



Saving Water with PittMoss

A collection of real customer testimonials, case studies, and scientific research

PittMoss Technical Communication
2025

INTRODUCTION

Since its commercial launch in 2017, PittMoss products have been known and sought after thanks to their incredible water-saving properties. PittMoss is a fibrous soil amendment and substrate ingredient made from recycled paper and cardboard. Similar to peat moss in its applications, PittMoss outperforms traditional substrate materials thanks largely to its ability to absorb, retain, and release moisture as needed.

For over a decade, PittMoss, LLC has been collecting scientific research, customer testimonials, and case studies demonstrating how PittMoss has helped conserve water, saving resources, time, and money for its users. This document is a compilation of those materials intended to help illustrate how PittMoss products can help conserve water in a variety of contexts and applications, ultimately guiding us towards our mission of being better for plants and better for the planet.

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EXECUTIVE SUMMARY

Over the years, PittMoss, LLC has conducted many studies and grow trials to quantify how and why PittMoss differs from traditional substrate components. [In a 2015 study](#), PittMoss was shown to contain more water at saturation than different types of peat moss, the most common substrate component on the market today. Despite this, it also retained sufficient air space for plant growth at saturation. [A meta-analysis from 2023](#) reviewed water efficiency data from multiple grow trials and studies conducted over the years, and it concluded that PittMoss is more hydrophilic than peat moss and improves the water-holding properties of various blends, specifically those including bark, peat moss, and/or wood fiber. It also showed that blends containing PittMoss hold more water for a longer time period after irrigation than traditional peat/perlite blends without PittMoss. Similarly, results from a [fertilizer efficiency study conducted in 2020](#) indicated that PittMoss retains more nutrients for a longer period after fertigation. This same study showed that runoff quantity was reduced by 50% when using a PittMoss blend, indicating the ability of the PittMoss to immediately retain more moisture than traditional peat blends.

While studies conducted by PittMoss have focused largely on containerized production, studies and experiences of our customers have also proven the ability of PittMoss to enhance the water holding abilities of native soils. An [independent study conducted in Phoenix, Arizona in 2021](#) mixed PittMoss with a native desert soil, concluding that PittMoss significantly enhanced the ability of the native soil to retain plant-available water. The blends containing PittMoss held water for far longer than the native soil itself, indicating that less irrigation would be necessary to grow thriving crops. Real customer case studies have echoed these findings. At [Farm Up Jamaica](#), PittMoss is used to improve the water absorption and holding abilities of the extremely challenging bauxitic soils native to South Manchester, Jamaica. Farm Up Jamaica has been using PittMoss for over eight years to overcome their soils' extremely rapid drainage and their months-long seasonal droughts without irrigation. PittMoss is an integral part of their climate-smart approach to agriculture. In California, an increasingly hot and dry place, one grower experienced truly remarkable water savings. Thanks to PittMoss, the crops grown in [2018 at Up The Hill Farm](#) used 86% less water than the same number of crops grown in a different substrate the year previous.

Though not always specifically quantified, customers have expressed time and time again that PittMoss helps them save water. In [testimonials](#), PittMoss customers, users, and collaborators have expressed gratitude for its ability to retain moisture, allowing them to save money in labor and avoid plant loss after dry spells. In the Greenhouse context, they save hours of watering and the resultant labor costs. People who purchase and install plants grown in PittMoss experience longer time to wilt and improved survivability.

PittMoss is a relatively new technology, but it has already proven itself to be a uniquely valuable asset to growers the world over. It helps conserve water resources in a variety of contexts, fulfilling the company mission of growing better plants while being better for the planet.

Scientific Studies

Understanding why, how, and to what extent PittMoss conserves water

Comparing the Physical Properties of PittMoss® to Those of Different Peat Types

C. L. Bethke, Ph. D. – Hort Soils & Nutrition Consulting

Introduction

This project was conducted to compare some of the physical characteristics of PittMoss® to the various types of peat commonly used in consumer, commercial, and industrial applications. The array of organic materials varies widely. What is designated as “peat” is derived from different parent materials. “Peat” varies widely in structure due to different degrees of decay, methods of harvest, and processing. Some “peat” has characteristics that make it exceptional for one purpose or another. Coarse, fibrous, top sphagnum moss is excellent for use in orchid production because it has extraordinary air porosity. Slightly decayed sphagnum peat moss has good structure to supply aeration and water-holding capacity for application in potting soils and container blends. Highly decayed peat, often derived from reeds and sedge grasses deposited on the bottom of wet bogs, is best blended into flower beds and gardens due to its high density of organic material.

Recently, challenges regarding the availability of sphagnum have developed. Supplies in Europe have become more limited. Environmental concerns have impacted the sphagnum peat supply in many areas. Weather conditions have frequently limited the harvest in North America. These factors have led to the examination of alternative components that can serve to substitute for or reduce the use of sphagnum in growing mixes. One material that has been developed is PittMoss®, an engineered cellulosic fiber designed to provide plant roots with optimal water, air exchange, and nutrients. PittMoss® was developed by Mont Handley in Pittsburgh, PA using recycled organic materials. It resembled coarse sphagnum peat and so he named it “PittMoss®”. It is lightweight, mixable, water absorbent (hydrophilic), slightly acidic (pH 5.4 to 6.2), low in soluble salts, and is easily incorporated into growing media blends. Because these manufactured fibers are derived from recycled organic materials, they are considered sustainable and earth-friendly, an issue that is popular with many in the garden industry.

Because this project is designed to assess the physical properties of PittMoss® compared to peat types, and because PittMoss® compares mostly to sphagnum peat moss, this project focuses on physical characteristics most important to the greenhouse and container plant industry. Here, we consider what is needed for a good substrate.

A good substrate must do four functional things:

1. Provide support to stabilize the plants.
2. Provide water in available form.
3. Provide nutrients in available form.
4. Provide gas exchange to the roots and microorganisms.

A good container substrate component must possess four important physical properties:

1. A manageable weight.
2. A manageable particle size and structure for handling and blending.
3. Good particle size distribution for gas exchange and water holding.
4. Resilience against decay for the life of a crop.

A good container substrate component should embody four socio-economic considerations:

1. Safe for all in manufacturing and production.
2. Pleasant to handle by workers and consumers.
3. Compatible with ecological systems in acquisition and use.
4. Affordable and consistently available in sufficient volumes.

This project compares peat types to PittMoss® and analyzes how some of the physical characteristics help to meet these requirements.

The Project

Samples of the five peat types representing the array used in horticulture were obtained from commercial suppliers (see appendix). Samples in triplicate were drawn from each peat type and used to fill the plastic cups (283 ml, 11.2 cm tall) with holes drilled in the bottom. Each filled cup was lightly packed, re-heaped full, and then lightly tamped down three times with a weighted canister (equivalent to 50 lbs/cu ft.) and then leveled to the top of the cup. The filled cups with drainage holes were inserted into identical cups with no holes. The filled cups were then fully saturated with water and left to equilibrate for 24 hours. They were then refilled with water to the top. Then each cup was lifted and held over the lower cup with spacers to drain for 24 hours when data was taken.

Data Collection and Analysis

A base tare weight of the cup and the residual water held in the lower cup was determined. That was the tare weight before drainage. The drained water and the moist cups of substrate were weighed and then adjusted for that tare weight. The drained water provided a measure of the air-filled pore space at saturation. Dry bulk densities of the individual components were measured on samples dried in an oven at 220 degrees F for 24 hours. The dry bulk densities were then used to calculate the weight of dry materials in each cup. Then, by difference, the volume of only the total water retained at saturation was determined for each cup. The total water retained included both plant available and unavailable water. A measure of unavailable water was assumed to be approximately equal to the water retained in the substrate when it was air dry. This approximation of unavailable water was determined by measuring the moisture that remained in the individual components when air dry, (i.e. unavailable water escapes between air dry and oven dry) and then using those values to calculate the amount of unavailable water expected to remain in a cup when air dry. By subtracting the estimated unavailable water from the total water retained we get the plant available water. Air porosity, plant available water, unavailable water, and solids then defined the physical properties of each component. Graphs and tables that represent the properties are presented here.

Results

Bulk densities are presented in **Table 1** and are reported in grams per cubic centimeter and pounds per cubic foot on “as received” and “oven dry” bases.

Particle size distributions are presented in **Figure 1**. These figures show the percentages by weight of the particles that passed through the larger sieve and remained held above the next finer sieve without passing through it. They provide the “fingerprints” of the distribution of particle sizes for each component.

The air- and water-holding properties are presented in **Figure 2**. The data are presented on a percent volume basis in each of the figures. Composites of the actual properties of each are compared in **Figure 2**. Note all these representations show the properties present in a settled or compacted (50 lbs./sq ft.) substrate about 4.4” (11.2 cm) deep. In containers of different depths and in loose-filled containers, the numbers will be considerably different.

Table 1: Bulk densities of PittMoss and some peat types.

Component	As Received		Oven Dry	
	g/cm ³	lbs/ft ³	g/cm ³	lbs/ft ³
PittMoss	0.31	19.3	0.119	7.4
TopMoss	0.09	5.6	0.061	3.8
Sphagnum (L)	0.13	8.1	0.091	5.7
Sphagnum (M)	0.13	8.1	0.098	6.1
Sphagnum (P)	0.16	10.0	0.107	6.7
Reed-Sedge	0.42	26.2	0.279	17.4

Comparisons

Bulk Densities

The bulk densities presented in Table 1 show some differences. The as-received basis cannot be usefully compared because of wide differences in moisture in the samples. The oven dry bulk densities effectively show that PittMoss® compares very favorably with all standard grades of sphagnum peat. It is more dense when oven-dry than Top Moss but is much less dense than Reed-Sedge peat. It is a little more dense when dry than Sphagnum-M and Sphagnum-L but a little less dense than Sphagnum (P), which is a little more decayed. PittMoss® is well within the densities that are desirable and common to typical sphagnum moss. As a result, it should blend well and not readily segregate when handled.

Particle Sizes

Figures 1 and 2 show the particle size “fingerprint” of the six samples compared. When comparing the peaks in the lines for each material, we see that the coarser materials are PittMoss®, Top Moss and Sph-M (the peaks are farther to the left) while Sph-L and Sph-P have peaks in the middle, with Sph-P showing the finest texture of all the sphagnum samples measured. Note the finer components in Reed-Sedge peat. When blending components together, the particles, regardless of source, bump and bridge together to create the large pore spaces. The coarser and medium sized particles combine to provide air space and good drainage. The finer materials, those below 1.0 mm, seem to fill in pore spaces and decrease air porosity. Note that all sphagnum and PittMoss® examples contribute more coarser materials than Reed-Sedge. The Reed-Sedge when blended with any of the sphagnum samples or PittMoss® would damage the drainage and air porosity. Note that over processing and excessive blending, especially when wet, will also increase the percentages of fine materials in any blend. While the particle sizes provide a view of how the materials may intermingle, the particle sizes do not identify the water absorptive properties or give any suggestion as to how shapes and surfaces of the blended materials will work together. Clearly PittMoss® shows very favorable particle size distribution compared to the other sphagnum samples and much better than the Reed-Sedge sample.

Space Distribution

Each growing substrate component takes up space and influences the composite of properties when blended with other materials. The components intermingle to influence the air-water relationships in a blend. **Figure 2** shows how the different peat types compare to PittMoss® when compacted to 50 pounds per square foot. That simulates handling and settling in production. This figure illustrates the space distribution as solids, unavailable water, available water and air space at saturation. Those conditions simulate what occurs in crops fully watered and drained for 24 hours. Note that over all PittMoss® compares very favorably to all three samples of sphagnum peat. Top Moss and Reed-Sedge are different. They are at opposite ends of the decay spectrum and the physical properties spectrum. Top Moss is too loose, and Reed-Sedge is too tight.

