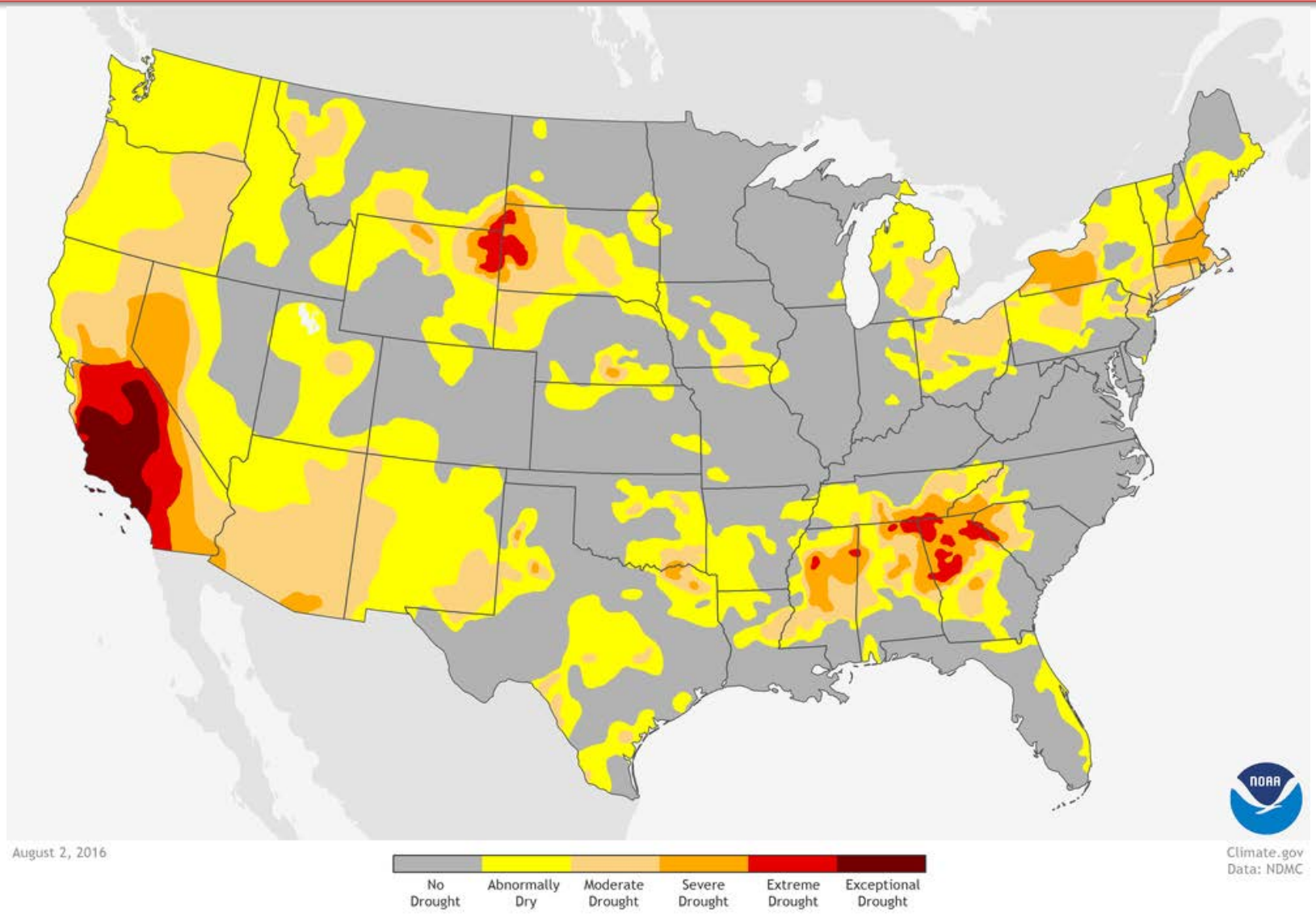
Drought in California

Palmer index dropping <-4

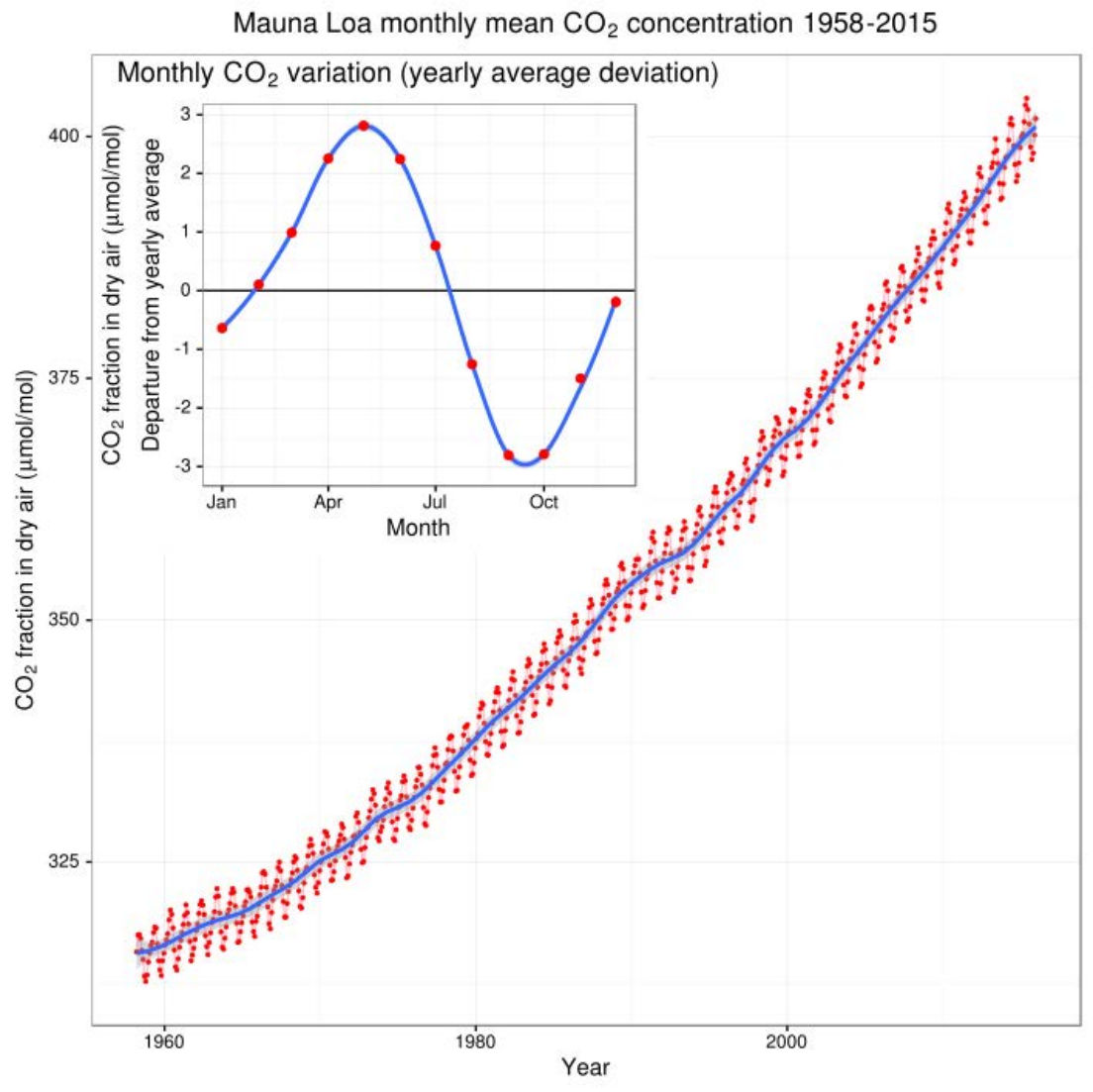
Source:http://www.zengardner.com/california-governor-received-evidence-proving-drought-geoengineered/

US Drought Area (August 2, 2016)

Source: https://www.climate.gov/news-features/featured-images/drought-building-places-other-california

