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ORIGINAL PAPER

A Systematic Review of Scientific Research on Municipal Solid Waste Compost: Impacts on Crop Productivity and Soil Fertility

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Abstract

Recycling Municipal Solid Waste into compost (MSWC) addresses waste disposal and soil organic matter decline. This review assesses MSWC's agronomic effects on crop productivity and soil fertility, highlighting key findings, limitations, and research needs. We analyzed 114 peer-reviewed quantitative studies selected from Web of Science (1985–2025) using Latent Dirichlet Allocation. The review covers MSWC effects on crop productivity across arable, horticultural, and orchard systems, and its impact on soil physical, chemical, and biological properties. Studies reported consistent positive effects at doses > 30–40 t ha^{-1}. Average yield increases were highest in arable systems (+ 63.3%), followed by horticultural (+ 37.3%) and orchards (+ 23%) compared to controls. Soil organic matter increased by + 2.5% in field conditions and + 248% in pot experiments. Benefits were particularly pronounced in degraded or saline-sodic soils, where MSWC reduced electrical conductivity by up to 39% and increased organic matter by up to 45%. However, most studies were short-term (only 18% >5 years) and lacked detailed compost characterization, limiting evidence on long-term dynamics. MSWC aligns with circular economy principles as a potential alternative to mineral fertilizers. Nevertheless, challenges regarding variable composition, high application rates, and contaminants (heavy metals, microplastics) persist. Future research must prioritize long-term field studies to optimize application strategies and assess environmental safety. This review was not registered in any public protocol database.

Keywords Urban waste management · Soil health · Crop performance · Circularity · Sustainable agriculture

1 Introduction

From time immemorial, organic wastes were used to enhance and maintain soil fertility and support agricultural productivity, fostering a natural nutrient cycle (Barles 2014; Güldner and Krausmann 2017). The industrialization of agriculture and the widespread adoption of mineral fertilizers during the 20th century reduced the amount of organic inputs almost to zero (Manlay et al. 2007). Agricultural intensification and specialization resulted in a concentration of livestock farms in limited areas, associated with the accumulation of organic residues, while areas with low livestock density face a deficit in soil organic matter (SOM), crucial for maintaining soil fertility and crop productivity (Feller et al. 2012; Garrett et al. 2020).

The rapid growth of urban population has significantly increased the amounts of Municipal Solid Waste (MSW), which now, globally, exceeds $2 \cdot 10^6$ ton yr^{-1} and it is projected to rise by 56% by 2050, reaching $3.8 \cdot 10^6$ ton. Waste collection efficiency varies considerably according to the Gross Domestic Product (GDP) per capita, where high-income countries are collecting over 90% of waste, and low-income ones less than 40%. Only 19% of the global MSW is currently recycled, so it represents a missed opportunity to recover agronomically valuable organic matter (OM) (World Bank 2018). Organic material constitutes a substantial proportion of MSW, yet 38% of global MSW remains unmanaged, either dumped or openly burned, exacerbating

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environmental degradation through greenhouse gas emissions and soil and water contamination (Chen et al. 2020; United Nations Environment Programme and International Solid Waste Association 2024). Landfilling and incineration, the traditional disposal methods, further contribute to these environmental impacts, underscoring the urgency of sustainable waste management strategies (Lou and Nair 2009). Circular waste management approaches, which prioritize the recovery and reuse of the organic fraction of MSW, align with the FAO's ten Elements of Agroecology, particularly with the principles of recycling and with circular and solidarity economy. Recycling OM, rather than burning it, helps to locally close nutrient cycles, to reduce reliance on external inputs, and to enhance resilience to market and climate variability. Repurposing OM and by-products not only supports sustainable agricultural practices, but also fosters agroecological innovation, offering new opportunities for resource-efficient farming systems (FAO 2018).

One of the most effective strategies for managing the organic fraction of MSW is composting (Babu et al. 2021). It transforms organic waste into a stable and nutrient-rich material through microbial activity, reducing waste volume and producing a valuable resource for agricultural use. Composting ensures that wastes can be safely reintegrated into farming systems by stabilizing OM and eliminating pathogens (Misra et al. 2003).

Municipal Solid Waste Compost (MSWC) is increasingly recognized as a valuable resource for agriculture. When distributed in the field, MSWC improves soil structure, increases SOM content, and provides essential nutrients like N, P, and K, both for crops and microbial community (Hargreaves et al. 2008; Diacono and Montemurro 2010). It is therefore most beneficial for degraded soils and low-input farming systems. Additionally, MSWC aligns with the principles of the circular economy by returning OM to the soil, reducing reliance on mineral fertilizers, and minimizing the environmental footprint of waste management (Razza et al. 2018; Valverde-Orozco et al. 2024). Although MSWC composition depends on feedstock and processing, variability is greatest across producers and compost types, whereas within-producer; this pattern directly impacts reproducibility and agronomic performance (Manea et al. 2024). While national legislation and producer compliance typically limit regulated contaminants in MSWC to legally acceptable levels, uncertainties persist for emerging contaminants (e.g., microplastics) and in less-regulated contexts, representing a potential risk to soil quality and crop safety; therefore, advanced processing technologies and strict quality controls are required to mitigate these drawbacks and ensure the safe agronomic use of MSWC (Belén Almendro-Candel et al. 2019).

The agronomic effectiveness of MSWC is also highly dependent on environmental and agronomic contexts. Its benefits vary with crop type, soil properties, and application rates, often requiring high doses to achieve rapid and significant results (Cao et al. 2023). While effective at improving soil health and productivity, such high doses may not always be practical or economically feasible for farmers. Furthermore, there is a limited understanding of the cumulative impacts of MSWC over time, including its effects on soil C sequestration, microbial communities, and nutrient cycling.

The agronomic utilization of MSWC provides a pathway for recycling MSW, but questions remain about its potential to mitigate greenhouse gas emissions and reduce reliance on mineral fertilizers. Few studies have examined its role in large-scale agricultural systems or its integration into circular waste management models. Addressing the limited understanding of its agronomic performance at field scale and its role in resource-efficient waste valorization, requires multidisciplinary research efforts. This includes long-term field experiments, advancements in processing technologies to improve compost quality and consistency, and comprehensive risk assessments to evaluate potential environmental and economic trade-offs. Such research efforts are essential to optimize MSWC production and application while ensuring environmental and economic sustainability along the entire chain.

Several reviews have investigated the role of organic amendments in agriculture (Diacono and Montemurro 2010; Hargreaves et al. 2008; Martínez-Blanco et al. 2013), but none have specifically and systematically evaluated the agronomic effects of Municipal Solid Waste Compost (MSWC). The aim of this review is therefore to provide an updated and in-depth synthesis of MSWC application in agricultural systems, with a focus on crop productivity and soil fertility outcomes derived from both field and pot experiments with soil. The underlying hypothesis is that MSWC, owing to its organic matter content and nutrient supply, can positively influence soil physical, chemical, and biological properties, ultimately supporting crop production. By summarizing current knowledge, highlighting variability across crops, soils, and climatic conditions, and identifying knowledge gaps, this review seeks to advance sustainable waste management practices and improve the integration of MSWC into agricultural systems.

2 Materials and Methods

2.1 Review Design, Information Sources and Search Strategy

This study adopted a structured literature review approach, supported by computational techniques for literature screening and topic refinement. The review focused on peer-reviewed scientific articles indexed in the Web of Science™ (WoS) Core Collection between January (Leogrande, et al., 1985) and March 2025.

The review followed the PRISMA 2020 guidelines (Page et al. 2021) for systematic reviews to ensure transparency and reproducibility. A schematic overview of the article selection process, adapted from the PRISMA 2020 flow diagram, is provided in Fig. 1. The diagram summarizes each step of the screening and refinement process, from the initial WoS query to the final manual selection of 114 articles specifically addressing the use of MSWC in agriculture.

The initial search in the WoS database was conducted using the keywords "compost" OR "composting", which yielded a set of 42,597 papers (database A, Fig. 1).

Some additional keywords such as "organic waste" OR "municipal solid waste" OR "urban food waste" OR "urban solid biowaste" OR "urban waste" OR "urban biowaste" were then added to further refine the search and focus on the application of MSWC in agriculture The search was furtherly narrowed down by including the terms "soil fertility" OR "soil" OR "crop productivity" to specifically target articles that examined the impact of MSWC on crop productivity and soil fertility. This process yielded 2,553 paper (database B, Fig. 1).The final search was performed on March 18, 2025.

Database B was analysed to assess both temporal and spatial trends, providing insights into the evolution of research activity over time and the geographical distribution of studies. For the temporal analysis, papers from 2025 were excluded to avoid partial data that would not accurately represent the total research output for the year.

Database C (2,232 articles, Fig. 1) was generated by database B by: (i) selecting "Article" and "Review" categories with abstracts available; (ii) selecting English peer-reviewed articles; (iii) removing duplicates.

2.2 Text Mining and Topic Refinement

Text Mining approach (Welbers et al. 2017), which analyzes individual words in the abstracts by examining their frequency to extract meaningful patterns from data, was then applied to the papers included in Database C. The core text mining procedures were carried out using the R package *tidytext* (Silge and Robinson 2016). The preprocessing steps included the removal of common stop words (e.g., "and," "the", "of") to retain only the most informative terms.

Subsequently, the text from the abstracts was tokenized into individual words, allowing for the transformation of the database into a structured format suitable for analysis. Following the text mining process, the tokenized output was used to generate a word cloud using the *wordcloud* package in R (Fellows et al. 2018), displaying the 100 most frequent terms in the database. To improve the representativeness of the visualization, some obvious words -e.g. "soils", "composts", "composted" "study", "experiment", "results", "significant", "significantly", "treatment", "treatments" - were excluded from the word cloud.

The Latent Dirichlet Allocation model (LDA), a widely recognized algorithm for topic modelling, was used to refine the selection. This model is an unsupervised machine learning algorithm that identifies underlying topics within a document corpus by modelling the probabilistic distribution of words across documents (Jelodar et al. 2019). The LDA model provides a more structured examination of the research field by organizing the literature into distinct thematic clusters and it was fitted using the *topicmodels* package in R (Grün and Hornik 2011).

Each topic is characterized by two key outputs of the LDA model, i.e. β and γ. The first output, $\beta_{k,w}$, represents the probability of term w belonging to a topic k. It is computed using the proportion of term occurrences within a topic relative to the overall term distribution across all topics and it is calculated as:

$$\beta_{k,w} = \frac{\sum_{d=1}^{D}\sum_{n=1}^{N}\varphi_{d,n,k}\cdot 1\left(w_{d,n}=w\right)}{\sum_{w}\sum_{d=1}^{D}\sum_{n=1}^{N}\varphi_{d,n,k}\cdot 1\left(w_{d,n}=w'\right)}$$

where:

- $D$is the total number of documents in the database,
- $N$is the number of words in document d,
- $\varphi_{d,n,k}$ is the posterior probability that word n in document d is generated by topic k,
- $w_{d,n}$ is the n-th word in document d,
- $1()$ is an indicator function, equal to 1 if the condition is true, 0 otherwise.

The second output, $\gamma_{d,k}$, indicates the proportion of topic k in a specific document d, was updated iteratively as:

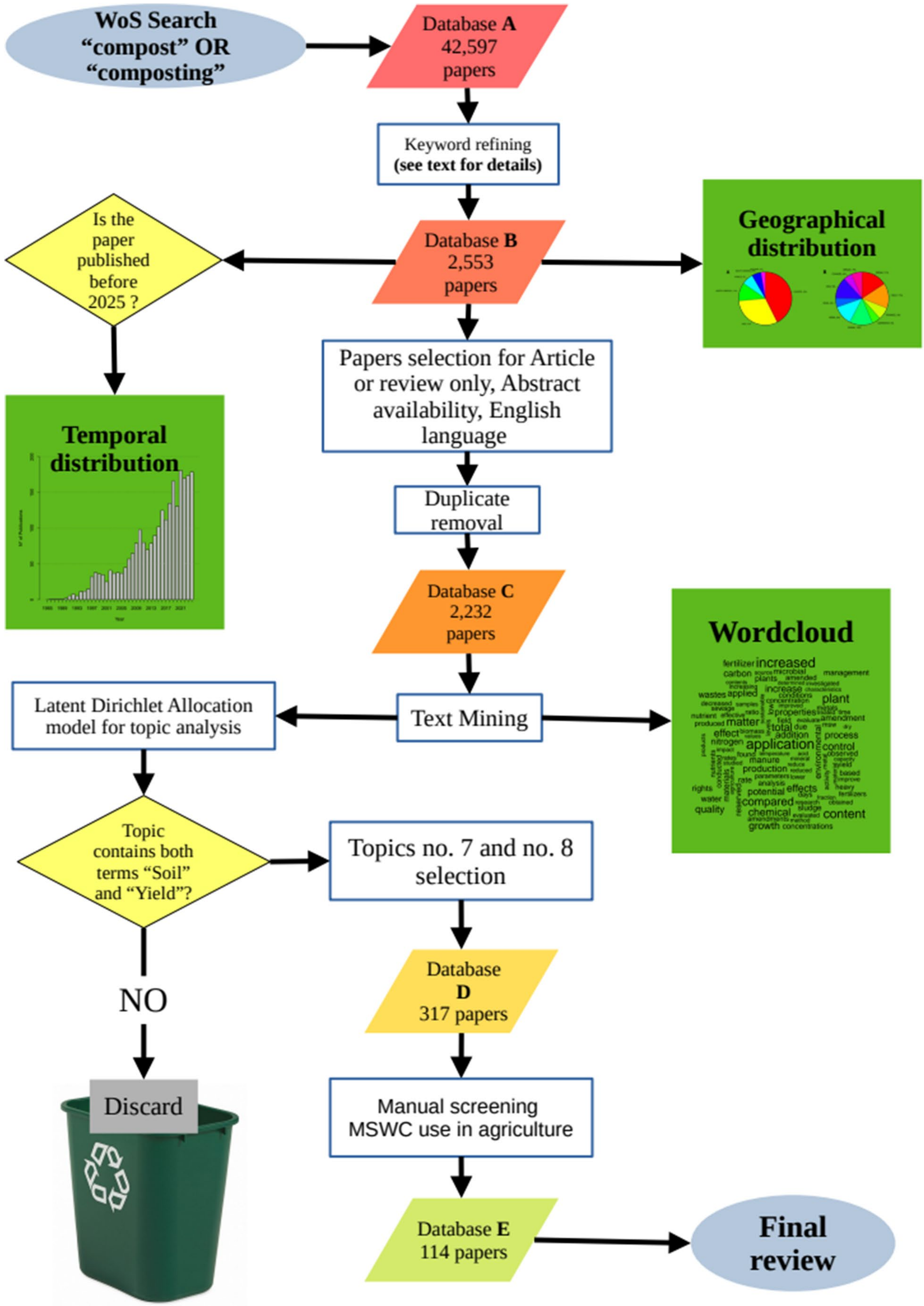
$$\gamma_{d,k} = \alpha_k + \sum_{n=1}^{N}\varphi_{d,n,k}$$

where:

- $N$is the number of words in document d,
- $\varphi_{d,n,k}$ is the posterior probability that the n-th word in document d is assigned to topic k,
- α_k is the Dirichlet prior for topic k.

In other words, β emphasizes the word distribution within topics and γ reflects the topic distribution within documents.

After fitting the LDA model, each document was assigned to the topic with the highest posterior probability. This was achieved by grouping the documents based on the $\gamma_{d,k}$ values, which indicate the relative contribution of each topic to


WoS Search
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Database E
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Fig. 1 PRISMA 2020 flow diagram of the literature screening. From the initial Web of Science (WoS) query (n=42,597) to keyword-refined records (n=2,553), then LDA topic modeling (n=2,232) and selection of "yield" topics (n=317), culminating in the final corpus (n=114) after manual screening. Abbreviations: PRISMA=Preferred Reporting Items for Systematic Reviews and Meta-Analyses; LDA=Latent Dirichlet Allocation; MSWC=municipal solid waste compost

the content of a document. Applying this approach, 15 thematic clusters were identified. Among these, topics no. 7 and no. 8 were selected for further analysis because they were the only clusters in which the keyword "yield" appeared, in addition to "soil". Since soil was present across nearly all topics, reflecting its inclusion in the original WoS search string, yield was considered the key discriminating factor to identify studies explicitly linking the two core outcomes of this review, namely crop productivity and soil fertility. This intentionally restrictive criterion allowed us to focus on the corpus most relevant to the objectives of the review, resulting in database D with 317 papers (Fig. 1).

