6 September 2022
GUDP Project: Biobased Growing Media for Plant Production – BioSubstrate 2.0

Research & Development of Peat Alternatives in Soilless Growing Media

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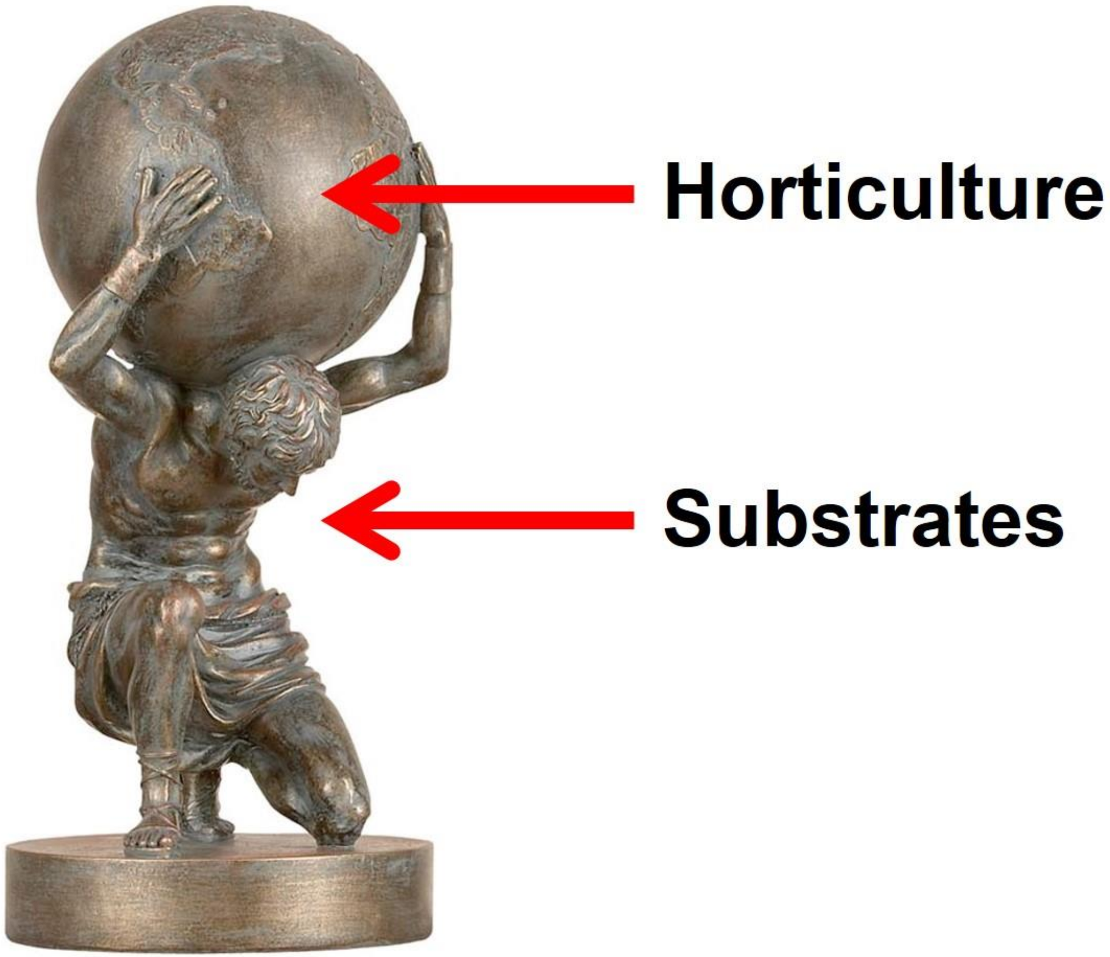
Substrate Science



"Solving Problems and Creating Opportunities"

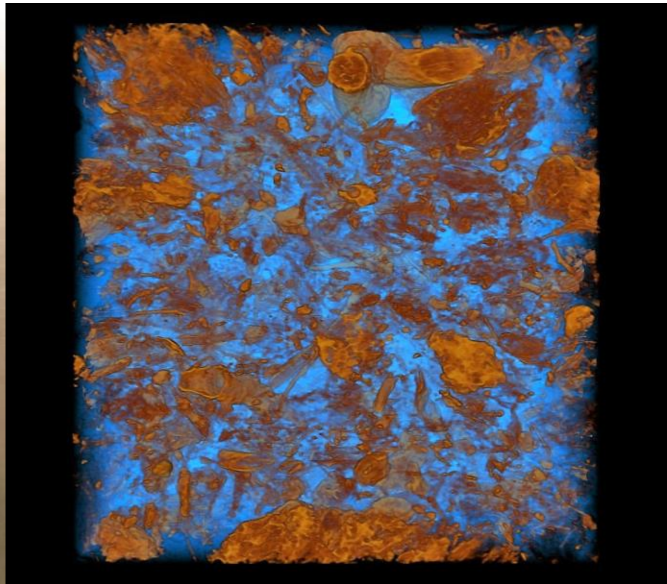
Horticultural Substrate Science Lab

Research & Service

Teaching & Mentoring

HSL: Substrate Analysis

- Physical Properties
- Hydrological Properties
- Chemical Properties
- Biological Properties



HSL: Material Engineering

- Bark Products
- Wood Products
- Agricultural Feedstocks
- Biomass Feedstocks

Soil vs Soilless Substrates

<u>Soil Scientist</u>

Water

Air

Solids

Plant Growth

Doctors:

Recovery and maintenance of functional systems

<u>Substrate Scientist</u>

Water

Air

Solids

Plant Growth

Engineers:

Creation of functional systems

Growing Media Demand

Future Demand for Growing Media

Table 4. Total estimated market in 2050 based on the expected market increase (Table 2) and a more realistic estimate of the potentially available materials (Table 3).

	2017 (Mm^3 $year^{-1}$)	2050 (Mm^3 $year^{-1}$)	Increase (%)
Peat	40	80	200
Coir	11	46	418
Wood fiber	3	30	1000
Bark	2	10	500
Compost	1	5	500
Perlite	1.5	10	667
Stone wool	0.9	4	433
Soils/tuffs	8	33	413
New		65	
Total	**67**	**283**	

Trend Setters and Market Drivers

“New Crops” Grown in Soilless Systems

- Leafy Greens & Herbs

"New Crops" Grown in Soilless Systems

- Veggies

"New Crops" Grown in Soilless Systems

- Veggies

“New Crops” Grown in Soilless Systems

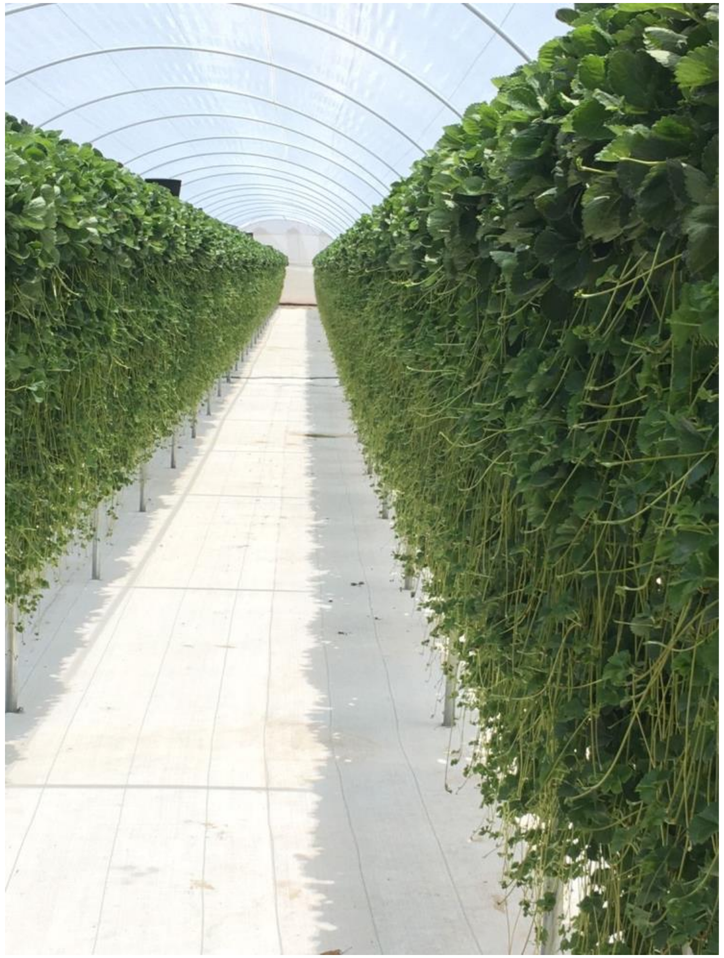
- Potatoes!!!!!!

"New Crops" Grown in Soilless Systems

- Cannabis

“New Crops” Grown in Soilless Systems

- Soft Fruit - Strawberries



“New Crops” Grown in Soilless Systems

- Soft Fruit - Blueberries

“New Crops” Grown in Soilless Systems

- Soft Fruit - Raspberries



“New Crops” Grown in Soilless Systems

- Soft Fruit - Figs

Controlled Environment & Vertical Farms

- Investment-backed Farming Systems have seen unprecedented acceptance& growth

- Engaged and educated the public on food production and security

Challenges Facing the Growing Media Industry

Challenges Facing the Growing Media Industry

- Due to on-going and future imposed, proposed, or perceived restrictions on peat extraction and use in horticulture, a global campaign to extend peat supplies and identify extenders and alternatives in underway.

Why Gardeners Should Stop Using Peat, and What to Use Instead

Finding a substitute for peat is a little like making your first cake without gluten. Here's what the experts advise.

