

Colgate University Study: Andela Glass Sand as a Soil Amendment for Tomato Plants

Data Collected: July – Sept 2023

Andela Pulverized Glass Sand – Medium to Fine mix (5mm - .1mm in size)

CONTROL PLOT – 100% Soil

Date/Average Plant Height

8.3.23 / 16" AVG.

8.10.23 / 31.6" AVG.

9.28.23 / 39.7" AVG.



SOIL & GLASS SAND MIX – 80% SOIL and 20% GLASS SAND

Date/Average Plant Height

8.3.23 / 13.3" AVG.

8.10.23 / 36.3" AVG.

9.28.23 / 50.6" AVG.





CIRCULAR SOLUTION: ANDELA GLASS-SAND FOR SUSTAINABLE SOIL

Glass waste is a plentiful resource. [Andela Glass Pulverizer Systems](#) convert glass waste into a safe to handle "friendly" glass-sand with no sharp edges.

Aggregate or natural sand is a finite resource. Our world is running out of quarried and dredged natural sand for industrial, landscaping, and other uses.

Reducing methane emissions produced by food-waste and other organic materials in our waste stream is critical. This can be achieved by converting these materials to mulch.

Sustainable soil is possible to engineer with Andela glass-sand and mulch.

Glass-sand, a relatively inert material, used in place of typical mineral aggregates provides benefits in terms of soil function and uniformity.

Greenhouse trial studies with Andela glass-sand assessed short-term plant growth, leachate quality, and water flow of glass-sand mulch mixes; results indicated that plants performed as well in glass-sand based soil as in natural sand based soil.

- leachate analysis met safety standards
- glass-sand retains water longer than natural sand, use suggestion 33-50% glass-sand
- glass-sand pH has a neutral effect in the soil mix because glass-sand pH is a relatively static characteristic
- lab and greenhouse tests show no significant differences in biomass between glass-sand based and natural sand based mixes.
- economic analysis showed benefits of diverting glass from municipal single-stream recycling

[University of Pennsylvania Department of Earth and Environmental Science](#) in conjunction with [OLIN Labs](#) performed the first ever life cycle analysis (LCA) on sustainable soil made with Andela glass-sand from recycled waste glass.

Using both database and first hand data, the study assessed the environmental impacts of the substitution of natural sand with glass-sand.

Among other positives, the results revealed that compared with conventional sand, glass-sand produced from waste-glass reduced by 67% greenhouse gas (GHGs) emission with a saving of 48% water usage.

The positive outcomes of the studies provide guidance on maximizing waste glass, encouraging the use of waste glass in green infrastructure applications.



Q & A – How to use crushed, pulverized, recycled, glass sand with compost and soils

Can I use crushed pulverized recycled glass sand with compost or soil?

Yes, you can use crushed pulverized recycled glass sand with compost or soil. Glass mulch is a commonly used synthetic, or inorganic mulch. [Using tumbled glass mulch made from used glass bottles, old windows, and other glass products keeps glass out of the landfills¹](#). The ground, tumbled glass, which may display minor flaws common to recycled glass, is available in various shades of amber, blue, and green. [Clear glass mulch is also available¹](#). Tumbled glass mulch has no jagged, sharp edges, which makes it useful for a variety of uses in the landscape including pathways, fire pits, or around potted plants. [The mulch works well in beds or rock gardens filled with plants that tolerate rocky, sandy soil¹](#). [Landscape cloth or black plastic placed under the glass keeps the mulch from working its way into the soil¹](#). [Using landscape glass as mulch tends to be relatively expensive, but the low maintenance and longevity help balance the cost¹](#).

Can I use the crushed pulverized recycled glass sand with soil to grow things better?

Yes, you can use crushed pulverized recycled glass sand with soil to grow things better. [A comparative life cycle assessment \(LCA\) completed in 2019 demonstrated that recycled glass-sand may reduce greenhouse emissions by 67% compared to virgin sand¹](#). [A 2019 pilot greenhouse trial showed that glass-based soils supported plant growth as well as a control mined-sand mix¹](#). The glass sand is easy to compact and mix with other materials. When mixed with compost and soils, this is great for drainage layers and backfills. [The filtration rate for glass and/aggregate is up to ten times faster than natural aggregates²](#). So, using crushed pulverized recycled glass sand with soil can be a good way to grow things better.