2.3 Study Selection and Screening Process

The relevance of all 317 articles in Database D was assessed through full-text screening. Studies were included if they: I) reported original quantitative data on crop productivity and/or soil fertility; ii) focused on the application of MSWC (and not other organic amendments) and iii) presented field or pot experiments with soil under agricultural conditions.

Title and abstract screening was conducted by one reviewer, while full-text assessment was independently performed by two reviewers. Disagreements were resolved by discussion and consensus. No automation tools were used for study selection.

After applying these criteria, 114 articles were selected and included in the final dataset (Database E, Fig. 1).

The studies included were then classified according to their main objective, trial duration, production system, experimental methods, and study conditions.

Although no formal review protocol was registered, the entire selection process was designed in accordance with the PRISMA 2020 statement. The final number of included studies and reasons for exclusion are documented in the flow diagram (Fig. 1, following the four standard phases: identification, screening, eligibility, and inclusion.

2.4 Data Extraction and Synthesis Strategy

Quantitative data on MSWC application rates (t ha^{-1} yr^{-1}, dry matter basis), variation in crop productivity (%), and soil organic matter (SOM, %) content for both treated and untreated plots were extracted when reported. Values were obtained directly or, when necessary, calculated from published figures and tables. Nutrient loads (kg ha^{-1} yr^{-1} of total N, P, K) were derived by combining reported MSWC composition (% d.m.) with the average annual application rate (see Tab. S1–S2). Unless otherwise stated in the original articles, yield and soil responses are interpreted relative to unamended controls. When studies explicitly used different baselines (e.g., compost-only baseline or mineral-fertilized controls), this is indicated in the text. No meta-analysis was performed due to the high heterogeneity in experimental conditions, study designs, compost compositions, and reported outcome metrics. Instead, we conducted a narrative synthesis without subgroup or sensitivity analyses. To contextualize site conditions, we summarized the distribution of soil texture classes across experimental sites (Tab. S3), and we documented data coverage and ranges for compost composition (Tab. S1), field nutrient loads (Tab. S2), and contaminants (Tabs S4–S6).

The papers selected in this review therefore outline a landscape shaped by interactions between MSWC and multiple agronomic and environmental factors. We examine this landscape from two complementary 'windows': one centered on crops and yield, the other on soil fertility. From the first, we track outcomes across cereals, vegetables, and trees; from the second, we assess the physical, chemical, and biological dimensions of soil fertility. This analytical separation is purely heuristic: crop productivity and soil fertility are tightly coupled, and observed outcomes are the result of numerous, interacting factors operating across scales.

2.5 Data Availability and Supplementary Material

The full list of reviewed articles included in database E is provided in the Supplementary Material. The file "reviewed_papers.csv"in Supplementary Material includes data on the average annual MSWC application rate, the mean variation in crop productivity, and the average values of SOM for both untreated plots and those treated with MSWC. Details on how these values were calculated are also provided in the file description in Supplementary Material. These materials, along with the R scripts used for text mining and topic modeling, can be made available upon request. In addition, the Supplementary Material contains several tables and figures supporting data interpretation and transparency.

3 Results

3.1 Study Selection

A total of 114 studies met the inclusion criteria for this review (Fig. 1). These articles specifically addressed the use of MSWC in agriculture and reported quantitative data on crop productivity or soil fertility. While some initially

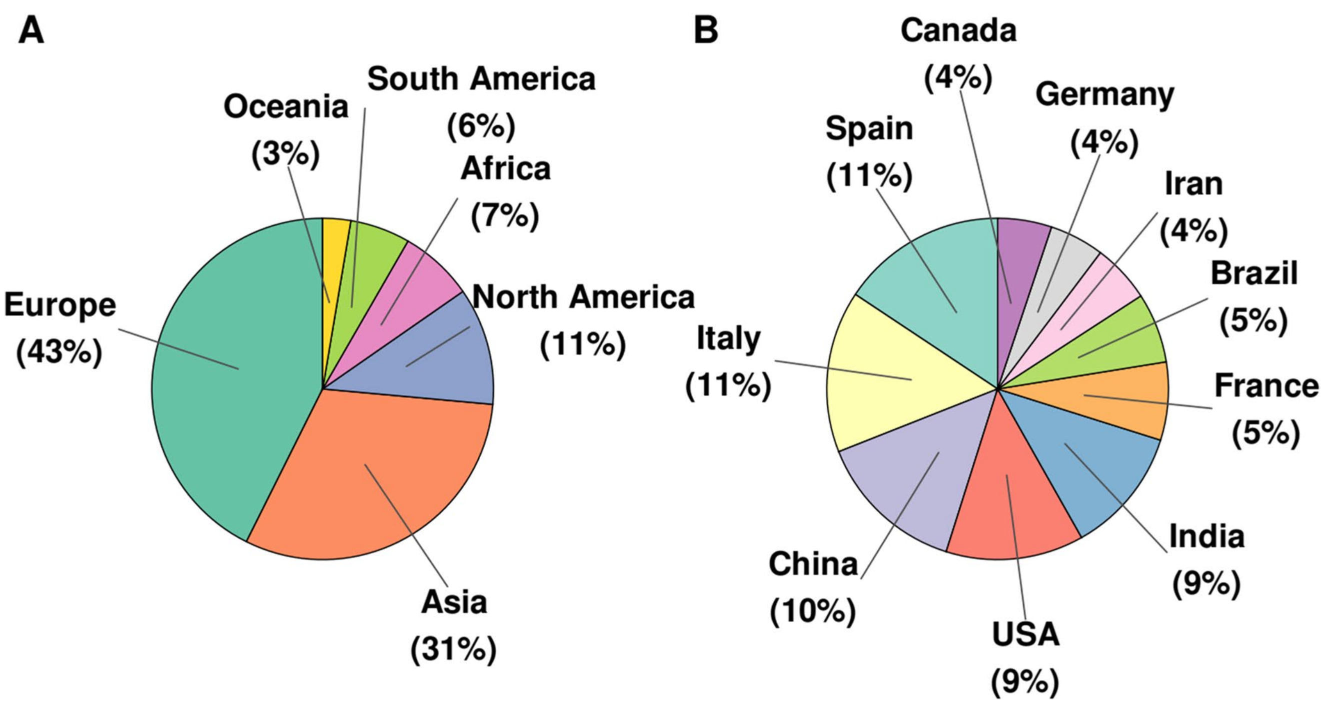

Fig. 2 Global distribution of articles (1985–2024) included in this review (n=2,553) from the Web of Science (WoS) Core Collection. (**A**) Share of studies by continent. (**B**) Top ten countries by publication share. Percentages are computed over all records; studies conducted in multiple countries contribute to each listed country, so panel totals sum to 100%

relevant studies were excluded - for example, those lacking quantitative results, focusing on other organic waste types, or consisting of review articles without original data - the final dataset represents a consistent and robust evidence base. Full details of the screening workflow and quality assessment criteria are reported in the Materials and Methods section, and the complete list of included studies is provided in the Supplementary Materials ("reviewed_papers.csv").

3.2 Geographical and Temporal Distribution

The geographical and temporal trends presented in this section (Figs. 2 and 3) result from the analysis of database B (Fig. 1) identified through the structured literature survey.

The global distribution of peer-reviewed articles published between 1985 and 2024[1], as indexed in the WoS Core Collection, is illustrated in Fig. 2. As shown in panel A, Europe emerges as the leading contributor, accounting for 43% of the total publications, and it is followed by Asia (31%) and North America (11%). Africa (7%) and South America (6%). Oceania represents the smallest share, with 2% of the total.

Panel B provides a closer look at the top 10 countries by publication share. Spain and Italy are the most prolific, each contributing to 11% of the total number of articles. China and India also rank highly, with 10% and 9%, respectively. Other notable contributors include France (5%), Brazil (5%), United States (9%), Canada (4%), Germany (4%), and Iran (4%).

Figure 3 shows the number of articles on MSWC from 1985 to 2024. The number of publications increased from the late 1990 s onward, in line with general growth in scholarly output driven by systemic changes in publishing and career incentives; thus, this trend should not be interpreted solely as rising topical interest. Initially, there were very few publications, with less than 10 articles per year, reflecting the nascent stage of research into composting and its agricultural applications. However, the early 2000 s marked a substantial rise in research output, corresponding with heightened global awareness of environmental sustainability and the introduction of policies aimed at reducing waste through recycling and composting. The number of publications continued to grow, peaking in 2021 with 181 articles, which accounted for 7.49% of the total publications. While the number declined slightly to 170 in 2022, it reached 174 in 2023 and 179 in 2024, suggesting a sustained high level of research activity in the field.

3.3 Text Mining and Topic Analysis

A Text Mining analysis was performed on database C (2,232 articles, Fig. 1) to identify recurring terms and emerging

[1] Being the last query on WoS done on March 2025, this year is considered incomplete and therefore not included in the temporal analysis.

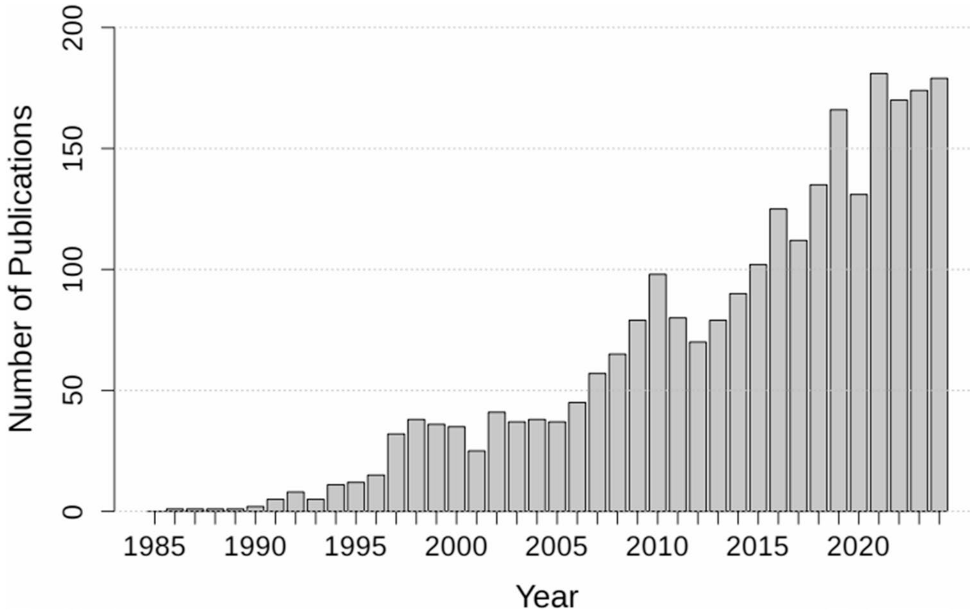

Fig. 3 Annual number of publications (1985–2024) on MSWC in agriculture retrieved from the Web of Science (WoS) Core Collection (n=2,553). Counts refer to peer-reviewed journal articles included in the Database **B**. Abbreviation: MSWC = municipal solid waste compost

themes in the literature. To provide a concise overview of the main topics emerging from the abstracts, a word cloud with the 100 most frequent terms was generated based on the text mining results (Fig. 4). This representation highlights the frequent occurrence of terms such as "increased" and "increase", reflecting the widespread reporting of positive effects of MSWC on various agronomic and soil parameters. The term "matter" also stands out, most likely in reference to OM or SOM. The presence of "rate" and "rates" suggests a consistent focus on application strategies and their impact on both crop performance and soil response. Additionally, although less prominent, the appearance of "microbial", "heavy", "metal", and "metals" confirms that both biological activity and potential contamination are recurring investigated concerns. Notably, other forms of contamination such as microplastics do not emerge among the 100 most frequent terms, suggesting that this issue remains largely unexplored in the current body of research.

After Text Mining, the LDA model was applied to further structure the analysis of the research field (Fig. 1). As shown in Fig. S1, certain topics appear to be linked to specific research areas: for instance, the presence of the term "microbial" in topics no. 6 and no. 2 suggests that these clusters likely include studies addressing soil biological activity. Similarly, the term "biochar" in topics no. 13 and no. 5 may indicate a focus on biochar use and its interaction with MSWC. The occurrence of contamination-related terms such as "metal" and "heavy" in topics no. 12 and no. 14, respectively, points to a probable concern with the presence of heavy metals in compost materials.

A total of 114 articles are distributed between crop productivity (84/114, ~74%), and soil fertility (70/114, ~61%). The total repetition of the main objective (154) exceeds the total number of articles (115) because some studies analyse both soil fertility and crop productivity. Regarding trial duration, 59 studies (52%) covered one year, 23 focused on two years (20%), 19 on three years (16%), and 13 extended beyond three years (12%). Production systems were predominantly focused on arable crops (57/115, ~49%), followed by horticulture (44/115, ~39%) and orchards (15/115, ~13%). Two articles (Jorge-Mardomingo et al. 2013, 2015) focus on the effects of MSWC on soil properties without targeting a specific crop. The total number of production systems analysed (118) is higher than the total number of articles (115) because two studies evaluated more than one system: one (Sánchez-Monedero et al. 2019), with a trial duration of three years, assessed the effects of MSWC on a crop rotation that included arable crops, horticultural crops, and orchard systems; the other (Gallardo-Lara et al. 2006), with a duration longer than three years, simultaneously investigated both arable and horticultural systems. Most of the studies (86, ~75%) were field-based experiments, while only 28 are pot experiments with soil (25%). A total of 97 experiments were conducted under open field conditions and 18 in greenhouses. The sum exceeds the number contained in database E because Sánchez-Monedero et al. (2019) evaluated multiple agroecosystems.

3.4 Crop Productivity: Within One Year Experiments

The limited number of publications (84, Table 1) prevents drawing broadly applicable and globally valid conclusions on the impacts of MSWC application on crop productivity. Nevertheless, some insights can be derived from consolidated findings, though constrained to specific pedo-climatic and production conditions.

