Impact of Biochar and Compost on Hydro-physical Properties and Yield Grown on Sandy Soils

SAUDI BIOCHAR RESEARCH GROUP

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OUTLINE

1. Introduction
2. Biochar Production from *Date Palm* Waste
3. Biochar Characterization
4. Biochar Application under Lab scales
5. Biochar Application under field scales
6. Conclusions

INTRODUCTION

Most of agriculture soils in Saudi Arabia are Calcareous Sandy Soils high $CaCO_3$ and pH and characterized by:

- Low in Fertility Status.
- Low Water Holding Capacity.
- Excessive Deep Percolation.
- High Infiltration Rate
- Low Water Use Efficiency.

- In addition, salinity problems could limit the productivity of soils in arid and semi arid regions.
- The water consumption for agricultural sector reached to more than 17 billion M3/year.

INTRODUCTION

- Soil additives such as organic amendments or polymers are needed to improve soil physico-chemical and biological properties and thus increase its fertility and productivity.
- Many attempt has been taken in the department to use natural deposits to improve soil physical properties.

BIOCHAR PRODUCED FROM *DATE PALM* WASTE

- Date Palm is an evergreen tree planted in Saudi Arabia in farms and around parking lots and along streets with over 28 millions trees.
- According to the Municipal Council of the city of Riyadh, management and recycling of Date Palm is problematic due to its huge aboveground Biomass, and widespread. Therefore, converting of Date Palm wastes into biochar may be considered as a tool for waste disposal and recycling option.

صورة

أشجار النخيل بالأحساء، في المملكة العربية السعودية


اخي المواطن اخي المزارع
فلنعمل معاً من أجل بيئة نظيفة
هيئة
الري
والصرف
بالاحساء
مشروع
نقل
المخلفات
الزراعية
الطريفي
AL-TRAIFI
٥٧


TOYOTA
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مشروع نقل المخلفات الزراعية
هيئة الري والصرف بالأحساء


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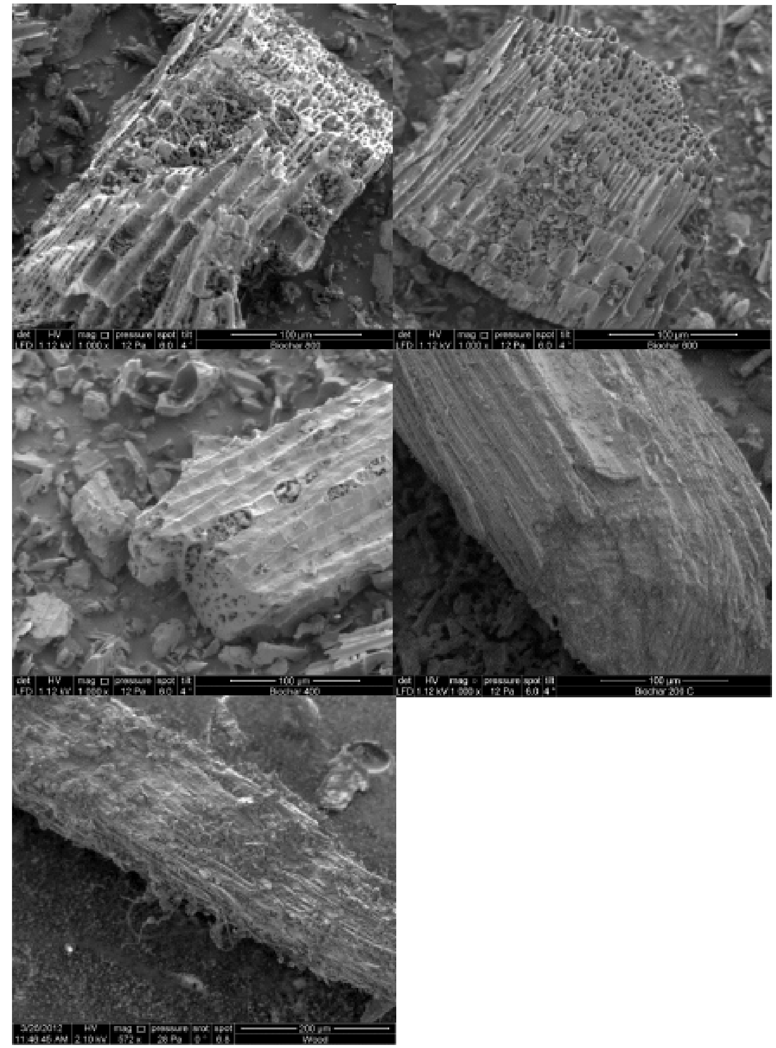
BIOCHAR PRODUCED FROM *DATE PALM* WASTE

- Biochar production under lab scales
- The pyrolysis process was conducted for 2-4 h to produce Date Palm biochars at different temperatures 300 ^{o}C, 400 ^{o}C, 700 ^{o}C and 800 ^{o}C under oxygen-limited conditions).

BIOCHAR PRODUCED FROM *DATE PALM* WASTE

- Biochar production under Laboratory and field scales
- Date Palm wastes were collected from the King Saud University campus, dried and then chopped to small pieces (7–10 cm). After that, wood pieces were pyrolyzed in stainless steel cylinder container in outdoor pyrolysis reactor for 3 hours at a temperature of 400°C±10.



Synergy in Science: Partnering for Solutions
ASA•CSSA•SSSA 2015 MEETING
November 15-18
Minneapolis, MN


GRANSEL


BIOCHAR CHARACTERIZATION

Table: Effect of pyrolysis temperatures on elemental composition of biochar derived from date palm wastes.

Parameters	Feedstock	Pyrolysis temp., ^{o}C		
		300	500	700
C	43.19	57.99	72.30	73.42
H	5.83	4.08	2.11	1.14
O	39.00	20.82	4.50	3.19
N	0.70	0.54	0.42	0.35
S	4.16	2.14	1.02	0.85

BIOCHAR CHARACTERIZATION

Table : pH, EC and ΔpH of biochar derived from date palm wastes.

Samples	EC (dS m^{-1})	$pH_{1:25}$ (Water)	$pH_{1:25}$ (KCl)	ΔpH
BC300	3.26±0.30	8.32±0.12	8.16±0.16	-0.16±0.04
BC500	3.50±0.01	9.59±0.01	9.80±0.08	0.21±0.07
BC700	3.66±0.01	11.50±0.11	11.65±0.07	0.15±0.04

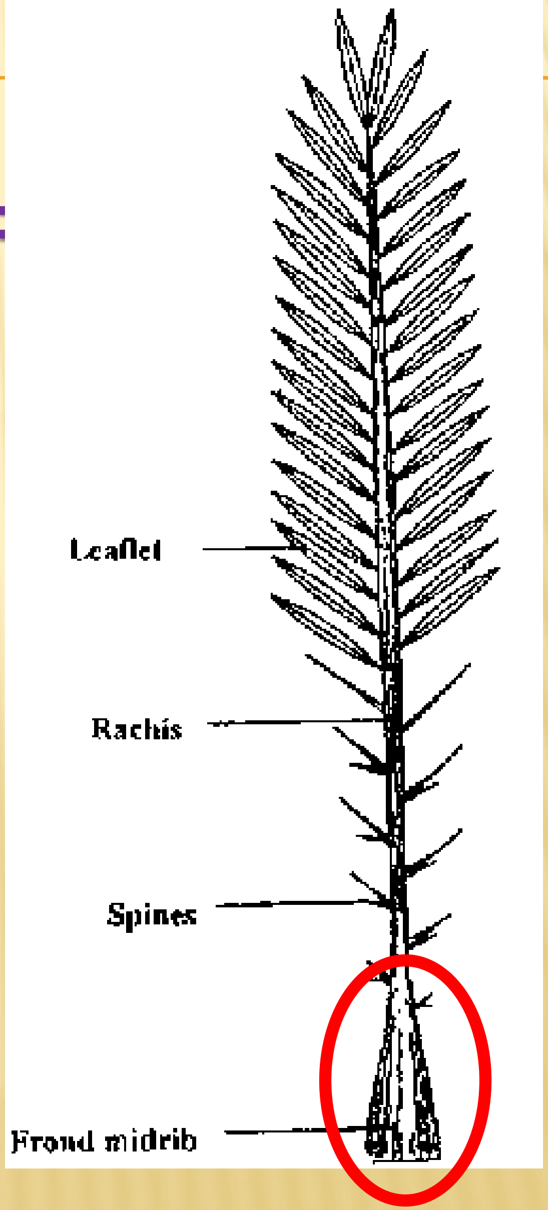
Laboratory Experiments

- Effect of compost and biochar
- Effect of temperature produced biochar
- Effect of particle size of biochar