The addition of glass sand to mulches or soils improves both mechanical properties, and chemical or nutritional properties.

The SBIR/OLIN study focuses on the mechanical properties that glass provides, compared to regular crystalline sand.

Glass sand provides better:

- Filtration rate
- Water retention
- Heat retention
- Angular shaped, inert particles that will not break down.
- Root/plant growth

The glass also provides better nutritional properties. Plants need silica to grow, and the glass sand makes that silica more available and at an accelerated rate.

Why does this happen? Plants need Silicic Acid to grow.

How do plants use Silicic Acid?

Silicic acid is the plant-available form of silicon. [It is assimilated by plants and stored in cell membranes, where it strengthens cell walls and increases crop's natural defense mechanisms¹. Silicic acid is also used by plants to store water molecules and create a gel-like substance for growth and permeability¹. Silicic acid is a powerful plant bio stimulant that can promote plant growth and protect crops from pests and abiotic stresses¹. The form of silicon taken up by plants is silicic acid, a neutral molecule that passes through membrane channels with water². After seminal work on rice identified an aquaporin that appeared to mediate the passage of silicic acid, several papers followed and classified similar channels \(referred to as "transporters"\) in a number of plant species².](#)

What is the chemical formula for Silicic Acid?

[The chemical formula for silicic acid is \$H_4SiO_4\$ ¹. Silicic acid is any chemical compound containing the element silicon attached to oxide \(=O\) and hydroxyl \(-OH\) groups, with the general formula \$\[H_2xSiO_x+2\]n\$ or, equivalently, \$\[SiO_x\(OH\)_{4-2x}\]n\$ ². Orthosilicic acid is a representative example of silicic acid².](#)

More studies need to be done to better understand how the water reacts with the surface of the glass particles, to exchange ions, and make the Silicic Acid. It happens now with water and crystalline silica sand. Since glass is the “liquid” form of SiO_2 and can react with the water quicker than crystalline sand, it supports the ongoing discovery that glass sand is an accelerator for plant growth. Plants grow faster and are healthier. This is good for the general nourishment of our planet.

Here is another interesting article:

<https://agsolutions.com.au/2019/08/09/silica-overlooked-element/#:~:text=Silica%20is%20converted%20into%20plant,uptake%20of%20silica%20is%20reduced.>



Silica - The Overlooked Element That is Essential for Soil and Plant Health

For many years we have promoted the importance and benefits of Silica, a common but often overlooked element that is essential for soil and plant health. In recent times industries such as cotton, sugar cane, small crops, turf and even pastures are recognizing the potential...

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Glass Sand as a Soil Amendment

Science Lesson: Silicon Dioxide (SiO_2) is the next most common molecule on our planet, after H_2O . It has three phases: crystalline, amorphous, and molten. Glass is amorphous silica, and a liquid; it just does not flow at room temperature.

Plants need water to grow: Amorphous silica has a negative charge on the surface and will attract and retain water on the surface of the glass, making it available to the plants for their use.

Plants need silicon dioxide to grow. Making the SiO_2 available in the amorphous/liquid form, instead of the crystalline form, will make it easier for the plants to absorb and metabolize into their plant structure.

Recycled glass sand surface area: In a fine granular form, glass has a lot of surface area with the available SiO_2 the plants need for their growth.

Particle shape and properties: Recycled glass that is processed and sized into an angular particle size will provide superior filtration properties and will not break down over time. Glass is inert and the water will not leach minerals or break down the particles over time.

Recycled Engineered Soils: Mixing the glass sand with compost will provide an engineered soil with the nutrients available from the compost, mixed with the glass particles that provide water retention, and structural integrity.



GBS Glass Based Soil: A Circular Solution

1. Glass diverted from the waste stream is a plentiful resource
2. Natural sand is a finite resource necessary for industrial, landscaping, and other uses
3. [Andela Products](#) Glass Pulverizer Systems convert glass waste into glass sand
4. [Andela Products](#) glass sand, with its rounded edges, is a safe and “friendly” natural sand substitute
5. Food waste and other organics can be diverted from the landfill and converted to mulch
6. GBS/Glass Based Soil is a sustainable soil mix of [Andela Products](#) glass sand and mulch
7. [Andela Products](#) glass sand provides benefits in terms of functionality and uniformity
8. GBS trial studies made with [Andela Products](#) glass sand and mulch assessed plant growth, leachate quality, and water flow; results indicated plants performed as well in GBS as in natural sand-based soil
9. Use suggestion: 33-50% [Andela Products](#) glass sand
10. University of Pennsylvania Department of Earth and Environmental Science and OLIN Labs performed the first-ever lifecycle analysis (LCA) on GBS made with [Andela Products](#) glass sand created from recycled waste glass. The study assessed the environmental impacts of substituting [Andela Products](#) glass sand for natural sand
11. Diverting glass from municipal single-stream recycling creates economic benefits
12. The positive outcomes of the studies provide guidance on maximizing waste glass and encouraging the use of waste glass in green infrastructure applications



