

Controlling Biochar Properties for Quality, Beautiful, and Resilient Turf

USBI Biochar 2018 Conference

Chase Center on the Riverfront
Wilmington, DE
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Cool Planet

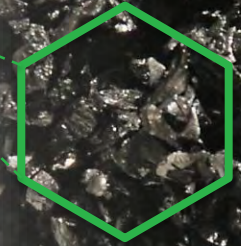
Biochar - carbon-enriched product from pyrolysis of biomass

BIOMASS → PYROLYSIS → BIOCHAR

**High Heat
(300-800+ C)
without Oxygen**



Biomass selection, pyrolysis conditions,
and other factors impact the quality of
biochar



Biochar – The Promise and Potential

Multiple benefits of biochar have been touted

- **Improve soil health**
- **Increase crop yields**
- **Protect water quality**
- **Sequester carbon/mitigate climate change**



Biochar – Environmental Solution or Snake Oil?

coolplanet

Biochar - The new frontier

The bright prospect of biochar

Biochar is amazing stuff

Can Biochar Help Save the World?



By Ron Dembo

BY PEEI DANKO / BIOFUELS, RENEWABLE ENERGY / OCTOBER 15, 2013

NOT SO FAST WITH THE BIOCHAR, SCIENTISTS SAY

Biochar: Black Gold or Just Another Snake Oil Scheme?

most promising developments in our fight against climate change. At the new website, <http://www.newcarboneconomy.info>, you can find out about biochar and



Soil carbon is a key component of soil health

Soil carbon comes in many forms and each play an important role



Labile

- Compost and manure
- Nutrient rich
- Highly degradable
- Short-lived



Humic

- Humus
- Humic / fluvic acids
- Complex organic compounds
- Degradable



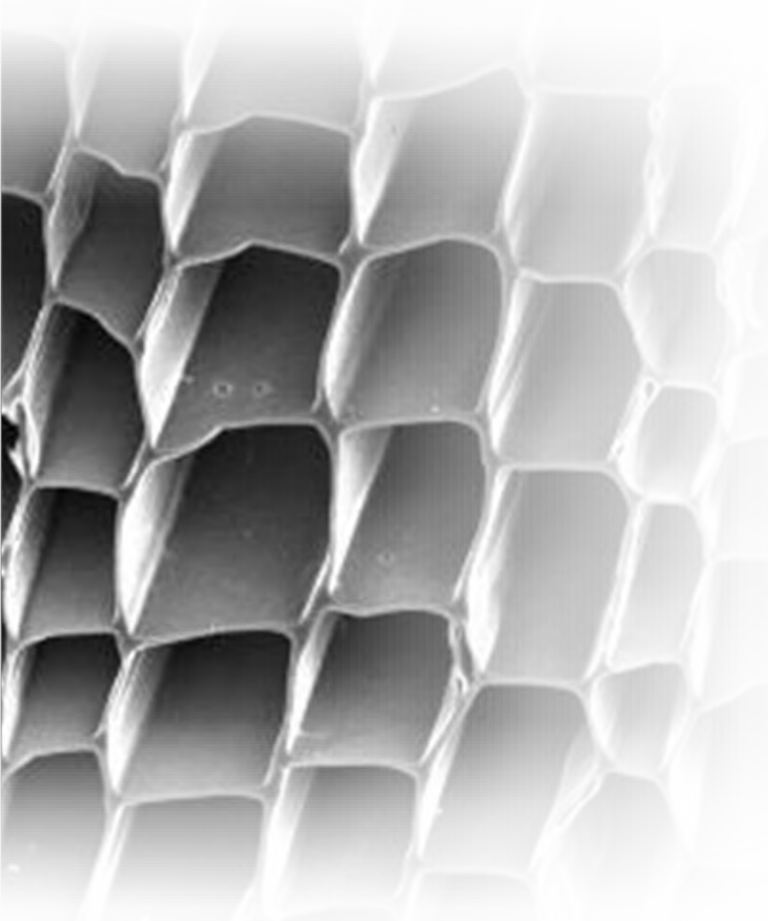
Recalcitrant

- Mostly pyrogenic
- Structural
- Fixed Carbon
- Long-lasting (100+ years)

