

# The Feasibility of Using Olive Mills Wastewaters Digestate as a Peat Substitute in Horticulture

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## Abstract

This study evaluates and demonstrates the potential use of the solid fraction from the digestate of thermophilic (55°C) anaerobic digestion of olive mills' wastewater (OMW) after sun drying and screening for too large clumps of sludge, collected several times through the thermophilic digestion, as an alternative cultivation medium for the horticulture industry. Integrating this fraction within plants' cultivation medium demonstrates a circular-economy approach, transforming an environmental pollutant, OMW, into a valuable input for horticulture. Replacing peat with OMW-derived digestate fraction is particularly important given the severe environmental impacts associated with peat excavation. It aims to show horticulturists that adoption of its use offers direct economic benefits, avoiding peat costs while simultaneously reducing environmental burdens and GHG emissions. The findings are based on successful experiments where OMW-digestate solid fraction was tested as a peat substitute in the cultivation mediums of plants. The positive results demonstrate the potential benefits of its use as a peat substitute for horticulture. The use of digestate from the anaerobic process as a peat substitute for horticulture allows full utilization of all the products of oil mill wastewater treatment: biogas for energy and digestate as cultivation media for horticulture. The result of this study also indicates that the possible use of OMW-digestate as a peat substitute in horticulture can reduce peat extraction, thereby helping to conserve a natural resource while contributing to the economic development of both the horticulture and olive oil production sectors.

## Keywords

Olive Mill Wastewater, OMW, OMW-Digestate, Peat, Circular Economy, Renewable Energy

## 1. Introduction

The agricultural sector, and horticulture in particular, has contributed to the over-extraction of peat and other natural resources. This is a major concern because such natural resources are finite and closely linked to the ecosystems from which they are extracted, and peat use increases carbon dioxide emissions. The present study proposes a practical pathway for the beneficial use of OMW that can create value while supporting environmental stewardship, thereby contributing to the sustainability of agri-business and society. It builds on previous studies on the treatment of OMW at a centralised site through thermophilic anaerobic digestion followed by an aerobic polishing stage (Marchaim & Levanon, 2025), and on the use of the OMW-digestate generated during thermophilic anaerobic methanogenic digestion (TAMD) as a peat substitute for horticulture.

Aurdal (2025) showed that a large body of research supports the use of peat-free blends in horticulture production systems in which fertigation supplies water and nutrients. However, peat replacement remains more challenging in containerised systems such as potted plants, since plants are fully dependent on the growing medium. That review further indicated that mediums retaining 25% - 50% peat together with renewable components such as wood fibre, coconut coir, and bark may combine environmental benefits with the functional reliability required in professional horticulture. Aurdal (2025) discussed various alternatives, including composts, coir, wood fibre, bark, and biochar, although not OMW-derived OMW-digestate, and highlighted the challenges of standardisation and end-user reliability. The review concluded that no single material currently offers a complete replacement for peat and suggested that peat is more likely to be replaced by mixtures optimised for both functionality and sustainability.

TAMD is a microbially driven process in which a diverse community of microorganisms breaks down complex organic matter under oxygen-free conditions (Xu et al., 2012; Marchaim et al., 1997), generating an energy-rich gas composed mainly of methane and carbon dioxide (Deena et al., 2022). In addition to biogas, TAMD of OMW produces OMW-digestate, the residual solid and liquid organic fraction that remains after anaerobic digestion (Czekala et al., 2022). During thermophilic anaerobic digestion, compounds that may enhance plant growth can also be generated, making OMW-digestate use even more attractive (Marchaim et al., 1997). OMW-digestate is rich in organic matter (OM) and essential nutrients such as nitrogen, phosphorus, and potassium, as well as trace elements, although its composition depends strongly on the feedstock and on digester operating conditions (Möller & Müller, 2012).

A study from the UK (Litterick et al., 2025) noted that peat use as horticultural cultivation media is being phased out because of environmental concerns and recommended that plant-pathogen risks associated with peat alternatives should be examined together with farmers. Despite the strong policy commitment and budget allocation to restore peatlands, the demand for peat-based growing media remains high and drives most of the peat demand (Koseoglu & Roberts, 2025). The search

for sustainable soilless media is intensifying because of the continued expansion of greenhouse production and the slow regeneration of peat bogs, which together are driving peat prices upward. Pressure to identify alternatives to peat is increasing, but so is recognition of the complexity of peat replacement.