Samples of soilless substrate materials to be tested for physical, chemical, hydrological and biological properties in the North Carolina State University research lab. Brian E. Jackson

By Margaret Roach

Feb. 2, 2022

FOR PEAT'S SAKE

A campaign led by Garden Organic

garden organic

The Issue | Peat-Free Growing | Our Campaign | Peat-Free Pledge

rte.ie

RTÉ

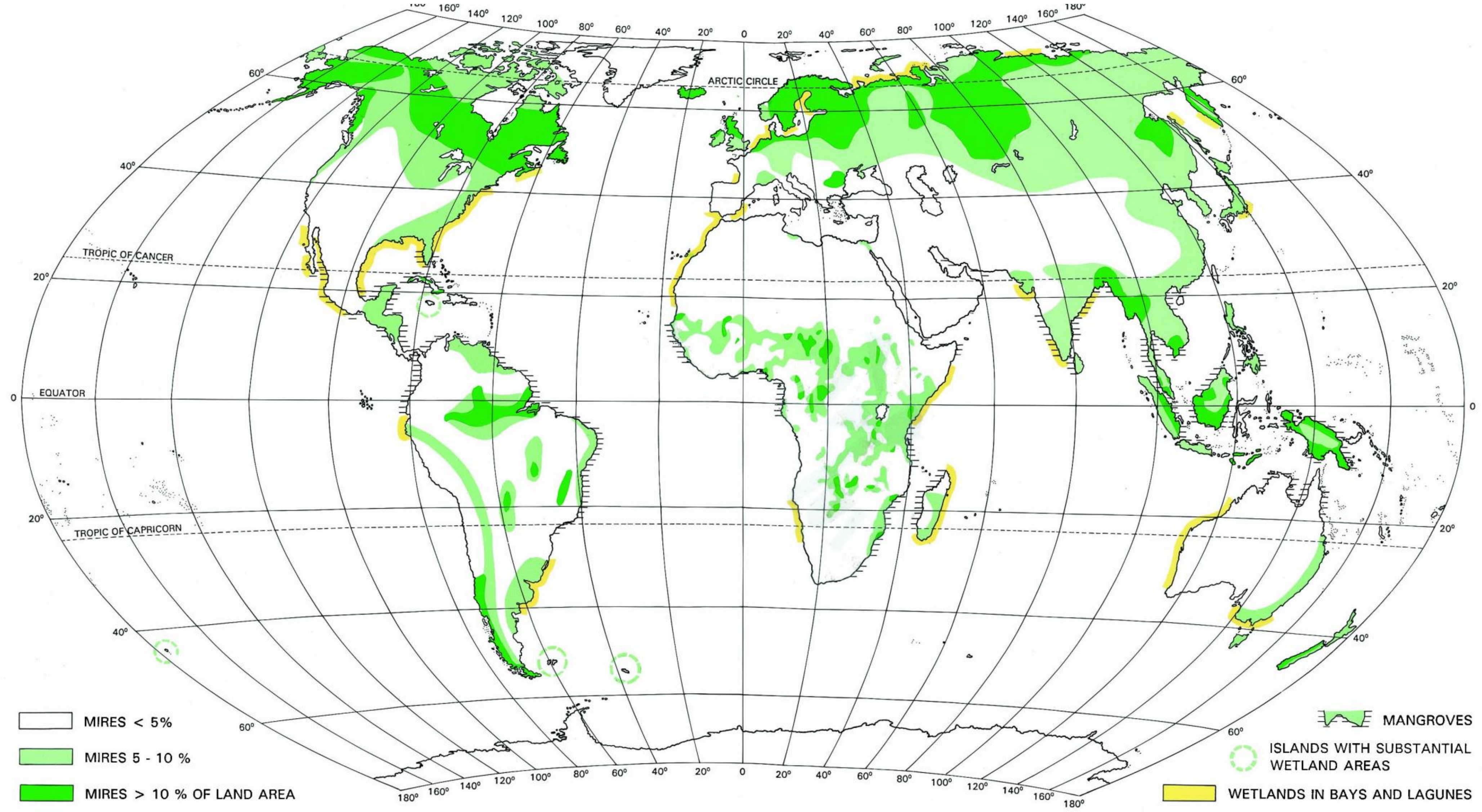
NEWS SPORT ENTERTAINMENT BUSINESS LIFESTYLE CULTURE PLAYER TV RADIO WEATHER

Horticulture at 'critical stage' over peat shortages

Updated / Tuesday, 6 Jul 2021 **16:02**

- **Current Demand AND Supply Chain is fueling the debate and concern.**

Peat Globally



Challenges Facing the Growing Media Industry

- ➢ Current regulatory threats on peat: Example in Chile….

Inside Climate News | Donate

Justice

Environmentalists in Chile Are Hoping to Replace the Country's Pinochet-Era Legal Framework With an 'Ecological Constitution'

A draft now being debated, which must be completed by July 5 and ratified in a national vote before September, would recognize the climate crisis and guarantee the rights of nature and animals.

By Katie Surma
April 3, 2022

moderndiplomacy.eu

HOMEPAGE > REGIONS > AMERICAS

Americas

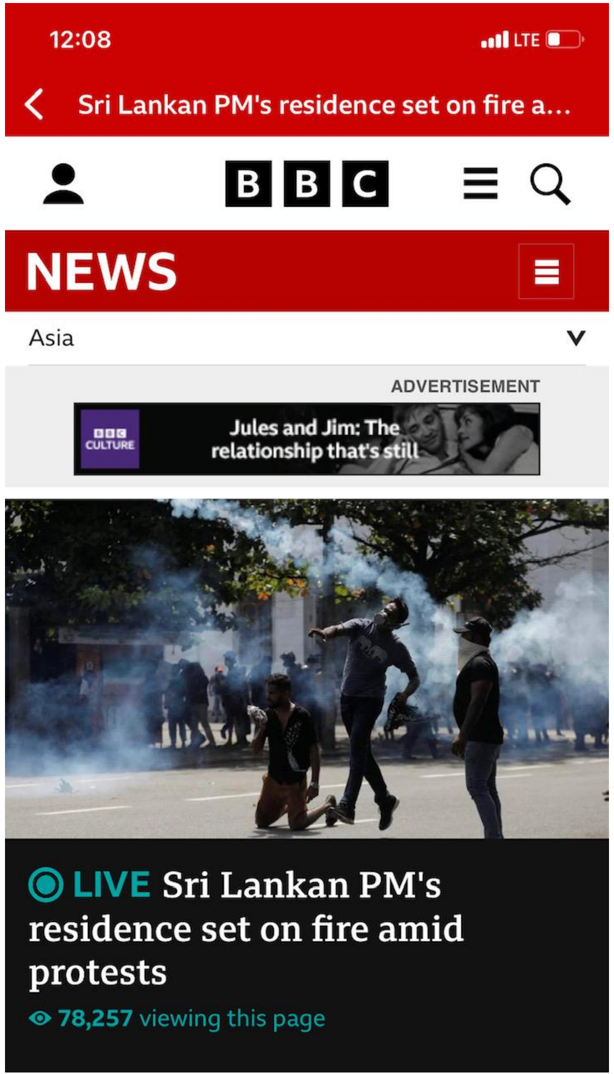
Balancing the Rights of Nature and Economic Development: The case of Boric's Chile

Chile, under its youngest President Gabriel Boric, has taken a historic step: to grant a Constitutional status to Rights of Nature. But can economic growth be simultaneously sustained?

A Green Constitution

Challenges Facing the Growing Media Industry

- Current governmental/economic situation in Sri Lanka (coconut coir)



BIO GROW NATURAL CHOICE

HORTI+

News from the Biogrow Group & more...

June 2022

Production continues in Sri Lanka

Anyone that follows the international news will have seen that Sri Lanka is going through some very difficult times at the moment.

Due to the complicated economic and political situation, the country is facing power cuts, and food, fuel and other essential items such as medicines are in short supply. There are multiple compounding factors that have caused this situation, which of course includes the impact of the COVID-19 pandemic.

In spite of the gravity of the situation, our production sites are all continuing to operate at full capacity. This is due in part to the Sri Lankan government's support of companies that export from Sri Lanka. Also, Biogrow is a well-established company with a strong network of local partners. Our director in Sri Lanka Nicolas Bourhis explained "We have a very close-knit and dedicated team of managers and suppliers, who really pull together when production needs to go up a gear. This is without a doubt one of our great strengths".

Innovation at the heart of the Vila Group

If you look behind the Biogrow brand you'll find the story of a family of French farmers, the Vilas, who have been growing fruit and vegetables in the South of France for the last 40 years.

They started off growing in open fields, then moved into greenhouse growing and for more than 2 decades now they've been producing and commercialising coco fibre substrates under the Biogrow brand, which they use in all their hydroponic production sites.

At the head of the operation is Bruno Vila. In the 15 years since Bruno took over the running of the family business, the Vila Group's activities have expanded, been modernized and this constant drive for more efficient and environmental growing continues today.

Nowadays, their activities include hydroponic production in greenhouses, orchards, organic growing, renewable energies, and of course the production and exportation of coconut fiber through the Biogrow company.

Connect with us:

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contact@bio-grow.com

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Edition 04

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IHC 2022
HORTICULTURE FOR A WORLD IN TRANSITION
ANGERS – FRANCE

Other New or Ongoing Challenges

- Geopolitical crises – pending and yet unknown
- Increasingly volatile global weather patterns affecting peat extraction
- Spread of misinformation and use of “cherry picked” data to drive corporate and political agendas (i.e. Sustainability Impact)
- Increasing global demand/reliance for MORE growing media!
- War in Ukraine and closing of RUS and BLR.
- Continued sea freight costs and Labor Shortages
- Fuel prices (material processing and ground transport)
- Discovery of ”Issues and Threats” of peat alternatives

Past, Present, and Future Initiatives to Address Problems and Evolve the Growing Media Industry

BioSubstrate 1.0

LCA OF PEAT, ALTERNATIVE SUBSTRATES AND GROWING MEDIA IN DENMARK

Fatemeh Hashemi
Postdoc
Agricultural systems and sustainability
Department of Agroecology

Conclusions

- All substrate components analyzed have a lower carbon footprint compared to peat
- Carbon footprint of peat-based substrates is almost the same except for wood fibre
- In order to achieve favorable plant cultivation properties, different components need to be blended depending on specific plant requirements
- We recommend substrate components:
  - ✓ That can be used without much processing,
  - ✓ That are not in competition with other users, and
  - ✓ That are based on local, low value, residual materials or wastes from forestry or agriculture