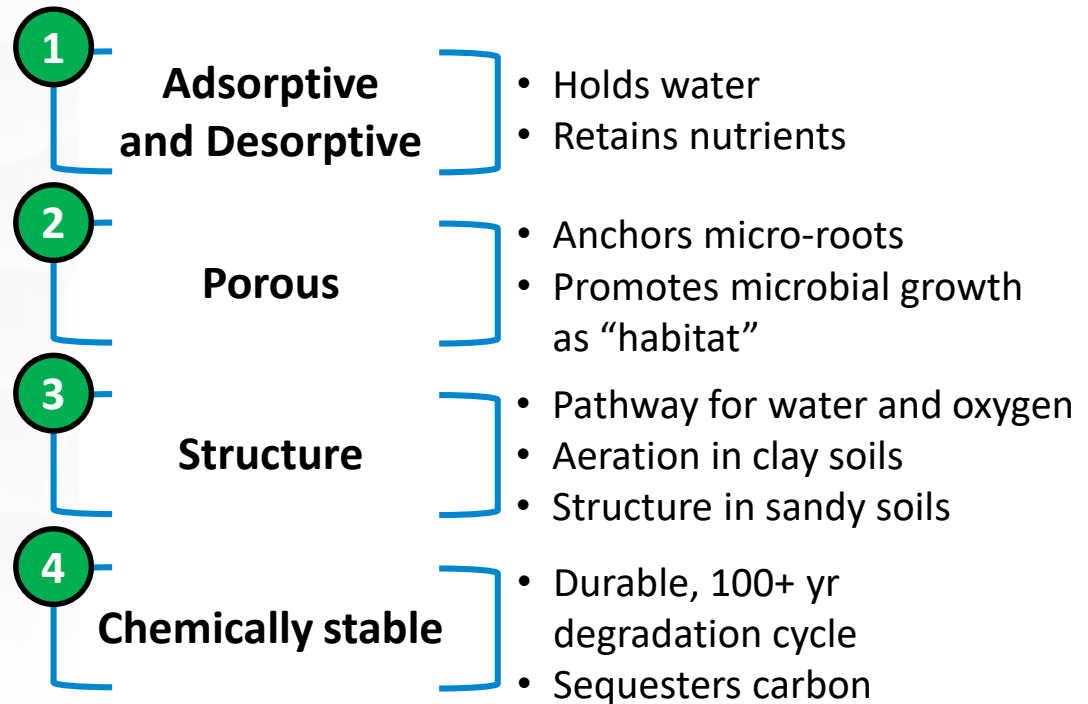
These three types of carbon can complement each other



Recalcitrant fixed carbon has the potential to address a range of soil issues...



Features & Benefits of recalcitrant carbon



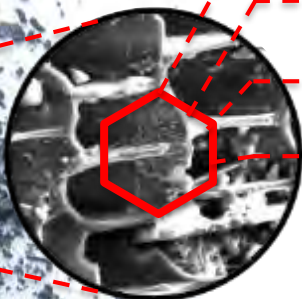
Cool Terra Structure under a scanning electron microscope

...but raw biochar has historically proven inconsistent

Historically, biochar has been inconsistent, due to lack of understanding of key properties and production process

Key physical and chemical properties

- High pH levels
- High phytotoxic concentration
- Low pore capacity
- Low process control

