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Sustainable Fertilization of Organic Sweet Cherry to Improve Physiology, Quality, Yield, and Soil Properties

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Abstract: Sustainable fertilization techniques are essential in Mediterranean farming systems, where the depletion of organic matter, influencing soil water and nutrient availability, is becoming an increasing concern. In this context, organic fertilizers offer an effective strategy to restore soil fertility while reducing environmental impacts. This research aimed to evaluate the effects of different organic fertilizers on soil quality and tree performance in a sweet cherry (*Prunus avium* L.) orchard. This study was conducted in two growing seasons (2021–2022) in an organic orchard in Southern Italy, comparing four treatments: (i) compost, (ii) compost combined with compost tea, (iii) mixed manure, and (iv) an unfertilized control. The results indicated that compost tea, applied both to the soil and as a foliar spray, significantly improved tree water status, particularly under water stress conditions, as reflected by more negative stem water potential values. Moreover, this treatment enhanced photosynthetic performance, yield, and fruit quality, achieving the highest ratio of soluble solids content/total acidity. The findings suggest that compost tea, in combination with compost, could be a sustainable and valuable fertilization option for Mediterranean organic tree orchards. However, further studies are necessary to understand the benefits of other fruit orchards as well as the long-term effects on soils.

Keywords: compost tea; EMI map; soil water content; organic cultivation; productivity; soluble solids content; *Prunus avium* L.; water use efficiency

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Academic Editor: Zhongyang Huo

Received: 12 December 2024
Revised: 30 December 2024
Accepted: 2 January 2025
Published: 8 January 2025

Citation: Gaeta, L.; Tarricone, L.; Persiani, A.; Fiore, A.; Montemurro, F.; De Benedetto, D.; Vitti, C.; Campi, P.; Diacono, M. Sustainable Fertilization of Organic Sweet Cherry to Improve Physiology, Quality, Yield, and Soil Properties. *Agronomy* **2025**, *15*, 135. https://doi.org/10.3390/agronomy15010135

1. Introduction

Fruit production has faced many challenges in recent years, as increasing safety and reducing the harmful effects of intensive farming practices (e.g., pesticides and fertilizers) are required [1]. In Mediterranean agricultural systems, sustainable fertilization practices are essential for maintaining soil fertility and crop productivity since organic matter is progressively depleting [2]. Organic fertilization plays a crucial role in improving soil health, enhancing microbial activity, and promoting the sustainability of agroecosystems. It contributes to the enrichment of soil organic matter and improves soil physical properties, thereby supporting long-term soil fertility and plant productivity. Organic fertilization is mandatory for organic orchards, where green manures, composts, and animal manure should be applied [3]. Despite its environmental and ecological benefits, organic fertilization also presents some challenges. The slower mineralization of nutrients (particularly nitrogen) does not meet the immediate nutritional needs of crops. Additionally, the high costs of organic fertilizers and their limited availability can pose economic issues for farmers [4].

The use of biofertilizers (e.g., compost) produced by recycling agricultural/agro-industrial waste directly on farms may represent, however, a sustainable "circular economy" strategy to recover valuable nutrients, reduce the environmental impact of improper waste disposal [2], and reduce the costs associated with organic fertilizers.

Several studies have shown that it is possible to produce good-quality compost on the farm, as well as compost extracts (compost tea), by using simple and cost-effective techniques [5,6] and managing the processes to obtain mature and stable products. Compost teas are organic liquid formulations obtained through the aqueous extraction of composted materials during a fixed incubation period with dechlorinated water under controlled conditions [7]. Their use should be encouraged as valid substitutes for agrochemicals, at least partly, considering the ease of production and the potential positive effects on crops linked to macronutrients, humic acids, and microorganisms [8]. Compost teas can benefit different crops by improving soil health, enhancing plant growth, and helping protect plants from diseases due to suppressive properties. The effects are linked to compost type, compost-to-water ratio, and aeration, which determines the development of specific microbial consortia in suspension.

However, there is still a need to better understand the effects of new waste-based fertilizers, both in solid (compost) and liquid (compost tea) forms, on soils and plant performance in Mediterranean conditions [9]. Although in many studies on-farm composting of organic wastes and residues has been found to be environmentally sustainable [10–12], direct production at a small farm scale and application to different crops is still not a common practice, and the same applies to compost tea. Few studies have examined the influence of compost/compost tea on the whole soil–plant system, especially considering the physiology and fruit quality of perennial species like fruit trees. Sorrenti et al. [9] observed benefits in the photosynthetic performance of a peach orchard due to the application of compost on the soil. A study on grapevines showed positive effects on plant growth and production parameters using different types of compost tea [13]. However, to the best of our knowledge, there are no studies investigating the effect of these organic materials, particularly compost tea, on sweet cherries.

Sweet cherry (*Prunus avium* L.) is widely grown and holds a significant economic value [14]. The global supply of sweet cherries increased from 1.85 to 2.75 million tons between 2008 and 2022 [15]. In Italy, cherry production has remained relatively stable, with an annual market supply of around 115,000 tons [15], and in the Apulia region (Southern Italy), the area harvested in 2023 was about 64% [16]. However, in the past five years, due to adverse climatic conditions (rain during harvest) and the spread of a significant new pest (*Drosophila suzukii*), yield losses have been reported. In sweet cherries, effective orchard management relies on ensuring adequate water and nutrient availability during critical periods such as flowering, fruit growth, harvest, and even post-harvest [17]. Therefore, understanding the plant's nutrient needs and analyzing water stress conditions at different phenological stages enables more efficient management with well-timed and synchronized fertilization. This, in turn, leads to higher fruit yield and quality [18].

The main objective of this study was to apply and compare different organic fertilizers, focusing on the effect of compost tea, which represents the novelty of this research. Therefore, compost tea was produced in a small-scale pilot plant and applied in an organic sweet cherry orchard, grown in Mediterranean conditions, to assess its feasibility as a sustainable alternative to traditional organic fertilizers.

2. Materials and Methods

2.1. Experimental Site and Agrometeorological Data

The study was carried out in an organic commercial sweet cherry orchard (longitude: 16°51′45″ E; latitude: 40°48′9″ N; about 372 m above sea level) in the Apulia region (Southern Italy) in the 2021 and 2022 growing seasons. The orchard was established in 2012 with a tree planting space of 5.0 m × 3.0 m (667 trees ha^{-1}), trained as a bush vase, and managed according to the usual farm practices. The field experiment was performed on the cherry cultivar "Lapins", which was grafted onto the drought-tolerant "S. Lucia" rootstock (*Prunus mahaleb* L.), known for its resilience to high temperatures and poor soil conditions. Soil management was carried out along the rows while inter-row space was occupied by permanent resident vegetation, which was mowed two times per year.

Soil texture was classified as sandy (USDA Soil Survey Staff, 1975) and contained 560 g kg^{-1}, 200 g kg^{-1} and 240 g kg^{-1} of sand, silt, and clay, respectively, determined by the hydrometer method. The volumetric soil water content at field capacity (FC, −0.03 MPa) and wilting point (WP, −1.5 MPa) was 0.290 and 0.125 m^3 m^{-3}, respectively (measured in the Richards chambers).

The experimental site exhibited a Mediterranean climate characterized by warm and dry summers and mild winters. In the last 30 years, mean minimum and maximum annual air temperatures were between 0 and 5 °C and 32 and 43 °C, respectively. The annual rainfall in the area is about 535 mm, concentrated mainly during the autumn–winter period and scarce during the spring and summer. The yearly average difference between precipitation and reference evapotranspiration is about −560 mm; consequently, the precipitation does not supply the water requirements from April to September, and most of the crops can be successfully cultivated only by supplying irrigation water [19]. Therefore, in the organic cherry orchard, all trees received water supply via a drip irrigation system, with two drippers per tree and a flow rate of 8 l h^{-1} per dripper throughout the growing season.

Agrometeorological data (daily rainfall, minimum and maximum temperatures, relative air humidity, solar radiation, and wind speed) were collected by a standard agrometeorological station located close to the experimental site. Vapor deficit pressure (VPD) was calculated using Allen et al.'s method [20].

2.2. Experimental Field Design and Treatments

The experimental design consisted of four treatments that were replicated three times and set up in a completely randomized block design comprising 108 cherry trees. Four fertilization treatments were compared: (i) application of a commercial compost (C, lsa Life, ILSA S.p.A., Arzignano, Italy) containing about 2% total nitrogen (N) and 28.5% total organic carbon (TOC); (ii) a combination of commercial compost applied to the soil during the winter period and compost tea applied to both soil and foliage during the spring season (C + CT); (iii) fertilization with commercial mixed manure (M, Fumier Humus Super, Agribios Italiana s.r.l., Canneto sull'Oglio, Italy) containing 2% total N and 24% TOC; and (iv) an unfertilized control (T).