The present study builds on earlier experiments that examined the use of OMW-derived digestate as a peat substitute (Marchaim & Levanon, 2025). Here, we further evaluated OMW-digestate as a peat substitute in cultivation media for greenhouse crops. Demonstrating that OMW-digestate can function as a reliable substitute may help growers reduce peat consumption. The broader concept explored in this study is the development of a centralised, full-scale OMW treatment plant that would collect OMW from nearby olive mills, reduce its harmful environmental impacts, and utilise all products generated during the anaerobic digestion.

## 2. Materials and Methods

### 2.1. Cultivation Medium and Treatment Definitions

We used the solid fraction from the digestate of thermophilic (55°C) anaerobic digestion of olive mills' wastewater (OMW), after sun drying and screening of the too large clumps of sludge, collected several times through the thermophilic digestion period. The chemical composition of the OMW-digestate contained cultivation media and the control cultivation medium is presented in Table 1. The OMW-digestate-enriched media were characterised by substantially higher available P and K, with more moderate differences in mineral N content.

**Table 1.** Selected nutrient concentrations in the cultivation media with increased OMW-digestate content, compared with the control.

Cultivation Medium Composition	P (mg/kg)	K by CaCl <sub>2</sub> Extract (mg/L)	NO <sub>3</sub> <sup>-</sup> -N/NAS (mg/kg)	NH <sub>4</sub> <sup>+</sup> -N (mg/kg)
20% OMW-OMW-Digestate	438.40	925.30	0.54	10.00
40% OMW-OMW-Digestate	1128.00	1108.43	3.04	6.80
60% OMW-OMW-Digestate	1764.00	1409.64	4.96	6.50
100% OMW-OMW-Digestate	1370.00	2274.70	7.82	7.40
Control Mixture	19.36	24.10	1.74	7.40

Plants were grown in pots under greenhouse conditions using standardized pots of 1.5 litres according to plant culture methodologies (CEN, 2011, Incrocci et al., 2020, Kafkafi & Tarchitzky, 2011), allowing precise control of drip irrigation and fertiliser supply. Experiments were organised in randomized complete block design (RCBD), in eight rows of replicates, and contained substrate compositions from a control with peat as the growth medium to 100% digestate content replacing peat. In the experiments, we first replaced different percentages of the entire growth medium mixture, and thereafter we replaced different percentages only of the peat fraction in the growth medium. Irrigation and fertigation were applied via Netafim drip systems following principles of optimised nutrient delivery, and

leachate was collected once a week. Environmental conditions in the greenhouse were natural and were not regulated.

To evaluate the potential peat replacement ability of OMW-digestate in pot-plant cultivation media, lettuce, corn, and wheat were used as indicator crops. The OMW-derived digestate was sun-dried, ground, and mixed at different ratios with peat enriched with tuff and, where relevant, also perlite. OMW-digestate incorporation was defined in two parallel ways: i) as a percentage of the total substrate mixture, and ii) as a percentage of the replaced peat fraction, while keeping the tuff and perlite contents constant. For the growth measurements, we calculated the average height and weight of five pots per treatment for each replicate.

## 2.2. Experimental Design

For the lettuce experiment, 4 treatments  $\times$  6 replicates  $\times$  5 pots per replicate were used, a total of 120 pots. The pots were arranged in a randomised block design in the greenhouse at the Experimental Farm. For each treatment group, irrigation leachate was collected several times during the plant growth from the first five pots in each row, which were placed on a bench designed to enable drainage collection. Lettuce was planted in all pots. The composition of the cultivation medium for lettuce is presented in **Table 2**. An additional row without fertilisation was included for all the treatments to examine the contribution of the OMW-digestate itself as a fertiliser. Irrigation regimes were adjusted during plant growth according to meteorological data and the weather's impact on plant water consumption.

For the corn experiment, 5 treatments  $\times$  10 replicates  $\times$  5 pots per replicate were used, a total of 250 pots. The pots were arranged in a randomised block design in the greenhouse at the Experimental Farm. For each treatment group, leachate water was collected from the first five pots in each row, which were placed on a bench that enabled drainage collection.

