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Implementing and Analyzing the Agricultural Consequences of Olive Wastewater Digestate on Crop Growth

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Abstract

Bio-waste can be effectively valued by anaerobic digestion (AD).Due to its high nutrient content, the digestate produced during digestion can be successfully used as a mineral fertilizer. This study examined if utilizing AD as an Olive Mill Waste (OMW) treatment method would yield the necessary renewable energy and digestate quality at different temperatures (ambient, mesophilic, and thermophilic).On crop growth, the impact of various raw digestate concentrations was assessed. The acquired information revealed that the Tr3 treatment's soft crop yields as well as germinating rate were both noticeably higher than those of the other three treatments. Moreover, the Tr3 treatment had considerably more leaves, thallus, and main stem height than the other treatments. These results indicate that digestate can replace synthetic fertilizers and has a positive impact on crop growth and development.

Keywords: Anaerobic Digestion (AD), Olive Mill Waste (OMW), Cellobacterin-T probiotic,Enzyme, Diet

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1. Introduction

New approaches must be created to manage and prevent the harmful effects of these wastes on adverse to health with the ecology stability due to the vast volume of organic waste that was also produced each year. In the Mediterranean region, a majority of olive oil is produced worldwide. 96% of the 2.7 million tonnes of olive oil produced, especially on the Indian side. 2.6% of all olive oil exports to the world market came from India. Significant amounts of highly phototoxic olive mill effluent are produced in the process of olive oil, which is hazardous to the environment, especially to water and soil. According to various studies, Olive Mill Wastewater (OMWW) represents some dangerous organic waste developed by the olive oil field[1].OMW is the liquid that is produced when olive oil is separated from olive fruit between November to March using presses, batching machines, and continuous operations. Notwithstanding their ongoing challenges with OMW management, countries that grow olives in the Mediterranean as well as recognize OMW as the greatest amount of effluent in terms of Chemical Oxygen Demand (COD) [2]. In recent decades, ascientific community has extensively investigated Anaerobic Digestion (AD) because of its enormous potential. Also, it was demonstrated that the digestate produced by combining Sewage Sludge (SS) with olive pomace or macroalgal wastes promoted the growth of tomato plants. Microalgae are an abundant supply of nutrients that can be digested by living creatures, making them an anaerobic digestate that is well-known for being used as an organic fertilizer. However, there haven't been many studies on the AD of OMSW used as plant food [3]. It processes more than 800 000 tonnes of oranges each year (tpy), producing approximately 500 000 tonnes per year in the trash as well as over 3.500.000 tonnes per year (tpy) of olives, producing more than 2000 tonnes per year in waste oil. Orange and olive food processing wastes can impact the environment even when they are free of pathogens or dangerous compounds due to their high quantities of polyphenols, acidic pH, and high salt content [4].One of the biggest problems is the enormous amounts of liquid and solid waste that are produced quickly during the manufacture of olive oil. According to estimates, 10 to 12 million cubic meters of OMWW are created annually when total oil output and extraction techniques are taken into account [5].

Using a crude waste management method called olive pomace-sulfur-bentonite palletization, fertilizers can be created that, especially in alkaline soils, can provide a zone of nutrients that are soluble whereas minimizing environmental leaching losses [6]. The article [7] investigated the ability of coal fly ash, zeolitic fly ash, and zeolite that had undergone Ca $(OH)_2$ treatment to accumulate phosphate phosphorus (PO_4-P) when digested by anaerobic olive mill effluent (ADOMW). The concurrent restoration of potassium (K) was also investigated using the outcomes of both adsorption and desorption. The research [8] introduced a novel mixed biological technique for treating OMW for the first time that has resulted in the production of both viable microalgae biomass and OMW.In this study, anaerobic co-digestion and low cut-off membrane ultra-filtration (UF) are used to grow Scenedesmus sp.The author of [9]contrasted the agronomic achievement of the experimental organic improvements over commercial organic fertilizer, as well as the short-term effects of such amendments on changes in soil organic carbon and soil mineral-N.The research [10] showed that peat may be replaced in the nursery business with compost derived from digestive waste. Also, they examined the same compost on hazelnut and olive trees, two quite different species that are both experiencing an upsurge in interest in new tree plantings. The author of [11] focused on its potential to be used as fertilizer for citrus seedlings in nurseries and an in-depth understanding of continuous anaerobic co-digestion of a feedstock mixture made up of various Mediterranean agri-food wastes through multi-element characterization, the agronomic value of industrial AD was evaluated. The effects of digestate fertilization on crop development, photosynthetic efficiency, vegetable output, and chemical nutrient levels were examined in greenhouse research of numerous crop species[12].The author of [13] discovered that temperature (ambient, mesophilic, and thermophilic) as well as the ratio of dairy manure to OMW produced the best digestate quality and renewable energy when AD was used to treat OMW.As two possible benefits of microbial adaptation to high concentrations of PP, it is important to take into account the kinetics of OMW anaerobic breakdown with enhanced methane synthesis[14].Three combinations of OMW and inoculum (digested from a biogas plant fed with agro-wastes) were evaluated in batches of anaerobic digestion under mesophilic conditions to fill in these knowledge gaps. Article [15] explored the creation of biochar from lignin, a rich resource that is easily accessible and produced in enormous quantities (approximately 100 million tonnes per year), as well as its actual application in the treatment of wastewater. With the widespread use of various agroecosystems, a field experiment was conducted to investigate the immediate effects of repeated amendment with solid AD on the integral fertility of an olive grove grown in clayey soil in Southern Italy [16].In two composting cycles (P1 and P2), SS was used to make two combinations with either OMW or green waste, respectively [17].One of the first significant facilities in AD using waste olive oil by [18] this two-stage facility is capable of producing 100 kWe of power. The first test involved pitted pomace and olive pulp, with the second containing biomass that contained 10% crushed cereal. Retention periods lasted 40 days in each cycle.