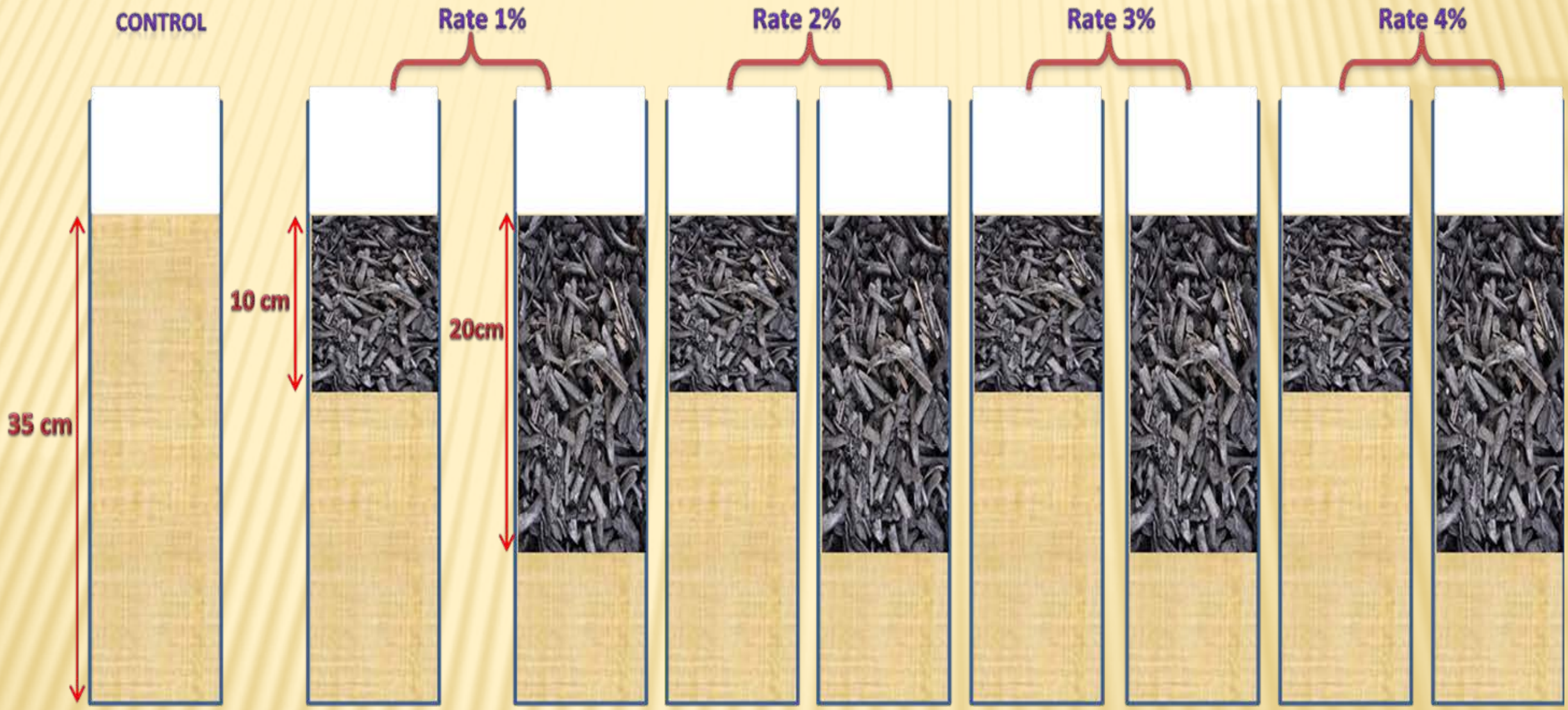
Treatments

Treatments	No	Notes
Layer thickness	2	10 (T_{10}) and 20 (T_{20}) cm
Addition Rate	12	- Biochar 1% - Biochar 2% - Biochar 3% - Biochar 4% - Compost 1% - Compost 2% - Compost 3% - Compost 4% - Biochar 0.5% + Compost 0.5% - Biochar 1% + Compost 1% - Biochar 1.5% + Compost 1.5% - Biochar 2% + Compost 2%
Replicates	3	*(%) mix rates by weight*
Total number of experimental units = 2 × 12 × 3 = 72 + 5 control = **75** columns		

* Date palm Biochar
* Commercial Compost
* Particle size : > 2 mm
* The materials mixed with sandy soil:
  1- biochar + soil
  2- compost + soil
  3- (biochar-compost) + soil