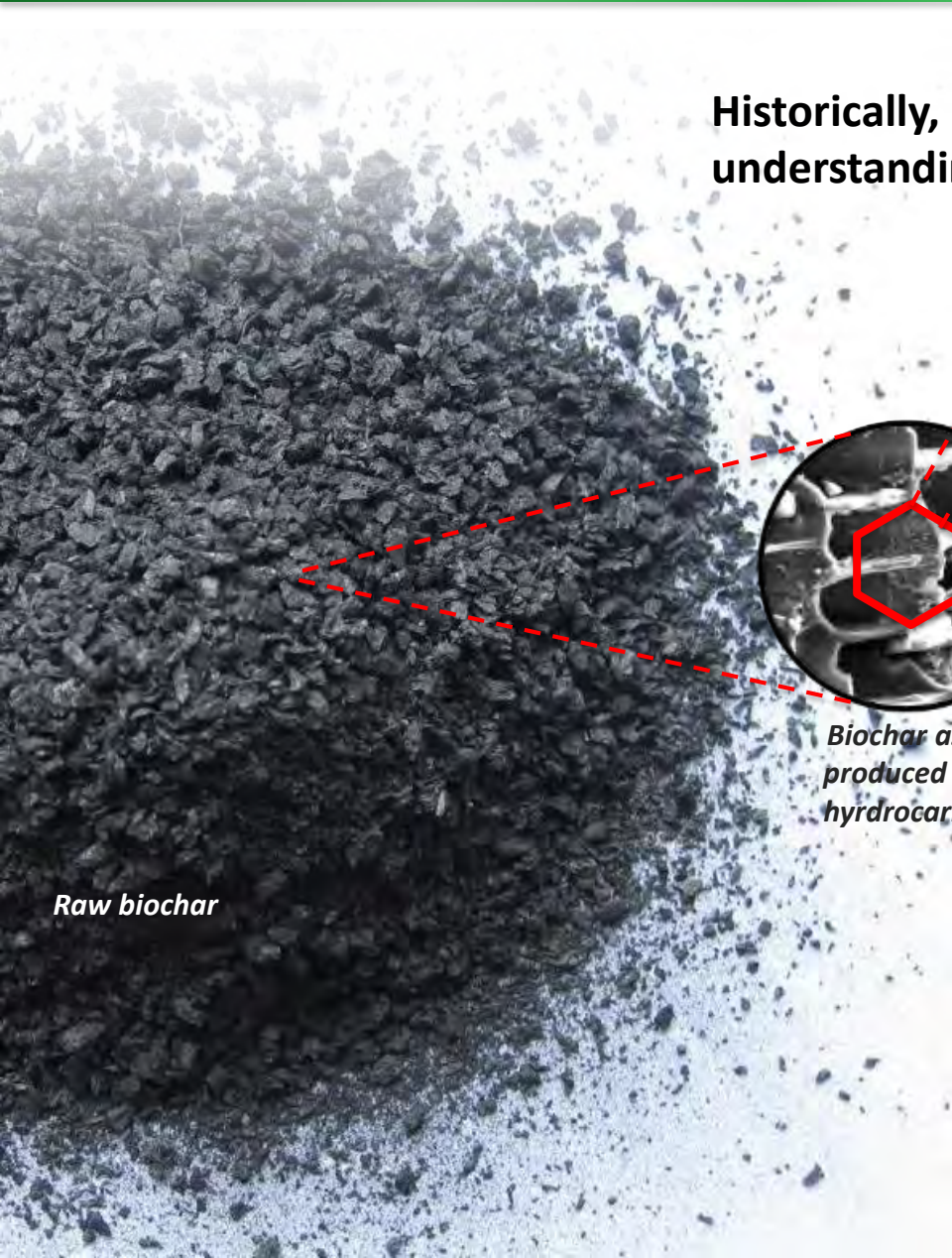


Biochar as co-produced with hydrocarbons

Can lead to inconsistent results

- Degraded elements of soil health
- Decreased crop productivity & plant health

Raw biochar



All Biochars Are NOT Created Equal!

The key properties of biochar are determined by:

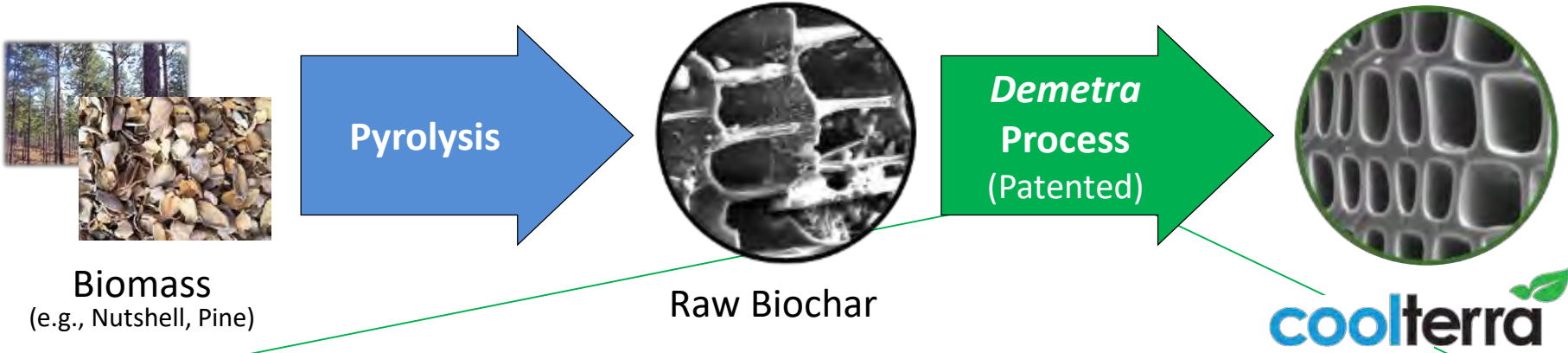
- 1 Source & quality of feedstock used
- 2 Pyrolysis type & conditions
- 3 Post-Pyrolysis treatment, *if any*