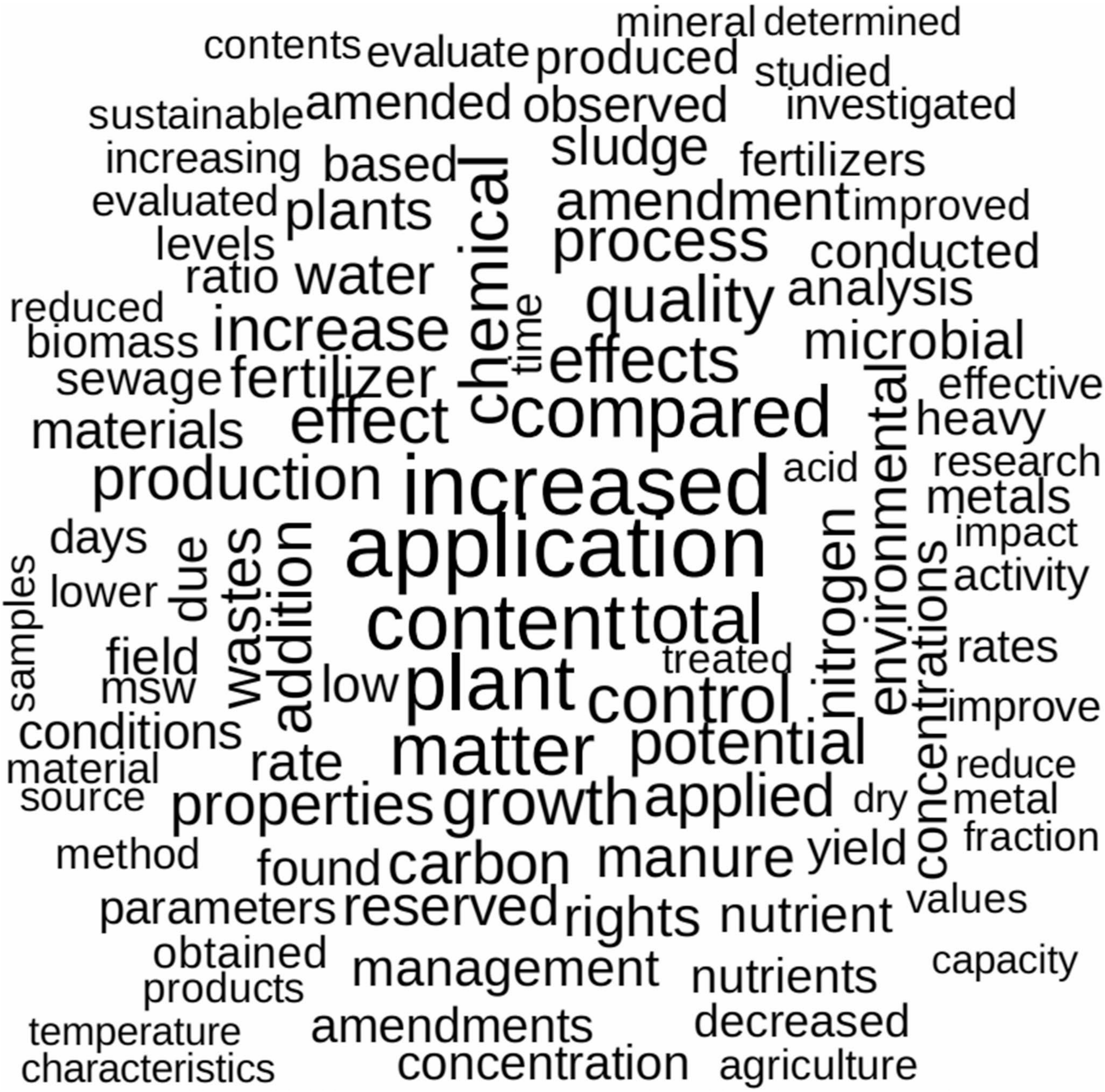

Fig. 4 Word cloud of the top 100 terms from the abstracts of the 115 reviewed articles on MSWC. Common stop-words were removed and terms lower-cased; word size is proportional to relative frequency. Source: Web of Science (WoS) Core Collection, 1985–2024. Abbreviations: MSWC = municipal solid waste compost

As shown in Tables 1 and 59 out of the papers contained in database E (Fig. 1) report findings from one-year experiments, where 47 specifically focus on the effects of MSWC on crop productivity.

The results describe the beneficial effects of MSWC on arable crops, highlighting its potential to enhance yield and plant performance across different species and environmental conditions. For instance, Prabpai et al. (2009) found 85% increase in *Zea mays* (corn) yield when applying rates of MSWC/soil vol/vol from 20 to 80%, with the highest yield observed at 60%. In a field study, Ulm et al. (2019) reported grain yields of 1.9 t ha^{-1} in unamended plots and 7.8 t ha^{-1} in MSWC treated plots. (+311%). In a pot trial, Okoli et al. (2022) found that 100% MSWC increased plant height from 127 cm in untreated plots to 162.6 cm (+28%), grains per cob from 220 to 350 (+59%), and cob weight from 100 g to 250 g (+150%); 75% compost yielded 152.4 cm (+20%), 320 grains (+45%), and 200 g (+100%) relative to the

Table 1 Summary of the 114 reviewed articles contained in database E and grouped by main objective, trial duration, production systems, experimental methods, and study conditions. The last row reports the total number for each group but for main objective, production systems, and study conditions the total exceeds 114 because some studies encompass multiple groups

	Main objective		Trial duration		Production systems		Experimental methods		Study conditions	
	Crop productivity	84	1 year	59	Arable crops	57	Field experiment	86	Open field	97
	Soil fertility	70	2 years	23	Horticulture	44	Pot experiment	28	Greenhouse experiment	18
			3 years	19	Orchards	15				
			Over 3 years	13	No crop	2				
Total		154		114		118		114		115

control. Similar positive effects have been reported for cereals such as *Oryza sativa* (rice), *Triticum aestivum* (common wheat) and T*riticum durum* (durum wheat), particularly in challenging soil conditions. Zaman et al. (2020) observed that MSWC distribution significantly increased the productivity of rice and common wheat in Pakistani saline-sodic soils: the highest yields were recorded for rice straw (1102 g m^{-2}), rice grain (605 g m^{-2}), wheat straw (984 g m^{-2}), and wheat grain (505 g m^{-2}). The increase in yield (+67% in rice straw, +132% for rice grain, +26% for wheat straw and +48% for wheat grain, respectively), was most pronounced when the compost underwent anaerobic decomposition, highlighting the role of composting techniques in influencing crop performance. Supporting these findings, Lakhdar et al. (2009) found that applying MSWC at rates as high as 80 t ha^{-1} resulted in an 87% increase in grain yield of durum wheat compared to unamended plots. In the second year of another of their experiments (Lakhdar et al. 2010a), biomass production also increased significantly, to 48% and 78% observed at compost application rates of 40 and 100 t ha^{-1}, respectively. More recently, Gadaleta et al. (2022) confirmed that MSWC increased durum wheat yield by 25.52% and 30.92% in two different cultivars. Martinez et al. (2022) observed an increase in *Fagopyrum esculentum* (buckwheat) biomass production, seed yield, seed quality, and nutrient content when using MSWC instead of mineral fertilization in a greenhouse study conducted on both clayey and sandy soils. The study reported average yields of 34.4 g/plant for biomass and 10.6 g/plant for seeds. However, the effectiveness of MSWC appears to be crop-specific and dose-dependent. Notably, the only exception among the arable crop studies reviewed is Kchaou et al. (2018), who found that MSWC application did not lead to significant increases in (*X Triticosecale Wittmack*) triticale plant height, leaf number, or chlorophyll index, suggesting that the effectiveness of compost may vary with environmental conditions, crop species, and application rate.

The advantages of MSWC application extend beyond cereals, as observed in oilseeds and forage crops. Montemurro et al. (2005) observed that MSWC produced *Helianthus annuus* (sunflower) yields comparable to those obtained with mineral fertilizers, particularly for oil and protein content, while Rashtbari et al. (2020) reported that MSWC improved plant height, stem diameter, and grain yield in *Brassica napus* (canola) under both well-watered and drought stress conditions. In forage crops, MSWC has shown potential in mitigating the adverse effects of salinity and enhancing biomass production, although responses tend to be crop and soil specific. Mbarki et al. (2020) reported improved plant growth when irrigation with saline water (50–100 mM NaCl solution) was combined with MSWC application. Similarly, Ouni et al. (2014) observed that MSWC improved both biomass production and photosynthetic efficiency in forage species grown under saline soil conditions. However, the effectiveness of MSWC varied with soil type, as demonstrated by Mbarki et al. (2008): in clay soils, compost application increased *Medicago sativa* (alfalfa) yield by 15% at 10 t ha^{-1}, 24% at 20 t ha^{-1}, and 18% at 40 t ha^{-1}. Thus, a compost dose higher than 40 t ha^{-1} was not necessary to improve yield in such soil. In contrast, a decline in productivity was observed in sandy soils with increasing compost rates, likely due to enhanced nutrient leaching and salinity accumulation. Positive outcomes were also reported in *Lolium perenne* (ryegrass), with Soumaré et al. (2003) documenting yield increases of 10% and 17.5% at application rates of 50 t ha^{-1} in two distinct tropical soils. The positive impact of MSWC is also evident in leguminous crops, as Ozdemir (2005) observed that *Cicer arietinum* (chickpea) responded best to MSWC application at 50 t ha^{-1}, significantly increasing seed yield. Confirming the crop- and condition-dependent nature of MSWC responses, as already noted in triticale (Kchaou et al. 2018), Sifola et al. (2025) reported that compost application under deficit irrigation reduced *Nicotiana tabacum* (tobacco) yield, despite improvements in soil water retention and N use efficiency (NUE), an outcome consistent with temporary N immobilization and lower plant N recovery during rapid growth, coupled with the crop's high sensitivity to water stress during key phenophases.

The application of MSWC has shown promising results in various horticultural production systems, enhancing biomass production, vegetable yield, and overall crop performance. Among leafy vegetables, Papafilippaki et al. (2015) reported that applying 60 t ha^{-1} of MSWC enhanced *Cichorium spinosum* (spiny chicory) yields in sandy soils, while De Nobile et al. (2021) showed that, despite the same nitrogen doses being applied, MSWC led to higher biomass yields in *Brassica oleracea* var. *italica* (broccoli) and *Lactuca sativa* (lettuce) than urea, especially at the highest application rates (6.2 ton ha^{-1}). Castaldi et al. (2023) also demonstrated that MSWC application (35 t ha^{-1}) enhanced *Beta vulgaris* var. *cicla* (Swiss chard) yields to levels comparable with mineral fertilization. By contrast, Coria-Cayupán et al. (2009) reported a slight yield reduction (−7%) in lettuce cultivated with MSWC. In the case of solanaceous crops Leogrande et al. (2016a) found that MSWC increased *Solanum lycopersicum* (tomato) yield by 9% compared to mineral fertilizers in Southern Italy. Tzortzakis et al. (2020) confirmed that MSWC additions (from 5% up to 40% vol/vol) to mineral soil improved tomato plant biomass and yield although excessively high ratios reduced fresh weight. Bhardwaj et al. (2023) also observed increased yields in tomato and *Solanum melongena* (brinjal)following MSWC amendments, with the best results obtained at a compost application rates of 25% MSWC/soil vol/vol. Leguminous horticultural crops also benefit from MSWC application, as demonstrated by Soobhany et al. (2017) which found that *Phaseolus vulgaris* (green bean) plants grown in soil mixtures containing 40% vol MSWC produced significantly higher legume yields compared to the unamended 100%-soil control. Likewise, Martinez et al. (2021) found that MSWC (115 g/L) increased *Vicia faba* (faba bean) biomass production by 38% in sandy soil compared to the control. Wilton et al. (2020) demonstrated that green bean yields increased linearly with compost application rates (up to 30% vol/vol), where all growth parameters, including leaf area and pod number, responded positively without reaching the yield plateau. In horticultural fruit crops, Saygi (2023) found that *Fragaria x ananassa* (strawberry) grown with 4 t ha^{-1} of MSWC had the highest fruit weight and yield. Likewise, Villena et al. (2018) observed a significant improvement in *Cucumis melo* (melon) yield under field conditions when MSWC was applied, especially at moderate rates (13 t ha^{-1}), which proved sufficient to maximize yield without exceeding environmental risk thresholds.

Regarding orchards, Basso-Figuera et al. (1995) found that MSWC increased *Carica papaya* (papaya) yields proportionally to the application rate, with no significant changes in leaf nutrient levels. Similarly, Blanco et al. (2024) evaluated the use of MSWC as mulch in a vineyard (*Vitis vinifera*) located in Southern Italy and observed that its application helped stabilize soil temperature, reducing heat stress on roots and improving water retention. These effects, although not quantified in terms of yield, suggest enhanced vine health and potential support for grape production. In another orchard crop study, Schulz et al. (2012) tested urban waste compost as a fertilizer source for *Jatropha curcas* (physic nut) under greenhouse conditions. They found that MSWC application increased plant growth parameters such as height, leaf area, and chlorophyll index up to a dose of 200 L m^{-3}, beyond which no further benefits were observed. In a semiarid shrubland setting, Cuevas et al. (2000) reported that MSWC increased total plant cover and biomass production of native species, with the most notable biomass gains occurring at 80 t ha^{-1}, confirming the positive role of MSWC in promoting vegetative productivity even under degraded conditions.

3.5 Crop Productivity: Two Year Experiments

In this review, of the 114 articles analysed, 25 cover a period of 2 years, as shown in Table 1. Notably, 17 of these investigate the impact of MSWC on crop productivity.

These experiments consistently observed the benefits of MSWC across different cropping systems, improving plant growth, yield, and nutrient availability. Regarding arable crops, in the context of corn production, Hossain et al. (2024) found that the application of MSWC (5, 10, and 15 t ha^{-1}) had a positive impact on plant growth and yield in their two-year field study in Saudi Arabia. Effects were further amplified when MSWC was combined with NPK, with the strongest responses at the highest application rate. Similarly, Wolkowski (2003) reported that mature MSWC significantly increased corn grain yields compared to a less mature one. The superior performance of mature MSWC was attributed to its lower N immobilization and the gradual release of N, which provided a continuous nutrient supply throughout the growing season. In tobacco cultivation, Sifola et al. (2024) showed that MSWC (12.5 t ha^{-1}) improved plant growth parameters such as leaf emergence rate and crop growth rate, ultimately enhancing the yield of cured product and resource use efficiency. For cereals, Montemurro (2009) found that MSWC increased common wheat yields by 12% compared to the control. However, the yields achieved with MSWC were lower than those obtained with mineral fertilizer and MSWC-mineral fertilizers blends. These observations align with findings from Mehdi et al. (2015), who reported that an 80/20 MSWC/mineral fertilizer mixture is capable to meet the crop's nutrient needs on a par with mineral fertilizer alone, but can significantly increase biomass production and grain yield in a rice/common wheat rotation. Jorge-Mardomingo et al. (2015) also noted that high doses of MSWC (160 t ha^{-1}) enhanced yield stability in cereals under Mediterranean conditions by ensuring a more gradual nutrient release and reducing nitrate leaching compared to less stable organic amendments.

In horticultural systems, for example in lettuce production, Leogrande et al. (2013) and Testani et al. (2020) observed that MSWC, either alone or in combination with agroecological practices like cover cropping, buffered yield performance against climatic variability, thereby sustaining crop productivity and improving NUE. Leogrande et al. (2013) noted that MSWC led to lower marketable yields than stable manure but both treatments enhanced soil fertility and contributed to yield sustainability, Testani et al. (2020) reported that MSWC, when integrated with roller crimper-based no-till systems and legume cover crops, supported consistent lettuce yields across two cropping cycles. For solanaceous crops, Clark et al. (2000) investigated MSWC effects on drip-irrigated and sub-irrigated autumn-grown green peppers and spring-grown fresh market tomatoes between 1992 and 1994. Initially, they found that the incorporation of immature MSWC (67 and 134 t ha^{-1}) reduced growth and yields of pepper in the autumn 1992. However, by the spring of 1993, the fully decomposed MSWC significantly enhanced plant size and fruit yields in tomatoes. Compared to control plots the application of 134 t ha^{-1} of MSWC increased tomato yields by 27% in the spring of 1993 and by 18% in 1994. Similarly, pepper yields improved by 17% in the autumn of 1993. These results are in line with the findings of Ozores-Hampton et al. (1994), who reported improvements in growth, nutrient concentrations, and yields in tomato and *Cucurbita maxima* (squash) after MSWC application.

However, other studies have shown less favourable outcomes under certain conditions: Farneselli et al. (2022) found that MSWC alone did not meet the N requirements of processing tomato and *Brassica oleracea* var. *botrytis* (cauliflower), leading to reduced aboveground biomass accumulation compared to mineral fertilization. Nevertheless, the early application of MSWC partly mitigated these negative effects.

The benefits of MSWC extend to perennial orchard systems as well. Aguilar et al. (1997) found significant increases in the yields of *Olea europaea* (olive), vine, and *Citrus* spp. (citrus) crops following the application of MSWC. Olive orchards showed a 50% increase in fruit yield, while vineyards experienced a 30% rise with applications of 30 t ha^{-1}, while citrus crops exhibited a 17% improvement in yield. These findings are consistent with those of Baldi et al. (2022), who observed that in vineyards, the use of MSWC significantly improved yield and nutrient uptake in *Vitis vinifera* L. cv. Sangiovese, particularly when used in combination with humic substances.