OMW-digestate was tested at several replacement levels of the medium's peat fraction, whereas the proportions of tuff and perlite were kept constant. The composition of the cultivation medium for the corn experiment is presented in **Table 3**. Drip irrigation was applied according to meteorological data and the weather's impact on plant water consumption.

During the wintertime, the growth of wheat was studied. For the wheat experiment, 4 treatments, 8 replicates, and 5 pots per replicate were used. Irrigation was operated based on the meteorological data and the weather's impact on plant water consumption.

### Lettuce Experiment

As part of the irrigation regime, the fertiliser Shefer 5-3-8 was applied. This fertiliser contains nitrate and ammoniacal nitrogen, phosphorus, and potassium, as well as Cortin as a source of trace elements. Cortin acts as a chelate that binds microelements and helps prevent their adsorption to the soil, thereby maintaining their availability to the plant. The fertiliser was supplied through the greenhouse irrigation system at a concentration of 60 ppm. A control treatment that was irri-

gated without fertilisation.

Throughout the experiment, the following parameters were recorded:

- Visual appearance of the plants.
- Plant height.
- Plant stem diameter.
- Final biomass (fresh and dry weight). After the lettuce plants reached maturity, fresh weight was measured, and dry weight was determined after drying at 105 °C for 3 days.
- Leachate water EC and pH were measured during the growth period.

**Table 2.** Composition of the lettuce cultivation medium.

Treatment (% of Total Volume)	OMW-Digestate (L)	Peat (L)	Tuff (L)	Total (L)
Control	0	25	25	50
10%	5	22.5	22.5	50
20%	10	20	20	50
30%	15	17.5	17.5	50

### Corn Experiment

- Corn was grown on media with different proportions of OMW-digestate, in which only the peat fraction was replaced. As part of the irrigation regime, the fertiliser Shefer 5-3-8 was applied. The plants' growth rate was examined by measuring the height of the plants during the growing period. Leachate water EC and pH were measured during the growth period.

**Table 3.** Composition of the corn cultivation medium in which only peat was replaced by digestate.

% Replacing Peat	Perlite (L)	OMW-Digestate (L)	Peat (L)	Tuff (L)	Total (L)
Control	18	0	36	36	90
20%	18	7	29	36	90
40%	18	14	22	36	90
60%	18	22	14	36	90
80%	18	29	7	36	90

### Wheat Experiment

The experimental design was based on randomised complete block design (RCBD), with 8 replicates of the 4 treatments, where in the cultivation medium, peat was replaced by OMW-digestate. The wheat Gadish cultivar was grown in pots of 1.5 Liters. Growth conditions in the greenhouse during February-April 2026 were natural winter temperatures. The measured variables were:

- Growth parameters (height, percentage of wheat crops that appeared after 6 weeks).
- Biomass accumulation in fresh and dry weight after 6 weeks. Dry weight was determined by drying at 105 °C for 3 days.

As part of the irrigation regime, the fertiliser Shefer 5-3-8 was applied. Irriga-

tion was operated based on the meteorological conditions.

Wheat was grown on media with different proportions of OMW-digestate, in which only the peat fraction was replaced. The growth medium that was prepared for the experiment is presented in **Table 4**.

**Table 4.** Composition of the wheat cultivation medium in which only peat was replaced in the cultivation medium.

Total (L)	Quantities (In Litres per Pot)				Treatment (% Peat Replacement)
	Digestate (L)	Tuff (L)	Peat (L)	Perlite (L)	
80	0	32	32	16	Control
80	16	32	16	16	50%
80	25.6	32	6.4	16	80%
80	32	32	0	16	100%

### 2.3. Statistical Analysis

Experimental data were analysed using one-way analysis of variance (ANOVA) to test for differences among treatment groups in the lettuce experiment. Given a single-factor experimental design with independent groups and continuous response variables, one-way ANOVA, which was used for analysis is the standard parametric approach for detecting differences among treatment means. Separate ANOVAs were performed for final height, height growth rate, and final plant weight. Growth rate was calculated from the recorded measurements over the experimental period. For the analysis of final lettuce weight, only fertilised plants were included, since the non-fertilised treatment set contained only one value per treatment and therefore did not permit a valid variance-based comparison. Statistical significance was set at  $p < 0.05$ .