The compost tea was obtained using an on-farm compost produced in the composting pilot plant located at an experimental farm of CREA (Metaponto-MT, southern Italy; lat. 40°24′ N; long. 16°48′ E). The compost for the extraction was made from lettuce, zucchini, field bean, and lawn residues, and the main characteristics of both compost and the obtained extract (compost tea) are reported in Table 1. Using Pant et al. [21] and Zaccardelli et al.'s methods [22], the compost was extracted with dechlorinated water in a 1:5 ratio (*v:v*). The extraction process lasted five days and used a system consisting of a plastic tank, jute bags, and a 250 W electric pump for aeration. The jute bag was filled with 40 L of compost, sealed, and immersed in 200 L of water. The extract was then diluted with water (1:3 *v*/*v*) to a final dilution of 1:15 (compost tea/water) based on electrical conductivity values (<1.5 mS cm^{-1}) [13,21].

Table 1. Main chemical–physical characteristics of on-farm compost and compost tea.

	On-Farm Compost		**Compost Tea (1:5) *v*/*v***	
pH	-	7.0	-	7.8
Ec	mS/cm^{-1}	3.6	mS/cm^{-1}	3.6
TOC	%	20.3	mg L^{-1}	190.0
N	%	2.9	mg L^{-1}	282.7
C/N	-	7.1	-	0.67
Ca	g kg^{-1}	88.6	mg L^{-1}	124.8
K	g kg^{-1}	17.6	mg L^{-1}	487.1
Mg	g kg^{-1}	10.9	mg L^{-1}	55.7
Na	g kg^{-1}	2.14	mg L^{-1}	127.8
P	g kg^{-1}	8.3	mg L^{-1}	16.68
Fe	g kg^{-1}	14.0	-	-
Cu	mg kg^{-1}	49.4	-	-
Mn	mg kg^{-1}	430	-	-
Zn	mg kg^{-1}	158.4	mg L^{-1}	0.53

Representative samples were collected and analyzed. Compost samples were dried at 70 °C for 24 h, ground to pass a <1 mm sieve, and then analyzed. The N contents were determined by the Dumas method, using a CHNS Analyzer (Flash EA 1112-CHNS, Thermo Electron Corporation, Waltham, MA, USA), whereas C content was measured with a TOC Vario Select analyzer (Elementar, Germany). To determine the total contents of Ca, K, Mg, Na, P, Fe, Mn, Cu, and Zn, the compost samples were mineralized using microwave-assisted pressure digestion and quantified by an ICP-OES optical spectrometer (Varian Inc., Vista MPX). The N and C contents in the compost tea samples were also analyzed with a TOC Vario Select analyzer (Elementar, Germany) in liquid mode, whereas the total contents of Ca, K, Mg, Na, P, Fe, Mn, Cu and Zn were quantified by ICP-OES optical spectrometer without mineralization. Table 1 shows the chemical–physical characteristics of compost and compost tea obtained.

Each year, in the C + CT treatment, the compost tea was added to the soil at a rate of 3 L $tree^{-1}$, while 0.25 L $tree^{-1}$ was sprayed onto the canopy at different BBCH-scale growth stages: the beginning of flowering (BBCH 61), fruit set (BBCH 72), and at the beginning of ripening marked by fruit coloration (BBCH 81; [23]), over an area of 405 m^2. The application rate both of commercial compost and manure was 2.1 t ha^{-1} (3 kg $tree^{-1}$).

2.3. Stem Water Potential, Gas Exchange, and Water Use Efficiency

To assess the impact of fertilization management practices on physiological tree performance, two trees of similar size, vigor, and health were selected [24]. In 2021 and 2022, at midday (12:00–14:00 h, solar time), six healthy, mature, and shaded leaves close to the tree trunk were used per treatment to measure stem water potential (Ψ_{stem}, MPa) with a Scholander pressure chamber (Model 3000, Soil Moisture Equipment Corp., Goleta, CA, USA) using the method described by Noar et al. [25]. In 2022, gas exchange measurements were also carried out, determining leaf net photosynthesis (A, µmol CO_2 m^{-2} s^{-1}), stomatal conductance (g_s, mol H_2O m^{-2} s^{-1}), and transpiration (E, mmol H_2O m^{-2} s^{-1}), which were measured at solar midday in six fully expanded mature leaves from the outer canopy, with an open circuit infrared gas analyzer fitted with a fluorimeter and a LED light source (Li-COR 6400XT, LI-COR, Lincoln, NE, USA). The light intensity was kept constant by adjusting the LED light source to match the natural irradiance that the leaf experienced just before measurement [26]. Intrinsic water use efficiency (WUE_i, μmol CO_2 $mmol^{-1}$ H_2O) was calculated as the ratio between A and g_s [27,28].

Measurements were taken at midday since they are more accurate during this time because Ψ_{stem} and g_s are more closely aligned with leaf water status [29,30]. The Ψ_{stem} and the gas exchange measurements were obtained throughout three cherry phenological stages: (i) the beginning of fruit coloration (BBCH 81), (ii) ripe for picking (BBCH 87), and (iii) post-harvest (BBCH 91) [23].

2.4. Yield and Fruit Quality Assessments

Fruits were hand-picked at their commercial ripening stage, defined by the producer, in the second week of June 2021 and 2022. Production per tree (kg $tree^{-1}$) was measured on three trees for each treatment. Moreover, at harvest, 20 fruits per tree were randomly sampled and promptly taken to the laboratory for analysis. Fruit weight, fruit size (length and width), soluble solids content (SSC), pH, and titratable acidity (TA) were measured. The maturity index (MI), which was calculated as the SSC/TA ratio [31], is commonly used to assess the sugar and acid balance in fruit flavor, and is also considered as one of the main analytical measures for fruit quality [32,33].

2.5. Soil Properties

2.5.1. Soil Water Content and Irrigation

Soil water content (SWC) volume was measured by capacitive probes (10HS, Decagon Devices Inc., Pullman, WA, USA), and three trees were monitored during the irrigation season (1/05–30/09) [34]. Two probes were installed horizontally into the soil profile, transversely to the row, at depths of −0.13 and −0.37 m from the soil surface to monitor the dynamics of SWC below the dripping lines. All sensors were connected to data loggers (Tecno.El, Formello, Italy), and data were transferred to a web server via GPRS mode. Integrated daily soil water content (SWC_i) was determined for the soil profile (0.5 m) by integrating the values measured at each depth since each probe was supposed to detect the water content within a 0.25 m soil layer [24]:

$$\int_0^{0.5} SWC_i = SWC_{\mathrm{i}(-0.13)}\left(m^3 m^{-3}\right)\cdot 0.25(m) + SWC_{\mathrm{i}(-0.37)}\left(m^3 m^{-3}\right)\cdot 0.25(m) \quad (1)$$

Irrigation was performed to restore 100% of crop evapotranspiration when readily available water (RAW) was exhausted, according to Allen et al.'s [20] methodology.

2.5.2. Electromagnetic Induction Survey

In May 2021 and June 2022, a geophysical survey utilizing Electromagnetic Induction (EMI) was carried out using an EMI-sensor (EM38DD, Geonics Limited, Mississauga, ON, Canada) connected to a DGPS (Differential Global Positioning System) over 23 rows between trees by sliding the sensors along the surface. For each date, 36 geo-referenced soil samples were collected from the soil surface at a 0.30 m depth, and the SWC was measured using the gravimetric method. The apparent soil conductivity was determined in agreement with McNeill [35]. The EMI sensor consisted of two perpendicularly superposed EM38 sensors that simultaneously measured apparent electrical conductivity (EC_a, expressed in mS m^{-1}) near the soil surface (0–0.75 m depth) using the horizontal mode (EC_a-H) and up to 1.5 m depth with the vertical mode (EC_a-V; [35]). Before the operation, the instrument was set to zero at a height of 1.5 m, according to the manufacturer's instructions, and at the end of the survey, the zeroing was checked to detect possible drift. The survey was performed using a nonmetallic platform with a wood cover, and the sensor was towed behind a quad. The EC_a was recorded every second, with a spatial resolution of 0.5 m, on average, along each transect.

2.5.3. Soil Sampling and Analyses

Three soil samples per treatment were randomly collected before the application of the different fertilizers at the beginning (t_i) of the 2021 growing season and at the end (t_f) of the 2022 season by using a 10 cm diameter soil auger at a depth of 15–20 cm. On the air-dried and sieved soil samples (<2 mm particle size), TOC was measured by dry combustion with a TOC Vario Select analyzer (Elementar, Langenselbold, Germany) [36], total N was analyzed according to the Kjeldahl procedure, pH was measured by extraction with a 0.01 M $CaCl_2$ solution (1:2.5, w/v) using a CRISON Titro Matic 2S pH meter, and available P (P-Ols) was analyzed according to the method described by Olsen et al. [37].

In neutral to alkaline soils, such as the tested soil (average pH = 7.35), the exchange bases (Ca, Mg, K, and Na) occupy the entire Cation Exchangeable Capacity. Consequently, this was quantified as the sum of the exchangeable cations obtained by extraction in a barium chloride–triethanolamine buffered solution (pH = 8.2), followed by ICP-OES determination [38].