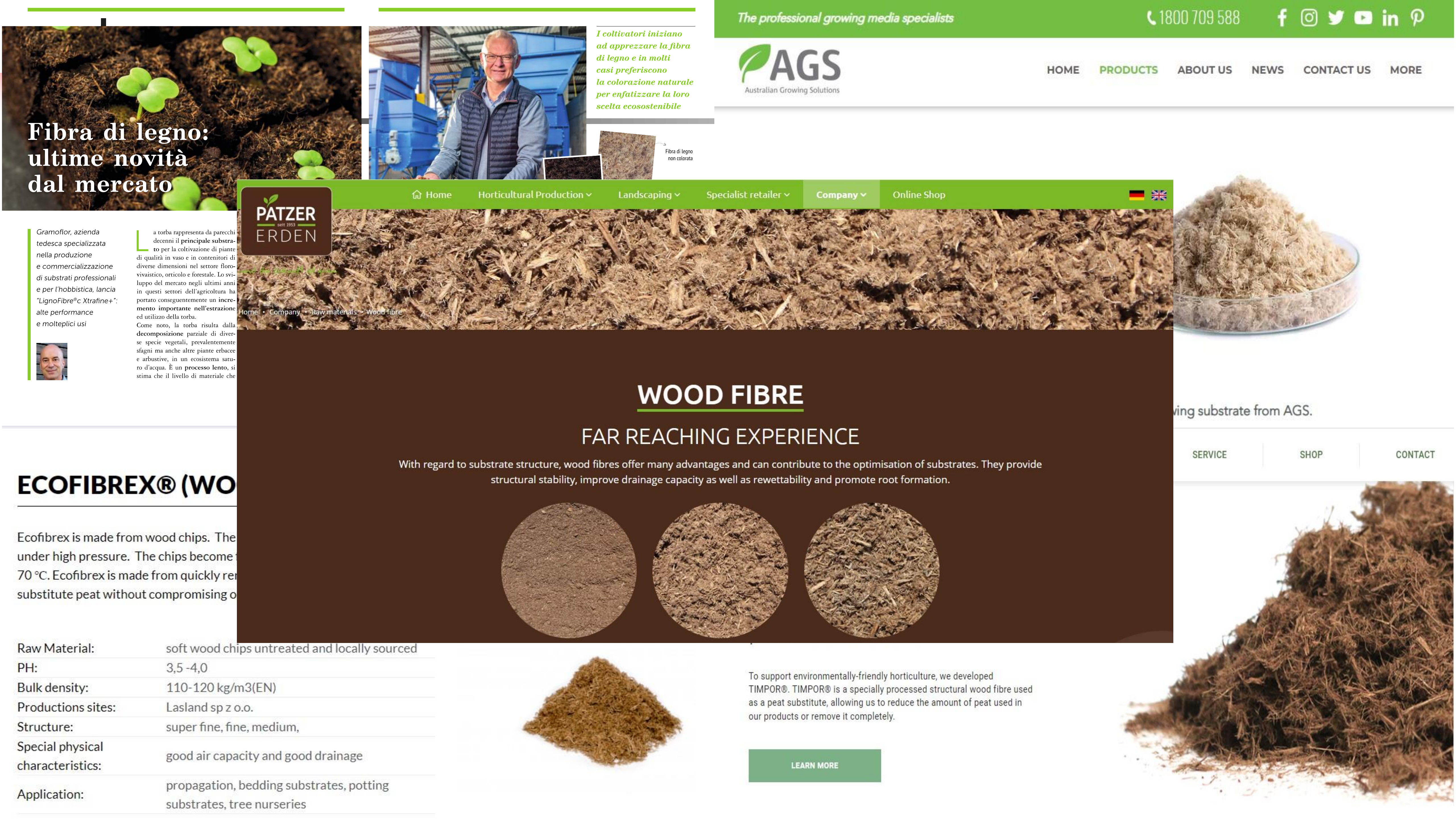
Wood Substrates

History of Wood Substrates

- Alain Courtabessis “invents” Hortifibre (circa 1979-1980)
- Original product was disc refined but switched to extruder
- Patented the process in 1981 (sold it; now expired)
- Since 1980………A LOT HAS HAPPENED!

Some Wood Products since 1980

- Hortifibre
- Toresa
- Culti-Fibre
- Pietal
- Torbo
- Torbella
- Bio-Culta
- Fibralur
- WoodPeat
- Fibrosana
- Ekofibre
- Lignofibre
- Ecofibrex
- Torpora
- Greenfibre
- Hydrafiber
- Forest Gold
- WoodGro
- Forest Fiber
- Forest Floor
- WoodTech
- West+
- LignoDrain
- Silvafibre
- TreeTechnology
- Pine Tree Substrate
- Clean Chip Residual
- EcoPeat
- Unalit
- Supa-Fyba
- WholeTree



Fibra di legno: ultime novità dal mercato
I coltivatori iniziano ad apprezzare la fibra di legno e in molti casi preferiscono la colorazione naturale per enfatizzare la loro scelta ecosostenibile
Fibra di legno non colorata
Gramoflor, azienda tedesca specializzata nella produzione e commercializzazione di substrati professionali e per l'hobbistica, lancia "LignoFibre®c Xtrafine+": alte performance e molteplici usi
La torba rappresenta da parecchi decenni il principale substrato per la coltivazione di piante di qualità in vaso e in contenitori di diverse dimensioni nel settore florovivaistico, orticolo e forestale. Lo sviluppo del mercato negli ultimi anni in questi settori dell'agricoltura ha portato conseguentemente un incremento importante nell'estrazione ed utilizzo della torba.
Come noto, la torba risulta dalla decomposizione parziale di diverse specie vegetali, prevalentemente sfagni ma anche altre piante erbacee e arbustive, in un ecosistema saturo d'acqua. È un processo lento, si stima che il livello di materiale che
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Landscaping
Specialist retailer
Company
Online Shop
Home • Company • Raw materials • Wood fibre
WOOD FIBRE
FAR REACHING EXPERIENCE
With regard to substrate structure, wood fibres offer many advantages and can contribute to the optimisation of substrates. They provide structural stability, improve drainage capacity as well as rewettability and promote root formation.
...ing substrate from AGS.
SERVICE
SHOP
CONTACT
ECOFIBREX® (WO
Ecofibrex is made from wood chips. The
under high pressure. The chips become
70 °C. Ecofibrex is made from quickly re
substitute peat without compromising o
Raw Material: soft wood chips untreated and locally sourced
PH: 3,5 -4,0
Bulk density: 110-120 kg/m3(EN)
Productions sites: Lasland sp z o.o.
Structure: super fine, fine, medium,
Special physical characteristics: good air capacity and good drainage
Application: propagation, bedding substrates, potting substrates, tree nurseries
To support environmentally-friendly horticulture, we developed TIMPOR®. TIMPOR® is a specially processed structural wood fibre used as a peat substitute, allowing us to reduce the amount of peat used in our products or remove it completely.
LEARN MORE

Wood Species Tested

- Literature suggests 32 species tested
- Conifers proven to be best
- Hardwoods breakdown too quickly
- North America: *Pinus taeda* most used
- Europe: *Pinus*, *Larix*, *Picea*

Why Wood? Why Now?

- Renewed interest within last 6-8 years:
  - Increasing governmental mandates of Peat Reduced/Free
  - One viable solution to demand of growing media in future
  - Occasional poor peat harvests (wet summers)
  - Wood products create new mixes with unique behaviors
  - Wood products often cheaper
    - Particularly compared to perlite

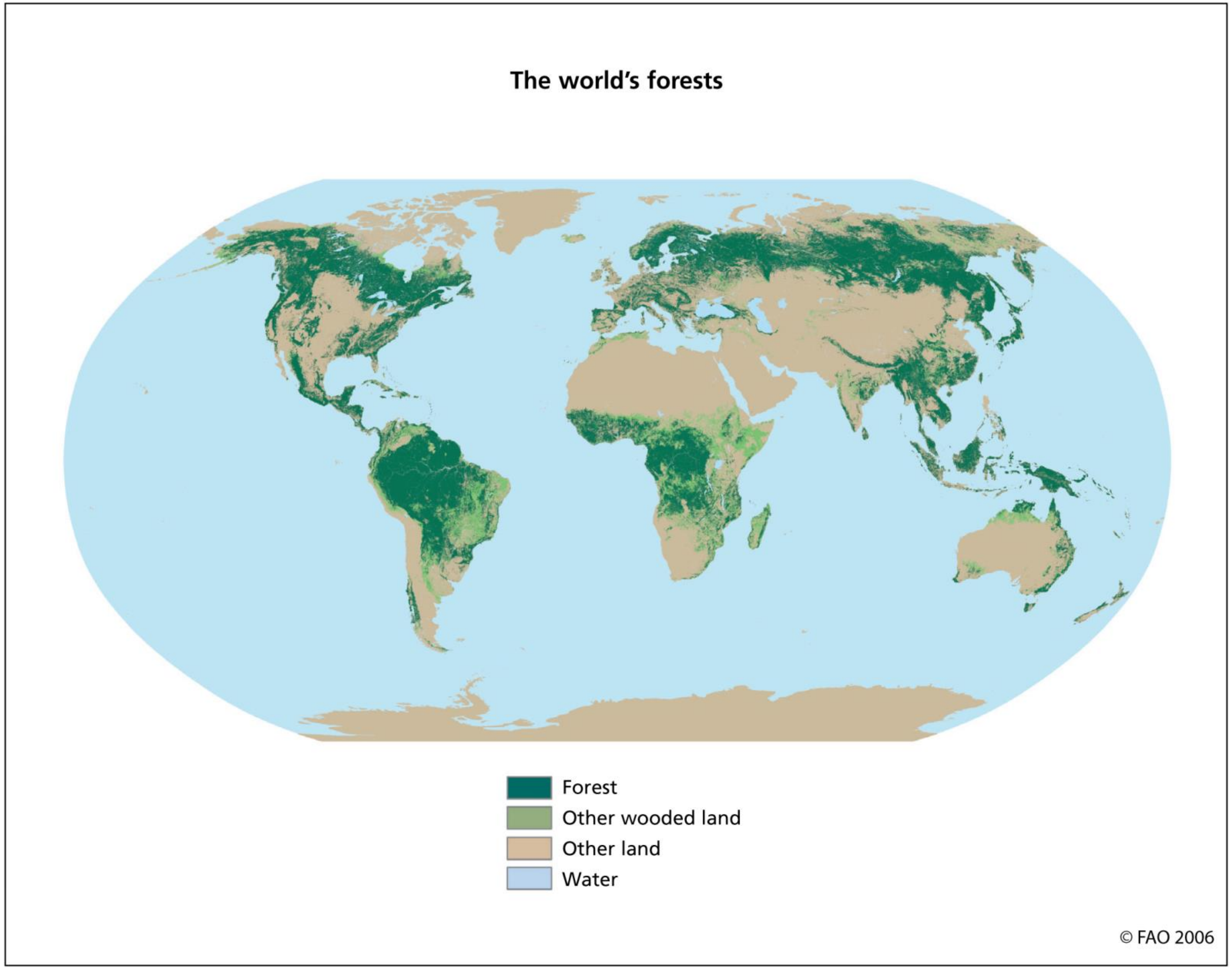









Global Forest Areas



Wood Substrate Manufacturing Methods

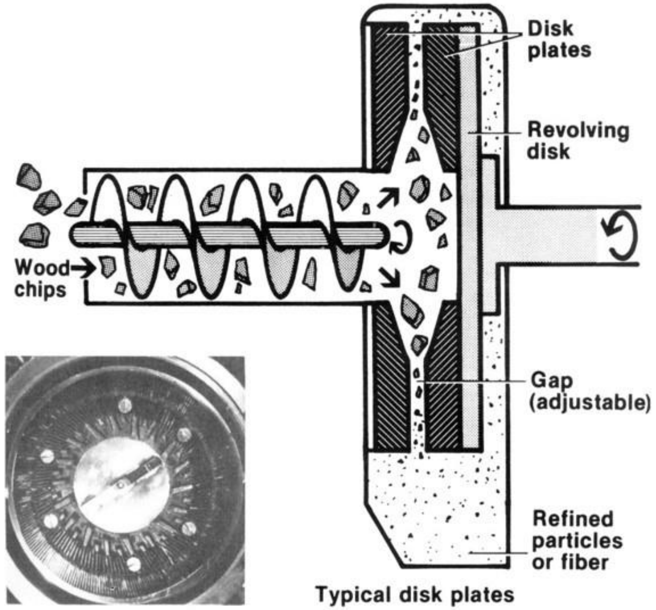
Making Wood: 1) Extrusion

- Extruder/Retruder (Single or Twin screw types)
- Chips may or may not be pre-washed/soaked
- Process utilizes friction to de-fiberize wood chips (120-160ºC)
- Fiber length/thickness adjusted with screw design and chip size