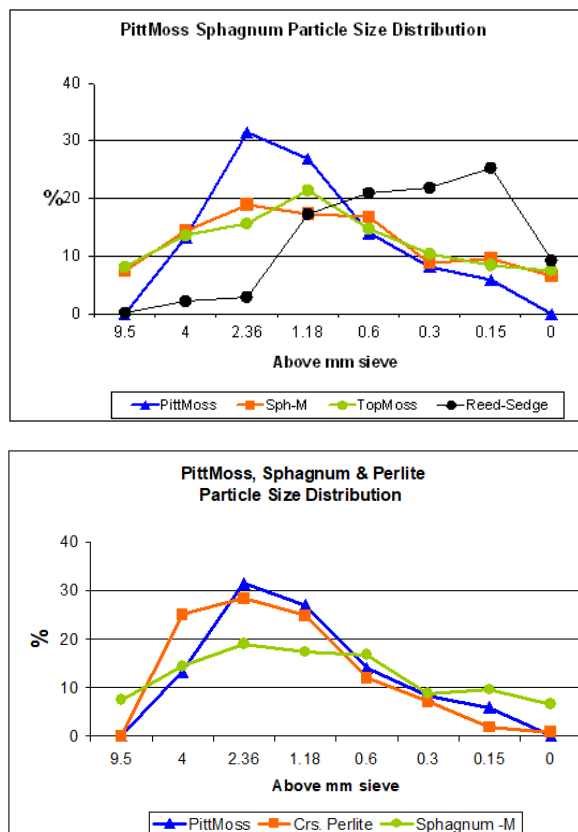


Figure 1. Graphic comparison of particle size distributions between PittMoss, peat, and perlite.

PittMoss® shows available water at greater levels than all other materials. Air space is highest in the Top Moss, sufficient in PittMoss® and the other sphagnum samples and insufficient in reed-sedge. The unavailable water, as depicted in Figure 6, is about the same for PittMoss® and all commercial sphagnum samples but is insufficient in the Reed-Sedge sample. Solids in the components ranged from 16 percent in PittMoss® to about 24% in Reed-Sedge. The lower volume of solid materials in PittMoss® is thought to arise from the nature of the engineered fiber that makes up PittMoss®. Under these test conditions, PittMoss® shows more effective use of air space than all other components. It is possible that different sources of peat may show some different results, but it is expected that they will generally be about the same.

Summary

PittMoss® competes very favorably when comparing physical properties to five currently available peat materials. It is similar in dry bulk density to all three commercial sphagnum samples tested. It is most comparable to Top Moss and Sph-M in particle sizes. PittMoss® has fewer fine particles than all materials evaluated. It excels in available water content when saturated; and like the other sphagnum samples, PittMoss® has sufficient air porosity immediately after irrigation. It has lower solids content than all samples tested in this comparison. The low bulk density when dry makes it easy to mix with similar products and also economical to transport. The larger and more uniform particle sizes will help to make blends with good aeration and drainage. PittMoss® is clearly exceptional in space utilization. Air space is sufficient, available water is exceptional, and the total solids are low enough to allow for effective use of space. All this is likely due to the structure of the engineered fiber.

This survey of physical properties demonstrates that PittMoss® provides the functions necessary for good crop production. PittMoss® appears to meet or excel beyond common commercial sphagnum resources in the physical properties examined. As for the socio-economic concerns: (1) it is safe for people and animals (2) it is very desirable to work with (3) it is made from recycled materials and can be incorporated into the environment without a concern. Clearly, this new component will be implemented extensively in the next generation of soilless mixes.

Appendix – Sources of Raw Materials

PittMoss® (Stock lot)
PittMoss LLC.
2603 Duss Avenue
Ambridge, PA 15003

Sphagnum Peat-L (Grower Bale)
Lambert Peat Moss Inc.
106 Lambert Rd
Riviere Ouelle, QC G0L 2C0
Canada

Sphagnum Peat-M (Manitoba Crs.)
Suntera Horticulture Inc.
P.O. Box 760
Riverton, MB ROC 2R0
Canada

Sphagnum Peat-P (Grower Bale)
Premier Horticulture Inc.
1 Avenue Premier
Riviere-Du-loup, QC G5R 6C1
Canada

Reed-Sedge (Michigan Peat)
Michigan Peat Co.
2243 Milford St.
Houston, TX 77098

Top Moss (Dried Sphagnum Moss)
Source Unknown - Stock
Said to be a Wisconsin Bog

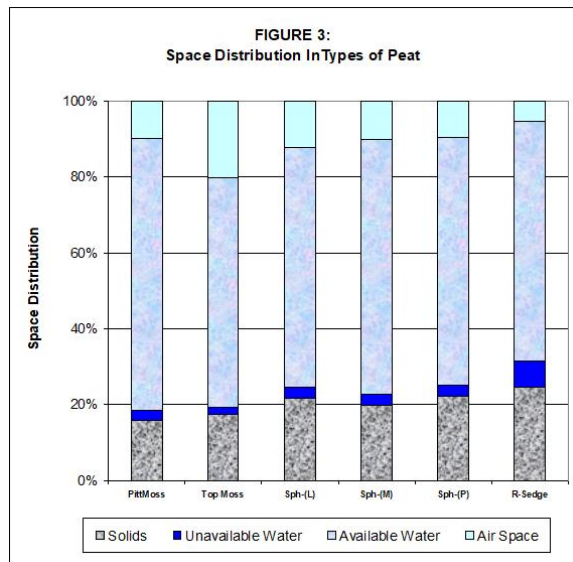


Figure 2. Space distribution comparison between PittMoss and various peat products.

Water Efficiency in PittMoss: A Review of Some Key Findings

C. L. Bethke, Ph. D. - Hort Soils and Nutrition Consulting

Following the invention of the PittMoss® engineered fibers it became apparent that the goal of improving the internal and external porosity of the particles provided the desired structure for both increased water availability along with increased air porosity. This was because the substrate had less space occupied by solids and the correct balance of macro- and micropores. One of the end results was greatly improved water efficiency when growing in blends containing PittMoss®. Discussed in this paper are summaries of some key observations over the past 8 years that demonstrate how PittMoss® works to increase the rate and volume of water absorption, retention, and availability in the substrate alone and in growing blends.

Air and Water Relations in Substrates

To understand the influences PittMoss® engineered growing substrates have on water dynamics, it is first necessary to understand how water and air interact and how the properties of a given growing substrate influence water management in container growing. It is important to recognize that most water held within a growing blend is available to plants, while a smaller portion of water is held so tightly that plants cannot pull the water out of the substrate.

The best way to understand the quantity of water available in a substrate is to understand the basic air/water relations. Efficiency can be demonstrated by examining the spaces that are filled with air and available water after watering to full saturation and draining. Figure 1 presents examples of space utilization of four different substrate components. The bottoms of the columns depict the space occupied by **particles** providing no available space for water or air. Above the solids in each column is presented a depiction of the **unavailable water**. Unavailable water is the water held so tightly by the substrate that at the permanent wilting point the plant cannot pull the water out. Note that PittMoss® has a low level of unavailable water. Graphically represented above the unavailable water is **the plant available water**. That is the water in freshly saturated growing mix that is readily available for use by plants. Given the greater volume of plant available water in PittMoss® as compared to other substrates, it is this property that likely gives blends containing PittMoss® the ability to supply plants with water longer before requiring watering or causing wilting. At the top of the columns is the **air space** that exists when the substrate is fully saturated and drained. Too much air space decreases plant available water, and too little air space inhibits gas exchange. Optimal air space is usually considered to range from 5 to 15%. Studies as early as 2014 showed that PittMoss® provides a very high pore space per unit volume and delivers more plant available water while retaining sufficient gas exchange properties in container growing.

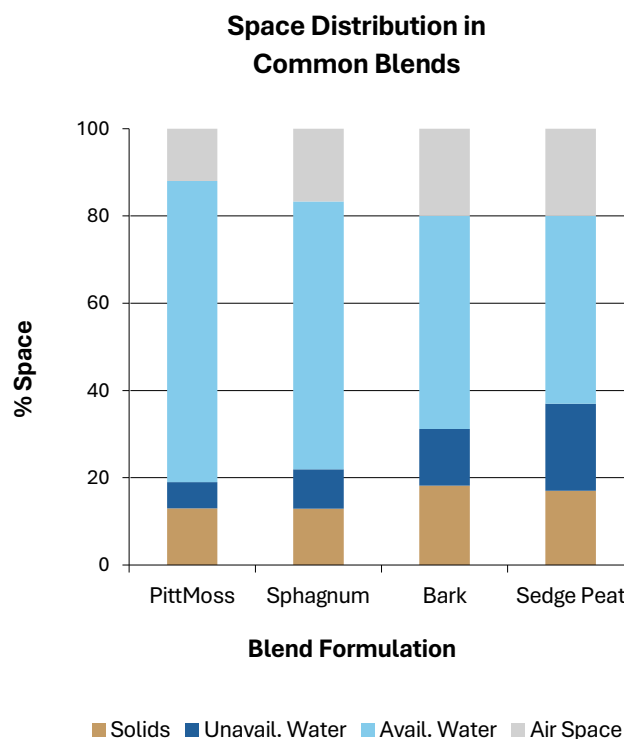


Figure 1. An example of space distribution in common substrates illustrating (from bottom to top) volume occupied by solid materials unavailable water, plant available water and air.

Rate of Water Absorption by PittMoss® Compared to Sphagnum Peat

Soon after its invention it was observed that PittMoss® absorbs water much more readily than dry sphagnum peat. The hydrophilic, or “water loving,” nature of the engineered fibers of PittMoss® saturate much more readily than peat. It was noted that this was the case both with and without the use of surfactants (wetting agents). A brief study was conducted in 2015 examining water absorption rates of PittMoss® at various moisture levels compared to common sphagnum peat. Samples of PittMoss® that contained from 8% to 70% moisture by weight were prepared. A sample of sphagnum was drawn from a commercial compressed bale that contained 44% moisture. Triplicate samples for each treatment were uniformly packed into clear plastic cups that held 283ml of substrate. Each cup had three holes in the bottom. The cups were suspended in a bath of pure tap water and another bath of tap water plus 600ppm of the surfactant AquaGro–L. The time was measured for full absorption of water through the holes in the bottom of the cup up to the top of the substrate. Comparisons of the times were made using the sphagnum in the clear water treatment as a reference as 100%. The average data for all 12 treatment levels

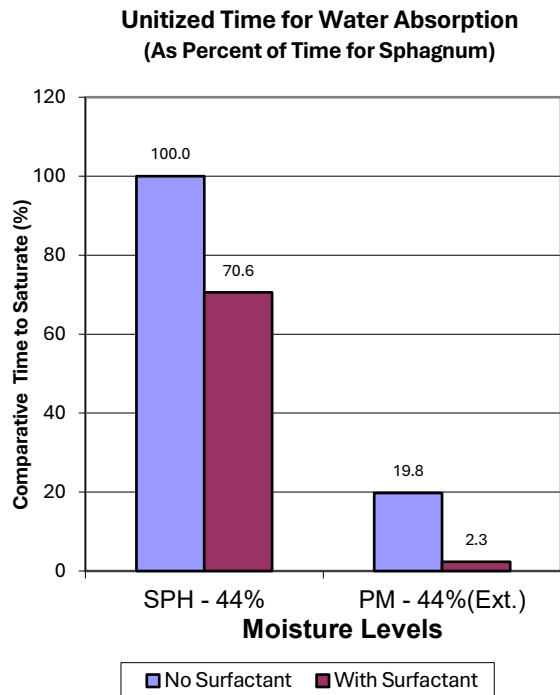


Figure 3. A comparison of wetting time between sphagnum peat and PittMoss® with and without surfactant. The PittMoss® rate is extrapolated to 44% moisture for a comparison to sphagnum as received at 44%.