2.6. Statistical Analysis

Soil parameters and physiology data of each year were subjected to a one-way analysis of variance (ANOVA) to test the effect of different organic fertilizers on the orchard. Means were compared using the Student–Newman–Keuls test with the SAS/STAT 9.2 software package (SAS, 2010). Similarly, yield and quality were processed using the Systat 11 package to evaluate the effect of climate trends each year (SYSTAT Software Inc., Richmond, CA, USA). The preliminary data analysis was characterized by both the data quality check and cleaning procedure of the EC_a data. The points at which the instrument was stationary and any negative values were also removed. EMI data were interpolated by ordinary kriging using ArcGIS 10.4 software (ESRI, Redlands, CA, USA), and continuous surfaces were obtained with a spatial resolution of 0.5 m × 0.5 m.

3. Results

3.1. Agroclimatic Conditions

The climatic trends recorded during the 2021 and 2022 seasons were in line with Mediterranean climate conditions. In 2021, during the vegetative phase of the sweet cherry orchard (1/4–30/9), the minimum temperature fell below 0 °C only once (−5 °C), while the maximum reached values > 30 °C several times. In 2022, the minimum temperature never fell below 0 °C, while the maximum temperatures reached > 30 °C several times. Considering the average air temperature, the 2022 season was 1.7 °C warmer and 171 mm wetter than the first season. Rainfall during the vegetative–reproductive phase of the sweet cherry orchard was 88 mm and 258 mm in 2021 and 2022, respectively (Table 2).

3.2. Plant Water Relations and Leaf Functionality

During 2021, midday stem water potential (Ψ_{stem}) ranged from −1.98 (for T on the 204 DOY (day of the year)) to −1.05 MPa (for C on the 169 DOY), and significative differences between the treatments were observed at 169 and 204 DOY (Figure 1a). On these two dates, trees under control (T) had the highest negative values of Ψ_{stem}, measuring 14.2% and 19.3% compared to the average of the fertilized trees on the 169 DOY and 204 DOY, respectively (Figure 1a).

Table 2. Minimum, maximum, and average monthly air temperature, relative humidity (RH), vapor deficit pressure (VPD), and rain for each season of the experimental trial.

Month	**T.min °C**	**T.max °C**	**T.avg °C**	**RH avg %**	**VPDavg kPa**	**Rain mm**
			Season 2021			
Apr	4.9	16.1	10.5	64.5	0.40	38.1
May	10.3	24.3	17.2	58.7	0.70	4.3
Jun	14.4	30.0	22.7	49.5	1.32	3.6
Jul	18.1	32.4	25.5	50.3	1.48	31.2
Aug	19.3	32.3	25.8	55.9	1.30	1.2
Sept	15.5	26.6	21.1	66.9	0.69	9.2
Mean	*13.8*	*27.0*	*20.5*	*57.6*	*1.00*	-
Sum	-	-	-	-	-	*87.6*
			Season 2022			
Apr	5.8	20.1	12.9	65.4	0.47	109.4
May	12.2	28.1	20.4	63.8	0.76	24.6
Jun	17.3	33.8	25.9	54.0	1.41	11.0
Jul	17.3	34.0	25.9	57.4	1.25	31.6
Aug	17.9	32.2	24.4	69.0	0.80	77.0
Sept	16.1	31.3	23.7	63.6	0.90	4.8
Mean	*14.4*	*29.9*	*22.2*	*62.2*	*0.9*	-
Sum	-	-	-	-	-	*258.4*

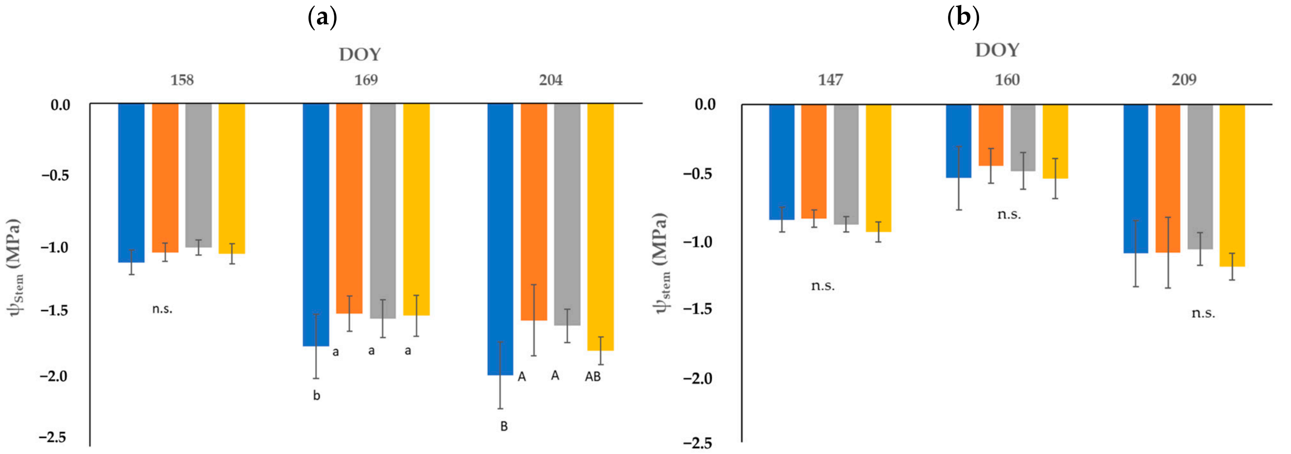
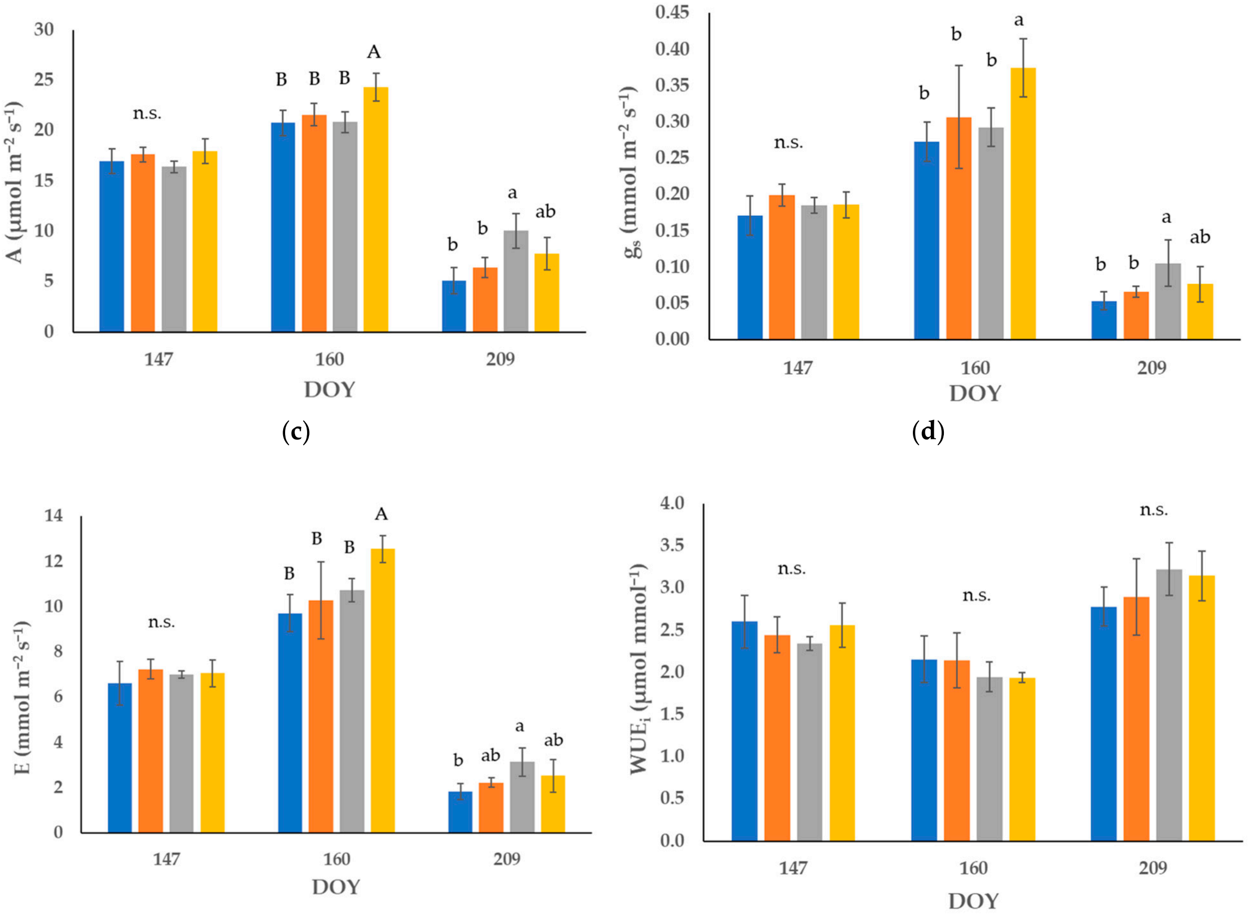


Figure 1. Stem water potential (ψ_{Stem}) of sweet cherry trees measured on three dates (DOY, day of the year) in 2021 (**a**) and 2022 (**b**). In blue, the control (T); in orange, the commercial mixed manure (M); in gray, the commercial compost (C); and in yellow, the combination of compost with compost tea (C + CT). Statistically significant differences between treatments are indicated by different lowercase letters at $p < 0.05$, different capital letters at $p < 0.01$, and ns means no significant difference.

