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Effect Evaluation of the Agricultural Waste on Improving Growth of Potted Sunflower (*Helianthus annuus*)

Chen Shunyi ✉, Liu Changchun
Modern Agriculture Research Center, Zhuji, 311800, China
✉ Corresponding email: ssoy1@outlook.com
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Abstract This review aims to evaluate the effect of agricultural waste on the growth of potted sunflowers. The rational utilization of agricultural waste is an important approach to address environmental issues and enhance agricultural sustainability. By comprehensively analyzing the findings and outcomes of relevant studies, this review explores the potential application value of agricultural waste in sunflower cultivation. Furthermore, it presents recommendations for further research and future prospects. These include comparing the effects of different types of agricultural waste on sunflower growth, delving into the mechanisms of agricultural waste, considering the comprehensive impact of environmental factors, and assessing the feasibility of practical applications. This study provides guidance for exploring future research directions and contributes important theoretical and practical value to promote the sustainable utilization of agricultural waste and the sustainable development of agricultural production.
Keywords Agricultural waste; Sunflower (*Helianthus annuus* L.); Nutrients; Organic matter

As the global population grows and agricultural production expands, the production of agricultural waste keeps increasing. Agricultural waste includes crop residues, livestock manure, leftover pesticides, and fertilizers, among others. Traditionally, agricultural waste has been seen as a source of environmental pollution, requiring proper treatment and management. According to statistics, China's total agricultural waste production reached 3.9 billion tons in 2019 (Li, 2023, Economic Daily, (27): 11). These wastes contain abundant organic matter and nutrients. If not effectively utilized, they not only cause resource waste but also result in varying degrees of pollution to the environment. Developing resource utilization methods for agricultural waste and achieving circular regeneration of waste in terms of materials and energy have become one of the current research hotspots (Wang et al., 2019).

Sunflower (*Helianthus annuus*) is a widely cultivated ornamental and economic crop, known for its unique morphology and versatility. Sunflower seeds are rich in protein, fats, and vitamins, making them widely used in food and feed production. In addition, sunflowers have ecological restoration potential; their root systems can improve soil structure and absorb harmful substances. However, the growth and yield of sunflowers are often limited by soil quality and nutrient supply. By studying the impact of agricultural waste on sunflower growth, we can gain a deeper understanding of the potential application value of agricultural waste while providing new insights and methods for achieving sustainable agricultural production. Agricultural waste can affect sunflower growth through various pathways, including nutrient provision, soil quality improvement, and stress alleviation. This study analyzes existing research findings to assess the impact of agricultural waste on potted sunflower growth. It explores their potential application prospects and discusses their environmental impact and management challenges (Wang et al., 2019).

The effective utilization of agricultural waste is crucial for reducing resource wastage, mitigating environmental pollution, and promoting sustainable development. However, to fully realize this potential, a comprehensive understanding of the characteristics of different types of agricultural waste and their mechanisms of influence on plant growth is required. Furthermore, the application methods and technologies for agricultural waste also need

further research and improvement to ensure their safe and effective utilization. This study focuses on discussing the potential uses and values of agricultural waste, especially in terms of plant growth and crop yield. Understanding the characteristics and applicability of different types of agricultural waste and their specific effects on sunflower growth will contribute to the targeted utilization of agricultural waste. The research will also address the application methods, quantification control, and possible technological challenges of agricultural waste to promote its sustainable utilization and the sustainable development of agricultural production.

This study aims to provide a comprehensive assessment of the impact of agricultural waste on the growth of potted sunflowers and explore its potential application prospects. This will serve as a reference and guide for the sustainable utilization of agricultural waste and the sustainable development of agricultural production. Simultaneously, the study is expected to contribute to the effective management and resource utilization of agricultural waste in practice, making a significant contribution to sustainable agriculture and environmental protection.

1 Potential Value of Agricultural Waste

1.1 Definition and types of agricultural waste

Agricultural waste encompasses a wide range of byproducts and residues generated from various agricultural activities (Obi et al., 2016). These waste materials are considered surplus or non-productive after the primary agricultural production process. Categorizing these wastes helps in understanding their origin and composition.

Crop residues are one type of agricultural waste, consisting of plant materials left behind after crop harvest. Stalks, stems, leaves, husks, and other parts that are not utilized for food or feed purposes fall under this category. Examples of crop residues include those from corn, wheat, rice, sugarcane, and soybeans. Livestock manure, commonly known as manure, is another form of agricultural waste. It includes animal excreta, bedding material, and uneaten feed. Animals such as cattle, pigs, poultry, and sheep produce this waste in various agricultural operations.