Biomass selection, pyrolysis conditions, and other factors impact the quality and performance of biochar!



Our Differentiator: Cool Terra® is Engineered Biocarbon™ Technology

Pyrolysis expertise and patented 'Demetra' process designed to maximize consistency & effectiveness



- ✓ **Modify surface chemistry** – Optimizing pH, ion exchange and hydrophilicity
- ✓ **Detoxify Raw Biochar** – Micropores cleaned to eliminate toxicity
- ✓ **Maximize Capacity** – Improves input holding capacity in pores
- ✓ **Sized for soil** – Consistent particle sizes designed for consistent results

<https://www.coolplanet.com/cool-terra/how-it-works/>

Cool Terra® Engineered Biocarbon™ Technology

A consistent and durable soil revitalizer



Engineered Biocarbon™ Technology



Fixed Carbon

Consistent

Durable

Granular

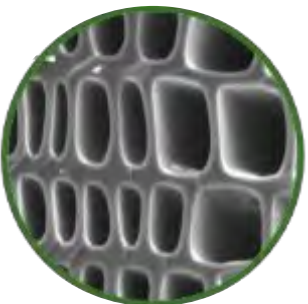
- Made from organic biomass biochar and treated to ensure consistency, quality, and performance
- Works in a complementary fashion to other soil carbons, but resists breaking down biologically over time

This means it will stay in your soil and maintain its physical, chemical, and biological properties over many years



Cool Terra® Engineered Biocarbon™ Technology

Modern science and engineering applied to biochar



Biochar

Predictable characteristics and performance	High variability
Processed to eliminate compounds which negatively impact plant growth	Potentially contains phytotoxins or other problematic compounds (dioxins)
Hydrophillic: Ready-to-use immediately	Hydrophobic: May need 'aging' to utilize
Low dust, higher crush strength	High dust content, low crush strength
Designed to flow through most common application equipment	Difficult to apply: flowability issues / large variability in particle sizes
Low application rates	High application rates

Proprietary process transforms biochar into a consistent, durable, and stable soil revitalizer



Cool Terra® Engineered Biocarbon™ Technology

Revitalizes the soil through physical, chemical & biological mechanisms



PHYSICAL



ENHANCE SOIL STRUCTURE

- **High porosity** benefits water and nutrient holding
- **Expansive surface area** creates free air space in heavy soil and can improve infiltration
- **Water holding capacity** improves plant available water and reduces evaporative loss in highly evaporative soils

CHEMICAL



ENHANCE NUTRIENT EFFICIENCY

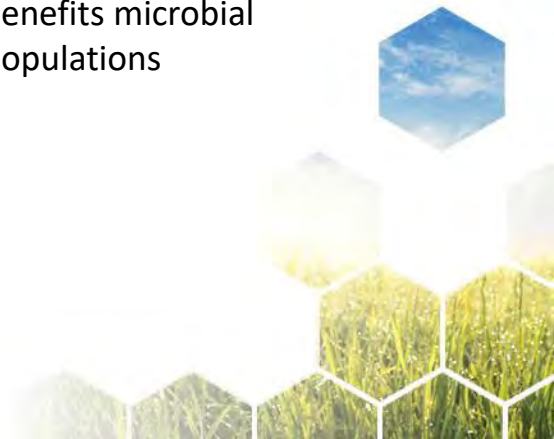
- **High ion (CEC and AEC) exchange capacity** can promote nutrient exchange and availability – holding nutrients in the root zone longer
- **Porous structure** of recalcitrant carbon can delay leaching – giving plants more time to use nutrients

