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Linking Soil Health and Human Wellness through Organic Approaches to Tomato Nutrition and Safety

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INTRODUCTION

Ensuring high-quality food under increasing environmental stress requires production systems that preserve soil integrity while improving crop nutritional value. Overuse of synthetic fertilizers may enhance yield temporarily but contributes to soil depletion, residue accumulation, and potential hazards to human health. Organic fertilization offers a biological route to restoring soil functionality while adding nutritional and phytochemical richness to crops (Țopa et al., 2025, Sarkar et al. 2024).

Tomato (*Solanum lycopersicum* L.) represents one of the world's most consumed vegetable crops and a major source of antioxidants, vitamins, and bioactive compounds that play a key role in human health (Raza et al., 2022). Its nutritional composition is highly influenced by soil conditions, fertilization type, and water availability, making it a relevant biological system for exploring how soil management can shape both food quality and safety Maffia et al., 2023). Understanding this relationship is crucial for designing productive and health-oriented agricultural practices.

Aim of Study

To assess how organic vermicompost derived from horse manure can strengthen soil properties, improve tomao plant tolerance to limited water supply, and enhance the fruit's nutritional and functional quality.

METHOD

The field experiment was carried out in Saada–Marrakesh, Morocco (31°37′39.9″ N; 08°07′46.7″ W) under a semi-arid Mediterranean climate (19.6 °C annual mean; ~250 mm rainfall/year). The soil is sandy clay loam and the field is drip-irrigated, with no previous chemical inputs.

Tomato (S. lycopersicum L.) was grown under two irrigation regimes: well-watered (8 L h^{-1}) and water-stressed (4 L h^{-1}), combined with two vermicompost doses.

RESULTS & DISCUSSION

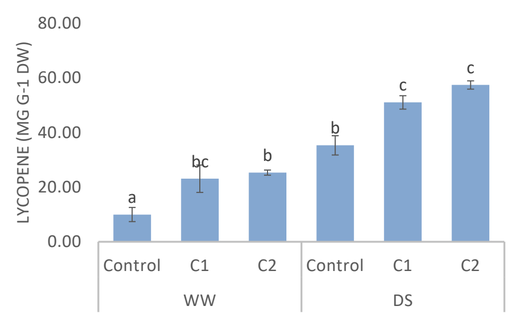
Soil quality assessment

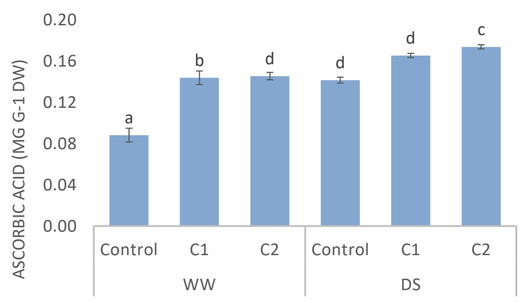
Water Regime	WW			DS		
Treatments	Control	C1	C2	Control	C1	C2
pH	7.74 ± 0.45 a	7.84 ± 0.52 bc	7.93 ± 0.82 c	7.74 ± 0.51 a	7.81 ± 0.38 a–c	7.86 ± 0.34 bc
EC (mS cm−1)	1.75 ± 0.36 cd	1.82 ± 0.41 cd	1.79 ± 0.34 cd	1.52 ± 0.57 a	1.67 ± 0.13 bc	1.65 ± 0.28 bc
TOC (%)	0.92 ± 0.12 b	1.35 ± 0.28 e–g	1.48 ± 0.19 gh	0.88 ± 0.11 a	1.25 ± 0.19 d	1.21 ± 0.25 d
AP (mg/kg)	26.74 ± 3.36 a	84.36 ± 3.86 ef	89.19 ± 4.18 fg	33.84 ± 3.68 b	72.19 ± 5.85 d	88.32 ± 4.86 fg
N (g/kg)	0.70 ± 0.09 a	0.84 ± 0.09 b	1.05 ± 0.15 de	0.85 ± 0.06 b	1.27 ± 0.19 fg	1.30 ± 0.21 g

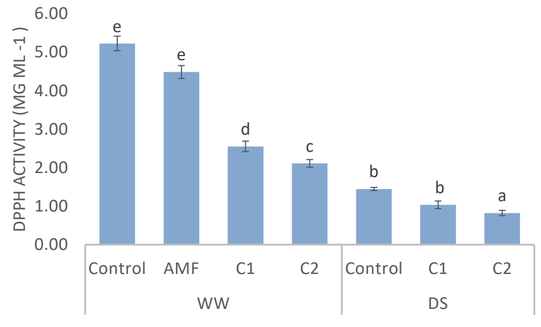
RESULTS & DISCUSSION

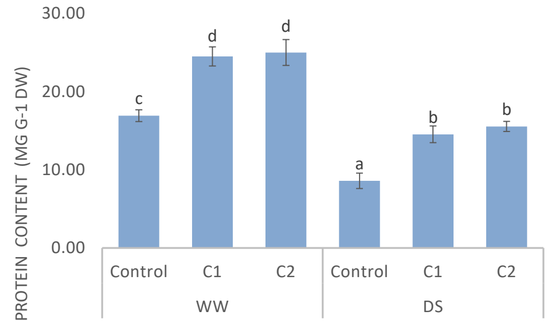
Organic amendments improved several soil quality indicators compared to the control. Vermicompost treatments (C1 and C2) increased soil organic matter and enhanced nutrient availability, while also improving water-holding capacity under both irrigation regimes. Electrical conductivity and pH remained within acceptable ranges, indicating stable soil conditions throughout the experiment. Overall, soils receiving organic amendments showed better physicochemical balance and improved fertility compared to untreated plots.

Fruit Quality Assessment









Organic amendments significantly enhanced tomato fruit quality under both irrigation regimes. Vermicompost treatments (C1 and C2) increased lycopene, vitamin C, protein content, and antioxidant capacity compared to the controls, with the highest values consistently observed in C2. Although drought reduced some biochemical traits, vermicompost mitigated these effects and maintained higher nutritional and antioxidant levels than the stressed control. Overall, the organic amendments—particularly the higher dose—showed clear benefits for improving fruit biochemical composition and stress resilience.

CONCLUSION

Organic fertilization using horse-manure vermicompost significantly improves soil health by enhancing nutrient availability. This amendment also strengthens tomato plant resilience under stress conditions and increases the nutritional quality and microbial safety of tomato fruits. Together, these benefits highlight a sustainable organic approach that links soil health to human wellness, offering a practical pathway to improve food quality and support food security under increasing climate constraints.

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