Biochar

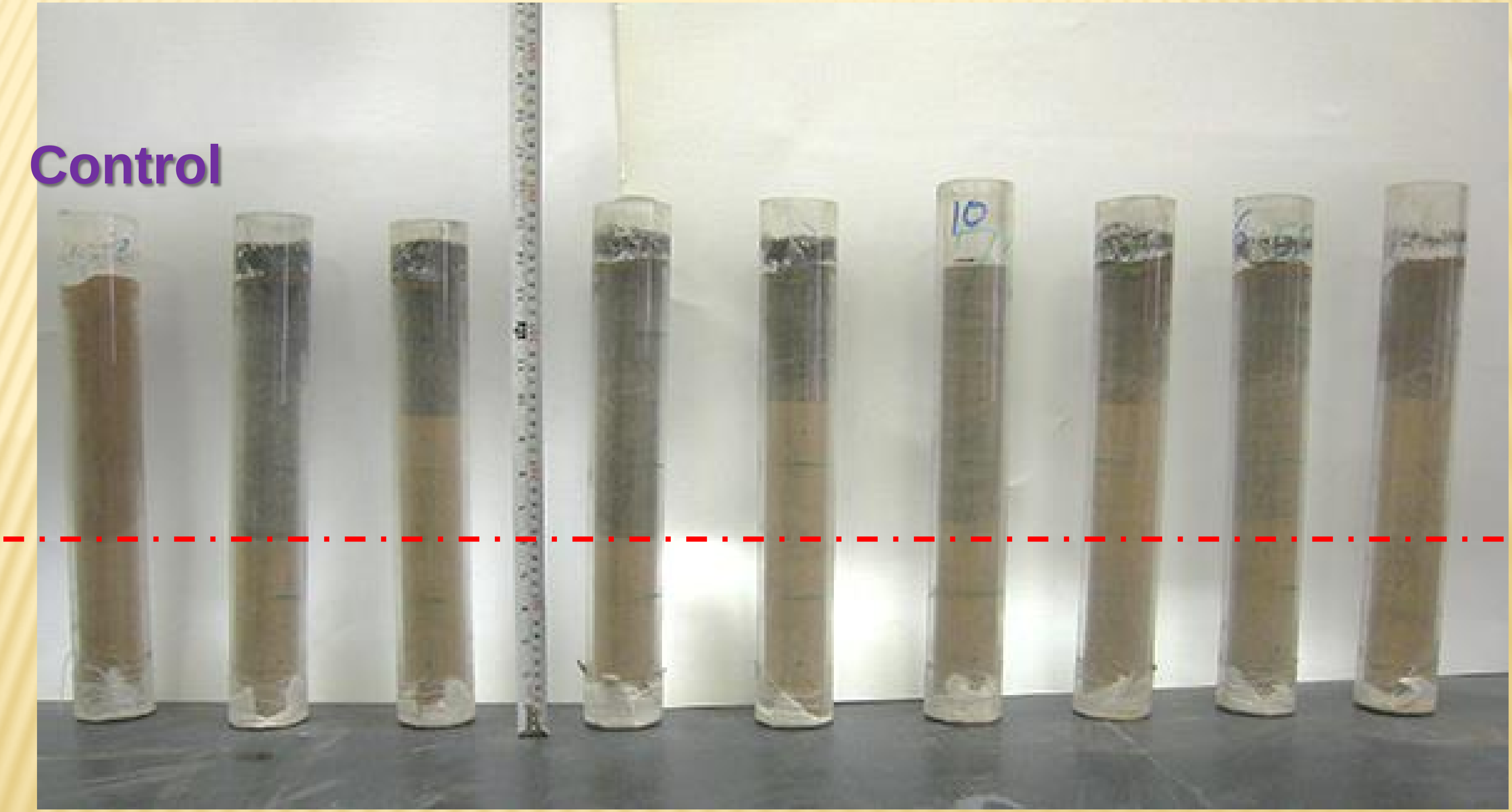


Preparing the columns

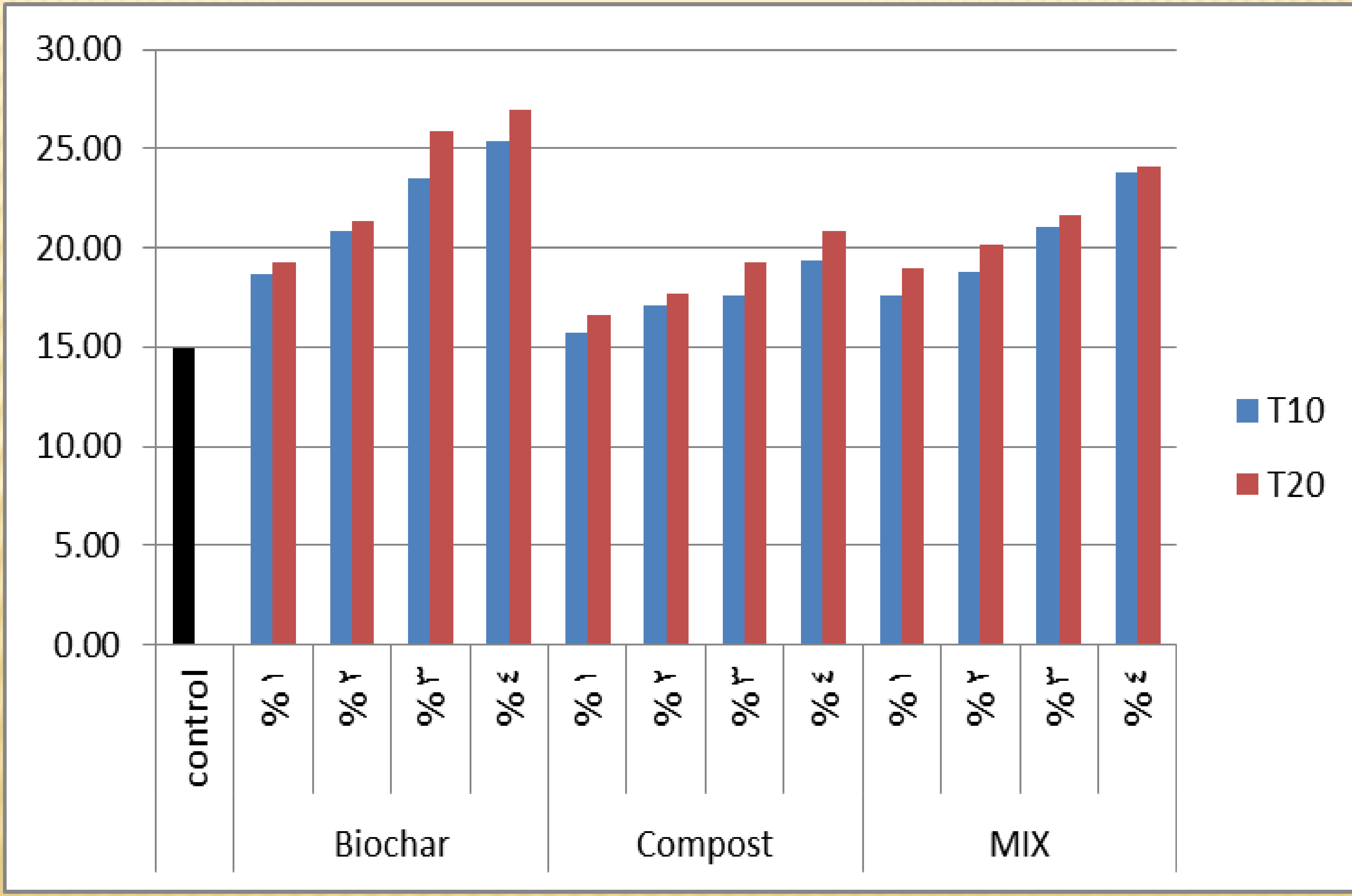
35 cm

Control Columns

BIOCHAR - COMPOST LAYER

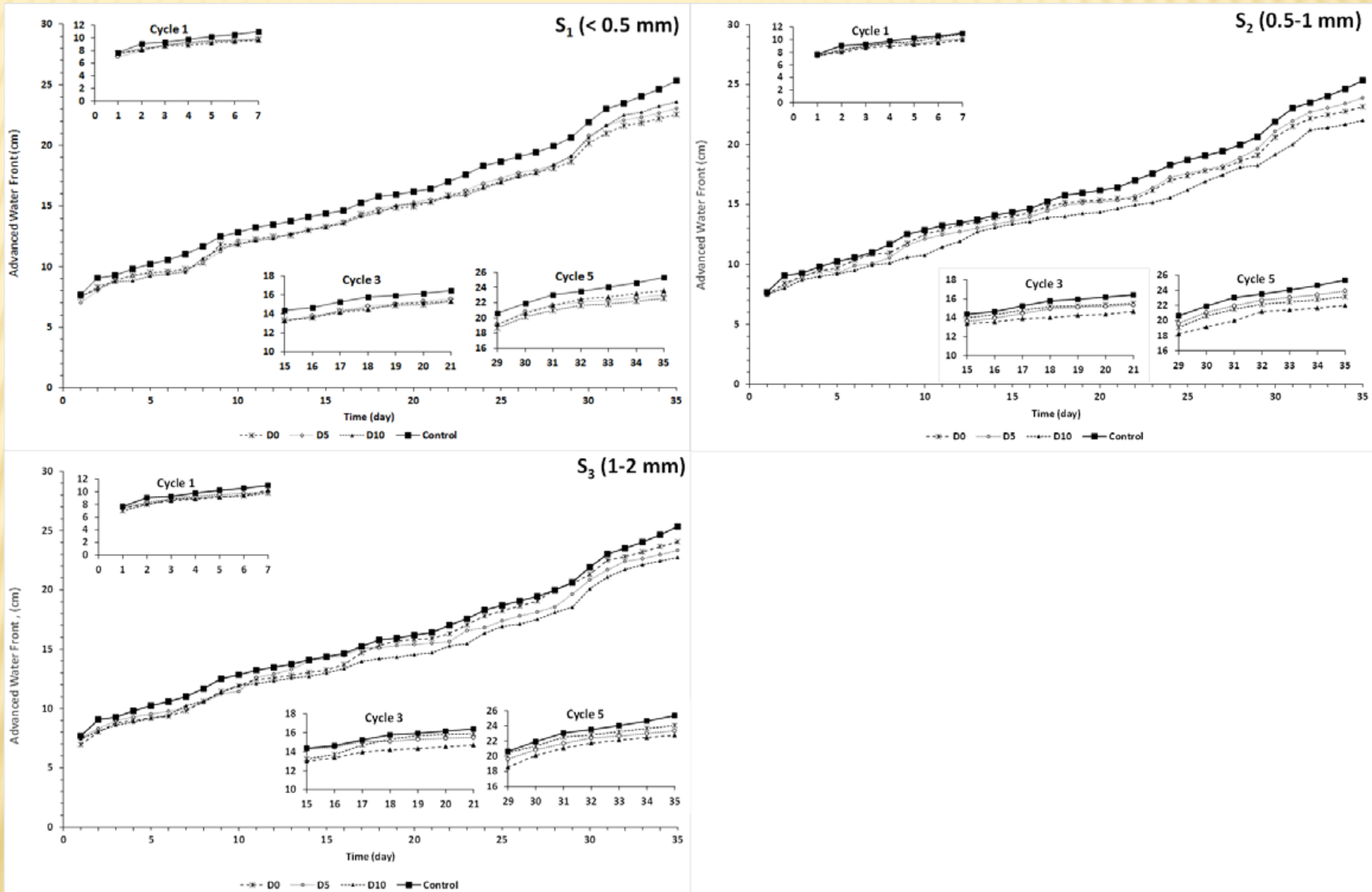