3.6 Crop Productivity: Three Year Experiments

The following section presents evidence from the subset of 15 articles out of 19 with three-year experiments (Table 1) that specifically investigated crop productivity.

In corn production, Golabi et al. (2021) found that MSWC improved yields over three growing seasons in northern Guam. During the rainy season, plots treated with 250 t ha^{-1} of compost yielded more than those treated with mineral fertilizers. Supporting this, Moretti et al. (2020) also reported that the substitution of mineral fertilizers with MSWC in continuous corn cropping systems led to a 55% yield increase by the third year, emphasizing the compost's effectiveness in arable summer crops. Conversely, in *Solanum tuberosum* (potato) cultivation, Warman et al. (2011) found that MSWC treatments did not consistently influence marketable tuber yield. In cereals system, Mousavi et al. (2017) reported that MSWC significantly enhanced rice yields, while Meena et al. (2022) found that MSWC improved soil structure in saline soils, leading to significantly higher grain yields in a *Brassica juncea* (mustard)/*Pennisetum glaucum* (pearl millet) cropping system in India. The beneficial effects of MSWC were also evident in some combined cereal-forage systems. Mbarki et al. (2022) observed that MSWC significantly boosted biomass yield in *Sorghum bicolor* (sorghum) during the second harvest and in alfalfa during the third one under saline conditions over three harvest periods. Similarly, Montemurro et al. (2006) reported that MSWC increased the mean cumulative dry weight of *Dactylis glomerata* (cocksfoot) by 20.85% compared to the control in a field experiment in Southern Italy. In alfalfa, the cumulative dry weight remained consistent across all treatments. Further supporting these findings, Salis et al. (2024) observed significant increases in dry matter production and crude protein content in rain-fed forage barley (*Hordeum vulgare*) with the application of MSWC. Zając and Skrajna (2024) added to these findings, showing that in perennial grasses like *Miscanthus sinensis* (Chinese silver grass), yields increased steadily, with the highest yields recorded in MSWC treated plots (17.5 ton ha^{-1}).

In horticultural systems, positive effects were also evident. Alashty et al. (2011) found that the continuous application of MSWC (20 and 40 t ha^{-1}) significantly enhanced plant growth by modifying soil chemical properties. They observed that higher compost rates increased root and shoot biomass in *Raphanus sativus* (radish) and lettuce, with the most notable effects occurring on the third year. Similarly, Warman et al. (2009) on winter squash cultivation in Nova Scotia, Canada, found that higher application rates (up to 72 t ha^{-1}) significantly improved yields, particularly in the third year, reaching levels similar to those obtained with mineral fertilizers. Complementing these results, Sánchez-Monedero et al. (2019) reported that in greenhouse-grown tomatoes, at the end of the third year MSWC application increased fruitweight, diameter, and hardness by 16%, 9%, and 8%, respectively.

In orchard systems, Bona et al. (2022) found that MSWC applied in intensive *Malus domestica* (apple) orchards showed a linear increase in productivity over time, with more evident effects than matured manure. Similarly, Sánchez-Monedero et al. (2019) found that MSWC (10.9 t ha^{-1}) in vineyards enhanced grape must acidity, a quality parameter important in wine production.

3.7 Crop Productivity: More than Three Year

Of the 114 articles analyzed in this review, 13 focus on the long-term effects of MSWC, with study durations exceeding three years. The following section will focus on six studies that specifically investigated crop productivity.

Leogrande et al. (2016b) found that MSWC (50 ton ha^{-1}) increased corn grain yield by 11% compared to mineral fertilizers in Southern Italy. Under saline irrigation, they observed a 19% higher yield with MSWC compared to mineral fertilizer and control treatments. Similarly, Hemmat et al. (2010), in arable cropping systems, found that long-term MSWC applications (from 25 to 100 ton ha^{-1}) significantly enhanced common wheat and corn yields, mainly due to increased SOM and N availability. In a eleven year field trial in Denmark, Gómez-Muñoz et al. (2017) reported that a mean of 20.7 ton ha^{-1} of MSWC applied annually contributed to increase soil N stocks and SOM content in an oat (*Avena sativa*) cropping system. However, crop responses were limited by low NUE, suggesting that compost quality and synchronization with crop N demand play a critical role in determining yield outcomes.

For horticultural crops, in a four year trial, Morra et al. (2010) found that up to 45 ton ha^{-1} had no significant effect on tomato or green bean yields in a greenhouse experiment. However, lettuce yields increased with applications at 30 and 45 ton ha^{-1}, once more highlighting the crop-specific effects of MSWC.

In orchard systems, MSWC at 10 ton ha^{-1}, successfully replaced mineral fertilizers in commercial *Prunus persica* (peach) orchards, maintaining or even increasing fruit yield over a nine-year period (Baldi et al. 2010). Likewise, compost mulch improved grapevine productivity, mainly through enhanced soil moisture retention and nutrient availability, though concerns regarding heavy metal accumulation were noted in some cases (Pinamonti 1998).

3.8 Soil Fertility: Within One Year Experiments

Developing broad and globally valid conclusions on the effects of MSWC application on soil fertility requires a careful examination of available studies, which are often limited to specific pedo-climatic and management conditions. As reported in Table 1, the articles reviewed that investigated MSCW effects on soil fertility are 70. While in the previous sections on crop productivity the effects were categorized across arable crops, horticulture, and orchards, here the effects will be grouped according their physical, chemical, and biological aspects of soil fertility.

Of the 114 articles analysed in this review, 60 focus on the short-term effects, i.e. on the results obtained after a single year. The following section will highlight some of the 35 studies that specifically investigated soil fertility.

The ability to enhance soil's physical properties is a key benefit of MSWC applications, and that seems particularly true for water retention and soil structure. For instance, Zgallai et al. (2024) compared the water retention properties of MSWC distribution with a commercial water-retaining product; at the beginning of the dry season, soil moisture tension was found lowest in compost-amended plots (48 cb), higher in commercial product treated ones (61 cb) and hjghest in the control (83 cb). Since tension is expressed as positive centibar values, lower values indicate wetter soil and more readily available water. At the end of the field trial, they also observed that compost application increased soil moisture, total N, and SOM by 9%, 50%, and 27% respectively, compared to the commercial water-retaining product. Similarly, Taheri et al. 2020) found that cumulative drainage content decreased from 35.68% in the control to 10.95% in the MSWC treatment (40 ton ha^{-1}). Additionally, they observed an increase in topsoil water content by up to 9.08% in the compost-treated group compared to the control. In horticultural systems, Mylavarapu and Zinati (2009) observed improved moisture retention under drought conditions in *Petroselinum crispum* (parsley) cultivation, while Cercioglu (2019) noted enhancements in overall soil structure. These findings are in agreement with those obtained by Sifola et al. (2025), which reported an increased water-holding capacity after MSWC application (18.5 ton ha^{-1}), contributing to greater resilience under water stress. Schulz et al. (2012) also observed improved soil physical conditions during early growth stages of physic nut in a pot trial. In vineyard systems, Blanco et al. (2024) found that MSWC mulching enhanced microbial decomposition activity (Tea Bag Index) and reduced the diurnal soil-temperature amplitude at 20 cm; these conditions may favor longer-term improvements in soil structure.

In addition to physical benefits, MSWC significantly contributes to soil chemical fertility by increasing SOM, nutrient availability, and by modifying some critical chemical properties. Zaman et al. (2020), in a rice-common wheat rotation experiment conducted on saline-sodic soils, reported substantial increases in SOM after MSWC application (34.3 ton ha^{-1}): +64.10% after rice and +86.32% after wheat. Compost also reduced soil electrical conductivity (EC) (−35.61%) and sodium adsorption ratio (SAR) (−45.22%) after rice harvest, with even greater reductions following wheat. Montemurro et al. (2005), working on a silty clay soil in Southern Italy, observed elevated levels of available P and SOM in sunflower-cultivated soils, while Lakhdar et al. (2011) observed that, in a sandy soil from semi-arid Tunisia, MSWC enhanced nutrient levels in saline soils, particularly N and K, helping to counteract the negative effects of salinity. Kasthuri et al. (2011) further confirmed these benefits in their pot experiment on *Vigna radiata* (green gram) and *Trigonella foenum-graecum* (fenugreek), finding increases in essential nutrients levels. Martinez et al. (2022) reported increases in SOM (+32%), total N (+62%), and pH (from 7.45 to 8.05) in MSWC treated plots compared with unamended controls, both under greenhouse and open-field conditions, Martinez et al. (2021) observed improved NUE in faba beans, lowering the need for mineral fertilizers. Regarding to horticulture production systems, Mylavarapu and Zinati (2009) reported increases in total organic carbon (TOC) and N, while Cercioglu (2019) found gains in total N, available P and K. Erana et al. (2019) also noted that MSWC increased soil pH and TOC, supporting enhanced root growth and nutrient absorption in *Allium cepa* (onion) crops. Leogrande et al. (2016a) showed that MSWC reduced the Na concentration while increasing those of Ca and K in tomato cultivation on saline soils. Guerini et al. (2006); Leogrande et al. (2016b) further confirmed increases in SOM (+20–30%), cation exchange capacity (CEC), and nutrient availability, while Soumaré et al. (2003) emphasized that co-application with mineral fertilizers enhanced N and P uptake. In subarctic soils, Wilton et al. (2020) reported significant increases in P and K availability for green beans, though excess accumulation of these nutrients at high compost rates (30% MSWC/soil vol/vol) raised concerns about nutrient saturation. Similar effects were noted by Cuevas et al. (2000), who observed higher N, available P, and exchangeable K levels in a degraded semi-arid shrubland.

Nevertheless, several studies cautioned against excessive MSWC application, particularly in sandy or degraded soils. Mbarki et al. (2008) and Bhardwaj et al. (2023) reported increased salinity and accumulation of Cd, Cu, Zn, and Pb. These effects were particularly evident in in the sandy soils of Tunisia (pH 8.0) studied by Mbarki et al. (2008), a in the sandy alluvial soils of India (initial pH 8.48) examined by Bhardwaj et al. (2023), where compost rates exceeding 25% MSWC/soil vol/vol markedly increased SOM and available P while altering N and K dynamics. Fagnano et al. (2011) also highlighted the increased bioavailability of Pb and Zn, underlining the need for careful monitoring.

Beyond chemical and physical improvements, MSWC substantially contributes to soil biological quality and ecosystem functioning. Hodson et al. (2021) demonstrated that MSWC altered microbial community composition and increased bacterial evenness in almond orchards, with a higher relative abundance of taxa involved in carbon degradation and distinct associations between bacterial groups and bacterial-feeding nematodes. These shifts in microbial and nematode communities enhanced nutrient cycling and contributed to long-term soil fertility. Lakhdar et al. (2010b) reported marked increases in enzymatic activity following compost application: dehydrogenase (+107%), β-glucosidase (+43%), and phosphatase (+20%), which were interpreted as positive outcomes reflecting enhanced microbial metabolism and nutrient turnover, thereby improving the biological quality of salt-affected soils. Elbl et al. (2019) observed increased microbial respiration following MSWC application, indicating enhanced substrate mineralization and CO_2 release; although this reflects short-term stimulation of microbial activity, it also implies that a relevant share of the added C may be lost rather than stabilized. Nonetheless, they reported that part of the carbon input contributed to soil C sequestration, suggesting a potential, though limited, long-term benefit for biological fertility. De Varennes et al. (2010) documented higher activities of soil enzymes such as β-glucosidase and phosphatase in degraded mine soils, with improved activity referring to a recovery of biological functioning compared to untreated controls, thereby reinforcing the restorative potential of MSWC. Consistent with these findings, in a field experiment under semi-arid climate, Jorge-Mardomingo et al. (2013) reported that a single high dose (160 t ha^{-1}) was able to significantly increase microbial biomass C, up to 1369.1 mg C kg^{-1}, to maintain high basal respiration rates, and to enhance enzymatic activities such as β-glucosidase, urease, and phosphatase. Unlike sewage sludge treatments, which induced initial microbial stress and seasonal fluctuations, MSWC was capable to keep a stable biological activity and a lower metabolic quotient (5.04 ng O_2 μg^{-1} Microbial Biomass Carbon h^{-1}) than sewage sludge, indicating efficient microbial function and low ecological disturbance. Terrile et al. (2024) confirmed the improved physical, chemical, and biological soil properties due to MSWC (40 ton ha^{-1}), while detecting low residual pollutants: Pb and As in some leaf-based composts, veterinary pharmaceuticals and trace pesticide residues in irrigation water and soils. Notably, contaminant concentrations in vegetable tissues were generally below admissible limits or not detectable. Similarly, Oguntade et al. (2019) found improvements in soil fertility indicators (e.g., total N, TOC, available P), while maintaining heavy metal concentrations within safe thresholds.

However, potential trade-offs must be acknowledged. Novinscak et al. (2022) reported increased N_2O emissions in compost-treated soils, pointing to the need for integrated management approaches that optimize nutrient use while minimizing environmental impacts.

3.9 Soil Fertility: Two Year Experiments

Among the 114 articles reviewed, 25 include experiments lasting two years, as shown in Table 1. The following sections summarize the findings from eleven papers that focus the medium-term effects on soil fertility.

In terms of physical improvements, Aguilar et al. (1997) reported that MSWC application in olive, vine, and citrus orchards led to significant enhancements in soil structure. Compost reduced bulk density, increased water-holding capacity, improved aggregate stability, and promoted better water infiltration, thereby increasing the soil's resistance to erosion. Similarly, Leogrande et al. (2013), who reported increased soil quality parameters. These findings are echoed by Moraes et al. (2014) observed that amounts up to 75 m^3 ha^{-1} distributed over two years under no-tillage in corn and sunflower cultivation, were able to improve soil aggregation compared to mineral fertilization in a Rhodic Hapludox, and by Testani et al. (2020), who highlighted the role of MSWC, especially when combined with cover crops, in sustaining soil structure under organic lettuce systems.

From a chemical perspective, Montemurro and Maiorana (2007) found that MSWC application (68 ton ha^{-1}) resulted in a substantial (+37%) TOC increase after two years under *Beta vulgaris* (sugar beet cultivation. Leogrande et al. (2013) confirmed these findings in lettuce cultivation, observing that MSWC improved the extractable fraction of TOC more than other organic fertilizers. Similarly, Moraes et al. (2014) noted that both TOC and total N increased linearly with MSWC application rates (from 25 to 100 m^3 ha^{-1}). Testani et al. (2020) also found that the use of MSWC, especially when combined with *Vicia* spp. (vetch) cover crops, supported the preservation of SOM and N levels across two consecutive growing seasons. Moreover, Aguilar et al. (1997) found that compost enhanced the availability of macro and micronutrients and increased soil CEC, indicating improved nutrient retention and supply potential. Mehdi et al. (2015) also reported increased levels of available P, K, and Zn following the combined application of MSWC and mineral fertilizers (20:80) in a rice-common wheat system, along with a slight reduction in pH and SAR. Gallardo-Lara et al. (2006) further contributed to this evidence by showing that MSWC (20 and 80 ton ha^{-1}) improved the phytoavailability of Fe and Mn in calcareous soils, enhancing micronutrient accessibility.

In relation to N dynamics and nutrient release patterns, Wolkowski (2003) highlighted that 6 ~ 17% of the N in mature MSWC became bioavailable within the first year of application. This gradual and consistent release of nutrients reduced the risk of NO_3^- leaching, thus mitigating adverse environmental impacts. These findings are supported by the positive linear relationship between application rates and total N availability reported by Moraes et al. (2014), reinforcing the role of MSWC in enhancing long-term nutrient supply. Jorge-Mardomingo et al. (2015) similarly noted that MSWC, when compared to other organic amendments, provided a more stable N release pattern under Mediterranean pedoclimatic conditions, reducing the risk of groundwater contamination. Rupasinghe and Leelamanie (2020) further emphasized the importance of site-specific MSWC application, noting that while it improved nutrient status, it also increased soil pH and EC.