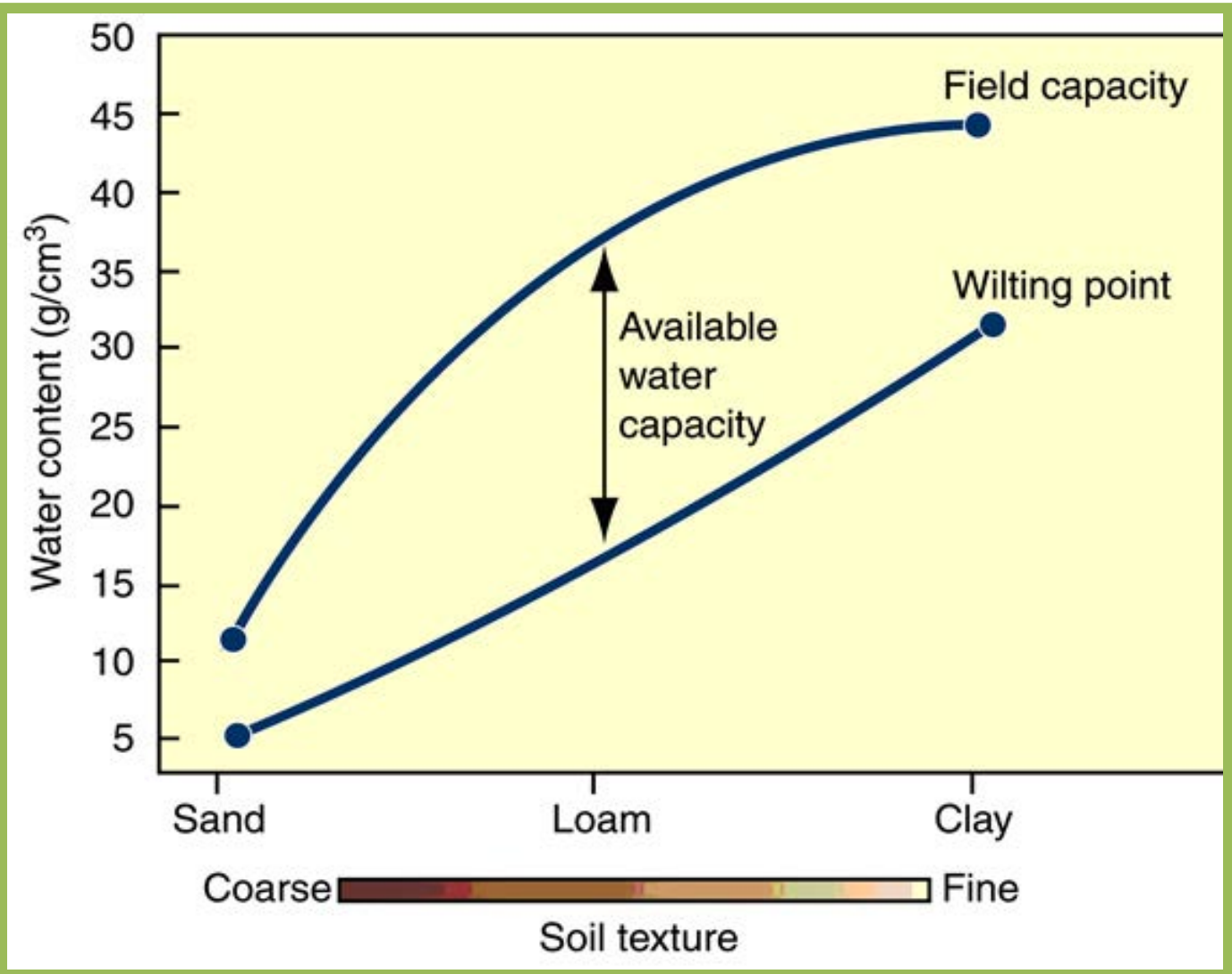


Mauna Loa Monthly Mean CO_2 Concentration 1958-2015



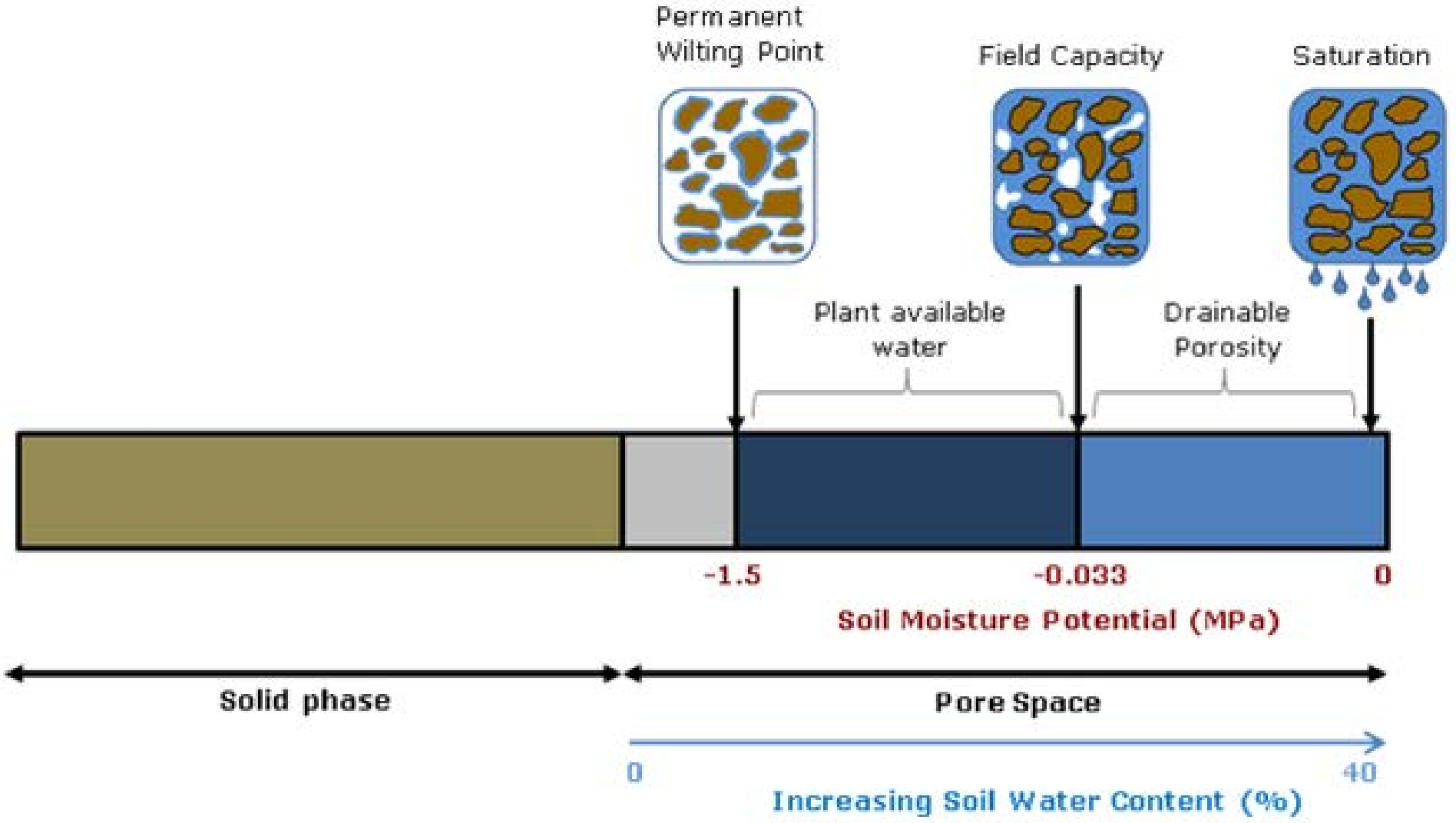
Source: https://en.wikipedia.org/wiki/Climate_change

The Interaction of Soil Texture, Bulk Density/Pore Space, and Aggregation Affect Water-Holding Capacity



Source: http://www.tankonyvtar.hu/en/tartalom/tamop425/0032_talajtan/ch07s02.html

Water Content and Water Potential at Saturation, Field Capacity and Permanent Wilting Point



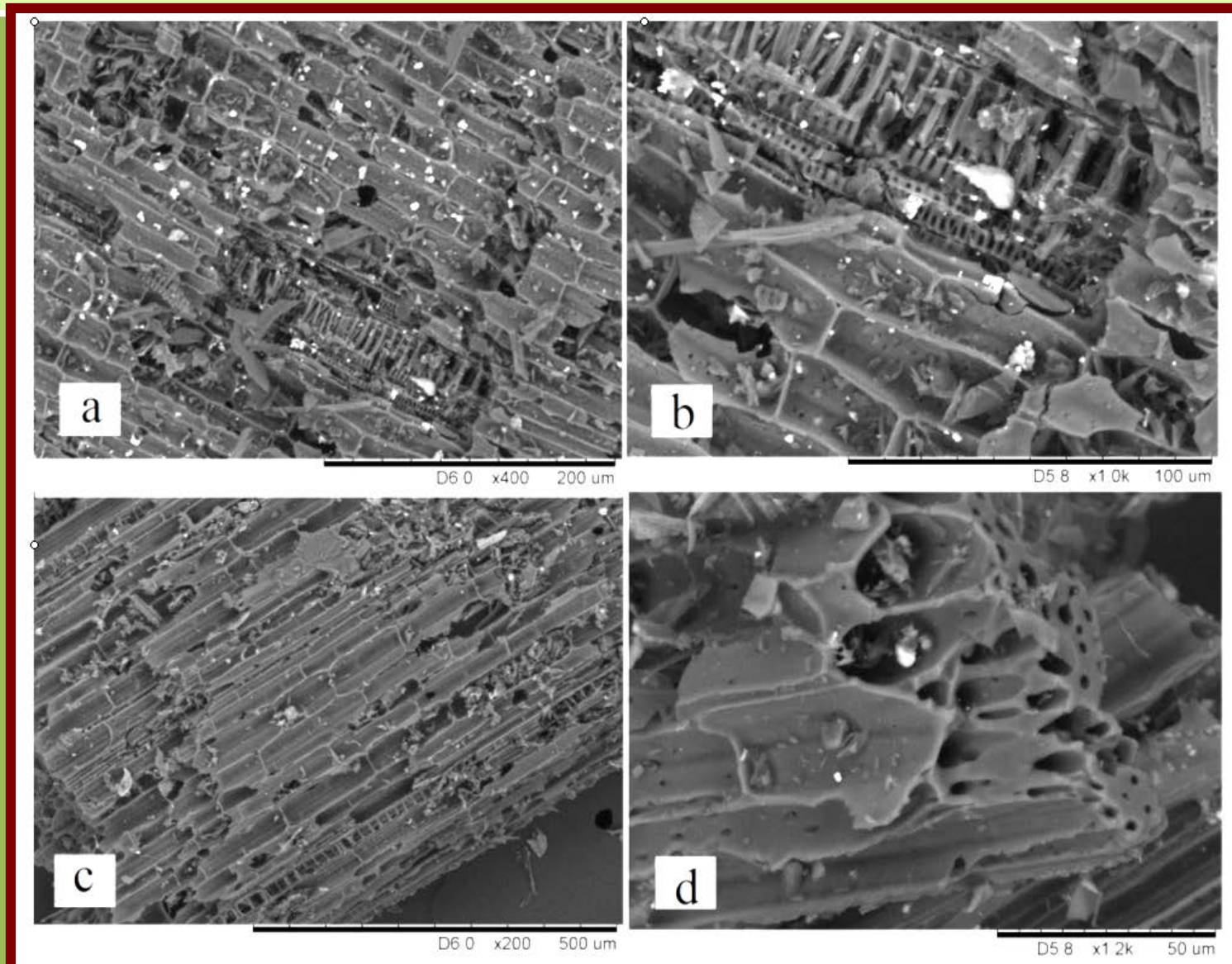
Source: http://www.nature.com/scitable/knowledge/library/soil-water-dynamics-59718900

Soil Water Holding Capacity

Soil water holding capacity is affected largely by factors such as:

- PORE SIZE/VOLUME DISTRIBUTION
- Soil texture
- Aggregation
- Bulk density
- Organic matter

SEM Images of Torrefied (a, b) and Pyrolyzed (c, d) Switchgrass

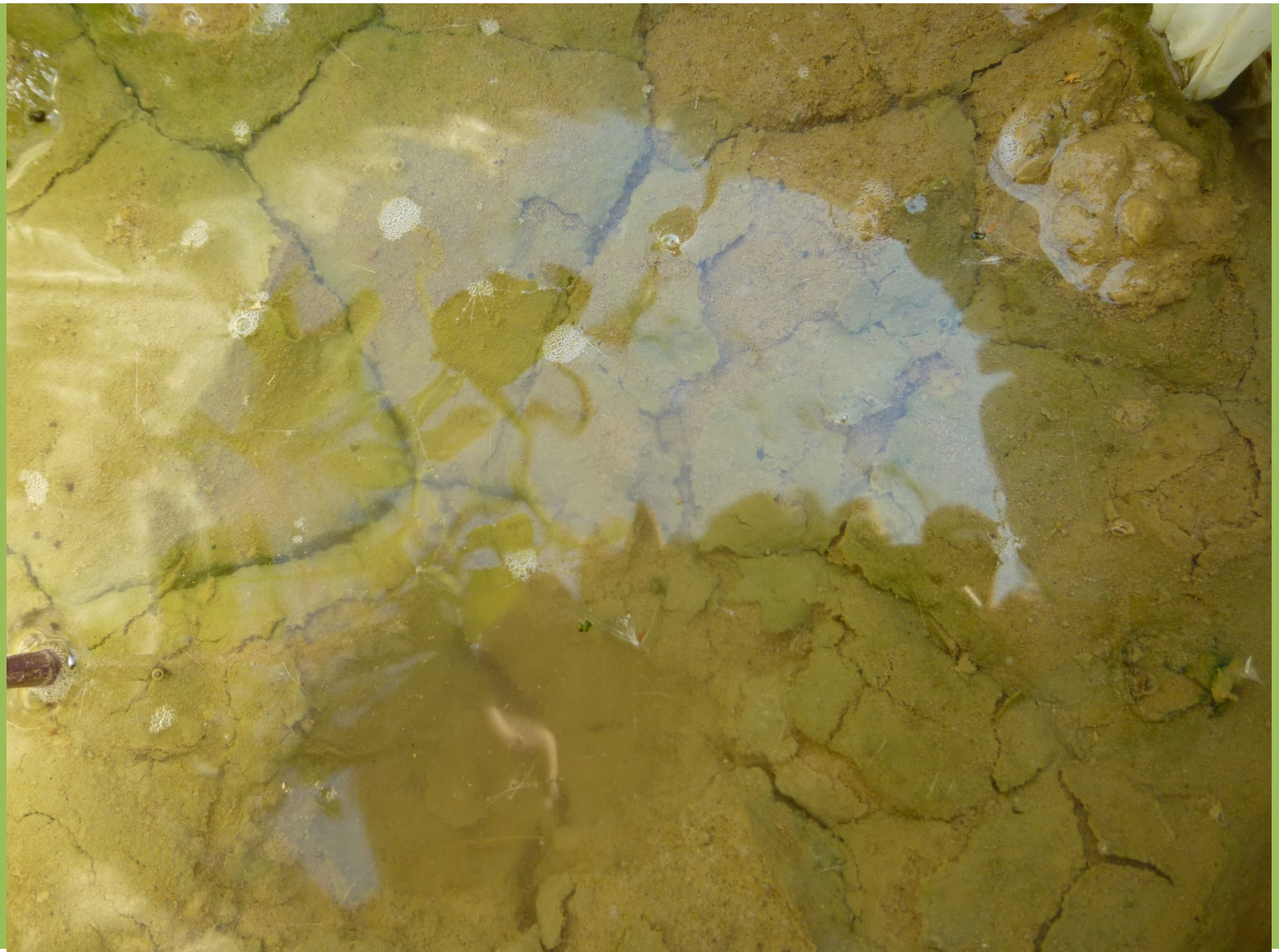


Claypan Material Mixed with Miscanthus Biochar

Effect of Switchgrass Biochar on Soil Structure
This biochar promoted aggregation