Water Holding Capacity



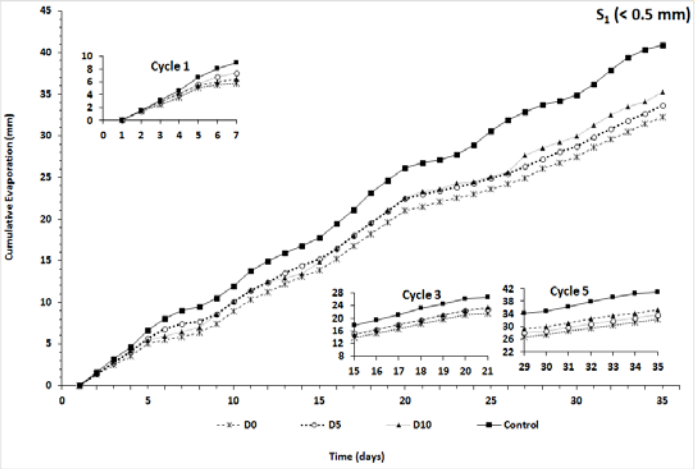
BIOCHAR AND SOIL PHYSICAL PROPERTIES

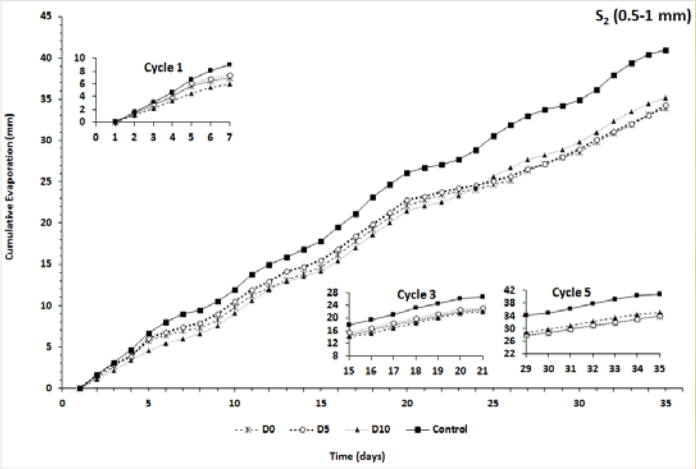
- Influence of biochars on advanced water front