BIOLOGICAL



ENHANCE MICROBIAL ACTIVITY

- **Strong and durable cell walls** enhance the structural habitat for microbes
- **Neutral pH** provides optimal microbial environment
- **Pore-size distribution** benefits microbial populations

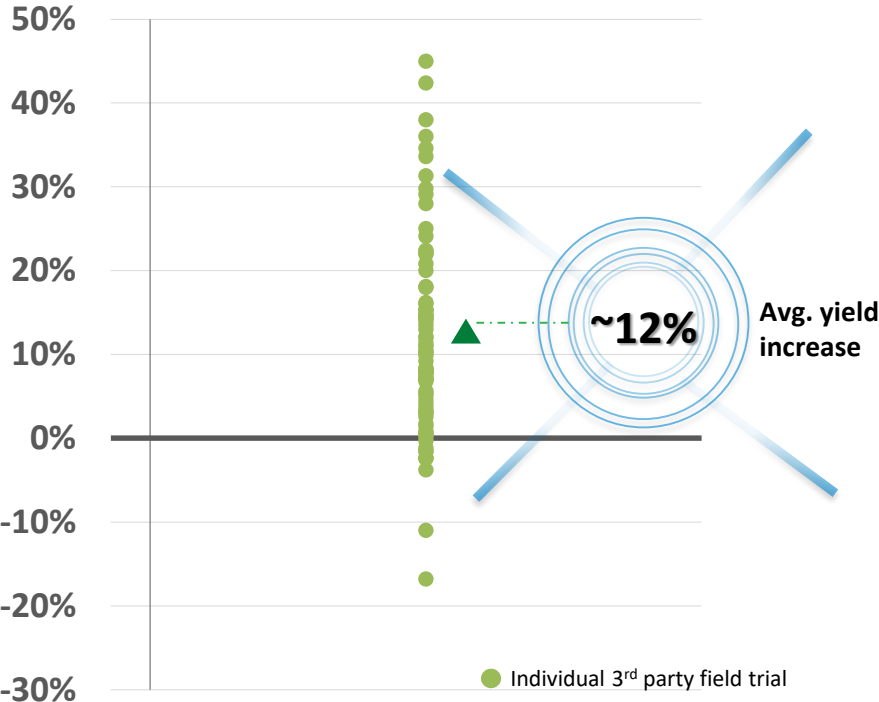


Cool Terra® Engineered Biocarbon™ Technology

100+ independent field trial results have shown consistent yield increases



Improvement in marketable yield (%) Cool Terra vs. control



Trials have shown average yield increase of ~12% with greater than 3:1 grower ROI

Trial result highlights

Results vs. grower standard (typical levels of water and fertilizer)



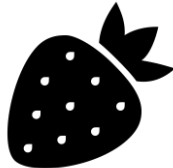
KS: 8% Increase
Corn bushels / acre
1 year ROI: 4x



OR: 15% Increase
Wheat lbs / acre
1 year ROI: 5x



FL: 9.2% Increase
Tomato lbs / acre
1 year ROI: 5.1x



CA: 42% Increase
Strawberry flats / acre
1 year ROI: 18x



OR: 35% Increase
Potato lbs / acre
1 year ROI: 4.9x

Includes results from 90 field trials that produced data on marketable yield for treated vs. grower standard control in 2016 and 2017