Before Biochar Application 60 Days after Application

Claypan Soil has a Low Hydraulic Conductivity



5% Switchgrass Biochar Treatment Increased the Hydraulic Conductivity of Claypan Soil

Apparently, Switchgrass Biochar has Affected the Expansion/Contraction of Smectitic Claypan

No Biochar - Soybean Plant Growing in Claypan Soil – Smectitic Clay Cracks as Soil Dries

2% Biochar - Soybean Plant Growing in Claypan Soil – Minimal Cracking of Soil

Biochars Influence Soybean Growth at Significantly Different Rates

Effect of Biochars on Soybean Growth

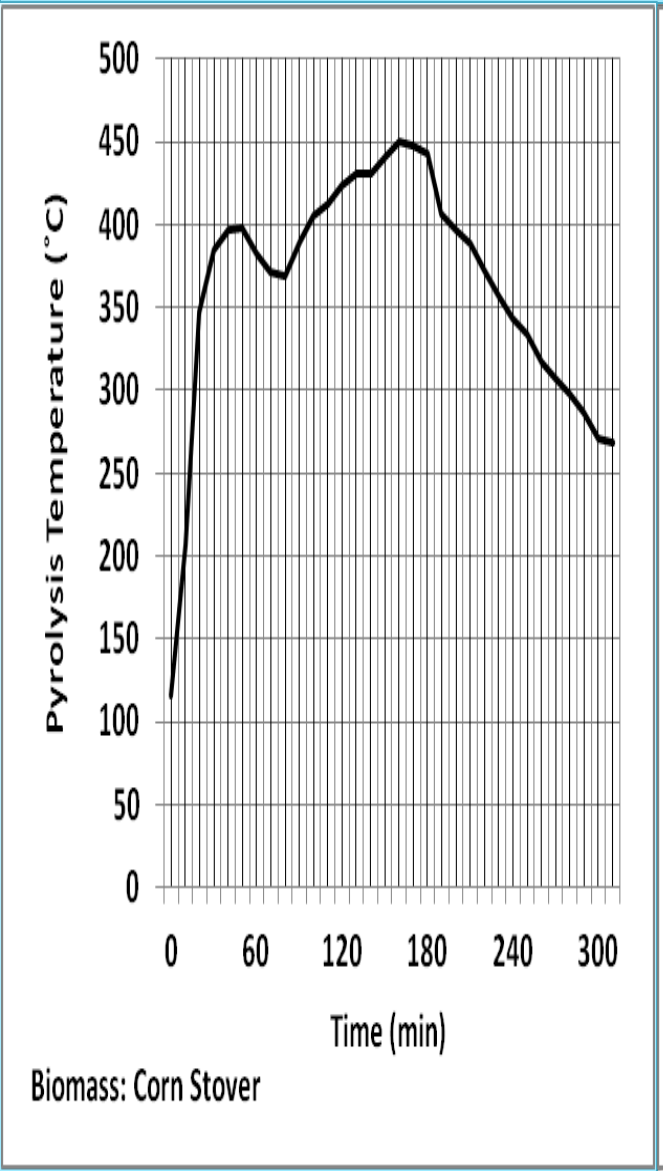

0%
Biochar
2% Miscanthus
Biochar
5% Miscanthus
Biochar

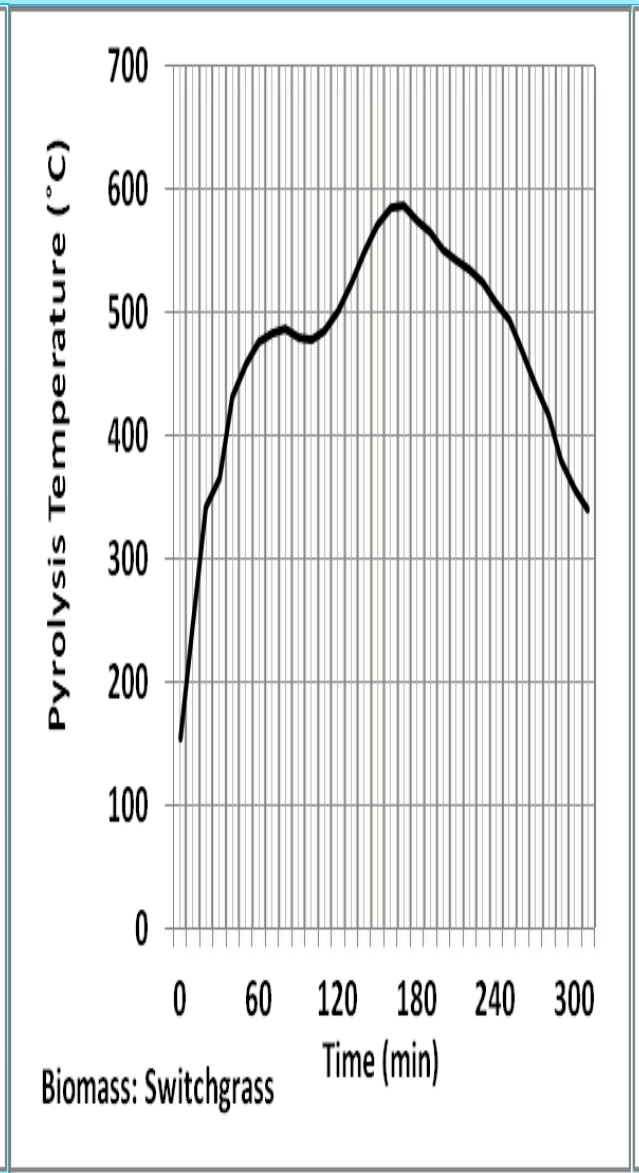

0%
Biochar
2% Pine
Biochar
5% Pine
Biochar

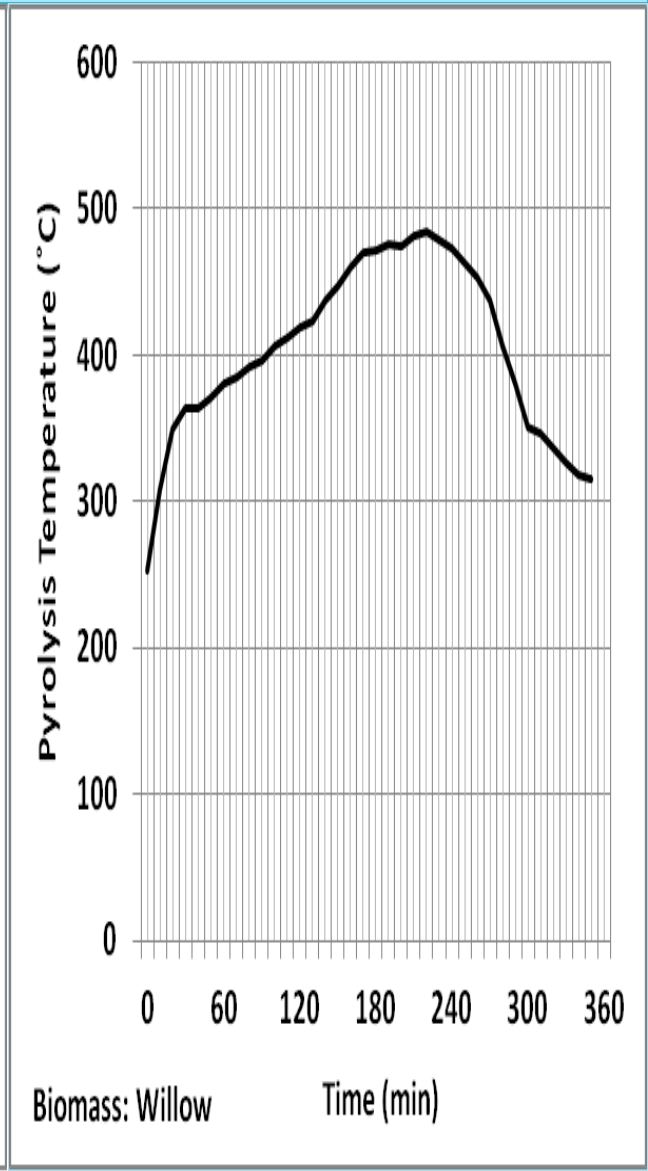
Biochar was Generated from a Variety of Feedstocks Using Slow Pyrolysis


EXTECH
INSTRUMENTS
436.4
6.6
°C

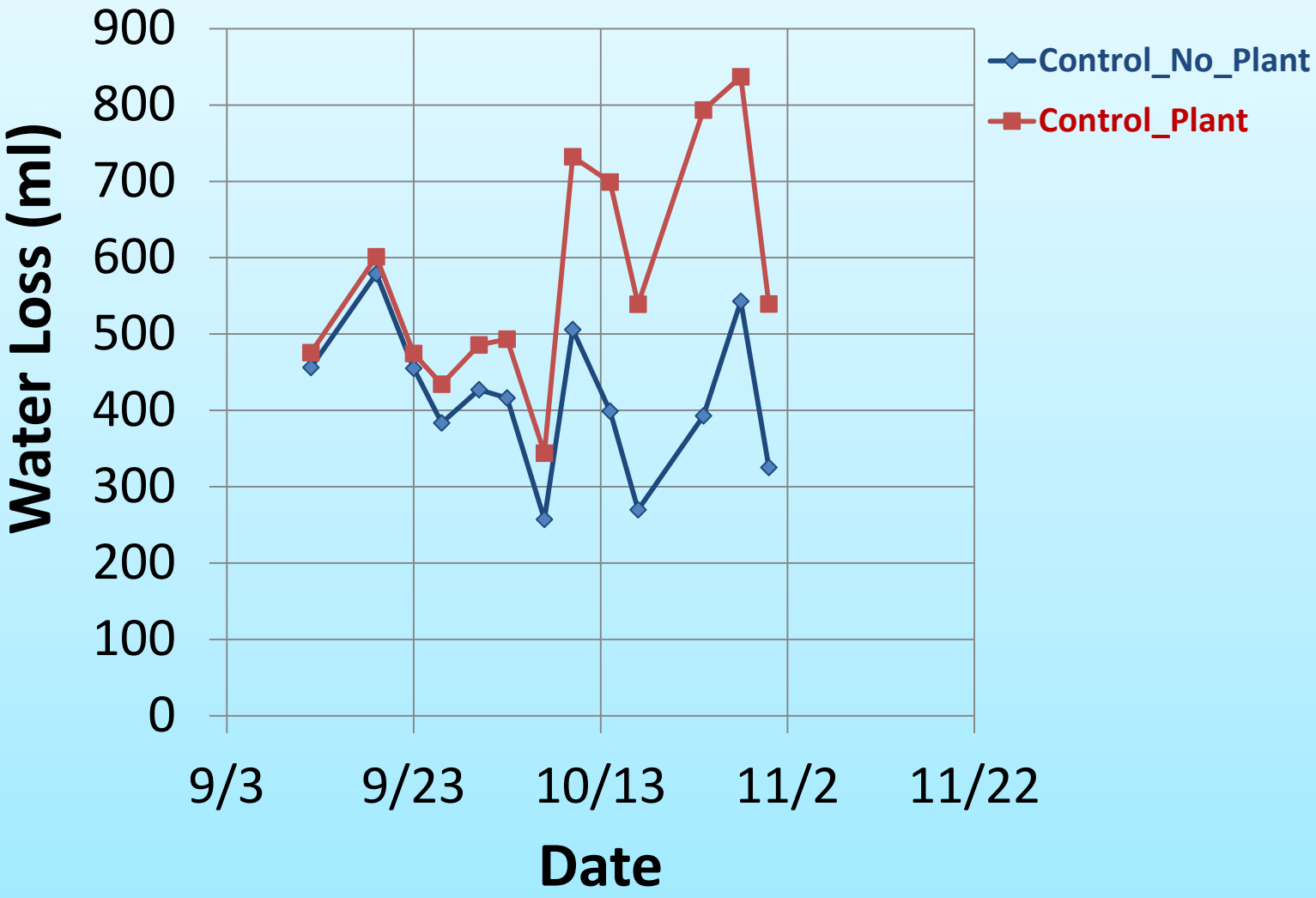
Thermographs of Biomass Pyrolysis through Slow Pyrolysis