Time for Water Absorption (As percent of time for sphagnum)

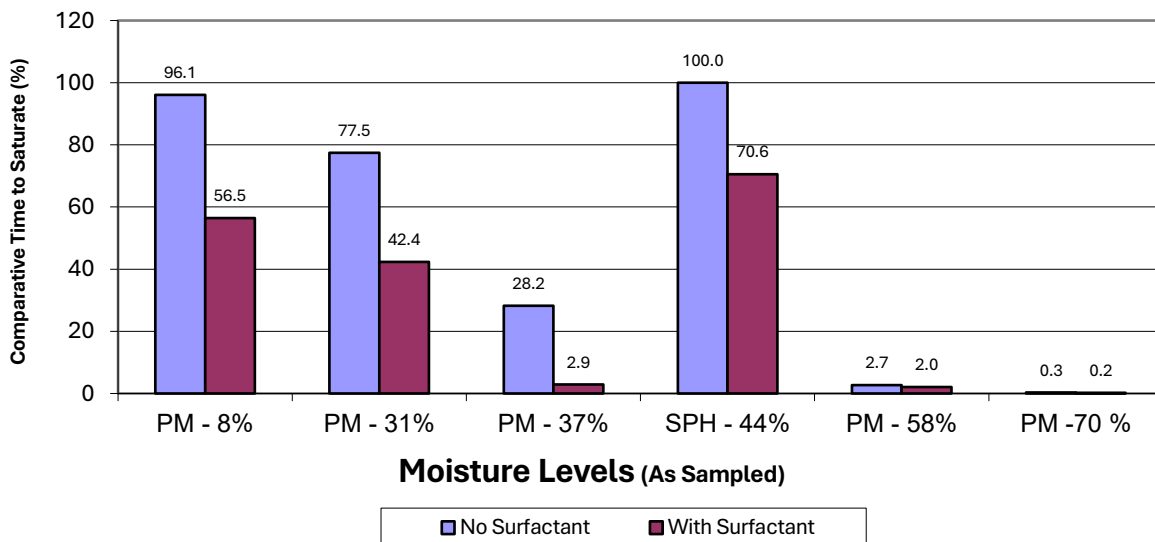


Figure 2. A comparison of wetting time between sphagnum peat and PittMoss® at various moisture levels with and without surfactant (wetting agent).

Table 1. A survey of data reported on total water holding capacity (%WHC) when saturated and drained.

Substrate/Blend	%WHC (Dry Material Basis)*	References/Sources
PittMoss – Regular	631	C.L. Bethke 11/9/14
PittMoss – Fine	520	C.L. Bethke 11/9/14
Sphagnum – Annapolis Valley	620	Abad, M. et al. 2005
Sphagnum (H2-H4)	614	Sambo, P. et al. 2008
Sphagnum	50	Mastalerz, J. 1977
Peat-Sedge	200-361	Mastalerz, J. 1977
Coir – IC1	276	Abad, M. et al. 2005
Peat Amorphous - Ireland	450	Huat, et al., 2011
Fibric Peat	~640	Boelter D. H. 1968
Sapric Peat	~340	Boelter D. H. 1968
Hemic Peat	~220	Boelter D. H. 1968
Composted Dairy Manure	182	Mastalerz, J. 1977
Sphagnum (50%) / Clay Loam (50%)	115	Mastalerz, J. 1977

**Expressed as a percent of dry matter (e.g., 650% means 1 gram of dry matter holds 6.5 grams of water when saturated and the excess is drained).*

are presented in Figure 2. Additionally, the data for PittMoss®, when extrapolated to a 44%

moisture level (to equally compare the materials at the same moisture level), show that all PittMoss® samples, even down to 8% moisture, absorbed water more readily than the sphagnum peat at 44% moisture. These data are presented in Figure 3.

The data also demonstrate that the surfactant accelerated the absorption in both materials at all moisture levels. When adjustments are made to compare both materials at 44% moisture, it is possible to directly compare the two substrates. Figure 3 shows that without a surfactant present PittMoss® fully absorbed the water in only 19.8% of the time that it took for sphagnum peat to do the same. That is about 5 times faster. With a surfactant, the sphagnum absorption time was cut to 70.6% of the initial of the initial rate, while the PittMoss® time to full absorption was reduced to only 2.3% of that of the untreated sphagnum.

These data show that:

1. PittMoss is much more hydrophilic even at lower moisture levels than sphagnum.
2. Sphagnum is quite hydrophobic when dry.
3. Surfactants accelerate water absorption in both materials.

While this was a simple evaluation, it strongly suggests that PittMoss®, whether alone or in a blend, will serve to absorb water much more readily and be of great help in increasing water use efficiency and management when growing plants.

Total Water Holding Capacity

Total water holding capacity is the amount of water held within a substrate after it has been saturated and drained by gravity. The measurement includes both plant available and unavailable water. The quantity of water held within a substrate is dependent on the size and amount of pore spaces. The “Total Water Holding Capacity” (TWHC or %WHC) is sometimes referred to as the “Capacity of Water Retention” (CRW, or %CRW). The values are expressed as a percentage of the weight (not volume) of the substrate dry matter (e.g., a WHC of 650% means 1g of oven dry substrate holds up to 6.5g water after the excess gravitational water has drained). PittMoss® has an exceptional quantity and array of internal pore spaces, making the total porosity, and specifically the water holding capacity, very high (631% WHC). Table 1 provides a comparison of PittMoss® to an array of peat types, substrate components, and some blends that are reported in scientific literature. Gelatinous materials produced by microbes in the substrate can work like glues that can dry and permanently fill pores. Often, these materials will solidify when drying and

cannot rehydrate when remoistened. Therefore, sample handling and processing systems should avoid excessive drying (except for measuring dry bulk density) of the substrates before physical analyses because that can greatly alter the nature of the components and will not represent the conditions in production.

Some Examples of PittMoss® Incorporated into Growing Blends

Replacing Sphagnum Peat with PittMoss® in a Bark Blend

In this comparison, a nursery blend which incorporated 15% sphagnum peat with pine bark was the grower's typical mix. The sphagnum was replaced with 20% PittMoss®. As a result, the water holding capacity of the nursery blend increased from 36.1% to 45.7%, representing a 26.8% increase in the total water held within the growing medium. Additionally, in this comparison, the solids within the blend increased from 19.6% to 27.1% with the added PittMoss®. These results are shown in Figure 4. The increased WHC and solids content are likely due to PittMoss® filling in excessive amounts of large air spaces and some providing more micropores that hold water thus increasing water holding capacity. While this was a single observation from a single grower with a blend provided by a specific mixing company, it does provide very significant indications that using PittMoss® to replace sphagnum peat in the bark-based mixes could have a very significant impact on the water holding capacity in these mixes and also provide a more economical and environmentally sustainable way of improving the water efficiency while reducing run-off when using bark-based blends.

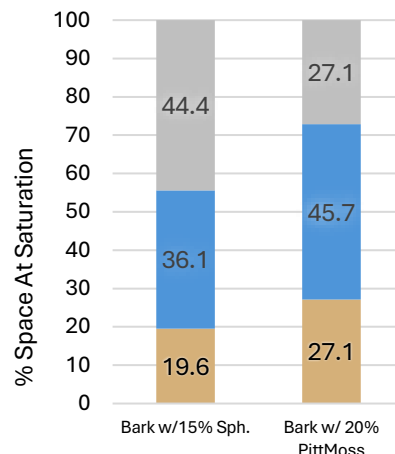
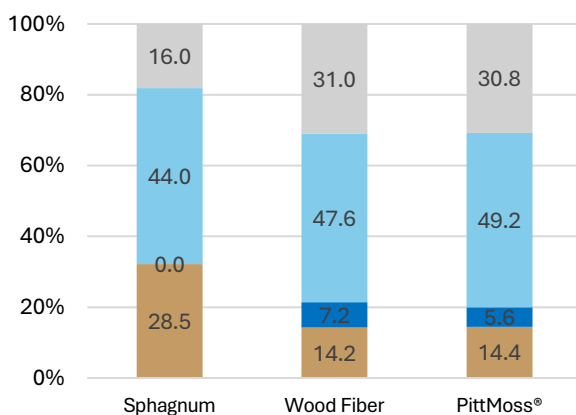


Figure 4. Comparison of air, water, & solids after saturation and drainage of two bark blends replacing sphagnum with PittMoss®.

Observations of Wood Fiber and PittMoss® Blends

Preliminary trials were performed in 2019 in the pursuit of producing more sustainable growing substrates for horticultural use. One aspect of the project was evaluating the effects of PittMoss® in combination with wood fiber on aeration and water availability. In these tests, three components (PittMoss®, wood fiber, and sphagnum peat), were compared alone and combined as blends of the following: 50% PittMoss® with 50% wood fiber, 67% sphagnum with 33% wood fiber, and 33% PittMoss®, 33% wood fiber with 33% sphagnum. The PittMoss® was the "Grower Grade-F" formulation, while the sphagnum was Lambert standard retail grade, and the wood fiber was standard grade

SPACE DISTRIBUTION IN THREE COMPONENTS



SPACE DISTRIBUTION IN THREE BLENDS

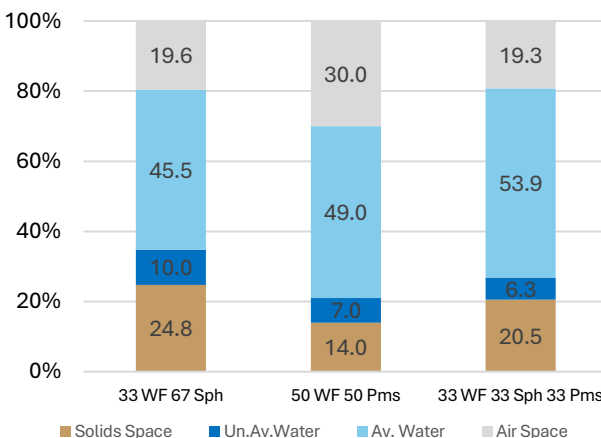


Figure 5. A comparison of space distribution of solids, unavailable water, plant available water, and air between individual components as well as blends of sphagnum peat, wood fiber, and PittMoss® following drainage after saturation.

obtained from a grower. All sample blends were hand mixed at moderate but low moisture content and run through a ¼ inch screen to ensure uniform mixing and no clumping. The air space and water holding capacity were measured

using cup in cup methods where the samples were saturated, left at saturation for 24 hours, then allowed to drain. The drainage was then collected. Using the collected data and making an estimate of unavailable water (water held at tensions greater than roots can pull it from the blend), space distributions were calculated. The same methods were applied to all components and blends. Figure 5 shows the results of this experiment. In the straight media components, the available water was greatest in PittMoss®. A curious effect was that, when combining equal portions of PittMoss®, sphagnum, and wood fiber, the greatest porosity was created and available water was the highest (53.9% of space) of all blends tested. Note that these measurements were not replicated and should not be considered definitive but should rather be treated as observations only.

Moisture Content While Growing in Large Containers

A grower in Northern PA worked in cooperation with PittMoss LLC to monitor moisture after water applications using a Blue Lab “Pulse Meter.” This grower was growing crops in large pots that held 7 gallons of substrate. The “Pulse Meter” reports the volume of water in the substrate using radio waves. The moisture level was recorded two days after application of nutrient solutions comparing ProMix (a peat perlite blend) and PittMoss® PM1 (a peat-reduced blend containing 30% PittMoss®). The results are illustrated in Figure 6. After drainage, the retained moisture in the PM1 blend was consistently higher, averaging 69% higher, than in the ProMix. The plants had more available water reserves and likely benefited from the increased supply of plant available water containing the applied nutrients. The additional water holding capacity also allowed for increased time intervals between nutrient solution applications and reduced the possibility of moisture stress between applications. As a result, the crop performed better. According to the grower, yields were lower in the ProMix blend (by possibly 10 to 15%).