In 2022, midday water potential ranged from −1.20 (for C + CT on the 209 DOY) to −0.45 MPa (for M on the 160 DOY, Figure 1b). The values of Ψ_{stem} in 2022 were higher than in 2021 by about 71% throughout the season of measurements and, on average, across the treatments. During 2022, no statistical differences were identified between the treatments (Figure 1b).

In 2022, except on the 147 DOY, the photosynthesis, the stomatal conductance, and the transpiration were significantly different between the treatments; therefore, results are reported in Figure 2a–c. In general, higher gas exchange values were recorded during the fruit ripe-for-picking stage (160 DOY) than in other phenological phases. The values ranged between the treatments from 24.3 to 20.8 μmol m^{-2} s^{-1} for the A parameter and

0.37–0.27 mmol m^{-2} s^{-1} for the degree of stomata opening, which facilitated the gas exchange between the leaf interior and the atmosphere (g_s) (Figure 2a,b), and from 12.56 to 9.72 mmol m^{-2} s^{-1} for the E parameter (Figure 2c). In the post-harvest phase (209 DOY), these values dropped dramatically, as expected. The intrinsic water use efficiency (WUE_i, Figure 2d) showed a variation in all treatments, reaching a minimum of 1.96 µmol $mmol^{-1}$ (160 DOY for C + CT) and a maximum of 3.22 µmol $mmol^{-1}$ (209 DOY for C), even if it did not significantly differ between the treatments. Among treatments, C + CT showed a better performance in terms of A and g_s at 160 DOY, showing values higher by 15.3% and 28.9% than the average of the other treatments, respectively. These results were combined with a higher E value.



(**a**)

(**b**)

(**c**)

(**d**)

Figure 2. Net assimilation rate of CO_2 by the leaf—A (**a**), conductance—g_s (**b**), transpiration rate—E (**c**), and intrinsic water use efficiency—WUE_i (**d**) measured on three dates (DOY, day of the year) in 2022. In blue, the control (T); in orange, the commercial mixed manure (M); in gray, the commercial compost (C); and in yellow, the combination of compost with compost tea (C + CT). Statistically significant differences between treatments are indicated by different lowercase letters at $p < 0.05$, different capital letters at $p < 0.01$, and ns means no significant difference.

3.3. Fruit Yield and Quality

Tables 3 and 4 show the effects of the different fertilization treatments on the fruit yield and quality parameters of sweet cherries in each season. In 2021 (Table 3), the C + CT treatment had the highest yield per tree, while T showed a 40% loss in yield compared to C + CT. The C and M treatments significantly affected fruit weight compared to T and C + CT. Fruit length was significantly higher when trees were treated with compost and compost tea. Concerning fruit juice composition, the soluble solids content (SSC) and maturity index (MI; SSC/TA ratio) were influenced by compost tea applications. In fact, the values of SSC and MI in C + CT were 10.5% and 21.4% higher than in C, respectively. The lowest TA was recorded in T, followed by C + CT. The lowest pH value of fruit juice was recorded in M, followed by T and C + CT (Table 3).

Table 3. Effect of treatments on fruit sweet cherry quality and yield in the 2021 season (SSC: soluble solid content; TA: titratable acid; MI: maturity index; C: commercial compost; M: commercial mixed manure; C + CT: combination of commercial compost with compost tea; T: control. In the column, means followed by different letters have statistically significant differences at $p < 0.05$).

Treatments	Yield (kg Tree^{-1})	Fruit Weight (g)	Fruit Length (mm)	Fruit Width (mm)	SSC (%)	TA (g/L)	MI (%)	pH
C	15.80 ^{c}	6.88 ^{a}	21.48 ^{b}	22.93 ^{b}	20.63 ^{c}	10.02 ^{a}	20.59 ^{c}	3.96 ^{a}
M	18.30 ^{ab}	6.89 ^{a}	22.37 ^{ab}	24.75 ^{a}	21.65 ^{b}	9.58 ^{b}	22.60 ^{b}	3.86 ^{c}
C + CT	20.30 ^{a}	6.74 ^{ab}	22.60 ^{a}	24.13 ^{a}	22.81 ^{a}	9.12 ^{c}	25.01 ^{a}	3.88 ^{b}
T	12.10 ^{d}	6.42 ^{b}	21.44 ^{b}	22.89 ^{b}	21.61 ^{b}	8.80 ^{d}	24.56 ^{ab}	3.87 ^{bc}
Mean	*16.6*	*6.7*	*22.0*	*23.7*	*21.7*	*9.4*	*23.2*	*3.9*

Table 4. Effect of treatments on fruit quality and yield in 2022 season (SSC, soluble solid content; TA, titratable acid; MI: maturity index; C: commercial compost; M: commercial mixed manure; C + CT: combination of commercial compost with compost tea; T: control. In the column, means followed by different letters have statistically significant differences at $p < 0.05$).

Treatments	Yield (kg Tree^{-1})	Fruit Weight (g)	Fruit Length (mm)	Fruit Width (mm)	SSC (%)	TA (g/L)	MI (%)	pH
C	15.70 ^{ab}	6.25 ^{a}	21.07 ^{a}	22.63 ^{a}	19.82 ^{b}	9.67 ^{ab}	20.49 ^{b}	3.71 ^{b}
M	17.90 ^{a}	5.85 ^{b}	20.41 ^{b}	21.90 ^{b}	19.54 ^{b}	9.02 ^{b}	21.66 ^{b}	3.83 ^{a}
C + CT	18.40 ^{a}	5.83 ^{b}	20.17 ^{bc}	21.45 ^{bc}	20.37 ^{a}	9.20 ^{ab}	22.14 ^{a}	3.72 ^{b}
T	11.60 ^{c}	5.15 ^{c}	19.77 ^{c}	20.97 ^{c}	19.00 ^{c}	9.86 ^{a}	19.30 ^{c}	3.68 ^{b}
Mean	*15.9*	*5.8*	*20.4*	*21.7*	*19.7*	*9.4*	*20.9*	*3.7*

In 2022, the highest yield per tree was obtained in M and C + CT, followed by C, whereas a −36% yield reduction was recorded in T compared to C + CT (Table 4). In addition, the C treatment significantly affected fruit weight and fruit diameters compared to the other treatments. The SSC and MI were higher in C + CT than in the other treatments, confirming the result of the first season. The lowest titratable acidity was recorded in M, which also showed the highest pH value of fruit juice. Moreover, yield per tree in 2022 showed a reduction of about 4.2% than in 2021, on the average of the treatments.

3.4. Soil Conditions

3.4.1. Soil Water Content and Irrigation

Seasonal irrigation volumes, depth, and number of irrigation events, as well as crop evapotranspiration, are reported in Table 5. During the 2021 season, the irrigation volume was lower than in 2022 due to the different weather conditions. In April 2022, rainfall occurred when the evapotranspiration of the sweet cherry orchard was generally low; therefore, it did not contribute to reducing the irrigation volumes.

Table 5. Seasonal irrigation volumes, depth, and number of irrigation events (n.) applied for each season, as well as crop evapotranspiration (ETc).

Irrigation Variables	2021	2022
Seasonal irrigation volume (m^3 ha^{-1})	2620	3527
Depth (m^3 ha^{-1})	238	294
Irrigation (n.)	11	13
ETc (mm)	347	396

In both seasons, SWC (mm) values varied between the field capacity (FC) and the readily available water (RAW) threshold (Figure 3). A seasonal RAW value of 0.5 was obtained from threshold values (p = 0.45) tabled in FAO56 following adjustments for ET_0, according to Allen et al. [20]. The irrigation scheduling allowed us to keep the water content values in the soil profile within the RAW threshold (105 mm) and avoid water stress. However, at the beginning of the 2021 season, there was a reduction in SWC below the RAW threshold, which was likely due to problems with the irrigation system. Subsequent irrigation brought the values back into the range of RAW.