In the corn experiment, the effect of replacing peat with OMW-derived OMW-digestate on plant growth was evaluated, and growth increment was calculated for each treatment relative to the control over the experimental period.

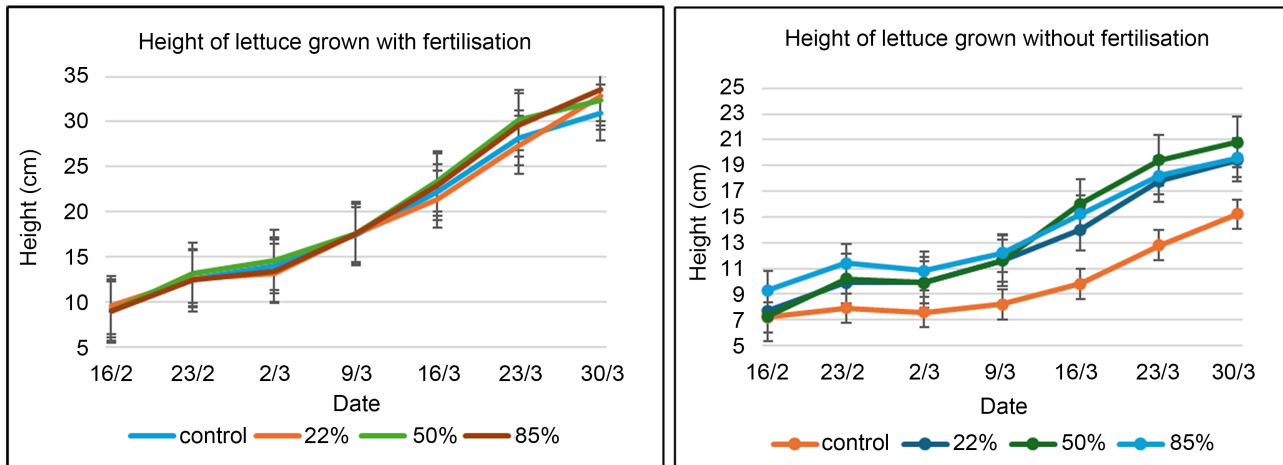
## 3. Results and Discussion

The experiments evaluated plant growth on different cultivation media composed of OMW-digestate, replacing peat at varying proportions, together with the common greenhouse cultivation media components. The crops used served as indicators of the value of the OMW-digestate as a cultivation medium, although these crops are not typically used in greenhouse horticulture.

### 3.1. Lettuce Cultivation on Media Containing Different Proportions of OMW-Digestate

The results presented in **Figure 1** compare the growth rates of lettuce plants grown in different cultivation media, in which OMW-digestate replaced peat at different proportions, with or without fertiliser. Plants grown under fertilised conditions consistently exhibited higher growth rates than those grown without fertilisation, although during the initial period, the OMW-digestate apparently supplied suffi-

cient nutrients, and growth rates were similar. Results represent the average of all lettuce plants grown in each treatment. Overall, no significant differences between the treatments were found (Figure 1), indicating that OMW-digestate can be used to replace peat in up to 85% of the cultivation medium.



**Figure 1.** Growth rate of lettuce plants for 6 weeks (height in cm along the dates presented). Digestate included in the cultivation medium in different contents and irrigation included fertilisation (left) or without fertilisation (right). Colours present different percentages of peat replacement by OMW-digestate.

The statistical analysis of the growth of lettuce on growth medium, where peat was partially replaced by the OMW digestate, did not detect significant differences among treatments for any of the tested parameters. Specifically, no significant treatment effect was found for final lettuce height ( $p = 0.236$ ), height growth rate ( $p = 0.118$ ), final dry weight ( $p = 0.490$ ), or final wet weight ( $p = 0.610$ ). Overall, although some variation among treatments was observed descriptively, the ANOVA indicated that these differences were not statistically significant under the conditions of the present experiment.

Lettuce biomass (wet and dry) was quantified at harvest (Figure 2). Comparison between the different treatments, in which OMW-digestate replaced part of the cultivation medium, showed almost no difference in either fresh or dry lettuce biomass.