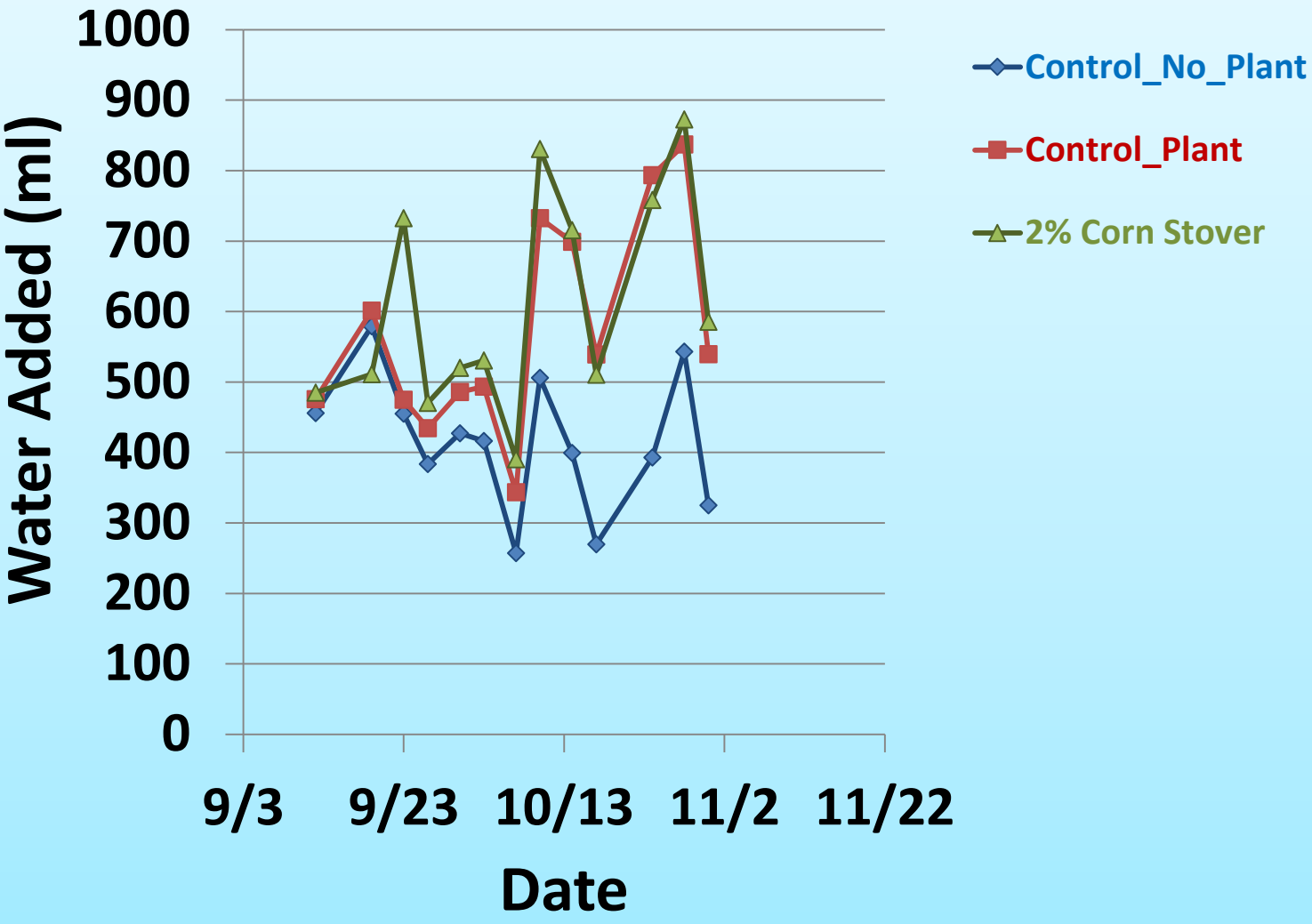




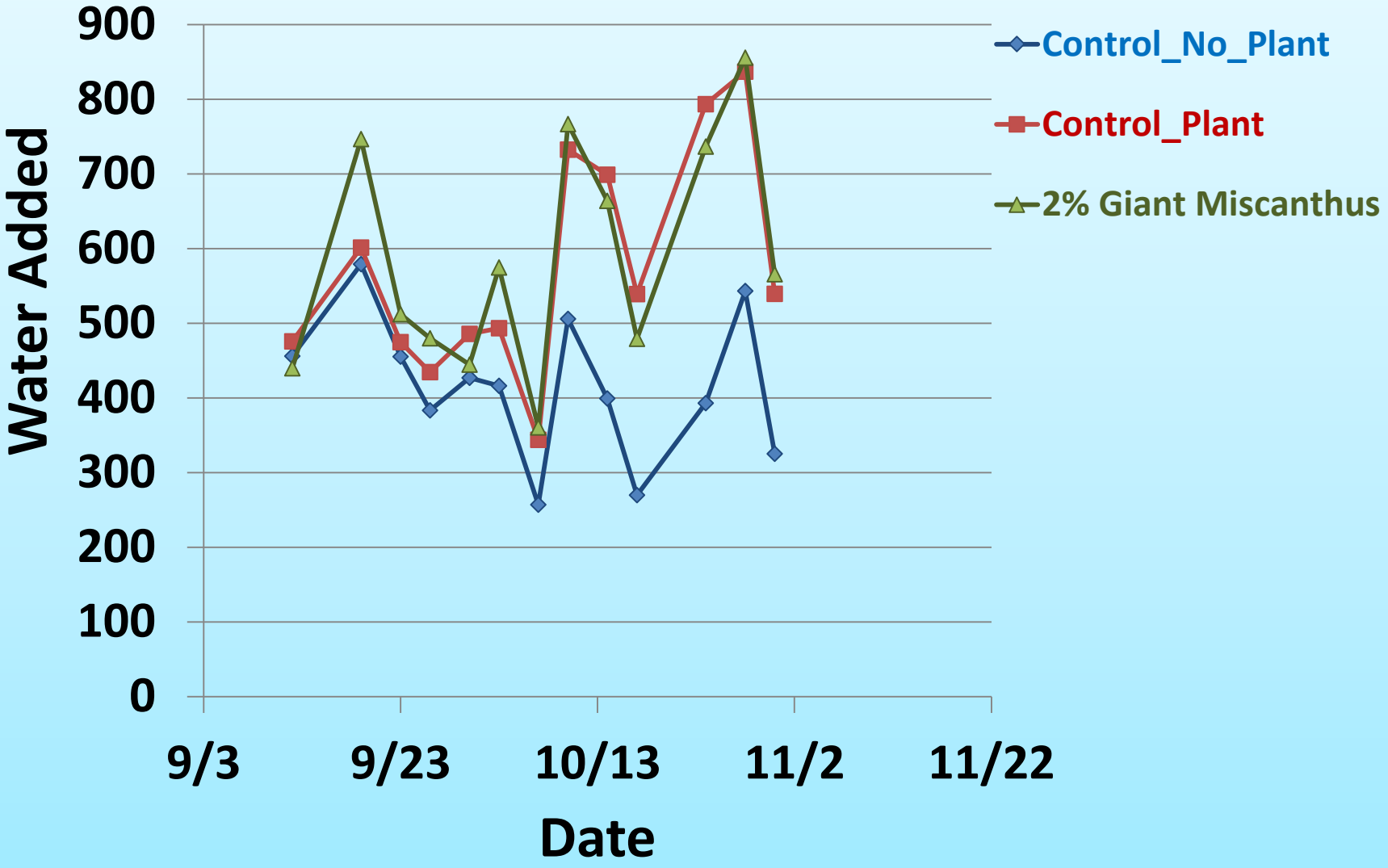
Water Loss through Evaporation and Evapotranspiration from Untreated Pots



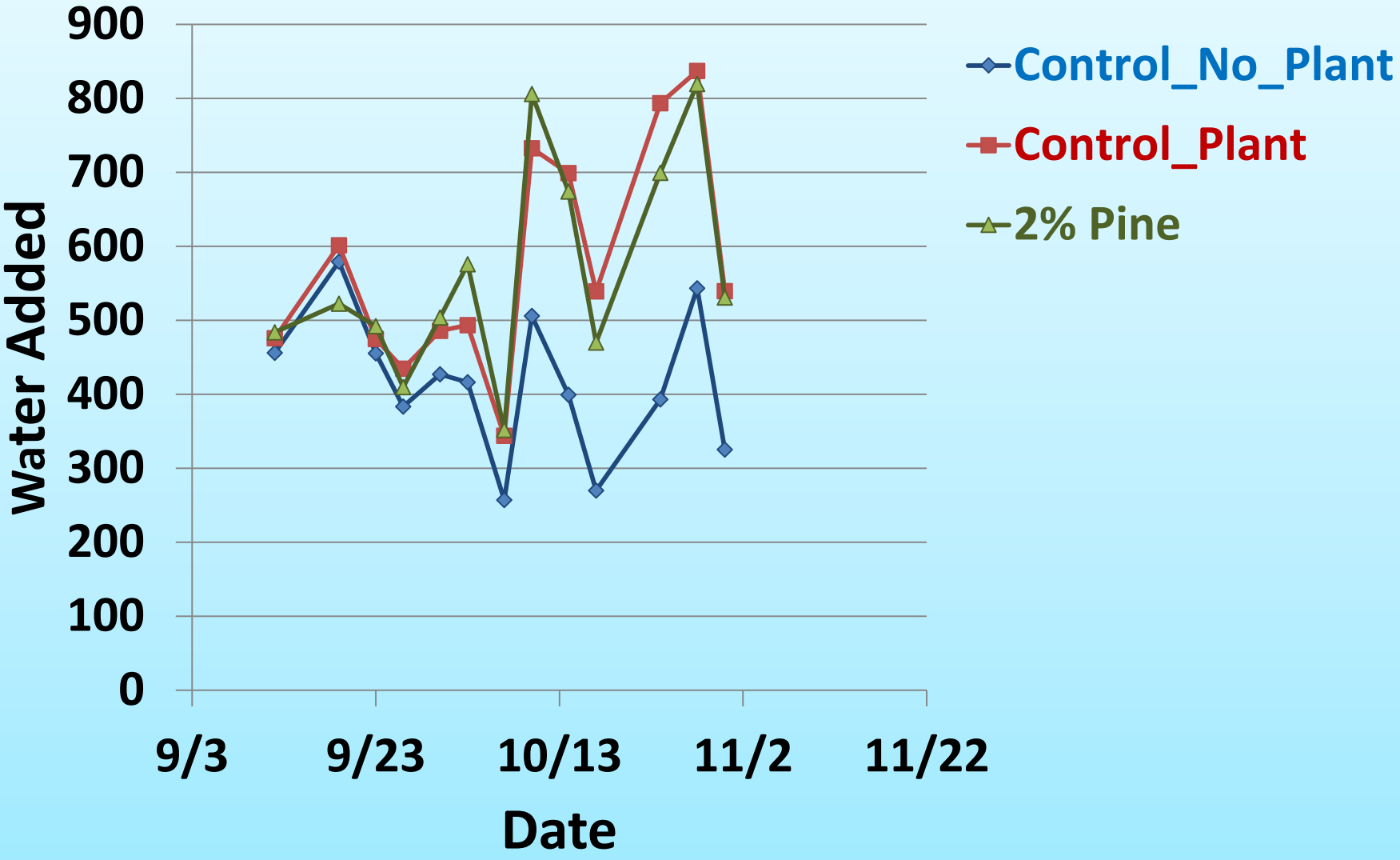
Water Loss through Evaporation and Evapotranspiration from Untreated and 2% Corn Stover Biochar Treated Pots