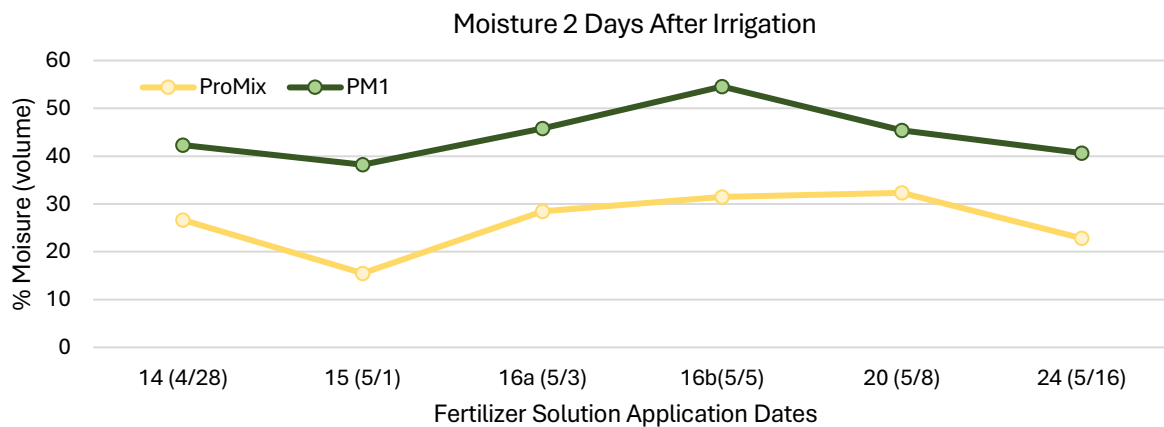


Figure 6. Moisture comparison at various fertilizer application dates two days after watering.

Summary of Water Efficiencies Observed to Date

The above selected observations provide support for the current studies underway which compare water applied in growing crops in various substrates with and without PittMoss®. These studies are recording the effects of applied water on the resulting growth of plants while also comparing the amount and frequency of applications, quantity of run-off, and ultimate extensions in time to wilting in finished crops in different substrates.

Some key observations to date on the water use efficiency of PittMoss® are:

1. PittMoss® increases the plant-available water in containers of assorted sizes.
2. PittMoss® improves absorption due to more hydrophilic properties.
3. PittMoss® increases retention of applied water.
4. PittMoss® allows for greater release of water than other common substrate components.
5. Blends containing various portions of PittMoss® have increased water availability.

Information from “Water and Fertilizer Efficacies: Comparing Two Blends at a Cannabis Production Facility”

The following section is pulled largely from a previous report written in April of 2020 by Dr. Charles Bethke regarding findings from a cannabis production facility in Erie, PA.

Methods

Some observational work at a large cannabis production facility in Erie, PA, has provided data which appear to reveal some significant influences of the PittMoss PM1 substrate. The work was conducted comparing the efficacies of three growing substrates:

1. Premier Modified ProMix
2. PittMoss PM1 (which includes 30% PittMoss)
3. PittMoss Modified PM1 with 22% perlite

The blends were tested with “light packing” and “heavy packing” methods.

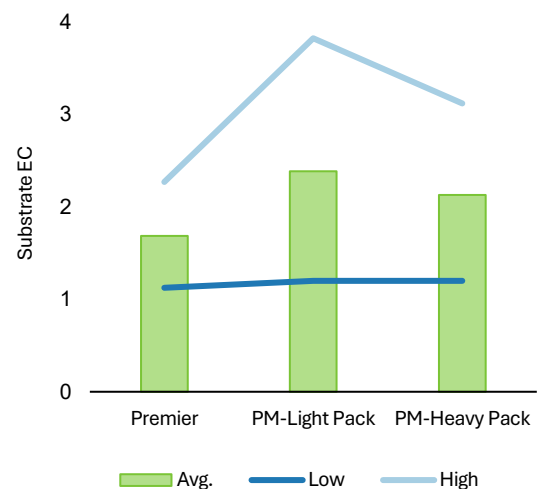
Data were collected over about one month of production in 7-gallon pots. Two plant strains were monitored with replications and data combined. All replications were treated with the same fertilizers, and water was measured and applied uniformly to each pot. Measurements were taken on the vegetative production between week 2 and week 6 of the crop. Substrate moisture and soluble salts (EC) were measured in the growing plants with a Pulse Meter (Blue Lab) at about one-week intervals over a period of four weeks. The leachate volume and EC (using a conductivity meter) were measured after four different watering events.

The averaged data comparing the substrates are summarized and presented in the graphics in this section of the report. Note that this information is distilled from “field sampling,” and that the data show trends and effects but do not provide statistical probabilities and exact precision regarding the differences of the treatments.

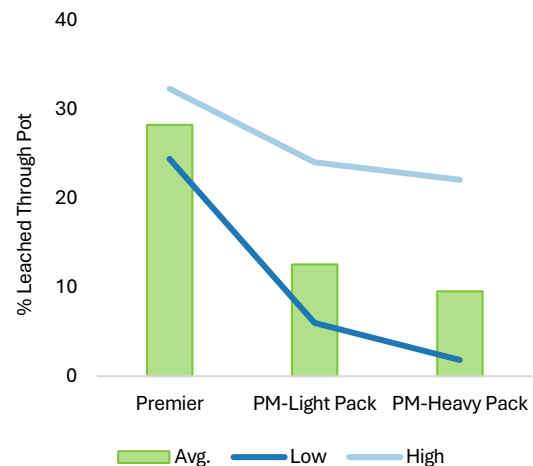
Nutrients Retained

Measurements of soluble salts in the substrate are presented here as electrical conductivity (EC) as measured using the Pulse Meter. Each EC unit in this study represented approximately 775 ppm of total soluble salts (mostly nutrients). The lows were about 1.2 in all three blends. The highest measured in the Premier blend was 2.3 and 3.8 for the light pack modified PM1. The heavy pack modified PM1 had a lower high EC of 3.1. That is likely due to the higher density of substrate material and thus less room for nutrient solution. On average, the Premier blend provided nutrients at an EC level of 1.7, while the lightly packed PM1 provided the most nutrients with an EC of 2.4 (vs 2.1 for heavily packed PM1). These data lead to the suggestion that up to 41% higher nutrient-holding (nutrient buffering) properties are present in the PM1 (Figure H).

H. Substrate Electrical Conductivity Comparison following Fertilization



I. % Fertilizer Solution Leached



Leachate Quantification

Wide differences were observed in the leachate. The modified PM1 allowed less than half of the water to leave through the bottom of the pot than the ProMix (Figure I). While the ProMix blend yielded 28% leachate, the light packed PM1 yielded about 13% run-off, and the heavy pack yielded about 10%. In other words, in this trial and under the same uniform solution applications, the PM1 had one-third to one-half the wasted nutrient solution of the ProMix. Note that the moisture held within the substrate was greater in both PM1 treatments, and that the crop was larger in the PM1 blends and likely drew more solution between applications. This provides evidence that PM1 provides greater fertilizer savings.

Nutrient Utilization Quantification

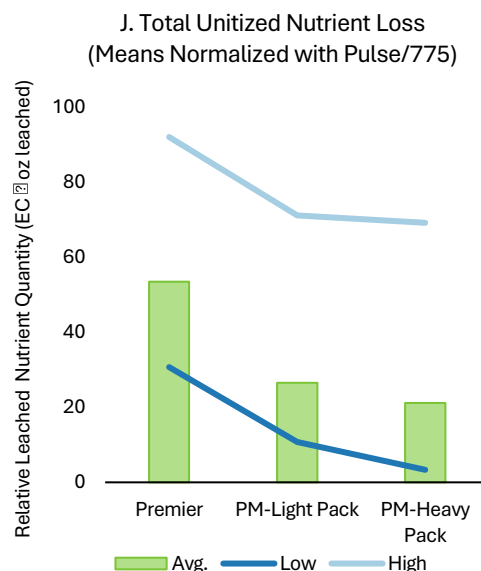
Since the volume of nutrient solution applied was the same for all pots, a comparison of the relative efficacy of nutrient holding and application by each substrate can be normalized by multiplying the volume by the concentration to get a normalized utilization factor. The EC leachate measurements (in ppm) were divided by 775 to obtain the normalized comparative EC units as measured by the Pulse Meter. This total normalized nutrient loss factor can then be used to compare the efficacy of the tested blends (Figure J). Lower units of loss mean higher utilization. The efficiency was much greater for the PM1 blends. The heavily packed PM1 showed about 2.5 times greater utilization of total nutrients than the ProMix, while the light pack showed about 2 times better efficiency compared to ProMix.

Substrate Nutrient Buffering Assessment

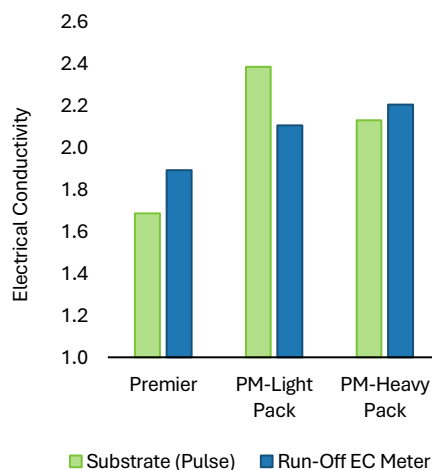
The ability of a substrate to hold nutrients against leaching provides a good measure of buffering in the substrate. Comparing the EC levels measured within the substrates with the EC measured in the leachate provides allows for comparative assessment of nutrient buffering ability between substrates. In order to make direct comparisons, the leachate EC values (in ppm) were divided by 775 to obtain normalized comparative EC units comparable to those measured by the Pulse Meter. These normalized EC values were when compared to determine the nutrient buffering ability of each blend (Figure K).

Highly buffered blends show higher substrate EC levels compared to leachate EC levels. However, lower leachate EC levels also indicate better use efficiency of applied nutrients. In this study, comparison of substrate and leachate EC values indicate that PM1 blends retained nutrients better against leaching. This was indicated by higher substrate EC levels on average. The ProMix blend had higher leachate EC levels, indicating a lower ability of the substrate to retain nutrients and provide efficient fertilizer use.

These data are from actual production rather than from a pure research project. The data demonstrate that selection of substrates significantly impacts crop and nutrient management, even in practice. That selection has important implications regarding the efficiency of nutrient use and limiting nutrient loss, both of which have become very important in this time of concern for increased sustainability and environmental stewardship. Fertilizer production is energy-intensive and generates high emissions, and nutrient loss creates far-reaching problems in critical waterways and sensitive ecosystems. Therefore, reductions in both the use and loss of applied nutrients are beneficial directly to growers and to society as a whole.



K. Electrical Conductivity in Substrate and Leachate of 3 Different Growing Blends
(Mean Normalized Pulse/775)



The Influence of PittMoss on Dryland Soil Water Retention

Study Design and Data Collection by Chad Berquist

Reporting by Margaret Cullinan, PittMoss

Note: The research documented in this report was done independently of PittMoss staff. Support provided to the researcher was limited to standard descriptions of available products and recommendations for their use. Study design and execution were performed entirely by the researcher.

INTRODUCTION

In a world of over 8 billion people and growing, food and fiber production are increasingly important, and supply chains continue to shift as climatic change introduces unpredictability into what were once stable weather patterns. Communities and economies are most resilient to threats like food scarcity and shifts in supply chains when they are able to produce needed crops for themselves. The Earth's drylands are home to over 2.3 billion people, and every year, more land becomes dryer than it was before.¹ Dryland and desert soils present extreme challenges to the farmers who manage them. Low water holding capacity, crusting, high salt levels, high alkalinity, and low fertilizer efficiency are just some of the struggles dryland farmers face.

Tackling the challenges of dryland soils (and preventing the spread of aridification and desertification) are now more important than ever. Certain ecosystem restoration techniques (e.g., tree planting, grassland restoration, etc.) can help mitigate the spread of drylands and restore more moisture to the soil. However, dryland soils which are to be used for food and fiber production are not good candidates for these techniques, as they preclude the use of the land for farming. Instead, these drylands must be managed in ways which are conducive to farming, yet still increase the soil's capacity to hold water, fertilizer, and support plants as they grow.

One such management option is the use of engineered soil amendments to improve specific soil physical, chemical, and biological properties. One such amendment is PittMoss, a material produced from waste cellulosic materials. PittMoss is a patented technology with the proven ability to utilize water and fertilizer more efficiently than traditional materials. In the greenhouse context, PittMoss has been shown to improve the properties of other common substrate components (e.g., peat moss, coconut coir, perlite) and promote stronger, more vigorous plant growth in shorter periods of time. The success of PittMoss is attributed not just to its physical properties, but also to its ability to provide suitable habitat for beneficial microbiota and suppress the growth of pathogens.