Agro-industrial byproducts are waste materials generated during the processing of agricultural commodities. They consist of residues from food processing, such as fruit peels, vegetable trimmings, husks, and shells (De Boer and van Ittersum, 2018). Citrus peels, potato peels, and rice husks are examples of agro-industrial byproducts. Excess pesticides and fertilizers also contribute to agricultural waste. These chemicals are wasted when they are no longer suitable for use or overused for crops.

Packaging and plastic waste are generated during agricultural activities. Packaging materials, plastic wraps, and containers used for agricultural inputs like seeds, fertilizers, and pesticides are part of this waste category. If poorly managed, these materials can lead to plastic contamination.

1.2 Environmental impact and management challenges of agricultural waste

Traditionally, agricultural waste has posed significant environmental challenges and has been regarded as a major source of pollution. Improper disposal and inadequate management of agricultural waste can have detrimental effects on the environment, including soil degradation, water contamination, and air pollution.

The sheer volume of agricultural waste generated presents a significant challenge for effective waste management. Crop residues, livestock manure, agro-industrial byproducts, excess pesticides and fertilizers, packaging waste, and agricultural machinery waste collectively contribute to the substantial quantity of waste generated in agricultural practices. Managing and disposing of such large amounts of waste in an environmentally responsible manner can be a complex task.

One of the primary environmental concerns associated with agricultural waste is soil degradation. When agricultural waste is not properly managed, it can contribute to soil erosion, nutrient depletion, and loss of soil fertility. Crop residues, if left on the field without appropriate management practices, can impede water infiltration

and increase the risk of erosion. Livestock manure, if applied in excessive amounts or improperly, can lead to nutrient imbalances, groundwater contamination, and soil acidification.

Agricultural waste has a significant environmental impact, including soil degradation, water contamination, and air pollution. The high volume of waste generated and the challenges associated with its management require proactive measures and sustainable practices to mitigate these environmental impacts. By implementing effective waste management strategies, we can protect the environment, preserve soil fertility, safeguard water resources, and reduce pollution associated with agricultural activities (Hercher-Pasteur et al., 2020).

1.3 Potential uses and value of agricultural waste

Agricultural waste can serve as an organic amendment to improve soil fertility, structure, and water-holding capacity (Figure 1). It enhances soil microbial activity, nutrient availability, and overall soil health, thereby promoting plant growth and productivity. Certain types of agricultural waste, such as crop residues and animal manure, can serve as raw materials for the production of bioenergy. Proper treatment and processing techniques ensure the removal of harmful pathogens, making it a valuable resource for livestock farmers. Agricultural waste can be composted to produce organic fertilizers. Compost improves soil structure, enhances nutrient cycling, and reduces the dependence on synthetic fertilizers (Ye, 2014, Energy and Environment, (6): 57-58). Agricultural waste can serve as a raw material for the production of value-added products. For example, fruit and vegetable residues can be used to extract bioactive compounds for pharmaceutical or cosmetic industries. Additionally, agricultural waste can be processed into biodegradable packaging materials and bio-based polymers, reducing the reliance on non-renewable resources and contributing to a circular economy (Figure 2).

2 Growth Characteristics and Requirements of Sunflowers

2.1 Species characteristics of sunflowers

Sunflowers (*Helianthus annuus* L.) are widely cultivated and beloved plants with unique growth characteristics and specific environmental requirements. Understanding the growth characteristics and requirements of sunflowers is crucial for evaluating the impact of agricultural waste on potted sunflower growth (Pang et al., 2012).

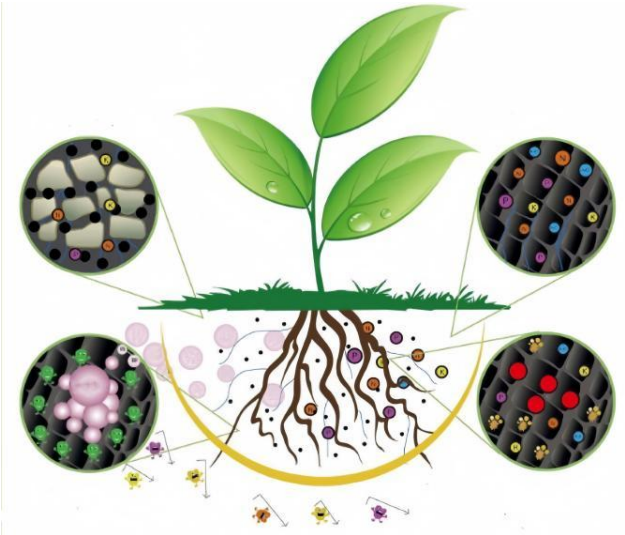

Figure 1 Composting to improve the soil structure (Image Source: http://nynct.shaanxi.gov.cn/www/kpxc0525/20231029/9830985.html)

