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# Subsoiling Treatment on Soil Permeability and Its Impact on the Growth of Sweet Potato (*Ipomoea atatas*)

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**Abstract** Subsoiling treatment is a crucial soil management practice that profoundly influences soil physical properties, especially soil permeability. This review aims to explore the impact of subsoiling treatment on soil permeability and sweet potato growth. It provides a comprehensive overview of subsoiling treatment methods, including mechanical, biological, and chemical approaches, emphasizing the pivotal role of soil permeability in field water management and crop growth. Furthermore, it delves into how subsoiling treatment enhances soil infiltration rates and water-holding capacity, creating favorable conditions for root growth and efficient water utilization by plants. The results highlight a significant improvement in soil permeability due to subsoiling treatment, reducing the risks of waterlogging and root water stress, thereby fostering an optimal growth environment for sweet potatoes. Moreover, subsoiling treatment positively impacts sweet potato yield, quality, and stress resilience. This review underscores the critical significance of subsoiling treatment as a soil management tool to enhance agricultural productivity and sustainability. Future research should delve deeper into the mechanisms of subsoiling treatment and explore best practices under varying soil and climatic conditions to support sustainable agriculture.
**Keywords** Subsoiling treatment; Soil permeability; Sweet potato; Soil management; Agricultural production

Sweet potato (*Ipomoea batatas*) is a globally important staple crop that has garnered attention due to its high yield, rich nutritional value, and widespread adaptability. As a staple food, sweet potatoes play a crucial role in the daily diets of many countries. The carbohydrates, vitamins, minerals, and dietary fiber found in sweet potatoes are widely recognized as effective tools in combating hunger and improving nutritional status (Prakash et al., 2016). Additionally, sweet potatoes are extensively utilized as a significant feed resource in livestock farming. Therefore, ensuring the production and quality of sweet potatoes is crucial, and the suitability and quality of the soil directly impact the growth and yield of sweet potatoes.

Permeability is a key soil property in agricultural production, influencing soil water retention, drainage, and nutrient supply capacity (Garg et al., 2021). Good soil permeability can reduce the risk of waterlogging, promoting root growth and nutrient absorption in plants. Therefore, a profound understanding and improvement of soil permeability are crucial for farmland management and crop growth.

This paper aims to delve into the effects of deep loosening treatments on soil permeability and their impact on the growth of sweet potatoes. By introducing the concept of deep loosening, including methods such as mechanical, biological, and chemical loosening, it provides readers with background information and foundational knowledge on deep loosening treatments. The analysis explores how deep loosening treatments affect soil structure, porosity, permeability, and water retention capacity, further revealing the close connection between deep loosening treatments and soil permeability. Additionally, the study investigates the impact of deep loosening treatments on the growth of sweet potatoes, including their influence on root development, yield, and quality. It is hoped that through this comprehensive analysis, valuable insights and references can be provided for the application of deep loosening treatments in improving soil quality, promoting sweet potato growth, and supporting sustainable agricultural production.

## 1 Definition and Methods of Subsoiling Treatment

### 1.1 Definition of subsoiling treatment

Subsoiling treatment is a crucial soil management practice aimed at improving the physical properties and structure of the soil. It typically involves altering the physical structure of the soil through various methods to increase its looseness and permeability (Song et al., 2016, Chinese Agricultural Digest: Agriculture Engineering, (3): 2). The objectives of subsoiling treatment include increasing soil porosity, enhancing soil permeability, improving the root growth environment, and augmenting soil water retention capacity. These changes contribute to the enhancement of crop growth and yield while reducing the risks of soil erosion and waterlogging.

### 1.2 Methods of subsoiling treatment

Subsoiling treatment can be implemented through various methods, categorized into different types based on their operational approach and techniques. Mechanical subsoiling (Figure 1), biological subsoiling, chemical subsoiling, etc., are some common methods of subsoiling treatments.