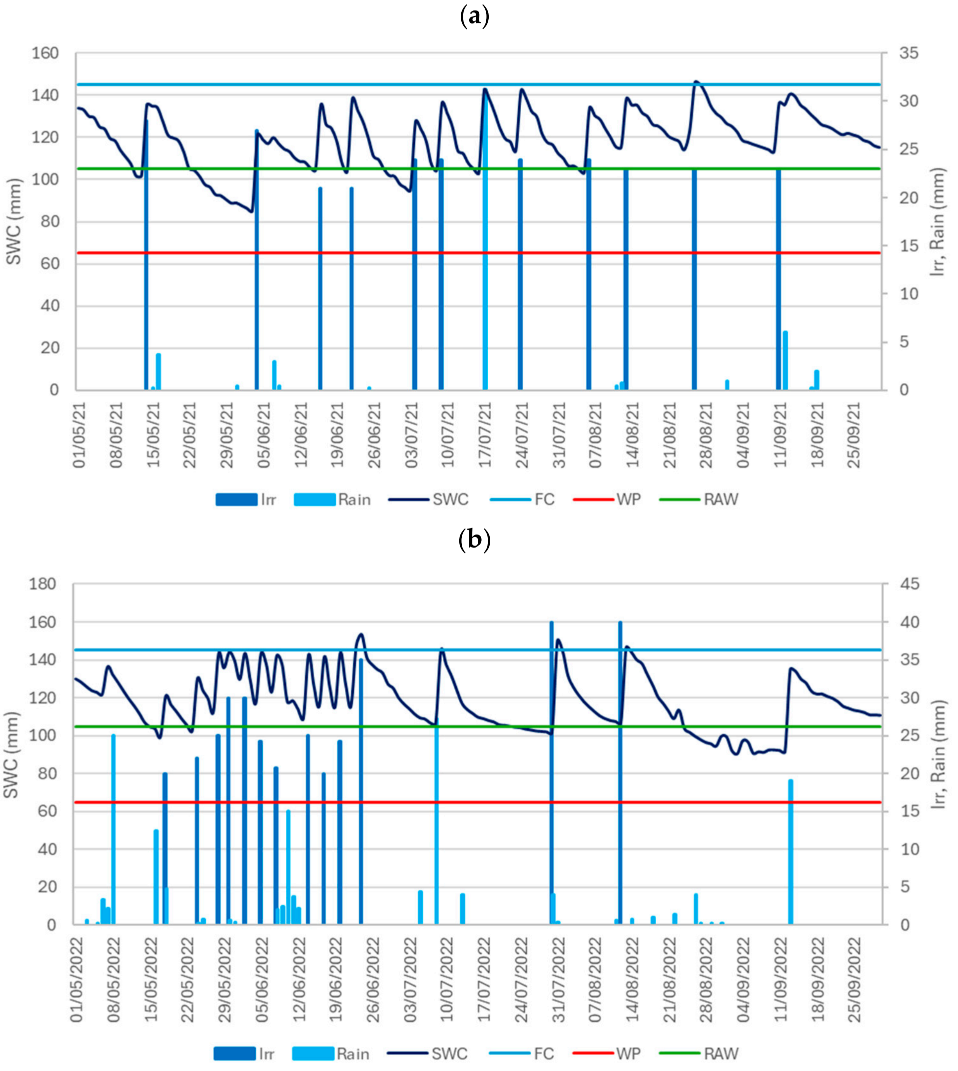
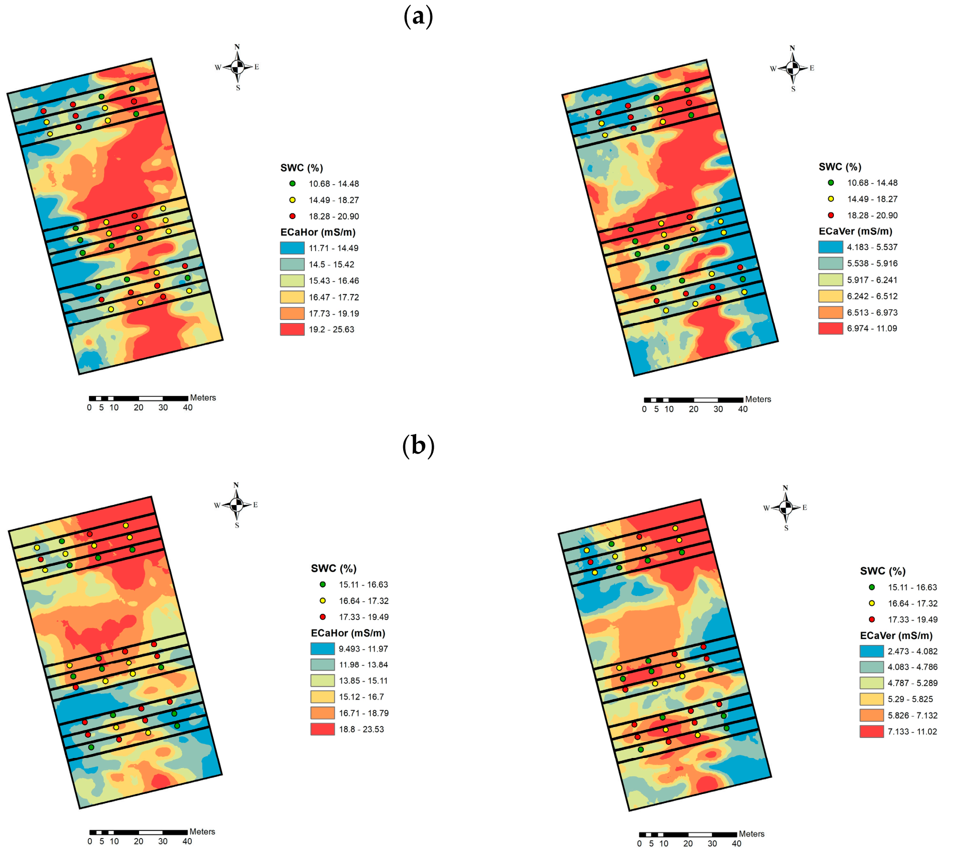


Figure 3. Soil water content (SWC), irrigation volume (Irr), and rainfall during the 2021 (**a**) and 2022 (**b**) seasons. Red is the value threshold of the wilting point (WP), blue is the field capacity (FC), and green is the readily available water (RAW).

3.4.2. Electrical Conductivity

EMI measurements were performed to map the apparent electrical conductivity (EC_a) in the orchard soil. The four obtained EMI maps in the two polarization modes and on the two dates appeared quite similar (Figure 4a,b), indicating both spatial continuity along the soil profile to approximately 1 m depth and temporal persistence of the main structures of spatial dependency. All the maps showed an area with higher EC_a in the NE and central parts of the field and a general increase in conductivity in both polarizations from May 2021 to June 2022. The persistence of higher values of EC_a in the central part of the field over time might be attributed to intrinsic properties of soil, such as textural and topographic characteristics because they did not change over the recording period. The increase in conductivity from May 2021 to June 2022 could be attributed to different moisture conditions in soil/subsoil. However, the relationship between SWC and EC_a on each date was low and not clearly defined, as can be seen by the overlap of SWC data on the maps (Figure 4a,b).


(**a**)

(**b**)

Figure 4. Electromagnetic induction (EMI) maps in May 2021 (**a**) and June 2022 (**b**) in horizontal mode (ECa-Hor) and vertical mode (ECa-Vert). SWC direct soil sampling scheme. The lines indicate the row of trees tested.

3.4.3. Soil Analysis

The evaluated soil properties are indicated in Table 6. At the beginning of the trial, the soil appears to be medium-rich in terms of TOC and well-rich for the total N content and the available P, with a high value of the cation exchange capacity as defined by Hazelton et al. [39]. In general, at t_f, an improvement in all the parameters investigated was observed except for the available P. Although there were no significant differences between treatments, the highest absolute values for TOC (28.63 g kg^{-1}) and N (3.01 g kg^{-1}) contents were observed with the C + CT application.

Table 6. Average values of soil properties measured from the soil samples collected at the beginning of the experimental trial (t_i, initial time) and average values of treatment effects on soil parameters at final time (t_f), with standard deviations (C: commercial compost; M: commercial mixed manure; C + CT: combination of commercial compost with compost tea; T: unfertilized control).

Sampling		**Soil Properties**				
		pH	**TOC**	**Total N**	**Available P**	**CEC**
			g kg^{-1}	g kg^{-1}	mg kg^{-1}	meq 100 g^{-1}
$\mathbf{t_i}$		7.35 ± 0.10	20.87 ± 1.63	2.52 ± 0.33	65.19 ± 17.16	26.11 ± 1.37
	Treatments					
$\mathbf{t_f}$	**C**	7.56 ± 0.16	28.44 ± 5.83	2.35 ± 1.22	36.70 ± 26.83	30.71 ± 1.12
	M	7.54 ± 0.25	27.54 ± 3.90	2.80 ± 0.26	41.56 ± 26.04	30.91 ± 2.22
	C + CT	7.58 ± 0.18	28.63 ± 3.23	3.01 ± 0.28	47.78 ± 15.35	31.28 ± 1.70
	T	7.56 ± 0.21	28.46 ± 3.46	2.87 ± 0.31	48.88 ± 29.35	31.62 ± 2.54

4. Discussion

A threshold value of −1.3 MPa for midday Ψ_{stem} is generally indicated as the limit for water deficit in sweet cherry trees in the post-harvest stage [40]. This phenological phase is generally less sensitive to water stress since, during post-harvest, cherry trees are no longer focused on fruit growth.