Variations in Extruded Products

Making Wood: 2) Disc Refiners

- Twin disc refiners utilize high pressure and heat (~150º C) to “precondition” wood chips before being de-fiberized.
- Fiber thickness adjusted with disc spacing and wood chip size

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Making Wood: 3) Hammer Mills

- Traditional machinery used for processing materials
- Variables influencing end-product type and consistency:
  - Moisture, wood chip size, screen size, rpm's,
- No heat generated in this process**
- Cannot make true "fiber" but can make many sizes

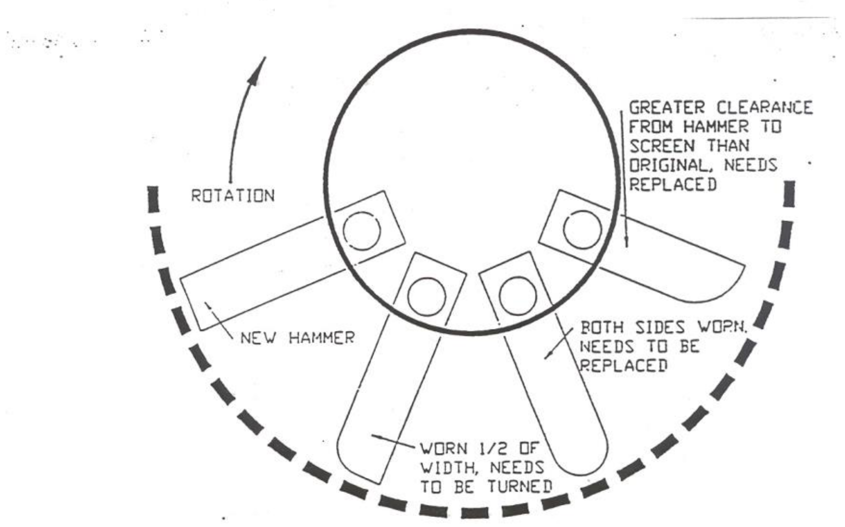
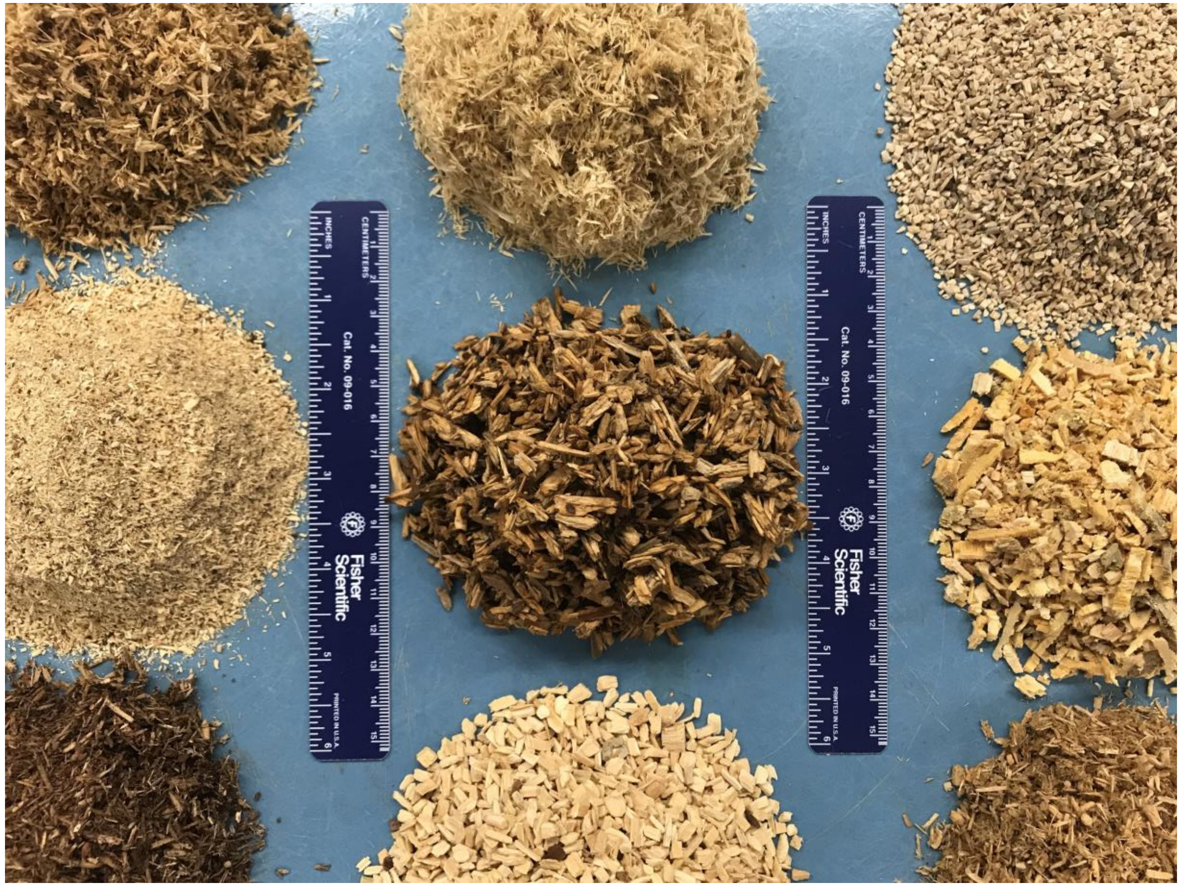


Figure 1. Maintenance of hammers on hammermills.

Hammer Mill Products

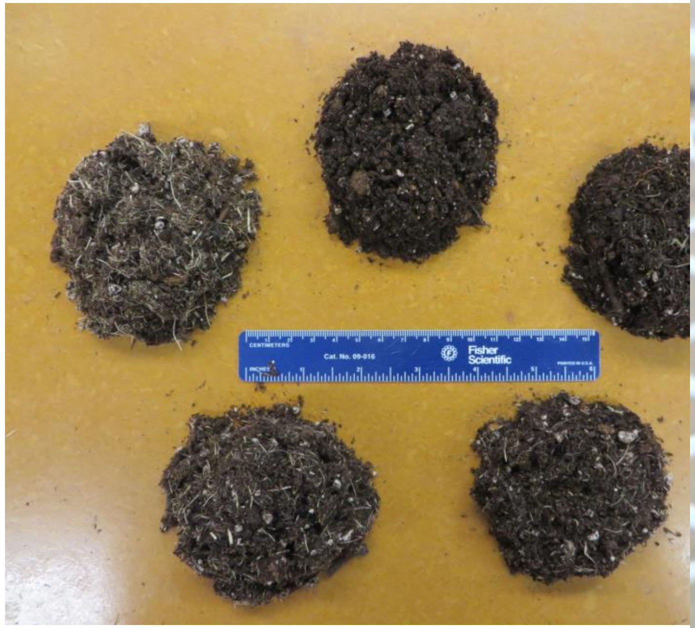
- Vary based on many variables: feedstock size, wood species, machinery, mill size/type, run speed, screen size, moisture, etc.



Some Known Advantages (Pros) of Wood Substrates

Wood + Peat = “Mix Matrix”

- What does wood do to peat? Bark?
- Fiber and peat do not stay “separate” but instead interlock
- This matrix influences: drainage, roots, humidity, spillage, etc.



Wood Fiber Substrate

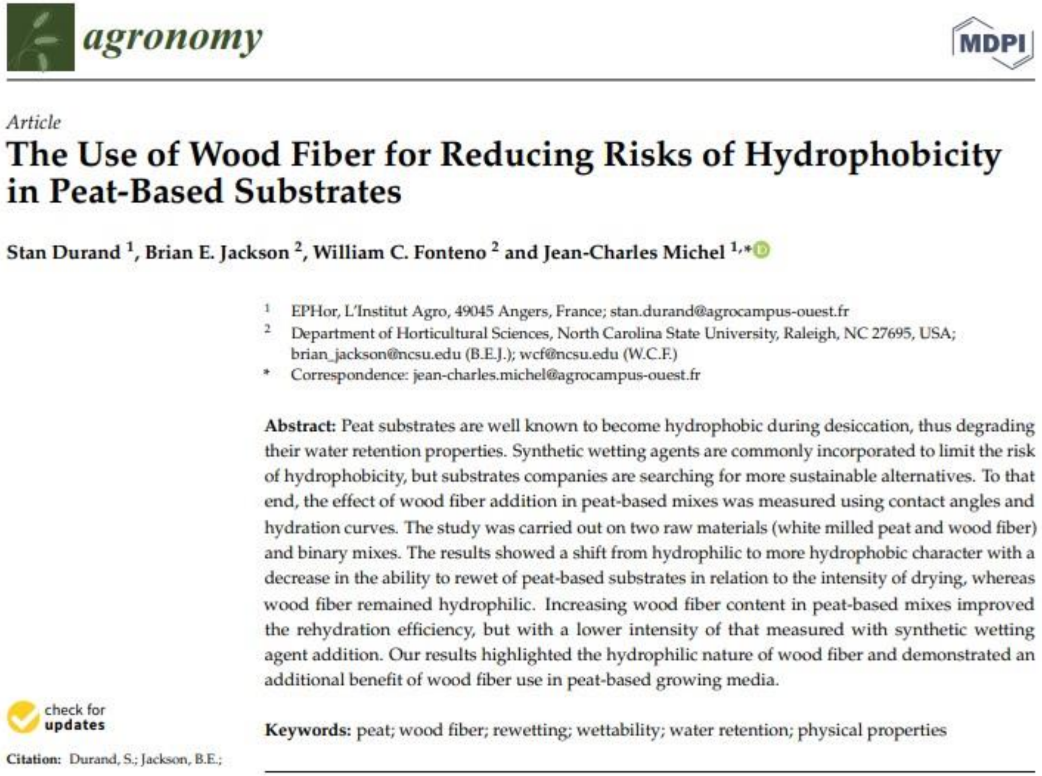
Sphagnum Peat Substrate

Enhanced Root Growth

- One of the most commonly reported observations of crops grown in wood substrates. Primarily due to physical environment.