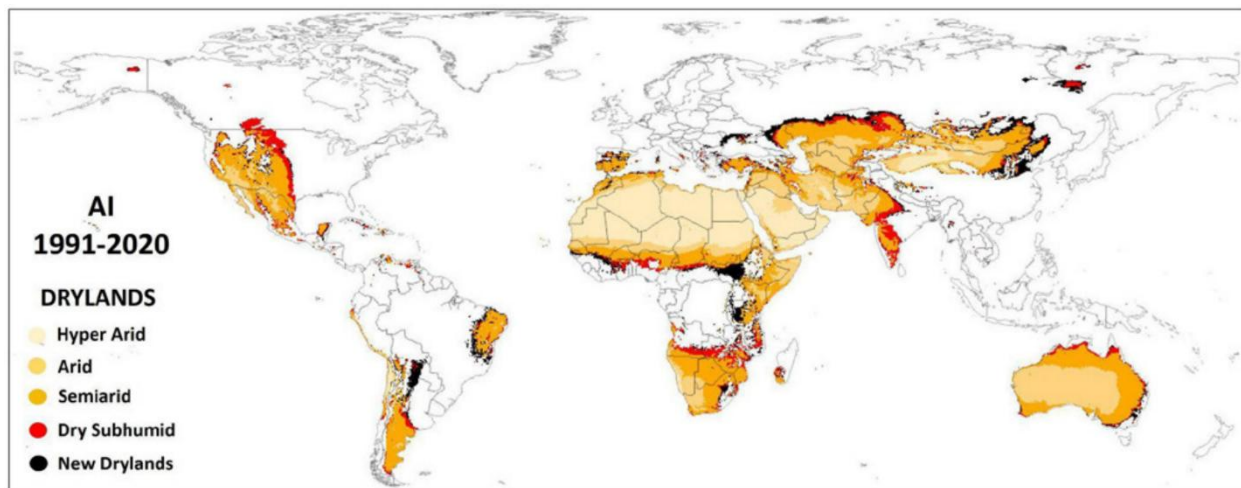


Figure 3. A global map of drylands from 1991-2020. New drylands are shown in black.¹

¹ https://www.unccd.int/sites/default/files/2024-12/aridity_brief.pdf

Other amendments have been explored as a means to improve the properties of desert soils for crop growth, including (but not limited to) biochar², agricultural waste and manure³, and biofertilizers⁴. These approaches are generally successful in improving plant yields and soil properties. However, these approaches typically result in improving only certain soil properties, or the properties of the actual amendment (especially in the case of biochar or compost) may vary based on the source of the amendment and how it is produced. For example, biochar properties vary based on feedstock and pyrolysis temperature, and the biochar may introduce high salt quantities or low air permeability to the soil. In contrast, PittMoss is manufactured in a facility using a patented process which ensures consistency and uniformity between batches. Additionally, PittMoss holistically improves the physical, chemical, and biological properties of the soil. The physical nature of PittMoss provides sites for biological growth as well as fertilizer and water retention. The pH of PittMoss contributes to ideal chemical conditions for the plant rhizosphere, promoting nutrient uptake and root development.

The nature of dryland soils necessitates the use of consistent amendments which benefit all soil properties. For this reason, PittMoss was explored as an option for improving the properties of dryland soils using water holding capacity as the primary indicator of improvement. This study was conducted entirely by Chad Berquist at his facility in Phoenix, Arizona, USA. In this study, PittMoss was mixed with his native desert soil at varying ratios. Mr. Berquist found that increasing quantities of PittMoss relative to the amount of native soil increased the water holding capacity of the substrate. Additionally, he noted increased resilience to heat and decrease in tendency to crust over and compact when PittMoss was present in the mix. Overall, he found that PittMoss improved the soil properties in his dryland context.



Figure 4. Vigorous roots of a tomato plant grown in PittMoss.

METHODOLOGY

Testing commenced on June 27th, 2021. Eight (8) different soil blends of 128 fluid ounces total of soil were tested for their ability to hold water over time. Two of the blends were composed of either 100% PittMoss Prime or 100% native soil. The other blends were mixtures of PittMoss and soil. A full list of the blends is as follows:

- | | |
|---------------------------------|----------------------|
| 1. 100% Native Soil (NS) | 5. 60% NS and 40% PM |
| 2. 90% NS and 10% PittMoss (PM) | 6. 50% NS and 50% PM |
| 3. 80% NS and 20% PM | 7. 40% NS and 60% PM |
| 4. 70% NS and 30% PM | 8. 100% PM |

The actual blends were created by measuring the volume of each component and then mixing them together. The PittMoss was not compressed when determining the volume. Each blend was first weighed prior to fully saturating each mix with water for 24 hours. Following the saturation procedure, the blends were allowed to drain for 24 hours,

² <https://www.mdpi.com/2073-4395/9/6/327>

³ https://www.researchgate.net/profile/Wail-Omran/publication/272176555_Benefit_From_Agricultural_Waste_to_Improve_the_Properties_of_Desert_Land_and_Resist_Environmental_pollution/links/54e321ad0cf2d618e195dc2e/Benefit-From-Agricultural-Waste-to-Improve-the-Properties-of-Desert-Land-and-Resist-Environmental-pollution.pdf

⁴ https://www.researchgate.net/profile/Khamees-Jweir/publication/351097269_The_Role_of_Bio-Fertilizers_from_Azospirillum_Spp_And_Bacillus_Megaterium_in_Improving_Wheat_Yields_of_Sham_2_in_Desert_Soils/links/608680c48ea909241e26604a/The-Role-of-Bio-Fertilizers-from-Azospirillum-Spp-And-Bacillus-Megaterium-in-Improving-Wheat-Yields-of-Sham-2-in-Desert-Soils.pdf

leaving them at field capacity (FC). The blends were then weighed again at FC and then every other day after that until July 31st, 2021, providing just over a month of data.

It is important to note that, due to its high compressibility and extremely low bulk density, the volume of PittMoss *solids* used in this study was very different than the volume of native soil solids used. Native soil, depending on texture and structure, has a bulk density of anywhere from 1.3 – 2.3 g/cm³. In contrast, PittMoss, depending on the product, has a bulk density of anywhere from 0.11 – 0.24 g/cm³, averaging closer to 0.16 g/cm³. In this study, 3.785 L of native soil weighed 5164 g, meaning the bulk density of the native soil was 1.36 g/cm³. The PittMoss weighed 516.2 g, yielding a bulk density of 0.136 g/cm³. In other words, in the 50/50 blend of native soil and PittMoss, there was roughly 2573.8 g of native soil and only 257.38 g of PittMoss. On the whole, there was much more native soil in each blend than PittMoss.

RESULTS

Overall, the inclusion of PittMoss was able to increase the water holding capacity of the native soil. PittMoss alone was able to hold 5 times its own dry weight at field capacity. In contrast, the native soil held only 22% of its weight in water. Adding PittMoss to the native soil was able to significantly increase the amount of time it took for the soil to dry. Even at the lowest inclusion percentage of 10%, the blend containing PittMoss was a full two days behind the native soil in terms of drying (Figure 3). The 100% native soil blend reached 10% water by weight on day 14, whereas the blend containing 60% PittMoss never achieved that level of dryness, even after a month. All of the PittMoss blends containing at least 30% PittMoss took at least 22 days from the start of the study to achieve less than 10% water by weight.

Differences between the blends were most prominent at field capacity. At field capacity, the blend containing 60% PittMoss was 42% water by weight. In contrast, the native soil blend was only 23% water by weight. The relationship between the quantity of PittMoss and water holding capacity was relatively linear, with each 10% increase in PittMoss resulting in a roughly 3% increase in water holding capacity (Figure 4). However, when accounting for the 100% PittMoss control, which held 5 times its own weight in water at field capacity, the relationship is more accurately represented using an exponential equation. There is an indication that, at higher PittMoss percentages, the water holding capacity of the soil changes even more dramatically. However, this study did not include PittMoss percentages higher than 60% by volume.

DISCUSSION

In this study, PittMoss was shown to improve the water holding capacity of a native dryland soil at field capacity even at low percentages. It was also shown that the PittMoss, even at just 10% of a blend, improved the ability of a soil to retain that moisture for longer.

As shown in the data, the native soil achieved 10% moisture by weight fairly quickly (after 14 days) with no wind or sun acting upon the soil surface. This threshold is important: the permanent wilting point of a soil, or the point at which plants can no longer remove water from the soil, varies according to soil texture (Figure 5). The coarser the soil, the lower the water percentage at which permanent wilting point becomes a concern. This is

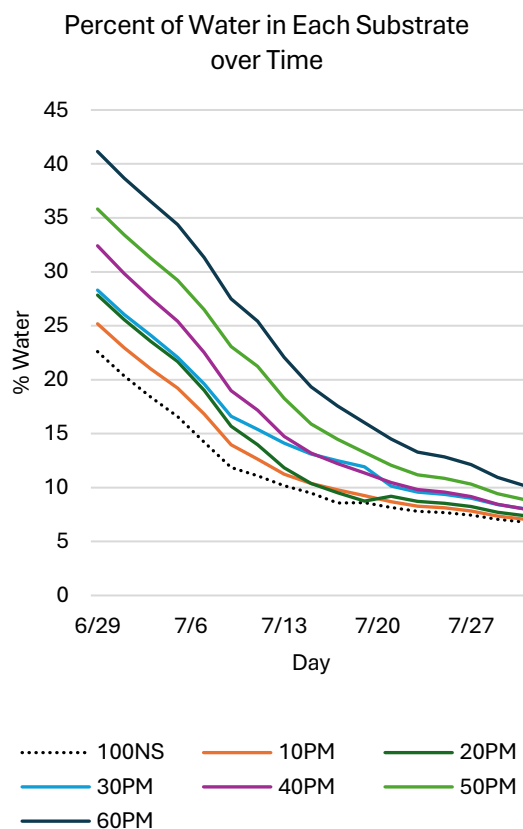


Figure 5. Percent of water in each blend over the course of the study. Percentages were calculated relative to the dry weight of each blend measured at the start of the study. The 100% PittMoss blend is excluded here to narrow the scale and better illustrate the curves of the other blends.

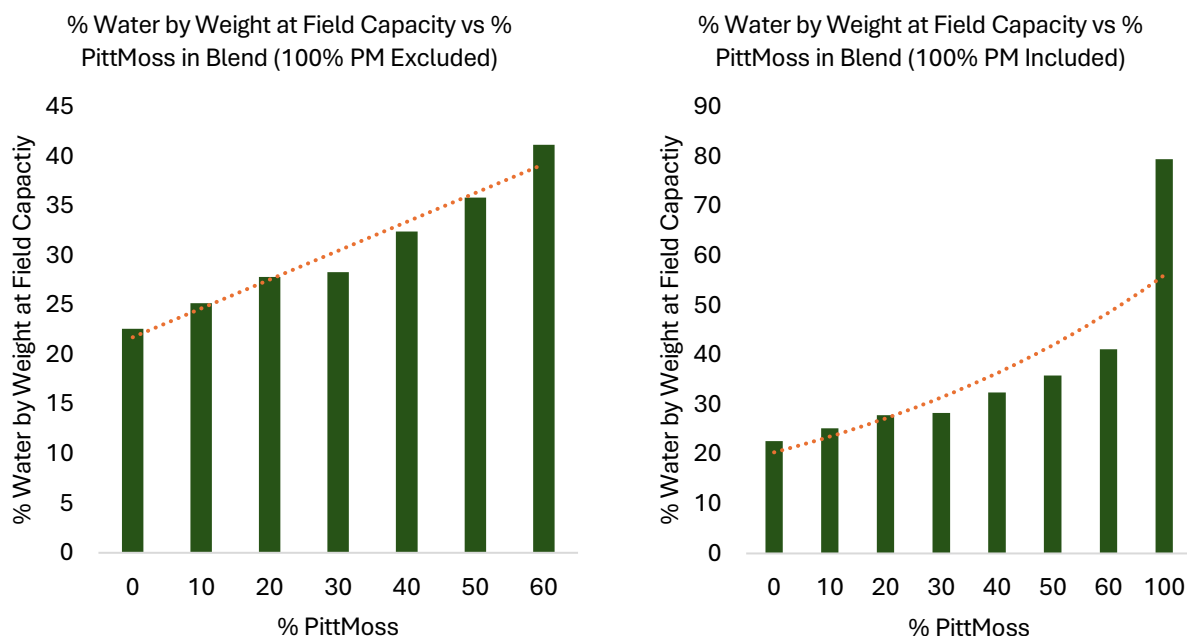


Figure 6. Percentage of water by weight at field capacity vs percent PittMoss in the blend. In the left graph, the 100% PittMoss control is not included. In the right graph, it is included.

because coarser particles hold water less tightly than finer particles. As the soil texture becomes finer, the moisture percentage of the permanent wilting point increases, meaning that, despite there being a higher percentage of water in the soil, plants can still wilt and die. A threshold of 10% is close to the permanent wilting point for loam, which reflects the likely texture of the soil used in this study.