In our study, in 2021, during the fruit coloration phase (158 DOY), Ψ_{stem} never exceeded −1.09 MPa (average across treatments), despite before its first measurement, a significant reduction in SWC below the readily available water threshold was found (−145 mm total from 23 May to 3 June). During this period, the trees showed a rapid recovery and did not exceed the water stress threshold. A further reduction in SWC compared to RAW (−35.5 mm total, between 15 June and 16 July) was observed from the first to the last Ψ_{stem} measurement (Figure 1a). Although SWC was promptly restored, the trees still recorded very negative Ψ_{stem} values, consistently below the water deficit threshold of −1.3 MPa (−1.60 MPa and −1.75 MPa at DOY 169 and DOY 204, respectively, as average across treatments). Water stress in the orchard could be attributed not only to the reduction in SWC but also to the increase in the air vapor pressure deficit (VPD), which rose from 0.70 kPa in May to 1.48 kPa in July. The results would suggest that irrigation in sweet cherry orchards should be managed considering both the relationship between SWC and environmental water demand (VPD), as indicated in Losciale et al. [41]. It is relevant to point out that the detected water stress allowed us to distinguish the physiological responses of the treatments. When Ψ_{stem} fell below the water deficit threshold, a better response in water status was observed in the organic fertilizer treatments compared to the unfertilized ones, in agreement with Lepsch et al. and Pergola [6,42].

During the 2022 season, the irrigation volume was higher than in 2021 due to different weather conditions. In 2022, the number of irrigation events was concentrated in one month (about 70% of total seasonal irrigation volume), when the mean maximum temperature and relative humidity reached 32.7 °C and 56.7%, respectively, compared to 27.5 °C and 53.4% in 2021 from May to June. These environmental conditions led to increased crop evapotranspiration, and the ET-based irrigation scheduling estimated higher crop water requirements in 2022. Soil water content remained well above the RAW threshold during physiological measurements, improving Ψ_{stem} compared to the previous year. However, in the second season, the better water status reduced the Ψ_{stem} differences between treatments (Figure 1b). By contrast, measured gas exchange values provided more informative data, highlighting the differences between the C + CT treatment and the other ones (Figure 2).

Different fertilizers could promote distinct photosynthetic responses due to varying nutrient availability. As indicated by Zaccardelli et al. [22], foliar or fruit spraying is considered a better option for optimizing plant nutrition, pathogen control [43], and the action of dissolved organic fractions, humic substances, and hormone-like molecules secreted by microbes. Authors have suggested that preventive applications are generally more effective than curative ones, as they allow the epiphytic microbiota to develop its own biomass [8]. The decrease in A and g_s observed in all treatments, from the pre-harvest stage (160 DOY) to the post-harvest stage (209 DOY), should be linked to the phenological phases. In the pre-harvest stage, the competition for carbohydrates between the vegetative and reproductive sinks tended to increase, as observed by Blanco et al. [44], thus fostering the photosynthetic demand of the tree. In the post-harvest stage, these values decreased dramatically, as expected. In general, the net photosynthetic rate in the leaves decreases following the product removal in various species of fruit trees, simply because when fruits are removed from a plant, an imbalance is created between the source (the leaves) and the sink (the fruits), leading to a downregulation of photosynthesis [45].

In both years of our study, the C + CT treatment showed higher productivity compared to the other ones (Tables 3 and 4). Better water status and photosynthetic activity induced by compost tea applications were reflected in this higher production. In fact, the variations in photosynthetic performance could result in differences in carbon accumulation, influencing the biomass produced [46]. The obtained results could also be attributed to the biostimulant effect, which improved plant growth and productivity, as indicated by some studies on pomegranate and vine. These studies found yield increases using organic inputs like compost tea [13,47]. The approximate 4% yield loss (average across treatments) in 2022 compared to 2021 could be due to water stress experienced by trees, demonstrated by the lower Ψ_{stem} values registered, which exceeded the water deficit threshold. In sweet cherry, as well as in other *Prunoideae*, floral initiation and organogenesis occur during the summer season and are typically completed before leaf fall, in the year prior to anthesis. Water availability is a key factor that can influence the consistency of these processes [48]. Therefore, the water stress suffered in 2021 could have induced a lower formation of flower buds, with a lower production than in 2022.

The difference in trees' physiological parameters observed in C + CT compared to the other treatments was also reflected in fruit quality. The most valued factors are undoubtedly the size, sweetness, and flavor of fruits [49]. Moreover, the C + CT treatment achieved the highest MI, indicating a good flavor profile. This result confirms other studies on the positive effects of compost tea on soluble solids content and MI of grapes with higher values than the control [13,22].

Regarding the soil, it is interesting to observe how there was an improvement in TOC and N contents despite similar values being recorded in T at the end of the experiment. This last result was probably due to the effect of permanent resident vegetation in inter-row space, as observed in other studies [50]. Nonetheless, the difference in the effects of the application of different organic fertilizers on soil characteristics, such as TOC, can be generally detected over a long time period [51]. In fact, no significant differences were observed between treatments in our two-year study (Table 6), which would indicate a situation of homogeneity of the field identified by traditional soil analyses.

In this study, EMI maps highlighted the heterogeneity of the orchard, being EC_a influenced by a variety of soil properties, including water content, texture, organic matter content and size and distribution of pores [52]. Mapping soil spatial variability, including texture and soil moisture, in irrigated orchards is often necessary to understand field-scale variability in crop yield and quality performance [53,54]. The correlation between EMI data and SWC was not well defined because in orchards, where water emitters are generally located along the tree lines, the difference in SWC near the trees and between the tree rows can be considerable [55]. Vanella et al. [56] concluded that soil moisture should be measured close to the driplines in order to understand soil water dynamics. Unfortunately, especially in orchards with trees with large and low canopies, measuring EC_a near the driplines with commercial equipment is impractical. This could be an issue to be further considered in future research.

Although values of soil properties were generally not significant, the treatment that received compost tea obtained the best absolute values of TOC and N soil content compared to the other treatments (Table 6). Thus, compost tea, similar to customized blends of humic acids, fulvic acids, and humin, can offer enhanced benefits for plant growth and health when applied to both the roots and aerial parts of the plant [8]. The decrease in available P observed after the two years of the trial can probably be linked to application rates based on N content because the decrease in P was also observed in T (Table 6). However, the fertilizer application based on N content was due to sweet cherries' medium–high mineral requirement of N and relatively low requirement of P [57]. It should be considered that fruits and seeds generally contain higher concentrations of macronutrients compared to vegetative tissues [58]. Therefore, production-related P removals may have led to a reduction in soil P availability in the two years. This information should be considered in future applications, keeping in mind that other authors found that a correct balance between N and P in the soil can help reduce the incidence of browning in sweet cherry fruits, improving their shelf life [57].

5. Conclusions

Based on the results of this study, although no differences in soil properties were detected over the two-year period, compost tea seems to have an impact on the water status, photosynthetic activity, productivity, and quality of sweet cherry trees. In water stress conditions, all organic fertilized treatments showed better stem water potential values than untreated ones. Therefore, the use of organic fertilizers could improve plant response to water stress conditions, save water, and likely help reduce irrigation costs. In conditions of optimal tree water status, the difference between the trees treated with C + CT and the other treatments (including the control) disappeared in terms of stem water potential but not in terms of photosynthesis and conductance, probably due to biostimulant effects of the compost tea. An integrated approach of foliar and soil application of compost tea in a sweet cherry orchard to provide enhanced benefits for plant growth and health could be a challenging yet promising opportunity for organic agriculture. Compost and compost tea could represent sustainable fertilizers that can be easily produced and applied flexibly over time (stored) and space (moved on to another part of the farm) from a circular economy perspective.

Our findings highlight the importance of integrating compost tea applications into organic orchard management to promote sustainable farming practices and reduce commercial fertilizer use. Further research is necessary to explore long-term benefits and optimize fertilization strategies for sweet cherry production, and possibly also for other types of orchards on other sites, promoting the improvement in technical knowledge on compost and compost tea production and use by potential stakeholders (e.g., farmers, technicians, etc.).

Author Contributions: Conceptualization, L.G. and M.D.; methodology, L.G., L.T., A.P., A.F., D.D.B., C.V., and P.C.; formal analysis, L.G., D.D.B., C.V., and P.C.; data curation, L.G., L.T., A.P., D.D.B., C.V., and P.C.; writing—original draft preparation, L.G.; writing—review and editing, L.G., L.T., F.M., D.D.B., and M.D.; project administration, L.T. and M.D.; funding acquisition, L.T. and M.D. All authors have read and agreed to the published version of the manuscript.

Funding: This study was financially supported by PSR-Regione Puglia-OLTRE.BIO, P.S.R. Puglia 2014/2020-Misura 16-Cooperazione-Sottomisura 16.2 "Sostegno a progetti pilota e allo sviluppo di nuovi prodotti, pratiche, processi e tecnologie"- Oltre il Bio: gestione innovativa della cerasicoltura e viticoltura da tavola biologica (DAG 169 del 28 July 2020).

