

Crop Authenticity in Organic Horticulture: Insights from Recent Research and Practical Applications

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1. Introduction

For more than two decades, organic management has been associated with beneficial effects on human and soil health, while being environmentally sustainable due to the removal of/reduction in pesticides used as plant protection agents and chemical fertilizers. Therefore, organic agriculture implies that the use of mineral chemical synthetic fertilizers is harshly prohibited, thus involving the application of organic fertilizers and alternative methods to improve plant nutrition. Accordingly, the existing knowledge gaps can be first identified as the optimization and validation of innovative and safe agronomic practices to improve organic crop yield, at the same time preserving and enhancing their quality. A recent comprehensive review on the impact of the most relevant agronomic practices on soil chemical and biological properties have highlighted that, if properly carried out, sustainable agronomic management can enhance soil fertility, nutrient cycling, and agricultural productivity while mitigating environmental consequences [1].

As far as the transition towards organic management is concerned, detailed reports on the effects of the application of organic fertilizers, the introduction of cover crops, and on the set-up of appropriate varieties specifically developed for organic farming in the specific environments are needed to help farmers make the right management choices. Through a meta-analysis approach, it has been recently demonstrated that the application of organic fertilizers can significantly improve the yield, growth parameters, and quality of Chinese cabbage in China, while increasing soil nutrients [2]. Regarding the need for organic farming focused breeding programs, Rempelos et al. [3] have recently compared the performance of modern varieties developed for conventional management with older and new varieties suitable for organic farming. They also reviewed evidence from wheat variety trials and factorial field experiments supporting the definition of trait combinations that should be targeted to improve crop yield.

In addition to that, one of the most important gaps to be filled for redefining the value of organic agriculture is related to the lack of a reliable and rigorous traceability system for organic productions. In fact, for more than two decades, several studies have been proposed targeting this specific need. Very recently, Giannioti et al. [4] reviewed the isotopic-based methodologies developed for organic food authentication, highlighting that, for this purpose, the stable isotope ratio of nitrogen (N) has been defined as the most reliable organic marker. They also reviewed the challenges of this kind of approach, concluding



Received: 11 June 2025

Accepted: 16 June 2025

Published: 1 July 2025

Citation: Fabroni, S.; Bontempo, L.; Montemurro, F. Crop Authenticity in Organic Horticulture: Insights from Recent Research and Practical Applications. *Horticulturae* **2025**, *11*, 757. <https://doi.org/10.3390/horticulturae11070757>

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that innovative multivariate approaches should be validated to overcome these limitations related to organic crop authenticity.

Finally, taking into account the increasing interest towards consumer health and safety, a relevant issue to be addressed is also related to health risk assessment. Indeed, Hurtado-Barroso et al. [5] concluded that large long-term intervention studies are needed to determine whether an organic diet is healthier than a diet including conventionally grown food products.

This Special Issue of *Horticulturae* has provided new insights from recent research and practical applications supporting the transition to the sustainable organic crop management while providing relevant validated tools for organic crop authenticity.

2. Innovative Agronomic Practices to Improve Organic Crop Yield

A study by Kilic et al. [contribution 1] has proposed a novel approach for organic strawberry fertilization based on joint vermicompost and microbial complementary nutrition, providing promising results for enhancing organic strawberry production. Another study by Foughar et al. [contribution 2] has compared black soldier fly and mealworm larvae frass with another organic amendment in two growth cycles of lettuce. They have provided evidence that mealworm larvae frass exhibits plant biostimulant effects, boosting productivity on lettuce, beyond nutrient release and improved soil properties. Useful insights for the application of mixed formulations containing soybean meal and peanut grain residue for the increase in organic button mushroom yield have been provided by Cardoso Caitano et al. [contribution 3]. In addition, Guerra et al. [contribution 4] implemented a novel technique for the management of crop load in conference pear orchards, validating an effective preharvest organic strategy for mitigating postharvest quality losses during storage, thereby promoting overall orchard sustainability. A novel sustainable phytosanitary management strategy based on the use of fungal extracts as plant growth promoters with biocontrol capabilities has been validated against *Pseudomonas syringae* in organic tomato plants under greenhouse conditions by Garcia-Latorre et al. [contribution 5]. A review article by Ierna et al. [contribution 6] on crop nutrition and soil fertility management in organic potato production systems highlighted the most relevant agronomic practices needed to effectively maintain good soil fertility and satisfy the nutritional needs of the crop. They also provided to growers an overview of the current innovative tools to reduce the yield gap between organic and conventional potato growing systems.