Figure 1 Deep tillage agricultural machinery operation (Image Source: Beijing Agricultural Mechanization Administration)

Mechanical subsoiling is a method of altering soil structure by using various agricultural machinery, including plows, deep loosening machines, and harrows (Liu, 2020, Contemporary Farm Machinery, (6): 62-64). These tools mechanically turn, loosen, and mix the soil, thereby enhancing soil permeability and porosity. This approach is commonly employed in large agricultural fields.

Biological subsoiling focuses on utilizing plant root systems to improve soil structure. Deep-rooted plants like Chinese cabbage and soybeans have roots that penetrate deep into the soil (Figure 2), enhancing soil stability and permeability (Homulle et al., 2021). Additionally, some agricultural practices involve adding organic materials (such as straw or wood chips) to increase soil organic matter content, further enhancing soil structure.

A B

Figure 2: Root systems of deep-rooted plants

Note: A: Chinese cabbage root system (Image Source: Sohu); B: Soybean root system (Image Source: Agricultural Planting Network)

Chemical subsoiling is the improvement of soil structure through the addition of chemicals. This may involve adding gypsum or other soil amendments to reduce soil stickiness and enhance permeability. Chemical subsoiling is often used to address alkaline soils or soils with excessive sticky clay content.

### 1.3 The principle of subsoiling treatment

The principle of subsoiling treatment lies in altering the physical characteristics of the soil to create a more favorable environment for plant growth. By increasing soil porosity, roots can more easily penetrate the soil, absorbing water and nutrients. Improving soil permeability aids in drainage, reducing the risk of waterlogging and root decay. Additionally, enhancing soil porosity helps increase oxygen supply in the soil, promoting the growth of beneficial microorganisms and soil respiration (Guo et al., 2023).

The methods of subsoiling vary depending on soil types, climate conditions, and agricultural practices. Selecting the appropriate subsoiling method requires a comprehensive consideration of these factors and adjustments based on specific circumstances. In conclusion, subsoiling treatment is an important soil management practice that can enhance soil quality, improve crop growth environments, and play a crucial role in agricultural production.

## 2 The Importance of Soil Permeability

### 2.1 Soil permeability

Soil permeability is a crucial indicator for agricultural water management and crop growth, reflecting the size, distribution, and connectivity of pores within the soil (Zhai and Rahardjo, 2015). This property is typically assessed through two main parameters: permeability and water retention capacity. Permeability measures the speed at which water spreads through the soil, and soils with high permeability can quickly drain, reducing the risk of water retention in the soil. Soils are generally categorized as sandy soil, clayey soil, and loamy soil, each having different permeabilities (Figure 3). For instance, sandy soil typically exhibits higher permeability, while clay has relatively lower permeability (Yost and Hartemink, 2019). Water retention capacity indicates the soil's ability to hold moisture in saturated conditions, depending on soil porosity and organic matter content, contributing to supplying plants with the required water during drought periods.

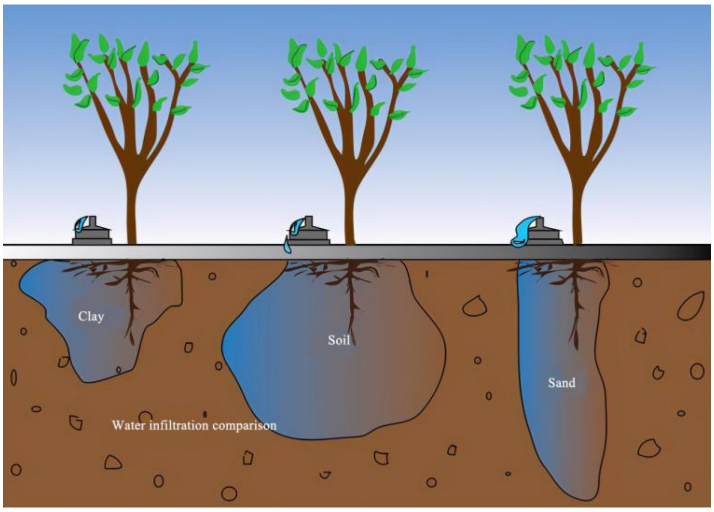


Figure 3 Permeability in different types of soils (Image Source: Baidu)