Cool Terra® Impact on Turf Establishment & Quality

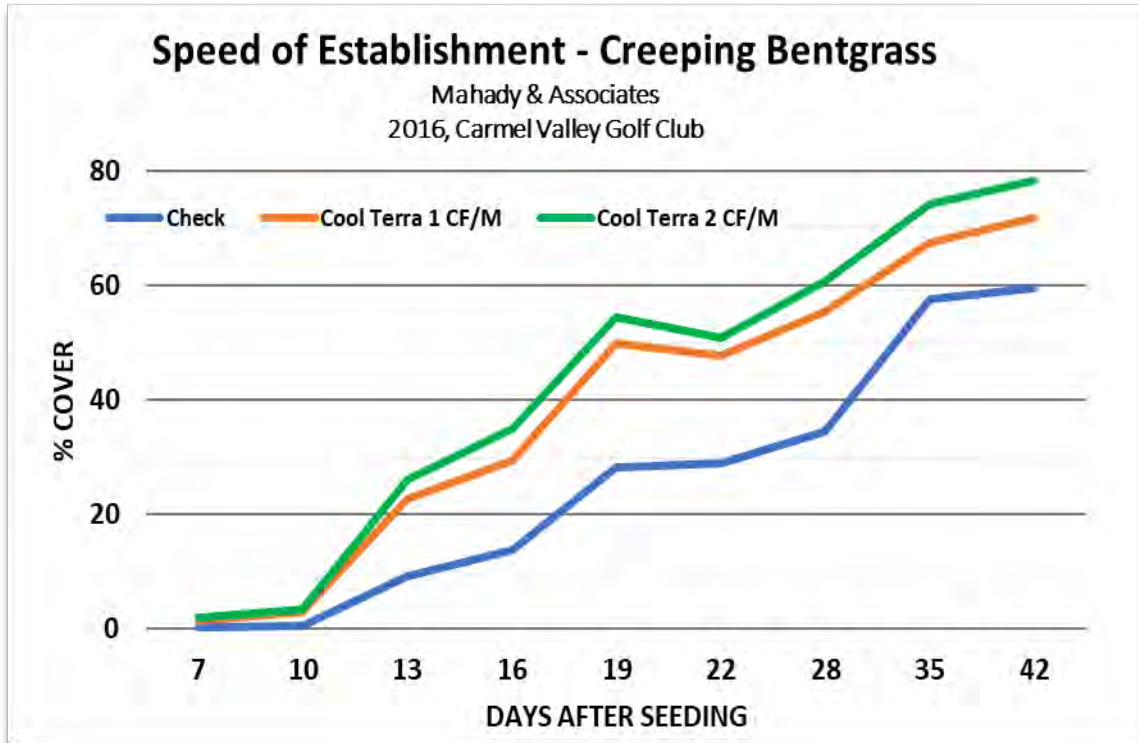


Impact of Cool Terra on Establishment & Quality of T-1 Creeping Bentgrass

Trial Description	
Trialist	Mark Mahady & Associates
Location	Carmel Valley Ranch Golf Club, Carmel, CA
Trial Initiation	September 12, 2016
Plot Description	9' X 8' plots, 4 replications
Objective	Evaluate Cool Terra for enhancement of speed to cover, rapid establishment and improved surface quality of a newly seeded T-1 creeping bentgrass putting green
Evaluations	Speed of Establishment (% Cover), Turf Quality (visual rating, 0 to 10 scale)