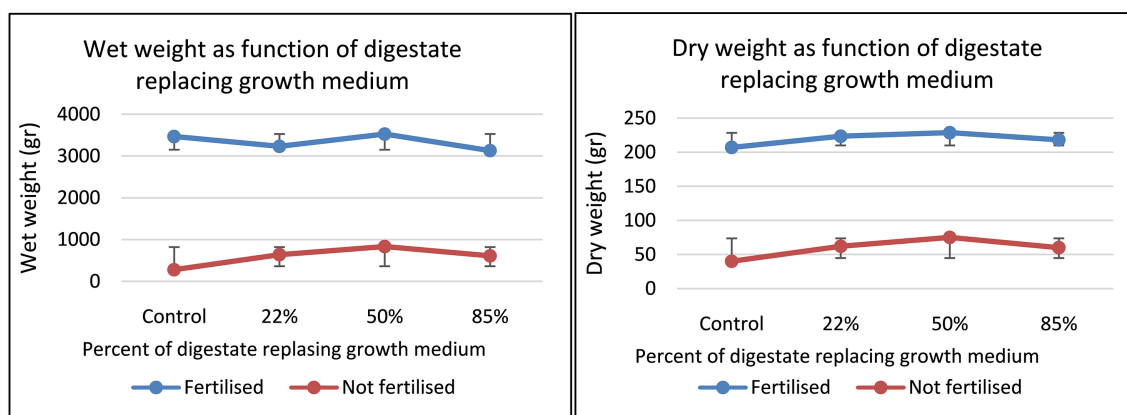
The non-fertilised plants were not included in the statistical analysis for final weight since only one observation was available for each treatment.

These trials showed that although the OMW-digestate contributed slightly to fertilisation, this effect was limited mainly to the early growth stages.

The similar final plant weights obtained on the different cultivation media, with different contents of OMW-digestate replacing peat, highlight the potential for substituting peat with OMW-digestate without compromising yield. This supports the development of OMW-digestate-based cultivation media within a circular-economy framework, in which OMW waste is reused as a cultivation substrate. As shown in Figure 2, OMW-digestate provided a good replacement of peat even when 30% of the total substrate was replaced, corresponding to the replacement

of 85% of the peat fraction of the medium.

Lettuce plants Biomass accumulation depended only slightly on the percentage of peat substituted by OMW-digestate. The similarity in yields across treatments indicates that dry biomass formation was maintained even when the cultivation medium composition was changed.



**Figure 2.** The weight of lettuce after harvesting, as a function of digestate peat replacement in cultivation mediums in various percentages. Lettuce plants were collected and weighed, first as wet weight (left figure) and after drying at 105 °C as dry weight (right figure). Colours represent fertilization treatments, blue with fertilisers and orange without fertilisation.

Leachate from the cultivation pots was analysed for EC and pH after three weeks of growth, when drainage occurred following prolonged irrigation (**Table 5**). Without fertilisation, leachate pH increased from 8.18 in the control to 8.61 in the treatment in which OMW-digestate replaced peat at the highest level, whereas under fertilised conditions it remained relatively constant, ranging from 8.21 to 8.25. EC without fertilisation was also relatively stable, increasing only slightly from 442 in the control to 460 in the treatment with the highest peat replacement.

Under fertilised conditions, however, EC increased from 575 in the control to 673 when OMW-digestate replaced 85% of the peat.

**Table 5.** Leachate analysis from pots used for lettuce cultivation with modified growth media was analysed after one month from planting.

OMW-Digestate % in the Cultivation Medium	Without Fertilisers		With Fertilisers	
	EC	pH	EC	pH
Control	442.17	8.18	575.00	8.21
10%	444.83	8.35	688.20	8.32
20%	468.67	8.46	648.80	8.22
30%	460.17	8.61	673.20	8.25