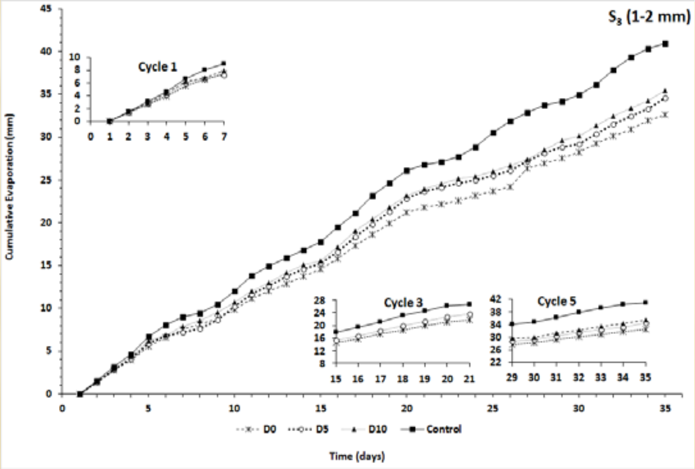


BIOCHAR AND SOIL PHYSICAL PROPERTIES

- Infleunce of biochars on cumulative evaporation

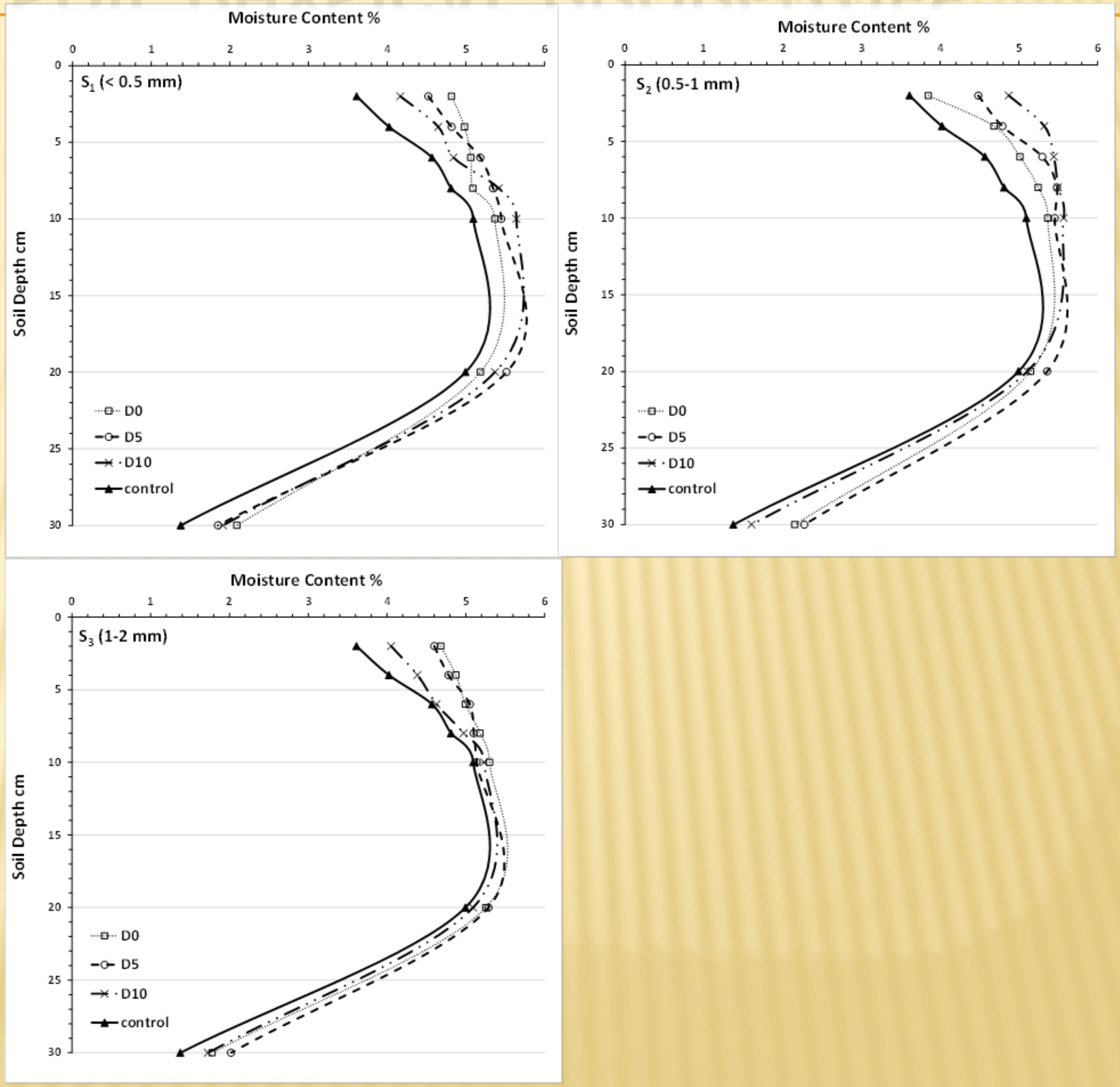






BIOCHAR AND SOIL PHYSICAL PROPERTIES

- Infleunce of biochars on soil moisture content

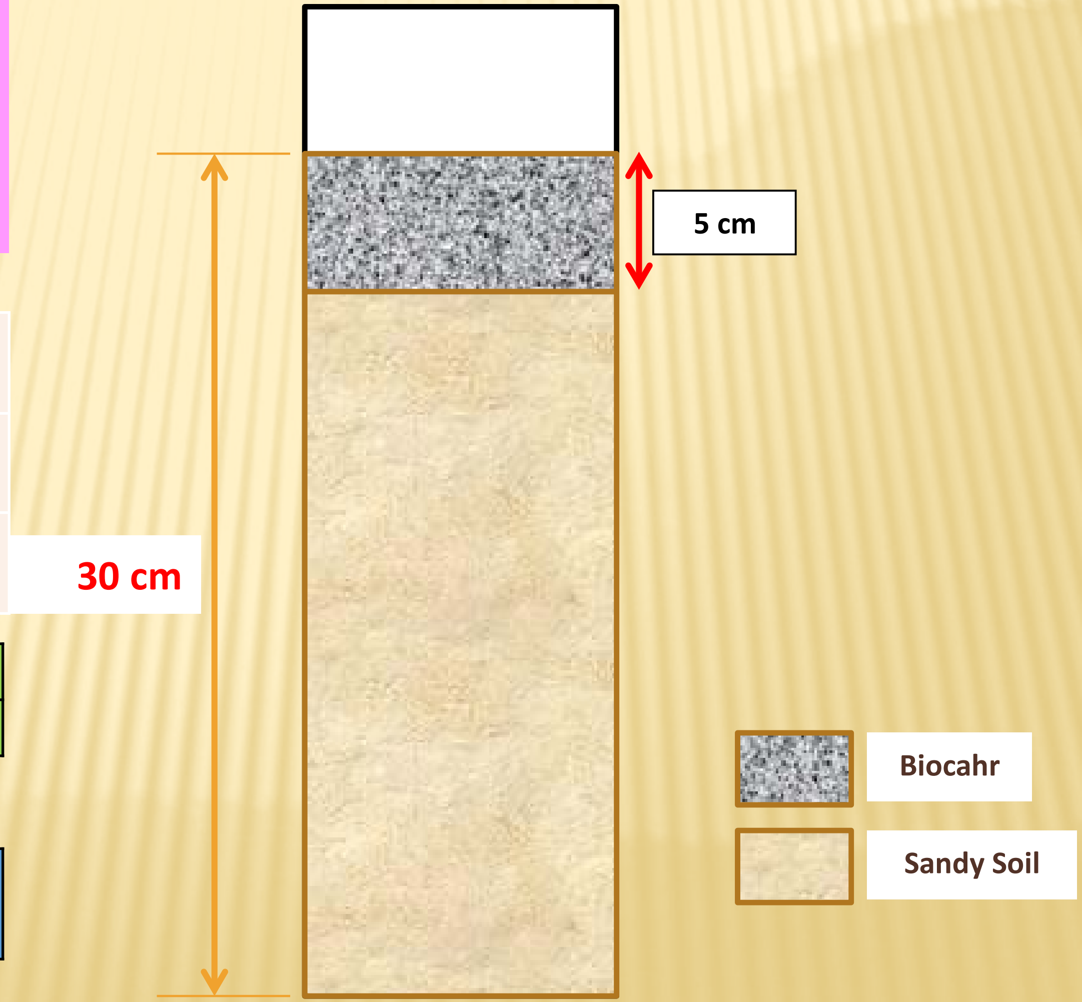


T_{300}	300 C
T_{500}	500 C
T_{700}	700 C

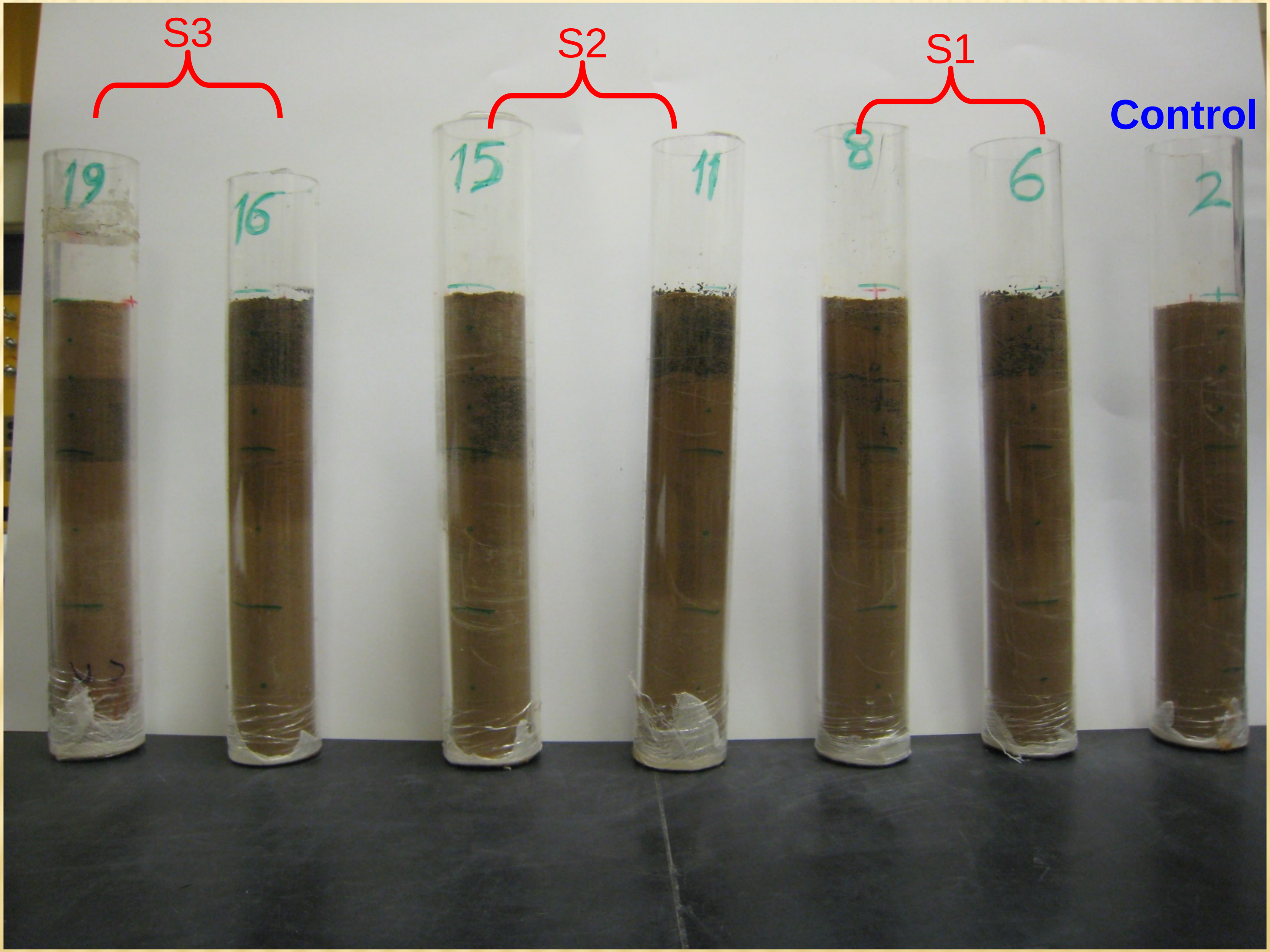
S_1 =	(1 - 2) mm
S_2 =	(0.5 - 1) mm
S_3 =	(0.25 - 0.5) mm