Figure 2 Agricultural waste is made into fertilizer (Image Source: www.ddnjzzs.com/PictureShow_159.html)

The height variability of sunflower plants is significant, ranging from several tens of centimeters to several meters. This wide range of heights allows sunflowers to adapt to various soil and climate conditions. Sunflowers are renowned for their large flower heads, which typically display bright yellow petals with a brownish disk. These flowers can have a diameter of 10 to 30 cm, providing visual appeal. Additionally, sunflowers exhibit rapid growth, taking only 2 to 3 months from seed germination to mature plants. This quick growth rate has made sunflowers a popular choice in both ornamental gardens and agriculture. Despite most sunflowers being annual plants, certain varieties are perennial, capable of growing and flowering in multiple seasons under suitable climate conditions.

The species characteristics of sunflowers are evident in the following aspects. Firstly, sunflower plants exhibit significant variability in height, ranging from a few centimeters to several meters. This height variability allows sunflowers to adapt to different soil and climate conditions. Secondly, sunflowers are known for their large flowers, typically bright yellow with a brown center. These flowers can reach diameters of 10 °C to 30 °C, providing visual appeal. Additionally, sunflowers have a rapid growth rate, taking only 2 to 3 months from seed to mature plants. This fast growth makes sunflowers a popular choice in ornamental gardens and agricultural crops. Lastly, while most sunflowers are annual plants, certain varieties are perennial, capable of continuous growth and flowering over multiple seasons under suitable climate conditions (Figure 3).

Figure 3 Sunflower growth (Image Source: www.huabaike.com/yhjq/7725.html)

2.2 Growth requirements and environmental adaptability of sunflowers

The growth requirements and environmental adaptability of sunflowers are crucial for their healthy growth and development. Sunflowers have a high demand for sufficient sunlight, requiring at least 6 to 8 hours of direct sun exposure daily. They also exhibit strong adaptability to temperature, with an optimal growth temperature range

typically between 15 °C and 30 °C. Although they can tolerate higher or lower temperatures, extreme temperatures may adversely affect their growth and flowering.

Furthermore, sunflowers require an adequate water supply during their growth period. The soil should be kept moist but not overly saturated to avoid root rot. Regular watering is particularly important during dry periods to maintain plant health and growth. In addition, sunflowers are adaptable to various soil types, but well-draining, fertile soil rich in organic matter is most suitable. The soil pH should also be within the appropriate range, typically between 6 and 7. Sunflowers have a high demand for nutrients, especially nitrogen, phosphorus, and potassium. Providing adequate fertilization can promote healthy plant growth and flower formation.

3 Effects of agricultural waste on sunflower growth

3.1 Effect of agricultural waste as soil amendments

Agricultural wastes, such as livestock manure, straw, and fruit peel, can be added to the soil as organic matter, so as to improve the texture and structure of the soil. These wastes are rich in organic matter, nitrogen, phosphorus, potassium and other nutrients, which can increase soil fertility and maintain soil moisture level.

Studies have shown that the addition of agricultural waste can improve the water retention and ventilation of the soil, and enhance its fertility and nutrient retention ability, thus providing a more ideal soil environment for the growth of sunflower.

3.2 Nutrient supply of sunflowers from agricultural waste

Agricultural waste contains abundant nutrients such as nitrogen, phosphorus, potassium, and other essential elements required for sunflower growth. Studies have shown that using agricultural waste as fertilizer can provide sufficient nutrient supply to sunflowers, promoting their healthy growth and development.

For instance, nitrogen elements from livestock and poultry manure can provide the necessary nitrogen nutrition for sunflowers, promoting leaf growth and chlorophyll synthesis (Liu et al., 2018). Additionally, agricultural waste can supply other trace elements and organic substances, further meeting the growth requirements of sunflowers.

3.3 Promotion of sunflower growth by agricultural waste

The application of agricultural waste can also promote sunflower growth and development (Obi et al., 2016). Research indicates that the addition of agricultural waste can improve soil water retention and moisture-holding capacity, helping maintain appropriate soil moisture and alleviating the impact of drought on sunflowers.