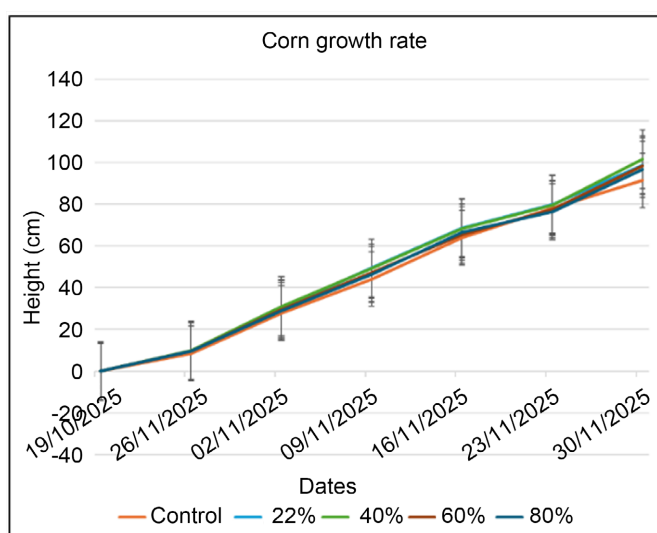
### 3.2. Corn Cultivation on Media with Different Proportions of OMW-Digestate Replacing Peat

The results presented in **Figure 3** demonstrate the effect of replacing high propor-

tions of peat in the cultivation medium with OMW-digestate. Similar growth rates were obtained across the alternative media, highlighting the potential for substituting peat with more sustainable materials without compromising yield.

Peat replacement by OMW-digestate at 20%, 40%, 60%, or 80% did not affect corn growth (Figure 3). The effect of peat replacement with OMW on corn growth increment was modest. The overall ANOVA showed that only 60% replacement treatment differed significantly from the control. The 20%, 40%, and 80% replacement treatments did not differ significantly from the control. Accordingly, the results suggest only a limited effect of OMW substitution on growth rate under the conditions tested, and the visual pattern in the graph is consistent with generally small differences among treatments.

Leachate EC and pH were analysed several times during the experiment and showed only minor variation within each group of pots with the same level of peat replacement. The EC and pH values are presented in Table 6 and show slight increases, particularly in EC, when high proportions of digestate replaced peat.



**Figure 3.** Growth rate of corn (measurements of plant height during the growth period) on alternative cultivation mediums, with digestate replacing peat by 20% - 80%.

**Table 6.** Leachate analysis from pots used for corn cultivation in media with peat replacement after one month from planting.

OMW-Digestate % in the Cultivation Medium	With Fertilisers	
	EC	pH
Control	765.2	7.107
20%	769.9	6.855
40%	805.7	6.957
60%	836.3	6.943
80%	886.5	7.102

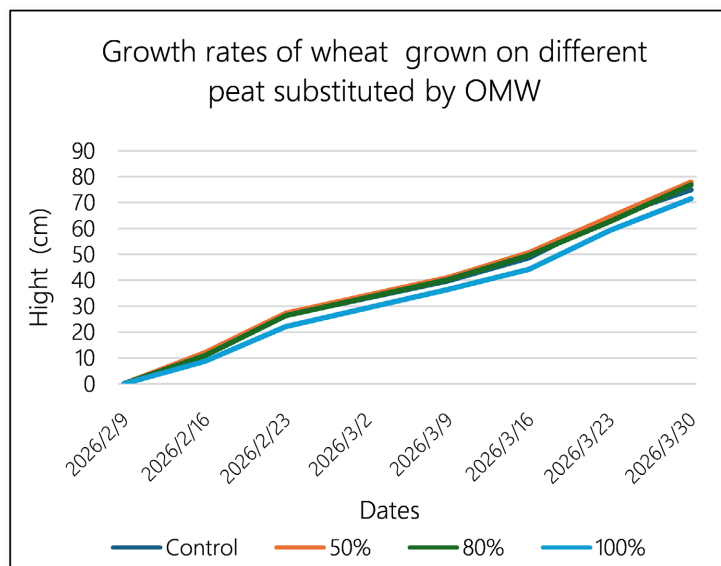
The photographs in **Figure 4** illustrate similarity in corn appearance between plants cultivated on different media in which OMW-digestate successfully replaced up to 80% of the peat. Further experiments are planned to examine the complete replacement of peat with OMW-digestate in cultivation media for several plant species in order to verify its suitability for horticultural use further.



**Figure 4.** Corn cultivation on different media, after the third week (right) and after the fifth week (left). Growth on the various mediums, in which the digestate replaced up to 80% of the peat in the medium, shows similar corn development among the treatments.