Additions of PittMoss were shown to lengthen the time between when the soil was at field capacity and when it achieved a permanent wilting point threshold of 10%, indicating that the amount of plant available water in the soil increased (Figure 6). PittMoss itself does not increase the permanent wilting point threshold; similar to loam, water in PittMoss becomes unavailable at approximately 10% moisture by weight. The implication of this finding is that plants can go significantly longer without additional water in dryland soils amended with PittMoss, and the amount of PittMoss added directly affects the quantity of plant available water in the soil.

Though this study was small, the implications are great. Drylands are places where water is a scarce resource provided infrequently by nature. Dryland soils are often depleted of clay particles and organic matter, both of which hold moisture, making them unsuitable for normal crop production. Moreover, conventional agricultural practices further deplete soils of organic matter and finer particles, worsening the problem. In the dryland context, soil amendments which hold significant quantities of moisture and retain it for long periods are essential. This allows for the production of

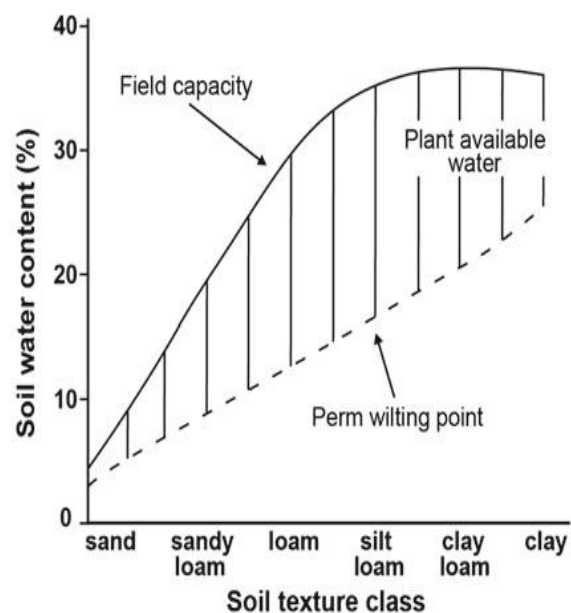


Figure 7. An illustration of different water thresholds in soil based on soil texture.

From: https://www.researchgate.net/publication/369074344_Soil_Water_and_Nutrients

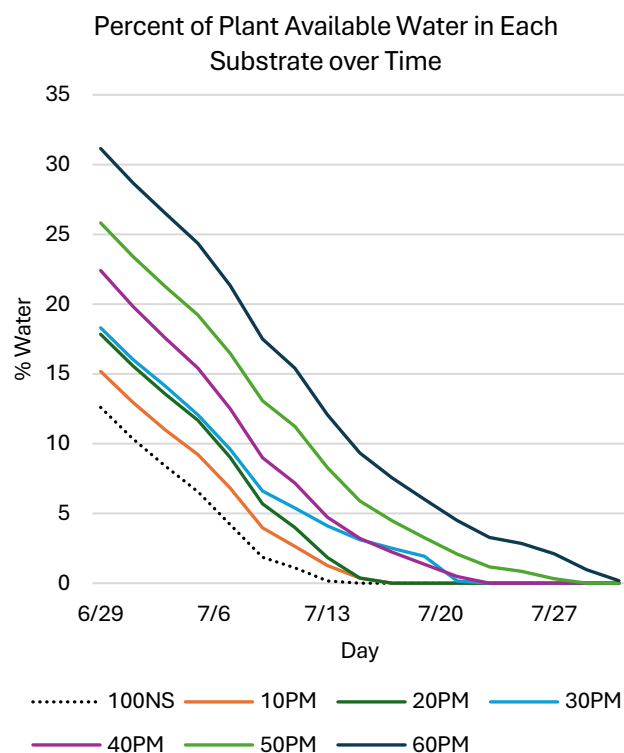


Figure 8. Percentage of water that is plant available in each substrate over the course of the study.

blends with higher percentages of PittMoss resisted crusting over, continuing to allow for gas exchange despite significant drying. In the blends with lower quantities of PittMoss, crusting and caking created a solid, impermeable layer on the surface of the soil which limited gas exchange. The addition of larger quantities of PittMoss (>30%) seemed to mitigate this effect.

CONCLUSIONS

The application of PittMoss to dryland soils should be further studied. It is anticipated that including PittMoss in dryland soils could result in significant water savings and improved crop development in most dryland environments, and, where soils are sandy, adding PittMoss would also significantly improve fertilizer efficiency. Similar benefits have been noted when using PittMoss as an amendment to typical substrate components in containerized production. Improvement of dryland soil conditions for crop production is critical as communities seek resilience and sustainability for themselves in the short and long term. PittMoss may contribute to this mission as a consistent, clean, high-performance amendment which may be produced locally using waste materials.

many food crops which rely on a consistent supply of water to grow and produce high yields without reliance on intensive irrigation schemes.

The climate of Phoenix, Arizona (where this study was conducted) is extremely dry, and the native soils there reflect the nature of the climate.⁵ The native soil used for this study was likely of the Estrella or Mohall series, both of which are typical alluvial desert soils with high pH values (>8), low organic matter percentages (0.5-1%), moderate sand percentages (30-45%), and somewhat high clay percentages (20-35%). Estrella is classified as a typic torrifluent, and Mohall is classified as a typic calciargid according to the USDA Soil Taxonomy system.⁶ These soils are not ideal for growing crops thanks to their challenging physical and chemical properties. Additions of PittMoss to these dryland soils were able to improve the physical properties of the native soil.

In addition to the quantitative study findings, the researcher also noted the benefit of added PittMoss in his regular production. During a 119°F heat wave, he noted that the plants he had growing in PittMoss and in PittMoss blends continued to thrive while his other plants suffered in the heat. He also noted that the study

⁵ <https://alluvialsoillab.com/blogs/soil-testing/soil-testing-in-phoenix?srsId=AfmBOop-gqMUmYd2Koj-MLBel67KW9kv5T2SYyPK5KKTYylsf21rn6D>

⁶ <https://cales.arizona.edu/oats/soils/surveys/az/az.html>

ORIGINAL STUDY REPORT FROM CHAD BERQUIST

This section includes direct correspondence from Chad regarding his study and its results. Chad's words have not been modified from their original form.

We are currently experiencing a massive heat wave. News said 119 yesterday. It is crazy hot right now. My personal garden is suffering during the hottest part of the day. But the PittMoss and soil blends are doing great. You can see during the hottest part of the day they get a little wilted due to the heat and dryness, but it bounces right back. I have high hopes for these plants and these particular soil blends.

When talking with the Pittmoss soil scientist and on their website itself they have recommended 30% to 50%. I'm currently putting together a study to test the moisture retention properties of 20%, 30%, 40%, 50%, 60%, 70%, Plus straight soil and straight Pittmoss controls.

Determining the proper amount will be difficult as it is so compressible. So the easiest way is probably to go by their own designation of cubic feet of product versus square-foot of the land. I put out 4 inches of loose Pittmoss and till it into a depth of 8+ inches. This may seem like a 50/50 mix, but due to the compressibility of Pittmoss it is not.

My growing season is unique in the fact that I have two. One in the spring and one in the fall. So far 25% does well for one growing season but its effectiveness tapers off as it breaks down halfway through the year. Conversely I have some tubs that are more than 50% Pittmoss that are now going on their third season with no amendments other than granular fertilizer.

I have found that it also depends on the plant itself. I had some plants grow spectacularly well in pure Pittmoss but they suffered when you started to mix in dirt. Whereas other plants suffered in the pure Pittmoss but grew very well once some dirt was mixed in. The correct ratio will definitely depend on the type of crops being planted.

Amount and frequency used will probably be determined by the type of crop. If you have a crop that is going to take an entire year to harvest adding a lot of Pittmoss at the beginning might be advantageous as to not disturb the soil throughout the year. Whereas a quick turn crop, herbs and things of that nature, a lower amount of Pittmoss over several applications during the year as the ground is turned over might be what is needed.

The chosen ratios were 100% dirt and 100% Pittmoss for control. Then 90%, 80%, 70%, 60%, 50%, 40% dirt, by volume, respectively. We are trying to find out the best ratio for water retention going forward with inground Pittmoss with desert soil.

I started this by taking 128 fluid ounces of the particular ratios and completely hydrating them for 24 hours. They were then covered with a fine material and allowed to drain off any excess moisture for 24 hours. At that point I consider them completely saturated holding as much moisture as possible.

Now testing could begin. All containers were placed in a test area with no sun or wind. One of the moisture/temperature sensors was placed near to monitor in real time the environment they were in and so it could be catalogued and reviewed if necessary. Everything was weighed every other day so we could monitor the amount of moisture leaving each container individually over the course of one month. All weights are in grams so calculating the volume of water will be easy.

In the inground scenario for the Pittmoss it is going to do two things I have found. It will help hold the moisture, yes. But more importantly it helps reduce the density of a given volume. This makes everything lighter and less likely to compact on itself. It's also allows much more diffusion of water, nutrients, and atmosphere to the roots.

What I found is a clear delineation in the soil heavy ratios at the 10 day mark. You can see this in the line graph. The surface becomes extremely hard and unable to pass moisture or air through. They basically become hard like Clay to the point I would need a hammer to drive a nail into the surface. It becomes near impossible to get any gas diffusion or

water absorption at this point. That's why it levels out fairly quickly as it no longer loses moisture through the top. It just stays a hard mess an inch under the surface.

The best looking option so far are;

#5 at 70% dirt, maximum dirt percentage to make Pittmoss A viable option.

#6 at 60% dirt, better than 70%.

#7 at 50% dirt, would be a good balance.

Proper incorporation with soil that is ready to receive Pittmoss will be key. Dry and dusty is no good, muddy and wet is no good. Keeping it as light and fluffy as possible to take advantage of its aeration and moisture retention properties be a main goal for best crop yields.

As you can tell by the Pittmoss's five fold water retention it will hold water extremely well, nearly 80% of its weight is water. It's just using it in a proper amount and incorporating it in the best fashion possible.

Customer Case Studies

Exploring how our customers have used PittMoss to conserve water in the real world

Farming Old Soils with New Technologies at Farm Up Jamaica

By Margaret Cullinan and Mark Goldman

INTRODUCTION

Farm Up Jamaica in South Manchester, Jamaica, is focused on farming despite extremely challenging conditions for agriculture. The climate in South Manchester is warm all year round and has distinct wet and dry seasons, with as little as half an inch of rainfall occurring during the height of the dry season from November to April. A summer dry season also occurs but often brings with it brief but extremely heavy rainstorms. The soils in Jamaica are extremely old and weathered, and they typically have rapid drainage and bauxitic properties. The challenging climate combined with limiting soil properties makes proper water management for crops very difficult, as crops are entirely rainfed and given no support via irrigation.⁷ At the Farm Up Jamaica facility, specifically, the farmers face the added challenges of sloping fields, further increasing the likelihood that water will be lost before crops have a chance to utilize it.



The fields at Farm Up Jamaica.

From: <https://farmupjamaica.org/gallery/>

Farm Up Jamaica strives to make Jamaica more self-sufficient by educating a younger generation of organic farmers to grow using climate-smart agricultural techniques and technologies. One of the technologies they have deployed with great success has been the use of PittMoss to increase the water holding capacity and workability of their local soils. Thanks to PittMoss, Farm Up Jamaica has had great success with their crops despite all their challenges.