Soil Density =	1.5 gm/cm3
Layer Thikness =	5 cm

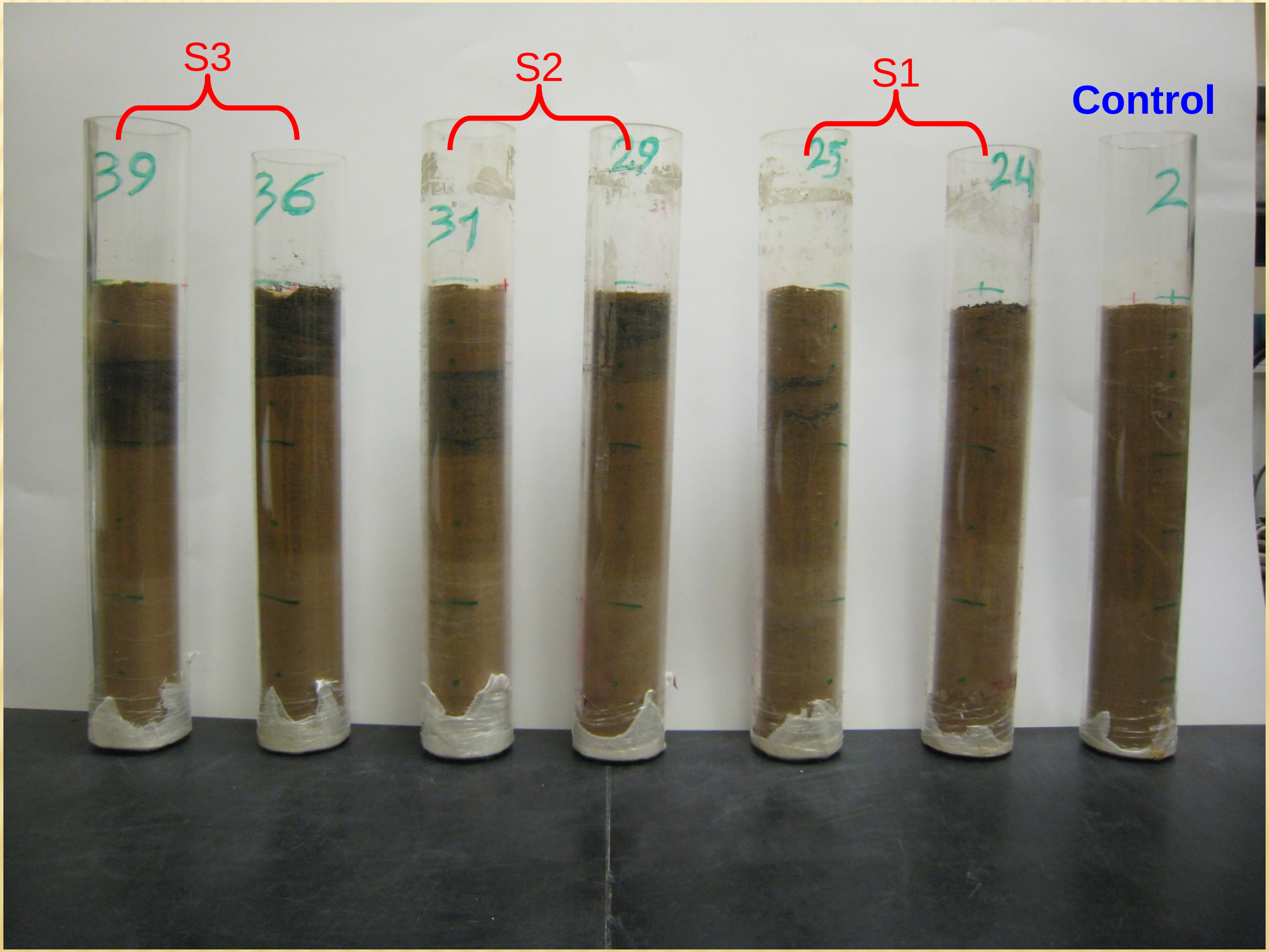
Application Depth	
D1 (surface)	0 cm
D2	5 cm