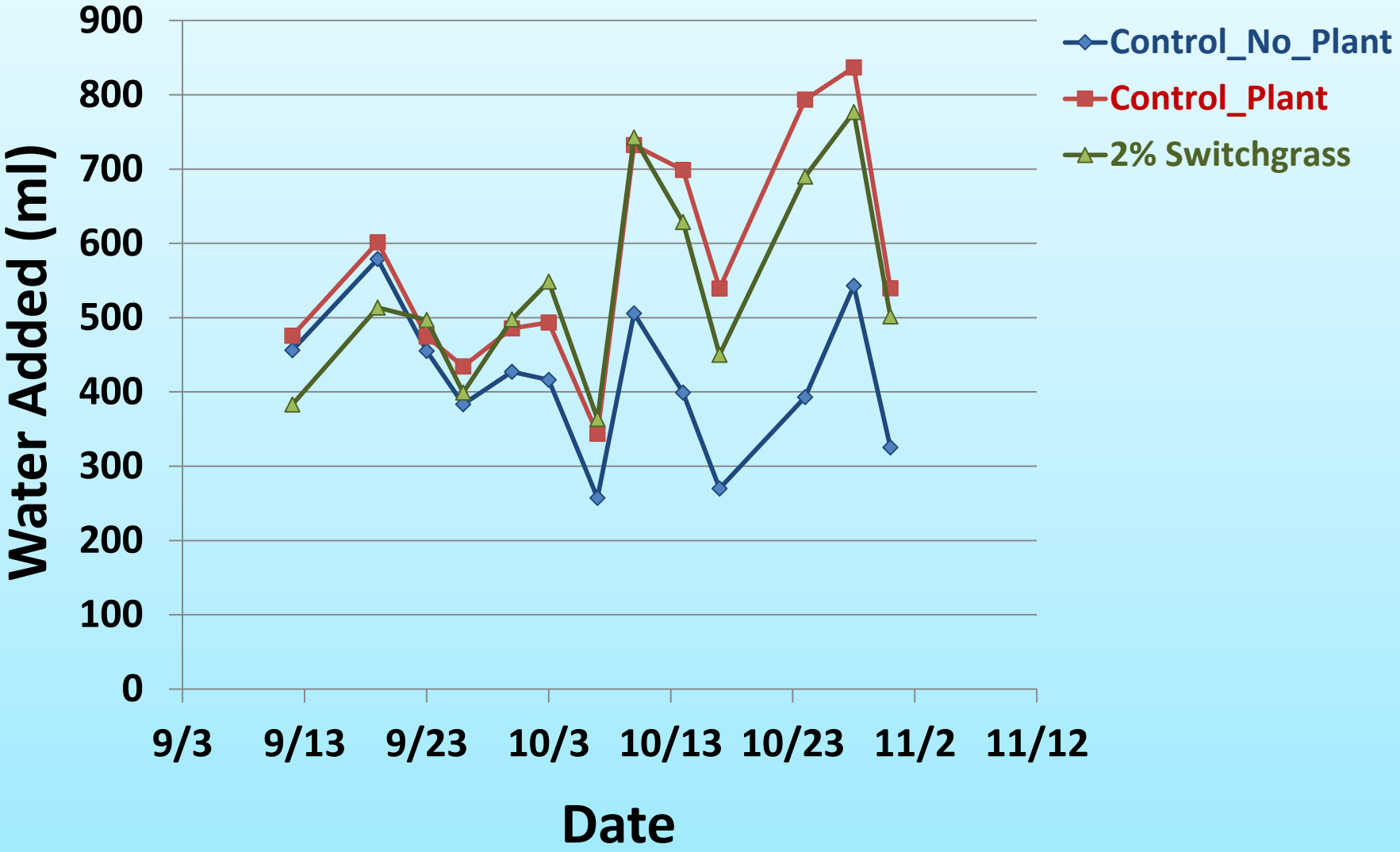
Water Loss through Evaporation and Evapotranspiration from Untreated and 2% Miscanthus Biochar Treated Pots



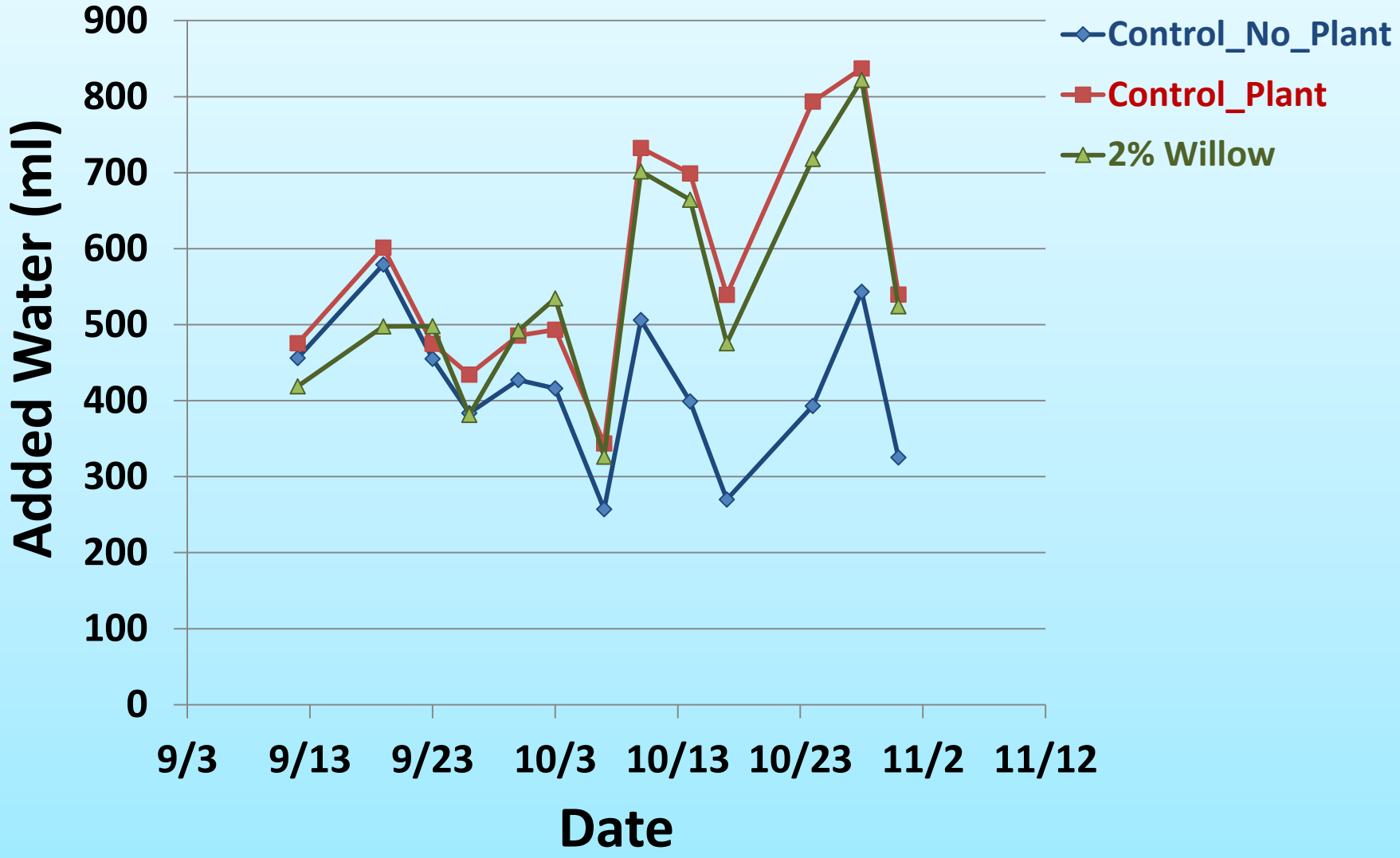
Water Loss through Evaporation and Evapotranspiration from Untreated and 2% Pine Biochar Treated Pots



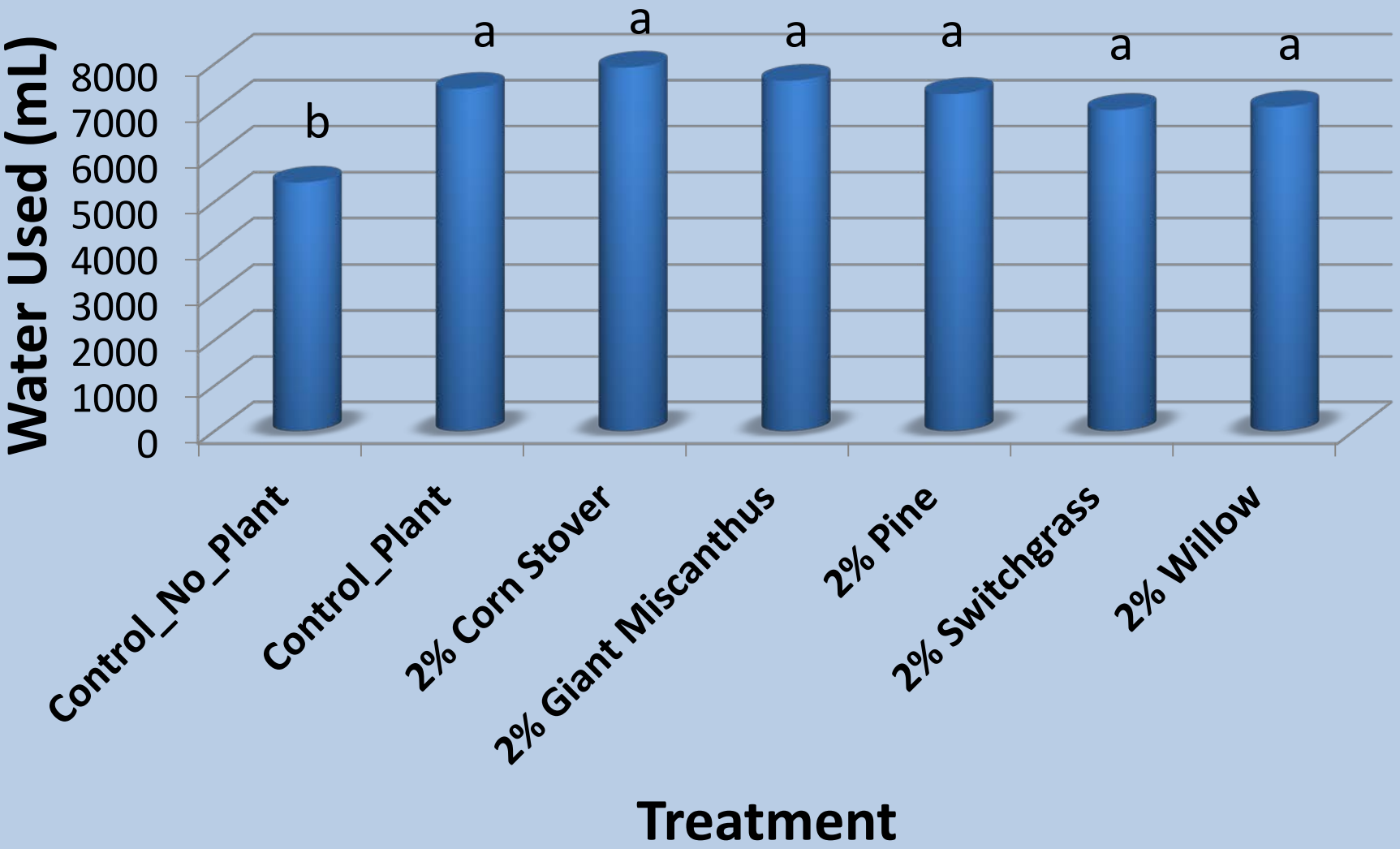
Water Loss through Evaporation and Evapotranspiration from Untreated and 2% Switchgrass Biochar Treated Pots