OLD SOILS MEET NEW TECHNOLOGIES

The soils in Jamaica are highly weathered, low in fertility, and extremely high in clay content. Despite their high clay content, these soils drain water freely thanks to their high degree of aggregation. Jamaican soils also have low cation exchange capacity, high quantities of aluminum and iron, and they may be resistant to fertilization.⁸ In addition to the natural limitations of the soil, at Farm Up Jamaica, the soils have a history of chemical overapplication, further jeopardizing plant health. Overall, these soils present multiple challenges to the farmers who wish to grow on them.

At Farm Up Jamaica, PittMoss is used to help mitigate some of these issues. PittMoss is a newer player in regenerative agriculture, but it can dramatically improve challenging soil conditions while simultaneously reducing waste. PittMoss is made from recycled paper and cardboard using a patented process to create a valuable soil amendment and PittMoss replacement. PittMoss is known for its incredible water holding capacity, light weight, and ability to retain and release nutrients as needed. Neil Curtis, Founder and Executive Director at Farm Up Jamaica, talked twice with Mark Goldman of PittMoss to discuss the benefits of PittMoss as experienced by his organization.

⁷ *Description of the Environment, Conrad Douglas & Associates Ltd.* https://www.nepa.gov.jm/sites/default/files/2019-12/final_report_south_manchester_eia_jamalco2.pdf

⁸ *Genesis, Mineralogy and Related Properties of West Indian Soils: I. Bauxitic Soils of Jamaica*, Ahmad et al. <https://access.onlinelibrary.wiley.com/doi/abs/10.2136/sssaj1966.03615995003000060019x>

Interviews with Neil Curtis, Founder and Executive Director at Farm Up Jamaica

Interview from September 18, 2025

Mark: Hi, Neil. Good to speak with you today. Would you speak to your experience with PittMoss, the value, the practical value, that you see it having for your application.

Neil: Sure. We've used PittMoss in several applications. In most applications, especially after we were able to perfect what we needed PittMoss to do, PittMoss did prove to do what it advertises that it does, which is to reduce usage of water and use water more efficiently. And saying that, compounded with the right mixtures, will give you the farming results that you need.

It'll help you to grow food in arid weather or drier weather, and it will do its job. It makes a few claims about aeration and the breaking up of clay soil and things like that. It actually does what it says it does. We've had success with pineapple in droughts that could last four to six months in some cases. And although pineapple is a succulent, the pineapple would still grow more successfully in a more reduced stressed type situation based on the mixture and the addition, adding PittMoss to the mixture.

So yeah, we've had great success. I mean, again, I think your farming practices are important in whatever you're doing; and I also believe that, done correctly, you can definitely extend the life of your crop by incorporating PittMoss.

Thank you for that. What is the nature of the soil that you're working with and the improvements that you see? But first, would you mention your position and the country you're working with?

The name of our organization is Farm Up Jamaica, and I'm with the executive team. I'm Neil Curtis, the executive director. And this has been maybe, I don't know, it's been at least what, eight or nine years? How long has it been?

Yeah, that's a good estimate.

Maybe seven, eight, nine years that we've been testing and researching with the product. And like I say, we work in Jamaica. It's very hot, very arid. In many cases, the soil is cracking because it's that arid, it's that dry. And again, if we put a little more time and effort into protecting our crops and using PittMoss in the equation to improve our soil, yes, we can do better for the future of indigenous agriculture. Even in the south, you can still grow crops.



Cracked soils at Farm Up Jamaica. The bauxitic soils of Jamaica are almost entirely clay and highly aggregated. In dry weather, this can lead to cracks where water may easily escape before plants have a chance to utilize it. With the help of PittMoss, crops are able to thrive in spite of infrequent rain and difficult soil conditions.

From: Neil Curtis, Farm Up Jamaica



Students and instructors at Farm Up Jamaica evaluate a PittMoss blend for use with their plants and soils.

From: <https://farmupjamaica.org/program-heart-trust/>



More crops at Farm Up Jamaica.

From: Neil Curtis, Farm Up Jamaica

Thank you for addressing the concerns of your organization and what you would like to accomplish. In terms of the pineapple crop specifically, how can you measure that PittMoss, in conjunction with your technology, will achieve the results that you need?

Well, we were able to grow pineapple. We had an influx or an abundance of peelings that the pineapple was generating. Again, our mixture of PittMoss with our technology is the answer. And I can say that as it relates to maintaining moisture, if you want to credit the better developed root system, it was instrumental definitely in that regard.

We grew pineapple. Our pineapple is very organic. We don't use chemicals or pesticides, so we end up with a higher quality of pineapple. And even to the point where people who have allergies can enjoy our pineapple. They don't get allergic to eating it, although they may get allergic to eating other pineapples that are probably chemicalized or whatever.

But PittMoss has worked in conjunction with our methodology and has helped in the bringing that crop to harvest. And, what are the right words, successful and healthy and climate-smart.

Thank you very much for speaking with me. Thank you for the interview.

Thank you. Bye.

Interview from February 20, 2022

Mark: Hi, Neil. It's Mark calling. I'd like to ask you about the event where the 3,000 pineapples were planted. Would you give us a description, please?

Neil: Yes, certainly. So on February 8th and 9th, 2022, we had approximately 300 people plant 3,000 pineapples in the parish of Hanover, Jamaica. Now, the group came down from the United States, but included people from around the world, China, Russia, just to name a few, and Americans, of course. And what it was for was to support Farm Up Jamaica through this company, and the company's name is doTERRA, and they make essential oils, probably one of the largest essential oil manufacturers in the world. I think they're number one right now. They came to support our cause in creating sustainable agriculture, and we explained to them how to do sustainable, organic, climate-smart agriculture.

One of the products that we used was PittMoss in creating a potting mix, if you want to call it, that would go in each hole that the pineapples were planted into. And so, each hole received a mixture of soil, PittMoss, and other elements and sands that we mixed together, and we planted 3,000 pineapples that day or those two days. It was a wonderful event. They came out to support us as part of their corporate social responsibility of their company, and these are the types of activities that Farm Up Jamaica does in addition to selling products like merchandise, whether it'd be a shirt or a hat or products, whether it'd be PittMoss or other agriculture inputs.



Planting pineapples with PittMoss.
From: <https://farmupjamaica.org/gallery/>

Could you explain briefly the relationship between PittMoss and Farm Up Jamaica in terms of the product that we're making for you and the smart event?

Certainly. So what happens is we've identified PittMoss as one of the inputs that can be very sustainable for regenerative and climate-smart agriculture, simply because it's a very sustainable use of products that are already on the Earth, whether it'd be newspaper, tree bark, and whatever else is used in that formula to create this wonderful amendment that helps us to now plant food. Whether it would be pineapples, or cucumbers, or whatever it is that we're planting, [we don't] worry as much as we would about drought. We also understand the additional benefits that it has of water retention and also the aeration of the soil, and also the whole idea of not having to use up all of our water resources and cutting down the amount of water that we use to water our crops since we've been using it.

It definitely speaks to the event that we had on the eighth and the ninth as it sends that signal that we are using all of the sustainable and climate-smart type materials in the soil. This particular event was to demonstrate that, so we did explain to them what it was that they were putting in the holes. The people understood that yes, this is a mixture of PittMoss and other elements that we use to do this climate-smart agriculture, which will keep the soil a bit moister and give these pineapples a longer life.

In terms of the limitations of the soil as is, would you address the industrial agriculture that existed and the mission of Farm Up Jamaica to improve the soil?

Well, because we're doing climate-smart and regenerative agriculture, what happens is that we look for items that work best in the soil. The soil that we are normally working in is soil that is tainted. It's been over-chemicalized simply because many of the farmers are not experienced in using the chemicals and end up using too much of the chemicals and actually mix at the wrong ratios and do tons of things that may not be so above board, if you call it that.

But here is where we are training young people in agriculture through the mission of Farm Up Jamaica, which is to help reduce the importation of foreign food into Jamaica, increase Jamaican exports out of Jamaica, put young people— young farmers—back into the art of agriculture in that organic, climate-smart, regenerative way, and to help reduce crime and poverty by creating opportunities to the point where we even want to kickstart a lot of these young farmers and get them their own farms and then have them supply the local hotels and this billion-dollar tourist industry that's here in Jamaica and also supply some of our buyers in the United States, whether it'd be Whole Foods or Aldi and what have you.

And then, that automatically creates sustainability because now, the young people that we put to work have a mission in life. They can wake up in the morning and make a living because the living wage in Jamaica is only about 10 to \$11 a day for people in agriculture, so that doesn't constitute much, and it's not enough for people to live off of. And so, we're trying to keep people alive through agriculture, and PittMoss would save a whole lot of crops that would normally die in the drought.

Great. Thank you for your time. I appreciate the interview, and I'll end the interview now. Thank you, Neil.

Wonderful.

Okay. Have a good day. Bye.

CONCLUSION

Farming in Jamaica is challenging thanks to its seasonal rainfall, lack of irrigation, and bauxitic soils. As more young Jamaican farmers strive for independence in their food supply chains, resilience to climate change, and sustainable living, new technologies can help them succeed in spite of the challenges they face. One such technology, PittMoss, is already helping farmers on the ground grow better crops with less water. PittMoss can have a large impact on farming in other areas of the globe where water is scarce and soils are poor for farming.

Growing in the Gulf: Helping Hot & Dry Soils in Kuwait with PittMoss

By Margaret Cullinan

INTRODUCTION

It is no secret that the countries in the Middle East are subject to a hot and dry climate, and they are more likely to face desertification in this era of climate change. Agriculture and urbanization can increase rates of desertification, especially in such hot and dry places, making proper soil and water management critical to food security in these regions.

A recent meta-analysis published in *Science of the Total Environment* has underscored the urgency of proper soil management and explored the use of constructed soils for soil restoration and preservation in the Middle East and North Africa.⁹ In this study, different approaches previously explored for amending and constructing soils in the Middle East using local waste materials were discussed. Various materials and approaches were examined for their efficacy in improving the water efficiency and plant growth properties of the soils in this region. The study highlighted the use of local wastes and paper materials as preferable for use in mulch layers, and emphasized the importance of implementing “cost-effective, scalable, and reliable solutions” to combat desertification in the Middle East and North Africa.

One such solution not considered in this study is PittMoss. PittMoss is made from locally sources cellulosic waste products like paper and cardboard. It can also be made with fibrous plant feedstocks, increasing the share of the solid waste supply chain which the production of PittMoss may divert from landfills. PittMoss is not just suitable as a mulch, however: it's a valuable soil amendment which may immediately increase the water holding capacity and structure of soils in dryland environments.

Dr. Jasim Basteki of Sustainable Organic Q8 has first-hand experience using PittMoss to improve soils in Kuwait. The soils in Kuwait are not naturally conducive to the cultivation of many crops. Kuwait's soils are classified mostly as aridisols. Aridisols are soils whose properties are largely governed by a lack of moisture. They are predominantly sandy, dry, and hot, and they are often limiting for agricultural use due to cemented horizons and high salt content. Some typical profiles of soils in Kuwait are shown in the figure to the right, which was originally published by Omar & Shahid in 2013.¹⁰ Growing in containers is also challenging thanks to the extreme heat and dryness in the region. Dr. Basteki has had success utilizing PittMoss both as a mulch and in soil mixes in different contexts for the purpose of conserving water resources.

Recently, Dr. Basteki sent us a video postcard to tell us about his experience using PittMoss in his region. Follow the link to his video or read the transcript included here to hear directly from Dr. Basteki.