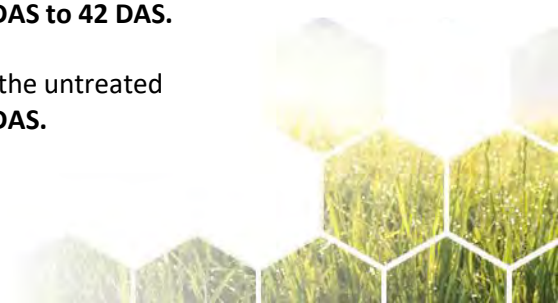


Cool Terra® Impact on Turf Establishment

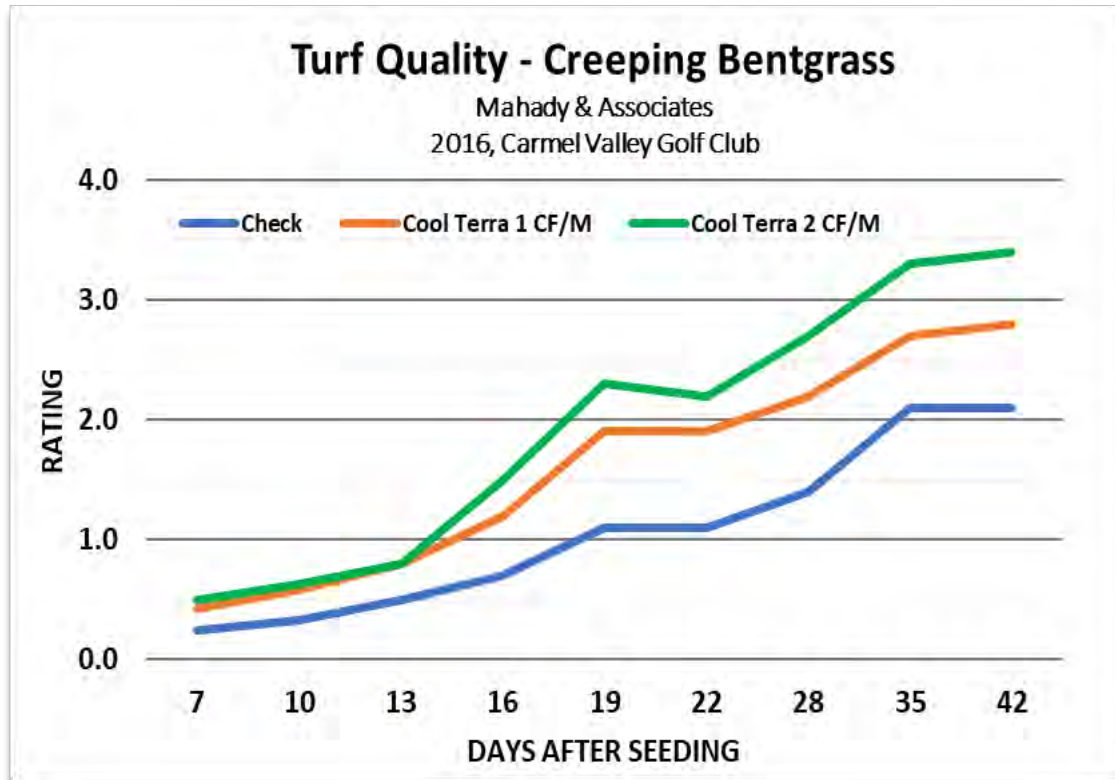


% COVER					
DAS	Check	CT 1 CF/M	% diff	CT 2 CF/M	% diff
7	0.26	1.55	596.2%	2.13	819.2%
10	0.60	3.00	500.0%	3.43	571.7%
13	9.25	22.75	245.9%	26.00	281.1%
16	13.75	29.50	214.5%	35.00	254.5%
19	28.25	50.00	177.0%	54.50	192.9%
22	29.00	47.75	164.7%	50.75	175.0%
28	34.50	55.50	160.9%	60.75	176.1%
35	57.50	67.50	117.4%	74.25	129.1%
42	59.50	71.75	120.6%	78.25	131.5%

- **Cool Terra 1 cf/1000 ft² (M)** exhibited enhanced speed to cover of creeping bentgrass when compared to the untreated fertilized check. **Differences were statistically significant on 7 of 9 evaluation dates from 7 DAS to 42 DAS.**
- **Cool Terra 2 cf/M** exhibited greatly enhanced speed to cover of creeping bentgrass when compared to the untreated fertilized check. **Differences were statistically significant on 9 of 9 evaluation dates from 7 DAS to 42 DAS.**



Cool Terra® Impact on Turf Quality



TURF QUALITY					
DAS	Check	CT 1 CF/M	% diff	CT 2 CF/M	% diff
7	0.3	0.4	172.0%	0.5	200.0%
10	0.3	0.6	175.8%	0.6	190.9%
13	0.5	0.8	160.0%	0.8	160.0%
16	0.7	1.2	171.4%	1.5	214.3%
19	1.1	1.9	172.7%	2.3	209.1%
22	1.1	1.9	172.7%	2.2	200.0%
28	1.4	2.2	157.1%	2.7	192.9%
35	2.1	2.7	128.6%	3.3	157.1%
42	2.1	2.8	133.3%	3.4	161.9%

- **Cool Terra 1 cf/1000 ft² (M)** exhibited enhanced creeping bentgrass quality when compared to the untreated fertilized check. **Differences were statistically significant on 7 of 9 evaluation dates from 7 DAS to 42 DAS.**
- **Cool Terra 2 cf/M** exhibited greatly enhanced creeping bentgrass quality when compared to the untreated fertilized check. **Differences were statistically significant on 9 of 9 evaluation dates from 7 DAS to 42 DAS.**