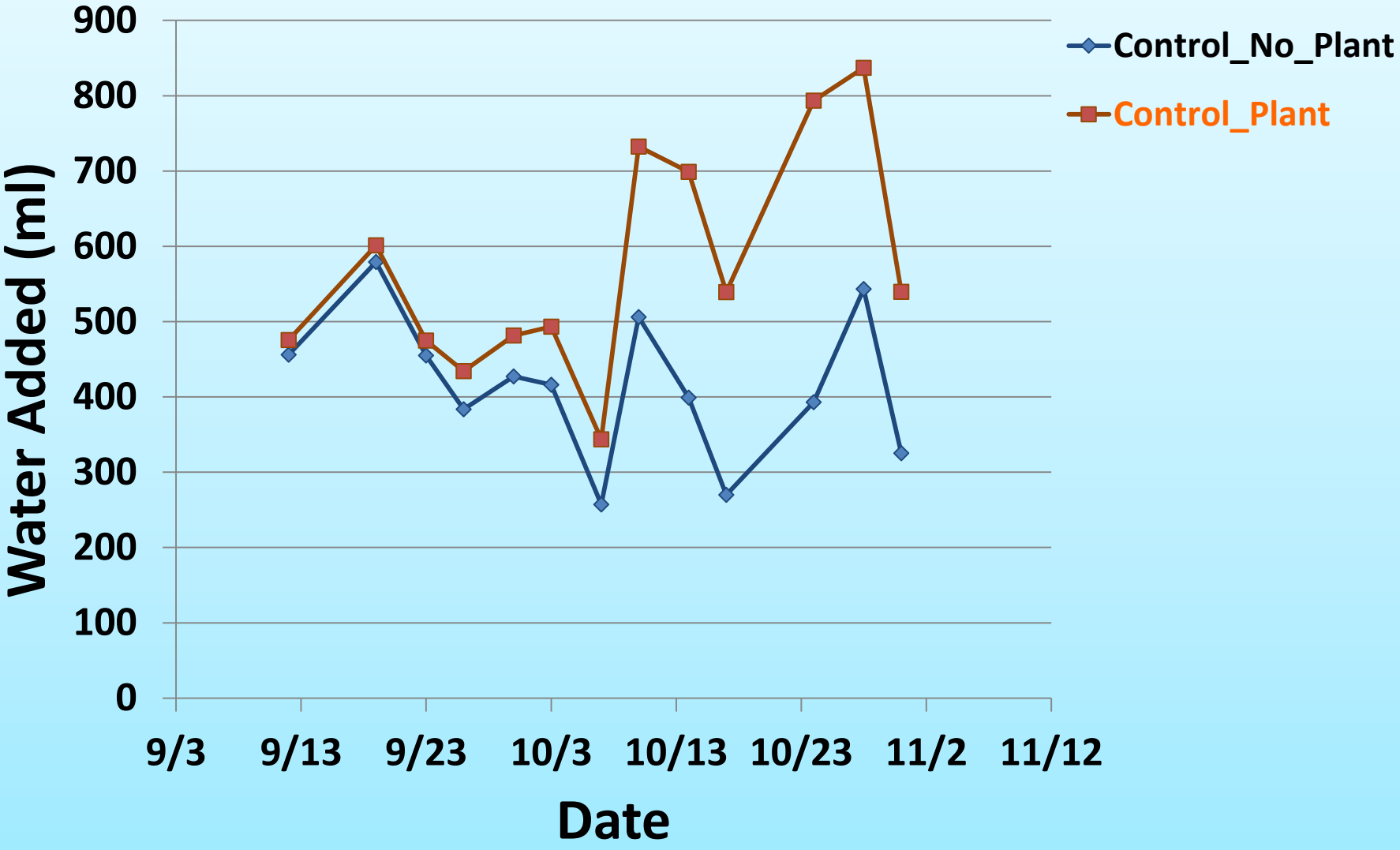
Water Loss through Evaporation and Evapotranspiration from Untreated and 2% Willow Biochar Treated Pots



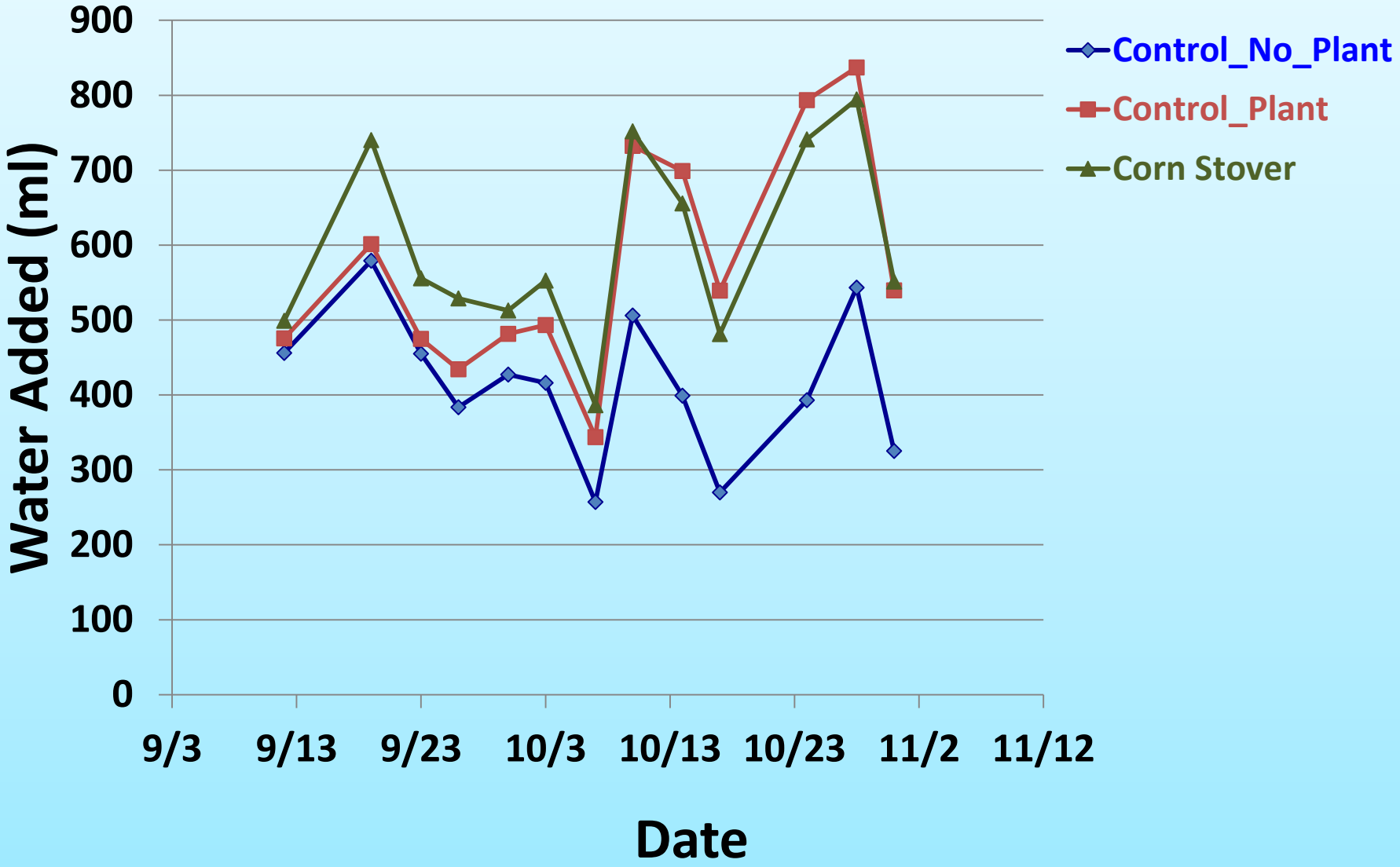
2% Biochar Application - Total Water Used per Soybean Plant (ml) through evapotranspiration



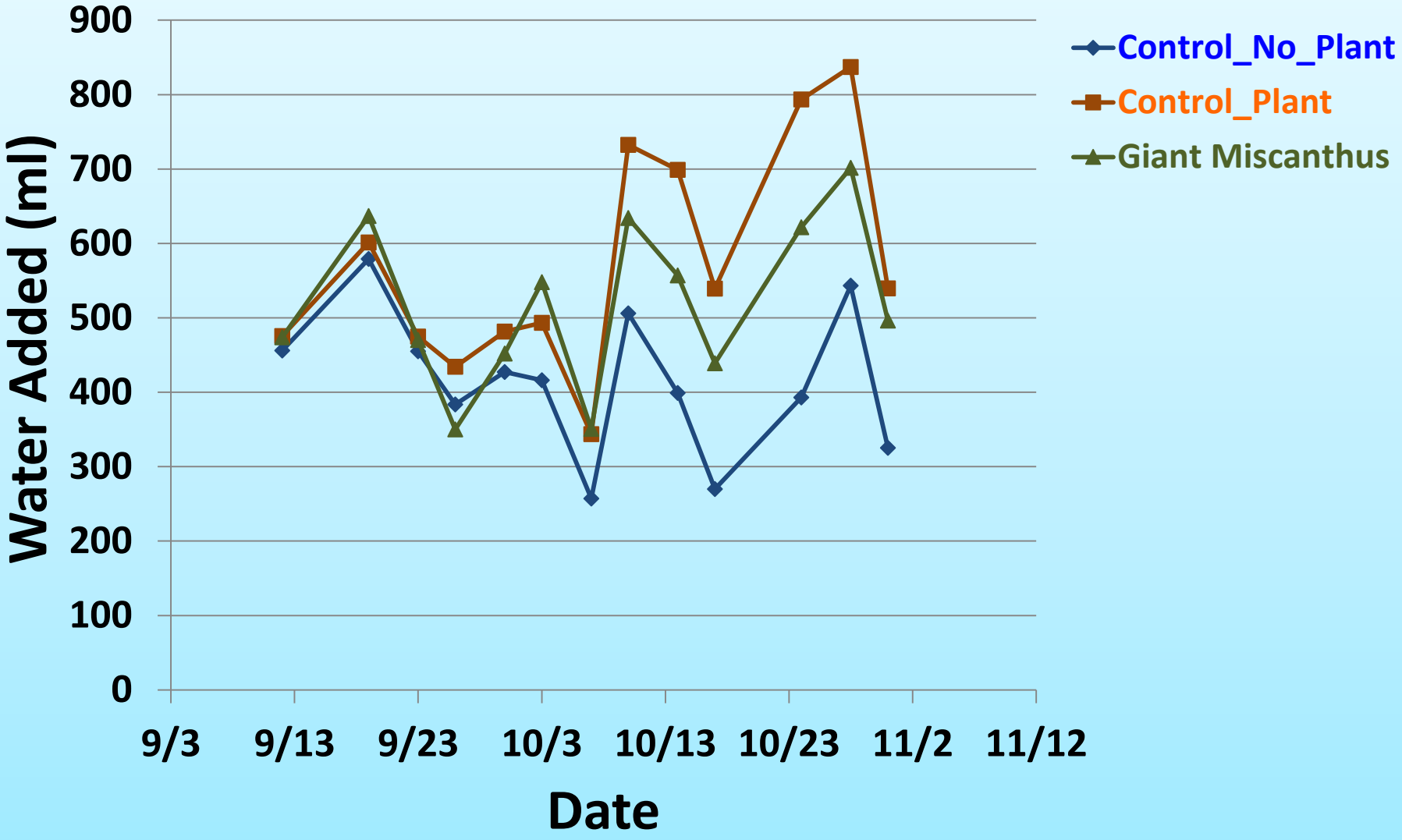
Water Loss through Evaporation and Evapotranspiration from Untreated Pots