Data Availability Statement: Data is contained within the article.

Acknowledgments: The authors wish to acknowledge Rosalba Scazzarriello, Francesco Rinaldi, Marco Favale, Antonio Maria Amendolagine, and Marcello Mastrangelo for their technical assistance.

Conflicts of Interest: The authors declare no conflicts of interest that could be perceived as prejudicing against the impartiality of the research reported.

References

1. Bursać Kovačević, D.; Brdar, D.; Fabečić, P.; Barba, F.J.; Lorenzo, J.M.; Putnik, P. Strategies to Achieve a Healthy and Balanced Diet: Fruits and Vegetables as a Natural Source of Bioactive Compounds. In *Agri-Food Industry Strategies for Healthy Diets and Sustainability*; Elsevier: Amsterdam, The Netherlands, 2020; pp. 51–88, ISBN 978-0-12-817226-1.
2. Tilman, D.; Fargione, J.; Wolff, B.; D'Antonio, C.; Dobson, A.; Howarth, R.; Schindler, D.; Schlesinger, W.H.; Simberloff, D.; Swackhamer, D. Forecasting Agriculturally Driven Global Environmental Change. *Science* **2001**, *292*, 281–284. [CrossRef] [PubMed]
3. Hallmann, E.; Rozpara, E. The Estimation of Bioactive Compounds Content in Organic and Conventional Sweet Cherry (*Prunus avium* L.). *J. Res. Appl. Agric. Eng.* **2017**, *62*, 141–145.
4. Chatzistathis, T.; Kavvadias, V.; Sotiropoulos, T.; Papadakis, I.E. Organic Fertilization and Tree Orchards. *Agriculture* **2021**, *11*, 692. [CrossRef]
5. Brito, L.M.; Mourão, I.; Coutinho, J.; Smith, S.R. Simple Technologies for On-Farm Composting of Cattle Slurry Solid Fraction. *Waste Manag.* **2012**, *32*, 1332–1340. [CrossRef] [PubMed]
6. Pergola, M.; Persiani, A.; Pastore, V.; Palese, A.M.; D'Adamo, C.; De Falco, E.; Celano, G. Sustainability Assessment of the Green Compost Production Chain from Agricultural Waste: A Case Study in Southern Italy. *Agronomy* **2020**, *10*, 230. [CrossRef]
7. Pilla, N.; Tranchida-Lombardo, V.; Gabrielli, P.; Aguzzi, A.; Caputo, M.; Lucarini, M.; Durazzo, A.; Zaccardelli, M. Effect of Compost Tea in Horticulture. *Horticulturae* **2023**, *9*, 984. [CrossRef]
8. De Corato, U. Agricultural Waste Recycling in Horticultural Intensive Farming Systems by On-Farm Composting and Compost-Based Tea Application Improves Soil Quality and Plant Health: A Review under the Perspective of a Circular Economy. *Sci. Total Environ.* **2020**, *738*, 139840. [CrossRef]
9. Sorrenti, G.; Muzzi, E.; Toselli, M. Root Growth Dynamic and Plant Performance of Nectarine Trees Amended with Biochar and Compost. *Sci. Hortic.* **2019**, *257*, 108710. [CrossRef]
10. Castellini, M.; Diacono, M.; Preite, A.; Montemurro, F. Short- and Medium-Term Effects of On-Farm Compost Addition on the Physical and Hydraulic Properties of a Clay Soil. *Agronomy* **2022**, *12*, 1446. [CrossRef]
11. Persiani, A.; Montemurro, F.; Fiore, A.; Scazzarriello, R.; Diacono, M. On-Farm Fertilizing Materials in Organic Horticulture: Agronomic Performance, Energy Use and GHG Emission Evaluation. *Arch. Agron. Soil Sci.* **2021**, *67*, 1944–1960. [CrossRef]
12. Diacono, M.; Gebremikael, M.T.; Testani, E.; Persiani, A.; Fiore, A.; Alfano, V.; Ciaccia, C.; Montemurro, F.; De Neve, S. Agricultural Waste Recycling in an Organic Zucchini-Lettuce Rotation: Soil Microbial Parameters Under Laboratory and Field Conditions, and Crop Production Parameters Assessment. *Waste Biomass Valorization* **2024**, *15*, 6941–6958. [CrossRef]
13. Mostafa, M.; El-Baz, E.; Abd El-Wahab, A.; Omar, A. Using Different Sources of Compost Tea on Grapes. *J. Plant Prod.* **2011**, *2*, 935–947. [CrossRef]
14. Ceccarelli, D.; Antonucci, F.; Costa, C.; Talento, C.; Ciccoritti, R. An Artificial Class Modelling Approach to Identify the Most Largely Diffused Cultivars of Sweet Cherry (*Prunus avium* L.) in Italy. *Food Chem.* **2020**, *333*, 127515. [CrossRef] [PubMed]
15. FAO STATISTICS. 2022. Available online: https://www.fao.org/statistics/en/ (accessed on 1 November 2024).
16. ISTAT. 2023. Available online: https://esploradati.istat.it/ (accessed on 1 November 2024).
17. Godini, A.; Palasciano, M.; Camposeo, S.; Pacifico, A. A Nine-Year Study on the Performance of Twelve Cherry Rootstocks under Non-Irrigated Conditions in Apulia (Southern Italy). *Acta Hortic.* **2008**, *795*, 191–198. [CrossRef]
18. Santos, M.; Pereira, S.; Ferreira, H.; Sousa, J.R.; Vilela, A.; Ribeiro, C.; Raimundo, F.; Egea-Cortines, M.; Matos, M.; Gonçalves, B. Optimizing Sweet Cherry Attributes through Magnesium and Potassium Fertilization. *Horticulturae* **2024**, *10*, 881. [CrossRef]
19. Campi, P.; Modugno, A.F.; De Carolis, G.; Pedrero Salcedo, F.; Lorente, B.; Garofalo, S.P. A Machine Learning Approach to Monitor the Physiological and Water Status of an Irrigated Peach Orchard under Semi-Arid Conditions by Using Multispectral Satellite Data. *Water* **2024**, *16*, 2224. [CrossRef]