In addition to these factors, the permeability of the soil is also influenced by the physical structure of the soil and the drainage system. A good pore structure can enhance the soil's permeability, making it easier for moisture to penetrate the soil and flow towards the plant roots. Furthermore, an effective drainage system can further improve soil permeability, ensuring that excess moisture is rapidly removed, preventing issues such as waterlogging and root rot. Therefore, in agricultural production, in-depth research and improvement of soil permeability are of paramount importance for the efficient utilization of water resources, reducing the risk of water-related disasters, and increasing crop yields. This is a crucial aspect in achieving sustainable agriculture.

**2.2 Impact of soil permeability on water resources management**

2.2.1 Water resource protection

Regions with good soil permeability play a crucial role in water resource protection. These areas can effectively facilitate the rapid infiltration of precipitation into the soil, reducing the formation of surface runoff. In contrast, soils with poor permeability are prone to generating significant surface runoff, thereby increasing the risks of flooding and wasting water resources. By minimizing surface runoff, good soil permeability helps prevent the occurrence of flood events, especially in cases of heavy precipitation (Sugianto et al., 2022). Furthermore, reducing water waste is essential for sustainable water resources management, particularly in areas experiencing drought or with limited water resources.

2.2.2 Groundwater recharge

Soil with good permeability plays a crucial role in groundwater recharge. These soils can more effectively allow water to permeate into the groundwater layer, maintaining the stability of the groundwater table. Groundwater serves as a primary source of drinking water and is essential for agricultural irrigation in many regions. Therefore, by promoting groundwater recharge, soils with good permeability support sustainable drinking water supplies and agricultural production. In some areas, soils with poor permeability may lead to a decline in the groundwater table, thereby impacting the sustainability of water resources.

2.2.3 Water quality protection

When water infiltrates into the soil, the soil can serve as a natural filter, removing pollutants and pollutant loads from the water. Well-draining soil helps improve water quality by reducing the chances of pollutants entering water bodies. This is crucial for maintaining the health of ecosystems and safeguarding human health. Through the natural filtration process of the soil, some harmful substances are intercepted or broken down, reducing pollution in the water and mitigating adverse impacts on aquatic organisms and ecosystems. Therefore, well-draining soil plays a positive role in water quality protection, contributing to the maintenance of the health and ecological balance of water bodies.

**2.3 Relationship between soil permeability and soil ecosystems**

Soil permeability is of significance in agriculture, ecosystems, and water resource management. By enhancing soil permeability, we can promote sustainable agricultural production, maintain ecological balance, improve the manageability of water resources, and safeguard water quality (Xiang et al., 2021).

2.3.1 Ecological diversity maintenance

Soil with good permeability plays a crucial role in maintaining ecological diversity. These soils provide suitable habitats for various types of plants and microorganisms, thereby promoting the stability and diversity of ecosystems. In these soils, water can more easily penetrate, creating a variety of ecological niches that encourage the growth of different plant species. Such diversity contributes to the development of rich vegetation, providing living space for grazers and other organisms in the food chain.

2.3.2 Root growth and nutrient absorption

The growth of plant roots and the absorption of nutrients are directly influenced by the permeability of the soil. Soils with poor permeability may restrict root development, reducing the depth and range of root growth, thereby affecting crop growth and yield. Roots need to be able to penetrate the soil easily to access water and nutrients, especially in dry conditions. Good soil permeability facilitates deep root penetration, allowing for the absorption of more water and nutrients. This not only benefits the growth of crops but also helps mitigate the adverse effects of drought on plants.