### 3.3. Wheat Cultivation on Media with Different Proportions of OMW-Digestate Replacing Peat

Wheat growth rates presented in **Figure 5** demonstrate the effects of high proportions of peat replacement in the cultivation medium by OMW-digestate. Similar growth rates were obtained across the different cultivation media, highlighting the potential for substituting peat with more sustainable materials without compromising yield.

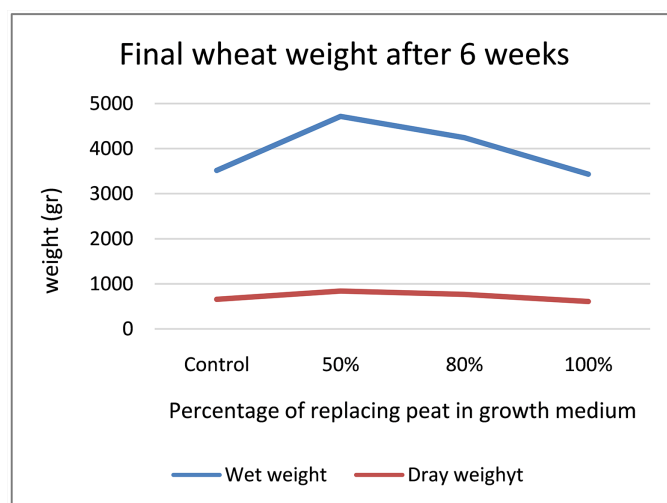


**Figure 5.** Growth rates of wheat grown on media where peat was replaced in different percentages by OMW-digestate.



**Figure 6.** Wheat after 6 weeks of growth (control on right and 100% peat replaced on left).

At the end of the experiment, the wet and dry weight of wheat cultivated on the different media were examined (**Figure 6**, **Figure 7**). A one-way ANOVA revealed a significant effect of treatment on wheat height at the final measurement date ( $F(3, 153) = 12.47, p < 0.001$ ). Mean final plant height was similar in the control, 50%, and 80% treatments, whereas the 100% treatment showed lower values. Final wet weight was also significantly affected by treatment ( $F(3, 28) = 7.86, p < 0.001$ ). The 50% treatment produced the highest wet weight, followed by 80%, while the control and 100% treatments showed the lowest values but did not differ significantly from each other.



**Figure 7.** Wet and dry weight of wheat cultivated on media with different peat substitution, after six months of growth.

The effects of irrigation on the pH and EC in the leachate of the pots during the experiment are presented in **Table 7**.

**Table 7.** Changes in EC and pH during the experiment.

Treatment	After Two Weeks from Seeding		After Six Weeks from Seeding	
	EC	pH	EC	pH
Control	446	8.04	412	7.6
50%	1558.00	7.62	582	7.13
80%	1739.00	7.64	667.5	7.3
100%	2314.00	7.73	833.5	7.36

High electrical conductivity (EC) in greenhouse pot systems means elevated soluble salt concentrations in the root-zone solution, which impose both osmotic and ionic stresses on the plants. Therefore, it was expected that using OMW-digestate would cause symptoms like reduced growth rates, leaf chlorosis or necrosis, and diminished yield and quality, but it did not happen. The severity of the response is crop-dependent and modulated by substrate properties, irrigation management, and the plant's intrinsic salt tolerance mechanisms. There is a substantive, physiology- and management-driven difference between ornamental plants and wheat in their response to elevated EC, although the underlying stress mechanisms (osmotic stress + ion toxicity) are the same. Wheat exhibits a relatively higher tolerance to salinity compared to many horticultural species. EC levels that might be considered acceptable or only moderately stressful for wheat could often be unacceptable in ornamental production systems, particularly under intensive fertigation in greenhouse pots. Therefore, the results obtained in this experiment should be verified with conventional greenhouse crops.

#### 4. Conclusion and Policy Implications

The cost-benefit analysis conducted earlier (Marchaim & Levanon, 2025) indicated that the best option is to treat OMW at a central location next to a WWTP that can utilise all the products generated during treatment, including the OMW-digestate. The use of OMW-digestate provides tangible cost savings and is consistent with European Environment Agency guidelines. It also supports proper waste management and disposal, in line with the European Commission's organic waste management hierarchy (European Union, 2022), which is based on prevention, reuse, recycling, and recovery, and allows disposal only as a last resort. The substantial fines imposed on olive mill owners for releasing OMW into sewage systems or the environment, together with their harmful effects on WWTPs and their potential to cause eutrophication and pollution, act as a strong deterrent against conventional disposal methods.