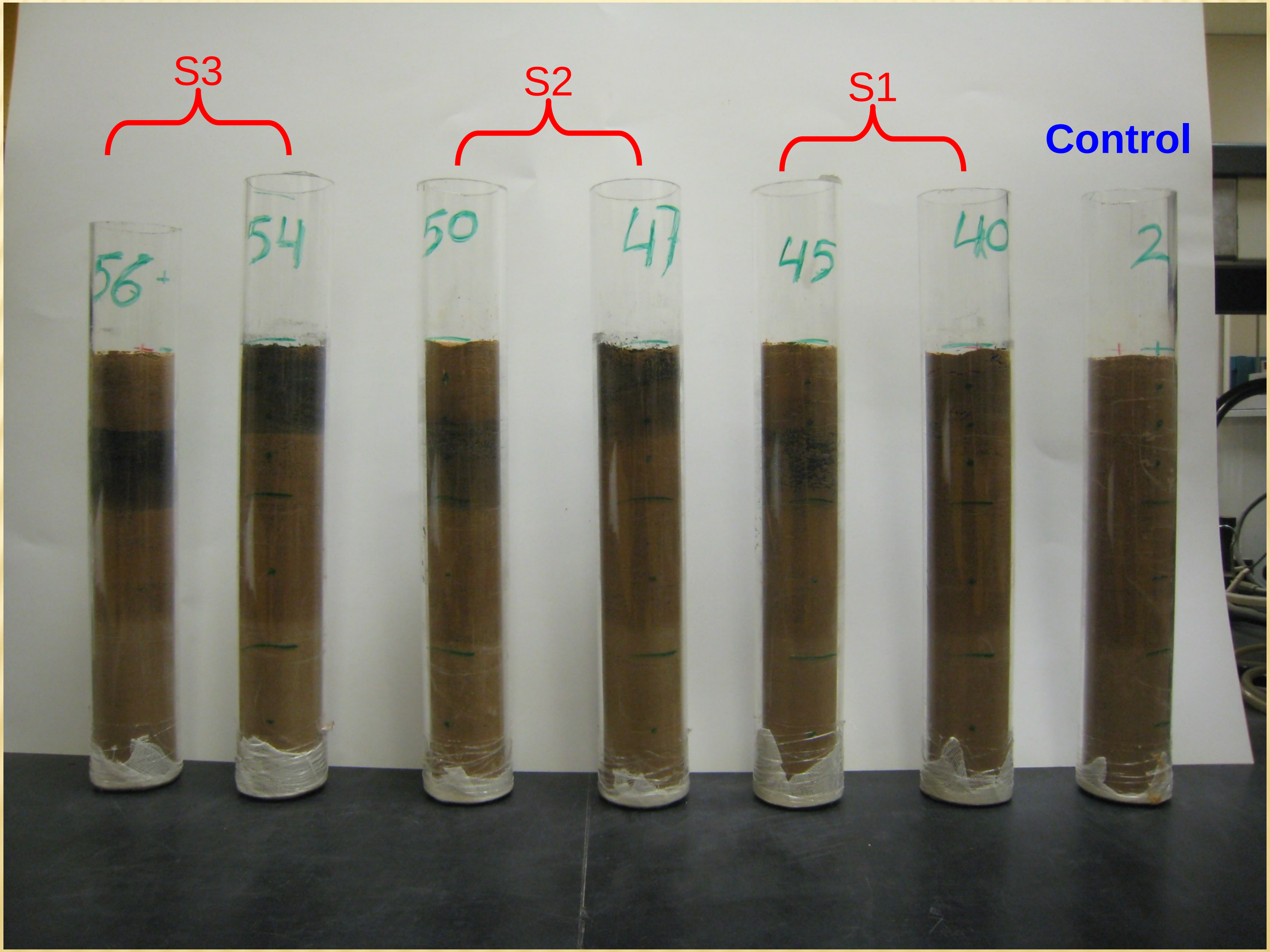
T300



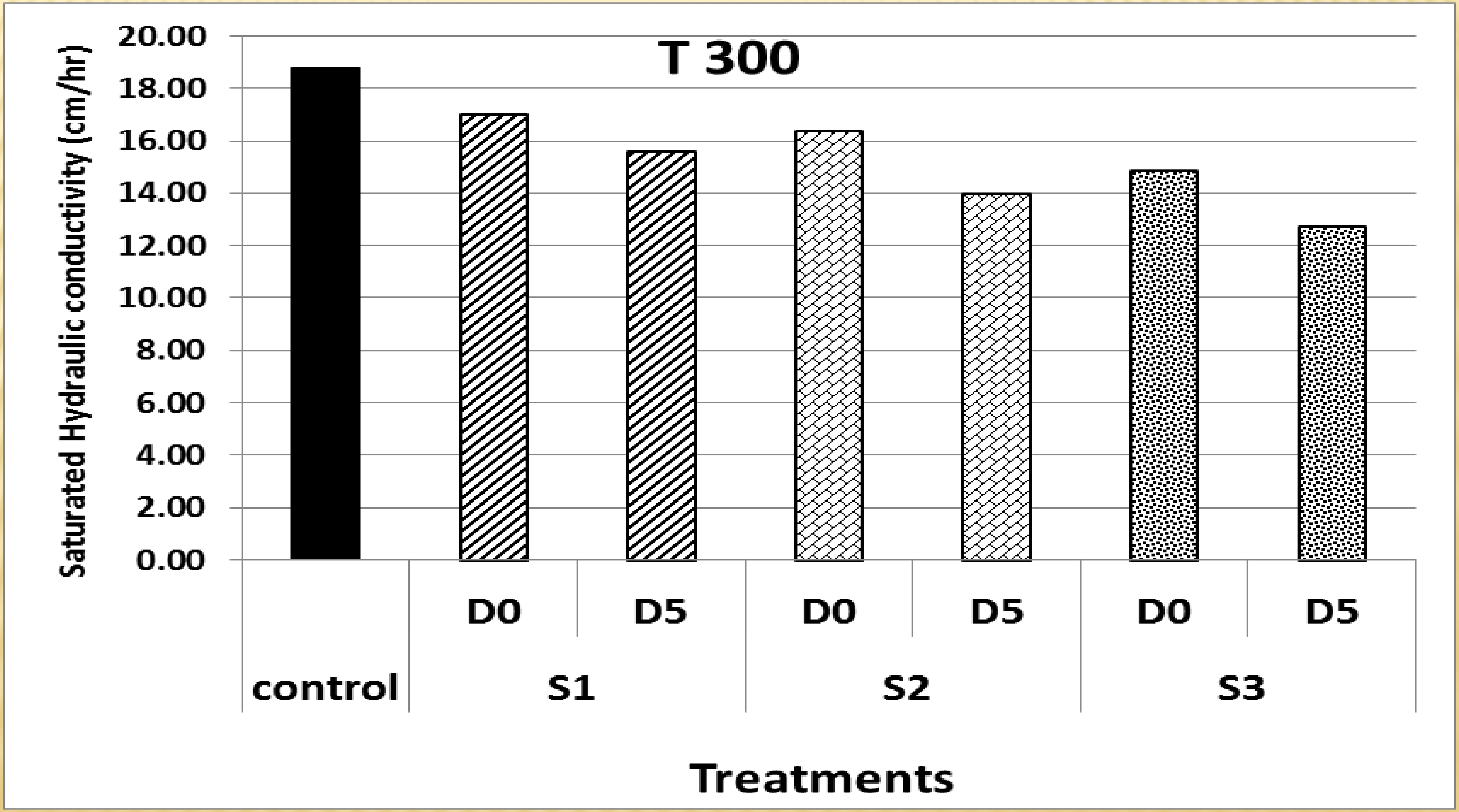
T500

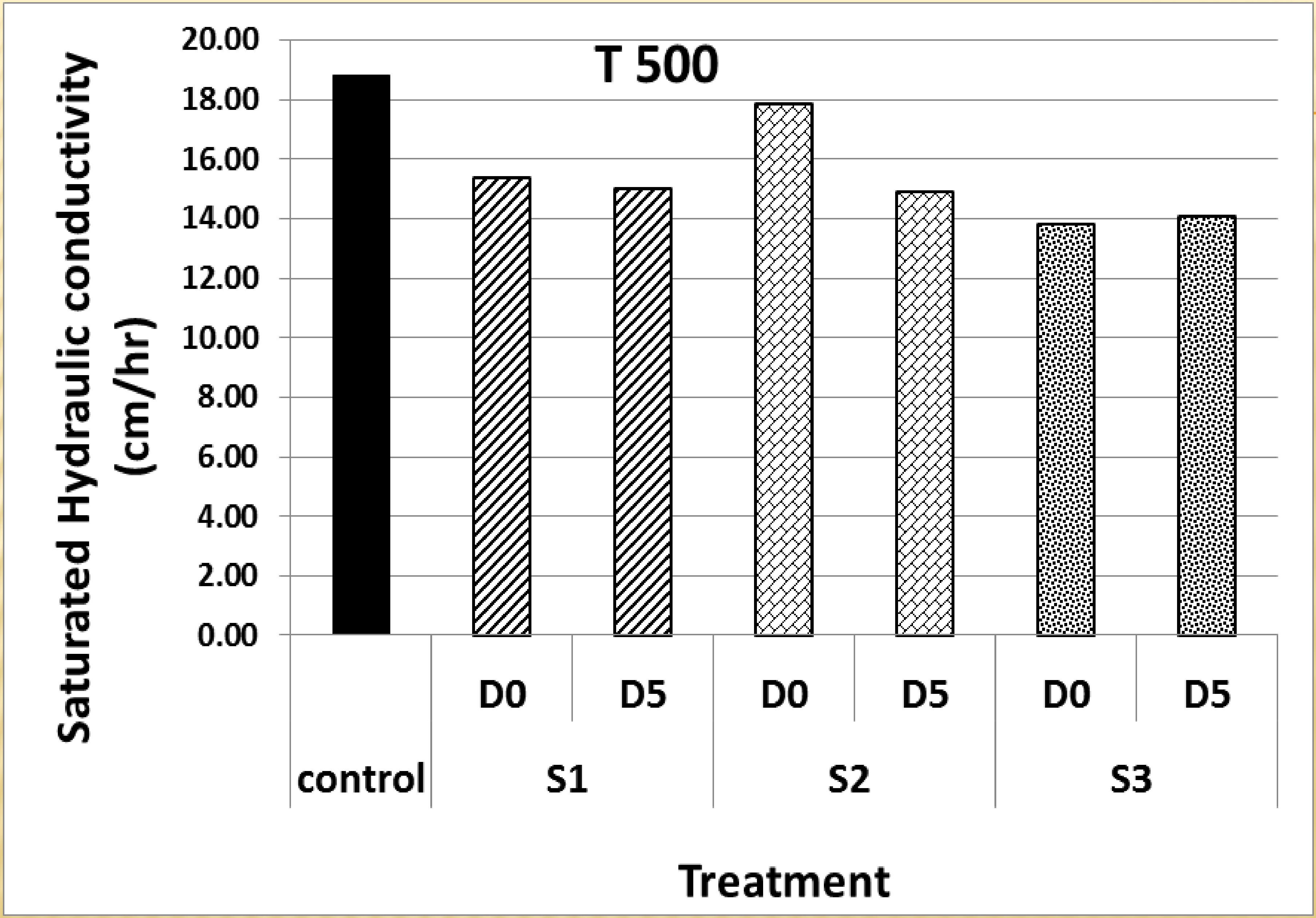


T700



Saturated Hydraulic Conductivity




T 500
Saturated Hydraulic conductivity (cm/hr)
20.00
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
D0
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D0
D5
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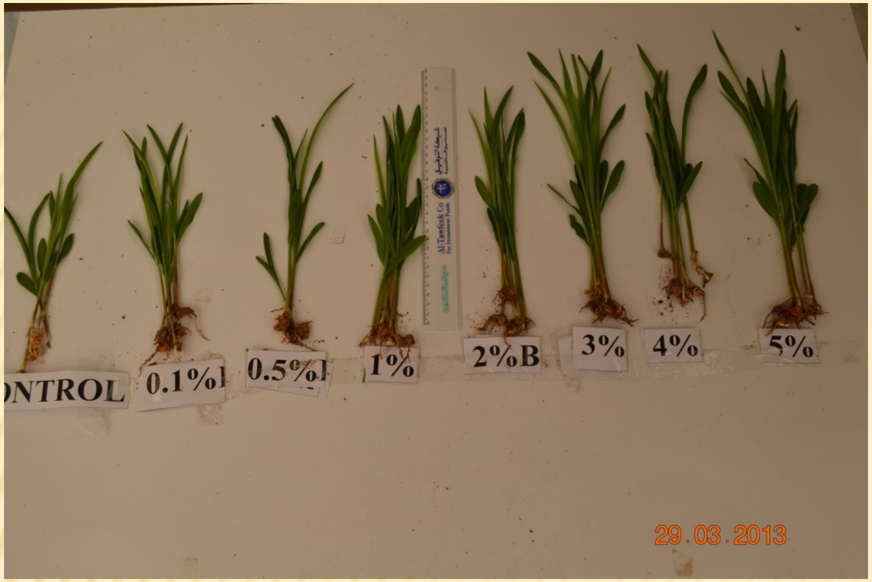
D5
control
S1
S2
S3
Treatment


ONTROL
0.1%
0.5%
1%
2%B
3%
4%
5%
29.03.2013

26.03.2013

BIOCHAR INDUCED CHANGES IN THE YIELD AND QUALITY OF TOMATO PLANTS

Treatments effects on plant growth, quality and yield of tomato plants

Treatments		Plant height (cm)	Plant fresh weight (g)	Plant dry weight (g)	No. fruits/plant	Fruit fresh weight (g)	Fruit dry weight (g)	Fruit length (cm)	Fruit diameter (cm)	Total yield (ton/ha)
Non-Saline water	Control	187.3	1461.7	147.3	76.7	159.6	6.9	6.7	7.0	244.733
	Biochar 4%	191.7	1568.3	158.3	82.0	166.7	9.1	7.3	7.4	273.400
	Biochar 8%	202.3	1769.0	186.0	81.3	180.8	9.6	7.8	8.2	294.133
	Farm residue 4%	189.7	1518.3	151.7	78.3	160.1	8.4	6.7	6.8	250.867
	Farm residue 8%	198.0	1630.3	175.7	80.7	171.9	9.5	7.5	7.7	277.333
Mean		193.8	1589.5	163.8	79.8	167.8	8.7	7.2	7.42	268.093
Saline water	Control	153.0	1032.0	118.3	61.0	124.4	5.1	5.4	5.5	151.800
	Biochar 4%	164.3	1254.7	131.3	68.3	126.7	5.2	5.8	5.9	173.133
	Biochar 8%	171.7	1358.3	143.0	70.0	155.4	5.9	6.2	6.3	217.600
	Farm residue 4%	156.7	1131.3	125.0	64.7	121.9	5.1	5.5	5.6	157.733
	Farm residue 8%	168.7	1284.7	134.3	69.7	147.7	5.5	6.1	6.3	205.800
Mean		162.88	1212.2	130.38	66.74	135.22	5.36	5.8	5.92	181.213
LSD^1		1.44	6.44	1.5	0.74	0.96	0.066		0.074	0.89