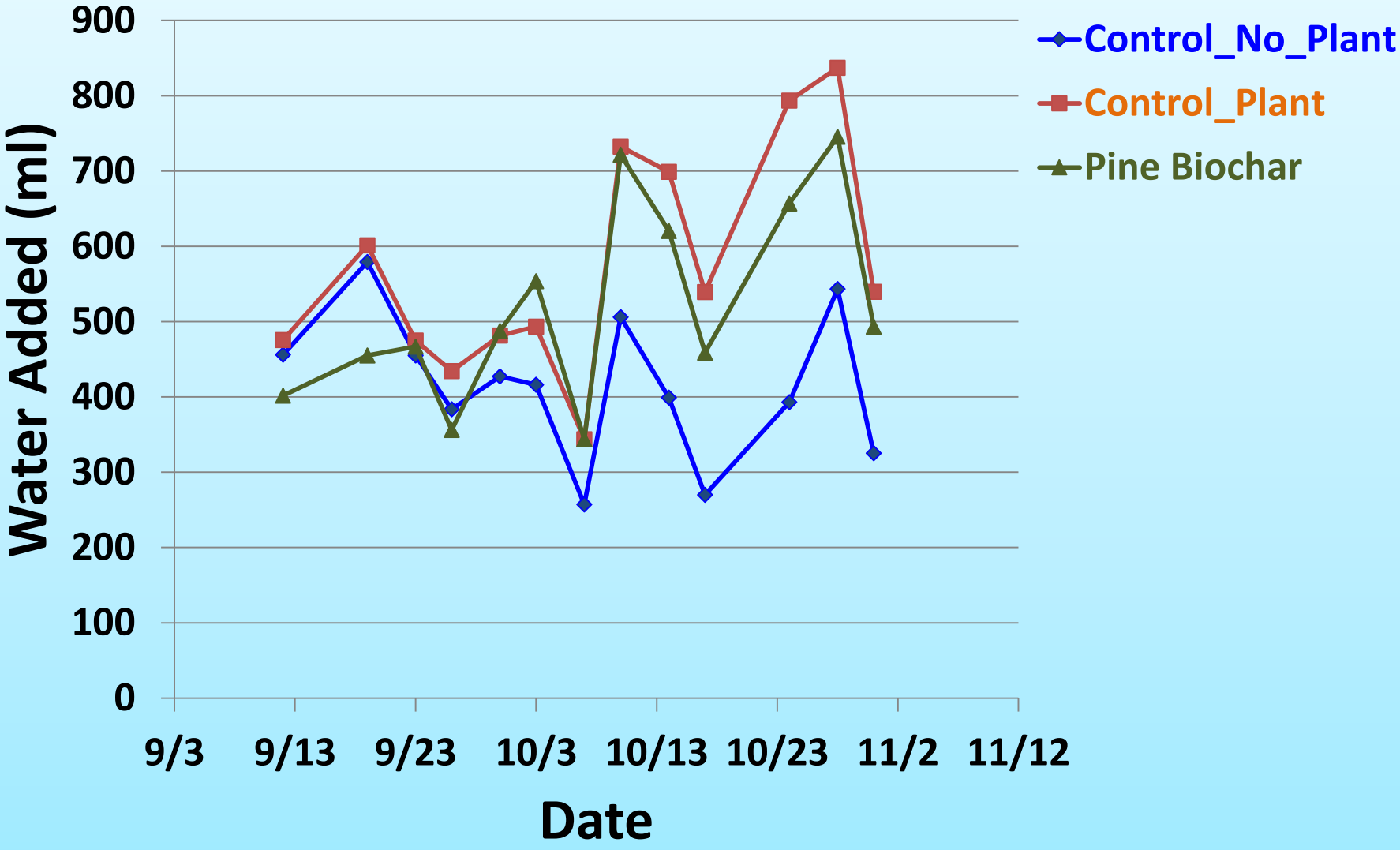
Water Loss through Evaporation and Evapotranspiration from Untreated and 5% Corn Stover Biochar Treated Pots



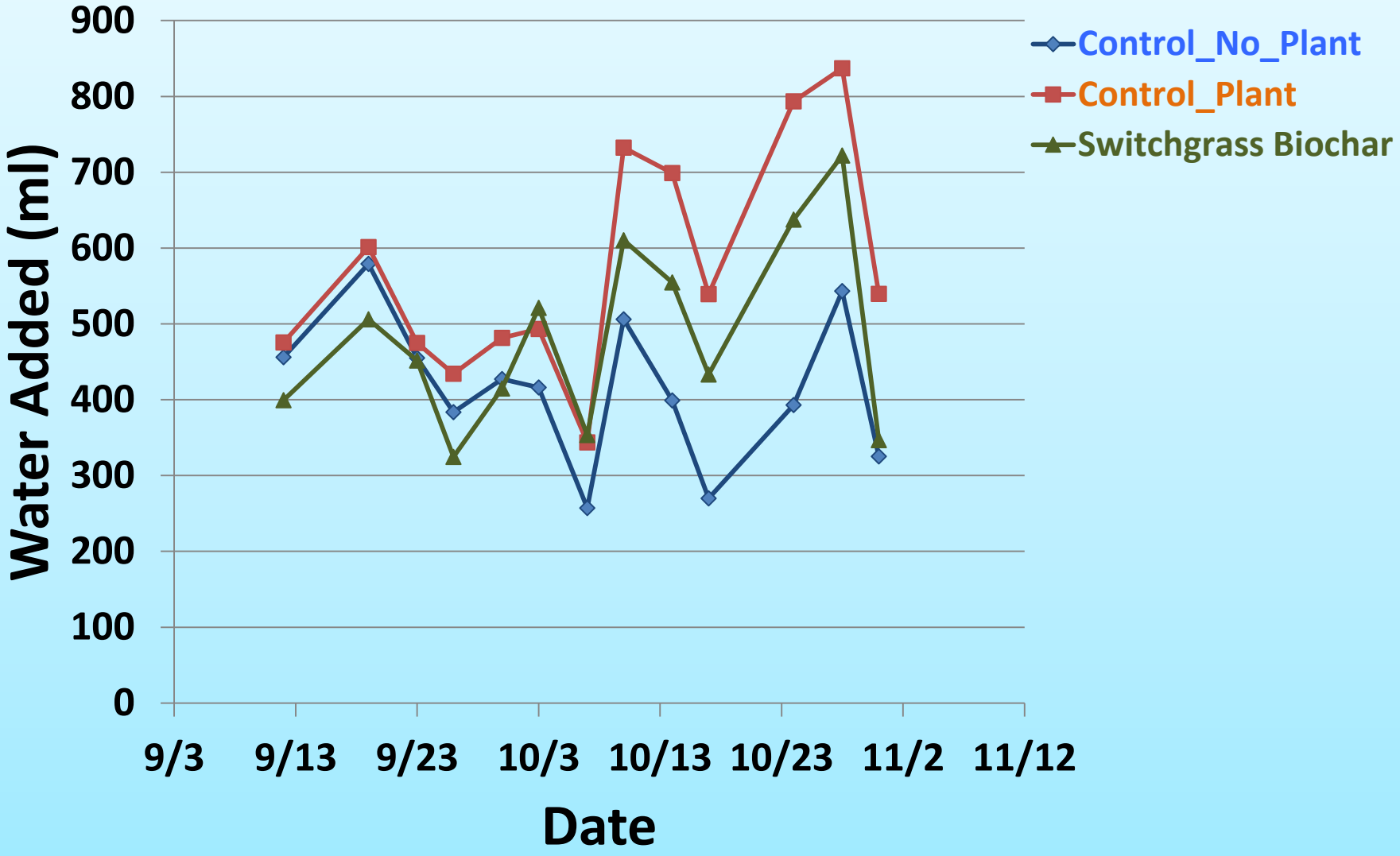
Water Loss through Evaporation and Evapotranspiration from Untreated and 5% Miscanthus Treated Pots



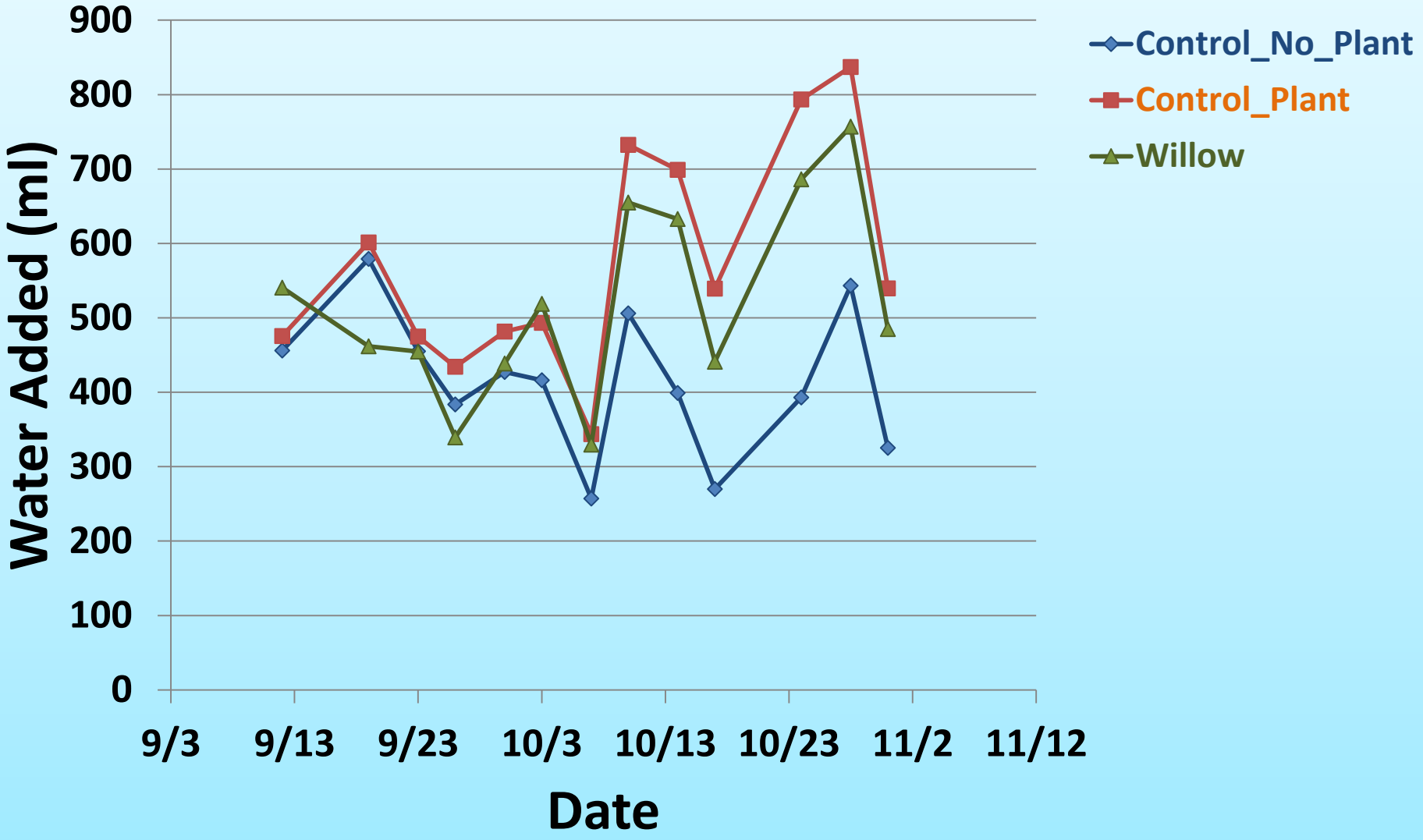
Water Loss through Evaporation and Evapotranspiration from Untreated and 5% Pine Biochar Treated Pots