3.10 Soil Fertility: Three Year Experiments

The following section presents evidence from the subset of 12 articles out of 19 with three-year experiments (Table 1) that specifically investigated soil fertility.

From a physical point of view, Meena et al. (2022) observed that MSWC applications in saline soils enhanced TOC, aggregate stability, water retention capacity, and pore size distribution, leading to a marked reduction (−75%) in soil salinity. Bona et al. (2022), in a study on intensive apple orchards, observed that MSWC improved the physical structure of soils by increasing porosity and reducing compaction in the surface layers, especially under reduced tillage. Similarly, Zając and Skrajna (2024) demonstrated that MSWC application in marginal soils cultivated with Chinese silver grass significantly improved soil structure and moisture retention, supporting plant development in nutrient-poor environments; these effects are likely context-dependent and may reflect a synergistic interaction between compost inputs and crop traits (e.g., rooting architecture, residue inputs), rather than MSWC alone.

From a chemical perspective, numerous studies highlight MSWC ability to enrich SOM and nutrient content. Golabi et al. (2021) observed that MSWC-treated plots in Guam had significantly higher SOM than those treated with mineral fertilizers. Likewise, Montemurro et al. (2006) found that three consecutive years of MSWC application significantly increased TOC in both alfalfa and cocksfoot plots. The study also observed that MSWC increased the C and N soil content, contributing to enhanced fertility. Similarly, Salis et al. (2024) reported that MSWC enhanced several critical soil properties, including TOC, total N, available P, exchangeable K, and Mg. However, they also noted that MSWC increased the percentage of exchangeable Na and EC, highlighting the importance of potential trade-offs when using compost as a soil amendment. In the corn system, Moretti et al. (2020) reported that although the total N and Mineral-Associated Organic Matter (MAOM) did not vary significantly over the three-year period, MSWC application led to a consistent increase in more labile organic fractions (free Particulate Organic Matter, fPOM, and occluded particulate Organic matter, oPOM) in the topsoil, indicating a gradual improvement in nutrient dynamics and SOM cycling. Further evidence comes from Leogrande et al. (2014), who observed increases in TOC and in humic and fulvic acid fractions after three years of MSWC use, indicating enhanced SOM quality and stability. Similarly, Zaccardelli et al. (2021) documented cumulative changes in most soil chemical parameters in horticultural systems following three consecutive years of MSWC application, with the exception of P and B, which remained stable. Alashty et al. (2011) found that applying MSWC (40 t ha^{-1}) lowered soil pH while increasing TOC and EC. Sánchez-Monedero et al. (2019), analyzing multiple systems including vineyards, arable crops, and greenhouses, reported that MSWC application increased TOC and nutrient availability (especially K, N, and extractable OC), while slightly rising pH in acidic soils and stimulating soil microbial activity. In line with these findings, Bona et al. (2022) noted significant increases in soil total N and SOM with MSWC use (20 ton ha^{-1}) in apple orchards, with effects becoming more pronounced over time.

The improvement of soil's biological properties and functionality was evident across several cropping systems. Sánchez-Monedero et al. (2019) observed that MSWC-treated soils showed enhanced microbial respiration, an increase of denitrification, and improved nutrient cycling, suggesting a more active microbial community with higher capacity to transform and recycle nutrients, thereby supporting soil fertility functions. These results were especially pronounced in tomatoes under greenhouse and in vineyards, where MSWC also contributed to maintain microbial biodiversity. Similarly, in the corn cultivation studied by Moretti et al. (2020), MSWC application helped to mitigate N_2O emissions compared to conventional mineral fertilization, pointing to a better ecological performance of the soil.

3.11 Soil fertility: more than three year experiments

The following section presents evidence from the subset of 12 articles out of 13 with three-year experiments (Table 1) that specifically investigated soil fertility.

Improvements in soil structure and water retention have been observed in response to increased SOM. For instance, Guerini et al. (2006) reported a 30% increase in SOM after five years of continuous MSWC applications (30 t ha^{-1} each year), which was accompanied by better soil structure and enhanced water-holding capacity. In vineyard systems, Pinamonti (1998) similarly observed that MSWC mulch increased soil porosity and water retention capacity, contributing to improved physical conditions in the root zone. In arable cropping systems, long-term applications of MSWC (7.1 ton ha^{-1}) significantly enhanced soil physical properties as well. Hemmat et al. (2010) found that compost-amended soils doubled their TOC, which was associated with reduced bulk density and improved consistency limits-key indicators like shrinkage limit (%), plastic limit (%) and friability index (%). Peltre et al. (2015) confirmed changes in physical structure led to practical agronomical benefits, such as reduced draught force during tillage and lower tractor fuel consumption, thus improving soil manageability.

As for chemical fertility, several studies emphasize the MSWC role in increasing TOC and total N levels. In arable systems, Leogrande et al. (2016b) found a significant increase (+25%) in the soil's TOC after MSWC application (50 ton ha^{-1}), while Montemurro et al. (2010) found that MSWC amendments contemporarily boosted soil total N, TOC, extractable OC, and humified carbon fractions, compared to the initial conditions and to the application of mineral fertilizer. Gómez-Muñoz et al. (2017) supported these findings, showing that MSWC repeated applications for eleven years (20.7 ton ha^{-1}) significantly improved soil total N and total C compared to mineral fertilization. Compost also enhanced nutrient availability, as evidenced by higher concentrations of available N, P, and K, along with increased soil pH and CEC (Guerini et al. 2006). In horticultural systems, Morra et al. (2010) noted similar chemical improvements with increasing compost application rates (from 15 to 45 ton ha^{-1}), though they also found that the efficiency of TOC conversion into stable soil pools peaked at 30 t ha^{-1} (36% efficiency) and declined at higher MSWC doses, suggesting a threshold beyond which those benefits diminish. In vineyard systems, Pinamonti (1998) found that MSWC mulch increased SOM, available P, and exchangeable K, confirming its role as an effective substitute for mineral fertilizers. Abbey et al. (2021b) showed that MSWC significantly improved soil fertility when compared to untreated plots. Their study noted that MSWC-amended soils exhibited higher levels of SOM, macro and micronutrients, and CEC.

Finally, improvements in biological fertility and soil functionality were also evident. Morra et al. (2010) explored the dynamics of C stabilization, indicating that organic inputs fostered more favorable C balances in the soil. Similarly, Hemmat et al. (2010) highlighted how increased TOC under MSWC treatments supported better physical conditions for root growth, indirectly enhancing microbial activity and nutrient cycling. No adverse effects on biological fertility were reported following MSWC application in the reviewed literature. However, this may also be a consequence of the limited number of studies specifically addressing this aspect.

4 Discussion

The aim of this review was to evaluate the scientific literature on the application of MSWC in agriculture, focusing on its impact on crop productivity and soil fertility, and to discuss its implications for sustainable waste recycling strategies.

To orient the reader, the principal results are synthesized in the summary figures: a dose-response map of average yield versus MSWC dose across cropping systems (Fig. 5) and a trade-off schematic of benefits, risks, and research needs (Fig. 6). Together, these visuals summarize the evidence base on crop productivity and soil fertility and frame the discussion that follows.

The response to MSWC application is influenced by several interacting factors, yet some facts emerge clearly across the literature. One of the most frequent and indisputable findings concerns the effectiveness of MSWC when applied at high rates. Across studies, grain yield increases, reported as percentage changes relative to unamended controls, reached up to 87%, when MSWC was applied at rates as high as 80 t ha^{-1} (e.g., Lakhdar et al. 2009, 2010a; Martinez et al. 2021). Similarly, in studies on horticultural crops, high doses of MSWC (up to 134 t ha^{-1}) produced better yields (up to 28%). The highest average application rates were recorded in arable cropping systems (100.8 t ha^{-1}), followed by horticultural crops (75 t ha^{-1}) and orchard systems (58.7 t ha^{-1}). This gradient in applied doses is mirrored by the corresponding average increase in yields, with arable crops showing the greatest improvements (+63.3%), followed by horticultural crops (+37.3%) and orchards (+23%). The positive effect of MSWC application on crop productivity and soil fertility is more pronounced in pot experiments. This enhanced response can be largely attributed to the higher MSWC application rates typically used in such experiments, where, due to logistical simplicity and ease of handling, doses range from a minimum of 3.9 ton ha^{-1} to a maximum of 875 ton ha^{-1} and are on average 116.1% higher than those applied in field experiments. As a result, pot studies report significantly greater yield increases (+63.3%) and +248.1% in SOM content when field conditions were able to reach + 2.47% only. The interpretation of results from pot

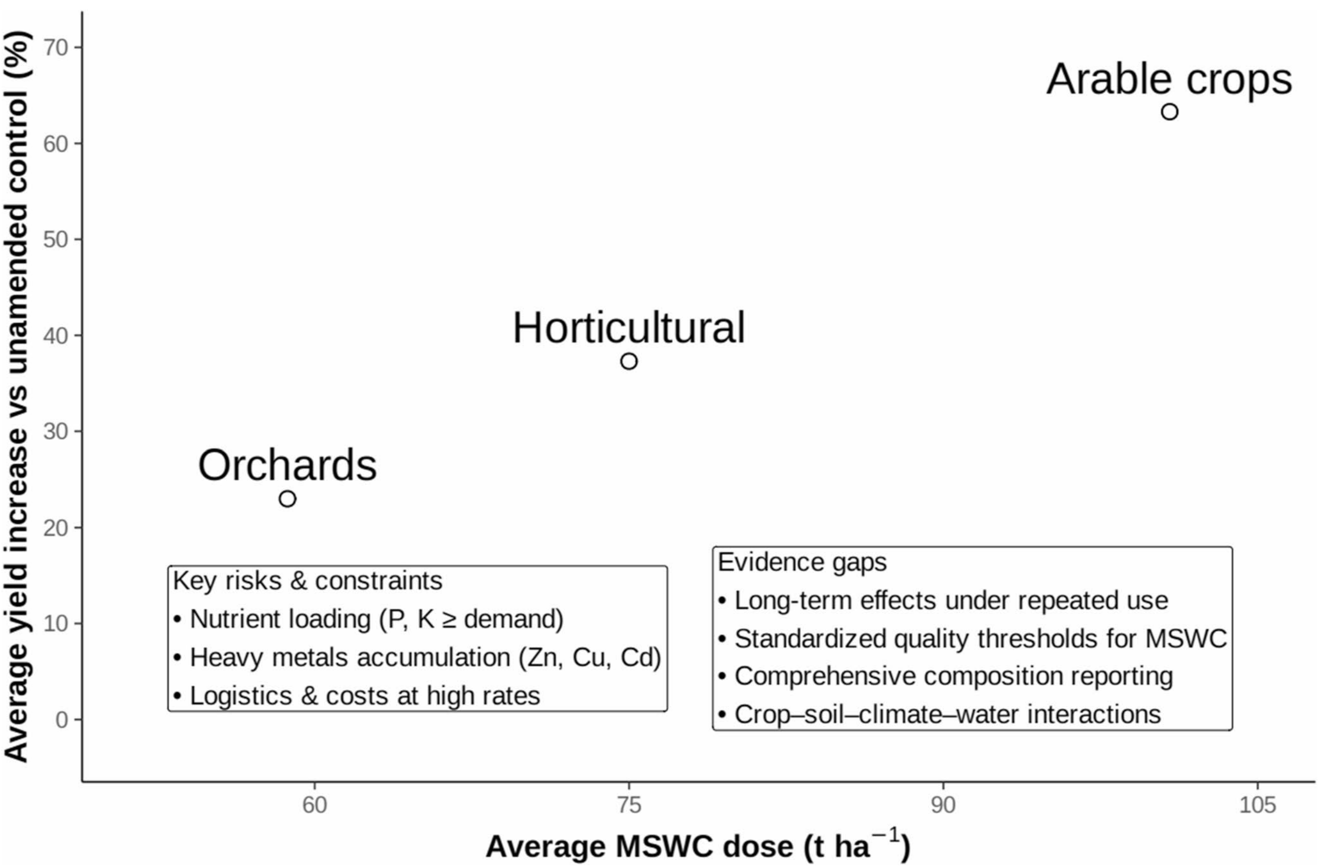

Fig. 5 Average crop yield increase as a function of MSWC dose (t ha^{-1}, dry matter basis) across arable, horticultural, and orchard systems. Values represent mean responses relative to unamended controls. Callout boxes summarize key risks and constraints (e.g., nutrient loading when P and K exceed crop demand; heavy-metal accumulation; logistics at high rates) and evidence gaps (e.g., long-term cumulative effects, standardized quality thresholds, incomplete composition reporting, crop–soil–climate–water interactions). Abbreviation: MSWC = municipal solid waste compost

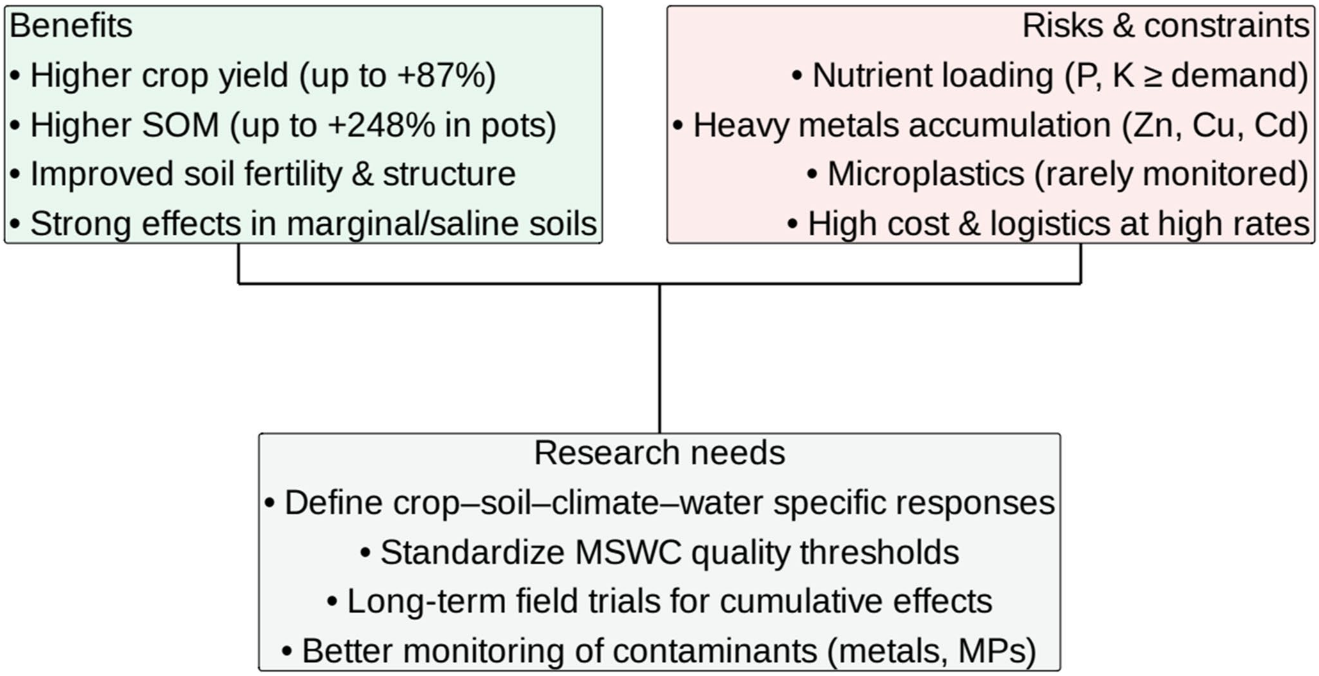

Fig. 6 Conceptual summary of the trade-offs associated with MSWC application. Benefits include increased crop yield (up to +87%), higher soil organic matter (SOM; up to +248% in pot trials), improved soil fertility and structure, and positive effects in marginal or saline soils. Risks and constraints include nutrient loading (P and K exceeding crop demand), heavy-metal accumulation (Zn, Cu, Cd), microplastics (rarely monitored), and high costs/logistics at large application rates. Research needs emphasize crop–soil–climate–water specific responses, standardized MSWC quality thresholds, long-term field trials, and improved monitoring of contaminants. Abbreviations: MSWC = municipal solid-waste compost; SOM = soil organic matter; MPs = microplastics

experiments must be approached with caution. These trials often involve unrealistically high application rates and controlled conditions that may not be representative of field realities. In their review Diacono and Montemurro (2010) also emphasized that the best agronomic performances of MSWC are generally achieved with high application rates and frequencies.