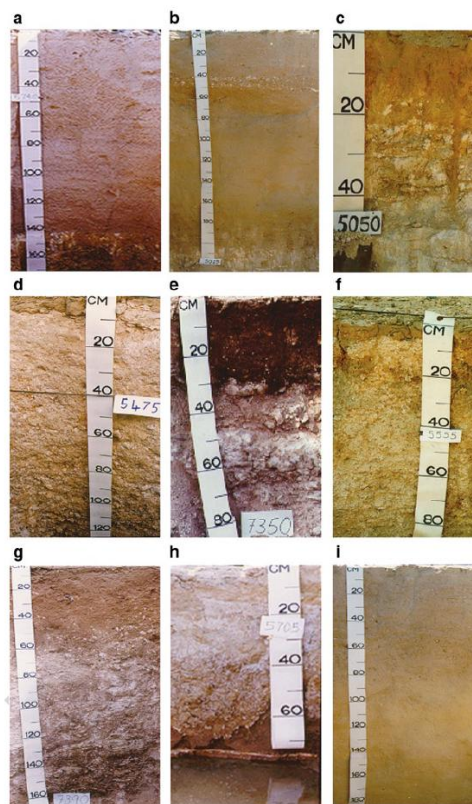


Fig. 3.3 Typical soil profiles of major soil families identified in Kuwait. (a) Typic Haplogypsis, (b) Typic Haplocalcids, (c) Calcic Petrogypsis Hardpan 40 cm, (d) Leptic Haplogypsis, (e) Petrocalcic Petrogypsis, (f) Typic Petrogypsis, (g) Typic Calcigypsis, (h) Gypsic Aquisalids, (i) Typic Torripsamments

⁹ The urgency of building soils for Middle Eastern and North African countries: Economic, environmental, and health solutions, Deeb et al. 2024; <https://www.sciencedirect.com/science/article/pii/S0048969724006661>

¹⁰ Reconnaissance Soil Survey for the State of Kuwait, Omar and Shahid, 2013; https://www.researchgate.net/publication/286837060_Reconnaissance_Soil_Survey_for_the_State_of_Kuwait

COMMENTS FROM DR. BASTEKI

This transcript has been lightly edited for clarity. The original video may be accessed here:

[20250924_Video Testimonial_Dr Jasim Basteki Sustainable Organic Q8.mp4](#)

My name is Dr. Jasim Basteki. I am from Kuwait and I have been working with and using PittMoss in my own soil mixes and also for our customers for a sustainable organic company in Kuwait for maybe four, five years, something like this. Let's say four years. The product is amazing. Let's not talk about how awesome it is that we are able to recycle and reuse a lot of the organic waste directly into the soil and substituting for scarce resources. Let's not talk about this.

In the Middle East specifically, PittMoss is incredible. It has insulating properties. I noticed that it has heat insulating properties that noticeably makes my soil and the root zone much cooler during the summer during this scorching hot summer in Kuwait—at least the hottest country in the Gulf, in the Middle East, actually, perhaps the whole world—but not just that; especially for people that grow on their balconies and on their rooftop, and there's a lot of people—there is a movement of people growing on a rooftop and on their balconies. Soil mixes made with PittMoss, be it the sole base material or even something as low as a 10, 20, 30% component into the mix is making the soil mix much, much lighter. And when used with fabric containers, it's an even lighter growing setup for your rooftop and your balcony than using any other soil. It's really great in that it holds a lot of moisture, and that's also amazing for our hot and dry summer. Our summer isn't just hot, reaching above 120 degrees Fahrenheit, but it's also super, super dry with high, obviously high, hot and dry winds. So PittMoss helps us amazingly as part of the soil mixes.

I know that I also use it in my mulch mixes; mixing about 50/50 between grower grade and bark fines, or even 40, 60, something like that. Like I said, it's insulating, but also when it dries, it creates a nice crust on the surface of the soil, making it an incredible mulch for resistant and annoying weeds, it prevents them from growing, but most importantly for the hot and dry summer, when PittMoss is incorporated in the mulch mixes, it creates a “biscuit” of crust that is resistant to the high winds, and that's—these are some of the reasons why I love PittMoss.

PittMoss also harbors amazing microbes, and it creates a good housing for nice soil biology, and it allows for the soil biology because it aerates the soil, because it retains moisture, and because it maintains the soil temperature at a shorter range, it allows for the soil biology to thrive amazingly. And we actually notice that a lot of mushrooms grow really nicely in our soil mixes and in our mulch mixes that have the PittMoss in it. And these are some of the reasons why I highly recommend using PittMoss in our region, especially in Kuwait and the Gulf. Now, with having a lot of organic waste here, It'll be amazing to turn all this waste into a sustainable source for growing vegetables, or at least for helping amend and improve the soil quality for growing in this region.

Managing Heat Stress and Water Use in Cannabis with PittMoss

By Margaret Cullinan and Mark Goldman

INTRODUCTION

Even in the Golden State, growing isn't without its challenges. In California, the largest consumer of water is irrigated agriculture, yet water availability in the western USA continues to decrease. With conflicts over water resources on the rise, it is imperative that all types of growers in California find ways to decrease their water use and conserve this valuable resource.

Cannabis is a heavily demanding crop. It requires large inputs of both water and fertilizer to produce adequate yields for growers. In outdoor contexts, cannabis may use anywhere from 5.5 to 6 gallons of water per day over the course of its 150-day growing season. This means that, by the time it's harvested, a single plant may use anywhere from 825 to 900 gallons of water. A small outdoor farm of just 100 plants would use anywhere from 82,000 to 90,000 gallons of water to produce a crop.¹¹

At Up The Hill Farms in Ukiah, California, grower Marshall Davis sought out PittMoss for its ability to conserve water. This case study describes his experience and the results he reported back to PittMoss staff.

GROWING MORE, WATERING LESS

In July of 2018, Marshall planted 520 1.5-2" cannabis cuttings in a blend of 30% PittMoss Cannablend, 30% coconut fiber, and 40% fermented bark in 5 gallon containers. The soil blend was topped with a 2" layer of PittMoss CannaBlend to help manage heat stress and water loss. The containers were placed outside atop the soil on his farm. Despite temperatures exceeding 100 degrees Fahrenheit, Marshall was able to water his plants every 2 to 3 days. Initially, Marshall anticipated a growing season of 16 weeks, or 112 days, after transplant. Using the PittMoss, he achieved maturity and began harvesting his crop after just under 14 weeks, or 95 days, almost 2.5 weeks sooner than anticipated.

Marshall reported that his water use on the same number of pots the year previous exceeded 75,000 gallons, or 1.3 gallons per plant per day of a 16-week growing season. This is under the average water requirements for cannabis likely due to occasional rain or an absorbent potting mix. When using the PittMoss blend, however, Marshall used just 10,500 gallons of water, or 0.21 gallons per plant per day over the course of his 13.5-week growing season. He did not note increases in rain events. Reporting by the California Department of Water Resources indicates that 2017, the year he did not use PittMoss, was a historically wet year,¹² whereas 2018 saw a return of hot and dry conditions with historically high temperatures.¹³



CONCLUSION

Growing in California is challenging due to increasing threats of drought and high heat stress to plants. By just using PittMoss on his farm, grower Marshall Davis was able to use 86% less water during a historically hot and dry year while still producing his cannabis crop ahead of schedule.

¹¹ A narrative review on environmental impacts of cannabis cultivation, Zheng, Fiddes, and Yang, 2021;

<https://jcannabisresearch.biomedcentral.com/articles/10.1186/s42238-021-00090-0#ref-CR65>

¹² <http://water.ca.gov/-/media/DWR-Website/Web-Pages/Water-Basics/Drought/Files/Resources/Water-Year-2017---What-a-Difference-a-Year-Makes.pdf>

¹³ https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/Flood-Management/Flood-Data/Climate-summaries/Hydroclimate-Report_2018-ADA-Final.pdf

Select Customer Testimonials

Small comments with big impact showing how PittMoss saves water and grows better

INTRODUCTION

If there's one thing we've learned from our customers, it's that they are all unique. Still, time and time again, our customers tell us that they are able to save money and time and prevent plant loss thanks to PittMoss and its ability to conserve water. Just some of the comments we've heard from our customers are included in this section.

VIDEO TESTIMONIALS

[Interview with Greg McNish from All About Groundcover, Grove City, PA](#)

"We were excited to give [PittMoss] a try because we were desperately seeking a good additive to our mix that would offer us some water holding capacity... We have tried some different things since, and by far, PittMoss is our favorite."

"What PittMoss has done for us is greatly decrease our watering intervals; when things do dry out, which unfortunately happens, it takes water on a lot easier again once it's dry, which is probably the biggest, most significant thing we like about it. If you had two flats side-by-side, one with PittMoss, one without, when you water, the PittMoss flat is going to hold considerably more water before it starts running out the bottom."

"One of the first things that we noticed with PittMoss was that—we'd been struggling to come up with a good mix. Our mix was too heavy, so we worked really hard to lighten our mix up, and we did a great job of that, and unfortunately, we made it too light, and it would no longer retain any of our liquid fertilizer. As soon as we introduced the PittMoss, the difference was night and day, as to the water holding capacity, it held our fertilizer so our plants could uptake it."

[Interview with Mark Voss from Voss Organics in Madison, WI](#)

"I have to say that [PittMoss] really saved us this year... just the water retention, the fertility, the consistency, we really loved growing in it... I think the plants are so healthy, and just knowing that there is a moisture reservoir in there for them if they need it, the PittMoss is unparalleled in that regard."

Interviewer: So the water efficiency is there for you? "Yeah, I can see it. I notice it. For sure."

CUSTOMER & COLLABORATOR QUOTES

"PittMoss was used in conjunction with compost [as mulch] and a preliminary study showed that water use per avocado tree was cut from 144 gallons to 62.8 gallons per week."

- Leighton Morrison, Founder and CEO at Kingdom Aquaponics, LLC

"PittMoss® helps us immensely because we use much less water and we have to water less often... I can save literally hours and have that time to work on something else in the nursery. So for that reason, I love it. ...Sometimes when you plant something at a client's house, you install irrigation, you mulch it, you do everything right, but something can go wrong. It's nice to know that if you plant into the ground from a container that has PittMoss®, it reduces the transplant shock."

- Dennis de Zeeuw, Owner at Sustainscape, Inc.

"The mums we grew did very well in PittMoss. We were impressed with how well it held fertilizer--less leaching and less watering, especially early on and in this very hot summer. The plants in one greenhouse without a regular drip did noticeably better due to the PittMoss water retention. We'd have nice pictures

except people just snapped up the plants even before we planned to officially sell them. I am very happy. I only wish we had planted more!”

- Jake Franz, Owner and Chris Rhodes, Senior Grower and Partner at Frank’s Produce & Greenhouse

“After a decade of building soil blends based predominantly in coco coir and amending NW native soils, I was made a believer in PittMoss from the moment I was able to implement it into my systems. The body of the soil improved in its ability to hold air and water within the structure, and promoted fungal growth in ways that I had not experienced. The product has been an even better addition to my compost piles that intentionally cultivate indigenous microorganisms.”

- Andrew J. Buck, Owner at Oregon Coast Cannabis

“Nursery liner stock with iron deficiency were restored when upsized into 3 gallon containers incorporating PittMoss grower amendment into the potting mix along with a nitrogen supplement. PittMoss held the supplement that would ordinarily have flushed out, making it available to the plant tissue, saving the nursery stock and reducing the production time from 8 - 9 weeks to 5 weeks. This certainly surprised us and surpassed all expectations.”

- Karen Atwood, Soil Specialist at Greendell Landscape Solutions

"I found with PittMoss® I could grow and use less water. I grew mums that developed a good root system and could handle drying down and going without water for longer. Also, PittMoss® uses fertilizer in a more economical and sustainable manner with less runoff going into the groundwater."

- Wagner’s Greenhouse, Pennsylvania

"The one crop we did (overwintered), we planted 500 and were able to get our customer 490. I’m thrilled with that. The water-holding capacity and the nutrient-holding capacity of the blending mix allowed us to only have to water, at the earliest, every third day. A lot of times, we were able to get out towards the tail end of five days, depending on crop and weather conditions.”

- Sunset Farmstead, New Jersey

"I'm pleased to say that the soil [PittMoss] has been amazing. There was actually a week where I'm embarrassed to admit the hanging baskets and pots didn't get watered. Out of all the hanging baskets the PittMoss soil ones are the only ones that the calibrachoa survived in."

- Harrisburg Country Club, Pennsylvania