LSD^2		1.65	5.57	1.62	0.89	1.99	0.068	0.092	0.096	1.19
LSD_3		2.81	9.48	2.71	1.52	3.4	0.116	0.156	0.163	2.02

BIOCHAR INDUCED CHANGES IN THE YIELD AND QUALITY OF TOMATO PLANTS

Treatments effects on acidity, vitamin C and TSS of tomato fruits

Treatments		Acidity	Vitamin C	TSS %
Non-Saline water	Control	0.45760	25.0	5.5
	Biochar 4%	0.54753	25.0	6.4
	Biochar 8%	0.57856	28.3	6.4
	Farm residue 4%	0.51263	23.0	6.1
	Farm residue 8%	0.54780	26.0	6.5
Mean		0.528824	25.46	6.18
Saline water	Control	0.65657	28.7	6.2
	Biochar 4%	0.63900	29.0	6.7
	Biochar 8%	0.61520	27.7	5.8
	Farm residue 4%	0.64943	29.3	6.8
	Farm residue 8%	0.64093	29.0	6.4
Mean		0.640226	28.74	6.38
LSD_1		0.007	0.614	0.118
LSD_2		0.001	1.111	0.0698
LSD_3		0.032	1.89	0.119

CONCLUSIONS

- Date Palm biochar application improved hydro-physical properties of sandy loam soil
- applying biochar restricted the movement of water penetrability as a result of decreasing the advancing waterfront, infiltration rate and saturated hydraulic conductivity.
- By contrast, the biochar addition caused significant increases in the amount of conserved and retained water compared to control soil. These results are more obvious with low temperature produced biochar and particle size of less than 1mm with no addition of compost.
- Applying biochar to coarse-textured soils irrigated with saline and non-saline water has potential impacts on increasing the vegetative growth, yield and chemical parameters of tomato.
- Therefore, under arid conditions having water shortage and limited water quality, biochar might be a promising amendment

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- Thanks and any questions.