The use of OMW-digestate after OMW treatment offers benefits that extend beyond cost savings, highlighting the important environmental value of reducing eutrophication and mitigating pollution through a regional circular economy ap-

proach. This sustainable pathway not only aligns with environmental priorities but also presents clear economic incentives. To advance this approach effectively, we adopted strategies focused on resource efficiency, innovation in olive-processing practices, and sustainable OMW management, while also addressing the rising cost of peat for greenhouse horticulture. The positive response of plants to the alternative growth medium where peat was replaced by OMW-digestate was demonstrated in the present study. Therefore, it represents a compelling cost-benefit opportunity and supports a transition toward more sustainable and economically viable agricultural practices.

The results of this study indicate that the possible use of OMW-digestate as a peat substitute in horticulture can reduce peat extraction, thereby helping to conserve a natural resource while contributing to the economic development of both the horticulture and olive oil production sectors. These findings align with the EU Green Deal and the Farm to Fork strategy (European Commission, 2019, 2020), both of which promote the preservation of natural resources while supporting sustainability and economic growth. Successful use of OMW-digestate will also contribute to the economic viability of OMW treatment plants, in addition to supporting alternative energy production. Further research with typical greenhouse crops cultivated on media containing OMW-digestate as a peat substitute will help to confirm these results and accordingly guide farmers in the proper use of OMW-digestate and potentially increase peat replacement. Diversification of substrates for use as cultivation media can enhance the performance of the horticulture sector while significantly reducing its dependence on peat. Reduced reliance on peat as a principal cultivation medium may also decrease resource depletion and improve environmental quality.

In line with the previous report on the use of OMW-digestate as peat substitute (Marchaim & Levanon, 2025), that emphasized that no single material fully replaced all peat properties, OMW-digestate may be positioned as a component in cultivation-media blends rather than as a standalone substitute. Its main contribution lies in the physical and nutritional properties it provides to the medium when combined with other materials. This approach is consistent with former peat-replacement research (Blok et al., 2024; Hirschler & Thrän, 2023; Kader et al., 2024; Mariotti et al., 2023; Alnsour & Alnsour, 2025). Thiessen et al. (2024) showed that substrate security may be improved by using alternative materials as amendments to horticultural cultivation media. While peat remains the horticulture industry standard, several materials, including coco coir, wood fibre, and bagasse, have shown potential as sustainable peat alternatives when blended with pine bark. However, substantial variations may occur among different types of wood fibre and among sources of coco coir and bagasse. The present study shows that OMW-digestate can replace peat to a relatively great extent.

Unlike several other organic peat alternatives that may carry plant or human pathogens, thermophilic digestion of OMW at 55°C provides an effective sanitation step, offering a biosecurity advantage. This phenomenon was demonstrated previously with digestate produced from the thermophilic digestion of cow ma-

nure (Chen et al., 1984). This directly addresses concerns raised in the peat-replacement literature regarding pathogen introduction through alternative substrates. Therefore, OMW-digestate represents not only a substrate alternative but also a waste-valorization pathway, transforming an environmentally problematic effluent into a productive agricultural input. It i) reduces disposal burdens, ii) recovers nutrients and organic matter, iii) decreases reliance on mined peat, and iv) strengthens regional circular-economy strategies. OMW-digestate also contributes available plant-nutrients, potentially reducing plants' fertiliser requirements.

In this study, we provide supplementary data supporting the potential viability of treating OMW at a central site adjacent to a WWTP by identifying productive uses for OMW-digesting. In doing so, we follow three natural-resource-based strategies for development (3R): reducing, replacing, and regenerating. To confirm the initial findings presented here, larger-scale experiments with distinct greenhouse crops need to be performed.

### Authors' Contributions

Both researchers were involved in developing the research conceptualization. U. Marchaim was the researcher, and D. Levanon supported the review of the implications for agriculture and horticulture & editing.

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### Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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