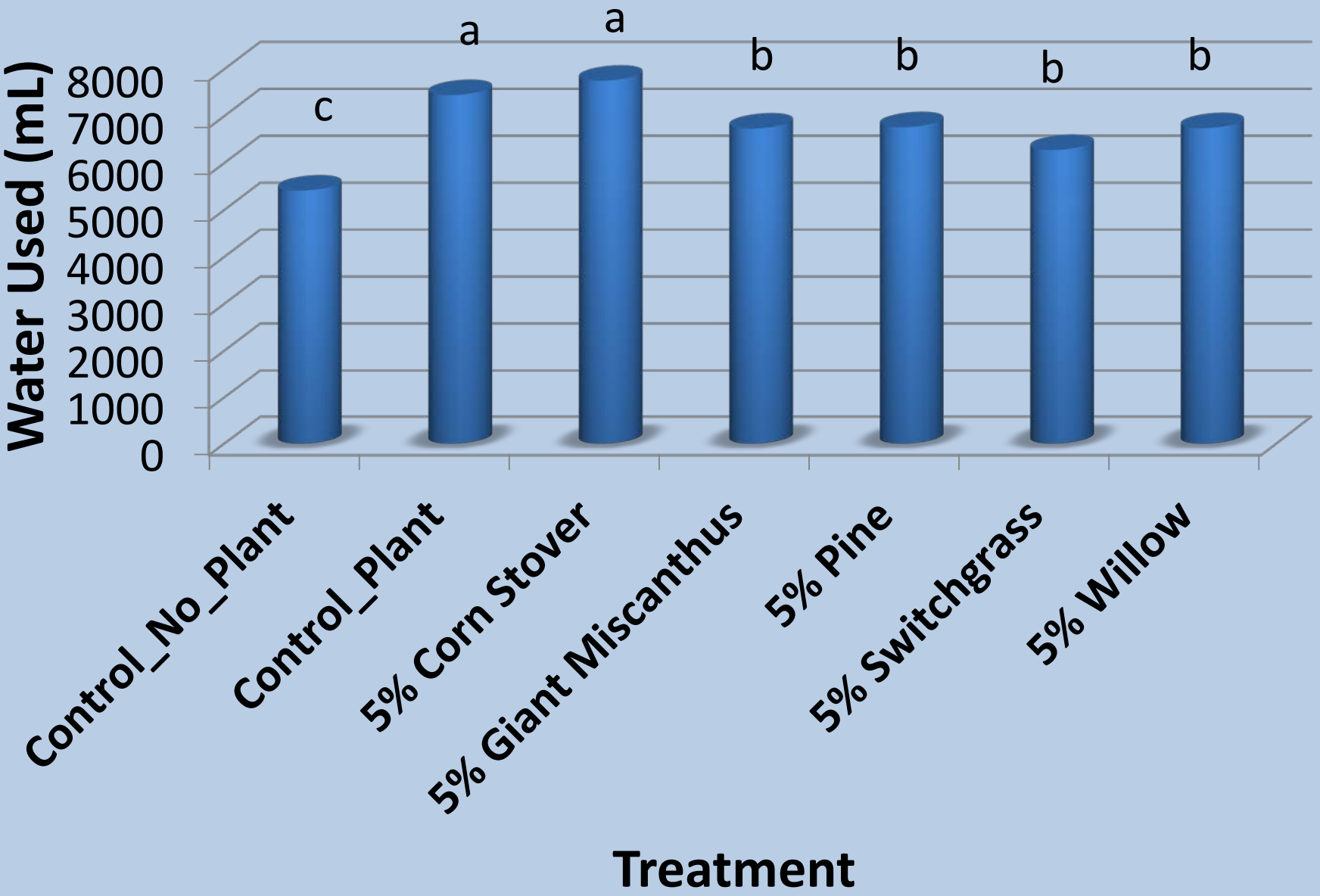
Water Loss through Evaporation and Evapotranspiration from Untreated and 5% Switchgrass Biochar Treated Pots

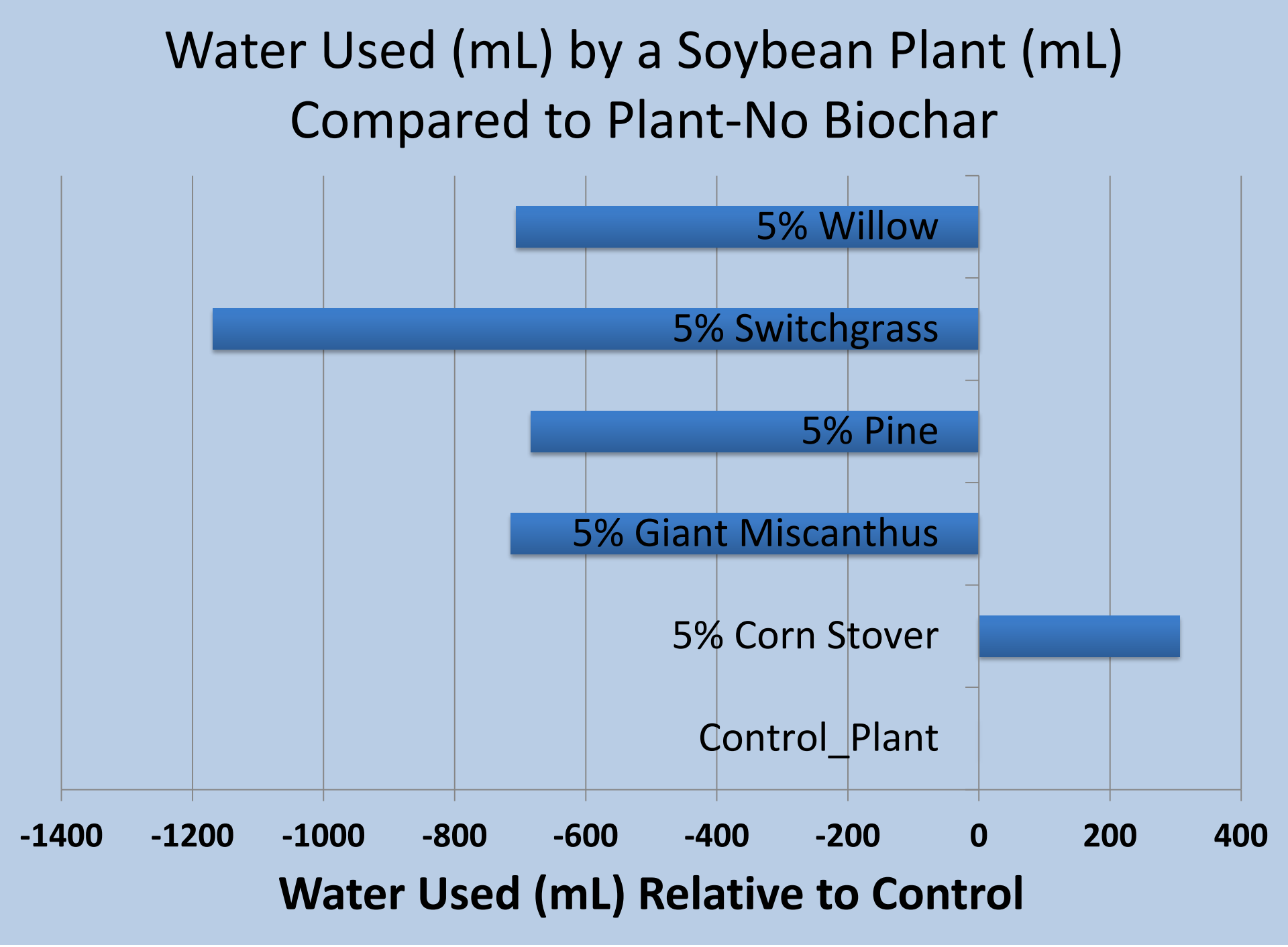


Water Loss through Evaporation and Evapotranspiration from Untreated and 5% Willow Biochar Treated Pots



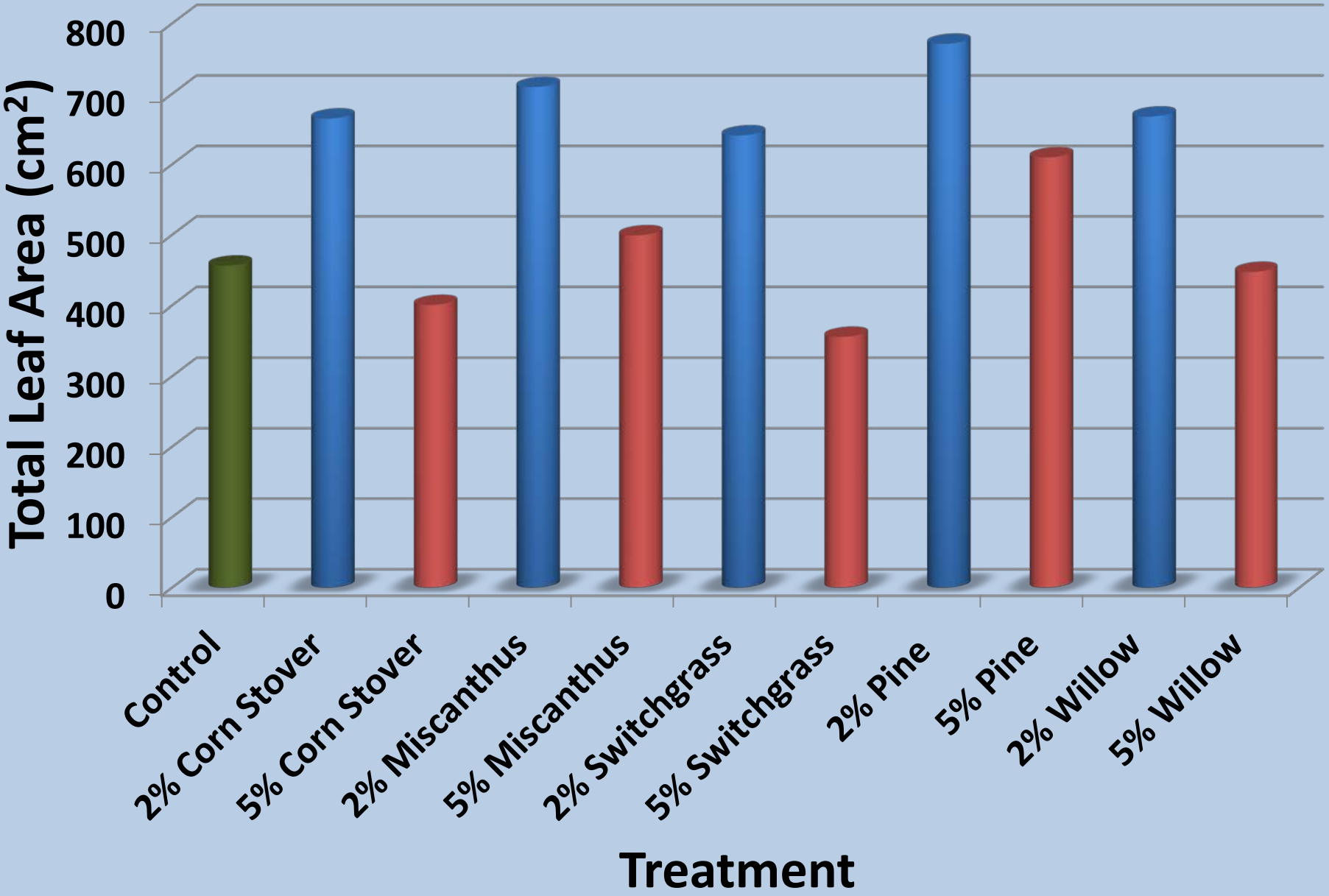
5% Biochar Application - Total Water Used per Soybean Plant (ml) through Evapotranspiration




Water Used (mL) by a Soybean Plant (mL) Compared to Plant-No Biochar
5% Willow
5% Switchgrass
5% Pine
5% Giant Miscanthus
5% Corn Stover
Control_Plant
-1400
-1200
-1000
-800
-600
-400
-200
0
200
400
Water Used (mL) Relative to Control

Treatment	Water Used Compared to Control per Plant	Water Use Compared to Control (Hectare - 250000 Plant)	Water Saved per Hectare (US gal)	Water Saved per Acre (US gal)	Water Saved in Terms of Rain (1 in rain/acre = 27154 gal)
Control-No Biochar-Planted	0	-	-	-	-
5% Corn Stover	**305.7**	**+76425L (76m^3)**	**+20189**	**8170**	**0.30**
5% Giant Miscanthus	**-714**	**-178500L (18m^3)**	**-47155**	**19083**	**0.70**
5% Pine	**-684.1**	**-171025L (17m^3)**	**-45180**	**18284**	**0.67**
5% Switchgrass	**-1169**	**-292250L (29m^3)**	**-77204**	**31244**	**1.15**
5% Willow	**-705.7**	**-176425L**	**-46607**	**18861**	**0.69**

Biochar Effect on Soybean Leaf Area



Conclusion

1. Biochars affect water consumption by soybeans on claypan soils but the effects are varied.
2. At 2% application rate, all studied biochars significantly increased leaf area without significantly affecting water use by soybean plants.
3. At 5% application rate, miscanthus and willow biochars significantly reduced water use but did not affect leaf area.
4. At 5% application rate, switchgrass biochar significantly reduced both water use and leaf area.
5. At 5% application rate, pine biochar increased the leaf area and reduced water use.
6. More study is needed to further investigate effects of biochars on soil water holding capacity and plant growth particularly in claypan soils.

THANK YOU…