Beside the undisputable results for high doses reported above, it can also be reasonably assumed that MSWC positive effects are strongly influenced by pedoclimatic conditions. In adverse soils such as saline-sodic or marginal environments MSWC has demonstrated a remarkable efficacy in enhancing both crop yields and overall soil health. For example, Zaman et al. (2020) found that MSWC not only increased yields (+69.7%) of rice and common wheat grown in saline-sodic soils, but also improved soil properties by reducing EC down to −38.8% and increasing SOM up to 45%. Similarly, notable benefits have been observed in semiarid shrublands and marginal soils, where MSWC application led to increased biomass production and denser/thicker plant cover, confirming the positive role of MSWC in environments with low natural fertility and limited water availability (Cuevas et al. 2000; Zając and Skrajna 2024). Under water shortage, the reviewed evidence suggests that MSWC can improve soil water storage, which may increase resilience to drought and heat, particularly when applied as mulch in perennial systems (Zgallai et al. 2024; Taheri et al. 2020; Blanco et al. 2024). However, improved soil water retention does not necessarily translate into yield gains when crop phenology and nutrient supply are limiting; for instance, under deficit irrigation tobacco yields decreased despite improved water-holding capacity and NUE, indicating that crop-specific sensitivity can override soil-level benefits (Sifola et al. 2025). These findings suggest that MSWC application strategies should be tailored to the local environmental context to optimize agronomic outcomes (Meena et al. 2022; Mbarki et al. 2022). The reliance on high MSWC application rates presents also several concerns. The distribution of large quantities of compost may not be feasible or cost-effective, particularly for farmers in regions with limited compost availability or high transportation costs. From a nutrient-loading perspective, across reviewed field studies, MSWC supplied on average 485 kg N, 140 kg P, and 218 kg K ha^{-1} yr^{-1} (total basis; Tab. S2). Assuming conservative first-year availability (N 10–20%, P 50%, K 80%), this corresponds to ~50–100 kg N, ~70 kg P (~160 kg P_2O_5), and ~175 kg K (~210 kg K_2O) ha^{-1} yr^{-1}. While N availability from MSWC typically does not exceed crop N demand, P and K inputs frequently meet or exceed typical requirements-especially in arable and perennial systems-indicating a risk of P accumulation and K-related cation imbalances under repeated high rates.

Those elevated application rates could also favour the accumulation of heavy metals in soils, further emphasizing a rigorous selection in waste collection and composting procedures to ensure high quality MSWC. Elements, such as Zn, Cu, and Cd, present in MSWC can pose serious threats to soil health and food safety. As reported by Abbey et al. (2021a), MSWC application led to significant increases in soil concentrations of these metals. Metal accumulation can occur even at moderate rates, leading to increased salinity and potential toxicity (Mbarki et al. 2008; Bhardwaj et al. 2023). Additionally, even when total heavy metal content remains below legal limits, repeated applications may lead to long-term build-up in soils. However, limited research has thoroughly investigated the extent of heavy metal contamination in compost or its long-term consequences on soil ecosystems and crop health (Alashty et al. 2011).

Although the facts described so far are well established, some aspects have not yet been fully clarified. The agronomic response to MSWC is context-dependent, arising from interactions among application rate, MSWC type/composition, baseline soil properties (e.g., texture, salinity, fertility), climate/season, and water management, in addition to crop identity (Shiralipour et al. 1992; Horrocks et al. 2014; Jodar et al. 2017). Soil texture emerges as a key moderator of MSWC performance: in sandy soils, benefits in SOM and water retention may be counterbalanced by higher risks of nutrient leaching and salinity/EC build-up at increasing rates, with yield declines reported at higher doses in some cases (Mbarki et al. 2008; Bhardwaj et al. 2023). In loamy/clayey soils, yield responses and fertility improvements appear more stable at comparable rates, likely due to higher buffering and retention capacity, suggesting that sandy soils require more conservative dosing and closer EC monitoring (Mbarki et al. 2008). While numerous studies have demonstrated the MSWC potential to boost crop productivity, these impacts are not consistently observed across all crop types and pedoclimatic settings. Cereal crops, such as corn and common wheat, have exhibited notable yield increases under MSWC treatment, with improvements reaching up to 85% (Prabpai et al. 2009; Zaman et al. 2020). Other cereals, like triticale, did not show significant yield benefits under MSWC application, highlighting that not all crops respond positively to it (Kchaou et al. 2018). Additionally, in the context of tobacco grown under deficit irrigation, yield reductions were observed despite improvements in soil water retention and NUE, suggesting that physiological crop responses may override soil-related benefits (Sifola et al. 2025). Temporal dynamics are also critical. For instance, comparing short-term and two-year studies on lettuce (e.g., Leogrande et al. 2013 vs. Testani et al. 2020) reveals that the residual effect in the second year is often crucial for stabilizing yields, suggesting that single-year trials may underestimate the MSW compost's value as a soil builder. Crop-specific responses were also reported over a decade ago by Diacono and Montemurro (2010). Overall, this variability argues for tailoring MSWC management to the crop–soil–climate–water context; although spring–summer horticultural species often show larger responses under comparable rates and materials (Zaccardelli et al. 2021), attributing differences to crop type alone is unwarranted without meta-analytic separation of effects.

The variability in MSWC composition remains quite uncertain in the reviewed literature and is an issue that still shows gaps. The physical, chemical and biological composition of MSWC is highly variable due to the diverse nature of the waste streams from which it is derived. This variability can influence the concentrations of both beneficial nutrients and harmful contaminants, including heavy metals and microplastics (MPs) (Vithanage et al. 2021). The nutrient and contaminant profile of the MSWC may differ significantly depending on where, when and how the raw materials were collected and processed. Such variability complicates the ability to reliably predict the agronomic benefits of compost and to accurately assess its environmental safety (Miyamoto et al. 2023). Consistently with this, across the studies reporting composition (Table S1), pH ranged from 6.3 to 9.5 (mean 7.8), EC from 0.4 to 23.2 dS m^{-1} (mean 6.6), total C from 8.7% to 89.3% d.m. (mean 23.3%), and total N from 0.51% to 4.97% d.m. (mean 1.7%). From a practical agronomic standpoint, MSWC-driven pH shifts imply more than a generic improvement: in acidic soils, a moderate pH increase can alleviate Al or Mn stress and enhance nutrient balance, whereas in neutral, alkaline or calcareous soils additional pH increases may reduce Fe, Mn, Zn and Cu availability, increasing the risk of micronutrient limitations in sensitive crops. Therefore, the same pH shift can be beneficial or constraining depending on baseline soil conditions, reinforcing the need for site-specific monitoring and rate adjustment (e.g., Erana et al. 2019; Martinez et al. 2022; Rupasinghe and Leelamanie 2020; Gallardo-Lara et al. 2006). Additionally, many studies do not provide a full physico-chemical characterization of the compost used, especially regarding heavy metals, pathogen load, or microplastic content. Among the 114 articles reviewed, total C was reported in 77 studies (ranging between 8.7 and 89.3% d.m.), total N in 90 (0.51–4.97%), and pH in 74 (6.3–9.5), while heavy metals were reported in 66 studies (57.4%) and only 1 study reported pathogens and 1 microplastics (see Supplementary Tables S1 - S6). This uneven coverage limits comparability and reduces reproducibility and transferability across regions and systems.

The introduction of MPs into MSWC represents the most recent critical issue. The ubiquity of MPs in urban environments can readily make their way into MSWC (Vithanage et al. 2021). While current European regulations do not explicitly address MPs in compost, the Italian legislation sets a threshold≥2 mm to exclude plastic fragments from MSWC, as defined in the Ministerial Decree of 2 February 2022 (Ministero delle Politiche Agricole Alimentari e Forestali 2022). However, this size is well above the typical dimensions of MPs, which are generally lower than 1 mm, highlighting a regulatory gap in controlling their presence. Once these MPs are incorporated into soils, they may persist for an extended period of time and potentially disrupt soil structure, water retention capabilities, and microbial community dynamics (Kumar et al. 2020; Steiner et al. 2022). The growing recognition of MPs' pollution is an emerging environmental concern, therefore the studies reviewed here do not adequately address this issue, constituting a significant gap in the current research.

In addition to the limitations of the evidence, some constraints related to the review process itself should be acknowledged. The review was restricted to peer-reviewed articles written in English and indexed in the Web of Science, which may have led to the exclusion of relevant grey literature or studies published in other languages or databases. While the use of Latent Dirichlet Allocation helped to refine the literature selection in an objective and reproducible manner, some potentially relevant studies may have been missed due to their limited representation within the extracted topics. Moreover, although each article was manually screened to ensure clarity of objectives and quantitative outcomes, the absence of a formal risk of bias assessment limits the ability to systematically evaluate methodological quality. The heterogeneity of study designs and reporting formats also prevented a quantitative meta-analysis, reducing the extent to which results can be generalized.This heterogeneity also limits robust attribution of MSWC efficacy to regions or climatic zones, because climate is often confounded with compost composition, application rate, irrigation regime, and baseline soil constraints.

Finally, this review outlines clear research priorities to improve the effective and safe use of MSWC in different farming systems. Identifying crop-specific and pedoclimatic-specific responses to MSWC is essential to optimize its use and to guide farmers toward best practices tailored to local conditions. At the same time, research should seek to define optimal trade-offs between compost application rates, agronomic efficacy, economic viability, and environmental safety. In this regard, future efforts should also focus on establishing the optimal balance between application rates, cost-effectiveness, and environmental sustainability across a wide range of agricultural systems. Particular attention should be paid to the long-term implications of MSWC use, especially in relation to heavy metal accumulation and the fate of MPs in agroecosystems, which have yet to be adequately characterized. These concerns call for standardized methodologies to monitor compost quality and for the establishment of clear safety thresholds to prevent cumulative contamination. Therefore, some standardization and rigorous quality control measures are essential to ensure that compost consistently meets agricultural and environmental standards and it does not introduce harmful substances into the soil. Lastly, long-term field studies are necessary to fully capture the dynamics of MSWC in soil systems over multiple cropping cycles, particularly its contribution to soil structure, organic matter stabilization, and sustained productivity in diverse farming systems.

5 Conclusions

The use of Municipal Solid Waste Compost (MSWC) in agriculture offers an alternative strategy to enhance crop yields and soil fertility, while contributing to waste recycling and circular economy goals. However, evidence from the literature spanning from 1985 to 2024 indicates that the effectiveness of MSWC is particularly pronounced at application rates typically higher than 50 tons ha^{-1}. Conversely, lower doses give more inconsistent results, with some studies reporting beneficial effects, while others highlighting limited or uncertain outcomes. Across studies, positive effects are most consistently observed at medium-high application rates, whereas responses at lower rates are often smaller or inconsistent; however, the economic and logistical feasibility of high-dose applications remains a concern, particularly in large-scale field settings. Crop response varies substantially across species and pedoclimatic conditions, suggesting that the benefits given by MSWC application are highly context-dependent. Therefore it is challenging to draw univocal conclusions about its performance across diverse agricultural systems. The inherent variability in the physical, chemical, and biological composition of MSWC is a critical aspect, driven by the heterogeneous nature of urban waste streams and processing practices. This variability affects both the nutrient value and the contaminant load of compost, complicating its predictable and safe integration into farming systems. Nevertheless, some findings can provide guidance to optimize its use. However, the risks associated with heavy metals and/or microplastics, suggest a future rigorous monitoring of the MSWC production process and quality control. Further efforts are required to assess and mitigate these risks, ensuring the safe and sustainable use of MSWC in agricultural systems.

Future research should prioritize long-term field trials to better understand the cumulative effects of MSWC on soil health, soil organic matter dynamics, and productivity across different cropping systems. Investigating the role of MSWC in soil C sequestration and ecosystem resilience under climate stress scenarios also represents a valuable research frontier. Ultimately, with continued innovation, regulatory development, and scientific support, MSWC can play a central role in advancing sustainable agriculture, enhancing food security, and closing nutrient cycles in line with circular economy principles.

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References

Abbey L, Ijenyo M, Spence B, Asunni AO, Ofoe R, Amo-Larbi V (2021a) Bioaccumulation of chemical elements in vegetables as influenced by application frequency of municipal solid waste compost. Can J Plant Sci 101:967–983. https://doi.org/10.1139/cjps-2020-0291

Abbey L, Ofoe R, Gunupuru LR, Ijenyo M (2021b) Variation in frequency of CQA-tested municipal solid waste compost can alter metabolites in vegetables. Food Res Int 143:110225. https://doi.org/10.1016/j.foodres.2021b.110225

Aguilar FJ, González P, Revilla J, De León JJ, Porcel O (1997) Agricultural use of municipal solid waste on tree and bush crops. J Agric Eng Res 67:73–79. https://doi.org/10.1006/jaer.1997.0149

Alashty S, Bahmanyar M, Sepanlou M (2011) Change of pH, organic carbon (OC), electrical conductivity (EC), nickel (Ni) and chrome (Cr) in soil and concentration of Ni and Cr in radish and lettuce plants as influenced by three year application of municipal compost. Afr J Agric Res 6:3740–3746. https://doi.org/10.5897/AJAR10.813

Babu R, Prieto Veramendi PM, Rene ER (2021) Strategies for resource recovery from the organic fraction of municipal solid waste. Case Studies in Chemical and Environmental Engineering 3:100098. https://doi.org/10.1016/j.cscee.2021.100098

Baldi E, Toselli M, Marcolini G, Quartieri M, Cirillo E, Innocenti A, Marangoni B (2010) Compost can successfully replace mineral fertilizers in the nutrient management of commercial peach orchard. Soil Use Manag 26:346–353. https://doi.org/10.1111/j.1475-2743.2010.00286.x

Baldi E, Polidori G, Germani M, Larocca GN, Mazzon M, Allegro G, Pastore C, Quartieri M, Marzadori C, Filippetti I, Ciavatta C, Toselli M (2022) Fertilizer potential of organic-based soil amendments on cv. Sangiovese (*V. vinifera* L.) vines: preliminary results. Agronomy 12:1604. https://doi.org/10.3390/agronomy12071604

Barles S (2014) History of Waste Management and the Social and Cultural Representations of Waste. In: Agnoletti M, Neri Serneri S (eds) The Basic Environmental History. Springer International Publishing, Cham, pp 199–226

Basso-Figuera C, Schaffer B, Crane JH, Colls AM, Bryan HH (1995) Mineral nutrient content, growth, and yield of papaya (*Carica papaya* L.) as influenced by trench depth and municipal solid waste compost. Trop Agric 72:231–235

Belén Almendro-Candel M, Navarro-Pedreño J, Gómez Lucas I, Zorpas A, Voukkali A, Loizia I (2019) P The Use of Composted Municipal Solid Waste under the Concept of Circular Economy and as a Source of Plant Nutrients and Pollutants. In: El-Din Mostafa Saleh H (ed) Municipal Solid Waste Management. IntechOpen

Bhardwaj P, Sharma RK, Chauhan A, Ranjan A, Rajput VD, Minkina T, Mandzhieva SS, Mina U, Wadhwa S, Bobde P, Tripathi A (2023) Assessment of heavy metal distribution and health risk of vegetable crops grown on soils amended with municipal solid waste compost for sustainable urban agriculture. Water 15:228. https://doi.org/10.3390/w15020228