20. Allen, R.G.; Pereira, L.S.; Raes, D.; Smith, M. *Crop Evapotranspiration. Guide-Lines for Computing Crop Water Requirements*; FAO Irrigation and Drainage; FAO: Rome, Italy, 1998.
21. Pant, A.; Radovich, T.; Hue, N. Chapter II—Compost Tea Production. In *Tea Time in the Tropics: A Handbook for Compost Tea Production and Use*; Radovich, T., Arancon, N.Q., Eds.; College of Tropical Agriculture and Human Resources, University of Hawaii at Manoa: Honolulu, HI, USA, 2011.
22. Zaccardelli, M.; Pane, C.; Scotti, R.; Palese, A.M.; Celano, G. Impiego Di Compost-Tea Come Bioagrofarmaci e Biostimolanti in Ortofrutticoltura. *Italus Hortus* **2012**, *19*, 17–28.
23. Fadón, E.; Herrero, M.; Rodrigo, J. Flower Development in Sweet Cherry Framed in the BBCH Scale. *Sci. Hortic.* **2015**, *192*, 141–147. [CrossRef]
24. Campi, P.; Gaeta, L.; Mastrorilli, M.; Losciale, P. Innovative Soil Management and Micro-Climate Modulation for Saving Water in Peach Orchards. *Front. Plant Sci.* **2020**, *11*, 1052. [CrossRef]
25. Naor, A. Midday Stem Water Potential as a Plant Water Stress Indicator for Irrigation Scheduling in Fruit Trees. *Acta Hortic.* **2000**, *537*, 447–454. [CrossRef]
26. Gaeta, L.; Amendolagine, A.M.; Di Gennaro, D.; Navarro, A.; Tarricone, L.; Campi, P.; Stellacci, A.M.; Losciale, P. Managing Orchard Floor for Saving Water in a Late Ripening Peach Cultivar: A Preliminary Result. *Acta Hortic.* **2021**, *1304*, 207–214. [CrossRef]
27. Pascual, M.; Lordan, J.; Villar, J.M.; Fonseca, F.; Rufat, J. Stable Carbon and Nitrogen Isotope Ratios as Indicators of Water Status and Nitrogen Effects on Peach Trees. *Sci. Hortic.* **2013**, *157*, 99–107. [CrossRef]
28. Fernández, J.E.; Alcon, F.; Diaz-Espejo, A.; Hernandez-Santana, V.; Cuevas, M.V. Water Use Indicators and Economic Analysis for On-Farm Irrigation Decision: A Case Study of a Super High Density Olive Tree Orchard. *Agric. Water Manag.* **2020**, *237*, 106074. [CrossRef]
29. Zhang, Y.; Meinzer, F.C.; Qi, J.; Goldstein, G.; Cao, K. Midday Stomatal Conductance Is More Related to Stem Rather than Leaf Water Status in Subtropical Deciduous and Evergreen Broadleaf Trees. *Plant Cell Environ.* **2013**, *36*, 149–158. [CrossRef]
30. Cappelluti, O.; Bruno, M.R.; Modugno, A.F.; Ferrara, R.M.; Gaeta, L.; De Carolis, G.; Campi, P. The Use of Mixed Composed Amendments to Improve Soil Water Content and Peach Growth (*Prunus persica* (L.) Batsch) in a Mediterranean Environment. *Water* **2023**, *15*, 1708. [CrossRef]
31. Serradilla, M.J.; Martín, A.; Ruiz-Moyano, S.; Hernández, A.; López-Corrales, M.; Córdoba, M.D.G. Physicochemical and Sensorial Characterisation of Four Sweet Cherry Cultivars Grown in Jerte Valley (Spain). *Food Chem.* **2012**, *133*, 1551–1559. [CrossRef]
32. Zhou, J.; Yang, S.; Ma, Y.; Liu, Z.; Tu, H.; Wang, H.; Zhang, J.; Chen, Q.; He, W.; Li, M.; et al. Soluble Sugar and Organic Acid Composition and Flavor Evaluation of Chinese Cherry Fruits. *Food Chem. X* **2023**, *20*, 100953. [CrossRef]
33. Pérez-Sánchez, R.; Gómez-Sánchez, M.Á.; Morales-Corts, M.R. Description and Quality Evaluation of Sweet Cherries Cultured in Spain. *J. Food Qual.* **2010**, *33*, 490–506. [CrossRef]
34. Padilla-Díaz, C.M.; Rodriguez-Dominguez, C.M.; Hernandez-Santana, V.; Perez-Martin, A.; Fernández, J.E. Scheduling Regulated Deficit Irrigation in a Hedgerow Olive Orchard from Leaf Turgor Pressure Related Measurements. *Agric. Water Manag.* **2016**, *164*, 28–37. [CrossRef]
35. McNeill, J.D. *Electromagnetic Terrain Conductivity Measurement at Low Induction Numbers*; Technical Note TN 6; Geonics Ltd.: Mississauga, ON, Canada, 1980.
36. Vitti, C.; Stellacci, A.M.; Leogrande, R.; Mastrangelo, M.; Cazzato, E.; Ventrella, D. Assessment of Organic Carbon in Soils: A Comparison between the Springer–Klee Wet Digestion and the Dry Combustion Methods in Mediterranean Soils (Southern Italy). *CATENA* **2016**, *137*, 113–119. [CrossRef]
37. Olsen, S.R.; Cole, V.V.; Watanabe, F.S.; Dean, C.A. *Estimation of Available Phosphorus in Soils by Extraction with Sodium Bicarbonate*; U.S. Dep. Agric. Cir. No. 939; United States Department of Agriculture: Washington, DC, USA, 1954.
38. Page, A.L.; Miller, R.H.; Keeney, D.R. *Methods of Soil Analysis. Part 2. Chemical and Microbiological Properties*; Soil Science Society of America; American Society of Agronomy: Madison, WI, USA, 1982; Volume 1159.
39. Hazelton, P.; Murphy, B. *Interpreting Soil Test Results; What Do All The Numbers Mean?* CSIRO Publishing: Clayton, Australia, 2007; ISBN 978-0-643-09915-9.
40. Marsal, J.; Lopez, G.; Del Campo, J.; Mata, M.; Arbones, A.; Girona, J. Postharvest Regulated Deficit Irrigation in 'Summit' Sweet Cherry: Fruit Yield and Quality in the Following Season. *Irrig. Sci.* **2010**, *28*, 181–189. [CrossRef]
41. Losciale, P.; Gaeta, L.; Corsi, M.; Galeone, C.; Tarricone, L.; Leogrande, R.; Stellacci, A.M. Physiological Responses of Apricot and Peach Cultivars under Progressive Water Shortage: Different Crop Signals for Anisohydric and Isohydric Behaviours. *Agric. Water Manag.* **2023**, *286*, 108384. [CrossRef]
42. Lepsch, H.C.; Brown, P.H.; Peterson, C.A.; Gaudin, A.C.M.; Khalsa, S.D.S. Impact of Organic Matter Amendments on Soil and Tree Water Status in a California Orchard. *Agric. Water Manag.* **2019**, *222*, 204–212. [CrossRef]
43. Eudoxie, G.; Martin, M. Compost Tea Quality and Fertility. In *Organic Fertilizers—History, Production and Applications*; Larramendy, M., Soloneski, S., Eds.; IntechOpen: London, UK, 2019; ISBN 978-1-78985-147-2.

44. Blanco, V.; Torres-Sánchez, R.; Blaya-Ros, P.J.; Pérez-Pastor, A.; Domingo, R. Vegetative and Reproductive Response of 'Prime Giant' Sweet Cherry Trees to Regulated Deficit Irrigation. *Sci. Hortic.* **2019**, *249*, 478–489. [CrossRef]
45. Veberic, R.; Stampar, F.; Vodnik, D. Autumn Photosynthesis of 'Golden Delicious' Apple Trees—The Effects of Picking and Fertilisation Treatment. *Gartenbauwissenschaft* **2002**, *67*, 92–98.
46. Losciale, P.; Gaeta, L.; Manfrini, L.; Tarricone, L.; Campi, P. Orchard Floor Management Affects Tree Functionality, Productivity and Water Consumption of a Late Ripening Peach Orchard under Semi-Arid Conditions. *Appl. Sci.* **2020**, *10*, 8135. [CrossRef]
47. Baldi, E.; Toselli, M.; Marcolini, G.; Quartieri, M.; Cirillo, E.; Innocenti, A.; Marangoni, B. Compost Can Successfully Replace Mineral Fertilizers in the Nutrient Management of Commercial Peach Orchard. *Soil Use Manag.* **2010**, *26*, 346–353. [CrossRef]
48. Bartolini, S.; Lo Piccolo, E.; Remorini, D. Different Summer and Autumn Water Deficit Affect the Floral Differentiation and Flower Bud Growth in Apricot (*Prunus armeniaca* L.). *Agronomy* **2020**, *10*, 914. [CrossRef]
49. Costa, G. Qualità Delle Ciliegie: Definizione Aggiornata e Nuovi Metodi Di Determinazione. *ACTA Italus Hortus 24* **2019**, 47–56.
50. Belmonte, S.A.; Celi, L.; Stanchi, S.; Said-Pullicino, D.; Zanini, E.; Bonifacio, E. Effects of Permanent Grass versus Tillage on Aggregation and Organic Matter Dynamics in a Poorly Developed Vineyard Soil. *Soil Res.* **2016**, *54*, 797–808. [CrossRef]
51. Diacono, M.; Montemurro, F. Long-Term Effects of Organic Amendments on Soil Fertility. A Review. *Agron. Sustain. Dev.* **2010**, *30*, 401–422. [CrossRef]
52. Brevik, E.C.; Fenton, T.E.; Lazari, A. Soil Electrical Conductivity as a Function of Soil Water Content and Implications for Soil Mapping. *Precis. Agric.* **2006**, *7*, 393–404. [CrossRef]
53. Mann, K.; Schumann, A.; Obreza, T. Delineating Productivity Zones in a Citrus Grove Using Citrus Production, Tree Growth and Temporally Stable Soil Data. *Precis. Agric.* **2011**, *12*, 457–472. [CrossRef]
54. Priori, S.; Martini, E.; Andrenelli, M.; Magini, S.; Agnelli, A.; Bucelli, P.; Biagi, M.; Pellegrini, S.; Costantini, E. Improving Wine Quality through Harvest Zoning and Combined Use of Remote and Soil Proximal Sensing. *Soil Sci. Soc. Am. J.* **2013**, *77*, 1338–1348. [CrossRef]
55. Scudiero, E.; Corwin, D.L.; Markley, P.T.; Pourreza, A.; Rounsaville, T.; Bughici, T.; Skaggs, T.H. A System for Concurrent On-the-Go Soil Apparent Electrical Conductivity and Gamma-Ray Sensing in Micro-Irrigated Orchards. *Soil Tillage Res.* **2024**, *235*, 105899. [CrossRef]
56. Vanella, D.; Cassiani, G.; Busato, L.; Boaga, J.; Barbagallo, S.; Binley, A.; Consoli, S. Use of Small Scale Electrical Resistivity Tomography to Identify Soil-Root Interactions during Deficit Irrigation. *J. Hydrol.* **2018**, *556*, 310–324. [CrossRef]
57. Palacios-Peralta, C.; Reyes-Díaz, M.; González-Villagra, J.; Ribera-Fonseca, A. The Potential Roles of the N and P Supplies on the Internal Browning Incidence in Sweet Cherries in the Southern Chile. *Horticulturae* **2022**, *8*, 1209. [CrossRef]
58. Fernández-Martínez, M.; Vicca, S.; Janssens, I.A.; Espelta, J.M.; Peñuelas, J. The Role of Nutrients, Productivity and Climate in Determining Tree Fruit Production in European Forests. *New Phytol.* **2017**, *213*, 669–679. [CrossRef]