Good Hydration/Hydrophilicty

- Most wood materials wet and rewet well.
- Can reduce rewetting/hydrophobicity issues in peat mixes



agronomy MDPI

Article

The Use of Wood Fiber for Reducing Risks of Hydrophobicity in Peat-Based Substrates

Stan Durand [1], Brian E. Jackson [2], William C. Fonteno [2] and Jean-Charles Michel [1,*]

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2 Department of Horticultural Sciences, North Carolina State University, Raleigh, NC 27695, USA; brian_jackson@ncsu.edu (B.E.J.); wcf@ncsu.edu (W.C.F.)
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Abstract: Peat substrates are well known to become hydrophobic during desiccation, thus degrading their water retention properties. Synthetic wetting agents are commonly incorporated to limit the risk of hydrophobicity, but substrates companies are searching for more sustainable alternatives. To that end, the effect of wood fiber addition in peat-based mixes was measured using contact angles and hydration curves. The study was carried out on two raw materials (white milled peat and wood fiber) and binary mixes. The results showed a shift from hydrophilic to more hydrophobic character with a decrease in the ability to rewet of peat-based substrates in relation to the intensity of drying, whereas wood fiber remained hydrophilic. Increasing wood fiber content in peat-based mixes improved the rehydration efficiency, but with a lower intensity of that measured with synthetic wetting agent addition. Our results highlighted the hydrophilic nature of wood fiber and demonstrated an additional benefit of wood fiber use in peat-based growing media.

check for updates

Keywords: peat; wood fiber; rewetting; wettability; water retention; physical properties

Citation: Durand, S.; Jackson, B.E.;

Quenching the thirst!

Substrate hydration and wettability

There is a continual need to evaluate and understand how water is utilized in substrates. **Dr. Brian E. Jackson**

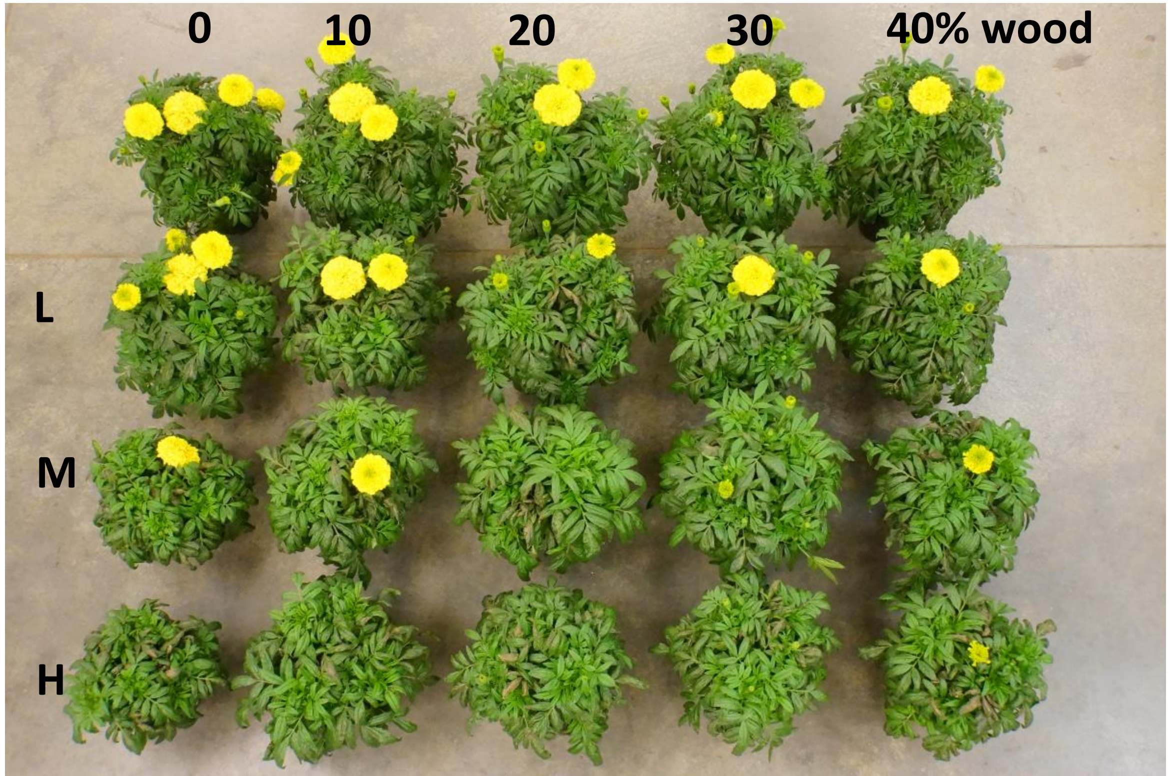
Water! Water! Water! Without doubt, one of the most valuable commodities on earth, water is a resource we must protect and respect in all aspects of our personal and professional lives. In container production systems, we have made tremendous advancements over the decades in water quality, water use efficiency, irrigation delivery methods and timing, water recapture/reuse/recycling, etc. Large multi-institutional projects (WateR3, for example), continue to innovate systems and educate growers on better water use technologies and management practices.

As new production practices and products enter the horticultural market, there is a continual need to evaluate and understand how water is utilized in these systems.

Fig. 1. Wood substrate components (A) produced by disc-refiners, extruders or hammer mills (clockwise) are most common. Wood fiber with adjusted moisture contents (from left to right) of 25%, 33%, 50%, 66% and 88%. Processing type and adjusted moisture content both affect blending consistency (C) and shrinkage/swelling in containers (D).

Cultural Practices: PGR Efficacy

- PGR trials show no efficacy changes or plant growth response differences with wood materials.
- However, with wood being different this may not be universal.



No Increased Root Disease Pressure

- No increased root disease problems (reported) during cultivation
- Some evidence of potential disease suppressiveness

Assessing the severity of damping-off caused by *Pythium ultimum* and *Rhizoctonia solani* in peat-based greenhouse substrates amended with pine wood chip aggregates

W.G. Owen[1,a], B.E. Jackson[2], B.E. Whipker[2], W.C. Fonteno[2] and M.D. Benson[3]

[1]Department of Horticulture, Michigan State University, Tollgate Farm and Education Center, MI, USA; [2]Department of Horticultural Science, North Carolina State University, Raleigh, NC 27607, USA; [3]Department of Plant Pathology, North Carolina State University, Raleigh, NC 27607, USA.

Abstract

Processed pine wood has potential as a greenhouse substrate component to replace perlite. However, there is limited information regarding processed pine wood's suppressiveness to soilborne diseases. A series of experiments were conducted to evaluate pine wood chips (PWC) suppressiveness to *Pythium ultimum* and *Rhizoctonia solani* on cucumber (*Cucumis sativus* L. 'Straight Eight') seedling growth. In Experiment 1, cucumber seeds were sown in substrates formulated to contain either 10, 20, or 30% perlite or PWC aggregates and were inoculated with no pathogen (control), 0.1 g L^{-1} *Pythium ultimum*, or 0.05 g L^{-1} *Rhizoctonia solani* isolates. Fourteen-day-old cucumber seedlings were evaluated to determine disease severity. *P. ultimum* inoculum concentration of 0.1 g L^{-1} did not cause damping-off in substrates amended with perlite or PWC aggregates. Regardless of aggregate amendment rate, *R. solani* severity of damping-off was generally similar among substrates amended with perlite. In general, less disease was observed with PWC aggregates than with perlite across all amendment volumes. In Experiment 2, cucumber seedlings were sown in substrates formulated to contain either 20, 30, or 40% perlite or PWC aggregates and were inoculated with 0 (control), 1.2, 2.4, or 3.6 g L^{-1} *P. ultimum* isolates. Disease severity of cucumber seedlings were similar among all substrates amended with 20 to 40% PWC aggregates. In Experiment 3, cucumber seedlings were sown in substrates formulated to contain either 20, 30, or 40% perlite or PWC aggregates and were inoculated with 0 (control), 1.2 g L^{-1} of *P. ultimum*, or 0.05 g L^{-1} *R. solani* inoculum isolates. Results found potential suppressiveness of *P. ultimum* and *R. solani* when peat-based substrates were amended with PWC.

Keywords: aggregate, bioassay, disease prediction, horticultural substrate, loblolly pine

Storage

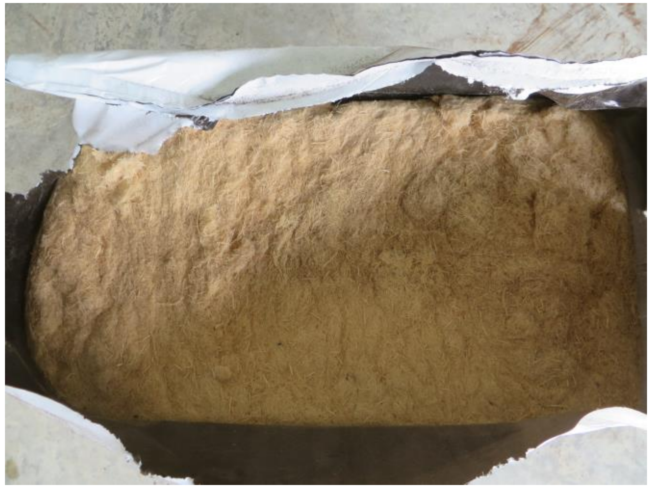
- Compact or Loose/Bulk Storage Options
  - Can save space or require space at grower/supplier facility






Other Advantages

- Easily processed in many ways/particles
- Compressible (depends on type)
- Can be “Sterile” after heating/processing
- Low EC
- Good Stability



Some Known Challenges (Cons) of Wood Substrates

Nutrient Immobilization: Nitrogen

- Nitrogen is primary nutrient immobilized by microbes
- As wood percent increases, fertility must adjust
- In 100% wood, an additional 100ppm N required
- Often a problem for growers who “feed at lower N levels”

Evaluating Peat Substrates Amended with Pine Wood Fiber for Nitrogen Immobilization and Effects on Plant Performance with Container-grown Petunia