2.3.3 Supplication of soil oxygen

Well-draining soil can better supply oxygen to the soil, which is crucial for the growth of beneficial microorganisms in the soil ecosystem. These microorganisms play key roles in the soil, including the decomposition of organic matter, providing nutrients, and maintaining soil ecological balance. They require oxygen for metabolic activities and the breakdown of organic matter, processes that are essential for soil health and nutrient cycling.

## 3 Impact of Subsoiling Treatment on Soil Permeability

Subsoiling treatment has a significant impact on the permeability of the soil, which is of great significance for agricultural management and water resource conservation (Ren et al., 2019). Subsoiling treatment affects soil permeability in various ways, including altering soil structure, increasing porosity, improving permeability, and enhancing water retention capacity. These changes are beneficial for both agricultural production and soil conservation, contributing to increased crop yields, reduced water resource wastage, and improved health of the soil ecosystem.

### 3.1 Changes in soil structure induced by subsoiling treatment

Subsoiling treatment, through altering the structure of the soil, establishes a solid foundation for improving soil permeability. This soil management approach involves methods such as mechanical and biological subsoiling, typically resulting in the soil becoming looser and more porous, thereby increasing the soil porosity. These soil pores, encompassing both large and small pores, provide essential pathways for water and gases, making it easier for moisture to penetrate into the soil and ensuring an ample oxygen supply for the root system. This structural transformation not only enhances soil permeability but also significantly reduces the risk of water accumulation.

The mechanical subsoiling breaks up soil aggregates through soil tillage and fragmentation, disrupting soil compaction and increasing the gaps between soil particles. These larger pores can accommodate more water, facilitating a faster infiltration of moisture into the deeper layers of the soil, thereby reducing the likelihood of surface water runoff. Such alterations in soil structure are crucial for preventing waterlogging and ensuring the efficient utilization of water resources.

On the other hand, biological subsoiling, through the root activities of plants and the formation of biological channels, also contributes to the improvement of soil structure. These roots and biological channels can enhance the arrangement of soil particles and increase soil porosity. Particularly during the process of root growth, the soil gradually becomes more relaxed, forming additional small pores. This porous structure helps retain moisture, making it more easily absorbed by plant roots, and contributes to alleviating water stress in the soil, thereby enhancing soil drought resistance.

### 3.2 Impact of subsoiling treatment on soil porosity

Subsoiling treatment can increase the porosity of the soil, including both large and small pores (Yang et al., 2021). Large pores are typically formed due to mechanical subsoiling or the action of deep-rooted plants, allowing a significant amount of water to quickly infiltrate the soil, reducing the risk of waterlogging. Small pores, on the other hand, contribute to soil moisture retention, enabling better supply to plant roots during dry periods. This porous structure enhances the soil's water retention capacity and drainage.

The impact of subsoiling treatment on soil porosity creates a balance that promotes rapid water infiltration while maintaining an adequate water supply to meet the needs of plants at different growth stages. This complex pore structure plays a crucial role in improving soil water management and crop growth, especially under changing weather conditions.

### 3.3 Impact of subsoiling treatment on soil permeability

Permeability is a critical parameter for assessing the water permeability of soil, representing the rate at which water infiltrates into the soil per unit of time (Avila et al., 2020). Subsoiling treatments typically result in an increase in permeability, making it easier for water to penetrate the soil. This is crucial for reducing the risk of soil erosion and waterlogging. Firstly, subsoiling treatment improves the physical structure of the soil by increasing the soil porosity, allowing water to penetrate more easily into the deeper layers of the soil. The formation of large and small pores facilitates smoother water flow in the soil, reducing the time water stays within the soil. This not only helps reduce the risk of waterlogging but also prevents root rot caused by prolonged immersion.

Secondly, the increased soil permeability is beneficial for reducing the occurrence of floods. In cases of heavy rainfall or substantial precipitation, soils with high permeability can absorb and store water more quickly, preventing rapid surface runoff into water bodies. This ability significantly decreases the occurrence of floods, contributing to the protection of surrounding areas from the hazards of flooding.