Agricultural waste as a kind of resource, can be through specific treatment and preparation methods, as well as the appropriate application and quantitative control to be applied to the cultivation of sunflower, in addition, the organic substances in agricultural waste can promote the activity of soil microorganisms, improve the soil ecological environment, and enhance the nutrient absorption and root development of sunflower. The combination of these factors enables the application of agricultural waste to improve the growth rate, the height of plants and the number of flowers, and thus improve the overall quality of sunflower.

4 Application Methods and Techniques of Agricultural Waste

4.1 Treatment and preparation methods of agricultural waste

The treatment and preparation methods of agricultural waste directly impact its effectiveness in sunflower cultivation. Common methods include composting, anaerobic fermentation, physical treatment, and chemical treatment (Wang et al., 2019).

Composting involves mixing agricultural waste with other organic materials and facilitating organic decomposition and conversion into organic fertilizer through proper stacking, ventilation, and humidity control. Anaerobic fermentation involves fermenting waste under anaerobic conditions to produce organic acids and gases, resulting in the preparation of organic fertilizers. Physical treatment methods, such as shredding, grinding, and

sieving, alter the physical properties and particle size of agricultural waste to improve its application effectiveness. Chemical treatment methods involve using chemicals to modify the chemical properties and nutrient composition of agricultural waste.

4.2 Application Methods and quantitative control of agricultural waste

The application methods and quantitative control of agricultural waste are crucial for achieving optimal results. Common application methods include direct application as a soil amendment, compost application, liquid fertilizer spraying, and mulching.

Direct application as a soil amendment involves incorporating processed agricultural waste directly into the soil to improve soil texture and fertility. Compost application involves treating agricultural waste through composting and then applying the compost to the soil. Liquid fertilizer spraying involves preparing agricultural waste as liquid fertilizer and applying it through irrigation systems or sprayers. Mulching involves covering agricultural waste on the soil surface, allowing gradual decomposition and nutrient release. Additionally, quantitative control of the application amount is essential. It is necessary to determine reasonable application amounts based on sunflower growth stages, soil conditions, and the characteristics of agricultural waste to avoid over-application or nutrient deficiencies.

4.3 Best practices for agricultural waste application in sunflower cultivation

In sunflower cultivation, the best practices for agricultural waste application require considering factors such as waste type, treatment methods, application methods, and quantitative control. For example, for agricultural waste like livestock and poultry manure, composting followed by direct soil application can provide nutrients and organic matter, improving soil fertility. In contrast, for waste like straw, physical treatment followed by mulching on the soil surface can reduce weed growth and water evaporation, while also providing soil coverage and moisture retention. Moreover, determining the optimal application amount and timing based on sunflower growth requirements and soil conditions, along with appropriate fertilization practices, can be beneficial.

By selecting appropriate treatment and preparation methods for agricultural waste, employing suitable application methods and quantitative control, and incorporating best practices, the potential of agricultural waste can be maximized to enhance sunflower growth and development (Wang et al., 2019). This not only improves sunflower yield and quality but also reduces environmental pollution from agricultural waste, promoting sustainable agriculture. Therefore, further research and exploration of application methods and techniques for agricultural waste are of significant importance for sunflower cultivation and the cultivation of other crops.

5 Progress

5.1 Existing research findings and discoveries

Significant research findings and discoveries have been made regarding the use of agricultural waste to improve the growth of potted sunflowers. However, there are also limitations and uncertainties that need to be further explored and addressed.

Existing research indicates that the application of agricultural waste has a positive impact on the growth of potted sunflowers. Agricultural waste can provide abundant nutrients and organic matter, improve soil structure, and enhance water retention, thereby promoting the growth and development of sunflowers. For example, composted agricultural waste can significantly increase soil nutrient content and improve plant nutrient uptake (De Boer, and van Ittersum, 2018). Additionally, agricultural waste exhibits certain biological activity, promoting soil microbial activity and enhancing soil ecosystem functions, further benefiting sunflower growth.

5.2 Limitations and uncertainties in research

The application of agricultural waste in sunflower cultivation still faces limitations and uncertainties. Different types of agricultural waste may have varying effects on sunflowers, necessitating further research to determine the most suitable waste types and treatment methods. The quality and composition of agricultural waste also influence its application effectiveness, requiring accurate assessment and analysis of the waste's quality (Zhang et al., 2023).

Furthermore, the application methods and quantitative control of agricultural waste need further investigation to ensure appropriate application amounts and timing, avoiding issues of over-application or nutrient deficiencies.