Crysta N. Harris[1], Ryan W. Dickson[2], Paul R. Fisher[3], Brian E. Jackson[4], and Anissa M. Poleatewich[1]

ADDITIONAL INDEX WORDS. consumer, floriculture, *Petunia ×hybrida*, pine tree substrate, production, soilless substrate

SUMMARY. Pine (*Pinus* sp.) wood products have potential to immobilize fertilizer nitrogen (N) and influence plant growth when used in soilless substrates for the production of containerized floriculture crops. Peat substrate was amended with (by volume) 30% pine wood fiber (peat:fiber) during a production phase with fertigation and a simulated consumer retail phase with clear-water irrigation using container-grown ‘Supertunia Vista Bubblegum’ petunia (*Petunia ×hybrida*). The objective was to evaluate substrate effects on substrate and plant tissue nutrient level and plant growth, with an emphasis on evaluating N immobilization from wood product amendments. Substrates consisting of peat amended with hammer-milled pine wood (peat:wood) or coconut (*Cocos nucifera*) coir (peat:coir) were used for comparison, and a 100% peat substrate (peat) served as a control. In Expt. 1, amending peat with pine wood fiber had no effect on leaf SPAD chlorophyll index, shoot growth, plant height and width, substrate N, or percent shoot tissue N at the end-of-production. In Expt. 2, plants grown in peat:fiber had reduced flower number, plant height and width, and shoot growth compared with plants grown in the 100% peat control. However, petunia grown in peat:fiber substrates maintained dark-green foliage with high leaf SPAD chlorophyll index values (≥44.4) and ≥45 flowers/plant, and therefore were considered marketable plants. During the production phase in both Expts. 1 and 2, N concentrations remained within the target range for petunia in both the shoot tissue and root-zone for all substrates. In addition, there was no statistical evidence of N immobilization for any substrate blend for either of the N drawdown procedures. In both Expts. 1 and 2, root-zone nutrients became depleted during the consumer phase when irrigation was with clear water (no fertilizer), and petunia developed uniform symptoms of leaf chlorosis and N deficiency. Results of this study indicate that peat amended with 30% pine wood fiber, hammer-milled pine wood, and coconut can be used for production of containerized petunia with minimal effects on plant growth or need to adjust the fertilizer program. However, increasing pine wood to >30% of the substrate volume may require growers to increase fertilization and adjust irrigation practices to compensate for greater risk of N immobilization and changes in substrate physical properties.

Growth of Chrysanthemum in a Pine Tree Substrate Requires Additional Fertilizer

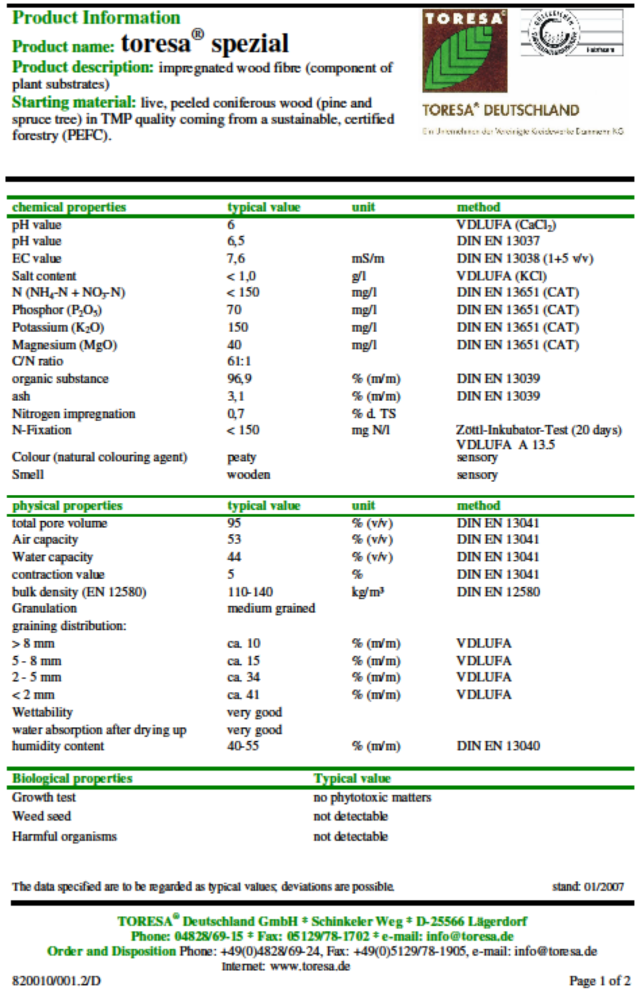
Robert D. Wright[1,2,5], Brian E. Jackson[1,3], Jake F. Browder[1,4], and Joyce G. Latimer[1,2]

ADDITIONAL INDEX WORDS. container media, greenhouse crops, loblolly pine, *Pinus taeda*, peat-lite

SUMMARY. A pine tree substrate (PTS), produced by grinding loblolly pine trees (*Pinus taeda*), offers potential as a viable container substrate for greenhouse crops, but a better understanding of the fertilizer requirements for plant growth in PTS is needed. The purpose of this research was to determine the comparative fertilizer requirements for chrysanthemum (*Chrysanthemum ×grandiflora* ‘Baton Rouge’) grown in PTS or a commercial peat-lite (PL) substrate. The PTS was prepared by grinding coarse (1-inch × 1-inch × 0.5-inch) pine chips from debarked loblolly pine logs in a hammer mill fitted with 3/16-inch screen. The PL substrate composed of 45% peat, 15% perlite, 15% vermiculite, and 25% bark was used for comparative purposes. Rooted chrysanthemum cuttings were potted in each of the substrates on 15 Oct. 2005 and 12 Apr. 2006 and were glasshouse grown. Plants were fertilized with varying rates of a 20N–4.4P–16.6K-soluble fertilizer ranging from 50 to 400 $mg \cdot L^{-1}$ nitrogen (N) with each irrigation. Plant dry weights and extractable substrate nutrient levels were determined. In 2005 and 2006, it required about 100 $mg \cdot L^{-1}$ N more fertilizer for PTS compared to PL to obtain comparable growth. At any particular fertilizer level, substrate electrical conductivity and nutrient levels were higher for PL compared to PTS accounting for the higher fertilizer requirements for PTS. Possible reasons for the lower substrate nutrients levels with PTS are increased nutrient leaching in PTS due to PTS being more porous and having a lower cation exchange capacity than PL, and increased microbial immobilization of N in PTS compared to PL. This research demonstrates that PTS can be used to grow a traditional greenhouse crop if attention is given to fertilizer requirements.

Nitrogen Impregnation

- Method to neutralize Nitrogen tie-up
- Proven successful in Europe
- Mitigated Fertility Modifications
- Cautions:
  - Bulk Storage
  - Bagged Products



Product Information

Product name: toresa® spezial

Product description: impregnated wood fibre (component of plant substrates)

Starting material: live, peeled coniferous wood (pine and spruce tree) in TMP quality coming from a sustainable, certified forestry (PEFC).

TORESA® DEUTSCHLAND

chemical properties	typical value	unit	method
pH value	6		VDLUFA ($CaCl_2$)
pH value	6,5		DIN EN 13037
EC value	7,6	mS/m	DIN EN 13038 (1+5 v/v)
Salt content	< 1,0	g/l	VDLUFA (KCl)
N (NH_4-N + NO_3-N)	< 150	mg/l	DIN EN 13651 (CAT)
Phosphor (P_2O_5)	70	mg/l	DIN EN 13651 (CAT)
Potassium (K_2O)	150	mg/l	DIN EN 13651 (CAT)
Magnesium (MgO)	40	mg/l	DIN EN 13651 (CAT)
C/N ratio	61:1		
organic substance	96,9	% (m/m)	DIN EN 13039
ash	3,1	% (m/m)	DIN EN 13039
Nitrogen impregnation	0,7	% d. TS	
N-Fixation	< 150	mg N/l	Zöttl-Inkubator-Test (20 days) VDLUFA A 13.5
Colour (natural colouring agent)	peaty		sensory
Smell	wooden		sensory

physical properties	typical value	unit	method
total pore volume	95	% (v/v)	DIN EN 13041
Air capacity	53	% (v/v)	DIN EN 13041
Water capacity	44	% (v/v)	DIN EN 13041
contraction value	5	%	DIN EN 13041
bulk density (EN 12580)	110-140	kg/m³	DIN EN 12580
Granulation	medium grained		
graining distribution:			
> 8 mm	ca. 10	% (m/m)	VDLUFA
5 - 8 mm	ca. 15	% (m/m)	VDLUFA
2 - 5 mm	ca. 34	% (m/m)	VDLUFA
< 2 mm	ca. 41	% (m/m)	VDLUFA
Wettability	very good		
water absorption after drying up	very good		
humidity content	40-55	% (m/m)	DIN EN 13040

Biological properties	Typical value
Growth test	no phytotoxic matters
Weed seed	not detectable
Harmful organisms	not detectable

The data specified are to be regarded as typical values; deviations are possible. stand: 01/2007

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Nutrient Immobilization: Sulfur

- Sulfur is immobilized by microbes and can become limited in substrates containing high wood percentages.
- Any sulfur form will work; 0.68kg/m^3 (1.5lbs/yd^3) $CaSO_4$

GROWING MEDIA

Fig. 2: Multiple species including geranium, marigold, poinsettia and mums have been grown in experimental bark and wood-based substrate trials to document sulfur deficiency and determine sulfur application types and rates.

CHANGING THE GAME

Crops in tree-based substrates may need additional sulfur in their diet.

By Brian E. Jackson and Robert D. Wright

Growers most often do not like to change the fertility programs that they are using and have used for years. Some new crops require some minor tweaking of dosage, fertilizer formulations, frequency of fertility, etc., but for the most part the fertility requirements (plus optimal substrate pH ranges) are pretty well dialed in. Then along comes wood fiber in growing media and the game changes a bit!