The positive impact of subsoiling treatment on soil permeability not only aids in improving water management in farmland but also helps reduce the risks of natural disasters such as soil erosion, waterlogging, and floods, thereby enhancing the stability and sustainability of agricultural production. This factor is crucial for the sustainable development of the agricultural sector.

### 3.4 Impact of subsoiling treatment on soil moisture retention capacity

Subsoiling treatment plays a crucial role in enhancing the soil's moisture retention capacity, presenting a significant advantage in the agricultural sector. This is particularly relevant in the face of unstable precipitation patterns caused by climate change. Improved soil structure is one of the key factors through which deep loosening enhances moisture retention. By increasing soil porosity and reducing soil compaction, subsoiling treatment allows the soil to more effectively store water. These pores can hold moisture and release it to plants when needed, extending the supply of water to plants over time. During periods of drought, this improved moisture retention capacity provides essential support for plant growth.

Furthermore, subsoiling treatment helps reduce evaporative losses. Due to the improved soil structure and better water storage capacity, the soil can resist moisture evaporation more effectively. This means that moisture in the soil is less likely to evaporate into the atmosphere and is instead supplied more to plants. This is particularly beneficial in hot and dry climatic conditions, aiding in maintaining crop water supply and enhancing resilience under drought conditions. Improving soil porosity also contributes to reducing soil erosion. Soil erosion is a severe process of land degradation that deprives the soil of fertility and moisture. By increasing the soil's moisture retention capacity, subsoiling treatment decreases the extent of soil erosion caused by water flow, contributing to the maintenance of soil health and fertility.

## 4 Effects of Subsoiling Treatment on the Growth of Sweet Potato

Subsoiling treatment has a widespread and positive impact on the growth of sweet potatoes (*Ipomoea batatas*), including factors such as root development, yield, and quality, holding significant importance for agricultural production and food supply (Behera et al., 2022).

### 4.1 Impact of subsoiling treatment on the root growth of sweet potato

Subsoiling treatment creates a more spacious and permeable soil environment, allowing the sweet potato roots to penetrate the soil more deeply. This facilitates increased absorption of water and nutrients by sweet potatoes, thereby promoting root growth and development.

Furthermore, subsoiling treatment contributes to an increase in the number of branches and lateral roots in sweet potatoes. This provides a larger root surface area, enhancing the sweet potato's ability to absorb water and nutrients.

### 4.2 Impact of subsoiling treatment on sweet potato yield and quality

Research indicates that subsoiling treatment can significantly enhance the yield of sweet potatoes by improving soil structure and permeability (Boonlertnirun et al., 2022). This impact is primarily attributed to several key factors, such as deeper root systems, improved water use efficiency, and increased nutrient supply.

Subsoiling treatment encourages the development of deeper root systems in sweet potato plants. These deeper roots can explore a wider range of soil depths, absorbing more water and nutrients. As a result, sweet potatoes can more effectively acquire the necessary growth resources, directly translating into higher yields. Improved soil structure and enhanced permeability mean that water can more easily enter the soil and be absorbed by plant roots, increasing the water use efficiency of sweet potatoes. This allows them to maintain better growth under dry or water-limited conditions, ultimately boosting yields. Subsoiling treatment also contributes to improving nutrient supply in the soil. The enhanced soil structure and permeability help nutrients distribute more evenly in the soil, making it easier for plants to access the required nutrients. This more efficient nutrient supply further elevates yields.

Subsoiling treatment also has a significant impact on the quality of sweet potatoes. By improving soil permeability, the risk of waterlogging and root rot during sweet potato growth is reduced, leading to fewer instances of rot, deterioration, and damage. This contributes to the production of more high-quality sweet potatoes, increasing the market value of agricultural products. Therefore, subsoiling treatment not only positively affects the yield of sweet potatoes but also brings about a significant improvement in their quality. This, in turn, enhances agricultural production efficiency and provides more high-quality agricultural products.