Blanco I, Cardinale M, Domanda C, Pappaccogli G, Romano P, Zorzi G, Rustioni L (2024) Mulching with municipal solid waste (MSW) compost has beneficial side effects on vineyard soil compared to mulching with synthetic films. Horticulturae 10:769. https://doi.org/10.3390/horticulturae10070769

Bona D, Cristoforetti A, Zanzotti R, Bertoldi D, Dellai N, Silvestri S (2022) Matured manure and compost from the organic fraction of solid waste digestate application in intensive apple orchards. Int J Environ Res Public Health 19:15512. https://doi.org/10.3390/ijerph192315512

Cao X, Williams PN, Zhan Y, Coughlin SA, McGrath JW, Chin JP, Xu Y (2023) Municipal solid waste compost: global trends and biogeochemical cycling. Soil & Environmental Health 1:100038. https://doi.org/10.1016/j.seh.2023.100038

Castaldi S, Bertolini T, Vannini A, Marinari S, Chilosi G (2023) Effect of compost derived from urban waste on chard (*Beta vulgaris* L., var cycla) yield and soil GHG fluxes in a Mediterranean agricultural system. Atmosphere 14:246. https://doi.org/10.3390/atmos14020246

Cercioglu M (2019) Compost effects on soil nutritional quality and pepper (*Capsicum annuum* L.) yield. Tarim Bilim Derg 25:155–162. https://doi.org/10.15832/ankutbd.396547

Chen D-C, Bodirsky BL, Krueger T, Mishra A, Popp A (2020) The world's growing municipal solid waste: trends and impacts. Environ Res Lett 15:074021. https://doi.org/10.1088/1748-9326/ab8659

Clark GA, Stanley CD, Maynard DN (2000) Municipal solid waste compost (MSWC) as a soil amendment in irrigated vegetable production. Trans ASAE 43:847–853. https://doi.org/10.13031/2013.2979

Coria-Cayupán YS, Sánchez de Pinto MI, Nazareno MA (2009) Variations in bioactive substance contents and crop yields of lettuce (*Lactuca sativa* L.) cultivated in soils with different fertilization treatments. J Agric Food Chem 57:10122–10129. https://doi.org/10.1021/jf903019d

Cuevas G, Blázquez R, Martinez F, Walter I (2000) Composted MSW effects on soil properties and native vegetation in a degraded semiarid shrubland. Compost Sci Util 8:303–309. https://doi.org/10.1080/1065657X.2000.10702003

De Nobile FO, Calero Hurtado A, Prado RDM, De Souza HA, Anunciação MG, Palaretti LF, Dezem LASN (2021) A novel technology for processing urban waste compost as a fast-releasing nitrogen source to improve soil properties and broccoli and lettuce production. Waste Biomass Valorization 12:6191–6203. https://doi.org/10.1007/s12649-021-01415-z

De Varennes A, Abreu MM, Qu G, Cunha-Queda C (2010) Enzymatic activity of a mine soil varies according to vegetation cover and level of compost applied. Int J Phytoremediation 12:371–383. https://doi.org/10.1080/15226510903051757

Diacono M, Montemurro F (2010) Long-term effects of organic amendments on soil fertility. A review. Agron Sustain Dev 30:401–422. https://doi.org/10.1051/agro/2009040

Elbl J, Maková J, Javoreková S, Medo J, Kintl A, Lošák T, Lukas V (2019) Response of microbial activities in soil to various organic and mineral amendments as an indicator of soil quality. Agronomy 9:485. https://doi.org/10.3390/agronomy9090485

Erana FG, Tenkegna TA, Asfaw SL (2019) Effect of agro industrial wastes compost on soil health and onion yields improvements: study at field condition. Int J Recycl Org Waste Agric 8:161–171. https://doi.org/10.1007/s40093-019-0286-2

Fagnano M, Adamo P, Zampella M, Fiorentino N (2011) Environmental and agronomic impact of fertilization with composted organic fraction from municipal solid waste: A case study in the region of Naples, Italy. Agric Ecosyst Environ 141:100–107. https://doi.org/10.1016/j.agee.2011.02.019

FAO (2018) The 10 elements of agroecology: Guiding the transition to sustainable food and agricultural systems. FAO, Rome, Italy

Farneselli M, Pannacci E, Tei F (2022) Does the timing of short-term biowaste compost application affect crop growth and potential nitrate leaching? The case studies of processing tomato and cauliflower under field conditions. Ital J Agron 17:2045. https://doi.org/10.4081/ija.2022.2045

Feller C, Blanchart E, Bernoux M, Lal R, Manlay R (2012) Soil fertility concepts over the past two centuries: the importance attributed to soil organic matter in developed and developing countries. Arch Agron Soil Sci 58:S3–S21. https://doi.org/10.1080/03650340.2012.693598

Fellows I, Fellows MI, Rcpp L, Rcpp L (2018) Package 'wordcloud.' R Package Version 2:331

Gadaleta A, Lacolla G, Giove SL, Fortunato S, Nigro D, Mastro MA, De Corato U, Caranfa D, Cucci G, De Pinto MC, Vita F (2022) Durum wheat response to organic and mineral fertilization with application of different levels and types of phosphorus-based fertilizers. Agron 12:1861. https://doi.org/10.3390/agronomy12081861

Gallardo-Lara F, Azcón M, Polo A (2006) Phytoavailability and fractions of iron and manganese in calcareous soil amended with composted urban wastes. J Environ Sci Health B 41:1187–1201. https://doi.org/10.1080/03601230600856991

Garrett RD, Ryschawy J, Bell LW, Cortner O, Ferreira J, Garik AVN, Gil JDB, Klerkx L, Moraine M, Peterson CA, Dos Reis JC, Valentim JF (2020) Drivers of decoupling and recoupling of crop and livestock systems at farm and territorial scales. Ecol Soc 25:art24. https://doi.org/10.5751/ES-11412-250124

Golabi MH, Galsim FP, Endale D, Tareyama SA, Iyekar C (2021) Agronomic value of composted organic waste application on porous soils of northern Guam. Malays J Soil Sci 25:143–160

Gómez-Muñoz B, Magid J, Jensen LS (2017) Nitrogen turnover, crop use efficiency and soil fertility in a long-term field experiment amended with different qualities of urban and agricultural waste. Agric Ecosyst Environ 240:300–313. https://doi.org/10.1016/j.agee.2017.01.030

Grün B, Hornik K (2011) topicmodels: an R package for fitting topic models. J Stat Softw 40:1–30. https://doi.org/10.18637/jss.v040.i13

Guerini G, Maffeis P, Allievi L, Gigliotti C (2006) Integrated waste management in a zone of northern Italy: compost production and use, and analytical control of compost, soil, and crop. J Environ Sci Health B 41:1203–1219. https://doi.org/10.1080/03601230600857031

Güldner D, Krausmann F (2017) Nutrient recycling and soil fertility management in the course of the industrial transition of traditional, organic agriculture: the case of Bruck estate, 1787–1906. Agric Ecosyst Environ 249:80–90. https://doi.org/10.1016/j.agee.2017.07.038

Hargreaves JC, Adl MS, Warman PR (2008) A review of the use of composted municipal solid waste in agriculture. Agric Ecosyst Environ 123:1–14. https://doi.org/10.1016/j.agee.2007.07.004

Hemmat A, Aghilinategh N, Rezainejad Y, Sadeghi M (2010) Long-term impacts of municipal solid waste compost, sewage sludge and farmyard manure application on organic carbon, bulk density and consistency limits of a calcareous soil in central Iran. Soil Tillage Res 108:43–50. https://doi.org/10.1016/j.still.2010.03.007

Hodson AK, Sayre JM, Lyra MCCP, Rodrigues JLM (2021) Influence of recycled waste compost on soil food webs, nutrient cycling and tree growth in a young almond orchard. Agronomy 11:1745. https://doi.org/10.3390/agronomy11091745

Horrocks A, Tregurtha C, Meenken E, Maley S, Beare M (2014) Potential for municipal compost to reduce inorganic fertiliser use in crop production systems. Acta Hortic 315–323. https://doi.org/10.17660/ActaHortic.2014.1018.33

Hossain S, Al-Solaimani SGM, Alghabari F, Shahzad K, Rashid MI (2024) Enhancing maize yield through sustainable and eco-friendly practices: the impact of municipal organic waste compost and soil amendments. Cogent Food & Agriculture 10:2307119. https://doi.org/10.1080/23311932.2024.2307119

International Solid Waste Association (2024) Global Waste Management Outlook 2024 - Beyond an age of waste: Turning rubbish into a resource. https://doi.org/10.59117/20.500.11822/44939

Jelodar H, Wang Y, Yuan C, Feng X, Jiang X, Li Y, Zhao L (2019) Latent Dirichlet Allocation (LDA) and topic modeling: models, applications, a survey. Multimed Tools Appl 78:15169–15211. https://doi.org/10.1007/s11042-018-6894-4

Jodar JR, Ramos N, Carreira JA, Pacheco R, Fernández-Hernández A (2017) Quality assessment of compost prepared with municipal solid waste. Open Eng 7:221–227. https://doi.org/10.1515/eng-2017-0028

Jorge-Mardomingo I, Soler-Rovira P, Casermeiro MÁ, De La Cruz MT, Polo A (2013) Seasonal changes in microbial activity in a semiarid soil after application of a high dose of different organic amendments. Geoderma 206:40–48. https://doi.org/10.1016/j.geoderma.2013.04.025

Jorge-Mardomingo I, Jiménez-Hernández ME, Moreno L, De La Losa A, De La Cruz MT, Casermeiro MÁ (2015) Application of high doses of organic amendments in a Mediterranean agricultural soil: an approach for assessing the risk of groundwater contamination. CATENA 131:74–83. https://doi.org/10.1016/j.catena.2015.03.013

Kasthuri H, Shanthi K, Sivakumar S, Rajakumar S, Son H, Song Y (2011) Influence of municipal solid waste compost (MSWC) on the growth and yield of green gram (*Vigna radiate* (L) Wilczek), fenugreek (*Trigonella foenum-graecum* L.) and on soil quality. J Environ Health Sci Eng 8:280–285

Kchaou R, Baccar R, Bouzid J, Rejeb S (2018) The impact of sewage sludge and compost on winter triticale. Environ Sci Pollut Res 25:18314–18319. https://doi.org/10.1007/s11356-017-0609-7

Kumar M, Xiong X, He M, Tsang DCW, Gupta J, Khan E, Harrad S, Hou D, Ok YS, Bolan NS (2020) Microplastics as pollutants in agricultural soils. Environ Pollut 265:114980. https://doi.org/10.1016/j.envpol.2020.114980

Lakhdar A, Achiba WB, Montemurro F, Jedidi N, Abdelly C (2009) Effect of municipal solid waste compost and farmyard manure application on heavy-metal uptake in wheat. Commun Soil Sci Plant Anal 40:3524–3538. https://doi.org/10.1080/00103620903326040

Lakhdar A, Iannelli MA, Debez A, Massacci A, Jedidi N, Abdelly C (2010a) Effect of municipal solid waste compost and sewage sludge use on wheat (*Triticum durum*): growth, heavy metal accumulation, and antioxidant activity. J Sci Food Agric 90:965–971. https://doi.org/10.1002/jsfa.3904

Lakhdar A, Scelza R, Scotti R, Rao MA, Jedidi N, Gianfreda L, Abdelly C (2010b) The effect of compost and sewage sludge on soil biologic activities in salt affected soil. Rev Cienc Suelo Nutr Veg 10. https://doi.org/10.4067/S0718-27912010000100005

Lakhdar A, Hafsi C, Debez A, Montemurro F, Jedidi N, Abdelly C (2011) Assessing solid waste compost application as a practical approach for salt-affected soil reclamation. Acta Agriculturae Scandinavica, Section B — Soil & Plant Science 61:284–288. https://doi.org/10.1080/09064710.2010.485738

Leogrande R, Lopedota O, Fiore A, Vitti C, Ventrella D, Montemurro F (2013) Previous crops and organic fertilizers in lettuce: effects on yields and soil properties. J Plant Nutr 36:1945–1962. https://doi.org/10.1080/01904167.2012.754042

Leogrande R, Lopedota O, Vitti C, Ventrella D, Montemurro F (2014) Effects of irrigation volumes and organic fertilizers on eggplant grown in Mediterranean environment. Acta Agric Scand Sect B — Soil Plant Sci 64:518–528. https://doi.org/10.1080/09064710.2014.927526

Leogrande R, Lopedota O, Vitti C, Ventrella D, Montemurro F (2016a) Saline water and municipal solid waste compost application on tomato crop: effects on plant and soil. J Plant Nutr 39:491–501. https://doi.org/10.1080/01904167.2015.1084325

Leogrande R, Vitti C, Lopedota O, Ventrella D, Montemurro F (2016b) Saline water and MSW compost: effects on yield of maize crop and soil responses. J Plant Nutr 39:1863–1873. https://doi.org/10.1080/01904167.2016b.1187744

Lou XF, Nair J (2009) The impact of landfilling and composting on greenhouse gas emissions – a review. Bioresour Technol 100:3792–3798. https://doi.org/10.1016/j.biortech.2008.12.006

Manea E, Bumbac C, Dinu LR, Bumbac M, Nicolescu CM (2024) Composting as a sustainable solution for organic solid waste management: current practices and potential improvements. Sustainability 16:6329. https://doi.org/10.3390/su16156329

Manlay RJ, Feller C, Swift MJ (2007) Historical evolution of soil organic matter concepts and their relationships with the fertility and sustainability of cropping systems. Agric Ecosyst Environ 119:217–233. https://doi.org/10.1016/j.agee.2006.07.011

Martinez S, Sánchez-Moreno S, Gabriel JL, Álvarez C, Delgado MDM (2021) Valorization of a bio-stabilized municipal solid waste amendment for faba bean (*Vicia faba* L.) fertilization. Agriculture 11:1109. https://doi.org/10.3390/agriculture11111109

Martinez S, Gabriel J, Allende-Montalbán R, San-Juan-Heras R, Delgado M (2022) The application of a bio-stabilized municipal solid waste-based fertilizer for buckwheat production. Agriculture 12:776. https://doi.org/10.3390/agriculture12060776

Martínez-Blanco J, Lazcano C, Christensen TH, Muñoz P, Rieradevall J, Møller J, Antón A, Boldrin A (2013) Compost benefits for agriculture evaluated by life cycle assessment. A review. Agron Sustain Dev 33:721–732. https://doi.org/10.1007/s13593-013-0148-7

Mbarki S, Labidi N, Mahmoudi H, Jedidi N, Abdelly C (2008) Contrasting effects of municipal compost on alfalfa growth in clay and in sandy soils: N, P, K, content and heavy metal toxicity. Bioresour Technol 99:6745–6750. https://doi.org/10.1016/j.biortech.2008.01.010

Mbarki S, Skalicky M, Talbi O, Chakraborty A, Hnilicka F, Hejnak V, Zivcak M, Brestic M, Cerda A, Abdelly C (2020) Performance of *Medicago sativa* grown in clay soil favored by compost or farmyard manure to mitigate salt stress. Agronomy 10:94. https://doi.org/10.3390/agronomy10010094

Mbarki S, Talbi O, Skalicky M, Vachova P, Hejnak V, Hnilicka F, Al-ashkar I, Abdelly C, Rahman MA, El Sabagh A, Tlustos P (2022) Comparison of grain sorghum and alfalfa for providing heavy metal remediation of sandy soil with different soil amendments and salt stress. Front Environ Sci 10:1022629. https://doi.org/10.3389/fenvs.2022.1022629

Meena MD, Narjary B, Sheoran P, Jat HS, Joshi PK, Chinchmalatpure AR (2022) Changes in physical and chemical properties of saline soil amended with municipal solid waste compost and chemical fertilizers in a mustard–pearl millet cropping system. Land Degrad Dev 33:1677–1688. https://doi.org/10.1002/ldr.4256