5.3 Future research directions and potential challenges

Future research can delve into multiple aspects, including comparative studies on the effects of different types of agricultural waste on sunflower growth to determine the most effective waste types and treatment methods. Understanding the impact of agricultural waste on soil microbial communities and soil ecosystem functions can reveal the mechanisms underlying its effects.

Exploring the interactions between agricultural waste and other environmental factors such as soil pH, temperature, and humidity can further optimize the application effectiveness of agricultural waste. However, future research also faces challenges such as standardizing research methods, evaluating long-term effects, and considering economic feasibility. Addressing these challenges will drive greater advancements in the application of agricultural waste in sunflower cultivation.

Authors' contributions

CSY was responsible for writing and revising the paper, conception of the project and collection and analysis of literature data. LCC participated in the revision of the paper and provided guidance on the growth and cultivation of sunflower. Both authors read and approved the final manuscript.

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Reference

Bai H.B., Mao G.L., Li X.H., Zheng G.Q., Yang J., and Xu X., 2009, The effects of desulfurized slag on antioxidant enzyme activity and lipid peroxidation of rice seedlings on saline-alkali land, Xibei Nongye Xuebao (Acta Agricultural Boreali-Occidentalis Sinica), 18: 122-126.

Bilderback T.E., and Fontano W.C., 1982, Physical properties of media composted of peanuthulls, pine bark and peat moss and theireffect on azalea growth, 107: 522-525.
https://doi.org/10.21273/JASHS.107.3.522

De Boer I.J.M., and van Ittersum M.K., 2018, Circularity in agricultural production, Wageningen University & Research, pp.1.

Deshpande A.N., Kamble B.M., Shinde R.B., and Gore S.B., Effect of Primary Treated Biomethanated Spentwash on Soil Properties and Yield of Sunflower (*Helianthus annuus* L.) on Sodic Soil, Communications in Soil Science and Plant Analysis, 43(4): 730-743.
https://doi.org/10.1080/00103624.2012.644011

Hercher-Pasteur J., Loiseau E., Sinfort C., and Hélias A., 2020, Energetic assessment of the agricultural production system. A review, Agronomy for Sustainable Development: A journal of the French National Institute for Agriculture, Food and Environment (INRAE), 40(4): 114-131.
https://doi.org/10.1007/s13593-020-00627-2

LiuX.Y., Wang X.B., Li S.T., 2018, Livestock and Poultry Faeces Nitrogen Loading Rate and Its Potential Return toFarmland in China, Huanjing Kexue (Environmental Science), 39(12): 5723-5739.

Mao G.L., Ma C.Y., Xie Y.J., Xu X., and Liu J.F., 2009, Influence of CaSO4 on germination of oil sunflowers seeds under saline-alkali stress, Nongye Kexue Yanjiu (Journal of Agricultural Sciences), 30, 21-23, 43.

Mehdikhani H., Torshizi H.J., and Ghalehno M.D., 2019, Deeper insight into the morphological features of sunflower stalk as Biorefining criteria for sustainable production, Nordic Pulp & Paper Research Journal, 34(3): 250-263.
https://doi.org/10.1515/npprj-2019-0032

Obi F.O., Ugwuishiwu B.O., and Nwakaire J.N., 2016, Agricultural waste concept generation utilization and management, Nigerian Journal of Technology, 35(4): 957-964.
https://doi.org/10.4314/njt.v35i4.34

Peng J., 2009, Review and dicussion on utilization of agricultural waste resources in China, Shengtai Huanjing Xuebao (Ecology and Environmental Sciences), 18(2): 794-798.

Peng J.F., Ma D.N., Wang D.S., Li L.S., and Wu Y.M., 2012, The biological characteristics of sunflower broomrape and research progress on Anti-broomrape molecular breeding, Shengwu Jishu Jingzhan (Current Biotechnology), 2(6): 391-396.

Wang X.Q., Li K., Wu C.R., and Shi W.B., 2019, Application of Garden Waste in Ornamental Sunflower Seeding, Heilongjiang Nongye Kexue (Heilongjiang Agricultural Sciences), (4): 30-33.

Zhang T., Feng M., Zhang Y.Y., Zhang L., Li X.C., Li H.Y., Shi A.L., and Li J., 2023, Screening and identification of low-temperature bacteria for composting, Anhui Nongxue Tongbao (Anhui Agricultural Science Bulletin), 29(13):123-127.

Zhou Y.Y., Zhu P.N., Chen Y., Hu W.J., Gong Y.J., Wu P.Z., And Gu L., 2023, Technical regulations for static composting fermentation of polymer membrane of agricultural waste, Changjiang Shucai (Journal of Changjiang Vegetables), (17): 36-38.