### 4.3 Impact of subsoiling treatment on stress resistance of sweet potato

Due to its ability to enhance soil moisture retention and promote root growth depth, subsoiling treatment strengthens the resilience of sweet potatoes under drought conditions. It enables them to more effectively withstand water scarcity, mitigating the adverse effects of drought on yield. Subsoiling treatment improves soil drainage, allowing sweet potatoes to better resist waterlogging during heavy rainfall or excessive irrigation. This helps reduce the risk of root rot and plant suffocation caused by waterlogging.

Subsoiling treatment has a positive impact on the growth and yield of sweet potatoes. By increasing root growth depth, improving yield and quality, and enhancing drought resistance and waterlogging tolerance, it makes a significant contribution to the sustainable production of sweet potatoes and agricultural success. The application of subsoiling treatment is expected to continue providing an essential soil management tool for agricultural production, especially in the context of climate change and resource management.

## 5 Potential Mechanisms and Factors

When studying the impact of subsoiling treatment on soil permeability and sweet potato growth, there are numerous potential mechanisms and factors to consider. These factors can help explain how subsoiling treatment affects both soil and crops, providing valuable insights for improving field management.

### 5.1 Impact on soil microbial communities

Subsoiling treatment may alter the rate of organic matter decomposition in the soil. Increased soil permeability and oxygen supply can stimulate microbial activity in the soil, accelerating the breakdown of organic matter and thereby providing nutrients essential for plant growth. Subsoiling treatment contributes to symbiotic interactions between plant roots and soil microorganisms. Certain microorganisms aid in nutrient absorption by plants, such as nitrogen-fixing bacteria, which can form symbiotic nitrogen-fixing nodules around the roots (Harindintwali et al., 2020).

### 5.2 Impact of soil nutrient status

The subsoiling treatment can influence the effectiveness of nutrients in the soil. By improving soil permeability, subsoiling treatment helps reduce nutrient leaching and accumulation, providing an appropriate nutrient supply. Some subsoiling treatment methods, such as adding gypsum, can adjust the soil pH, improving the suitability of acidic or alkaline soils and benefiting nutrient absorption by plants.

### 5.3 Interaction between subsoiling treatment and climatic factors

Subsoiling treatment may have an impact on soil moisture management. Increasing soil permeability contributes to drainage, reducing the risk of waterlogging during periods of drought or heavy rainfall. Improving soil permeability can also influence the temperature distribution in the soil. In cold regions, subsoiling treatment may help raise soil temperature, favoring the early growth of crops. Subsoiling treatment could also enhance the stress resistance of crops, improving the growth environment of roots and nutrient supply makes crops more resilient to drought, salinity, and other adverse conditions.

Considering these potential mechanisms and factors, we can better understand how subsoiling treatment affects soil and sweet potato growth. In-depth research into these aspects contributes to optimizing subsoiling methods for achieving higher agricultural yields and sustainable farming practices.

## 6 Research Progress and Challenges

### 6.1 Research trends

The field of research on the impact of subsoiling treatment on soil permeability and crop growth is experiencing rapid development to meet the growing demand for food and the requirements of sustainable agriculture.

An increasing amount of research is focusing on how to integrate subsoiling treatment with sustainable soil management (Ning et al., 2022) to maximize soil quality and reduce environmental impacts, including soil erosion and nutrient loss. Researchers are also exploring ways to enhance the adaptability of crop root systems through genetic improvements to better utilize the improved soil conditions resulting from subsoiling treatment. This may involve improving crop tolerance to low oxygen conditions and increasing nutrient absorption efficiency.

The application of advanced sensing technologies and data analysis methods is also increasing our understanding of the effects of subsoiling treatment. This includes using remote sensing data and Geographic Information Systems (GIS) to monitor changes in soil permeability and analyzing large datasets to reveal the relationship between deep tillage and crop growth (AbdelRahman, 2023).

