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Evaluation of peat-alternative organic materials in growing media for more sustainable cultivation systems of container-grown ornamental plants

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BACKGROUND and AIM OF THE WORK

The ornamental plant production sector, especially container-grown crops, is increasingly seeking to improve the sustainability of its cultivation systems, including organic farming, due to both market expectations and legislative requirements. Nursery growers are now encouraged to revise long-established practices and adopt more eco-friendly inputs together with precision cultivation techniques and technologies. A key aspect concerns the transition toward peat-free growing media, with current market trends aiming for a 30% reduction in peat use by 2050. Several raw materials are available as effective alternatives, including cocopeat, green compost, and stabilized wood fibre. Each material provides distinct opportunities for eco-friendly cultivation in the context of organic farming while potential limitations can be addressed through tailored agronomic practices.

This work aims to evaluate the performance of wood fibre and green compost as peat substitutes (30%, 65%, and 100% v/v) in the cultivation of bedding plants and ornamental shrubs, with *Lantana camara* L. and *Photinia* × *fraseri* 'Red Robin' used as test crops, respectively. The study also considers how substrate physical and chemical properties influence growing media behaviour and plant vegetative and physiological responses.

METHODS

Raw substrate materials

Blonde peat moss (PM), pumice 3-8 mm (Pu), coconut coir dust (CD), conifer stabilized wood fibre (CWF), broadleaf stabilized wood fibre (BWF), green compost (GC), renewable (cultivated) sphagum moss (SM).

PM, Pu and CD supplied by a local company ;CWF and BWF supplied by FIBRA S.R.L.; GC supplied by FERTIL s.r.l.; renewable sphagum moss (SM), i.e. BVB Accretio, supplied by Kekkilä-BVB.

Cultivation setup

Bedding plant production

- Greenhouse cultivation
- 1 L pot
- Fertigated
- 2 months growing cycle

Ornamental shrub production

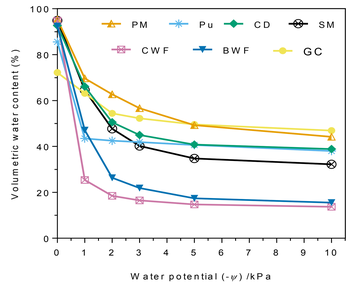
- Outdoor pot production
- 2 L pot
- CRF at transplanting
- ~6 months growing cycle

Mixture formulation criteria and plant performance assessment

The mixtures were prepared according to the physical-chemical properties (De Boodt method and UNI-EN standards) of both organic and inorganic matrices, with a target available water content of 20–30%. Plant performances were evaluated through biometric traits (e.g., plant height and shoot fresh weight) and eco-physiological parameters, such as the maximum quantum yield of photosystem II (Fv/Fm). Experimental design: randomized blocks, triplicate (10 pls. x replicate)

RESULTS and CONCLUSIONS

Raw material physical-chemical characterization and plant production performances



Raw material water retention curves. Each line represents the mean value of three replicates of the same material

Raw materials	AC (% v v^{-1})	EAW (% v v^{-1})	AW (% v v^{-1})	BD (g cm^{-3})	TPS (% v v^{-1})	pH	EC µS/cm
PM	25.7±2.7	20.4±0.6	25.5±1.1	0.076±0.001	95.4±0.1	5.0±0.6	61.4±9.3
Pu	42.1±1.4	2.8±0.1	5.4±0.3	0.393±0.025	85.2±0.9	7.3±0.2	101.2±5.4
CD	26.6±1.0	25.3±0.6	27.3±0.6	0.119±0.001	92.7±0.6	6.4±0.2	440.7±2.4
CWF	69.4±0.7	10.7±0.4	11.7±0.4	0.076±0.001	94.8±0.1	5.7±0.3	52.00±1.2
BWF	45.3±1.0	29.7±1.0	31.6±0.8	0.110±0.001	92.4±0.1	4.3±0.2	93.7±5.0
GC	10.2±0.7	13.6±1.0	16.2±1.1	0.402±0.007	72.2±0.5	8.0±0.1	1563.0±39.9
SM	30.4±2.4	20.7±2.0	32.3±2.2	0.074±0.001	94.9±0.1	4.4±0.1	115.0±5.5