Cool Terra® Impact on Turf Establishment & Quality



Establishment @ 13 Days After Seeding

Mahady & Associates

2016, Carmel Valley Golf Club



Cool Terra® Impact on Turf Establishment & Quality



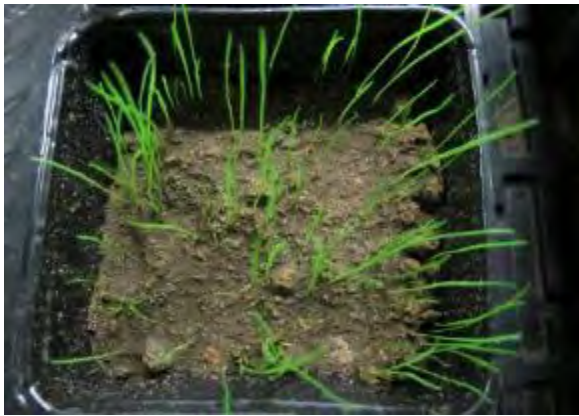
Cool Terra® Impact on Turf Establishment



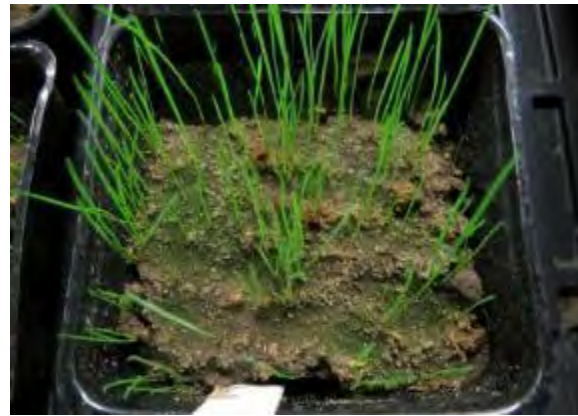
Speed of Establishment - Tall Fescue

Cool Planet R&D Plant Lab
Camarillo, CA

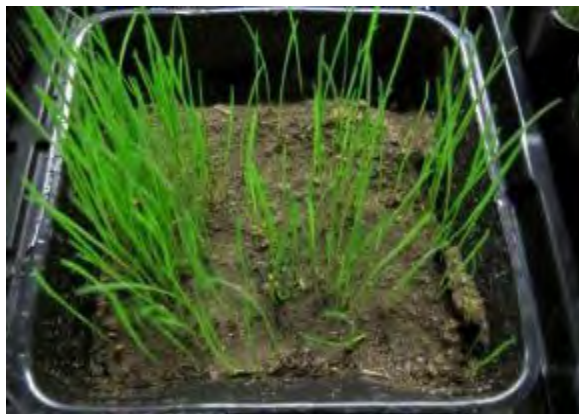
Control 1
(No Fertilizer)



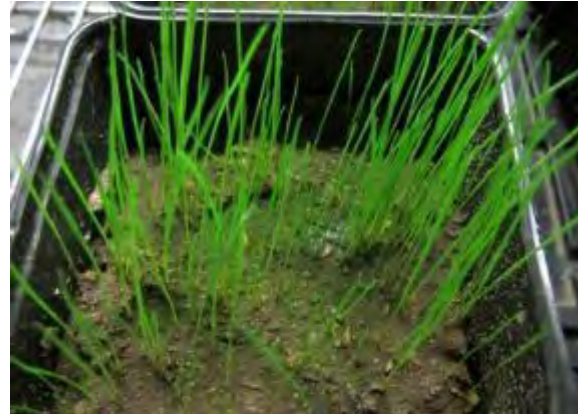
Control 2
+ Fertilizer



coolterra
Applied with
Seed
(No Fertilizer)



coolterra
Applied with
Seed
+ Fertilizer



Cool Terra® Engineered Biocarbon™ Technology

Can provide increased root development & biomass in turf

Cool Terra was applied on top of the soil surface without rototilling and before sod installation. Images at 19 weeks after installation.

Control

2 CY/acre

6 CY/acre



Significant increase in turf root development and biomass

Cool Terra® Engineered Biocarbon™ Technology



Optimizes water holding in soil



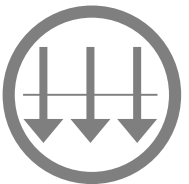
Increases nutrient efficiency



Nurtures microbial growth



Impacts germination and establishment



Sequesters carbon

1 ton CT = 2.7 tons CO₂ removed from atmosphere

Feeding more people...

Higher crop yields

...with increased grower & user benefits...

More production. Optimized inputs. Greater profitability.

...and a healthier planet

Improved soil health | Less fertilizer leaching

Carbon sequestration | Healthier soil, Cleaner water



Thank You For Your Attention!



Cool Terra is produced with 100% biobased biochar

<https://www.coolplanet.com>