### 6.2 Knowledge gaps and unresolved issues

Despite the potential of subsoiling treatment in soil management, there are still some knowledge gaps and unresolved issues, such as ecosystem effects, regional variations in applicability, and sustainability concerns.

Research on the long-term impacts of subsoiling treatment on soil ecosystems is still relatively limited. More studies are needed to understand the effects of subsoiling treatment on soil microbial communities and ecosystem functions. The effects of subsoiling treatment may vary between different geographical regions and soil types. Therefore, further research is necessary to determine the most suitable subsoiling methods for different regions and conditions. While subsoiling treatment can enhance crop production, improper implementation may lead to soil erosion and environmental issues. Hence, ongoing research is needed to explore how to achieve the sustainability of subsoiling treatment in practice, minimizing adverse impacts.

### 6.3 Prospects for the practical application and sustainable agriculture

As a method of soil improvement, subsoiling treatment holds enormous potential for enhancing agricultural productivity and sustainability. By further investigating the impacts of subsoiling treatment, overcoming knowledge gaps and challenges, we can better harness this technology to meet the ever-growing demand for food while safeguarding the health of soils and ecosystems. Subsoiling treatment is poised to play a crucial role in future sustainable agriculture, contributing to global food security and environmental sustainability.

## 7 Conclusion

This paper presents a comprehensive study and analysis of the impact of subsoiling treatment on soil permeability and its influence on the growth of sweet potatoes. By delving into the definition, methods, and effects of subsoiling treatment on soil permeability and sweet potato growth, the following conclusions have been drawn.

Subsoiling treatment is a soil management practice that improves the physical properties of the soil, including increased porosity and permeability, through mechanical, biological, or chemical methods. Common methods of subsoiling treatment include mechanical, biological, and chemical approaches, which can be selected and adjusted based on different soil and field conditions.

Soil permeability is crucial for agricultural production. Well-permeable soil helps reduce the risk of waterlogging and root waterlogging, enhances the growth environment for plant roots, and facilitates the supply of water and nutrients. Additionally, it has significant implications for water resource management and the health of soil ecosystems. Subsoiling treatment, by increasing soil looseness, porosity, and permeability, significantly improves soil permeability. This improvement helps reduce waterlogging and root waterlogging, enhances soil drainage capacity, provides better permeability for crop roots, and facilitates the supply of oxygen and beneficial microorganisms in the soil.

The positive impact of subsoiling treatment on sweet potato growth is multifaceted.Subsoiling treatment promotes the growth of sweet potato roots, crucial for nutrient and water absorption by the plant. Increased soil porosity resulting from deep loosening provides more growth space for sweet potato roots, allowing them to explore nutrients and water resources deeper in the soil. This means sweet potatoes can more effectively obtain the necessary nutrients, supporting healthier growth and higher yields. Furthermore, subsoiling treatment improves the growth environment for roots. By increasing soil permeability, subsoiling treatment helps alleviate oxygen deficiency in the soil, ensuring that roots receive an adequate supply of oxygen. This is crucial for plant respiration and the activity of root microorganisms, contributing to the health and growth rate of sweet potatoes.

In conclusion, subsoiling treatment plays a crucial role in improving soil quality, promoting sweet potato growth, and supporting sustainable agricultural production. However, further research is needed to deepen our understanding of subsoiling treatment, including its potential mechanisms and best practices under different soil types and climatic conditions. As a powerful soil management tool, subsoiling treatment is expected to play an even greater role in advancing agricultural sustainability in the future. In-depth research and implementation of subsoiling treatment will provide robust support for better utilization of soil resources, increased food production, ecological balance maintenance, and the achievement of sustainable agricultural goals.