2. Materials and methods

2.1 Anaerobic Digester examination of the soil's chemistry (AD)

OMWWs were being digested in a semi-continuous reactor that was operating in batch mode. NH_4 (249,12 mg/L), pH (7.4), EC (6.15 ms/cm), HCO_3 (29,76), Mg (148.8 mg/L), Na (690 mg/L), Ca (360 mg/L), NO_3 (104.66 mg/L), Cl (994 mg/L) SO4 (13.68 mg/L), with the K (97.5 mg/L), were all present in the raw digestate.

The soil sampled came from the university grounds and was in the 40 cm to 60 cm layer. The dirt that was collected was sandy, basic clay with little organic substance.The soil had the following elements: pH (7.6), organic matter (1.16%), K2O (0.130 mg/g), $CaCO_3$ (49%), Mg (1.30 mg/g), Na (0.29 mg/g) and P2O5 (0.50 mg/g),. The soil's granulometry is displayed in Table 1.

2.2 Experimental description

A Study was utilized as the four-repeat entirely random block layout and was carried out in a greenhouse. There were four fertilization methods tested: no fertilization, diluted digestate fertilization, and raw digestate fertilization. Te (witness), Tr1 (50% digestate), Tr2 (75% digestate), and Tr3 (100% digestate) are various solutions of raw digestate that were made by diluting them with water. These treatments were used to assess crop growth so that the best treatment could be selected for the development of the culture. To assess the impact of anaerobic digestate on crop development, measurements of the leaf count, the amount of thallus per foot, along withthe primary stem height were made after each month.

$$Germination\ index\ (\%) = \frac{Final\ number\ of\ seeds\ that\ germinated}{Number\ of\ initial\ seeds} * 100$$

$$Soft\ wheat\ yield\ (G) = Number\ of\ ears\ /m^2 \times Number\ of\ gains/ear \times Weight\ of\ 1000\ grains$$

2.3 Performance analysis

An analysis of variance (ANOVA) was carried out to find the result of time as well as various treatments on the development as well as the growth of the crop. The different treatments were compared using the Tukey-Kramer test. The soft crop yields, the height of the main stem, the number of leaves, and also the count of thallus per foot were noted.

3. Results and Discussions

3.1 Study of Variance for Continually Measured Time Series

The number of leaves as well as the height of the main stem is considerably influenced by time, treatment, or their interactions, according to the examination of recurrent variability across time. The examination of recurrent variability over time demonstrates that time, and treatments, especially their interactions have a substantial impact on the count of leaves and also the primary stem height.