Each value represents the mean value of three replicates ± st.er. AC: air capacity; EAW: easily available water; AW: available water; BD: bulk density; TPS: total pore space; EC: electrical conductivity

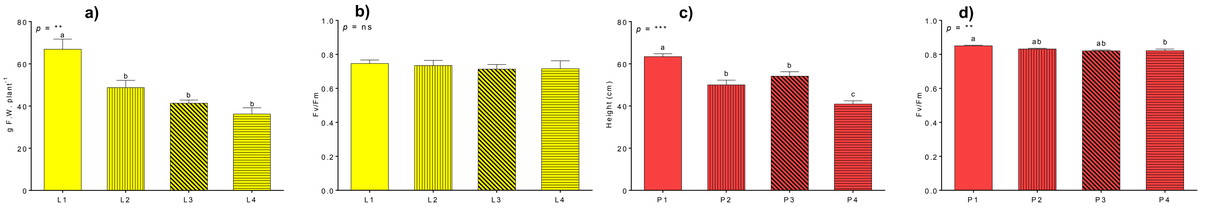
Four growing media were selected for the indoor cultivation of *L. camara* and other four growing media were selected for the outdoor cultivation of *P.* × *fraseri* 'Red Robin' based on the results obtained from substrate characterization. These mixtures showed most of the investigated hydrological parameters within the optimal ranges and comparable to those of both standard peat-based control substrates selected for the comparison, especially for the available water (AW).

Bedding plant production
Mixture composition and plant performances

L1 (Standard peat-based control substrate) = PM:CD 70:30 v/v (**AW: 30.4%**)
L2 = PM:BWF:CWF:GC 49:31:10:10 v/v (**AW: 31.7%; PM: -30%**)
L3 = PM:BWF:CWF:GC:SM 24.5:30:9:9.5:27 v/v (**AW: 29.27%; PM: -65%**)
L4 = BWF:GC 70:20 v/v (**AW: 35.2%; PM: -100%**)

Ornamental shrub production
Mixture composition and plant performances

P1 (Standard peat-based control substrate) = PM:Pu:CD 65:30:5 v/v (**AW: 25%**)
P2 = PM:Pu:GC:BWF 45,5:25:10:19,5 v/v (**AW: 24%; PM: -30%**)
P3 = PM:Pu:CD:GC:BWF 22,75:20:5:22,25:30 v/v (**AW: 23%; PM: -65%**)
P4 = Pu:CD:GC:BWF:CWF 20:15:30:25:10 v/v (**AW: 20%; PM: -100%**)



Biometrical and eco-physiological plant performances. Figure a) and b) shown the shoot biomass fresh weight (F.W.) per plant and the F_v/F_m ratio (maximal quantum yield of photosystem II, PSII) measured on *L. camara* plants at the end of the growing cycle (72 days after transplant) respectively. Figure c) and d) shown plant height and F_v/F_m ratio measured on *P.* × *fraseri* 'Red Robin' roughly 60 days after transplant. Each bar represents the medium value of three replicates ± st.er.. Statistical analysis performed through one-way ANOVA: ns = not significant, or ** and *** = significant at p ≤ 0.01 and 0.001, respectively. Different letters for the same parameter indicate significant differences according to Tukey's multiple-range test (p = 0.05).

Although the selected pat-reduced and peat-free mixtures showed optimal hydrological characteristics, plant performance of the two species was negatively affected. Collected data showed reduced growth in both plant species cultivated on peat-reduced and peat-free substrates (especially in the latter, where the reduction was more pronounced). Despite these results, F_v/F_m remained unchanged across treatments in *L. camara*, suggesting no detectable PSII-level stress. This would suggest that minor adjustments of the agronomic practices, especially for plant fertilization and/or chemical pre-treatments of the selected mixtures, would help to improve plant performance. In conclusion, this preliminary work put some basis for irrigation management of new peat-free substrate mixtures while more research is required to properly address the chemical characteristics of the root zone and related agronomic practices.

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