**References**

AbdelRahman M.A., 2023, An overview of land degradation, desertification and sustainable land management using GIS and remote sensing applications, Rendiconti Lincei. Scienze Fisiche e Naturali: 1-42
https://doi.org/10.1007/s12210-023-01155-3

Avila R., Schoenau J., King T., Si B., and Grevers M., 2020, Effects of subsoiling tillage on structure, permeability, and crop yields on compacted Solonetzic and Chernozemic dryland soils in Western Canada, Canadian Biosystem Engineering Journal, 62: 1-9.
https://doi.org/10.7451/CBE.2020.62.1.1

Behera S., Chauhan V.B.S., Pati K., et al., 2022, Biology and biotechnological aspect of sweet potato (*Ipomoea batatas* L.): A commercially important tuber crop, Planta, 256(2): 40.
https://doi.org/10.1007/s00425-022-03938-8
PMid:35834064

Boonlertnirun S., Sirikesorn L., Kongsorn A., and Boonlertnirun K., 2022, Effects of tillage in combination with spacing on yield and proximate composition of sweet potato (*Ipomoea batatas*) grown in an abandoned paddy field, Tropical Agriculture, 99(1): 1-10.

Garg A., Huang H., Cai W., et al., 2021, Influence of soil density on gas permeability and water retention in soils amended with in-house produced biochar. Journal of Rock Mechanics and Geotechnical Engineering, 13(3): 593-602.
https://doi.org/10.1016/j.jrmge.2020.10.007

Guo R., Zhang N., Wang L., Lin T., Zheng Z., Cui J., and Tian L., 2023, Subsoiling depth affects the morphological and physiological traits of roots in film-mulched and drip-irrigated cotton, Soil and Tillage Research, 234: 105826.
https://doi.org/10.1016/j.still.2023.105826

Harindintwali J.D., Zhou J., and Yu X., 2020, Lignocellulosic crop residue composting by cellulolytic nitrogen-fixing bacteria: a novel tool for environmental sustainability. Science of the total environment, 715: 136912.
https://doi.org/10.1016/j.scitotenv.2020.136912
PMid:32014770

Homulle Z., George T.S., and Karley A.J., 2021, Root traits with team benefits: understanding belowground interactions in intercropping systems, Plant and Soil, 1-26.
https://doi.org/10.1007/s11104-021-05165-8

Ning T., Liu Z., Hu H., Li G., and Kuzyakov Y., 2022, Physical, chemical and biological subsoiling for sustainable agriculture, Soil and Tillage Research, 223: 105490.
https://doi.org/10.1016/j.still.2022.105490

Prakash P., Kishore A., Roy D., and Behura D., 2016, Economic analysis of sweet potato farming and marketing in Odisha, Journal of Root Crops, 42(2): 163-167

Ren L., Nest T.V., Ruysschaert G., D'Hose T., and Cornelis W.M., 2019, Short-term effects of cover crops and tillage methods on soil physical properties and maize growth in a sandy loam soil, Soil and Tillage Research, 192: 76-86.
https://doi.org/10.1016/j.still.2019.04.026

Sugianto S., Deli A., Miswar E., Rusdi M., and Irham M., 2022, The effect of land use and land cover changes on flood occurrence in Teunom Watershed, Aceh Jaya, Land, 11(8): 1271.
https://doi.org/10.3390/land11081271

Xiang X., Li Q., Khan S., and Khalaf O.I., 2021, Urban water resource management for sustainable environment planning using artificial intelligence techniques, Environmental Impact Assessment Review, 86: 106515.
https://doi.org/10.1016/j.eiar.2020.106515

Yang Y., Wu J., Zhao S., et al., 2021, Impact of long-term sub-soiling tillage on soil porosity and soil physical properties in the soil profile, Land Degradation & Development, 32(10): 2892-2905.
https://doi.org/10.1002/ldr.3874

Yost J.L., and Hartemink A.E., 2019, Soil organic carbon in sandy soils: A review, Advances in agronomy, 158: 217-310.
https://doi.org/10.1016/bs.agron.2019.07.004

Zhai Q., and Rahardjo H., 2015, Estimation of permeability function from the soil–water characteristic curve. Engineering Geology, 199: 148-156.
https://doi.org/10.1016/j.enggeo.2015.11.001