3.2 Soft crop development and growth

3.2.1 Leaf count per square foot

Between treatments, there is a substantial variation in the number of leaves (F=86.9; dF=5; P<0.0001). When compared to the other therapies, it was much higher with the Tr3 therapy (figure 1). With both the control therapy and the Tr1 treatment, it was much lower. These findings demonstrated how the substantial nutritional content of digestate improved crop growth and development. A beneficial impact of digestate on a crop has already been noted in a prior study. Another study that looked at the impact of applying digestate and fly ash on the functional qualities of soil had encouraging results**.**

3.2.2 Thallus count per square foot

Figure 2 illustrates how the various treatments changed the quantity of thallus per foot. Betweentreatments, each person produces significantly different amounts of the thallus (F=65.8; dF=5; P<0.0001).When compared to the other medicines, it is significantly higher with the Tr3 treatment. Although the output of thallus per foot is significantly reduced inside the two treatment groups (Control and Tr1), which are comparable to one another, it does not alter over time.

3.2.3The main stem's size

The two treatments were compared head-to-head using the Tukey-Kramer test. If there are various symbols on the graph to indicate the variations in the therapies are substantial (P<0.0001). Figure 3 shows the significant treatment changes in the height of the main stem (F = 9.6; dF = 4; P<0.0001). Between the Tr3 therapy and the other three therapies, there were barely any differences (in which it was much higher).

Table 1: Soil Granulometry

Granulometry	Value
Fine silt(%)	2.1
Fine sand (%)	36.7
Coarse sand (%)	70.8
Coarse silt (%)	1.6
Clay (%)	4.0

Table 2: Assessment of yields from soft crops

ANOVA					Avg			AverageComparison
	F	dF	P	Te	Tr1	Tr2	Tr3	
No ofm^2/ear	1.59	3	0.2478	283,5± 6.7	277±7.5	290±0,2	290±0.0	$T_e^a Tr_1^a Tr_2^a Tr_3^a$
No ear/ grains	19.81	3	<0.0003	18.01.9	18.3± 2.0	25.8± 0.11	35.3± 2.3	$T_e^c Tr_1^{bc} Tr_2^b Tr_3^a$
weight of 1000grains (g)	5.46	3	0.0139	46.10.9	49.4± 0.9	45.1± 1.7	49.8± 0.5	$T_e^{cha} Tr_1^{ba} Tr_2^c$ Tr$_3^a$
Soft crop yield(g)	20.8	3	<0.0003	234028 ± 21306	250287 ± 29829	336452 ± 16377	509983 ± 38637	$T_e^c Tr_1^{bc} Tr_2^b Tr_3^a$