Mehdi SM, Sarfraz M, Ilyas M, Amjad Qureshi M, Zaka MA (2015) Integrated nutrient management using P-fixation factor in rice-wheat cropping system under salt affected conditions. Int J Agric Biol 17:643–647. https://doi.org/10.17957/IJAB/17.3.13.930

Ministero delle Politiche Agricole Alimentari e Forestali (2022) Decreto 2 febbraio 2022: Aggiornamento degli allegati 2 e 7 al decreto legislativo 29 aprile 2010, n. 75

Misra RV, Roy RN, Hiraoka H (2003) On-farm composting methods. UN-FAO, Rome, Italy

Miyamoto H, Shigeta K, Suda W, Ichihashi Y, Nihei N, Matsuura M, Tsuboi A, Tominaga N, Aono M, Sato M, Taguchi S, Nakaguma T, Tsuji N, Ishii C, Matsushita T, Shindo C, Ito T, Kato T, Kurotani A, Shima H, Moriya S, Wada S, Horiuchi S, Satoh T, Mori K, Nishiuchi T, Miyamoto H, Kodama H, Hattori M, Ohno H, Kikuchi J, Hirai MY (2023) An agroecological structure model of compost—soil—plant interactions for sustainable organic farming. ISME Commun 3:28. https://doi.org/10.1038/s43705-023-00233-9

Montemurro F (2009) Different nitrogen fertilization sources, soil tillage, and crop rotations in winter wheat: effect on yield, quality, and nitrogen utilization. J Plant Nutr 32:1–18. https://doi.org/10.1080/01904160802530979

Montemurro F, Maiorana M (2007) Nitrogen utilization, yield, quality and soil properties in a sugarbeet crop amended with municipal solid waste compost. Compost Sci Util 15:84–92. https://doi.org/10.1080/1065657X.2007.10702317

Montemurro F, Maiorana M, Convertini G, Fornaro F (2005) Improvement of soil properties and nitrogen utilisation of sunflower by amending municipal solid waste compost. Agron Sustain Dev 25:369–375. https://doi.org/10.1051/agro:2005038

Montemurro F, Maiorana M, Convertini G, Ferri D (2006) Compost organic amendments in fodder crops: effects on yield, nitrogen utilization and soil characteristics. Compost Sci Util 14:114–123. https://doi.org/10.1080/1065657X.2006.10702272

Montemurro F, Charfeddine M, Maiorana M, Convertini G (2010) Compost use in agriculture: the fate of heavy metals in soil and fodder crop plants. Compost Sci Util 18:47–54. https://doi.org/10.1080/1065657X.2010.10736933

Moraes MTD, Silva VRD, Cherubin MR, Carlesso R, Debiasi H, Levien R (2014) Changes in a rhodic hapludox under no-tillage and urban waste compost in the northwest of Rio Grande do Sul, Brazil. Rev Bras Ciênc Solo 38:1327–1336. https://doi.org/10.1590/S0100-06832014000400028

Moretti B, Bertora C, Grignani C, Lerda C, Celi L, Sacco D (2020) Conversion from mineral fertilisation to MSW compost use: nitrogen fertiliser value in continuous maize and test on crop rotation. Sci Total Environ 705:135308. https://doi.org/10.1016/j.scitotenv.2019.135308

Morra L, Pagano L, Iovieno P, Baldantoni D, Alfani A (2010) Soil and vegetable crop response to addition of different levels of municipal waste compost under Mediterranean greenhouse conditions. Agron Sustain Dev 30:701–709. https://doi.org/10.1051/agro/2009046

Mousavi SM, Bahmanyar MA, Pirdashti H, Moradi S (2017) Nutritional (Fe, Mn, Ni, and Cr) and growth responses of rice plant affected by perennial application of two bio-solids. Environ Monit Assess 189:340. https://doi.org/10.1007/s10661-017-6050-z

Mylavarapu RS, Zinati GM (2009) Improvement of soil properties using compost for optimum parsley production in sandy soils. Sci Hortic 120:426–430. https://doi.org/10.1016/j.scienta.2008.11.038

Novinscak A, Goyer C, Wilson C, Zebarth BJ, Burton DL, Chantigny MH, Filion M (2022) Seasonal changes in the abundance and activity of bacterial and fungal denitrifying communities associated with different compost amendments. Can J Microbiol 68:91–102. https://doi.org/10.1139/cjm-2021-0256

Oguntade OA, Olagbenro TS, Odusanya OA, Olagunju SO, Adewusi KM, Adegoke AT (2019) Assessment of composted kitchen waste and poultry manure amendments on growth, yield and heavy metal uptake by Jute mallow *Corchorus olitorius* Linn. Int J Recycl Org Waste Agric 8:187–195. https://doi.org/10.1007/s40093-018-0232-8

Okoli F, Chukwura E, Mbachu A (2022) Quality assessment of compost produced from agricultural wastes: Impact on the growth and yield of Zea mays L. Int J Recycl Org Waste Agric 12. https://doi.org/10.30486/ijrowa.2022.1954860.1430

Ouni Y, Mateos-Naranjo E, Lakhdar A, Andrades-Moreno L, Abdelly C, Barhoumi Z (2014) Municipal solid waste compost application improves the negative impact of saline soil in two forage species. Commun Soil Sci Plant Anal 45:1421–1434. https://doi.org/10.1080/00103624.2013.875209

Ozdemir S (2005) Effects of municipal solid waste(MSW) compost on nodulation, plant growth and mineral composition of chickpea in marginal land. Fresenius Environ Bull 14:599–604

Ozores-Hampton M, Bryan HH, Schaffer B, Hanlon EA (1994) Nutrient concentrations, growth, and yield of tomato and squash in municipal solid-waste-amended soil. HortScience 29:785–788. https://doi.org/10.21273/HORTSCI.29.7.785

Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, Shamseer L, Tetzlaff JM, Akl EA, Brennan SE, Chou R, Glanville J, Grimshaw JM, Hróbjartsson A, Lalu MM, Li T, Loder EW, Mayo-Wilson E, McDonald S, McGuinness LA, Stewart LA, Thomas J, Tricco AC, Welch VA, Whiting P, Moher D (2021) The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ n71. https://doi.org/10.1136/bmj.n71

Papafilippaki A, Paranychianakis N, Nikolaidis NP (2015) Effects of soil type and municipal solid waste compost as soil amendment on *Cichorium spinosum* (spiny chicory) growth. Sci Hortic 195:195–205. https://doi.org/10.1016/j.scienta.2015.09.030

Peltre C, Nyord T, Bruun S, Jensen LS, Magid J (2015) Repeated soil application of organic waste amendments reduces draught force and fuel consumption for soil tillage. Agric Ecosyst Environ 211:94–101. https://doi.org/10.1016/j.agee.2015.06.004

Pinamonti F (1998) Compost mulch effects on soil fertility, nutritional status and performance of grapevine. Nutr Cycl Agroecosystems 51:239–248. https://doi.org/10.1023/A:1009701323580

Prabpai S, Charerntanyarak L, Siri B, Moore MR, Noller BN (2009) Effects of residues from municipal solid waste landfill on corn yield and heavy metal content. Waste Manag 29:2316–2320. https://doi.org/10.1016/j.wasman.2009.02.009

Rashtbari M, Hossein Ali A, Ghorchiani M (2020) Effect of vermicompost and municipal solid waste compost on growth and yield of canola under drought stress conditions. Commun Soil Sci Plant Anal 51:2215–2222. https://doi.org/10.1080/00103624.2020.1820023

Razza F, D'Avino L, L'Abate G, Lazzeri L (2018) The role of compost in bio-waste management and circular economy. In: Benetto E, Gericke K, Guiton M (eds) Designing Sustainable Technologies, Products and Policies. Springer, Cham, pp 133–143. https://doi.org/10.1007/978-3-319-66981-6_16

Rupasinghe ISU, Leelamanie DAL (2020) Comparison of municipal and agriculture-based solid waste composts: short-term crop-yield response and soil properties in a tropical Ultisol. Biol (Bratisl) 75:809–818. https://doi.org/10.2478/s11756-020-00464-4

Salis L, Cabiddu A, Sanna F, Sitzia M, Carboni G (2024) Municipal solid waste compost use can improve crop barley production and enhance soil chemical fertility. Eur J Agron 153:127064. https://doi.org/10.1016/j.eja.2023.127064

Sánchez-Monedero MA, Cayuela ML, Sánchez-García M, Vandecasteele B, D'Hose T, López G, Martínez-Gaitán C, Kuikman PJ, Sinicco T, Mondini C (2019) Agronomic evaluation of biochar, compost and biochar-blended compost across different cropping systems: perspective from the European Project FERTIPLUS. Agron 9:225. https://doi.org/10.3390/agronomy9050225

Sayğı H (2023) Effect of municipal solid waste compost on yield, plant growth and nutrient elements in strawberry cultivation. Sustainability 15:9447. https://doi.org/10.3390/su15129447

Schulz DG, Fey R, Ruppenthal V, Malavasi MDM, Malavasi UC (2012) Initial growth of physic nut as a function of sources and doses of organic fertilizers. Cienc E Agrotecnol 36:615–623. https://doi.org/10.1590/S1413-70542012000600003

Shiralipour A, McConnell DB, Smith WH (1992) Uses and benefits of MSW compost: a review and an assessment. Biomass Bioenergy 3:267–279. https://doi.org/10.1016/0961-9534(92)90031-K

Sifola MI, Cozzolino E, Todisco D, Palladino M, Sicignano M, Del Piano L (2024) Organic fraction municipal solid waste compost and horse bean green manure improve sustainability of a top-quality tobacco cropping system: the beneficial effects on soil and plants. Sustainability 16:6466. https://doi.org/10.3390/su16156466

Sifola MI, Carrino L, Cozzolino E, Palladino M, Sicignano M, Todisco D, Del Piano L (2025) The effect of eco-friendly/sustainable agricultural practices (legume green manure and compost soil amendment) on a tobacco crop grown under deficit irrigation. Sustainability 17:769. https://doi.org/10.3390/su17020769

Silge J, Robinson D (2016) tidytext: Text Mining and Analysis Using Tidy Data Principles in R. J Open Source Softw 1:37. https://doi.org/10.21105/joss.00037

Soobhany N, Mohee R, Garg VK (2017) A comparative analysis of composts and vermicomposts derived from municipal solid waste for the growth and yield of green bean (*Phaseolus vulgaris*). Environ Sci Pollut Res 24:11228–11239. https://doi.org/10.1007/s11356-017-8774-2

Soumaré M, Tack FMG, Verloo MG (2003) Effects of a municipal solid waste compost and mineral fertilization on plant growth in two tropical agricultural soils of Mali. Bioresour Technol 86:15–20. https://doi.org/10.1016/S0960-8524(02)00133-5

Steiner T, Möller JN, Löder MGJ, Hilbrig F, Laforsch C, Freitag R (2022) Microplastic contamination of composts and liquid fertilizers from municipal biowaste treatment plants: effects of the operating conditions. Waste Biomass Valor 14:873–887. https://doi.org/10.1007/s12649-022-01870-2

Taheri Soudejani H, Shayannejad M, Kazemian H, Heidarpour M, Rutherford M (2020) Effect of co-composting municipal solid waste with Mg-modified zeolite on soil water balance components using HYDRUS-1D. Comput Electron Agric 176:105637. https://doi.org/10.1016/j.compag.2020.105637

Terrile R, Martinez N, Paz N, Brunotto F, Costa M, Budai N, Ruiz C, Rizzi M, Invernizzi M, Scarpeci T, Piacentini RD, Winter K, Tornaghi C (2024) Urban food waste for soil amendment? Analysis and characterisation of waste-based compost for soil fertility management in agroecological horticultural production systems in the city of Rosario, Argentina. Front Sustain Food Syst 8:1338451. https://doi.org/10.3389/fsufs.2024.1338451

Testani E, Montemurro F, Ciaccia C, Diacono M (2020) Agroecological practices for organic lettuce: effects on yield, nitrogen status and nitrogen utilisation efficiency. Biol Agric Hortic 36:84–95. https://doi.org/10.1080/01448765.2019.1689531

Tzortzakis N, Saridakis C, Chrysargyris A (2020) Treated wastewater and fertigation applied for greenhouse tomato cultivation grown in municipal solid waste compost and soil mixtures. Sustainability 12:4287. https://doi.org/10.3390/su12104287

Ulm F, Avelar D, Hobson P, Penha-Lopes G, Dias T, Máguas C, Cruz C (2019) Sustainable urban agriculture using compost and an open-pollinated maize variety. J Clean Prod 212:622–629. https://doi.org/10.1016/j.jclepro.2018.12.069

Valverde-Orozco E, López-Martínez A, González-Carreón R, Ramírez-Arias JA, Martínez-López Y, Chacón-Hernández JC, Rivera-Gómez R, Chávez-Díaz IF (2024) Approach to the circular economy through agro-livestock waste composting. J Clean Prod 448:141636. https://doi.org/10.1016/j.jclepro.2024.141636

Villena R, Castellanos MT, Cartagena MC, Ribas F, Arce A, Cabello MJ, Requejo MI (2018) Winery distillery waste compost effect on the performance of melon crop under field conditions. Sci Agric 75:494–503. https://doi.org/10.1590/1678-992x-2016-0507

Vithanage M, Ramanayaka S, Hasinthara S, Navaratne A (2021) Compost as a carrier for microplastics and plastic-bound toxic metals into agroecosystems. Curr Opin Environ Sci Health 24:100297. https://doi.org/10.1016/j.coesh.2021.100297

Warman PR, Burnham JC, Eaton LJ (2009) Effects of repeated applications of municipal solid waste compost and fertilizers to three lowbush blueberry fields. Sci Hortic 122:393–398. https://doi.org/10.1016/j.scienta.2009a.05.024

Warman PR, Vernon Rodd A, Hicklenton P (2011) The effect of MSW compost and fertilizer on extractable soil elements, tuber yield, and elemental concentrations in the plant tissue of potato. Potato Res 54:1–11. https://doi.org/10.1007/s11540-010-9167-9

Welbers K, Van Atteveldt W, Benoit K (2017) Text analysis in R. Communication Methods and Measures 11:245–265. https://doi.org/10.1080/19312458.2017.1387238

Wilton MJ, Karagatzides JD, Tsuji LJS (2020) Fertilizing bush beans with locally made compost in a remote subarctic community. Agrosyst Geosci Environ 3:e20109. https://doi.org/10.1002/agg2.20109

Wolkowski RP (2003) Nitrogen management considerations for landspreading municipal solid waste compost. J Environ Qual 32:1844–1850. https://doi.org/10.2134/jeq2003.1844

World Bank (2018) What a Waste 2.0: A Global Snapshot of Solid Waste Management to 2050. World Bank, Washington, DC. https://doi.org/10.1596/978-1-4648-1329-0

Zaccardelli M, Pane C, Di Mola I, Ronga D, Mori M (2021) Municipal organic waste compost replaces mineral fertilization in the horticultural cropping systems, reducing the pollution risk. Ital J Agron. https://doi.org/10.4081/ija.2021.1756

Zając M, Skrajna T (2024) Effect of composted organic waste on *Miscanthus sinensis* Andersson yield, morphological characteristics and chlorophyll fluorescence and content. Agron 14:1672. https://doi.org/10.3390/agronomy14081672

Zaman G, Murtaza B, Imran M, Shahid M, Shah GM, Amjad M, Naeem MA, Mubeen M, Murtaza G (2020) Utilization of bio-municipal solid waste improves saline-sodic soils and crop productivity in rice-wheat. Compost Sci Util 28:16–27. https://doi.org/10.1080/1065657X.2019.1709106

Zgallai H, Zoghlami RI, Annabi M, Zarrouk O, Jellali S, Hamdi H (2024) Mitigating soil water deficit using organic waste compost and commercial water retainer: a comparative study under semi-arid conditions. Euro-Mediterr J Environ Integr 9:377–391. https://doi.org/10.1007/s41207-023-00437-4