3. Evidence Supporting the Sustainable Organic Crop Management

A research study by Mineată et al. [contribution 7] has shown that significant quality differences increased between the organically grown cherry fruits depending on the ripening phase and cultivar, enabling growers to appropriately choose the better agronomic settings to be applied. In this context, Tagiakas et al. [contribution 8] have demonstrated that selected inbred lines originated from tomato landraces developed under low-input conditions were better suited to organic farming systems. Moreover, they also ensured high-quality products with satisfactory yield and low requirements, offering an innovative pathway toward sustainable agriculture. In addition, it has been demonstrated that organic fertilization exhibited a performance similar to that of a conventional one, in terms of plant growth indexes, physiological parameters, and antioxidant levels, in wild edible species (purslane and sow thistle) cultivation under field conditions [contribution 9]. Roussos et al. [contribution 10] have demonstrated that a multisite two-year evaluation of the quality characteristics of olive oils produced under organic and conventional cultivation systems highlighted no significant variations. However, sustainable management practices leading to healthy fruit production and oil extraction may significantly influence

the quality attributes of the oil produced by applying different fertilization and plant protection programs.

4. Traceability Systems for Organic Productions Authenticity

Based on the multivariate results of their long-term study on 'Navelina' oranges and 'Clemenules' mandarins under organic and conventional management, Domínguez-Gento et al. [contribution 11] have proposed a method that allows the successful differentiation of citrus fruits from organic and conventional production as a tool to predict the production system of citrus fruits based on easy-to-measure parameters. While stable isotopes have emerged as a powerful tool for this purpose, Muñoz-Redondo et al. [contribution 12] have isotopically characterized fertilizers, soil conditioners, and micronutrient fertilizers commonly used in intensive organic agriculture in the largest organic production region in the world (Almería, Spain). They demonstrated that some plant-based fertilizers, protein hydrolysed fertilizers, and chelated nutrients presented a wide range of variability in their $\delta^{15}\text{N}$ values, including some very low or even negative values, more similar to those of conventional fertilizers. These results have highlighted the challenges of authenticating organic foods in agriculture when using only nitrogen isotope analysis. With an attempt to overcome these limitations, Fabroni et al. [contribution 13] have proposed an integrated approach to discriminate organic from conventional products based on different isotopic signatures, due to the different nitrogenous sources, combined with the qualitative profile of the crops, which are significantly affected by the different agronomic treatments. This approach is intended to be coupled to the application of chemometric multivariate analysis on quality and nutraceutical parameters combined with isotopic data. As a case study, Montemurro et al. [contribution 14] have validated the aforementioned integrated approach for the reliable classification of organically and conventionally grown fennel productions obtained by applying different treatments at diverse percentages of mineral fertilizers, even introducing N-fixing plant (alfalfa) as an agroecological service crop in the intercropping fennel.

5. Health Risk Assessment

Elbagory et al. [contribution 15] have provided valuable insights into the biomonitoring of potentially toxic element contamination in widely consumed summer fruits of Northern India and the subsequent health risk assessment. Moreover, based on the environmental issue linked to the presence of high copper concentrations in soils as a consequence of its use for vegetable productions, Schmitt et al. [contribution 16] have compared Cu levels in soils from different agronomic systems on 25 sites in the Rio Grande do Sul region in Brazil. They showed that the Cu concentration in soils cultivated with vegetables increased in comparison to native soil as a result of agricultural management.

6. Conclusions

The Special Issue "Crop Authenticity in Organic Horticultural Production: Recent Studies and Applications" has been aimed at providing growers with new effectual elements for the improvement of organic crops' growth, yield, quality, safety, and authenticity. Further research should extend its application to a wider range of horticultural and/or fruit crops to confirm and expand upon the current findings.

Author Contributions: Writing—original draft preparation, S.F.; logical conception, S.F.; writing—review and editing, S.F., F.M. and L.B. All authors have read and agreed to the published version of the manuscript.

Conflicts of Interest: The authors declare no conflicts of interest.

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