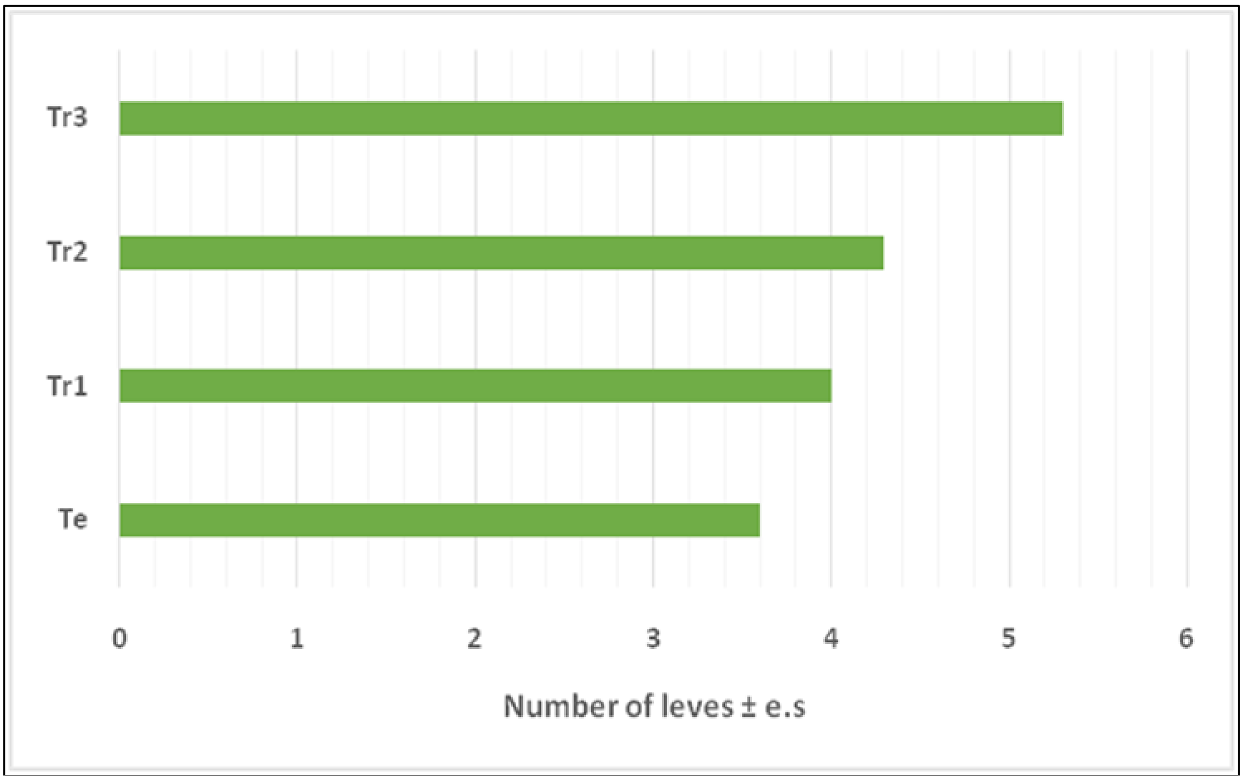

Figure 1: Effects of various treatments on the number of green leaves

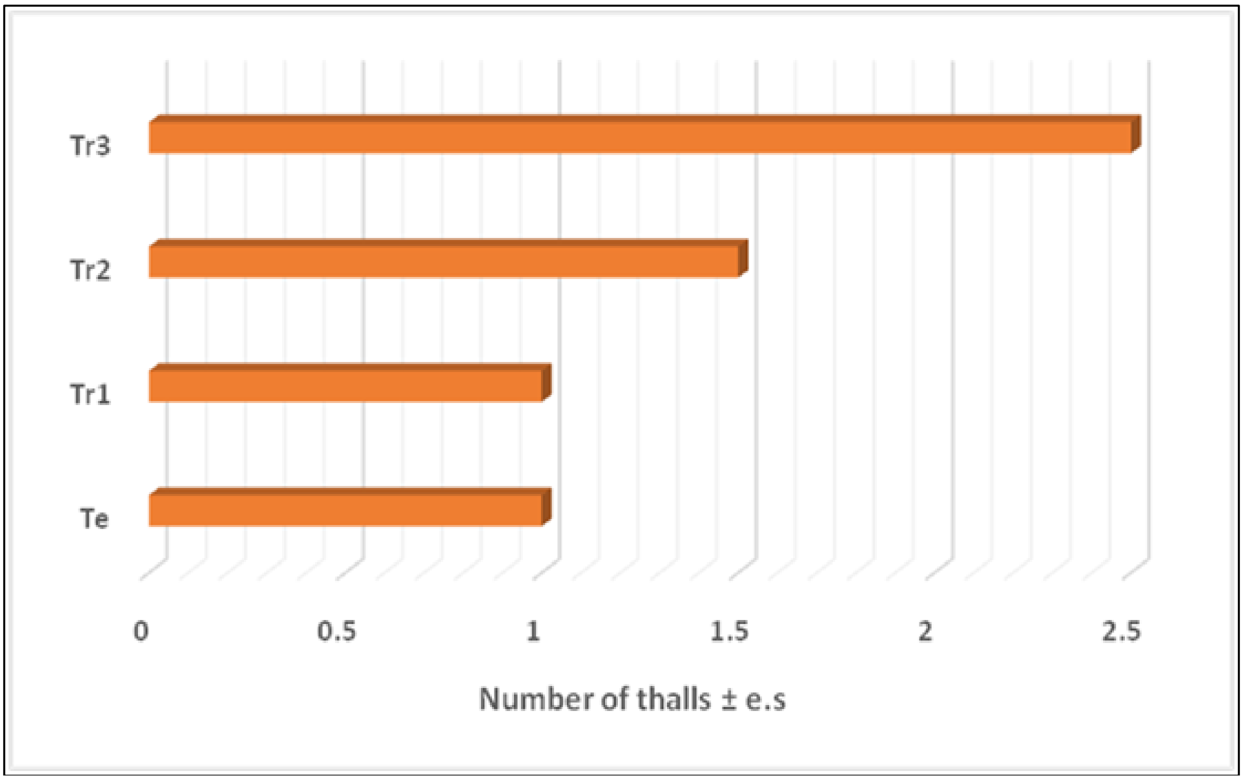

Figure 2: Several treatments' effects on the density of thallus per foot

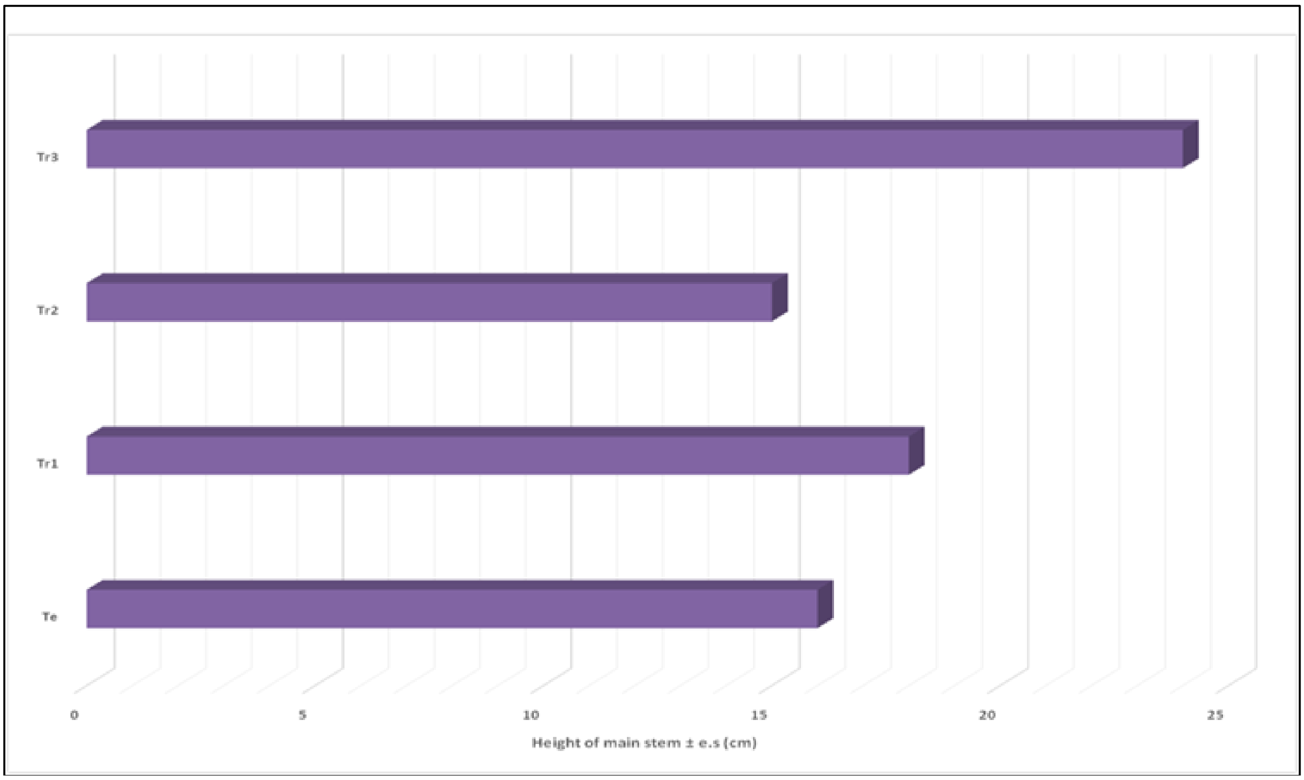

Figure 3: The effect of several medications on the height of the main stem

3.3 Analysis of soft crop yields

Table 2 displays the findings of the ANOVA for the evaluation of groups for yield per ear, weight per thousand kernels, as well as quantity of ears per square meter. To assess the comparability of treatment pair comparisons, the Tukey-Kramer test was performed. In the table, different symbols represent significant (P0.0001) variations between treatments.

The number of ears generated by each plant was noticeably constant among treatments. The number of grains that each ear generated varied dramatically between treatments. In the Te and Tr1 treatments, it was lower; however, it was considerably greater in the Tr3 treatment. There was a significant variation in the weight of grains generated between treatments. Grain generated by the plants in the Tr3 and Tr1 treatments was substantially heavier than grain from the Tr2 treatments. Crop grain production varies dramatically between treatments depending on the number of ears per m2, the count of grains per ear, and the weight of a thousand grains. When compared to the other three therapies, the Tr3 therapy was superior.

4. Conclusions

Inorganic fertilizer has been replaced with raw digestate produced by AD n of wastewater from olive mills. Due to the presence of potassium as well as nitrogen in significant amounts, the analysis's findings indicated that the digestate can have an extremely intriguing fertilization impact. Our study demonstrated the potential for enhancing crop growth and development by using digestate in various doses. The Tr3 treatment outperformed the other treatments in terms of soft crop yield. To improve crop development and soil fertility, the digestate can thus substitute commercial fertilizer and is strongly advised as a source of nutrients.

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