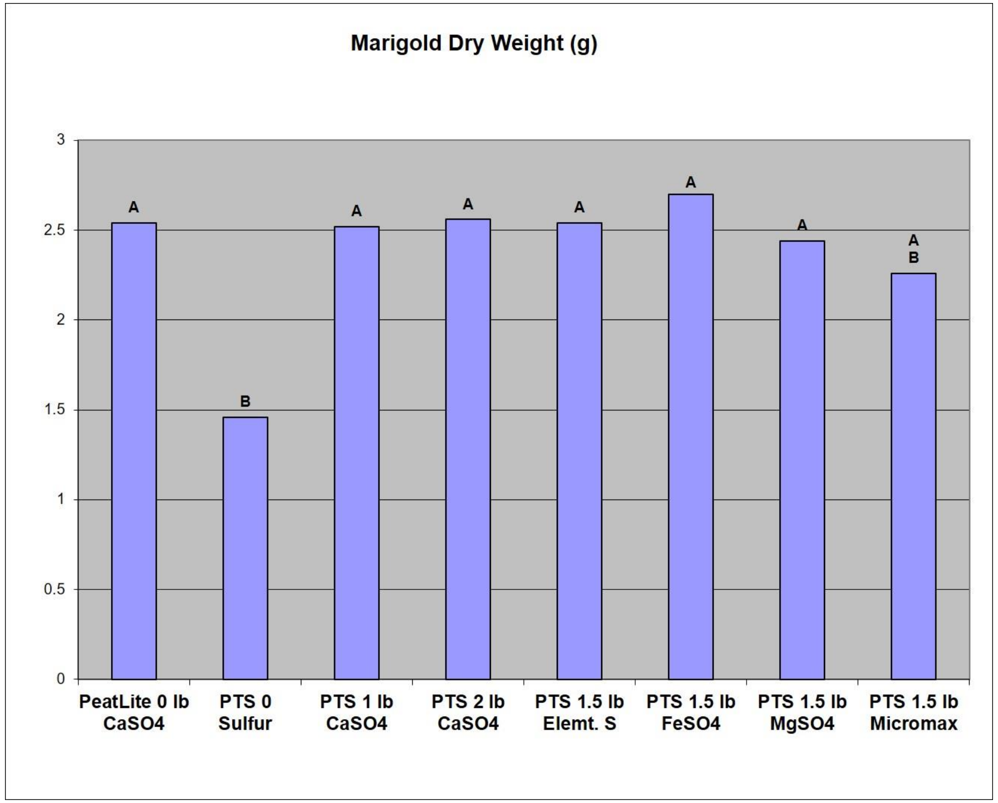
As noted over the past decade by growers and researchers alike, the most frequent and noticeable changes in cultural practices when switching to a mix that contains wood products are 1) irrigation management, 2) pH management and 3) fertility. Now, not all growers see changes or face challenges in all of those areas but many do see some. Not on that list is green wood toxicity (phytotoxicity) that can be present in freshly harvested/processed pine tree substrate (PTS; hammer milled product). Despite some changes to growing practices, growers are rapidly trialing and adopting wood in their mixes due to the many positives of using them. One "trend" that we are seeing across North America and some in Europe is the increase of wood product percentages in various greenhouse substrates. At this time, the "typical" and most common wood amendment rate is between 20 and 40% (by volume). Above this threshold, the changes in growing practices can change substantially. For the purpose of this article, we want to focus on one nutritional challenge that we have seen in a few growing operations this year: sulfur-deficient plants.

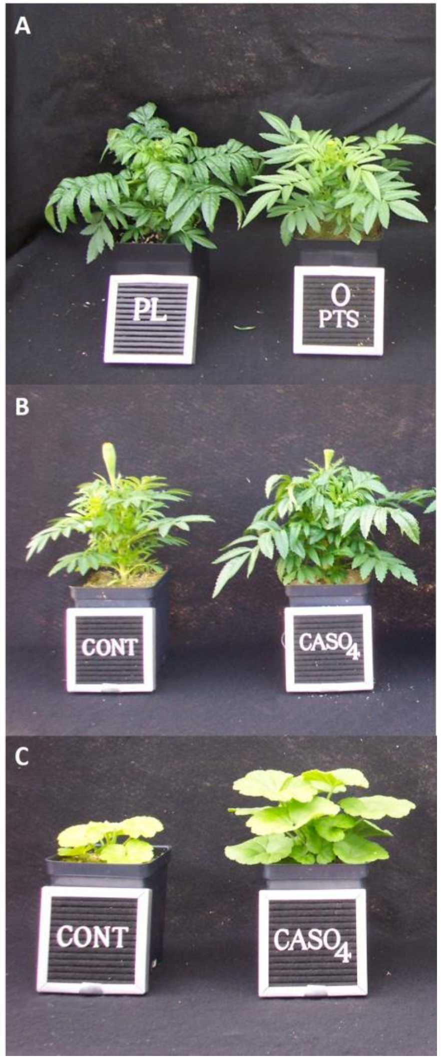
Fortunately, there is a decent amount of research trial data on the issues and potential solutions when growing greenhouse crops in high-percentage wood materials. As we and others have written before, the initial research on wood sub-

Fig. 1: Sulfur deficiency has been observed in many species grown in bark and wood-based substrates.

PHOTOS COURTESY OF BRIAN E. JACKSON

36 Greenhouse Management ◆ December 2019 ◆ www.GreenhouseMag.com





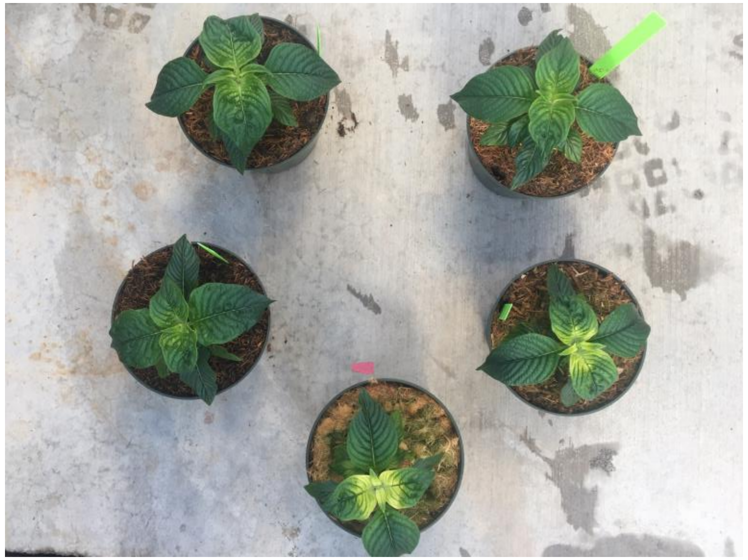
Substrate Surface Drying

- Wood can dry faster than peat (surface)
- Overwatering often a problem

24 hours after irrigation

Substrate pH Management

- Wood has inherently higher pH than peat and bark
- pH can vary based on species, time of year harvested, etc.
- Wood is very weakly buffered (pH can shift quickly)
- Liming should be adjusted based on % amendment



Green Wood Toxicity

- Natural chemicals in wood can be phytotoxic to young plants
- Oils, Tannins, Phenolic’s, VOC’s, etc.
- More of an issue with greenhouse crops than nursery crops.
- Degree and severity of toxicity in wood materials depends much on how wood was processed (machine process).

Mitigating Wood Toxicity

- Various "Preconditioning" treatments to hammer-milled wood being investigated to reduce or eliminate toxins.
  - Aging, steaming, drying, charcoal binders, etc.




Blending, Mixing, and Volume Yields

- Based on fiber type, some require special blending equipment
- Others can be mixed with traditional methods/systems
- 1 + 1 = does not always equal 2!
  - Materials of different densities & moistures will have different yields

• Growing Media

Making, Mixing or Buying

This second article in a five-part series highlights some of the pros and cons of choosing to make your own wood substrate materials vs. purchasing a commercial product.

Dr. Brian E. Jackson

The growing media industry continues to evolve and grow in some pretty exciting and innovative ways. From coast to coast and from continent to continent, the advancement in growing media offerings are equipping growers to be more successful and profitable.

Regarding the development and commercialization of wood substrate components, the number of product offerings and company options has increased rapidly in the past 18 months (Figure 1). The "trend" of using wood components in our growing mixes has moved beyond "trend" and into more of a "mainstay" reality. While still a very new material to many in the industry, enough is known about the potential of wood and enough growers are using it successfully across the globe (hundreds of growers growing millions of plants in wood substrates) that there's now some confidence regarding the future of these materials. Below are several options available to you.

Making wood substrates

The past decade has seen several growers make the decision to produce their own wood substrate materials. Beginning with Young's Plant Farm in Auburn, Alabama, other large and even some smaller operations have been successful in this endeavor.

There can be big advantages to making your own wood substrate, especially if you own property with pine trees (mostly loblolly—*Pinus taeda*) or have close access to reliable and abundant quantities. The utilization of existing wood resources, plus the complete control of the harvesting and processing of the materials, can give you a lot of flexibility, not to mention savings.

If land/trees aren't owned, then they have to be sourced from some forestry industry or individual. Aside from locating and securing quality tree resources, there are a lot of up-front costs and operating variables that can present challenges to making your own substrate. Despite the initial costs and annual substrate production expenses, the savings of making and using wood are reported to be substantial, with investment costs being returned within three to five years.

To make your own wood substrate, as discussed in previous articles, there are several methods/processes that can be employed—mainly hammer mills, screw extruders or disc refiners. Currently, the growers manufacturing their own substrates are using hammer mills. Hammer mills are cheap and readily available compared to the other machinery types.

After acquiring trees/wood chips and a mill (or other machine) for processing there are other expenses, including building/shed, tractor, super sack (tote) fillers, conveyors, personnel, training, storage facilities, etc. The wood chips to be hammer-milled (whole tree chips or pulp chips) need to be stored dry (as can be seen at Young's Plant Farm in Figure 2A and American Color Greenhouse Figure 2B).

Figure 1. Wood substrate components vary in their manufacturing processes, particle size and shape, and color, as well as the ability to be easily mixed.

The need for keeping the wood chips dry relates to the inability/difficulty in milling wet wood chips. Wood chips used in the production of commercial wood fiber substrates that use processing equipment other than hammer mills do not have to be kept dry because the moisture doesn't negatively affect the processing like it does in hammer mills. Wood chip storage outdoors is common at facilities that use twin-disc refiners (Profile Products—HydraFiber; Pindstrup—ForestGold; Kleeschulte—Topora, etc.) or extruders (Klasmann—GreenFibre; Florentaise—Hortifiber; Floragard—Florafibre, etc.) as seen in Figures 2C and 2D.

After the wood products are manufactured, they have to be stored under adequate conditions until they're used. The storage method and duration can vary depending on greenness of wood chips, method of wood processing, time of year, etc. If storage indoors or in totes is required/suggested, there is, of course, space needed to accommodate this. Pine tree substrates (hammer-milled products) are most often stored in totes to age and can be covered (Figure 3A) or uncovered. Other commercial wood fibers are also kept protected from rain after production (Figure 3B). Others, including sawdust that's used at some greenhouse operations (Figure 3C) and fiber-peat blends (Figure 3D), can be stored outdoors due to their ability to be mixed/blended adequately even if wet.