ANDELA PRODUCTS

GBS Glass Based Soil: A Circular Solution



ANDELA and Landscaping



How about adding [Andela](#) glass sand to compost to make a better soil?

Benefits include better filtration, available-silica as a plant nutrient, and a mulch that provides better insulation around plant roots, especially as the arctic cold settles in for the winter!

[Andela](#) systems turn any glass, from bottles to mixed waste, back into sand. The end products--clean glass cullet, sand, or aggregate--have many uses, from landscaping to construction. One of our favorite uses for glass sand is to combine it with compost to create rich soil.

We are participating in a project by the University of Pennsylvania Department of Earth and Environmental Sciences in conjunction with OLIN Labs Landscape Architects. They performed a lifecycle analysis on glass sand-based soil made with [Andela](#) glass sand. The results reveal that glass sand-based soil performs as well as, and in some cases better than, natural sand in terms of plant growth, leachate quality, and water flow.



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ANDELA and Landscaping



What is [Andela](#) glass mulch?

Recycled, tumbled glass can be used for landscaping mulch in place of gravel, pebbles or bark. Our glass sand mulch has no jagged or sharp edges, making it useful for a variety of landscaping projects including pathways, fire pits, or around plants.

Benefits include root insulation, for our wintry climate--glass sand acts as a warm wet blanket, keeping plant roots protected. [Andela](#) glass mulch doesn't rot or mold and it repels insects, especially slugs!

Our glass mulch comes in many different colors and sizes, making it easy to inspire you or match to a particular landscaping design scheme. First, lay landscape cloth or plastic, this keeps the mulch from working its way into the soil, then layer about an inch of finer glass mulch, finally, finish with a sparkly or colored mulch of your choice.



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SOILLESS SOIL

Locally-Sourced Recycled Soil for Green Stormwater Infrastructure

GREENER STORMWATER INFRASTRUCTURE

Green stormwater infrastructure (GSI) has many environmental benefits, but sustainable sourcing of materials for GSI remains a challenge. Large quantities of sand are typically a critical component of soil blends used in GSI systems. The environmental costs of sand mining can be significant, so replacing mined sand with a locally-sourced recycled material would make GSI systems considerably more sustainable.

Meanwhile, recycling glass is economically difficult in many municipalities due to the high costs of transporting and shipping glass, and the low commercial value of the mixed-color glass cullet that is the result of most single-stream recycling processes.

To simultaneously reduce reliance on mined sand and provide a sustainable outlet for glass waste, the research team is developing an manufacturing process that repurposes waste-stream glass into recycled glass-sand for use in GSI soils.

RESEARCH TEAM

Since 2017, landscape architecture firm OLIN has led the Soilless Soils Initiative in collaboration with Philadelphia city agencies, circular economy nonprofits, local universities, soil scientists, green stormwater infrastructure experts, and companies engaged in glass recycling, composting, and soil blending. The team's current research is funded by SBIR project award from the U.S. Environmental Protection Agency.

DEVELOPING A RECYCLED SOIL BLEND

To develop a glass-based soil (GBS) blend that supports healthy plant growth and effective stormwater infiltration, the research team has tested a variety of potential blends in a series of lab and greenhouse-based experiments. In Fall 2022, the most successful GBS blend was installed in a pilot bioretention basin in Fairmont Park. The team is now studying the pilot bioretention basin to further confirm that the soil blend performs effectively.

To learn more, please visit the project website
at <https://olinlabs.com/soil-less-soil>



Waste glass is reclaimed & crushed to use as a sand substitute in GSI soils.



The soil blend is designed to support plant growth and stormwater infiltration.



In partnership with Philadelphia Parks & Rec, the research team installed the soil blend in a Fairmont Park bioretention basin.