The up-front capital costs associated with equipment, facilities and personnel needed to make wood substrates have mainly limited this option to larger growers. That could change in the future if growers were to form cooperatives to achieve their substrate processing needs while distributing the costs. The other potential downside to making your ▶

Summary of Potentials/Advantages

- Wood is a blank canvas…..
- Abundant, Local/Regional (depends on location
- Physically stable
- Excellent rooting
- Excellent storage properties (when dry)
- Good wettability, drainage, water relations
- Offered in various forms to fit specific needs
- Can be economical
- Production not reliant on weather

Summary of Concerns/Issues

- Competition for wood resources in future
- Science can’t keep up with demand
- Some use of bad wood sources
- Green wood toxicity
- Nutrient tie-up and fertility
- Changes to pH Management
- Changes to irrigation management
- Many unknowns remain

R&D of Other Organic Biomass (Feedstocks)

Some Other Organic Feedstocks

- Biochar(s)
- Miscanthus and Bamboo
- Cotton and Corn Stalks
- Dairy Manure/Fiber
- Palm Oil Fiber
- Hemp Biomass
- Reed Grass
- Fique
- Jute (Burlap)
- Anaerobic Digestates

Responsible Assessment of Non-peat Materials

Raw Material Assessment

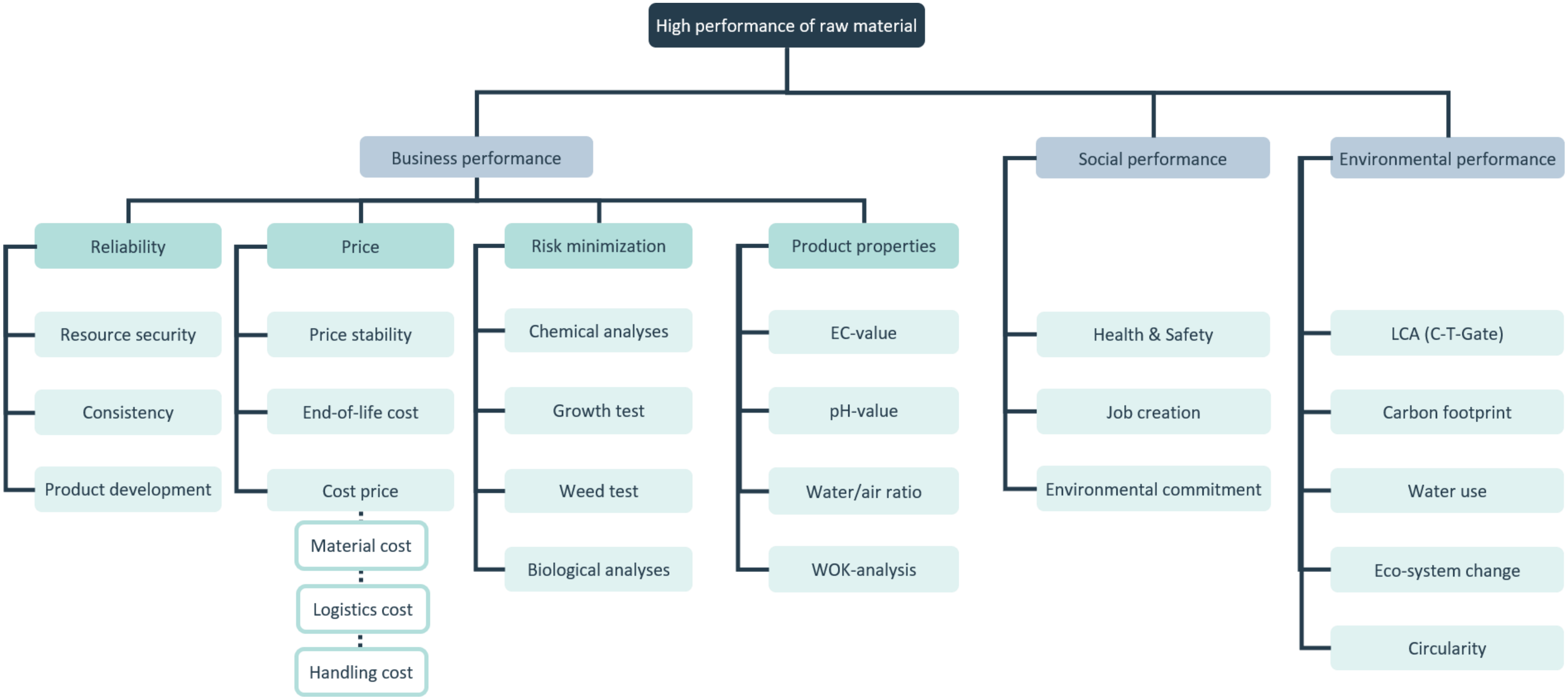
- Multi-value comparison for (raw) materials and innovations in the growing media sector. M.Sc. Thesis by Martijn van Vliet at Delft University of Technology, 2020.

A Multi-Criteria Decision Analysis comparing alternatives to contribute towards the use of more sustainable materials in the growing media sector considering all the business constraints, applied to a selection of materials from growing media company Kekkilä-BVB

Executive summary

The world population is expected to grow to 8.5 billion by 2030 and to 9.7 billion by 2050, while the current population is 7.7 billion. The increase in the global population and the shift towards a healthier diet is leading to several global challenges such as the growing demand for safe and healthy food and therefore also for growing media. A study by Wageningen University & Research shows that a 400% growth is expected for growing media globally between 2017 and 2050. Currently, peat is the most common raw material (76%) and it is complex to find similar raw materials. The sector is looking for sustainable alternative raw materials, but at the same time the global population needs to be provided of food. The aim of this research is to contribute to the use of more sustainable materials in the European growing media sector, considering all the business constraints. The following research question has been formulated for this goal:

Raw Material Assessment



Summary Points

Focus on the Future

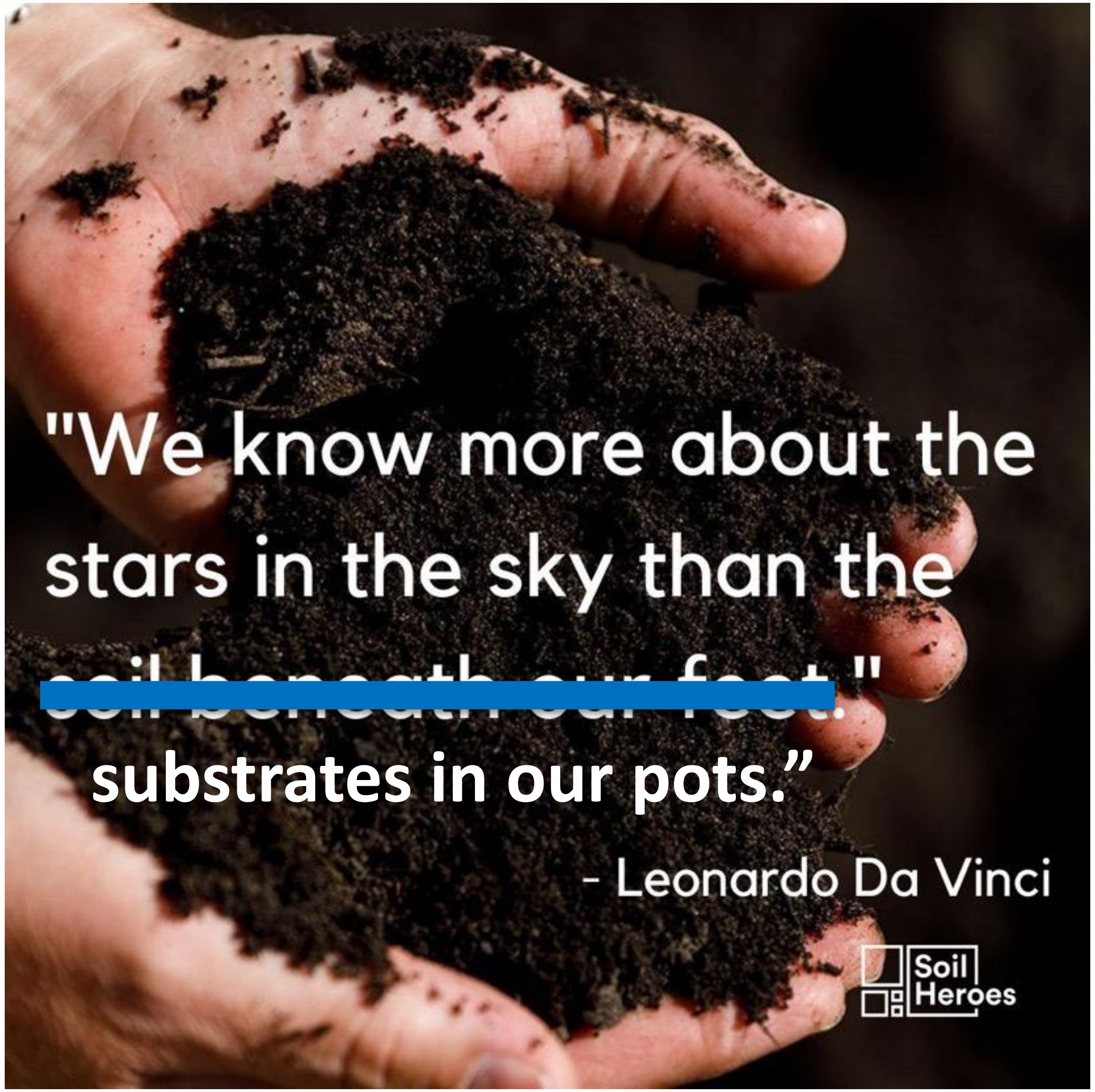
- Partnership and Collaboration is Imperative:
  - Public (Academic and Government Scientists)
  - Growing Media Manufacturers
  - CSPMA, GME, IPS, etc.
  - Local/Regional Commodity Groups
  - Regional/National/Global Associations

- **The Growing Media Industry (regionally and globally) HAVE to stand together against common threats AND communicate our value better!**

A Few Takeaways….

- Our industry is on the <u>FOREFRONT</u> of global change
- "Substrate Security" is Food/Health/National Security!!!!!!!!!!!!!
- Every industry has to renew and reinvent itself over time
- Global trends based on <u>perceptions, social media, political platforms</u>, etc. **ARE** helping to steer the future of our industry
  - Ecological awareness of consumers is increasing and we now face the challenge of responding to this demand
- We must remain both **PROACTIVE** and **REACTIVE**

THANK YOU!


"We know more about the
stars in the sky than the
~~soil beneath our feet.~~"
substrates in our pots."
- Leonardo Da Vinci
Soil Heroes